Perspectives on Geographical Marginality

Raghubir Chand
Walter Leimgruber *Editors*

Globalization and Marginalization in Mountain Regions

Assets and Challenges in Marginal Regions

Springer

Perspectives on Geographical Marginality

Volume 1

This book series *Perspectives on Geographical Marginality* comprehensively overviews research, on areas and communities impacted by processes of marginalization as a result of globalization, economic, environmental, political and social change. This series seeks to discuss and determine what is geographical marginality by inviting leading international experts to publish theoretical and applied work. It also seeks to rigorously debate the degree to which local areas and communities are responding to these process of change and with what success.

The series stems from the International Geographical Union's (IGU), 'Commission on Globalization, Marginalization, and Regional and Local Response' (C12.29). As is suggested by its name, the commission researches the problem of geographical marginality offering a leading forum from which this series will be led. Marginality cannot be defined without putting it into a certain perspective: economic, political and social (including cultural). Marginality has to be clearly distinguished from peripherality. Marginal areas may be a part of periphery or even the centre, but "cannot really be attributed to them".

Proposed themes which will be covered include:

- Mountainous regions and globalization;
- Regional development and policy/or: Globalization and its impact on local and regional development;
- Theory of marginalization;
- Transformation of rural areas from the viewpoint of globalization and marginalization;
- Drivers of marginalization in border and peripheral areas.

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Preface

Many parts of the globe and innumerable social groups within it remain marginal even in the present era of globalization. Though various marginal societies have gained some prosperity, many are subjected to increasingly demanding market forces. While mountain regions and other marginal areas are becoming better known to the world, the majority of the residents within them are still facing challenges such as poverty, physical isolation, and social marginalization. The developmental initiatives undertaken by local government and planning institutions have often failed to significantly improve socioeconomic conditions in and between mountainous and other marginal areas and in their neighboring territories. The models of development imposed by outside agents have often undermined the needs and structures of local mountain societies and ultimately have often only served the causes of market forces.

The fate of marginal and mountain communities depends on the framework of national or international economic policies. It is worthwhile to mention that mountain regions are particularly vulnerable to open market policies, mainly because of their fragility and environmental sensitivity. They do not have equal access to the same social and political rights or the same opportunities for development. The conditions of marginality in its various shades are evident in the various modes of local and regional responses. The primary focus of this volume is to investigate the nature and processes of marginalization and the degree to which effective responses to such marginalization have been initiated, either from within affected areas or by outside organizations, both within mountainous and other marginal areas. In the context of globalization, it is important to acknowledge and understand the impact of climate change at different scales in mountain and marginal areas of the world. The local and regional impacts of climate change are of considerable importance in guiding and determining policy- and decision-making system. Three key processes, namely marginalization, globalization, and climate change, underlie the assessment of the challenges and opportunities which impact livelihoods in the mountainous and marginal areas of the world, and collectively, these considerations provide the basis for this book.

This volume has grown out of a number of papers presented at the International Geographical Union's (IGU) Commission conference held in Nainital, India, from May 1 to 9, 2011, jointly organized by the IGU Commission on Marginalization, Globalization and Regional and Local Response CO8.27 and the Department of Geography, DSB Campus, Kumaun University Nainital, India. The theme of the conference was "Local and Regional Responses to Globalization in the Mountains and Marginal areas of the World." It comprised three days of paper presentations, followed by a field trip to various parts of the Kumaun Himalaya, particularly to the Johar Valley to pay tribute to Pundit Nain Singh, a famous nineteenth-century explorer of Tibet, visiting his home regions Munsiary and Pithoragarh.

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List of Figures

List of Tables

Chapter 1
Introduction: Globalization and Marginalization in Mountain Regions

Raghubir Chand and Walter Leimgruber

Living in a totally interconnected world where neoliberal economic thinking prevails, humanity faces two major challenges for the future: an on-going disequilibrium of the ecosystem, of which global warming is but one element, and a growing gap between the rich and the poor, which persists despite considerable international efforts. Ecosystem deterioration and growing social inequality occur globally, although with regionally different levels of intensity. They are particularly acute in fragile living spaces. Mountains are such fragile environments, both from the perspective of the ecosystem and of human societies. Economic thinking (based on the law of the jungle) has eclipsed our sense for both the natural environment and those people that are on the losing side of society—it is marginalization taking place in certain people's minds.

For years there has been an exciting debate on the concept of marginality and marginalization in academic circles (Leimgruber 1994, 2004; Déry et al. 2012). In geography specifically, marginality is primarily related to conditions of spatial structures and processes through which certain components of a region are assumed to have 'lagged' behind an expected level of performance in terms of economic and other forms of well–being, compared to a broader reference area, usually a political unit of some kind. The chief problem with this approach is of a methodological nature, viz. the definition of the point or region of reference: what is the norm or the mainstream, where are the eventual thresholds? A second perspective sees marginal regions as being disconnected from the rest of the world, as lying further away from

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a centre than a periphery (a sort of 'periphery of the periphery'). Whichever way we look at it, it appears that the concept of marginality is neither fixed nor absolute and can be defined in various terms: socially, psychologically, culturally, economically, politically, physically and structurally.

Scale plays an important role in this context. A region may be marginal inside a larger region, but even within this marginal region there may be more and less marginal sub-regions. Poverty and social marginalization are issues, even in rich countries (particularly worrying in the case of the working poor), and in poor countries there are certain segments of the population that are better off than others.

From the background of globalization, the most frequent type of marginality is contingent marginality, "a product of market forces which is considered responsible when communities are impoverished and distressed due to *unequal* competition in open societies and free markets." (Mehretu et al. 2003, p. 320; original emphasis). This is certainly the case with mountain regions where difficult production conditions are responsible for low harvests and high costs. Globalization can also lead to leveraged marginality, which manifests itself when people's "bargaining position as stakeholders in an economic system is compromised by transnational corporate agents that leverage beneficial concessions by pitching them against alternative opportunities in other places." (ibid., p. 321). Delocalizing the production from one country to another in order to profit of lower wages or favourable regulations (e.g., on the environment) is a typical example from the late 20th and early 21st centuries. Mountain regions, usually with little industry, will not so much suffer from these two types of marginality, but they may become victims of a "political and economic system that produces *inequities* in the distribution of social, political and economic benefits" (Mehretu et al. 2002, p. 198; original emphasis). Political decisions to support life and production in mountain regions can help to avoid this type of marginality.

Today, the international integration of the world following the wide acceptance of the neoliberal market economy, is progressing at a very rapid pace. This process encompasses economic transformations in production, consumption, technology, and ideas. It is also intimately linked to transformations in the political system as well as to socio-cultural and environmental changes (Gwynne et al. 2003, p. 8). It is different from the international economy model in the sense that the principal entities are the governments facilitating economic interaction at the global scale. In the global economy model, the key assumption is of a movement towards a global market and global prices, and nationally determined policies are subordinate to wider international determining factors (Michalak 1994). Some scholars (Klak 1998) present globalization as a process that itself has a power which is an unquestionable empirical manifestation of contemporary capitalism. Held et al. (1999) also identified three key discourses on globalization in the social science literature. These are hyper-globalist, sceptical, and transformationalist. The hyper-globalist thesis defines globalization as a new epoch in human history in which traditional nation states have become unnatural, even impossible units in a global economy (Ohmae 1995). Some sceptics countered the above view of globalization arguing that many of the fundamental features of global capitalism today remain as they were decades and even

centuries ago (Wallerstein 2000). The sceptics think that true globalization must imply a fully integrated world economy which remains a long way into the future. The transformationalist thesis sees globalization as a powerful transformative force which is responsible for a massive 'shake-out' of societies, economies, institutions of governance and world order. The geographical perspective of this thesis emphasizes the continuation of global divergence—increasing inequalities between and within countries, between North and South or First World and Third World by forging new hierarchies which cut across and penetrate all societies and regions of the world (Held et al. 1999, p. 8). Divergence and unevenness have therefore become interwoven with globalization, and in this book we take globalization as it is seen reflecting with mountain and marginal societies of the world.

As such the process of globalization is multi-dimensional and complex. It goes beyond international trade and the delocalization of production processes to countries with low production costs as suggested by Held et al. (1999, p. 2) or "the greater standardization and homogenization of output" (Robins 1995, p. 259). In his seminal work, published in German in 1997, Ulrich Beck defines it as "the *processes* through which sovereign national states are criss-crossed and undermined by transnational actors with varying prospects of power, orientations, identities and networks." (Beck 2000, p. 11; original emphasis)". The use of the plural signifies that globalization is not simply an economic phenomenon (as it is commonly believed) but includes cultural, social, and technological aspects.

With his definition of the globalization process, Beck shows that the traditional model of the Western society is no longer valid. The political system (i.e., the nation-state) was traditionally placed between and depended on the economic and the legitimating system (Offe 1973). The former provided the state with income and received favourable regulations and the necessary infrastructure in return, whereas the latter offered loyalty to the state and received protection and social security in return. However, the rise of the neoliberal credo has led to an alliance between political and economic system, which is opposed to the population (the legitimating

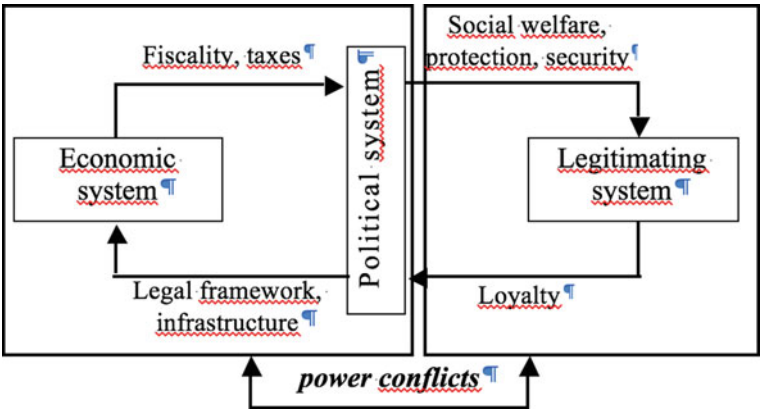

Fig. 1.1 The new social order (Own elaboration, based on Offe 1973)

system) and results in new power conflicts (Fig. 1.1). Reducing taxes on enterprises and on capital returns (which is currently being discussed in Switzerland) will eventually deprive the State of income needed to fulfil its tasks on behalf of the population.

While globalization belongs doubtlessly to the human sphere, it has nevertheless consequences for the entire globe, including the ecosystem. On the downside of the many free trade agreements that have been signed in the process of the elaboration of globalization there is the increase of long-distance transport requiring substantial energy input, with negative influences on the environment. Our human understanding of time with its emphasis on velocity (illustrated by expressions like 'the quicker, the better', 'just-in-time production', 'best before yesterday' etc.) is radically different from nature's rhythm where everything evolves slowly—even sudden events (landslides, volcanic eruptions, earthquakes) are part of a long-term evolutionary process that extends far beyond human life expectancy and imagination. Not everybody can follow the speed of social and economic changes. People who can keep up may succeed in remaining afloat in the mainstream, but if they lose track they will be rapidly submerged and marginalized. Poverty (including the working poor) and social exclusion are the price many people pay for the benefits others reap from the globalization process. Temporary crises (such as the 2008/9 global financial crisis) reinforce marginalization.

In the context of mountain regions, globalization is usually perceived by the local inhabitants as an external force contributing to the growing polarity of world income. Life patterns and traditional livelihoods in mountains have generally evolved independently, according to the local geography and history in isolation from rest of the societies. As a result of a legacy of the colonial rule in the case of the majority of mountain systems (the Himalaya in particular), the marginal and mountain people were deliberately kept apart from the majority populations in lowland areas. Mountain resources were exploited by the colonial powers to strengthen their own economies. Even after independence, the policy of assimilation adopted by the local and regional governments has not yielded good results due to fear still persistent in the minds of mountain people. The more convenient way is to practice a policy of integration through protective and promotional measures to curtail the indifference of marginal mountain people that exist still today. It is imperative that globalization does not disturb the harmony of mountain life and the local fragile ecosystem. The issue of poverty is inseparable from the development-environmental debate, and the eradication of poverty through an enhanced protection of livelihood strategies could work for their integration into the global society. Mountain areas are characterized by a high degree of fragility, marginality, limited accessibility, and specific niche resources as well as by human adaptations to these conditions. Historically evolved patterns and practices of land use in the mountains (the Himalayas in particular) are interlinked with diversified production systems. Uncontrolled intensification of resource use in mountains, driven by external demand, have posed economic and environmental risks.

The driving forces of globalization are not conducive to mountain areas. The particularities of mountain regions determine the relevance and effectiveness of any

intervention including those associated with globalization. Globalization tends to ignore people living in marginal settings, with difficult local production systems, and in contact with nature. If this particular situation were to be taken into account, these people would no longer be losers in the globalization process. The market driven incentives and approaches to production and consumption should therefore take care of the socio-economic vulnerability of the mountain people. The focus should be on global investments for local resource regeneration by involving local communities.

Both social and natural systems are subject to continuous transformations—this is not new. Nothing is permanent—the Buddhists speak of "the universal law of impermanence" (Dalai Lama et al. 2005, p. 154), which stipulates that "all conditioned things and events are in constant flux." (ibid.). This includes mental flexibility leading to a possible "transformation of the state of one's mind" (ibid., p. 155). We have to take this continuous instability of things into account when dealing with phenomena and processes in the human as well as in the natural world. There is no real long-term planning security as economic leaders often demand (particularly in times of great economic and political uncertainty).

Economic and social transformations are man-made and, among others, the result of our thinking and value systems. They are continuous processes that vary according to circumstances and can be influenced, but they remain probabilistic. However, our value system is not stable, and changes in economy and society reflect this. Fashion is an excellent illustration of this instability: old style elements return in clothing, for example, in design (the so-called retro-look), or in nutrition (back to natural food).

Environmental change, on the other hand, is of a different nature. We are confronted with a natural phenomenon, which follows certain deterministic laws. Besides, human activities can reinforce or even trigger off such changes, often with catastrophic consequences. We cannot influence the laws of physics that are responsible for a landslide, for example, but we can act upon human decisions and actions. The effects are visible on different scales. From a macroscopic perspective, we recognize changes in weather patterns and new, shorter rhythms of extreme weather events, whereas on meso- and microscopic scales, we discover the many spatial repercussions due to these new phenomena. Such consequences are dealt with in a number of chapters in this book.

At all times mountains have attracted human curiosity and at the same time inspired fear. As the see of the Gods (Mount Olympus in Greece), as "the body of God" (Price 1981, p. 17) or as holy places (Uluru in Australia) they were taboo and could not be climbed, but ever since people travelled, they had to be crossed, both for peaceful trade and (military) invasion (e.g., Hannibal). The (European) image of mountains has gradually evolved from a hostile environment prior to the Renaissance to the idea of a complex and fragile ecosystem in the 20th century (Leimgruber 1992).

Nowadays, mountains are no longer 'distant places', neither mentally nor physically. On the contrary, they have become central elements of the present globalized world. The 1992 Earth Summit in Rio de Janeiro was a milestone for the political recognition of the unique services mountains provide to the global

economy and the pursuit of sustainability. The summit was led by a group of people concerned with the fate of mountains in an increasingly interconnected world, which took the name of *Mountain Agenda UNCED* 1992 (Stone 1992). As a consequence of their engagement, the Rio Conference adopted Chap. 13 on Sustainable Mountain Development (SMD) in Agenda 21, demanding better stewardship of mountains and mountain regions for global well-being.

Since then, other initiatives have emerged, including the International Year of Mountains 2002 and, in 2012, the Rio+20 conference, where more than 130 Heads of State committed themselves to put mountains, their populations and the goods and services they provide at centre stage. All these efforts suggest that mountains receive priority globally; after all, more than 50 % of the world's population draws benefits directly or indirectly from mountain resources and services. Mountains cover 24 % of the Earth surface and are home to 12 % of the global population. Although mountains are among the most sensitive ecosystems of the world they perform both protective and productive functions for ecological and economic wellbeing, often beyond their geographical settings. Mountains are the sources of the world's major rivers, which are essential not just for drinking water and irrigation but to support the global industries through the generation of power. Mountain forests and minerals have been exploited for centuries to support the global economy. Mountains are the original home of many of the world's major food crops. They have now spread throughout the world, but the original genetic resources remain in the mountains. Mountain specific products, like medicinal herbs, flowers and certain organic food products are in global demand.

Apart from the ecosystem services just mentioned and the worldwide marketing of their products, there are other possibilities to increase the benefits of globalization for mountain people. Tourism and hydropower are two of them. However due to bio-physical constraints and limited infrastructure, mountain regions are poorly equipped to adapt to globalization and therefore survive in conditions of marginality.

Research on mountains and marginality have been at the centre of an IGU working group since the 1980s. The International Geographical Union, during its 1984 congress in Paris, set up a study group on the "Development of High lands and High Latitude Zones" of the World (originally founded in 1981) which focused on the northern hemisphere with few contributions concerning the global South. After the Washington DC congress of 1992 the group widened its field and continued as the "Study Group on Development Issues in Marginal Regions" (1992–2000), as the "Commission on Evolving Issues on Geographical Marginality in the early 21st Century World" (2000–2004), and the "Commission on Marginalization, Globalization and Regional and Local Responses" after 2004.

Research into marginality issues, marginal regions at various scales, and the marginalization process from different perspectives have therefore a tradition of more than 30 years. These topics have accompanied mankind throughout its history, certainly since differentiated social systems and the division of labour have existed. Apart from thematic issues (such as social exclusion) there have always also been spatial aspects (such as the location of certain groups).

Ongoing research on globalization and marginalization has generated a considerable amount of literature examining the way in which the impact of globalization is seen and experienced in areas regarded as marginal, and mountain regions occupy a prominent position among them (Chang et al. 1994; Andersson and Blom 1998; Mazuri 1999; James 2000; Jussila et al. 2001; Murshed 2002; Bernhard and van der Rolph 2004; Appelbaum and Robinson 2005; Basu 2006; Leimgruber 1994, 2015; Pelc 2001, 2015). Globalization, in particular its economic dimensions, manifests itself through the growing interconnectedness of many parts of the world, promoting and facilitating an increased movement of capital, goods and services and, to a certain extent, also people. This is not without consequences on both ecosystem and local/regional societies and their culture and livelihood.

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Part I
Explorations

Although mountains were for a long time perceived as a hostile environment, humans did not lack a certain amount of curiosity towards them. They were afraid of them but at the same time used them for farming to secure their livelihood. Even the dangerous volcano Vesuvius in Italy was "clothed everywhere in vineyards and orchards" in the late fourteenth century, according to Giovanni Boccaccio's affirmations (Scarth 2009, p. 113), and in the seventeenth century it was at least used for animal husbandry (ibid., p. 138).

However, people had begun to settle in mountain regions in prehistoric times. Settlements were created and abandoned as the environmental (climatic) conditions varied. Forms of transhumance between mountains (deer hunting) and plains (buffalo hunting) emerged many thousand years ago in North America (Price 1981, p. 8). Important civilizations developed in the Andes, largely based on agriculture (potatoes, corn). Tradesmen regularly crossed the mountains, in the Alps as well as in the Himalayas, exchanging goods between different natural regions and cultures.

Scientific interest in mountains began in the eighteenth century. The discovery of marine fossils on the Mont Blanc (France/Italy) revealed the complex history of mountain building through the Earth's history. Explorers started to climb and survey mountains—a sign that the idea of a hostile environment was gradually replaced by curiosity and scientific interest. Mountain explorers were particularly important in the late eighteenth and throughout the nineteenth centuries, but because of their importance as an ecosystem for humanity, they have continued to be the focus of research.

The most famous of the nineteenth century's explorers were the geographers who 'filled in the blanks on the maps' particularly in the mountains of the central Asia, the deserts of central Australia, the north-west passage and the approaches to the poles and of course the heart of Africa (Keay 1991, p. 10). In 1802, Baron Alexander von Humboldt climbed almost to the top of the volcano Chimborazo in Ecuador and was sure that he was ascending the highest mountain in the world. Chimborazo was finally scaled in 1879 by Edward Whymper, the man who in 1865 had been the first to reach the summit of the Matterhorn. This was the start of the

marvellous new era of exploration (ibid., p. 11). The history of world exploration is full of amazing endurance. Judging by the gold medals awarded by the Royal Geographical Society, the heart of Asia between the Caspian Sea and Great Wall of China represented the nineteenth century's most important arena of exploration. Here, the highest mountains in the world plus the sources of all main rivers of central, south and southeast Asia are locked in to an increasingly complex system of mountain ranges flanked by high plateaux and vast deserts (ibid., p. 78). The biggest challenge was to enter and explore the Tibetan territory. After the invasion from Nepal in 1792 and from Punjab, India, in 1841, Tibet followed a policy of self-imposed isolation, a policy that banned all foreigners. Tibet became the ground of intense rivalry among three empires: Britain, Russia and China. Having witnessed the failures of attempts made by many European explorers, an idea clicked in the mind of Captain Montgomerie of the Survey of India to recruit and train natives from the Kumaun region of India (men of Tibetan stock) to undertake the exploration of Tibet. Pundit Nain Singh Rawat and his brothers were thus chosen and trained by Survey of India. "They were not simple hill-men programmed to quarter Tibet like a fleet of robots but daring men of substance and scholarship, whose accuracy of their marathon route surveys transcended the limitations of the necessarily basic survey instruments they carried. Typically, these included a boiling point thermometer concealed in the Pundit's hollowed out walking stick, a sextant packed in the false bottom of his trunk, a compass built in his prayer wheels and a specially made rosary on which he could keep count of his previously measured strides" (Keay 1991, p. 84). The contribution of Pundit Nain Singh as explorer-surveyor, a pioneer teacher (and therefore known as pundit by local people in his native place in India), writer, historian and above all a trainer par excellence attracted the attention not only in England but among geographers all over Europe.

Pundit Nain Singh, a famous Indian explorer and surveyor, dedicated most part of his life to the field of exploration and cartography. He was born in Bhatkura Village of Munsyari Tehsil in the Pithoragarh District of Uttarakhand, India, on 21 October 1830. His childhood was spent in utter poverty but by his indomitable willpower, he was able to surmount all possible odds. He was the first native to engage himself in education, as a teacher in Milam, the last village of Gori Valley, and later established a school in Darma valley of Pithoragarh. His first experience as a surveyor was gained in the service of an eminent and scientific officer, Richard Henry Strachey. In 1856–1857, he worked with the Schlagintweit brothers Hermann, Adolf and Robert in their mission to carry out their magnetic survey in Ladakh and Kashmir (Schlagintweit 1861–1866). He was employed in the Great Trigonometric Survey of India and was trained as a surveyor. He played an extraordinary role in mapping and discovering the unknown interiors of central Asia for the first time and plotting the locations of places such as Lhasa and many other unexplored lands on the world map. Fewer would even know that a mountain range in Tibet was named after him and he was the first and only Asian to be awarded the "Victoria/Patron's Gold Medal" by the Royal Geographic Society

(RGS), London, in 1877 for his extraordinary contribution. Also, the honour of Companion of the Indian Empire (CIE) was conferred upon him by the British Government along with a land grant. He is the only Asian whose bust was installed in the Royal Geographical Society, London, and recently in the Survey of India headquarters at Dehradun, India. Nain Singh Rawat was a surveyor in the Great Trigonometrical Survey and conducted five important expeditions (1865–1875):

1865–1866: Kathmandu—Lhasa—Mansarovar Lake.
1867: Origin of Sutlej and Indus rivers, and Thok Jalung (Tibet).
1870: Douglas Forsyth's First Yarkand—Kashgar Mission.
1873: Douglas Forsyth's Second Yarkand—Kashgar Mission.
1874–1875: Leh—Lhasa—Tawang (Assam).

The first part of this book looks at the history of the exploration of the Himalayas and Tibet and at the importance of the Arctic World. It contains two of four Pundit Nain Singh memorial lectures delivered at the Nainital conference as a special feature and tribute to an important figure in the creation of knowledge about the Himalaya and beyond. Although these two regions are totally different, there are certain parallels. Both have fragile ecosystems that are menaced by human activities, both are sparsely populated, and both are of significant geopolitical relevance.

R.S. Tolia presents the role of the Pundits in opening Tibet to the world. It is well known that the geography and history of Tibet, in combination with politics, impede access from the outside world. The real credit for the opening of Tibet goes to Tibet's founder, King Songtsen Gampo (617–649 A.D.) and to Indian Buddhist teachers. Until the beginning of the nineteenth century and William Moorcroft's journey in disguise through the Niti Valley to Tibet in 1812 in search of the fabled pashmina wool, Tibet remained cut-off for the Western world. It was through meeting the Johari traders of the Kumaun region in western Tibet that the British East India Company came in contact with these border people of the Johar Valley who had been trading with Tibet for centuries. The British thought of employing these Johari Bhotias by training them in surveying. Pundit Nain Singh was selected and trained to undertake his great journeys in the central Asian high lands. He was able to fill the 'Asian cartographic white space' and contributed significantly to the knowledge of this previously 'forbidden land'. The scientific information recorded by Nain Singh was fully validated by the Younghusband expedition when western Tibet was opened up to the outside world after 1904.

The Arctic World is presented by Donald F. Lynch (†) as the last frontier, very much as the Himalaya and Tibet were in the nineteenth century. What is happening in the Arctic World in the twenty-first century is of global relevance because of the impact it is having on global climate and on global mineral supplies, timber, energy resources, transportation, fisheries, tourism, environmental concerns and scientific study. Rather than being isolated, the Arctic World today is no longer a strange and remote region but a centre of global concern. It is the deliberations of economic and political powers from outside the Arctic which have the greatest impact. Due to vast

improvements in transportation and communications, the speed of innovation diffusion has increased. In numerous countries mineral and energy development and fisheries play a major role, usually driven by international companies such as British Petroleum. China, for example, is involved in resource development in Siberia, Japan, in the Bering Sea fisheries, and Canadian companies own major mines in Alaska. The voices of the peoples of the Arctic World are being heard in the corridors of power today far more than in the past, and the time when they could simply be shoved aside and ignored is long gone.

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Chapter 2
Opening the Door of Tibet

R.S. Tolia

Introduction

For the information of our honoured guests from across the globe, all eminent scholars and geographers, may I say that today they stand not 'nearly at the gateway to Tibet' but also in the home-land of some of the most eminent explorers the modern world has known, recipient of arguably the highest honours which the Geographical societies of Europe could bestow on any one, including the Royal Geographical Society, the Paris Geographical Society and the Italian, as well as the Government of the day. Coming as I do from this region myself it was not surprising that professor Raghubir Chand asked me to bring to the notice of the delegates the great exploratory works which had been performed by several sons of the soil, collectively described as the 'Pundits', in the official geographical proceedings and related records (Alcock 1877, p. cxxxvii).

I wonder if you all have been pointed out the arch-gates near Gochar, at Thal, announcing the road that you have traversed to reach here, named as Nain Singh Rawat Road, and when we go down for our village excursion, we will be taking a road named after the other, as Kishan Singh Road. Nain Singh and Kishan Singh, two of the most eminent persons produced by this region, belonged to a region known as Johar, and both of them were Johari Shaukas. While Nain Singh's was the only name and the only one from Asia inscribed on the Honour's Board of the Royal Geographical Society, London, Kishan Singh, his protégé and first cousin, missed joining him by a whisker, owing to the impatience of a retiring Surveyor General of India, General Walker. By any accounts Kishan Singh's four year long survey of what constitutes South China today, was of no less significance than the celebrated journey to that celebrated city of Lhasa, by his cousin and Guru, Nain Singh.

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Tibet: The Forbidden Land

In my welcome I have mentioned that you are literally at the 'gateway to Tibet', which indeed you all are, as the crow flies, a matter of a few hours, albeit across the high Himalayan peaks and passes; a small idea of which you may have noticed the way the climate changes no sooner than you cross the Kala-muni ridge. To the best of my knowledge, no country or region, has remained forbidden to foreigners for such a long stretch of time, as Tibet. Geography and history have conspired with politics to make it difficult to access, and religious curiosity and practice have made it tantalizing and highly vulnerable to brute muscle-power.

To geographers reflecting on globalization and marginalization I need not waste time in explaining the role played by geography and geology in making Tibet difficult of access, nor that by politics, in continuing to keep the Tibetan 'elected government' in exile, or that by people practising a particular religion (Buddhism) that has made its people highly vulnerable to brute military power. Before welcoming you here I have had the pleasure of listening to presentation by Dr. A. Matsukova and Dr. M. Batsova on the 'Impacts of Marginalization and Globalization on the Czech-German-Austrian Borderland' (see Chap. 4). I could not help comparing the 'Iron Curtain' of the Soviet Block with the High Himalayan Wall, which separates our Johar region from neighbouring Western Tibet. The 'Iron Curtain' in Europe has had a finite life, and the after-effects of its collapse are presently under study. Here I shall briefly discuss how the high Himalayan wall has helped in moulding and shaping a 'border-people' and forced them into enduring and overcoming the harshest possible physical conditions imaginable, a nearly superhuman endurance story. Cis-Himalayan living conditions are nothing but stories of extreme human endurance and successful narratives of climatic adaptations, over centuries of existence (Tolia 2005).

Three Distinct Tibetan Regions

As we all know the southern border of Tibet is formed by the Himalayas; the western by the Karakoram Range, and the northern by the Altyn Tagh, which borders on Chinese Turkestan. Tibet in fact has three distinct regions, known as Chol-kha-sum. The extreme west from Ngari Korsum to Sokla Kyao is known as U-Tsang; the region from Sokla Kyao to the upper bend of the Yellow River (Ma Chu, its name in Qinghai) is known as Kham (Dotod in Tibetan), and from the Yellow River bend to Chortenkaro lies Amdo (Domed in Tibetan). There is a saying in Tibet that emphasizes the particularities of these three regions (Tsepon 1984):

> The best religion comes from U-Tsang (the region adjoining Uttarakhand); the best men come from Kham (Dotod); and the best horses come from Amdo (Domed).

Let me share with you very briefly the significance of these Tibetan statements and their impacts on its history, politics and Tibet's ultimate and continuing marginalization.

The Best Religion

It is the westernmost part of Tibet, which hosts Mount Kailash, the celebrated Lakes of Mansarovar, equally important to Hindus, Buddhists, Jains as well as the Bönpas. The Bön religion, as many of you may know, precedes Buddhism. Much before Lhasa became the centre of Buddhism all over Tibet it was in U-Tsang that the earliest Buddhist monk Atisha (Depankarjanan of Vikramshila monastery in Magadh) arrived in the Toling monastery along the Sutlej in 1042 A.D. via Nepal. Atisha and his disciples made corrections and revisions of the Tibetan translations of Buddhist texts and while at Toling, Atisha wrote a Sanskrit work called Bodhipath pradeep (the lamp that shows the path of enlightenment). Atisha, in fact, arrived and worked much later; the real credit of opening the doors of Tibet should go to Tibet's founder-king, Srongtsan Gampo (617-649 A.D.), who sent Thon-mi Sam Bhota with sixteen companions to India (Kashmir) to learn the Sanskrit language. After their return to Tibet he used his knowledge of the Brahmi and Gupta scripts to devise a Tibetan script. Atisha, Santirakshita and Guru Padmasambhava are but just a few names who helped to establish Buddhism in Tibet, while it declined in its country of birth. So, western Tibet, starting with the pre-Buddhist Bön religion, followed by Buddhism in the eleventh century, became well known for the flowering of religion. A look at the present day practice of Buddhism, along the Indian border, indicates its strongest influence in Ladakh, in the border regions of Himachal Pradesh, and a tapering presence in the westernmost part of Uttar Kashi district of Uttarakhand. Its near absence in the Johar and Darma valleys of the Pithoragarh district (with the latter retaining Bön residues), excepting of course, enclaves of migrants from Tibet (Bidang in Darma and the Molpas of Mana) reinforces the belief of U-Tsang's eminence as home to the 'best religion' (Sherring 2006).[1]

The Best Men

There are two traditions concerning the racial origin of the Tibetan people. While leaving aside the tradition of Indian ancestry, one may be surprised to know that their second tradition maintains that the Tibetans are descended from monkeys, especially from a male monkey, and are the incarnation of the deity Avalokiteshvara (Cheresi),

[1]Personal communication from interviews in the settlement of Bidang in Darma.

who produced six progenies through a mountain ogress. These hybrid monkeys looked like any others, except that they had no tails! Modern anthropologists claim that the Tibetans belong to what was formerly called the Mongoloid race,[2] and such a classification seems plausible since the Tibetans had a close relationship with the Mongols for centuries. The majority of people in the U-Tsang are short of stature, round-headed with high-cheek-bones, therefore slightly different from those other two regions. The people of Kham (Dotod) and Amdo are tall, long headed and long limbed. When the Dalai Lama fled Tibet his entourage exited through Kham, escorted by the best of men (Khampas).

And the Best Horses

It was indeed the search for these fabled 'best horses' of the Amdo region, about which that intrepid superintendent of the company stud William Moorcroft had heard from the Haridwar Kumbha mela, that enticed him to visit these Himalayan border valleys, a land at that time (1812) under the control of the Gorkhas. It was the search for pashmina wool and good quality equine germ-plasm that brought East India Company servants in contact with the Johari traders in western Tibet in 1812, near the Mansarovar region, which established contacts with a border people who had been in contact with Tibet for several centuries. Moorcroft's description of his journey in disguise through the Niti valley provides a graphic description of both the ruin and desolation that had been wrought by the cruel Gorkha rule in these border tracts (1792–1815) and the flourishing land-trade that existed between these two adjoining Himalayan regions. British colonial expansion wrested these border lands from the Gorkhas in 1815, and during the next four decades the entire Cis-Himalayan foothills came under British rule. The newly acquired territories became the North Western Province and the Punjab.

Thus he secured (1792–1856) the Bengal Lower Provinces, carved out of them two new provinces, and set the East India Company into an northward expansion mode, in order to prevent the expansion of Russia towards the east, eventually halted by the Sepoy rebellion in 1857. Earlier in the 1830s the North Western Provinces had commenced a new kind of land revenue settlement, providing a financial soundness to a commercial company which had now assumed a governing suzerain role. These new revenue settlements needed land surveys, which gave rise to the Great Trigonometrical Surveys (GTS). This new survey organisation of India and Nain Singh Rawat, the Pundit of Pundits, were born the same year, 1830. The cadastral and cartographic surveys moved northwards, first to the foothills and

[2]"The term Mongoloid has come to mean demented physical and mental developments, features similar to the Asiatic race. A more appropriately neutral, modern term would thus be the East Asian race, from Mongolians, Koreans, Chinese and Japanese in the North to Burmese, Laotians, Cambodians, Vietnamese, Thais, Malaysians, Singaporeans, Filipinos and Indonesians in the South" (Chong 2009, p. 3).

thereafter to the great Himalayas. Nain Singh's hitherto hapless circumstance took a turn for the better, his engagement as an interpreter with the scientific Magnetic Surveys of the Prussian Schlagintweit brothers, Hermann, Adolf and Robert, came handy, when the search for a way out after the murder of Adolf near Kashgar, put a stop to the white man's entry into the Central Asian region.

The Asian White Spot

Quite like the scientific data on the 'white spot' highlighted by the latest Assessment Report of the IPCC, the murder of Adolphe Schlagintweit near Kashgar, rendered any exploration by a 'white man' impossible. However, by this time a visit to the source of the Sutlej River in western Tibet by the Schlagintweit brothers (Schlagintweit and Schlagintweit 1861–1866) and the earlier visit of William Moorcroft to the Mansarovar region, had thrown up the possibility of a way forward. It presented itself in a set of border-people who had been trading with the Tibetans for a long time, in the same trans-himalayan regions, and it was apparent that they exercised considerable influence in these areas because of their trading superiority. The plan was to recruit young persons from these communities, train them for survey work, and deploy them to continue with the scientific survey. Their competence to undertake such surveys, their commitment, industry and honesty, had already been vouchsafed by the published works of the authors of the Magnetic Surveys of India, in the volumes of explorations in High Asia. The brothers had even offered Nain Singh an assignment in the company in Europe but reported that his attachment to his home-land proved stronger.

Pioneer Teacher and Self-taught Linguist

Even today, after six decades of independence and promotion of science, the Indian Himalayas suffer from being a "white spot" as concerns scientific data. This contrasts with the career of Nain Singh Rawat, a humble and indebted young man from this region. He started frequenting a school at Milam, while the North Western Province had just commenced setting up the Tahsili schools (Allender 2006, pp. 22 f., 39 f.), i.e. vernacular schools funded out of 1 % of tax revenue, at the Tahsil (subdistrict) level (Mir 2010, p. 55). Without a formal schooling, as none existed then, Nain Singh taught himself Hindi, English, both spoken and written Tibetan, not to mention Persian which was the official language. That he was quick at picking up measurement knowledge and even the use of sophisticated surveying instruments has been testified in the reports of the Schlagintweits. Of late, his control of words and expression, in some of these foreign and Indian languages, has now been testified by recent research. His contributions to the development of the modern Hindi language proved him worthy to be included as one of its fine practitioners.

His 'Akshansh Darpan' or mirror of Latitude, an instruction booklet that he wrote on the specific request of the officials of the education department, makes him arguably the first author of a technical treatise in Hindi. This book also testifies also to his excellent qualities as a trainer as it was he who in his final years assumed the role of a Chief Trainer for the younger surveyors recruited by the GTS (Tolia 2000).[3]

From a penniless indebted young man Nain Singh through his major exploratory works was able to considerably fill-up the 'Asian cartographic white spot', and he was acknowledged by the authorities as 'one individual who had contributed maximum to our extant knowledge of the Asian High Plateau'. His pupils were also as well trained by him, as the master trainer. Geographers have mentioned that some of these pupils later excelled the master himself.

Growing Literature, Awards and Decorations

Highest scientific and official awards followed. His multi-faceted talents are best reflected by the fact that the headquarters of the Survey of India, one of the oldest scientific organizations of the world and his employer, erected his bust alongside the one of his cousin Kishan Singh Rawat and the most celebrated Surveyor General of India, Sir George Everest. Besides, a road and the main auditorium of the Survey of India were named after him. Independent India has honoured his achievements and memory by releasing a postal stamp and a first-day envelope, thus raising him to one of the most outstanding sons-of-the-soil. The Royal Geographical Society honoured him with its highest distinction by bestowing the 'Patron's Medal' upon him. He is the only Asian to have his name on its Honour's Board. The British Government matched it with the highest civil honour conferred to an individual, namely Companion of the Indian Empire (C.I.E.), with land jagirs (land grants) in Sitapur. Gold Watches and other honours followed from various Geographical Societies of Europe.

In this age of 'scientific white spots', with the state spending millions in the name of science and technology, teaching and training, the eminence and the value of the contributions made in all these respects by Nain Singh Rawat and other 'Pundits' engaged in these scientific explorations stand out in sharp contrast. In passing, when soon after the well-known Young husband Expedition to Tibet in 1904 (Tibet Frontier Commission) Tibet opened up to the outer world for the first time, a technical mission was mounted, primarily to test and validate the existing scientific knowledge available in the official records. Most of this had been

[3]For the sake of record, and to provide a sense of the extent of this recorded scientific information, let me provide brief details of Nain Singh's celebrated four survey explorations in Tibet and Central Asia (1865–1875): 1865–66: Kathmandu—Lhasa—Mansarovar Lake (21 months, 1200 mi), 1867: Origin of Sutlej and Indus rivers, and Thok Jalung in Tibet (7 months, 850 mi), 1873–74: Douglas Forsyth's Second Yarkand—Kashgar Mission, and 1873–75: Leh—Lhasa—Tawang, Assam (1319 mi).

sedulously collected by these Indian explorers, led by Nain Singh. This mission was declared a failure as it was unsuccessful in discovering any major discrepancies, but its leader Captain C.G. Rawling, himself from the Survey of India (with Captain C.S.D. Ryder and Captain Wood) felt proud of the fact that the scientific information recorded by Nain Singh, under extremely difficult working conditions, stood fully validated!

All these surveys, needless to say, were undertaken on foot, measuring distances, simultaneously taking various observations, and meticulously keeping a day to day diary including his personal observations. Thousands of square miles of hitherto uncharted regions were thus mapped for the first time, along with their latitudes and other related scientific observations which were taken along the route. The co-ordinates of all habitations and places were also recorded and mapped. Large areas of Tibet hitherto unknown to the outer world were thus recorded, with various social and economic observations, which only a person with Nain Singh's background could possibly attempt (Singh 1973; Bhatt and Pathak 2006).

Teacher and Trainer Par Excellence

Nain Singh and Kishan Singh were unknowingly following the foot-steps of great savants like Aisha, Santirakshita and Padmsambhava. While the latter were simply fulfilling requests made by the Tibetan Kings to impart to them the teachings of the greatest reformer India gave to the world, Lord Buddha, the Pundits were filling the 'white spots in the scientific knowledge' on the geographical maps of the modern world, with which our scientific community is still battling.

Here it may be useful to briefly explain the term 'Pundit' (or Pandit) often applied before the names of Nain Singh Rawat and also Kishan Singh. When the vernacular schools were being opened in the 1860s during the colonial period, formal teaching was restricted to the study of the three R's (reading, writing, arithmetics). Prior to this, schooling was confined to just two communities, both at home: for the Brahmin youth for the purpose of performing the rituals, and for the Bhotia youth, as the trading community needed to keep their trade accounts. As the teachers employed were mostly Brahmins from the Pundit class, the teachers employed in the schools acquired the epithet of 'Pundit', for a school-master, similar to the Master ji of later times. Thus, the expression 'Pundit' simply meant a teacher ('Moulvi' for a Muslim teacher). Nain Singh had been employed as a teacher first at Milam, his home-land, and later in Darma, where he was sent to start a new school in Garbyang. After his training at the Survey of India in Mussoorie in 1863 he and Kishan Singh were entrusted with the Tibetan explorations and given the pseudonym of 'Pundits', to hide their real identity. By this time Tibet had become a totally forbidden land, closed to outsiders.

The first exploration report mentioned 'the Pundit', hiding Nain Singh's identity, as the explorations were to be carried on further and the identity of the explorers had to be protected from the Tibetan officials. In due course the 'original Pundit' i.e.

Nain Singh, was to assume the role of a trainer for the new recruits of the GTS, and ultimately he was recognized as the chief trainer and thus the Chief Pundit, in the official records. Thus the expressions Pundit and 'the original Pundit' merely alluded to a pseudonym applied for a teacher, who later became an explorer, and ultimately the chief trainer for an entire crop of outstanding geographical explorers, who mapped the length and the breadth of a vast country like Tibet. This was no ordinary phenomenon as these explorations were conducted and completed while a sword of death hung over them, any disclosure of their identity resulting in instant death. Much was made of this 'epithet' in one of the discussion held in the Royal Geographical Society with an unsuccessful attempt to belittle the importance of a great work recently completed by Kishan Singh, in a bid to secure RGS honours to the retiring Surveyor General, Colonel Walker via the presentation of preliminary results of south China explorations, completed in 1884. However, as the RGS had several old India hands, who knew India like the back of their palms, this nefarious attempt to belittle the great achievements of the likes of Nain Singh and Kishan Singh, were completely thwarted. The only consequence was that Kishan Singh Rawat's work did not receive the highest honours that certainly were due to him, as Kenneth Mason later insinuated. That Nain Singh was a trainer par excellence is best testified by the instructive language that he used in his master piece, the Akshansh Darpan, and the re-iterative pedagogy that he deployed to explain the intricacies of taking measurements and applying menstruation formulae to his adult protégés at the Survey school (ibid.; see also Tolia and Prakashan 2010, Book IV, pp. 131–150).

Just as the abiding contributions made by the early Buddhist savants of the middle ages remain to be fully assessed and acknowledged by India and the Buddhist world, the contributions to physical and social sciences and the world of literature made by some of these intrepid explorers of our times also remains mostly un-acknowledged, unaccompanied as these are with the academic degrees or patronage enjoyed by the likes of Swen Hedin or David Livingstone. I would like to describe it as a case of 'academic marginalization in an era of global excellence' and how this has been possibly averted thanks to this field trip to this remote Himalayan region. Field work has unfailingly lent depth to all academic studies.

Our dialogue will continue to add more to what I have tried to share through this brief presentation, intended to perpetuate the memory of arguably the greatest among the many 19th century surveyors. It is indeed no less an academic feat by which the accomplishments of these ordinary looking local greats have been rescued from being lost to the scientific and literary worlds.

Acknowledgements I would like to thank the convener of the IGU Commission conference Nainital 2011, Professor Raghubir Chand, for inviting me to deliver this lecture. He has afforded me this opportunity to share some of my time with the participants from across the world and share this information with them, in the company of able teachers and young students of our Munsyari region. I also thank Prof. Shekhar Pathak and Dr. Sher Singh Pangtey who have made outstanding contributions to bring to notice the life and works of these relatively unknown scientific explorers to the outside world.

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Chapter 3
The Arctic World in the Twenty-First Century: The Impact of Globalization on Demarginalization

Donald F. Lynch

The Awakening of the Arctic World

The Arctic World is a region that has become an object of major interest and significance to the world at large in spite of its sparse population.[1] What is happening in the Arctic World is of importance globally because of the impact it is having on global climate and also on global mineral supplies, timber, energy resources, transportation, fisheries, tourism, environmental concerns, and scientific study (Arctic Council 2009).

Donald F. Lynch—deceased.

Note by the editors: This chapter is the 7th Pundit Nain Singh memorial lecture, delivered by Professor Emeritus Donald F. Lynch at the 2011 International Geographical Union Commission on Marginalization, Globalization and Regional and Local Responses Annual Conference in Nainital, Uttarakhand, India. Unfortunately he could not see it printed as he died on January 30, 2014. Given these particular circumstances, we have taken care to edit the paper in his spirit. This concerns particularly the subdivision into sections, which Don did not furnish. Also, the endnotes were converted into footnotes and the bibliographical references exported into a reference list. Finally, we completed the subtitle (which only referred to globalization) because the paper illustrates how an entire region is gradually moving out of oblivion and marginalization to become an active member of the global society. Prof. Lynch travelled to Nainital from Fairbanks, battling with cancer but so bravely that he was able to read the text on the famous explorer of nineteenth century, Pundit Nain Singh, on the way. He delivered an excellent lecture presenting an overview of a space (the Arctic world) that had been in the focus of our predecessor study group on highlands and high-latitude areas. We pay our sincere gratitude to him for attending the conference, which was the last conference of our commission he attended. We thank his former colleague, Professor Emeritus Roger Pearson, for reading through and amending the text.

[1] A low estimate might be that the Arctic World contains about six to seven million people depending on where one draws the boundaries. Leaving out the great cities along the Trans-Siberian Railroad, the Russian portion is at least three million people. Some argue that the Arctic itself has three million people.

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The region has been defined in various ways. Over two thousand years ago it was thought of as that part of the world beyond the Arctic Circle where the sun never appears in the winter but was under the constellation of the Great Bear, Arktikos in Greek, from which our term Arctic is derived, Ursa Major in Latin, and the Big Dipper in English. Another frequently used definition is that of the Koeppen-Geiger climatic system which divides the region into northern tundra and taiga (taiga) environments separated by the 10 °C July mean temperature. By taiga was meant the circumpolar boreal forest, but the term also is used for the transition zone between the two. Another definition relates to lowland permanently frozen ground and divides the region into three zones, continuous, discontinuous, and sporadic permafrost. The real difference here is the temperature of the ground, which is significantly lower in continuous than in discontinuous permafrost so that the former is generally speaking more stable. In addition, frozen ground with little moisture, that is dry permafrost, is far more stable than wet permafrost, with a high moisture content.

From a human viewpoint, these physical descriptions do have a major impact on how people live, but most indigenous peoples have used the resources of both the tundra and the taiga as have the reindeer and the caribou as well as wolves and other mammals. Separating the two zones makes little sense in the contemporary human geography of the Arctic World. The use of a summer temperature to separate the two is deceptive because it conceals the reality that winter is the dominant season, the one to which people and all forms of life must adapt. This winter world is often described as being "severe" and "harsh," which indeed it is for temperatures do reach as low as −45 or even −51 °C below zero and the coastal regions often are subject to blizzards, high winds and white out conditions. Indigenous peoples, however, adapted to these conditions in a manner those from elsewhere found most intriguing and imaginative as well as effective. The term Polar Regions is more commonly used today and highlights the central fact that the Arctic Ocean unites the landmasses of the Northern Hemisphere. The shortest distances between these land areas cross the Arctic Ocean.

However, the central fact is that the region has a very sparse population, probably about seven million people, most of whom live in the Russian Federation. The real key to understanding this world today, however, is that over the past half century the physical difficulties of building and operating in the Arctic World have

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(Footnote 1 continued)

Some selected population data:

The Scandinavian north has probably about one million.

Yakutia has about one million.

The Canadian North has about 105,000 divided amongst the Yukon and Northwest Territories and Nunavut.

Northern Quebec and Ontario, the region of Hudson's Bay, and Labrador are often considered part of the Arctic World.

Svalbard has 2753 people.

Murmansk has 336,137, Archangel 356,051, Noril'sk about 150,000.

The central Ob'Basin, Tyumen Oblast', has about 3,000,000.

Interior, Arctic and Western Alaska including Fairbanks has about 200,000 people.

been overcome. This has been the result of decades of research and engineering achievements which have led to new lubricants for vehicles, housing, water and sewage systems, drilling technologies, communications, and a host of other achievements which have made economic development feasible and have reduced, but not eliminated, the high cost of transportation.

There are also political definitions, which are probably more significant. Each of the Scandinavian countries has a political unit prefaced with the term "north," and Canada sometimes uses the sixtieth parallel that separates the provinces from the territories. With the exception of the Sakha Republic (Yakutia), Russia divides its Arctic and Sub-Arctic regions from south to north. Each of the political units of the Arctic World is tied to the south in terms of communication and economic and social development and thus has become more integrated not just to the respective nation states but also to the world at large.

The Russian Federation contains the largest and most developed part of the Arctic and seems determined to develop it further (Bank of Finland 2010).[2]

[2]From Bank of Finland Weekly, No. 44, Nov. 5, 2010 Russia Survey.

"**Russia pushes for development of the Arctic**. Russia has recently witnessed a sharp increase in interest of the Arctic region. This year, the country has arranged a number of international conferences on the Arctic economy, natural resources and environmental challenges. A major economic advance took place in September when Russian foreign minister Sergei Lavrov and his Norwegian counterpart Jonas Gahr Støre signed a treaty on territorial borders and resource exploitation for a 175,000 km^2 block of the Barents Sea and Arctic Sea. The territorial issue had been pending since 1970.

The Arctic region consists of all the area north of the Arctic Circle. The total area of the Arctic exceeds 30 million km^2 and represents about 6 % of our planet's surface area. Even so, its resident population is only about 4 million. The Arctic Council provides an intergovernmental forum for countries with territories north of the Arctic Circle (Canada, Denmark (Greenland), Finland, Iceland, Norway, Russia, Sweden and the United States).

A 2008 US Geological Survey study estimated 22 % of the world's undiscovered oil and gas reserves lie within the Arctic region. The undiscovered oil in the Arctic region would represent about 13 % of global reserves, while natural gas about 30 %. The lion's share of natural gas deposits is located in Russian territory, most notably in the West Siberian Basin, the Timan-Pechora Basin and the South Barents Basin.

It is estimated that over 80 % of natural resources in the Arctic region are located in sub-sea areas, which partly explains the lack of utilisation of the areas. The region's harsh environment, lack of infrastructure and the sheer magnitude of investment needed to develop the area have limited plans to exploit natural resources.

Russians nevertheless believe in the Arctic region's potential. Russia's natural resources ministry says that over the next two years Russia will invest 2 billion rubles (about €48 million) to study the area.

The Arctic holds value not just for natural resources. A recent report from the Arctic Monitoring Assessment Programme, a working group of the Arctic Council, found the ice mass has been shrinking steadily for decades; by 2007 the summer ice mass was about 40 % smaller than in 1979–2000 on average. As a result, the Northeast Passage, which runs from the Atlantic via the Arctic Ocean to the Bering Straits and the Pacific Ocean, is expected to become a viable shipping route. Sovkomflot Shipping, which is owned by the Russian state, completed its first trial navigation of the Northeast Passage in September. The trip from Murmansk to Ningbo in China took 22 days, or half the time the same trip would take following the southern route through the Suez Canal. Even with reduced Arctic sea ice, the route would require icebreakers most of the year."

The Arctic World constitutes the major source of Russian exports and is a major contributor to the Russian economy. The Kola Peninsula and Noril'sk are major, global sources of nickel and palladium. The central basin of the Ob' River is Russia's major source of petroleum and natural gas. Alaska produces zinc, gold, and 600,000 barrels of oil daily and enormous quantities of fish. Alaska's economy is heavily dependent on oil and, but less so, on rich fisheries and tourism. Norway is quite dependent on oil and gas exports from the North and Barents Seas. Arctic Canada is a major, global source of diamonds and other minerals.

Climatic warming has been visible in the Arctic for a century with glacial retreat, and all the scientific evidence since the first real satellite data in 1979 indicates that this warming has been continual and continuing. This is a strong argument for reducing green house gases on a global scale. Economic development in the Arctic World should logically contribute to climatic change on a global basis with Arctic air masses perhaps becoming more intense and moving farther south in North America and west in Eurasia, while tropical air masses might become more intense and move farther north into the Arctic Ocean.

The Arctic World produces significant quantities of petroleum and natural gas as well as wood products and such important minerals as gold, zinc, nickel, diamonds, apatite, palladium, and in addition has massive deposits of coal and also sources of tin and other minerals. A major expansion of oil and gas production is both possible and probable. The fisheries of the North, Barents, and Bering Seas are a major global food source. Since 1960, passenger and commercial aircraft have been using the Arctic in ever increasing numbers to connect Asia, Europe and North America. Big Science has entered into the Arctic World and involves numerous countries, while tourism has expanded dramatically. National and international environmental organizations are also having a significant influence on government policies particularly regarding resource development. In short, the Arctic World is now one, which is not just of major significance, but is being increasingly integrated into a global economy. For those who live in this world, the most important aspect of our lives is to understand and influence these external forces which impact us with increasing force and complexity. This is globalization with a vengeance affecting a sparsely populated but very large part of the Northern Hemisphere (see also Smith 2010).

The Dynamics of Urban Life and Frontier Society

I live in Fairbanks, the Golden Heart City, located in the center of Alaska's great Interior about one hundred miles south of the Arctic Circle. Fairbanks lies in the boreal forest, has a continental climate, and is considered Sub-Arctic. The boreal forest is part of the Arctic World. My home illustrates the major trend which has impacted the human geography of the Arctic World, that is the expansion of an urban frontier way of life which has developed over the past sixty or more years throughout the Circumpolar North, as we describe our greater world. Alaska

presents itself as *The Last Frontier*, a phrase immortalized in our state anthem.[3] We are an example of the development of the western American frontier, which has followed a pattern similar to that of the rest of the Arctic World. As settlers moved west following early explorers they sought first the furs, while living off the land, and then they sought gold, silver and copper, followed by the development of transportation links to more settled areas. Towns like Fairbanks developed as mining service centers, agriculture became significant, land grant colleges created in the United States, and communities evolved which were and are similar to those the immigrants had left behind. Alaska Natives were simply shunted aside, denied citizenship, and ignored. The history of Fairbanks replicates this sequence of development except that due to decreased transportation costs commercial agricultural development was stifled from the 1960s, although it continues to play a much bigger role in our lives than statistics would indicate. In addition the indigenous peoples were not pushed on to reservations as was true in the American west.[4] In the Russian Federation native peoples were organized into "autonomous regions" with various special privileges, but kept subordinate to the national government.

The most important trend over the past several decades has been the extension of the urban way of life northward replicating in Alaska west coast cities. One example of this is my house situated within easy walking distance of ten different churches and our downtown. It is very much a 1970s west coast American suburban house, except it is almost in the center of the city and sometimes moose walk around my yard and eat the vegetation in this neighborhood. For our major cities, Anchorage, Fairbanks and Juneau, this is an example of the expansion of the urban frontier not just within but more importantly beyond cities creating suburbs. Today two thirds of the people living in the greater Fairbanks area live outside city limits.

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[3]The Alaska Flag Song is easily and frequently sung.

Eight stars of gold on a field of blue,
Alaska's flag, may it mean to you,
The blue of the sea, the evening sky,
The mountain lakes and the flowers nearby,
The gold of the early sourdough's dreams,
The precious gold of the hills and streams,
The brilliant stars in the northern sky,
The "Bear," the "Dipper," and shining high,
The great North Star with its steady light,
O'er land and sea a beacon bright,
Alaska's flag to Alaskans dear,
The simple flag of a last frontier.

[4]This is the concept of sequent occupance formulated by Whittlesey (1929). The concept is described in detail for the American West in Goetzmann (1966). This was just as true in Siberia and Northern Scandinavia where the main objects were first reindeer skins and subsequently fish and minerals such as iron ore. For the Alaskan and Greenland coastal areas, original exploration lead to whaling which in turn created trading posts.

Anchorage suburban development particularly in the Palmer, Willow and Wasilla area has been very rapid. The expanding urban frontier has been accompanied by the concentration of people in central cities, towns, and smaller settlements. The larger Anchorage region today encompasses about half of Alaska's 720,000 people, the result of continuing immigration. Alaska's population has increased ten fold in the last seventy years, most of that occurring after statehood in 1959. This same trend can be found throughout the Arctic.

However, the American frontier way of life is still evident. Many people in our urban and suburban areas and most people in the over 170 small settlements ranging in population from fifty to five hundred people, still rely on hunting, fishing and gathering, called "subsistence," as well as fur trapping. Many live in log homes and rely on wood as their principle fuel and in spite of four wheelers and snow machines dog teams are still very much part of our way of life. As fuel oil prices have increased, more people have begun using wood for fuel even in major urban areas. In addition, even in urban areas, large numbers raise their own vegetables and potatoes which grow very well in our Interior Alaska continental climate. Similarly, Siberians cultivate their own gardens in the famous Russian "dacha." Socially the frontier ethos presents itself in numerous different social and religious organizations, which cut across economic class lines, and people here are able very quickly to organize themselves around a specific activity, for example dog mushing or politics. The latter was massively demonstrated in our 2010 Senatorial contest, while fundraisers for those in need are quickly organized and successful. Another element of the continued existence of a frontier society is the ease with which different ethnic groups and individuals become accepted. We literally have here people from all over the world, but they are for the most part not separated by where they live as is true in major American cities. As part of becoming in many ways a west coast urban world we also have the crime, drugs and other social and criminal problems found elsewhere.

Expansion of an urban way of life, however, has been and is occurring in smaller settlements. Housing, very much along American styles, is funded in large part by government and other sources, heating and electricity relies on imported fuel oil, the state has dramatically expanded the school system into smaller and particularly Alaska Native communities, telephone and television services exist, and one of the current objectives is to expand broad band internet services. Medical care in smaller communities has expanded significantly over the past thirty years, and today there are special medical facilities for natives in both Anchorage and Fairbanks. This has been made possible by expanded air services. In addition Alaska Native populations have shown a steady increase and secondary cities with populations between three and five thousand (Nome, Kotzebue, and Barrow) particularly have shown growth. Bethel reports a population of 17,000. With exceptions in some areas, what we term the village or "bush" population has also increased.[5] Much of this has been the result of government expenditures and also improvements brought about by the

[5]These rounded data are from the 2010 Census.

twelve Alaska Native corporations established in 1971 by the federal Alaska Native Claims Settlement Act. These corporations provide not only social services, but also dividend payments from corporate business earnings. About 15 % of Alaska's population are Native Alaskans who play an increasingly significant role in Alaskan politics. Natives are the dominant people throughout most of Interior, Western and Arctic Alaska, as is also true of the First Nations in Arctic Canada.

