



## Su Khyim<sup>1</sup>

*The land of the Lho-Men-Tsong-Sum<sup>2</sup>*

Edited by Viren Lobo/ Anusa Rai<sup>3</sup>

On behalf of **IELA**

*( The Political Ecology of Rivers - for the people of Sikkim ? )*



The majestic Teesta River and the Fambong Lho Wildlife sanctuary in Sikkim

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<sup>1</sup> The origin of the word Sikkim from the two Limbu word Su meaning new and Kyhim meaning palace/house.

<sup>2</sup> The Threesome namely Bhutia, Lepcha and Limbu

<sup>3</sup> Managing Trustee IELA and International Justice Mission respectively

## Foreword

Sikkim is a basin surrounded on three sides by precipitous mountain walls. There is little lowland, and the variation in relief is extreme. Within a stretch of roughly 50 miles (80 km), the land rises from an elevation of about 750 feet (225 metres) in the Teesta River valley to nearly 28,200 feet (8,600 metres) at Kanchenjunga India's highest peak and the world's third highest mountain. The Singalila Range separates Sikkim from Nepal in the west, while the Dongkya Range forms the border with the Tibet Autonomous Region of China to the east. Several passes across this range afford easy access to the Chumbi valley in Tibet and, beyond the valley, to the Tibetan capital of Lhasa.

Two-thirds of Sikkim consists of perpetually snow-covered mountains, dominated by the Kanchenjunga massif. The residents of Sikkim have traditionally viewed the mountain as both a god and the abode gods. The legendary Abominable Snowman, called Nee-gued in Sikkim, is believed to roam its slopes. Other major peaks—all above 23,000 feet (7,000 metres)—include Tent, Kabru, and Pauhunri.<sup>4</sup> The origin of Sikkim itself is shrouded in mystery. The Lepcha people themselves do not have any tradition of migration, and hence they conclude that they are autochthonous to the region, currently falling under the state of Sikkim, Darjeeling District of West Bengal, eastern Nepal and the southwestern parts of Bhutan<sup>5</sup>.

The Sikkim basin is drained by the Teesta River and its tributaries, such as the Rangit, Lhonak, Talung, and Lachung which have cut deep valleys into the mountains. Originating in the northeast from a glacier near the Tibetan border, the Tista River descends steeply, dropping about 15,700 feet (4,800 metres) to Rangpo (Rongphu), on the border with West Bengal where it has cut a gorge through the Darjeeling Ridge (7,000–8,000 feet [2,100–2,400 metres]) before emerging onto the Indo-Gangetic Plain.

Sikkim's economy is based predominantly on agriculture, engaging more than half of the working population. Corn (maize), rice, buckwheat, wheat, and barley are produced in terraced fields along the valley flanks. Beans, ginger, potatoes, vegetables, fruits, and tea also are grown. Sikkim is one of the world's principal producers of cardamom. Many of Sikkim's farmers also raise livestock, including cattle, pigs, sheep, goats, and poultry. Cattle and buffalo are limited mainly to the subtropical humid belt, while yaks and sheep are herded in the higher elevations in the north. Until the early 1970s, Sikkim had only cottage industries—producing handwoven textiles, carpets, and blankets—as well as traditional handicrafts, such as embroidery, scroll paintings, and wood carving. Since that time, several small-scale industries have developed. These produce, most notably, processed foods (including liquor), watches and watch jewels, and small electronics parts.

With the Independence of India, the movement to abolish feudalism gained momentum in Sikkim and in 1949 the system of absentee landlords was abolished. The 1950 treaty with Sikkim made it an Indian Protectorate in 1975 in a referendum 97% opted to for merger of Sikkim with India<sup>6</sup>.

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<sup>4</sup> <https://www.britannica.com/place/Sikkim>

<sup>5</sup> [https://en.wikipedia.org/wiki/Lepcha\\_people](https://en.wikipedia.org/wiki/Lepcha_people)

<sup>6</sup> <https://www.britannica.com/place/Sikkim>

## Background

<https://en.gaonconnection.com/turbulence-along-the-teesta-the-lepchas-of-dzongu-valley-in-sikkim-reignite-their-protest-against-the-520-mw-hydropower-project/>

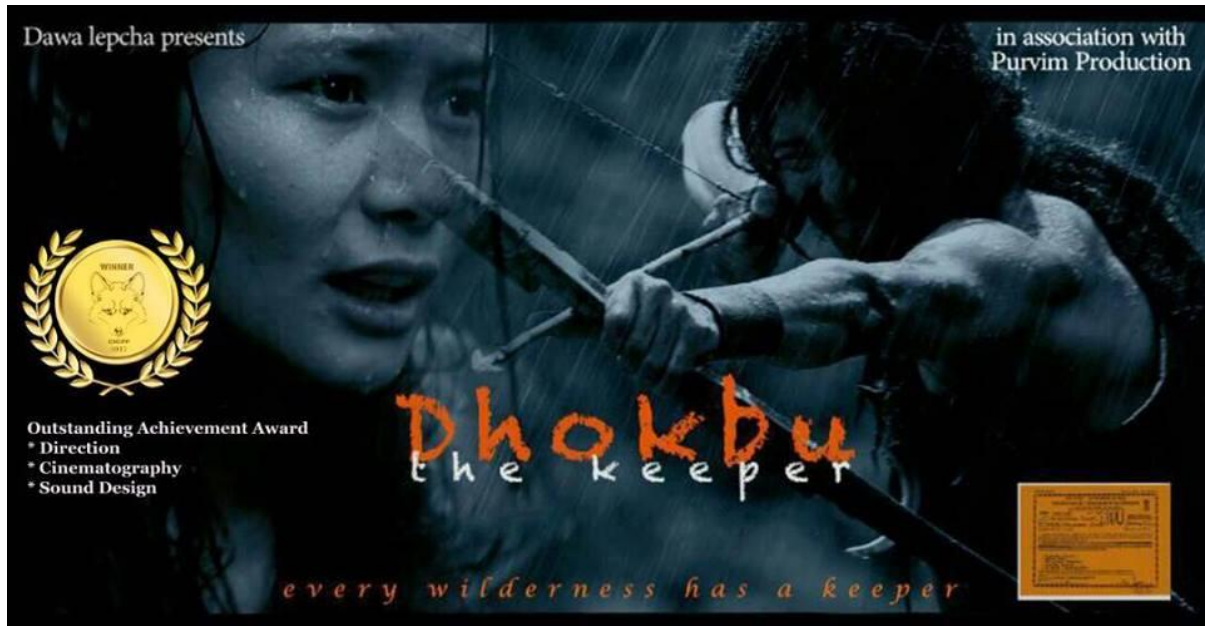
The Lepchas of Dzongu Valley in North Sikkim, the original inhabitants of the state, have stepped up their long standing protest against an upcoming 520 mega watt (MW) hydropower project. The stage IV of the project, allotted in 2012 to National Hydro Power Corporation (NHPC) near Tingchim Chandey and Hee Gyathang village in north Sikkim, was to be commissioned in June last year. In keeping with the official procedure, the state land revenue department formed an expert committee for Social Impact Assessment (SIA) in the area. However, all the *gram panchayats* in the region refused to cooperate with the officials of the assessment team who came to the villages to conduct the survey. It is their overriding fear that construction of the hydropower project would destroy the rich Himalayan ecosystem and the cultural heritage of the Lepcha community, which is also known as the Rongkup, meaning the children of God, and the Rong.

