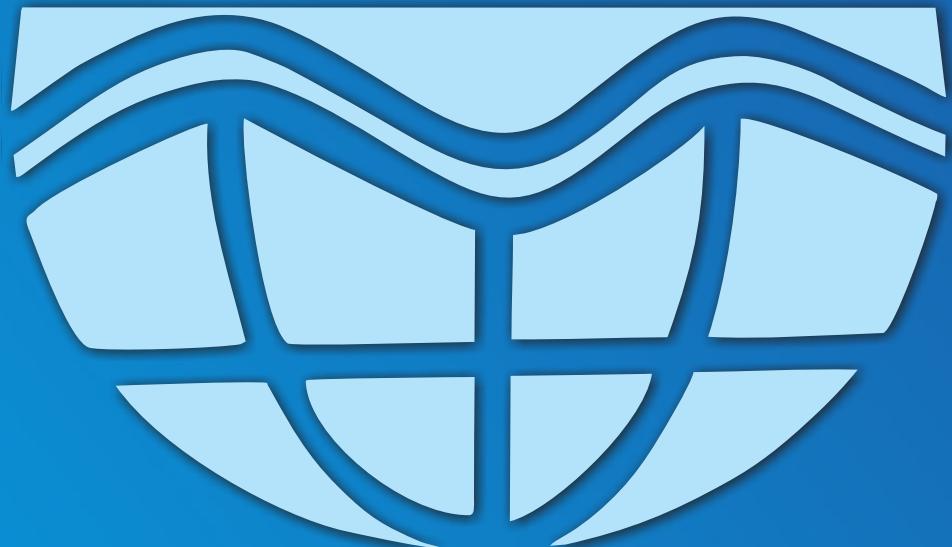


**UTTARAKHAND**



**UEPPCB**

State of Environment (SoE) Report of  
Uttarakhand  
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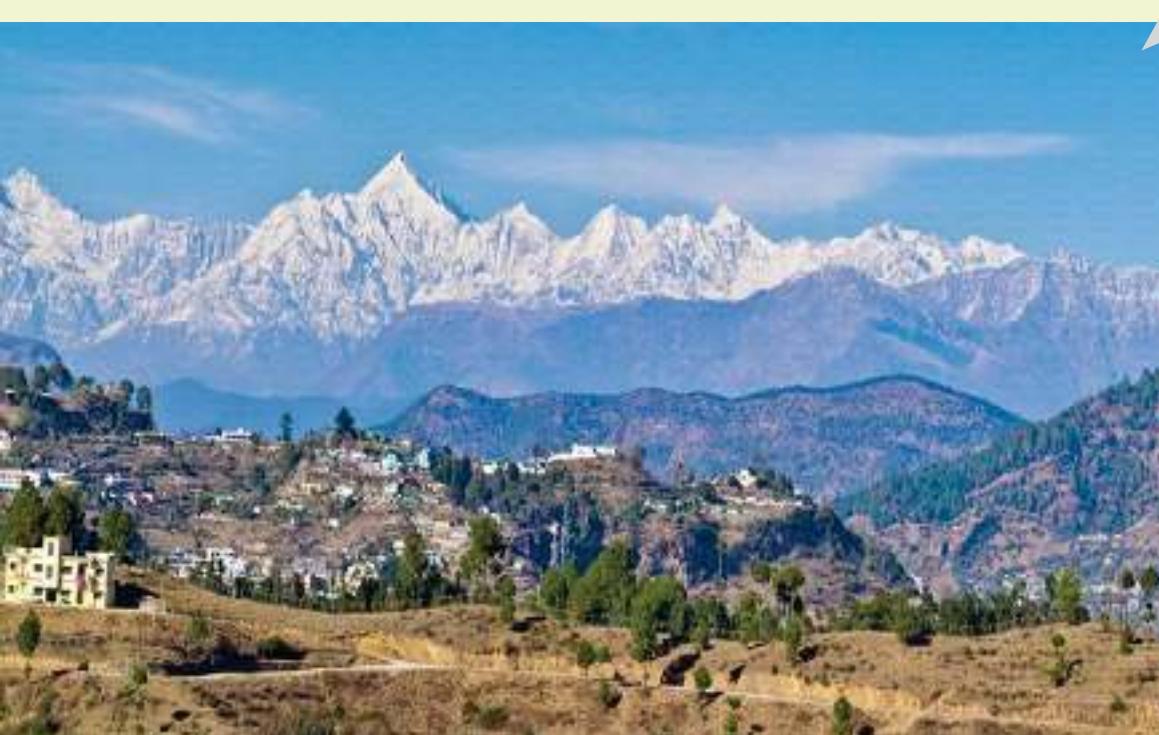
# Uttarakhand- Political Map



# >> Introduction



# 01

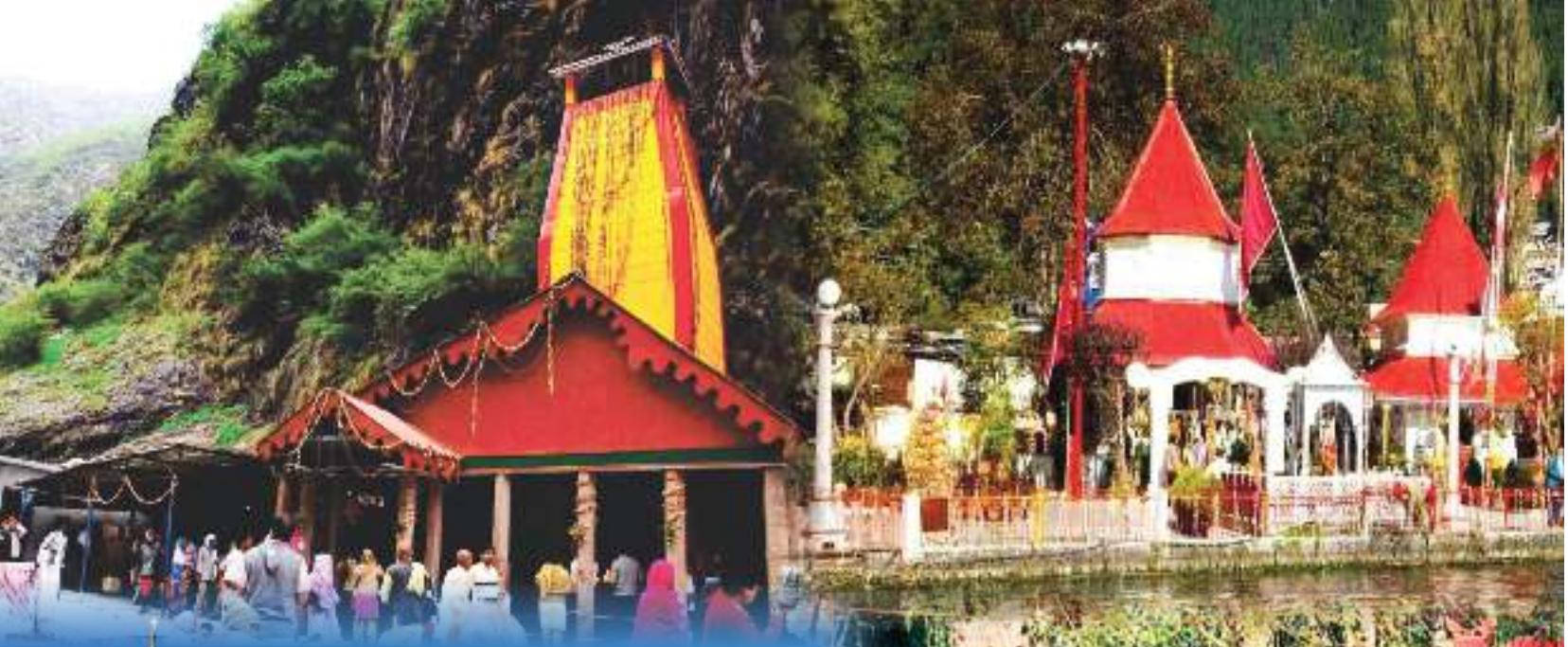


- i) Uttarakhand: facts and figures
- ii) Context of SoE
- iii) Objectives of SoE
- iv) Framework of SoE



Uttarakhand





## i. Uttarakhand: facts and figures

Uttarakhand state was formed on November 9, 2000 as the 27th state of India. The newly formed hill state in the Indian Himalayan Region became a separate state, carved out of hill districts and sub Himalayan regions of Uttar Pradesh. It has two divisions namely Garhwal and Kumaon and 13 districts namely, Chamoli, Pauri, Tehri, Uttarkashi, Dehradun, Haridwar and Rudraprayag in the Garhwal region and Nainital, Almora, Pithoragarh, Udhampur Singh Nagar, Champawat and Bageshwar in the Kumaon region (Fig 1.1). Of these 13 districts, four districts (Nainital, Haridwar, Dehradun and Udhampur Singh Nagar) have large areas in the plains, whereas the other nine districts comprise the hilly region of the state.

Dehradun is the capital of Uttarakhand which is one of the most beautiful resorts in the sub-mountain tracts of India. It is well known for its scenic surroundings. The town lies in the valley called Dun Valley, on the watershed of the Ganga and Yamuna rivers. The geographical location ( $30^{\circ}43'N$  to  $31^{\circ}27'N$  and  $79^{\circ}34'E$  to  $81^{\circ}02'E$ ) of Uttarakhand is unique and it borders the Tibet (Autonomous Region of China) in the north east, Nepal in the east, Uttar Pradesh in the south, Haryana in the west and Himachal Pradesh in the north west. Uttarakhand has a total geographical area of 53,483 Km<sup>2</sup>, of which 93% is mountainous and 71% is forest area. Most of the northern parts of the state are part of Greater Himalaya ranges, covered by the high Himalayan peaks and glaciers, while the lower foothills are densely forested. The difference in altitude between the lowest parts and the highest part (snow peaks of Nanda Devi) is almost 7,800 m.

Uttarakhand mainly has two different climatic regions: the hilly terrain and the smaller plain region. So, the weather is also quite varied, depending on the particular place. Environment in the northern part of Uttarakhand is typically in influence of Himalayan mountain range. This mountain range itself exerts an appreciable extent of influence on monsoon and rainfall patterns. At altitudes over 4,880 m (16,000 feet), the climate is bitterly cold with temperatures consistently below the freezing point and the

area perennially shrouded in snow and ice. The eastern flanks of the Himalayan ranges are subject to heavy rainfall while the western section is relatively dry. Summers, in most of the Uttarakhand are mostly pleasant, but some places do have hot climate. The temperature, in places like U. S. Nagar, Haridwar, Rishikesh, etc. can reach the 40°C mark. Coupled with humidity, this can be pretty uncomfortable. The summer season of Uttarakhand extends from April to June. Winter in Uttarakhand is very cold, with many places receiving regular snowfalls (Chamoli, Rudraprayag, Pithoragarh, Uttarkashi, etc.). Temperature during the winter season ranges from sub zero to about 15°C. The winter season in Uttarakhand generally extends from October to February. During the period of July to September, monsoon season lies in Uttarakhand and temperature ranges from 15 to 25°C at most of the places. The state receives approximately 90% of its annual rainfall in this season. It is also one of the most pleasant seasons of Uttarakhand<sup>1</sup>.

Uttarakhand is one of the best places, visited by tourists and one is bound to notice its beautiful landscapes and the vibrant and laid back lifestyle. The state not only consists of some beautiful landscapes, but it also has a rich heritage and history as well. Places of Uttarakhand are mentioned in the ancient Hindu scriptures as Kedarkhand, Manaskhand and Himavant. Moreover, the state is often called as the Land of Gods (Dev Bhoomi) because of its various holy places and abundant shrines. The hilly regions offer pristine landscapes to the tourists. It's almost all major climatic zones and special environmental conditions making it amenable to various agricultural practices to enhance commercial opportunities in various sectors such as horticulture, agriculture, pisciculture etc. The state is rich in about 175 rare species of aromatic & medicinal plants and it also has a vast tourism potential in adventure, leisure, and eco-tourism. Uttarakhand has more than 27,000 small, medium and heavy industries with an investment of Rs. 20,000 crore and provided employment to around 5 lakh people<sup>2</sup>. Table 1.1 gives the brief idea of basic facts about Uttarakhand.

<sup>1</sup> <http://www.himalaya2000.com>

<sup>2</sup> State at a Glance Uttarakhand, 2015



> Introduction



**Fig 1.1**  
District map  
with divisions  
of Uttarakhand<sup>3</sup>



**Table 1.1: General basic facts about Uttarakhand<sup>4</sup>**

Location	North India
Geographical area	53483 km <sup>2</sup>
Latitude	28° 43' 24" N to 31° 27' 50" N
Longitude	77° 34' 24" E to 81° 02' 02" E
Capital	Dehradun
Physical characteristics	Most of the northern part of the state is covered by high Himalayan peaks and glaciers
Natural vegetation	Himalayan temperate vegetation to the west and alpine and sub alpine vegetation to the east
Official language	Hindi, Sanskrit
State wise area rank	19 <sup>th</sup>
Population (Census, 2011)	1,01,16,752
State wise population rank	20 <sup>th</sup>
Population density	189 Km <sup>2</sup>
State wise population density rank	20 <sup>th</sup>
(Rural) %	69.44
Sex ratio	963 females in 1000 male
Literacy rate	79.63%
State wise literacy rank	17 <sup>th</sup>

<sup>3</sup>hi.wikipedia.org/wiki

<sup>4</sup>State at Glance Uttarakhand (2015); Economic survey 2017-18, Directorate of Economics and Statistics, Deptt. of Planning, Govt of Uttarakhand



Number of divisions	2
Number of districts	13
Number of sub-districts	78
Number of tehsils	110
Number of sub-tehsils	18
Number of blocks	97
Number of nyaya panchayats	670
Number of district panchayats	13
Number of gram panchayats	7956
Number of villages (census, 2011)	16793
Municipal corporations	6
Nagar palika parishads	38
Nagar panchayats	46
Cantonment boards	9
Census towns	41
Vidhan sabha assembly seats	71
Lok Sabha seats	05
Rajya sabha seats	03
State created on	November 09, 2000
Highest peaks	Nanda Devi (Chamoli District) Altitude: 7816 m
Best time to visit Uttarakhand	April to June and October to December
Domestic Airport	Jolly Grant (Dehradun) and Pantnagar
Local major festivals	Basant Panchmi, Vat Savitri, Harela and Bhaitauli, Khatarua, Makar Sankranti, Olgia, Phool Dei
Major Fairs	Kumbh, Jauljibi, Nanda Devi, Uttaryani fair
Tourist Attractions	Almora, Auli, Badrinath, Chakrata, Chamoli, Corbett National Park, Gangotri, Haridwar, Kalsi, Kedarnath, Lansdowne, Mukteshwar, Mussoorie, Nainital, Pauri, Pithoragarh, Rajaji National Park, Ranikhet, Rishikesh, Yamunotri

#### Development Indicators:

**Year 2017-18**

A. Gross state domestic product at current price	Rs. 1,94,293/- Crore
B. Economic growth rate <ul style="list-style-type: none"> <li>i. State</li> <li>ii. District with highest growth rate</li> <li>iii. District with lowest growth rate</li> </ul>	6.82 % Dehradun (7.62 %) Champawat (5.75 %)
C. Per capita income <ul style="list-style-type: none"> <li>i. State</li> <li>ii. District with highest per capita income</li> <li>iii. District with lowest per capita income</li> </ul>	Rs. 1,74,622/- Haridwar (Rs. 2,54,050/-) Rudraprayag (Rs 83,521/-)
D. Share of major sectors in the state gross value added <ul style="list-style-type: none"> <li>i. Primary sector</li> <li>ii. Secondary sector</li> <li>iii. Tertiary sector</li> </ul>	10.50 % 49.74 % 39.76 %



Protected Areas and Conservation Sites	
Biosphere Reserves	1. Nanda Devi 1. Jim Corbett National Park 2. Gangotri National Park 3. Govind National Park 4. Nanda Devi National Park 5. Rajaji National Park 6. Valley of Flowers National Park
National parks	1. Askot Musk Deer WLS 2. Nandhaar WLS 3. Binsar WLS 4. Govind Pashu Vihar WLS 5. Kedarnath WLS 6. Mussoorie WLS 7. Sonanadi WLS
Wild life sanctuaries (WLSs)	1. Corbett National Park 2. Rajaji Tiger Reserve
Conservation reserves	Jhilmil Jheel, Asan Wetland, Pawalgarh, Naina Devi Himalayan Bird
State animal	Himalayan Musk Deer ( <i>Moschus leucogaster</i> )
State bird	Himalayan Monal ( <i>Lophophorus impejanus</i> )
State flower	Brahma Kamal ( <i>Saussurea obvallata</i> )
State tree	Burans ( <i>Rhododendron arboreum</i> )
State language	Hindi, Sanskrit and local Dialects
Major rivers	Ganga, Yamuna, Alaknanda, Bhagirathi, Ramganga, Kali, Tons, Pindari, Saryu, etc
Major industries	Tourism, Floriculture and Horticulture, Agro and Food Processing, Forest Products (Herbs and Spices), Biotechnology, Pharma, Cosmetic and Paper industries, Auto manufacturing, hydro power etc.



#### a. Historical aspects of Uttarakhand

In 1930, during Karachi session of Indian National Congress, demand of a separate state was arrived, that is further taken ahead by P.C.Joshi. (1st General secretary of Communist party 1935-47). The present state of Uttarakhand was earlier as part of the United Province of

Agra and Awadh which came into existence in 1902. In 1935, the name of the state was shortened to the United Province. In January 1950, the United Province was renamed as Uttar Pradesh and Uttrakhand remained a part of Uttar Pradesh before, it came into being on 9 November 2000, the 27<sup>th</sup> state of India. The state was further renamed from



Uttaranchal to Uttarakhand in year 2007.

The earlier historical references to the region are found in the Vedas, paeans to the purity of the Himalayas. Specific mention of the mountains exist in the

Mahabharat, dated to about 1000 BC, when the protagonists of the epic, the Pandavas, are said to have ended their life on the earth by ascending the slope of peak in western Garhwal called Swargarohini-literally, the 'Ascent to Heaven'.





A rare Surya temple constructed  
by the Katyuri Kings in the 9th  
century at Katarmal

**Fig1.2** Highest mountain peak of Uttarakhand, Nanda Devi



The Garhwal Himalayas have nurtured civilization from the week hours of history. It appears to have been a favourite locale for the voluminous mythology of the Puranic period. The traditional name of Garhwal was Uttarakhand and excavations have revealed that it formed part of the Mauryan Empire. It also finds in the 7th century travelogue of Huen Tsang. However, it is with Adi Shankaracharya that the name of Garhwal will always be linked, for the great 8th century spiritual reformer visited the remote, snow laden height of Garhwal, established a math (Joshimath) and restored some of the most sacred shrines, including Badrinath and Kedarnath. The early medieval history of Kumaon is the Katyuri dynasty. The Katuri kings ruled from the 7th to the 11th century, holding sway at the peak of their powers over large area of

Kumaon, Garhwal and Western Nepal. The town of Baijnath near Almora was the capital of this dynasty and a centre of the arts.

In the colonial period, the numerous districts of present Uttarakhand were ruled over by petty hill princes, who owed their loyalties to the British. Garhwal and Kumaon regions were included in Uttar Pradesh but they were culturally and geographically different from people in the plains. Creation of Uttarakhand is infact an outcome of peoples long struggle for survival amidst the extreme conditions of regional economic backwardness and high rates of unemployment. The local people envisaged the political entity of the new state as an instrument to fulfil their aspirations of development and quality of life.



In Uttarakhand, Nanda Devi is the first highest peak of the state at altitude of 7816 m (Fig 1.2). This is also second highest peak of India after Kanchanjangha (altitude 8526 m. The second and third highest peaks of Uttarakhand are Kamet (altitude: 7756 m) and Badrinath (7138 m) respectively. Ganga and Yamuna (origin from Gangotri and Yamunotri, respectively), are two most holy rivers of country originated from Uttarakhand. Jim Corbett national park was the oldest national park of India, established at Nainital district in 1936 for protection of endangered Royal Bengal Tiger (Fig 1.3). It is located in Nainital district of Uttarakhand state and was named after Jim Corbett who played a key role in its establishment. The area of Corbett National Park is 520.8 Km<sup>2</sup> area of hills, riverine belts, marshy depressions, grasslands and a large lake. Jim Corbett National Park offers convenience of elephant and jeep for travel purpose of tourists (Fig 1.4).

The 1970's Chipko Movement, which was a non violent movement was aimed to protect trees and forests from being destroyed by government policies (Fig 1.5). Chipko movement was based on the Gandhian philosophy of peaceful resistance to achieve the goals. Initially people from Chamoli district of Uttarakhand (formerly in Uttar-Pradesh) used to hug the trees and protect them from wood cutters from felling them. The major event in this struggle took place on March 26, 1974, when a group of females in Reni village, Hemwalghati, (Chamoli) acted to prevent the felling of trees and reclaim their traditional forest rights that were threatened by the contractor system of the State Forest Department and transpired hundreds of such grassroots level actions, throughout the region.

**Fig 1.3 Royal Bengal Tiger**



# The Jim Corbett National Park

**Fig 1.4**  
Safaris including elephant and jeep in Jim Corbett National Park, Uttarakhand



**Fig 1.5**  
Historical photograph of Chipko movement in Chamoli, Uttarakhand



Valley of flowers (World Heritage Site) is an Indian national park, located at west Himalaya in Uttarakhand is famous for rarest thousands of varieties of flowers, medicinal plants, etc. (Fig 1.6). Out of seven national parks of early Uttar Pradesh, six parks are now in Uttarakhand. They are Jim Corbett National Park, Rajaji National Park, Nanda Devi National Park, Valley of Flowers, Kedarnath Sanctuary, and Gangotri National Park.



**Fig 1.6**  
Views  
of Valley of  
Flowers, Uttarakashi



The official state seal and other emblems used by the Government of Uttarakhand on all official correspondences are shown in Fig 1.7. Seal of Uttarakhand is a diamond-shaped emblem of white background and blue borders supported by the stylized mountain peaks of the Himalaya with four streams charging from the left to right. It was adopted by the newly formed Interim Government of Uttarakhand at the establishment of the state on 9 November 2000.



उत्तराखण्ड राज्य

a



c



b



d



e

**Fig 1.7**  
The official state seal (a) and other emblems (b: State bird, c: State animal, d: State flower, and e: State tree) of Uttarakhand

**Fig 1.8**  
Tehri dam  
is the highest  
dam of India



#### b. Economical aspects of Uttarakhand

Uttarakhand state is supposed to be the second fastest growing state of India after Madhya Pradesh. Economy is mainly dependent on mineral resources such as lime-stones, copper, graphite, magnesite, dolomite, gypsum, soapstone, rock phosphate, etc., as well as tourism. Mussoorie, Nainital, Almora, Haridwar, Rishikesh, Dehradun are major tourist places/ hill stations. Establishment of various types of industries by State Infrastructure and Industrial Development Corporation of Uttarakhand Ltd. (SIIDCUL) at Haridwar, U. S. Nagar, and Dehradun districts has provided job opportunities to the unemployed youths to some extent and enhanced the economic growth of state. Moreover, due to presence of major and large rivers of India, hydroelectric power generation along with tourism is also a great industry in the state.

Tehri Dam is the highest dam in India (Fig 1.8), is located on the Bhagirathi River, with a height of 261 m and the eighth tallest dam in the world. The high rock and earth-fill embankment dam first phase was completed in 2006 and other two phases are under construction. The Dam water reservoir use for irrigation, municipal water supply and the

generation of 1,000 MW of hydroelectricity. Tehri lake on which the dam is built is attracting tourists as a destination for lots of water sports.

#### c. Social and cultural aspects of Uttarakhand

- **Ethnic:** The Garhwali and Kumaoni are main groups of people, rather than this, Bhotias, Thatus, jaunsaries, Bokshas, Rajies, etc. are other notable ethnic groups of people living in Uttarakhand. Apart from Hindus and Muslims, the state also houses smaller communities of Sikhs, Christians, Buddhists, and Jains.
- **Languages:** The people of Uttarakhand mainly speak Indo Aryan languages, of which Hindi is most widely spoken language. Other languages such as mix of Hindi and Urdu, Garhwali, Kumaoni, Punjabi, and Nepali, are also frequently used. Although regional variations in a language can also be found.

In Uttarakhand as per 2011 census report 43.73 lakhs people speaks in Hindi. The details of spoken languages in the state is given as below:

Mother tongues Language spoken	Number	Mother tongues Language spoken	Number
Hindi	43,73,951	Nepali	1,06,399
Garhwali	23,22,406	Bhojpuri	95,330
Kumauni	20,11,286	Maithili	54,553
Urdu	4,25,752	Tharu	48,286
Punjabi	2,63,310	Tibetan	10,162
Bengali	1,50,933	Bhotiya	9,287
Jaunsari	1,35,698		

- Festivals and other:** Important national festivals celebrated in Uttarakhand are Holi, Diwali, Navratri, Christmas, etc. the festival celebrations are mostly done by participating in fasting, joining the festival processions,

cooking of various kinds of foods etc. Specific festivals that are important in Uttarakhand include Ghughutia, Basant Panchami, Bhituli, Harela, Phool Dei, Ganga Dusshara, Ghee Sankranti, Khataruwa, Vat Savitri Amawas, etc. (Fig 1.9).

**Fig 1.9**

Some festivals of Uttarakhand. Harela (a), Phool Dei (b), Ganga Dusshara (c), Khataruwa (d), and Vat Savitri Amawas (e)



a



b



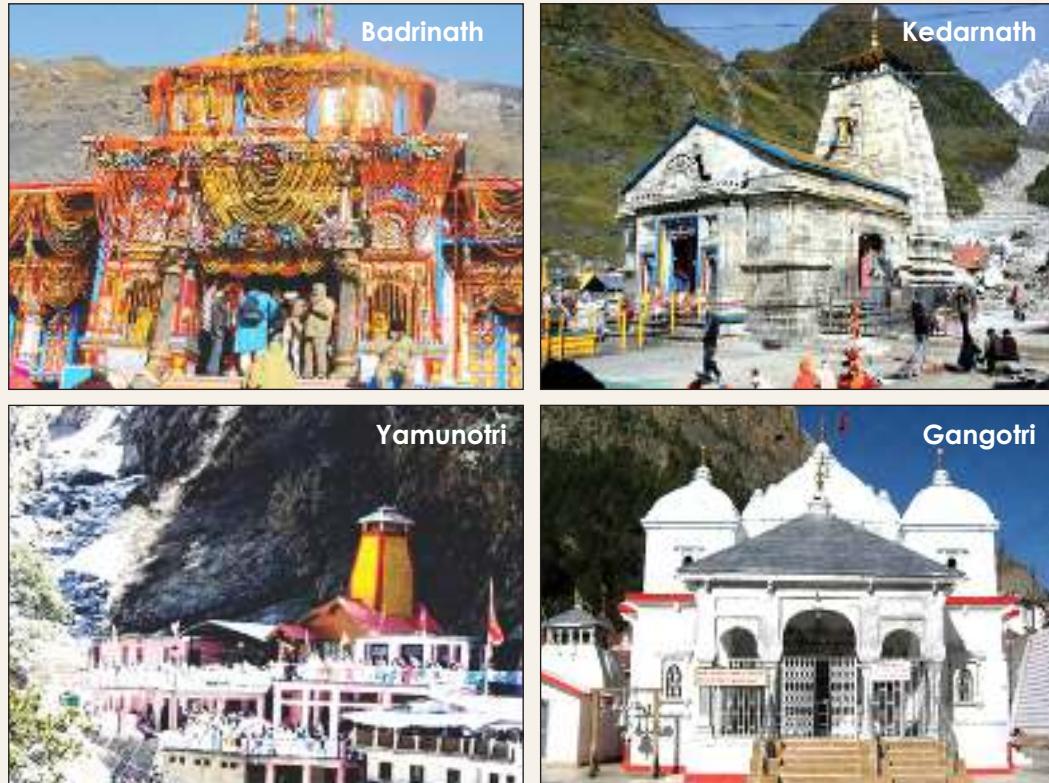
c



d



e



**Fig 1.10**  
Char Dham of  
Uttarakhand  
(a), and Maha  
Kumbh Mela  
at Haridwar (b)



(b)

## > Introduction



Bhetuli is celebrated in Hindi month of Chaitra mid of March to show love of brother/parents to their sister/daughter (mostly who has been married) by exchanging the gifts, sweets and money in between them. Phool Dei is celebrated on the first day of same month, to mark the welcoming of the spring season. In this festival, youthful girls sometimes sing the charming song and spread the sprinkling flowers at the doorsteps. Moreover, the Khataruwa festival is celebrated because of the assumption that it destroys evil influences in lightned bonfire, and also due to the victory of king of Kumaon. Vat Savitri Amawas has approximately same significance as Karwa Chauth i.e, for the victory and good health of husband and children.

Uttarakhand is the only state of India that uses Sanskrit as its second official language. Uttarakhand also called Devbhoomi, due to many religious sites such as Haridwar, Rishikesh, Gangotri, Yamunotri, Badrinath, Kedarnath, ; Patal Bhuvneshwar, etc. specially, Kumbh mela is organised at Haridwar, Kedarnath is one of the 12 Jyotirlingas of Lord Shiva, and Badrinath is one of the Chardham of Hindu pilgrimage (Fig 1.10). Hemkund sahib, also a famous Sikh place of worship is situated at Chamoli district.

### ii. Context of the SoE

Various activities of human being place a big pressure on many aspects of the environment; such as change in water quality, air quality, land quality and its use, ecosystem health and functioning, and some social and cultural matters. Therefore, on a global scale, the United National Environment Programme (UNEP) produced an annual State of the Environment Report from 1973 through 1992, followed by the Global Environmental Outlook (GEO). These reports employ the pressure-state-response framework that has become the most prevalent methodology for state of the environment reporting.

Further, the Organisation for Economic Co-operation and Development (OECD) recommended in 1979 that member countries intensify their efforts to improve scientific

knowledge, information, statistics and indicators: on the state of the environment in order to contribute to the evaluation of the state of the environment; and of activities that have an impact on the environment and environmental policies themselves.

The Organisation for Economic Co-operation and Development (OECD) also recommended that member countries prepare periodic national reports on the state of the environment and its changes over time. A number of OECD countries have given effect to this recommendation. Therefore, there is a need to collect such type of huge environmental data in a place or in the form of a report for the knowledge of state of the environment. The detailed description of each burning aspect of the environment is useful for the government action programmes to reduce or cure the environmental problem.

The need of environmental reporting was also realised in the agenda 21 mandate that was passed in the Earth Summit of 1990 in Rio. Under this mandate, Urban Local Bodies (ULBs) required to undertake the preparation and publication of annual State of Environment (SoE) Report or equivalent to know environment status and predict future policies and planning for environment sustainability and development.

In response to the growing acceptance of the need for dovetailing environmental protection with development, the Planning Commission of India launched in its 10th Plan a nation-wide exercise to prepare State of Environment (SoE) reports for each state and Union Territory (UT) under the aegis of the Ministry of Environment and Forests and climate change (MoEF & CC), as a step towards enhancing the capability of states and Union Territories for handling environmental and sustainability issues. The SoE is the first step in the development of an environment policy and strategy for the state to foster sustainable development. SoE serves to identify the priority areas related to environment and sustainability as well as provide pointers for frameworks to be put in place effectively to manage the environment.



The SoE report also provides understanding about environment and its degradation issues such as over exploitation of natural environmental resources, loss in fertile land and biodiversity, pollution from various industries and solid waste, natural disaster, exploitation of forests and its land for other purposes etc. and suggest various measures and practices for environment protection and sustainable development such as human practices for ecosystem/environment compensation carbon credit and most importantly conservation of natural resources. Since the formation of the Uttarakhand state, there has been a strong focus on infrastructure and economic development, with a recognised need to ensure that the development path adopted does not compromise the local environment. This SoE report can also be able to give the idea about current actions, policies and plans of state government for environment protection and some important recommendations for preparation of future environment related policies and action plans for the practical implementation to protect and to save environment degradation. Therefore preparation of the state of environment (SoE) report is a very important from environment protection point of view, considering both qualitative and quantitative information on the respective topics.

### **iii. Objectives of SoE**

State of Environment report of Uttarakhand is prepared to understand, describe, analyze and communicate information regarding environmental status of the state. SoE report helps to assess the condition of available natural resources as well as the environment. It also envisages the effect of condition of environment on economy, health and lifestyle of human and other living organisms.

#### **Objectives:**

1. To provide data and information of environmental components, status and trends of Uttarakhand state.
2. To create a mechanism for the integration of environmental, social and economic information with the goal of providing a clear picture of the condition of the state.
3. To develop a knowledge about long term ecological, sustainable, social and economic policies, for protection of the environmental components and assess the State's progress towards achieving ecological sustainability.
4. To provide relevant information to the public, government, non-government organizations and decision makers on the state of current environment and future outlook for a region's environment.
5. To report on the effectiveness of the policies and programmes that have been designed to respond to environmental changes, including progress towards achieving environmental standards and targets.
6. To provide early warning of the potential problems as well as allowing for the evaluation of possible scenario for the future.

### **iv. Framework of SoE**

The framework for SoE report of Uttarakhand is the underlying structure which can give idea how one could use to assess the environmental condition of the state. It is very important that it builds on an internationally accepted framework of SoE. The DPSIR (Driving forces, Pressures, States, Impacts, and Responses) is such type of globally recognised framework and is an extension of the pressure-state-response (PSR) model which was earlier developed by Organisation for Economic Co-operation and Development (OECD).



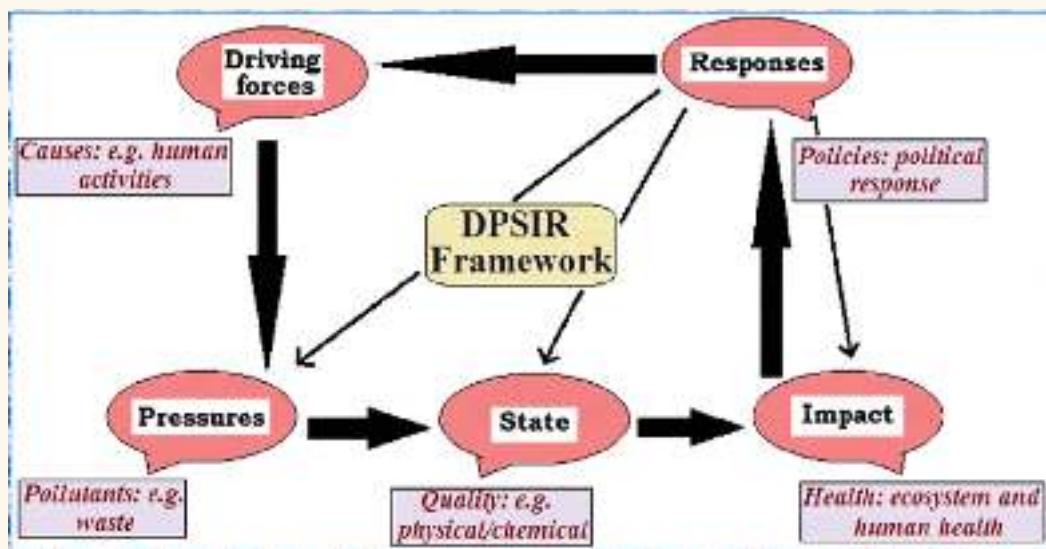
## > Introduction



The DPSIR framework also used for describing the interactions between society and the environment which was developed by the European Environmental Agency (EEA). Fig 1.11 shows the response model of DPSIR framework that is based on EEA 1998. As far as possible DPSIR (D= driving forces of environmental change, P= pressure on the environment, S=

state of the environment, I= impacts and R= response) format which is based on cause-effect relationship between interacting components of the social, economic and environmental systems has been adopted for the preparation of the report. In these reports attempt has been made to draw a baseline based on secondary data.

**Fig 1.11**  
The DPSIR  
assessment  
framework



The environment and interaction of its various components play vital role to sustain life of human and other biotic communities. Therefore, for the government and human community, preparation of SoE report is very important aspect to know current status of environment. This documentation will give brief introduction of important facts, geography, topology, basic environmental conditions, status of natural resources, biodiversity etc. of Uttarakhand state.

The Uttarakhand state is very rich in its varying natural, environmental, historical and socio-economical aspects therefore by using an appropriate frame work (such as DPSIR), it is necessary to prepare a instant note on the each and every environmental conditions.

Further preparation of SoE report of Uttarakhand state is done on following various sections/ (sub) themes:

### From Environmental Assessment to Sustainable Development

- i. Development status
- ii. Driving forces and pressure
- iii. Significant environmental issues
- iv. Environment of concern
- v. Environment: movement and its impact
- vi. Clean production and development



## Land & People

- i. Geological characteristics
- ii. Drainage pattern
- iii. Land resources
- iv. Soil types and its characteristics
- v. Demographic characteristics: decadal population growth; sex ratio; population density; literacy
- vi. Rural and urban population
- vii. Caste stratification
- viii. Women of Uttarakhand
- ix. People and environment

## Forests and Biodiversity

### A. Forests

- i. Status of forests
- ii. Regulatory regime.
- iii. Forests types and characteristics.
- iv. Forest based livelihood.
- v. Government schemes.
- vi. Diversion of forest land.
- vii. People and forests
- viii. Forest related conflict
- ix. Forest fires
- x. National parks, sanctuary and protected areas
- xi. Problems and threat to forest

### B. Biodiversity

- i. Biodiversity profile of Uttarakhand
- ii. Floral biodiversity
- iii. Faunal biodiversity
- iv. Biodiversity and ecosystem services
- v. Biodiversity act, 2002 and its impact
- vi. Medical and aromatic plants/herbs: development in the state
- vii. Government scheme related to medicinal plant
- viii. Traditional health care system
- ix. Institute/agency working in the area of medicinal plants and herbs

## Agriculture and Horticulture

- i. Agriculture and horticulture land use.
- ii. Land holding pattern
- iii. Irrigation network
- iv. Major crops
- v. Organic agriculture, horticulture and floriculture
- vi. Agriculture/horticulture inputs of fertilizers, pesticides and seeds
- vii. Integrated pest management
- viii. Tea cultivation: status and its potential
- ix. Government schemes
- x. Regulatory mechanism
- xi. Livelihood based on agriculture, horticulture & floriculture
- xii. Marketing of agriculture horticulture & floriculture produces
- xiii. Livestock: status and policies
- xiv. Constraints in agriculture, horticulture & floriculture



## > Introduction



### Water Resources

- i. Water sources of Uttarakhand
- ii. Glaciers and recession of glaciers; hazardous related to glaciers
- iii. Riverine network
- iv. Water requirement in Uttarakhand
- v. Water quality of rivers
- vi. Traditional water harvesting systems
- vii. Status of drinking water: quality and quantity and sanitation
- viii. Water management system in Uttarakhand
- ix. Dwindling of perennial water resources
- x. Development of water resources
- xi. Recharge of water sources of spring

### Energy Resources

- i. Energy: status in Uttarakhand
- ii. Energy need: status of national and state
- iii. Installed capacity of energy
- iv. Energy resources: hydropower; wind; solar; biomass based power
- v. Renewal energy: govt. policies and potential and utilization.
- vi. Rural electrification
- vii. Hydropower project and its implications

### Urbanization

- i. Urbanization in Uttarakhand
- ii. Urbanization centres and urban agglomeration: Its trend and possible impacts
- iii. Housing
- iv. Urban slums
- v. Water supply and sanitation
- vi. Air quality of urban settlement
- vii. Status of solid waste management
- viii. Status of bio-medical waste management
- ix. Non-sustainable urbanization: Its impact on environment
- x. Balancing urbanization: need of integrated planning

### Health

- i. Health status
- ii. Health indicators
- iii. Health infrastructure
- iv. National programs and schemes
- v. Ayurvedic and alternative healthcare system

### Transport

- i. Road development in Uttarakhand
- ii. Vehicular population
- iii. Energy and transport
- iv. Road network: Its environmental implications
- v. Alternative mode of transport: rail; air, ropeway etc
- vi. Future transport options



### **Climate Change and its Impact**

- i. Temperature and rainfall
- ii. Snow and glaciers
- iii. Biodiversity
- iv. Streams and rivers
- v. Agriculture
- vi. Health
- vii. Policy and governance

### **Disaster**

- i. Vulnerability of Uttarakhand
- ii. Disaster scenario and management
- iii. Major disaster: fold; landslides; earthquakes; forest fires; road activities
- iv. Disaster mitigation and response
- v. Disaster management: structure in Uttarakhand
- vi. Policies and legal framework

### **Industry**

- i. Industrial development in Uttarakhand
- ii. Present status of industries in Uttarakhand: large, medium and SSI
- iii. Khadi and village industries
- iv. Resource based industrialization in Uttarakhand
- v. Industrial policies
- vi. Environmental impacts of industrialization
- vii. Waste management

### **Tourism**

- i. Tourism in Uttarakhand: status and potential
- ii. Types of tourism: eco-tourism; wildlife tourism; religious tourism; health tourism; adventure tourism; culture and rural tourism
- iii. Economic aspects of tourism
- iv. Environmental aspects of tourism
- v. Government programs and policies

### **Sustainable Development and Environmental Security**





# From Environmental Assessment to Sustainable Development

- Development status
- Driving forces and pressure
- Significant environmental issues
- Environment of concern
- Environment: movement and its impact
- Clean production and development.





# 02

Uttarakhand is blessed with a relatively clean and non-polluted atmosphere. It also enjoys a rare diversity of flora and fauna. Two thirds of the land mass is under forest cover. Several rare species of aromatic and medicinal plants are found in hilly areas of the state. Besides this the state has rich mineral deposits. With a literacy level of 72% Uttarakhand is well above the national average of 65%. Hence, the potential for human resource development is substantial. Several national level technical and educational institutions are located within the state. The state has excellent potential for hydro-power generation. Above all, a peaceful environment exists in the state making it conducive for tourism and industrial development. Indeed, the state of Uttarakhand has prerequisites for rapid industrial development and growth.