Fairbanks represents a trend towards extending the urban frontier northward found throughout the Arctic region. The first examples occurred in the Arctic and Sub-Arctic parts of European Russia and extended into Siberia in the 1930s with the construction of standardized Communist settlements. These involved three to five storey rectangular apartment blocks surrounding a courtyard, a municipal power plant providing heat, water, and sewage to the entire community, as well as community cultural centers and a shopping center composed of small stores. This pattern was even imposed on the Russian mining towns on West Spitsbergen, Svalbard. Much of the actual economic development, which occurred, however, was based on concentration camps in which millions of people lived in atrocious conditions and were literally worked to death.[6] This system was abolished in the 1950s and economic development based on Siberian mineral and energy resources played a critical role in the Third Program of the Communist Party of the Soviet Union. Major projects were undertaken including oil and gas development in the Yenisey basin, a huge dam and hydroelectric project on the Angara river, the construction of the Baykal Amur Railroad, the opening of diamond and coal mines in the Lena basin, and the construction of large, ocean going fishing fleets in Archangel, Murmansk, Vladivostok and Petropavlovsk-Kamchatskiy. These were accompanied by the construction of standardized towns. In addition, from the early 1930s the Russians organized the Northern Sea Route Administration, which for sixty years was responsible for supplying the mining enterprises, and ports along the Arctic coast by building and operating ice breakers and ice strengthened vessels and opening the Northeast Passage to Russian commerce. These great programs were halted with the onset of Perestroyka in the late 1980s with the exception of oil and gas production, and at the same time the ports of the Russian Far East bordering the Bering, Chukchiy and Okhotsk seas were officially opened to foreign commerce. The result was a substantial out-migration from Siberia and the Russian Far East with many projects left unfinished, the quasi-commercial reorganization of the fishing fleets, a major decline in military expenditures, the conversion of the Northern Sea Route Administration to a shipping company, the removal of the social welfare net, and the closure of many small communities. Diamond mining, however, expanded in the Lena river basin, as did gold mining elsewhere and the

[6]There have been many descriptions of the miseries of the concentration camps over the past more than seventy years (e.g. Shalamov 1978). The camps in the Kolyma river basin northwest of Magadan were the worst in the U.S.S.R., and some three million people are estimated to have died in them.

nickel mines in Pechenga and Noril'sk and the coalmines in the Pechora basin continued to operate. The Russians closed a major coal mining operation in Svalbard and severely reduced their subsidies for the remaining settlement.[7] While elsewhere in the Arctic world people were moving northward, in Russia the reverse happened. Northern Scandinavia has also seen a decrease in population, but not to anywhere near the same degree, and that has been caused simply by the attraction of better economic opportunities farther south.

The 1950s also saw major changes in the Canadian north, Greenland, and northern Scandinavia. In Arctic Canada and Greenland native peoples were provided housing in major settlements and in some cases were compelled to move to larger places. A major investment in their northern and Arctic regions also occurred in Scandinavia including Svalbard. In each case, Scandinavian housing styles, which meant individual houses, and social security systems were extended northward. In all these cases, the funding came from central governments with from the 1960s onward major investments in highways, airports, and harbor facilities. The Norwegians in the 1970s built a major airport at Longyearbyen in Svalbard, just as an example. These changes in the 1950s and 1960s were oriented not just in Siberia but also throughout the North on resource development and integrating the Arctic world into national systems.

What urbanization means is that the Arctic World has become increasingly dependent on other regions to satisfy its needs. Disruptions in transportation can cause serious difficulties as communities have become dependent on outside sources of supply including fuel oil. Most communities today are far more dependent on imported goods and services than was true even fifty years ago. As connectivity has increased, so has dependency, and this includes obtaining support from national and regional governments. As a consequence, the peoples of the north have become very politically aware and involved in both national and international arenas. However, the reality remains that most outside of the urban areas are very dependent on hunting, fishing and gathering and indeed prefer to maintain that way of life. A large number of urban residents also rely on these "subsistence" activities as well as personal farming to meet their needs for food. Increasingly even urban dwellers are using wood for heat due to high fuel oil costs.

The Dynamics of the Economy

These for the most government sponsored or encouraged programs were accompanied by very significant changes in the engineering skills required to build communities and operate equipment under extremely cold conditions. They

[7]The author had the pleasure of visiting the two active Russian coal mines, Barentsburg and Pyramiden, in 1974. Frankly, I thought living conditions were quite good, but the mines seemed to exist more to maintain a Russian presence on Spitsbergen than serving an economic purpose.

accelerated in the 1970s and in Alaska accompanied the construction of the Trans-Alaska (Alyeska) pipeline. New construction techniques, special lubricants and other techniques made it possible to adapt technologies to Arctic conditions. This is a process that has continued particularly in Alaska, Canada, Russia and Northern Scandinavia. Extreme cold has been found to be quite advantageous for some types of construction, while by using various heating techniques the construction season has been extended. In addition, major improvements in mining technologies have resulted in globally significant new mines. Norway and the United Kingdom as well as the Russians have also pioneered the technologies for off shore oil and gas exploration and exploitation in the North, Bering and Kara seas. Even the techniques for providing water and sewage systems in smaller communities are well known, just very expensive. Similarly, green house technology able to permit plants to grow almost year around under Arctic conditions is known, but uneconomical. Ice breaking technology has also advanced especially in Russia and Finland so that year around Arctic navigation may be possible, but not probable. The Arctic region today, thus, is no longer an impossible area in which to operate, and air transportation and modern communications has significantly reduced the factor of "remoteness." Costs, however, remain significantly higher than in the more settled areas of the world.

In short, the engineering problems faced in the 1950s have for the most part been solved. This in turn has lead to numerous proposals for major, some call "mega," projects to further economic development, all tied basically to moving resources southward to the densely populated parts of the world.[8] Some of these have actually occurred including the partially functional Baykal Amur Railroad, the Dempster Highway leading to the delta of the Mackenzie River, the Dalton Highway to Prudhoe Bay in the Alaskan Arctic, oil shipment by sea from the Kara Sea,[9] and off shore oil exploration and development in the Barents Sea.

The year 1960 was enormously significant. In 1960 Scandinavian Airlines started the first trans-polar commercial passenger route and the Americans sent a nuclear submarine to the North Pole.[10] What both these events highlighted was the central location of the Arctic Ocean to the northern hemisphere. During the Cold War this basic fact lead to the construction of early warning sites along the Arctic coast in case of a bomber attack and subsequently the establishment of sites to detect missile launches, while after the 1960s nuclear-armed submarines prowled

[8]North American mega projects are described in Bone (2003). Similar grandiose Russian projects have including diverting water from the Ob' Basin southward to Central Asia, building a railroad across the Bering Straits which is a very old both Russian and American idea, and building a dam across the Bering Straits with pumps to move more warm water into the Arctic Ocean to cause a major climatic change improving the conditions for life in the Russian north.

[9]For oil in Barents and Kara Seas see: Bambulyak and Svanhovd (2005) and subsequent reports.

[10]Scandinavian Airlines was the first western airline allowed to fly into Soviet airspace under very controlled conditions. One of the simple factors that made flying over the Arctic possible was the use of an azimuthal equidistant map projection for navigation.

the Arctic Ocean.[11] Fortunately for everyone involved, this activity has been significantly reduced in the past twenty years and the Arctic World has remained what it should be, a zone of peace. The building, however, of ever larger jet aircraft has made the air space over the Arctic a zone of significant commerce, something facilitated by the opening of Russian air space for civilian use. A substantial number of cargo carrying aircraft stop in Alaska to refuel and for some activities to transfer cargo, especially express mail. This has made Anchorage international airport a major hub, with Fairbanks playing a secondary role. The geographic reality is that Alaska, and especially Anchorage and Fairbanks do occupy a location central to all the major, populated areas of world. This factor explains our military bases in the Interior and the international air force training exercises that occur here.[12]

The northern world has also long been significant because it is crossed by the great circle shipping routes connecting North America to Asia and Europe. These pass just south of Adak Island in the Aleutians and south of Greenland and Iceland. One branch goes northward around the northern tip of the British Isles to the Barents Sea and the ice-free Murmansk coast and the great port of Archangel. This geographic factor goes far to explain the historical, military and economic significance of the White Sea and Murmansk areas important for oil, timber, mineral and fish exports. Undoubtedly the region's significance economically will increase in the future with expanded production of oil and gas.

The Arctic Environment

One can hardly overlook the ever-expanding research interests in the Arctic funded by a wide variety of governments including India, China, Poland and others. From the small beginnings with American and Russian ice islands to today's major interest in measuring sea ice extent and thickness, changes in the Greenland ice cap, various environmental threats to Arctic wild life including especially polar bears and caribou as well as studies of migratory birds, sea mammals, and ecosystems, Big Science has arrived in the Arctic. From small efforts to study "global change" in the 1970s, scientific study of the Arctic has virtually exploded among other reasons because of the availability of air transportation and satellite communications and

[11]The DEW line, Distant Early Warning Sites followed the construction of the Pine Tree Line across central Canada and the still operational BMEWS stations in Thule Greenland and Clear Alaska. This involved building a large number of radar stations along the Arctic coasts of Alaska and Canada. Unmanned stations and then other means subsequently replaced it. However, for much of the Arctic this was the first real contact indigenous peoples had with the influences of the outside world. The Russians built a similar early warning system, but the details are unknown, at least to this writer. The Russians, sadly, used Novaya Zemlya as a center for nuclear weapons testing and the disposal of nuclear waste.

[12]The Indian Air Force has participated in our Red Flag exercises and American Air Force contingents have had exercises in India.

measuring techniques. Just as an example, modern satellites can measure accurately wave heights. While coverage of the Arctic Ocean is not as good as elsewhere, polar orbiting satellites do provide masses of information hitherto unavailable and prior to the l960s hardly imaginable. Sea ice, permafrost temperature readings, and glacial studies all point to the global impact of changes in the Arctic World. One example is the possibility that the extensive frozen bogs in the North may thaw, and some measurements indicate that they are thawing, and in the process the vegetation will oxidize and spew what are termed greenhouse gases into the atmosphere, which in turn may accelerate global warming. Another is that the interior regions will undergo a decrease in precipitation and a drying out of the land, which may well cause the forests to die off, creating the real possibility of forest fires even greater than those recently experienced. In addition melting of the Greenland ice cap may increase world sea levels.

The unalterable fact is the tilt of the earth's axis against the plane of the ecliptic, which means that the world north of the Arctic circle, and indeed north of the sixtieth parallel experiences a major reduction in insolation during at least half of the year, and during the other half, due to the low sun angle in the higher latitudes, will have in lowland areas less heat from the sun than in the sunnier south. In fact, however, the longer day light hours provide more heat in the north than simple models would suggest, but that plants appreciate.[13] This also conceals the reality that south and west facing slopes also receive an increased amount of heat, more in mid-summer than the tropics because the air is dry and the days longer. The basic heat transfer mechanism, the source of heat, in the atmosphere is, however, moisture, not sun light, but instead the heating and cooling of the surface which alters the sun's short wave to long wave radiation. The basic heat transfer mechanism, therefore, is air masses and ocean currents. There are two major entrances for heat into the Arctic basin, the North and Barents seas and, but of less significance, the Bering Straits. Moisture laden air masses enter the Arctic and then circle around it from west to east. On occasion these storms penetrate as far as the North Pole. The major oceanic influx is the North Atlantic drift originating in the tropics. The scientific evidence indicates that this heat transfer has enlarged and that the primary cause is increased human use of fossil fuels including coal, wood, and other energy producing fuels. What is happening in the Arctic World, therefore, creates a powerful argument for reducing the use of fossil fuels on a global basis to reduce global warming. The truly low temperatures occur, however, not in the Arctic itself but in the continental interiors, most of northern Canada and Siberia, particularly in the basins of the Lena, Yenisey and Ob' rivers, and, but to a lesser extent in the upper Yukon. These masses of extremely cold and dry air move southward in North America and eastward and westward in the Russian Federation. They bring cold, and when they come into contact with maritime air masses they cause blizzards and

[13]Many efforts have been made by both American and Russian climatologists to quantify the impact of long periods of sunlight on the growing season. The measurements, known as thermic days, are useful but only approximations.

extreme cold periods, which often raise havoc in the American Middle West and east coast, European Russia and Europe, Manchuria and North Korea as well as coastal Alaska. In a simplistic view of climatic change, one might expect these air masses characterized by very high pressures to become even more pronounced and to decrease the amount of moisture available for vegetation in the circumpolar boreal forest. There are some indications that this is already happening in the Alaskan Interior. In addition, more intense storm activity should occur.

Another and major factor impacting the Arctic World has been the growth of environmental movements. Alaska has experienced this in the creation of large national parks and wildlife preserves, justified under the argument that large areas must be "protected" in their "pristine environment, essentially untouched by the hand of man." Canada and other parts of the North including the Russian Federation and Norway have also created similar nature preserves and environmental regulations governing land use.[14] The idea that the "natural environment" must be protected from "pollution" of the atmosphere and water resources of the entire planet has grown in strength and popularity especially in North America and Western Europe, but also in Russia and has some support in China and elsewhere. Some organizations, like PETA (People for the Ethical Treatment of Animals) and Green Peace are quite passionate in their beliefs and seek to protect individual species including whales, caribou, polar bears, walrus and other mammals. This has resulted from a major change in perception of the Arctic World developed over more than half a century. One could say that this idea started in the United States with the creation of Yellowstone National Park in 1872 or the state of California setting aside Yosemite in 1864. The real impact, however, came in the 1970s. Prior to the 1950s in general the perception of the Arctic World was that it was cold, forbidding, had a "severe" climate, and was uninhabitable, perhaps a place in which to have a great adventure, but not where human activities could have much of an impact. Nature then was to be "conquered" and "subdued."

At one time people conquered mountains, today they just climb mountains. The change was to an attitude that holds that nature is to be enjoyed, is not dangerous, and should be preserved and protected. The Arctic World became a benign place, particularly in tourist advertisements. The protection of land and animals even more than a century ago was related to tourism, and in the Arctic World that has expanded dramatically in the past thirty years (Hall and Saarinen 2010). One can today take an expensive tour on a Russian ice breaker to the North Pole, lodge and other facilities offering excellent service are available, and bear watching is fashionable. Alaska, Greenland, Iceland, Northern Scandinavia and even Russia have become tourist destinations. Of course, this is for most of the Arctic a summer time experience, as is true for most scientists. Winter tourism, however, is increasing at least in Fairbanks and Northern Scandinavia, and visiting buildings made of ice

[14]The key legislation creating 'federal national conservation units' such as national parks and wildlife refuges is the Alaska National Interest Lands Conservation Act of 1980. Canada has created two large national parks abutting the boundary with Alaska. Wrangell Island off the north eastern Arctic coast of the Russian Federation has long been a national wildlife preserve.

brings pleasure to many.[15] Those who live in the Arctic World do not all share the view that this is a benign part of the world and the opinion that the animals are friendly and cute. Facing an angry bear or even moose, living in 40–60 °F below zero, fighting masses of mosquitoes, experiencing an Arctic blizzard and white out are not pleasant experiences. However, environmental movements are vibrant in the North, but much less passionate and more restrained than elsewhere.

Political Implications and Demarginalization

Perhaps the origin of the increasing power of native groups owes its origin to Alaska in the late 1960s and early 1970s. At least, we would like to think that. The proposal to construct a major oil line and road from Prudhoe Bay in the Arctic to Valdez created a circumstance in which the long postponed Alaskan Natives' rights to land had to be settled.[16] Native leadership proved itself very astute politically and well organized, the oil companies wanted the issues settled quickly, and the environmental movements sided with Alaska Natives. The state was also involved, as it too wanted the land it had been allotted in the Statehood Act (1959) transferred from federal ownership. The result was the Alaska Native Claims Settlement Act (1971) which created twelve regional Native corporations able to derive significant income from their lands and other sources. The preservation and enhancement of native cultures and traditions became a significant activity. Similar actions occurred in the Northwest and Yukon Territories and led eventually to land settlements and in northeastern Arctic Canada the creation of Nunavut for the indigenous people, in Canada referred to as the First Nations. The Saami (Sami, Lapps) in northern Scandinavia and various indigenous groups in the Russian Federation including of economic significance the Yakuts in the Sakha Republic also acquired rights and sources of revenue. The Greenlanders obtained home rule from Denmark.[17] The result has been the formation of international organizations representing the circumpolar peoples matched by the Arctic Council and other Arctic oriented organizations. The voice of the Arctic began to be heard both in the national and the international political arenas. One area where this occurred was in the International

[15]Ny Aalesund is an example of winter tourism. It is located at about 78° north latitude on the northwest coast of Svalbard. Originally a coal mining settlement, the mines were closed, and in the mid-1970s only a few people were there manning a research station. In recent years, however, the Norwegians have advertised it as a tourist destination and even the King of Norway has promoted it for snowmobiling.

[16]The rights of Alaskan Natives to land were postponed under the Organic Act of 1881 for future settlement by the U.S. Congress. The issues were addressed with the 1971 Alaska Native Claims Settlement Act, but its provisions are still being implemented.

[17]There is an argument that the 57,000 people of Greenland look forward to oil development to provide the financial basis for becoming an independent country rather than a dependency of Denmark.

Whaling Commission in which the Alaskan Arctic Inuit (Eskimos) where able to assert their rights for traditional hunting. In addition, the peoples of the Arctic World are having increasing influence in their various national governments. Alaska, since it is a state, probably is ahead of the rest of the North in its political power.

Thus, today there are multiple actors involved in developments in the Arctic World. One of these, and indeed the major one, is simply that the technology and capabilities exist to operate more or less efficiently in the Arctic, while the consequent expanding urban frontier has made life easier. However, costs remain high. This in turn has made oil and gas and mineral exploitation possible. The United States Geological Survey argues that the Arctic's extensive continental shelves may contain more than one third of possible global oil and gas reserves. This leads to the conclusion that these resources will be developed given the rapid expansion of the global demand for energy. Greenland, Arctic Canada, the Chukchi and Beaufort seas, and the enormous continental shelf of Arctic Russia all seem promising. One reflection of this is the significant amount of sea transportation in the Arctic Ocean and the adjacent seas in the summer navigation season. This in turns leads to questions regarding marine safety and regulation and pollution of the Arctic basin. Arctic navigation has been facilitated by satellite monitoring of both sea ice and weather conditions so that ships can now travel with more knowledge of conditions than ever before. In addition, there is the scientifically at least accepted view that the summer ice pack in the Arctic will recede as it did in 2007 making sea transportation far more feasible.

Time is also running out for the circumpolar nations to establish their claims to the continental shelves off their coasts under the Law of the Sea. The only country not participating in this effort is the United States, which has not ratified this international agreement. So far, it has been impossible to get two thirds of the U.S. Senate to agree on ratification as required under the United States Constitution. Older boundary issues, which in the past were quietly ignored, are now being taken more seriously. The Barents Sea boundary between the Russian Federation and Norway has been resolved, but the others, for example those between Greenland and Canada and the United States and both Canada and Russia,[18] have not been. Both Canada and Russia claim the sector principle that is that they own the Arctic from their eastern and westernmost points all the way to the North Pole, which others including the United States do not accept. Canada has long argued that the Northwest Passage is an internal waterway, while the United States claims instead that it is an international waterway. None of these is a new issue, but under the influence of climatic warming and economic potentials they have acquired a certain urgency. Finally, and hardly to be ignored, are the interests of the indigenous

[18]Under the Treaty of Cession of 1867, Russia and the United States agreed on the boundary separating the two countries in the Bering and Chukchi Seas, but neither has been able to agree on what that boundary is specifically and instead use the two hundred mile economic limit. This left a large area in the middle of the Bering Sea, known as the Donut Hole, as international waters free of supervision regarding fishing. A treaty is this regard was negotiated between Russia and the U.S. in 1994.

peoples often combined with those of environmental movements. Basically they are both vitally concerned with the potential impacts of increased shipping and mineral exploitation on Arctic ecosystems, and in this they have the support of tourism promoters. In short, the Arctic World, rather than being an isolated, strange and remote region is today a center of global concern. As, however, has always been the case, it is the centers of economic and political power outside of the Arctic World which have the greatest impact. One can think of this world as being at the end of a diffusion chain for ideas developed elsewhere, but these are usually modified as they proceed into the North. Due to vast improvements in transportation and communications, however, the speed of diffusion has increased. In mineral and energy development and in fisheries numerous countries and such international companies as British Petroleum play a major role. China, for example, is involved in resource development in Siberia, Japan in the Bering Sea fisheries, and Canadian companies own major mines in Alaska.

Serious concerns have been raised about environmental pollution in the rivers and seas of the Arctic. This has been of special attention in the Barents Sea and Novaya Zemlya, which the Russians for decades used for nuclear weapons testing and disposal of scrapped nuclear submarines. There should also be concern over the wastes produced upstream on the major Siberian Rivers in major manufacturing centers and cities. In addition, the upper Vilyuy River, a major tributary of the Lena, is believed to have nuclear wastes from underground nuclear explosions. Of equal importance is the importation of pollutants in the ocean currents and air masses entering the Arctic Ocean including the phenomenon known as Arctic haze, air pollution caused by the Russian Arctic smelters. Some argue that the Arctic Ocean and surrounding seas simply cannot absorb pollution very well so that future development could prove very harmful. This would include the pollution caused by shipping and increasing air traffic in the upper troposphere of the Arctic. These are all issues that have been of major national political concern and, for instance, have delayed (or perhaps cancelled) oil exploration and development in the Chukchi Sea and have prevented oil development in Arctic Alaska's National Petroleum Reserve and the Arctic National Wildlife Refuge.

From a human's perspective, each part of the Arctic World shares some common attributes in spite of the reality that they are divided into different nations, political units, and diverse cultures and languages. One is that there are people who want to live in this region, and another is that the region is a recipient of ideas, values and enormous pressures from the external world and indeed the globe. Some of these ideas are resisted, others fail due to the physical environment, but most are modified often after sometimes bitter political controversy. The Arctic World can from a human viewpoint be divided into two perceptual categories. The most important is that held by people residing in densely populated temperate climates who see in the Arctic World resources, which they want and need, and also an environment they wish to protect and enjoy under safe circumstances. Of increasing significance, however, is the attitude of the peoples who live in the Arctic Ocean basin and surrounding seas and lands who wish for prosperity tempered with close connections to what we in Alaska term "the Outside" and the preservation of traditional

ways of life, by which is meant maintaining fishing, hunting and gathering for personal use, and on the part of indigenous peoples the enhancement of their cultural values as well as plentiful opportunities for simply enjoying the out of doors. The voices of the peoples of the Arctic World are being heard in the corridors of power today far more than in the past, and the time when they could simply be shoved aside and ignored are long gone. This is as true for those who are immigrants as for those who are indigenous.

Conclusion

As a concluding thought, permit me to express a personal viewpoint.[19] While impossible to prove, the permanent resident peoples of this Arctic World seem in large part and in spite of cultural and language differences to share similar values and behavior. We just seem usually to relate well to one another and somehow or other feel that those coming from the more settled parts of the world are just different in some way. Perhaps there truly is a magic in living in the lands under the Great Bear, Arktikos, the Big Dipper, the North Star and seeing in much of the Arctic World the glories of the Auroras, delighting in the wonderful long summer days, enjoying snow activities and the winter social whirl, and knowing that wherever you go you will find friends who really do not care about your past, your religion, your economic or social status, or your skin color, or even how you dress or what language you speak, but rather instead care only about what kind of a person you really are.

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[19]Pierre Burton, a famous Canadian writer, has expressed a concept of Northerliness, by which he meant that people in the North were special. Siberians and Alaskans have often made the same claim. This author's view is based on living in Alaska for more than forty years and on meeting people from other parts of the north. There are those who would disagree strongly with this opinion.

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Part II
Development Potential of Mountain Regions and Globalization

Mountains are important ecosystems, and the lives of billions of people depend directly or indirectly upon them across the world. However, all mountain regions are facing the challenges of economic development, policy formulation and democratization in our so-called era of globalization, to say nothing of the numerous problems found in the natural environment. Ample research has been dedicated to this topic (see, e.g. Borsdorf et al. 2010). In spite of the steps taken to eradicate the problems confronted by the marginal mountain people through various planning measures in different parts of the world, more effective policies are required to eliminate the conditions of marginality. Development as a theme has so far been concentrated on the realization of potentials of natural resources to full utilization without covering every sector and aspect of mountain life. In fact, development is a collective action comprising all aspects of life to achieve sound living conditions. Hence, the ideology of mountain development aims at higher value and ethics based on the dual purpose of nature and human well-being. In addition, the changing social and economic scenario is in no way uniform across different mountain regions. Problems such as the suppression of rights, land alienation, non-payment of minimum wages in different employment schemes and restrictions of the right to collect minor forest produce continue to exist in these marginal areas. These disadvantages to large sections of the global society should have been abolished long ago. However, the Millennium Development Goals (which cover a number of these aspects) have only partially been achieved (UN 2015), and mountain societies are not in a position to compete with the efforts and investment made.

The second part of this book is therefore devoted to the significance of mountains, looking at their development and potential. By definition, a mountain has certain altitude (both absolute and relative to its surroundings), steep slopes and a rugged terrain. They can be found in all eco-regions of the world. The chapters in this part of the book therefore cover a range of mountain types from low and medium mountain regions in Central Europe and Malaysia to the various high mountain ranges in South America and Asia.

Debarbieux and Price discuss the concept of mountain regions as a global common good. Their specific argument to declare mountain as a common good is based on the growing interest in mountain regions in recent decades: the ongoing rush for water and raw materials such as minerals and timber; the growing will of states to control resources, border regions and cultural minorities in the peripheral mountains of their territories; and the rise of a global concern and of global institutions for mountain governance. Indeed, the idea of mountains as a global common good has emerged from the concurrent evolution of a globalized scientific knowledge and networks and rhetoric focusing on this scale. This global attention paid to mountains has been supported and advanced in view of the vital importance of mountains to the global population. The authors conclude that the natural and cultural diversity of mountain areas should be treated as an asset of great value at the global level and that the consequences of climate change and economic or cultural globalization in these areas should be assessed and, where possible, reduced.

Mountains are often used for political boundaries, as Matuskova and Rousova show. Their contribution has to be seen in the context of political–military events of twentieth century in Europe. The Iron Curtain contributed significantly to the process of marginalization in the immediate border zones, in this case covering the three countries of the Czech Republic, Austria and Germany. The roles and perspectives of this area (and of others) were particularly affected by the geopolitical changes immediately after World War II and again around 1990. The collapse of the bipolar system of international relations meant a significant change for the entire Central European space and also within borderlands, in this case the Euro-region Šumava-Bayerischer Wald–Mühlviertel. This geopolitical shift has led to significant and evolving processes of demarginalization and integration in the last twenty years, demonstrating the variable functions of the state border. The effects of globalization became visible in this area after the collapse of the Iron Curtain in 1989 when the major barrier for local development was removed. A new integration process started to affect the region after the accession of the Czech Republic into the EU in 2004 and the Schengen area in 2007. The authors conclude that the guiding perspective of the Euro-region is its integration into a larger economic and political entity that can better solve a number of specific problems and will have greater political and economic power within Central Europe. This allows us to view globalization not just in economic terms but also as a multifaceted process with power relations, the frequent lack of representation and freedom and incipient counter movements.

Borsdorf discusses water resources with particular reference to their hydropower potential, its role in marginality studies and sustainable regional development. The chapter is based on a comparative case study of Tyrol (Austria) and Aisén (Chile), representing two major mountain systems, namely the Alps and the Andes. He analyses how hydropower installations may reduce marginality and slow down the population exodus from remote mountain regions and serve to initiate sustainable

regional development processes. Thus, hydropower enhancement can give new impulses to and reduce the danger of marginality in mountain regions.

The perceived 'holiness' of mountains was often regarded as a form of protection against human encroachment, but in Shektar Pathak's opinion, they have increasingly become victims of human activities. He makes an attempt to understand the ecological, social, economic, cultural, spiritual and geopolitical importance and centrality of the Himalaya through its geography, culture, resources and protests. He addresses the negative impacts of globalization. According to Pathak's argument, the highest and most sacred mountain range on earth has been hijacked by the forces of privatization and globalization, using the state apparatus under the incomplete model of development created by our political economy. The biggest challenge for mountain communities is to maintain their dignity and self-respect, as well as the right to live in their territories. The author remarks that unless we are able to develop and foster this sensibility, any attempt to initiate development will prove fragile and devastating.

Schild highlights the importance of ecosystem services provided by the mountains, in particular the Himalayas. The mountain systems of the world have not always received the attention they deserve, which has increased their marginalization. Mountain systems must be viewed in the frame of climate change and enhanced ecosystem services. He emphasizes and analyses the impacts of global summits and conferences concerning the mountain agenda, the persistent marginalization of mountain systems, climate change and biodiversity issues, the importance of mitigation and adaptation, but also scientific uncertainty and the knowledge gap. He concludes by pointing to the opportunities arising from the Rio +20 process and conference in 2012.

Bosak and Kanthola present the first of a number of Himalayan case studies. They explore the way in which the Bhotias have operated within and across scale and constructed scale in order to adapt to changes brought about by globalization. The authors examine the process of globalization in the Niti Valley of the Garhwal Himalaya in India, arguing that the continuum between global and local is not a one-way road and that the residents of the area must not only react to global events that change local livelihood activities but must also portray their local struggle as one of global importance in order to combat marginalization. This chapter presents a unique example of a marginal region that relied on international trade on a regional scale well before the present form of global economy took shape and came to dominate the whole world. Prior to 1962, the Bhotia people of the Niti Valley (Uttaranchal, India) were primarily transhumance pastoralists who engaged in the trade of goods from the Tibetan Plateau to the Ganges Plain. This changed in 1962 when India went to war with China over a border dispute and the border between the two countries was closed; as a consequence, the Bhotia could no longer trade with Tibet and standards of living dropped. Such rapid changes in livelihoods due to opportunities and constraints provided by globalization have led to boom and bust cycles for local people. 1962 started a bust cycle when trade with Tibet was cut off. The opening of the Nanda Devi to foreign expeditions in 1974 produced a

boom cycle, followed by a bust cycle after the closure of this activity. Finally, the collection of Cordyceps is currently producing a boom cycle, but people are already anticipating the bust cycle that will follow and are safeguarding themselves and their families up by investing in their children's education and in alternative livelihoods, both of which have unintended consequences that are discussed in the chapter. These boom and bust cycles indicate that the Bhotia have had few opportunities to interact with/influence the global scale and are instead reacting to the forces of globalization that are acting upon them.

T.S. Papola (†) deals with natural and man-made factors that combine to marginalize areas inhabited by tribal and ethnic communities. The focus is on the impacts of globalization on Indian Himalayan states. Their geopolitical marginality is exacerbated by the isolation due to relatively low levels of transport and communication, causing cultural marginalization along with economic retardation. Globalization is described by the author as a secular and equalising process and, as such, is expected to bring marginalized areas and communities into the mainstream of economic and social activities by enabling them to link up with other areas and wider markets through the use of the comparative advantage provided by their special resource endowments. Globalization, in such cases, may lead to the reduction of isolation, but at the same time, may make the local population highly dependent on other areas, both for income and products. The major outcomes of globalization, namely increased external trade and foreign investment, may not have made any significant contribution in these states as they are distant from the centres of the globalization-induced economic growth. Although measures to liberalize border trade with neighbouring countries, especially to the north-east of the region have been taken, no information on the enhancement of trade is available. Nonetheless, it appears that globalization can benefit even these areas which stand on the geographical, political and often cultural margins of a country, provided they are able to identify their comparative and unique advantages, including those which exist for different locations within the state, and utilize them for their growth.

The development of highland regions is also a topic in other Asian countries, such as (peninsular) Malaysia, where the issue is controversial. This point is highlighted by Abdullah's contribution. Controversies over highland development issues emerge particularly because it is perceived to impact negatively on both the environment and the resident population. The public responses to some of these highland developments illustrate how the populations have managed to influence the government to reconsider these projects.

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Chapter 4
Mountain Regions: A Global Common Good?

Bernard Debarbieux and Martin F. Price

What Is "Common" and What Is Global in a "Global Common Good"?

The statement that mountains belong to anyone or to everyone has become so frequent that it seems almost obvious to many people. Yet it can mean different and contradictory things: that private ownership does or should not exist in mountain regions; that local people or landowners cannot decide alone what to do and how to behave; that everyone should take care of mountains; that individuals can climb, hike, dig, collect plants, and so on wherever and however they want without any kind of constraint; or, alternatively, that being everyone's good, only state administrations can decide what to do; or, for those who think that the nationalization of mountains is also a type of specific appropriation, that mountains should be the common good of humanity as a whole.

This diversity of meanings, and the diversity of scale-levels for which such statements are made, should be examined seriously, for they can lead to huge misunderstandings and sharp controversies. A second reason to tackle this question seriously has been the growing interest in mountain regions in recent decades: the on-going rush for water and raw materials such as minerals and timber; the growing will of States to control resources, border regions and cultural minorities in the peripheral mountains of their territories; and the rise of a global concern and of global institutions for mountain governance.

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To clarify the question, the first need is to differentiate the social and political meanings which are beneath such statements, and the juridical dimensions associated with each one. We will limit the discussion to three wide meanings. The first relates to property regimes. When owned by a local community as a whole, land is said to be in common ownership, or "commons" (Ostrom 1990), a phenomenon with long-lasting traditions in mountain regions. Alpine pastures have often been such common properties, either with private or public status. State property is also very important in mountain regions that were more recently colonized—such as in North America, Australia, New Zealand and Russia—and for areas where modern States wanted to appropriate national symbols (such as emblematic peaks) and fragile landscapes and ecosystems, often through expropriation and the creation of national parks and reserves (Debarbieux and Price 2008).

The second meaning of the idea of "commons" relates to rules of use and access to resources which can be independent from the property regime. The concept of a common pool resource has been defined according to this second meaning. Access to such resources is open to anyone but, except when the resource has (almost) no limits (such as for sunlight at the global scale-level), social or institutional rules are required to prevent too many people from threatening the resource. Mountain forests have often been considered in this way (Price 1990).

The third meaning leads to the examination of the collective importance given to something by a society, or collectivity of any size, in a less formal manner, beyond property regimes and rules of use and access—a meaning which diffuses in institutions and collective practices. Many authors refer to the notion of common good in such cases (Vogler 1995; Constantin 2002). One example is biodiversity. According to this third meaning, what would be a global common good? It would be something that is defined as of major importance by humanity as a whole (but can humanity express itself as such?) or by States, global institutions and experts, and for which attitudes should be influenced. According to this, the UNESCO World Heritage list can be seen as an example of global common good (Frey and Pamini 2009), though there is no unanimity about this. Haas (1992) proposed calling such an assemblage of national and international institutions and scientists or experts involved in the shaping of a common idea an "epistemic community," relying on a common framing of a problem, a description of a reality, and a set of initiatives or solutions. This paper suggests that the idea of mountains as a global common good has been promoted by a specific epistemic community, and contested by people who were not willing to share the analysis and priorities defined by this epistemic community. Both the promoters of the epistemic community and some of its opponents are presented below.

The Rise of a Global Concern for Mountains

The key starting point of the rise of a global concern for mountains is the United Nations Conference on Environment and Development (UNCED), or Rio Earth Summit, in 1992 (Messerli 2012). One major document endorsed at this conference

is its plan of action, *Agenda 21*; Chap. 13 of this is entitled "Managing fragile ecosystems: sustainable mountain development" (UNCED 1992). The inclusion of this chapter in *Agenda 21* followed extensive lobbying, particularly by the Government of Switzerland, and was supported, in terms of evidence, by 2 publications: a report on the state of the world's mountains (Stone 1992), and an illustrated brochure made available to UNCED delegates (Mountain Agenda 1992). In his foreword to the former document, the President of the Swiss Confederation, René Felber, stated "perhaps half of humanity depends in some way on mountain resources, such as water, energy, minerals, forests or recreation areas" (Stone 1992, p. xvii). To move towards the implementation of Chap. 13, the Food and Agricultural Organization of the United Nations (FAO) was designated in 1993 as the lead agency, or "Task manager." FAO created a "Mountain coordination unit" for this purpose, and convened an ad hoc Inter-agency Group on Mountains which, despite its name, included not only UN agencies but also other international organizations and nongovernmental organizations (NGOs) (Price 1998).

In 1995, the Global Environment Facility (GEF), which involves 4 UN agencies, the World Bank, and regional development banks, identified mountain ecosystems as the subject of one of its 10 operational programs. In 1998, the UN General Assembly declared that the year 2002 would be the International Year of Mountains (IYM). The motto for the IYM was that "We are all mountain people;" as noted by the Director-General of FAO, "We are all dependent on mountains, connected to them, and affected by them" (Diouf 2002, p. 4). During the IYM, many UN agencies and national governments organized events and publications which highlighted various aspects of the importance of mountains to people at all scale levels. In the same year, at the World Summit on Sustainable Development (WSSD), an International Partnership for Sustainable Development in Mountain Regions (Mountain Partnership) was established to facilitate coordination and cooperation between concerned States and organizations. Notably, the UN General Assembly has continued its attention to mountain issues, requesting reports and passing 6 resolutions on sustainable mountain development between 2004 and 2014. Thus, for 20 years, there has been an impressive coordination of various initiatives at the intergovernmental scale for promoting mountains as a major issue of global politics.

This global attention to mountains has been supported and advanced in three particular ways. First, in books (e.g., Stone 1992; Messerli and Ives 1997; Price et al. 2004) and reports (e.g., Blyth et al. 2002; United Nations General Assembly 2005, 2007, 2009) which have presented a wide range of arguments as to the vital importance of mountains to the global population. Second, though the establishment of global networks which foster either sustainable mountain development, e.g., the Mountain Forum (MF), or the coordination of associated scientific research, e.g., the Mountain Research Initiative (MRI). Third, advances in remote sensing and geographical information technologies have permitted an evaluation of the quantitative importance of mountains as defined by height and slope criteria and then in terms of human population. In particular, Kapos et al. (2000) estimated that 24 % of the Earth's land surface is covered by mountains; building on this analysis,

Meybeck et al. (2001), working with relatively coarse spatial data, estimated that 26 % of the global population lived in and immediately adjacent to mountains, and Huddleston et al. (2003), working with finer-resolution data, found that 12 % of the global population lived in mountain areas.

Thus, the rise of a global concern for mountains can be seen though several global initiatives and many sources providing views (maps, syntheses, data, descriptions, etc.) on mountains at the global scale level. However, this is not a sufficient basis for an argument that mountains as a whole should be a global common good. For this, we need to identify discourses which can express the common conviction of the stakeholders, their ways of explaining the importance of mountains for the global ecosystem and for humanity, and to evaluate their relevance in the current context.

Biodiversity, Ecosystem Services and Climate Change: Mountains Through the Lens of Global Problems

One process through which the importance of mountains has been recognized at the global level derives from the proposition that they constitute a key component of the global ecosystem. The first sentence of Chap. 13 specifies their importance as a source of water and biological diversity (and also energy), and its second "programme area" highlights the need for integrated watershed management. During the 1990s and early 2000s, the key role of mountains as "water towers" was reiterated (e.g., Viviroli and Weingartner 2004). Equally, the Conference of Parties (COP) to the Convention on Biological Diversity (CBD), also signed at UNCED, recognized the need for projects to conserve and sustainably use mountain biodiversity in decisions at many of its meetings, and established a program of work on mountain biodiversity at its seventh meeting in 2004. Similarly, recognition of the particularly high biodiversity of mountains at the global scale led to the establishment of the Global Mountain Biodiversity Assessment (GMBA) in 2000 and to global assessments of mountain biodiversity (e.g., Körner and Spehn 2002).

Over the same period, increasing attention to ecosystem services led to the Millennium Ecosystem Assessment. One of the 10 chapters on specific systems in its "state and trends assessment" specifically considers mountain systems (Körner and Ohsawa 2005). This explicitly links the provision of water from mountains with their rich biodiversity.

Chapter 13 of *Agenda 21* states that "Mountains are the areas most sensitive to all climatic changes in the atmosphere" (UNCED 1992). Similarly, the UN Framework Convention on Climate Change (United Nations 1992), also signed at UNCED, states that "developing countries with fragile mountainous ecosystems are particularly vulnerable to the adverse effects of climate change." Given this concern, the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) devoted a chapter to the impacts of climate change on mountain

regions (Beniston and Fox 1995) and, in 2004, the CBD programme of work on mountain biodiversity recognized climate change as one of four key challenges to mountain ecosystems and species. There has also been considerable attention to the impacts of climate change on human systems, particularly in the context of changes in water supplies due to the melting of glaciers and changes in precipitation patterns; likely increases in the frequencies of extreme events; and the uphill spread of diseases affecting people, crops, animals and trees (e.g., Price 2008). Thus, climate change is increasingly seen as a challenge relating to all of the issues outlined in this and the preceding paragraphs (e.g., Kohler and Maselli 2009), with implications for most, if not all, of the world's population.

In summary, the arguments for calling global attention to mountains in global conferences and initiatives has related particularly to 2 phenomena:

1. A growing focus on biodiversity, water resources, and climate change within a global consciousness about the Earth's features and resources;
2. A considerable volume of publications, produced by growing and globalized networks of scientists and experts.

Indeed, the idea of mountains as a global common good has emerged from the concurrent evolution of a globalized scientific knowledge and networks and rhetoric focusing on this scale-level.

Mountain Populations: Whose Common Good?

As noted above, Huddleston et al. (2003) estimated that 12 % of humankind live in mountain areas. Beyond the recognition that this is a significant proportion of humankind, arguments related to the importance of mountain people have followed two main lines.

A first is that mountain people are particularly disadvantaged, especially in relation to food and water security, income and health and particularly in developing countries. For instance, Huddleston et al. (2003) estimated that about 50 % of the rural mountain population in developing or transition countries were vulnerable to food insecurity. Mountain people in countries with a high proportion of mountains that are poor in economic terms tend to have relatively higher levels of undernourishment, lower access to water sources, and lower levels of women in wage employment in the non-agricultural sector (Wymann von Dach et al. 2006). However, the economic conditions of people living in mountains are highly heterogeneous (e.g., Ives 1997); some mountain people, such as those living in touristic regions of industrialized nations, have high incomes and high standards of living, even in comparison to adjacent lowland populations. This is of great importance, showing a key limitation of any general statement on mountains from a human point of view. When adopting a global scale-level for observation and analysis and promoting a mountain focus on global issues, there is a high risk of making generalizations about mountain people, as empirical knowledge proves how

diverse are their conditions of existence, and that reliable and disaggregated statistical data are lacking, even in data-rich parts of the world such as Europe (e.g., European Environment Agency 2010).

A second argument is that mountains are centers of cultural, religious, and ethnic diversity (see also the chapter by Pathak in this volume). The regions of the world with the greatest diversity of language and religion (e.g., the Caucasus, the eastern Himalaya, and Papua) are said to be mainly located in mountain regions. Scientists have adopted three main different points of view in analyzing this diversity. A first group has focused on the sacred significance of mountains (Bernbaum 1997), promoting the idea that specific landscapes and senses of place induce specific religious beliefs and experiences. A second group has correlated this cultural diversity with the degree of biodiversity. This ecological approach has been also applied to sacredness itself by those who have focused on understanding relationships between religion and ecosystems (e.g., Verschuuren et al. 2010). A third group has promoted a more political explanation: mountain areas have often been refuges for people who tried to keep their cultural specificity when facing the homogenizing forces of centralized States (e.g., Scott 2009). This cultural diversity of mountain regions has been highly popularized through the media and has become one of the main motivations for a global and mass form of tourism—another major driver for global common goods.

The parallel between cultural diversity and biodiversity in mountain regions, made by the people and institutions who promote mountain regions as a global common good, has led to the idea that mountain regions should be considered as a living and exemplary proof of global diversity, and as a priority for their conservation (Debarbieux and Price 2008; Debarbieux and Rudaz 2010). However, this argument is highly controversial for the following reasons. First, the will of many so-called mountain people to reach modern standards of comfort and conditions of life, sometimes at the expense of their cultural traditions, cannot be ignored. Being a living set of beliefs and practices, highly linked to economic conditions, cultural diversity cannot be seen as a material asset liable to be protected by itself. Second, the main expectations of many of these mountain people, though not specific to them, are development and autonomy (Barkin 2012). Promoting the idea of mountains as a global common good can lead to authoritarian and conservationist attitudes which may restrict both expectations. Such a concern has fueled social movements, local or global (such as the World Mountain People Association), whose members are suspicious of any attempt to subordinate the daily condition of mountain people to any exogenous global agenda (e.g., Barkin and Dominy 2000).

Towards Conclusions

As discussed above, an epistemic community comprising people, countries, and institutions has promoted the idea that mountains could and should be considered as global common goods, even if this phrase has not been explicitly used as far as we

know. These proponents consider that the natural and cultural diversity of mountain areas should be treated as an asset of great value at the global level, and that the consequences of climate change and economic or cultural globalization in these areas should be assessed and, where possible, reduced.

However, this way of framing mountains and stating the problems related to them is highly controversial for various reasons. Mountains are a very large and heterogeneous category (Debarbieux 2004), and often a sensitive question for States wishing to maintain full sovereignty over their territory. Therefore the level of normativity of initiatives taken at the global or regional scale-levels has remained quite low. In general, the concerned institutions have tried to develop joint initiatives, disseminate knowledge and exchange experiences. Yet, the process remains ambiguous with regard to the question of the rights of mountain people to decide about the future of the places where they live. On one hand, it is said that mountain people should get greater recognition, if not some kind of political autonomy, within national societies—as has already happened in some European States, though not for the reasons presented above; on the other, the trend of framing mountains as natural assets and fragile environments may lead to contradictions between conclusions and recommendations at the local and the regional or global levels.

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Chapter 5
The Impact of Marginalization and Globalization in the Czech-German-Austrian Mountain Borderland in the Former Iron Curtain Area

Alena Matuskova and Magdalena Rousova

Introduction

The Czech Republic is considered a successful transition economy in Central Europe, with a development level close to average European countries. The spatial distribution of the population and economic activity within the country vary from densely populated and developed core areas to sparsely populated peripheral areas. This territorial hierarchy and regional organization is the result of long-term development and gradual building of the state (Hampl et al. 1987; Havlícek and Chromý 2001; Chromý and Jancák 2005), which includes not only natural tendencies but also external factors.

The polarization of space is the result of political, economic, and social changes which have occurred in the Czech Republic. This polarization is most evident in the capital, Prague, as compared with other Czech regions; moreover, there is a steady increase in the differences (divergence) between them. Marginal areas have fallen behind economically, as well as socially, due to these changes. The process of marginalization also existed under socialism; however, it was artificially suppressed in order to balance regional differences. In general, the borderlands are examples of marginal territories, because the state border itself is the major cause of marginalization.

This chapter deals with a marginal territory in the south-western part of the Czech Republic, close to the border of Bavaria, in Germany and Upper Austria—

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more specifically, the Czech part of the Euroregion Šumava-Bayerischer Wald–Mühlviertel, which underwent a unique historical development. The marginality of this territory arises mainly from its location, its natural condition with rugged topography, strict nature protection rules in the area within Šumava National Park, and, finally, geopolitical changes within Europe.

The objective of this study is to capture crucial changes within the mountainous Czech-German-Austrian borderland, using the Euroregion Šumava-Bayerische Wald–Mühlviertel as an example. The transition is related to major geopolitical shifts in the last century, particularly variable border functions within this area, which have led to significant processes of marginalization, integration, and globalization in the last twenty years. The chapter exemplifies the role of mountains as barriers to communication, a topic also found in the contributions by Tolia and by Papola in this volume.

Methodology

From a methodological standpoint, the research specifically used available statistical socioeconomic data from all three of the Euroregion states—i.e. from the statistical offices of the Czech Republic, Germany (Bavaria), and Austria. For statistical purposes, the Euroregion was defined as one contiguous territory, though member municipalities do not actually cover all of the Euroregion area. The selected data had to be comparable, from a methodological perspective, which was rather problematic in the given territory.

Standard geographical methods of analysis were used in this paper, such as appropriate statistical methods for processing statistical materials (particularly socioeconomic data), cartographic methods, field research, and a questionnaire. The survey took place in the Euroregion municipalities monitored in 2010. The results were inferred using analytic-synthetic methods, genetic and causal analysis, and comparison.

Brief Characteristics of the Study Area

A large number of Euroregions have originated on the borders of neighbouring states across Europe. The purpose of these Euroregions is to improve mutual cooperation and living conditions of populations living in neighbouring areas on both sides of border. The Euroregions are geographically located at the borders and are typically known to be areas of lesser interest and importance to governments; therefore, they are peripheral. These Euroregions organize various projects to stimulate the economies that are financially supported by the EU and other sources. Cross-border cooperation significantly contributed to regional cohesion and stability at a time when regional policy was generally weak (Turnock 2002).

The Euroregion Šumava-Bayerische Wald—Mühlviertel is an international association of cities and municipalities. This area includes the mountain and foothill areas of Šumava National Park and southwest Bohemia, part of southern Bavaria, and upper Austria. The main goal of this Euroregion is to recover cooperation in the areas which were intersected by the Iron Curtain for forty years and thus revive century-old cultural relations. The Euroregion was founded in 1993 and its main purpose is to establish cross-border cooperation through natural, economic, social, and cultural conditions.

The Euroregion covers an area of approximately 16,000 km^2, with a population of more than 1.3 million people, and its territory comprises approximately 350 towns and villages (Fig. 5.1) (Euroregion Bayerischer Wald 2011). The Czech part of the Euroregion represents less than a quarter of the territory's total land area and approximately 190,000 of its inhabitants (20 Jahre Euregio 2013). The closest major economic centres within the Euroregion are the cities of Plzeň and České Budějovice, in the Czech Republic; Linz, as an administrative centre of upper Austria; and Nürnberg, Regensburg, and Passau, within Bavaria, Germany.

The core of the Czech portion of the Euroregion is formed by mountains, referred to as "Šumava and Český les", reaching maximum altitudes of about 1500 m above sea level (Fig. 5.2). The mountain range is surrounded by a system of highlands. A minimum altitude of about 300 m above sea level may be found in the German and Austrian portions of the Euroregion, in the Danube River

Fig. 5.1 Location of the Euroregion within Europe. *Source* Euroregion Bayerischer Wald www.euregio-bayern.de/

Fig. 5.2 Geographical map of the Euroregion. *Source* Centre Bavaria Bohemia www.bbkult.net

valley (Centre Bavaria Bohemia 2011). The local economic potential is limited, due to the presence of the National Park and its surrounding area, as well as the fact that local spring-fed rivers are not suitable for energy use. Similarly, there are no exploitable mineral resources, and the only high-quality renewable material available in this region is wood from the large spruce forest.

The entire Euroregion previously lay on the strongly-guarded Iron Curtain border. There was a prohibited border zone in the Czech portion of the Euroregion for four decades—a belt that was several kilometres wide, from which civilians were explicitly banned or access was heavily restricted. Due to these restrictions, a unique and undisturbed natural environment was preserved in this area. The highest portions of the Euroregion are still protected within the Šumava National Park, which was established in 1991. Economic activity in this territory is forbidden.

Historical Geography of Czech-Bavarian-Austrian Borderland

According to Chromý (2004), the main determinants of borderland development were primarily its geographical and geo-economic location, location in relation to important centres of development, location in relation to historical development

axes, physical conditions, degree of barriers and limitations, and neighbours throughout Czech history. The Czech-Bavarian, as well as the Czech-Austrian borderland are unique areas where most of these determinants were combined; thus, this borderland area was considered an external periphery of the state or Central European periphery (Chromý 2004). From a spatio-temporal perspective, the borderland may be assessed in a wide context of changes in the geopolitical orientation of the Czech Republic, which reflect integration and disintegration processes within Europe.

As mentioned earlier, the Euroregion is divided by the state lines between the Czech Republic, Germany, and Austria. In addition, the state border is also a linguistic boundary (between Slavonic and German populations), which may also be a barrier, to some extent. The border has always been permeable since it was first established; however, Word War II (WWII) and related subsequent events led to the closure of the border for a long time. Therefore, the German-speaking inhabitants, who had been living in Czech territory for several centuries, were moved out of the Czech borderland (i.e. the future Euroregion) at the end of the war. Similar transfers of German populations took place in other European countries. The Czech borderland faced problems as a result of this displacement, and only now are these problems beginning to diminish.

Within the framework of ensuing geo-political integration, Czechoslovakia became part of the so-called Eastern Bloc in the second half of the 20th century, established as socialist countries oriented towards the Soviet Union. The Iron Curtain was established directly on the border, comprised of barricades and electric wire fences, and guarded by the army. It divided Europe into Eastern European socialist countries and Western European democratic for forty years (see Fig. 5.3). Thus, former permeable boundaries became impermeable barriers. The economic development on both sides of the border differed radically. The Czech borderland thus recorded economic decline and deliberately-restricted development of the area during this period.

During the communist regime, several waves of resettlement were conducted in the Euroregion's Czech borderland, which was almost completely depopulated after the transfer of Germans. The government attempted to support the population by managed migration, the promotion of individual housing construction, as well as the reparation of buildings (which had been seized by their former inhabitants), and, moreover, by the proclaimed support of underdeveloped social and technical infrastructure. Despite all of this, most areas within the so-called Sudetenland did not reach their pre-war population level until now. The new populations had difficulties getting used to a different way of life and often failed to manage agricultural conditions in the foothills. Moreover, due to supply problems and housing difficulties, many people decided to move away.

The pre-war industry, to the extent that it had previously existed, was restored only in some places. New industrial plants were built in other parts of the country, as the area near the Iron Curtain was not considered appropriate. Local inhabitants were primarily employed in agriculture and forestry, though people did not own land, as it was nationalized (as well as factories). As in other parts of the country,

Fig. 5.3 A view of the iron curtain prior to 1989

communist leaders made all of the decisions, and economic development took place according to five-year plans.

Further development of the region was primarily influenced by political events—internal, as well as external. In 1989, the Iron Curtain fell, which meant the emergence of qualitatively new development opportunities for the borderland (Chromý 2004), and the Czech Republic changed its international relations orientation towards the West. The border thus became permeable again after several decades, particularly with regard to the movement of people and goods, as well as capital. Restitution, i.e. returning property into private hands, was extremely important for the area. Foreign direct investment (FDI) started to flow into the Czech Republic; however, the FDI did not (and still does not) target all regions equally and was primarily concentrated in major economic centres. The accession of Czechia into the EU, in 2004, and subsequently into the Schengen area, in 2007, initiated qualitatively different steps for integration of the borderland into the Central European area. Despite the impact of integration, there are still many problems related to its peripheral location within the Euroregion's three countries. At the same time, it is also influenced by an international environment, particularly in Central Europe, and globalization.

Impact of Integration and Globalization in the Euroregion

As is evident from the history of the borderland, the roles and perspectives of this area have been particularly affected by geopolitical changes in the 1980s and 1990s. The collapse of the bipolar system of international relations meant a significant change for the Central European area (Houžvička and Řehák 1999). This area has been mainly influenced by border permeability and the reorientation of the Czech Republic from relationship with the East (i.e. the Soviet Union) to the West (towards Western European countries). The Euroregion could finally start to benefit from its newly-acquired strategic location close to its economically powerful neighbours. The economic inequality, resulting from the proximity of two very different economic environments, was profitable for Germany and Austria, to some extent, as well as the Czech side of the border.

Germany quickly gained significant economic influence in the eastern part of Central Europe. The largest inflow of foreign direct investment into the Czech economy came from Germany. From 1990 to 1998, German investment represented about 28 % of the total FDI (ibid.). However, most of these investments were directed to the central part of the Czech Republic, mainly to Prague and its surrounding, as well as other cities where large industrial zones were created, good access to transportation was provided, and agglomeration effects could be suitably used. Foreign investors (especially from Germany) used, and still use, relatively inexpensive skilled workers from the Czech portion of the Euroregion. Investments flowed into industry and services, primarily manufacturing automotive components, electrotechnics, plastics, and the wood-processing industry. Due to the global economic crisis, some foreign companies had to end their activities in the Czech Republic. However, German investments accelerated the restructuring of the Czech economy and created necessary job positions. The main obstacle to foreign investors was the poor regional transportation network.

The newly enabled bilateral population movement across the border created specific forms of mutual migration. Germans and Austrians used less-expensive Czech services (i.e. healthcare, catering, etc.), while the Czech practice of cross-border commuting and periodic short-term commuting to work in the neighbouring states provided higher salaries. In 1992, approximately 12,000 workers were commuting to work in Germany from the Czech Republic (Vavrejnová 2004). Labour migration has significantly decreased since the initial boom in the early 1990s, primarily due to an increased purchasing power in the Czech Republic and a partial shift of German production to the Czech borderland, as well as the arrival of the global economic crisis. Cross-border commuting of Czechs into Germany and, to a lesser extent, into Austria, helped solve the problems such as unemployment in relation to the economic transformation in the Czech borderland.

The volume of Czech labour in Germany was limited from the beginning, due to a very high unemployment rate in the Bavarian borderland (above the German average). The protection period of the German and Austrian labour markets ended

in May 2011. Despite concerns of German and Austrian authorities and citizens, their labour market was not flooded with Czech workers, although their numbers are slowly rising. For example, as of 30.6.2014, Czech workers represented 0.4 % of the Bavarian labour market. The percentage was higher in border counties, reaching a maximum of 4.9 % in Cham and 4.3 % in Tirschenreuth; most other counties, however, had much lower percentages (Bundesagentur für Arbeit Schwandorf 2014). A similar situation exists in the Austrian borderland labour market.

Bavaria has relaxed working regulations for Czech citizens, actually welcoming them and implementing worker recruitment at job fairs or through employment agencies like Arberland Regio. The Bavarian borderland, as the Czech borderland, is suffering from the departure of young people, an aging work force, and a low birth rate. A revived demand for labour has not been met, thus far, even with some employers offering potential employees accommodation, training, and German-language courses. Whereas employment opportunities in the past were primarily limited to gastronomy, tourism, and some crafts, current employment opportunities are more diverse and available to skilled and educated workers (Petr 2011).

In comparison, Austria feared an inflow of cheap labour from the Czech Republic, toughening its employment regulations (which are complex and difficult for Czech employees to understand) and establishing a minimum wage for foreigners. Czech workers in Austria currently occupy positions whose capacity Austrian workers are not able to fill (i.e. gastronomy, tourism, construction, or healthcare) (Křivánková 2013).

Thanks to a prosperous economy, Czechs have started commuting across the border to shop for quality industrial goods. With the introduction of free movement of goods, border areas are now able to offer global products. A special phenomenon on the Czech side of the border is the concentration of Vietnamese tradesmen in large markets close to the border (see Fig. 5.4). These businessmen often use their long-term experience of living in the Czech Republic. In the past, Vietnamese primarily worked in socialist factories, due to the friendly exchange of labour force among socialist states. Most of these people remained in the Czech Republic and started their own businesses after 1989. They found a gap in the Czech market for cheap and short-lived goods, thus providing a large volume of cheap Asian products, mainly from China. Because neither Germany nor Austria allows this kind of business, these Vietnamese goods in the Czech borderland are attractive to customers from these countries.