Since last June, the indigenous community of Sikkim has upped its protests against the 520 MW project, and has organised several meetings and rallies in the past three months. They met the state power minister M N Sherpa, and also attempted to meet the newly elected chief minister, Prem Singh Tamang, but failed to do so. The local people allege that police deployment in their area has increased and the state is keeping a close eye on outsiders to the villages in the Dzongu Valley. Dzongu is a protected area as per a 1956 notification when Sikkim was a separate kingdom. “They have taken our land for two other mega projects on the Teesta river (Stage III and Stage V). The people of Dzongu have already suffered a lot of environmental damage,” said Tenzing Gyatso Lepcha, vice-president of ACT, who went on an indefinite hunger strike as far back as 2007 demanding the scrapping of the hydropower project. Tenzing accused the project of being a planned attack on Lepchas. “We are fighting to protect our lands. The people of Dzongu have tried all options — we tried the pen, used the sickle and now the youth are ready to pick up firearms to protect their land. We are ready to come out on the streets,” he warned.

According to the Environmental Impact Assessment (EIA) report, while 256 families are likely to be affected due to construction of the dam, there will be no displacement. However, local people say about 324 hectares of land will be acquired for this project. This includes 31.5 hectares of the river bed, 14.40 hectares of land for underground works and the rest is private land belonging to indigenous people. Around 4,000 villagers living in the four *gram panchayat* units of Hee Gyathang, Barfok Lingdong, Lingthem Lingdem and Lum Gor Sangtok will be directly affected. And, they refuse to accept any compensation or rehabilitation package in exchange for their land.

<https://kalpavriksh.org/wp-content/uploads/2018/07/Dzongu-final-report-as-sent-on-23.09.09.pdf> provides a nuanced take : *Not all residents of Dzongu oppose the hydro power projects. For most of these Lepchas, who till now were mostly reliant on cardamom as their main source of livelihood (which is now failing), to oppose the Government would mean inviting unfavourable implications: including family members losing Government jobs etc. Some locals also feel that to be compensated financially for the lands which anyways do not yield any economic benefits (land in Sikkim cannot be bought by a non Sikkimese) is an easy way of earning money*

## Dedication



Dhokbu: The keeper

Dhokbu (which translates as ‘the keeper’) represents Dawa’s understanding of what it means to be a Lepcha. In an interview with Darjeeling Chronicle, he said, “Like every tribal community around the globe, we Lepchas also believe in natural deities and protectors of wild forest and wilderness. This film is about a mythical character, who is the guardian of the wilderness of the Sikkim Himalayas, who rescues and protects a young university student who gets lost in the wild while on a research recce, and helps her return to civilization. The film reflects a few of my own thoughts influenced by what I went through during my days of intense activism.” (“Sikkimese Filmmaker Dawa Lepcha Nominated for Golden Fox Award - The Darjeeling Chronicle”, 2017). Dawa continues to record the disappearing ways of life through a medium that he is confident in. Reviving memories of food, the process of preparing it and sharing it with others, also underlines Dawa’s goal of retaining the link with the land and his people. His documentary, Finding Pushen, records the all but forgotten food, an ingredient derived from a species of palm that grows in the jungles of Dzongu. Through his research he found some elderly people who knew about it.<sup>7</sup>

“Dhokbu – the Keeper” is a film that showcases the beautiful scenery of the Himalayan state Sikkim, India. The movie is filled with adventure and interesting plot twists. Stories of local folklore, with which many Sikkimese generations have grown up, make up the background of the film. The storyline follows the journey of a research scholar on fieldwork who gets lost in the wild and encounters a guardian deity who protects her in the wilderness, while narrating stories and myths of the land. Kikee D. Bhutia is the film’s lead actor. She is also currently a PhD student in the Department of Estonian and Comparative Folklore, University of Tartu. Her research interest includes the belief narratives related to the supernatural landscape, pilgrimage, and relationship between humans and deities in Sikkim<sup>8</sup>.