Environmental concern is one of the global major issues that can affect the state. To achieve the sustainable development, there is a demand for the integration of environment and development. Thus, sustainable development requires a close collaboration and cooperation between environmentalists and the decision-makers (government). To achieve the sustainable development, study of environmental consequences (both positive and negative) of a particular government plan, policy, or project is highly mandatory. After monitoring various consequences, the proposed work for any environment protection/development programme can be moved in forward direction. This type of study comes under 'Environmental Assessments, (E.A.) and very useful to prepare an Environmental Impact Statement (EIS), i.e. the document that provide information for E.A. In this context Environmental Impact Assessment (EIA) and sometimes strategic

Environmental Assessment (SEA) can be applied to policies, plans and programmes most often proposed by organs of state. Final purpose of environmental assessment is to decide whether or not a project is to be proceeded.

## i. Development status

The geographical area of Uttarakhand is 53,483 sq. Km which accounts for only 1.63 % of India's area. About 4.53% of India's forest and about 3.1 % of India's agricultural area is covered in Uttarakhand. 43.6 % of the state agricultural area is under irrigation as against the national average of 40.3 %. The ratio of irrigated area in the hills and plains of Uttarakhand is 10.2: 88.8. Hill districts are less developed in terms of basic infrastructure development requirements such as electricity, roads, irrigation, education, health facilities, etc., thereby creating a vicious cycle of poverty. More than three-fourth population of Uttarakhand economy is directly or indirectly depends on mountain agriculture for their livelihood. As a result, the majority of the rural population in the hills migrates to other parts of the country for employment and basic amenities and facilities<sup>1</sup>.

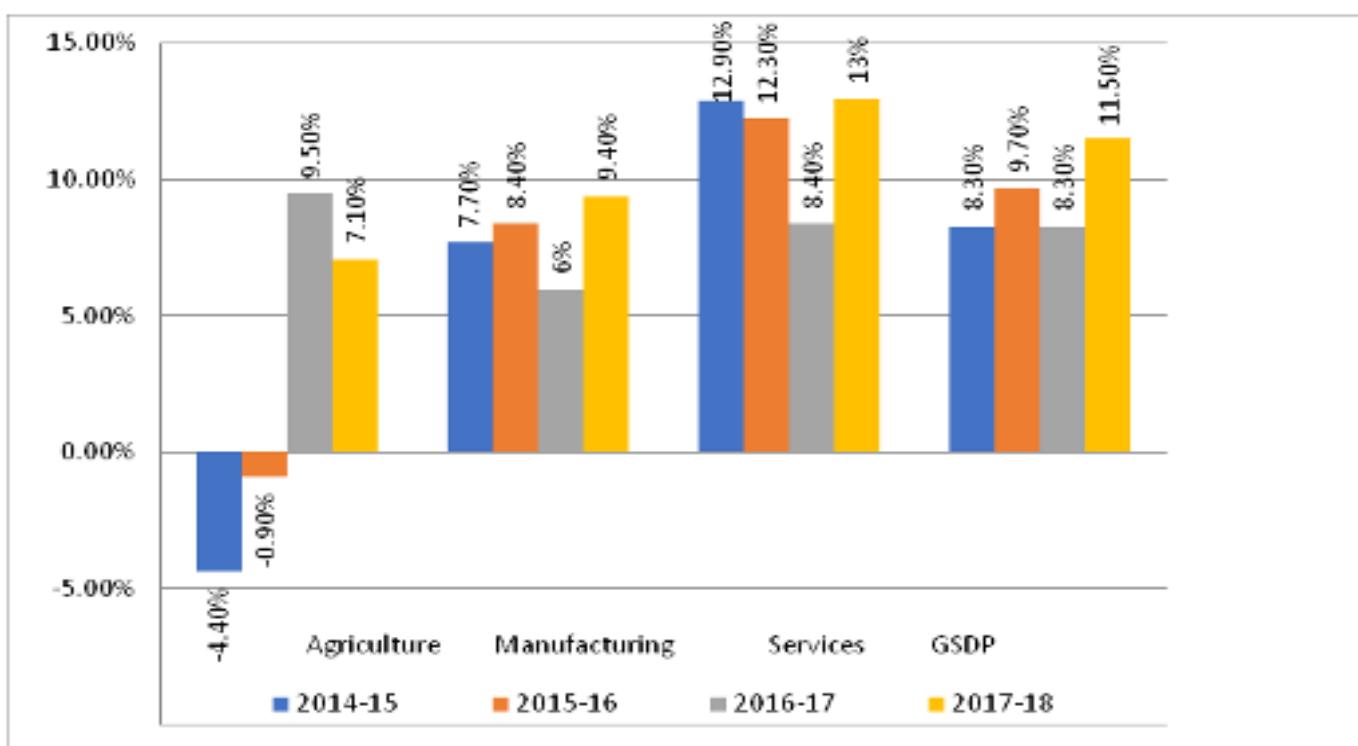


<sup>1</sup>[gbpihedenvis.nic.in](http://gbpihedenvis.nic.in), Central Statistics Office, MOSPI; PRS

❖ After formation of state in year 2000, Uttarakhand produces about 8% of the total output of the old Uttar Pradesh state. The Gross State Domestic Product (GSDP) at current prices has grown at a rate of 9.5% during the period 2013-14 to 2017-18. In 2017-18, the sectors of Agriculture, Manufacturing and Services contributed to 11%, 49% and 40% of the State

Gross Value Added (GSVA) of the state. In the same year, these sectors grew by 7.1%, 9.4% and 13% respectively for Agriculture, Manufacturing and Services sectors. The per capita GSDP of Uttarakhand in 2017-18 at (current prices) was Rs 194,293. This is 10.1% higher than the figure for 2016-17 (Rs 1,76,544) as shown in Fig 2.1<sup>1</sup>:

**Fig 2.1**  
Growth in GSDP and  
various sectors in  
Uttarakhand



❖ Uttarakhand is one of the fastest growing states of India. The massive growth is dependent on capital investments, because of its industrial and sector specific policies, Uttarakhand is able to attract long-term investments. Moreover, due to its hydropower electric potential the state is being developed as 'Energy state'. The industrialization has generated employment and wealth in state but the disaster in June 2013 again put question on sustainable

development. Along with disasters, heavy out-migration from districts of mountain, lack of proper agricultural practices and basic amenities in mountain areas are some basic hurdles in economic growth of Uttarakhand.

- ❖ Due to establishment of industries by State Infrastructure and Industrial Development Corporation of Uttarakhand Ltd. (SIIDCUL) especially in Haridwar, Udhampur Singh Nagar (Pantnagar and Sitarganj), & Dehradun districts; job opportunities and industries have increased but confined to plain areas. Thus, in Uttarakhand development programmes and regeneration of sustainable agriculture is highly required.
- ❖ Tourism is biggest and fastest growing economic sectors with both positive and negative impacts which have significant environmental, social, and economical effects. Uttarakhand is globally recognised by tourists due to its natural beauty and climatic conditions. Plain areas of Uttarakhand are well connected to each other and other states of India by roads, railways and airlines. Although problem arise in hilly areas where only buses and taxies are used for convenience. To achieve global recognition, Uttarakhand government now is focusing on up-gradation of Jollygrant airport Dehradun, Naini Saini Airport Pithoragarh, and Pantnagar Airport Udhampur Singh Nagar; in coordination with Airports Authority of India (Fig 2.2). Bharkot airport Tehri and Gauchar Airport Chamoli are other airports that also need the up-gradation.
- ❖ Especially for the remote and flood-hit hilly areas of the state, Uttarakhand government has announced micro, small and medium enterprise (MSME) policy, which aims to bring inclusive development in the state. The policy used to boost

entrepreneurship and pause outward migration. For this policy, Government of Uttarakhand announced to invest US\$ 16.78 million during 2015-16. It basically aims to utilize local resources and to create employment opportunities for educated unemployed people, promotes self-employment, skill development, training etc. The policy will remain effective till the year 2020. After the insertion of this policy, the Government of Uttarakhand is expecting a growth of 15 % in next few years. The Government of Uttarakhand has also announced the implementation of single window clearance system in the MSME policy introduced in 2015.

❖ The state government is planning to launch a rail project between Rishikesh and Karanprayag. The government will transfer around 300 hectares of forest land to the railways. The ministry of railways is doing its best to comply with the conditions so that work on the 125 km railway line between Rishikesh and Karnaprayag kicks off early.

❖ Software Technology Parks of India (STPI), established in year 2001 at Dehradun, now offers high-speed data communications to IT/ITES companies. There are more such earth stations planned at other locations.

❖ The state government has decided to set up a horticulture marketing board to boost horticulture in the state. Government is



committed to set up of cold chain storage warehouses in every district by 2022, and to use leverage biotechnology for accelerating the economic development by converting its bio wealth into economic wealth.

- ❖ The status of economic development of Uttarakhand is satisfactory with some minor problems. The infrastructure development of state has also been initiated after its creation. More than 78% of its villages are now electrified and have very high percentage of the road a-head villages (Fig 2.3).
- ❖ Uttarakhand Urban Sector Development Investment Program (UUSDIP) is an Asian Development Bank (ADB) assisted program under Multi Tranche Financing Facility (MFF), conceives to support the government of India and government of Uttarakhand in their policy of balanced

regional socio-economic development and poverty reduction. This program works through improvements in urban governance, management/ infrastructure and service provision throughout the urban sector in Uttarakhand. The Government of Uttarakhand is the executing agency for all subproject components of the UUSDIP including both ADB and JNNURM (Jawaharlal Nehru National Urban Renewal Mission) funded components. Furthermore, Uttarakhand Urban Sector Development Agency (UUSDA) acts as an independent autonomous body and will form the Investment Program Management Unit (IPMU) to execute, coordinate and monitor implementation of the UUSDIP in the urban areas of Uttarakhand whose executing agency is Ministry of Urban Development, Government of Uttarakhand.

**Fig 2.2**  
Dehradun  
airport  
(Jolly Grant)<sup>2</sup>



- ❖ Establishment of country's first women industrial parks, exclusively for women entrepreneurs, is other important target of Government of Uttarakhand. For this the

government has allocated 200 acres SIIDCUL land in Udhampur Singh Nagar. In the first phase, a 10-acre industrial park will be started in Sitarganj (Phase-II of SIIDCUL)<sup>3</sup>.

<sup>2</sup><http://www.tribuneindia.com>

<sup>3</sup><http://timesofindia.indiatimes.com>

**Fig 2.3**  
Distribution of villages on the basis of distance from road



## ii. Driving forces and pressure

According to the 'Report of the World Commission on Environment and Development: Our Common Future' by Ms. Harlem Brundtland, sustainable development is very necessary and is defined as 'development that satisfies the needs of the present without compromising the needs of future generations. A 'driving force' is a need for performing the particular development work. In general terms it is defined as the power or energy behind something in the motion or for the development of new process. For example, primary driving forces are the needs that force an individual to search for shelter, food and water, while the secondary driving forces are the needs for mobility/travelling, entertainment etc. For an industrial sector driving forces can be the conditions that responsible for the low cost and profitable production, while lowering unemployment levels could be the driving force for state to grow. Some important points that could seem to be potential driving forces, creates the pressures to sustainable development of Uttarakhand's environmental conditions, are discussed in following section:

**Technological development-** Technology development not only brings powerful influences on economy but also on society, environment and politics. Therefore, development in technology can be a driving force which moves society to another direction for satisfies the essential needs. Development in various areas along with infrastructure development and better education facilities can be a direction for sustainable development of the state.

**Transient environments and geology-** Due to the transient environment and hilly geology, seismicity in Uttarakhand is one of the major pressures for consideration. The entire state is prone to earthquake hazards which are expected in the two highest seismic zones, zone IV and V. According to the seismic zoning map of India<sup>4</sup>, Dehradun, Chamoli, Tehri, Rudraprayag, Pauri, Uttarkashi, Almora, Pithoragarh, Bageshwar, Champawat and Nainital, have PGA (peak ground acceleration) values above 0.4g (gravity), that is an indication of a very high level of seismic hazard to occur in

<sup>4</sup>JAIN, S. K. (2003). Review of Indian seismic code, IS 1893 (Part 1): 2002. Indian concrete journal, 77(11), 1414-1422.

future. These phenomena often result in adverse consequences such as damage to the built environment and loss of life and injuries to people.

**Economic growth in hills and outmigration-** The encouraging high economic growth and development of Uttarakhand mainly centred in three plain districts of the state, while remaining ten hill districts are far behind. Uttarakhand has to

sustain forestry and agriculture for the survival of the people who largely live in rural and hilly areas for normal life (Fig 2.4). Growth of agriculture in rural and hilly areas creates a pressure on government as this is one of the important constraints in these areas. Therefore, there is a need to modify or reschedule the current schemes according to condition of hill districts.

**Fig 2.4**  
Dependency of hill economy on forests and agriculture



Per capita income in Bageshwar, Champawat, Tehri Garhwal and Almora districts is almost half of that in Dehradun and Haridwar districts. A very slow growth in population was reported during the last census in 2011, which showed an absolute decline of more than 17,000 persons in the population of Almora and Pauri-Garhwal districts between 2001 and 2011. The pace of out-migration is so huge that many of the villages are completely left by people. This

depopulation in remote and border areas has raised the panic concern of security to borders of the country falling along with the hill districts of Uttarakhand. This is in fact, a serious policy challenge that deserves immediate attention.

**Entrepreneurship-** Entrepreneur senses the opportunities of economic growth and builds economic organizations to materialize those opportunities (Fig 2.5).

**Fig 2.5**

Rural entrepreneurship is a good option for people living in hills of Uttarakhand<sup>5</sup>

The 4M (Men, Money, Machines and Material) are used by entrepreneur to start or maintain a venture and in a way add to the GDP of the state or Nation. In Uttarakhand state, huge resources and opportunities are available but need perfect entrepreneurs with full of imaginations and courage for their own and society benefit. Moreover, the industrial sector is growing very fast in Uttarakhand as SIIDCUL. Both state and central governments have taken initiatives to boost the entrepreneurial ecosystem. It is realised that entrepreneurship brings the economic growth to the state and ultimately to the country.

**Liberalisation, privatisation and globalisation** are also shown to be the driving forces for sustainable development in Uttarakhand. This LPG phenomenon was first initiated in the Indian economy in 1990 when the Indian economy experienced a severe crisis. Therefore, the government decided to introduce the New Industrial Policy (NIP) in 1991 to start liberalizing the Indian economy.

In Liberalization, it was believed that the market forces of demand and supply would automatically operate with greater efficiency without any interruption of government and the economy would recover. Privatization is closely associated with the globalization and liberalization. When the public sector experienced various problems from government schemes and rules such as low efficiency and profitability, mounting losses, excessive political interference, lack of autonomy, labour problems, delays in completion of projects, etc., the situation can be remediated with Introduction of privatization into the Indian economy. Globalization implies a free flow of information, ideas, technology, goods, services, capital and even manpower across different countries and societies. It increases connectivity between different markets in the form of trade, investments and cultural exchanges thereby important factor for sustainable development.

<sup>5</sup><http://www.euttarakhand.com>

### iii. Significant environmental issues

Uttarakhand state increasingly aware that environmental and natural resource degradation endanger the potential for long-term development. As a result, state is more receptive to the implementation of measures which ensure that development projects take both the environment and natural resources into account. The major mountainous part and the mountains of Himalaya in the state are one of the youngest mountain systems of the world. Due to which the major part of state is ecologically very fragile and relatively much more susceptible to natural disasters such as earthquakes and landslides. Physiographically, Uttarakhand state is divided into three major zones namely, the Himalaya, the Shivalik and the Tarai region. Some key issues that are significantly affecting the ecosystem, environmental or natural resources are as follows<sup>6</sup>.

#### a. Forest protection & forest fires:

Uttarakhand ranked in seventh position among other

states of India in terms of recorded forest area (Fig 2.6). This state is a forest and biodiversity rich Himalayan state with 45.43% of its geographical area under forest cover as per Indian State of Forest Report (2017). In remote areas of Uttarakhand, the day-to-day life of villagers is dependent on the forests nearby. The forest fires are significant environmental issues that adversely affect the forest ecosystem and wildlife. In every summer, hundreds of hectares of forest area are affected by fires. Almost all ( $\geq 90\%$ ) forest fire cases are expected to be caused by human activities. Recently the year 2019 was noted for forest fires in various districts of Uttarakhand in the area of 2521 ha as depicted in Fig 2.7. Lack of moisture in the forests, burning of Chir Pine forests, agricultural fields where agricultural biomass is burned, cigarettes thrown by travellers etc. are some major manmade factors for forest fire initiation. Moreover, the hilly mountains of Uttarakhand makes it very difficult to control fires as such sites are often away from road-head. Many a times there are no foot tracks to reach there.



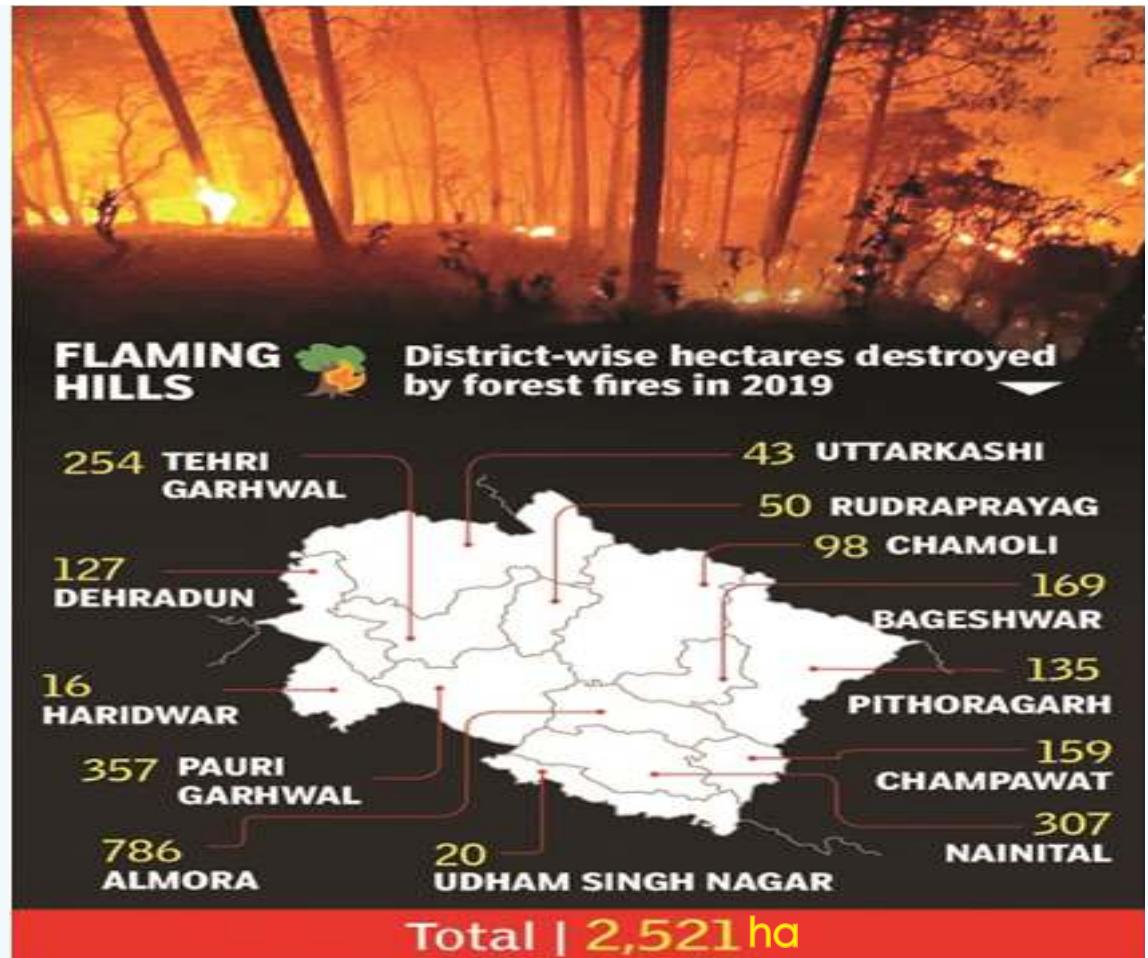
**Fig 2.6**

A very large forest cover area of Uttarakhand<sup>7</sup>

<sup>6</sup>[forest.uk.gov.in](http://forest.uk.gov.in)

<sup>7</sup><http://fsi.nic.in/isfr2017/uttarakhand-isfr-2017.pdf>

**Fig 2.7**  
Forest fire in Uttarakhand responsible for major loss in biodiversity<sup>8</sup>



#### b. Solid waste generation

Non biodegradable wastes such as plastic materials that is used in packaging of food, drinks, mineral drinking water bottles etc. are very common solid wastes in urban as well as remote hill areas of Uttarakhand. These wastes are non degradable and if burnt, release harmful chemicals/gases to the environment. Uttarakhand government has proposed a huge plant at Roorkee (Haridwar) to produce electricity by utilizing various kinds of biodegradable and non biodegradable wastes such as plastics or agricultural residues. Surprising data were reported about the non biodegradable plastic waste generation in and around the

Valley of Flowers (Chamoli) and Pindari valley (Bageshwar) in the year 2005. The non biodegradable waste comprised 84.5 and 66.4% of total generated waste at valley of flowers and Pindari respectively. Thus, non biodegradable waste is comparatively much higher in Uttarakhand mainly due to dumping of garbage by tourists.

#### c. Water conservation

The forests of Uttarakhand Himalayas served as water reservoir and provide a vegetative cover for the major river systems in India. Out of 18 major rivers of India, 12 rivers originated from the Himalaya, but water conservation remains a burning issue in Uttarakhand. According to the

<sup>8</sup>[www.google.com/tbmc=isch&q=fire incident graph in Uttarakhand 2019](http://www.google.com/tbmc=isch&q=fire incident graph in Uttarakhand 2019)

global estimation, 17% of population is suffering from water scarcity. This scarcity is resultant of the fast growing population that result into the high demand of water for industrial and agricultural sectors<sup>9</sup>.

In hilly area, degradation of a large number of natural water sources and springs is observed due to human activities. The involved human activities are mainly cutting of slopes for roads/highway constructions or other irregular activities that negatively affect the natural water resources. The public water supply system is largely not operating correctly due to its inappropriate construction, poor maintenance and distribution problems. These problems have pushed mountain residents, especially women and girls (72% women and 14% children); to store the water. They walk several meters to kilo-meters for bring potable water (Fig 2.10). Data showed that average 60% females have to walk half Km while 10% of them walk 4 Km for fetching water. Furthermore, out of total 16000 villages in state around 8800 villages have been found as drinking water scarce. Especially the districts such as Pithoragarh, Almora, Pauri Garhwal, Tehri Garhwal, and Chamoli are facing challenging drinking water crisis<sup>10</sup>.

In Uttarakhand water quality is also a major problem due to manmade, and some natural contaminations. Plain regions are more prone to water related problems. Additionally, most of the water supply schemes are very old thereby facing severe problems of water contamination.

Several major problems in safe drinking water distribution to mass population of state are described in following points:

- Increased population in certain locations is main factor that is responsible for major water crises and the water pollution.
- Industrialization and urbanization are major causes of water pollution.
- Due to the lack of advanced sewage disposal facilities, faecal waste and domestic waste water is directly disposed off in open sources which

deteriorate the water quality.

- In hilly regions, due to the slope factor, disposal of human and animal excreta directly to rivers, gadheras, lakes etc. pollute water sources.
- Chemical (fertilizer, germicide, insecticide) used in agricultural sector are absorbed in soil and mixed with ground water or directly runoff in open streams lead to the contamination of available water sources.
- Due to difference in geochemistry of different regions and flow of rain water to nearby streams/rivers, water contamination gets increased specially in rainy season.

#### **d. Floods and landslides**

In previous decades a massive cloudburst, rain and landslides have wreaked havoc in the hills of Uttarakhand. Every year heavy rainfall with water disasters were reported in rainy season. June 2013 has been a month of catastrophies in the Garhwal Himalaya in Uttarakhand (Fig 2.9). Many theories and explanations for the disaster have surfaced in the aftermath of the floods in the state. This abnormally high amount of rainfall has been attributed to the fusion of Westerlies with the Indian monsoonal cloud system. During that time a great loss in environmental conditions and communities had occurred. The National Disaster Management Authority said that the road connectivity to 4,200 villages was broken out of which connectivity to 2,865 villages has been reinstated. Around 2,397 houses and 194 bridges were damaged in the floods. According to the official data, missing people count has reached up to 3,500 to 3,700 but over 11,000 people are likely to be missing in the state. After 2013 disaster, floods at hilly area of Garhwal division are considered as most important environment issue that faced by people and continuously in front of people in each rainy season of the year.

<sup>9</sup> Vision 2050, IISWC; Dehradun, [www.cswcrtiweb.org](http://www.cswcrtiweb.org)

<sup>10</sup> <http://hindi.indiawaterportal.org>





**Fig 2.8**  
Hill women  
are bringing  
potable water

#### e. Necessity of Environmental common infrastructure facility

There is a need of safer and sustainable infrastructure facility like hydro power development, tourism and related activities such as roads and building construction. A new approach is required from planning to approvals, constructions and regulation. A Planning Commission Task force has recommended that "The balance between natural resources exploitation and conservation should tilt in favour of nature"



*According to ISRO it was believed that the flood disaster was generated due to large number of landslides in the area because of heavy rainfall between June 16 and 17. The preliminary data shows that a total of 745 landslides occurred along the river valleys of Mandakini, Mandani, Kali and Madhyamaheshwar. The debris created by these landslides was carried along with the flood water and added to the destruction of Kedarnath.*

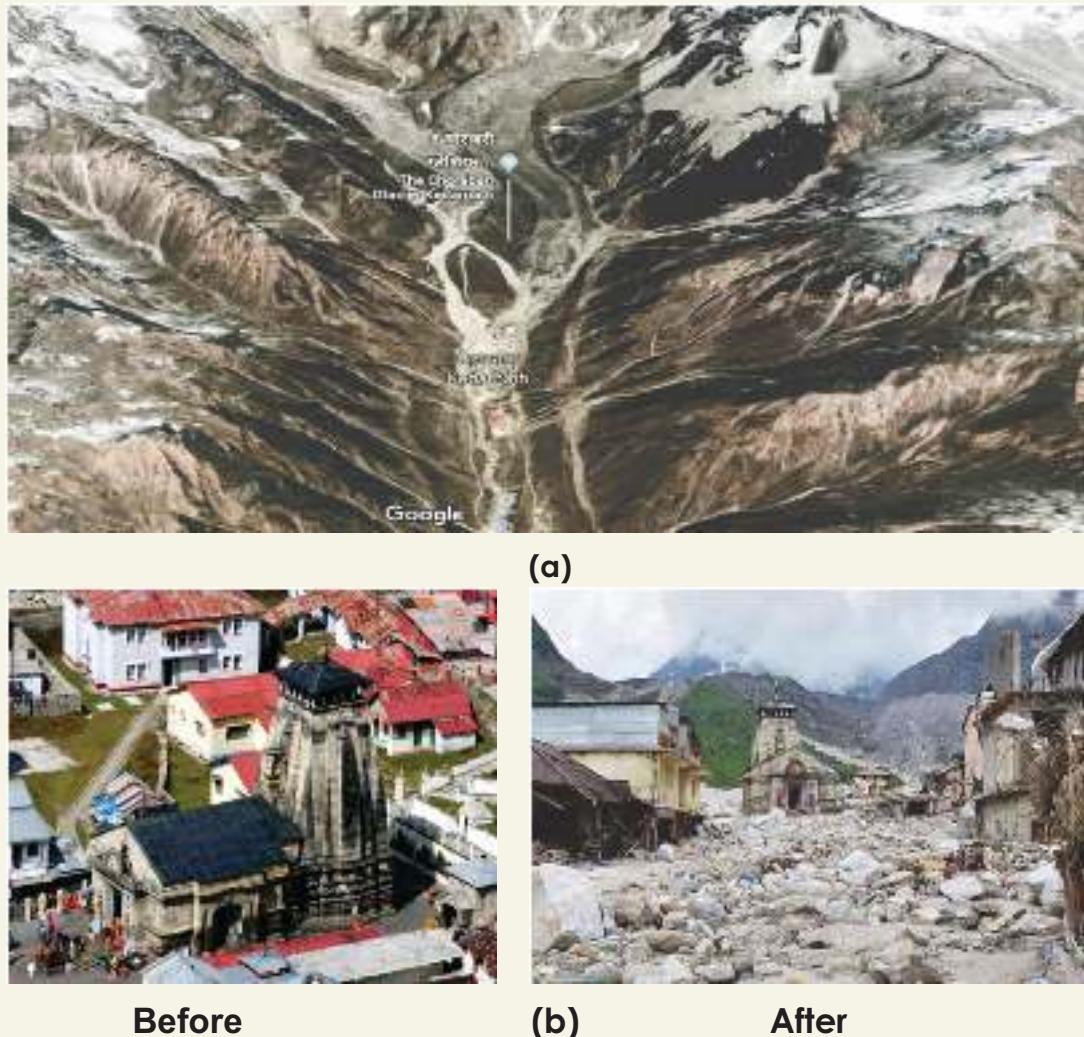
**DISASTER MITIGATION AND MANAGEMENT CENTER** is working as autonomous institute under guidance of department of disaster management government of Uttarakhand. The centre is the apex centre in the field of disaster mitigation & management in Uttarakhand, to protect the community and the environment from the over whelming obliteration caused by disasters. DMMC is responsible for formulating appropriate policies and strengthening their capabilities to cope up with all aspects of disaster management.

In addition to offering an extensive range of training programs, DMMC also spreads-up the latest and advance information about disaster through latest technologies and prepares network of experienced experts and institutions of excellence that are colaboreately working in the field. DMMC will also provide consultancy services to all levels of government, international agencies and non-government organizations.

The centre has also undertook the responsibility to train communities and community based organizations and through them in developing a strong regional knowledge base towards disaster policy, prevention mechanisms, mitigation measures, preparedness, and response plans. Furthermore, Disaster vulnerability assessment is to be incorporated in the state development process by DMMC so that projects and future investments reduce, rather than increase vulnerability. In order to overcome resource constraints, the action plan for disaster reduction is to be incorporated in the overall economic and social development plans thereby making them effective and sustainable.



**Fig 2.9**  
View of Kedarnath valley in 2017  
(a), Kedarnath temple before and after disaster (b)<sup>11</sup>



#### f. Air and Water Pollution

Air and water pollution are globally recognised major environmental issues. For describing and making efforts to minimise these problems, Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) was constructed in year 2002. Although, good air quality index was observed in Uttarakhand, but unregulated and continuous emission of green house gases (GHGs) from various sources, may cause serious environment and health hazards<sup>12</sup>.

CPCB has inventoried and monitored 138 drains in Ganga river catchment where 76 % of the pollution load was contributed by Uttar Pradesh. Whereas most of the rivers that are originating from Himalayas in Uttarakhand are unpolluted near to the origin. The hardness and turbidity is gradually increased in zones of downstream sites but mostly found to be under the permissible limits in Uttarakhand. Although discharging of untreated waste water in these water courses are a serious problems.

<sup>11</sup>google map, google images  
<sup>12</sup><http://airpollutionapi.com>

#### **g. Illegal wildlife trade**

Illegal hidden commercial products that are made from fur, bones, glands, tusks, feathers etc. of some common and endangered species are offered to unsuspecting buyers as souvenirs and local produce. Government and our awareness could really make a difference and help to protect the wildlife resources of the region.

#### **h. Land degradation**

In Uttarakhand state, basically agriculture and forest lands are rapidly converting for other purposes like mining, installation of hydro power station. Afforestation, unplanned urbanization and unorganised infrastructure development are major reason behind diversion of forest and agriculture land.

#### **iv. Environment of concern**

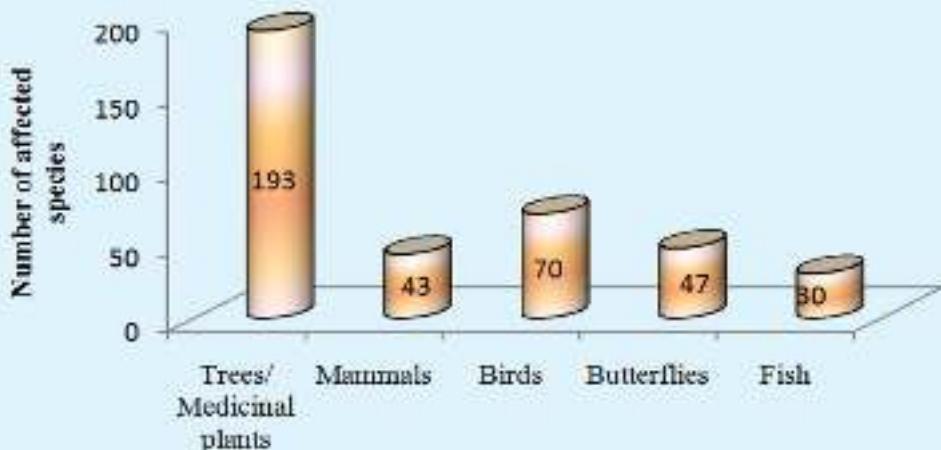
The naturally beautified Uttarakhand has large hilly and forest area with various especial types of environments. Some of these environments are very important to study due to their direct link with environment-related issues.

■ The forests are the most important natural resource for people of Uttarakhand. They provide the base of survival in the mountains such as food, fuel, fodder, and shelter. Total forest area under various classes of the state is 37,999.53 km<sup>2</sup>,

which is 71% of the geographic area. About 19% area of the state is under permanent snow cover, glaciers and steep slopes. Therefore, the area limit under forest is quite satisfactory in the state. The forest quantity is satisfactory, but forest quality improvement is a major aspect of concern. Fires are major problems in forests of Uttarakhand. Moreover, forests were exploited and degraded, while people's needs went unfulfilled. This also affected the floral and faunal diversity present in the forest, and finally to the environment.

■ The man-made big hydroelectricity projects that are made by submerging a very large area (such as Tehri dam, and upcoming Pancheshwar dam) are the artificially created environment to be considered seriously. India will provide fund of Rs 1500 crore to Nepal's Pancheshwar multi-purpose project on Mahakali river. The proposed height of dam is 315 meters. After completion, dam will be the second largest dam in the world with a capacity of 6720 Mega Watt (MW) power production. This project will regulate and control the free flow of Karnali and Mohana rivers which cause floods in Kheri, and Pilibhit districts of Uttar Pradesh and other Terai districts of northern India. About 87 villages of Pithoragarh, Champawat and Almora districts will completely be submerged in Pancheshwar dam lake. Various floral and faunistic spp. also will be in danger after completion of the dam (Fig 2.10).

**Fig 2.10**  
Approximate number of species that will be endangered after construction of Indo-Nepal Pancheshwar dam<sup>13</sup>



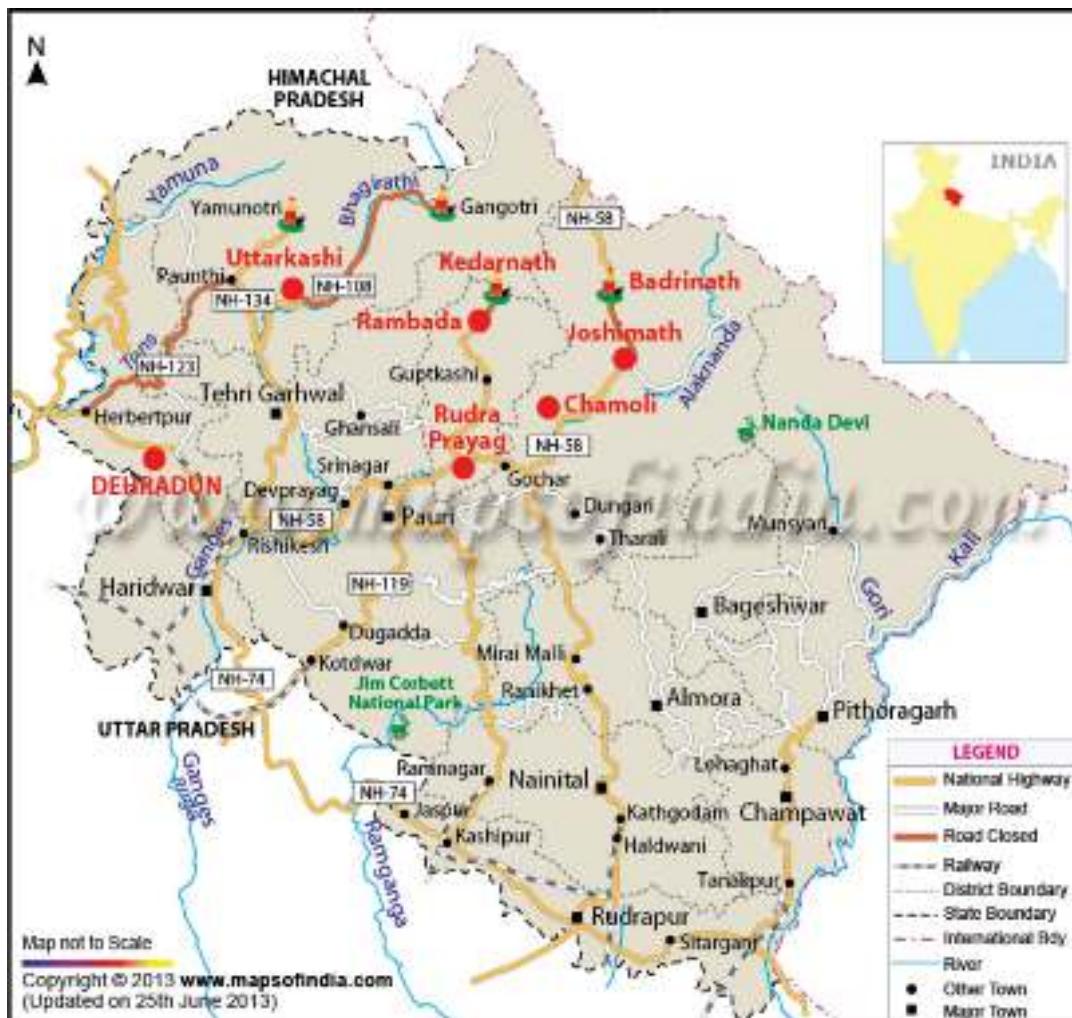
<sup>13</sup>Hindustan, July 20, 2017

■ Same environmental problems are being observed in case of Tehri dam. The dam has a submerged water surface area of 52 Km<sup>2</sup>. Though, such kinds of man-made construction are very beneficial for the nation, but a wide disturbance in environment and its various factors occurred at the site. Such disturbances are some time very harmful to the environment because it disturbs the floral and faunal diversity of very large proportion. Habitat restoration is very important but difficult or some time impossible in such types

of cases. Therefore, practicing re-habitation for such sites to cope up the environment degradation is a good solution to the problem.

■ Floods and landslide prone areas are very important sites to be considered by environmentalist and the government (Fig 2.11). The central and the state governments have to acknowledged floods and landslides in Uttarakhand as potential environmental concerns that perhaps need to be considered with more seriousness.

**Fig 2.11**  
Flood affected  
major areas of  
Uttarakhand  
shown in red



## v. Environment: movement and its impact

♦ The 'Uttarakhand movement' is the events of statehood activism within the state Uttar Pradesh which ultimately resulted in a separate state Uttarakhand of the Republic of India. It is notable that the formation of Uttarakhand was achieved with a very long struggle and heavy sacrifices. 1 September 1994 is considered the darkest day of the Uttarakhand movement on which the Khatima firing case was happened. Subsequently Mussoorie firing case, Rampur Tiraha (Muzaffarnagar) firing case, Dehradun Firing case, Kotdwar case, Nainital firing case, and Sriyantra Tapu (Srinagar) case were responsible for statehood of Uttarakhand in the year 2000. The establishment of the new state led many challenges but ultimately beneficial for the development of the environment status as state government is now able to work on it.

♦ Besides the Uttarakhand movement, other movements such as Rawai movement, Chipko movement, Pani Rakho movement, Rakshasutra movement, and Maiti movement are very important that done for protection of the land, environment and agriculture.

♦ The Rawai Movement was started at the bay of Yamuna river at Teladi field of Rawai area. It had started to take the agricultural land by the villagers of Tehri Riyasat that has already been announced to merge with the forest land by present king Maharaja Narendra Shah. Although king returned the land but the 30th May 1930 was the black day for innocent villagers. With the order of ministers of the king, the soldiers shot fire from three sides. Many people died and many were missed in Yamuna river.

♦ The 1970's Chipko a non violent movement was aimed to protect trees and forests from being destroyed by government policies. Chipko movement was based on the Gandhian philosophy of peaceful resistance to achieve the

goals. Initially in Chamoli district, people used to hug the trees and protect them from wood cutters. In 1987, the Chipko movement was awarded the Right to Livelihood Award. Gaura Devi, Sudesha Devi, Bachni Devi, Sundarlal Bahuguna and Chandi Prasad Bhatt are main persons that actively participated. It is believed that the Chipko movement consisting of nearly 4000 groups to save forest wealth have prevented logging on approximately 10,000 sq. Km. of watershed areas in the Alaknanda basin. This issue gained worldwide popularity as it was discussed in historical 1972 Stockholm conference. The issue was presented again in June 1982 in UNEP meeting in London. This movement also advocate the slogan of planting 5Fs: Food, Fooder, Fuel, Fibre, and Fertilizers. There were also public protests and rallies by Chipko movement from Srinagar to Siliguri a trans Himalayan foot march for protection of forest trees during 1981-1983.

♦ After the Chipko movement, the state government took upon itself the responsibility of protecting the forests, and imposed a ban on felling of trees at a height of more than 1000 metres. Drawing inspiration from their age-old traditions, the villagers of Tehri and Uttarkashi districts again come forward to launch another novel movement known as the Rakshasutra (safety thread) movement to save their forests and environment (Fig 2.12). Like Chipko, women villagers are the main force behind this movement. Some women of Khawada and Dalgaon villages along with a few Sarvodaya workers, undertook an uphill trek of 15 km to stop cutting the trees.

♦ Paani Rakho movement was started by Sachidanand Bharti at Ufer Khal, Pauri Garhwal. By building Dudhatoli Lok Vikas Sansthan, Mahila Mangal Dal, and with the help of youth, the invalid cutting of forests was stopped in the area for water conservation. Moreover, more than 150000 plants were planted by females of the area. Sachidanand Bharti was felicitated by Bhagirath Puruskar on 2015.



**Fig 2.12**  
Rakshya sutra movement for protection of trees



◆ Dunga-Paintoli movement was started at Dunga Paintoli of Chamoli district to save oak tree forest from cutting. The females participated in the movement and finally government returned back their policy to deforestation.