The presence of the Vietnamese is just one example of the presence of different groups within the Czech borderland (other examples include Slovaks, Ukrainians, etc.). Thus, it is possible to observe expressions of cultural globalization in the Euroregion, particularly interactions among different cultures (primarily from neighbouring countries). At the same time, worldwide globalization of Anglo-Saxon culture is also evident in the observed area (for example, the presence of global chain fast food restaurants).

Fig. 5.4 View of flourishing Vietnamese markets after 1989

The socialization process in the Euroregion was affected by new media communication and technology, which allowed local people to connect with the rest of the world (i.e. internet connection, various mobile network operators, a broad range of television channels and radio broadcasts, etc.). It is quite common that people living in border areas may watch TV channels from neighbouring countries, thus receiving information about those countries. The existence of signal jammers on both sides of the border during the communist era is a thing of the past. All of these new opportunities emerging in the Euroregion are used only by part of the local population, thus a polarization of the social structure within the population can be observed. Moreover, the population structure is negatively affected by the departure of the younger generation, who cannot find adequate employment in the Euroregion.

At the political level, the entrance of the Czech Republic into the EU and NATO also demonstrates globalization. Despite this fact, there still remains a certain lack of confidence in the inhabitants of neighbouring states in the Euroregion, rooted in the older generation's memory and knowledge of historical relations in the past. The situation is, however, rapidly improving with the development of various joint activities within the Euroregion. Another indicator of political globalization is the declining influence of the individual state on political decisions within the Czech Republic, as well as the increasing impact of the economy on political decisions.

The entry of the Czech Republic into the EU in 2004, and Schengen area in 2007, enabled EU citizens to cross the border at any place, not just at border checkpoints. Results from a survey conducted among the Euroregion's population (approximately 800 people were surveyed) showed that the possibility of freely crossing the border has not significantly changed the lives of local people. The existence of the Šumava National Park's protected area close to the border is a primary obstacle to freely crossing the border, due to the fact that entry into this restricted area is not allowed. Most of the economic activity in this area since 1989 has been concentrated on currently existing border checkpoints and road or railway crossings. Similarly, cross-border cooperation tends to be concentrated primarily on these axes and growth poles. The impact of opening the border progressively decreases the further a municipality lies from the border.

Impact of Marginalization on the Euroregion

Despite new opportunities for growth and progress, the Euroregion still remains underdeveloped, even almost three decades after the collapse of the old regime. The Czech side of the Euroregion has never reached its pre-war population level, whereas the Bavarian side recorded a rapid increase in population after WWII. Thus, the population density on the Czech side is still significantly below the national average (134 persons per sq. km in the Czech Republic; e.g. the district of Český Krumlov has about 30 persons per sq. km). Most of the population is concentrated in several cities some distance from the border, such as Domažlice, Klatovy, Prachatice, Vimperk, and Český Krumlov (Fig. 5.5). These are major population centres in an otherwise sparsely populated area. The lowest population density level (less than 20 persons per sq. km) may be found in the borderland area of Šumava National Park, which is highly protected and restricted. The current low population density in the Euroregion is mainly due to the area being protected, its history (for example, the displacement of German citizens following WWII), several waves of resettlement, repeated emigration from the Czech side, and the intentionally slow development of the area under socialism.

On the German and Austrian sides of the border, the population density is notably higher than in the Czech Republic. Local populations on these two sides of the border were not displaced after WWII and many people moved into these areas afterward; thus local settlement has been continued to develop, without any major changes. Local residents have roots and a sense of belonging in relation to the place their families have lived for generations. In addition to this, state financial support favoured the German and Austrian sides of the border under communism.

Figure 5.6 indicates the natural population growth in the Euroregion, i.e. the average natural increase/decrease of population between 2006 and 2008. The three-year average was chosen to avoid distortions caused by occasional fluctuations within some municipalities with low population; random phenomena are thus minimized and the results of natural population growth within the region are more

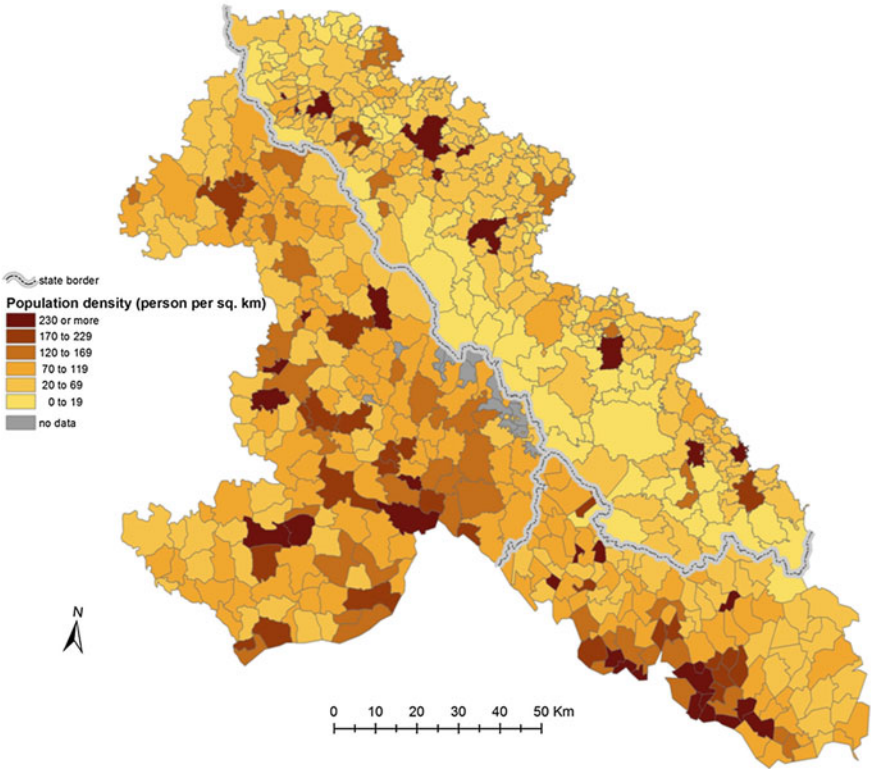

Fig. 5.5 Population density in the Euroregion. *Source* Based on data from Czech, Bavarian, and Austrian statistical offices; processed by T. Orsulak

objective. It is evident that the Czech side of the Euroregion's natural population growth is imbalanced. There are areas with a population increase, such as in southern Bohemia near the České Budějovice agglomeration. In contrast, there are territories, mostly located in the higher altitude area within Šumava National Park, which show a natural population decrease. These extreme differences in natural population growth are unfavourable for local development. Young people tend to migrate to economically prosperous areas while the older population remains, lessening the chances of natural reproduction. In the long-term, only a few of these municipalities will be able to reverse this unfavourable trend and keep, or even attract younger people. These more prosperous communities, such as Modrava, Prášily and Železná Ruda, lie directly on the border, close to border check-points and primary communication routes, connecting them with the neighbouring country. These municipalities usually take advantage of their situation by developing tourism and business opportunities, and promoting their attractive environment.

The Bavarian and Austrian parts of the Euroregion show quite different trends from each other in natural population growth. Most of the municipalities on the

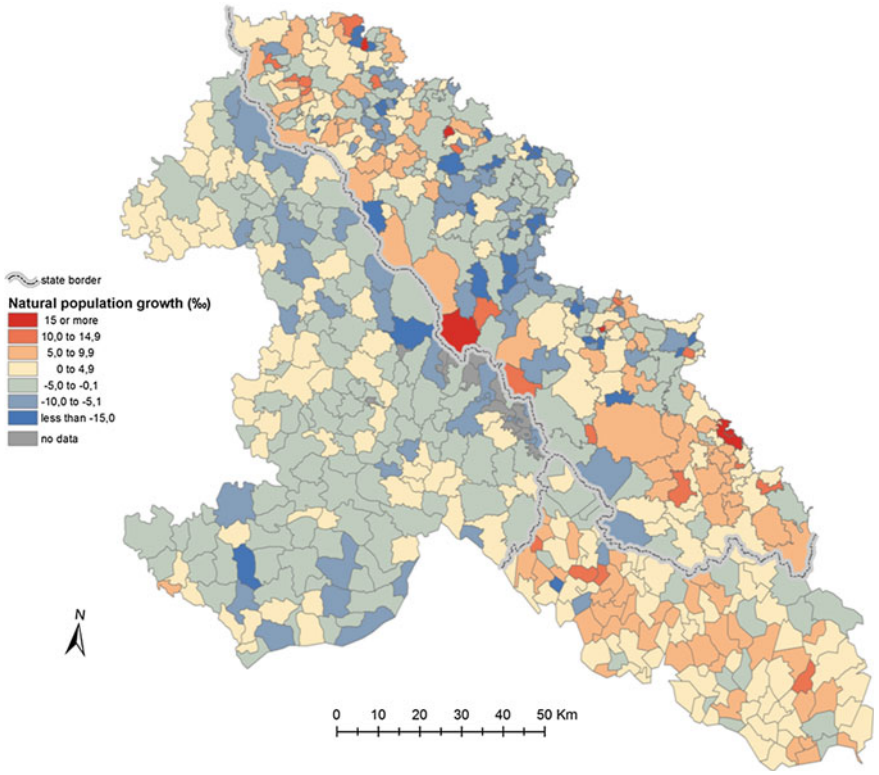

Fig. 5.6 Natural population growth in the Euroregion. *Source* Based on data from Czech, Bavarian, and Austrian Statistical Offices; processed by T. Orsulak

Austrian side have experienced a natural increase, whereas the Bavarian side shows an extreme natural decrease during the same period. Depopulation trends particularly occur within a wide strip of villages along the Czech-Bavarian border. A natural population increase only occurred in a few municipalities further from the border on the Euroregion's Bavarian side.

Corresponding trends may also be observed in the migration growth indicator during the same period (2006–2008). The most inviting areas of the Euroregion's Czech side, such as the southeastern area near Český Krumlov, recorded the highest level of population influx. Surprisingly, certain areas in Šumava National Park also experienced a migratory influx, due to the fact that these areas had good transportation accessibility and were conducive for economic development, particularly tourism. Emigration resulted in a population decrease in the highest area of the central Šumava mountains, as well as in municipalities lying further away from the border.

On the Euroregion's German side, the area is characterized by an increasing number of municipalities, particularly along the border, with increased emigration. It is evident that the Bavarian-Czech borderland is not attractive to Germans, who

often move away seeking better job opportunities and living conditions. The entire Austrian side of the Euroregion is similarly characterized by a decreasing population, due to emigration.

These results indicate that total population growth is mainly influenced by the economy, transportation accessibility, and population structure. The highest population decrease in the Euroregion was recorded in Germany, where serious problems exist with regarding to population stabilization within the borderland area.

Czech borderland demographics are influenced by a number of factors. Some of the positive factors are: the high environmental quality, the connection of the local people to the region, and, more recently, an almost unlimited possibility of business contacts with other stronger economic regions, both within and outside the Czech Republic. In spite of this, there are several negative factors as well, for example, the lack of employment opportunities. Typical employment opportunities in this area are primarily limited to agriculture and forestry, which is not particularly appealing to young people, and the limited number of job opportunities that are not able to satisfy everyone. In the foothills, extensive agriculture is not profitable and intensive agricultural production is prohibited, due to nature protection. A new and progressive sector which is developing is organic farming (i.e. production and the sale of organic food), which is currently quite popular these days, and brings in higher revenue than traditional agriculture. Unfortunately, other agricultural areas are neglected with the border area being characterized by many brownfields.

A mix of traditional and new production sectors, due to FDI, characterizes local industry in the area. Food, paper, and wood-processing industries are still traditional sectors found on the Euroregion's Czech side. Other traditional sectors, however, have ceased to exist in the area, including glass and leather manufacture. Still others, like the textile industry, are experiencing serious difficulties with production. The recent decline in textile manufacturing has been influenced by the influx of competitive cheap textile products, which are being distributed by Vietnamese retailers within the borderland. There are also various industries, primarily located near larger towns near the border, which are connected with foreign investment (for example, engineering and production of plastics for the auto industry).

Foreign capital (primarily from Germany), started flowing into the border region during the 1990s, resulting in the rise of new industrial plants throughout the entire area. However, these were mostly small plants, due to the fact that large investments were directed inland, to important development poles. Foreign investors took advantage of lower production costs and inexpensive labour. Incoming foreign investment structure was characterized by labour-intensive production, usually without the added cost of assembly manufacturing. Nevertheless, the FDI's presence in the Czech borderland is a significant factor in relation local unemployment and the area's overall development. Due to the global economic crisis, some foreign investors decided to close their factories and leave the area. Due to Europe's economic resurgence, foreign investment in the border region has increased and been restructured, already having a high added value.

In the past twenty years, there has been a marked increase in services on the Czech side of the Euroregion, an economic sector which was previously undersized,

due to the region's history. The opportunity to run businesses (which was not possible prior to 1989) attracted a new labour force connected to tourism (i.e. hotels and restaurants, wellness centres, and retailing), which was primarily concentrated along the main communication routes.

Currently, the most progressive economic sector in the Czech borderland is tourism; however, not every place has suitable conditions for tourist development. Recently, the emergence of summer and winter sports facilities may be observed in the Czech borderland near the Lipno Dam or in the Železná Ruda area. Beside these nature attractions, there are also world heritage sites, the most unique in the Czech Republic being the city of Český Krumlov, which is registered on the UNESCO list of World Heritage Sites.

Expansion in the area of services has been significantly influenced by the frequent arrival of wealthy German and Austrian clients. Unfortunately, this has also produced certain negative socially pathological phenomena, such as an increasing number of nightclubs and casinos, and the spread of prostitution criminality, and drug production and distribution (Fig. 5.7). Not all of these businesses are legal and most of these problems remain to this day.

Some remote areas in the Czech borderland have not developed at all, primarily due to low population density, causing most schools to close, as well as local shops which cannot compete with supermarkets located in nearby towns. Supplying small municipalities in these areas is simply not profitable. Many remote areas do not have such civic amenities as education and health services and the local population

Fig. 5.7 Casino in the Czech-Bavarian borderland

has to travel to larger centres for these services. This is complicated due to deteriorating public transportation, which is not profitable either. As stated previously, young people do not desire to live in these areas and often emigrate. As a result, the local population of many municipalities is dramatically aging (Fig. 5.8). This index shows that in the Czech-Bavarian-Austrian borderland, which expected rapid development after the border opening and accession to the EU and Schengen, progress occurred only in certain areas with good transportation accessibility (i.e. along main communication routes). As previously mentioned, other locations in the borderland are underdeveloped, due to an aging population.

The Euroregion's German and Austrian sectors resumed their pre-war condition following World War II. In spite of this, there were still significant problems connected with the massive immigration of Sudeten Germans who were deported from Czechoslovakia. Fortunately, both countries recovered quickly. The borderland, near the impermeable frontier with communist Czechoslovakia, was not appealing for local people, both on the Czech and German sides of the border, and the population has continued to decline until today. German and Austrian government support for economic development was available prior to 1989, so that the area could develop,

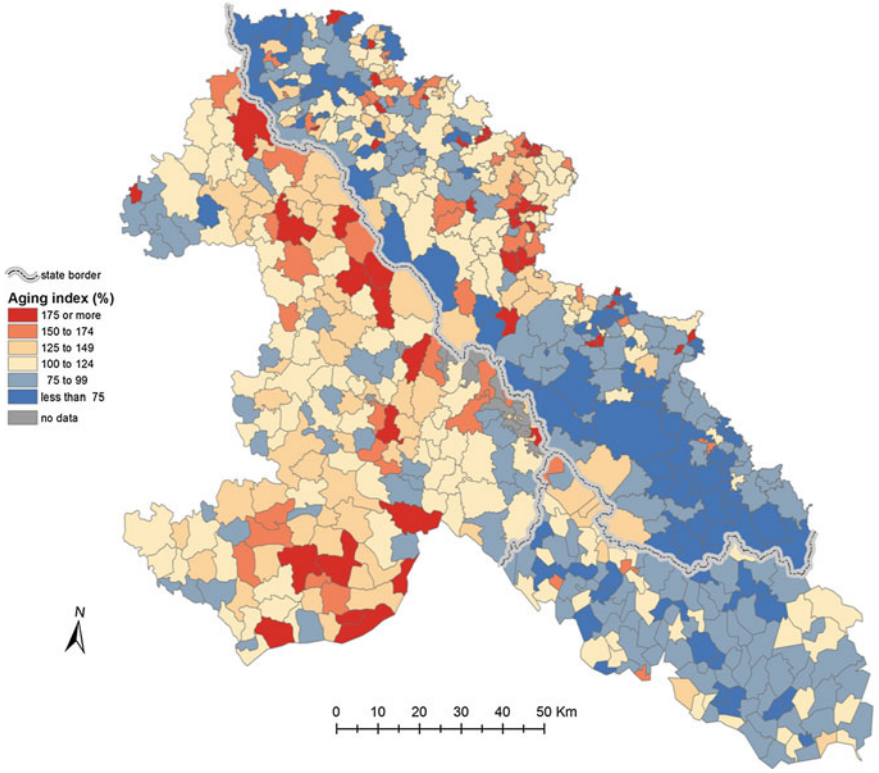

Fig. 5.8 Aging index in the Euroregion. *Source* Based on data from Czech, Bavarian, and Austrian statistical offices; processed by T. Orsulak

despite its difficult conditions. More recently, however, these financial incentives have ceased and, subsequently, living in an area next to a less-economically developed neighbour, and with unfavourable conditions, is no longer attractive. Small businesses providing services and retailers have difficulties because of nearby cheap competition on the other side of the border. An example of this may be seen in Železná Ruda (Czechia) and Bayerisch Eisenstadt (Germany), two neighbouring municipalities separated only by the border. Figures 5.9 and 5.10 show the various demographic developments in these communities during the past twenty years (Český statistický úřad Plzeň 2009; Bayerischer Landesamt für Statistik und Datenverarbeitung München 2009).

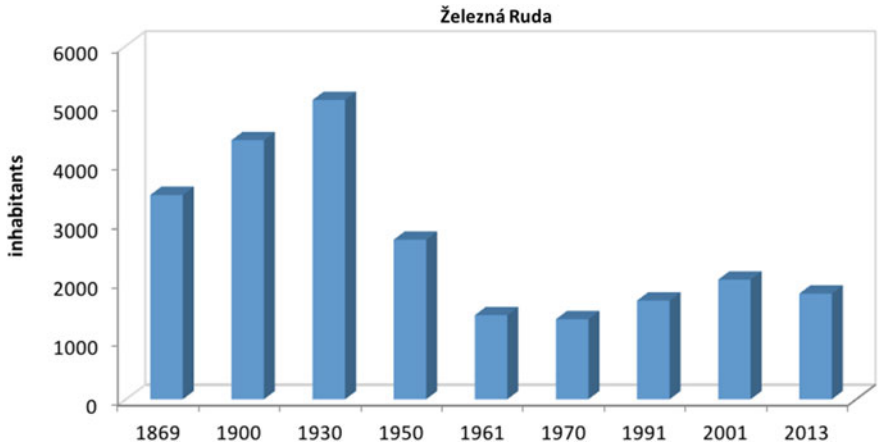

Fig. 5.9 Population growth in Železná Ruda (1869–2013). *Source* Based on data from the Czech Statistical Office

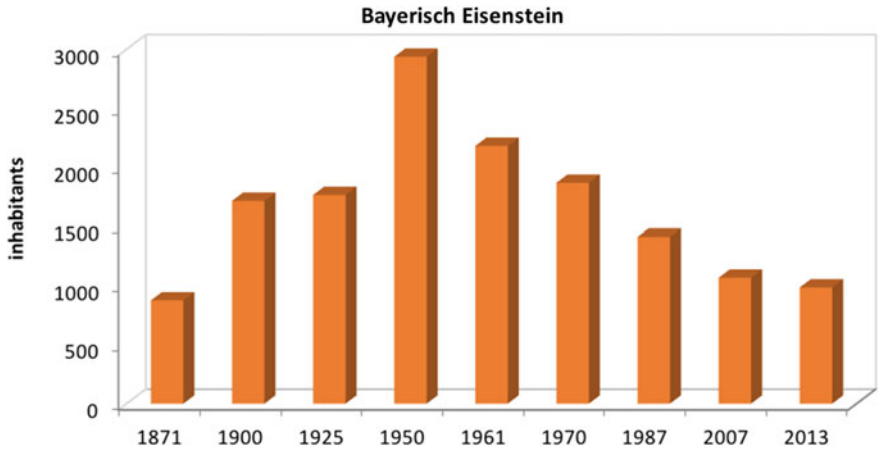

Fig. 5.10 Population growth in Bayerisch Eisenstein (1871–2007). *Source* Based on data from the Bavarian Statistical Office

Current Status and Perspectives

Perspectives on the Euroregion stem from its intrinsic potential, as well as its increasing cooperation with foreign countries. The region has great natural wealth which needs continued protection, not only at the national level (Národní park Šumava, National Park Bayerischer Wald, Natur Park Oberer Bayerisch Wald, etc.), but also at the international level (Natura 2000 area and UNESCO Biosphere Reserve). There is a consensus among all three Euroregion states regarding the need to preserve the valuable mountain area containing remains of glacial activity, primeval growth and other surrounding natural forest, extensive wetlands, and peat bogs. There are numerous valuable and well-preserved habitats in which many endangered species of flora and fauna may be found. In contrast with this consensus, varied approaches by participating states regarding interventions related to the bark beetle may be observed. On the Bavarian side, the development of the bark beetle is left to natural processes, whereas, on the Czech side, the bark beetle is exterminated in various ways, and, on rare occasions, affected trees are felled in the most valuable areas of the national park. A messy situation has existed on the Czech side for a long time regarding the possibility of extending the first zone in Šumava National Park's most protected areas. Long discussions have taken place regarding the possibility of expanding already existing settlements located in the midst of national parkland (i.e. Stožec, Modrava, Kvilda, Prášily). These inhabitants would like to develop their communities further (developing tourism, for example), but they feel constrained by the National Park authorities. In general, it may be argued that the territory's marginalized position is advantageous for protecting and preserving nature and natural values.

The Euroregion's natural surroundings attract thousands of visitors every year. In the summer, recreation includes hiking and visiting cultural and historical heritage sites and, in winter, the local terrain offers a variety of winter sports. Therefore, this region has a considerable development potential, including sports facilities (i.e. skiing and water sports), restaurants, hotels, shopping malls, etc.

The Euroregion is also a connecting point, both for cooperation among inhabitants of the three countries and also for cross-border projects, as well as being a platform for promoting regional interests and regional development. A significant factor in the Euroregion is mutual cooperation with German and Austrian partners, helping to solve problems common to both sides of the border (i.e. improving transportation accessibility and labour force mobility; improving mutual communication and awareness of one another; coordinating emergency services; implementing waste management concepts; creating joint projects related to recreation, tourism, etc.).

The Euroregion focus has changed as a result of the new EU planning period. Attention will now be paid to strengthening research, technological development, and innovation; promoting business investment; and creating synergy among businesses, research and development centres, and universities (Dotace EU 2015). In the mountain region, ecological and social innovation, as well as support of

investment in the area of services is definitely welcomed, while, in the foothills, the focus is on developing investment in product manufacturing, technology transfer in industrial production, and on-going sustainable rural development and agriculture production. Additional priorities in the region include: environmental protection and conservation; development of cultural heritage; effective handling of local resources, including the use of local renewable energy sources; investment in competence and education; and creation of sustainable networks and investment cooperation. The permanent goal of the Euroregion is to build a cross-border transport infrastructure; strengthen population mobility, removing barriers in the labour market; and support the increased knowledge about neighbouring countries, including providing language training (Dotace EU 2015). It is expected that the development of tourism will have a significant impact on the economy.

New perspectives have been emerging related to the possibility of establishing a new Euroregion, called Vltava-Danube. This Euroregion will cover a larger space, with the Šumava-Bayerische Wald-Mühlviertel Euroregion as the core area. The potential enlargement of the current Euroregion would include more strong economic centres with universities and science and innovation centres (i.e. Plzeň, České Budějovice, Linz, Regensburg, Passau). The new Euroregion could potentially create socially, economically, and ecologically balanced living space, with the potential to prosper and help address issues like joint marketing, healthcare provision, trans-European communications planning, management of tourism destinations, as well as a common labour market and cross-border public transportation.

Conclusion

The Šumava-Bayerische Wald—Mühlviertel Euroregion has specific problems related to both its location on the border of three countries and its unique historical development. This area struggles with the consequences of long-term isolation, depopulation, poor infrastructure, unemployment, and low economic development, much of which is essentially the result of strict conservation measures in protected areas and unfavourable natural conditions for agriculture. These specific problems which affect individual localities, particularly in the mountain and foothill areas, are persistent signs of a marginalized territory.

Due to geopolitical changes, the function of the border within the Euroregion has changed, becoming permeable. This change has contributed significantly to the development of the territory, since reducing the negative effects of marginalization usually necessitates cross-border cooperation. This cooperation has been implemented in various sectors of life and at various levels of local government, where local community involvement and cooperation has greatly impacted the way the entire region operates. Significant development trends may currently be seen in the Euroregion's economy and infrastructure.

The Euroregion's perspective (which corresponds with global tendencies) is integrated with a larger economic and political entity, thereby better solving a

number of specific problems and having greater political and economic power, at least within Central Europe.

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Chapter 6
Hydropower Potential, Marginality and Sustainable Regional Development. Examples from Tyrol/Austria and Aisén/Chile

Axel Borsdorf

Introduction

The nuclear disaster in Fukushima, Japan, in 2011 once more demonstrated the vulnerability of nuclear power plants. The event was ranked on the international scale at the highest danger level 7 (NISA 2011). As a consequence large amounts of radioactive material contaminated soil, air, drinking and seawater. More than 100,000 people were evacuated, and even more farm animals were left in the stables and died of hunger. Because of this nuclear hazard all over the world and specifically in Europe and the Andean countries strategies to enhance the exploitation of renewable energy sources were newly discussed and let to concrete measures. In Austria projects of building new or expand existing hydropower plants were initiated. In Chile the catastrophic drought which let to severe consequences in irrigation, drinking water supply and a shortage of electricity let to the reflection how to better use the enormous hydro electrical potential of the Andes.

The search for more and safe energy is stimulated by the expected expansion of electricity consumption. Specifically the advances in mobility technology, using electricity to propel vehicles will lead to a rising demand. Volkswagen is developing the car XL1 that will only consume 0.9 l petrol/100 km, but this means that additional energy must be provided by electricity. In contrast to this scenario in Austria the electricity production was reduced from 62,000 GWh in 2001 to 57,000 GWh in 2011, whereas the consumption rose in the same period to 75,000 GWh and is expected to reach 83,000 GWh in 2015. Today in Austria, 61.5 % of the

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energy is produced by hydropower, 1.8 % by wind, solar and biomass, and 10.7 % by thermal plants (Borsdorf and Pfurtscheller 2009).

For Chile economic projections indicate that by the year 2030 energy consumption will have increased up to 3.3 times at an average annual rate of 5.4 %. However, such an increase of energy consumption entails associated risks. The consequences of climate change in Chile indicate that the up shifting in altitude of the isotherm 0 °C will cause an increase in winter floods of the rivers. As a consequence of this, snow reserves of water will decrease. This situation represents an important challenge for the central area of the country, being the most productive in forestry, farming and livestock sector as well as energy production. Furthermore, pessimistic projections in the oil market and consequently its derivates should also be considered. A gradual decrease in the global supply of petrol is expected to take place, as current reserves go up to 1 billion barrels, enough for approximately another 30 years. Moreover, the steadily increase in consumption will reach 39,420 millions barrels a year by the end of the third decade of this century. This situation will lead to a constant increase in the prices of petrol, which might reach US$210 per barrel by the year 2035 (EIA 2010).

Considering these facts, it is necessary to search for more stable and economic sources to satisfy the energy demands of the country, especially where Chile has comparative advantages. It is precisely here where mountain areas play a fundamental role, as in addition to the existent hydro resources there are potential resources such as solar, aeolian and geothermal energy (see also the chapters by Papola and by Basumajumadar in this volume).

With a factor analysis of regions of similar development in the Alps (Tappeiner et al. 2008), it could be demonstrated that about one quarter of the Alpine Arc belongs to “forgotten rural areas” and “rural retreats”. Marchant and Sánchez (2011) realized a similar factor analysis for the Chilean mountain regions. They demonstrated that most mountain communities are depressed and in a marginal position, too. As the hydropower potential in mountainous regions lies in marginal areas it can be questioned if the exploitation of hydro energy will fight marginality and induce regional sustainability. The rising demand of energy caused by new technologies in mobility, the need to reduce CO_2 emissions and to produce safe, clean and renewable energy is obvious. As climate change and increased water scarcity become more and more critical, the construction of hydro power plants may decrease the mountain exodus in remote areas and the structural weaknesses in marginal regions (Fig. 6.1). Dams not only produce electricity, but also drinking water for the people and irrigation water for agriculture. They have retention function in periods of heavy rainfall, mitigate inundations and complement the retention function of smelting glaciers. In many cases they also provide recreational (swimming, sailing, wind surfing, hiking etc.) and educational functions (visitor centers). Furthermore, by their storage facilities pump storage hydropower plants complement the production of wind and solar energy, which is not produced continuously.

The goals of the European energy policy for 2020 are to save 20 % of energy consumption by more effective engines, installation of cero-energy and improved

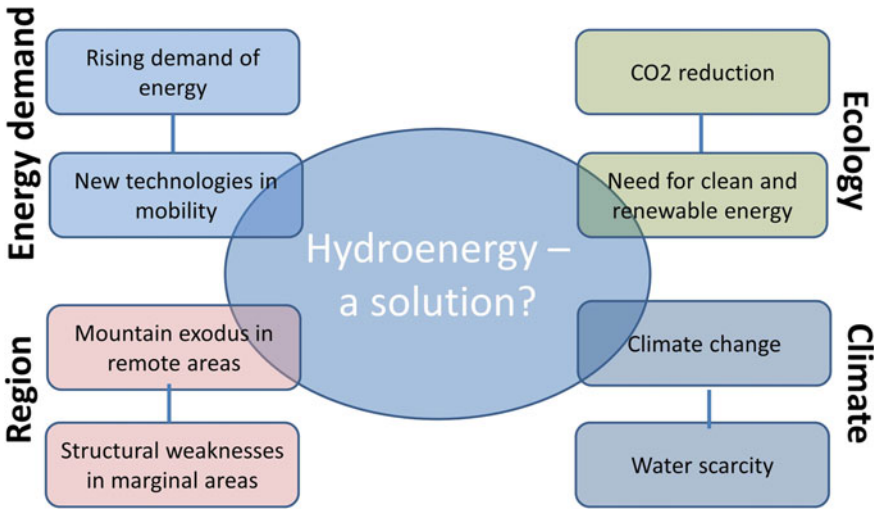

Fig. 6.1 Hydropower—solution for marginal mountain regions?

insulation of existing buildings, to increase the production of renewable energy by 20 % and to reduce the CO_2 emissions by 20 %, according to the Kyoto protocol, signed by Austria on May 31, 2002, and Chile on August 26, 2002. This paper intends to analyze how hydropower installations may reduce marginality and the rural exodus of remote mountain regions and serve to initiate sustainable regional development. It is based on detailed analyses, realized for the Tyrolean Hydropower Company (TIWAG) and on studies in the Chilean Andes (Borsdorf 2010).

The Tyrolean Alps—A Hotspot of Hydropower Energy Production

Tyrol, because of its huge relief energy possesses an enormous potential of hydro energy. It seems to be feasible to even duplicate the installed capacity (Fig. 6.2). Pump storage power plants can use a water drop height of up to 2000 m.

The expansion of the existing hydropower plant in Kühtai/Tyrol will be realized by an investment of 369 million €. During the construction 950 workers will be employed, in the following operating stage 5–20 working places will be created. In winter the dam and reservoir will not be visible, so there will not be any effect on tourism. In summer, however, it may become a tourist attraction. In the neighboring federal state of Salzburg, the hydro power plant is one of the three main tourist attractions of the region, is visited by 500,000 visitors yearly and creates an enormous value for the regional economy besides the value created by electricity

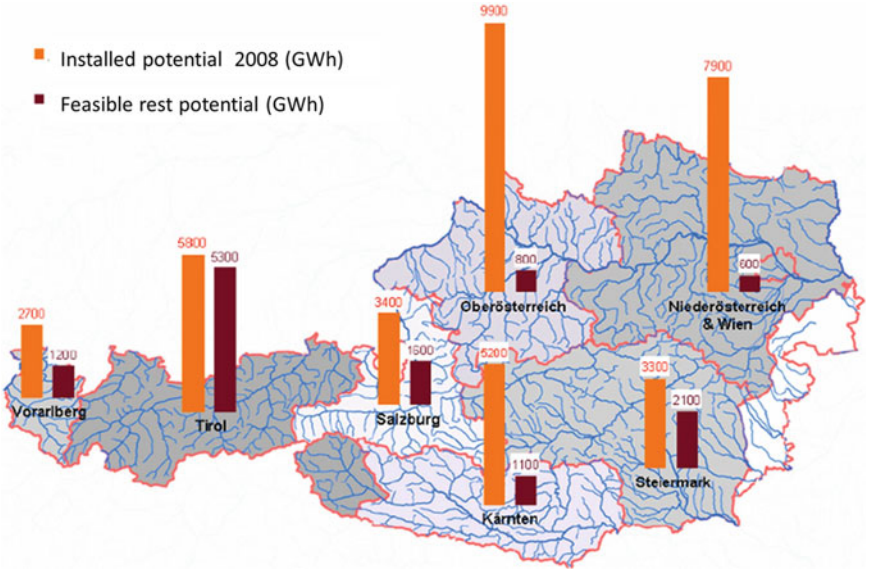

Fig. 6.2 Regional distribution of hydro energy potential in Austria. *Source* Pöyry Energy 2008

production and export. It can be expected that the construction and operation of the plant will duplicate the investments for the benefit of the regional economy.

An inquiry of tourists at Kühtai demonstrated that one third expected positive effects of the new reservoir during the construction phase, 28 % of tourists were neutral, and after construction only 22 % of tourists would see negative effects. A hiking trail around the reservoir, display boards, an educational trail, a visitor center "House of Water", expositions on clean and renewable energy production, guided tours through the power plant, and a program for school classes and other groups will enhance the touristic offer around the power plant.

The Andes—Source of Energy Diversity in Chile

A study conducted by the National Commission of Energy and the National Commission of Irrigation (2007) reports that the hydroelectric potential associated to irrigation systems between the regions of Atacama and Araucanía reaches 866.2 MW, out of which almost 45 % of it is located in mountain areas. For electricity production the exploitation of hydro energy potentials in the North could be doubled, and in the Central South more than tripled. An outstanding potential is found in the southernmost region, where the installed capacity today is only 18 MW, whereas the potential is up to 9609 MW (Table 6.1). The proposed projects for new hydropower plants in this region are demonstrated in Table 6.2.

Table 6.1 Hydropower potential in Chile ower potential in Chile 1957–2007

Zone	Installed capacity (MV)		Total capacity (MV)	Exploited (%)	
	2007	1957		2007	1957
North	27	23.2	259	10.4	9.0
Central	2193	464.9	5806	37.8	8.0
Central South	2500	25.5	10,325	24.4	0.2
Austral	18	0.2	9624	0.2	0.0
Total	**4738**	**513.8**	**26,014**	**18.3**	**2.0**

Sources Rudnick and Mocarquer (2008), United Nations (1960), compilation by the Author

Table 6.2 Proposed dam projects in the extreme South of Chile until 2016

Project	MW	Start date
Baker 1	600	2015
Baker 2	360	2018
Pascua 1	460	2018
Pascua 2.1	770	2014
Pascua 2.2	500	2016
Total	**2750**	

Sources Rudnick and Mocarquer (2008), United Nations (1960), compilation by the Author

In 1957, only 2.0 % of the hydroelectric potential of Chile was exploited (Table 6.1). There are very few new dams constructed in the northern regions (Norte Grande) with their hyper-arid climate, while the capacity was multiplied in the central (Zona Central) and Southern Central (Sur Chico) parts of the country. Given the transmission technology of the time, exploitation of the capacities in the most southern regions of Chile (Sur Grande) was only designed to fulfill the needs of the local and regional population.

It is interesting to compare the estimate of 26,014 MW in Table 6.1 with a calculation made by the UN in 1960 (United Nations 1960: 77), when it was estimated the total capacity of Chile as 20,294.4 MW and the potential of the southern provinces (Aisén and Magallanes) as 9956 MW. Based on the technology available in 1960, the UN estimated that 4900 MW would be exploitable at that time. With the current plans (Table 6.2), Aisén alone could provide 74.6 % of the hydroelectric potential of the Southern regions.

Chilean power companies have been forced to find new energy sources since Argentina began cutting natural gas exports to Chile in 2004. HidroAysén, a joint venture between the Chilean companies Endesa and Colbun SA, proposed a solution of vital importance for the country's future energy supply. The project moved forward at a time when Chile faced an energy crisis and the need to increase its power generation to meet the growing demand, expected to increase by 5 % annually until 2030.

In contrast to this huge potential that exists in Chile, a lot of barriers and structures hinder the exploitation of water. Seasonal availability, the cultural

differences, and the lack of knowledge and the interventions of the irrigation authorities influence an optimal use and distribution of water. However, new reservoirs if run efficiently can help to solve the problems.

On the other hand, a study conducted by the National Commission of Energy about the capacity of wind and solar energy in the north of Chile shows that this region possesses vast areas with appropriate topographic conditions which could allow the development of Aeolic parks with a total (capacity/supply) of thousands of megawatts. Particularly important are highland areas located above 2000 m given that here winds blow at an average speed between 8 and 10 m/s. Regarding the availability of solar resources, the north of the country presents adequate conditions, though somewhat reduced in the coastal region due to morning cloudiness, and in the high plateau areas, mostly in summer. Again, mountain areas are chiefly suitable, for these have the highest averages of radiation, reaching even 8 kWh per m^2 daily. Despite these facts, the technology in charge of supplying aero generators capable of operating in high altitudes is still reduced, nor are cost comparative conversion technologies of solar energy into electricity compared to other energy sources. If wind and solar energy will be more exploited it is necessary to store the power for times of no-production. Pump storage power plants are up-to-now the only effective possibility for this.

Furthermore in Chile droughts are natural phenomena that affect and weaken the water supply. This phenomenon affects the availability and utilization of water and has a strong impact on agriculture, livestock, forestry and energy supply for industrial and residential use, thus leading to large losses for the country's economic activity. It is estimated that in at least 100 out of the last 450 years, there has been some degree of drought (Arrese 2008). In the past 50 years, 12 drought events have been registered. The scale of impact on the economy that these events have is reflected (as far as the drought of 1968–1969 is concerned) in a loss of 65 % of grains and vegetables, as well as of 22,500 jobs related to agricultural activity, reaching a loss of US$1 billion. Subsequently, the event in 1996 cost the country approximately US$93.7 million (Arrese 2008). In most recent events—2007–2008 and 2010–2011—80000 farmers have been affected and the economic impact reached $12 million, which corresponds to the funds intended to support this sector (Meza et al. 2010).

Recently, during the drought of 2010–2011, there has been a decrease in precipitations, with reductions between 25 and 50 % in the Central Core and between 10 and 25 % in the Southern regions (DGA 2011). This was reflected in the water storage capacity in the reservoirs, which during the period from 2010 to March 2011 reached a storage capacity of only 33.6 %.

Under this perspective it is interesting to take a deeper look at the projects which have been planned for the region of Aisén. The study area consists of the Aisén ecosystems from their fluvial or lacustrine origins to the adjacent ocean. This area includes the water system of glacially formed islands and channels that constitutes 95 % of the Chilean coastline. Moreover, it is one of the most complex and pristine hydrological systems on the planet. This vast zone also contains valuable freshwater reserves of global importance. We can distinguish three relevant hydrographic

basins in the region. These have large, Trans-Andean, mixed regime rivers (Baker, Pascua, Vagabundo) and an extensive ice field, the Campo de Hielo Norte (Fig. 6.3).

The existence of the extensive Northern and Southern Ice fields, even today and considering the atmospheric and oceanic circulations patterns of the Southern

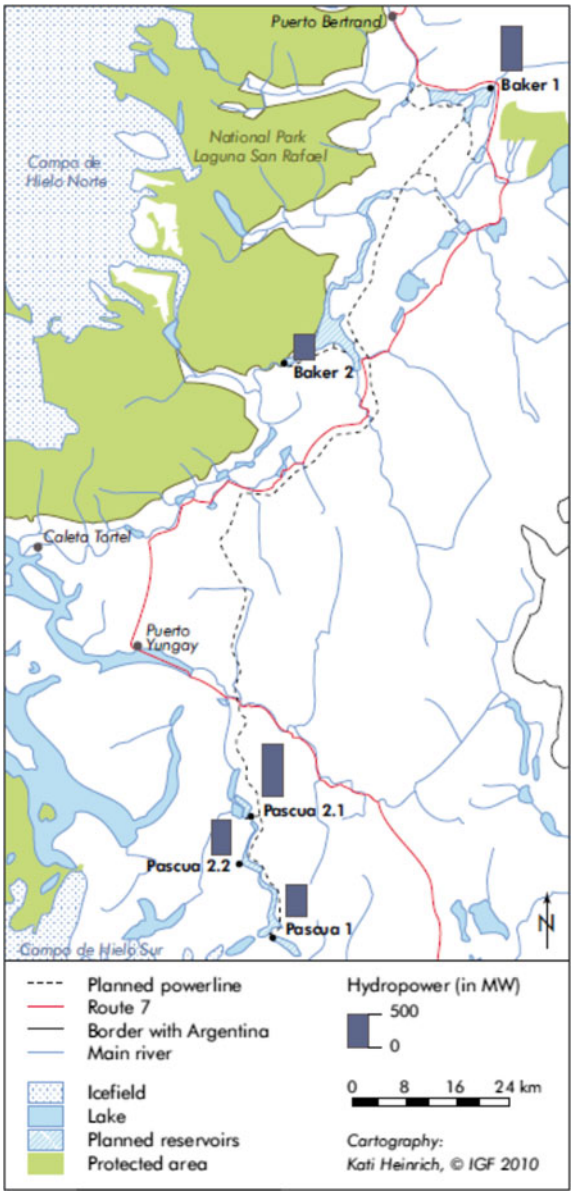

Fig. 6.3 Dam projects and road infrastructure in Aisén. *Source* Borsdorf (2010)

Pacific, is unique in the world at this latitude. Important records of climatic changes in the Holocene associated with the displacement of the Westerlies drift and the circumpolar Antarctic current make this zone highly vulnerable to global climate change, coinciding with the local intensification of human activities.

The hydropower plants in Aisén were planned to be located on the Baker and Pascua rivers. A total of five hydroelectric power plants with a joint installed capacity of 2750 MW were foreseen to be installed by 2022. In addition, the projects involved the construction of a 2000 km transmission line to link the power plants directly with the center of the largest demand, the capital Santiago. An inversion of 4000 million US$ was calculated. The main objective was to increase Chile's production of clean energy, to decrease CO_2 emission and to reduce foreign fuel dependency.

The hydropower produced in Aisén would complement that from rivers that currently feed the main Chilean interconnected electricity system. Another advantage was seen in the abundant availability of water in the Baker and Pascua, located as they are in the Westerlies drift and fed by the Northern Ice field, so that even during periods of extreme drought in the central zone, electricity production in Aisén would not suffer. In the national system the inter-annual variation would be reduced from 21 to 12 % if the Baker and Pascua rivers are added (Borsdorf 2010).

However, the Aisén project has created a lot of controversy, with detractors claiming this is a business that will bury large wooded areas, will appropriate a natural resource, will interfere in tourism, and cause environmental damage (Consejo 2007). The area's valuable environmental heritage is made up of a wide variety of ecosystems and rich aquatic and terrestrial biodiversity. The region was said to contain some of the few places on earth where anthropogenic activities have not left a significant mark on primary natural cycles. A campaign drive by the initiative "Patagonia sin represas" became very powerful and at least succeeded in the unanimous decision of the ministers of Chile, dated on 10-06-2014 to stop the project. This may be seen as a severe setback of the development of hydropower in Chile. However, at the moment 9 new projects with a volume of 541.15 GWh/year (Table 6.3). This is one quarter of the projected production of HidroAysén.

Table 6.3 Capacity of new hydropower projects in Chile

Plant	MW
Neltume	490.00
Pangui	9.00
Río Huasco	0.01
Los Hierros II	5.1
Trilaleo 2	2.24
Collil	5.00
Túnel Melado	3.00
Butamalal	9.00
Pasada Baquedano	17.8
Total	**541.15**

Source Newspaper La Tercera 09-05-2012

Effects of Hydropower to the Regional Economy

On the other hand the hydro energy projects will have a strong impact on the regional economy. In a study developed for TIWAG, the Tyrolean hydropower corporation, on an alpine power plant project at Kühtai (Tyrol), Borsdorf and Pfurtscheller (2009) showed that the benefits of large hydropower plants for the regional and national economy are considerable.

As advantages for the national economy they mentioned an increase in the gross domestic product and a more favorable trade balance through reduced energy dependency on neighboring countries. Currently, Chile depends on Argentina for natural gas. However, since Argentina cannot guarantee that the exported gas stems completely from Argentinian gas fields without any portion of Bolivian origin, Bolivia is fighting its gas war not only with Chile but also with Argentina (Linkohr 2006: 112). This is why Chile has to import expensive liquid gas from Asia and already suffered a severe energy shortage in 2008. The country is thus forced to look for and exploit its own energy resources to become more independent.

In terms of the regional economy, Borsdorf and Pfurtscheller (2009) argued that new hydropower plants contribute to reduce the costs for flood protection, improve the road infrastructure and accessibility, have considerable employment effects, enhance municipal incomes and give impulses to the regional economy through cheaper energy supply. There is also a remarkable rise in the regional economic value added (EVA). Based on an input-output analysis, they proved that the EVA amounted to the equivalent of 4000 new jobs. The multiplier effect of each euro invested is 1.59 in production; 1.61 in income and 1.63 in employment.

In terms of technology, the high efficiency and the long operating life of the installations are major benefits. In addition, such a power plant is able to provide flexibly for daytime and seasonal changes in demand. In environmental terms, Borsdorf and Pfurtscheller (2009) mentioned the reduced dependency on fossil energy sources and the CO_2 emission-free energy production.

Conclusion: Overcoming Marginality by Hydropower Exploitation

Hydropower production in mountains is mostly located in remote areas, which are endangered by demographic losses, economic decline and marginalization. This is even true for highly developed Austria, where climate change (heavy precipitations in summer, snow scarcity in winter) and globalization (global mobility, competition with exotic destinations) effect the tourism industry and lead to economic problems in some Alpine regions. It is absolutely true for Chile, where the traditional mountain communities are threatened by an enormous population exodus and a strong economic decline, also caused by the impact of climate change and globalization. Other regions, like Aisén in Chile, are not yet exploiting their regional

potential in a sufficient way. As the mountains provides water for human consumption and irrigation, the changes in mountain ecology also effect the lowlands and the urban population, suffering by frequent droughts and electricity shortages and even black-outs.

With regard to Chile the hydropower projects in Aisén doubtlessly would have important effects on environment, economy and the social development of this mountain region in the periphery of Chile. However, it can be argued that in terms of sustainability these effects are mainly positive. Only a small percentage of land would have been flooded by the reservoirs, only few farmers had to be evacuated, the impact on biodiversity and habitat is likely to be small and the ecological effects relatively insignificant. On the other hand, the effects on the national and regional economy would have been considerable. Employment and complementary effects on the energy sector, tourism and on regional demand would be lasting. This could even influence the social cohesion and life chances in the region in a positive way.

The development that finally achieves the Aisén project has been a test of maturity for the Chilean society and its economic model. The collapse of the project confronts Chile with immense challenges to secure its energy demand. The state needs a long-term vision that goes far beyond any short-term particular interests or necessities. The benefits or costs that come with the construction of these hydropower plants will go on for several generations of Chileans to come.

However there are several lessons that can be learnt by this example. Chile has a huge potential of hydroelectric energy due to the Andes, but climate change will diminish the water supply. It is certainly wiser to develop pump storage plants instead of river power plants. Furthermore the huge potential of geothermic, solar and wind energy is by far not realized.

Under this perspective it can be stated, that a progress in hydro energy production cannot only diminish the effects of climate change and water supply on the lowland population and agriculture, reduce the dangers indurations, and droughts, provide sufficient electricity for the national economy and even for the export of high-priced top-demand energy to other countries, but also enhance the local, regional and even national economy, not only by the direct effects of energy production (value creation), but also by indirect effects on the tourism industry. Thus hydropower enhancement can give new impulses and reduce the danger of marginality in mountain regions. The electricity production by other renewable energy sources could effectively complement such a policy. Chile counts with an immense potential, which until today is not at all realized.

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Chapter 7
Himalaya: Highest, Holy and Hijacked

Shekhar Pathak

Introduction

The Himalaya, the 'abode of snow', is home not only to an imposing geological, geographical and biological diversity but also to a multitude of flourishing human concerns and constructs, from hunting-gathering communities to agrarian societies and their settled cultures, and also to the economies of modern trade and industry. This mountain system has created and fostered a distinctive ecology that has become the basis for the existence of the natural as well as the cultural systems of South Asia. It simultaneously connects the lush green hills and tropical rainforests of Myanmar, Arunachal and Bhutan with the sparse and cold semi-desert of the Ladakh-Karakoram region, and the great plains of Indus, Ganga and Brahmaputra with the Tibetan plateau. From the east to the west, the Himalaya stands like a sub-continental arc. In so many ways, it is dynamic and active. Its rich soil and water, in spreading abundant fertility and life in the plains below, transform the landscape extraordinarily; its communities and their cultures, which arrived and settled over millennia, have in turn spread out in many directions.

Our existence is deeply connected with the Himalaya. Its geology teaches us about continental drift, the disappearing of the Tethys Sea, or about its own rising height, still ongoing, or yet about its own peculiar nature, which hides within itself a complex dynamism. With its peaks, passes, glaciers, moraines, rivers, confluences, gorges, pastures and meadows, its geography is akin to the myriad faces of nature. Its glaciers and rivers have been called the 'water towers' for the 21st century. Its lofty peaks make a formidable barrier for the monsoons, resulting in heavy rainfall on the windward side. This mountain, indeed, produces and controls the climate of South Asia.

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The expanse of its vegetation and forests is like green lungs that absorb the ever-rising atmospheric carbon. Its flora is the basis for a variety of medicines. Its wilderness has given natural expression and embodiment to a plethora of floral and faunal species, from birds, fish, and butterflies to lichens, orchids and Yarsha Gumba.[1] Its natural beauty and tranquillity has inspired and mesmerized many, including some of the greatest human beings ever lived. The abundance of raw material that it provides is the basis for mining, metallurgical, oil, timber and drug industries. Its wilderness has been a meeting point for natural and spiritual energies, and within a broader cultural context, it is still the main attraction for pilgrims and tourists. The mighty snowy peaks, the grim passes and the forbidding glacial vistas fascinate and beckon the adventurers and explorers.

For these reasons, this mountain region, which is spread across many countries, is being rapidly encroached upon. This very day, the resources of the Himalaya are being exploited. They are being destroyed in many different ways, and at an unsustainable rate, much beyond which they could be naturally regenerated. Hydroelectric projects, mining, pressure on biodiversity, the out-migration of mountain communities and finally the impact of globalization, privatization, consumerism and climate change are serious concerns, with deep implications on the future of the Himalaya; these issues—and their various ramifications—need to be thoroughly and critically investigated.

The highest and most sacred mountain range on the earth has been hijacked by the forces of privatization and globalization using the State apparatus under the incomplete model of development created by our political economy. The biggest challenge for the mountain communities is to maintain their dignity and self-respect, as well as the right to live in their territories. We have not yet been able to develop and foster this sensibility, which can perceive and discern the acute sensitivity of this young and fragile mountain range.

There is a need to understand the fact that if the Himalaya continues in its place, well-protected and cared for, it will also sustain our own lives and cultures. Only then will Himalayan communities live on and so will its birds and animals. Without the Himalaya neither is poetry possible nor can the dialectics of nature be understood. Without it, we will not be able to fathom our own lives. So, if many people today are crying that our existence is possible only if the Himalaya is there and expressing their anger through different forms of resistance, we must realise that this is a moment of reckoning and a chance to right the wrongs. We must take a hard look at the distressing condition of the Himalaya and make a serious attempt to find answers to the questions of its health and harmony.

Here an attempt is being made to understand the ecological, social, economic, cultural, spiritual and geo-political importance and centrality of Himalaya through its geography, culture, resources and protests.

[1]Caterpillar fungus (Cordyceps sinensis) is also known as Keeda Jadi. Finds a number of uses in traditional medicine of China, Tibet, Nepal and India.

The Himalaya: Creation and Creator

Even if we do not pursue the geological tale of the Indian subcontinent's drift from far away Africa towards Asia, and how the eventual collision of the two landmasses led to the formation of the mighty Himalaya around 50 million years ago, let us still broach open the present dialogue by considering the single biggest outcome of that upheaval, the Himalaya, the 'largest physical mass on earth' with a complex geology and geography. This expanse of the Himalaya encompasses countries like Afghanistan, Nepal and Bhutan, parts of Pakistan (Northern Areas), India (Jammu & Kashmir, Himachal, Uttarakhand, Darjeeling Hills, Sikkim, and the north-eastern states) and north-western Myanmar. Large regions of Tibet, today an autonomous province of China, are also part of the Himalayan complex.[2]

Kalidas's '*devatatma*' and 'measuring rod of the earth' and Allama Iqbal's '*Faseele–Kishware–Hindustan*' is indeed the backbone of a living body, rising from the plains to the north, transforming itself into a variety of hills and mountains. These are like the ribs of the Himalaya. Numerous micro-societies and cultures live in thousands of its valleys. These areas are extraordinarily rich in mineral deposits and biodiversity. They are also home to the sources of three large river systems.

While today, the Himalaya is being considered a natural–cultural heritage of all humanity, it has in fact vibrated and pulsated, rhythmically and perpetually, in the conscious as well as the subconscious minds of different Asian societies. This vibrant rhythm is born of the snowy peaks and lofty mountain ranges, which are ever a part of the huge expanse from the northern fringe of Indus-Ganga-Brahmputra plains to the plateau of Tibet.

This vibrant rhythm belongs to thousands of glaciers, to innumerable rocks—from the very weak to the very strong, and to the faults and thrusts that have developed across them (among these, MCT-Main Central Thrust, MBT-Main Boundary Thrust and THF-Trans Himadri Fault are already well known) as well as to the inherent geo-energy (manifest as earthquakes, landslides, volcanoes and thermal springs). It belongs to the lakes, streams, flora and fauna. To the human beings, who are creators and representatives of hundreds of communities, societies and their cultures. A number of religions and faiths have been nurtured here. Himalaya has also been an ideal place for mythological stories and dreams. Before getting bound up in the faiths and beliefs of humans, their political and economic systems, its vibrant rhythm is the expression of a highly dynamic geology, and a geography that still rises as it flows down (Khatri 1987; Gaur 1993; Valdiya 1993; Bhatt 1997).

[2]Many experts opine that the Hindu Kush and Karakoram are also part of Himalaya, and according to some it lies between the rivers Indus and Brahmaputra or between the Mts. Nanga Parvat and Namche Barwa. Then its length is considered as varying between 2070 and 3000 km., breadth between 250 and 400 km, with an overall area of 600,000 sq km., and population of 5 crores (50 million); See Burrard et al. (1907), Wadia (1953), Heim and Gansser (1939), Gansser (1964), Zurick and Pacheco (2006).

The Asian societies share an ancient and deep bond with Himalaya. Various communities have witnessed myriad facets of the Himalayan landscape, cheerful or gloomy, lush green or barren, captivating or terrible. Few realize that Himalaya is not simply a lavish, seasonal retreat for the rich, nor solely a sanctuary for the pilgrim, an arena full of glory for the mountaineer, or the birthplace of mighty rivers, but it's also a region where several cultures and societies thrive in its natural diversity, and where the common humans are concerned about the preservation of their environment and traditions as well as for the betterment of their lives. This 'abode of Gods' belongs to the humans first, and to the Gods later. The humans founded and laid down their beliefs as well as their Gods upon this natural expanse. This is a much ignored fact, due to the mesmerizing, almost hypnotic, beauty of Himalaya.[3]

Majestic and exalted, overarching the mythologies of old and looming over today's geo-political reality, the Himalaya is, nevertheless, young and fragile. The geologists are only now getting to know its inner workings. It is still rising (at the rate of 2 cm/year) and the Indian plate is relentlessly pushing against the Tibetan (or Eurasian) plate. Apart from pushing the Himalaya further up, this process frequently gives rise to earthquakes and landslides.[4]

A number of thrusts and faults criss-cross the Himalaya, the reason behind its restless nature. Himalaya is steeped in a resentment fuelled by the geo-tectonic activity underneath. The colours of the Himalaya, the whites, greens or blues, hardly reveal the inner narrative. Of late, its green exterior has diminished and the scars from numerous landslides and large-scale erosions are visible on its face. The bursting of the glacial lakes, fast-paced melting of the glaciers, deforestation, forest fires, floods, large-scale erosion, the transport and deposition downstream of thousands of tons of sediment/soil, and the flooding and submerging of large parts of the northern plains: all this has become more or less an annual spectacle. This is partly a natural process; the rest is man-made. By itself, this is an expression of the natural processes at work in the Himalaya; our political and economic setup, which has given rise to the indifferent, unrelenting modern civilization, has helped accelerate and multiply the contributing factors.

Nonetheless, the natural beauty and splendour of the Himalaya glows unabated, and the aforementioned processes are not unnatural. Himalaya, as nature itself, is well-versed in the art of self healing and regeneration; its flora, the woods, plant cover and undergrowth, try their best to check the erosion and retain its rich soil cover. The geography of the Himalaya rises up from the northern plains to *tarai–bhabar* to *doon* to Shiwalik–*duar* (*bhabar* of Bhutan), and, progressing tentatively, reaches its lofty pinnacle before descending upon the plateau of Tibet. In the higher

[3]For this see Pathak (2003).

[4]The highest 14 mountains of the world are located in the Himalaya and also the deep gorges of Kali Gandaki, Satluj or Brahmaputra rivers (Zurick and Pacheco 2006, pp. 3–4).

reaches, between the peaks lie those ancient passes,[5] which have for centuries been the sole passages for transport between India and Tibet, and which have seen in their day not only the songs and caravans of nomadic and trading cultures, or the transhumance of pastoral societies, but also the progress of countless pilgrims as they made their way to Tholing, Tirthapuri, Kailas-Mansarovar, Lhasa and other places in Tibet. The routes connecting India with the main Silk Route also passed through here.