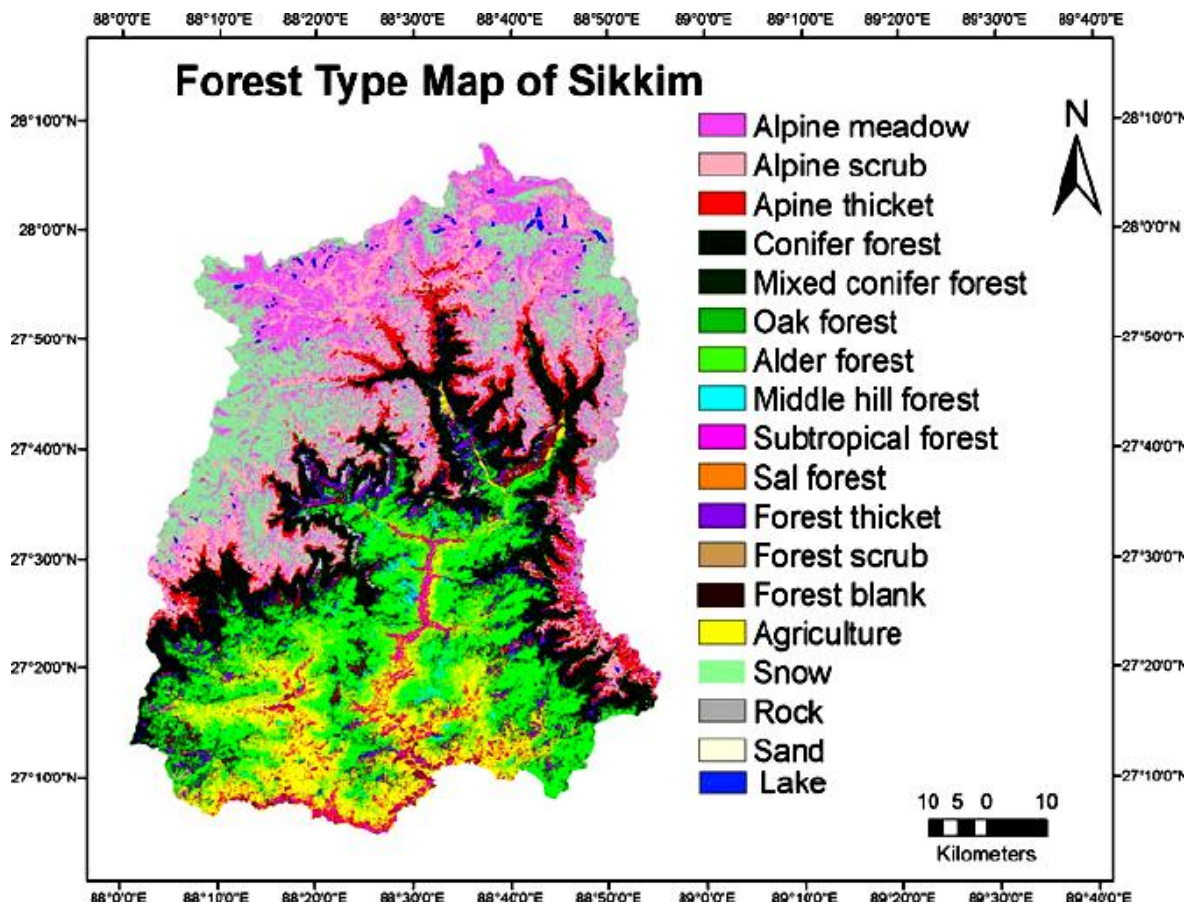
<sup>7</sup> <https://www.sikkimproject.org/making-of-a-sacred-land-and-its-guardians/>

<sup>8</sup> <https://aasiakeskus.ut.ee/en/content/feature-film-dhokbu-keeper-1606>



# Part I

## Forests of Sikkim

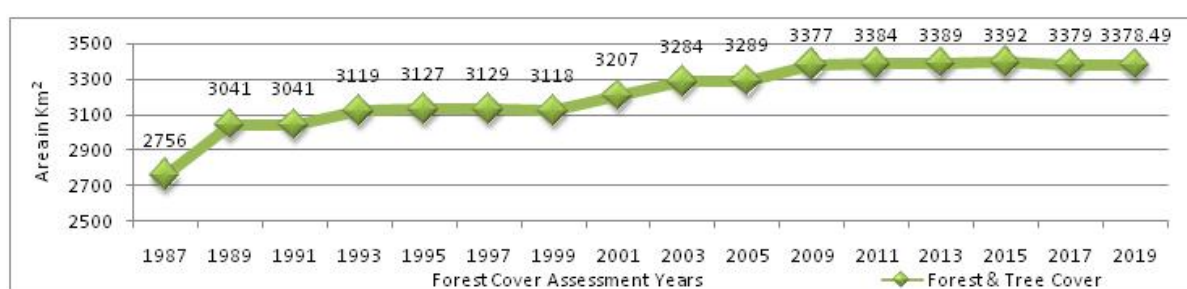


Forest Map of Sikkim<sup>9</sup>

<sup>9</sup> Assessing the Priorities for Sustainable Forest Management in the Sikkim Himalaya, India: A Remote Sensing Based Approach: S. Tambe Department of Forest, Environment and Wildlife Management, Government of Sikkim, Forest Secretariat, Gangtok 737102( Sikkim, India, , M. L. Arrawatia : N. Sharma Department of Science and Technology and Climate Change, Government of Sikkim, Development Area, Gangtok 737102( Sikkim, India

## Forests:

Forest is one of the richest natural resources of Sikkim. With luxuriant forest abounding in all part of state, Forestry has been the major land use in the State and 82.31% of the total geographical area of the State is under the administrative control of the State Forest Department. The total forest and tree cover of the State as per the latest India State of Forest Report 2019 is 3378.49 sq. km (47.61% of the total geographical area of the state). The composition ranges from tropical Dry Deciduous Forests with Sal and its associates in the valleys of Teesta and Rangit to the Alpine Scrub and grassland in high altitude.



*Note: In the State of Sikkim about 44 % of total geographical area is under Alpine pasture & scrub and under perpetual snow cover. Hence, in these areas, it would not be possible to bring the tree cover. The area considered for the tree cover may therefore be excluding these areas.*

## Biodiversity:

Covering just 0.22% of the geographical area of India, Sikkim shows great biological diversity. The vast altitudinal variation of elevations from around 300 m to 8598 m within very short distances is responsible for the varied ecoregions of the State. This is evident from the presence of Sal (*Shorea robusta*) forests in the lowland Rangit Valley in the south, to the temperate fir forests in the north, beyond which lie the Trans-Himalayas and the cold desert of the Tibetan plateau.

**Broadly speaking, there are five altitudinal zones of vegetation, not clear-cut at their boundaries as they merge into one another**

**The Tropical Ecoregion** extends roughly from the foothills of the Outer Himalayas to an altitude of about 1,200 m. It contains steep-sided valleys and gorges with well-drained flanking slopes. Various species of orchids, climbers like the robust Aroid *Rhaphidophora*, wild banana *Musa sikkimensis*, *M. balbisiana*, Himalayan Screwpine *Pandanus nepalensis*, Date Palm *Phoenix sylvestris* and the rare *P. rupicola*, the only living fossil tree of Sikkim *Cycas pectinata*, nettles and giant bamboo are characteristic of the region. In the region of Rangit Valley, Sal *Shorea robusta* shows a unique association with the Chir Pine *Pinus*

roxburghii. In patches of protected forest, it is possible to see the weak Sal being slowly dominated by the Pine. These patches are relatively poor in bird life. However, the lowland forests of Sikkim are home to several threatened species of birds such as the possibly locally extinct Vulnerable Rufous-necked Hornbill *Aceros nipalensis* (but visitor from Neora Valley National Park in North Bengal), Great Pied Hornbill *Buceros bicornis*, locally called 'Hongraio', Chestnut-breasted Partridge *Arborophila mandelli*, even the now uncommon Red Junglefowl *Gallus gallus*. Other lowland fauna includes the introduced Peafowl *Pavo cristatus*, Sikkim's largest reptile Burmese Python *Python bivittatus*, house geckos, Himalayan Crestless Porcupine *Hystrix brachyura*, Assamese Macaque *Macaca assamensis*, Chinese Pangolin *Manis crassicaudata*, and Barking Deer *Muntiacus muntjak*, a variety of hill-stream fish, freshwater and tree frogs, toads and a host of butterflies and other invertebrates. Several species of migratory water birds use the river systems during transit. Six sq km of a representative area of the Kitam Reserve Forests has been declared as Kitam Bird Sanctuary.