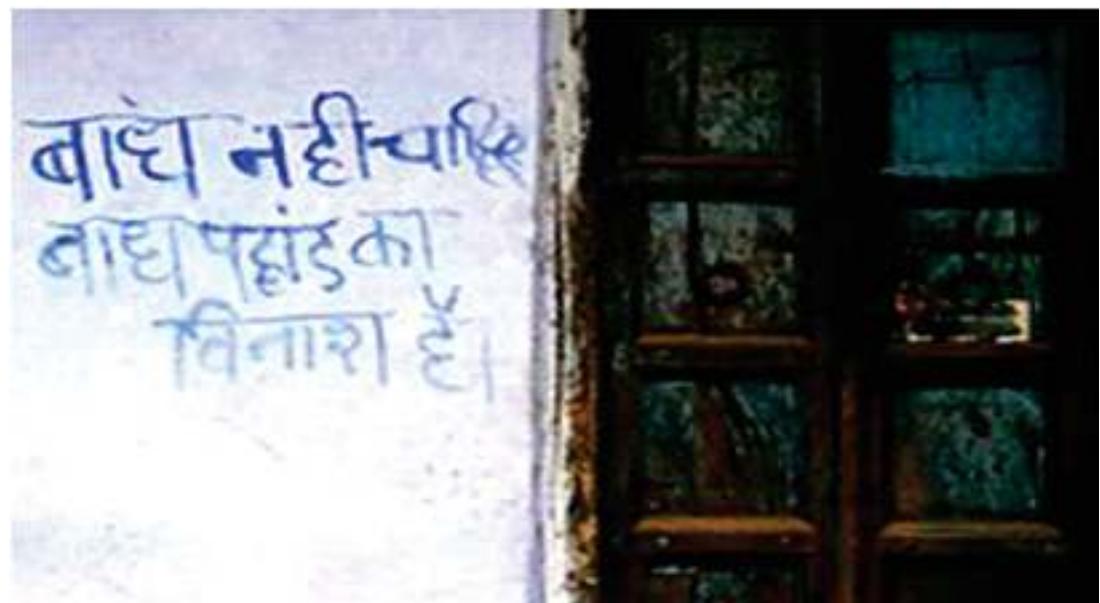
◆ Kalyan Singh Rawat in 1996 has started the Maiti Movement. Maiti is derived from the term 'mait' which in Uttarakhand means married woman's parental home. This

movement does not cost any money, but to plant a sapling by a newlywed girl while she leaves her home on the day of marriage. The parents and family are responsible for care of the plant as it is the memory of their daughter. The movement started as eco-women centric in a small village and spreads its wings across India and all over the world. The message of this movement is very simple: 'For every happy occasion, plant a tree for a beautiful memory'.

♦ Tehri Dam Movement: Environmental activist Sunderlal Bahuguna (active participant of Chipko movement) led the Anti-Tehri Dam movement for years from 1980s till 2004 (Fig 2.13). The protest was against the displacement of town

inhabitants and environmental consequence of the weak ecosystem. This initiated other local protest against the dam, because the Bhagirathi is considered part of the sacred Ganges whose waters are crucial to Hindu beliefs.

**Fig 2.13**  
A protest message against Tehri dam. It says "We don't want the dam. The dam is the mountain's destruction".



#### vi. Clean production and development

The clean production is an environment protective initiative scheme that relies on maximizing industrial production with minimizing waste generation. Basically it depends on analysis of flow of raw materials and energy in a company and one tries to identify options to minimize waste and emissions, sometimes through source reduction strategies. Moreover, technological improvements in a production organisation help to reduce use of materials and energy, thereby minimizing the waste production. Following is the detail of major clean production examples that has been implemented in Uttarakhand state.

#### Sustainable & Environment-Friendly Industrial Production (SEIP)

"Sustainable and Environment-friendly Industrial

Production" (SEIP) is a joint project of the Ministry of Environment, Forest and Climate Change (MoEF&CC) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH within the framework of the Indo-German Technical Cooperation. States selected for this project are Uttarakhand, Gujarat and Delhi. The SEIP project has duration of March 2015 to February 2018 (likely to be extended by one year) and a budget of EUR 6.5 million.

The SEIP project works on selected environmental problems with the main thematic focus on industrial wastewater and solid waste management. The project aims to showcase solutions on how acute environmental pollution can be reduced and how resource efficiency in industrial production can be improved. Project outputs are grouped into 3 areas



- Environment-oriented modernization of industrial areas
- Establishing appropriate framework conditions at the national and state levels, and
- Knowledge management and dissemination.

Uttarakhand is exploring new strategies to make full use of the state's solar energy potential. The state government recently launched a programme for urban households, commercial establishments and business developers to help them to set up small-scale rooftop solar power plants that can be connected to the grid. Households which opt for the scheme will not only get electricity during power cuts from the plant, but can also earn a profit by exporting any excess electricity they generate to the grid. With the help of Uttarakhand Renewable Energy Development Agency (UREDA) around 200 individuals in the state will now be known as 'power farmers' that set up solar power generation plants on their land. Under the scheme, solar power plants will be set up in all the 13 districts of the state in upcoming period. For commercial solar power production in plains, the UREDA office in Dehradun is flooded with over 300 proposals to set up plants in different districts.

Due to the difficult terrain and inaccessibility of many of the remote areas of the state, providing CNG or LPG is a difficult task. However, the cooking and water heating requirements can be met through solar cookers and solar water heaters respectively. The alternative in the form of the use of improved cookstoves could also be lucrative to meet the cooking needs in the villages of Uttarakhand.

#### **Electrical power generation**

Uttarakhand is estimated to have a hydropower potential to the tune of 20,236 MW. The state is gifted by nature with rivers like Ganga, Yamuna, Sharda etc. So it provides an ideal location for hydropower development. However hydro power stations could have strong local impact on the environment and therefore have to be designed after long study of the catchment area, climate, vegetation and related impact of other hydropower stations. Construction of the hydropower projects often involves forest clearance for the structure or for approach roads. Rock blasting while constructing tunnels tend to weaken rock

structures and adversely affects village water recharging springs. Closely located projects from each other tend to divert water away from larger section of the stream channel and severely affect river ecology.

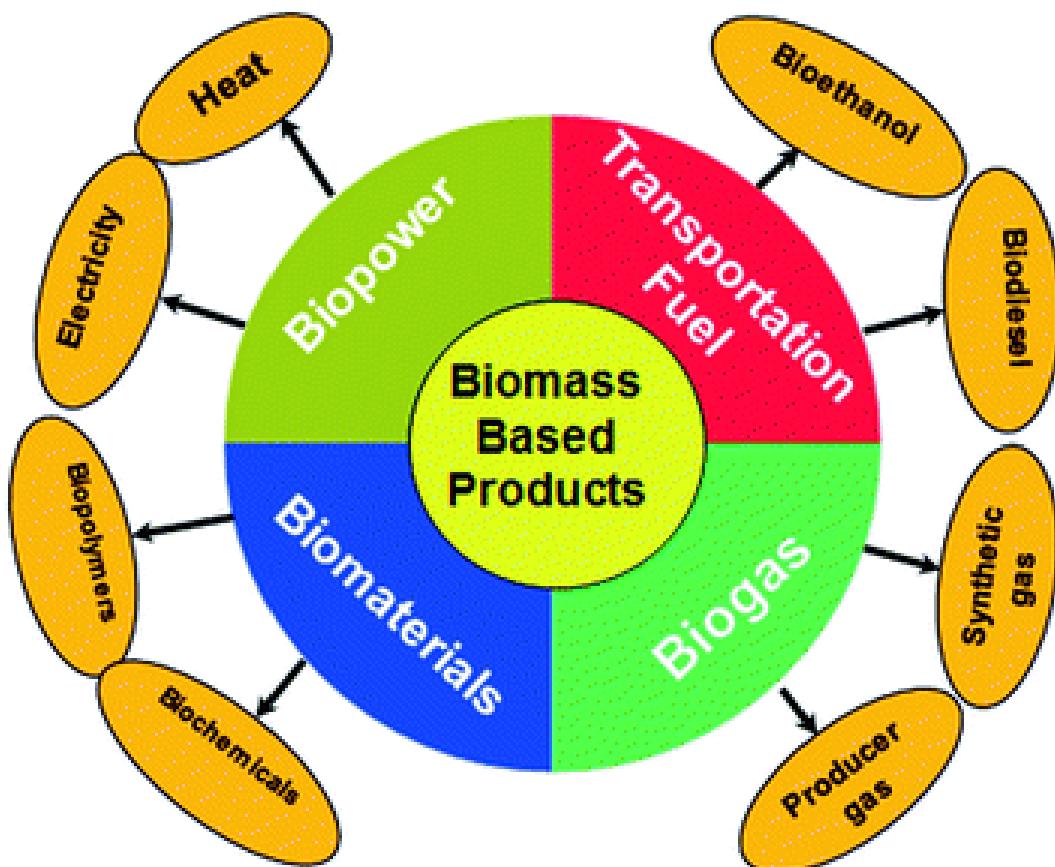
Avani Bio Energy, an NGO working for the sustainable energy generation using pine needles. According to the Uttarakhand Renewable Energy Development Agency (UREDA), the total area of Pine forest in the state is about 3.43 lakh hectare. These pine forests produce about 20.58 lakhs tonnes of dry biomass every year in the state. The company provide power supply using the locally available pine needles for power generation using biomass gasification technology for its conversion into electrical energy. This also minimizes the forest fire hazards in summer season due to pine needles burning. In 2009, they set up its first small scale gasifier of 9 kW capacity in its campus at Pithoragarh. The electricity generated through the biomass gasification plant sell to the state grid through a 20 year power purchase agreement between Avani and Uttarakhand Power Corporation Limited (UPCL).

#### **Biogas Project**

This clean energy project envisages the construction of 3,000 Deenbandhu model biogas plants in households in rural areas in the state of Uttarakhand. The project is envisaged for a span of 7 years from 2014 to 2020 and is currently in its implementation stage. The goal of the project is to enhance climate resilience and quality of lives in rural households in Uttarakhand through deployment of clean energy technology in the form of biogas digesters.

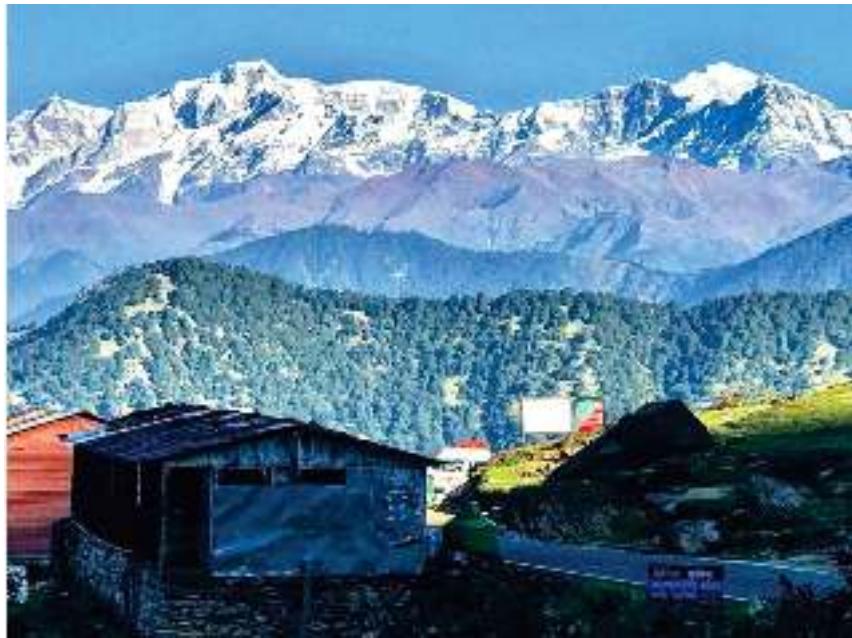
#### **Biofuel project**

Government of Uttarakhand has established India's first second-generation (2G) ethanol plant at Kashipur in year 2016 with a capacity of 10 tonnes of biomass conversion per day. The technology is suited for both Indian and global needs and it is projected to be capable of converting all types of agricultural residues like bagasse, rice and wheat straw, bamboo, cotton stalk, corn stover, wood chips to ethanol in less than 24 hours, with optimum product yields. The bioethanol is the clean liquid fuel that can be utilised as such or by blending with the petrol. The blend reduces the green house gas emission as ethanol is a renewable energy source.



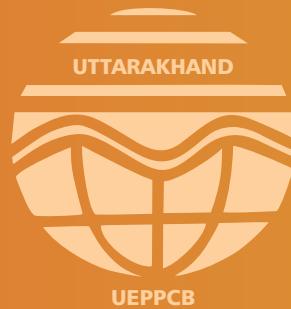


# Land and People



- i) Geological characteristics
- ii) Drainage pattern
- iii) Land resources
- iv) Soil types and its characteristics
- v) Demographic characteristics: decadal population growth; sex ratio; population density; literacy
- vi) Rural and urban population
- vii) Caste stratification
- viii) Women of Uttarakhand
- ix) People and environment





### I Geological characteristics

The Uttarakhand land comes under lesser Himalayan part. The slope of hilly areas of state is formed by sound rock of quartzite, limestone and phyllite. U-shaped and V-shaped valleys are generally found in this state. Physiography of Uttarakhand is divided into two distinct physiographic regions.

1. Himalaya in the North
2. Indo-Gangetic plains in the South

The region of Himalayan segment is 2500 km long and about 250 km wide with belt of mountain ranges which

stretches from Nanga Parbat in J&K in west to Namcha Barua in Tibet in the east. The Himalayan region has been divided into four linear east-west trending physiographic zone such as outer or sub-Himalaya, lesser Himalaya, the great Himalaya and the Tethys Himalaya.

Sub-Himalaya is the southern most part comprising chiefly of cenozoic sediments and is also called as Shivalik range (Fig 3.1). It arises from the Indo Gangetic plain along HFT (Himalayan Frontal Thrust) and is limited by lesser Himalaya along MBT (Main Boundary Thrust) in North and largest portion extending from Kalsi in the west to Ganga valley in the East.



**Fig 3.1**  
Shivalik range  
of Himalayan  
region

The lesser Himalayan region lies between the sub Himalayan in the south and the great Himalayan in the north. It attains a height between 1200 m to 3000 m.

The Great Himalayan region is a narrow zone lying between the lesser Himalayan region in south and the Tethys in the north and made up of archean paleoproterozoic sequence constituting the central crystalline and mesoproterozoic formation, which forms the basement for phanerozoic succession of the Tethys Himalaya. The Great Himalaya varies between 4800m to 6000m. These zone have snow bound peaks and number of glaciers.

The Tethys Himalaya is the northern most division of the Himalaya that passes from the great Himalaya and lies to its south. Tethys Himalayan zone and trans Himalayan zone in

north is separated by Indus Sanpo Suture zone from the traces of Himalayan zone in the north. Tethys Himalayan zone in north is chiefly made up of phanerozoic rocks and is characterized by anticlinal and synclinal valleys. The altitude of Tethys Himalayan region is 3500 m to 4800 m.

- **Indo-Gangetic Plain**

It is the largest alluvial plain in the world with an area of 7,00,000 Km<sup>2</sup>. Out of which 2,23,000 Km<sup>2</sup> lies in UP and 5326 km<sup>2</sup> of it lies in Uttarakhand. This region is referred as the Ganges Plains. The plain forms a featureless undulatory surface with an average gradient of about 34 cm/Km towards south east UP (Fig 3.2).

**Fig 3.2.**  
The Indo-Gangetic plains



- **Geomorphology**

Geomorphology provides information regarding the origin and evolution of topographic and bathymetric features created by physical, chemical and biological process operating at or near the earth's surface. In the state, Bhagirathi river originates from Gangotri Glacier in Gaumukh and the Alaknanda river originates from Satopanth Bhagirath Kharak group of glaciers of Himalaya form 'U' Shaped valley in their upper reaches. This U shaped valley includes:

- i) Lesser Himalayan Seismic Block: It is crustal block laying between the MBT in the south and MCT (Main Crustal Thrust) in the north has highest seismicity level with source faults. The epicentral location in this block is concentrated close to MCT.
- ii) Frontal Hill Seismic Block: This crustal block lies to south of MBT upto HFT and beyond this its include a number of thrusts and transverse team faults in the foothill belt. These longitudinal and transverse fault surfaces are neotectonically active.

The landforms in area of Uttarakhand are structural, glacial and fluvial in origin. Common geomorphic features are the cliffs, rocky slopes, waterfalls, major and minor ridges, quaternary deposits along the hilly slope, the river terraces and various fluvial geomorphic features like point bar, meandering scars, natural levees terraces.

- **Geology**

The Uttarakhand hills form the easternmost part of the western Himalayas. The geology of this region resembles that of Himachal Pradesh in the west and Nepal in the east. The main difference between the geology of Himachal Pradesh and Uttarakhand is that in Himachal Pradesh the tethyan zone is very well developed as compared to this state.

Uttarakhand Himalayas is divided into:

- i. Shivalik Himalayas or Sub Himalayas
- ii. Lower or Lesser Himalayas
- iii. Central or Higher Himalayas
- iv. Trans or Tibetan or Tethyan Himalayas

### 1. Shivalik Himalayas or Sub Himalayas

The Shivalik range runs more or less parallel to the lesser Himalayan range and this sub Himalayans rock sequence developed in Dehradun area where section are exposed around Mohand, Kansrao, Motichur, Rishikesh and Haridwar area etc.

The following succession occurs in the Shivalik range of Uttarakhand.

#### a) Upper Shivalik-

1. This contains boulder conglomerates, coarse conglomerates, sand grits and clays.
2. Pinjori stage consists coarse grits, conglomerate and sandstone
3. Tatrot stage comprises soft sandstone, conglomerate and drat clays

#### b) Middle Shivalik

1. Dhok pathan stage is the top most stage of the middle Shivalik made up with brown sandstone gravel beds, drabshales, orange days and clay stone.
2. Nagri stage underlies the Dhok pathan stage which consists of grey hard compact sand stones associated with grey, green and muddy shade.

#### c) Lower Shivalik

- Chinji stage is the uppermost stage of lower shivalik which is formed by bright red to maroon shales and sandstone with intercalations of siltstone.
- Kamlial stage underlies the chinji stage is hard, compact red or grey sandstones and people shales accompanied by pseudo - conglomerates in lower Shivalik region.

The boulder conglomerates jam the top most horizon of the Shivalik rock sequence.

They comprises of a thick deposit of conglomerates derived from the lesser and main Himalayan rocks lying towards the north. The conglomerate occurs in a matrix of fine material.





### d) Post Shivalik

Recent to sub recent deposits have been laid down over the Shivalik. These are primarily gravels and are known as the dun gravels in Dehradun valley.

### 2. Lower or lesser Himalayas

The geology of the lesser Himalayas of Uttarakhand is very complex and classified in the following group.

#### a) Kumaon Group

The rocks of this group lie immediately to the north of the main central thrust. They are of pre Cambrian to Cambrian age. The Kumaon group is well exposed in various parts of both Garhwal and Kumaon.

The Saknidhar formation is exposed at the base of the Kumaon group. This formation is very well exposed in the Ganga valley of Garhwal at Sakindar near Deoprayag. It consists of limestone, shales and quartzites. Near Nainital this formation has been intruded on by Amritpur granite. It is considered to be equivalent to the Shimla slates of Himachal Pradesh. The Chandpur formation overlies the Saknidhar formation. It comprises a thick sequence of dark grey, green,

maroon and purple green coloured phyllites, slates and shales.

The nagthats are conformably overlain by a thick sequence of phyllites rock in the southern limb of the dudatoli syncline in Almora. This is known as the manila formation.

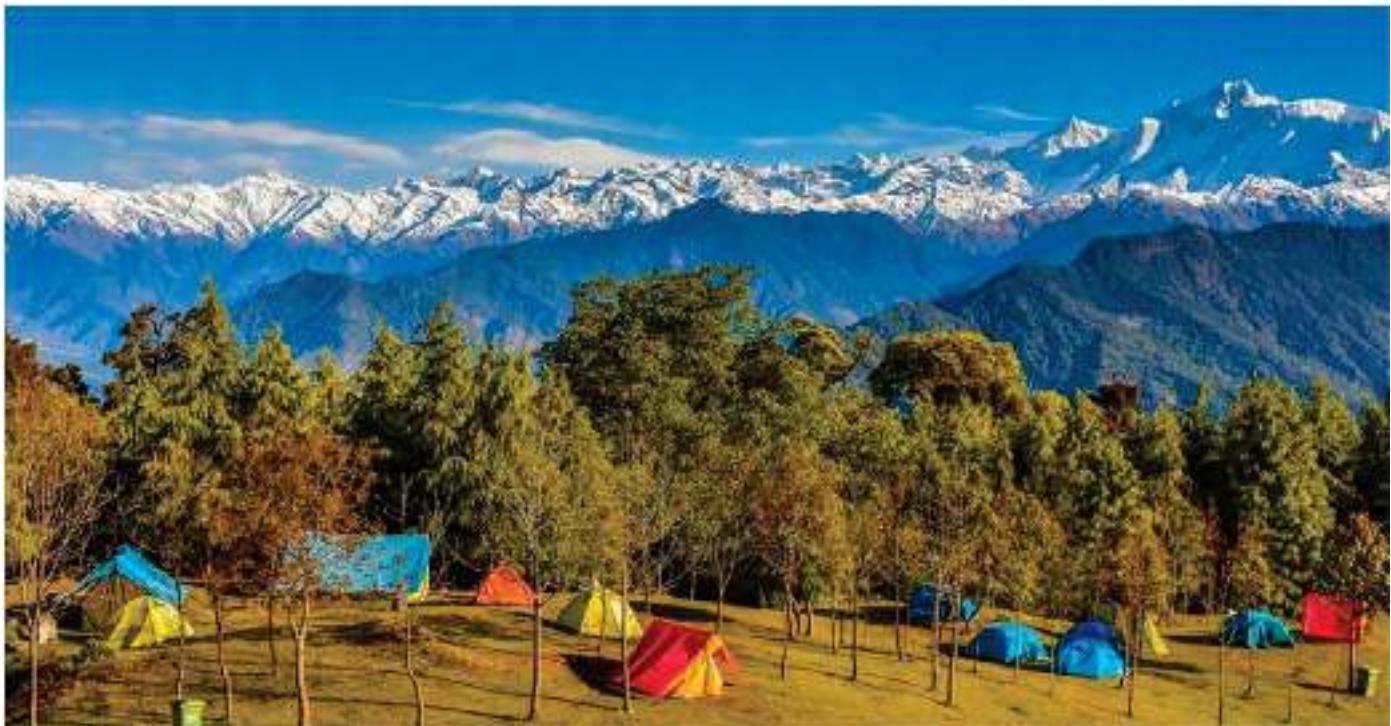
#### b) Garhwal Group

**The Rudraprayag formation is the lowest member of the Garhwal group and come under lameri formation which comprises** of following sequences:

- i) Slate–chert sequence – Black, grey coloured slates cherts and grey quartzites
- ii) Rudraprayag Quartzite- A thick sequence of medium grained compact, massive and greyish white to white coloured quartzites.

Lameri formation includes:

- i) Lameri A – This layer of black coloured slates and chert in association with dolomitic bands.
- ii) Lameri B – This layer is made up of Black pyritious shales, ash grey slates
- iii) Lameri C –It comprises of dolomites, phyllites cash



- iii) Basal quartzites: – greyish to white coloured basal cherty dolomitic quartzite.

#### c) Krol formation

This formation is well developed throughout the lesser Himalayas of Garhwal and Kumaon it consist of the following members.

Krol E – Mainly argillaceous limestone pocket of barite.

Krol D – Sulphurous cherty limestone and occasional pocket of barite

Krol C – Thick sequence of limestone mixed with dolomite

Krol B – Red maroon and green coloured shales with sporadic occurrences of gypsum

Krol A – Limestone, cellulite and calcareous shale  
Infra Krol – Grey shales, slats, greywackes, siltstone etc.

#### d) Tal formation

This formation lies over Krol E member. It is well developed in the Mussoorie syncline on top of the Mussoorie ridge. The tals may further be subdivided into:

- i) Upper tals consist mainly quartzite with association of limestone.
- ii) Lower tals consist purple, red, maroon, black and green coloured shales, phyllites etc.



Swargarohini peaks in Garhwal Himalayas (Uttarkashi)



Panchachuli peaks in kumaun Himalayas (Pithoragarh)

### **iii. Central or Higher Himalayas**

The central Himalayan rocks of Garhwal – Kumaon can be studied in 3 distinct belts viz, the Garhwal belt, the Kumaon belt and the lower sedimentary belt.

#### **a) Garhwal belt**

Swargarohini peaks in Garhwal Himalayas (Uttarkashi) The main central thrust separates the rocks of the Garhwal belt from those of the lesser or lower Himalayas from south to north, the following rock types constitute the Garhwal belt.

- Granular Gneiss
- Badrinath Granite
- Black Schistis

#### **b) Kumaun belt**

The belt comprises the following rock type from south to north.

- Amphibolitic silts
- Gneiss and quartzite
- Sedimentary section of sirdang

- Quartzite and lime silicate
- Budhi-schists

#### **c) Lower sedimentary belt**

Lower sedimentary belt extends from the Garhwal region in the west to beyond the Kali river marking the eastern boundary of the Kumaon Himalayan. This belt comprises the following rock type:

- Slate
- Siltstone
- Greywacke
- Protoquartzite
- Phyllite
- Limestone

### **iv. Tibetan or trans or Tethyan Himalayas**

The tethyan zone rocks are well developed in Malla, Johar Darma and other parts of northern Pithoragarh. The succession of tethyan rocks in Garhwal – Kumaon region is given in Table 3.1.

<b>Age</b>	<b>System/series/formation</b>
<b>Jurassic</b>	Laptal series
<b>Triassic</b>	Kioto limestone
	Kiots limestone
	Kuti shales
	Kalapani limestone
	Chocolate series
<b>Permian</b>	Kuling shales
<b>Middle to up devonian</b>	Muth series
<b>Carboniferous</b>	Kali series
<b>Silurian</b>	Variegated series
<b>Silurian</b>	Variegated series
<b>Ordovician</b>	Shiala series
<b>Cambrain</b>	Garbyang series
<b>Pre Cambrian</b>	Vaikrita system.

**Table 3.1**  
Succession  
of tethyan  
rocks

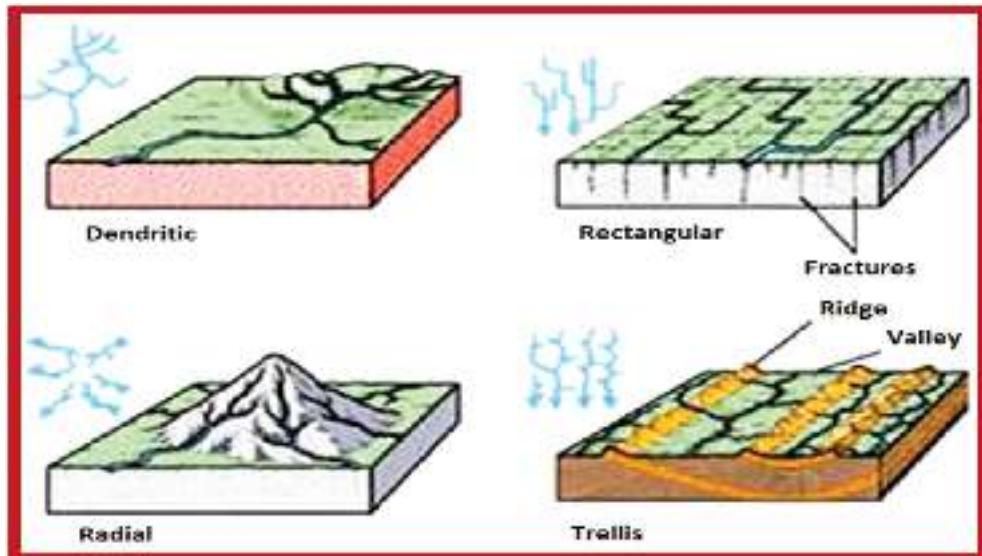
## ii Drainage pattern

Drainage patterns are formed by the streams, river and lakes in a particular drainage basin. They are governed by the topography of the land whether a particular region is dominated by hard or soft rocks and gradient of land. For achieving sustainable and efficient land and water management, drainage is as important as are surface and ground water based irrigation system. Lack of appropriate drainage results in water logging on surface and under the ground.

Fig 3.3 represents the drainage pattern of river in Uttarakhand.

- I. Dendritic pattern: This pattern follows the tree like branches. The river of northern plains are dendritic in pattern.
- II. Radial pattern: river originates from hill and flow in all the directions.
- III. Trellis pattern: when primary tributaries of river flow parallel to each other and secondary tributaries join them at right angle, the pattern is known as trellis pattern.
- IV. Rectangular: when river and their tributaries display many right angle bends in all the direction in a lake the pattern is called rectangular.

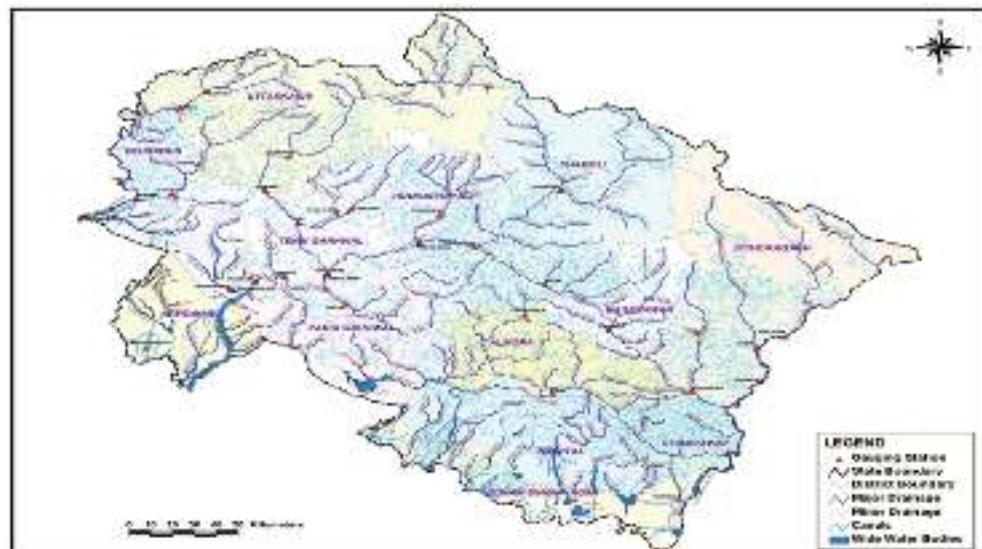
**Fig 3.3**  
Type of drainage pattern in Uttarakhand



There is long geographic history of drainage system in the state. It includes mainly the Ganga and the Yamuna river basins. Both rivers are fed by melting of snow and

precipitation and they are perennial in nature. The following are the major river flow system in the Uttarakhand (Fig 3.4).

**Fig 3.4**  
Drainage pattern map of Uttarakhand



#### a) Ganga River Flow

Ganga is the holy river of India. It has its own basin and cultural significance. Ganga originates from Gangotri Glacier near Gaumukh at the height of 3,900 m above MSL in Uttarkashi district of Uttarakhand, where it is known as

Bhagirathi. At Devprayag, Bhagirathi meets the Alaknanda, and from there it is known as the Ganga. Alaknanda arises from Satopanth Glacier above Badrinath. Alaknanda is formed by the combination of Dhauliganga and the Vishnu Ganga which meet at Vishnupryag near Joshimath.

The tributaries of Alaknanda such as the Pindar join it at Karna Prayag while Mandakini meets with Alaknanda at Rudraprayag. Ganga enters the plain at Haridwar and from this place it flows first to the south, then to the south east and cover a distance of 2525 Km.

Ganga flows from Uttarakhand (110Km), U.P. (1450 Km), Bihar (445 Km) and West Bengal (520 Km). The Ganga basin spreads in large area, occupies and covers about 8.6 lakh Km<sup>2</sup> in India alone. The Ramganga, the Gomati, the Ghaghra, the Gandak, the Kosi and the Mahananda are the left bank tributaries, while the Son is its major right bank tributaries. Finally River Ganga discharge itself into the Bay of Bengal near the Sagar Island.

Ramganga tributaries of river Ganga is a small river rising in the Garhwal near Gairsain. Ramganga changes its course to the southwest direction after crossing the Shivalik enters into the plain of U.P. near Najimabad, and joins the Ganga near Kannauj.

#### **b) Yamuna River Flow**

Yamuna is the largest tributary river of the Ganga . It originates from the Yamnotri glacier, on the south western slope of Banderpoonch peak, in the lower Himalayas. Yamuna travels through an area of 3,66,223 Km<sup>2</sup>. It crosses states of Uttarakhand, Himachal Pradesh , Haryana ,Delhi and Uttar Pradesh and meets several of its tributaries on the way including Tons which is largest and longest tributary in Uttarakhand of river Yamuna.

#### **c) Ramganga East River Flow**

Ramganga East originates from the Namik Glacier in Pithoragarh district of Uttarakhand and flows towards South East. This river is fed by numerous small and big rivers and

finally joins river Sarju at Rameshwar near Ghat of Pithoragarh. The Sarju in turn confluences with Kali.

#### **iii.Land resources**

Land and its soil are considered as important resources of earth as these provide essential medium for development of agriculture, forestry vegetation etc. Forest covers the major portion of Uttarakhand land and around 71% of the land of the state is under forest. Northern part of the area is covered with Himalayan peak and glaciers.

#### **Land**

The part of earth's surface which is not covered by water is known as land. It is the most valuable assets for all nations. It provides food, fuel, fodder, fabric, shelter and materials needed for sustenance. Uttarakhand is famous for its natural beauty with amazing landscapes, diverse culture and kind people. Uttarakhand has a highly varied topography, with snow covered peaks, glaciers deep canyons roaring streams, beautiful lakes and a few patches of dusty plains in the south. Forest land is the major land use in the hills of the Uttarakhand and the forest department is the sole owner of the forest land. Land use patterns in the hills and the plain districts in terms of net sown area, barren land, cultivable land, pasture land varies. Some of these classification show degraded upland and lowland ecosystem and the other indicates the important role in maintaining the ecological balance. The district of Pauri Garhwal, Chamoli and Rudraprayag have considerable percentage of barren and fallow lands. A mere 10% of area is sown in the hill districts due to constraints of irrigation and physiography, whereas the sown area in plain districts is more than 5 times of hill. Table 3.2 represent the district wise land use pattern in Uttarakhand.



**Table 3.2.**  
Districts wise  
land use pattern  
of Uttarakhand<sup>1</sup>

Districts	Reported area (Ha.)	Land use Categories (area in %)								
		Forest land	Uncultivable Waste land	Other than agriculture	Cultivable waste land	Pasture land	Tree, bushes, etc.	Current fallow	Other fallow	Net Sown Area
<b>Uttarkashi</b>	801600	88.39	4.63	0.64	0.28	1.01	0.53	0.47	0.69	3.36
<b>Chamoli</b>	803000	60.42	18.93	0.95	5.74	4.75	4.83	0.11	0.11	4.16
<b>Tehri Garhwal</b>	364200	66.29	1.12	1.09	10.08	0.12	0.06	7.45	1.18	12.61
<b>Dehradun</b>	308800	54.7	0.99	5.91	7.35	0	14.1	2.09	2.07	12.79
<b>Pauri Garhwal</b>	532900	57.31	5.33	2.3	5.57	5.23	8.34	1.16	2.71	12.05
<b>Rudraprayag</b>	198400	76.41	3.08	1.27	3.4	1.82	4.92	0.29	0	8.81
<b>Haridwar</b>	236000	31.33	1.07	11.53	0.89	0.16	0.23	1.12	1.68	51.99
<b>Pithoragarh</b>	709000	49.98	5.07	2.45	9.48	12.98	6.94	0.33	1.06	11.71
<b>Almora</b>	313900	50.7	5.51	2.17	9.1	6.33	5.84	0.94	1.67	17.74
<b>Nainital</b>	425100	73.42	0.06	2.28	6.57	0.11	4.38	0.98	0.74	11.46
<b>U S Nagar</b>	254200	33.35	0.35	8.99	1.16	0.08	0.44	0.89	1.02	53.72
<b>Bageshwar</b>	224600	55.51	2.27	1.97	6.39	8.02	11.13	1.22	2.84	10.65
<b>Champawat</b>	176600	58.21	3.54	2.07	7.42	8.39	0.09	10	1.23	9.05
<b>Uttarakhand</b>	5348300	61.47	5.5	2.68	6.79	3.73	4.38	0.73	1.2	13.52



<sup>1</sup>Sah R .2017.Changing land use pattern in Uttarakhand. Aayushi International Interdisciplinary Research Journal.4.

#### iv. Soil types and its characteristics

Uttarakhand has a wide variety of soil types. The parameters which characterize the soil type include structural, textural and chemical properties of the soil, soil fertility, geographical distribution and extent, soil horizon and their composition.

##### a) Himalayan alluvial soil – Group A

These soils are non-calcareous to moderately calcareous soil that have been laid down by rivers and streams and found in following physiographic zones:

- I) Tarai and Bhabhar tract
- II) Dun Valleys
- III) River valleys in the lower and middle Himalayas

The main characteristics of these soils are –

- ✓ They are of reddish color
- ✓ Deficient in lime, humus and phosphoric acid
- ✓ Top soil is usually deficient in calcium and phosphate, its Nitrogen content may vary under different conditions.
- ✓ The soil texture varies from clayey to sandy loam
- ✓ Acidic in reaction
- ✓ These soils are of fairly old origin.

The properties of various horizons of Himalayan alluvial soils (group A) are given below:

Horizon	Soil depth (cm)	Properties
A	0-15	Pale yellowish, brown, loamy angular, blocky, plastic, abundant plant roots.
B	15-25	Yellowish brown colour clayey angular blocky, it is sticky when moist and hard when dry; plant roots are abundant in this horizon.
C	25-35	Darker yellowish brown shade, angular body sticky and very plastic when wet mildly alkaline,
D	35-55	Yellowish brown, clayey, angular blocky mildly alkaline
E	55-70	Yellowish brown, plant roots virtually absent large sized sediment are found in this horizon

##### (a) Himalayan alluvial soil – Group B

These soils are transported by rivers and streams. These soil are found in several physiographic zones of Uttarakhand.

- i) Tarai and Bhabhar tract
- ii) Dun valleys
- iii) Along rivers and streams in the lower and middle Himalayas, usually on terraces that have been built by the water course.

##### b) Red and black soils

These soils are limited in Uttarakhand. These soils are

originated from acid igneous rocks, mainly granite i.e. Amritpur, Nainital and Rudraprayag granites.

Red and black soils are subdivided into two sub types.

- i) Red soils dominant; light textured and deficient in carbonates of calcium
- ii) Black soil dominant; less clayey and deficient in carbonates of calcium

The characteristics of these soil types are

- ✓ They are deficient in lime, humus and Nitrogen
- ✓ Soil depth varies from 1 cm up to 45 cm





The properties of various horizons are as below:

Horizon	Soil depth (cm)	Properties
A	0-20	Reddish brown; sub angular sandy, clay brown permeable, hard and dry
B	20-40	Reddish brown; clay loam breaks into angular
C	40-60	Dark reddish brown to deep brown; clayey loam, low to moderate permeability

### (d) Ferruginous red soil

Ferruginous red soil developed over the main Himalayan rocks of Uttarakhand.

- i) Red earth; loose fragile top soil rich in iron
- ii) Red loam; argillaceous, blocky structure with high base status. Characteristics of ferruginous red soil are

as follows:

- ✓ Lack in Nitrogen, humus and phosphorus
- ✓ Light textured porous and friable
- ✓ Soil depth may be up to 75 cm

The properties of various horizons of this soil types are as follow:

Horizon	Soil depth (cm)	Properties
A	0-10	Reddish yellow in colour; loamy sand; friable when dry, plant root abundant
A1	10-30	Yellowish red, sandy loam
B	30-45	Yellowish red, sandy loam compact and crumbly
B1	45-60	Yellowish red, sandy loam and blocky to crumbly

### e) Forest soil

This soil type is found in many parts of the hilly region, forest soil occurs under conifer and broad leaved forests. It is found in following physiographic zones.

- I) Tarai and Bhabhar
- II) Dun valley
- III) Lower, middle and main Himalayas

The formation of forest soils may take place under two conditions.

- ✓ Moderately acid to almost neutral conditions.

✓ Acidic condition; acidic humus with low base status, sub types of this soil are found in Uttarakhand are as follows.

- Brown forest soil (acidic to neutral) under pasturage
- Brown forest soil (acidic to neutral) virgin

The main properties of different horizons of forest soil are given below:

Horizon	Soil depth (cm)	Properties
A	0-10	Dark brown to brown, sandy loam, fine sub angular blocky, fine roots abundant
A1	10-30	Yellowish red to reddish yellow, clay loam, sub angular blocky roots abundant
B	30-45	Yellowish red to reddish yellow, clay loam, sub angular blocky thin clay skin, occasional quartzite gravels; slightly sticky but non-plastic when wet; roots abundant
B1	45-60	Yellowish red to reddish yellow, clay loam, sub angular blocky, quartzite gravels present thin clay skin, coarse roots abundant
B2	60-80	Yellow red to reddish yellow, clay, moderate to abundant thin clay skin, coarse roots abundant
B3	90-120	Yellowish red to reddish yellow, clay moderate to abundant
C	<120	Yellowish red to reddish yellow gravelly, clay, sub angular blocky, slightly sticky when wet.

### (f) Podzolic soil

These soils developed in humid and temperate climate under the following condition:

- I) In temperate region, sub-alpine and alpine areas

- II) Over rock which is rich in quartzite

The properties of different horizon of podzolic soil are presented below:





Horizon	Soil depth (cm)	Properties
A	0-10	Black, attains a darker hue on moistening
A1	10-30	Sandy to clay loam loose, rich in humus, acidic
B	30-50	Black through a relatively lighter shade sandy to clay loam, acidic
B1	50-70	Brownish black, sandy to clay loam, more compact than the other horizon, acidic
B2	70-90	Brownish, sandy loam large pockets of parental material may be found in this horizon acidic
B3	<90	Brownish, parent rocks may be found in the lower layers

### (g) Foot hill and Tarai soils

This is the name given to the soils found in the foot hill and Tarai tract, viz.