The expanse of the rocky terrain was divided up by the rivers into catchment areas, and waters originating from the two sides of a ridge may meet again faraway downstream in the plains. Complex geography, hostile or favourable conditions, gave rise to lifestyles—expressed in the patterns of food and clothing, song and dance—that were bound by necessity and feasibility. The way geology influences geography, and geography informs the food habits, songs, dances and dress of its people can be seen and understood in the Himalaya. This geography often helped create and foster the dignity and honour of those who took shelter here or otherwise lived on here.

The lustre of its vegetation is dependent on form and gradient of the terrain, the composition and spread of the soil, rock and snow cover. These, in turn, temper the form and spirit of the lakes and rivers. As the rivers flow out from the glaciers in the Tethys Himalaya, it is difficult to believe that these are innate, self regulating and self-sufficient natural systems. The terrain here does not allow them to become aggressive. This is the Himalayan River in its infancy. It is here where we can hear a river babble and stammer its way through the first tentative sounds.

Through what the geologists have termed the 'central crystalline zone', the rocky and boulder-hewn terrain counterpoints the river, catapulting it into its youth. The river becomes angry and aggressive. This duel between rock and water can be seen throughout the Himalaya. This is the most challenging age for the river. On occasion, mountains hurtling down rocks and boulders obstruct the river's flow, and try to make a lake out of it. But the river invariably refuses to be tamed. Man calls this anger of the river as 'flood', and the mountains' efforts to check its flow as a 'landslide'. Further down, the rivers gradually settle down into a more regulated rhythm, and meet their tributaries at various confluences (*sangam*). Throughout, they nurture habitable spaces, where humans can settle, till the soil and raise livestock. Human settlements in the Himalaya developed in such places.

In the Plains, we actually see the aged river, tired and enfeebled by the faint memory of her homeland in the mountains. To make it worse, man flushes his industrial and urban wastes into it, and draws out canals from it. Once reverberant and flamboyant in Yamunotri, upon seeing the same river pick its way through the

[5]Pamir, Karakoram, Khardung La, Jauji La, Baralacha, Kunjum La, Sipki La, Mana Pass, Niti Pass, Kingri Bigri La, Untadhura, Lipu Lekh, Tinker La, Nathu La, Jalap La, Dongkya La, Letavasa Pass, Tunga La etc are situated between the two valleys of the Himalaya or between the Himalaya and Tibet. Older trade and pilgrim routes passed through these. Most of the passes are situated on lower ridges of mountains (5000–6500 m) or along the rivers.

backyard of Taj Mahal, it's impossible to believe that this is the same *Kalindi*, which spent her childhood amidst glacial snow and hot springs (during the year 2010, Yamuna did prove itself to be a river, not a mere urban drain). When Sutlej, originating from the north western corner of Rakastal (which also receives surplus waters from Manasarovar) in Tibet, is dammed by humans in Himachal-Punjab, it seems as if they want to enslave the rivers as well. Arising from the western wing of Mt. Gurla Mandhata, the river Karnali (which becomes Ghaghra after its confluence with Mahakali/Sharda, and is known as Saryu in Ayodhya), having been witness to the victory and subsequent defeat of the Dogra army chief Joravar Singh in 19th century Taklakot, and to the destruction of monasteries by the Red Army in the 20th century, has also beheld the demolition of a mosque in Ayodhya in more recent times.

The river Sindhu (Indus), eponym for India, becomes Mehran in Pakistan, and takes the songs of Tibet, Ladakh and the Karakorum to the Arabian Sea. Indus isn't merely the chief of the five rivers of Punjab (the others being Sutlej, Ravi, Chenab and Jhelum), it also drains such tributaries as Nubra, Shyok, Kabul, Chitral and Gilgit. These are the rivers by which must have once stood the first few caravans of those migrant humans, who later formed Indian society. Today, all these rivers lie in two or three countries, and finally flow into the Arabian Sea. The havoc and destruction these rivers caused in Ladakh and Pakistan in 2010 is an indication of their changing temper.

The course of the river Kosi, which flows to India from Tibet–Nepal, has been shifting over the centuries, due to geological and geographical reasons, but equally due to human intervention. It may sound surprising to many that the waters arising from the north eastern and north western glaciers of Chomolangma (Mt. Everest), which is situated in Tibet, and where Mallory and Irvine lie buried since their fatal Everest expedition of 1924, finally merge into the Kosi through the Arun and Bhotkosi rivers.

We even have two rivers that are considered masculine and sonly—Brahmaputra (Sangpo of Tibet) and Rangit. The Brahmputra, which originates from the eastern slopes of Maium La, very close to Lake Mansarovar and Mt. Kailas, flows through Tibet at altitudes between 11,000–10,000 ft. (3300–3000 m) a.s.l., and while it does attain a more disciplined flow in Assam, it has yet to be tamed. It took man thousands of years to bridge the Brahmaputra, but now China and India have already started controversial projects to dam the Brahmaputra or its tributaries. Rangit originates from western Sikkim and disappears into the Teesta, as does Teesta itself into the Brahmaputra.

Of all these Ganga forms the largest river system in the context of India. Even today several Indians would not believe that Shipra, which originates in Kalidas's Ujjain, ultimately reaches Ganga via Yamuna, just as the distant waters from Tibet also meld into Ganga through Karnali and Kosi rivers. Similar relationships exist between Padma or Meghna and Himalaya and Trans-Himalaya. The mythological and epic narratives associated with Ganga exalt her into motherhood. Yet there is a mother in every river. No river can be anything less than a mother and man is adept in exploiting her. In what way have we not already violated Mother

Ganga? It's a miracle that it still flows! Our conscience has become so small that we are searching for sacredness in the river from Gomukh to Uttarkashi only.[6]

Flanking these rivers and all their tributaries, stand the towering peaks, majestic and proud, highly individualistic and self-centred, that transform man into poet, painter, philosopher or mystic. They converse with each other or with humans alike. They lie ever closer to the sky than us. If one poet has called this the 'depth of the Himalaya', the other invites us to behold 'as the sky reaches down to kiss its peaks'. This distinguishes the Himalaya from other mountain systems of the world. This imposing succession of peaks includes all from Nanga Parvat to Chomolangma (Sagarmatha or Everest) to Namche Barwa and many more beyond these as well.[7]

Each peak has several facets and the glaciers that lie sprawling across them give rise to several rivers. These rivers tumble down and flow out into the plains, before finally disappearing into the ocean. In the end, these rivers return back to their birthplaces as monsoon, cloud and snow. Since the very beginning, the clouds have resented their stark inability to bring back the soil and silt that was borne by the rivers to the oceans. The 'Mountains of the future' will indeed arise from the 'Oceans of today'. Every mountain is decidedly a painstaking feat, millions of years in the making.

These mountains are surrounded by unending tracts of natural beauty. This is the 'Himalayan wilderness.' It has a spirit and a visage for each season. It converses with the sun in one way and with the moon and stars in another. There still remain pristine pockets of Himalayan wilderness that are untouched and yet unsullied by human action. There are places of pilgrimages and adventure; abodes of the Gods; lands frequented by the fairies; valleys of flowers, forests of the white *buransh* (rhododendron), *Betula utilis* (Himalayan birch) *bhojpatra* and juniper; alpine meadows; homelands of *bharal* (Himalayan blue sheep), *kastura* (Musk Deer), *monal* (a bird in the pheasant family), snow cock and *himchitua* (snow leopard); thousands of species of flora and fauna. There are lakes and passes, and trails travelled by our ancestors since millennia. There are some seasonal habitats, with their communities, yaks, sheep, horses, *mithun* (Gemini) goats, two-humped (or Bactrian) camels and *Bhotia* dogs/Tibetan Mastiffs. They have their own culture and economy, their songs and music. And all life is regulated according to the constraints of this environment.

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[6]Among these rivers, Sindhu, Ganga and Brahmaputra make up 4.28, 25 and 33.71 % respectively by volume of India's river water, and drain 9.8, 26 and 7.8 % respectively of India's total area. In this way, their combined basin is 43.8 % of India's total surface area, and supply 63 % of India's fresh water.

[7]The heights of various peaks is as follows—Rakaposhi (7788 m), Nanga Parbat (8125 m), K-2 (8811 m), Gasherbrum (8068 m), Nunkun (7135 m), Kinner Kailash (6500 m), Swargarohini (6252 m), Bandarpunch I & II (6102/6316 m), Kedarnath I & II (6940/6830 m), Chaukhamba (7138 m), Bhagirathi (6856 m), Shivling (6543 m), Nanda devi (7817 m), Nanda Kot (6881 m), Panchachuli (6904 m), Rajrambha (6537 m), Aapi (7132 m), Manaslu (8163 m), Sheeshapangma (8013 m), Dhaulagiri (8167 m), Annapurna (8091 m), Cho Oyu (8201 m), Lhotse (8516 m), Chomolangama or Sagarmatha or Everest (8850 m), Makalu (8481 m), Kanchenjunga (8585 m), Kunla Kangri (7600 m), Namche Barwa (7800 m).

In this way, where a specific kind of geologic–geographic process has given rise to the Himalaya, the Himalaya has further rendered itself into its present form.

Social and Cultural Diversity

The sacred Himalaya finds permanent place in the consciousness of various Asian societies and has been vividly described in their myths and literature. Its natural beauty, geographical complexity and a rich mythic tradition have given birth to various pilgrim destinations (Bernbaum 1990, pp. 2–23, 206–248). Various societies and cultures have settled here; while some of them have maintained an interactive existence, many have also chosen a more separate, isolated identity. Perhaps, this is the reason why the Himalaya is an unparalleled location in terms of its natural and human diversity.

Different stages of social development can be seen here, with tribal,[8] caste and class-based societies living alongside each other. While animal husbandry is actively practiced in the mountains and agriculture in the valleys, the barter system of trade spreads across the Himalaya. This has led to the creation of a unique social, cultural and economic system, containing elements brought in by different constitutive communities.

Being the melting pot of several human groups, a juncture of different political systems, and the source of the most important rivers of Asia, the continuously increasing geo-political importance of the Himalaya has ensured that we ought to understand it deeply and comprehensively by engaging with its geology, geography, history, anthropology, sociology, ecology, economics, and indigenous knowledge systems. Today it is necessary that the Himalaya should be studied not only for its myths and folklore but its various aspects should become the object of study for scientific and independent research as well (Pathak 2005).[9]

The next dimension of the history of the Himalaya is about its various human groups and societies, and their inter-relations. The process of migration and habitation of humans in Himalaya is an interesting one. It is yet to be analysed in detail as to how the Negroid, the Caucasian, the Mongoloid[10] and other ancient

[8]Kalash, Balti, Bakarwal, Janskari, Gaddi, Gujjar, Jaunsari, Shauka, Tharu, Boksa, Banraji, Bhotiya, Byansi, Magar, Gurang, Tamang, Nevar, Sherpa, Rai, Limbu, Lepcha, Drokpa, Monpa, Abor, Mismi, Apatani, Naga, Mizo, Khasi and Jayantiya are the best known among them but there are also other tribes and communities.

[9]Since the Himalaya spreads across so many regions and nations, it should be given a research platform in regional and national studies. Simultaneously, its wholeness and trans-national identity should also be kept in mind. Such an approach would allow conceptualizing the Himalaya as the centre and also the periphery. This will be the beginning of an effort to understand this diverse mountain range more deeply.

[10]These terms are nowadays rather discredited and refer to an old type of racial science. [Editors' note].

communities struggled, compromised and assimilated each other after arriving in the Himalaya (Majumdar 1946a; Dabral 1964–1968; Pathak 1988). Witzel (2005) has carried out a new and multifaceted study in this regard; this issue needs to be probed and understood even further. During this process, each community tried to learn from and understand the other. They constructed their preliminary culture, developed economic activities and experimented with indigenous science. Thus, practices such as *jhum* (shifting farming), animal husbandry, water mills, irrigation systems, mining and metallurgy, transportation and bridge building, vernacular architecture, sculpture and mask-making art and so on, were developed under the special ecological and geo-political pressures of the place (Pande and Geijerstam 2002; Geijerstam 2004; Cautley 1854; Agrawal and Narayan 1997; Olschak et al. 1987; Saklani et al. 1999; Bisht 2002).

Today when we look at the blue-eyed Drokapas of Ladakh; the Shaukas (Bhotiyas), Banrajis, Tharus and Bokshas of Uttarakhand; the Banrajis and Sherpas of Nepal; the Lepchas and Bhotias of Sikkim; the Brokapas of Bhutan, Arunanchal and Tibet, and the many tribes of north-eastern India, their presence speaks of a variety of human contacts and rich social engagement, which became possible in the Himalaya (Robertson 1987; Srivastav 1958; Loude and Lievre 1987; Peissel 1992; Joshi 1983; Chand 2004), Here they tried to absorb the different religious traditions and myths they encountered and also gave them a distinct identity in the form of folk traditions (Pathak 2003).

The Hindu, Bonpa, Buddhist, Jain, Christian, Muslim and Sikh traditions have certainly associated themselves with the Himalaya due to its unique natural attraction. Many old and mutually disparate societies and cultures have existed in the Himalaya. It seems as though this natural persona of Himalaya gave birth to an endless series of Pauranic stories. Such an intense proximity between the historical tradition and that of myths is not visible anywhere else in the world. Each and every river, peak, pass, lake and cave has a story, and most of the time neither logic nor the prudence works to explain its meaning.

Our Himalaya is in the north while for the nomads of Tibet, most of who are Buddhists, the Himalaya is in the south. Quite clearly, it belongs equally to the people on both sides. Such a wholesome understanding of the Himalaya can be found in many stories of various Gods which circulate in its different language cultures. This includes the oral literature of the Himalaya with thousand faces.

The Shaiva, Shakta and Vaishnava traditions of the Indian sub-continent can be clearly seen in the Himalaya (Atkinson 1882–1886). Lord Shiva is an influential God here and the entire area is under his influence. From Amarnath to the Panch Kedars, and further on to Kailas-Mansarovar and the Kathmandu valley, he finds a place of prominence and makes appearances in various forms such as head (*sir*), bunch of hair (*jatā*), arm (*bāhu*), back portion of the body (*paścabhāga*) and navel (*nābhi*). There was an effort to relate Vaishnava deities with the Himalaya, but Lord Shiva is the indisputable hero and will remain so. Several efforts have been made to relate also the traditions of local deities with Lord Shiva.

From Kamakhya (Assam) to Punyagiri (Uttarakhand) and to Vaishnav Devi (Jammu and Kashmir) in the southern strip of the Himalaya, there is a strong

tradition of Shakti or Mother Goddess, which seems to hark back to the most ancient times. There are also a few Vaishnavite centres like Badrinath and Muktinath. Simultaneously, mountain like Chomolangama and Nanda Devi are still standing in between myths and social reality (Sax 1991).

Before being embodied by the peak, Chomolangma's identity is that of a local Mother Goddess. The Nanda Devi of Uttarakhand is a part of this genre of mother goddesses; yet, she is also different in ways. Her identity has grown out of her existence as a mountain on the one hand, a mythic character on another and part of a larger social reality on yet another. Probably she is the only goddess who refuses to be confined to the role of a mother; she is also a daughter, a sister and a daughter-in-law. She is the daughter of the Himalaya and also its mother. She is the Kul Devi (goddess of the clan) of Katyuri kings and also the daughter of Chand and Paramar rulers. Her name is attached to as many mountains as those of Lord Shiva. Not only is she the goddess of faith and joy but also of sadness. In fact, Nanda Devi and Latu are popular even in today's society (Hatwal et al. 2000; Hatwal and Bainjwal 2000).

Buddhist monasteries in the inner Himalaya, which spread from Afghanistan and Kashmir to Myanmar, are markers of a rich, living tradition. This Buddhist strip is connected to Tibet in both cultural and geographical ways. It is also present on both sides of the highest summits. Old memorials, dating back more than a 1000 years, are also present there. The Bamiyan Buddha of Afghanistan,[11] the remains at Takshshila (Pakistan), various monasteries and forts of Ladakh, the Tabo monastery of Spiti and the Lalung monastery of Kinnaur in Himachal, and other Buddhist monuments are the evidence of a historical past of more than a 1000 years. At the same time, they are also the key to understand the demolished architecture of today's Tholing and Chhaprang along with the rest of western Tibet (Agrawal 2000; Thakur 1996; Handa 1994; Francke 1914; Lama 1966; Singh 1983; Vitali 2002).

The same could be said about all the shrines and monasteries of Nepal, Sikkim, Bhutan and Arunachal Pradesh (especially Tawang) and their relations with the monasteries in adjoining Tibet. In Uttarakhand, such a presence is visible in architecture and sculpture, but in terms of social organization, Buddhism is practiced only by the Jad community. However, it is also true that the Tibetans, who came with the Dalai Lama and settled in Uttarakhand, have maintained a strong Buddhist presence in the region.

Folk deities, among them some that are moving in the sense that they are taken from one village to another during the winter months for worship (of which Mahasu is the most important), have an active tradition here, independent of pan-Asian gods and goddesses. In fact, this diversity of folk deities is inherently linked to the human and natural diversity of the Himalaya. The places which were constituted as pilgrim centres through practices of culture and belief-systems were and continue to be the most beautiful places in the world even without memorials, temples, monasteries or

[11]Destroyed in 2001. [Editors' note].

gurudwaras (Sikh temples). This fact also illustrates the aesthetic sense of our ancient ancestors and their belief in the purity of wilderness (Tucci 1932–1941, 1973; Snelling 1990; Jain 1995; Alter 2001; Sharma 2006; Jaunsari 2006).

The Himalaya is still home to many communities and cultures, some of which strikingly do not believe in any dominant religion of the world. Instead, their belief-systems respect the sun and the moon, the trees and ponds, and nature in general. Such a faith, in fact, seems to be the true and original representative of current religious practices, which are often on the verge of madness. Thus the nature of beliefs prior to institutionalized religions can still be traced in some of the inhabitants and communities of the Himalaya. Despite the differences in religion and culture, their dependence on each other and the advent of a shared cultural legacy is also an important part of this history.

The limits of religion often divide the society by branding mankind as Hindu, Buddhist, Jain, Parsi, Christian or Muslims. However, it has not been successful in the Himalaya and despite this religious-psychological apparatus, a specific and shared socio-cultural identity has been able to develop here. For instance, the singers of Vaishno Devi and the managers of the Amarnath Yatra are themselves followers of Islam. Simultaneously, it is the Buddhists who make the pilgrimage arrangements for Hindus and others in Tibet. The number of non-Sikh and non-Buddhist pilgrims to the various Sikh pilgrimage sites and Buddhist monasteries in the Himalaya is indeed higher than those belonging to the respective religions. Many of the workers and helpers at Hemkunt Sahib and Ritha Sahib were/are non-Sikhs. The doors of Badrinath shrine are opened jointly by the Lambudiri Brahmin of Kerala origin and the tribal head of Mana village. While there is cooperation between Hindus, Buddhists and Muslims in Jammu & Kashmir, in the North-East, it is the Hindus, Buddhists, Christians and Muslims who live together. It should also be kept in mind that the Chakmas, who have migrated from Bangladesh, are also Buddhists.

The situation is altogether different and extraordinary in the Kailas-Mansarovar region of western Tibet. Ancient Bonpas (the followers of Bön religion), Hindus, Buddhists, Jains and also the modern western and Chinese tourists travel together to this mountain and lake and take part in its circumambulation (*parikrama*) (Swami 1949, 1950; Pathak 2001a, 2009). This region is indeed a unique multicultural destination. In this part of western Tibet of Communist China, neither are we witness to a scene of Ayodhya nor that of Jerusalem. This region cannot be treated as the prerogative of any one community, religion or belief. In fact, it is a unique example of the original unity of humankind.

The Himalaya has a number of tribes and ethnic groups, who have their own autonomous worlds comprising a little bit of everything. This has kept their diversity, specificity and also their interrelations intact. The most surprising and important fact is that the primary concern of Gujjars, Sherpas, Banarajis, Brokpas, Drokpas, Lepchas and the many tribes of the north-eastern India-Myanmar border, is still with nature and not with any institutionalised religion. Close to the Vaishnavite traditions of Manipur stand the rich tribal traditions of the Nagas, who have maintained their originality despite being attached to Christianity. A little

further are the borders of Arunachal, Tibet and Myanmar where Buddhist culture is still alive. In the pilgrimage sites of Uttarakhand, there is a strong presence of visitors from other religions.

The memory of Parashuram spreads from Renuka Lake of Himachal and Renuka temples of Uttarakhand to the Arunachal-Myanmar border, where Parashuram Kund is located at the origin of the river Lohit. Rishi Vyas is constantly invoked in the valleys of the rivers Kali in Kumaon, Vishnu Ganga in Garhwal and Beas (Kulu) in Himachal. Rishi Kanva finds a presence near Kotdwar and so does the story of Shakuntala, Dushyant and Bharat. All the *rishis* had established themselves in the Himalaya. There are also stories of Gautam Buddha visiting the foothills of Himalaya and Jesus Christ visiting Kashmir. Stories of Saiyads and songs of Sufis are on our lips. The tales of Ramayana are limited in Himalaya but those of Mahabharata are extensive and in multiple forms and they spread from Kashmir to Tripura.

The transformation of Pandavas and Kauravas into folk-gods has been possible in Himalaya only. Their so called journey to heaven was also from here (Bijlwan 2003). The Pandavas and Kauravas are still revered in the Tons valley of Uttarakhand. The temples of Karna and Duryodhana are located here and gods travel from one place to another with human beings. People do not leave their gods alone or one can also say that the gods do not want to remain away from their people.

The first Jain Tirthankar Rishabhdev (Adinath) breathed his last at Ashtapaad near the southern slopes of Mt. Kailas, while Adi Shankaracharya extensively toured Uttarakhand and Kashmir. It is also believed that Adi Shankaracharya breathed his last in Kedarnath. His memorial is constructed there. Before the coming of British rule in Uttarakhand the pilgrims used to commit religious suicide at Brahmjhaap near Kedarnath. Nanak had reached Mansarovar via Kumaon, and Ladakh-Bukhara and Gorakhnath are still alive in some parts of the Himalaya. Huen-tsang (Xuanzang), Fa Hien (Faxian) and many Buddhist preachers as well as explorers travelled back and forth the Himalaya many times. Mani Padma travelled from Bengal to Tibet.

So many great personalities—poets, saints, explorers and mountaineers—have visited the Himalaya and stayed here.[12] Many Pundits, Sherpas and Bhotiyas are its own children.[13] The more they visited the Himalaya, the more they must have felt how little they know it. The number of peaks they had set their feet on must have always been less than those unclimbed, challenging ones.

Within these myths and realities lie many small societies and cultures, which are correlated despite being unknown to each other. Festivities, fairs, songs, dances,

[12]Kalidas, Shankardev, Gorakhnath, Vivekanand, Rabindranath Tagore, Mahatma Gandhi, Aurobindo Ghosh, Sarala Behn, Uaday Shankar, Nikolai Roerich, Govinda Anagarika Lama, Antonio De Andrade, Soma De Korosi, Jack Mont, William Moorcroft, Sven Hedin, Verrier Elwin, George Mallory, Younghusband, Edmond Hillary, Chris Bonington, Herzog and so many.

[13]Nain Singh, Kishan Singh, Mani Singh, Kinthup, Tenzing, Ang Dorji, Latu Dorji, Chandraprabha Aitwal, Lavraj Dharamsaktu and Bachhendri Pal etc.

musical instruments, implements and social systems are part of this, as are also swords and arrows—original as well as ornamental. Different forms of traditional knowledge exist here and also those of relationships, manners and traditions. While some communities accept polyandry, some others follow polygamy (Majumdar 1946b; Parmar 1975). Widow re-marriage is prevalent in some communities but impossible in others. There are many areas and communities influenced by Buddhist compassion, who hesitate to kill even a bird. Vaishnavite traditions are followed in Manipur and in the nearby Naga areas the practice of 'head hunting' was common a few decades back. There are customs of burial at some places, cremation at others and feeding the corpses to the birds at yet other places (Sherring 1906; Haimendorf 1955; Srivastav 1958; Dabral 1964–1968; Joshi 1983; Pangti 1992; Joshi 1929; Majumdar 1944).

Despite an east-west geographical continuity in the entire Himalaya, north-south social, economic and ecological relations are also prevalent. Relations between the societies of the north Indian plains and Tibet have evolved centuries ago through the communities of the Himalaya and were working up till half a century back in spite of different political systems. After the occupation of Tibet by China, this relationship has disappeared in most areas.

For instance, Uttarakhand shares a special relationship with the society and culture of Tibet and the plains of Ganga and Yamuna. It is intense in some places and sparse at others. At the same time, it is also close to the Mahakali region of Nepal and Himachal's Sutluj-Baspa valley. The same argument can be made about Kashmir, Himachal, Nepal, Sikkim, Bhutan and the seven sisters of Northeast. Many layers of humanity can be read and recognized in the Himalaya; also, many have been lost and many are still hidden.

The languages and dialects, arts (of cloth, clay, stone, metal, wood, fibre and colour) and other socio-cultural expressions of Himalaya have developed amidst these lifestyles. There are still many uneducated and illiterate societies here, even though circumstances have made them multilingual. Exchange between Indo-European, Burmo-Tibetan, Austric and Dravid language families has been taking place since millennia and can be traced in the Himalayan languages and dialects. The studies undertaken by linguists like George Grierson and D. D. Sharma help us in understanding this cultural diversity, although it must be noted that the nature and degree of development and modernity today are contributing to their disappearance (Grierson 1916; Bailey 1920; Joshi 1964; Sharma 1983, 1985/1987, 1988, 1989/1990; Ruvali 1996; Chatak 2000; Bhatt 2000; Bisht 2005; Moseley 2010.

In order to understand the Himalayan culture and its relations with the rest of Asia, it is necessary to understand the tradition of pilgrimage. Himalaya is home to Bonpa, Hindu, Buddhist, Jain, Islamic and Sikh pilgrimage sites. The rich tradition of pilgrimage sites and routes includes Amarnath, Charar-e-Sharief, Vaishno Devi, Lamayuru, Manimahesh, Tabo, Yamunotri, Gangotri, Kedarnath and Badrinath (the *chaar dhams* of Uttarakhand), Ritha Sahib-Nanakmatta-Hemkund Sahib, Kailas-Mansarovar-Tirthapuri-Tholing, Muktinath, Buddhist monasteries on the northern and southern slopes of Everest, pilgrimage centres in and around

Kathmandu, Buddhist monasteries of Sikkim-Bhutan and Arunachal (Tawang), Parashuram Kund, Kamakshya Dham (Guwahati), and Lhasa-Samaye-Sigaste-Gyantse.

All over the country, children are named after the above pilgrimage centres and their corresponding gods. Most of the pilgrimages of Himalaya are seasonal and take place between spring and autumn. These travels also connect people from other parts of Asia with Himalaya. A system of *chattis* (resting places) existed along the pilgrimage routes, which now in most cases are lost due the construction of motor roads. Local societies arrange for the shelter and food of visitors, and one can witness innumerable examples of such mutual dependence and co-operation. Sights of saints travelling alongside family folks were also very common (Corbett 1996; Allen 1992; Dabral 1960; Vaishnav 2010; Alter 2001).

Thus, there are many natural areas shared by societies and cultures in Himalaya. These are inexhaustible markers of social and cultural diversity with many layers of hunter-gatherers, artisans, pastoralists, farmers, traders and service holders. The 'Yeti' could be a figment of Himalayan imagination or it could be a bear of the higher Himalaya, but there are still societies here who continue to depend on hunting and collecting. Jhum or shifting cultivation is still a way of livelihood. Nomads and pastoralists still exist here as do also people migrating to the plains, just like their own soil and waters.

Among the illiterate and yet multilingual societies age old oral traditions have entered the realm of writing in the last 200 years.[14] Yet, these traditions have remained dynamic. Jhusia Damai (1910–2005) had kept the mixed tradition of myths and folk-tales alive till recently, in a composite language form of Nepali, Kumaoni and some Bhot-Tibetan, in which prose suddenly transforms into songs and songs into dances. Similarly, Mohan Singh Rithagari (1905–1984) and Gopidas (1902–1975) kept alive Malushahi or Ramol Gatha, while Keshav Aruragi (?–1993) contributed to Dhol Sagar and 'Saiyad Vani'. There could be many folk singers in Himalaya today of whom we are not aware and yet continue to represent its oral traditions.

Resources of Many Kinds

But Himalaya is not just about its beauty, society and culture. Like any mountain range, it is also home to natural resources, which humans have been using since time immemorial. To this is tied the ecological aspect of Himalaya. These resources have been in constant use by societies of hunters, nomads, pastoralists, artisans,

[14]Poet Lokratn Gumani (1791–1846) wrote in Hindi, Sanskrit, Kumaoni and Nepali, while Molaram (1743–1833) contributed to Hindi through his paintings, poems and history-writing. Nepali poet Bhanubhakt (1814-?) was influenced by Ramayana, while Sufi poetry had a wonderful influence on the Kashmiri language through the works extending from those of Nuruddin Wali (1376–1438) to those of Ahmed Zargar (1908–1984).

agriculturists, traders to the present day non-residents or 'money order' economies, and there is no hope of its stopping in the foreseeable future. The colonial regime had declared these 'life resources' to be 'goods' and the multinational approach of the open market economy has turned them into 'commodities', with the resources, raw or finished, being silent victims to a relentless, institutionalized plunder. That's why the Himalaya, like other remote regions of the country, has been plagued and tormented by an internal colonialism.

The resources of Himalaya have always been divided into land, forests, water, humans-animals and I would like to add one more—wilderness. Land (soil, minerals, metals and hydrocarbons) is the fundamental or the mother resource. Land bears the pastures, the forests and agricultural fields. The rivers flow on it, and all the glaciers and lakes lie sprawling among its folds. In fact, geology, weather and altitude decide the disposition of the land. Whether it is covered with snow or takes the form of a gorge or becomes an alpine meadow, or else a normal pasture. Humans have brought it to the extent of individual ownership. This is actually agricultural land. Hence they buy and sell it. Today the newly rich and the businessmen have started trading in it.

The Himalaya has been bestowing soil, fertility and water upon northern India by way of its rivers, without being asked to. Man's rashness has hastened the depletion of the soil. This fact can be seen from Dayara region to the Moor islands of the Bay of Bengal. And it is the soil that saves us from being reduced to soil. In fact, most of the social and ecological movements of the Himalaya are centred round the conservation of soil.[15]

Water manifests itself in all three forms in the Himalaya, solid, liquid and vapour, but the critical mobility is achieved only in the second form, because it knows how to flow. The experts have started calling the Himalaya the 'water towers of modern civilization'. This water quenches our thirst. Some of it is used for water mills and irrigation. The energy flowing in it can be captured and commoditised. The consumer's mindset or the capitalist's acumen can merely envision dams like Tehri, or the business of bottled water, packaged in plastic and sold at Rs. 10–15. They will neither dwell on the future of fish nor be concerned about the fate of ordinary humans.

Meanwhile, the construction of a series of dams is underway throughout the Himalaya, needless to say without the 'honest' cost-benefit analysis and proper assessment of the geo-tectonics, catchment areas reality and the consequences.[16] The small-scale but sustainable and successful efforts of our ancestors, for the conservation and use of water and snow, practised for thousands of years, are invariably rejected as 'traditional knowledge systems', when they are as meaningful

[15]In the entire Hindukush-Himalaya range, pastures make up 39 % of the area, forests 21 %, protected areas 11 % and agricultural land 5 %. The income of 47 to 83 percent of people in this region is 2 USD per day, while it is 1 USD per day for 17 to 36 percent (Sharma 2004). Per capita land for farming in Indian Himalayas is 0.29 hectares (Ya and Tulachan 2003).

[16]Presently, Himalaya (India, Pakistan, Nepal and Bhutan) has 100 functioning hydro projects, 46 under construction and 406 planned (see: Dharmadhikari 2008, p. 7).

and useful today as ever (Stone 1992; Ives and Messerli 1989; Subba 2001; Gyawali 2001; Caspari and Dixit 1999). Some are even considering the 'linking of the rivers', without knowing and respecting the right of the river to flow.

The forests are just as much an integral and distinctive feature of the Himalaya as snow, ice and water. The 'water towers' lie not just in the glaciers; their roots go deep into the forests. Hunting and collecting, livestock and agriculture, crafts and cottage industries, traditional medicines and trade are all supported by the forests. Forests are critical to the formation and retention of soil. Forests fill the lives of people with song, music, journeys and a range of arts and implements. They are home to animals and birds. They make possible the extent of biological diversity.

The Himalayan biological diversity has many dimensions to it. The rarest of flora and fauna can be found here. If less than five percent of the total geographical area can support life in Ladakh, more than eighty percent of all land in Arunachal Pradesh is crammed with forests (Dietrich 1994; Pant 1922; Guha 1989; Grove et al. 2000; Pouchepadass 1995; Shiva and Bandyopadhyay 1986; Pathak 2001b). If elephants, tigers and rhinos walk in the foothills, snow leopards, musk deer, pandas, monals and snow cocks are visible in the higher reaches. A variety of species live in between. Some fly from north of the Himalaya to its south annually and are known as 'migratory birds'. Some species are already extinct, and many others are threatened or critically endangered and have been duly included in the red data list of IUCN.

There are some remarkable areas with an extraordinarily rich biodiversity in Arunachal Pradesh, Bhutan, Sikkim, Nepal and Uttarakhand. To put it simple, the Himalaya occupies 0.3 % of the planet area, while making up 10 % of its biodiversity (Stone 1992). This fact has now been recognized by the 'enemies' too. The forests of the Himalaya and its vegetation have been a ready source of food and fodder, fuel, timber, roots and herbs, manure, cloth, colours, fibre and so on. Agricultural diversity is closely linked to biodiversity (Maikhuri et al. 1997; Kunwar 1995; Jardhari 2007). But humans and their modern apparatus, under tremendous pressure from the international economic establishment, want to 'cut', 'dig', 'collect' and 'kill' as much as possible in the shortest time. They want to earn more and learn nothing. This is a gradual and slow suicide being hatched in the new economy. But for the unsuspecting ordinary folk of the Himalaya, this is nothing short of murder. Climatic and atmospheric changes will no doubt hasten this process (Ramakrishnan et al. 1998; Gadgil and Guha 1995; Dhar 1993; Pathak and Ghildiyal 2007).

Humans in the Himalaya are a resource and at the same time consumers of all other resources. On the other hand, the wild animals are linked to forests, rangelands and to biodiversity, as the domestic animals are to agriculture, transport and food systems. They can be termed as 'cash fauna'. If the population of the Himalayan region is estimated at over 50 million, the projection for domestic animals may also go to around 40 million. But the resources of the Himalaya influence the lives of more than 500 million Asians directly or indirectly. For the Himalayan experts, the big task is to make universally available the actual data and statistics on different aspects of the Himalaya, so that the widespread guesswork about this large region can come to an end.

There is also a need to understand Himalayan migrations. For example, how can we approach and understand the concept of 'money order economy' today? While its meaning has changed for Uttarakhand, to some extent it is still a useful term in understanding the out-migration economy of Nepal. How to understand the forced migrations of Tibetans and Pundits from their respective lands? How to analyse the migration of labourers from Bihar, Jharkhand and eastern UP to remotest and difficult Himalaya?

The most special, 'niche', resource of the Himalaya is its 'wilderness', its natural beauty and tranquillity. This beauty is not just the peaks, glaciers, confluences, springs, lakes, valleys of flowers, green and blue forests and perennial rivers considered by themselves, but a combined and juxtaposed whole, much greater than the sum of its parts. At times rain would embellish the scene, at other times snow, fog or hailstorms would add to the beauty. The moon and the sun adorn the wilderness in their own way. Many a times, the stars would descend upon its lakes, and often the rising or setting sun or moon would set its beauty ablaze. How the clouds alight on the meadows to graze, or how the moon with swift manoeuvre becomes the sovereign of the sky, as soon as the sun goes down, all these are such sights to behold that they can only be experienced. The spectacle of the falling snow is also like a silent, meditative dance of an animated grandeur.

In this vast panorama, the flight of a bird, the sighting of a Monal (the Himalayan pheasant) or a musk deer, the timid tone of a Kakar (barking deer) or growl of a Guldar (leopard), the slithering of a reptile or a fish leaping out from a lake, break the monotony of the Himalaya's imperial splendour, spontaneously inventing sublime flourishes. Amidst all this, communities or their dwellings and architecture, or their songs and caravans, or the smoke rising from their houses in the settlements, all add a very unusual human beauty to the canvas. This endless palette endows their vision with art and poetry, fills in the blank spaces of the modern mind and deconstructs monoculture.

This immeasurable beauty cannot be manufactured by nation-states or multinational companies. This wilderness is the perpetual possession of the Himalaya. Pilgrimage and tourism are very dependent on these assets. A major part of these assets is associated with aesthetics, and visual intensity and 'cutting' or 'digging' is not involved. This 'wilderness' can be the basis for the dust and smoke-free industry of the twenty first century, i.e. people's tourism. And there is tremendous pressure on this resource today.

Between Silence and War

In these beautiful and certainly difficult areas of the earth, the Himalaya shows signs of prosperity and also of poverty. The present scenario, therefore, makes one upset and this sadness is not only felt by more than 50 million Himalayan people but it is also part of a larger national and regional sadness. It has become so pronounced because the flowing rivers speak of it, the mountains insist on it and the forests and

minerals, which no longer belong to the people of the region, echo with it. The natural environment, which is the primary context for the dances and songs of the people, is being consistently destroyed. Unsound developmental processes are being forcefully thrust upon the region. Nevertheless, the people have not yet surrendered.

Even amidst this sadness, they are fighting for their forests, soil, minerals, folk culture, and in a way, for their very identity.[17] They have been gauging the conspiracies of supporters of big dams and corporate and captive tourism, the contractors of mines and road construction and their destructive methodology of work, and the looters of raisin, timber and herbs. This realization is not limited to some pockets only.

Many active sections of the society are of the opinion that the Himalaya cannot be sustained and saved separately. Its environment is linked to its economy and this ultimately brings in the question of political will in a national and international context. The societies of the Himalaya have been protecting themselves for centuries, but self-defence has become acutely difficult today.

The Himalayan societies have historically engaged in warfare in order to establish and protect themselves from each other and also from competitive feudal powers. There could be some difference in the degree of endurance that different societies possess, but the human quality to protest exists amongst all. Its form is contingent upon the particular spatio-temporal context in which it takes root, and it thereby spreads socially, sometimes gaining a generous quality and at other times an aggressive one. The stability achieved after the struggles with medieval feudal powers was disturbed by the arrival of the Europeans, who heralded an empire of exploitation and slavery. However, this was followed by retribution and resistance.

There was an overall decline of feudal powers in the Himalaya by the last decades of the eighteenth century, with the exception of three, which evolved and became even bigger for some time. These were the Dogra, Gorkha and Ahom empires, which the colonial rulers could not fully destroy. By the nineteenth century, Company rule had gradually entered in some parts of the Himalaya. In response, individual and collective resistance from the communities of Himalaya also started to get stronger. Most of the social movements in the Himalaya were led by peasants and tribes. The form and significance of resistance can be gauged by studying the revolts of Jayantiya, Kuki and Manipur, the Phulagarhi movement of Assam, the anti-*begar* (forced labour) and forest movements of Uttarakhand, Dhandhak and Prajamandal movements of Tehri State, Prajamandal movement of Himachal States, Chanaini movement of Jammu and National Conference movement of Kashmir.

Struggles against the feudal and colonial rule have been carried out in all parts of the Himalaya. The movement of the Nepali Congress can also to be placed in this

[17]For example through the Chipko movement, described by Bosak and Kainthola in this volume. See Shekhar Pathak's forthcoming book 'Green Hope' for Chipko and other forest movements in 20th century Uttarakhand.

context. This era witnessed the emergence of many leaders and revolutionary heroes. Tikendrajit and Hizam Eravat of Manipur; Shivcharan Rai of Meghalaya; Naga Rani Gaidinlue; Vishweshwar Prasad Koirala of Nepal; Govind Ballabh Pant, P.C. Joshi, Chandra Singh Garhwali and Sridev Suman of Uttarakhand; Veer Ratna Singh, Fakir Chand Bhapa, Yashpal, Satyadev Bushhari and Yashwant Singh Parmar of Himachal and Sheikh Abdullah of Kashmir are the names of some of them. The soldiers who refused to fire upon unarmed Pathans in Peshawar and those who enrolled themselves in the Azad Hind Fauz (INA) and the RIN mutineers are also part of this list of fighters (Walia 1972; Pathak 1987, 1998; Guha 1989; Koirala 2001; Saklani 1987; Rawat 2002; Verghese 1996; Misra 1988).

This tradition did not stop even after 1947. Mass movements continue even today. The resistance in both parts of Kashmir and in north-eastern India has repeatedly turned violent. Tribal areas of Pakistan have been in a continuous state of disturbance. Movements in Uttarakhand also did not stop after independence (Pathak 1999), and it was only mass movements which finally brought democracy to Nepal. Movements are going on in Tibet and Bhutan as well. In such an atmosphere, sometimes there is a lull and sometimes the situation turns explosive. Nevertheless, it must be hoped that new movements lead to a deepening of democratic foundations. Bhutan has entered into the era of constitutional monarchy. The very idea of GNH (Gross National Happiness) has emerged from this small Himalayan country. Presently Himachal and Sikkim are states where processes of development are being slowly and peacefully implemented, though these states are also experiencing ecological movements.

The political and social systems of the Indian sub-continent have not been able to earn complete trust of these communities. Our centralized republics have yet not understood their decentralized lifestyles. The colonial government had at least showed its good sense in recognizing them as ‘non-regulated’ areas, but it was a cleverly created safety valve. These societies and cultures do not exist in order to be administered by one-dimensional central systems. These community-governed decentralized systems have actually not yet been able to make up their minds to fully recognize the centralised democratic governments.

It must be remembered that if we thrust externally derived solutions on the issues of the Himalaya, it will only lead to more instability and unrest. In fact, such an understanding is urgently needed. If the Himalaya and its resources are used for commercial exploitation only, neither the Himalaya nor the north Indian plain will remain safe. There is no dearth of people, from India and elsewhere, who, on the one hand, willingly declare that the Himalaya is the highest symbol of human civilization and on the other, do not hesitate at all in destroying its natural wealth and cultural prosperity. In fact, it is these people who are running the system. This is the real scenario which has placed the Himalaya in a dangerous situation, and it is a matter of concern for all of us.

What we need at the moment is a steady middle path with long-term goals for the overall betterment of our larger society and fulfilment of our needs, and not hasty frenzies of development which only benefit a few. Globalization, privatisation of commons and climate change are bound to have a direct impact on the Himalaya.

However, we are also certain that despite these processes, it will maintain its presence amidst us and will continue to support our existence in various ways. Why we want to save the Himalaya? Because of the realization that we have only one Himalaya and our own safety is linked to it.

The Himalaya can be likened to the father who is unable to scold his spoilt children and to the mother who is unable to doubt them. In order to save the Himalaya, we must be ready to lose something, which might have a veneer of glitter albeit of a temporary nature.

One should hope that the children of the Himalaya and the rest of humankind will realize this in time! Alongside, it should also be remembered that this understanding is neither available in the international market, nor can it be developed by the World Bank or any multinational company. This realization and awareness already exists in the societies and communities of the Himalaya as elsewhere in other mountains, and we can learn and imbibe it only from there. Hopefully, we and our policy makers will awaken to this fact well in time.

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Chapter 8
The Himalayas as the Providers of Essential Ecosystem Services—Opportunities and Challenges

Andreas Schild

Introduction

Mountains occupy 27 % of the global land surface area and are home to 12 % of the world's population (FAO 2011). Mountains have significant ecological, aesthetic, and socioeconomic importance not only for those living there but also for people living beyond. About 10 % of the world's population depends directly on the use of mountain resources for their livelihoods and well-being, and an estimated 40 % depends indirectly on them for water, hydroelectricity, timber, biodiversity and niche products, mineral resources, recreation, and flood control (Schild 2008). Despite their important contribution, mountains are still marginalized in the development agenda. Although the importance of ecosystem services arising from mountains is recognised, approaches to economic valuation of services and payment mechanisms in mountain areas, which are needed to comprehend and realise the benefits, have not yet been much developed (Rasul et al. 2011).

The Hindu Kush Himalayas (HKH) range covers over 4.3 million sq km with varied geographical terrain and has many unparalleled characteristics. It is often referred to as the 'Third Pole' and 'Water Tower of Asia' regulating the flow of ten major river systems. The region is home to many diverse ethnic communities speaking about 1000 languages and dialects with enormous socioeconomic and cultural diversities. It is endowed with diverse farming practices and rich natural resources including global biodiversity hotspots that form the source of ecosystem services directly to more than 200 million people living in HKH and indirectly to 1.3 billion people living in the down-stream areas, the countries (totalling up to 3 billion people) benefiting from food and energy produced in the river basins (Schild 2008).

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Ecosystems are capital assets that provide a wide range of services. These include supporting services that maintain the conditions for life; provisioning services that provide direct inputs to livelihoods and the economy; regulating services such as those that provide flood and disease control; cultural services that provide opportunities for recreation, spiritual or historical sites; and supporting services that sustain and fulfil human life (MA 2005). Increasing demands on ecosystem goods and services are now putting pressure on the natural resources that they contain. On the one hand mountains are gaining in importance as a result of the recognition of their ecosystem services, but on the other there is a pressing need to develop sound methodologies to value them in order to realize the benefits (Rasul et al. 2011).

Climate change has emerged as the most prominent force of global change; however it is embedded in the matrix of drivers, which include globalization, population growth and local land-use cover change. While climate change is the product of globalization and mitigation implies global norms and measures, mountain systems prove highly fragile and particularly sensitive. Despite the fact that mountains generally contribute virtually nothing to the output of carbon and other polluting gases they are a central climate regulatory system and at the same time are particularly affected. Responding to climate change calls for very specific tailor-made solutions (Schild 2008).

Mountain systems must be viewed in the context of climate change and enhanced ecosystems services. This chapter highlights and analyses the impacts of global summits and conferences in relation to the mountain agenda, marginalization of mountain systems, climate change and biodiversity, mitigation and adaptation, the scientific uncertainty and knowledge gap, and finally reflects on the opportunities arising from the Rio+20 process and the 2012 conference.

The 1992 Rio Conference and Its Impacts

The global community recognised the importance of mountains at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992, which led to the inclusion of Chap. 13 in Agenda 21, relating to sustainable mountain development (see the chapter by Debarbieux and Price in this volume). Chapter 13 sets the scene by stating the role of mountains within the global ecosystem and expresses serious concerns about the decline in the general environmental quality of many mountains (UNEP 1992).

The Rio Conference delivered in its Agenda 21 a framework for the future orientation of policy makers and planners. The mountains received for the first time an official recognition as ecosystems deserving a special recognition. What has been the special focus of Chap. 13? Basically it concentrated largely on natural science. The conference proceeded by recognizing the “Mountains of the World” and their importance for global goods and services. It highlighted the most important ecosystem services, dealing especially with forests, watershed development,

soil conservation etc. The initiative of the Swiss government subsequently became the champion of the mountain agenda. Professors Bruno Messerli and Jack D. Ives played an eminent role in its preparation and documentation. It was based on a scientific analysis carried out by researchers of industrialized countries but with a distinct global outlook. The summit resulted in many UN Conventions, such as on climate change (UNFCCC), biodiversity (CBD) and combating desertification.

What has been the impact? How far has Chap. 13 managed to influence the actions and the national and international agenda? We observe an impressive number of follow up initiatives. For example the UN General Assembly votes a declaration in favour of the mountains every 2 years. The World Summit on Sustainable Development (WSSD) in Johannesburg especially considered on 'How to operationalize the Chap. 13?' The International Year of Mountains in 2002 observed events like WSSD, the Adelboden Conference and finally culminated in The Global Mountain Conference held in Bishkek (Kyrgyzstan). These efforts of 2002 helped in the creation of the Mountain Forum, and later the Mountain Partnership emerged, which is hosted by FAO.

What was the consequence on the development agenda? These initiatives hardly influenced the international development agenda. It continued to be dominated by globalization and macroeconomic stability with related topics of structural adjustments, human rights, debt crisis, Millennium Development Goals (MDGs). The policy instruments (e.g. PRSPs) were strengthened in countrywide approaches without differentiating between changing regional needs. Industrialized countries became increasingly concerned with the consequences of growth and environmental hazards due to industrialization. The now prevailing global concerns focus on economic growth, macroeconomic stability, trade liberalization, communication, privatization, deregulation, and structural reform.

The mountain agenda experienced the fate of increased isolation and marginalization. In the development programmes basically the same recipes were applied for mountain and non-mountain areas, which largely ignored the mountain specificity; as a consequence their impact on development was nominal. Therefore 'Sustainable Mountain Development (SMD)' remained largely marginal and limited to the concern of a small group of professionals, mainly the scientific community. The politicians and the development agenda did not follow developments in science!

Climate Change and Biodiversity in Global Agendas

After the Rio UN Conference in 1992 'Sustainable Mountain Development' remained marginal and never reached the desired impetus in the global agendas. However, the three UN conventions on climate change (UNFCCC), biodiversity (CBD) and combating desertification have substantially moved forward. The UNFCCC became gradually more prominent with the establishment of its

secretariat designated as the Intergovernmental Panel on Climate Change (IPCC). The IPCC's fourth assessment report for the first time demonstrated a common view of the scientific community (IPCC 2007). The Kyoto Protocol put forward the internationally agreed framework for the reduction of green house gases. The follow up conferences of Parties in Bali, Copenhagen and Cancun did not achieve any international breakthroughs, but they created financial instruments for the promotion of mitigation and funding of adaptation to climate change.

In the assessment reports and the above mentioned conferences mountain systems are mentioned only randomly, if at all. The HKH region in spite of its importance in providing global goods and services is not getting anything more than journalistic coverage. The fact is that very little and only scarce research is done in the Himalayas. The postcolonial period continued to consider mountains with benign neglect, as part of a military defence bulwark, or as the home of not integrated hill tribes. The unavailability or inaccessibility of reliable data has its consequences till the present day. The lack of scientific data certainty lead to the controversy on glaciers in 2009; for example the IPCC report mentions 500,000 sq km of glaciated surface in the HKH region (IPCC 2007). However the most published area coverage is about 110,000 sq km. A detailed internal paper by ICIMOD shows glaciated area coverage of 60,000 sq km (ICIMOD 2011).

The Convention on Biological Diversity (CBD) has been more discreet on developing a 'Programme of Work on Mountain Biodiversity (PoWMB) in 2004. The PoWMB invites the Parties to the CBD to adopt outcome-oriented targets for mountain biodiversity, taking into account the Strategic Plan of the CBD, the Global Strategy for Plant Conservation, the Plan of Implementation of the WSSD, and the MDGs. In the process, many international legal instruments relevant to conservation, benefit sharing, and the protection of the rights of indigenous local communities have evolved. Although there are still unresolved issues associated with rights and responsibilities, the CBD has made it difficult to ignore the enormous challenge of biodiversity conservation and the crucial role of local knowledge and local custodians in maintaining and managing natural resources. An analysis of ICIMOD on the paradigm shift in the policy on biodiversity management and convergence of policy with practice of the HKH provides an understanding to guide biodiversity agenda in the future (Sharma et al. 2010).

The concept of biodiversity corridors got prominence in the 10th Conference of Parties in 2010 at Nagoya, Japan. During this conference mountain biodiversity including the use of natural resources received attention of global players who led to declarations on making use of environmental goods part of the national accounting. In addition the idea of creating an international CBD panel will give a new impetus to biodiversity related global agendas.

The debate on the consequences of climate change has created a new awareness for the role and importance of mountain systems. However, science has not followed the political agenda!

Economic Development and Relevance to Mountains

What are the framework conditions that have brought about changes? The last 20 years have been characterized by economic growth, with its implications of increasing demand and pressure on ecosystems and resources. Growth has not been evenly shared among or within the various countries. A number of national economies particularly in Asia have brought a new dimension to the equation north—south equalling rich—poor. Particularly India and China have emerged as new global economic powerhouses.

Mountain systems have benefitted only marginally from this situation. The policies in the mountain countries were also focusing on growth. Yet, with the growing awareness of the scarcity of resources (in particular freshwater) the effects of climate and the relevance of the ecosystem services of mountain systems became a focus of attention. However, methods of economic valuation of ecosystem services and payment mechanisms in mountain areas are needed to comprehend and realize the benefits (Rasul et al. 2011).

The perception of mountain systems has experiences an important change since 1992. While science dominated by northern researchers continues to emphasize the physical dimensions of their work, the development needs of the mountain areas in the southern hemisphere are calling for a greater role of social sciences. While changes in the mountain systems in the subtropical zones of Asia, Africa and Latin America have a direct influence on the livelihoods and food security of the millions of people, mountains in industrialized countries are much more perceived as areas of tourism and recreation. Mountain systems in subtropical zones introduced new criteria for the relevance of mountains: increase in vulnerability and reduced food security in the downstream areas will be the consequence if they are not managed sustainably.

These aspects of vulnerability and fragility had as a consequence that the relevance of the mountain agenda has moved south into the subtropical zones and has changed its perspective.

Mountain Systems—Challenges and Opportunities

The mountain systems of the world have not been receiving the attention deserved, which has increased their marginalization. Due to the massive economic growth and the development of communication and transport along the globalization of international relations, the evolution of mountains has taken place in the wake of the dynamics of urban centres. Rapid urbanization, a rural—urban continuum and migration resulted in increased marginalization.

At the same time the relevance of the availability of freshwater (see the chapter by Basumajumadar in this volume), the importance of biodiversity (see the chapters by Bargali and by Lodhiyal et al. in this volume) but also the relevance of the

identification with local values in a globalized environment has provided the mountains with an attention, which the mountains never had in recent history. Melting glaciers, the intensification of floods and extended droughts are the most visible and alarming signs. Compared to the situation during the Rio Conference in 1992, the mountain systems are now seen as the providers of strategic ecosystem services, which are a prerequisite for food security and poverty reduction and a central argument for sustainable development. Here again we observe a shift: while climate change is weakening the mountain ecosystem services in subtropical and tropical zones, other regions, e.g. the Scandinavian mountains, will be winners in terms of increasing precipitation and energy production.

The growing awareness of the importance of mountain systems, particularly of the Andean and HKH ranges gives new significance to upstream—downstream relations. The question is how services from the mountains provided to the downstream areas are compensated or, in other words what are the policies and strategies that make the services sustainable in the interest of regional development? The river systems having their origin in the HKH have their footprint in the food security of 1.5 billion people, and for energy security up to three billion people!

Climate Change Mitigation and Adaptation

Climate change is in recent times an additional driver of change particularly for mountain systems. On the one hand mountains are particularly fragile and their vulnerability is of particular importance for the mountain population. The increased awareness creates on the other hand also new opportunities. Of particular importance are the consequences and the instruments, which are being discussed in order to reduce global warming, and the impact on climate change.

Mitigation: Simplifying the discussion associated with mitigation we often exclusively focus on green house gases, whereas adaptation is associated with water. The reduction of green house gases requires a long-term effort of global dimensions. Optimal measures will not hinder global temperature to increase during the coming 50 years. Mountain systems serve as early birds for changes of climate and framework conditions created by the outside world. The glaciers serve as an excellent indicator for the measures reducing climate change. Glaciological research in the Himalayas is therefore not only in the interest of the regional countries but also has a global concern!

Adaptation on the other hand has to start with greater attention. While mitigation needs global agreements, adaptation calls for tailor made ecosystem specific measures. While the development agenda has been globalizing for the past 30 years, adaptation calls for mountain specific measures. For the first time specific programs for mountain systems enjoy political and diplomatic support, in the interest of a

sustainable mountain development and of sustainable ecosystem services for downstream populations.

In addition increasing evidence shows that a distinct separation between mitigation and adaptation is no longer possible. Black carbon and tropospheric ozone are hazardous to health and also influencing the agricultural productivity and is contributing substantially to glacier melt. These short living aerosols (contrary to green house gases) can be reduced with appropriate measures. According to the present status of research such measures could contribute substantially to the slowing of earth warming in the coming thirty-to-forty years, i.e. before he global mitigation measures are kicking in. Reduction of the emission of black carbon is a mitigation measure. Contrary to green house gases they are also the product of non-industrial production. They are produced also locally by households through the burning of biomass, wild fires etc. Reducing black carbon therefore calls for action also in the mountain areas. Adaptation to climate changes need well targeted regionalized and localized strategies.

The Rio+20 Conference: An Opportunity for the Mountain Agenda

The Rio conference of 2012 had two main topics: 'Green Economy' and 'Governance' in the frame of sustainable development. Green Economy should address the issue of low carbon economy. The addressees are mainly the country with a substantial degree of industrialization and a high output of carbon.

The advocates of the mountain agenda were split in two camps: Those who tried to link the "Green Economy" with the mountain economy arguing that the global community should engage in helping the mountain economy to remain with a low carbon output, and those defending the mountain agenda of 1992. The most important outcome was the intention to create mountain knowledge centers in the major mountain systems of the world. The renewal of the agenda and its adaptation to a globalized was postponed to the subsequent debate on the sustainable development agenda post—2015.

We see a high potential for the mountain systems if we manage to argue in a smart way and if we manage to construct the rational in a consistent and convincing way. We see a unique opportunity to put the mountain agenda in the frame of CBD and UNFCCC and in view of the Sustainable Development agenda.

There are two hurdles to be overcome: we need a robust science base and knowledge to make the case of the mountain systems and mountain known to the peoples of the world, and we need to take the mountain agenda out of its corner and make it a mainstream concern in order to create a sustainable world.

Reducing Scientific Uncertainty: Responsibilities for Scientists

Some thematic areas that require urgent attention are:

Climate trends: Changing behaviour of the monsoon; role of the winter monsoon and the Westerly's; role of the heating of the atmosphere (Tibetan Plateau); customizing global climate change scenario.

Mitigation: Black carbon and tropospheric ozone; REDD+, REDD++.

Cryosphere: Mass balancing; hydrological balancing; behaviour of glaciers (sweep and debris covered); role of Karakorum glaciers; glacier lakes as risks and potentials; snow melt and monsoon discharge.

Water: Hydrological balance; discharge modelling; water storage; changing discharge pattern due to climate change and consequences for debris flow.

Livelihoods: Vulnerabilities; disaster risks; adaptation (herders, below the tree line); adaptation or SDM; labour migration and remittances; how to build resilience in a changing social fabric; changing gender patterns and role of women; new forms of livelihoods.

Biodiversity: Changes in biodiversity due to climate change (biodiversity corridors versus crowding out); changes in plant sociology and soils stability; invasive species and soil stability; management of biodiversity as a source of livelihoods; market driven biodiversity management.

Green Economy: Costs for green to remain green; mechanisms to ensure the sustainability of marginal and fragile areas; valuation of ecosystem services; payment for ecosystem services; use of national resource as part of the national accounts.

Need to Bridge the Knowledge Gap

Are we ready to take up the challenge? The deficit of reliable and consistent research has been the main drawback of the HKH region. The example of glaciers is representative for this situation. Largely non-regional researchers have conducted research. This has hardly enriched the regional academia and has recently led to controversies, which are in nobody's interest. When talking of research we have to ask ourselves if we are ready to propose well-targeted measures of adaptation? Currently we experience a rebranding of development measures because in practice we do not distinguish between sustainable development and adaptation.