**The Sub-Tropical ecoregion** extends from about 1800 m to 3000 m. The rainfall in this zone is very heavy and conditions remain humid throughout the year. The upper-storey mainly consists of trees like *Castanopsis hystrix*, *Machilus* spp., *Rhododendron* spp., *Symplocos spicata*, *S. theifolia*, *Michelia excelsa*, *Quercus lamellosa*, *Q. lineata*, *Q. pachyphylla*, *Engelhardia spicata*, and *Leucocephalum canum*. In the understory are *Eurya japonica*, *Rhododendron arboreum* and *Viburnum* spp. In the middle storey, *Symplocos theifolia* is the main species and *Litsea* spp. and *Bucklandia populnea* are other associates. Dense tall evergreen forests with oaks and *Rhododendrons* predominate. The undergrowth consists of the bamboo *Arundinaria maling*, varieties of ferns, epiphytic mosses and orchids. Red Panda *Ailurus fulgens*, Red Fox *Vulpes vulpes*, Golden Jackal *Canis aureus*, Leopard Cat *Prionailurus bengalensis*, Spotted Linsang *Prionodon pardicolor*, Common Leopard *Panthera pardus*, Asiatic Black Bear *Selenarctos himalayanus*, Palm Civet *Paguma larvata*, Flying Squirrel *Petaurista magnificus*, Wild Boar *Sus scrofa* and Barking Deer *Muntiacus muntjac* have been recorded here. This area is also rich in forest birds including the Rusty-bellied Shortwing *Brachypteryx hyperythra*, Lesser Shortwing *Brachypteryx leucophrys*, Kaleej Pheasant *Lophura leucomelanos* and Satyr Tragopan *Tragopan satyra*; reptiles such as Japalura lizards *Japalura* sp., Cobra *Naja naja*, Krait and Mountain Pit Viper *Ovophis monticola*; Himalayan Bullfrog *Paa leibigii*; butterflies, Atlas moth *Attacus atlas*, Moon moth *Actias selene*, jewel beetles and leeches. Fambong Lho and (lower elevations of) Pangolakha Wildlife Sanctuaries in East Sikkim, Barsey in West Sikkim and Maenam Wildlife Sanctuary in South Sikkim as well as lower fringes of the Khangchendzonga National Park and Biosphere Reserve are the protected IBAs in this ecoregion. Lake Khecheopalri in West Sikkim occasionally hosts the Critically Endangered Baer's Pochard *Aythya baeri* and once even a Vulnerable Black-necked Crane *Grus nigricollis* (photographed by a bird-watcher tourist Roger Ahlman in April 2006 in the reed-beds beside the lake).

**The Temperate ecoregion** extends from 3000 m to 4000 m, with mixed coniferous forests of Hemlock, Spruce, Pine, Fir and Junipers and with shrubby undergrowth of

Rhododendron and Arundinaria as well as the increasingly rare climber Aristolochia griffithii and insectivorous herb Drosera peltata. Red Panda Ailurus fulgens, Common Langur Semnopithecus entellus, Yellow-throated Marten Martes flavigula, the Vulnerable Asiatic Black Bear Ursus thibetanus, Himalayan Goral Naemorhaedus goral, Himalayan Serow Capricornis thar both Near Threatened like Golden Cat Catopuma temminckii, Endangered Wild Dog or Dhole Cuon alpinus, Vulnerable Clouded Leopard Neofelis nebulosa, (all photographed by camera-traps in Khangchendzonga National park), Himalayan Monal Lophophorus impejanus, Fire-tailed Sunbird Aethopyga ignicauda, and some species of reptiles and amphibians are characteristic of this region. The Brown Trout Salmo trutta fario and Rainbow Trout Oncorhynchus mykiss have been introduced in high-altitude lake and river systems over four decades ago. Tender shoots of Cardamine macrophylla, roots of Arisaema spp. and fruit of Seabuckthorn Hippophae salicifolia are collected for food, medicine and dyes.