- I) Tarai and Bhabhar tract
- II) Dun Valley
- III) Foot hills and valleys in the lower Himalayas

The main characteristics of this soil are:

- ✓ They are poor in plant nutrients and phosphate

- ✓ Acidic in reaction
- ✓ Color varies from deep black to greyish black
- ✓ These soils are affected by floods in the monsoon season and long spells of dry weather characteristics of different horizon of podzolic soils.

The properties of various horizons of the foot hill and Tarai soil are:

Horizon	Soil depth (cm)	Properties
A	0-10	Black, attains a darker hue on moistening, sandy to clay loam, rich in under composed organic matter.
A1	10-30	Black, sandy to clay loam, loose, rich in humus, acidic
B	35-55	Light greenish dry, silty loam, very fine granular structure
B1	<55	Light yellowish, silty loam, very fine granular

### (h) Mountain and hill soils

These are found in various parts of Uttarakhand. The main characteristics of these soil are.

- ✓ They are very thin and fragile
- ✓ Soil depth may be from less than 1 cm to over 100 cm

- ✓ Texture varies from loamy to sandy loam
- ✓ Pebbles, shingles, gravels or fragments of the parent rock may be found mixed with the soil.

The properties of various horizons of the mountain and hill soil are:



Horizon	Soil depth (cm)	Properties
A	0-10	Light brownish grey, sandy loam, moderate permeability
A1	10-30	Yellowish brown, clay loam, fragments of parent rocks abundant
B2	50-70	Yellowish brown, clay loam, poor permeability
C	<70	Yellowish brown, the lower layers of the horizon are underlain by the parent rocks.

### (i) High altitude meadow soils

These soils are usually found below the high altitude meadows near the snow line on the main Himalayan ranges of Uttarakhand. The main characteristics of these soils are.

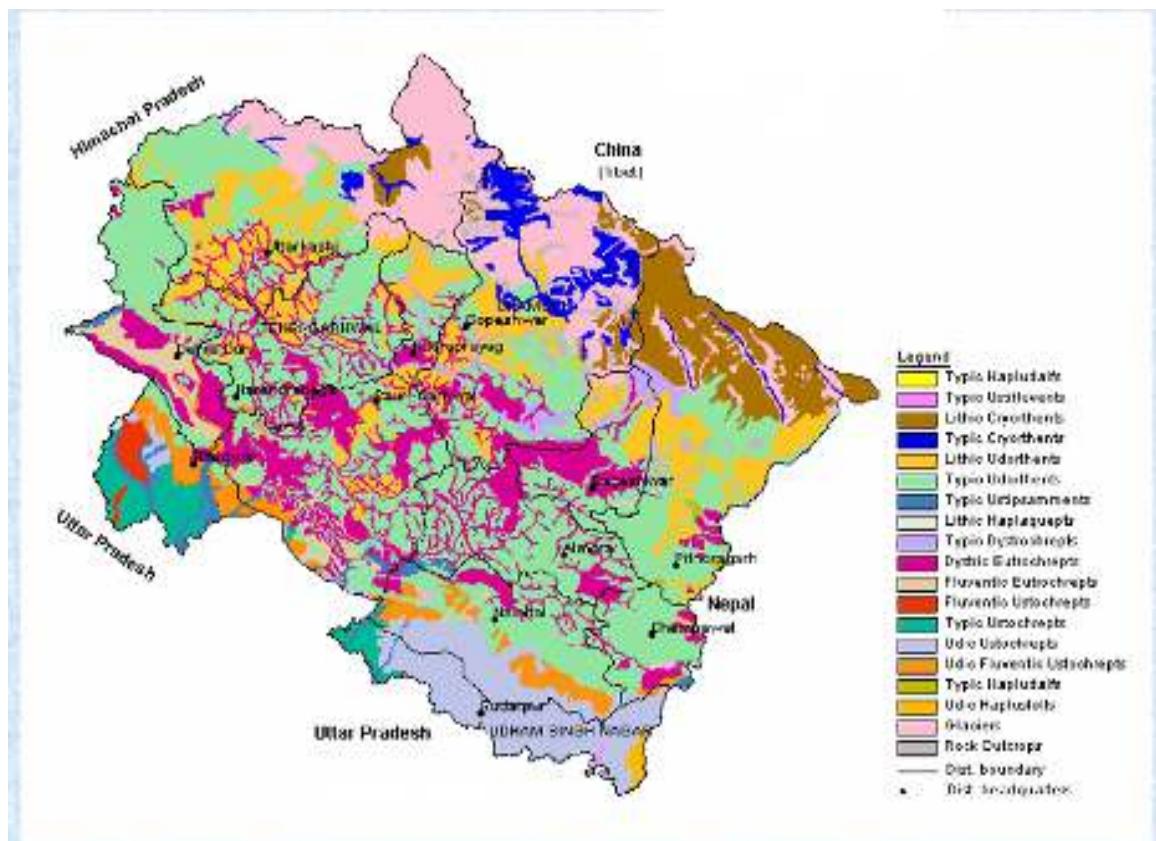
- ✓ They are very thin and fragile
- ✓ Their composition is extremely rocky
- ✓ Such soils are liable to be displaced by slides creeps and avalanches
- ✓ Under moist alpine meadows, these soils are dark in

color and rich in humus

- ✓ The permeability varies from moderate to rapid.

All plants and animals directly or indirectly depend on the soil. Uttarakhand has wide variation in the soil type and soil subgroups. It varies from the deep, alluvial and fertile soils of the Tarai tract to alluvial of the Dun valley, the thin fragile soil of the Shivalik hills, the black soil of temperate zone and the arid bare soil of the inner dry valleys. Fig 3.5 shows the various soil subgroups of Uttarakhand.

**Fig 3.5**  
Soil subgroups  
of Uttarakhand



### **Productivity of soil**

Soil productivity is an important property which has a direct bearing on the well-being of people living in the area. It's primarily dependent on

- i) Availability of soil nutrients such as Nitrogen, Phosphorus, Potassium, Sulphur, Zinc etc.
- ii) Structure and texture of the soil
- iii) Slope and aspect
- iv) Addition of fertilizers and manures

### **Salient features of the productivity of the soils of Uttarakhand**

- i) Soils in the valley bottom are more fertile than those found on the ridge top. This is due to the presence of a large quantity of humus, mineral nutrients, moisture and suitable soil depth.
- ii) There is more effect of monsoonal washing on

the top soil and mineral nutrients in lower valleys.

- iii) The accumulation of organic matter in the soils is more under moist broad-leaved forests than those under coniferous forest.
- iv) Alluvial soils have moderate productivity. The alluvial soils of lower river terraces are deficient in Nitrogen and other minerals.
- v) The topsoil is severely eroded on steep slope.

Productivity of soil depends upon its nutrient status and amount of organic carbon. The maximum carbon pool of  $142.14 \text{ t ha}^{-1}$  is found in the altitudinal range of 2501 to 4200 m from MSL followed by  $105.28 \text{ t ha}^{-1}$  between 1001-1500 m and least is  $37.09 \text{ t ha}^{-1}$  at the 501-1000 m from MSL altitude in Uttarakhand state.

### **v. Demographic characteristics: Decadal population growth; sex ratio; population density; literacy**



### Decadal Population Growth

It is an important part of census operation. It gives an overview of the percent of total population growth in a particular decade. Hence it is known as decadal growth rate.

The census 2011 indicates that population of Uttarakhand has increased from 84.89 Lakh in 2001 to 1.01 crore in 2011. In the male and female population in the state has been recorded as 50.86% and 48.99% respectively.

However 50.94% male and 49.16% female population was recorded as per previous census 2001. The total population growth in this decade is 18.81% while in previous decade it was recorded 19.20%. The population of Uttarakhand contributes to 0.83% of country's population. Some of demographic features of Uttarakhand and district wise decadal population growth are given in Table no.3.3 and 3.4 respectively.

**Table 3.3**  
Demography of  
Uttarakhand<sup>2</sup>

Description	2011	2001
<b>Approximate Population</b>	1.01 Crores	84.89 Lakh
<b>Actual Population</b>	10,086,292	8,489,349
<b>Male</b>	5,137,773	4,325,924
<b>Female</b>	4,948,519	4,163,425
<b>Decadal Population Growth</b>	18.81%	19.20%
<b>Percentage of total India's Population</b>	0.83%	0.83%
<b>Sex Ratio</b>	963	962
<b>Child Sex Ratio</b>	890	908
<b>Density/Km<sup>2</sup></b>	189	159
<b>Area(Km<sup>2</sup>)</b>	53,483	53,483
<b>Total Child Population (0-6 Age)</b>	1,355,814	1,360,032
<b>Male Population (0-6 Age)</b>	717,199	712,949
<b>Female Population (0-6 Age)</b>	638,615	647,083
<b>Total Literate</b>	6,880,953	5,105,782
<b>Literacy</b>	78.82 %	71.62 %
<b>Male Literacy</b>	87.40 %	83.28 %
<b>Female Literacy</b>	70.01 %	59.63 %



<sup>2</sup>[www.census2011.co.in/censes/state/uk](http://www.census2011.co.in/censes/state/uk)

**Table 3.4**  
District wise  
decadal growth  
in Uttarakhand  
from year  
2001-2011<sup>3</sup>

Sl. No.	Districts	2001	2011	Percentage
1	Uttarkashi	295013	330086	11.89
2	Chamoli	370359	391605	5.74
3	Rudraprayag	227439	242285	6.53
4	Tehri Garhwal	604747	618931	2.35
5	Dehradun	1282143	1696694	32.33
6	Pithoragarh	462289	483439	4.85
7	Bageshwar	249462	259898	4.18
8	Almora	630567	622506	-1.28
9	Champawat	224542	259648	15.63
10	Nainital	762909	954605	25.13
11	U S Nagar	1235614	1648902	33.45
12	Haridwar	1447187	1890422	30.63
13	Pauri Garhwal	697078	687271	-1.41

**Table 3.5**  
Sex ratio of  
Uttarakhand  
(district wise)<sup>4</sup>

District	1991	2001	2011
Uttarkashi	918	964	880
Chamoli	918	941	1019
Rudraprayag	1094	1171	1114
Tehri Garhwal	1048	1051	1077
Dehradun	843	893	902
Pauri Garhwal	1058	1104	1103
Pithoragarh	992	1031	1020
Champawat	945	1024	980
Almora	1099	1147	1139
Bageshwar	1055	1110	1090
Nainital	881	906	934
U.S Nagar	863	902	920
Haridwar	846	868	880

#### Sexratio

It gives the idea of the number of female per 1000 of males. Most of the high hill districts such as Chamoli, Rudraprayag, Tehri Garhwal, Garhwal, Pithoragarh, Almora and, Bageshwar show more than 1000 sex ratio, while districts located in plains (fully or partially) such as U.S Nagar, Haridwar, Dehradun, Nainital and two hilly districts Uttarkashi and Champawat show sex ratio of less than 1000. The sex ratio in Uttarakhand is given in Table no.3.5

#### Population density

It is a measurement of population per unit area.

Population density of Uttarakhand increased from 132 people per Km<sup>2</sup> of land in 1991 to 189 people per Km<sup>2</sup> f land area in 2011 growing at an average annual rate of 2.85 person per Km<sup>2</sup> per year. The population density of Uttarakhand is lower than national average of 382 person per Km<sup>2</sup>. Table 3.6 present population density in Uttarakhand. The maximum density at the district level 801person per Km<sup>2</sup> in Haridwar whereas it was lowest in uttarkashi 41 person per Km<sup>2</sup> as per previous decadal pattern of density. The same position has been noticed at 2001 census where highest density was noticed in Haridwar and lowest in Uttarkashi.

<sup>3</sup>[www.census2011.co.in/census/state/district\\_list/Uttarakhand](http://www.census2011.co.in/census/state/district_list/Uttarakhand)

<sup>4</sup>[www.census2011.co.in](http://www.census2011.co.in)



**Table 3.6**  
Population density rate of Uttarakhand<sup>5</sup>

Year	Value	Change %
2011	189	18.87
2001	159	20.45
1991	132	-

#### Literacy rate in Uttarakhand

A person with age 7 years and above who can both read and write with understanding in any language has been considered as literate. People who are blind and could read in Braille are also treated as literates, while a person who can neither read nor write or can only read but cannot write in any language is treated as illiterate.

Large number of public and private institution provides education in Uttarakhand. There had a long tradition of learning and culture in the state. There are 15331 primary schools with 1040139 students and 22,118 working teachers in Uttarakhand. The total literacy rate of the state is 78.82% with 87.40% literacy for male and 70.01% literacy for females as per census 2011. The literacy rate of Uttarakhand is greater than average literacy rate of (72.98%) of India.

	Uttarakhand	India
Female	70.01%	64.63%
Male	87.4%	80.88%
Total	78.82%	72.98%

The language of instruction in the schools is either English or Hindi. The education in the state is mainly imparted by government and private schools/institutions including primary schools, high schools, inter college, degree colleges

and technical institutions. The schools in Uttarakhand are mostly affiliated to CBSE, ICSE and UBSE. District wise literacy rate of Uttarakhand is given in Table 3.7.

<sup>5</sup>[www.census2011.co.in](http://www.census2011.co.in)





**Table 3.7**  
District-wise literacy in Uttarakhand 2011<sup>6</sup>

District	Literate population		
	Total	Male	Female
<b>Uttarkashi</b>	216,322	129,289	87,033
<b>Chamoli</b>	284,118	157,013	127,105
<b>Rudraprayag</b>	169,626	91,016	78,610
<b>Tehri Garhwal</b>	401,040	227,423	173,617
<b>Dehradun</b>	1,280,462	712,934	567,528
<b>Pauri Garhwal</b>	499,212	263,853	235,359
<b>Pithoragarh</b>	350,844	192,237	158,607
<b>Champawat</b>	179,844	103,170	76,674
<b>Almora</b>	440,918	233,748	207,170
<b>Bageshwar</b>	181,713	98,693	83,020
<b>Nainital</b>	706,750	391,234	315,516
<b>Udham Singh Nagar</b>	1,060,739	611,229	449,510
<b>Haridwar</b>	1,225,845	718,335	507,510

### vi. Rural and urban population

Total population of Uttarakhand as per census 2011 is 10,086,292. Out of its total population 69.77% resides in rural areas which is 70,36,954. The rest of the 30.23 % reside in urban areas, which is 30,49,338.

### vii. Caste stratification

Caste is a form of social stratification characterized by endogamy, hereditary transmission of a lifestyle which often includes an occupation, status in a hierarchy and customary social interaction and exclusion.

Uttarakhand has a multiethnic population that spreads across two geo cultural regions of the Garhwal and the Kumaon. The social structure of the region is characterized by caste. Society is mainly divided into 3 castes namely Brahmin, Rajput and Shilpkars. Some of the ethnic groups and sub groups comprising the Uttarakhand society are:

- ✓ Jaunsari–Koltas, Khasa;
- ✓ Bhotia – Jadus, Marchas, Shankas;
- ✓ Garhwali – Kumaoni, Buksha, Tharu, Raji

#### Jaunsari

This group of people has a distinctive style of dress and unique cultural practices. Jaunsari society, being a collection of smaller tribes is caste stratified into the indigenous koltas and khasa. In fact, the Jaunsari society is known to be one of the few polyandrous societies in the world. They inhabit in Junsar-Bawar area of upper Dehradun

#### Bhotia

The bhotias traditionally lived in the high Himalayas and are divided into many sub-groups namely the Jadus, Marchas and the Shankas. These groups have different cultures, yet they share a common Tibetan like physical appearance.

<sup>6</sup>[www.census2011.co.in](http://www.census2011.co.in); population of Uttarakhand census 2011

### Buksha

Buksha are the inhabitants of the Tarai region of Uttarakhand and they claim similarity to the Rajput. The culture of buksha reflects a typical Hindu society. They are spreaded over 173 villages of mainly Nainital and Dehradun districts.

### Tharu

The tharus are tribals from the eastern zone of Tarai. They are related to the Tibetan tribes. The tharu culture celebrates large families living under one roof. A typical feature of tharu culture is that their society is a matriarchal society. They live in southern foothill of Uttarakhand.

### Raji

Rajis are known as vanrawats and they inhabit in the forest area of Uttarakhand. The rajis boast of a different culture with women as the head of their society. They are original inhabitants of central Himalaya.



The work participation rate of women has been constantly increasing at a large extent than men in the state over past few years. Women play a crucial role in agricultural development and allied fields, including crop production, livestock, horticulture, post harvest operations, fisheries etc.



### Garhwali

Any person who has ancestral Garhwali roots or lives in Garhwal and has a Garhwali heritage is called a Garhwali. They include all those who speak the Garhwali language or any of its numerous dialects.

### Kumaoni

The people living in the Kumaon region of Uttarakhand. Men and women both are treated equally in the society. Kumaoni still follow ancient customs and rituals and these aspects of their culture reflect in their society.

#### viii. Women in Uttarakhand

In rural Uttarakhand women are contributing upto 90% of the total work in agriculture and animal care. The participation rate of women in the economy of the state is much higher than other several states and also than the national average.



They devote as much as 62.17% of time for outdoor activities, 21.11% for indoor activities 8.72% for recreational activities and remaining time for some other activities.

Women usually work for 16.49 hours on a daily basis. Work related to agriculture and livestock consumes 29.35% of their time. It has been generally recognised that the work burden among women in the state is very high and they have to participate in almost every household activity including social and religious function in the absence of male family members

The women of Uttarakhand have always been actively participating in many movements and play an important role in the society. Inspite of that they are not equal to the men in the society. Women are excluded from any important decision making process.

There are so many women empowerment programmes for their education, welfare and economic development, however they are still deprived of facilities necessary for quality life. There are several self help groups of women playing a constructive role in resolving this problem. There are several schemes by the government for women

empowerment like-

- 1) Uttarakhand women integrated development scheme
- 2) Nanda Devi Kanya Dhan Yojana
- 3) Kishori Shakti Yojana
- 4) Matritvo Sahyog Yojana
- 5) Protection of Women from Domestic Violence Act
- 6) Beti Bachao Beti Padhao
- 7) Ujjwala
- 8) State resource Centre for Women
- 9) Poorna Shakti Kendra
- 10) Mukhyamantri Satat Aajivika Yojana
- 11) Anganwadi Worker Prize Scheme.

#### **ix. People and environment**

The native people of Uttarakhand are generally called Uttarakhandi and sometimes specifically either Garhwali or Kumaoni depending on their place of origin in either the Garhwal or Kumaon region. Uttarakhand has a

multiethnic population spread across two geocultural regions: the Garhwal, and the Kumaon. A large portion of the population is Rajput (various clans of erstwhile landowning rulers and their descendants), including members of the native Garhwali, Kumaoni and Gujjar communities, as well as a number of immigrants. Hindi belonging to Indo-Aryan languages is the sole official language of Uttarakhand and is spoken by 87.95% of the population (figure includes Garhwali, Kumaoni and Jaunsari as variants of Hindi). Sanskrit has been given the status of second official language. Many Tibeto-Burman languages are also spoken in this state, including Bhoti, Jad, Rangkas, Darmiya, Byangsi and Chaudangsi.

People and environmental interaction in the state is defined as interaction between the human social system and the ecosystem. Both the systems have many parts and connection between them. In order to analyse people's

environmental interaction it is important to be aware of specific characteristics of the human social system because the type of society strongly influences people attitude towards nature, their behavior and their impact of ecosystem.

The people modify the environment for their purpose and obtain benefits from ecosystem services which is essential for people well beings and includes- for example the provision of resources like water, timber, food, energy, information, land for farming and many more. By obviously using these resources people affect the environment in lot of ways. Furthermore, they often recognize existing ecosystem to achieve new gains that seems to be more effective in serving their needs. This has made people to thrive and flourish beyond the natural constraint. As a result of which the anthropogenic pollutants have overloaded the system and the natural equilibrium is disturbed.





# Forest and Biodiversity



## A. Forest

- I. Status of forests
- II. Regulatory regime
- III. Forest types and characteristics
- IV. Forest based livelihood
- V. Government schemes
- VI. Diversion of forest land
- VII. People and forest
- VIII. Forest related conflicts
- IX. Forest fires
- X. National Parks, sanctuaries and other protected areas
- XI. Problems and threats to forest

## B. Biodiversity

- I. Biodiversity profile of Uttarakhand
- II. Floral biodiversity
- III. Faunal biodiversity
- IV. Biodiversity and ecosystem services
- V. Biological Diversity Act 2002 and its impact
- VI. Medicinal and aromatic plant: development status
- VII. Government schemes related to medicinal plants
- VIII. Traditional health care system
- IX. Institutes/agencies working in the area of medicinal plants



#### A. Forests

Forests and biodiversity are the prime natural resources in Uttarakhand. A variety of forests exist in Uttarakhand owing to its diverse topography and climatic regions. These forests sustain rich floral and faunal diversity. The human and livestock populations in the villages are largely dependent on forests due to agrarian economy

and old age pastoralism leading to heavy pressure on forests that causes degradation of ecology and environment of the area. Although the state of Uttarakhand is well endowed with biological resources, the past decades have seen an increase in pressure on the state's natural ecosystems. The Uttarakhand state ranks 7<sup>th</sup> among other states in terms of recorded forest area.

**Fig 4.1**

Chir pine (*Pinus roxburghii*) forests are the dominant forest types in Uttarakhand and constitute about 28.81% forest cover of the state



### i. Status of forests

The total forest cover under various classes of the state is 24295 Km<sup>2</sup> and total forest area in the state is 37999.532 Km<sup>2</sup>, which is 71% of the state geographical area. 19% area of the state is under permanent snow

cover, glacier and steep slopes where tree growth is not possible due to physical limitations. As per India State of Forest Report 2017, forest cover of different districts of Uttarakhand is mentioned in Table 4.1 and change in state forest cover during 1997 to 2017 is given in Table 4.2.

**Table 4.1**  
Distribution of forest cover (Km<sup>2</sup>) in Uttarakhand districts<sup>1</sup>

District	Geo-graphical Area (GA)	2017 Assessment				% of GA
		Very dense forest	Moderate dense forest	Open forest	Total	
Almora	3144	199	837	682	1718	54.64
Bageshwar	2241	162	762	337	1261	56.27
Chamoli	8030	443	1580	686	2709	33.74
Champawat	1766	367	593	264	1224	69.31
Dehradun	3088	636	626	343	1605	51.98
Pauri Garhwal	5329	552	1925	917	3394	63.69
Haridwar	2360	75	277	236	588	24.92
Nainital	4251	765	1742	541	3048	71.70
Pithoragarh	7090	505	965	608	2078	29.31
Rudraprayag	1984	252	580	309	1141	57.51
Tehri Garhwal	3642	272	1085	708	2065	56.70
Udham Singh Nagar	2542	150	193	93	436	17.15
Uttarakashi	8016	591	1719	718	3028	37.77
<b>Grand total</b>	<b>53483</b>	<b>4969</b>	<b>12884</b>	<b>6442</b>	<b>24295</b>	<b>45.43</b>

**Table 4.2**  
Change in forest cover during 1997-2017<sup>1</sup>

Year	Forest Cover (Km <sup>2</sup> )	Percentage of State Geographical Area	Source
1997	23243	43.46	SFR 2001
1999	23260	43.49	SFR 2001
2001	23938	44.76	SFR 2001
2003	24465	45.74	SFR 2003
2005	24442	45.70	SFR 2005
2009	24495	45.80	SFR 2009
2011	24496	45.80	SFR 2011
2013	24508	45.82	SFR 2013
2015	24240	45.32	SFR 2015
2017	24295	45.43	SFR 2017



<sup>1</sup>India State of Forest report 2017

**Fig 4.2**  
Changes in  
forest cover in  
percentage  
during  
1997 to 2017

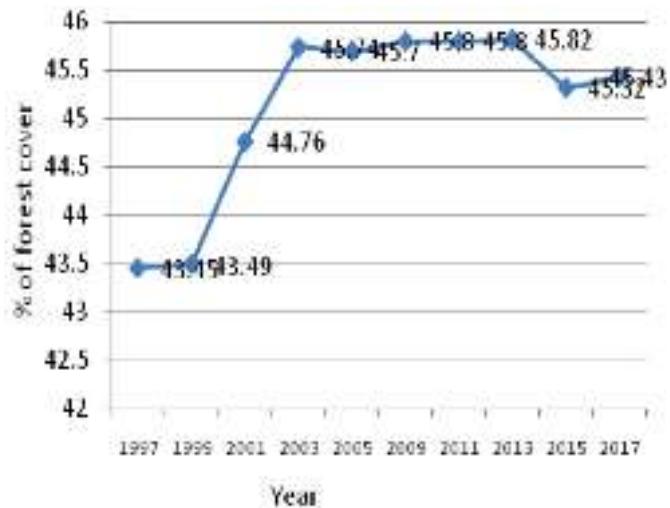


Fig 4.2 depicts changes in forest cover area in Uttarakhand during 1997- 2017. In the duration 1999-2003 forest cover increased by about 1205 Km<sup>2</sup> (2.25% of geographical area of state) and remain more or less similar till 2013 but afterward has a reducing trend. During 2013-2015 forest cover reduced by 268 Km<sup>2</sup> (0.5% of geographical area). It has marginally improved in 2017 by an increase of 55 Km<sup>2</sup>. In totality Uttarakhand contains 3.43% forest cover of India.

#### ii. Regulatory regime

Any type of authority which can operate at either industrial, national or international levels and which can influence, direct, limit or prohibit any activity undertaken by any stakeholder is called regulatory regime. The laws/acts/schemes have been formulated by Government of India for conservation of forest and wild flora and fauna. The review assessment of regulatory regime and existing laws to forest conservation are given in Table 4.3.



**Table 4.3**  
Assessment of regulatory regime and existing laws to conserve the forests

Year	Legislation	Description
1972	Wild life (Protection Act)	Medicinal plants and animals present in the protected areas like national parks and sanctuaries also require protection.
1980	The Forest conservation act (amended 1988)	It puts a restriction on the use of forests or forest land for non-forest purpose which include the cultivation of tea, coffee, spices, rubber, palms, oil-bearing plants, horticultural crops or medicinal plants.  Puts restriction on felling of trees above 1000m altitude.
1986	The Environment (Protection )Act 1986 (amended 1999, 2002)	Provides a holistic framework for the protection and improvement of the environment.
1988	National Forest policy	Provides a regulatory framework for conservation and protection of forests and wildlife which include medicinal plants. It states that special attention should be paid for protection, regeneration and optimum collection of minor forest produce along with institutional arrangements for the marketing of such produce.
2001	The Uttarakhand panchayati forest rule 2001	This is applicable to the districts of Almora, Bageshwar, Champawat, Pithoragarh, Chamoli, Rudraprayag, Uttarkashi, Tehri Garhwal, Pauri Garhwal, Nainital
1994	Environmental clearance (notification 2006)	Environmental clearance required from MoEF&CC for new projects as well as for its expansion/modernization.

### iii. Forest types and characteristics

The state, based on its topography, can be divided into three zones, namely the Himalaya, the Shivaliks and the Tarai region. The state is located in subtropical latitudes but on account of elevation in mountainous terrain, exhibit temperate climate at the

elevations above 1500 m. Valleys below this elevations are hot and show subtropical climate. Shivalik and Tarai areas also exhibit subtropical climate where the temperature ranges from 0°C to 43°C. According to the climate and geography different types of forests have evolved in the state Table 4.4.

S. No.	Forest type	Region	Major species found
1	Tropical moist deciduous forest	Moist regions of the lower Himalaya and Tarai arc	<i>Haldina cordifolia, Anogeissus latifolia, Shorea robusta, Terminalia tomentosa</i> etc and patches of Bamboo, climbers and canes
2	Tropical dry deciduous forest	Dry southern face of Shivaliks and adjoining plains	<i>Anogeissus latifolia, Shorea robusta, Terminalia tomentosa</i> etc.
3	Sub-tropical pine forest	Lower regions of the Himalayas	<i>Pinus roxburghii</i> as the dominant species
4	Himalayan moist temperate forest	Occurs between 1600 - 2900m altitudes in the Himalaya	Coniferous species such as <i>Abies pindrow, Cedrus deodara, Picea smithiana</i> and broad leaf species like <i>Betula spp. and Quercus spp.</i>
5	Himalayan Dry temperate forest	Inner dry trans-Himalayan valleys	<i>Cedrus deodara, Juniperus spp. and Pinus wallichiana.</i>
6	Sub-Alpine Forest	Exists at elevations of 2900m to 3500m in the middle and upper Himalaya	Patches of <i>Abies-Betula</i> forest interspersed with shrubby growth and grassy patches or alpine grasslands called bugyal
7	Moist Alpine Scrub	Occurs above tree line at around an altitude of 3500m elevation	<i>Betula utilis, Rhododendron campanulatum, Sorbus spp.</i> and numerous alpine herbs
8	Dry Alpine scrub	Found in the dry zones of the higher Himalaya above tree line	Main shrub species as <i>Juniperus spp., Artemisia spp.</i> and alpine herbs like <i>Primula spp.</i>

**Table 4.4**  
Forest types  
in Uttarakhand





**Fig. 4.3**

Deodar  
(*Cedrus deodara*)  
forest

#### iv. Forest based livelihood

Uttarakhand's forests have been an essential part of the state development and nearly 80% people in rural areas are directly or indirectly dependent on forests either for their sustenance or subsistence. Tribal's are among the poorest and most vulnerable groups in the society and they depend upon forest for their cultural, economic and spiritual needs.

Forests provide fodder, fuel wood, many wild foods, construction material and medicines for humans and cattle. Besides this forests also create microclimate for cultivation of several crops of the hill. Thus forests and their produce provide substantial livelihood for forest fringe areas. Non wood forest products (NWFPs) mainly medicinal plants and bamboos are gaining importance in bringing better livelihood opportunities to local populace.

Collection of forest products from nearby forest, animal husbandry and water management are some of attractive options for rural people. It appears that the mix of farm forestry and water management jobs helps rural people to lead a self sustaining life.

Following are some forest based products used for livelihood:

##### Medicinal plants

Uttarakhand state is the hub of medicinal plant species due to wide altitudinal variation, different habitat types, and varying microclimatic conditions. The state has nearly 700 species of medicinal plants which are in usage in common folk and documented systems of medicine like Ayurveda, Siddha, Unani and Homoeo-pathy. There are some medicinal plants such as neem, bhringraj, gokhru, tulsi, dhatura etc. which enjoy open harvest (from forests)





status. Few other plants such as hattajari, atis, kutki (in the above image), bach, giloy, sarpgandha etc. are totally banned to be exploited from forests and their demand is to be met through cultivation by the farmers. Some other species are allowed to be harvested in a sustainable manner e.g. harad, bahera, bael, amla, amaltas, tejpat etc. Medicinal plants are not only a major resource base for the traditional medicine and herbal industry but also provide livelihood and health security to a large segment of Indian population.

### Bamboos

Bamboos are regarded as the poor man's timber and have been associated with human's civilisation since ages. There are mainly eight bamboo species growing naturally in Uttarakhand. Out of these four are of thick bamboo and remaining four are thin species locally known as 'ringals'. The thick bamboo species *Dendrocalamus strictus*, *Dendrocalamus somdeviiiae*,

*Ampelocalamus patellaris* and *Bambusa bambos* grow between 300-1500 MSL and are used for making paper and diverse household items. The 'ringal' species *Drepanostachyum falcatum*, *Thamno calamus* *spathiflorus*, *Yushania anceps* and *Himalayacalamus falconeri* grow between 1500-3500 MSL and are commonly used for making baskets, mats, flowerpots and other products. Bamboos play an important role in rural economy by providing subsistence activity, employment generation and household income.

### Others

Few other forest products also provide large livelihood opportunities in the state. They include wild edibles such as edible fungi, berries, nuts and flowers for human and fodder for cattle. They also include fuel wood, fibres, seeds, honey, leaves, bark, resins, gums and many other products obtained from forest. 'Keeda jadi', a caterpillar fungus (*Ophiocordyceps sinensis*, adjacent

image) found at and above the elevation of 3500 m, due to high medicinal value, has greatly enhanced the economic status of the collectors of Pithoragarh, Chamoli and Bageshwar districts. 'Jhula' (adjacent image), which is a mix of many lichens, is a source of livelihood due to its use in perfumery and dye making. Some multipurpose tree species like 'Bhimal' (*Grewia optiva*) and 'Khadik' (*Celtis australis*) are a part of rural culture in hilly regions and indispensable for carrying out their day to day activities. In Uttarakhand there are various industries which are based

on forest product and generate revenues. Uttarakhand Forest consists of very useful trees like Cedar, Fir, Spruces, Surai, Oaks, Pines, Sal, Teak, Rosewood, Eucalyptus, Poplar and Bamboo. While laying emphasis on protection of the environment, with the help of scientific research, crores of revenue is generated from forests. On the other hand, the general public from various forest based industries receive direct and indirect employment. Most of the Eucalyptus wood is used in paper mills for paper making like in Century Paper Mill (Lalkuan, Uttarakhand). It is also used in plywood industries and as fuelwood.



#### v. Government schemes

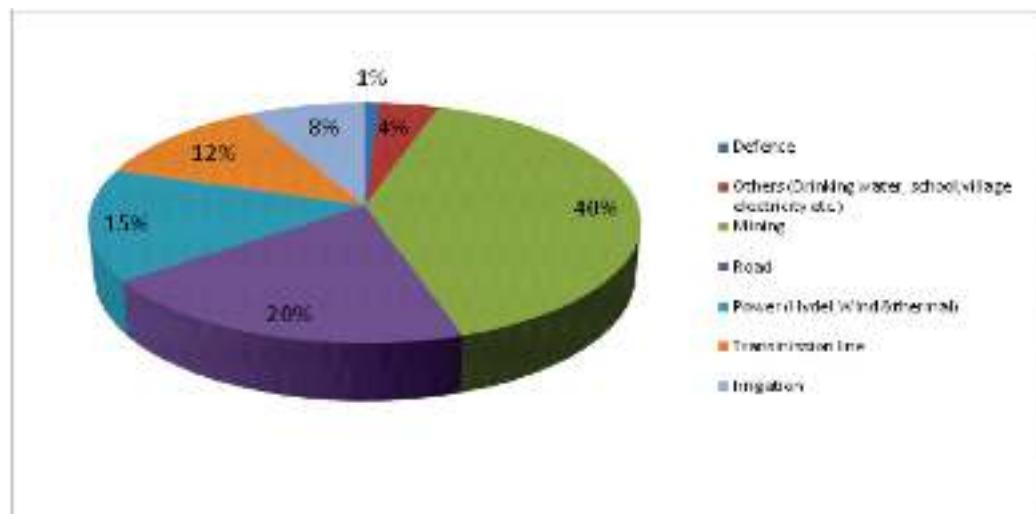
There are various schemes started by government to increase forest area and forest cover. These schemes include afforestation programme, integrated forest production scheme, Eco development scheme, Gram van yojana for afforestation on non-forest land, assistance for development of National Policy and regeneration of forest cover. MGNREGA campa fund, integrated forest management, Ministry of New and Renewable Resouruces, twelfth finance commission grant are the area which involved in forest protection and regeneration programme. National Afforestation scheme is implemented by Ministry of Environment, Forest and climate change Govt. of India which supports the ongoing process of developing forest protection management.

In Uttarakhand Joint Forest Management Committee (JFMC) at the village level and forest department agency at the forest division level have been one of the most significant

scheme that proved to be very effective in forest cover development.

#### vi. Diversion of forest land

The approval of clearing the forest land for different purpose like for construction of road, agriculture land, irrigation, mining and other field is given by Ministry of Environment, Forest and climate change. The MoEF and CC has given approval to 1136 proposals that involve the diversion of 15,639 ha of forest land from July 13, 2014 to July 12, 2015. The category of projects accorded with the approvals for road projects (308), followed by transmission lines (137). Some of the other categories of projects that received clearance for a significant area of forests are mining, hydel and irrigation projects. However, most land was diverted for mining related projects i.e., 40% of the total forest land diverted in this period. (Fig 4.4) shows a breakup of the extent of forest land diverted for various categories of projects during 2014 to 2015.



**Fig 4.4**  
Forest land  
diverted for  
various categories  
of projects in  
Uttarakhand<sup>2</sup>

#### vii. People and forest

Three-fifths of the working population of Uttarakhand is engaged in agriculture and less than one-fifth of the total area of Uttarakhand is cultivable. Major portion of Uttarakhand is covered under forests, which provide timber for construction, fuel wood, and various manufacturing activities, including handicrafts. People of Uttarakhand are directly or indirectly dependent upon forests. Many farmers of Uttarakhand practice animal husbandry. The largest concentration of cattle to support

dairy farming is found in the southern foothills. Goats and sheep are more common in the mountainous areas, although some cattle are kept in every village. These livestock are led to graze in the mountain pastures and forest areas. People of Uttarakhand have great sentiments towards their forest land. Several tribes of Uttarakhand live in forest area and depend upon non timber forest products for their livelihood. For protecting the forest the people of Uttarakhand started Chipko movement. Vanpanchayat are also formed to manage the forest related issues.



<sup>2</sup>forest.uk.gov.in

### **Vanpanchayat**

People in Uttarakhand depend highly on forest to draw livestock fodder, fuel-wood and leaf litter for manuring crops. About 38% green feeds come from trees and another 31% from grasses. Oak and other broad-leaf species are fed to livestock during dry season. Due to close interrelation with forest people have developed indigenous way of managing forest resources. For managing the forest resources Vanpanchayat is formed. These are traditional decision making bodies occasionally imposing restrictions or regulates the pattern of forest resource utilization. Since earlier time people lived in forest, sustainably utilized it and nurtured the forest that is how forests thrive with remarkable biodiversity and ecosystem services.

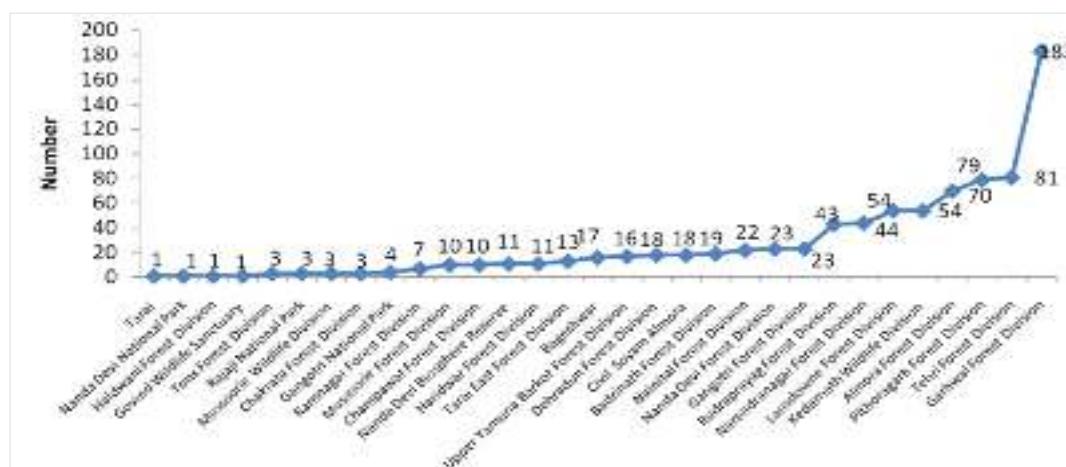
### **viii. Forest related conflicts**

The growing human interference in forest territories has lead to spurt in man-animal conflict in Uttarakhand. As a result, over 250 humans and more than 900 animals have lost their lives since year 2007 in last 11 years. The alarming condition can be noticed from the fact that 646 deer, 193 elephants and 65 tigers were killed in the fight for survival. The tigers are in more dangerous condition they are mainly killed because of poaching. In spite of having 71% area of recorded forest area, the state forests are converting into battleground for survival. Human interference, shrinking of forest areas, practice of animal husbandry are the factors responsible for

promoting man-animal conflict in the state. Rising man-animal conflict in the state is a concerning issue and to tackle the problem various plans are being checked out. But the prime focus is on the conservation of forests and to ensure adequate availability of food for the animals.

Attacks on humans by leopards have been a serious issue for many decades in Uttarakhand. Leopards are common in the forests across the Pauri Garhwal. Their food consists of wild prey species such as goral, barking deer, wild boar, jungle fowl and langur. Due to severe human pressure mainly hunting, cattle grazing, fire wood collection, forest fire, deforestation and habitat alteration, most of these prey species are either locally extinct or their numbers are too low to sustain the existing leopard populations. Leopards are unable to find their natural prey in diminishing forests and have been making regular visits in human habitat in to prey upon domestic animals and often encountered with human. Man and animal conflicts are rising in forest areas. Uttarakhand government provides compensation by increasing the ex-gratia amount for kin of those killed due to human wildlife conflict to Rs. 5 lakh from Rs. 3 lakh. In case of severe injury a victim will now get a compensation of Rs. 2 lakh up from Rs. 50,000. The data on leopard attacks on human are shown in Fig 4.5 as animal human conflicts during the period of 2016.

**Fig 4.5**  
**Animal-Human**  
**conflicts in**  
**Uttarakhand**  
**region<sup>3</sup>**



<sup>3</sup>Uttarakhand leopard social survey report April, 2016

In Uttarakhand estimated tiger numbers (>1.5 years of age) in 2019 compare with estimates for 2006 is given below<sup>4</sup>.

State	Tiger population			
	2006	2010	2014	2018
Uttarakhand	178	227	340	442

### Forest Fire

A forest fire is an uncontrolled fire occurring in nature. Sometimes, the forest fire is so large that it takes a long time for the fire fighting crews to gain control over the situation. This could result in massive destruction. Within last 10 years, mitigating the forest fires has become a major concern of the forest department. The cause of forest fire is due to natural occurrences or to human interventions is still unexplained.

There are three primary classes of forest fires. These are surface, crown and ground fires.