There is no evidence that the Earth Sciences are strong enough to prominently take part in the discussion. We have to understand demographic dynamics, poverty as well as governance issues. These capacities in the region are missing and there is a tremendous and rewarding field of work.

Defending the Mountain Agenda

Who is going to defend the mountain agenda? We have to assume that the industrialized countries have other priorities. They can be supportive but will hardly take a leading role. The discussions in such platforms as Mountain Partnership continue to be dominated by topics of physical geography. Issues of food security, increasing vulnerability, poverty and migration, and the quest for new livelihood strategies, which are the relevant issues in the HKH but also in the Andean countries and Africa, need more attention, if sustainable mountain development is to lose its marginality.

We have seen that in the framework of climate change and biodiversity the relevance of mountain systems in the south has increased. This means also that adaptation to climate change and the sustainability of ecosystem services has to be articulated in the interest of the south especially the mountains. We therefore have to assume that the mountain agenda has to be defended by the riparian countries of the subtropical zones, where these systems are pre-eminently important for sustainable livelihood. The experience of the new century has also taught us that the increasingly fragile mountain systems may turn into a region of outmigration, insecurity and terrorism. Therefore the mountain agenda has to be part of global sustainable development agenda.

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Chapter 9
Going Global: Livelihoods and Globalization in the Niti Valley, Garhwal Himalaya, India

Keith Bosak and Sunil Kainthola

Introduction

The local Bhotia people of the Niti valley have experienced dramatic changes in their livelihood options over the last 50 years. Prior to 1962, the Bhotia practiced transhumance and trade with Tibet. When the border with Tibet was closed in 1962, the Bhotia continued to practice transhumance in a more limited geographic area. In 1974, the peak of Nanda Devi was opened to western mountaineers and the Bhotia began earning money as porters and guides for expeditions. Unfortunately, the mountain was closed to all people in 1982 following serious concerns of environmental degradation from too many visitors. The Bhotia had to return to farming and grazing animals. In 2001, after almost 20 years of economic and cultural decline, the Bhotia began an ecotourism initiative with the goal of providing a livelihood option that would promote conservation and equity while providing an income for local people. Then in 2005, Cordyceps sinensis, a medicinal herb that is highly valued for its curative properties was discovered in the region causing a rush for local people to collect as much as possible. People are earning as much as $3000.00 US in a month collecting Cordyceps and what they are doing with the money is changing the villages of the Niti valley in a dramatic way. This project explores the way in which the Bhotia have operated within and across scale and constructed scale in order to adapt to these changes brought about by globalization.

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Scale and the Politics of Scale

Inherent in globalization discourse is the notion of a spatial hierarchy, conceptualized as the global, national, regional and local. These scales of analysis are often used as fixed "containers" within which environmental policies and discourses are framed and debated. A growing number of researchers however are challenging the unquestioned use of these discrete scales of analysis. This is because when we refer to "global" "environmental problems," or to "regional" violence, or "local" unemployment we automatically privilege particular frames of reference over others. In thinking about environmental problems as global, for example, local actors and outcomes become relatively powerless. Likewise by referring to unemployment as a local issue, we shift our gaze from the structural problems within which this unemployment occurs (Smith and Dennis 1987; Smith 1992; Cox 1997).

To overcome discrete scales, social agents continually seek to produce and reconstruct scale in a manner that will help them attain their political goals. Numerous case studies illustrate scale as socially constructed. Herod (1997), for example, illustrated how labour unions deployed scale to their advantage in contract negotiations. Sometimes it is more advantageous for unions to negotiate local contracts knowing that they could draw on the support of union members across the US. Kurtz (2001) highlighted the use of scale politics in the controversy surrounding the siting of a petrochemical company in a predominantly poor, African-American parish in Louisiana. Whereas the company management and the Louisiana governor sought to cast the issue as highly localized and questioned the motives of the activist organizations, the environmental justice advocates repeatedly framed the controversy within the more universal language of civil rights and family/community to appeal to a larger audience. These and many other examples reveal that agents often negotiate their way within and between scales and often "jump scales" as when local actors "go global." Therefore, scale is both discrete, acting as a fixed container and a social construct. As such, actors move between and within scales such as those imposed by administrative units and simultaneously construct scale as the examples of Kurtz and Herod Illustrate.

In this section we will give a brief overview of scale and how it has been defined by geographers. This will lead into a discussion of the 'politics of scale' as they are broadly defined. After providing this background we will move into a discussion of how scale is theorized as both a fixed container and a social construct. This is a rich debate which demands some attention.

At first glance, the concept of scale seems straight-forward. We all use it in our everyday lives when we talk about things like the federal government or globalization. Geographers also work regularly with scale in their research, whether it is with a regional housing authority or a watershed management program, most research projects are defined at a certain scale. Delaney and Leitner (1997: 91) define scale as, "referring to the nested hierarchy of bounded spaces of differing size such as the local, regional, national and global." However, scale is much more complicated than the level of analysis of a research project. Scale was once thought

of as an ontological category, meaning that it exists somewhere in the 'real' world. Recently however, geographers have begun to question this categorization and see scale as an epistemological structure, a way of knowing about the 'real' world (Jones 1998). This is because scale both exists materially and is a social construct. As a social construct, scale becomes fluid, an outcome of an ever-changing series of events which continually produce and re-produce scale. When addressed from this perspective, scale becomes a reflection of space and power relationships (Delaney and Leitner 1997). Scale inhabits these two realms simultaneously. Jonas (1994) provides an excellent summation of the complexity in defining scale:

> Sometimes scale depicts a geography of difference in landscapes. On other occasions, scale is a set of abstractions through which we make sense of social processes making and remaking these material landscapes. To complicate matters further, scale is often used metaphorically in the sense that scale differences are implicit but are not fundamental to the idea being presented. (Jonas 1994: 257)

Jonas defines scale as a set of material processes, an abstraction and as a metaphor. All three of these definitions of scale are not mutually exclusive and each has its own set of implications. Furthermore, scale is not hierarchical in the way it is defined here. Instead, it is nested. In this way, several scales can be simultaneously implicated in a single event such as Tiananmen Square, 1989 (Smith 1992). The interest here is to engage with the 'politics of scale' so we will focus primarily on scale as a metaphor, bringing in ideas of scale as a material process into the discussion. No one can question the material existence of hierarchical scales of the state (municipalities, counties, councils of government). The interest here is the social context from which these material scales emerged. This idea that scale is socially constructed is embedded within its definition as a metaphor. Using this perspective, we begin to speak of the 'politics of scale' or the social construction of these material processes.

In using scale as a metaphor, it is useful to discuss the discourse of scale and its use in rhetoric. As noted above, the politics of scale reflects space and power relationships. As such, political actors seek to construct scale through space and time. "Groups and organizations strategically 'map out' material scales that eventually might liberate them from their existing scale constraints" (Jonas 1994: 263). This can be seen in the global indigenous movement. Although the movement is constructed as global, the rhetoric only reflects a series of localized struggles which have been portrayed to be global in order that indigenous groups may position themselves against the forces of global capitalism. In this way, the global indigenous movement establishes an identity with which to struggle against what is seen as an oppressive force. To further complicate matters, the discussion of socially constructed scale as both an abstraction and metaphor has been taken further where scale is seen as a series of networks (Cox 1998).

Cox (1998) introduced the idea of scale politics as a series of networks. Within this he categorized two 'spaces': the spaces of dependence and the spaces of engagement. Cox defines spaces of dependence as: "a space within which it is possible to substitute one socio (-spatial) relation for another but beyond which

substitution is difficult if not impossible" (Cox 1998: 5). Cox gives the examples of local housing and job markets in order to illustrate his concept. In a local job market, it is much more likely a firm will substitute a worker from the immediate area rather than from a neighbouring city. In this way, spaces of dependence take on an immobile form. Because of this, local interests are often expressed within spaces of dependence. It is also important to note, these spaces of dependence can occur at an array of scales and their boundaries are not clearly defined. Spaces of engagement exist in relation to spaces of dependence and extend into and beyond spaces of dependence to construct networks of exchange. This is best illustrated through an example from Cox (1998). The example is from a landuse conflict in England. This conflict began because in the implementation of a national landuse plan, an aggregate quarry was to be built near the town of Chackmore. The immediate response of local residents was to form an opposition group to contest the development. Quickly realizing they could not protect their interests by simply fighting within their local space (space of dependence); the group formed a network of agents at the national level. This was because the space of engagement had already been set at that level due to the national landuse plan. The group organized nationally by bringing into the issue, the potential degradation of Stowe Park, a nationally recognized green space located near the proposed development, thereby 'jumping scales'. In this way, they turned local interests into a national issue and were successful in their struggle. So for Cox (1998): "Spaces of engagement which have been the focus of the politics of scale are constructed through networks of association and these define their spatial form". Therefore, scale can be thought of as a network whereby local struggles are linked to regional, national or global events. In doing so, local groups use discourse in order to jump scales, allying themselves with other groups and/or finding a constituency at the level of engagement.

In response to Cox (1998), Judd (1998: 30) argued that: "the scales constructed by the state often make it difficult for political agents to construct a scope of conflict which is more advantageous to them." Furthermore he argued that this is not an accidental occurrence. His argument is based on the idea that there may be an absence of scales which makes it difficult to construct scale as a discursive strategy. Judd (1998) gives the example of the takeover of Eastern Europe by the former Soviet Union after World War II. In this case, the Soviet Union abolished local government structures giving citizens nowhere to raise issues about industrial poisoning in their cities. By removing the government at the local scale, the Soviet Union was able to effectively remove the local scale. Therefore, citizens concerned about toxic exposure would have to take their grievances to higher levels of government.

Globalization and Adaptation in the Niti Valley

The Bhotias of the Niti Valley (Fig. 9.1) are a hearty and adaptive community who has lived in a harsh environment for hundreds of years. While one may at first assume that their livelihood practices have been sustainable and static over this

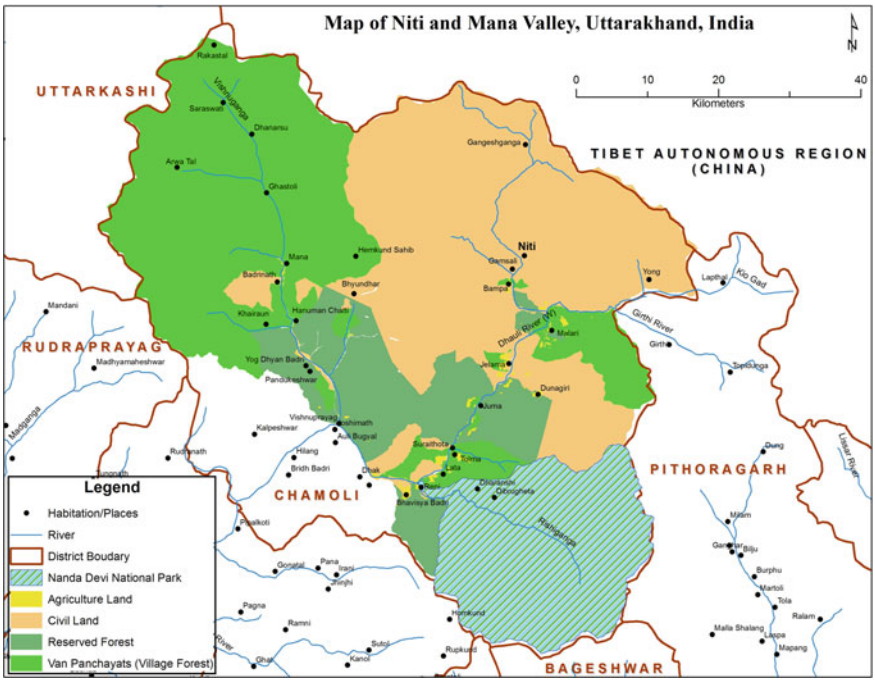

Fig. 9.1 Map of the Niti valley, Garhwal Himalaya (by B.S. Mehta)

entire time, that assumption is partially false. The Bhotias react dynamically to a dynamic environment. This is not just a reaction to the physical environment that they encounter but also various social, economic and political forces that have encountered them over the decades. This type of dynamic adaptation to the environment can be seen most prominently in the era from 1962 until the present as the forces of globalization have crept in and begun to influence the Bhotia.

Prior to 1962, the Bhotias were primarily transhumant pastoralists who engaged in the trade of goods from the Tibetan Plateau to the Gangetic plain. Many Bhotias were quite wealthy from this combination of livelihood activities. The women were adorned with massive necklaces made from silver and gold and many wore ear and nose rings of gold and silver. This all changed in 1962 when India went to war with China over a border dispute. At this time, the Border between the two countries was closed, meaning the Bhotia could no longer trade with Tibet. Although this was a major blow to their way of life, the Bhotia adapted quickly, intensifying grazing on village lands in the summer and conducting trade with the lowlands in winter. The pattern of transhumance was modified to fit the restrictions of the two governments on the Bhotia's movements.

Then in 1974, the Chipko movement further opened the Bhotia to globalization. While the movement started in the village of Reni and quickly spread through the region, it was for the people a local movement until it was appropriated by western

academics and environmentalists as the first examples of ecofeminism and grassroots environmentalism in the developing world. While the Bhotias were not reacting to globalization directly with this movement, they were becoming increasingly aware of the global-local continuum and the notion that global issues and events can affect local people and vice versa. This same year, the peak of Nanda Devi was opened up to foreign expeditions for the first time in decades. This led to an immense amount of interest in the peak as a mountaineering destination. Many expeditions came through the Niti Valley on their way up the Rishi Gorge and into the Nanda Devi Sanctuary (Fig. 9.2).

The whole affair could take from 3 to 6 months. Nanda Devi quickly became a popular destination for climbers and trekkers and the local people began to enjoy an increased standard of living due in part to the wages garnered from portering and guiding for expeditions. The other important and often overlooked outcome of the opening of Nanda Devi was that a route to the inner sanctuary of the peak through the precipitous Rishi Gorge was opened up. This route was well maintained and eventually became suitable for goat traffic. The Bhotias would simultaneously take loads for expeditions on the backs of their goats (up to 20 kilos per goat) and graze their sheep along the way to base camp. This proved lucrative for the local Bhotias

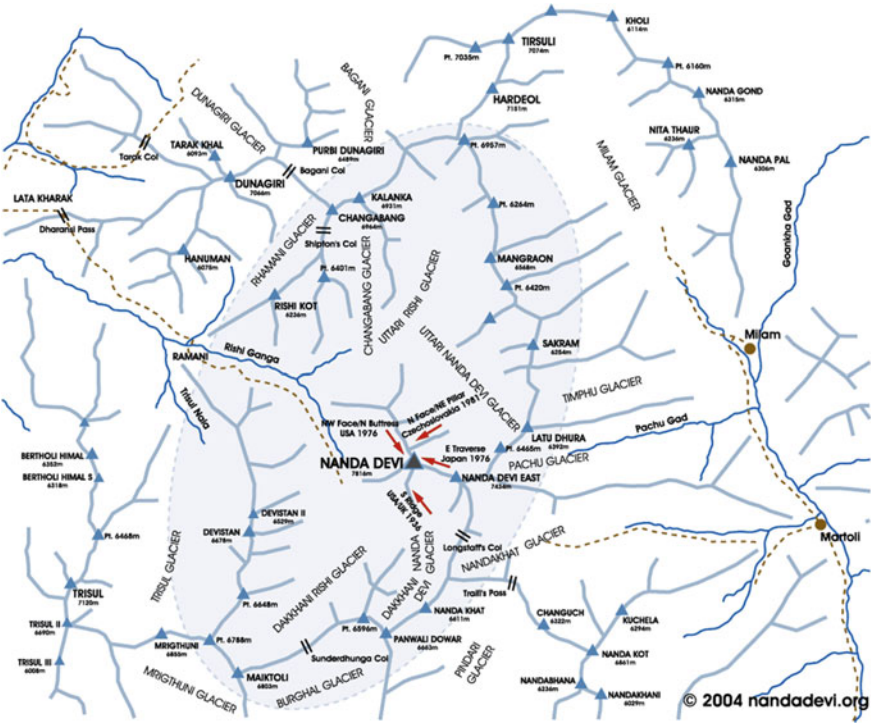

Fig. 9.2 Map of Nanda Devi and the surrounding region showing climbing routes on Nanda Devi (Map by Rajiv Rawat)

and many were now enjoying western clothing, cameras and other items. It is interesting to note here that it was the trail made by international mountaineering expeditions that allowed the Bhotias to graze their herds in places they never traditionally grazed. Unfortunately, the area became overused by both the mountaineering community and also by the local Bhotias. As early as 1977, reports of environmental degradation in the Nanda Devi Sanctuary were being circulated. In 1982, the area was finally closed to all people.

During this era from 1974 to 1982, the Bhotia had largely abandoned farming in favour of working as porters and guides as those jobs paid much more than farming. As part of their adaptive strategy, they also began to graze goats along the path to base camp that was opened up and maintained by largely foreign expeditions. Beginning in 1982, standards of living dropped. The closure of the park took away vast amounts of pasture, both traditional and non-traditional grazing grounds. This coupled with the limits to transhumance placed on the Bhotias due to the border closure led to a period of economic and cultural decline and further adaptation. With their grazing lands severely limited, the Bhotias began to sell and slaughter their sheep as there was no alternative. Farming practices were intensified but farmlands were not substantially expanded. Therefore, as sources of income were being lost, other less lucrative sources of income were being re-introduced. This led to a decline in standards of living for many families.

In an article published in 1998, Maikhuri and Rao report on the restrictions imposed on the local people by the Biosphere Reserve authorities. They note that policies have "disturbed the rural lifestyle and economy, doing little to conserve the ecology." The article also states that the village elders are of the opinion that the forests were better protected before the creation of the Nanda Devi Biosphere Reserve (NDBR). In concluding the article the authors note: "The locals are not familiar with high-sounding terms like biodiversity, conservation and sustainability, but they certainly know the immense significance of forests, wildlife and medicinal plants" (Maikhuri and Rao 1998: 2). As we will see, the ignorance of the locals to the discourse of global biodiversity conservation was short-lived once they began to 'scale up' their struggle.

Then, in 2001 an Indian Mountaineering Foundation (IMF) expedition came to Lata Village to hire porters for a so-called scientific expedition into the core zone to determine if it was fit to be reopened to mountaineering. The locals were quite happy about this development as many remembered the era between 1974 and 1982 as one of great prosperity. However, a tiff between the local people and expedition members broke out over payment of fees to the village of Lata and the relationship became strained. After finding out that the expedition members were not in fact conducting scientific studies but were assessing the area to be opened back up for tourism under the control of the IMF and tourist companies from Delhi, the Bhotias began to protest and organize. From this came the ecotourism declaration, an assertion of how the Bhotias would like to promote locally managed ecotourism as a sustainable livelihood activity (Appendix A).

The local people have always maintained that the reason for agitation is the lack of economic opportunities caused by the policy restrictions of the biosphere reserve.

Even a senior Forest Department official noted: "They never meant to carry out any research in the first place; hence they had no qualms proposing whatever they felt like. The expedition looks like a team of businessmen on a reconnaissance mission for new business opportunities" (Sethi 2001: 21). In response to this, Dhan Singh, a local leader was quoted as saying: "The Forest Department has made thieves out of us in our own backyard. Now they want us to beg before the tourist operators to earn menial amounts. If the NDBR is to be opened for tourism, let the people of the region manage the business and earn off it" (Sethi 2001: 21). The distress of the local people over the possibility that the NDBR would be re-opened for tourism without their involvement led to a workshop in Lata in October 2001 attended by local people and the Alliance for Development. This watershed event signalled the emergence of this struggle from one of local significance to one of global significance that began to use the discourse of global biodiversity conservation and sustainable development to further its own goals.

In an article focusing on the conflicts between local people and park management over crop and livestock depredation, Rao et al. (2000) write about the conflict: "The experience of top-down conservation programs in recent decades has led to a breakdown of the local community's relationship to the natural environment and is the cause of the increasing hostility of local people to conservation. This is especially true with respect to the reserve management authority" (Rao et al. 2000, p. 323). The authors go on to write: "It is conceivable that more effective conservation could be achieved with less government enforcement if some forms of control were turned over to local villages, as planned for the Annapurna Conservation Area in central Nepal" (ibid., p. 323). The first quote expresses the authors' opinions that current management practices are the source of the conflict and that the conflict is primarily taking place at the local level between the community and local management authorities. The second quote makes reference to a possible outcome that may alleviate the conflict. This quote specifically states that local control could both quell the conflict as well as promote conservation in the area and echoes the views of the communities that local control will not only help maintain Bhotia culture and livelihoods but also promote the conservation of biodiversity. In another article, the same group of authors concludes:

> If development interests of local people are marginalized for a long period of time, they might adopt actions detrimental to the goal of conservation. Though it will be unrealistic to expect biosphere reserve authority to solve all socio-economic problems to the satisfaction of local people, people's participation in management planning and monitoring could reduce the prevailing conservation-people conflicts (Maikhuri et al. 2001).

Once again, the authors conclude that the top-down, globalized policies of the NDBR have ignored the interests of local people and that the conflict can be alleviated through local participation in management. In addition to this, there is a warning that further marginalizing local people will be detrimental to biodiversity conservation and thus contradictory to the goals of the World Heritage Committee and the Man and the Biosphere program.

Another recent example of local responses to globalization is most easily explained as the rush to collect Cordyceps sinensis. Cordyceps sinensis is known in the west as Caterpillar Fungus and it first gained global notoriety in 1993 when two Chinese runners smashed world records in three events at the Chinese National Games in Beijing. The women claimed that the revitalizing properties of Caterpillar Fungus helped them achieve their stunning results (Hugonoit 2004). In the last few years, global demand has pushed the price of Caterpillar Fungus to $7000.00 a kilogram, causing severe overharvesting and environmental damage in Tibet where the herb was historically collected (Hooper 2005). Recently, Caterpillar Fungus has been discovered in the Indian Himalaya, causing a caterpillar rush in some villages of the Garhwal region. Herb collectors are making as much as $3000.00 per month during the harvest season. The economic boom coming from legal and illegal harvesting of caterpillar fungus on village lands as well as public and protected lands is causing rapid social and cultural change in these remote villages. Entire families are leaving their villages for weeks at a time during the summer months to camp in the alpine meadows and search for the herb, leaving their children, crops and livestock behind. Like in other areas, Cordyceps sinensis, locally known as Kidajadi is being severely overharvested and will likely be gone within a few years. In the meantime, people are spending the money they earn in myriad ways. Some are investing in their children's education by paying to send them to nearby towns that they might get better schooling. Table 9.1 illustrates this trend in the villages of Lata and Tolma. Some people are using the money as an investment in another livelihood. For example, many young men are buying vehicles that they can use as local taxis to transport people up and down the valley. Others are improving their houses and some are buying consumer goods such as TV's and satellite dishes. Regardless of how the money is being spent, it is having an effect on the culture and social systems of the region. In adddition, the competition between villages for collection areas has caused unprecedented conflict in the valley over territorial rights. These conflicts have even led to violence when villagers from one village tried to collect in the territory of another village. These events all illustrate the global-local continuum at work within the NDBR. The Bhotias have had to adapt their livelihood activities to the changes that globalization has brought to their location. On the other hand, the Bhotias have also seen that the continuum between the global and local is not a one-way street and that they must not only react to global events that change local livelihood activities but also must portray their local

Table 9.1 Students studying in the villages of Lata and Tolma and those studying in the towns

Village	Number of house holds	No of students studying in the village primary school	No of students studying outside the village	Location where studying	Average monthly expenses
Tolma	17	4	19	Tapovan-Joshimath	4000
Lata	105	38	26	Tapovan-Joshimath	4000

Source Field work 2011

struggle to maintain their culture and resource rights as one of global importance. Within this context, scale and the politics of scale play an integral role in how the Bhotias of the Niti Valley have engaged global discourses in their effort to maintain viable livelihood options. In the next section, we discuss the broader implications of this interaction (or lack thereof) with globalization and the global-local continuum.

Discussion

Through this discussion, we intend to elucidate the most salient themes that have emerged from our study of the people of the Niti Valley and their responses to globalization. We will also discuss how scale has been successfully negotiated and constructed by the people of the Niti Valley in order to craft responses to globalization. The themes we have identified are as follows: 1-Globalization has resulted in the need to quickly adapt local livelihoods to changing conditions; 2-Globalization has also resulted in boom and bust cycles; 3-There have been limited opportunities for the Bhotias to interact/influence directly with the global scale despite efforts; 4-Changing livelihoods also produces changing culture as the two are intimately connected.

One response to globalization that the Bhotias of the Niti valley have crafted is the ability to quickly adapt local livelihoods to changing conditions. This is evidenced in the change from trading with Tibet to trading internally in India after 1962. Furthermore, livelihoods have changed several times since 1962. The opening of Nanda Devi in 1974 for foreign expeditions provided the opportunity for the men of the villages to work as porters and guides, earning enough that many families abandoned farming during this period. After the closure of Nanda Devi in 1982, livelihoods shifted again back to subsistence farming as portering and guiding were no longer an option and the land once used for grazing became integral for global biodiversity conservation. The next shift in livelihoods occurred in 2001 with the Nanda Devi Biodiversity and Ecotourism Declaration that revived ecotourism in the region. Unfortunately, this endeavour has not had widespread success (which we will discuss below) so people have moved on to collecting Cordyceps sinensis as a more lucrative livelihood option. What we are observing in this case is that people have to change their livelihoods rapidly, about once a decade over the last 50 years.

These rapid changes in livelihoods due to opportunities and constraints provided by globalization have led to boom and bust cycles for local people. We can trace these cycles beginning in 1962 when trade with Tibet was cut off, leading to a bust cycle. Then in 1974, the opening of Nanda Devi to foreign expeditions produced a boom cycle, followed by a bust cycle after the closure. Finally, the collection of Cordyceps is producing a boom cycle but people are already anticipating the bust cycle that will follow and are shoring themselves and their families up by investing in their children's education and in alternative livelihoods, both of which have unintended consequences that we will discuss below. These boom and bust cycles

indicate to us that the Bhotias have had few opportunities to interact with/influence the global scale and are instead reacting to the forces of globalization that are acting upon them.

This is evidenced in the collection of Cordyceps whereby people are making money but are isolated from world markets because herb dealers come directly to the villages and offer a fixed price for the Cordyceps. Local people have no knowledge of what Cordyceps is going for in global markets or if what they are being paid is fair. A second example of limited participation in the global-local continuum is through ecotourism. The 2001 Nanda Devi Biodiversity and Ecotourism Declaration set out the ideals for ecotourism in the region with a purpose of attracting tourists from India and around the world. However, the people of the Niti Valley have virtually no access to technology such as the internet and few locals speak English. Therefore, efforts to develop ecotourism at the local level have largely stalled due to the lack of ability of local people to interact with global or even national tourism markets. In addition, if the NDBR is ever reopened for tourism, the lack of ability for local people to access and influence global tourism markets will result in them being out competed for business by companies operating out of Delhi or internationally who can access global markets. Therefore, the idea that community-owned ecotourism can be a viable livelihood option is not realistic unless people can access or influence the national and global scales at which tourism operates and move beyond their spaces of dependence.

Given this, there have been two examples where the Bhotias have engaged with globalization through the global-local continuum, creating spaces of engagement. The first is through the Chipko movement. While this was a local struggle in many ways, the attention in garnered at the regional, national and international scales helped to propel the movement onto the world stage, leading in part, to its success in reforming logging practices in Northern India. Second has been the struggle for resource rights in the Nanda Devi Biosphere Reserve. While resource rights have not been fully restored, the Bhotias have had some success in using the global scale to influence national and regional scales at which the Reserve is administered. This was accomplished through the formation of a loose network of academics, advocates and other interested parties across the planet with interests in this region who also had influence at the global scale (Bosak 2008). It is significant to note that both of these situations involved the need to assert rights to resources that were being threatened. The right to access local resources is one of the major issues surrounding global conservation and development. If local people cannot access resources, they have nothing on which to base their livelihoods and thus have to find new livelihood options. The increasing frequency with which this is happening as a response to globalization has implications for culture change.

As livelihoods in the Niti valley become more closely tied with globalization, culture also changes. Culture change is of course always occurring but in this case, the changing culture is not a result of deliberation but rather a response to the need to develop new livelihood strategies. For example, the rush to collect Cordyceps has led more and more people to send their children off to the towns for school. Many of the children in the Niti valley no longer grow up in their home village, learning

about traditional livelihoods and culture. Rather, they grow up in urban environments. So, while many wish to return to their villages some day, many have no desire to pursue traditional livelihoods and most have abandoned traditional animist beliefs in the environment as sacred. Compounding this effect is the commodification of nature brought about by global demand for Cordyceps. Cordyceps is being harvested as quickly as possible and is not being regulated through traditional resource management regimes. It is simply seen as a commodity that can be exploited for maximum profits. People are well aware that they are overharvesting and that collecting Cordyceps in this manner is not sustainable. This is an unprecedented shift in paradigm from one where nature is sacred and integral to human survival to one in which nature exists as a resource to exploit for profit.

The Bhotias of the Niti valley have increasingly been exposed to globalization since 1962. However, the interaction has largely been one-sided with the Bhotias simply responding to the forces of globalization rather than engaging with them. In the cases where the Bhotias were able to manipulate or construct the scale of their grievances at the global level, they have had some success. However, there is still not evidence here that there is a true global-local continuum whereby local people can directly engage with the global scale. Many times, regional and national scales act to block access to the global scale and other times, the lack of access to technology and the global language (English) acts as a barrier. In addition, responses to globalization in a one-sided manner as we have seen in this case, produce a boom and bust economy, increasingly commodify nature and produce unintended consequences for the local culture.

Appendix A: The Nanda Devi Biodiversity Conservation and Eco Tourism Declaration, Gram Sabha Lata, Chamoli, Uttaranchal, October 14, 2001

Today on the 14th of October, 2001 in the courtyard of the temple of our revered Nanda Devi, we the people's representatives, social workers and citizens of the Niti valley, after profound deliberations on biodiversity conservation and tourism, while confirming our commitment to community based management processes dedicate ourselves to the following:

1. That we, in accordance with the resolutions adopted by the World Tourism Organisation's Manila Declaration 1997 on the Social Impact of Tourism will lay the foundation for community based tourism development in our region
2. That in our region we will develop a tourism industry free from monopolies and will ensure equity in the tourism business
3. With the cessation of all forms of exploitation like the exploitation of porters and child labour in the tourism industry, we will ensure a positive impact of tourism on the biodiversity of our region and the enhancement of the quality of life of the local community

4. That in any tourism related enterprise we will give preference to our unemployed youth and under privileged families, we will also ensure equal opportunities for disabled persons with special provisions to avail such opportunities
5. That we will ensure the involvement and consent of the women of our region at all levels of decision making while developing and implementing conservation and tourism plans
6. While developing appropriate institutions for the management of community based conservation and eco tourism in our area we will ensure that tourism will have no negative impact on the bio diversity and culture of our region, and that any anti social or anti national activities will have no scope to operate in our region
7. We will regulate and ensure quality services and safety for tourists and by developing our own marketing network will eliminate the middlemen and endeavour to reduce the travel costs of the tourist
8. While developing the tourism infrastructure in our region we will take care of the special needs of senior citizens and disabled persons
9. As proud citizens of the land of the Chipko movement we in the name of Gaura Devi will establish a centre for socio-culture and biodiversity, for the conservation and propagation of our unique culture
10. We will ensure the exchange and sharing of experiences with communities of other regions to develop eco tourism in accordance with the Manila Declaration of 1997 in those regions
11. Acknowledging the spirit of Agenda 21 of the Earth Summit, Rio 1992, the Manila Declaration on the Social Impact of Tourism 1997 and the InternationalYear of the Mountains and Eco tourism, 2002, we will strive for bio diversity conservation and an equitable economic development within the framework of the Constitution of the Republic of India
12. Today on October 14, 2001, in front of our revered Nanda Devi, and drawing inspiration from Chipko's radiant history we dedicate ourselves to the transformation of our region into a global centre for peace, prosperity and biodiversity conservation.

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Chapter 10
Globalization and the Indian Himalayan States: Mitigating or Accentuating Marginalization?

T.S. Papola

Introduction

Eleven Indian States, Arunachal Pradesh, Assam, Himachal Pradesh, Jammu and Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and Uttarakhand have entire, major or minor parts of their territory in the hilly and mountainous region of the Himalayas. They also happen to be on the geographical and political margin of the country. Each of them shares borders with one or more foreign countries. Seven of them are located in the North Eastern part of the country, which are beyond another large country (Bangladesh), and are connected with main-land India by only a narrow passage (see Fig. 10.1 for the geographical location of these states). The geo-political marginality of these states is exacerbated by isolation caused by relatively low levels of transport and communication connectivity. Thus natural and man-made factors combine to marginalize these areas. And when they are inhabited by tribals and ethnic communities, as happens quite often, they also suffer from cultural marginalization.

Globalization is often seen as a secular and equalising process and as such is expected to bring marginalized areas and communities into the mainstream of economic and social activities by enabling them to link with other areas and wider markets through the use of the comparative advantage provided by their special resource endowments. The extent to which these areas can benefit from globalization would depend on the availability and utility of unique resources, as they face

Editor's note: Prof. T.S Papola, a known economist of international repute left for heavenly abode on 23rd November, 2015. We pay our sincere gratitude to him for his worthy contribution.

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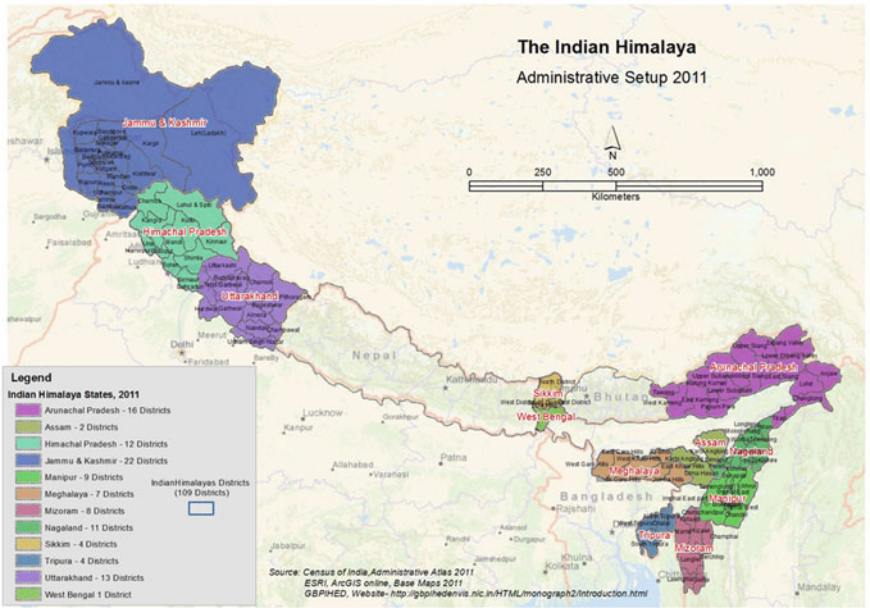

Fig. 10.1 The Indian Himalaya: administrative set up 2011 (map by R.C.S. Taragi)

distinct disadvantages in the production of goods and services that are in competition with those produced in low land areas in the plains. Dependence on the production of common goods is, in fact, likely to lead to an exacerbation of marginalization of these areas in so far as globalization, with the opening up of these areas to the products from outside will put the local production at a disadvantage. Globalization in such cases may lead to a reduction of isolation, but at the same time, it makes the local population highly dependent on other areas, both for income and products. Outmigration may increase and those left behind may have to subsist primarily on remittances.

The Resource Base

The Indian Himalayan region where the eleven states mentioned above lie fully or partially is proverbially rich in resources. Low population density adds to this richness as it leads to high per capita availability of these resources, particularly land. Most of them have large parts of their area under forests rich not only in wood but also in minor forest resources, flora and fauna and biodiversity. They are rich in rivers with a high potential for hydro power generation. Some of them also have mineral resources of high value. What, however, appears as richness of resources on the surface, does not translate into actually useable potential for economic benefit.

No doubt, the population is thinly distributed across vast tracts of the land. But most of this land is not fit for cultivation. Population density as per provisional figures from the 2011 Census is as low as 17 in Arunachal Pradesh and 52 in Mizoram. It is more than 100 in Uttarakhand (189), Nagaland (119), Himachal Pradesh (123) and Meghalaya (132) but still much lower than the national average of 382 for India. It is of course high at 350 in Tripura, a predominantly low land state. This is also the case with Assam with a figure of 397, but it is much lower in the two hill districts of North Cachar and Karbi Anglong. In 2001, it was 65 for these districts as compared to 340 for the whole state.

Low population density, however, does not really mean larger availability of agricultural land. Only 5 % of the geographical area in Arunachal Pradesh, 4.7 % in Jammu and Kashmir, about 11 % in Manipur, 15 % in Himachal Pradesh, and 18 % in Mizoram was cultivable, as against 56 % in the country as a whole. As a result, the net sown area per person was only 0.07 ha in Jammu and Kashmir, 0.08 in Himachal Pradesh, Tripura and Uttarakhand, and 0.09 in Meghalaya, as against 0.12 hectare across India (Table 10.1). Cultivable land that is available is also of poor quality, most of it being on slopes, can only be used in small terraces which does not permit the use of technology suitable for larger plots. Besides, it is mostly

Table 10.1 Population density, cultivable area and per capita net sown area in Indian Himalayan states, 2011

States	Population density (persons per km^2 area 2011)	Cultivable land (% geographical area (2007–08)	Per capita net sown area (ha) (2007–08)
Arunachal Pradesh	17	5.0	0.18
Himachal Pradesh	123	14.6	0.08
Jammu & Kashmir	124	4.7	0.07
Manipur	122	10.8	0.10
Meghalaya	132	47.1	0.09
Mizoram	52	17.8	0.10
Nagaland	119	40.8	0.15
Sikkim	86	21.1	0.18
Tripura	350	29.5	0.08
Uttarakhand	189	28.2	0.08
Assam—Hill Districts (2001)	397 65	40.9 15.2	0.14 0.10
India	**382**	**55.5**	**0.12**

Sources Column 1: Census of India 2011: Provisional Population Tables, Table 1 posted in the Census Website (www.censusindia.gov.in) on 31st March 2011; Column 2: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India 2007–2008; column 3 calculated by the author

not irrigated, as to conduct water from rivers flowing in the valleys to the cultivated fields mostly located in uplands is technologically difficult and economically non viable. Thus of the net sown area while about 40 % is irrigated in the country as a whole, it is only 11 % in Mizoram, 17 % in Sikkim and 18 % in Himachal Pradesh.

In view of the geological fragility of the Himalayan region and the environmental sensitivity of its resources, the scope for carrying out economic activities on a highly intensive basis and an extensive scale is rather limited. Even the cultivation of food grains, the mainstay of the mountain population, is not considered to be environmentally sound on lands with slopes beyond a certain degree. Forest occupies large areas in most of the Himalayan states: over 70 % in Manipur, Mizoram and Sikkim, and 60–70 % in Arunachal Pradesh, Himachal Pradesh, Tripura and Uttarakhand, as against only 23 % for India as a whole (Table 10.2). The actual forest cover is similarly large in these states except for Himachal Pradesh, Sikkim and Uttarakhand where it is much lower than the area on record. Exploitation of forests for economic purposes is, however, constrained by environmental concerns: disastrous effects of deforestation are floods and other ecologically adverse impacts on lives and livelihoods of local, and more important, lowlands population, which places severe restrictions on the use of forests for improving the economic condition of the people in the mountain states. The construction of large dams to generate hydroelectricity on a sizeable scale is also found to be environmentally unsafe in the geologically fragile Himalayas. Even the construction of roads to improve the connectivity of settlements among themselves and to the markets and the rest of the world is viewed with a serious frown by environmentalists. And mining in hills and mountains is, of course, seen to lead to great ecological disasters.

Table 10.2 Area under forests: Indian Himalayan States (% of geographical area)

States	Recorded area in % (2005)	Forest cover in % (2007)
Arunachal Pradesh	61.55	60.43
Himachal Pradesh	66.52	26.35
Jammu & Kashmir	9.20	15.21
Manipur	78.01	77.40
Meghalaya	42.34	77.23
Mizoram	79.30	91.27
Nagaland	55.62	81.21
Sikkim	82.31	47.31
Tripura	60.02	76.95
Uttarakhand	64.79	45.80
Assam	34.23	35.30 (Assam Hill Districts—67.8)
India	**23.41**	**21.02**

Source India: State of Forest Report (2009), Forest Survey of India, Ministry of Environment and Forests, Government of India

Levels of Economic Development: Per Capita GSDP and Poverty

Use of the local resources by the people of the Himalayan States for any substantive improvement of their economic conditions is, in any case, constrained by the limitations to using modern, scale biased technologies, high cost of inputs, and inaccessibility to remunerative markets. This is reflected in the relatively low per capita Gross State Domestic Product (GSDP) in these states (Table 10.3). All, except Himachal Pradesh which came close to the all-India average of Rs. 46,492, had a per capita GSDP that was less than two thirds of the national average, in 2006–07. It must be noted here that the GSDP does not reflect the income at the disposal of the local people; it represents the income produced or originating in the state and not the one accruing to the people in the state. The latter may be smaller (because the disposable income is wages minus taxes and other compulsory payments like social security etc.) than the former in states where extracting and harvesting and collection of natural resources is an important source of GSDP. Forestry, which makes an important contribution to GSDP in most of these states, is an example of such an activity in which it is mostly the wages of those engaged in cutting and logging of wood that accrue to the local people while most of the income from forestry leaks out elsewhere through contractors and traders. The actual income that accrues to the local people could thus be much lower than what the GSDP figures indicate.

Estimates of poverty, however, do not suggest that the disposable income of the inhabitants of these states is below the national average. As is well known, poverty estimates are based on private consumption expenditure. For example, people in households with a per capita per month expenditure of Rs. 478 in rural and Rs. 638 in urban areas of Uttarakhand were considered to be below poverty line, in

Table 10.3 Per capita Gross State Domestic Product (GSDP): Indian Himalayan states, 2006–07

State	GSDP (Rupees)
Arunachal Pradesh	27,203
Assam	21,607
Himachal Pradesh	45,391
Jammu & Kashmir	26,488
Manipur	29,712
Meghalaya	28,130
Mizoram	30,346
Nagaland	28,346
Sikkim	25,018
Tripura	28,512
Uttarakhand	30,362
India	**46,492**

Source Central Statistical Organisation, Government of India (2006–2007)

Table 10.4 Percentage of population below poverty line: Indian Himalayan states, 2004–05

State	% of total population
Arunachal Pradesh	17.6
Assam	19.7
Himachal Pradesh	10.0
Jammu & Kashmir	5.4
Manipur	17.3
Meghalaya	18.5
Mizoram	12.6
Nagaland	19.0
Sikkim	20.1
Tripura	18.9
Uttarakhand	39.6
India	**27.6**

Source Planning Commission, Government of India, Poverty Estimates for 2004–05, PIB, Press Release, March (2007)

2004–05. In that year, except Uttarakhand, where about 40 % of the people were estimated to be below poverty line, the other 10 hill states had much lower incidences of poverty than the national figure of 27.5 % (Table 10.4). Jammu and Kashmir which had one of the second lowest per capita GSDP among the eleven Himalayan States had the lowest, in fact a very low incidence of poverty at 5.4 %. It is rather intriguing to find that people in these states have much a lower income than the national average, but often spend much more than the national average of those above the poverty line. These estimates would strongly suggest that remittances play a significant role in meeting the excess expenditure over the income in the case of a large part of the population in these states. In other words, their own income-generating capacity is not sufficient to sustain their livelihoods and they are vulnerable to the risk of falling below the poverty line once the flow of remittances stops or becomes uncertain and irregular.

An important point that needs to be noted here is that of the application of the common poverty line for the measurement of the extent of poverty in the hilly and mountain areas. As is well known, the poverty line was set at the average level of total consumption expenditure of households that met the calorie requirement in their food basket of 2400 kcal in rural and 2100 kcal in urban areas, in 1978. Since then, it has been periodically adjusted for change in prices. The figure for rural India was estimated to be Rs. 356.30 per capita per month and for urban India Rs. 538.60 per capita per month, in 2004–05. The application of this poverty line for the hilly and mountain states is fraught with the following limitations:

i. The effort required and, therefore, the energy spent for similar physical tasks is significantly larger in these areas than in the plains. And physical tasks constitute a much larger proportion of work in these areas than in the plains. One has to walk to reach a destination whereas most of the travel in the plains is undertaken by some means of transport, animal driven or mechanised. And

walking in the hills for the same distance consumes much more energy than in the plains. Productive or household activities in the hills are performed manually much more often than in the plains, due to the non-availability and applicability of mechanised technology (e.g. use of tractor and threshers in farming). As a result, the minimum calorie norms for the inhabitants of these areas have to be much higher (may be about 3000 kcal sometimes prescribed for the manual work in the factories).

ii. Besides food energy requirements, the minimum required in the case of other basic needs is also higher in these areas. For example, the cold climate in most of these areas requires a higher minimum amount of clothing, including woollens, besides the requirements of heating, for mere survival. Similarly essential is the shelter of a minimum quality for protection against cold.

iii. Prices in these areas are significantly higher due to the non-availability of most of the consumption items locally and high transport costs.

The price factor has now been taken into account in recent years as the poverty lines are computed for each state applying the state specific price indices. The poverty line applying the state-specific price indices for 2004–05, for example, are Rs. 387.64 for Assam, Rs. 394.28 for Himachal Pradesh, Rs. 391.26 for Jammu & Kashmir and Rs. 478.02 for Uttarakhand, for rural areas, which are significantly higher than the national estimate of Rs. 356.30. But they still under-estimate the minimum consumption expenditure required for subsistence, in so far as they do not take into account the higher food energy requirements and minimum clothing, shelter and heating requirements as mentioned above. Once these factors are taken into account, the incidence of poverty would turn out to be significantly higher than officially estimated. It may also be noted in this connection that no estimates of the poverty line have been made for seven states in the North East, and the poverty line for Assam, a predominantly lowland state, is used for estimating poverty in these states.

Infrastructure: The Case of Transport Connectivity

Besides the technical problems of measurement which place limitations on the estimates of income and poverty, there are real disadvantages that the hilly and mountain areas face in pursuit of economic growth and improvement in livelihoods. Their physical disadvantage lies in inaccessibility, isolation, less availability of resources, and ecological fragility. Partly because of these reasons, and partly for economic and political reasons (high cost and small number of voters), these areas also tend to get limited administrative and political attention for building infrastructure to improve their connectivity and reduce inaccessibility and isolation. Thus six (Sikkim, Arunachal, Manipur, Meghalaya, Mizoram and Nagaland) of the 11 hill states had virtually no rail road in 2008–09. Jammu and Kashmir, in spite of a good part of the state is located in the plains has only 1.08 km of railway line per 100 km^2

Table 10.5 Transport density in Indian Himalayan states, 2001 to 2008–09

States	Railway density (km of railway line per 100 km^2 of area)		Road density (km of road length per 100 km^2 of area)	
	2000–01	2008–09	2000–01	2007–08
Arunachal Pradesh	0.01	0.01	219.27	196.97
Assam	32.08	29.12	1111.33	2936.44
Himachal Pradesh	4.83	5.12	132.78	652.02
Jammu & Kashmir	0.43	1.08	104.85	100.45
Manipur	0.04	0.04	512.65	739.01
Meghalaya	0.00	0.00	423.41	438.65
Mizoram	0.09	0.09	235.77	292.13
Nagaland	0.78	0.78	1267.85	1345.24
Sikkim	0.00	0.00	280.56	263.80
Tripura	4.29	14.39	1337.56	3025.07
Uttarakhand	6.66	6.45	596.13	767.41
India	**19.17**	**19.47**	**744.29**	**1014.96**

Source Centre for Monitoring Indian Economy (2010), New Delhi

of geographical area; the figure for Himachal is 5.12 km and for Uttarakhand, again with a large part in the plains, only 6.45 km. Assam, of course, with only a small part in the hills, has a better railway density (29.12 km per 100 sq. km of area) than the country which is 19.47 km as a whole (Table 10.5). Road networks are, however, better. In some states, they are even above the national average, often built for strategic reasons. Thus, Assam had 2936 km of road for 1000 km^2 of area in 2007–08. The figure for Nagaland is 1345 kilometres. Uttarakhand (767 km), Himachal Pradesh (652 km) and Manipur (739 km) are also reasonably well endowed. Arunachal Pradesh (197 km), Jammu and Kashmir (100 km), Mizoram (292 km) and Sikkim (264 km) have, of course, a much lower road density than the country as a whole (1015 km). Over the period 2000–01 to 2007–08, the road length in the country has increased by about 36 per cent; only Himachal Pradesh and Manipur have seen a similar or higher expansion in road network among the predominantly hill states. Uttarakhand saw a reasonable increase of about 30 % in its road length during this period.

Economic Growth in Recent Years: Impact of Globalization?

How have the Himalayan states performed with respect to economic growth over the period following economic reforms? Has globalization helped them to grow faster? As is well known, the Indian economy has seen accelerated growth rates in

the post reform period, from an average of 5.5 % during 1981–91 to 6.1 % during 1991–2001 and 8.3 % during 2001–2009. For the shorter period of 2004–09, the growth rate has been still higher at 9.6 %. Barring Arunachal Pradesh and Assam which experienced a low growth, and Himachal Pradesh with an average growth, the other six states (Uttarakhand was not then formed and data are not available for J&K) in the Himalayan region recorded significantly higher growth than the national average, during 1991–2001. Incidentally, all these six states belonged to the north-eastern region. In the period 2001–09, only the new state Uttarakhand, and Arunachal Pradesh registered a growth rate higher than the national average, and Sikkim, Tripura and Himachal Pradesh were almost at par with the average. The remaining six Himalayan states performed relatively poorly. In the shorter, high growth period of 2005–09, only Arunachal Pradesh exceeded the national average rate of growth. Himachal Pradesh, Uttarakhand, Sikkim and Meghalaya have a growth rate above 8 % per annum, but below the national average of 9.6 % (Table 10.6).

Arunachal Pradesh, Uttarakhand and Sikkim have sustained a high growth during 2000–09, even during 2001–05, the period of low growth at national level. Himachal and Meghalaya displayed low growth during 2001–05, but much higher during 2005–09, and Tripura with somewhat lower growth but a sustained one during the shorter period also, comes next. Other Himalayan states have performed poorly both in the longer and shorter periods.

What inferences can be drawn from these patterns of growth regarding the impact of globalization on the mainstreaming or further marginalization of the Indian Himalayan states? Some states are able to reduce the gap in per capita income with the national average while others are falling behind. During the period

Table 10.6 Growth rates of GSDP in Indian Himalayan states from 1990–91 to 2008–2009 (% per annum)

States	1990–91/ 2000–01	2000–01/ 2008–09	2000–01/ 2004–05	2004–05/ 2008–09
Arunachal Pradesh	3.67	9.79	9.83	9.87
Assam	2.40	5.40	5.31	5.87
Himachal Pradesh	6.35	7.74	6.56	8.93
Jammu & Kashmir	NA	5.16	4.73	5.76
Manipur	9.98	5.43	6.13	4.33
Meghalaya	10.48	6.70	5.97	8.00
Mizoram	17.89	4.97	6.18	4.92
Nagaland	8.81	6.36	7.63	4.88
Sikkim	9.85	8.36	8.32	8.29
Tripura	12.76	8.03	7.87	7.67
Uttarakhand	NA	9.04	9.08	8.79
India	**6.12**	**8.26**	**6.52**	**9.56**

Source CSO, www.mospi.gov.in

2001–09, Arunachal Pradesh, Uttarakhand and Sikkim have clearly been in the former category while Assam, Jammu and Kashmir, Manipur and Mizoram belonged to the latter category. Meghalaya and Nagaland are also closer to the losers while Tripura and Himachal Pradesh are quite close to the winners. So, is globalization treating different states differently? And if yes, why?

The major outcomes of globalization, namely, increased external trade and foreign investment, may not have made any significant contribution in these states as they are far away from the centres of globalization–induced economic growth. Border trade, especially in the North East, has been facilitated by certain liberalizing measures, although no information is available on the extent to which trade has increased. But faster growth of Arunachal Pradesh, Sikkim, Meghalaya and Tripura could be attributed to some extent to this development. Measures of domestic deregulation, following economic reforms and globalization could have made an impact on the economies of these states, particularly in their industrial sector. Himachal Pradesh has always followed a policy of comparative advantage by focussing on horticulture and has diversified into new products—off-season vegetables and spices, in addition to the traditional product, apple, in recent years to take advantage of domestic and international trade. Uttarakhand has achieved its high growth mainly on the basis of industrial growth in the lowland part of the state, taking advantage of domestic deregulation and offering incentives available to special category hill states as designated by the Central Indian Government for development. Besides, a few other sectors with comparative advantage—such as medicinal plants and tourism have become a special focus for growth. Sikkim seems to have utilised its traditional comparative advantage in large cardamom production and further developed and utilised its tourism potential. States like Meghalaya and Mizoram have not been able to capitalize on the special advantage they enjoy in horticulture, particularly in certain fruits like citrus and pineapple and ginger; nor do they appear to have been able to take advantage of border trade with Bangladesh and Myanmar.

Conclusion

These inferences on the rates and sources of growth of the economies of Himalayan states are, of course, tentative and require further investigation to draw definite conclusions and policy implications. But it appears that globalization can benefit even these areas situated on the geographical, political and often cultural margins of the country, provided they are able to identify their comparative and unique advantages, including for different locations within the state, and utilise them for their growth. Some examples of such efforts are seen in the faster growing states like Himachal Pradesh, Uttarakhand and Sikkim. But use of unique advantage, for example, in eco-tourism, small hydro electricity generation and medicinal herbs and plants, has not been made on a wide scale in these and other Himalayan states due to the continued dominance of development ideas based on the ‘plains or lowland

model' and the consequent lack of efforts on the part of the states to innovate towards mountain-specific development strategies, on the one hand, and the national policies that have often discouraged local resource based development, on the other. These states need to be supported in their quest for benefitting from globalization, by obtaining access to markets, domestic and international, to sell their products. This is particularly necessary for the states in the North East for which the neighbouring countries are closer than mainland India. Liberalizing and promoting border trade with them will be of immense benefit to these states. In the absence of conscious efforts to identify and utilise their respective special advantage and without a government providing policy support to access markets—domestic and external—the states in the Indian Himalayan region face the danger of further economic marginalization.

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Chapter 11
Highlands Developments in Malaysia

Jamalunlaili Abdullah

Introduction

Malaysia, covering the Malay Peninsula and the northern part of Borneo Island contains significant highland areas with considerable elevations. In the Peninsula, the main Titiwangsa Range straddles north to south and soars to more than 3000 m a.s.l. and divides the Peninsula into an eastern and a western part. In the state of Sabah the Crocker Range is home to the highest mountain in Southeast Asia, the Kinabalu Mountain, which stands at over 4300 m.

Due to the hot and humid weather of the lowlands, some of these highlands were developed by the British as hill resorts during colonial times. These were of a small scale and sustainable nature and included Fraser Hill, Penang Hill, and Cameron Highland. The lack of accessibility and urban development pressure and a small population then had ensured that developments did not cause much environmental problems. After Independence in 1957, Genting Highlands in Pahang was the first intensive highland development with a casino and a theme city. However, not many objections were raised towards this development since environmental consciousness was not very much part of people's life at that time.

Due to globalization and development pressure especially since the 1980s, more intensive developments of these highlands have been proposed and carried out by the government, developers, and commercial farmers. Some were received warmly by the people while others were hotly contested by the public, especially by non-governmental organizations. This paper analyzes these highland developments

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and the public's responses to them. It evaluates why certain highland developments faced strong objections by the public. The intensity of development as well as their locations seems to influence the public's responses to the projects. Among the cases presented are the proposed Penang Hill development and Cameron Highlands tourism activities. The paper analyzes these highland developments descriptively and is a rather brief overview of highland development in Peninsular Malaysia.

Highland Developments During Colonial Times and Early Nationhood

Many land developments in British Malaya are concentrated in the lowlands, especially on the west coast of the Peninsula. These tend to be concentrated on the mining of tin especially in the Kinta Valley in Perak (where Ipoh is located) and the Klang Valley where Kuala Lumpur was founded. The resultant water pollution tended to concentrate in the rivers of the lowlands and was later addressed in part by the various mining enactments adopted by the government in the 1950s.

Another major development was the clearing of vast areas of lowland forests for the sale of timber and the plantation of rubber which had been imported into Malaya from Brazil. These two main economic activities became the economic pillars of British Malaya and continued after Malaya (later Malaysia when Sabah, Sarawak and Singapore joined the Federation in 1963) gained Independence in 1957. The reliance on tin mining, rubber and later palm oil since the 1980s as export commodities was the characteristic of this tropical land.

These economic developments had led to environmental problems due to the siltation of rivers by mining activities and the loss of precious tropical rainforests caused by land conversions into export crops such as rubber and palm oil. Despite the severity of these problems by today's standards, not many public protests were evident then since the focus was on the improved livelihood of the population. Environmental consciousness as we know today was not very much part of people's agenda. An agricultural society with a small population and a relatively fertile soil which was found in Malaya was not a fertile ground for environmental movement.

Most of these developments and resulting environmental consequences were found in the lowlands of the Peninsula, to a much lesser extend in Sabah and Sarawak (the latter two on Borneo Island had a significantly smaller population and larger land area compared to the Peninsula). Although some hilly lands were cleared for rubber plantation, this was limited to elevations generally below 300 m above sea levels.

Highland developments were practically non existent at that time due to the abundance of lowland for the needs of the population. The only developments for the highland were the resort hill stations for the British colonial officers. Notable among them were Cameron Highlands in Pahang, Penang Hill in Penang, Fraser Hill in Selangor and Maxwell Hill in Perak. With the exceptions of Cameron

Highlands, which had a few small towns, the other hill resorts consisted mainly of a few bungalows that catered for the needs of the British in Malaya. The locals simply did not have any needs to venture into these highlands, and the lack of accessibility and car ownerships had ensured that the hill resorts remained in the domain of the wealthy British colonial officers and a handful of local dignitaries.

After Independence of 1957 and the formation of Malaysia in 1963, development trends continued to focus on the lowlands since land was still abundant in both the Peninsula and Sabah/Sarawak. Various massive land development schemes were initiated whereby vast tracts of mainly lowland virgins forest were cleared and planted with rubber in South Pahang, Southeast Johor and other rural regions of Kelantan and Perak in the Peninsula in the late 1960s and the 1970s. Despite massive losses of precious tropical rainforest and its associated biodiversity, environmental criticisms of these land developments were practically muted since the logs brought massive revenues to the government coffers and provided much needed plantation lands to the landless rural population. The socio-economic benefits of these land developments were indisputable and their success in achieving the government's economic development objectives was hailed by international development agencies.

When palm oil became the darling of the plantation economy since the 1980s, rubber plantations started to make way to the new crop. Still much attention was on the lowlands. When Malaysia started to industrialize heavily during the Mahathir's era of the1980s to the mid 1990s, intensive industrialization and its resulting urbanization were mainly restricted to the lowlands. Not much attention was given to the development of highlands in Malaysia until the late 1980s and 1990s.