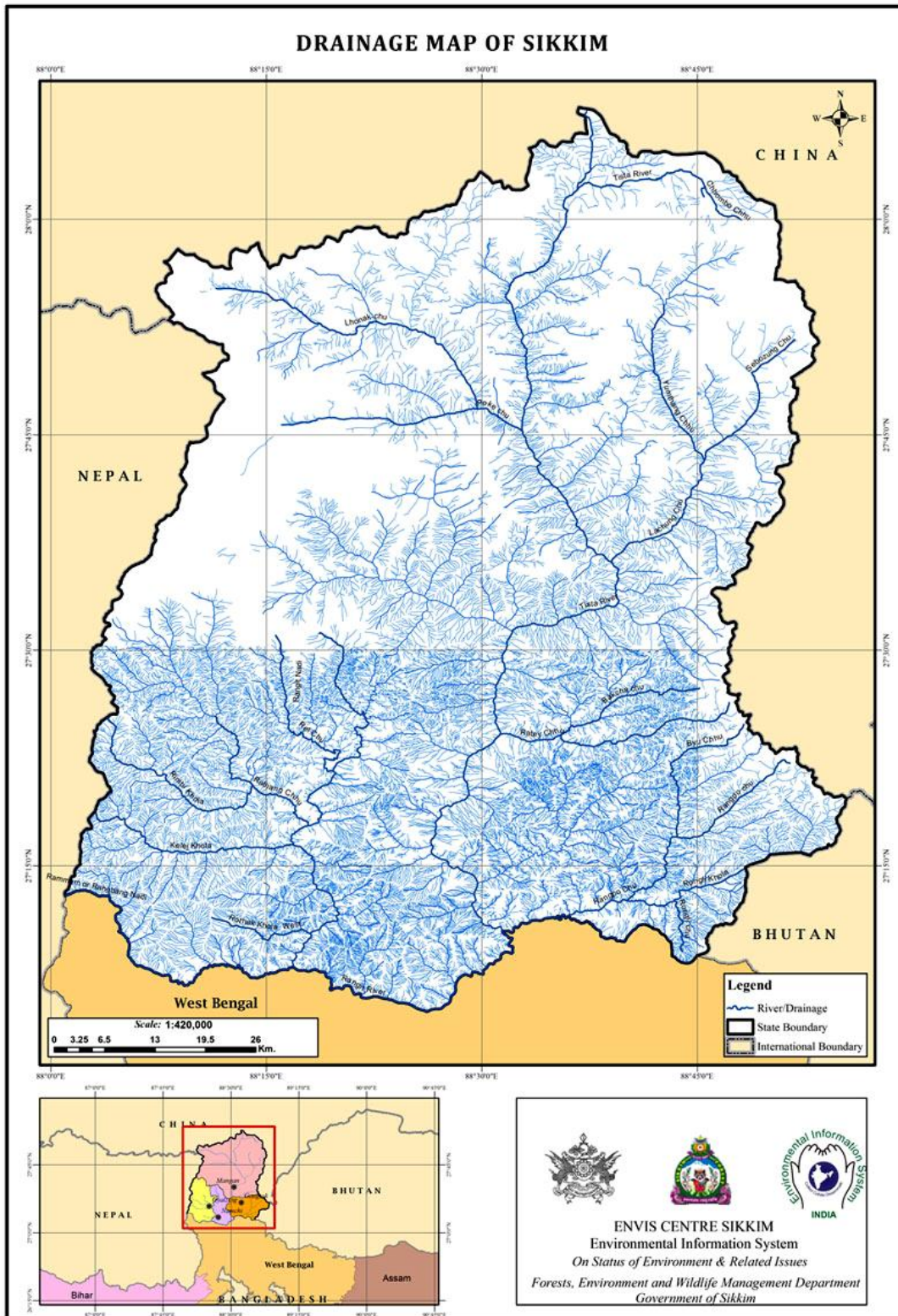
**The Alpine forests** and scrub extend up to 4500 m with small crooked trees and spreading shrubs interspersed with fir and pine. The stunted forest is mainly of Birch Betula spp. and Rhododendron with alpine herbs like various species of colourful Primulas and Potentillas. Dominant wild fauna include the Endangered Alpine Musk Deer Moschus chrysogaster, Near Threatened Himalayan Tahr Hemitragus jemlahicus, Blue Sheep or Bharal Pseudois nayaur, Blood Pheasant Ithaginis cruentus and Ibisbill Ibidorhyncha struthersii. River systems harbour some (introduced) Brown Trout Salmo trutta fario. Most of the flora of this region attracts interest for medicinal purposes. Dwarf rhododendron leaves are used for burning as incense. An important species recorded from this zone is the Caterpillar-fungus Cordyceps sinensis which is aggressively harvested by the local people due to its great commercial potential. This region has a very small resident human population, mainly Bhutias and mostly pastoral, herding livestock such as Yak, Dzo (cow-yak hybrid), a few horses and domestic cattle. The Temperate and Alpine ecoregions are protected in four wildlife sanctuaries at Shingba (North), Kyongnosla (East), Pangolakha (East) and Barsey (West) and one national park namely Khangchendzonga National Park (North and West). They harbour representative biodiversity of these ecoregions. They also harbour many high altitude glacial lakes and tarns which are important stop-over sites for migratory waterfowl and breeding grounds for Brahminy Shelduck Tadorna ferruginea, Common Redshank Tringa totanus and Ibisbill Ibidorhyncha struthersii. Shingba Rhododendron Sanctuary is home to the endemic Rhododendron niveum which has been designated the State Tree of Sikkim, with a small population recently discovered in Khangchendzonga National Park. The Kyongnosla Alpine Sanctuary has sheltered the Takin Budorcas taxicolor, which wandered over probably from Bhutan in 1999 through the recently declared Pangolakha Wildlife Sanctuary, which itself is contiguous with West Bengal's Neora Valley National Park. One of India's largest bovids, the Gaur Bos gaurus has been recorded in Pangolakha in the last decade and confirmed from a poached male confiscated by the State Forest Department. The 104 sq km Barsey Rhododendron Sanctuary with its pure Rhododendron stands is contiguous with the Singalila National Park in West Bengal.



**The Trans-Himalayan ecoregion** extends from 4,500 m to over 5,500 m with characteristic cold desert vegetation, exclusively restricted to the north of Sikkim. This ecoregion has not yet been included in the protected area network of the State and is perhaps the most threatened. It contains many endangered species such as the Kiang or Tibetan Wild Ass *Equus kiang*, Near Threatened Nayan or Tibetan Argali *Ovis ammon*, and Tibetan Gazelle *Procapra picticaudata*, Endangered Snow Leopard *Panthera uncia*, Eurasian Lynx *Lynx lynx*, Near Threatened Pallas's Cat *Otocolobus manul*, Tibetan Fox *Vulpes ferrilata* and Tibetan Wolf *Canis lupus chanco*. Occurrence of Brown Bear *Ursus arctos* can be confirmed from a report of it predating an injured yak in this region. The Tibetan Snowcock *Tetraogallus tibetanus*, Lammergeier *Gypaetus barbatus*, Golden Eagle *Aquila chrysaetos* and Ruddy Shelduck *Tadorna ferruginea* are also found here. The Vulnerable Black-necked Crane *Grus nigricollis* has attempted breeding here. The region has a short four-month growing season during which grasses, sedges and medicinal herbs spurt abundantly supporting a host of insect fauna as well as wild and domestic herbivores, Himalayan marmots, pikas, Tibetan and Horned Larks, Tibetan Sandgrouse, Red-billed and Yellow-billed Choughs, Black and Guldenstadt's Redstarts, pipits, wagtails and Mountain and Snow finches. Mongolian Plover *Charadrius mongolus* has been seen breeding at a small lake on the border called Bam Tso. There are no permanent settlements. The human population consists of a small number of nomadic Tibetan graziers or 'Dokpas' (who herd Yak, sheep and goats) and a large number of Defence personnel, as the area forms the international border with Tibet Autonomous Region of China.

# Part II

## Water Resources of Sikkim



Drainage map of Sikkim

<http://www.sikkimforest.gov.in/soer/Water%20Resources.pdf>

Teesta river originates as Chhombu Chhu from a glacial lake Khangchung Chho at an elevation of 5,280 m in the northeastern corner of the state. The glacial lake lies at the snout of the Teesta Khangse glacier descending from Pauhunri peak (7,056 m) in north western direction. Teesta Khangse glacier and Chho Lhamo are also considered as the source of Teesta river by many authors. Along its traverse from its origin to the plains, the river receives drainage from a number of tributaries on either side of its course. The tributaries on the eastern flank are shorter in course but larger in number whereas the tributaries on the western flank are much longer with larger drainage areas, consequently contributing much more amount of discharge to the main Teesta river. Furthermore, right-bank tributaries drain heavily glaciated areas with large snow-fields. The left bank tributaries, on the other hand, originate from semi-permanent and much smaller snow-fields as compared to right bank tributaries.