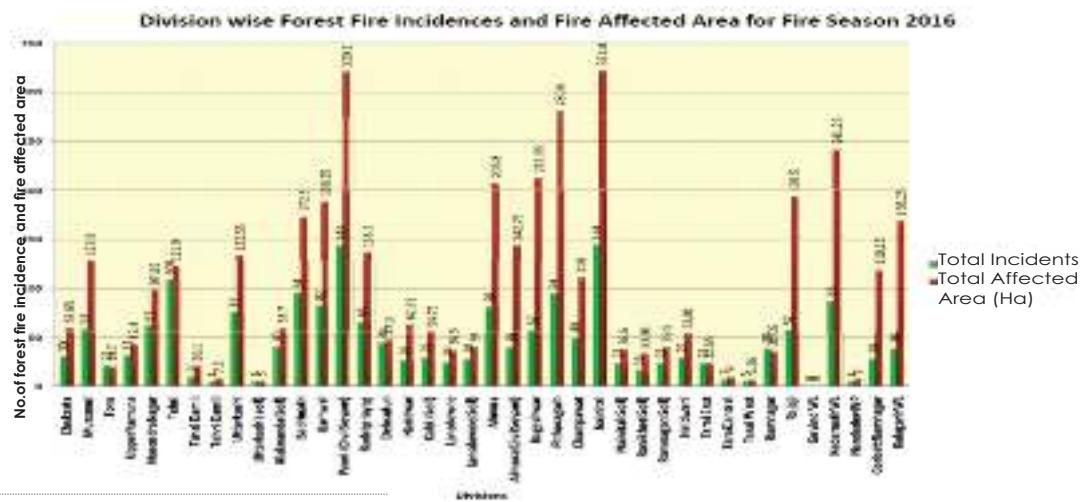
**Surface fires** typically burn readily but at a low intensity and partially consume the entire fuel layer while presenting little danger to mature trees and root systems. Fuel build up over many years will increase intensity and especially, when associated with drought, can become a rapidly spreading ground fire. Regular controlled fire or prescribed burning effectively reduces the fuel build up leading to a damaging ground fire.

**Crown fires** generally result from intense rising ground

fire heat and occur in the higher sections of draping trees. The resulting "ladder effect" causes hot surface or ground fires to climb the fuels into the canopy. This can increase the chances of further spread of fire by burning branches falling in unburned area when these are blown by the wind.

**Ground fires** are the most infrequent type of fire but leads to very intense blazes that can potentially destroy all vegetation and organic matter, leaving only bare earth. These largest fires actually create their own winds and weather, increasing the flow of oxygen and "feeding" the fire. These fires destroy biodiversity directly and have more indirect long-term impacts including the encroachment of fire resistant and pioneer species in burnt areas. It has been suggested that the dark carbon dust emitted by the fires has deposited on the upper surface of Himalayan glaciers and could hasten their melting by absorbing more solar radiation. This could affect the hydrology of the rivers that are a source of water for human populations in northern India. Fig 4.6 depicts the division wise forest fire incidence and fire affected area of Uttarakhand.

**Fig 4.6**  
Division wise  
forest fire  
incidences  
and fire  
affected area<sup>5</sup>





As per the Working Plan many forest compartments were classified as sensitive, moderately sensitive and most sensitive based on the parameters such as aspect, forest type, forest cover, proximity from the habitation and road etc. A

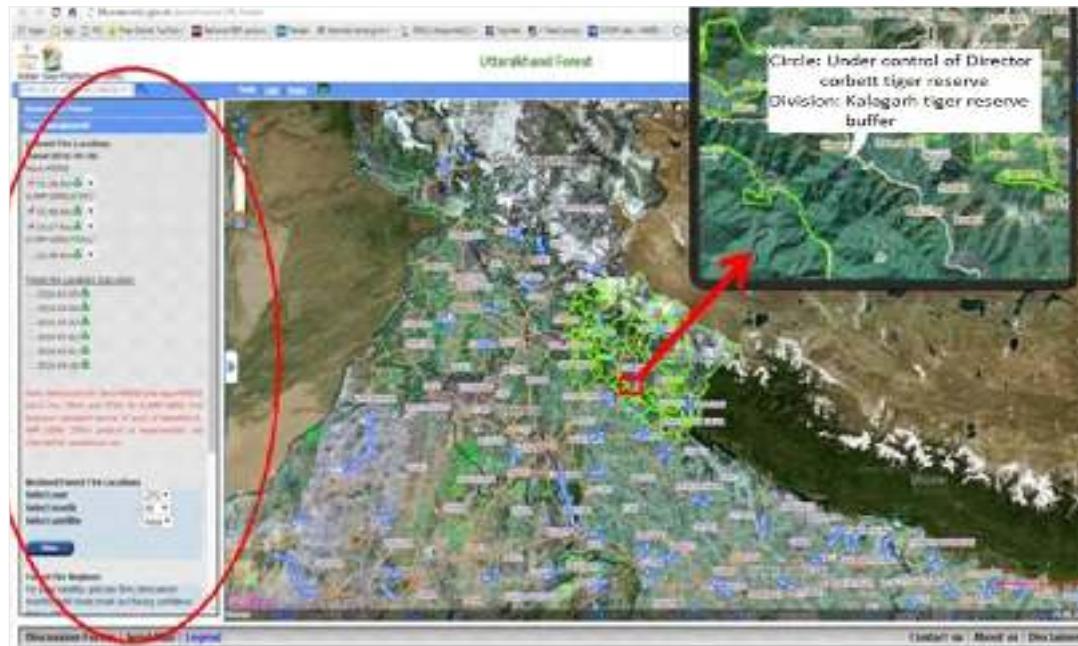
composite map of the identified forest areas sensitive to forest fire was prepared and released to the respective divisions for the planning purpose.



**Use of Public Portal BHUVAN During Fire Season -** BHUVAN is a Geo-portal of Indian Space Research Organisation (ISRO) showcasing Indian Imaging Capabilities in Multisensor, Multi-platform and Multi-temporal domain. The Portal gives a gateway to explore and discover virtual earth in 3D space with specific emphasis on Indian Region. The satellite data helps to identify whether the fire is in forest or in a non-forest area. All the fire locations are filtered and the information is sent to concerned forest division through SMS and WhatsApp application. Same is also uploaded on the website of forest department. The Uttarakhand Bhuvan Portal can be accessed by the public and has proved as a very useful tool in forest fire mitigation services.

**Pre- Fire Alerts by FSI** - In 2016 during the fire season Forest

Survey of India (FSI) initiated a pre fire alerts/pre-warning alert system for forest fires based on several parameters including forest cover, forest type, temperature, recent fires signals etc. Based on a suitable algorithm developed for the purpose and tested for specific areas, a pre fire alerts/pre-warning alert system has been put in place which alerts the states with high fire risk forest areas based on ground and climatic factors. FSI sends pre forest fire alerts through email to ITGC, for processing and further disseminating the information to the concern divisions during the fire season. The data sent by FSI is downloaded and processed further to find the areas (forest divisions wise) having high risk of forest fire. The same data is then uploaded in the official website in a report format and a copy is send to the concerned forest divisions. Fig 4.7 shows the image of pre-warning alert system of forest fire.



**Fig 4.7**  
Image of  
pre-warning  
alert system  
of forest fire.

#### ix. National parks, sanctuaries and other protected areas

Uttarakhand is renowned for its unique bio-diversity. Due to geographic and climatic diversity in different areas of the state different forest types are found spanning from the Himalayas to the plains of the Tarai. To protect the rich biodiversity present in state 12% of total geographical area is designated as protected area which includes one biosphere reserve, 6 National Parks & 7 Wildlife Sanctuaries and 4 Conservation Reserves. Uttarakhand is home to rare species of plants and animals, many of which are protected by

sanctuaries and reserves. National parks in Uttarakhand include the Jim Corbett National Park (first national park of India) at Ramnagar in Nainital district, and Valley of Flowers National Park and Nanda Devi National Park in Chamoli district, which together are a UNESCO World Heritage Site. A number of plant species present in the state are internationally threatened. Rajaji National Park in Haridwar district and, Govind Pashu Vihar National Park and Sanctuary and Gangotri National Park in Uttarkashi district are some other protected areas in the state.

**Table 4.5**  
National Parks,  
Years of  
notification  
and total areas<sup>6</sup>

Sl. No.	Name of National Park	Year of notification	Total area (km <sup>2</sup> )
1	Nanda Devi Biosphere Reserve and National Park (includes Nanda Devi and Valley of Flowers National Parks)	1988	5860.69
2	Corbett National Park	1936	520.82
3	Gangotri National Park	1989	2390.02
4	Govind National Park	1990	472.08
5	Rajaji National Park	1983	820.42
6	Valley of Flowers National Park	1982	87.5

National park is an area which is strictly reserved for the betterment of the wildlife & biodiversity, and where activities like developmental, forestry, poaching, hunting and grazing or cultivation are not permitted. In these parks, even private ownership rights are not allowed. Their boundaries are well marked and circumscribed. In national parks, the emphasis is on the preservation of a single floral or faunal species. National parks of Uttarakhand are given in Table 4.5.

A biosphere reserve is an international conservation designation for reserves designated by UNESCO under MAB program. It corresponds to scientific reserves and strict nature reserves of IUCN. Biosphere reserves are areas comprising

terrestrial, marine and coastal ecosystems. Each reserve promotes solutions reconciling the conservation of biodiversity with its sustainable use. Biosphere reserves are 'Science for Sustainability support sites' – special places for testing interdisciplinary approaches to understanding and managing changes and interactions between social and ecological systems, including conflict prevention and management of biodiversity. Biosphere reserves conserve a bigger representative sample of an ecosystem, provide long term in situ conservation of general biodiversity, and promote world conservation strategies.

### **1. Nanda Devi Biosphere Reserve and National Park**



Nanda Devi Biosphere Reserve was initially established as a national park in 1982. Later by inclusion of Valley of Flowers and adjacent areas it was converted to biosphere reserve and part of it is now included in World Heritage Site by UNESCO. The Nanda Devi biosphere reserve covers about 5860 Km<sup>2</sup> area within which two national parks- Nanda Devi National Park (630.33 Km<sup>2</sup>) and Valley of Flowers National Park (87.50 Km<sup>2</sup>) are located. The Nanda Devi National Park

situated around the peak of Nanda Devi (7816 m) in the state. The entire park lies at an elevation of more than 3,500 m above MSL.

The Nanda Devi Sanctuary within the National Park can be divided into two parts, Inner and Outer part. Together, they are surrounded by the main sanctuary wall, which forms a roughly square outline.

Common larger mammals are Himalayan musk deer, mainland serow and Himalayan Tahr. Goral are not found within, but found in the vicinity of the park. Carnivores are represented by snow leopard, Himalayan black bear and brown bear. Langurs are found within the park, whereas Rhesus macaque is known to occur in the neighbouring areas of the park. In a scientific expedition in 1993, a total of 114 bird species were recognized.

Nanda Devi National Park is home to a wide variety of flora. Some 312 floral species that include 17 rare species have been found here. Fir, birch, rhododendron, and juniper are the main flora. Vegetation is scarce in the inner sanctuary due to the dryness of the conditions.

## **2. Corbett National Park**

Jim Corbett National Park is a part of the larger Corbett Tiger Reserve which is a Project Tiger Reserve spread in the Nainital and Pauri Garhwal districts of Uttarakhand. Established in the year 1936 as Hailey National Park, Corbett national park has the glory of being India's oldest and most prestigious National Park. It is also being honored as the place where Project Tiger was first launched in 1973. This unique tiger

territory is best known for the highest tiger count in the country.

Spanning over an extent of 520.82 Km<sup>2</sup>, its whole area comprises of hills, marshy depressions, riverine belts, grasslands and large lake. It is among the few tiger reserves in India that allows overnight stays inside the national park. Nature watch and wildlife viewing in the park is allowed in an open four wheeler Jeep and on elephant back. The park harbours a healthy population of 250 tigers, as per 2019 tiger estimation exercise. Corbett tiger division has emerged as the single-largest area with tiger density, highest in India, and rare species like Otters and the endemic fish eating crocodile. The national park is one of the most sought after destinations for the wildlife enthusiasts. Dhikala, situated at the border of the extensive Patli Dun valley, is the most popular destination in Corbett because of its superb location and sheer abundance of wildlife presence.

As per the nation wide tiger census data for the year 2019 the total tiger population in Uttarakhand is 442, which has increased from 178 in 2006 census data. State has emerged at the third spot in the country after Madhya Pradesh (526) and Karnataka (524) in terms of tiger numbers<sup>6</sup>.



<sup>6</sup>tiger estimation exercise 2019

Corbett is virtual haven for lovers of bird watching tourists with more than 650 species of residents and migratory birds. Particularly, Dhikala is a fine place to look for birds of prey, more than over 50 species of raptors alone shows the healthy biodiversity of the area. Their multiplex behaviour is intriguing and their varied songs are very much pleasing to the ear. In a nutshell, this finest national park of India is well known for rich and varied wildlife including royal Bengal tiger, elephant, four to five species of deer and rich birdlife.

### **3. Gangotri National Park**

This park is located in the upper catchment of Bhagirathi river in Uttarkashi District of Uttarakhand and was established on 16 September 1989. The park covers about

2,390.02 Km<sup>2</sup> area. The park provides majestic beauty of coniferous forests and grandeur of glacial world combined with lush green meadows. The elevation of land ranges from 2,600m – 7,138 m above MSL. The park area falls under the Biogeographical zone – 2A West Himalaya and sustain temperate, alpine and nival zones. The Gaumukh glacier, the origin of river Ganges is located inside the park and the Gangotri, after which the park has been named, is one of the holy shrines of Hindus. The park area forms a viable continuity between Govind National Park and Kedarnath Wildlife Sanctuary. High ridges, deep gorges and precipitous cliffs, rocky craggy glaciers and narrow valleys characterize the area. Within the territory of park 68 species of Pteridophytes, 11 species of Gymnosperms and 844 species of Angiosperms have been recorded.





**Wildlife of Govind Pashu Vihar Wildlife Sanctuary**

#### 4. Govind National Park

Govind National Park, also known as Govind Pashu Vihar, was initially established as a sanctuary in 1955 but later converted to the status of national park in year 1990. The park area is spread over an area of 472 Km<sup>2</sup> with a varying altitude of 1,300 m to 6,323 m from MSL and representing temperate, alpine and nival zones. River Tons and its tributaries enrich the entire area with sediments and help the vegetation to grow uninhibited. This area is extremely rich in medicinal plants and is much sought after by Ayurvedic doctors. The sanctuary is also a home to the elusive and extremely endangered Snow Leopard that stays at 3,500 m. Govind National Park is located

in the Purola Tehsil of Uttarakashi district in Uttarakhand and Naitwar is the entrance and starting point of the park. Govind National Park has a rich forest area in which there are about 15 species of mammals and 150 species of birds are known. The most significant of these animals are Himalayan Snow leopard, Himalayan Black bear, Brown bear, Musk deer, Bharal, Himalayan Tahr, Serow and Common leopard. The endangered birds found in this region are Monal Pheasant, Koklas Pheasant, Bearded Vulture, Himalayan Snow Cock, Golden Eagle, Western Tragopan, Steppe Eagle and Black Eagle. Other varieties of birds include Owls, Pigeons, Minivets, Thrush, Warblers, Bulbul, Cuckoo and Finches.



## 5. Rajaji National Park

Rajaji National Park is an Indian national park and tiger reserve that encompasses the Shivaliks, near the foothills of the Himalayas. The park is spread over 820 Km<sup>2</sup> within three districts of Uttarakhand- Haridwar, Dehradun and Pauri Garhwal. In 1983 this park was established by merging three wildlife sanctuaries in the area namely, Chilla, Motichur and Rajaji and named after C. Rajagopalachari (Rajaji), a prominent leader of the freedom struggle, the second and last Governor-General of independent India and one of the first recipients of India's highest civilian award Bharat Ratna in 1954.

Rajaji National Park of India is nestled between the

Shivalik ranges and the Indo-Gangetic plains. Broad leaved deciduous forests, riverine vegetation, scrubland, grasslands and pine forests form the range of flora in this park. The dense jungles and varied topography of the national park is responsible for vivid animal life inhibited here. The under-wood is light and often absent. This park consist of rohini (*Mallotus philippensis*), amaltas (*Cassia fistula*), shisham (*Dalbergia sissoo*), Sal (*Shorea robusta*), palash (*Butea monosperma*), arjun (*Terminalia arjuna*), khair (*Senegalia catechu*), baans (*Dendrocalamus strictus*), semul (*Bombax ceiba*), sandan (*Desmodium oojeinense*), chamaror (*Ehretia laevis*), amla (*Phyllanthus emblica*), kachnar (*Bauhinia variegata*), ber (*Ziziphus mauritiana*), chilla (*Casearia sp.*), bel (*Aegle marmelos*), etc.



Rajaji National Park is predominantly formed from dense green jungles, and habitat for a number of animals. The park is at the north western limit of distribution for both elephants and tigers in India. The park is renowned for its elephants. It is mainly confined to the precipitous pine-covered slopes. Sambar, barking deer, hog deer, nilgai, wild pigs, sloth bears and gorals also inhabit these forests. The rhesus macaque and the common langur are fairly common here. Tigers and leopards are the prime predators in Rajaji. The leopard cat, jungle cat, civet and yellow-throated marten are other carnivores. Mammals like the hyena, jackal and the Bengal fox scavenge in the park. The Himalayan black bear though uncommon, can be sighted in the higher reaches of the park.

Over 315 species of birds are found in the park,

whereas the wider region has over 500 species of birds, including both residents and migrants. The most prominent avian species include pea fowl, vultures, woodpeckers, pheasants, kingfishers and barbets, supplemented by a number of migratory species during the winter months. The park is also home to the great pied hornbill, pied kingfisher and the fire tailed sunbird. This area is the first staging ground after the migratory birds cross over the Himalayas into the Indian subcontinent.

#### **6. Valley of Flower National Park**

Valley of Flowers National Park was established in year 1982 and located in the West Himalaya, within the state. It is known for its meadows of endemic alpine flowers and the variety of flora.





**Fig 4.8**  
A glimpse  
of floral  
wealth of  
Valley of  
Flowers



This richly diverse area is also home to rare and endangered animals, including the Asiatic black bear, snow leopard, musk deer, brown bear, red fox, and blue sheep. Birds found in the park include Himalayan monal pheasant and other high altitude birds. At 3,352 to 3,658m above MSL, the gentle landscape of the Valley of Flowers National Park complements the rugged mountain wilderness of Nanda Devi National Park to the east. Together, they encompass a

unique transition zone between the mountain ranges of the Zanskar and Great Himalaya. The park stretches over an expanse of 87.50 Km<sup>2</sup>. Both parks are encompassed in the Nanda Devi Biosphere Reserve which is further surrounded by a buffer zone of Nanda Devi biosphere (5,148.57 Km<sup>2</sup>). This reserve is in the UNESCO World Network of Biosphere Reserves since 2004 and now also recognized as world heritage site.

The Valley of Flowers is located in the upper expanses of Bhundar Ganga near Joshimath in Chamoli district of Garhwal region in the Pushpawati valley 23 Km north-northwest of Nanda Devi Park. It is one of two hanging valleys lying at the head of the Bhundar valley, the other being the shorter Hemkund valley which runs parallel around 10 Km south. It runs east –west approximately 15 Km by an average of 6 Km wide, in the basin of the Pushpawati river, a small tributary flowing from the Tipra glacier which descends from Gauri Parbat in the east.

The valley has three vegetation zones- sub-alpine between 3,200m and 3,500m which is the limit for trees, lower alpine between 3,500m and 3,700m, and higher alpine above 3,700m. The habitats include valley bottom, river bed, small forests, meadows, eroded scrubby and stable slopes, moraine, plateau, bogs, stone desert and caves. The lower surrounding hills in the buffer zone are thickly forested. More than 600 species of angiosperms and 30 pteridophytes have been recorded in the valley and surrounding areas. Himalayan monkshoods (*Aconitum falconeri*, *Aconitum Balfouri*), Himalayan maples (*Acer acuminatum*), the blue Himalayan poppy (*Meconopsis aculeata*) and Saussurea species are noteworthy flora. Some important medicinal plants of the valley are *Aconitum heterophyllum*, *Aconitum falconeri*, *Arnebia benthamii*, *Dactylorhiza hatagirea*, *Gymnadenia orchidis*, *Megacarpaea polyandra*, *Picrorhiza kurrooa*, *Podophyllum hexandrum* and *Taxus wallichiana* here.

The density of wild animals in the valley is not high, but all the animals found are rare or endangered. A total 13 species of mammals are recorded in the park and its vicinity. Northern plains grey langur (*Semnopithecus entellus*), flying squirrel (*Petaurus petaurus*), Himalayan black bear (*Ursus thibetanus*), red fox (*Vulpes vulpes*), Himalayan weasel (*Mustela sibirica*), and Himalayan yellow-throated marten (*Martes flavigula*), Himalayan goral (*Naemorhedus goral*), Himalayan musk deer (*Moschus leucogaster*), Indian

chevrotain (*Moschiola indica*), Himalayan thar (*Hemitragus jemlahicus*) and serow (*Capricornis sumatraensis*) are found in this park. The serow, goral, musk deer and bharal, blue sheep are rare.

The common leopard (*Panthera pardus*) and snow leopard (*Panthera uncia*) are also reported from lower parts of the valley closer to the villages. Local people have also reported evidence of brown bear (*Ursus arctos*) and bharal or blue sheep (*Pseudois nayaur*). Some avian species frequently seen in the valley include lammergeier (*Gypaetus barbatus*), Himalayan vulture (*Gyps himalayensis*), yellow billed and red billed choughs (*Pyrrhocorax graculus*) and (*P. pyrrhocorax*), koklass pheasant (*Pucrasia macrolopha*), the nationally listed Himalayan monal pheasant (*Lophophorus impejanus*), scaly-bellied and yellow-nape woodpeckers (*Picus squamatus* and *P. flavinucha*), great and bluethroated barbets (*Megalaima virens* and *M. asiatica*), snow pigeon (*Columba leuconota*) and spotted dove (*Stigmatopelia chinensis*) etc. The area is relatively poor in reptiles: most often seen are the high altitude lizard (*Agama tuberculata*), Himalayan ground skink (*Leiolopisma himalayana*) and Himalayan pit viper (*Gloydius himalayanus*). Along with the flowers are wild bees and many species of butterfly which need to be more researched. A few of the more evident species are lime butterfly (*Papilio demoleus*), common yellow swallowtail (*Papilio machaon*), common Mormon (*Papilio polytes*), spangle (*Papilio protenor*) and common blue apollo (*Parnassius hardwickei*).

#### **Wildlife Sanctuaries**

Sanctuary is an area which has an adequate ecological, faunal, floral, geomorphological, natural or zoological significance. The Sanctuary is declared for the purpose of protecting, propagating or developing wildlife or its environment. Certain rights of people living inside the sanctuary could be permitted. Further, during the settlement of claims, before finally notifying the sanctuary, the District magistrate may, in consultation with the Chief Wildlife Warden, allow the continuation of any right of any person in or over any land within the limits of the Sanctuary.





A sanctuary is a protected area which is reserved for the conservation of only animal and human activities like harvesting of timber, collecting minor forest products and private ownership rights are allowed as long as they do not

interfere with well-being of animals. Boundaries of sanctuaries are not well defined and controlled biotic interference is permitted. List of wildlife sanctuary that exists in Uttarakhand is given in Table 4.6.

**Table 4.6**  
*List of wildlife sanctuaries and their details in Uttarakhand<sup>6</sup>*

Sl.No.	Name of the Wildlife Sanctuary (WLS)	District	Year of Establishment	Area ( Km <sup>2</sup> )
1	Askot Musk Deer WLS	Pithoragarh	1986	599.93
2	Binsar WLS	Almora	1988	47.07
3	Govind Pashu Vihar WLS	Uttarkashi	1955	485.89
4	Kedarnath WLS	Chamoli	1972	975.2
5	Sonanandi WLS	Pauri Garhwal	1987	301.18
6	Nandhaur WLS	Nainital and Champawat	2012	269.96
7	Mussorrie WLS	Dehradun	1993	10.82

### **1. Askot Wildlife Sanctuary**

Askot Musk Deer Sanctuary is located 54Km from Pithoragarh near Askot in Uttarakhand at an elevation of 1,650 m above from MSL. This sanctuary has been setup in 1986 in the area of 599.93 Km<sup>2</sup> primarily with the object of conserving the musk deer (*Moschus moschiferus*) and its habitat.

Though the musk deer are present in significant numbers in the sanctuary, they need further protection as they are an endangered species. The other animal species which are found in the Askot Sanctuary are the Jungle Cat, the Leopard, the Serow, the Barking Deer, the Civet Cat, the Ghoral and the Brown Bear.

### **2. Binsar Wildlife Sanctuary**

Binsar Wildlife Sanctuary is located in the Himalayas on top of the Jhandi Dhar hills. It is about 33 km north of the Almora city in Uttarakhand. Binsar was established in 1988 and cover an area of 47.07 Km<sup>2</sup> for the conservation and protection of the shrinking broad leaf oak (*Quercus*) forest of the Central Himalayan region, and it has over 200 birds

species. Binsar has a museum about the flora and fauna of the region. Binsar wildlife sanctuary is known for its wide variety of flora ranging from 25 types of trees and 24 types of bushes to seven varieties of grasses. The higher altitudes of sanctuary are covered with oak and rhododendron trees.

The mammals include leopard (*Panthera pardus*), Himalayan goral (*Naemorhedus goral*), Chital (*Axis axis*), musk deer (*Moschus spp*) and Indian muntjac (*Muntiacus muntjak*).

### **3. Govind Pashu Vihar Wildlife Sanctuary**

Govind National Park and Sanctuary was earlier known as Govind Pashu vihar sanctuary and was established in year 1955 in the area of 485.89 Km<sup>2</sup> in Uttarkashi district of Uttarakhand. It is named after a prominent Indian freedom fighter and politician Govind Ballabh Pant. The park lies in the higher reaches of the Garhwal Himalayas. The total area of Govind National Park and Sanctuary is 912.89 Km<sup>2</sup>. The Snow Leopard Project started by the Government of India is being managed at this sanctuary. Also, it is one of the remaining strongholds of the bearded vulture in the Himalayas.





The altitude of the park ranges from 1,400 to 6,323 m from MSL above sea level. The Hari-ki-dun valley and Ruinsiyara high altitude lake are located inside the sanctuary. These places are famous for trekking and tourism respectively.

The sanctuary contains western Himalayan broadleaf forests at its lowest elevations, transitioning to western Himalayan subalpine conifer forests and western Himalayan alpine shrub and meadows at its highest elevations. Trees present in the lower parts of the sanctuary include chir pine, deodar cedar, oak and other deciduous species. At altitudes over about 2,600 m common species of conifers such as blue pine, silver fir, spruce, yew, and other deciduous species such as oak, maple, walnut, horse, chestnut, hazel and rhododendron are also found.

There are about fifteen species of large mammals

and one hundred and fifty species of birds in sanctuary. This is the place from which the Indian Government has inaugurated the Snow Leopard Project. This project aims to provide special conservation measures to protect the snow leopard. Other mammals found in the sanctuary include the Asian black bear, the brown bear, the common leopard, the musk deer, the bharal, the Himalayan tahr and the serow. Smaller mammals include the Indian crested porcupine, European otter, goral, civet, hedgehog, Himalayan field rat, Hodgson's giant flying squirrel, wild boar, masked palm civet and Sikkim mountain vole.

Birds found here include several endangered species such as the golden eagle, the steppe eagle and the black eagle, the bearded vulture, the Himalayan snowcock, the Himalayan monal pheasant,



the cheer pheasant and the western tragopan. Smaller birds include owls, pigeons, minivets, thrushes, warblers, bulbuls, parakeets, cuckoos, tits, buntings and finches.

#### **4. Kedarnath Wildlife Sanctuary**

Kedarnath Wild Life Sanctuary, also called the Kedarnath Musk Deer Sanctuary, is a national sanctuary in Uttarakhand. Its alternate name comes from its primary purpose of protecting the endangered Himalayan musk deer. Consisting of an area of 975 Km<sup>2</sup>. It is the largest protected area in the western Himalayas and internationally important for the diversity of its flora and fauna.

Located in the Himalayan Highlands with an elevation ranging from 1,160 m near Phata to the Chaukhamba peak at 7,068 m, it was a notified reserve forest between 1916 and 1920 and changed to a sanctuary on 21 January 1972, and has been designated a "Habitat/Species Management Area" by the IUCN. Since 1972, the area of the park has expanded from 967 to 975 Km<sup>2</sup>.

The sanctuary straddles a geographically diverse landscape and transitional environment. IUCN has reported 44.4% to 48.8% of the sanctuary as forested, 7.7% comprises alpine meadows and scrub, 42.1% is rocky or under permanent snow and 1.5% represents formerly forested areas that have been degraded.

The sanctuary takes its name from the famous Hindu

temple of Kedarnath which is just outside its northern border. The entire 16 Km route from Gauri kund to Kedarnath temple (3,584 m) passes through this sanctuary.

- *Carnivores includes Indian jackal (*Canis aureus*), red fox (*Vulpes vulpes*), Himalayan black bear (*Ursus thibetanus*), yellow-throated marten (*Martes flavigula*), leopard cat (*Felis bengalensis*), Indian leopard (*Panthera pardus*) and snow leopard (*Uncia uncia*). Indian boar (*Sus scrofa cristatus*), Himalayan musk deer (*Moschus leucogaster*), and Indian muntjac. The primates recorded are rhesus macaque (*Macaca mulatta*) and common langur (*Presbytis entellus*). Among the smaller mammals are Hodgson's brown-toothed shrew (*Episoriculus caudatus*), red giant flying squirrel (*Petaurus petaurista*), and Royle's pika (*Ochotona roylei*).*

Important bird species reported are Himalayan monal (*Lophophorus impejanus*), Snow Partridge (*Lerwa lerwa*), kalij pheasant (*Iophura leucomelanos hamiltonii*), koklass pheasant (*Pucrasia macrolopha*), West Himalayan bush warbler (*Locustella kashmirensis*), little pied flycatcher (*Ficedula westermanni*), grey-cheeked warbler (*Seicercus poliocephalus*) and Rusty-flanked treecreeper (*Certhia nipalensis*). Recorded reptile species are Himalayan pit viper (*Gloydius himalayanus*) and Boulenger's keelback (*Amphiesma parallelum*).





## 5. Sonanadi Wildlife Sanctuary

Sonanadi Sanctuary is established in year 1987 and spread over 301.18 Km<sup>2</sup> in Pauri district of the Shivalik Tarai biotic province. Sonanadi literally means the 'river of gold'. Gold panning used to be carried out in the river before the area became a sanctuary. The Palain and the Mandal are the perennial streams of the sanctuary. Historically, it was carved out of Kalagarh Forest Division and brought under the umbrella of Project Tiger and became a part of the Corbett Tiger Reserve in 1991 and also a part of Project Elephant. The forests of Sonanadi are remarkable for dense sal and rich bamboo clusters besides other species and is teeming with wildlife.

Sonanadi range is blessed with amazing beauty of flora and fauna. As situated in the north of Sonanadi river, this zone is favourite place for Asiatic Elephant along with tiger, cheetal, sambhar, leopard and reptiles. 550 of birds are known to occur in this sanctuary. Some important birds are Thrushes, Pheasants, Hornbills, Warblers, Flycatchers, Wall-Creeper, Changeable Hawk-Eagle, Emerald Dove,

Himalayan Bearded Vulture, Falcon, Brown Fish Owls etc.

## 6. Nandhaur wildlife sanctuary

Nandhaur Wildlife Sanctuary in the state is located in Nainital and Champawat districts of Uttarakhand, and this was established in 2012. The sanctuary is part of the Tarai Arc Landscape (TAL), a forest zone stretches from Uttarakhand in India and extends into Nepal.

The Tarai Arc Landscape (TAL) extends from River Yamuna in India in the west to River Bagmati in Nepal in the east covering an area of about 50,000 Km<sup>2</sup>. The landscape is part of the Tarai-Duar Savana Eco-region and has two distinct physiographic regions, the tarai and the bhabar. TAL has one of the world's densest tiger populations. The tiger, Asian elephant and Indian rhinoceros are three flagship species of the region. In Uttarakhand, the rivers Yamuna, Ganga, Gola and Sharda divide the tarai into three large landscapes. The Nandhaur Sanctuary lies between the Gola and Sharda rivers in the Haldwani forest division and covers an area of 269.96 Km<sup>2</sup>.

The Nandhaur Sanctuary is a link between the Bramhadev and Sukhaphata Wildlife Reserves of Nepal and the western forests of Ramnagar and the Tarai central forest division in India. Before its notification as a wildlife sanctuary by the Ministry of Environment, Forest and climate change most of the Nandhaur landscape was a reserved forest. Since 2002, Nandhaur has been a part of the Shivalik Elephant Reserve. The Wildlife Institute of India in 2004 recognised Nandhaur as one of three viable habitats key to the long-term future of the tiger. Nandhaur is home to about 25 species of mammals, 250 species of birds, 15 species of reptiles and 20 species of fishes. The major mammalian species include Asian elephants, leopards, tigers and sloth bears.

**Table 4.7**  
Conservation reserves in Uttarakhand

Sl.No	Conservation reserve	Area (km <sup>2</sup> )	Inauguration year
1	Jhilmil Jheel Conservation Reserve	37.84	2005
2	Aasan Wetland Conservation Reserve	4.44	2005
3	Pawalgarh Conservation Reserve	5.82	2012
4	Nainadevi Himalayan Bird Conservation Reserve	111.91	2015



#### x. Problems and threats to forest

##### **Deforestation:**

Deforestation is clearing away woodlands to use the cleared land for other uses. Deforestation happens to all types of woodland, including jungle and rain forest. The land is often used for farming or urban development. The British began extending their control over forests in India (including Uttarakhand) after passing the Forest Acts of 1865 and 1878. This was driven by the increasing demand for timber, and hence the growing significance of forests as a source of revenue. Forests also acquired strategic importance with the growing requirement of timber for the expanding railway network.

During the period of colonial rule tree-felling in state was distinguished into three phases. In the first phase (1815-

1865) the demand for wood was low and there was only limited interest in managing forests. The demand for timber began to grow toward the end of this period, and it gained momentum in what can be seen as the second phase (1865-1913). During this phase the government built roads and improved waterways to ensure rapid transport of wood. As a result, between the 1860s and the early 1910s timber production, on average, increased from 0.72 to 4.5 million cubic feet per annum. In the third phase (1913-1947), timber out-turns fluctuated and was quite low between 1925 and 1935. However, the felling of trees peaked during World War II. Deforestation of forest resources across the state has posed a serious threat to the environment. The quantity of timber seized by the forest department in last 10 years since 2006 has ranged between 440 m<sup>3</sup> to nearly 868 m<sup>3</sup> / annum.





### Forest fire

Forest fires remain a major hazard in many ecosystems of the world, and a fire event may burn areas, influencing the species composition and ecosystem processes. In the Central Himalaya, particularly Uttarakhand, frequent man-made fires are an integral part of the chir-pine (*Pinus roxburghii*) – banj oak (*Quercus leucotrichophora*) in forest zone between 800 and 2000 m altitude. These man-made forest fires are also a major source of pollutants including black carbon which is regarded as a major cause of glacier melt in the Himalaya and has the capacity to influence regional climate. In Uttarakhand every summer, hundreds of hectares of forests are affected by forest fires. Wild fires lead to loss of human lives and wildlife species and also cause damage to the ecosystem. Almost every forest fire is caused by human beings. Some areas are set afire by local

communities to reduce grass on the forest floor. Many fires are caused by travellers throwing cigarette butts on roads passing through forests.

### Illegal trade and diversion of forest land

Encroachments, illegal tree felling and unregulated collection of forest products are also responsible for damage to forests. Many wildlife corridors have been choked due to unplanned development and this also contributes to increased human-wildlife conflict. The Ministry of Environment, Forests and Climate change data reveals that over 30,500 ha of forests have been diverted to non-forest use in Uttarakhand since the formation of the state in 2000. Over 60% of the diversions have been for road construction and power projects, primarily in Uttarkashi, Rudraprayag, Chamoli and Pithoragarh districts.



## B. Biodiversity

The United Nations Conservation on Biological Diversity define biodiversity as "the variability among all the organisms from all the sources, including, terrestrial, marine and other aquatic ecosystems and the ecosystem complexes of which they are part; this includes diversity within species, between species and of ecosystems". The United Nations has proclaimed May 22 as the International Biodiversity day to increase the understanding and awareness of biodiversity issues. Uttarakhand state constitutes a part of megadiversity hotspot. The biodiversity in any region provides the opportunities for discoveries of new crops, medicines, new

paths to economic development and also the means to mitigate the adverse effects of changing climate. A rich and unaltered biodiversity is always needed for the stability of ecosystems, though; in present time developmental activities and human interference in wilderness area have adversely affected the biodiversity. Even today the exploration of biodiversity in the state is incomplete particularly in the case of microorganisms. For the conservation of biodiversity the Uttarakhand state biodiversity board is constituted in 2006 at state level under the provision of Biological Diversity Act 2002. This board is reconstituted in 2011 and again in 2013. Based on several available sources the biodiversity profile of the Uttarakhand state is compiled here.

### i. Biodiversity profile of Uttarakhand

The floral and faunal composition in Uttarakhand is diverse and interesting. The territory of Uttarakhand spreads from snow covered high Himalayan peaks in the north to flat fertile land of Indo-Gangetic plains in south. Physiographically Uttarakhand comprises of Trans-Himalaya or semiarid zone close to Indo-Tibetan border, the Greater Himalaya or Himadri, The Lesser Himalaya, Shivalik ranges, and foot hills. The southernmost area has Bhabhar, the Dun valleys, Tarai and the flat land of Indo-Gangetic plains.



The major wealth of the state is its forests with very rich biodiversity. The state ranks 4<sup>th</sup> among the other states in terms of percentage of recorded forest area. The state has thus varied terrain, major portion of which is mountainous with unique ecological diversity consisting of high alpine areas to the Sub-tropical and Tropical regions. The forest diversity of the state comprises of Tropical Moist Forest (500-1000m) which is

Tarai and Bhabar belt of Sub Himalayan Tract, Sub-Tropical Pine Forest (1000-2000m), Himalayan Moist Temperate Forest (2000-3000m), Sub-Alpine Forests (3000-4000m) and Alpine Forests 4000-5000m). The state has a temperate climate except in plain areas where the climate is sub-tropical. The average annual rainfall is 1550 mm.

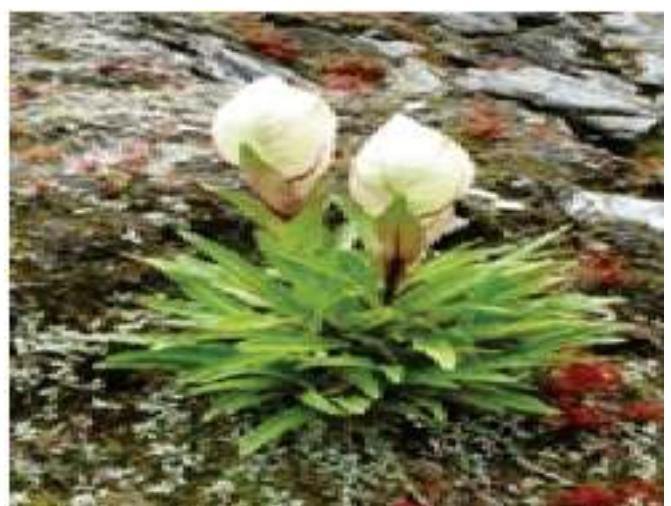
BIRDS 622 species	BUTTERFLIES 576 species	ORCHIDS 242 species	LICHENS 539 species
			

Enormous floristic and vegetation diversity marks the upper limit of vegetation, with variety of orchids, horticulture and economic plants, including Bamboo, wild germplasm of some cultivated species. By virtue of its extensive geographical stretch, varied terrain and climate of Himalayan Mountain Ranges in Uttarakhand are bestowed with a series of wetlands. Important perennial rivers are Ganga, Yamuna, Bhagirathi, Alaknanda, Ramganga, Nayar, Kosi, Saryu, Sharda and their tributaries. These wetlands, some of the most productive and endangered ecosystems, exhibit tremendous faunal diversity from Protozoa to Mammalia. They are roosting & breeding grounds and shelters for migratory and resident birds during various times of the year.

With abounding diversity on all accounts, the biodiversity of the state is bound to be rich. After the creation of Uttarakhand, as many as 3748 faunal species were inventoried and documented which included 451 species and sub-species. Ten species occurring in the state are

endemic to India. The faunal species included 1060 species of vertebrates, 2020 species of Insecta Invertebrates and 4346 invertebrates excluding Insecta.

The state is also home to several rare and endangered species of herbal and aromatic plants. Realizing the immense potential of this resource in the state, the state government has declared Uttarakhand as a Herbal state.





## **ii. Floral biodiversity**

Uttarakhand is the state located at the foothills of the snow clad Himalayas with lush green vegetation. There is a diverse range of flora and fauna in Uttarakhand. Traditionally, the mountains in the lower regions of Uttarakhand are covered with moist deciduous forest. Between elevations of 1,500-3,000m, the major natural vegetation entails of

Pine, Oak, Rhododendron, Walnut and Larch. Below

the timber line, the vegetation consists of forests of Spruce, Fir, Cypress, Juniper and Birch, while above the timber line (in the higher altitude of the state) is alpine vegetation which includes Mosses, Lichen and a diversity of wildflowers such as Blue Poppies and Edelweiss. As a result of deforestation, many of the original floral diversity is restricted to protected areas and sanctuaries. The flora of the state ranges from tropical deciduous to alpine vegetation; broadly categorized into three major types:

## 1. Sub-Tropical Zone of Uttarakhand:

The sub-tropical zone has pure as well as mixed forests of *Shorea robusta* (Sal), the others being *Lannea coromandelica* (Jhingan), *Buchanania lanza* (Chroli), *Dalbergia sissoo* (Shisham), *Haldina cordifolia* (Haldu), *Syzygium cumini* (Jamun), *Mallotus philippensis* (Rohini), *Mitragyna parvifolia* (Kadamb), *Terminalia spp.* (Myrobalans), *Ficus spp.* (Figs), *Macaranga denticulate* (blume), *Callicarpa arborea* (Bonmola), *Diploknema butyracea* (Chyura), *Bauhinia variegata* (Kachnar), *Bombax ceiba* (Semal), *Kydia calcina* (Pula), *Schleichera oleosa* (Kusum), *Holoptelea*

*integifolia* (Karanj), *Cassia fistula* (Amaltas), *Nyctanthes arbor-tristis* (Parijat), *Anogeissus latifolia* (Bakli, Dhaura), etc. The shrubby vegetation is represented by *Murraya koenigii* (curry patta), *Carissa opaca* (Amatungulu), *Clerodendrum cordatum* (bagflower), *Justicia adhatoda* (Malabar nut dusmuli), *Jasminum multiflorum* (jasmine), *Solanum erianthum* (wild tobacco), *Callicarpa macrophylla* (white berry), *Eranthemum nervosum*, *Phlogacanthus thyrsiformis* (Nongmang kha), *Jatropha curcas* (Jatropha), *Rhus parviflora* (Tintidika), *Dodonaea viscosa* (Hop bush), *Woodfordia fruticosa* (Dhataki) and many others.