The first major highland development occurred about 30 km east of Kuala Lumpur when a significant size of virgin land about 800 m above sea level in Genting Highland was cleared for the building of Malaysia's first and only casino in the 1960s. The initial development was later expanded into theme parks and urban development during the economic boom years of the 1990s. Not much environmental resistance was evident when the Genting Highlands area was cleared for development since there were still endless forested highlands surrounding the site and elsewhere in the country.

Highland Developments in Recent Years and the Public Responses

Highland developments which provoked controversies and unfavorable public responses in Malaysia started to emerge in the 1980s. Due to the increasing wealth of the population and the subsequent rapid rise of the urban population, much urban development started to encroach upon hilly areas, especially in populated areas in Klang Valley and on Penang Island. In Penang, the expansion of the city of Georgetown is hampered by the Penang Hill, while Kuala Lumpur and other towns

in the Klang Valley are located close to the Titiwangsa range. As Malaysia officially became an urban nation in 1991, the pressure for more development has caused some highlands near the main urban centers to be developed intensively. Consequently, the environmental destructions started to shift from low land areas to the highlands.

The proposed Penang Hill development of the late 1980s was the first major highland development which received widespread opposition from NGOs and the Malaysian public. It was a massive project proposed by the then Chief Minister of Penang for economic reasons—developing the pristine hill for intensive tourism to attract more international investments in the property sector on the island. Unfortunately, Penang Hill, which is located very close to the capital of Georgetown, is a very ecologically sensitive hill station which also acts as the water catchment area and a buffer to the relentless expansion of urban areas on Penang Island.

The proposal received widespread oppositions from the people of Penang Island which is home to some of the most active non-governmental organizations in Southeast Asia. A campaign, Save Penang Hill, was spearheaded by Friends of Penang Hill, an alliance of NGOs led by the Consumers Association of Penang and the Malaysian Nature Society, with the support of academics at Universiti Sains Malaysia and various other groups. With more than 40,000 signatures opposing the proposed development, the Save Penang Hill movement managed to convince the state executive council to annul the memorandum of understanding between the previous Chief Minister and the developer. It also helped that the new chief minister who took office in 1990, despite coming from the same ruling party, was more sympathetic to environmental issues, being an academic and a founder member of the Malaysian Friends of the Earth (SAM). The first local plan of the island was also initiated, which due to its policies has been able to stave off any major development on the hill so far (Nasution 2001).

Another controversial proposal was the "Highland Highway" which was conceived to link three highland resorts in the Peninsula by cutting a road through the Titiwangsa Main range. The proposed development, for tourism purposes, was expected to open up and eventually destroy previously undisturbed highland forests. Despite some criticisms from environmental NGOs the project seemed to be moving ahead due to the insistence of the then Prime Minister Mahathir. It was only shelved due to the 1997–1998 Asian economic crisis that affected Malaysia badly (Sharom 2002).

The rapid economic development of the 1990s and after the 1997–1998 crisis brought more development pressures on Malaysia's highlands, this time mostly for agriculture and tourism. The two areas which saw rapid negative development of highlands were in Cameron Highlands, Pahang and in the neighboring Lojing Highlands in Kelantan. The former is an overdeveloped highland tourism area while the latter was promoted for large scale highland agriculture projects.

Perhaps it is in Cameron Highlands where many issues related to highland development surfaced frequently. It is a district of 71,218 hectares with elevations ranging from 1070 to 1830 m above sea level. With a cool average temperature of

15 °C, it is the most popular highland holiday destination and boasts of having most development among all highlands in Malaysia. Tanah Rata and Brinchang are the two major towns with a few smaller settlements that are home to about 32,000 people. Although 79 % is still forested, rapid development and conversions of land for agriculture and built-up areas have brought many environmental problems into the resort (MD Cameron Highland 2003). The opening of a second and straighter access road into Cameron Highlands from the lowlands brought more traffic and development especially for agriculture and tourism.

Cameron Highlands are the most important temperate agricultural area in Malaysia where 7340 hectares (16.4 % of total land) are currently utilized for that purpose. Tea and vegetables are the main crops with half of the vegetables exported to Singapore. In addition, tourism is another big revenue earner. The number of tourists has more than doubled from 301,941 in 2001 (Barrow et al. 2005) to over 750,000 in 2009. Rather than relying on the old winding road from Tapah to the southwest, visitors now can reach Cameron Highlands from Ipoh in the northwest and Kelantan in the east, which has effectively tripled its accessibility. Greater accessibility led to a greater influx of tourists and business people, which resulted in more constructions, especially big hotels to cater for increased demand. Unfortunately, these developments may have exceeded the carrying capacity of Cameron Highlands.

Land clearing for agriculture and built-up areas has caused environmental problems such as soil erosion, flooding and landslips. As the gradients of half of the land area of Cameron Highlands exceed 20°, and the erosion rates in more than three quarters of Cameron Highlands are beyond 150 ton/hectare/year, the likelihood of landslides occurring is high if land clearing continues unabated. The siltation of rivers and water shortages are likely to become constant features (REACH 2009).

Land clearing resulting in increased erosion due to rainfall is a major threat to Cameron Highland's natural environment, causing tillage erosion, water erosion and mass movements. Also unsustainable development and agricultural activities as well as mismanagement and non compliance to policies contribute to increasing soil erosion rates. This results in hosts of difficulties such as flooding, sedimentation, hydropower generating problem, pollution of water resources, loss of biodiversity and landslides.

Agriculture covering almost 30 % of the land in the area has resulted in erosion and sedimentation which have polluted rivers. Almost 45 % of the agricultural land in Cameron Highlands exceeds 25° slopes, with run off causing massive siltation. The main sources of pollution to rivers in Cameron Highlands as stated by REACH (2009) are:

- Agricultural activities: sediments, nutrients, pesticides, pathogens and organic pollutants
- Municipal discharges (sewage treatment plants): nutrients, pathogens, organic enrichment, and toxicants
- Runoff from construction sites: sediments.

In November 2014, a massive flashfloods hit Cameron Highlands, killing 5 people and displacing a hundred of others. The tragedy was blamed on illegal and indiscriminate opening of lands for agriculture. This tragedy followed another landslide in the area that occurred about a year earlier which killed 3 people. The latest tragedy has caused NGOs and the public to demand greater enforcements from the government (The Star November 8th 2015).

The situations in the highlands are not confined to Cameron Highlands only. In the neighboring Lojing Highlands, Kelantan, large tracts of highland forests were cleared for agriculture. The opening of the Simpang Pulai—Cameron Highlands—Lojing road had opened up the previously inaccessible area about 1400 m above sea level. Massive areas of about 25,000 hectares were replanted with agriculture. Twenty two projects were given approval to clear the land for agriculture, however, only five disposed of an approved Environmental Impact Assessment as required by law. The fact that the state is under a party different than the ruling federal government has made enforcement and pressure by the latter difficult since land matter is practically a state matter.

Taken together, the tourism and agriculture development in Cameron Highlands and the massive agricultural activities in the neighboring Lojing Highlands have created huge negative environmental impacts to this part of the Titiwangsa range. Due to an increasing demand for agricultural products from the highlands and an intense promotion of tourism, one can expect more projects in the future in these highlands.

In addition to these high scale highland developments, various other hill stations have been developed or will be developed for tourism. These include the Mt Kinabalu Park in Sabah where the tallest mountain in Southeast Asia can be found, the Mulu National Park in Sarawak, Fraser Hill in Selangor, Jerai Mountain in Kedah and Mat Chincang Mountain in Langkawi where a 2.2 km cable car system was built (Jabil et al. 2009). However, unlike developments in Cameron and Lojing, these developments are of a smaller scale and can be considered to be sustainable and do not cause public resentment. Even the replacement of the vernacular train up to Penang Hill by a modern train did not create much environmental opposition except by a few who feel that the traditional vernacular train had to be retained for historical and sentimental reasons.

It was perhaps hillside development for residential and commercial purposes which had caused greatest uproar among the public in Malaysia. They are perhaps due to the fact that these hillside developments, close to existing settlements have greatest impacts to the residents and can also be seen clearly, unlike Cameron Highlands and Lojing, which are far from big cities. Furthermore, some of these developments had destroyed many properties and had caused losses of life.

In Kuala Lumpur, the collapse of the Highland Tower in 1993 which killed 44 people had jolted the public and the government alike about the susceptibility of hill slopes and highland developments. Since then, some landslides have led to the loss of lives of several people and many residential buildings. Most of these happened in Ampang, a suburb of Kuala Lumpur which borders the Titiwangsa Range.

Other developments which require the clearing of hill lands in the Klang Valley had brought about public protests, although not as massive and as organized at that of the Save Penang Hill Movement. Notable examples of the public opposition occurred at U11 in Shah Alam, Kota Damansara Forest in Selangor, Bukit Damansara residential development in Kuala Lumpur, and residential development on hillslopes in Batu Feringhi, Penang. Most of the opposition tends to be localized in nature, though.

Public and Government Responses

The Malaysian populations had reacted strongly to some of the controversial hills and highland developments in Malaysia. The biggest and most organized was perhaps the Save Penang Hill Movement which managed to rally several ten thousand people through a signature campaign opposing the proposed development. It also led to a setback of the Penang state government in the 1990 elections, which led to the annulment of the Memorandum of Understanding between the state and the developer. It also helped that the new Penang chief Minister who, although from the same ruling party as his predecessor, was sympathetic to the environmental causes of the population.

The Penang Hill proposal controversy and the Highland Tower tragedy as well as various other smaller scale landslips disasters, have opened up people's consciousness about the peril of insensitive hill and highlands developments. Various NGOs have sprung in action to oppose these developments. Some of the notable and active are the Malayan Nature Society (MNS), World Wide Funds for Nature (WWF), Environmental Protections Society (EPSM), and the Consumer Association of Penang (CAP). These NGOs have joined hands with other organizations, academics and even political parties to address the issue of highlands development.

In Cameron Highlands, a community based organization named Regional Environmental Awareness Cameron Highland (REACH) was formed in 2001 by a group of local residents alarmed by the rapidly deteriorating environment. Its aim is to preserve, restore and maintain the Cameron highland as an environmentally sustainable agriculture and hill resort within a permanent nature reserve. It highlights environmental problems, creates public awareness and conducts water and forest biodiversity studies (REACH 2009).

In addition, the public has availed itself to the opportunity to influence government policies and actions in relation to highland development. This is done through their participations in Environmental Impact Assessment and various development plans proposed by government agencies (Maidin 2011). During the public hearing process of the Kuala Lumpur City Plan many citizen groups had participated to voice concern and to protest the planned residential development of Bukit Gasing, a hilly forest at the border of the city. As a matter of fact, the

opposition to this hill development was the single strongest opposition to the KL City Plan.

The Malaysia governments, at the federal, state and local levels have also reacted rather positively to the public's concerns about highland development. After the debacle of the proposed Penang Hill mega development which had been signed secretly, the state government had to abandon the proposal after massive public protests. The Highland Tower tragedy had also compelled the government to seriously consider revamping outdated policies to come up with new policies, laws and guidelines on highland development.

The cabinet Committee on Highland Development was formed after the Highland Tower tragedy and other landslips incidents. After the Highland Towers tragedy the public had felt compelled to urge the government to ban developments on hill slopes, with which the authorities duly complied, albeit temporarily, until another disaster struck Bukit Antarabangsa in Kuala Lumpur in 2008. This resulted in another temporary freeze of highland development (Pertubuhan Arkitek Malaysia 2010).

The governments have come up with at least three guidelines on hill slope and highland development during the past two decades. The Ministry of Housing and Local Government issued Hill Area Development Guidelines in 1997. This was followed by the Highland Area Development Guidelines issued by Ministry of Natural Resources and Environment in 2005. In 2009, the cabinet had approved new planning guidelines for hill slope and highland area development which were proposed again by the Ministry of Housing and Local Government (Pertubuhan Arkitek Malaysia 2010).

The latest guidelines classify hill slope to different classes based on varying degrees. In addition to slope it also considers the soil structure. It prohibits development in Class IV (over 35° slope) while Class III slopes (between 25° and 35°) can be developed with some restrictions on density, plot ratio and building area. Thus, it allows development where technological and engineering aspects are also considered in addition to elevation, slope and soil conditions. (MHLG 2009).

The Malaysian Town and Country Department has also prepared various land use and physical developments plans which are sensitive to highland areas. After the Penang Hill controversy, a local plan for Penang Hill was drafted and gazetted which spelled out permitted developments in the areas. It was essentially a conservation plan of the hills whereby only limited developments are allowed. In addition various local district plans for all districts in the Peninsula have been prepared which allow for environmentally sensitive highlands to be protected.

The National Urbanization Policy has also come out with policies that protect hills and highlands in the country. The National Physical Plan 2 (2010–2015) which covers the whole Peninsular Malaysia has also designated the highlands as areas for total conservations or at least low intensity, controlled development. It has designated the whole Titiwangsa range as conservation area and has even proposed the gazettement of the Central Forest Spine throughout most of the mountain range (Federal Department of Town and Country Planning 2010).

The latest tragedy of massive flooding in November 2014 in the Cameron Highlands has prompted the government to act more swiftly towards illegal land clearing for agriculture in the area. Massive integrated operations under the purview of the Deputy Prime Minister were carried out against illegal structures and illegal migrants employed by farm businesses. The government also allocated funds to deepen Sungai Bertam which became shallow due to the intensive agriculture and construction activities in the Cameron Highlands (Malaysian Insiders, 9 November 2014).

Conclusion

This chapter has highlighted the issues of highlands development in Malaysia, basically covering hill and mountain developments, pointing to some controversial highland developments in the country and the environmental impacts to the population. It has also analyzed the public responses to some of these highland developments and how they have managed to influence the government to consider these developments. The public and the concerned NGOs may be considered marginal in these highland developments due to their lack of power to stop the farmers and developers from developing the highlands indiscriminately. However, they keep trying their best in influencing the government to be more sensitive to the highlands environment. To its credits the government has responded positively by drafting comprehensive hill and highlands development guidelines and preparing physical development plans at the national, state and local levels which protect these highlands. In addition it has allowed and even encouraged the public to voice their concerns of these plans through the public hearing process of the development plans as evidenced in the Kuala Lumpur City Plan. It seems highland development in the country now is more sustainable compared to what it was 15–20 years ago, but whether these initiatives are sufficient remains to be seen. The latest tragedy in Cameroh Highland has shown that continuous vigilance towards highland development is the order of the day.

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Part III
Climate Change, Mountain Ecology, and Adaptation in the Himalayas

Mountains are a key element and integral part of the world climate system. They are "weather makers for large parts of the world" (Stone 1992, p. 4) and as such the source of rivers (hence for our daily water supply), and "privileged places for spiritual and physical recreation." (ibid.). The same author also highlights their role for biological diversity, for example for our food supply (ibid., p. 5). Biological (and cultural) diversity is key element for our economic well-being (Edwards and Abivardi 1998) as well as for human survival (Leimgruber 2014, p. 72 f.).

The chapters in Part III focus on climate change in mountain areas (exemplified by the Indian Himalayas), specifically on water supply, air quality and various aspects of the vegetation. To understand these various processes and their results is essential to prepare strategies for mitigating the adverse effects of global climate change for the benefit of the populations. The local differences in climate features in the mountains produced by various micro-scale processes are influenced by relief, latitude and other environmental factors. Owing to this micro-climatic contrast in the mountains and also due to the insufficient database, climate change perceptions in the mountains are highly variable. However, the devastating consequences of cloud bursts, floods, droughts, glacial retreat, avalanches and mud slides have demonstrated the significant impact of these phenomena on the fragile mountain environments. Abrupt changes in temperature and precipitation have led to changes in to the distribution of ice, snow vegetation and agricultural fields. The changing timber and snow line will in turn lead to the shift of socio-economic pursuits of the local people and could have indirect impacts on the populations which depend on mountain resources. More focussed research attempts are therefore needed based on field studies to compare with the results obtained at the global scale.

An example for this type of research is the chapter by A. Basumajumdar. He deals with the impact of global warming on water supply in the Darjeeling Hills of the Eastern Himalaya, India. The surface water availability during the dry months over the past hundred years has declined considerably, due to rapid population growth coupled with heedless deforestation, and unscientific and unplanned land-use practices. The Darjeeling Himalaya as a whole and in particular Darjeeling

Town is facing a severe water crisis, particularly during non-monsoon months. Climate change due to global warming is in fact accelerating the processes. Only 40 % of the rural population has access to water at all, and the amount per capita falls far short of the daily-recommended amount of 10 gallons (45 litres) for drinking, cooking and washing. The scenario is even worse in urban areas, and scarcity creates conflicts and tensions as well as rampant corruption and misuse. Near the foothills, the water table is dropping dramatically or has disappeared completely, leaving entire villages without a nearby water source. The author therefore suggests a long-term strategy for the future.

Thakur and Kuniyal discuss the ambient air quality in the urban and semi-urban settlements of Himachal Pradesh. The deterioration of ambient air quality is recognized as one of the major threats to the populations in the Himalaya and in other mountain regions of the world. Local sources such as vehicles, the arrival of visitors, burning of fuel wood, coal and solid waste production and dust blown from nearby unmetalled roads are the most important causes. However, also long-range air mass movements from outside the region contribute to the current concentrations of aerosols in the region. Due to the environmental and health impacts of air borne particles, controlling the ever-increasing level of air pollution in towns and villages in the ecologically sensitive and topographically fragile part of the Himalaya is urgently required.

The impact of climate change on the shifting of the vegetation line in the Indian Himalaya, presented by J.S. Rawat et al. is not only a natural process but has also has consequences for the local populations via agriculture and water supply. A case study from the Kutiyangti watershed in Kumaun Himalaya reveals that the average height of the vegetation line in the alpine zone in Kutiyangti watershed was 4,700 m in 1972, 5,000 m in 1990, 5,160 m in 1999 and 5,330 m in 2010. These data suggest that due to global warming, the vegetation line in the alpine zone has been shifting upwards at an average rate of 16.84 m/year over the last 38 years between 1972 and 2010. During this period, about 166.80 km^2 of non-vegetated areas of the alpine zone of the study area was converted into vegetated area at an average rate of 4.27 km^2/ year. If the trend of depletion continues, the water resources of the region will be in danger, which may result in severe environmental degradation, social disruption and ecological damages in the region.

Research by K. Bargali demonstrates how climate change influences plant life, in particular leguminous plants in the Kumaun Himalaya. However, human activities also account for the changes observed. Based on meticulous field surveys, she found that the diversity of legumes is slowly decreasing and that certain species are threatened by extinction. Habitat fragmentation and overexploitation are the chief human causes that combine with the general warming and shift in weather patterns. Conservation measures and better information of the local population are urgently needed.

One of the most important challenges to our society is how to save and conserve our forests, biodiversity and environment, and how to use them more sustainably to prevent further depletion. The growing population pressure on forests has not only

reduced species diversity but also impoverished soil fertility and productivity across the entire altitudinal gradient in hills and mountain regions, which is becoming critical for the continued existence of natural resources and human society. The research by L.S. Lodhiyal et al. on plant diversity and vegetation composition of the Shiwalik forests along an altitudinal profile in Kumaun Himalaya contributes to this understanding. They examine soil characteristics, plant diversity, vegetation composition and regeneration pattern of the Shiwalik forests to understand the structure, species composition and plant diversity of forest ecosystems in the Kumaun Himalaya. The study suggests that an appropriate and more suitable strategy is required to conserve the flora and fauna of the region, involving both the government and non-governmental organizations and including the participation of the local population.

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Chapter 12
Impact of Global Warming on Climate Change Regarding Water Supply in the Darjeeling Hills of the Eastern Himalaya and Change in Mountain Ecology

A. Basumajumdar

Introduction

Global warming is the increase of the average temperature of the Earth's near-surface air and oceans since the mid-20th century and its projected continuation. According to the 2007 Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC 2nd Report), global surface temperatures increased by 0.74 ± 0.18 °C (1.33 ± 0.32 °F) during the 20th century. Most of the observed temperature growth since the middle of the 20th century has been caused by increasing concentrations of greenhouse gases, which result from human activities such as the burning of fossil fuel and deforestation.

Climate model projections summarized in the latest IPCC report indicate that the global surface temperature is likely to rise a further 1.1–6.4 °C (2.0–11.5 °F) during the 21st century (IPCC 4th Report). The uncertainty in this estimate arises from the use of models with differing sensitivity to greenhouse gas concentrations and the use of differing estimates of future greenhouse gas emissions. An increase in global temperature will cause sea levels to rise and will change the amount and pattern of precipitation, probably including an expansion of subtropical deserts. Warming is expected to be strongest in the Arctic and would be associated with a continuing retreat of glaciers, permafrost and sea ice. Other likely effects include more frequent and intense extreme weather events, species extinctions, and changes in agricultural yields. Warming and related changes will vary from region to region around the globe, though the nature of these regional changes is uncertain. As a result of the contemporary increase in atmospheric carbon dioxide, the oceans have become more acidic, a result that is predicted to continue.

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The scientific consensus is that anthropogenic global warming is occurring. Nevertheless, skepticism amongst the wider public remains (Green and Armstrong 2007). The Kyoto Protocol is aimed at stabilizing greenhouse gas concentration to prevent a "dangerous anthropogenic interference". As of November 2009, 187 states had signed and ratified the protocol. Proposed responses to global warming include mitigation to reduce emissions, adaptation to the effects of global warming, and geo-engineering to remove greenhouse gases from the atmosphere.

The Problems Faced by the Residents in the Darjeeling Hills

Water shortages in the Darjeeling hills is one of the most pervasive problems that undermine the socio-economic and aesthetic development of one million permanent residents (projected population in 2008) and 100,000 tourists during the dry months (February to May). Historically, the settlements in the Darjeeling hills developed at and near the perennial sources of water, mostly jhora (springs). Conducive climatic condition along with the natural vegetation cover in the watershed ensured perennial supply over centuries.

Rapid population growth coupled with heedless deforestation, unscientific and unplanned use of land has led to the establishment of a vicious cycle of degradation. As a result, the surface water availability during the dry months dropped considerably over the past hundred years. A sample survey in the Bijanbari area (2005) reveals that over 40 % of the springs remain dry during the lean period, whereas according to the elderly villagers, the springs were perennial in their early childhood. Even in the protected Senchal watershed out of 26 perennial springs only 14 continue to exist. The water yield of the surviving springs was also found to be considerably reduced. One experimental study in 1991 on the Veenita jhora near St. Paul's school showed a minimum yield of 15 gallon/h (68 l) that has been reduced to only 6 gallon/h (27 l) in 2006 i.e., a reduction of an alarming 60 % over 15 years.

As a result, water, potable or otherwise, is in desperately short supply. Only 40 % of the rural population has access to any water at all, and the amount per capita falls far short of the daily recommended amount of 10 gallon (45 l) for drinking, cooking and washing. The scenario is even worse in urban areas, and scarcity creates war-like situations vis-à-vis rampant corruption/misuse. Near the foot hills, the water table is dropping dramatically or has disappeared completely leaving villages without a nearby water source.

The climate change vis-à-vis global warming scenario is in fact accelerating the processes. Temperatures rise along with lowering of atmospheric humidity, which increases the biological demand of water. At the same time a gradual decrease in the number of rainy days and amount of precipitation further complicates the situation.

Perhaps the most hopeful aspect is that the climate and geography of the Darjeeling hills, while a challenge, also provides the solution to the water crisis in the region. Paradoxically for an area with such desperate problems with water, there

is no lack of available water in the Darjeeling hills, which receive 3 m average rainfall in a year. The Darjeeling hills receive about 7041 million cubic meter of fresh and pure water every year. The amount is equivalent to a staggering 1549 billion gallon fresh water, but the actual requirement for the hill people of 10 gallon/head/day (45 l) is only 0.2 % of the total (calculations based on the projected population of 2008). In spite of this fact, the Darjeeling Himalaya as a whole and in particular Darjeeling town are facing an age old unprecedented severe water crisis particularly during non-monsoon months.

History of Water Supply in Darjeeling

Water supply in the Darjeeling hills entirely depends on surface water i.e., springs (jhora). Long pipelines were laid down across the hills connecting many settlements for the supply of water during the lean months. With the drying up of sources, over one half of such pipelines in fact fail to supply water during the most crucial period of March-May every year. As a result, villagers (mostly women and children) have to walk over miles to fetch drinking water for survival.

The early developers of Darjeeling town understood the importance of water supply in its proper perspective and developed the Senchal watershed cum reservoir for this purpose a hundred years back, which till today is considered as the back-bone of the urban water supply in Darjeeling. Over the years, population growth (Figs. 12.1 and 12.2) induced an increase in demand, and only after half a century another serious effort was initiated at the Singdhap reservoir, which found partially crippled tanks due to poor quality of work. The hundred years old distribution system was never revamped (rather manipulated), repaired and extended at the expense of its efficiency. As a result, even conservative estimates showed over 20 % of the precious water wasted or misused.

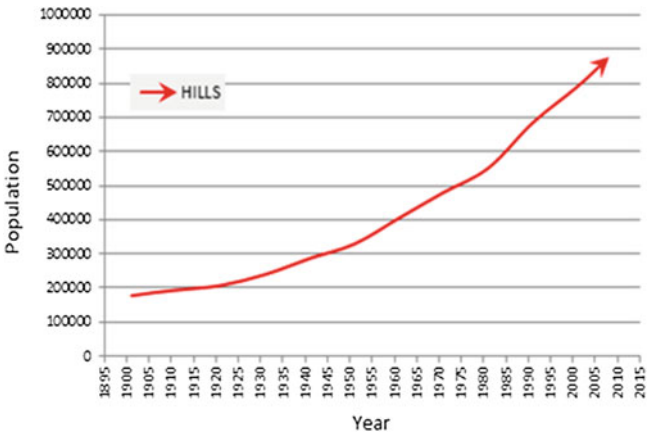

Fig. 12.1 Population growth in Darjeeling hills

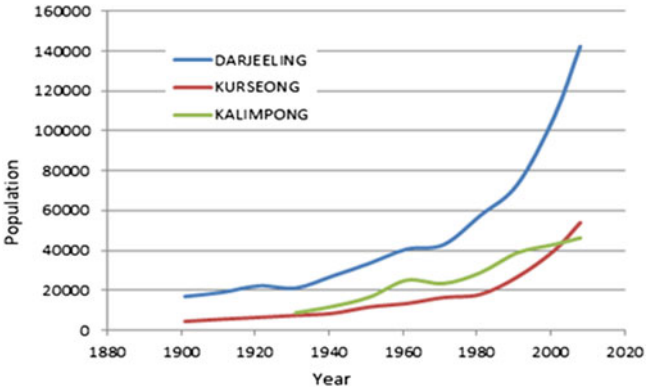

Fig. 12.2 Population growth in Darjeeling and other major towns

Sources of water in the Darjeeling hills are available mostly in the form of springs (jhora), which directly depend upon the natural reserves in the respective watersheds as well as rainfall. It is essential to preserve the catchments area, which feeds such springs. Indiscriminate deforestation and misuse of land within the catchment has caused the drying up of many such perennial springs—a conservative estimate put the figure at over 50 % during last century. The rapid land-use transformation accelerated the downward processes. During the past hundred years the forest and pasture land shrank from 77.86 to 38.54 %; consequently the net sown area increased from 19.73 to 44.21 % (Fig. 12.3).

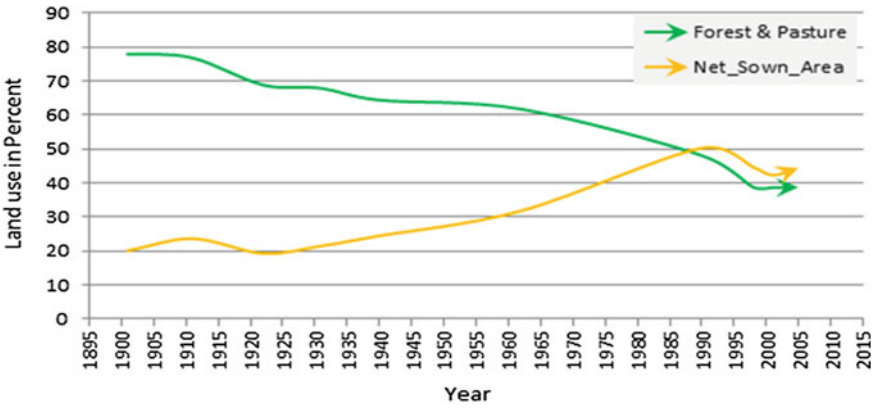

Fig. 12.3 Major land use pattern in Darjeeling hills

Global Warming Scenario and Its Impact

Global warming is a phenomenon involving the increase in the average temperature of the Earth's near-surface air and oceans since the mid-twentieth century and its projected continuation. The IPCC concludes that "most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations" via the greenhouse effect (Solomon et al. 2007, p. 10). IPCC indicates that average global surface temperatures will likely rise a further 1.1–6.4 °C during the twenty-first century. The temperature record (Source: IMD) for the past 116 years reveals the alarming rise of average temperature in Darjeeling of 4 °C, i.e., more than double in comparison to the global figure. A long term projection displays an even worse scenario with the possibility of mean maximum and minimum temperatures reaching a staggering 26 and 11.5 °C respectively with an increase of another 3.5 °C by the next century (Fig. 12.4).

Climate change also affected the relative humidity level in Darjeeling (Fig. 12.5) over the past hundred years. A decrease of 7 % relative humidity has been recorded during this period. Projections for the next century expected a decrease of another 7 %. This will have an adverse effect on the biosphere as it increases biological demand of water at the one end and might cause the extinction of the invaluable biodiversity of the Darjeeling hills on the other. It will also affect agriculture in general and Darjeeling's famous tea production and quality in particular.

The effect of global warming can also be detected in the precipitation pattern of the Darjeeling Himalaya. The precipitation record (Source: IMD) for the past 116 years reveals a clear decreasing trend in precipitation at an alarming rate: 300 mm decrease during the past hundred years, and another 350 mm decrease expected by the next century (Fig. 12.6). The possible effect of such a drastic

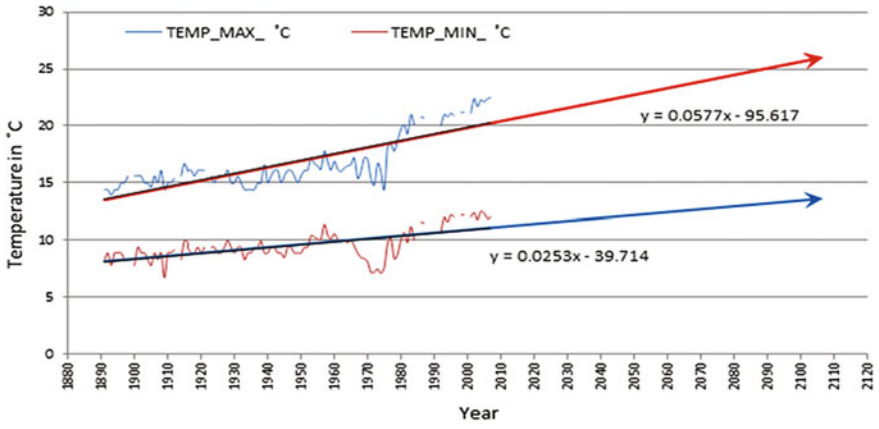

Fig. 12.4 Long-term temperature projection in Darjeeling based on 1891–2007

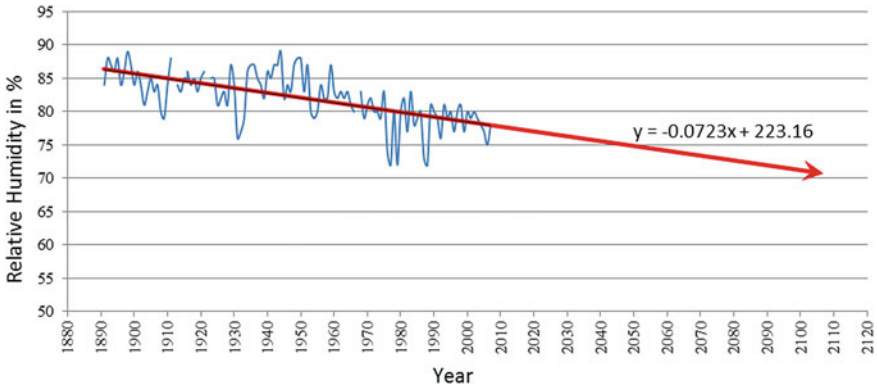

Fig. 12.5 Long term trend of relative humidity in Darjeeling based on 1891–2007

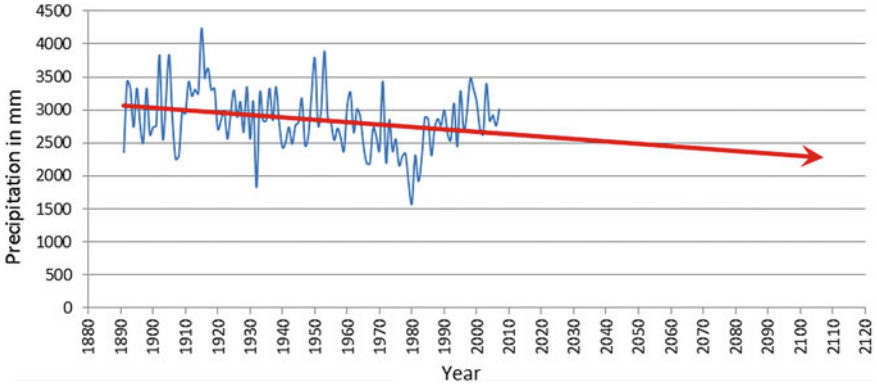

Fig. 12.6 Precipitation pattern of Darjeeling (1891–2007) and projection

change would be disastrous unless the society is prepared with possible mitigation measures.

The Darjeeling Himalaya, due to its special location against the backdrop of the mighty Himalayan barrier, will display massive ramifications of the possible effects of global warming phenomena by the next hundred years. These include the following:

- The Himalayan glaciers have started to melt and the average rate of retreat is almost twice (34 m) per year as compared to the 1971 levels of 19 m. Glacial meltdown in North Bengal is particularly serious as it concerns the major perennial rivers like Tista, Torsa, Jaldhaka and Sankosh and hence global warming would cause devastating floods followed by prolonged drought.

- As the greenhouse gas emissions increase, the global warming rate results in strange climatologic phenomena, such as an altered stratospheric jet stream path that may lead to an irregular monsoon. This would be a death blow to agriculture and agro-based industry.
- The Darjeeling Himalaya is famous for its precious forests and wildlife; an increase in ecological disturbance would result in a very poor wild flora and fauna; it has been proved that a temperature change of a mere 5 °C can result in the extinction of 30 species.
- Global warming influences the glacier melting process. Glaciers like Zemu are the source of large rivers of North Bengal (Tista), which are economically very important. But an excessive supply of water due to a glacial meltdown would cause a flood so devastating that thousands would become landless and homeless. Further, it would obstruct fisheries. Last but not least, the land would never again get adequate water for cultivation, as the rivers would dry up soon after the glaciers have melted. Many of these rivers might cause a premature termination of perennial water supply.

Global Warming Vis-à-Vis Drinking Water Scenario in Darjeeling Hills

The meteorological record for the past hundred years conclusively proved a very strong presence of global warming vis-à-vis climate change in the Darjeeling Himalaya at a magnitude much higher than expected according to IPCC global models. It is now understood that the rapid deterioration of the hill slope hydrological system as demonstrated by the large scale drying up of the springs/jhora in the Darjeeling Himalaya is not only caused by anthropogenic interferences within the watershed; rather the process has been further accelerated by the adverse effect of global warming during the past hundred years. It is also expected that this effect will have a telescopic impact in the next hundred years, which will probably put a big question mark on the sustainability of the Darjeeling Himalaya. The adverse effects of global warming in the arena of drinking water scenario include:

- A rise of the atmospheric temperature of 0.04 °C per annum will cause an increase of biological water demand by 0.05 % per annum for survival. In the case of drinking water in Darjeeling town, an additional amount of 13,650 gallon/year (62,000 l) will be required to offset the effect of global warming.
- Consequently, the fall of relative humidity as documented at 0.07 % per annum will cause an increase of water demand by plants of 0.06 % per annum for maintaining sustainability. Human demand will increase by 0.02 % in the form of drinking water. Thus the authorities concerned will have to provide for an

additional amount of 5460 gallon/year (24,800 l) to alleviate the effect of global warming in Darjeeling town.

- Long term precipitation records reveal a decreasing tendency, which is estimated to be 3.5 mm/annum. The number of rainy days has also been found to be considerably lower. A more significant effect of global warming is the increasing tendency of uncertainty in intensity and duration of precipitation in the Darjeeling Himalaya. This not only puts additional stress on the water supply system but also reduces the water available for the water intake structure.
- The drinking water scenario in Darjeeling hills is thus not only stressed further but becomes more complicated under the backdrop of climate change vis-à-vis global warming. Comprehensive long term multi-spectra modeling aided by state-of-the-art technology is a must to address the scenario in years to come.

Future Requirement of Drinking Water

The present population (2008) of Darjeeling municipal area is estimated to be 142,255 (based on projection) plus another 60,000 'floating' population, a total of about 2.02 lakhs (202,000) of population for whom water has to be provided especially during the crucial dry season, i.e. February to mid-June. In view of the rapid growth of Darjeeling town a population projection is attempted (Fig. 12.7). Darjeeling urban agglomeration has a population of 132,016 (2011 census). In 2011, Darjeeling district had a population of 1,846,823 of which male and female

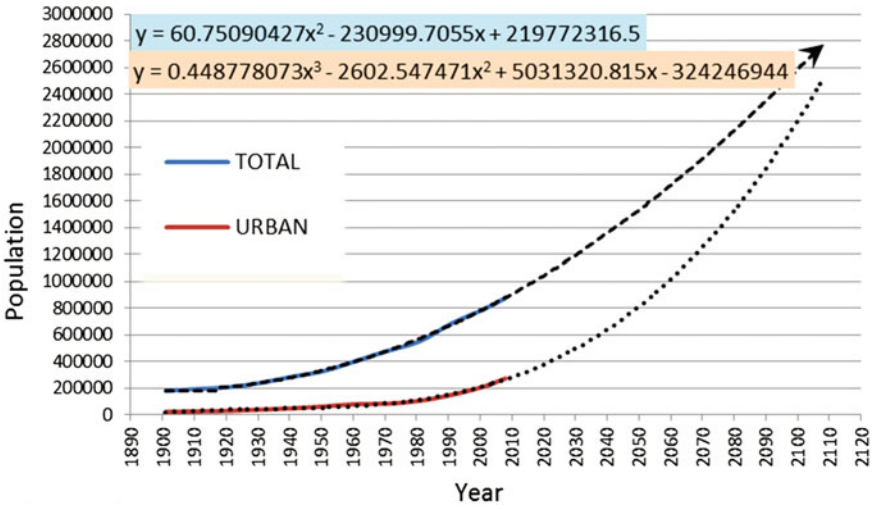

Fig. 12.7 Population projection for Darjeeling hills (based on 1890–2120)

were 937,259 and 909,564 respectively. In the 2001 census, the district had a population of 1,609,172 of which males were 830,644 and 778,528 females.

Only 11.58 % of the actual water demand is currently being met through the Municipal Water supply system of Darjeeling town. Without any other alternative source for drinking water (except bottle water), the citizen of Darjeeling have to face the ever increasing severity in fetching a bucket of water (non-potable) at the cost as high as Rs. 100/- during the time of crisis.

The projected demand versus supply of drinking water curve has been depicted in Fig. 12.8 and Table 12.1. It reveals that the drinking water demand in Darjeeling town only will increase from 1.35 million gallon/day (6.14 million litres) in 1991 to an estimated 4.0 million gallon/day (18.18 million litres) by the year 2021. A total increase of 196 % has been registered between the periods 1991–2021, i.e. an annual increase of 6.5 %.

To keep pace with the increasing demand and to ensure a gradual improvement of the situation, it is suggested (based on a mathematical model) to provide an annual increase of 11.6 % in storage capacity and supply of drinking water in Darjeeling town.

It would be a herculean task for the authorities concerned to keep pace with the ever-increasing demand and to eliminate the increasing gap between supply and demand in the Darjeeling hills in general and in Darjeeling town in particular. Not only must the source of water supply be increased; it is also necessary to revamp the existing distribution and supply system, imparting a maximum transparency into the entire system. A GIS-based drinking water supply system (DWSS) armed with the necessary database would be extremely helpful not only for need-based distribution and monitoring but also to maintain the necessary surveillance in the technical, financial and administrative management of the water supply system in the Darjeeling hills (ICIMOD 2009).

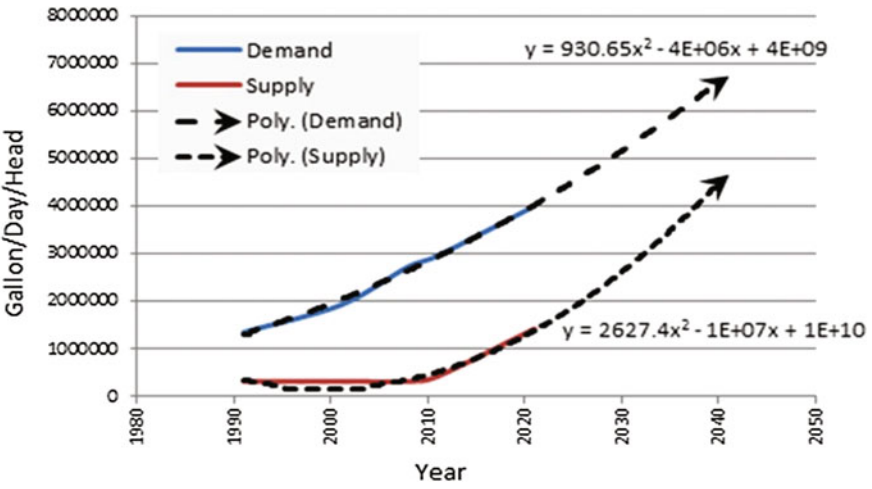

Fig. 12.8 Supply and demand for drinking water in Darjeeling with projection

Table 12.1 Projected water demand and supply in Darjeeling town

Year	2008	2011	2021	WATER supply in gallon/day	2008
Population[a]	202,255	227,279	320,000		
WATER demand in gallon/day				Conduit @6000 gallonX24hours	144,000
Domestic demand @10 gallon/day/head	2022,550	2272,790	3200,000	Khong Khola Pumping Station @5000gallonX12 h	60,000
Industrial/commercial demand @10 % of total	202,255	227,279	320,000	Sindhap lake @1000 gallonX10hours	100,000
Public utility demand @5 % of the total	101,127	113,640	160,000	Rambi line @1500 gallonX24 hours	36,000
Fire demand	Not available	Not available	Not available	Bakshi Jhora, Laldighi Jhora, Bhagyakul Jhora, Bhotay, Giri Jhora	32,000
Loss/waste/leakage etc. @20 % of the total	404,510	340,919	320,000[a]	Loss en-route @15 %	55,800
Total (gallon/day)	2730,442	2954,628	4000,000	Total	316,200

[a]including estimated floating population
1 gallon equals 4.55 litres

Strategy for the Future

The Darjeeling hills are endowed with plenty of sub-surface water resources in the form of aquifers, which are tapped in confined and unconfined conditions. The aquifers are mainly found in *paleo-channels*, *fluvio-glacial* and *paleo-slope deposits* in the Darjeeling hills.

The future area of exploitation for augmenting the drinking water supply in the Darjeeling hills should concentrate on the following three sources in a balanced manner and based on detailed and micro-level analysis of the controlling parameters: lithology and structure, geomorphology, land use, hydro-meteorology, and anthropogenic factors, considering local people and public institutions as stakeholder of the intervention.

- Rain water harvesting for both drinking and other purposes
- Tapping of surface water i,e., springs/jhora
- Harnessing sub-surface/ground water through bore-hole wells.

Of course, it is not certain as to how long the water resources as mentioned above are going to last, when water sources all over the world are drying up and ground water levels are going down due to overexploitation and to the effect of global warming. However, in the Darjeeling Himalaya we might expect a bounty of ground water as the climate warms and the snows melt. In fact, during the next few

decades, the volume of water will increase in the mountains at an alarming rate as a result of melting of snow due to global warming.

Conclusion

Recognizing the agony of the citizen of the Darjeeling hills in general and Darjeeling town in particular, and pending further study/analysis of facts and figures, the following strategy is suggested. Keeping in mind the scenario of global warming and its possible effects on the future/projected water demand and supply in the Darjeeling Himalaya and to ensure the sustainability of the very existence of the *queen of the hill stations*, a long term water resource management plan based on serious R&D is the need of the time. Extensive field data on terrain, hydrometeorology, land use/land cover, socio-cultural factors and existing interventions under the back drop of local self-governments may be accessed under a GIS platform.

- An Arc hydro data model could be an extremely useful tool in this regard that is capable of delineating watershed even at sub-meter level accuracy, identifying possible sources of water both underground and on the surface. It would be extremely valuable in identifying the precise location of paleo-channel, fluvio-glacial and paleo-slope deposits, i.e. possible source of aquifers.
- The proposed model would also be capable of identifying the precise location of possible sites for a rainwater harvesting structure of optimum dimension to conserve precious rain water to be re-distributed during the dry season.
- The state-of-the-art technology, which will be supported by high resolution GPS and Satellite data once developed, would be extremely beneficial to develop, manage and monitor the rural (even less-accessible high altitudes) as well as the urban water supply systems in the Darjeeling Himalaya. It is also capable of developing models under assigned conditions, which would facilitate the projection/prediction under the condition of global warming with regard to climate change in the Darjeeling Himalaya.

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Chapter 13
Ambient Air Quality Status and Its Sources in Urban and Semi-urban Locations of Himachal Pradesh, India

Harinder Kumar Thakur and Jagdish Chandra Kuniyal

Introduction

The Asian continent is characterized by its rapid growth of emissions in recent decades in terms of level of pollution as well as per capita emission rates. The burning of town waste, biomass burning (fuel wood, dried cow dung cakes, agricultural waste, etc.) and vehicular emissions (Sharma et al. 2007) and human activities are adversely affecting air quality in the towns. Aerosols (air pollutants) such as particulate matter like total suspended particulate matter (TSP), particulate matter below 10 micron (PM_{10}), trace gases like sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and ammonia (NH_3) are critically dangerous to human beings as well as to animals, plants and crops (Tanner 1999). Aerosols also disturb the atmospheric chemistry. Aerosols in large quantities in the atmosphere produce a narrow spectrum of small cloud droplets and do not allow these droplets to grow further. These clouds do not give rise to precipitation and the rain formation is inhibited (Jayaraman 2001).

Recently, it has been noticed that some of the towns in the Himalayan region have been facing a variety of problems such as rapid population growth, ever-expanding human settlements, anthropogenic activities, and ultimately human induced pollution. The ever-increasing populations and consequent anthropogenic interferences have recently been considered to be the major reasons for day-today environmental pollution, especially in sprawling towns in the Himalaya. Due to the high degree of human interferences the different pollutants discharged into the environment are exceeding its carrying capacity; as a result the assimilation capacity of nature weakens (Gupta 2002). Among the ever-increasing forms of pollution, air pollution among invisible pollution occupies top priority in urban

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environmental management in the Himalaya. Waste, one of the main sources of air pollution in urban environment, is collected and generally dumped on open slopes, but sometimes it is also burnt, releasing toxic gases into the atmosphere. Organic matter dumped in landfills according to this old technique produces methane gas. The widespread practice of burning waste worsens ambient air quality. Most of the management authorities in the towns yet lack sufficient policies and infrastructure to deal with such environmental problems. If these fast growing problems are not tackled in time, they may create, directly or indirectly, many other dreadful and incurable health hazards for visitors and the communities attached to the region (Kuniyal et al. 2003b).

There is a dearth of studies in terms of air pollution in the Himalayan region. The Himachal Unit of the G.B. Pant Institute of Himalayan Environment and Development has conducted research from the 1990s onwards (Beegum et al. 2008; Gajananda et al. 2005; Kuniyal et al. 1995, 2003a, b, 2004, 2005, 2006, 2007a, b, 2009; Kuniyal and Bhomick 2005; Kuniyal and Vishvakarma 2006; Safai et al. 2002). The Intergovernmental Panel on Climate Change (IPCC 2007) also considered aerosols to be a major cause to affect adversely the climate of the Himalayan region.

Site Selection for Ambient Air Quality Monitoring (AAQM) and Methodology

Study Sites

All the three experimental sites are hill towns selected from the northwestern part of the Indian Himalaya in Himachal Pradesh state (Fig. 13.1). Himachal Pradesh is located between 30° 30′ and 33° 15′N latitude and 75° 30′ to 79° 00′E longitude and covers a geographical area of 55,673 km^2, which is about 1.69 % of the country's total geographical area (Jreat 2006). The population is unevenly distributed in twelve districts and likewise the density also differs from 2 in Lahul and Spiti district to 109 persons per km^2 in Hamirpur district (Anonymous 2001). The experimental sites at Bilaspur (Lat. 31° 20.342′N, Long. 76° 45.704′E, Alt. 556 m), Mandi (Lat. 31° 42.505′N, Long. 76° 55.974′E, Alt. 760 m) and Keylong (Lat. 32° 34.240′N, Long. 76° 02.054′E, Alt. 3100 m), represent the three important mountain ranges of the Shiwalik, Lesser and Greater Himalaya. According to the 2001 Census, Bilaspur, Mandi and Keylong had 13,058, 26,858 and 1977 inhabitants on a surface of 10.68, 4.26 and 2 km^2 respectively (Anonymous 2001). The monitoring sites were selected in a manner as to represent the central part of the town. According to the setting, Bilaspur is a residential locality, Mandi residential cum commercial, whereas Keylong is a rural town. Bilaspur lies close to Govind Sagar Lake, on the left bank of the River Satluj. It is the capital of Bilaspur district. The Chandigarh-Manali National Highway (NH)-21 crosses the town centre.

Fig. 13.1 Location of ambient air quality monitoring (AAQM) sites in Himachal Pradesh

The climate is sub-tropical with an average annual rainfall of about 1374 mm and a very high humidity during the rainy season. Mandi extends on both sides of the River Beas. The climate of the town is sub-temperate with maximum rainfall in monsoon season. However, it also receives sufficient rainfall in winter. Keylong is situated on the right bank of the River Bhaga and is the capital of the Lahul and Spiti district. The climate of the region is dry-temperate. Because of its high altitude, the town has a cool summer and a very harsh winter. Snowfall in winter interrupts the electricity supply, disrupts transportation, and the area beyond the Rohtang Pass (3978 m) remains cut-off from the rest of the country for about six to eight months.

The ambient air quality (AAQ) was monitored for a week in the three selected towns. In all monitoring sites, regular and simultaneous air sampling was conducted during the pre-monsoon period from 28th June to 5th July, 2009. The measuring site was selected in such a manner as to represent approximately the central part of the town. The selected AAQM site at Bilaspur is a residential area almost in the

Fig. 13.2 Respirable Dust Sampler (RDS) installed in Keylong, district Lahul and Spiti

middle of the town on the roof of the administrative building of the MCl Bilaspur. The monitoring site in Mandi is also located almost in the middle of the town, on the floor of MCl's administrative building. This location corresponds to the residential cum commercial urban land use category. The measuring site in Keylong was also located in the middle of the village, at a forefront of the old Circuit House (Fig. 13.2), and represents the rural category. All three selected sites are free from any restrictions of air flow.

Monitoring of Particulate Pollutants

As a part of AAQM, the monitoring of particulate matter such as TSP and PM_{10} were monitored with the help of different air pollution equipments. The equipments to monitor TSP and PM_{10} were mainly High Volume Sampler (HVS APM-430, made by Envirotech) at Bilaspur and Respirable Dust Sampler (RDS APM-460 NL, made by Envirotech) at both monitoring locations in Mandi and Keylong (see Fig. 13.2).

TSP and PM_{10} monitoring were carried out on the basis of filtration-gravimetric methods. For this, Whatman Glass Microfibre Filter GF/A (20.3 $\times$ 25.4 cm) with a pore size of 1.6 μm was used to obtain TSP and PM_{10}. Filter papers prior to monitoring were conditioned in desiccators for at least 16 h. Then they were weighed in

an analytical balance to determine the initial weigh. The exposed samples were again desiccated and weighed for obtaining the TSP and PM_{10} concentration.

In India, the Central Pollution Control Board (CPCB) is a regulatory body that defines the permissible limits of different kind of air pollutants. The limits are set by the body according to the site's location (Table 13.1).

Monitoring of Gaseous Pollutants

Atmospheric trace gases, mainly SO_2, NO_2 and NH_3, were simultaneously monitored along with particulate pollutants with the help of a thermo electrically cooled impinger box attached to HVS and RDS at each selected experimental sites. The colourimetric determination, using a modified West and Gaeke Method (Potassium Tetra Chloromercurate (TCM) method) for SO_2 (West and Gaeke 1956), the Jacob and Hochheiser Method for NO_2 analysis (Jacobs and Hochheiser 1958), and a modified Nesslers Reagent Method for NH_3 were used to analyze these trace gases.

Sampling Criterion for AAQM

The air quality sampling was done in the pre-monsoon period from 28th June to 5th July 2009. Daily measurements were taken in three time slots of 24 h of a day: (00:00 h Indian Standard Time (IST) from midnight to 08:00 h, from 08:00 to 16:00 h, and from 16:00 to 24:00 h (midnight). Monitoring was done simultaneously at all three sites. The exposed samples, which covered more than 75 % of the total duration of 8 h sampling time, were considered for analysis. However, samples which did not cover the 8 h due to electricity failure or other technical faults were rejected. Table 13.2 shows the total number of accepted and rejected samples of particulate (TSP & PM_{10}) and gaseous (SO_2, NO_2 and NH_3) pollution during the 2009 pre-monsoon period at the three monitoring sites.

HYSPLIT Model Analysis and Terra MODIS Data

To find out the possible reasons why certain pollution periods display a heavy load of aerosols in the air mass, the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model was used (Draxler and Rolph 2010; Rolph 2010). The Terra Moderate Resolution Imaging Spectroradiometer (MODIS) Satellite's Aerosol Optical Depth (AOD) analysis was carried out with the help of the Giovanni online data system, developed and maintained by the NASA Goddard Earth Sciences (GES) Data and Information Services Center (DISC) (Acker and Leptoukh 2007).

Table 13.1 AAQM stations, their land use type, parameters under observation and their permissible limits as set by CPCB (Anonymous 2009)

AAQM station	Station type	TSP	PL* ($\mu g/m^3$)	PM_{10}	PL ($\mu g/m^3$)	SO_2	PL ($\mu g/m^3$)	NO_2	PL ($\mu g/m^3$)	NH_3	PL ($\mu g/m^3$)
Bilaspur	Residential	√	140[a]	×	60[a]	√	60[a]	√	60[a]	√	100[a]
			200[b]		100[b]		80[b]		80[b]		400[b]
Mandi	Residential cum commercial	√	140[a]	√	60[a]	√	60[a]	√	60[a]	√	100[a]
			200[b]		100[b]		80[b]		80[b]		400[b]
Keylong	Rural	√	140[a]	√	60[a]	√	60[a]	√	60[a]	√	100[a]
			200[b]		100[b]		80[b]		80[b]		400[b]

*Permissible limit (PL) set by CPCB under the National Ambient Air Quality Monitoring (NAAQM) programme
√/×Parameters monitored/not monitored
[a]Permissible limit (annual mean)
[b]Permissible limit (24 h mean)

Table 13.2 Collected samples for particulate (TSP & PM_{10}) and gaseous (SO_2, NO_2 and NH_3) pollution during pre-monsoon 2009 at Bilaspur, Mandi and Keylong

Study locations	Number of samples collected									
	TSP		PM_{10}		SO_2		NO_2		NH_3	
	SA[a]	SR[b]	SA	SR	SA	SR	SA	SR	SA	SR
Bilaspur	19	2	–	–	19	2	19	2	19	2
Mandi	21	–	21	–	21	–	21	–	21	–
Keylong	20	1	20	1	17	4	20	1	18	3

[a]Samples accepted (SA); completed more than 75 % h duration of total 8 h sampling duration
[b]Samples rejected (SR); which could not complete 75 % h duration due to electricity failure or other technical faults
–Indicates 'nil'

Results and Discussion

Total Suspended Particulate (TSP) Matter

The diurnal mean concentrations of TSP during the pre-monsoon period in Bilaspur, Mandi and Keylong are shown in Fig. 13.3a. The highest mean TSP concentration was recorded with 229.3 ± 32.5 μg m^{-3} between 16:00 to 24:00 h in Keylong, and the lowest with 67.3 ± 7.8 μg m^{-3} in Mandi between 00:00 to 08:00 h. Sample wise diurnal concentration was highest with 418.5 μg m^{-3} on June 29, 2009 between 16:00 to 24:00 h in Bilaspur and lowest with 32 μg m^{-3} on July 1, 2009 between 08:00 to 16:00 h in Mandi.

The daily mean TSP concentration was highest with 274.6 ± 89.6 μg m^{-3} on 29th June 2009 and lowest with 98.3 ± 4.8 μg m^{-3} in Bilaspur. In Mandi, the highest and lowest values of TSP concentrations were 197.7 ± 15.5 μg m^{-3} on

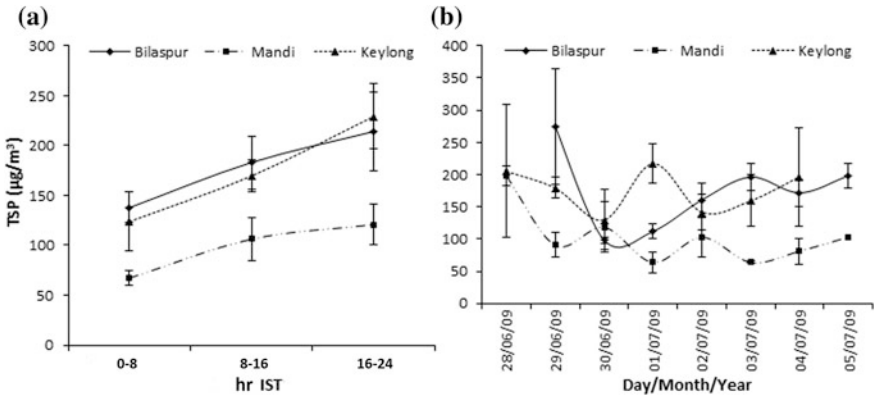

Fig. 13.3 **a** Diurnal and **b** daily mean concentration of TSP at Bilaspur, Mandi and Keylong during pre-monsoon, 2009

28th June 2009 and 63.9 ± 2.3 μg m^{-3} on 3rd July 2009 (Fig. 13.3b). At the high altitude site of Keylong, it remained highest with 217.1 ± 31 μg m^{-3} on 1st July 2009 and lowest with 129.7 ± 47 μg m^{-3} on 30th June 2009 (see Fig. 13.3b). The mean concentration of TSP in the 7 days sampling stood to be highest with 180.3 ± 18.13 μg m^{-3} in Keylong followed by 174.6 ± 18.47 μg m^{-3} in Bilaspur and 98.1 ± 11.02 μg m^{-3} in Mandi.