Unique in its complex and diverse drainage characteristics, the antecedent river Teesta offers a fascinating study for Himalayan drainage basin evolutionary processes under fluvial environment in particular. Studies of the Teesta drainage characteristics particularly of the river channel changes including river deposits and fluvial or fluvio-glacial processes in the Sikkim Himalayan terrain have been in progress for more than a decade. These landforms and drainage patterns include mainly the four tier terraces, canyons or gorge-valley at different altitudes, asymmetric valleys, polyprofic U-shaped valleys and steps or troughs, lakes, alluvial cones, truncated ridge-spurs, soil profiles, terracettes (soil landscape systems), rectangular-barbed-parallel-trellised-radial –sub-dendritic, etc. drainage patterns, straight meandering braided etc, channels and others.

The per-humid climate of the Teesta basin in Sikkim is characterized with enormous water surpluses. The prevalent monsoon climates have supported evergreen (broad leaf) rainforests including grasses which become dense and luxuriant in some parts of middle Teesta basin. It is important to note that depending upon the terrain properties e.g. structure, rocks in different geological formations, surface cover, and slope, the water surplus takes its course either through surface run off or deep percolation to underground regions. This becomes available for exploitation as ground water. In certain years, due to strong monsoonal activity or frequent occurrence of depressions and local severe storms, the precipitation may be much greater than normal; local water surpluses do occur, for brief periods producing not only enormous surface flow resulting in severe floods but also significantly contribute to the ground water resources. The orographic influence of the Sikkim Himalayan terrain including their hill-side and valleysideslopes is, however, responsible for the occurrence of wet climatic types throughout the upper and middle Teesta basin. Practically, per humid climatic types are found in the whole mountainous terrain according to the moisture regime which plays a decisive role in the water potentialities of various sectors within the basin. Obviously, the southwest monsoon season which is the principle rainy period for almost the entire Teesta basin is responsible for more than 80% of the total annual rainfall in these mountainous ecological sites, and significant in controlling the water balance.

Assessment of surface water resources of a basin is an important component for planning and development of water resources for various uses. The state of Sikkim is characterised with enormous water resources available through various rivers and hill streams. However, the same could not be put to utilization because of the land availability constraints. Teesta is a perennial river with substantial flows even in lean season. The river flows generally in North

South direction bisecting the State of Sikkim. It is the single major river in the State draining 95 % of the total area of the State. Enormous fall of the order of 3,300 m over a river stretch of 175 km. makes this river an ideal and reliable source of hydropower. This necessitates the establishment of a hydrometeorological network for collecting the gauge, discharge and precipitation data to estimate the water availability in the Teesta valley for development of power. The collection of discharge data during the lean as well as monsoon seasons is equally important. The former is required for assessing the firm power draft while the later is required for the design of hydraulic structures for hydro power projects.

The increase in human activities in the hot spring areas has led to various ecological stresses. The people demand on the surrounding forests for firewood due to lack of alternative fuel. There is a lack of proper solid waste disposal as huge quantities of solid wastes are generated during the peak season. Waste materials lie scattered along the surrounding huts and the river banks. The sanitary facilities available are unhygienic and insufficient as temporary toilets are constructed on the river bank where the faecal matter is directly discharged into the river without any treatment. The demand for meat and meat products had further accelerated the rate of fishing in the rivers. The large number of patients with various communicable diseases frequenting this hot spring may further spread these diseases. It is feared that due to the unhygienic conditions prevailing around these hot springs, the people on their way back may be infected by new diseases. The hot springs in Sikkim are regarded as place of worship and hold a high religious esteem in the hearts of the local people. The people drink the hot water and bathe in it, considering these factors detailed microbiological and radio-activity study of these water is felt essential taking into account, the study of the geomorphologic aspect of these hot springs and their economic exploitation.

<https://www.indiawaterportal.org/articles/water-quality-and-quantity-analysis-sikkim-north-eastern-himalaya-paper-published-current>

The study found that there was a significant variation in terms of water quality and quantity in different areas of Sikkim. It was found that water management in terms of supply of water to all cities and households and the existing infrastructure was inadequate to meet local demands. The study revealed that the region, despite being a water feeder to planar India, suffered water shortages and crisis in the South district, one of the most populated districts after East Sikkim. Many people in the vicinity were not aware of the available water quality and water conservation techniques. Majority of water samples not only contained coliform bacillus, but also had high basicity; only a few exceptions were found. The paper ends by arguing that in order to improve the quality and quantity of water in the region there is need for an integrated approach, planning of research into water resources and their management and educational outreach and that studies of this type may help policymakers as well as the public to understand the implications of receding water resources in the mountains and to search for potential alternatives before any severe crises occurs.

## Part III

### Energy sector in Sikkim

Electricity Consumption (in Kwh per annum)

Category	2008-09	2009-10	2010-11	2011-12	2012-2013	2013-14	2014-15	2015-16
Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Domestic	56.20	58.40	57.97	82.77	78.98	83.98	78.93	74.96
Commercial	28.90	29.30	29.23	29.72	38.26	35.43	35.33	37.43
Public Lighting	2.60	2.60	2.60	2.30	0.43	0.35	0.29	0.15
Temporary Supply	0.10	0.10	0.15	0.30	0.09	1.61	1.36	1.16
HT Industrial consumers	57.50	59.20	58.39	71.63	91.76	97.11	110.49	126.30
LT Industrial consumers	1.20	1.90	1.31	8.63	1.15	1.15	1.37	1.34
Bulk Supply	13.50	14.50	13.35	13.21	16.23	17.74	20.98	23.37
Outside State	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>160.00</b>	<b>166.00</b>	<b>163.00</b>	<b>208.56</b>	<b>226.90</b>	<b>237.37</b>	<b>248.75</b>	<b>264.71</b>