## 2. Temperate Zone of Uttarakhand:

The Temperate zone is marked by the presence of *Quercus oblongata* and *Quercus leucotrichophora* (Banj oak), *Rhododendron arboreum* (Burans), *Myrica esculenta* (Kaphal), *Lyonia ovalifolia* (Anyar), *Ilex diphyrena* (Himalayan holly), *Quercus semecarpifolia* (Kharsu Oak), *Quercus dilatata* (Moru Oak), etc. The coniferous forests in this zone are unique. Pure stands of *Pinus roxburghii* (Chir Pine) and *Cedrus deodar* (Deodar, Cedar), *Abies pindrow* (Raga), *Pinus wallichiana* (Kail), *Taxus wallichiana* (Thuner, Himalayan Yew) at places give a pristine look to the slopes. The slopes in

temperate zone also have insectivorous plants like *Drosera peltata*, *Pinguicula alpina* and species of *Utricularia*. The saprophytes and parasites are also well represented by *Monotropa uniflora* (ghost plant), *Dendrophthoe falcata* (Banda), *Balanophora involucrata* (stone fungus), and species of *Viscum*, *Korthalsella*, *Arceuthobium*, *Scurrula*, etc. This zone has a variety of useful plants, some of them are well known for centuries. These include *Cedrus deodara*, *Pinus spp.*, *Abies pindrow*, *Quercus spp.*, *Aconitum heterophyllum*, *Paeonia emodi*, *Swertia chirayita*, *Bergenia ciliata*, *Dioscorea deltoidea*, *Angelica glauca* (Choru), etc.



### 3. Sub-Alpine and Alpine Zones of Uttarakhand:

The altitude above 3,000 metres is generally considered a zone of sub-alpine and alpine vegetation. The tree species are represented by *Pinus wallichiana* (chir pine), *Abies pindrow* (fir), *Prunus cornuta* (bird cherries), *Betula utilis* (Bhoj Patra) and *Quercus semecarpifolia* (beech). Species of the genera like *Cotoneaster*, *Rosa*, *Berberis*, *Ribes*, *Junipers*, *Rhododendron*, *Salix*, *Lonicera* are the shrubby components of the zone. The herbaceous vegetation is represented by a number of species of genera like *Potentilla*, *Primula*, *Aster*, *Saxifraga*, *Delphinium*, *Polygonum*, *Corydalis*, *Pleurospermum*, *Meconopsis*, *Pedicularis*, *Saussurea*, *Rheum*, *Silene*, *Stellaria*, *Gentiana*, *Ranunculus* etc. The Bugyal (alpine meadows) of this zone are well known for a rich and

diversified flora. Plant species like *Nardostachys grandiflora* (Jatamansi), *Podophyllum hexandrum* (Himalayan May-Apple, Papri), *Picrorhiza kurrooa* (Kutaki), *Armenia benthamii* (Bal char), *Rheum moocroftianum* (Dole), *Ephedra gerardiana* (somalata), *Dactylorhiza hatagirea* (Hatthajari), etc., in this zone, are of immense medicinal value.

The rich floral diversity of the state comprises of about 7066 species of plant species which includes 5096 species of Angiosperms and Gymnosperms. Uttarakhand is a home for many species of birds, mammals and reptiles. A total of 4917 faunal species including mammals, birds, reptiles, etc have been reported from the state. Table 4.8 shows the status of flora and fauna.

Group	Number of Species	Group	Number of Species
<b>Floral Diversity</b>		<b>Faunal Diversity</b>	
Algae	346	Thysanura	4
Bryophytes	478	Odonata	163
Lichens	539	Plecoptera	20
Pteridophytes	365	Orthoptera	116
Gymnosperms	35	Dermoptera	43
Monocotyledons including Orchids (Angiosperms)	1250	Isoptera	52
Orchids	242	Hemiptera	479
Dicotyledons	3811	Coleoptera	422
<b>Faunal Diversity</b>		Lepidoptera	576
Trematodes	48	Trichoptera	60
Cestodes	36	Hymenoptera (excluding Ichneumonidae)	235
Plants and soil Nematodes	196	Ichneumonidae (Hymenoptera)	302
Mollusca	129	Diptera	676
Annelida	69	Fishes	142
Crustacea	20	Amphibia	20
Chilopoda: Scolopendromorpha (Centipedes)	32	Reptiles	75
Arachnida	249	Aves	622
Collembola	31	Mammals	100

**Table 4.8**  
Status of flora  
and fauna in  
Uttarakhand<sup>7</sup>

#### Threatened Flowering Plants of Uttarakhand

Due to various reasons large numbers of flowering plant species are threatened in Uttarakhand. A list of such

species compiled from authentic sources indicates presence of 176 threatened species under 51 families. These species are listed in Table 4.9 with their habit and threat status.

<sup>7</sup>[www.utrenvis.nic.in/data/flora%20&%20%20-fona%50oct%2013.pdf](http://www.utrenvis.nic.in/data/flora%20&%20%20-fona%50oct%2013.pdf)



**Table 4.9**  
Threatened  
flowering plant  
species of  
Uttarakhand<sup>8</sup>.

S. No	Species Name	Habit	Threat Status
<b>Family- SCHIZANDRACEAE</b>			
1	<i>Schisandra grandiflora</i> (Wall.) Hook.f. & Thoms.	CI	I <sup>2</sup>
2	<i>S. propinqua</i> (Wall.) Baill.	CI	I <sup>2</sup>
<b>Family- LAURACEAE</b>			
3	<i>Cinnamomum glanduliferum</i> (Wall.) Meisn.	T	I <sup>2</sup>
4	<i>C. tamala</i> (Buch.-Ham.) T.Nees & Eberm.	T	VU <sup>4</sup>
<b>Family- DIOSCOREACEAE</b>			
5	<i>Dioscorea belophylla</i> (Prain) Viogt ex Haines	CI	I <sup>2</sup>
6	<i>D. deltoidea</i> Wall. ex Griseb.	CI	V <sup>1</sup> , EN <sup>4</sup>
<b>Family- MELANTHIACEAE</b>			
7	<i>Paris polyphylla</i> Sm.	H	EN <sup>4</sup>
<b>Family- COLCHICACEAE</b>			
8	<i>Gloriosa superba</i> L.	H	VU <sup>4</sup>
<b>Family- SMILACEAE</b>			
9	<i>Smilax wightii</i> A.DC.	CI	R <sup>2</sup>
<b>Family- LILIACEAE</b>			
10	<i>Fritillaria cirrhosa</i> D.Don (= <i>F. roylei</i> Hook.)	H	EN <sup>4</sup>
11	<i>Lilium polypodium</i> D.Don ex Royle	H	CR <sup>3</sup> , CR <sup>4</sup>
12	<i>L. wallichianum</i> Schult. & Schult. f.	H	I <sup>2</sup>
<b>Family- ORCHIDACEAE</b>			
13	<i>Aphyllorchis gollanii</i> Duthie	H	E <sup>1</sup> /PE <sup>1</sup> , Ex <sup>2</sup> /E <sup>2</sup>
14	<i>Bulbophyllum rauvii</i> Arora	H	I <sup>2</sup>
15	<i>Calanthe alismaeifolia</i> Lindl.	H	I <sup>2</sup>
16	<i>C. alpina</i> Hook.f. ex Lindl.	H	R <sup>1</sup> , R <sup>2</sup>
17	<i>C. mannii</i> Hook.f.	H	R <sup>1</sup>
18	<i>C. davidii</i> Franch. (= <i>Calanthe pachystalix</i> Reichb.f. ex Hook.f.)	H	E <sup>1</sup>

<sup>8</sup>Nayar, M.P. and Sastry, A.R.K. (eds.).(1987-90). Red Data Book of Indian Plants, vol- 1-3. Botanical Survey of India, Calcutta.; Rao, C.K., Geetha, B.L. and Suresh, G. (2003). Red list of threatened vascular plant species in India compiled from the 1997 IUCN red list of threatened plants. Botanical Survey of India, ENVIS Centre, Howrah.; Ved, D.k., Kinhal, G.A., Ravikumar, K., Prabhararan, V., Ghate, U, Vijaya Shankar, R. and Indresha, J.H. (2003). Conservation Assessment and Management Prioritization for the Medicinal Plants of Jammu & Kashmir, Himachal Pradesh and Uttarakhand. FRLHT, Bangalore.; IUCN Redlist (2017). IUCN Redlist of Threatened Species (published on internet & available at <http://www.iucnredlist.org/>; Uttarakhand Biodiversity Board (<http://www.sbb.uk.gov.in/>, accessed 13 June 2018).

19	<i>Coelogyne cristata</i> Lindl.	H	R <sup>2</sup>
20	<i>C. flaccida</i> Lindl.	H	I <sup>2</sup>
21	<i>C. nitida</i> (Wall. ex D.Don) Lindl.	H	R <sup>2</sup>
22	<i>Cymbidium eburneum</i> Lindl.	H	V <sup>1</sup>
23	<i>C. hookerianum</i> Rchb.f.	H	V <sup>1</sup>
24	<i>Cypripedium cordigerum</i> D.Don	H	R <sup>1</sup> , VU <sup>3</sup>
25	<i>C. elegans</i> Rchb.f.	H	R <sup>1</sup> , EN <sup>3</sup>
26	<i>C. himalaicum</i> Rolfe	H	R <sup>1</sup> , EN <sup>3</sup>
27	<i>Dactylorhiz hatagirea</i> (D.Don) Soo	H	CR <sup>4</sup>
28	<i>Dendrobium hesperis</i> (Seidenf.) Schuit & Peter B.Adams (=Flickingeria hesperis Seidenf.)	H	E <sup>1</sup> , E <sup>2</sup>
29	<i>Dendrobium macrostachyum</i> Lindl. (= Dendrobium gamblei King & Pantl.)	H	I <sup>2</sup>
30	<i>D. fimbriatum</i> Hook. (=Dendrobium normale Falc.)	H	I <sup>2</sup>
31	<i>Diplomeris hirsuta</i> (Lindl.) Lindl.	H	V <sup>1</sup>
32	<i>Eria occidentalis</i> Seidenf.	H	R <sup>1</sup> , R <sup>2</sup>
33	<i>Eulophia mackinnonii</i> Duthie	H	R <sup>1</sup> , R <sup>2</sup>
34	<i>E. obtusa</i> (Lindl.) Hook.f.	H	I <sup>2</sup>
35	<i>Galeola falconeri</i> Hook.f.	H	I <sup>2</sup>
36	<i>G. lindleyana</i> (Hook.f. & Thomson) Rchb.f.	H	I <sup>2</sup>
37	<i>Habenaria intermedia</i> D.Don	H	EN <sup>4</sup>
38	<i>Malaxis muscifera</i> (Lindl.) Kuntze	H	VU <sup>3</sup> , EN <sup>4</sup>
39	<i>Neottia acuminata</i> Schltr. (=Aphyllorchis parviflora King & Pantl.)	H	R <sup>1</sup>
40	<i>Neottia microglottis</i> (Duthie) Schltr. (= Archineottia microglottis (Duthie) Chen)	H	R <sup>1</sup> , R <sup>2</sup>
41	<i>Nervilia plicata</i> (Andrews) Schltr. (= Nervilia biflora (Wight) Schltr.)	H	I <sup>2</sup>
42	<i>Nervilia mackinnonii</i> (Duthie) Schltr.	H	I <sup>2</sup>
43	<i>Oreorchis foliosa</i> (Lindl.) Lindl. var. <i>indica</i> (Lindl.) N.Pearce & P.J.Cribb (= <i>Oreorchis indica</i> (Lindl.) Hook.f.)	H	I <sup>2</sup>
44	<i>O. micrantha</i> Lindl.	H	I <sup>2</sup>
45	<i>Pecteilis gigantea</i> (Sm.) Raf.	H	--
46	<i>Phaius tancarvilleae</i> (Banks et L. Herit.) Blume	H	--
47	<i>Tipularia cunnighamii</i> (King & Prain) S.C.Chen, S.W.Gale& P.J.Cribb (= <i>Didiccia cunninghamii</i> King & Prain ex King & Pantl.)	H	E <sup>1</sup> , E <sup>2</sup>



Family- IRIDACEAE			
48	<i>Iris kemaonensis</i> Wall. ex D.Don (= <i>Iris duthie</i> Foster)	H	I <sup>2</sup>
49	<i>Iris milesii</i> Baker ex Foster	H	I <sup>2</sup>
Family- AMARYLLIDACEAE			
50	<i>Allium auriculatum</i> Kunth	H	E <sup>2</sup>
51	<i>A. stracheyi</i> Baker	H	V <sup>1</sup> , V <sup>2</sup> , VU <sup>4</sup>
52	<i>A. loratum</i> Baker	H	E <sup>2</sup>
53	<i>A. roylei</i> Stearn	H	E <sup>2</sup>
Family- ASPARAGACEAE			
54	<i>Dipcadi reidii</i> Deb & S. Dasgupta	H	PEx <sup>1</sup> , Ex <sup>2</sup>
55	<i>Polygonatum cirrhifolium</i> (Wall.) Royle	H	VU <sup>4</sup>
56	<i>P. graminifolium</i> Hook.	H	I <sup>2</sup>
57	<i>P. verticillatum</i> (L.) All.	H	VU <sup>4</sup>
Family- ARECACEAE			
58	<i>Phoenix rupicola</i> T.Anderson	Sh	R <sup>1</sup> , V <sup>2</sup>
59	<i>Trachycarpus takil</i> Becc.	T	R <sup>1</sup>
Family- ZINGIBERACEAE			
60	<i>Cautleya spicata</i> (Sm.) Baker (= <i>Cautleya petiolata</i> Baker)	H	I <sup>2</sup>
Family- JUNCACEAE			
61	<i>Juncus duthiei</i> (C.B.Clarke) Noltie (= <i>Microschoenus duthiei</i> C.B.Clarke)	H	I <sup>1</sup> , I <sup>2</sup>
Family- CYPERACEAE			
62	<i>Kobresia duthiei</i> C.B.Clarke	H	I <sup>2</sup>
63	<i>K. esenbeckii</i> (Kunth) Noltie (= <i>Kobresia trinervis</i> var. <i>foliosa</i> (C.B.Clarke) Kuekenth.)	H	I <sup>2</sup>
Family- POACEAE			
64	<i>Cymbopogon microstachys</i> (Hook.f.) Soenarko (= <i>Cymbopogon flexuosus</i> var. <i>microstachys</i> (Hook.f.) Bor)	H	E <sup>2</sup>
65	<i>C. osmastonii</i> R.Parker	H	V <sup>2</sup>
66	<i>Elymus duthiei</i> (Melderis) G.Sing (= <i>Agropyron duthiei</i> Meld.)	H	I <sup>2</sup>
67	<i>Festuca lucida</i> Stapf	H	I <sup>2</sup>
68	<i>Microstegium falconeri</i> (Hook.f.) Clayton (= <i>Ischnochloa falconeri</i> Hook.f.)	H	I <sup>2</sup>
69	<i>Piptatherum hilariae</i> Pazij (= <i>Oryzopsis humilis</i> Bor)	H	I <sup>2</sup>
70	<i>Poa pseudamoena</i> Bor	H	I <sup>2</sup>
71	<i>P. rhadina</i> Bor	H	E <sup>2</sup>
72	<i>Pseudodanthonia himalaica</i> (Hook.f.) Bor & C.E.Hubb.	H	I <sup>2</sup>
73	<i>Puccinellia thomsonii</i> (Stapf) R.R. Stewart	H	I <sup>2</sup>
74	<i>Trisetum micans</i> (Hook.f.) Bor	H	I <sup>2</sup>
Family- PAPAVERACEAE			
75	<i>Corydalis cashmeriana</i> Royle	H	E <sup>2</sup>
76	<i>Meconopsis aculeata</i> Royle	H	E <sup>2</sup> , EN <sup>4</sup>

Family- BERBERIDACEAE			
77	<b>Berberis affinis</b> G. Don	Sh	R <sup>1</sup> , R <sup>2</sup>
78	<b>B. lambertii</b> R.Parker	Sh	V <sup>1</sup> /E <sup>1</sup> , V <sup>2</sup>
79	<b>B. osmastonii</b> Dunn	Sh	R <sup>1</sup> , R <sup>2</sup>
80	<b>B. petiolaris</b> Wall. ex G. Don var. <b>garhwalana</b> Ahrendt	Sh	I <sup>2</sup>
81	<b>B. pseudumbellata</b> R.Parker	Sh	I <sup>2</sup>
82	<b>Mahonia jaunsarensis</b> Ahrendt	Sh	I <sup>2</sup>
83	<b>Sinopodophyllum hexandrum</b> (Royle) T.S.Ying (=Podophyllum hexandrum Royle)	H	EN <sup>4</sup>
Family- RANUNCULACEAE			
84	<b>Aconitum ferox</b> Wall. ex Ser.	H	V <sup>1</sup> , V <sup>2</sup>
85	<b>A. heterophylloides</b> (Bruhl) Stapf (=A. deinorrhizum Stapf)	H	V <sup>1</sup>
86	<b>A. heterophyllum</b> Wall. ex Royle	H	EN <sup>3</sup> , CR <sup>4</sup>
87	<b>A. lethale</b> Griff. (= A. falconeri Stapf var. <i>latilobum</i> Stapf; A. balfouri var. <i>rhombilobatum</i> Stapf; A. falconeri Stapf var. <i>falconeri</i> )	H	V <sup>1</sup> , I <sup>2</sup> , VU <sup>4</sup>
88	<b>A. violaceum</b> Jacquem. ex Stapf	H	VU <sup>3</sup> , VU <sup>4</sup>
89	<b>Aquilegia nivalis</b> (Baker) Falc. ex B.D.Jacks	H	E <sup>2</sup>
90	<b>Delphinium koelzii</b> Munz	H	I <sup>2</sup>
91	<b>Trollius acaulis</b> Lindl.	H	E <sup>2</sup>
Family- SAXIFRAGACEAE			
92	<b>Saxifraga jacquemontiana</b> Decne.	H	E <sup>2</sup>
Family- CRASSULACEAE			
93	<b>Rhodiola heterodonta</b> (Hook.f. & Thomson) Boriss.	H	VU <sup>4</sup>
94	<b>Sedum duthiei</b> Frod.	H	I <sup>2</sup>
Family- FABACEAE			
95	<b>Astragalus stewartii</b> Baker (=Astragalus bakeri Ali)	Sh	I <sup>2</sup>
96	<b>Hedysarum astragalooides</b> Benth. ex Baker	H	R <sup>1</sup> , R <sup>2</sup>
97	<b>H. cachemirianum</b> Baker	H	R <sup>1</sup> /V <sup>1</sup>
98	<b>H. microcalyx</b> Baker	H	V <sup>1</sup>
99	<b>Indigofera cedrorum</b> Dunn	Sh	I <sup>2</sup>
100	<b>I. dosua</b> D.Don var. <b>simlensis</b> (Ali) Sanjappa (=Indigofera simlensis Ali)	Sh	I <sup>2</sup>
101	<b>Indopiptadenia oudhensis</b> (Brandis) Brenan	T	--
102	<b>Meizotropis pellita</b> (Prain) Sanjappa	H	--
103	<b>Saraca asoca</b> (Roxb.) Willd.	T	VU <sup>3</sup>
104	<b>Thermopsis inflata</b> Cambess.	H	I <sup>2</sup>
Family- ROSACEAE			
105	<b>Cotoneaster simonsii</b> Hort ex Baker	Sh	I <sup>1</sup> , I <sup>2</sup>
106	<b>Rubus almorensis</b> Dunn	Sh	I <sup>2</sup>
107	<b>Spiraea diversifolia</b> Dunn	Sh	I <sup>2</sup>
Family- ULMACEAE			
108	<b>Ulmus wallichiana</b> Planch.	T	E <sup>2</sup> , VU <sup>3</sup>
Family- DATISCACEAE			
109	<b>Datiscaria cannabina</b>	H	EN <sup>4</sup>



Family- HYPERICACEAE			
110	<i>Hypericum perforatum</i> L.	H	VU <sup>4</sup>
Family- VIOLACEAE			
111	<i>Viola kunawurensis</i> Royle	H	I <sup>2</sup>
Family- STAPHYLEACEAE			
112	<i>Turpinia cochinchinensis</i> (Lour.) Merr. (= <i>Turpinia nepalensis</i> Wall.)	T	--
Family- SAPINDACEAE			
113	<i>Acer caesium</i> Wall. ex Brandis	T	V <sup>1</sup> , V <sup>2</sup>
114	<i>A. oblongum</i> Wall. ex DC. (= <i>Acer oblongum</i> var. <i>membranaceum</i> Banerji)	T	E <sup>1</sup> , S <sup>2</sup>
115	<i>A. calcaratum</i> Gagnep. (= <i>Acer osmastonii</i> Gamble)	T	E <sup>1</sup>
Family- RUTACEAE			
116	<i>Zanthoxylum armatum</i> DC.	T	VU <sup>4</sup>
Family- SANTALACEAE			
117	<i>Santalum album</i> L.	T	VU <sup>3</sup>
Family- POLYGONACEAE			
118	<i>Rheum australe</i> D.Don (= <i>Rheum emodi</i> Wall. ex Meisn.)	H	EN <sup>4</sup>
119	<i>R. webbianum</i> Royle	H	VU <sup>4</sup>
Family- CARYOPHYLLACEAE			
120	<i>Arenaria curvifolia</i> Majumdar	H	E <sup>1</sup> , E <sup>2</sup>
121	<i>A. ferruginea</i> Duthie ex F.N.Williams	H	E <sup>1</sup> , E <sup>2</sup>
122	<i>A. neelgherrensis</i> Wight & Arn.	H	I <sup>2</sup>
123	<i>A. thangoensis</i> W.W.Sm.	H	V <sup>1</sup> , V <sup>2</sup>
124	<i>Cerastium thomsonii</i> Hook.f.	H	I <sup>2</sup>
125	<i>Silene kumaonensis</i> F.N.Williams	H	R <sup>1</sup> , R <sup>2</sup>
126	<i>Stellaria depressa</i> Em. Schmid	H	I <sup>2</sup>
Family- PRIMULACEAE			
127	<i>Embelia tsjeriam-cottam</i> (Roem. & Schult.) A.DC.	T	VU <sup>4</sup>
128	<i>Primula drumondiana</i> Craib	H	I <sup>2</sup>
129	<i>P. minutissima</i> Jacquem. ex Duby	H	E <sup>2</sup>
Family- SYMPLOCACEAE			
130	<i>Symplocos paniculata</i> (Thunb.) Miq.	T	VU <sup>4</sup>
Family- RUBIACEAE			
131	<i>Clarkella nana</i> (Edgew.) Hook.f.	H	R <sup>1</sup> , R <sup>2</sup>
132	<i>Rubia edgeworthii</i> Hook.f.	CI	V <sup>1</sup>
Family- GENTIANACEAE			
133	<i>Gentiana cachemirica</i> Decne.	H	E <sup>2</sup>
134	<i>G. crassuloides</i> Bureau & Franch.	H	R <sup>2</sup>
135	<i>G. infelix</i> C.B. Clarke	H	R <sup>2</sup>
136	<i>G. kurroo</i> Royle	H	CR <sup>3</sup> , CR <sup>4</sup>
137	<i>G. saginoides</i> Burkill	H	R <sup>2</sup>
138	<i>Swertia chirayita</i> (Roxb.) Buch.-Ham. ex C.B.Clarke	H	EN <sup>4</sup>
Family- APOCYNACEAE			
139	<i>Ceropegia angustifolia</i> Wight	CI	V <sup>1</sup> , V <sup>2</sup>
140	<i>C. bulbosa</i> Roxb.	CI	V <sup>2</sup> , EN <sup>4</sup>
141	<i>Rauvolfia serpentina</i> (L.) Benth. ex Kurz	Sh	VU <sup>4</sup>

Family- BORAGINACEAE			
142	<i>Arnebia benthamii</i> (Wall. ex D. Don) I.M. Johnst.	H	E <sup>2</sup> , CR <sup>4</sup>
143	<i>Arnebia euchroma</i> (Royle) I.M.Johnst.	H	EN <sup>4</sup>
Family- SOLANACEAE			
144	<i>Hyoscyamus niger</i> L.	H	VU <sup>4</sup>
Family- OLEACEAE			
145	<i>Schrebera swietenioides</i> Roxb.	T	--
Family- GESNERIACEAE			
146	<i>Didymocarpus pedicellatus</i> R.Br.		VU <sup>4</sup>
Family- PLANTAGINACEAE			
147	<i>Picrorhiza kurrooa</i> Royle ex Benth.	H	V <sup>1</sup> , CR <sup>4</sup>
Family- LENTIBULARIACEAE			
148	<i>Pinguicula alpina</i> L.	H	--
Family- LAMIACEAE			
149	<i>Elsholtzia densa</i> Benth.	H	I <sup>2</sup>
150	<i>Nepeta campestris</i> Benth.	H	I <sup>2</sup>
151	<i>Phlomoides superba</i> (Royle ex Benth.) Kamelin & Makhm. (=Eremostachys superba Royle ex Benth.)	H	VU <sup>4</sup>
152	<i>Roylea cinerea</i> (D.Don) Baill.	Sh	VU <sup>4</sup>
Family- CAMPANULACEAE			
153	<i>Campanula wattiana</i> B.K.Nayar & Babu	H	R <sup>1</sup> , R <sup>2</sup>
154	<i>Cyananthus integer</i> Wall. ex Benth.	H	R <sup>1</sup> , R <sup>2</sup>
Family- ASTERACEAE			
155	<i>Ageratum houstonianum</i> Mill.	H	I <sup>2</sup>
156	<i>Catamixis baccharoides</i> Thomson	Sh	V <sup>1</sup> , V <sup>2</sup>
157	<i>Cremanthodium arnicoides</i> (DC. ex Royle) R.D. Good	H	E <sup>2</sup>
158	<i>Himalaiella foliosa</i> (Edgew.) Raab - Straube (=Saussurea foliosa Edgew.)	H	I <sup>2</sup>
159	<i>Jurinea dolomiaeae</i> Boiss.	H	EN <sup>4</sup>
160	<i>Lactuca filicina</i> Duthie ex Stebbins	H	E <sup>1</sup> , E <sup>2</sup>
161	<i>Saussurea atkinsonii</i> C.B. Clarke	H	I <sup>2</sup>
162	<i>S. bracteata</i> Decne.	H	R <sup>1</sup> , R <sup>2</sup>
163	<i>S. clarkei</i> Hook.f.	H	R <sup>1</sup> , R <sup>2</sup>
164	<i>S. costus</i> (Falc.) Lipsch.	H	E <sup>1</sup> , E <sup>2</sup> , CR <sup>3</sup>
165	<i>S. gossypiphora</i> D.Don	H	VU <sup>4</sup>
166	<i>S. obvallata</i> (DC.) Edgew.	H	EN <sup>4</sup>
167	<i>S. roylei</i> (DC.) Sch. Bip.	H	I <sup>2</sup>
Family- CAPRIFOLIACEAE			
168	<i>Nardostachys jatamansi</i> (D.Don) DC. (= Nardostachys grandiflora DC.)	H	V <sup>1</sup> , CR <sup>3</sup> , CR <sup>4</sup>
169	<i>Valeriana jatamansi</i> Jones	H	VU <sup>4</sup>
Family- PITOSPORACEAE			
170	<i>Pittosporum eriocarpum</i> Royle	Sh	I <sup>1</sup> , I <sup>2</sup> , EN <sup>3</sup>
Family- ARALIACEAE			
171	<i>Panax pseudoginseng</i> Wall.	H	V <sup>1</sup>
Family- APIACEAE			
172	<i>Angelica glauca</i> Edgew.	H	EN <sup>3</sup> , EN <sup>4</sup>
173	<i>Ferula jaeskeana</i> C.B.Clarke	H	VU <sup>4</sup>

Ex-Extinct, PEx - Presumed Extinct, E-Endangered, R-Rare,

I - Indeterminate, CR - Critically Endangered

EN- Endangered, VU - Vulnerable,

Cl- Climber, T-Tree, H-Herb, Sh - Shrub



### iii. Faunal biodiversity

The fauna exhibits an admixture of Oriental, Palaearctic and Indo-Malayan elements. Faunal diversity of the state exceeds 4900 species of which Arthropods constitutes the richest group followed by birds. Mammals are represented by about 100 species. Uttarakhand is home to many endemic and threatened faunal. The birds top the list of threatened taxa with 45 species listed in IUCN Red list. Similarly,

27 Mammals, 14 Reptiles, and one species each of Amphibian, Pisces, Odonta and Mollusca are listed in IUCN Red list. Nearly 35 faunal species are endemic to Uttarakhand and the list is dominated by invertebrates (24 species) followed by 11 species of Pisces. Common birds and other fauna species are given in Table 4.10.

SI.NO	SPECIES	SCIENTIFIC NAME	IMAGES
1	Black Drongo	<i>Dicrurus macrocercus</i>	
2	Emerald Dove	<i>Chalcophaps indica</i>	
3	Golden Eagle	<i>Aquila chrysaetos</i>	

**Table 4.10**  
Common fauna species in Uttarakhand<sup>9</sup>

<sup>9</sup>[www.utrenvis.nic.in](http://www.utrenvis.nic.in)

4	Great Hornbill	<i>Buceros bicornis</i>	
5	Grey Francolin	<i>Francolinus pondicerianus</i>	
6	Himalayan Monal	<i>Lophophorus impejanus</i>	
7	Indian Cuckoo	<i>Cuculus micropterus</i>	
8	Indian Grey - Hornbill	<i>Ocyceros birostris</i>	



9	Indian Roller	<i>Coracias benghalensis</i>	
10	Little Green Bee-eater	<i>Merops orientalis</i>	
11	Red Junglefowl	<i>Gallus gallus</i>	
12	Spotted Dove	<i>Streptopelia chinensis</i>	
13	Parakeet	<i>Psittacula krameri</i>	

14	Robin	<i>Saxicoloides fulicatus</i>	
15	Blue-capped Rock Thrush	<i>Monticola cinclorhynchus</i>	

### b) ANIMALS

	SPECIES	SCIENTIFIC NAME	Images
1	Elephant	<i>Elephas maximus</i>	
2	Barking deer	<i>Muntiacus muntjak</i>	
3	Bharal	<i>Pseudois nayaur</i>	



4	Black bear	<i>Euarctos americanus</i>	
5	Ghoral	<i>Nemorhaedus goral</i>	
6	Musk deer	<i>Moschus leucogaster</i>	
7	Serow	<i>Capricornis sumatraensis</i>	
8	Leopard	<i>Panthera pardus</i>	
9	Sambar	<i>Rusa unicolor</i>	

10	Snow leopard	<i>Panthera uncia</i>	
11	Spotted deer	<i>Axis axis</i>	
12	Swamp Deer	<i>Rucervus duvaucelii</i>	
13	Tiger	<i>Panthera tigris</i>	

#### iv. Biodiversity and ecosystem services

Human kind benefits from a multitude of resources and processes that are supplied by ecosystem, collectively termed as "Ecosystem services". They include all the tangible and non tangible assets or products which human get from nature like food, recreation, clean water, air and processes such as decomposition of waste.

The term 'ecosystem services' was defined in the Millennium Ecosystem Assessment (MEA 2005) as 'the benefits people

obtain from ecosystems', both natural and managed. These services may be categorized as provisional, regulative, cultural or supporting services, also referred to as supporting processes. The first three categories have a direct impact on human well-being, whereas the latter has an indirect impact by supporting provisional, regulative, and cultural services. For simplicity all categories are referred as services in this report. However, all these services, whether direct or indirect, are essential for human life and the well-being of humans.

## Classification of ecosystem services

Service type	Examples of goods or services provided
Provisional	Fiber; Food; Freshwater; Fuel wood and other essential resources
Regulative	Climate regulation; Disease control and suppression of pathogens; Water purification and regulation
Supporting (processes)	Nutrient cycling; Primary production; Soil formation
Cultural	Aesthetics; Cultural heritage and sense of place; Educational; Recreational; Spiritual and religious

Quantifying the value of ecosystem services is of great importance for developing arguments and programs for protecting them. The value of some ecosystem services, such as the provision of food, fuel and fiber, can be quantified, but estimates often reflect single services rather than incorporating all services provided by an ecosystem. Moreover, for other services, such as mitigation of drought and floods, climate regulation, soil erosion prevention and water filtration, and services provided in the form of recreational, aesthetic or cultural values, it is very difficult to assign a price tag particularly because values vary across national and local boundaries. Nonetheless, preliminary estimates of the value of ecosystem services provided by Earth's biodiversity are on the order of trillions of US dollars annually. This value is likely grossly underestimated, but points toward the great impact of such services have on our lives and how a continued provision of these services is necessary to maintain the human population.

Uttarakhand has been maintaining a stance that the Uttarakhand forests were providing eco-system services to the state to the tune of Rs. 40,000 crore every year and thus need to be compensated as it was providing these services at the cost of development. The demand of green bonus by state from central government is technically and logically sound idea because the forests surplus state live with lots of handicaps due to the overbearing existence of forests, its benefit of ecosystem services and environment shared by forest deficit states.

### v. Biodiversity Act 2002 and its impact

It is as an act of parliament of India for preservation of biological diversity in India, and provides mechanism for equitable sharing of benefits arising out of the use of traditional biological resources and knowledge.

After an extensive and intensive consultation process the Govt. of India has brought Biological Diversity Act, 2002.

The objectives of the biodiversity act 2002 are as follows.

- To regulate access to biological resources of the country's equitable share in benefits arising out of the use of biological resources.
- To conserve and sustainable use of biological diversity.
- Setting up of National Biodiversity Authority (NBA), State Biodiversity Board (SBB) and Biodiversity Management Committees (BMCs).
- NBA and SBB are required to consult BMCs in decisions relating to bio resource/ related knowledge within their Jurisdiction.



- To respect and protect local communities traditional knowledge related to biodiversity.
  - To secure sharing of benefits with local people as conservers of biological resources and holders of knowledge and information relating to the use of biological resources.
  - All foreign nationals / organizations require prior approval of NBA for obtaining biological resources and / or associated knowledge for use.
  - Conservation and development of areas of importance from the standpoint of biological diversity by declaring them as biological diversity heritage sites.
  - Protection and rehabilitation of threatened species.
  - Involvement of institutions of state Government in the broad scheme of the implementation of the Biological Diversity Act through constitution of committees.
  - Protect India's rich biodiversity and associated knowledge against their use by foreign individuals and organizations without sharing benefits arising out of such use and check Biopiracy.
  - Indian Industry needs prior intimation to SBB to obtain bio resource. SBB has right to restrict if found to violate conservation and sustainable use and benefit sharing.
  - Provisions for notifying heritage sites by state Government in consultation with local body.
  - Creation of National, state and Local Biodiversity Fund and its use for conservation of biodiversity.
- The impact of biodiversity act 2002 broadly includes:
- More emphasis to conservation of biological diversity
  - Sustainable use of the components of biodiversity.
  - Fair and equitable sharing of benefits arising out of the utilisation of natural resources.



#### vi. Medicinal and aromatic plant: development in the state

The Himalaya has a great wealth of medicinal plants and traditional medicinal knowledge. The Central Himalayan Region covers the Uttarakhand state, provides excellent opportunities for studying the Traditional Knowledge Systems. The Central Himalayan region alone supports about 18,440 species of plants (Angiosperms: 8000 spp., Gymnosperm: 44 spp., Pteridophytes: 600 spp., Bryophytes: 1736 spp., Lichens: 1159 spp. and Fungi: 6900 spp.) of which about 45% are having medicinal properties.

According to a study out of the total species of vascular plants, 1748 species are medicinal. Uttarakhand is a storehouse of a rich variety of herbs and medicinal and aromatic plant species. Uttarakhand has observed an increase in the area under cultivation of aromatic and medicinal plants. The number of farmers engaged in cultivation of aromatic plants in Uttarakhand has dramatically increased from 301 in 20011-12 to 2714 in 2014-2015 and the area under aromatic plants has increased tenfold. Table 4.11 shows some important medicinal and aromatic plants found in Uttarakhand.

**Table 4.11**  
Some important medicinal and aromatic plants of Uttarakhand.

Sl. No	Botanical Name	Local Name	Parts Used	Uses	Mode of treatment
1	<i>Capsella bursa-pastoris</i> Moench.	Torighash	Whole Plant	For Sikka Rog	Two palmful whole plant decoction in water given two times for vigor
2	<i>Cardamine impatiens</i> , L.	Bittercress	Whole plant	For Tantrka in calf	One palmful whole plant decoction in one liter water given two times for vigor
3	<i>Viola biflora</i> L.	Banapsa	Whole plant	In calf for heart & faint problem	Two palmful whole plant two times a day for attack. Three/four parts of two palmful whole plant & a spoon honey given two times for heart & skin problem
4	<i>Viola patrinii</i> DC.	Zihuadiding	Root	For liver	Two palmful root decoction in one liter water given two times for vigor
5	<i>Viola serpens</i> Wall.	Banapsha	Root	For Liver	Two palmful root decoction in one litre water given three times with honey
6	<i>Hypericum cernuum</i> Ro xb.	Vaya, Culi	Whole plant	For Hoskins, and wound	Two palmful whole plant decoction in one litre water given two times for vigor
7	<i>Linum usitatissimum</i> L.	Alsi	Whole plant	For strength	Two palmful whole plant decoction in 1 & 1/4 litre water given two times for strength

<b>8</b>	Melilotus albus Lamk.	Banmethi	Whole plant	For stomach problem and Indigestion	One palmful whole plant given three times in a day for vigor
<b>9</b>	Trifolium repens L.	Garila	Whole plant	For Satrika	Four palmful whole plant given two times a day
<b>10</b>	Agrimonia pilosa Ledeb.	Kafliya	Whole plant	For purification of blood	Half palmful whole plant decoction in three/ four litre water given one fourth part with gur in morning
<b>11</b>	Fragaria vesca L.	Pudalia Kafal	Leaf	To protect abortion	Two palmful leaves given daily
<b>12</b>	Potentilla argyrophylla Wall. ex Lehm.	Danti, Brajdanti	Leaf/ Root	For stomach problem	One palmful leaves/two matured root decoction in 3/4 litre water given thrice in a day
<b>13</b>	Rhamnus virgata Roxb.	Chaitula	Fruit	In Leg swelling	Five matured fruit decoction in 1/4 litre water given daily
<b>14</b>	Rosa moschata Herrm.	Kunj pani	Fruit	For leucorhea, bleeding, pregnancy termination	Two palmful fruit with one spoon honey given daily
<b>15</b>	Rubus paniculatus Sm.	Kala Hisalu (Kadula)	Leaf	In pregnancy	Two palmful leaves decoction in 1/2 litre water given its one cup twice a day
<b>16</b>	Rubus lasiocarpus, Sm.	Kala Hisalu	Leaf	In pregnancy	Leaf is useful for cow specially in pregnancy pain
<b>17</b>	Bergenia ciliata Moench.	Silfora	Root	For Hydrophobia	Two palmful root decoction in 1/2 litre water given its one cup thrice a day
<b>18</b>	Ribes grossularia L..	Caktu	Whole plant	For preventing abortion	One palmful whole plant given daily
<b>19</b>	Punica granatum L.	Darim	Skull of fruit	As antimicrobials	One palmful skull of fruit decoction in 1/2 litre water given its one cup three times a day with gur
<b>20</b>	Woodfordia floribunda Salisb.	Dhow	Flower	As energy syrup	One palmful dry flower decoction in water is useful for animals
<b>21</b>	Centella asiatica, (L.)Urban	Brahmi	Leaf	For brain fever	Apply Paste of green leaves on forehead during fever
<b>22</b>	Cuminum cyminum L.	Jeera	Seed	For indigestion	One palmful seed in 1/4 litre water given daily



23	<i>Foeniculum vulgare</i> Mill.	Saunf	Seed	For Hookworm	One palmful seed in 1/8 litre water given before morning meal
24	<i>Pimpinella diversifolia</i> DC.	i	Seed	For Lactation	One palmful seed given daily
25	<i>Adina cordifolia</i> Hook. f.	Haldu	Bud & leaf	For Wound & fever	Applying paste of new bud on the wound. Decoction of leaves in ½ litre water given thrice a day in fever
26	<i>Valeriana hardwichii</i> Wall.	Samyo, Dhup	Root	For titaini	Four matured root decoction in two litre water given ¼ litre twice a day
27	<i>Aesculus indica</i> Coleb. r.	Pangar	Fruit	In stomach problem	One palmful fruit decoction in ½ litre water given with gur
28	<i>Artemisia maritima</i> ,L.	Seawarmw ood	Bud/ Leaf	For Indigestion	One palmful bud/leaves decoction in one litre water given one cup daily
29	<i>Artemisia nilagirica</i> , Pampanini.	Patti, Kunj	Whole Plant	For urinary tract infection	One palmful whole body decoction in one liter water given one cup with gur
30	<i>Artemisia parviflora</i> Roxb.	Patti, Dhopani	Leaf/ Bud	For round worm	One palmful leaves/ bud decoction in a litre water given 1/8 litre in one hour interval
31	<i>Artemisia sacrorum</i> , Ladeb.	Kapar Patti, Jholpatti	Leaf/ Bud	For hair fall	One palmful leaves & bud decoction in two litre water given one cup twice a daily
32	<i>Senecio chrysanthemoides</i> DC.	Ratpatia	Whole plant	For skin disease	Two palmful whole plant decoction in 3/4 litre water given one cup daily
33	<i>Senecio rufinervis</i> DC.	Ragwort	Seed	For wound	Three palmful seed given twice a daily
34	<i>Geranium pratense</i> , L.	Chalmori	Whole plant	In fever, urine problem, eye problem	Two palmful whole plant decoction in 3 / 4 litre water given one spoon thrice daily
35	<i>Tanacetum nubigenum</i> Wall.	Bitter buttons	Leaf/ Fruit	As energy syrup, anti microbes.	One palmful leaves/ fruit decoction in one litre water given one spoon with honey
36	<i>Lobelia pyramidalis</i> Wall.	Ban tobacco	Whole Plant	For liver disease	Two palmful whole body decoction in 3 / 4 litre water given one spoon with honey thrice a daily

<b>37</b>	<i>Anagallis arvensis</i> L.	Vish Khaparia	Fruit/Le af	As pain killer	Two palmful fruit/ leaves given daily
<b>38</b>	<i>Primula denticulata</i> , S mith.	Vish Khaparia	Fruit	In cough, useful for mammary glands	Two palmful flower given with gur
<b>39</b>	<i>Primula macrophylla</i> D. Don.	Primrose	Whole Plant	As painkiller	This plant works as painkiller
<b>40</b>	<i>Holarrhena antidysenterica</i> Wall.	Quiar, Indraw	Seed & bark	In fever, Gastric & dysentery	One palmful powder of bark/ seed decoction in one liter water given one cup with gur
<b>41</b>	<i>Calotropis procera</i> R. Br.	Ank	Root	In indigestion	One palmful powder of root decoction in one litre water given one cup twice a day
<b>42</b>	<i>Gentiana tenella</i> (Roltb.) H. Smith.	Kutuki, Katuwi	Fruit	In hysteria, in weakness	25g of bark of fruits decoction in one litre water given one cup with honey per day
<b>43</b>	<i>Swertia purpurascens</i> Wall.	Chiraita	Whole Plant	In fever, In weak appetite.	Two palmful whole plant decoction in one litre water given one cup thrice a day
<b>44</b>	<i>Capsicum annum</i> L.	Khursane, Marac	Fruit	As oil massage	One palmful fruit decoction in three litre water gives one cup twice a day
<b>45</b>	<i>Datura metal</i> L.	Dhatura	Seed	As pain killer (for external use only)	25g roasted seed in one litre oil is used for massage
<b>46</b>	<i>Hyoscyamus niger</i> L.	Ban juwan	Leaf & Seed	As pain killer	Paste of leaves and seed is used as ointment
<b>47</b>	<i>Digitalis purpurea</i> L.	Prawasit tilpushpi	Leaf	In burning	One palmful leaves is roasted with oil is used as ointment
<b>48</b>	<i>Verbascum thapsus</i> L.	Akalvir	Leaf	In bronchitis	One palmful leaves decoction in 3/4 litre water given one cup thrice a day
<b>49</b>	<i>Clerodendrum infortunatum</i>	Aranyo	Bark	In diarrhea and liver disorder	Powdered bark decoction in 2 litre water given one cup thrice a day
<b>50</b>	<i>Ajuga parviflora</i> Benth.	Ratpatia	Whole plant	In arthritis	One palmful whole plant decoction in 3/4 litre water given one cup daily

Medicinal & aromatic plants (MAPs) have been a vital substrate for human health ever since the dawn of civilization. The Indian Sub-continent, particularly the state of Uttarakhand, has the distinction of supporting a wide range of faunal and floral diversity including rare and valuable MAPs, as also being the abode of the ancient health system of 'Ayurveda' that has been used to the benefit of mankind for more than 5000 years.