During the initial days of observation (28th to 30th June, 2009), the TSP concentration on an 8 h and daily mean basis was recorded highest at all the monitoring stations. This was due to the long dry spell in June 2009. On some hours and days, TSP concentration recorded exceeds the prescribed limits as set by the CPCB (Table 13.1). Of the total 19 samples in Bilaspur, five samples lay above the permissible limit of TSP, in Mandi, only one out of 21 (28th June 2009, 08:00 to 16:00 h), and out of 20 samples in Keylong, 6 samples exceeded the critical TSP concentration threshold value. The dust storms in Keylong were one of the reasons of this high concentration during the period of monitoring. Bilaspur and Keylong experienced more days with a very high TSP concentration than Mandi, because of a long drought period. In Bilaspur, there was only little rain on two occasions (30th June 2009, between 11:00 to 12:00 h and between 23:00 to 24:00 h). It rained a little three times in Keylong, on 29th June 2009 (22:00 to 22:30 h), 1st July 2009 (17:00 to 19:00 h), and 3rd July 2009 (16:00 to 16:30 h). In spite of a negligible amount of rain, both monitoring stations remained dry, and as a result the TSP concentrations touched relatively high values. In Mandi, on the other hand, heavy rain occurred four times and little rain twice during a period of 21 samples.

Particulate Matter Below 10 Micron (PM_{10})

PM_{10}, was monitored only at two sites, i.e. Mandi and Keylong. In Mandi, diurnal mean concentrations of PM_{10} in the pre-monsoon period was recorded highest with 60.3 ± 13.1 μg m^{-3} between 4 p.m. to midnight, followed by 38.3 ± 4.1 μg m^{-3} and 44.6 ± 6 μg m^{-3} between 08:00 to 16:00 h (Fig. 13.4a). The sample wise PM_{10} concentration was highest with 111.3 μg m^{-3} on 30th June 2009 between 16:00 to 24:00 h in Mandi and lowest with 14.4 μg m^{-3} on July 2, 2009 between 08:00 to 16:00 h in Keylong.

The daily mean PM_{10} concentration was highest with 65 ± 9 μg m^{-3} on 28th June 2009 and lowest with 29.8 ± 8.7 μg m^{-3} in Mandi. These highest and lowest values of PM_{10} concentration measured were 40.1 ± 5 μg m^{-3} on 28th June 2009 and 20 ± 3.2 μg m^{-3} on 3rd July 2009 in Keylong (Fig. 13.4b). During the 7 days period, the mean concentration of PM_{10} was 47.7 ± 5.18 μg m^{-3} in Mandi and 29.4 ± 2.2 μg m^{-3} in Keylong.

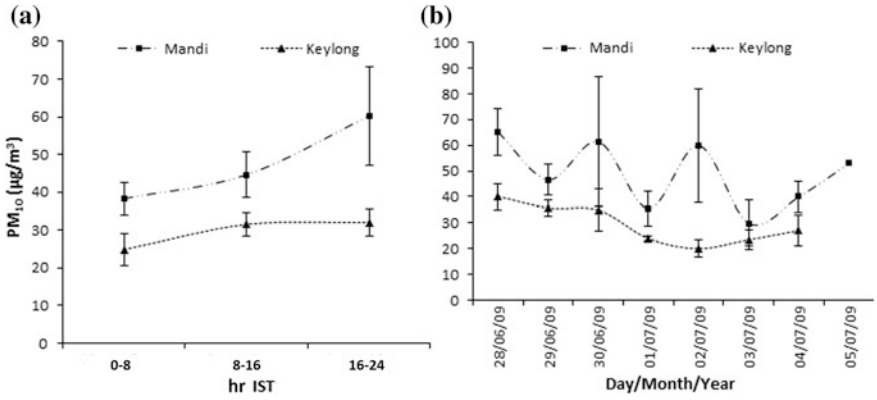

Fig. 13.4 **a** Diurnal and **b** daily mean concentration of PM_{10} at Mandi and Keylong during pre-monsoon, 2009

Sulphur Dioxide (SO_2)

The observations of SO_2 on the diurnal basis were monitored at Bilaspur, Mandi and Keylong. The values of SO_2 remained significantly below the National Ambient Air Quality Standards (NAAQS) set by its regulatory body CPCB. The diurnal mean concentration of SO_2 in Bilaspur was observed as 4.1 ± 2.8 µg m^{-3}, 4.5 ± 1.4 µg m^{-3} and 4.5 ± 1.1 µg m^{-3} between 00:00 to 08:00 h, 08:00 to 16:00 h and 16:00 to 24:00 h respectively. The values for Mandi were 0.9 ± 0.2 µg m^{-3}, 0.9 ± 0.3 µg m^{-3} and 1 ± 0.4 µg m^{-3} respectively, and 1.6 ± 0.4 µg m^{-3}, 1.3 ± 0.2 µg m^{-3} and 2.1 ± 0.5 µg m^{-3} respectively in Keylong for the same time slots (Fig. 13.5a). The sample wise highest

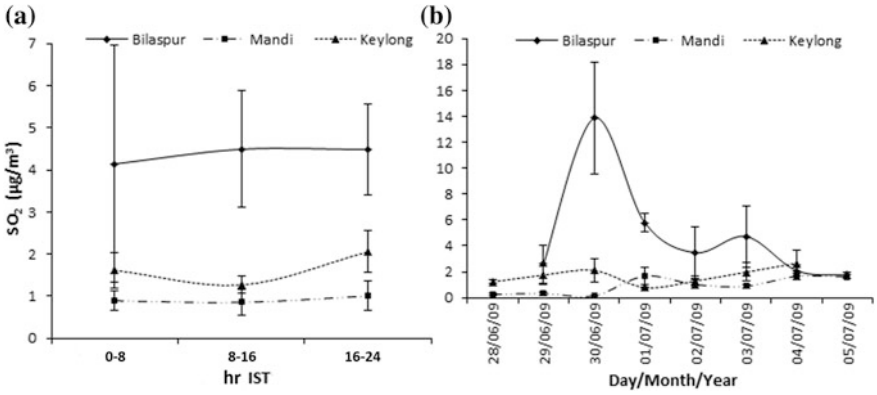

Fig. 13.5 SO_2 concentration at Bilaspur, Mandi and Keylong during pre-monsoon, 2009: **a** diurnal and **b** daily mean concentration

concentration was measured in Bilaspur on 30th June 2009 between 00:00 to 08:00 h indicating 18.2 μg m^{-3} SO_2. The maximum value in Mandi was 2.43 μg m^{-3} on 1st July 2009 between 16:00 to 24:00 h, whereas for Keylong the highest value was 3.8 μg m^{-3} on 30th June 2009 between 16:00 to 24:00 h. The lowest SO_2 concentration was found in Mandi, a negligible concentration due to the washout effect of the rain.

Regarding the daily mean concentration of SO_2 in Bilaspur, the values ranged between 1.7 ± 0.2 μg m^{-3} on 5th July 2009 and 13.9 ± 4.4 μg m^{-3} on 30th June 2009. In Mandi, they oscillated between 0.2 ± 0.001 μg m^{-3} on 30th June 2009 to 1.7 ± 0.7 μg m^{-3} on 1st July 2009, and in Keylong between 0.8 μg m^{-3} on 1st July 2009 to 2.7 ± 1 μg m^{-3} on 4th July 2009 (Fig. 13.5b). Of the total 19 samples of SO_2 at each location, the highest mean concentration was recorded with 4.4 ± 1 μg m^{-3} in Bilaspur. In Mandi, this mean value for SO_2 was recorded as 0.9 ± 0.17 μg m^{-3}, and at the high altitude station Keylong, it was almost double that figure with 1.7 ± 0.25 μg m^{-3}.

Nitrogen Dioxide (NO_2)

The highest values of NO_2 concentration were 17.3 μg m^{-3} at Bilaspur on 4th July 2009 between 00:00 to 08:00 h, 17.2 μg m^{-3} on 30th June 2009 between 16:00 to 24:00 h in Mandi and 6 μg m^{-3} on 3rd July 2009 between 16:00 to 24:00 h in Keylong. The diurnal mean concentration of NO_2 was observed as 10.4 ± 2.3 μg m^{-3}, 5.4 ± 0.4 μg m^{-3} and 9.7 ± 1.2 μg m^{-3} from 00:00 to 08:00 h, 08:00 to 16:00 h and 16:00 to 24:00 h in Bilaspur, as 7.4 ± 1.3 μg m^{-3}, 8.9 ± 1 μg m^{-3} and 9.5 ± 1.7 μg m^{-3} in Mandi, and as 2.6 ± 0.3 μg m^{-3}, 2.2 ± 0.3 μg m^{-3} and 2.7 ± 0.7 μg m^{-3} in Keylong during the same three time slots (Fig. 13.6a). The daily mean concentration of NO_2 in Bilaspur was as high as 9.9 ± 1.6 μg m^{-3} on 3rd July 2009 and as low as 6.1 ± 0.9 μg m^{-3} on 29th June 2009. In Mandi, these values were recorded as 11.5 ± 3.5 μg m^{-3} as highest on 30th June 2009 and 5.3 ± 2 μg m^{-3} as lowest on 3rd July 2009. At the same time, these values in Keylong varied between 1.4 ± 1 μg m^{-3} (on 4th July 2009) and 3.3 ± 1.4 μg m^{-3} (on 3rd July 2009) (Fig. 13.6b).

Of the total 19 collected samples of NO_2 at each study locations, its mean concentration was recorded as 8.6 ± 1 μg m^{-3} at Bilaspur. In Mandi, this mean value for NO_2 was found to be 8.6 ± 0.8 μg m^{-3}. Keylong is at such a high altitude that only 2.5 ± 0.3 μg m^{-3} was recorded.

Ammonia (NH_3)

The concentration of NH_3 was highest with 53.6 μg m^{-3} on 4th July 2009 between 16:00 to 24:00 h in Bilaspur, 62.2 μg m^{-3} on 4th July 2009 between 00:00 to

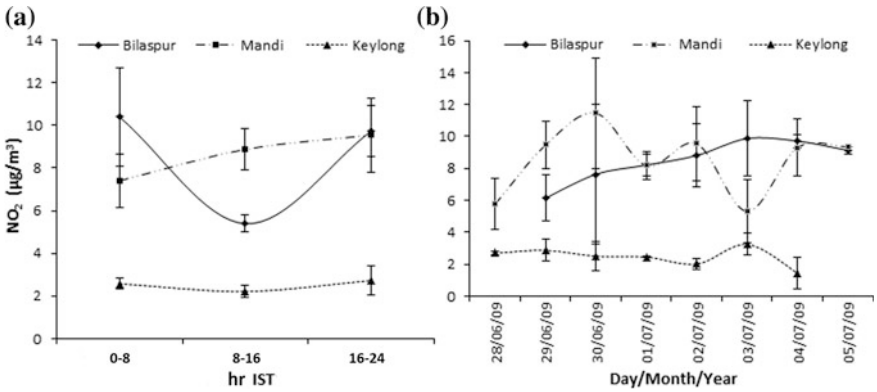

Fig. 13.6 NO_2 concentrations at Bilaspur, Mandi and Keylong during pre-monsoon, 2009: **a** diurnal and **b** daily mean concentration

08:00 h in Mandi, and 54 µg m^{-3} on 29th June and 1st July 2009 between 08:00 to 16:00 h and 16:00 to 24:00 h in Keylong. The daily mean concentrations of NH_3 at Bilaspur were observed with 21.1 ± 4 µg m^{-3}, 21.9 ± 4.9 µg m^{-3} and 28.3 ± 5.6 µg m^{-3} between 00:00 to 08:00 h, 08:00 to 16:00 h and 16:00 to 24:00 h. These values for Mandi were 34.9 ± 6.8 µg m^{-3}, 28.1 ± 6.3 µg m^{-3} and 35.6 ± 6.7 µg m^{-3}, and 25.2 ± 6 µg m^{-3}, 32.4 ± 7.1 µg m^{-3} and 33.9 ± 5.3 µg m^{-3} in Keylong (Fig. 13.7a).

The diurnal mean concentration of NH_3 in Bilaspur was observed as high as 41.2 ± 6.6 µg m^{-3} on 4th July 2009 and as low as 8.1 ± 2.4 µg m^{-3} on 5th July 2009. In Mandi, these values recorded highest with 54.6 µg m^{-3} on 5th July 2009 and lowest with 4.9 ± 2.3 µg m^{-3} on 28th June 2009. Similarly, the values ranged from 6.9 µg m^{-3} to 41.8 ± 3.1 µg m^{-3} on 4th July 2009 and 29th June 2009 in Keylong (Fig. 13.7b). Of the total 19 collected samples of NH_3 at each study site, its mean concentration was recorded as 24 ± 2.8 µg m^{-3} in Bilaspur. In Mandi, the mean value for NH_3 was found to be 32.9 ± 3.7 µg m^{-3}, and the high altitude sampling location Keylong showed this mean value as 30.1 ± 3.5 µg m^{-3}.

Sources of Pollution Episodes: HYSPLIT Model and Terra MODIS Satellites Data

The back trajectories allowed pinpointing the origin of the air mass and its path at different heights to see the distant transport sources of particles. The five days back trajectories were drawn and analyzed to show the sources of particles located outside the region. For the different time periods of monitoring, the trajectories ending at different times were drawn. For the time slot from 00:00 to 08:00 h, the ending trajectories were selected at 23:00 h Coordinated Universal Time (UTC),

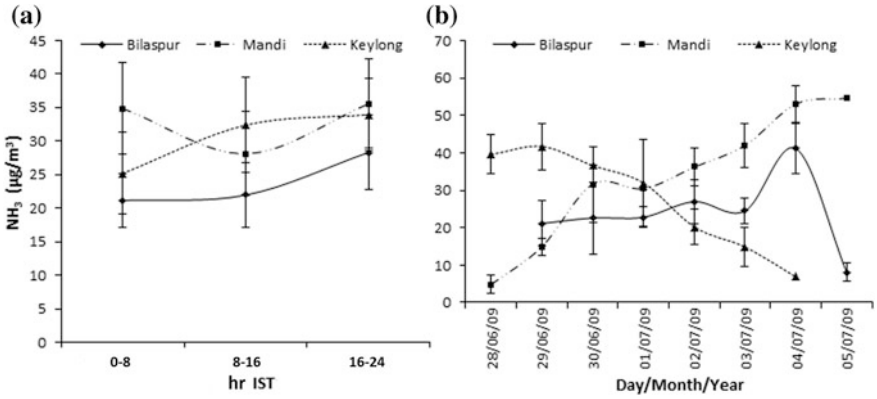

Fig. 13.7 NH_3 concentration at Bilaspur, Mandi and Keylong during pre-monsoon, 2009: **a** diurnal and **b** daily mean concentration

that is, 04:30 IST, from 08:00 to 16:00 h, 07:00 UTC/12:30 IST, and for 16:00 to 24:00 h, it was 15:00 UTC/20:30 IST.

For Bilaspur, three back trajectories were analyzed. Among them, two were for 29th June 2009, one for 08:00 to 16:00 h and the second for 16:00 to 24:00 h. The third back trajectory was drawn for 3rd July 2009 for the sampling period from 16:00 to 24:00 h. These back trajectories were analyzed at three different altitudes; 600 m, 1000 m, and 2000 m above ground level (agl) (Fig. 13.8). This was the period when the highest TSP concentration was observed.

The back trajectories drawn at 600 m and 1000 m agl for 29th June 2009 ending at 07:00 UTC originated from the Jaisalmer district of Rajasthan, and after following the Indo-Pak border these air masses reached Bilaspur. Both air masses were coming close to the surface when passing through the Thar Desert. As a result, it becomes evident that the high concentration of aerosols on this day was largely affected by the passage across the desert. The trajectory for 29th June 2009 ending at 15:00 UTC was observed from the same direction and was very close to the

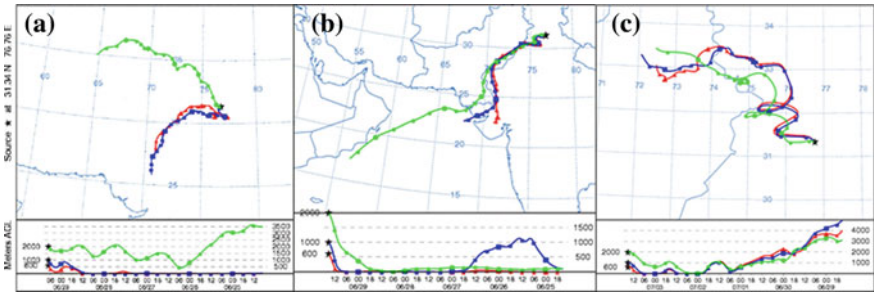

Fig. 13.8 Back trajectory analysis for Bilaspur on 29th June 2009 ending at: **a** 07:00 UTC, **b** 15:00 UTC, and **c** on 3rd July 2009 at 15:00 UTC (*Source* http://www.arl.noaa.gov/ready)

surface at three different altitudes (i.e., 600 m, 1000 m and 2000 m agl). The trajectories for 3rd July 2009 ending at 15:00 UTC started from the northeastern part of Pakistan, i.e., the first from 33.038°N latitude and 72.496°E longitude, the second from 33.272°N latitude and 72.077°E longitude, and the third from 33.429° N latitude and 72.465°E longitude. In the beginning, all three trajectories occurred between 3000 to 5000 m agl. At 06:00 UTC of 1st July 2009 these air masses came close to the surface. The path which they followed was not sufficiently dry to transport many aerosol particles. Therefore, these air masses did not have the potential to transport outside dust to the study site. As a result, the high concentration on that day may be a result of local sources (see Fig. 13.8).

Figure 13.9 shows the back trajectories for Mandi AAQM station. At 800 m agl, the back trajectory for 28th June 2009 ending at 0700 UTC started 5 days before from northeastern Pakistan. The air masses at 1,500 m moved in from Uzbekistan, and at 2,500 m agl they originated in Afghanistan. The source of all these trajectories moved from dry regions and the air came again close to the ground, therefore carrying a heavy dust load. The trajectories for the same day ending at 15:00 UTC displayed almost the same pattern. The trajectories for 30th June 2009 ending at 15:00 UTC for the two relatively lower altitudes (800 m and 1,500 m agl) started from southwestern Rajasthan. After having followed the Indo-Pak border at the Thar Desert, it was close to the ground with a heavy load of aerosols.

The back trajectory analysis for the high aerosol loading of 28th June 2009 (15:00 UTC) in Keylong, 1st July 2009 (23:00 UTC) and 4th July 2009 (15:00 UTC) clearly indicate that all the trajectories were coming from long distances such as Mediterranean Sea, central, northern and western Europe, except for the trajectories drawn at 3,200 m of 28th June and 4th July 2009. All these trajectories passed through the Arabian countries and could be adversely influenced by the sea salt and sulphate aerosols (Fig. 13.10).

The images of averaged AODs were taken into account to observe the atmospheric turbidity before and during AAQM at the selected test sites (Fig. 13.11a, b). Before monitoring AAQ, the AOD value at 550 nm was between 0.42 and 0.52,

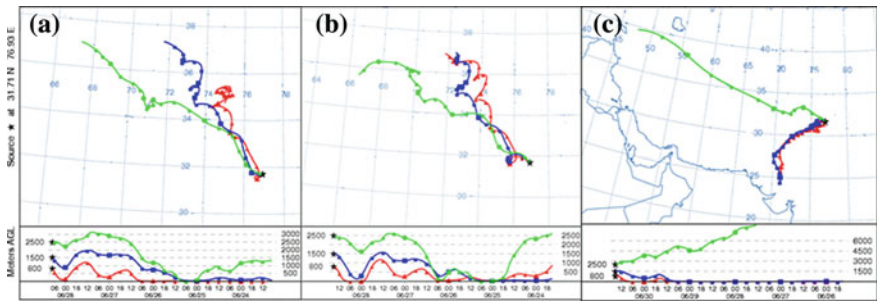

Fig. 13.9 Back trajectory analysis for Mandi on: **a** 28th June 2009 ending at 07:00 UTC, **b** 28th June 2009 ending at 15:00 UTC, and **c** 30th June 2009 at 15:00 UTC (*Source* http://www.arl.noaa.gov/ready)

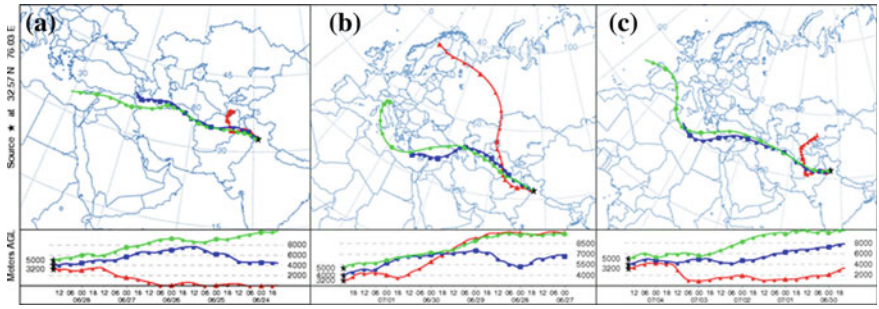

Fig. 13.10 Back trajectory analysis for Keylong: **a** June 28, 2009 ending at 15:00 UTC, **b** July 1, 2009 at 23:00 UTC, and **c** July 4, 2009 at 15:00 UTC (*Source* http://www.arl.noaa.gov/ready)

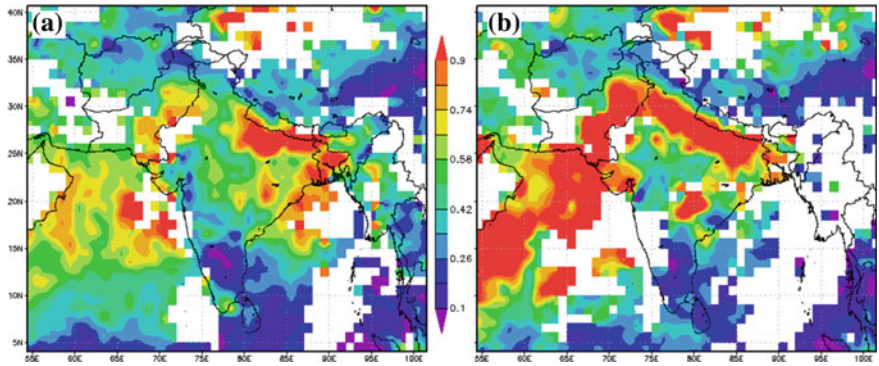

Fig. 13.11 Images of mean Aerosol Optical Depth (AOD) between: **a** 23 to 28 June, 2009, and **b** 28 June to 5 July, 2009 using Terra MODIS data (*Source* http://gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=aerosol_daily)

during monitoring it ranged from 0.42 to 0.74. This, directly or indirectly, increased air pollution values that were also affected by outside pollution sources. For example, the air mass back trajectory reaching Bilaspur on a high pollution loading day (i.e., June 29, 2009) clearly followed a route through the high AOD areas of the Indo-Pak border.

Recommendations

Based on the present results, the following recommendations to maintain air quality standards are made:

i. There is a need to inform the local communities regarding the future consequences of polluted air among them and to adopt pollution free technologies.

ii. Burning and open dumping of solid waste should strictly be prohibited in the towns to free the environment from toxic air. To manage solid waste in towns, the authorities should be scientifically informed to dispose of the waste properly.
iii. The local communities and managing authorities should be aware of the practice of energy driven technologies, the use of quality fuel in the vehicles, and the practice of non-conventional energy sources which need to be supplemented with solar energy.
iv. Plantation along roads, streets, open places, and around the towns under a green belt concept should be encouraged as a sustainable option to bring ambient air pollution under control.
v. The management of ambient air pollution needs to be done in a coordinated manner, with active cooperation between local residents, management authorities, research institutions, and local government.

Conclusions

The AAQM study carried out under the present selected sites showed the particulate pollution (TSP and PM_{10}) to be higher than gaseous pollution (SO_2, NO_2 and NH_3). Sometimes, TSP and PM_{10} have crossed their permissible limits at all sites. On a diurnal basis, TSP was recorded up to 418 μg m^{-3} as highest at Bilaspur and 32 μg m^{-3} as lowest at Mandi. At the same time, PM_{10} was noted to be highest with 111.3 μg m^{-3} at Mandi and lowest with 14.4 μg m^{-3} at Keylong. It is observed that the TSP concentration at Keylong was comparatively too high as compared to PM_{10}. The gaseous pollutants such as SO_2, NO_2 and NH_3 were found far below the permissible limits. TSP and PM_{10} concentrations were greatly influenced by both local and outside sources. The local sources such as vehicles and visitors' influx, burning of fuel wood, coal and solid waste, use of diesel generators, and dust blown from nearby un-metalled roads were the most important ones. The long-distance transport sources of air masses moving in from outside regions can also be considered to be contributing to the existing concentrations of these aerosols in the region. Environmental and health impacts of the air borne particles require that authorities urgently step up control of the ever-increasing level of air pollution not only in large cities but also in the towns/villages under study in this ecologically very sensitive and topographically fragile part of the Himalaya.

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Chapter 14
The Impact of Climate Change on the Shifting of the Vegetation Line in the Indian Himalaya: A Case Study from the Kutiyangti Watershed

J.S. Rawat, M. Kumar, V. Viswas, V.S. Rawat and N. Gahlaut

Introduction

The highest mountain chain of the earth, viz., the Himalaya is a hotspot of biological diversity. The Indian Himalaya has over 18,500 taxa, belonging to various groups of plants (RTF 2010). The Himalayan region with only 16 % of India's land area houses 81 % of the country's stock of gymnosperms, 47 % of angiosperms, 59.5 % of lichens, 58.7 % of pteridophytes, 43.9 % of bryophytes, and 53.07 % of fungi found in India (ibid). The hydrological cycle in such a biodiversitically rich domain of the earth indicates that the Himalayan climate is changing rapidly. A large part of the Himalayan flora is concentrated on its alpine zone. A high mountain ecosystem, which is the alpine vegetation life zone above the treeline, is determined by low temperature conditions. Hence, alpine ecosystems are considered to be particularly sensitive to the impact of climate change and are thus vulnerable to climate warming (Gottfried et al. 1999; Grabherr et al. 2003). Simulation studies have shown that the climate change impact will result in the shift of the alpine vegetation to higher altitudes (Noble 1993). Field studies have shown evidences of upward migration of alpine vegetation in the European Alps (Grabherr et al. 1994, 2000, 2001; Pauli et al. 2001) and in the Ural mountains (Moiseev and Shyiatov 2003). Regarding the impact of climate on vegetation in China, Yang

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(2003) reports, "The greatest impact of climate warming observed in nature can be seen in the response of vegetation. Many annual observations and interviews with local people show that alpine *ermannii* birch has moved toward the tundra ecosystem over the last twenty years." Recently Pauli et al. (2006) have done detailed observations under the GLORIA project (Global Observation Research Initiatives in Alpine Environments) on vegetation migration towards higher altitudes in Alpine regions of Europe. The effect of rapid change in climate can be expected to affect alpine life severely; plants adapted to cold environments will suffer habitat losses and will, in many cases, have nowhere to migrate as the climate becomes progressively warmer (Grabherr et al. 1995). A study from the Nanda Devi Biosphere Reserve (NDBR) in Central Himalaya, India (Panigrahy et al. 2010) has indicated that the ecosystems in the Himalaya have shown significant changes during the last three to four decades probably due to global warming. This study reports about >300 m shift of the timberline from 1960 to 1986 in the NDBR. The present paper aims to report the results of vegetation line shifting from a Central Himalayan watershed, viz., the Kutiyangti.

The Study Area

The study area, viz., the Kutiyangti Watershed (Fig. 14.1) which extends between 30°8′34″ N to 30°28′17″ N latitudes and 80°31′44″ E to 80°52′12″ E longitudes, encompasses an area of 561 km^2. Kutiyangti is a north east flowing tributary of the

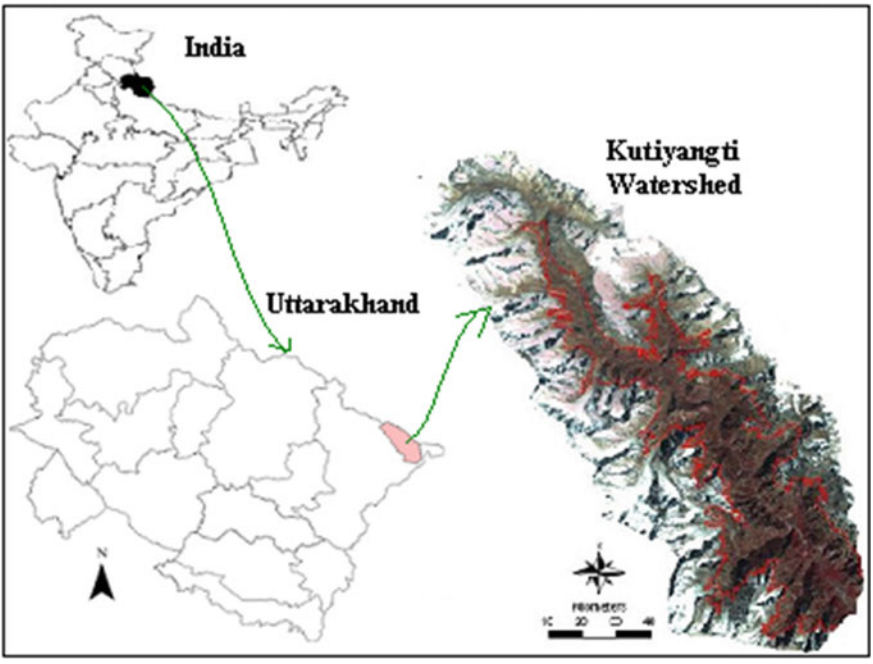

Fig. 14.1 Location map of the study area

Kali River situated in the eastern part of the Uttarakhand state. The altitude of the watershed varies between 2941 and 6265 m.

Methodology

To work out the temporal shifting of vegetation line, remote sensing data are extremely valuable (Ahmadi and Nusrath 2010). To examine the shifting of vegetation in the Kutiyangti watershed, Landsat satellite imageries of four different years were acquired by Global Land Cover Facility site and Glovis. The first imagery Landsat MSS of October 1972 was used at 60 m resolution. The second imagery Landsat TM of 15th October 1990 had a 30 m resolution. The third and fourth imageries were of Landsat ETM + data of 15th October 1999 and 2010 at a resolution of 30 m. From Cartosat 1 data, a digital elevation model (DEM) was used to derive the average elevation of the vegetation line. The Landsat images were resample to a 60 m pixel size using the nearest neighbor resampling method. The change of resolution was necessary in order to gain better results. These images helped in understanding the process of the gradual shift of the vegetation line in the watershed over the last 38 years (i.e. 1972–2010). Erdas Imagine software was used for processing the satellite spictures. Firstly, different bands of the image were stacked to produce a false colour composite. The Area of Interest (AOI) was calculated and finally the required image was extracted by sub-setting of the image. The subset image was then reprojected. The upper limit of the vegetation line was delineated using a normalized difference vegetation index (NDVI = NIR-RED/NIR +RED) with values ranging in between 0.2 and 0.4 (http://www.earthobservatory.nasa.gov). After displaying the NDVI imagery on the screen of the Arc map, the upper limit of the vegetation line in the watershed area was digitized for different years (Figs. 14.2 and 14.3). The contours generated through Cartosat 1 based on DEM were overlaid onto the vegetation line to calculate the average altitude of the vegetation line (Table 14.1). By superimposing the vegetation lines of different years, the area of change from non-vegetation to vegetation was worked out (Fig. 14.4 and Table 14.2).

Results and Discussion

Figure 14.2a depicts the geographical location of the vegetation line of the Kutiyangti watershed in 1972 which is based on the NDVI values, i.e., 0.2–0.4 (Fig. 14.2b). The DEM overlay on this vegetation line suggests that the average height of the vegetation line in the watershed was about 4700 m in 1972 (Table 14.1). Figures 14.2c, d and 14.3a, b and c, d depict the location of vegetation lines and spatial distribution of NDVI values in 1990, 1999 and 2010, respectively. These maps reveal that the vegetation line has shifted towards higher elevations in

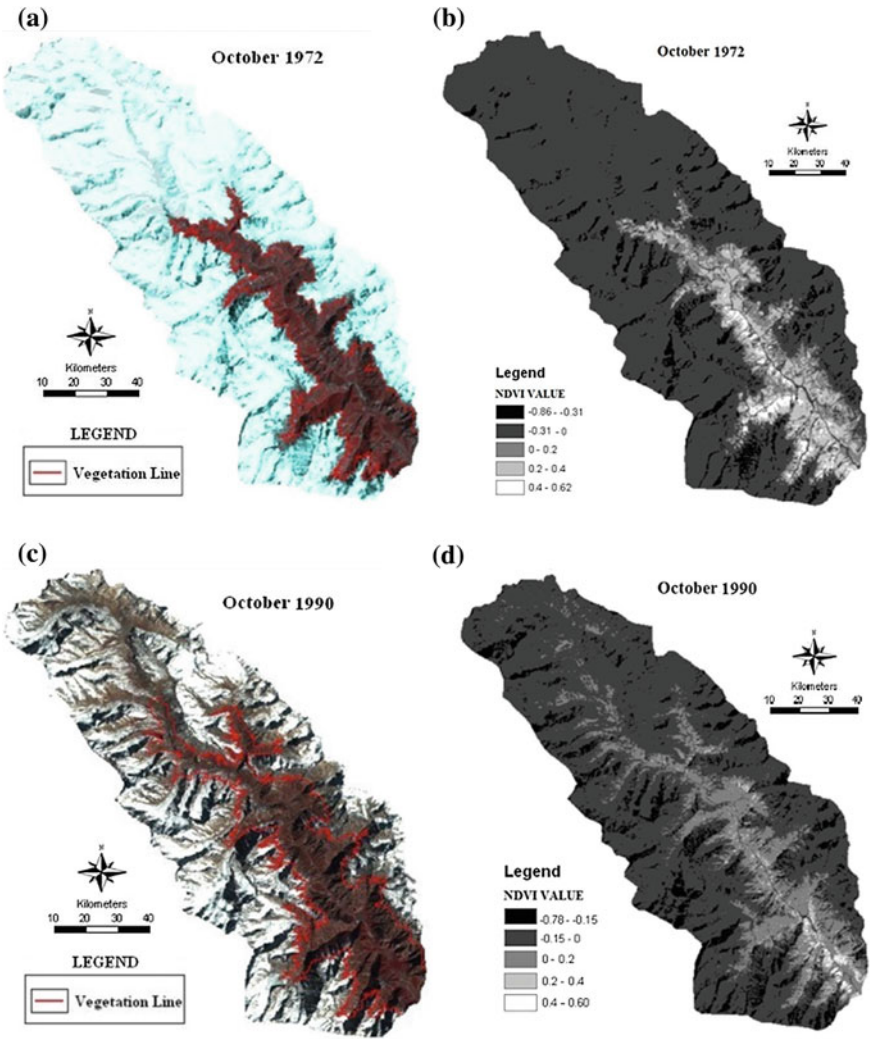

Fig. 14.2 Geographic location of the vegetation line based on NDVI values (0.2–0.4) in different years in the Kutiyangti watershed; **a**, **b** in October 1972 and **c**, **d** in October 1990

the watershed by about 300 m during 1972–1999 at the rate of 16.69 m/year; 160 m during 1990–1999 at the rate of 17.78 m/year; and 170 m at the rate of 15.45 m/year during 1999–2010 (Table 14.2). These data suggest that, during the last 38 years (i.e., 1972–2010), the vegetation line in Kutiyangti watershed has been shifted about 370 m towards higher elevations at an average rate of 16.58 m/year (Table 14.2). The vegetation line doesn't coincide with a contour line because elevation is not the only factor by which the vegetation line is controlled. Other parameters such as

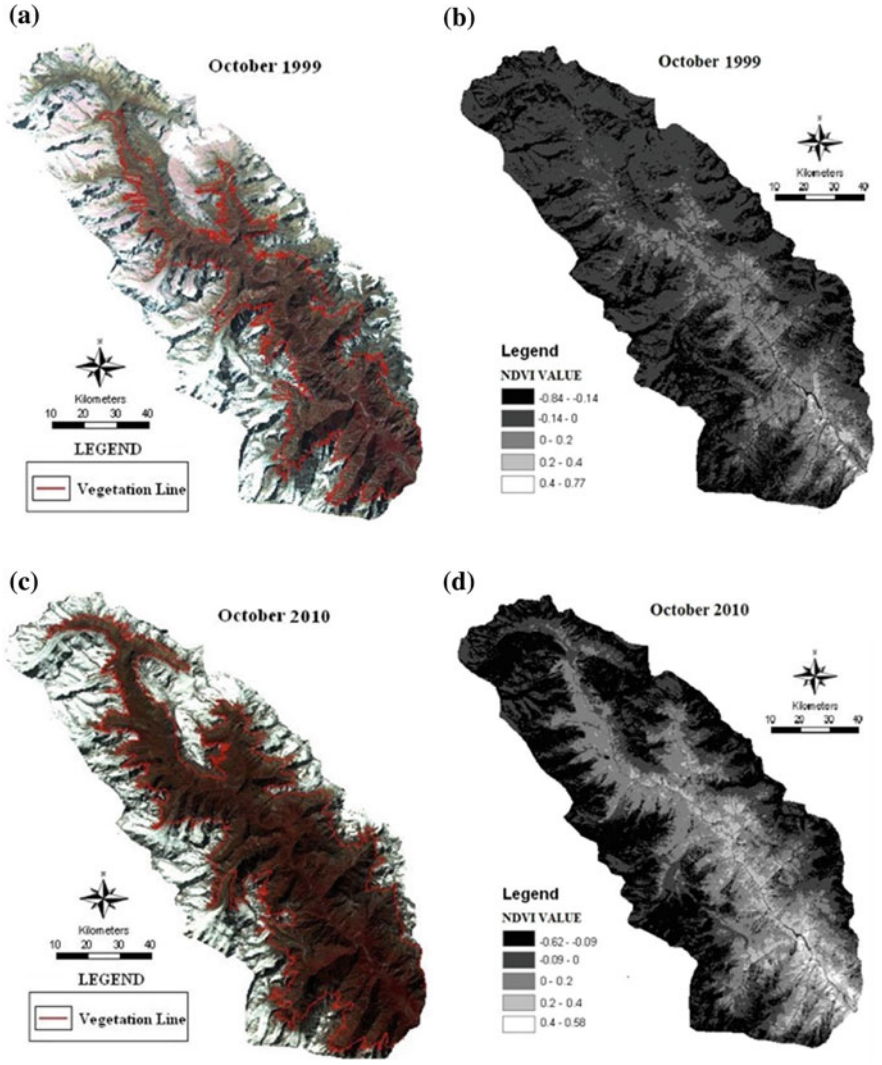

Fig. 14.3 Geographic location of the vegetation line based on NDVI values (0.2–0.4) in different years in the Kutiyangti watershed; **a**, **b** in October 1999 and **c**, **d** in October 2010

Table 14.1 Average height of vegetation line in different years in Kutiyangthi Watershed, Central Himalaya, India

Year	Average height (m)
1972	4700
1990	5000
1999	5160
2010	5330

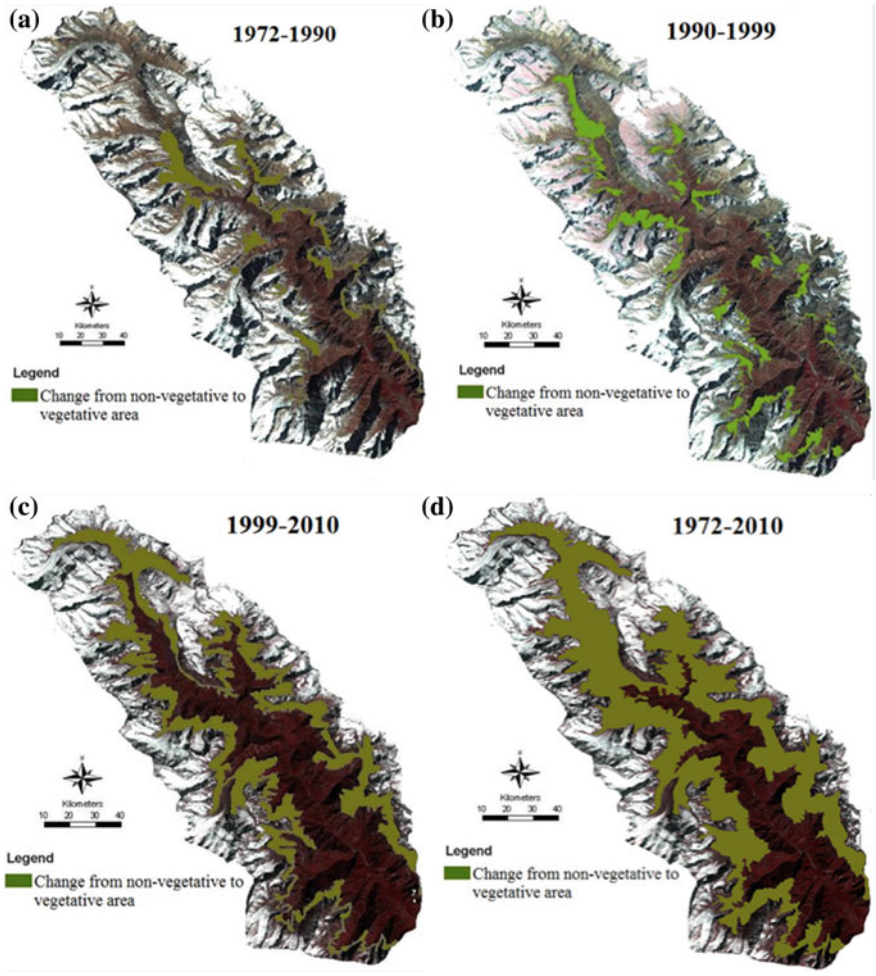

Fig. 14.4 Change from non-vegetative area to vegetative area in the Kutiyangti watershed in between 1972–1990 (**a**); 1990–1999 (**b**); 1999–2010 (**c**) and 1972–2010 (**d**)

aspect (Kank and Barancok 2005), slope steepness and rockiness also influence the vegetation growth and development.

Figure 14.4 depicts the spatial dynamics of the non vegetative area which has been converted into vegetative area in between 1972–1990 (Fig. 14.4a), 1990–1999 (Fig. 14.4b), 1999–2010 (Fig. 14.4c) and 1972–2010 (Fig. 14.4d). Due to the vegetation shift during 1972–2010, about 166.80 km^2 non-vegetative area of the watershed in between 4700 and 5330 m elevation has been converted into vegetative area at an average rate of 4.27 km^2/year (Table 14.2). In different periods, the non-vegetative area changed into vegetative area at the rate of 1.66 km^2/year during 1972–1990, 4.32 km^2/year during 1990–1999 and 8.92 km^2/year during

Table 14.2 Amount and rate of vegetation shift in different periods in the Kutiyangti watershed, Central Himalaya, India

Years	Period (Years)	Shift of vegetation line		Change from non-vegetative to vegetative area	
		Amount (m)	Rate of shift (m/year)	Area (km^2)	Rate (km^2/year)
1972–1990	18	300	16.69	29.81	1.66
1990–1999	9	160	17.78	38.86	4.32
1999–2010	11	170	15.45	98.13	8.92
1972–2010	38	630	16.58	166.80	4.27

1999–2010 (Table 14.2). The situation of vegetation shifting is similar to the Kutiyangthi watershed in the entire Central Himalayan region due to global warming.

Conclusions

With the help of the present study carried out in a Central Himalaya watershed, viz., the Kutiyangti, it can be stated that the vegetation line in the Central Himalayan region is shifting towards higher elevations due to global warming. In the Kutiyangti valley—a tributary watershed of the mighty Kali River bordering India and Nepal, the vegetation line has shifted at an average rate of 16.58 m/year during the last 38 years (i.e., 1972–2010). The process of shifting vegetation line is converting the non-vegetative area into vegetative area towards a higher elevation at an average rate of 4.27 km^2/year. The shifting of the vegetation line towards higher elevations is sharp evidence that the snow cover area is depleting steadily in the Central Himalaya due to global warming. If the trend of depletion continues, the water resources of the region will be in danger which may result in severe environmental degradation, social disruption and ecological damages in the region.

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Chapter 15
Leguminous Plants of the Kumaun Himalaya: Diversity, Distribution, Threats and Management

Kiran Bargali

Introduction

The family Leguminosae (*Fabaceae*) is a large and economically important family of flowering plants. It provides a wide range of food sources, gums for cosmetics, fodder and timber in temperate and tropical part of the world (Rao and Husain 1993). This family is represented by approximately 19,400 species placed in 730 genera in three sub families (Stevens 2001). According to one estimate, the family is represented in India by about 179 genera and 1152 species (Husain and Kapoor 1990; Sanjappa 1991). Plants of this family are found throughout the world growing in different environments and climates. They also range in habit from giant trees to small annual herbs, with the majority being herbaceous perennials (Rao and Husain 1993). Many plants host bacteria in their roots within structures called root nodules (Allen and Allen 1981).

Legumes play a major role in agricultural production and resource conservation. They improve soil quality, reduce nitrogen requirement, enhance wildlife habitat, enhance pasture and land quality and reduce soil erosion (Bargali and Bargali 2009). They are also useful in crop rotation, as they maintain soil fertility in the absence of adequate manuring. In addition, legume-rhizobium is the most important symbiotic nitrogen-fixation system, offering a low input and cost effective tool in ecosystem restoration. Thus, the importance of leguminous nitrogen fixing plants in the restoration of degraded land is well known. In view of their paramount importance, an International Legume Data-base and Information Service (ILDIS) has been established at Kew, for developing the data base on world legume. The National Botanical Research Institute Lucknow is recognized as the nodal organization for developing the data on legumes of South East Asian countries.

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The present study is devoted to the diversity, distribution, threats and management of leguminous plants of Kumaun Himalayan region.

Study Area and Methods

Kumaun Himalaya (28° 44′ N–30° 49′ N Lat. and 78° 45″–81° 1′ E Long.) occupies the central part of the Indian Himalaya and covers an area of about 21,035 km^2. The great range of altitude (300–7436 m) along with a dissected topography and landscape resulted in different climatic conditions. This eco-climatic variation has resulted in several micro/macro habitat types with high species diversity.

An extensive survey of the Kumaun flora was made and leguminous plant species were collected and identified with the help of Prof. Y.P.S. Pangtey, Taxonomist, Department of Botany, Kumaun University, Nainital. Information on distribution, habit, habitat, flowering and fruiting time were also collected from the flora described by Osmaston (1927), Kalakoti (1983), Pande (1984), Joshi (1986), Samant (1987) and Bankoti (1990). This information was used to determine plant diversity, distribution pattern and existing status of leguminous plant resources which are being over exploited by the local inhabitants.

Diversity of Legumes

In the present study, a total of 73 genera of legumes belonging to 255 species distributed in three sub-families were identified. The maximum genera and species were recorded from the sub-family Papilionaceae, followed by Caesalpiniaceae and the minimum in Mimosaceae (Fig. 15.1). 59 genera with 204 species were reported from Papilionaceae family, 8 genera with 30 species were from Caesalpiniaceae and 6 genera with 21 species from Mimosaceae.

Among different species, the maximum number of plants recorded was herbs (125) followed by shrubs (78), and trees (37), whereas the minimum number (15) was climbers (Fig. 15.2). The legume flora of the Kumaun region was enriched

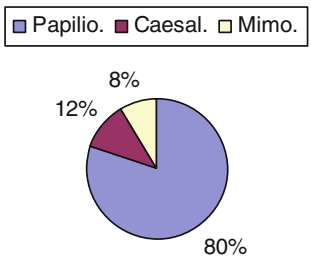

Fig. 15.1 Percent distribution of Kumaun Himalayan leguminous plants in three sub-families

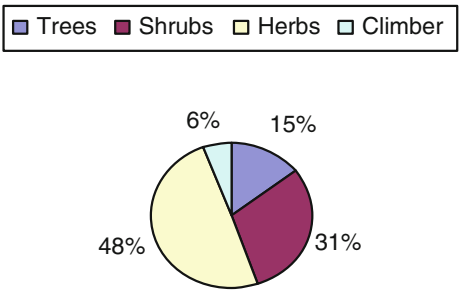

Fig. 15.2 Distribution of leguminous herbs, shrubs, trees and climbers in the Kumaun Himalayan region

by several invasive species from tropical Africa and Madagascar. These were the cultivated *Delonix regia* (Bojer ex Hook.) Rafin; *Acacia* spp. etc. (Rao and Husain 1993). Some dominant genera present in the Kumaun Himalayan region are *Astragalus* (22 spp.), *Desmodium* (19 spp.), *Crotalaria* (15 spp.), *Indigofera* (11 spp.), *Vicia* (06 spp.), *Acacia* (10 spp.), *Bauhinia* (06 spp.), *Flemingia* (08 spp.) etc. Among the legumes, diversity can also be observed in a number of timber species such as *Acacia catechu* (L.F.), *Albizia odoratissima* (L.F.) Benth., *Bauhinia purpurea* L., *Dalbergia sissoo* and *Ougeinia oojeinensis* etc. Several fodder species such as *Medicago* sp. and *Trigonella* sp. were also reported.

Legumes also showed great diversity in habitats. They were reported from forests, waysides/roadsides, waste places, rock boulders/rocky slopes, along river banks, agricultural fields, exposed places (landslides/landslips) etc.

Distribution Pattern of Legumes

The distribution of legumes in the Kumaun Himalayan region greatly varies with regard to different altitudes (Fig. 15.3). The distribution of legumes along an altitudinal gradient indicated maximum diversity in the lower elevation zone (165 spp.) and decreased with increasing altitude. The lowest diversity in the zone above 4000 m is possibly due to harsh climatic conditions. Based on the altitude, the vegetation has been grouped under tropical/subtropical (300–1800 m), temperate (1800–3600 m), and alpine (3600–4500 m) types. The maximum diversity in the tropical/subtropical region is exhibited by genera such as *Albizia*, *Bauhinia*, *Dalbergia*, *Desmodium*, *Indigofera*, *Tephrosia* etc. As compared to the tropical and subtropical zones, the temperate zone has a lesser number of species and is dominated by genera like *Hedysarum*, *Lathyrus*, *Lespedeza*, *Medicago*, *Trifolium*, *Vicia* etc. The Alpine zone is particularly characterized by stunted and perennial herbaceous forms such as *Astragalus*, *Trifolium*, *Trigonella* etc. Overlapping within different altitudinal zones is noted in most cases.

Some species like *Desmodium triflorum* were distributed within a maximum range between 700 and 2250 m a.s.l., followed by *Cassia* spp. between 600 and 1800 m, *Flemingia stroblifera* from 600 to 1750 m elevation. The extreme climate

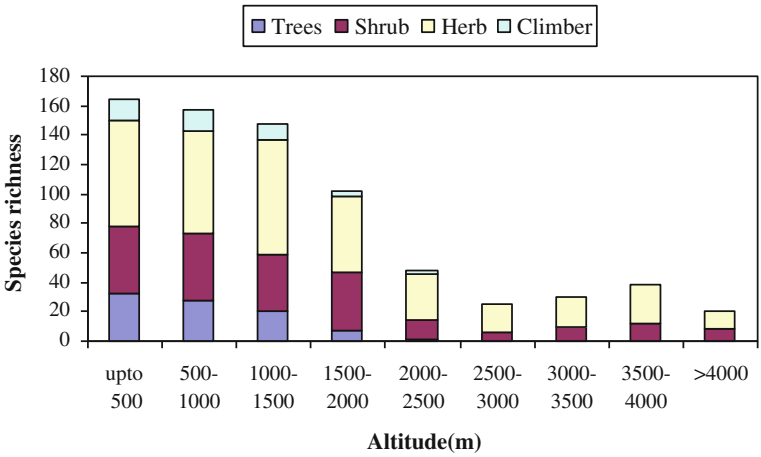

Fig. 15.3 Species richness in relation to altitude in leguminous plants of the Kumaun Himalayan region

and the high elevation are responsible for the rich concentration of endemism in this region. Some important endemic taxa of legumes in the Kumaun Himalayan region were *Abrus fruticulosus*, *Acacia pseudo-eburnea*, *Astragalus maxwellii*, *Hedysarum kumaonensis*, *Meizotropis pellita*. In certain shady and mesic habitats alpine species like *Trifolium* sp. and *Astragalus* sp. predominates.

Threats to Legumes

Legumes are being over-exploited for economical, medicinal and commercial purposes as timber, food, fodder, gums, oils, medicine and ornamental plants etc. Throughout the Himalayan region, habitat destruction due to road constructions, industrialization, mining, dam constructions etc. has brought about a decline in legume diversity. Legumes are a repository of many valuable resources. They grow in diverse habitats and localities. Most of them are collected by the rural population for their daily needs as well as to earn money. There is no restriction of time and area of collection. As a result, some immature plants are also collected without getting a chance of regeneration. Due to this practice many species are now endangered.

Numerous wild types of legumes (e.g. gram) that were in cultivation in certain tribal pockets are now being replaced by improved varieties, although the wild types are more important to build up a strong genetic base for the improvement of these crops. In addition, the habitats for wild relatives of legumes are rapidly disappearing under land use pressure with population increases and will be further threatened with climate change (Rao and Husain 1993). Unlike crops, wild relatives are restricted to uncultivated lands and crop margins. Their persistence as in situ

collections is under threat due to an increase in population associated with the competition for land for urban and grazing needs. These resources are further threatened by climate change, and extinction is possible within 50 years (Lane and Jarvis 2007).

Management and Conservation of Legumes

Conserving biodiversity is gaining importance precisely under a new conservation framework of saving, studying and using biodiversity sustainably and equitably (Reid 1992). An analysis of endemic legumes in the different region of Himalaya reveals that the west Himalayan region (including Kumaun) is rich in endemic plants (Rao and Husain 1993) and needs conservation of these endemic species. Some management options to conserve the legume diversity of the Kumaun Himalayan region are:

- Rare, endangered and endemic genera should be located and measures should be taken for the conservation of their habitats. For this, community-based natural resource management practices should be adopted and the over-exploitation of legumes should be banned.
- As it is not possible to conserve the entire legume genetic resources under in situ conditions, legume-rich zones should be identified and declared as legume sanctuaries such as Sobla, Sandev and Narayan Ashram in the Pithoragarh district (Rao and Husain 1993). The other rare endangered and even endemic legume taxa from the neighbouring region could be introduced in these sanctuaries for their conservation.
- Indigenous knowledge for the management of plant resources should be encouraged. For local management of plant resources, the villagers should be trained for collecting plants on a rotational basis in different localities.
- Low fertility is a common problem in establishing vegetation on barren lands. Since nitrogen is generally deficient in these lands afforestation may be accomplished using such plants that can fix atmospheric nitrogen for their growth and development (Bargali 2011). Kumaun Himalaya has a vast potential of nitrogen-fixing plants. Therefore, the cultivation and plantation of nitrogen-fixing legumes should be started to promote conservation as well as the restoration of degraded lands.

Conclusions

The present study describes leguminous plants of Kumaun Himalayan region. Of the known wild 488 species of legumes of Indian Himalaya, 255 species under 73 leguminous genera were represented in the Kumaun Himalaya. The maximum

number of legumes was distributed between 500 to 1000 m elevations and number decreased with increasing elevation. Herbs were far richer in number (125) than shrubs (78), while trees (37) and climbers (15) were less in number. Some species like *Desmodium triflorum* showed a wide range of distribution while some species like *Meizotropis pellita* were endemic. Due to their great economic importance legumes are highly depleted due to overexploitation and destruction of forests in the region. To conserve rare and endemic leguminous plants, certain hot spots of legume diversity should be identified and conserved as protected areas. In addition, cultivation and plantation of nitrogen-fixing legumes should be promoted.

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Chapter 16
Plant Diversity and Vegetation Composition of Shiwalik Forests Along an Altitudinal Gradient in the Kumaun Himalaya, India

L.S. Lodhiyal, Neelu Lodhiyal and G.C. Pathak

Introduction

Forests are one of the major natural resources for every country in the world. They acquired increasing importance in the recent past for their role not only to meet the material needs of industries and communities but also for their ecological and environmental functions. Forests are biologically highly diverse ecosystems, where the complex interaction between the forest and ecological conditions allows continuous adaptions to changing environmental conditions while maintaining ecosystem functions. But recent deforestation, degradation and fragmentation as a consequence of human actions have caused the decline of forest biological diversity. The conversion of forests to agriculture land, overgrazing, shifting cultivation, unsustainable forest management, introduction of invasive alien plants and animal species, infrastructure development, mining, quarrying, anthropogenic forest fires, pollution and climate change all are having negative impacts on forest biological diversity. However, forest plant diversity and species composition refer to all the plant life forms found in forested areas where they perform both productive and protective functions. Several studies have shown that forests are depleting very fast in the world. About 13 million hectares of forests are lost due to deforestation each year, and the annual net loss of forest area was accounted for 0.18 % of the total world forests between 2000 and 2005 by an FAO (Anonymous 2005). Forests are affected by climate change but the impact of climate change may be negative in some areas and positive in others. Forests act like sinks as they moderate the global climate. One of the most important challenges to the present society is how to save

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and conserve our forests, biodiversity and environment and how to use them more sustainably so that they may not further be depleted from the natural ecosystems (Lodhiyal 2010). Keeping this in view, the United Nations declared the year 2011 as the International Year of Forests.

As far as Uttarakhand is concerned, forests are playing a significant role in the economy and ecology of the region. The forest area and forest cover accounted for 65 and 45 % of the State's geographical area (53,483 km^2), respectively. The State lies between 28° 43′ and 31° 28′ N latitude and 77° 34′ and 81° 03′ in E longitude and is divided into three major regions i.e. the Himalayas, the Shiwaliks, and the Tarai-Bhabar plains. The Shiwalik of Uttarakhand is a very fragile and complex Himalayan ecosystem. Topography, availability of resources, and land use pattern of Shiwalik region are substantially distinct from the other parts of the Central Himalaya. The Shiwaliks consist of alternate sequences of various sandstones, mudstones, clay and boulder conglomerates, which are often soft and friable. The climate of the State includes temperate, sub-tropical and tropical zones. The temperatures of the state ranges from sub-zero to 43 °C with an average rainfall of 1550 mm (FSI 2009).

The State has 37 forest types which mainly belong to the 08 forest type groups (Champion and Seth 1968). The major forest groups are tropical moist deciduous forests, tropical dry deciduous forest, sub-tropical pine forests, Himalayan moist temperate forests, Himalayan dry temperate forests, sub-alpine forests, moist alpine forests and dry alpine scrubs. Among forest group types, the Himalayan moist temperate, sub-tropical pine forest and tropical moist deciduous forests accounted for about 37, 29 and 19 %, respectively (FSI 2009). In Uttarakhnad, the forest ecosystems and pasture lands, i.e. Bugiyals, are home to a rich flora and fauna, and people have conserved and managed them for centuries. Thus forests are essential components for the very survival of people as because they provide a wide range of goods and services to the societies in various ways, such as forest products, employment and protection of sites as well as cultural values that exist through them. Apart from these, forests also improve the economy of the State as well as the country.

The growing population pressure on forests has not only depleted the species diversity but also led to impoverished soil fertility and productivity across the entire hills and mountain region. The result was an alarming situation for the existence of natural resources and human society. The area is suffering from depletion of forest resources due to faulty road constructions, extensive agriculture on marginal lands, uncontrolled grazing, surface quarrying and mining, soil erosion, and unscientific and excessive exploitation of forest resources. It is therefore imperative to know the existing plant species diversity and other related vegetation information of the Shiwalik forests so that the findings will be useful for a future sustainable development strategy of forests as well as for the region.