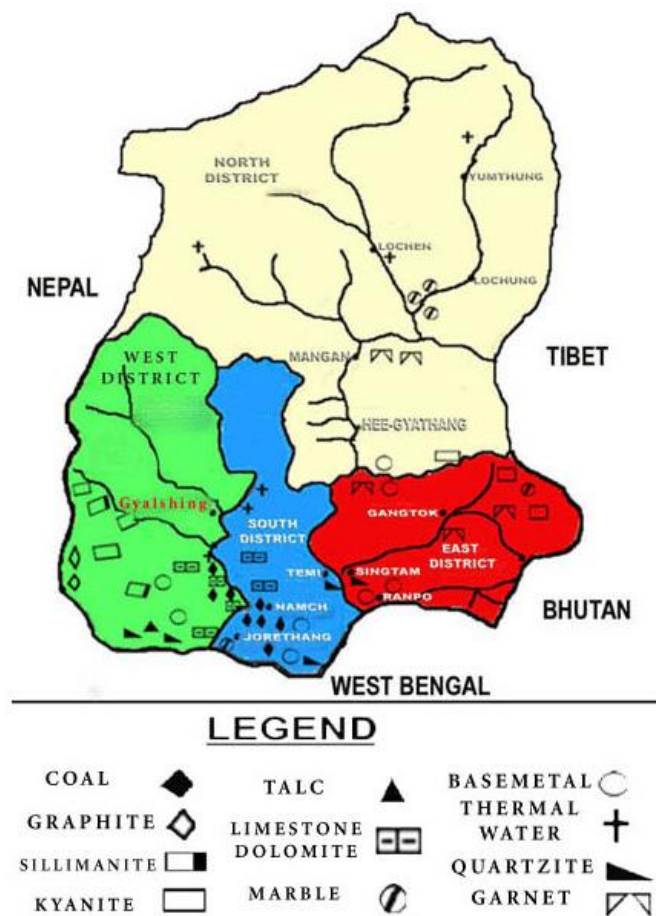
Foundation of Power (Energy) sector in Sikkim was laid on 27th May 1927 with the commissioning of first micro hydel project at Ranikhola near Gangtok with the installed capacity of 50 KW. During this era, activities under power sector in Sikkim were not at all significant. Till the year 1954, operation and maintenance of power supply system were managed with the help of a foreman and an electrician, under the supervision of Sikkim Public Works Department. In the year 1957, keeping in view of growing demand for electricity and as a standby measure, a Diesel power house was established and commissioned at Gangtok with a capacity of 257 KW. The then Prime Minister of India late Pandit Jawaharlal Nehru inaugurated it on October 1, 1958.

Following this development one more 150 KW SKODA Diesel generating set was added in this Diesel Power House. The year 1974 witnessed an important historical event in Sikkim. Following a Political upheaval Sikkim joined the mainstream of the Indian Union on May 16th 1975 as the 22nd state of India. Ever since Sikkim became a part of India there has been all round development in the state. Since then the sector has achieved the tremendous mileage in terms of installed capacity coupled with the Transmission & Distribution networks virtually connecting the every household in Sikkim. Sikkim with its picturesque landscape and amazing terrain has some of swiftest rivulets system has a huge power potential.

The Energy & Power Department of Sikkim is engaged in the generation of electricity, its transmission to various load centers and finally distribution to the consumers of all categories. As a whole the Department is responsible for the development of power project in the state in order to meet the ever growing requirement and raise revenue from there. Now with the liberalized power policy Sikkim is poised to gain in a big way. With the opening of this sector for private developers, Sikkim can look forward for developing and exploiting its huge Hydro Power Potential which has been assessed to 8000 MW Peak with a firm base of 3000 MW. At present the total Installed Capacity of the state is 95.70 MW. Total hydro power potential in the state so far is 5352.7 MW and they are in different stages of implementation.

## Part IV

### Minerals



Note the Dominance of Mineral reserves in East and Central Sikkim

## MINERAL RESOURCES

Several minerals are found in the state, among them, coal, copper, limestone and graphite are the most important. Dolomite, garnet, talc and magnetic are less important.

### *Copper:*

The ores of copper are widespread in Sikkim and are in the Daling beds. Some are situated in the transition rocks between the Daling and the gneiss, but none in the genuine itself, Copper depositors are found in East and West Sikkim. Two deposits, one at Rangpo and the other near Dikchu (north of Gangtok) are being explored. Both are small, multimetal deposits. Sikkim Mining Corporation is working on the copper deposits which envisages mining and milling only.

### *Coal:*

A coal field bounded on the south by the Ramman and Rangit Rivers near Naya Bazar occur in South Western Sikkim. The coal is reportedly non-cooking variety, low in moisture and volatile matter and high in fixed carbon.

### *Limestone:*

Crystalline limestone has been reported from Chhangu in Eastern Sikkim and Chungthang in North Sikkim. Sedimentary deposits of limestones are reported in West Sikkim in Naya Bazar-Reshi-Namchi area and in the North Sikkim.

### *Graphite:*

Graphite occurrence in North Sikkim and West Sikkim of amorphous to lumpy varieties have been reported.

### *Iron:*

This occurs chiefly as pyrites in association with chalcopyrite. It is most plentiful at Bhotang, where magnetite also occurs. The iron ores have nowhere been put to any economic use.

### *Garnet:*

It is abundant in the gneiss and mica schists at places. But it does not appear to be fit for the market.