However, many once abundant species of MAPs, have suffered a serious decline due to an ever-expanding market fuelled by the needs of an exploding human and animal population, making them a topic of worldwide concern. The major reasons for the depletion of this important natural resource are uncertain tenurial regimes over land and plant resources, over collection of wild populations and unsustainable management practices, in addition to other factors such as destruction and reduction of habitat, competition by invasive weeds, pollution and climate change.

At present it is estimated that more than 90% of all the herbal raw material is a produce of collections from the wild. The responsible use of the natural resources to ensure their availability for the future is a major global concern and sustainable utilization of MAP populations is the most tenable strategy for conserving them. This state offers a wide range of habitats extending from Sub-tropical to Temperate to Alpine and Cold Desert types of climate that supports more than 5000 species of vascular plants out of which 800 species have been used traditionally and are of known medicinal value. The physical and cultural environment is highly conducive for the growth of MAPs in this state.

The state govt. of Uttarakhand has thus decided to adopt a policy that allows the extraction of medicinal plants from the wild only up to a sustainable extent and the promotion of large scale cultivation of MAPs to meet the growing demands of industries. It is visualized that such an

eco-friendly policy shall ensure proper development and conservation while at the same time providing suitable opportunities of better economic returns to the local communities.

#### **vii. Government scheme related to medicinal plants**

The Central Government has decided to commission a study on what needs to be done for boosting Indian systems of medicine. The idea is to help the herbal drug manufacturing industry and to raise its export revenue to the same high level as exists for allopathic medicines. From year 2015-16 onwards, "Centrally Sponsored Scheme of National Mission on Medicinal Plants" (NMPB) has been merged with "National AYUSH Mission (NAM)" as a component viz. "Medicinal Plants" and is continuing with the same activities. Under this scheme financial assistance to develop nurseries and cultivation of medicinal plants for AYUSH purpose is provided to all states including state of Uttarakhand.

National mission on medicinal plants -This mission in the state is being implemented with the support of National medicinal plant board, which aims to establish model and small nurseries in public/ private sector for ensured supply of quality planting material, promote mass cultivation of selected species in identified clusters. Near about 100 nurseries have been established and net area of over 500 ha is targeted for cultivation of species.

#### **viii. Traditional health care system**

The traditional knowledge of medical systems of northern India (such as Ayurveda) is a part of time tested culture. Medicinal plants have strong acceptance in religious activities, ritual and belief system of north Indian native communities, who worshipped the plants in the form of god, goddesses and minor deities. The name of some, *Origanum vulgare*, *Saussurea obvallata*, *Ocimum sanctum*, *Cedrus deodara*, *Cynodon dactylon*, *Aegle marmelos*, *Juniperus communis*, *Musa paradissica*, *Nardostachys grandiflora*, *Zanthoxylum armatum*, *Ficus benghalensis* and *Ficus religiosa*



are examples of the medicinal plants used commonly for medicinal as well as a religious purposes by the Hindus and local people in northern India. Despite of human use, different plant species also has application in animal husbandry as the primary source of healthcare. Plants are one of the most valuable sources of medicines system. In India the references to the healing properties of some herbs in the Rig-veda seems to be the earliest account of use of plants in medicines. The medicinal plants are broadly utilized all over the world in two distinct areas of health management; traditional system of medicine and modern system of medicine. The traditional system of medicine mainly functions through two distinct streams

- (1) Local or folk or tribal stream and
- (2) Codified and structured Indian system of medicines like Ayurveda Siddha and Unani etc.

More than the centuries, the use of medicinal herbs has become an important part of daily life despite the progress in modern medical system. Around 3000 plants species are known to have medicinal properties in India. Our traditional systems of medicines, for primary health care viz.,

Ayurveda, Unani, Siddha and Homeopathy etc. use herbs for treatment. It is likely that 40% of the humankind populations depend directly on plant based medicine for their health care. In India, medicinal plants offer low cost, easily available, less side effects as compared to modern medicine and safe health care solutions. The medicinal characteristics of many plants are found in leaves, used as alterative, tonic diuretic, blood purifier and antiphlogistic. They are used as remedy against chronic eczema, chronic ulcers, chronic rheumatism, chronic nervous diseases, madness, cholera amenorrhoea, piles and fistula.

Recent approximation suggests that over 9,00 plants are known for medicinal uses in various cultures of Uttarakhand and this is without having conducted comprehensive research amongst numerous indigenous and other communities. Medicinal plants are used at the family or household level for taking care of their families at the village level. According to the World Health Organization, over 80% of the world's population rely upon such traditional plant based systems of medicine for primary health care. Table 4.12 shows some traditionally used plants in Uttarakhand.

**Table 4.12**  
Some traditionally used plants in Uttarakhand.

Local name	Botanical name	Part used	Used to cure
Kalonji	<i>Nigella sativa</i>	Seeds	Diarrhoea, dysentery
Neem	<i>Azadirachta indica</i>	Root, bark, flower	Arthritis, bronchitis, cough, diabetes
Dhatura	<i>Datura stramonium</i>	Leaves and fruits	Asthma, cardiac pains
Tulsi	<i>Ocimum sanctum</i>	Leaves	Antiallergic, antidiabetic
Anar	<i>Punica granatum</i>	Seeds, flowers	Syphilis, bronchitis, stomachic
Methi	<i>Trigonella foenum</i>	Seeds	Constipation, diabetes
Paiya	<i>Prunus cerasoides</i>	Bark, fruit	Antipyretic, leprosy
Ajwain	<i>Thymus vulgaris</i>	Seeds	Antiseptic, antispasmodic
Peepal	<i>Ficus religiosa</i>	Bark, leaves, fruit, seeds, latex	Skin diseases, neuralgia, constipation and gynecological diseases



## **ix. Institutes/Agencies working in the area of medicinal plants**

### **1. Herbal Research & Development Institute (HRDI)**

The Herbal Research and Development Institute (HRDI), a nodal agency of Uttarakhand Medicinal Plant Board, has been established at Gopeshwar in 1989 for conservation, development and sustainable utilization of the valuable medicinal and aromatic plant resources of Uttarakhand. Distance from district headquarter Gopeshwar is 16 km far from the institute.

It is an autonomous institute of the Uttarakhand Government registered under the Registration of Societies Act, 1860. Area of institute is surrounded by dense forest in western side and villager's habitation in eastern side. It is situated at 1600m elevation and occasionally snow fall occurs during winters but snow does not exist for long time due to low height. Wild satawar, chirayata, daruhaldi and other important medicinal plants with many species of orchids exists nearby forest.

The main objective of HRDI is to co-ordinate medicinal and aromatic plants activities carried out by various Govt agencies, farmers, research institutes, NGOs, etc. The main field activities of the institute cover the following areas:-

- Cultivation of valuable medicinal and aromatic plants of Uttarakhand, primarily to improve livelihood opportunities.
- Survey, inventorisation and conservation of biodiversity of medicinal and aromatic plants.
- Research on agro-technique, bio-diversity, biotechnology and genetic improvement of medicinal plants.
- Development of cultivation techniques for

medicinal and aromatic plants and transfer of technology to the farmers and growers.

- Revitalization of traditional knowledge and the ancients Indian medicine system, Ayurveda.
- Quality control assessment and research on active ingredients and substances of medicinal and aromatic plants.
- Human resource development, extension and dissemination of information relating to medicinal and aromatic plants.
- Co-ordination of activities of institutions/ departments engaged in development of medicinal and aromatic plants in Uttarakhand.

### **2- Central Institute of Medicinal and Aromatic Plants (CIMAP)**

Central Institute of Medicinal and Aromatic Plants, popularly known as CIMAP, is a frontier plant research laboratory of Council of Scientific and Industrial Research (CSIR). Established originally as Central Indian Medicinal Plants Organisation (CIMPO) in 1959, CIMAP is steering multidisciplinary high quality research in biological and chemical sciences and extending technologies and services to the farmers and entrepreneurs of medicinal and aromatic plants (MAPs) with its research headquarter at Lucknow and Research Centres at Panthagar and Purara in Uttarakhand and Bangalore and Hyderabad . CIMAP Research Centres are aptly situated in different agro-climatic zones of the country to facilitate multi-location field trials and research. A little more than 50 years since its inception, today, CIMAP has extended its wings overseas with scientific collaboration agreements with Malaysia.



CIMAP's contribution to the Indian economy through its MAPs research is well known. Mint varieties released and agro-packages developed and popularised by CIMAP has made India the global leader in mints and related industrial products. CIMAP has released several varieties of the MAPs, their complete agro-technology and post harvest packages which have revolutionised MAPs cultivation and business scenario in the Uttarakhand as well as in the country. Recognizing the urgent need for stimulating research on medicinal plants in the country and for coordinating and consolidating some work already done by organizations like the Indian council of Agricultural Research, Indian Council of Medical Research, Tropical School of Medicine of Kolkata and various states Governments and Individual workers, the Council of Scientific and Industrial Research established CIMAP with the following objectives.

To co-ordinate and channelise along fruitful directions the present activities in the field of medicinal plants carried out by the various agencies, state Governments etc.,

To develop the already existing medicinal plants resources of India,

To bring under cultivation some of the important medicinal plants in great demand and also to introduce the cultivation of exotic medicinal plants of high yielding

active principal content.

CIMAP is equipped with state-of-the-art multidisciplinary laboratories, ultra-modern instrumentation facilities and scientific expertise in agriculture, genetics and plant breeding, molecular taxonomy, molecular and structural biology, plant biotechnology, biochemistry, microbiology, bio energy and chemical sciences, apart from development of herbal products. CIMAP, Lucknow houses the National Gene Bank of medicinal and aromatic plants, in addition to seed gene bank, tissue and DNA bank. Further, Field Gene Bank of different varieties of MAPs is maintained at CIMAP Lucknow and its four research centres situated across the country in which two centres Pantnagar and Purora are located in Uttarakhand state and rest two are in Bangalore and Hyderabad.

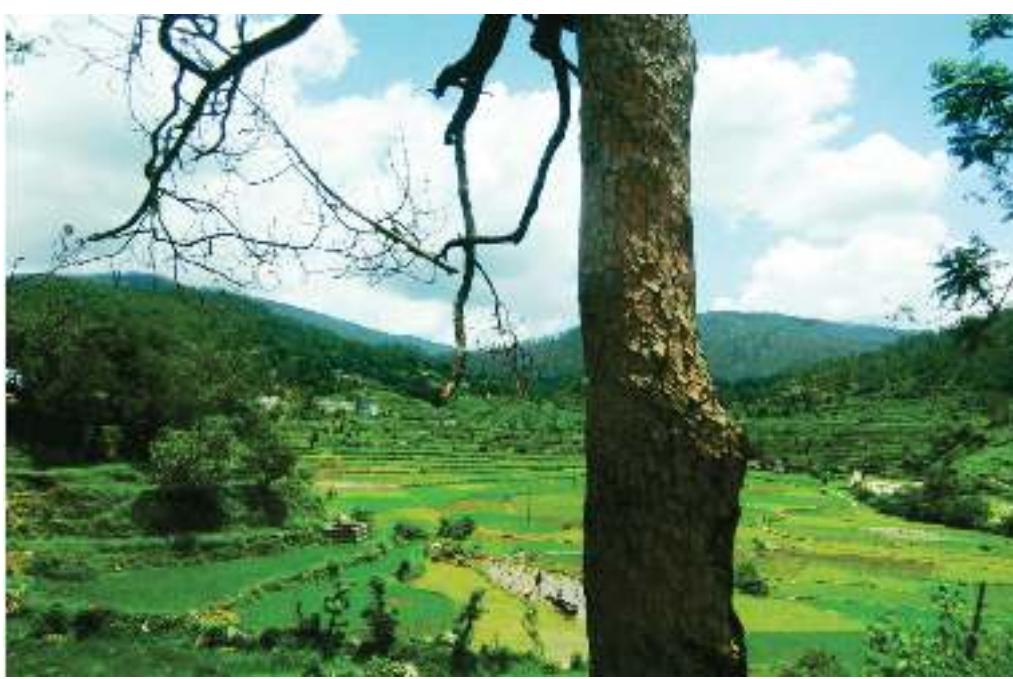
### **3. Regional Ayurveda Research Institute Ranikhet**

RARI is established under the Council of Research in Ayurvedic Sciences Ministry of Ayush. It is a premier institute in the frontier areas of the research on medicinal plants. The institute is maintaining a herbarium holding more than 62935 herbarium sheet & 624 museum crude drug specimen belong to North West Himalayan region used in Ayurvedic system.





# Agriculture and Horticulture



- i. Agriculture and horticulture land use
- ii. Land holding pattern
- iii. Irrigation network
- iv. Major crops
- v. Organic agriculture, horticulture and floriculture
- vi. Agriculture/Horticulture inputs of fertilizers, pesticides and seeds
- vii. Integrated pest management
- viii. Tea cultivation: status and its potential
- ix. Government schemes
- x. Regulatory mechanism
- xi. Livelihood based on agriculture, horticulture & floriculture
- xii. Marketing of agriculture horticulture & floriculture produce
- xiii. Livestock: Status and policies
- xiv. Constraints in Agriculture, horticulture & floriculture



# 05

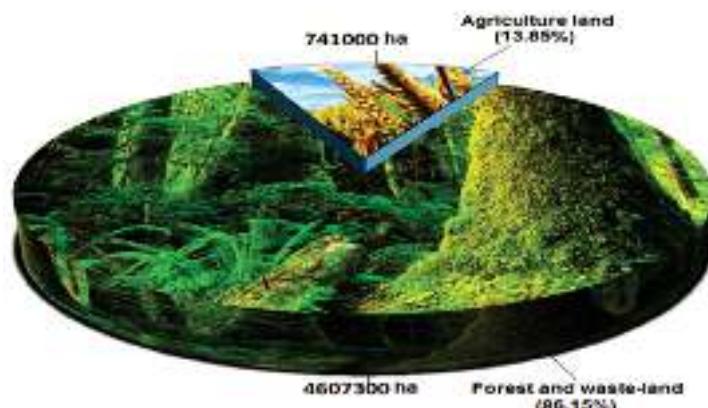
Like most states in India, agriculture is one of the significant sectors of the economy of Uttarakhand. Agriculture sector employs approximately 55 percent of workers and provides livelihood security to the major proportion of population in the rural areas (Census 2011). In Uttarakhand as in whole of the country, majority of farmers belong to the small and marginal category and produce near about half of the total grains. Over 55 percent of cultivated area of Uttarakhand is rainfed with frequent moisture stress to crops. The soil is low to medium in fertility status. Uttarakhand state has diverse agro-climatic endowments. The plain and hilly areas present differing scenarios for agriculture. Commercial agriculture is practiced largely in the plains. The hill farmers practice mixed cropping, while in the plains in a given season, mostly unicropping is practiced. Uttarakhand state falls under 9th and 14th agroclimatic zones as given by the agro-climatic regional planning by Planning Commission. Altitude wise the

state is divided into 4 zones (zone A, B, C, and D). The physiographic details of Uttarakhand's various zones are given in Table 5.1.

Out of the total 5348300 hectares area of Uttarakhand, most of the area is under forests and wastelands (86.15%) and a small portion of total land (13.85%) is available for practicing agriculture (Fig 5.1). The soil of Tarai region is very fertile and supports a number of crops. Currently, gradual reduction in fertility/productivity of the soil has been reported by government owing to non-judicious use of chemicals and over-exploitation of groundwater. On the other hand, the hill region is prone to constant soil erosion due to steep slopes which again makes it less fertile. Generally two kinds of agricultural practices are adopted by the state farmers i.e. rain fed and irrigated. Most of the agriculture in the state is rainfed. Moreover, a larger geographical area is occupied by hills; irrigation water is available mostly in plains and valleys.



**Fig 5.1**  
Available area  
for cultivation  
in Uttarakhand



**Table 5.1**  
Distribution of state in various physiographic zones<sup>1</sup>

Zone	Altitude (m)	Average Rainfall (mm/yr)	Farming situations	Soil	Districts under zone
Zone A (Valleys)	Up to 1000	1400	Tarai irrigated	Alluvial	All other districts except Chamoli and Uttarkashi
		1400	Bhabar irrigated	Alluvial	
		2000-2400	Lower hills irrigated	Alluvial sandy	
		2000-2400	Rainfed lower hills	Residual sandy loam	
Zone B (Mid hills)	1000-1500	1200-1300	Mid hills south aspects	Sandy loam	Almora, Bageshwar, Champawat, Dehradun, Nainital, Tehri Garhwal
Zone C (High hills)	1500-2400	1200-2500	High hills	Red to dark	Almora, Bageshwar, Chamoli, Pithoragarh
Zone D (Alpine zone)	>2400	~1300	Very high hills	Red to dark black clay	Chamoli, Pithoragarh, Uttarkashi

According to agriculture statistics, the food grain production is quite variable in different areas of the state. Food grain productivity of the districts Udhampur, Haridwar, plain areas of Nainital and Dehradun is always observed very high. On the other hand, productivity of the hilly areas such as Pithoragarh, Uttarkashi, Tehri, Bageshwar, etc. is comparatively low, even the valleys of these districts are more fertile than that of other hilly parts. Although, Green revolution had highly benefitted the farming system of the plain area of the state but it has no impact in the hilly region. Environment and weather conditions and fragility of mountainous land are most significant constraints to the crop production in hilly parts of state.

#### i. Agriculture and horticulture land use

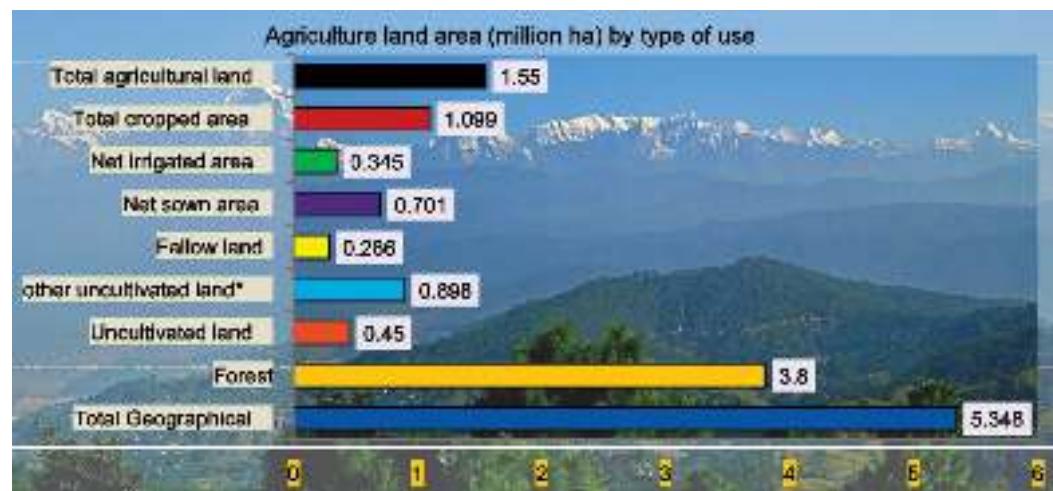
Uttarakhand accounts for 1.62 % of the total geographical area of the country and 0.83 % of the total population. Out of the total area, the Kumaon division of the state covers an area of 21,034 Km<sup>2</sup> with a total of 42.28 lakh people, whereas the Garhwal division has an area of 32,449 Km<sup>2</sup> with a population of 58.56 lakh (Census 2011). Therefore, population density of the state is 189 people per square kilometre having 2001–2011 decadal growth rate of 19.17%. Most of the land of Uttarakhand is under forests with forest

<sup>1</sup>Mani, S. C. 2013. Status paper on rice in Uttarakhand. (RKMP), Directorate of Rice Research, Rajendranagar.:.

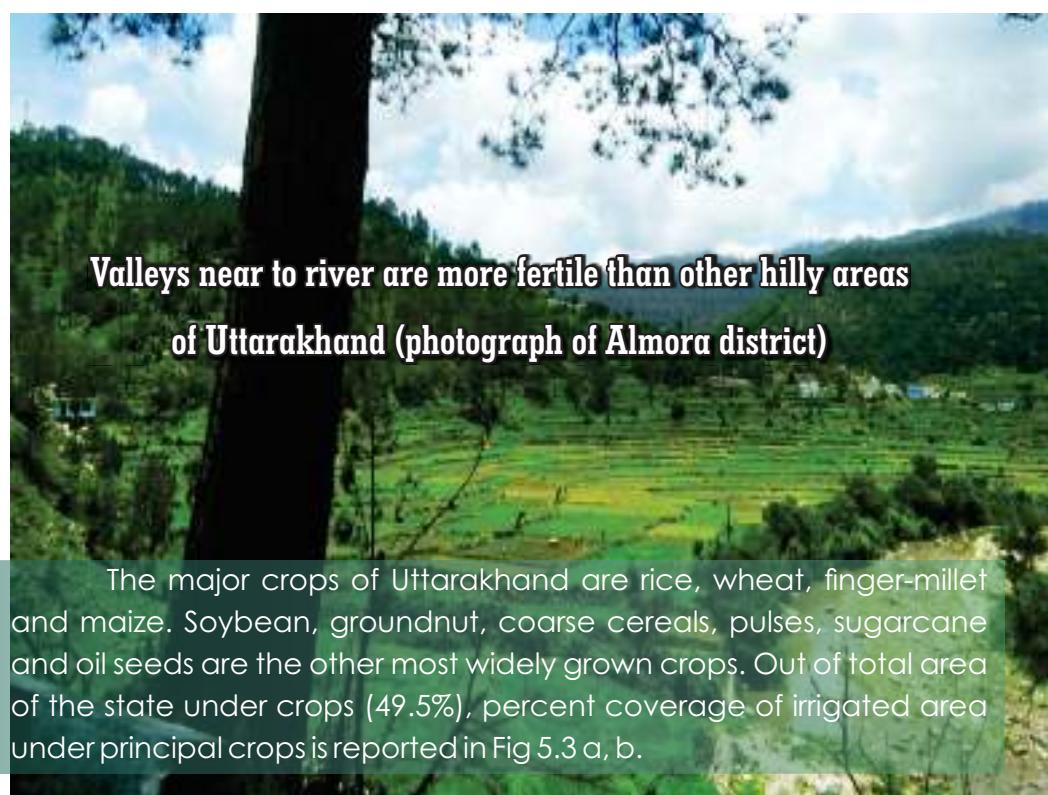
cover of around 45.43 % of the total area of state. Out of total, more than 85% area is hilly, mostly uncultivated. The total area of the non cultivable land is 7.8% which includes the

barren land or uncultivable land. Uttarakhand's total land use patterns and its statistics is given in following Fig 5.2.

**Fig 5.2**  
Agriculture  
land area  
(million ha) by  
type of use in  
Uttarakhand<sup>2</sup>

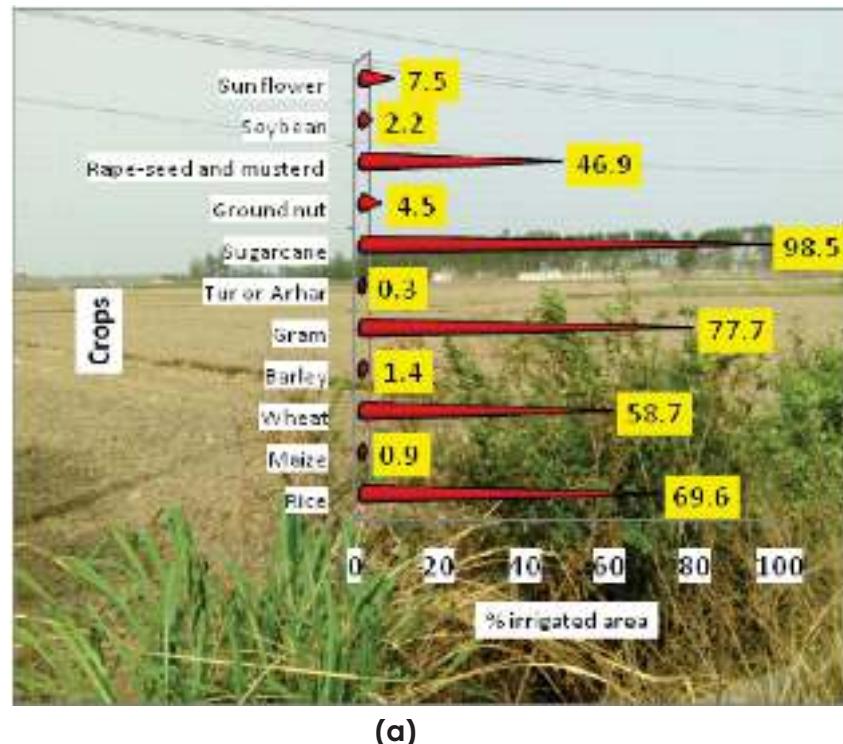


\*permanent pastures, other grazing lands, and culturable waste land

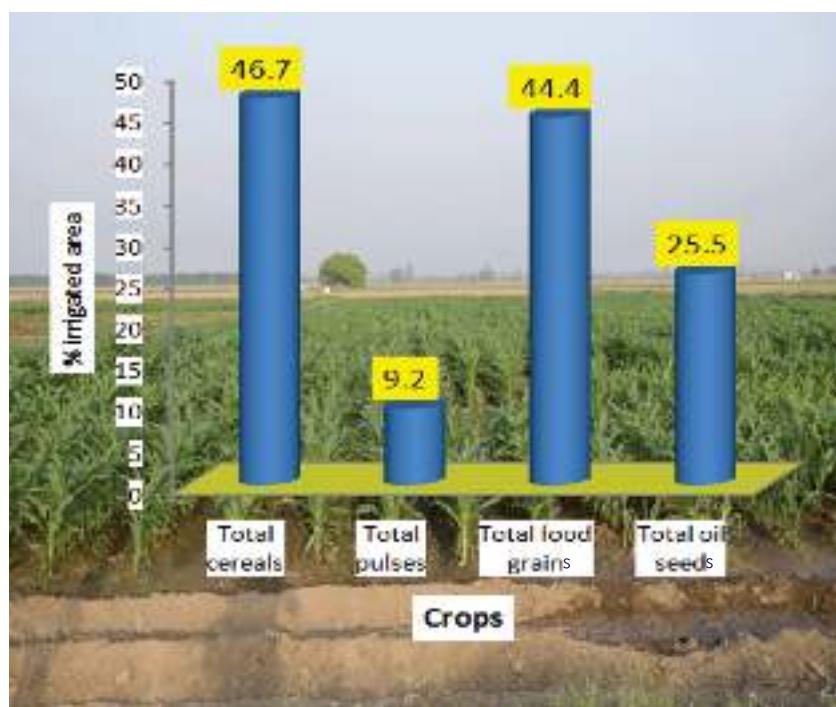


<sup>2</sup>Agricultural statistics at a glance: 2016 (Department of Agriculture, Cooperation & Farmers Welfare, GOI); gbpihedenvis.nic.in

**Fig 5.3**  
Per cent coverage of irrigated area under principal crops (a) and total crops (b)<sup>3</sup>



(a)



(b)

<sup>3</sup><http://shm.uk.gov.in/>

State's different agro-geo-climatic zones make it very good for commercial horticulture. The share of culturable wasteland in state is about 7% which has a huge potential for fodder trees and fruits. The geographical attributes and climatic conditions of the state are ideal for production of temperate and subtropical fruit crops. In hilly areas, fruits like apple, pear, peach, plum, apricot and walnut are produced, while mango, litchi, lemon, aonla, guava and pomegranate are mostly grown in Tarai and

valley areas. Major vegetables grown in the state are potato, cauliflower, tomato, onion, brinjal, pea, cabbage and okra. The state has a unique advantage of producing off-season vegetables in hilly areas, which fetches good prices in the market. Major spices are ginger, garlic, turmeric and chilli. State Horticulture Mission, Govt. of Uttarakhand detailed description of the geographic area covered in year 2017 by horticultural crops in the state are given in following Tables 5.2-5.4.

**Table 5.2**

Area under horticulture crops in Uttarakhand<sup>3</sup>

Crop	Area (lakh ha)	Production rank in India
Fruits	1.77	18 <sup>th</sup>
Vegetable including potato	0.91	19 <sup>th</sup>
Spices	0.12	
Flowers	0.014	overall 7 <sup>th</sup> , 2 <sup>nd</sup> in cut flowers

**Table 5.3**

Area under fruits and vegetables cultivation in Uttarakhand<sup>4</sup>

Fruits		Vegetables	
Name of fruit	Area (ha)	Name of vegetable	Area (ha)
Apple	25201	Pea	12576
Pear	62061	Radish	4901
Peach	7939	French bean	5753
Plum	8898	Cabbage	6144
Apricot	7992	Cauliflower	3050
Walnut	17373	Onion	4117
Citrus	21275	Capsicum	2401
Mango	36422	Okra	3431
Litchi	10393	Tomato	8626
Aonla	1291	Brinjal	2455
Guava	3432	Potato	26038
Other fruits	24031	Other (vegetables)	11740

**Table 5.4**

Area under spices and flower cultivation in Uttarakhand<sup>4</sup>

Spices		Flower	
Name	Area (ha)	Name	Area (ha)
Turmeric	1482	Gerbera	101
Chilli	2754	Carnation	15
Coriander	1240	Gladiolas	285
Garlic	1695	Marigold	779
Ginger	4474	Rose	107
		Tuberose	17
		Others	86

<sup>3</sup><http://shm.uk.gov.in/gbpihedenvis.nic.in>





#### Important horticulture facts<sup>4</sup>

- Second in production of cut flowers ( 3567.56 Lakhs spikes) after Maharashtra.
- Second in walnut (21.8 thousand MT) after J&K.
- Third in apples (1.23 Lakh MT) after J&K and Himachal Pradesh.
- Productivity of spices is highest (7.21 MT/ha) against national average of 1.8 MT/ha.

#### ii. Land holding patterns

In India, small and marginal land holdings predominate operational land holdings. According to 2011 Census, 67% of holdings classified as marginal (less than 1 ha) and 18% classified as small (1-2 ha) and 0.7% land holdings are classified as large holdings. Similarly, average size of most operational holdings in Uttarakhand is less than 1 ha (Fig 5.4, Table 5.5). According to latest data, total number of operational holdings in all groups are about 912650, in an area of 815681 ha. Around 74 % of holdings are marginal and

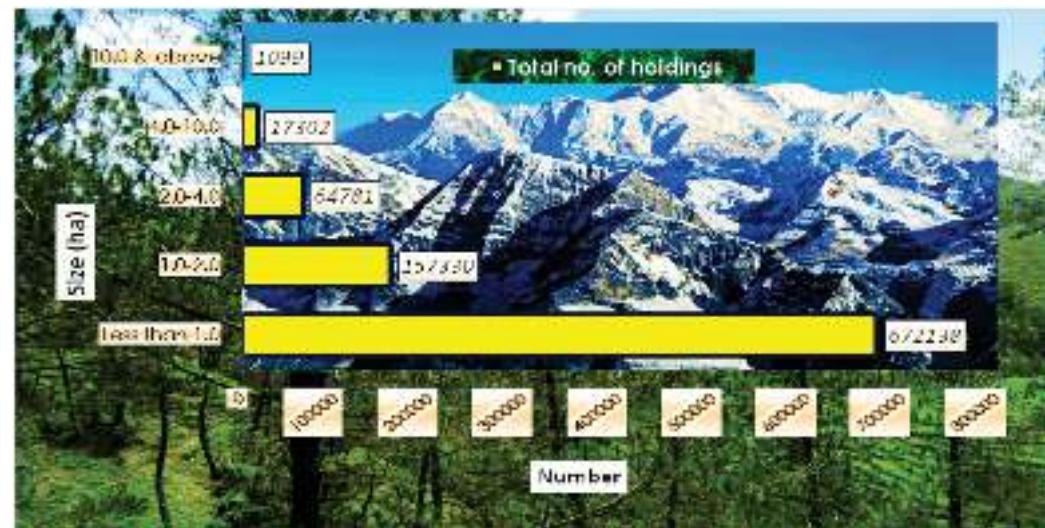
average area operated by this category of farmers is only 0.35 ha. Further, 17% of operational holdings are small operating less than 2 ha of area. Policy initiatives are needed for the development of small holdings since size of these holdings is tiny and therefore, scale of economies cannot be availed which makes crop husbandry a nonviable preposition. The options like dairying, poultry and cultivation of high value horticultural crops including medicinal and aromatic plants should be encouraged to increase per unit income and productivity from the available small pieces of land for cultivation.

**Table 5.5**  
Percentage of operational holdings in Uttarakhand<sup>5</sup>

Size	% No.	% area
Less than 1.0	73.64	36.23
1.0-2.0	17.24	27.60
2.0-4.0	7.10	21.50
4.0-10.0	1.90	11.55
10.0 & above	0.12	3.11

Marginal holdings	: Size 1 ha or less
Small holdings	: Size 1 to 2 ha
Semi-medium holdings	: Size 2 to 4 ha
Medium holdings	: Size 4 to 10 ha
Large holdings	: Size above 10 ha

<sup>5</sup>Tuteja, U. 2015. Agriculture profile of Uttarakhand. Agricultural Economics Research Centre University of Delhi.

**Fig 5.4**

Total number of different size holdings in Uttarakhand<sup>5</sup>

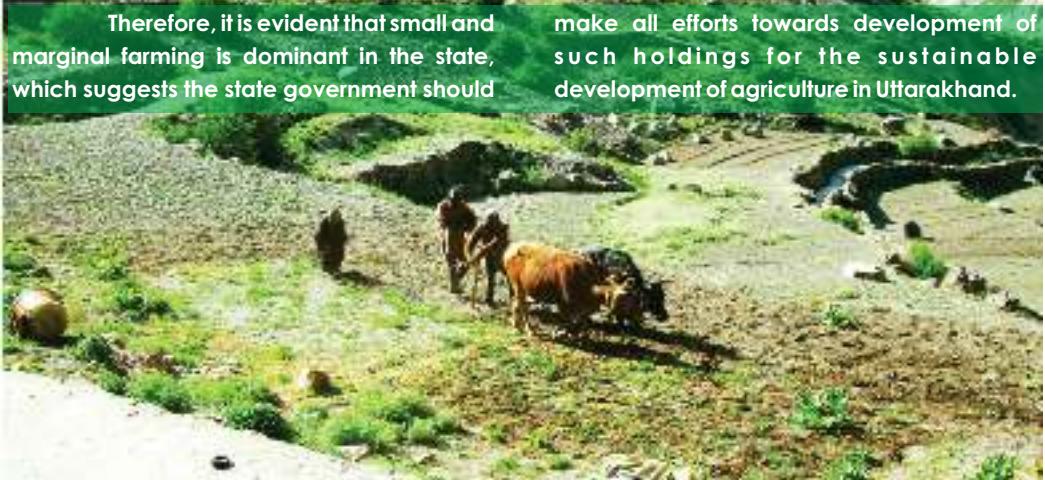
In another estimate, over 27 % of the area under cultivation consists of plots of size less than 1 ha. Another 26 % of land holdings are between sizes 1 and 4 ha, and account for 51 % of the total cultivated area. 22 % of the cultivated land consists of plots over 4 ha, and these account for 3 % of the land holdings. According to agriculture census of

Uttarakhand (2011), institutional, scheduled caste (SC), scheduled tribe (ST) and others constitute 0.23%, 13.73%, 3.25% and 82.79% of the total holdings (Table 5.6), which envisage that other groups are dominantly representing in operational land holdings in Uttarakhand.

**Table 5.6**

Social group-wise operational land holdings and area coverage<sup>6</sup>

Item	No .	%	Area	%
<b>Institutional</b>	2002	0.23	12698	1.56
<b>SC</b>	125351	13.73	67533	8.28
<b>ST</b>	29673	3.25	47860	5.87
<b>Others</b>	755624	82.79	687590	84.29
<b>All Social Groups</b>	<b>912650</b>	<b>100</b>	<b>815681</b>	<b>100</b>



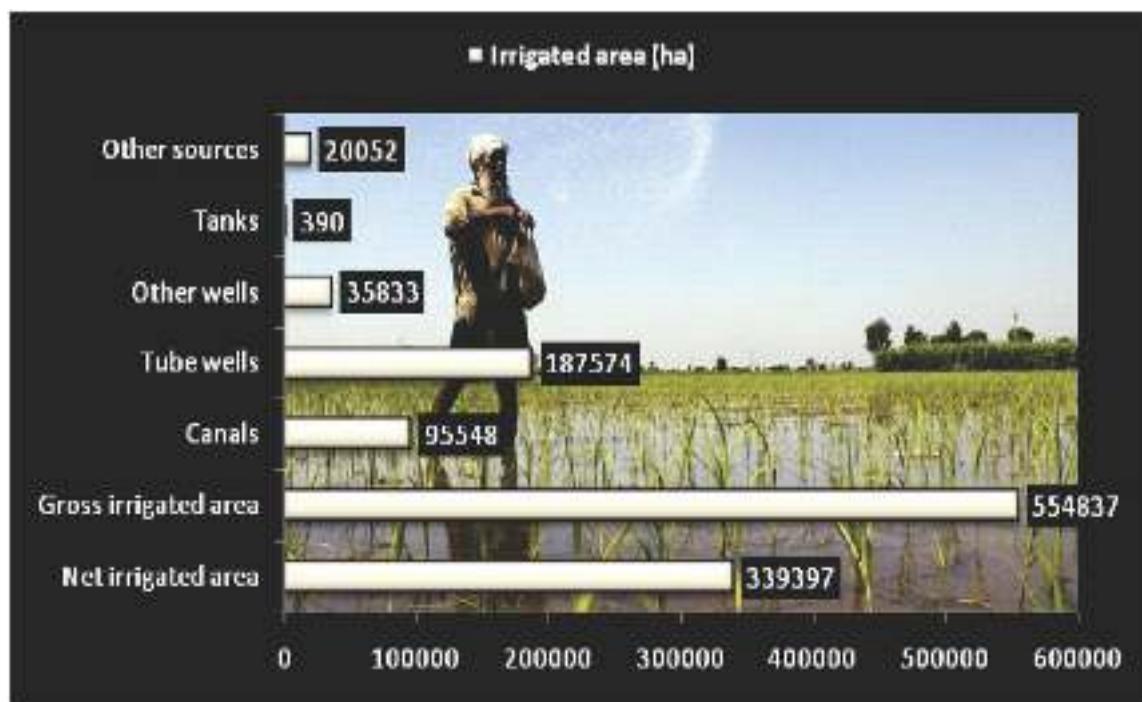
<sup>5</sup>Tuteja, U. 2015. Agriculture profile of Uttarakhand. Agricultural Economics Research Centre University of Delhi. <http://gbpihedenvis.nic.in>.

### iii. Irrigation network

Agriculture engages more than 70% of population for livelihood in Uttarakhand. More than half of the cultivated land in the state is rainfed. Irrigated land is largely available in the plains, with over 87% land being irrigated as against about 10% in the hills. The net irrigated area of the state stands at 3.36 lakh ha. The net irrigated area, as a percentage of the net sown area in the state, is 47%. Hence, even half of the cultivated land is not irrigated. But, there are variations across the districts in availability of irrigation facilities. The major sources of irrigation are tube wells (about 55%) and canals (about 28%).