The present study was carried out in the Shiwaliks of the Kumaun Himalaya in Uttarakhand. We studied the dominant forest communities occurring in the Shiwaliks with special reference to plant diversity and other related vegetation parameters, with the aim to minimize the impact of anthropogenic pressure and

achieve sustainable forest development in the region. In this context, it is essential to thoroughly investigate the forests with regard to quantitative information of plant diversity and vegetation parameters along an altitudinal gradient in the Shiwalik region. Based on these data for future conservation, management and development, an appropriate and more suitable planning strategy could be implemented.

The Sal (*Shorea robusta* Gaertn. F., a broad-leaved forest tree species) and Pine (*Pinus roxburghii* Sarg, a conifer forest tree species) are two pre-dominant forest communities in the Shiwalik of Kumaun Himalaya. The Sal forests occur in the lower plains and valleys, inter mixed with *Terminalia* species, while the upper region of Sal is associated with *Anogeissus latifolia, Adina cordifolia, Terminalia bellirica, Mallotus philippinensis, Emblica officinalis, Cassia fistula* and some other under canopy species. The Shiwalik Sal forest extends from 400 to 1500 m and consists of loamy, sandy loamy soils, sometimes mixed with sandstones and boulders. The pine forest community, on the other hand, extends between 800 and 1500 m in the Shiwalik region. Pine tree species commonly occur as pure forest stands, sometimes mixed with Sal and other tree species in the lower part of the region, oaks, conifers and other broad-leaved tree species in the upper part. The forest soils are sandy loam, sometimes mixed with sand stones and boulders in this region. The Sal and Pine forests are the climax community in the Shiwalik region (Champion and Seth 1968). The chronic form of disturbance is when people remove only a fraction of the forest biomass in the form of grazing, lopping, surface burning and surface removal of litter and herbs for various uses at a given time in a given space. As a result the plants or ecosystem often do not get enough time to recover adequately since the human onslaught never stops (Singh 1998). The species composition of the major forest types of the central Himalaya is described by Saxena and Singh (1982a, b), Bankoti et al. (1992), Tewari and Singh (1985), Rawal et al. (1994), Rawal and Pangtey (1994), Rana et al. (1989), Chaturvedi and Singh (1987a, b), Rawat and Singh (1988). The vegetation parameters like stand structure, biomass productivity and leaf phenology of forest species were studied by Singh et al. (1994) in low to high altitude regions of the central Himalaya. The present study deals with soil characteristics, plant diversity, vegetation composition and regeneration pattern of Shiwalik forests in order to understand the structure, species composition and plant diversity of forest ecosystems along an altitudinal gradient in the Kumaun Himalaya.

Study Site, Materials and Methods

The study was carried out in the Shiwalik forests of Kumaun Himalaya, located at three different altitudinal zones: 400–600 m, 800–1000 m and 1300–1500 m, between 29° 17′ 39″ to 29° 30′ 40″N lat. and 79° 9′ 13″ to 79° 26′ 24″E long. The Shiwalik Himalayas are the low rolling hills lying parallel to the main Himalayan range and formed as the youngest Himalayan mountain chain. The Shiwalik hills are well developed in the western and central Himalaya but they gradually merge

with the lower Himalaya in the east. The Shiwalik belt spreads over three million hectares in the country and consists of highly degraded landmasses. The altitude of the Shiwaliks ranges from 400 to 1500 m in cthe entral Himalaya. The region has a sub-tropical vegetation, usually dominated by Sal (*Shorea robusta*) forest with broad-leaved tree species, whereas the Shisham-Khair (*Dalbergia sissoo-Acacia catechu*) species commonly occur in the riverine succession zones. However, the top hills of the Shiwaliks are dominated by Chir-pine (*Pinus roxburghii*), a conifer tree species in the Shiwaliks of the Kumaun Himalaya.

For the detailed study of plant diversity and vegetation composition analysis, the whole study area was divided into three forest sites, Jeolikote, Dogaon and Ranibag, in descending elevation order, based on forest species composition and altitude. The Sal mixed with pine forest was studied at the higher elevation (1300–1500 m) has), Sal mixed with broad leaved forest at middle elevation (800–1000 m), and Sal dominated forest at lower elevations (400–600 m) in the foothills of the Shiwaliks.

The climate of the study area is influenced by the monsoon rainfall pattern, of the sub-tropical monsoon type. Of the 2076 mm rainfall, about three fourth occurs between mid- June to mid-September. The mean daily temperature ranges from 13.1 °C in January to 32.0 °C in June. The year is divisible into three distinct seasons: (i) a dry and warm summer season (mid-March to mid-June), (ii) a wet and warm rainy season (mid-June to mid-September), and (iii) a dry and cold winter season (October to February) with frequent frost. As far as the geology of Shiwalik Himalaya is concerned, the rocks are relatively young and consist of sandstones, conglomerate beds, quartzites and more or less unconsolidated segments made up of cobbles, shingles pebbles, gravels and boulders. The Shiwalik rocks are usually in contact with the sediments of the Indo-Ganga plain along the prominent fault zones.

The soil study was conducted in each selected forest site. From each site, a total of nine samples were collected, i.e. three samples from 0 to 10 cm, 10 to 20 cm and 20 to 30 cm soil depths respectively with the help of a soil corer. The twenty seven soil samples from each studied forest were packed in polythene bags and brought to the laboratory for physico-chemical analysis. Soil texture, bulk density, soil moisture content, water holding capacity and soil porosity were determined according to Mishra (1968), Lodhiyal (1990) and Lodhiyal et al. (2002). The soil pH extract was determined using a digital pH meter.

Vegetation analysis was made for all the three layers of the forest i.e. trees, shrubs and herbs. The plants were identified with the help of a plant taxonomist and also by consulting the literature of Forest Flora of Kumaun (Osmaston 1926) and Flora Simlensis (Collett 1971). The trees, saplings and seedlings were analyzed by sampling ten squares of 10 × 10 m selected randomly in each site. The size and number of samples was determined as followed by Saxena and Singh (1982a, b). The vegetation data were quantitatively analyzed for density, abundance and frequency (Curtis and McIntosh 1950). The Important value index (IVI) for the trees, shrubs and saplings was determined as the sum of the relative frequency, relative density and relative dominance (Curtis 1959). The distribution pattern of different

species was studied using the ratio of abundance to frequency. This ratio has indicated regular (<0.025), random (0.025–0.05) and contagious (>0.05) distributions of plant species (Whitford 1949). Trees were considered to be individuals when >30 cm circumference at breast height (cbh), saplings at 10–30 cm cbh and seedlings of <10 cm cbh (Saxena et al. 1984; Saxena and Singh 1985; Mishra 1968). The shrub layer was analyzed by sampling ten squares of 5 × 5 m randomly selected on each site. The herbs were analyzed by placing ten squares of 1 × 1 m randomly on each site during the rainy season (peak growth period). The species richness, diversity and concentration of dominance of species in the stand were considered for detailed analysis, where species richness was the number of species per unit area (Whittaker 1972). The diversity index for all the three layers at each site was computed using Shannon-Weiner Index's (Shannon and Weaver 1949) as: $H = -\sum = Ni/N \log 3.322\ Ni/N)$, where Ni is the IVI of single species and N is the IVI of all species for tree, saplings and shrubs, whereas for seedlings and herbs Ni is the density of single species and N is the density of all species. The concentration of dominance (Cd) was computed by Simpson's index (Simpson 1949) as: $Cd = (Ni/N)^2$, where Ni and N were same as for Shannon-Wiener Index. The dominance-diversity curve was drawn for tree and shrub layers by a coordinate point of its relative important value index (IVI) on the Y-axis and its position in the sequence of species from highest to lowest IVI on the X-axis (Whittaker 1975), while on the basis of density, it was drawn for herbs and seedlings.

Results

Forest Soil

The physico-chemical characteristics of soils such as soil texture, soil moisture, water holding capacity, bulk density, soil porosity and soil pH were studied up to 0–30 cm soil depth on each elevation forest site (Table 16.1). A variation was observed for each soil parameter on each site. Sand, silt and clay ranged from 37.67 to 48.74, 46.00 to 56.39 and 5.26 to 5.94 %, respectively. The maximum sand content was reported for the Sal mixed pine forests in higher elevations while silt and clay prevailed in the Sal dominated forest at lower elevation. Soil moisture and water holding capacity ranged from 19.7 to 26.5 and 12.3 to 22.4 % respectively with the maximum in lower elevations. The soil bulk density and soil porosity ranged from 1.10 to 1.24 g cm^{-3} and 43.7 to 56.5 % respectively. The soil bulk density was higher in Sal dominated forest in lower elevations whereas soil porosity has shown the reverse trend. The soil was acidic in each studied forest site; its pH ranges from 5.3 to 6.0 and decreases from higher to lower elevation (Table 16.1).

Table 16.1 Physico-chemical characteristics of forest soils along an altitudinal gradient in Shiwalik of Kumaun Himalaya

S. No.	Soil depth (cm)	Forest site at different elevation (m)		
		Sal mixed pine forest in Jeolikote site (1300–1500 m)	Sal mixed broad-leaved forest in Dogaon site (800–1000 m)	Sal dominated forest in Ranibag (400–600 m)
Soil texture (%)				
Sand	0–10	50.42 ± 4.25	44.86 ± 4.10	39.60 ± 4.20
	10–20	48.36 ± 4.89	42.50 ± 4.25	38.16 ± 4.26
	20–30	47.43 ± 4.92	40.40 ± 4.22	35.25 ± 4.39
	Average	48.74 ± 4.69	42.59 ± 4.19	37.67 ± 4.28
Silt	0–10	44.00 ± 3.96	49.18 ± 3.26	53.95 ± 3.40
	10–20	46.39 ± 4.20	51.88 ± 3.70	56.00 ± 3.50
	20–30	47.62 ± 4.32	54.36 ± 3.56	59.23 ± 3.74
	Average	46.00 ± 4.16	51.81 ± 3.51	56.39 ± 3.55
Clay	0–10	5.58 ± 2.56	5.96 ± 2.66	6.45 ± 2.72
	10–20	5.25 ± 3.06	5.62 ± 2.90	5.84 ± 3.03
	20–30	4.95 ± 3.16	5.24 ± 3.04	5.52 ± 3.18
	Average	5.26 ± 2.92	5.60 ± 2.87	5.94 ± 2.98
Soil moisture (%)	0–10	18.90 ± 1.26	21.56 ± 1.82	24.78 ± 1.76
	10–20	19.35 ± 1.70	23.24 ± 1.90	26.20 ± 1.82
	20–30	20.86 ± 1.76	24.50 ± 1.98	28.44 ± 1.80
	Average	19.70 ± 1.57	23.10 ± 1.90	26.47 ± 1.79
WHC (%)	0–10	10.20 ± 2.50	16.24 ± 2.42	20.20 ± 2.32
	10–20	12.40 ± 2.42	18.45 ± 2.50	22.44 ± 2.40
	20–30	14.40 ± 3.01	20.26 ± 2.95	24.62 ± 2.98
	Average	12.33 ± 1.57	18.32 ± 2.62	22.42 ± 2.57
Bulk density (g cm^{-2})	0–10	1.04 ± 1.56	1.12 ± 1.64	1.21 ± 1.58
	10–20	1.10 ± 1.70	1.15 ± 1.70	1.23 ± 1.64
	20–30	1.16 ± 1.90	1.17 ± 1.82	1.28 ± 1.76
	Average	1.10 ± 1.72	1.15 ± 1.72	1.24 ± 1.66
Soil porosity (%)	0—10	53.42 ± 2.46	43.46 ± 2.36	41.06 ± 2.40
	10–20	56.48 ± 2.56	48.95 ± 2.50	43.20 ± 2.42
	20–30	59.60 ± 2.44	53.10 ± 2.60	46.96 ± 2.56
	Average	56.50 ± 2.49	48.50 ± 2.49	43.74 ± 2.46
Soil pH	0–10	6.0 ± 1.52	5.2 ± 1.50	5.0 ± 1.62
	10–20	6.4 ± 1.80	5.5 ± 1.70	5.3 ± 1.64
	20–30	6.6 ± 1.76	6.2 ± 1.82	5.9 ± 1.70
	Average	6.0 ± 1.69	5.5 ± 1.67	5.3 ± 1.65

Vegetation Analysis for Species Composition

A total of 167 species of plants were reported from the study forest sites, out of which trees, shrubs and herbs accounted for 39, 27 and 101, respectively. The detailed vegetation analysis of tree, shrub and herb layers of each studied forest is described and illustrated in the following Tables 16.2, 16.3, 16.4, 16.5 and 16.6.

Table 16.2 Vegetation analysis of trees of Shiwalik forests along an altitudinal gradient in Kumaun Himalaya

S. No.	Name of species	Density ha^{-1}	MBA cm^2 ind^{-1}	TBA m^2 ha^{-1}	IVI
Sal mixed pine forest of Jeolikote at higher elevation (1300–1500 m)					
1	*Acer oblangum*	20	2163.65	4.32	20.77
2	*Albizzia lebbeck*	20	510.44	1.02	12.08
3	*Alnus nepalensis*	20	803.84	1.60	10.58
4	*Boehmeria rugulosa*	20	122.65	0.24	7.00
5	*Emblica officinalis*	20	254.34	0.50	7.68
6	*Engelhardtia colebrookiana*	20	989.29	1.97	11.55
7	*Eugenia frondosa*	10	706.50	0.70	6.54
8	*Myrica esculanta*	20	754.38	1.50	13.34
9	*Pinus roxburghii*	260	657.00	17.08	109.53
10	*Premna barbata*	10	176.62	0.17	5.14
11	*Pyrus pashia*	20	490.62	0.98	11.97
12	*Sapium insigne*	20	415.26	0.83	11.58
13	*Shorea robusta*	50	735.04	3.67	30.12
14	*Syzygium cumini*	40	371.35	1.48	19.66
15	*Terminalia chebula*	10	530.66	0.53	6.08
16	*Terminalia tomentosa*	20	240.40	0.48	7.64
17	*Toona ciliata*	20	452.16	0.90	8.73
	Total	600	10374.20	37.97	299.99
Sal mixed broad-leaved forest of Dogaon at middle elevation (800–1000 m)					
1	*Adina cordifolia*	20	415.26	0.83	6.06
2	*Aegle marmelos*	10	153.86	0.15	3.30
3	*Albizzia procera*	20	754.38	1.50	9.35
4	*Bahunia perpuria*	10	2041.78	2.04	7.59
5	*Boehmeria rugulosa*	10	314.00	0.31	3.67
6	*Buchanania latifolia*	20	1256.00	2.51	11.63
7	*Casearia graveolens*	10	615.44	0.61	4.35
8	*Cassia fistula*	10	379.94	0.03	3.04
9	*Diploknema butyracea*	20	1045.81	2.09	8.92

(continued)

Table 16.2 (continued)

S. No.	Name of species	Density ha^{-1}	MBA cm^2 ind^{-1}	TBA m^2 ha^{-1}	IVI
10	*Emblica officinalis*	40	188.59	0.75	11.84
11	*Ficus cunia*	10	490.62	0.49	4.07
12	*Ficus cuniata*	20	153.86	0.30	6.62
13	*Ficus regligiosa*	10	706.50	0.70	4.56
14	*Glochidion velutinum*	10	254.34	0.25	3.53
15	*Grewia hainesiana*	20	254.34	0.50	7.08
16	*Lagerstroemia parviflora*	10	1589.62	1.58	6.56
17	*Mallotus philippinensis*	10	314.00	0.31	3.67
18	*Mangifera indica*	20	660.18	0.66	4.45
19	*Olea glandulifera*	10	907.46	0.90	5.02
20	*Ougeinia oojeinensis*	30	586.33	1.75	11.14
21	*Phoenix humilis*	20	226.86	0.45	5.21
22	*Pinus roxburghii*	10	254.34	0.25	3.53
23	*Premna barbata*	10	176.62	0.17	3.36
24	*Sapium insigne*	10	94.98	0.09	3.78
25	*Schleichera oliosa*	10	803.84	0.80	4.78
26	*Semecarpus anacardium*	10	200.96	0.20	3.41
27	*Shorea robusta*	270	277.37	12.88	77.96
28	*Syzygium cumini*	50	326.68	1.63	16.80
29	*Terminalia belerica*	10	3846.50	3.84	11.69
30	*Terminalia chebula*	20	1256.00	2.51	11.63
31	*Terminalia tomentosa*	80	107.66	0.86	23.98
32	*Toona ciliata*	10	1962.50	1.96	7.41
	Total	830	22616.62	43.9	299.99
Sal dominated forest of Ranibag at lower elevation (400–600 m)					
1	*Adina cordifolia*	10	961.62	0.96	13.90
2	*Mallotus philippinensis*	20	329.89	0.65	23.85
3	*Schleichera oliosa*	10	200.96	0.20	11.53
4	*Semecarpus anacardium*	10	754.38	0.75	13.25
5	*Shorea robusta*	440	563.81	24.80	166.47
6	*Syzygium cumini*	40	466.20	1.86	49.44
7	*Terminalia tomentosa*	20	1417.90	2.83	21.56
	Total	550	4694.76	32.08	300.00

Tree Layer

(a) Trees

The total tree density was comparatively higher (830 ind/ha) in middle elevations as compared to 600 and 550 ind/ha in higher and lower elevations. The mean basal

Table 16.3 Vegetation analysis of tree saplings of Shiwalik forests along an altitudinal gradient in Kumaun Himalaya

S. No.	Name of species	Density ha^{-1}	MBA cm^2 ind^{-1}	TBA m^2 ha^{-1}	IVI
Sal mixed pine forest of Jeolikote at higher elevation (1300–1500 m)					
1	*Boehmeria regulosa*	10	16.61	0.01	7.04
2	*Bombax ceiba*	10	50.24	0.05	9.40
3	*Buchnania latifolia*	30	19.62	0.05	13.79
4	*Cassaria tomentosa*	30	60.82	0.05	13.20
5	*Ehretria arborescens*	20	19.23	0.03	10.46
6	*Myrica esculanta*	30	16.61	0.04	13.15
7	*Pinus roxburghii*	150	47.75	0.71	102.60
8	*Pyrus pashia*	30	17.78	0.05	13.40
9	*Sapium insigne*	10	12.56	0.01	6.70
10	*Shorea robusta*	120	20.65	0.24	60.04
11	*Syzygium cumini*	70	15.47	0.10	40.80
12	*Terminelia tomentosa*	20	10.74	0.02	9.27
	Total	530	308.08	1.42	299.9
Sal mixed broad-leaved forest of Dogaon at middle elevation (800–1000 m)					
1	*Buchnania latifolia*	10	16.61	0.01	6.77
2	*Cassia fistula*	30	44.15	0.13	22.53
3	*Deploknema butyracea*	10	38.46	0.06	8.30
4	*Emblica officinalis*	20	60.10	0.12	17.07
5	*Lagerstroemia parviflora*	20	15.89	0.03	9.87
6	*Mallotus philippinensis*	70	21.88	0.15	46.42
7	*Pyrus pashia*	10	50.24	0.05	9.12
8	*Semecarpus anacardium*	40	22.89	0.09	25.28
9	*Shorea robusta*	250	28.26	0.70	136.23
10	*Syzygium cumini*	30	28.82	0.08	18.31
	Total	490	327.30	1.42	299.9
Sal dominated forest of Ranibag at lower elevation (400–600 m)					
1	*Mallotus philippinensis*	50	22.89	0.11	59.41
2	*Shorea robusta*	280	36.29	1.02	164.32
3	*Syzygium cumini*	60	22.97	0.13	76.24
	Total	390	82.15	1.26	299.97

area (MBA) ranged from 94.98 cm^{-2} $tree^{-1}$ for *Sapium insigne* to 3846.50 cm^{-2} $tree^{-1}$ for *Terminalia belerica* across the study forest sites. A maximum total basal area (TBA) of 43.9 m^2/ha was reported in middle elevations, followed by 37.97 m^2 ha^{-1} in higher elevation, while in lower elevations, it was on the lower side (32.08 m^2 ha^{-1}). The TBA for individual tree species was smallest (0.15 m^2 ha^{-1}) for *Aegle marmelos* and highest (24.80 m^2 ha^{-1}) for *Shorea robusta* across all sites. *Shorea robusta* with an IVI of 77.96 and 166.47 was the dominant species in middle and lower elevation sites respectively, while *Pinus roxburghii*

Table 16.4 Vegetation analysis of tree seedlings of Shiwalik forests along an altitudinal gradient in Kumaun Himalaya

S. No.	Name of species	Higher elevation (1300–1500 m)			
		Density ha^{-1}	Frequency %	Abundance	A/F ratio
Sal mixed pine forest of Jeolikote at higher elevation (1300–1500 m)					
1	*Acer oblangum*	20	10	2.0	0.20
2	*Albizia lebbeck*	30	10	3.0	0.30
3	*Pinus roxburghii*	340	50	6.8	0.13
4	*Pyrus pashia*	40	10	4.0	0.40
5	*Shorea robusta*	390	50	7.8	0.15
6	*Sygyzium cumini*	120	20	6.0	0.30
7	*Terminalia tomentosa*	30	10	3.0	0.30
	Total	970			
Sal mixed broad-leaved forest of Dogaon at middle elevation (800–1000 m)					
1	*Aegle marmelos*	120	20	6.0	0.30
2	*Cassia fistula*	50	20	2.5	0.12
3	*Elacodendron glaucum*	10	10	1.0	0.10
4	*Emblica officinalis*	20	20	1.0	0.05
5	*Glochdion velutinum*	40	20	2.0	0.10
6	*Mallotus philippinensis*	280	50	2.8	0.05
7	*Ougeinia oogenesis*	30	20	1.5	0.07
8	*Premna barbeta*	10	10	1.0	0.10
9	*Shorea robusta*	930	100	9.3	0.09
10	*Sygyzium cumini*	260	50	2.6	0.05
11	*Terminalia tomentosa*	50	20	2.5	0.12
	Total	1800			
Sal dominated forest of Ranibag at lower elevation (400–600 m)					
1	*Mallotus philippinensis*	180	40	4.5	0.11
2	*Schleichea oliosa*	80	30	2.66	0.08
3	*Semecarpus anacardium*	30	20	1.5	0.07
4	*Shorea robusta*	1210	100	12.1	0.12
5	*Sygyzium cumini*	100	60	1.66	0.02
	Total	1600			

with an IVI of 109.53 was the most dominant species in higher elevations. The least dominant tree species were *Schleichera trijuga, Cassia fistula and Premna barbata* with an IVI of 11.52, 3.04 and 5.14 on all three elevations (Table 16.2).

(b) Saplings

The total sapling density was reported highest in higher elevation (530 ind/ha) as compared to 390 and 490 ind/ha in lower and middle elevations, respectively. The total basal area for saplings was highest with 1.42 m^2/ha in higher and middle

Table 16.5 Vegetation analysis of shrubs of Shiwalik forests along an altitudinal gradient in Kumaun Himalaya

S. No.	Name of species	Density ha^{-1}	MBA cm^2 ind^{-1}	TBA m^2 ha^{-1}	IVI
Sal mixed pine forest of Jeolikote at higher elevation (1300–1500 m)					
1	*Aechmenthera gossypiana*	240	0.26	0.006	9.20
2	*Berberis asiatica*	40	1.76	0.006	3.38
3	*Boehmeria scabrella*	200	0.03	0.001	8.05
4	*Caryoptris fragrans*	120	1.13	0.013	5.47
5	*Cassia floribunda*	240	13.58	0.005	34.76
6	*Cocculus laurifolius*	200	2.37	0.047	9.95
7	*Coriaria nepalensis*	120	3.14	0.037	7.58
8	*Desmodium pulchellum*	120	0.22	0.002	6.58
9	*Eupatorium adenophorum*	1440	0.42	0.060	47.18
10	*Fluggea microcarpa*	200	0.91	0.018	9.47
11	*Inula cappa*	200	0.26	0.005	8.36
12	*Jasminum dispermum*	80	0.86	0.006	4.15
13	*Lantana camara*	440	1.56	0.068	26.60
14	*Lawsonia inermis*	120	2.26	0.026	8.69
15	*Maesa indica*	440	2.26	0.099	27.22
16	*Martynia annua*	280	1.13	0.031	14.22
17	*Murraya koenigii*	120	4.90	0.058	13.49
18	*Osbeckia stellata*	80	0.33	0.002	3.77
19	*Rubus ellipticus*	320	1.24	0.039	17.72
20	*Woodfordia fructicosa*	160	18.61	0.297	30.80
21	*Zanthoxylum alatum*	40	0.78	0.002	3.36
	Total	5200	58.01	0.828	300
Sal mixed broad-leaved forest of Dogaon at middle elevation (800–1000 m)					
1	*Desmodium pulchellum*	80	0.63	0.004	6.36
2	*Eupatorium adenophorum*	120	0.34	0.004	7.35
3	*Flamengia bracteata*	160	0.15	0.060	10.91
4	*Inula cappa*	80	0.09	0.004	6.52
5	*Lantana camara*	760	1.83	0.138	79.91
6	*Maesa indica*	640	1.69	0.108	65.78
7	*Murraya koenigii*	560	1.00	0.056	60.25
8	*Pogostemone bengalensis*	120	0.45	0.130	7.65
9	*Woodfordia fruticosa*	440	1.65	0.072	55.27
	Total	2960	7.83	0.576	300

(continued)

Table 16.5 (continued)

S. No.	Name of species	Density ha^{-1}	MBA cm^2 ind^{-1}	TBA m^2 ha^{-1}	IVI
Sal dominated forest of Ranibag at lower elevation (400–600 m)					
1	*Ardisia solanacea*	160	2.06	0.032	18.63
2	*Clerodendron viscosum*	680	0.86	0.058	65.93
3	*Desmodium pulchellum*	120	0.19	0.002	13.11
4	*Flacortia indica*	120	3.66	0.043	19.08
5	*Inula cappa*	160	0.10	0.001	12.89
6	*Lantana camara*	1000	3.14	0.314	122.06
7	*Murraya koenigii*	80	1.88	0.014	12.24
8	*Pogostemone benglensis*	160	2.74	0.043	20.62
9	*Woodfordia fruticosa*	80	3.97	0.031	15.33
	Total	2560	18.6	0.538	299.89

Table 16.6 Vegetation analysis of herbs of Shiwalik forests along an altitudinal gradient in Kumaun Himalaya

S. No.	Name of species	Density ha^{-1}	Frequency (%)	Abundance	A/F ratio
Sal mixed pine forest of Jeolikote at higher elevation (1300–1500 m)					
1	*Ageratum conyzoides*	600	80	7.50	0.09
2	*Ajuga parviflora*	90	50	1.80	0.03
3	*Anaphalis contorta*	100	50	2.00	0.04
4	*Anaphilis busua*	90	40	2.25	0.05
5	*Apluda mutica*	70	30	2.33	0.07
6	*Arthroxon priomnoides*	40	10	4.00	0.40
7	*Barleria cristata*	120	40	3.00	0.07
8	*Bidens bipernata*	150	30	5.00	0.16
9	*Bidens pilosa*	100	50	2.00	0.04
10	*Capillipedium parviflorum*	60	30	2.00	0.06
11	*Cassia saemosoides*	360	70	5.14	0.07
12	*Carex nubigena*	40	10	4.00	0.40
13	*Chlorophytum tuberosum*	50	30	1.66	0.05
14	*Chrysopogon gryllus*	660	100	6.60	0.06
15	*Commelina bengalensis*	180	60	3.00	0.05
16	*Conyza japonica*	130	30	4.33	0.14
17	*Crotalaria scsiflora*	80	40	2.00	0.05
18	*Crotolaria humifusa*	140	40	3.50	0.08
19	*Cynoglossum lanceolatus*	90	20	4.50	0.22
20	*Cynotis vaga*	120	50	2.40	0.04
21	*Cyperus triceps*	90	30	3.00	0.10
22	*Desmodium elegans*	60	30	2.00	0.06

(continued)

Table 16.6 (continued)

S. No.	Name of species	Density ha^{-1}	Frequency (%)	Abundance	A/F ratio
23	*Desmodium parviflorum*	60	30	2.00	0.06
24	*Habeneria accuminata*	90	30	3.00	0.10
25	*Hydiotis prinifolia*	250	20	12.50	0.62
26	*Justicia simplex*	1040	80	13.00	0.16
27	*Leucas lanata*	50	30	1.66	0.05
28	*Lindernia cristata*	70	20	3.50	0.17
29	*Micromeria biflora*	110	30	3.66	0.12
30	*Murdania nudiflora*	130	30	4.33	0.14
31	*Neotis colycina*	60	30	2.00	0.06
32	*Oxalis corniculata*	110	40	2.75	0.06
33	*Phyllanthus simplex*	150	10	15.00	1.50
34	*Plectranthus japonicas*	190	60	3.16	0.05
35	*Polygala chinensis*	10	10	1.00	0.10
36	*Polygonum nepalensis*	20	10	2.00	0.20
37	*Pouzolzia hirta*	310	50	6.20	0.12
38	*Siegesbeckia orientalis*	170	60	2.83	0.04
39	*Setaria hamonyma*	500	80	6.25	0.07
40	*Smithia ciliata*	320	30	10.66	0.35
41	*Spiranthus sinensis*	30	20	1.50	0.07
42	*Strobilanthus alatus*	310	20	15.50	0.77
43	*Teucrium royleanusum*	120	50	2.40	0.04
44	*Themeda annua*	90	30	3.00	0.10
45	*Triumfetta annua*	710	50	14.20	0.28
46	*Zorina diphylla*	130	40	3.25	0.08
	Total	8450	–	–	–
Sal mixed broad-leaved forest of Dogaon at middle elevation (800–1000 m)					
1	*Acyranthus aspera*	40	10	4.00	0.40
2	*Ainsliacea latifolia*	30	20	1.50	0.07
3	*Arthroxon lanceolatus*	360	70	5.14	0.07
4	*Barleria cristata*	20	20	1.00	0.05
5	*Capillipedium parviflorum*	60	30	2.00	0.06
6	*Carex crucida*	320	10	32.00	3.20
7	*Cerestium vulgatum*	60	10	6.00	0.60
8	*Chlorophytum tuberosum*	20	10	2.00	0.20
9	*Chrysopogon gryllus*	690	80	8.62	0.10
10	*Cissampelos pareira*	40	30	1.33	0.04
11	*Clematis grata*	50	20	2.50	0.12
12	*Commelina bengalensis*	60	30	2.00	0.06
13	*Conscora diffusa*	20	10	2.00	0.20
14	*Conyza japonica*	90	60	1.50	0.02

(continued)

Table 16.6 (continued)

S. No.	Name of species	Density ha^{-1}	Frequency (%)	Abundance	A/F ratio
15	*Crotalaria sessiliflora*	20	10	2.00	0.20
16	*Cyanoglossum glochidion*	100	50	2.00	0.04
17	*Cynoglossum lanceolatus*	80	50	1.60	0.03
18	*Desmodium elegans*	10	10	1.00	0.10
19	*Desmodium gangiticum*	70	40	1.75	0.04
20	*Desmodium parviflorum*	130	60	2.16	0.03
21	*Dioscorea bulbifera*	40	10	4.00	0.40
22	*Elephantopus scaber*	40	30	1.33	0.04
23	*Glinus lotoides*	120	10	12.00	1.20
24	*Hedychium spicatum*	20	20	1.00	0.05
25	*Hedyotis hispida*	40	20	2.00	0.10
26	*Ixeris sagittifolia*	20	10	2.00	0.20
27	*Justicia simplex*	510	50	10.20	0.20
28	*Leucas lanata*	60	20	3.00	0.20
29	*Lindenbergia grandiflora*	290	80	3.62	0.04
30	*Lindernia cordifolia*	80	10	8.00	0.80
31	*Lindernia indica*	20	10	2.00	0.20
32	*Lindernia multiflora*	20	10	2.00	0.20
33	*Marsedenia lucida*	20	10	2.00	0.20
34	*Microstylis wallichii*	30	10	3.00	0.30
35	*Murdania nudiflora*	20	10	2.00	0.20
36	*Neametis cerycima*	20	10	2.00	0.20
37	*Ophroglossum reticulatum*	20	10	2.00	0.20
38	*Oplismenus composirus*	400	70	5.71	0.08
39	*Phyllanthus simplex*	80	10	8.00	0.80
40	*Polygala chinensis*	40	10	4.00	0.40
41	*Rungia pactinata*	40	30	1.33	0.04
42	*Sida cordata*	60	50	1.20	0.02
43	*Sida cordifolia*	40	40	1.00	0.02
44	*Spiranthus sinensis*	110	70	1.57	0.02
45	*Strobilanthus alatus*	290	80	3.62	0.04
46	*Teucrium royleanusum*	250	90	2.77	0.03
47	*Triumfetta annua*	40	30	1.33	0.04
	Total	4990	–	–	–
Sal dominated forest of Ranibag at lower elevation (400–600 m)					
1	*Abrus fruticosa*	30	10	3.00	0.30
2	*Aeginetia indica*	100	10	10.00	1.00
3	*Ageratum conyzoides*	580	80	7.25	0.90
4	*Apluda mutica*	50	20	2.50	0.12
5	*Aresaema tartolum*	10	10	1.00	0.10

(continued)

Table 16.6 (continued)

S. No.	Name of species	Density ha^{-1}	Frequency (%)	Abundance	A/F ratio
6	*Arthroxon lanceolatus*	90	40	2.25	0.05
7	*Arundinenella nepalensis*	320	30	10.66	0.35
8	*Barleria cristata*	70	30	2.33	0.07
9	*Bidens bipernata*	20	10	2.00	0.20
10	*Bidens pilosa*	20	10	2.00	0.20
11	*Boehmeria diffusa*	10	10	1.00	0.10
12	*Carex crucida*	60	20	3.00	0.15
13	*Carex spp*	20	10	2.00	0.20
14	*Cirsium arvensis*	20	10	2.00	0.20
15	*Cissampelos pareira*	20	20	1.00	0.05
16	*Commelina bengalensis*	50	10	5.00	0.50
17	*Crotalaria sessiliflora*	10	10	1.00	0.10
18	*Curcuilgo orchidioles*	150	60	2.50	0.04
19	*Cynotis barbata*	80	20	4.00	0.20
20	*Cynotis vaga*	50	10	5.00	0.50
21	*Cyperus monocephala*	30	10	3.00	0.30
22	*Desmodium gangeticum*	120	60	2.00	0.03
23	*Desmodium parviflorum*	160	60	2.66	0.04
24	*Dioscorea biofila*	20	20	1.00	0.05
25	*Eclipta indica*	20	10	2.00	0.20
26	*Elephantopus scaber*	50	40	1.25	0.03
27	*Emilia sonchifolia*	20	10	2.00	0.20
28	*Globba racemosa*	20	20	2.00	0.20
29	*Gonatanthus pulinus*	30	10	3.00	0.30
30	*Hedychium spicatum*	100	50	2.00	0.40
31	*Ipomoea nil*	10	10	1.00	0.10
32	*Isachne albens*	100	20	5.00	0.25
33	*Justicia simplex*	120	20	6.00	0.30
34	*Leucas lanata*	190	80	2.37	0.02
35	*Leucas mollissime*	10	10	1.00	0.10
36	*Lindenbergia grandiflora*	360	80	4.50	0.05
37	*Lysimachia alternefolia*	30	10	3.00	0.30
38	*Oplismenus composirus*	70	50	3.40	0.06
39	*Oxalis corniculata*	40	10	4.00	0.40
40	*Paspalum dhasticum*	10	10	1.00	0.10
41	*Peperomia pellweida*	50	10	5.00	0.50
42	*Phyllanthus niurea*	40	10	4.00	0.40
43	*Setaria glauca*	20	10	2.00	0.20
44	*Setaria hamonyma*	20	10	2.00	0.20
45	*Sida acuta*	40	10	4.00	0.40

(continued)

Table 16.6 (continued)

S. No.	Name of species	Density ha^{-1}	Frequency (%)	Abundance	A/F ratio
46	*Sida cordata*	80	40	2.00	0.05
47	*Solanum spp.*	20	10	2.00	0.20
48	*Triumfetta annua*	110	40	2.75	0.06
	Total	3650	–	–	–

elevations as compared to 1.26 m^2/ha in the lower elevation. *Shorea robusta* was the dominant sapling in middle and lower elevations with an IVI of 136.23 and 164.32 respectively. *Pinus roxburghii* with an IVI of 102.60 was the most dominant sapling in higher elevations. The least dominant saplings in higher, middle and lower elevations were *Sapium insigne, Buchnania latifolia* and *Mallotus philippinensis* with an IVI of 6.75, 6.77 and 59.41 respectively (Table 16.3).

(c) Seedlings

The tree seedling density ranged from 970 to 1800 ind/ha across all sites (Table 16.4). The tree seedling density showed its maximum (1800 ind/ha) in middle elevation sites, followed by 1600 ind/ha in lower elevations, whereas the lowest (970 ind/ha) seedling density was reported in higher sites. *Shorea robusta* showed the maximum seedling density in all forest sites. Its density and frequency was 390 ind/ha and 50 % in higher elevations, 930 ind/ha and 100 % in middle elevation sites, and 1210 ind/ha and 100 % in lower elevations (Table 16.4). The lowest seedlings density was recorded for *Elaeodendron glaucum and Premna barbeta* (10 ind/ha), the highest for *Shorea robusta* (1210 ind/ha) across the entire range of studied sites.

The regeneration pattern of some important plant species is given in Table 16.4. The seedlings of *Shorea robusta* and *Syzygium cumini* were present in all the sites. *Mallotus philippinensis* seedlings were present in the middle and lower elevations whereas *Terminalia tomentosa* seedlings were present in the higher and middle elevation. The regeneration of *Pinus roxburghii and Albizzia lebbeck* was restricted to the higher, *Cassia fistula, Aegle marmelos* and others to middle, and *Schleichera trijuga* and *Semecarpus anacardium* to the lower elevation only (Table 16.4).

Shrub Layer

The total density of shrubs ranged from 2560 to 5200 ind/ha across the studied forest sites (Table 16.5). The shrub density was comparatively higher (5200 ind/ha) in higher elevations as compared to 2560 and 2960 ind/ha in lower and middle elevations respectively. The total numbers of shrubs reported in the present study were 21 in higher and 09 middle and lower elevation, respectively. *Eupatorium adenophorum* with IVI 47.18 was the most dominant species of shrub in higher elevations. *Lantana camera* with IVI 122.06 and 79.91 was the most dominant species of shrub in lower and middle elevation, respectively. The least dominant

shrubs in higher, middle and lower elevation were *Zanthoxylum alatum*, *Inula cappa* and *Murraya koenigii* with an IVI of 3.04, 5.25 and 12.24, respectively (Table 16.5).

Herb Layer

The total herb density (individuals per hectare) was highest (8450) in higher elevation sites, followed by 4990 in middle elevations. The lowest density of 3650 ind/ha was reported in lower elevations. The herb species such as *Justicea simplex, Crotalaria sessiliflora, Commelina bengalensis, Desmodium parviflorum, Barleria cristata* and *Chlorophytum tuberosum* were present across all forest sites. The most dominant species of herb was *Justicia simplex* with a density of 1040 ind/ha in higher elevations. *Chrysopogon gryllus* with a density of 690 ind/ha was the most dominant herb in the middle elevation sites, and *Ageratum conyzoides* with a density of 580 ind/ha was the most dominant herb in lower elevation. A maximum frequency (100 %) was reported for *Chrysopogon gryllus* in higher elevations, *Teucrium royleanusm* (90 %) in middle elevations, and *Ageratum conyzoides* and *Linderbergia grandiflora* (80 %) in lower elevation sites (Table 16.6).

Species Richness, Species Diversity and Concentration of Dominance

From this detailed analysis we can describe the species richness (SR), species diversity (H) and concentration of dominance (CD) of the different vegetation layers with the respective values (Table 16.7). The species diversity for the tree species were 3.4, 4.3 and 1.9 in higher, middle and lower elevation, respectively. The sapling diversity was 2.9, 2.5 and 1.4 in higher, middle and lower elevation respectively while the concentration of dominance was 0.18, 0.22 and 0.40 in higher; middle and lower elevation, respectively (Table 16.7). In tree seedling, species richness and species diversity was 5–11 and 1.2–2.0, respectively whereas the concentration of dominance was 0.30–0.59 (Table 16.7). The species diversity of shrubs ranged from 2.5 to 3.9, it was maximum (3.9) in higher elevation and minimum (2.5) in lower elevation. In shrubs, species richness and concentration of dominance ranged from 9 to 21 and 0.07 to 0.23, respectively. In herb layer, species richness and species diversity ranged from 46 to 48 and 0.6 to 4.9, respectively where as the concentration of dominance was 0.01 across the studied forests of Shiwalik (Table 16.7).

Table 16.7 Comparative analysis of various vegetation parameters of Shiwalik forests along an altitudinal gradient in Kumaun Himalaya

Altitudinal gradient (m)	Forest site	Vegetation parameter	Trees	Saplings	Seedlings	Shrubs	Herbs
1300–1500	Jeolikote	Density (ind ha^{-1})	600	530	970	5200	8450
800–1000	Dogaon		830	490	1800	2960	4990
400–600	Ranibag		550	390	1600	2560	3650
1300–1500	Jeolikote	Basal area (m^2 ha^{-1})	37.97	1.42	–	0.828	–
800–1000	Dogaon		43.90	1.42	–	0.576	–
400–600	Ranibag		32.08	1.26	–	0.538	–
1300–1500	Jeolikote	IVI	299.99	299.90	–	299.7	–
800–1000	Dogaon		299.38	299.90	–	299.9	–
400–600	Ranibag		300.00	299.97	–	299.9	
1300–1500	Jeolikote	Species richness	17	12	07	21	46
800–1000	Dogaon		32	10	11	09	47
400–600	Ranibag		07	03	05	09	48
1300–1500	Jeolikote	Species diversity	3.4	2.9	2.0	3.9	4.9
800–1000	Dogaon		4.3	2.6	2.1	2.8	4.7
400–600	Ranibag		1.9	1.4	1.2	2.5	4.6
1300–1500	Jeolikote	CD	0.16	0.18	0.30	0.07	0.01
800–1000	Dogaon		0.09	0.22	0.39	0.17	0.01
400–600	Ranibag		0.35	0.40	0.59	0.23	0.01

Discussion

From a comparison of the physical properties of soil at the elevation range of 400–1500 m covering the complete study area, we detected that the soil moisture content (%) decreased with altitude during winter, while in summer and in the rainy season it was comparatively higher in the middle elevation. The percentage of sand and clay decreased with altitude, whereas a reverse trend was observed for silt. Chaudhary (1989) reported a similar trend in the Kumaun Himalaya for fine soil contents (increase with altitude). The bulk density decreases with elevation while the porosity increases with altitude. The water holding capacity of soils was higher on the lower elevation sites than on the upper ones.

The species richness of the Shiwalik forest was found to be in the following order: herbs (101) > trees (39) > shrubs (27). This shows a closer relationship of trees to the herb layer than to shrubs because herbs play an important part in the soil characteristics as they decompose annually and take part in the nutrient cycle of the ecosystem. The seedling and sapling richness was higher in middle elevations as

compared to higher and lower elevations, i.e. the higher tree richness in middle elevations resulted in higher sapling and seedling richness. Tree density and basal area was found highest in the middle elevation sites as compared to the other two. The herb and shrub density declined with altitude, and the composition of the tree species declined as the density and basal area of Sal increased. Sal always forms a thick canopy and allows very little sunlight to penetrate to the ground, thereby restricting the establishment of the ground flora and decreasing their density. Herb richness decreased with altitude and showed no impact of the Sal canopy as far as its richness is concerned. Shrub richness also decreased with altitude. The maximum richness for herbs and shrubs was 46 and 21 respectively in the higher elevation in Pine mixed with Sal forest, which is similar to the findings reported by Ram et al. (2004) for Pine mixed broad leaved forest in other parts of Himalayan region. In the middle elevation, species richness was 47 for herbs and 10 for shrubs while it was 50 for herbs and 09 for shrubs in lower elevation. The overall species richness i.e. tree, shrubs and herbs was found in the following decreasing order: (89) middle > (84) higher and > (66) lower elevation sites, indicating that the elevation has no impact on the richness of trees, shrubs and herbs.

The species diversity (H) and concentration of dominance (Cd) for trees ranged from 1.9 to 4.3 and 0.09 to 0.35 respectively, higher than the values 0.41 to 1.74 and 0.04 to 0.60 reported by Agarwal et al. (1993) and 0.08–1.29 and 0.07–0.25 (Shivnath et al. 1993) respectively for similar types of forests. The diversity and concentration of dominance values of the present study were above earlier reported values, which could be attributed to a lower rate of community evolution (Simpson 1964). The variability observed in the diversity index in these forest types was not solely due to species richness but also because of the IVI values of individual species. The species diversity is regulated by long term factors like community stability and evolutionary time, a s the heterogeneity of both micro and macro environment effects influence the diversification among different communities. According to Baduni and Sharma (1997) the concentration of dominance i.e. Simpson's index is strongly affected by the IVI of the first three relatively important species in a community. On each forest site, the most widely distributed species were *Shorea robusta, Terminalia tomentosa* and *Syzygium cumini* in the tree category, *Lantana camera, Woodfordia fructicosa, Desmodium pulchellum, Murraya koenigii* and *Inula cappa* in the shrub category, and *Justicia simplex, Crotalaria sessiflora, Commelina bengalensis, Desmodium parvifolium, Barleria cristata and Chlorophytum tuberosum* in the herb category.

The present range of tree density (550–830 ind/ha) of Shiwalik forests was higher than the value (443 ind/ha) reported for the Sal forests of a similar region by Rana et al. (1989) and fall within the range of 550–820 ind/ha as reported by Bohra et al. (2010). The total basal area (TBA) ranged between 32.08 to 43.9 m^2/ha. Of this, the total individual basal area, the minimum and maximum was shared by *Sapium insigne* (0.09 m^2/ha) and *Pinus roxburghii* (24.80 m^2/ha) respectively. The present values are slightly lower than 56.40 m^2/ha reported by Rana et al. (1989) for the Sal forests in foothills of Central Himalaya.

Dominance Diversity

The dominance diversity (dd) curves for each vegetation layer i.e. tree, shrub, herb and seedling fit for the log normal situation as depicted in Fig. 16.1. This indicates the partitioning of niches and the route of diversity evolution among the species in various spaces which has occurred due to various ecological factors (Whittaker 1965). In the higher elevations the present study indicates that trees of *Pinus roxburghii* were present in the higher girth classes, while *Shorea robusta* and *Syzygium cumini* indicate a successional trend of the forest community as shown in Fig. 16.2. In middle and lower elevations a few trees of *Shores robusta, Terminalia*

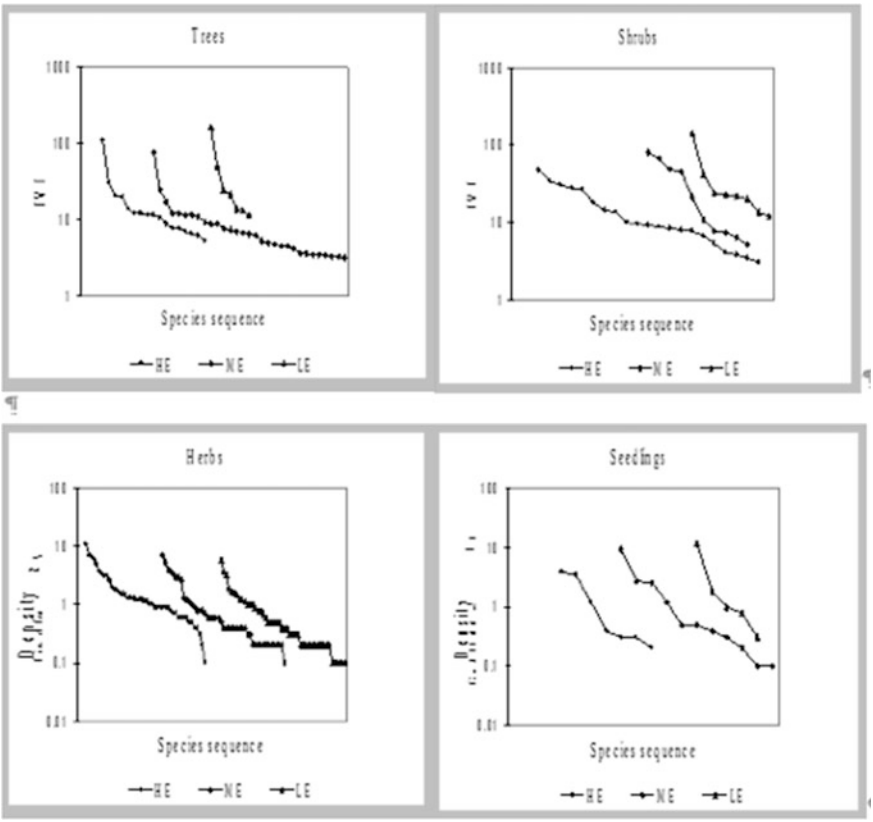

Fig. 16.1 Dominance-diversity curves for different vegetation layers (trees, seedlings, shrubs and herbs) along the altitudinal gradients. HE = higher elevation, ME = middle elevation and LE = lower elevation

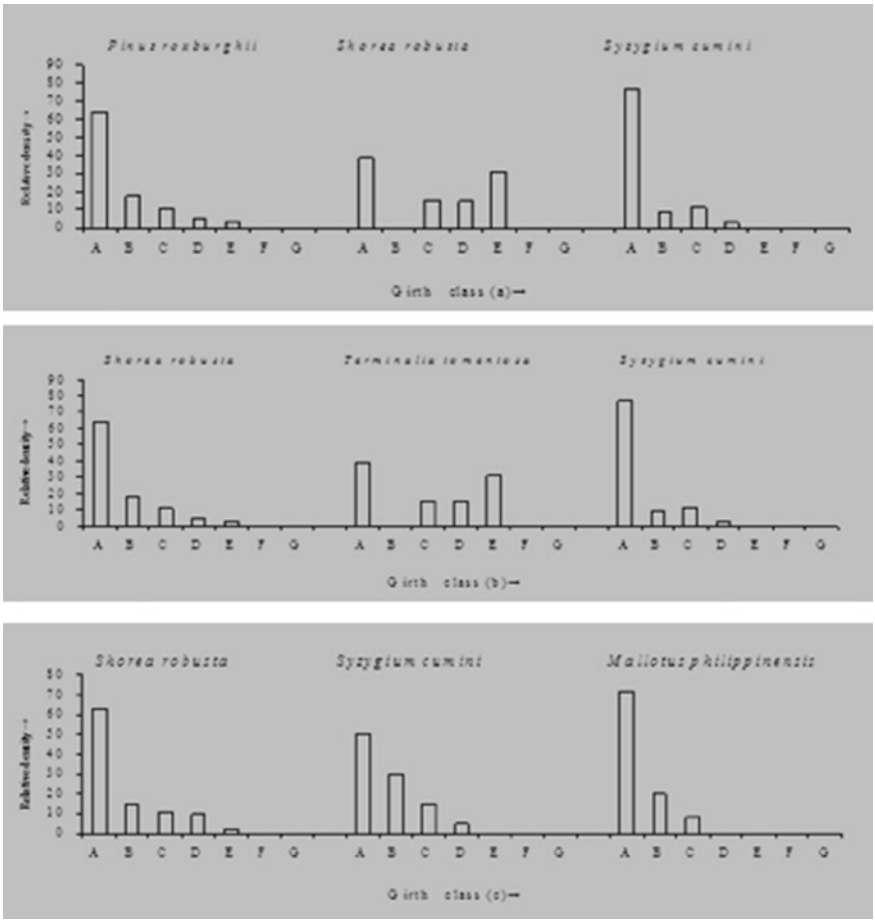

Fig. 16.2 Population structures of three important tree species along the altitudinal gradient in Shiwalik forest of Kumaun Himalaya; **a** Higher elevation, **b** middle elevation and **c** lower elevation; the relative density is on the y-axis and the size class is on the x-axis; A = Seedlings, B = Saplings, C = Trees, 30–80 cbh, D = 80–130 cbh, E = 130–180 cbh

tomentosa and *Syzygium cumini* were present in middle girth classes but absent in the higher girth class. The seedlings and saplings of *Shorea robusta, Mallotus philippinensis* and *Syzygium cumini* were reported in all the studied forest sites whereas the seedlings and saplings of *Pinus roxburghii* were only present in the higher elevation sites, which indicate regeneration of species in the respective area. This resembles the hypothesis of a vegetation mosaic across the landscape for different age and or serial classes with time, as given by Spies and Turner (1999). The relative seedlings density of *Shorea robusta* was found highest in all the forest sites, while for *Pinus roxburghii* the maximum occurred in higher elevations only; however the proportion of saplings and lower girth classes in relation to seedlings

dominated in lower elevation sites. This is because the seedlings are unable to reach into saplings and trees of lower girth classes.

Consequently, the mortality of seedlings was due to a higher intensity of forest fire as well as competition for moisture, space, nutrients and sunlight for their growth. Thus all the above factors have shown that they are responsible for the changes in plant diversity and composition of forests in the study sites of Shiwalik region of Kumaun in Uttarakhand. Appropriate and suitable strategic plans are urgently needed to ensure conservation and management of the flora and fauna of the region in an integrated way. Government should cooperate with non-government organizations and invite the local people with their expertise to participate.

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Part IV
Conclusion

Chapter 17
Summary and Conclusion

Raghubir Chand and Walter Leimgruber

Although mountains are home to about 800 million people (Kohler et al. 2014, p. 8), more than 10 % of the global population, and have always been part of human existence, they had for a long tie "remained largely excluded from the dominant global economic processes" (Mountain Agenda 1992, p. 22) and were spatially and politically marginalized. The Rio Conference in 1992, in particular Agenda 21, has changed that and increased awareness of the key role of mountains for the ecosystem and for human societies, marking a turning point in the perception of mountains by political leaders. To be effective, measures must be taken on a regional scale. An important and probably the first political initiative occurred a year prior to Rio when Austria, France, Italy, Liechtenstein, Switzerland, Germany and the European Community [now Union] signed an international treaty, the Alpine Convention, in Salzburg in 1991 (Gantar 1998, p. 375). Slovenia joined in 1993, and Monaco in 1994 (ibid.).

While the spirit behind the Convention is holistic, its implementation necessarily follows a sectional approach. It is laid down in a number of Protocols that have to be signed and ratified individually by the contracting parties. They comprise, among others, environmental protection, mountain farming, sustainable development, tourism, energy, transport (ibid., p. 376 f.). To put such good intentions into practice is a thorny affair, however. The political processes are often long and complicated, and it is the practical details that usually pose problems. Switzerland, for example, has signed and ratified the entire Convention, but not ratified the Protocols (with the exception of the one concerning the accession of Monaco to the Convention)—the major obstacle being the sovereignty of the cantons. Of course,

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voluntary individual action in the spirit of the Convention will yield better results than waiting for politicians to take decisions and enforce them.

The chapters in this book have drawn our attention to a number of topics that are of political relevance: the fact they are the water towers for humanity, play a major role in climate change, and are a haven of biodiversity. However, these are also highly political issues, often involving strategies for conflict solution between two or more countries (Vick 2014). Our ancestors were fully aware of the importance of mountains and therefore often saw them as sacred, limiting or even prohibiting access. Sacredness conveys respect, to declare nature sacred is a primitive (original) form of nature protection. The fact that we can nowadays walk up Uluru (Ayers Rock) in Australia demonstrates the triumph of worldly thinking over the spiritual background to a society. Uluru has become the victim of the modern idea that tourists should be allowed to go everywhere.

Mountains play an important role in the provision of ecosystem services, a point stressed by Debarbieux and Price (Chap. 4 in this book). The inhabitants of mountain regions, in particular the farmers, bear a high responsibility in this. While they are usually conscious of their role, they have to balance economic survival against the costs of ecosystem preservation. Farmers who see their job not only as a business but also part of their culture, may be more inclined to try and reconcile these two. Information is a key element if they are interested in participating in schemes that offer payments for ecosystem services (Wynne-Jones 2013).

Poverty is a major issue with many mountain people, particularly in the Himalayas (Gerlitz et al. 2012), in many parts of Southeast Asia (where it concerns mainly the indigenous minority groups; see Leepreecha et al. 2008; McCaskill et al. 2008) or in the Andes (see e.g. Sánchez 2010, p. 105). It is caused by both natural and social factors (remoteness, access to basic facilities, household structure, policy, etc. (Gerlitz et al. 2012, p. 253). Poverty is an important obstacle to improving people's livelihood. For centuries they have been using the resources of the mountains, exploiting them according to their needs and using the technology available. Globalization has nowadays entered this world as well. The exploitation of gold, silver, copper and other minerals by multinational companies acting on a worldwide scale causes not only irreversible ecological damage but is also a threat to people's resources for survival (e.g. water; Marchant 2010, p. 148 f.). Marginalization and outmigration are the consequences. Only during the last few decades, people have understood that resource use can also lead to resource depletion and the degradation of the living space. The links between globalization, marginalization and environmental degradation have become obvious.

While mountain people lead a difficult life, surviving often at the edge of poverty, they sometimes also show a high degree of adaptability. Parish and Funnell (1996) have shown how farmers in the Atlas Mountains (Morocco) often operate according to locally prevailing conditions. Abandoning fields during a spell of dry years is not necessarily a sign of complete abandonment; "production may well be revived if rainfall conditions improve." (p. 152). Outmigration (to Moroccan cities and to France) is nevertheless a fact, and the income of migrants and their remittances—fragile as they may be due to the domestic and international

labour markets—are important for the improvement of the living standard of local populations (ibid., p. 148).

The example of the Yungas region in the Bolivian Altoplano (Gerold 2003) shows that agrarian colonization and development occurred even during the late 20th century. Such modern projects usually try to develop sustainable production systems, preferably on the basis of economic farming, but the implementation may often be difficult because farmers initially responded negatively, organic farming being too labour intensive and providing insufficient yields in the short to medium term; in addition, there was a lack of information, and marketing was not immediately guaranteed (ibid., p. 111). This case demonstrates that adaptability is not an automatic quality but can only be achieved through information and persuasion. The production of cocoa, the main crop, has started to follow ecological criteria (ibid.).

A major problem at present is the global economic uncertainty. The world economy is not growing as much as it did before the 2007/8 financial crisis, and China as the 'global growth engine' is currently showing signs of a slowdown. Such crises seem to be inherent in our current economic system, and according to Anderson (2013, p. 48) they appear to have a number of traits in common, such as "excessive exuberance, poor regulatory oversight, herd mentalities and, in many cases, a sense of infallibility." Actors tend to behave in an irrational way instead of learning from past errors. Irrational, though, is not the right term; Simon (1957) speaks of bounded rationality, according to which man limits his actions to satisfy (not optimize) his perceived needs.[1] In an economic bust situation weak regions risk to be forgotten and will become marginalized. Mountain regions as ecosystems as well as social systems are particularly vulnerable, and their needs will be overlooked when the entire globe is struggling.

In marginality studies we have therefore to take this human weakness of bounded rationality into account.

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[1]The use of the male gender is justified in this case because most decisions have been and are still taken by men.

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Index

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