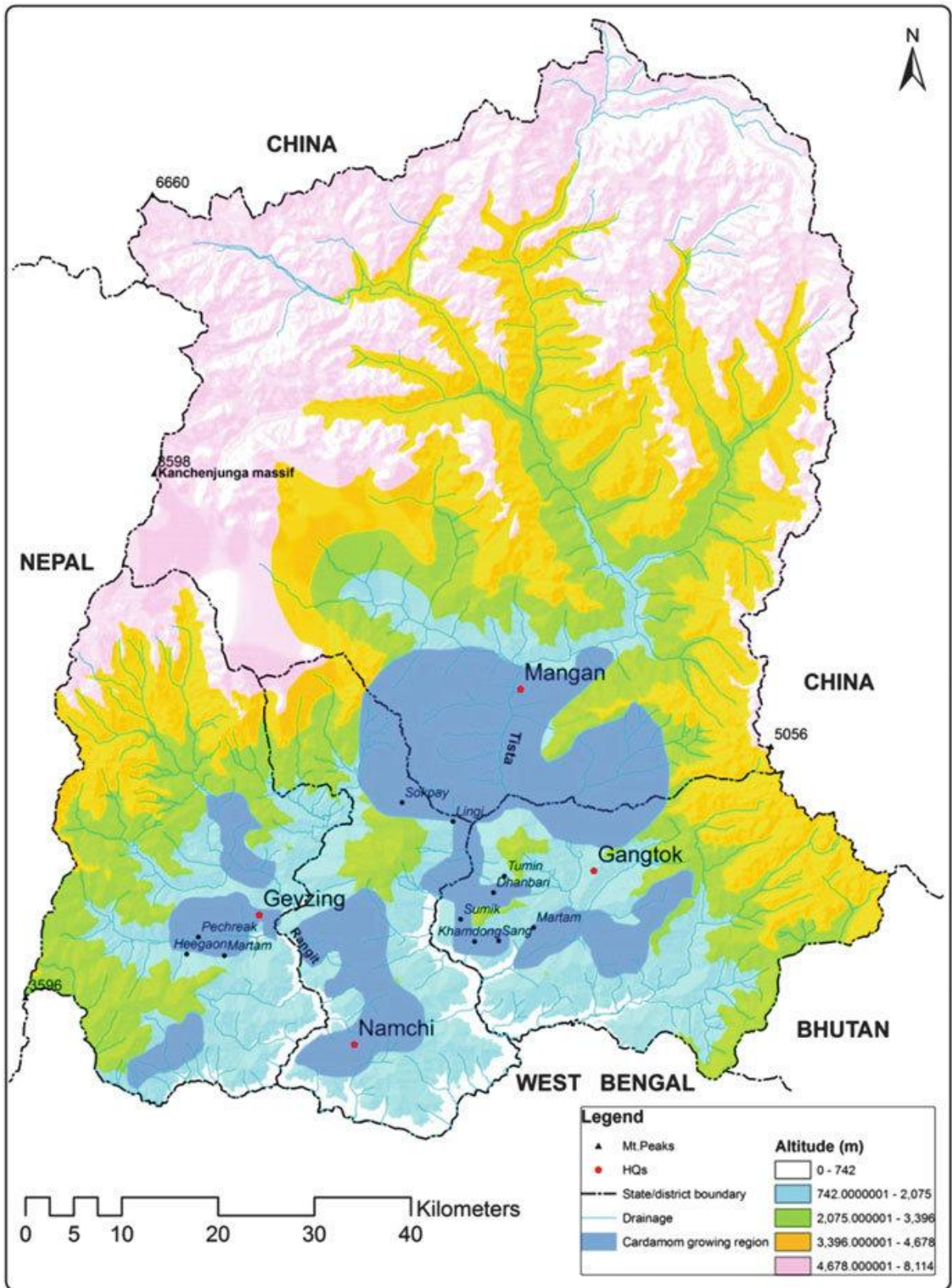
## Part V

### Agriculture in Sikkim



Soil map of Sikkim

Cardamon along with potato the major cash crop in Sikkim



Five major Cardamom growing areas in Sikkim - Map prepared by Dilli Ram Dahal



Prior to the arrival of the Bhutias, the tribes of Sikkim were primarily hunter gatherers. With the arrival of the Bhutias they started practising a semi pastoral form of agriculture. The Bhutias practised sedentary agriculture. However it was only with the influx of Nepalis into Sikkim that agriculture started within the territory of Sikkim. Rice is one among the staple food crop in Sikkim as inferred from the epithet “Denzong”-meaning “Valley of Rice”. Its antiquity in Sikkim is difficult to trace out but some experts consider the entire NE Region including Sikkim and adjoining area of China shall be the probable home of rice. A large number of landraces are cultivated in Sikkim in addition to introduced since 1970s.

<https://sikkim.gov.in/departments/food-security-and-agriculture-development-department/crops>

The economy of Sikkim is linked with agriculture that serves as the source of livelihood and economic security of sizeable native population. The growth, however, has been restricted because of biotic and abiotic factors. It is estimated that over 80 per cent of the rural population depends on agriculture and allied sectors for economic, food, and nutritional security. The agriculture systems practiced in Sikkim are integrated in nature that have evolved through years of experimentation by the farmers. A marginal improvement in the lifestyle of the farmers has been witnessed with the adoption of modern technologies.

Sikkim State has some inherent strength that largely supports organic farming. The policies and programmes on organic farming, in tune with our natural endowment envisage making Sikkim a Model Organic State. The march towards organic farming has led to substantial departmental intervention. A large number of initiatives have been taken by the Agriculture and Horticulture departments. [http://www.sikervis.nic.in/Database/Agriculture\\_777.aspx](http://www.sikervis.nic.in/Database/Agriculture_777.aspx)

The existing agroforestry practices in the Traditional Farming Systems (TFS) have gained wider attention in the international agreements and among academicians and policymakers for their multifunctional role and dynamics of ecosystem services. The Convention on Biological Diversity has advocated an ecosystem approach while Intergovernmental Panel on Climate Change (IPCC) emphasizes agroforestry to reduce emissions and enhance sinks of greenhouse gases. The multifunctional Sikkim Himalayan TFS are examples from the Eastern Himalayas that support ecosystem services and livelihood to mountain communities. They are considered to be adaptive to the climate change situations and serve as efficient means to carbon sinks. Due to the remarkable significance of TFS in the mountain ecosystem, environment and livelihood, the Sikkim Himalayan Agriculture Systems has been considered as an associate site under FAO's Globally Important Agricultural Heritage (GIAHS) Programme. With climate change rapidly impacting both ecosystems and services in the mountainous region, the sustainability of dynamic Himalayan TFS is now facing new challenges and vulnerabilities. The adaptive TFS offer opportunities for sustainable management of natural resources from a unit land use type to a landscape level land use stages and support socio-ecological and socioeconomic benefits. The TFS need to be further strengthened through research and development to achieve the goals of sustainable development. <http://sikervis.nic.in/writereaddata/chapter21.pdf>

## Part VI

### Case Study of Namcheybung Village in East Sikkim



Dried up Rani Khola river near Namcheybung in East Sikkim



Fish Catch from the dried up Rani Khola river: Nothing to eat and struggling to survive

Namcheybung comes under Nimtar Constituency in Pakyong Dist. The local name of the river is Rani khola (Khola meaning river in the local language) which flows through Ranipool to Singtham where it joins the Teesta.

Pakyong town with an elevation of 1,700 mtrs is a district headquarter of the Pakyong Dist. When we come down towards the valley from Pakyong, the Rani Khola flows.

Over the past few years due to reconstruction of the Dam in Nimtar, the Rani Khola has dried up as the water from the river is diverted towards the Dam periodically and this has endangered and exploited the water bodies in the region.

The river earlier used to be a fishing and a picnic spot for locals in the region but with water becoming dirtier the locals have stopped going to the river anymore.

Even though the govt claims of having an adequate waste management system that Pharma companies follow, the Torrent Pharmaceutical Company located in the bank of the Rani Khola at 32 No Middle Camp in the past have known to dump their medical waste into the water. The smoke from the company has been known to affect and impact the orange farming in the neighboring villages.

Till date, there has been no research or any initiatives wither by govt or non govt organization in addressing this issue.