Canals lift irrigation and rainwater harvesting methods are used in hilly regions of the state. Moreover, only surface water harvesting is the main source for irrigation, as

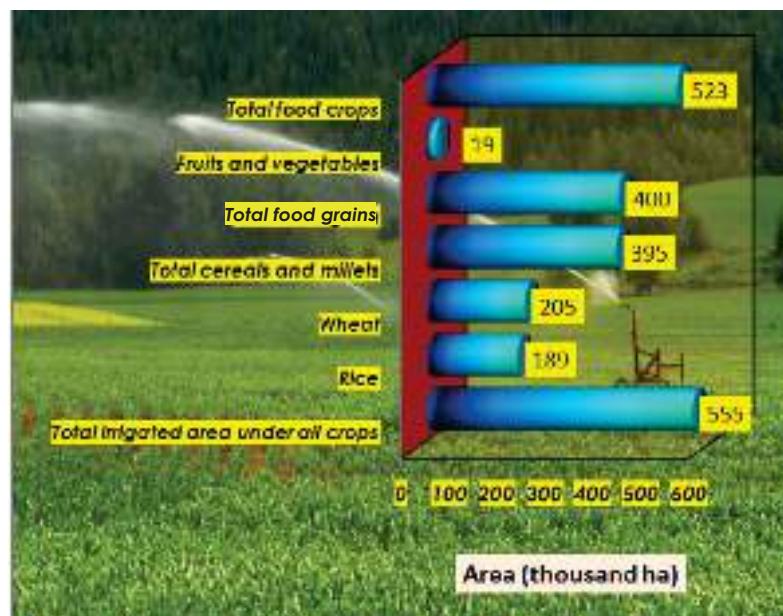
ground water harvesting is very tough in hilly areas. The total number of minor irrigation system is 80053 and the total length of canals [medium and minor] is 8328 km. The total state-owned surface flow and lift systems are 5776 in number; the total non-state surface and lift flow systems are 20458 in number; the total dug, shallow, and deep tube wells amount to 53819. Net irrigated area, gross irrigated area, and area under various irrigation techniques are depicted in Fig 5.5. Area irrigated by major and medium schemes is about 6.97 % of the total actual irrigated area. Actual area irrigated by minor Irrigation is about 93.02%. Other techniques used for irrigation include hauj, gool, hydrum etc. The irrigation infrastructure of Uttarakhand state is briefed in Table 5.7. Crop wise details of under irrigation gross area of Uttarakhand is reported in Fig 5.6.



**Fig 5.5**  
Pattern  
of irrigation in  
Uttarakhand

1	Length of canals	12421 km.
2	Length of lift canals	281 km.
3	Tube wells (State)	1478 nos.
4	Pump sets (boring/Free boring)	55456 nos.
5	Hauj	36761 nos.
6	Gool	29785 km.
7	Hydrum	1471 nos.
8	Culturable Command Area (CCA) under State canal	3.338 lakh ha.

**Table 5.7**  
Irrigation infrastructure in Uttarakhand<sup>7</sup>



**Fig 5.6**  
Gross area under irrigation by crops<sup>7</sup>

#### iv. Major crops

Uttarakhand is traditionally an agrarian state. Cereals, pulses, oilseeds are the major groups of food crops of the state. About 1.7% of nation's food grains and coarse cereals are produced in Uttarakhand. Sugarcane, wheat and rice are the key agricultural products of the state. Apart from these, finger millet and maize are other major crops followed by some important pulses and oilseeds. On an average 63% of land under cereals and 77.5% land under pulses are rain-fed. Wheat is the main crop and accounts for

about 50% of total food grain production in the state, still Uttarakhand is deficit in production of food grains and depends on imports from other states. The Table 5.8 gives details about all major crops that are produced in Uttarakhand.

Rice, wheat, maize, small millets, ragi, barley are common food grains (cereals) of Uttarakhand. Gram, urad, tur/ arhar etc. are important pulses. Groundnut, sesame, rapeseed and mustard, linseed, sunflower, etc. are important oil seeds of Uttarakhand. Apart from these, it is also common

<sup>7</sup>Tuteja, U. 2015. Agriculture profile of Uttarakhand. Agricultural Economics Research Centre University of Delhi. <http://gbpihedenvis.nic.in>; Economic survey, Uttarakhand, 2017-18 (Deptt. of Planning, GOI)

that the farmers cultivate some traditional crops such as mandua (finger millet), gahat (horse gram), urd (black gram), riains (adzukibean) and sonta (cow pea). Other traditional crops that are very important for Uttarakhand but

not very common are chaulai (amaranth), ogal and haper (black wheat), and cheena (hog-millet). The agricultural productivity of Uttarakhand under major agricultural crops is given in Table 5.9.

**Table 5.8**  
Major crops cultivated in Uttarakhand<sup>8</sup>

S. No.	Group	Crop
1	Cereals	Barley, maize, rice, wheat, amaranth, buck wheat, chenopodium
2	Millets	Barnyard millet, finger millet, foxtail millet, proso millet, kodo, and sorghum
3	Pulses	Pigeon pea, chick pea, soybean, khesari, lentil, horsegram, french bean, scarlet bean, lima bean, garden pea, adzuki bean, green gram, blackgram, rice bean, cowpea
4	Oil seed	Yellow and brown mustard, toria, sunflower, linseed, perilla, sesame and lepidium

**Table 5.9**  
Area, yield and production of principal crops of Uttarakhand<sup>9</sup>

Crop	Area under crop ('000ha)		Average yield (kg/ha)		Production '000 Tonnes	
	2015-16	16-17	15-16	16-17	15-16	16-17
<b>A) Food Grain (Cereals)</b>						
Rice	250.29	245.65	2341	2332	585.9	575.9
Maize	23.20	21.85	1696	1703	39.37	37.21
Small millets	59	63.28	1210.9	-	74.4	
Wheat	342.65	341	2307	2583	790.37	882
Ragi	107.42	107.17	1402	1489	150.51	159.6
Barley	18.36	21.66	983	1219	18.06	26.4
<b>B) Food Grain (Pulses)</b>						
Gram	0.646	0.668	836	795	0.54	0.531
Urad	14.83	14.569	632	812	9.37	11.83
Tur	4.32	2.99	769	890	3.34	2.668
Other pulses	41.16	42.563	884.84	-	36.42	
Total pulses	60.96	60.79	814.19	-	49.67	51.34
<b>C) Oil seeds</b>						
Ground-nut	1.055	0.729	1426	1299	1.504	0.947
Sesamum	1.766	2.087	271	288	0.478	0.602
Rapeseed & mustard	12.275	13.129	946	856	11.61	11.23
Soyabean	13.539	11.585	1332	1153	18.03	13.35
<b>D) Other</b>					('000 MT)	
Sugar cane	96.85	92.95	60769	59216	5885	5504.56
Potato	24.7	26.03	13840	-	360	360
Chillies	2.55	2.75	3470.5	-	8.85	8.85
Ginger	4.87	4.47	9673.5	-	47.11	47.11
Turmeric	1.407	1.48	8990.7	-	12.65	12.65

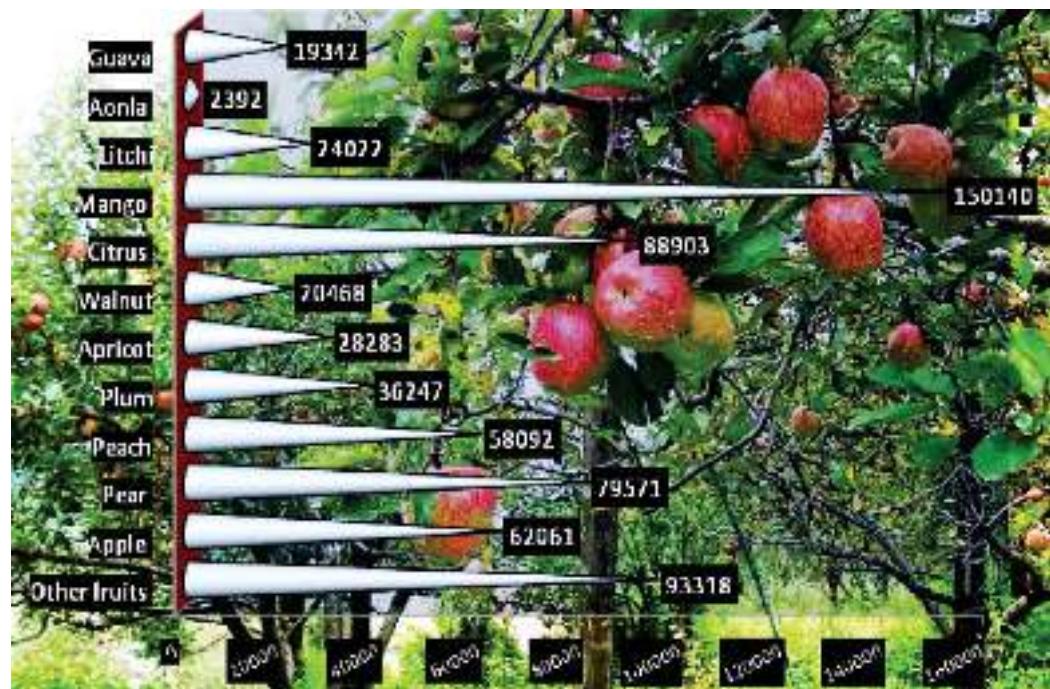
<sup>8</sup><http://shm.uk.gov.in/agriculture.uk.gov.in>.

Horticulture sector is now contributing significantly in the economy of Uttarakhand. It provides a huge employment to the people as agriculture sector is very limited in hilly areas. The topography of state is very complex but is good for horticulture crop production. Moreover, Uttarakhand is known for its horticulture crops, which especially include off season vegetables, flowers and medicinal and aromatic plants. Among fruits mango, apple and citrus, occupy top production positions in the state. Malta, lime, mandarin, and galgal are important citrus fruits.

Insufficient data is available for the production of traditional hilly fruits of Uttarakhand such as aonla, butter fruit

(chyura), kafal and timila as these fruits are mostly naturally produced and used locally rather than commercially.

About 2.26 lakh ha area of Uttarakhand is under production of fruits from which a production of about 678500 MT was achieved in the year 2016, with the productivity of 4 MT/ha. Around 91232 ha area is under vegetable production (potato included), about 11645 ha area is under spices production and 1390 ha area is used for floriculture. The detailed description of area under principal horticulture crops is given in Table 5.3. The production data of the various horticultural crops in the year 2017 are given in the Fig 5.7( a-d)<sup>9</sup>.



**Fig 5.7 (a) Fruits production in MT**

<sup>9</sup><http://shm.uk.gov.in/>

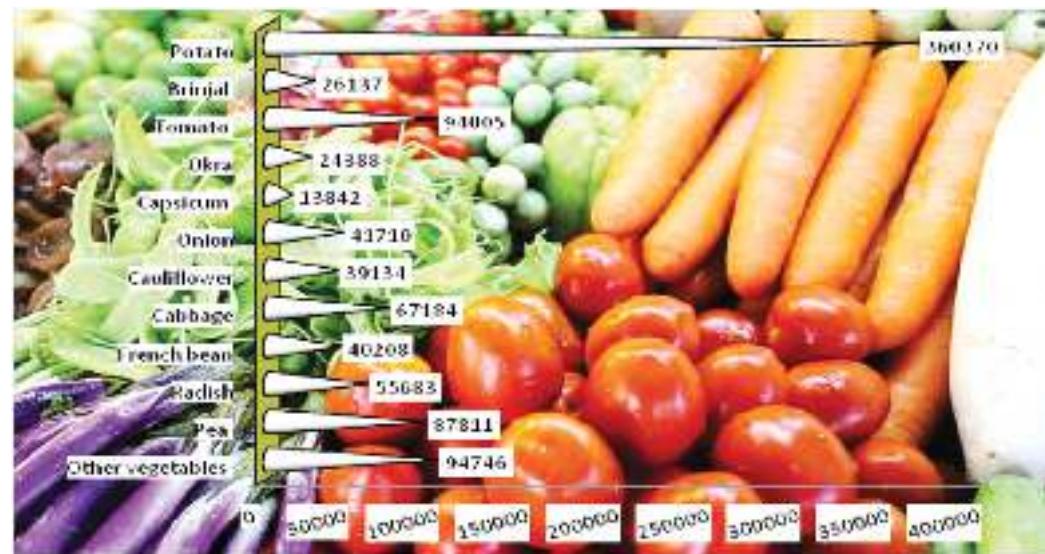
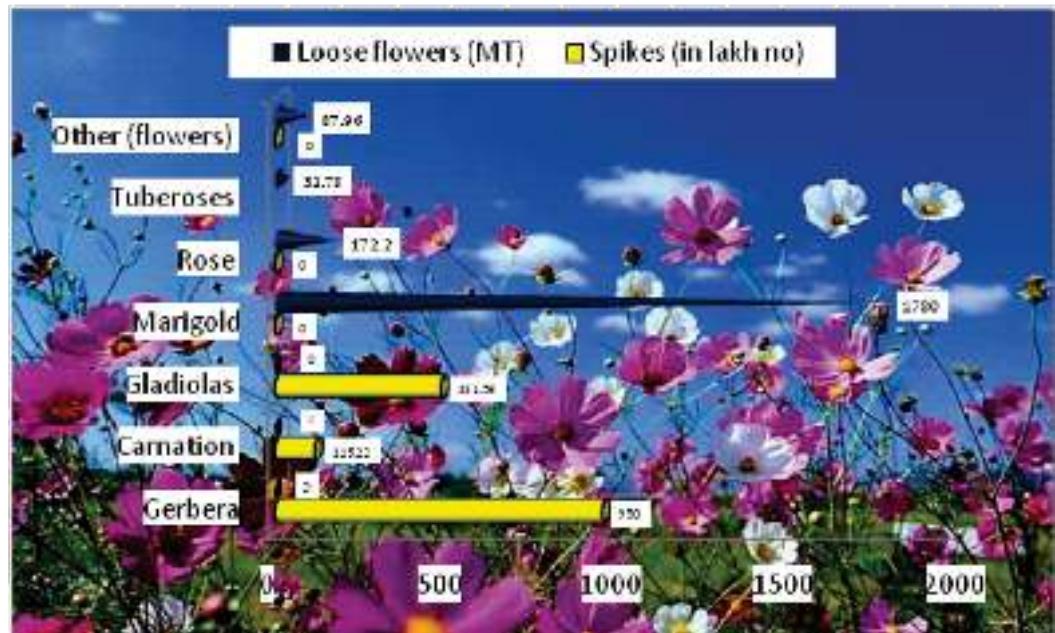


Fig 5.7 (b) Vegetable production in MT



Fig 5.7 (c) Spices production in MT



**Fig 5.7 (d) Flower production in MT**

**Productivity of spices is highest in Uttarakhand (7.21MT/ha) whereas national average is 1.8MT/ha.**

#### v. Organic agriculture, horticulture and floriculture

Uttarakhand is the first and only province in India, which elaborated organic farming policy. The state has immense potential in the field of organic crop production. The key objectives of diversifying towards organic farming are to improve crop productivity, soil health and the price of the output, and thus the income of the farmers. Since extensive use of chemical fertilizers ultimately leads to soil deterioration, therefore, yield levels can be effectively raised in a stable and sustainable manner only by adopting organic farming methods. The demand for organic food emerged during 1970s when environmental and human health hazards were

realized due to the use of agrochemicals in agriculture. In Uttarakhand hills, organic farming is prominent, but mostly unorganised, therefore the result and productivity is much lower than what is required. Majority of the traditional settled upland agriculture is organic by default. Earlier this was because of problems of inaccessibility of agrochemicals, lack of knowledge, poor crop response to chemical fertilizers in the good rainfed condition etc. and due to fairly satisfactory crop yields using organic manure. Therefore, for development of organic farming, government of India released many schemes such as National Project on Organic Farming, National Horticulture Mission, Paramparagat Krishi Vikas Yojana, Jaivik Mulya Shrankhala Vikas Mission Project,

for conversion of status to organic state. As most agriculture is rain fed, therefore, organic materials also help to bind the moisture to the soil, therefore, enhance the productivity. Use of organic manure is complementary to livestock because it is promotion of livestock also. About 25,000 farmers are engaged in organic farming on 60,000 ha land. Government has also planned to declare few districts as fully organic districts of the state. Therefore, Government has taken

initiative to draw traditional farmers into organic farming by setting up Uttarakhand Organic Commodity Board.

Millets, amaranth, buck wheat, spices, mustard, maize, ginger, chilli, turmeric etc. are the major crops that are produced organically in Uttarakhand. Most of the state's soil is rich in nitrogen therefore, additional supply is not required. Major organic crops and products of Uttarakhand are reported in Table 5.10.

**Table 5.10**  
Organic  
crops and  
products of  
Uttarakhand<sup>10</sup>

1.	Paddy	Different varieties of Basmati & Pusa rice
2.	Spices	Various kinds of Chilli, Turmeric, Jamboo, Hemp seeds, Black Carve, Ginger, Onion, Fenugreek.
3	Pulses	Rajma, Arhar, Urad, Gram, Soyabean, Pea, Lentil, Lobia
4	Cereals	Maize, Wheat, Barley
5	Millets	Foxtail, Barnyard, Finger, Proso Millets Amaranthus, Buck Wheat
6	Medicinal	Rosemary, Thyme, Kutki, Oregano, Parsley
7	Other products	Soap nut, Honey, Wild apricot oil, Hamp seed oil

## SUGGESTIONS FOR ORGANIC FARMING

- ⇒ Use of organic manure like farm yard manure, poultry manure, fish manure, sheep compost and green manure. As they also bind moisture to prevent its loss. It also promotes earthworm abundance in the soil.
- ⇒ Use of organic cakes of neem, groundnut, castor etc.
- ⇒ Use of crop residues to enhance soil organic matter/ soil fertility status.
- ⇒ Application of crop residues such as bhang leaves, parthenium (before flowering), gulmohar and peepal leaves to soil has also reported to show positive effects on yield of cowpea, potato, cucumber etc. by enriching soil with organic matter.
- ⇒ Use of legume crops like beans, peas, cowpea etc. for fixing atmospheric nitrogen by nitrogen fixing microorganisms.
- ⇒ Use of biofertilizers such as Rhizobium, Azotobacter, Azospirillum etc. to enhance crop yield organically.
- ⇒ Use of phosphorus solubilising microorganisms (PSM).
- ⇒ Use of biopesticides & biocontrol agents such as *Trichoderma* sp. and *Pseudomonas* sp. etc.
- ⇒ Use of mycorrhizal fungi is also very important to increase the crop resistance against common plant pathogens such as *Rhizoctonia* sp., *Fusarium* sp., *Pythium* sp.

<sup>10</sup>mRjk[k.M tSfod fodkl ifj"kn% fgeksRFkku ifj;kstuk  
(organicuttarakhand.in); uk.gov.in; gbpihedenvis.nic.in



**Following organic farming methods are suggested for agriculture movement to organic manure<sup>10</sup>**

- 1) Biodynamic compost
- 2) E.M. compost
- 3) NADEP compost (with bricks)
- 4) Bokashi khaad
- 5) Cow pet pit
- 6) Compost
- 7) Matka khaad
- 8) NADEP with bamboo
- 9) NADEP pit with stones
- 10) Vermi wash
- 11) Vermi compost
- 12) Kurmula control

#### vi. Agriculture/horticulture inputs of fertilizers, pesticides and seeds

Plant requires nutrient for its growth. These nutrients can be classified into macronutrient such as nitrogen, phosphorous and potassium, secondary macronutrients such as calcium (Ca), magnesium (Mg), and sulphur (S) and micronutrients such as copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), zinc (Zn), boron (B). Moreover silicon (Si), cobalt (Co), and vanadium (V) and some other rare minerals are also important for plant development. Naturally, these elements are derived from soil but nowadays due to over crop production, and due to some natural constraints such as, presence of insoluble forms of iron, phosphorus, zinc, etc., crop yield get reduced. Therefore, external application of fertilizers is necessary. However, use of fertilizers in our country or in Uttarakhand is hardly scientific and done without knowing soil requirement based on scientific soil test. Further, there is indiscriminate use of urea due to subsidy by government. Over reliance on urea and improper nutrient management has led to multinutrient deficiency in soils. The inadequate and imbalanced nutrient use coupled with negligence of organic manures has caused multi-nutrients deficiency in

many areas with time. Fertilizer consumption in the state is given in Table 5.11 a.

Integrated nutrient management (INM) encompasses conjunctive use of chemical fertilizers including secondary and micronutrients, organic manures, composts/ vermi composts, bio-fertilizers and green manures on a large scale. Adequate and timely inputs to agriculture are prerequisite for the good and healthy production. Seeds, fertilizers, chemicals that are used to prevent plant infection, other pesticides, biofertilizers, biopesticides, and agriculture machinery should be used by farmers on time. Input management has now become a very important part of modern agriculture. Quality should be high for good and healthy agriculture production. Thus utilization of fertilizers, pesticides etc., plays an important role to boost agriculture. Unfortunately, Uttarakhand is lagging behind in proper input use. This may be because most part of the state is under hills and therefore, floods, earthquakes and other natural disasters are prominent. This affects agriculture and also the dispersion or extension of knowledge about the government schemes is another challenging factor in Uttarakhand.



Fertilizer consumption is very low in Uttarakhand and only the agricultural areas of plains are supposed to be using normal amount of fertilizers in agricultural practices. In Uttarakhand, nitrogenous fertilizer is preferred over others. Although organic farming using organic manure is prominent

in state but it is unorganised and therefore has many problems. Moreover, because of lack of physical infrastructure, input distribution in hilly area is difficult, but excellent organic farming is famous in those areas.

**Table 5.11**  
**(a) Fertilizer consumption in Uttarakhand<sup>11</sup>**

Fertilizer consumption (NPK) in '000 tons					
Year	2011-12	2012-13	2013-14	2014-15	2015-16
NPK	166	152	163	170	201
Per ha use of chemical fertilizer (Kg/ha)					
NPK	147.02	135.69	164.13	159.95	169.18

Undoubtedly, seed is the most important input that plays a key role in good agricultural productivity. Timely supply of seeds, good seed quality, natural /acquired resistance to disease, diverse seeds according to agro-climatic zones, genetically pure and viable seeds are the key factors. Also, seed replacement rates (SRR) in Uttarakhand is very low. Ideally seeds should be replaced every year for hybrids and every three to four years for non hybrids. But in practice, seeds are replaced rare in case of open pollinated crops. Therefore, seed replacement rate is lower than recommended rates. Poor quality of seeds, high prices of high quality seeds and failure of timely availability are other important issues, which also have adverse effect on adoption rate of new seed varieties by the farmers in Uttarakhand.

It is absolutely necessary to increase the productivity per unit area of crop so as to keep pace with the requirement of food to ever increasing population. To achieve this goal, availability of high quality seed, in adequate quantities, is of paramount importance. In this very context, a project known as Tarai Development Corporation (TDC), was launched on 29th June, 1969 with the assistance of World Bank and Govt. of India. The Corporation is now functioning under the administrative

control of Uttarakhand Government. It is now known as Uttarakhand Seeds and Tarai Development Corporation Ltd. (UKS & TDC). The mission of UAS & TDC is to act as an effective instrument in accelerating the farm production, productivity per unit and thus, improve the socioeconomic status of the rural areas. For this purpose, the corporation is endeavouring to:

- Make available quality seed, timely and in adequate quantity at reasonable and economical price in its marketing territories; through Public, Cooperative and Private network of distributors and dealers.
- Liaise and associate with research organizations of repute, for developing production of scientifically proven high yielding seed varieties.
- Arrange, through selected growers at suitable location, production of foundation seeds and certified seeds, as required from season to season.
- Maintain organization, systems and procedures to ensure quality of seeds grown, procured, processed and packed, stored and marketed.
- Aim at generating internal resources for facilitating steady growth and development in servicing the farmers.

<sup>11</sup>[gbpihedenvis.nic.in:](http://gbpihedenvis.nic.in/)  
[agriculture.uk.gov.in](http://agriculture.uk.gov.in)



The state also seeks to lay thrust on promoting agro-processing industries in order to ensure value addition, minimize post-harvest losses and at the same time ensure better market prices to the farmers. Quantity of seed

produced by Uttarakhand Seeds and Tarai Development Corporation Ltd. in its various seed plants is shown in following Table 5.11 b.



**Uttarakhand Seeds  
and  
Tarai Development Corporation LTD. Uttarakhand**

Destination	Seed Plants	Capacity in Quintals
<b>One Lakh &amp; Above</b>		
Nainital		1,80,000
Haldibari		1,00,000
Motichur		1,20,000
<b>Twenty Five Thousand</b>		
Khemti		40,000
Dhanonj (Haldibari)		40,000
<b>Mobile Plant</b>		
Haldibari		5,000
Dehradun		5,000
<b>Vegetable Plant</b>		
Haldibari		20,000

Phone : 09914-230222, 230073  
Fax : 09944-330500, 230040, 230098  
<http://www.panthagarseeds.com>  
[tdc@uaseedsandtdc.com](mailto:tdc@uaseedsandtdc.com)

**Table 5.11**  
(b): Seed production capacity of various seed plants under Uttarakhand Seeds and Tarai Development Corporation Ltd.<sup>12</sup>

#### vii. Integrated pest management

Integrated pest management (IPM) is the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. Due to harsh topography and climate and the subsequent inaccessibility of the area, traditional mountain farming systems in Uttarakhand were self sufficient, self contained, closed systems, which generally did

not require any outside input.

Fortunately, in Uttarakhand hills, chemical pesticides have not been popular yet and farmers still rely on indigenous methods of pest management. This is an opportune time to popularize integrated pest management by making it cheap and location specific. For this to happen, scientific testing and integration of effective indigenous pest management practices with new science of IPM is necessary.

White grub (Fig 5.8) constitutes a major pest of field crops in Western Himalayas. Earlier, their damage was

<sup>12</sup><http://www.panthagarseeds.com>; [tdc@uaseedsandtdc.com](mailto:tdc@uaseedsandtdc.com)



from few pockets only but over the years, it has assumed the status of serious pest in the entire hilly region causing damage to upland rice, a major hill crop to the extent of about 80% under rain-fed conditions. Out of 31 identified species of white grub beetles in Western Himalayas so far, *Anomala dimidiata* (Hope) has been the most prominent species in

Kumaon hills of Uttarakhand. White grub depredations are particularly heavy in the terraced slopes of the hills situated between 1400–2200 m elevations, which are mostly rain-fed. For controlling it, the hill farmers of Uttarakhand are following some practices (Table 5.12).

**Fig 5.8**

White grub is one of the major pests that affect most field crops in Uttarakhand



S. No.	Method	Methodology	Merits/demerits
<b>A. For pests (mostly white grub)</b>			
1.	Setting fire in field	By using pine leaves and sometimes by dry crop waste residues	Can not consider as good practice because it also kills important microbes.
2.	By making heaps of undecomposed FYM	Undecomposed FYM attracts the pests from field and decompose it (IPM)	Rational method but checking the development of pest before it spreads is necessary.
3	Paddy transplantation	Farmers believed that paddy nursery preparation and its transplantation to field naturally destroys the homes of insects.	Although a good practice, but adopted very less, natural water in the field is required.
4	Use of table salt	1 kg table salt per nali field and salt stone and ash of normal wood is used.	Good practice for the fields where white grub damage is severe
5	Buring cow dung cakes and sometimes cow urine	Burning of cow dung cake and leaves of plants	Safe method and ash also provides nutrients to plant. Specially used in vegetable crop like chilli.

<b>B. For rodents</b>			
1.	Baiting	Wheat flour + ground glass + water Balls are made and kept at mouse's hole of entrance	Most preferred and popular technique to hill farmers.
2	Urea balls	Urea+water used to make urea balls	Although not recognised scientifically but used popularly
3	Specific plants	Bichhu ghas ( <i>Urtica dioica</i> ), Kilmora plant ( <i>Berberis asiatica roxb.</i> ) are used. Plants are placed at the mouth of mouse hole. Gubasi plant ( <i>Barleria buxifolia</i> ) is also in use. Gubasi and Kilmora are full of thorns and Bichhu ghas causes irritation on touching	Keep rats away and farmers have experienced them as best method.
4.	Powdered faeces of horse.	Dry faeces of khacchar (mules) placed at entrance of mouse hole	Useful because of its odour.
<b>C. Other practices (indigenous)</b>			
1.	Sun drying	Sun drying of seeds, grains etc.	Very useful before storage
2	Storage of green gram & black gram	Paste or mixture of turmeric + walnut leaves + mustered oil for green gram and only mustard oil for black gram	Keep pests away.
3.	Normal chullah ash	Chullah ash is made by burning fuel wood. Dusted on grains	Ash kills harmful insects. Safe to use
4	Neem leaves	Neem leaves are stored with paddy seeds. Other plant leaves which can be used are walnut ( <i>Juglans regia</i> ) and timur ( <i>Z. alatum roxb.</i> )	Considered as a rational practice by scientists

**Table 5.12**  
important methods for pest management in Uttarakhand<sup>13</sup>

Agriculture in Uttarakhand is considered eco-friendly because of rich traditional and distinctive practices. Despite limited irrigation facilities, fragmented and small land holdings agriculture in Himalayan region has supported people for generations in adverse conditions and continued to remain, even today the principal source of livelihood.

<sup>13</sup>Chandola, M., Rathore, S., & Kumar, B. (2011). Indigenous pest management practices prevalent among hill farmers of Uttarakhand.; uk.gov.in; Annual report 2016-17, Department of agriculture, cooperation and farmer welfare (GOI)



### vii. Tea cultivation: status and its potential

Uttarakhand Tea Development Board was created by govt. of Uttarakhand on 12 February, 2004. Agro climatic condition of Uttarakhand is unique and quite suitable for quality tea production. Kumaon Mandal Vikas Nigam, Nainital is the nodal agency to implement the tea development projects.

The board has been working appropriately for tea cultivation at different places of Almora, Bageshwar, Champawat, Chamoli, Nainital, Pithoragarh and Rudraprayag districts of Uttarakhand. Govt. of Uttarakhand has also decided to encourage organic tea cultivation in the state. Uttarakhand Tea Development Board has converted 218 ha of the plantation into organic tea gardens in Ghorakhal (Nainital), Champawat (Champawat) and Nauti

(Chamoli). The organic tea produced in the state has tea quality comparable to tea of Darjeeling district.

#### Tea factories

Initially Kausani area was selected to develop 200 ha tea garden. After that the first tea factory entitled "Uttaranchal Tea Factory" was established at Pingalkote (Kausani) in Bageshwar District in the year 2001 with tea brand name "Uttaranchal Tea." The demand of Uttaranchal Tea then escalated at global market along with local markets. This brand of Tea is exported to South Korea, Japan, Germany, USA, Netherlands, etc. Later on, with the establishment of other tea gardens in small pockets in different areas viz., Champawat, Ghorakhal (Nainital), and Nauti (Chamoli), factories have been established in respective areas by Uttarakhand Tea Development Board

**Table 5.13**  
Details of tea factories in Uttarakhand year 2017<sup>14</sup>

S. No.	Tea factory	Company	Established year	Capacity (kg made tea as on today)
1	Kausani Tea Factory	Uttaranchal Tea Company (Pvt.) Ltd., Pingalkote, Kausani (Bageshwar)	2000-01	70,000
2	Ghorakhal Tea Factory	Uttarakhand Tea Development Board, Shyamkhet (Nainital)	2007-08	11,000
3	Champawat Tea Factory	Champawat Tea Factory Khark Karki (Champawat)	2013	11000
4	Nauti Tea Factory	Nauti Tea Factory Bhatoli (Chamoli)	2013	11000

itself. Table 5.13 gives the detailed description of the tea factories established in Uttarakhand.

Statistically, a total of one hundred eleven (111)

employees are working in the Uttarakhand Tea Development Board including the Director, Scientists, Managers, Assistant managers, Supervisors, Field assistants

<sup>14</sup>[utdb.uk.gov.in](http://utdb.uk.gov.in)



etc. At present, about 1500 labourers are employed in tea gardens out of which women have the representation of 60%.

Details about the area under inorganic/organic tea cultivation are given in following Table 5.14 a, b.

**Table 5.14**

a: Inorganic tea gardens<sup>14</sup>

Sl.No.	Tea estates	Area in ha.
1	Kausani	211.06
2	Block Garur, Bageshwar	118.04
3.	i) Block Berinag, Pithoragarh ii) Block Kapkot, Bageshwar	30.7 18.8
4	Tea development under MNREGA i) Block Dhuladevi, Almora ii) Block Didihat, Pithoragarh	8.64 4.27

**Table 5.14**

b: Organic tea gardens<sup>14</sup>

Sl.No.	Tea estates	Area in ha
1	Champawat	155.01
2	Ghorakhal	83.08
3	Nauti	149.49
4	Tea development under MNREGA i) Block Pokhri, Chamoli ii) Block Tharali, Chamoli	7.06 6.40

## ix . Government schemes

### (a) Central schemes

- Rural Infrastructure Development Fund (RIDF)
- NABARD Infrastructure Development Assistance (NIDA)
- Dairy Entrepreneurship Development Scheme (DEDS)
- Kisan Credit Card (KCC)
- Food Processing Fund (PPF)
- Re-finance Support
- Jalagum Vikash Nidhi
- Janjaateeya Vikas Nidhi
- Farmer Producer Organization (FPO)
- Umbrella Programme for National Resource Management
- Producer Organization Development Fund (PODF)
- Investment Loan by Agriculture Marketing Infrastructure Grading and Standardization (AMIGS)
- Gramin Bhandaran Yojna.
- NABARD Consultancy Services – Nabcons





## Agriculture and Horticulture



### (b) Other central schemes

- National Mission for Sustainable Agriculture (NMSA)
  - Rainfed Area Development Programme (RAD)
  - Paramparagat Krishi Vikas Yojana (PKVY)
  - Soil Health Management (SHM)
- Pradhan Mantri Krishi Sinchaa Yojna (PMKSY)
  - Per Drop More Crop
  - Har Khet Ko Paani
  - Samekit Jalagam Vikas Karyakram
- Prime Minister Crop Insurance Scheme (PMFBY)
- National Food Security Mission (NFSM)
- Rashtriya Krishi Vikas Yojna (RKVY)
- National Mission on Agricultural Extension and Technology (NMAET)
  - Submission on Agriculture Extension (SMAE)
  - Submission for Seed and Planting Material (SMSP)
  - Submission on Agriculture Mechanization SMAM
  - Submission on Plant Protection
- National Mission on Oilseed and Oil Palm (NMOOP)
- Shree Dev Suman Farm Machinery Bank Scheme.

### (c) State sector schemes

- Agriculture Development Scheme in SC & ST Majority Villages
- Veer Shiromani Madho Singh Bhandari IMA Village Scheme
- E-National Agriculture Market (e-NAM)
- Deendayal Upadhyay Kisan Kalyan Yojna
- Crop Insurance Scheme.

### (d) District Sector Schemes

- Sahkari Krya Vikranya Yojna
- Sahkari Upbhokta Yojna
- ICDP (Aekikrit Sahkari Vikas Pariyojna)

### (e) Animal Husbandry, Dairy and Fisheries

- Backyard Poultry Scheme
- Breed Goat Rearing Scheme
- Cow Rearing Scheme
- Assistance to State for Control of Animal Disease (ASCAD)
- Deep Frozen Semen Production
- Liquid Nitrogen Distribution Scheme
- Gau Mutra Ark Utpadan
- Reservation of Fodder Development Program
- Livestock Insurance Scheme
- Uttarakhand Sheep and Wool Development Board



- Mobile Veterinary Van
- Ahilyabai Holkar Sheep Goat Development Scheme
- National Agriculture Development Scheme
- Sheep and Wool Improvement Scheme
- Integrated Livelihood Support Project
- Mahila Bakri Palan Yojna

#### x. Regulatory mechanism<sup>15</sup>

Various government schemes, implemented by government are acting as regulatory mechanisms for agriculture/ horticulture productivity. This section contains brief details of all the departments/boards/ organizations which are regulating agriculture:

#### a. Twenty point programme

The Twenty Point Programme was initially launched in 1975 and was subsequently restructured in 1982 and again in 1986 with the introduction of LPG (Liberalization, Privatization & Globalization). The Twenty Point Programme covered various social economic aspects like poverty, employment, education, health, drinking water, food security, agriculture productivity, environment conservation, empowerment of women and other weaker sections etc.



#### b. Agriculture department

Agriculture department of Uttarakhand was established on 02-08-2003. The department is engaged in every aspect of agriculture. Spreading all the government schemes/GOs /plans is the main role of the department.



<sup>15</sup>uk.gov.in





#### c. Department of animal husbandry

Intensifying & creating new opportunities in the field of animal husbandry for increasing employment generation and enterprise development in the state are main objectives of the department. Its visions are providing prophylactic & therapeutic veterinary services, doorstep animal breeding facilities & production support activities to the livestock farmers through its vast institutional network to improve animal productivity & employment.



#### d. Department of budget

Consolidated fund, contingency fund and public account are three major parts of budget of Uttarakhand and are responsible for various scheme implementations with the financial support.



#### e. Chief Development Office

Office of the chief development officer co-ordinates among different departments of the state along with central government for planning and development. These departments are responsible for the execution and monitoring of the poverty alleviation as well as infrastructure creation.



#### **f. Disaster mitigation and management centre (DMMC)**

Disasters are very common in Uttarakhand which not only lead to loss of lives, but also result in degradation of soil. At present Disaster Mitigation & Management Centre is working as an autonomous institute under aegis of Department of Disaster Management Government of Uttarakhand. It generates the sense of worthiness amongst common people and helps the government authorities in formulating appropriate policies and strengthening their capabilities to cope up with all the aspects of disaster management.



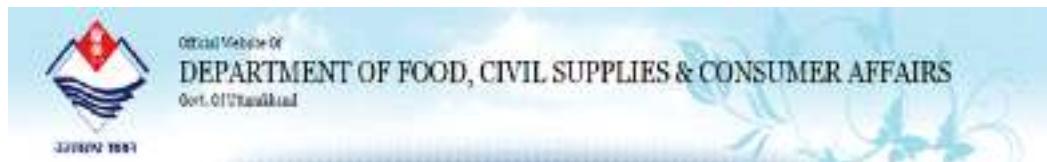
#### **g. Fisheries department of Uttarakhand**

Due to availability of huge water resources, the fisheries can be a very productive and employment generating area in Uttarakhand. Therefore, fisheries department of Uttarakhand is responsible for regulation of various schemes regarding development of fisheries in the state.



#### **h. Department of food, civil supplies & consumer affairs**

The mission of the department is to ensure supply of food grains (rice & wheat) and other commodities (sugar & kerosene) to the consumer in a transparent manner under the public distribution system and other government schemes at fair price. Various schemes implemented by the department are: National Food Security Scheme-NFSA (AAY+ PHH), State Food Scheme (SFY), Mid Day Meal etc.





#### i. Uttarakhand irrigation department

After the creation of Uttarakhand on November 9, 2000, Irrigation Department, Uttarakhand also constructed the Maneri Bhali Hydroelectric Project Stage-II, commissioned in Feb. 2008, and remained primarily responsible for maintenance of hydropower projects in the state up to April 2010.

The department is well established and works in the field of agriculture development with following main activities:

- Investigation and Planning of Water Resources and Hydropower Development Projects
- Design of WRD and Hydropower Projects
- Hydraulic Modelling, Geotechnical Investigations and Material Testings etc.
- Fabrication of Hydromechanical Equipments
- Imparting Training to Engineers



#### j. Rural works department

The department was created in the year 1972 by former state Uttar Pradesh to strengthen the rural infrastructure. Department executes the construction works on deposit basis and is also providing technical guidance to block level administrative officers. It executes the construction works of various government departments like Medical and Health, Revenue, Rural Development, Police, Forest, Primary and Secondary Education, Tourism, Fisheries, Women Empowerment, Border Area Development Programme, Agriculture, Social Welfare, Ayurvedic, SSA, RMSA, Food and Supply department including Sansad Nidhi & Vidyak Nidhi.



#### k. Department of sericulture

In the year 2001, a separate directorate of sericulture Uttarakhand was established in the state by govt. of Uttarakhand under the ministry of horticulture for vide extension of sericulture in all over the state.





#### I. State horticulture mission

Uttarakhand is on its way to encourage food and nutritional security for the ever increasing population. The scheme of the government 'state horticulture mission' is engaged in preparing and promoting various GOs/acts that are able to improve productivity, thereby enhancing income of farmers.



#### m. State planning department

For ensuring optimal use of available resources it is essential to formulate the state Plan through a series of interactive & multi-level exercises and integrating it with regional, district and block level strategies. Thus planning department Uttarakhand with using a wide manpower as technologists, geographers, economists, statisticians, sociologists, management experts, general administrators and scientists engaged in overall developmental planning including agriculture.



#### n. Bhagirathi river valley development authority

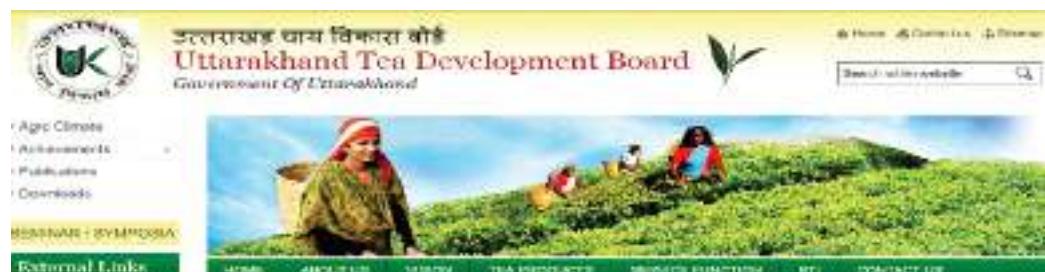
The Bhagirathi river valley development authority was constituted in the year 2005. Out of various mandates of the authority, soil conservation and fodder and fruit species development, are important. The government scheme is basically working in the field of agriculture and horticulture development in nearby areas of Tehri dam.





**o. Uttarakhand tea development board**

Uttarakhand tea development board is responsible for overall development of the tea sector in the state. The board has been proving its worth to a great extent in fulfilling its prime objectives by tea development work in establishing tea gardens in Almora, Bageshwar, Champawat, Chamoli, Nainital, Pithoragarh and Rudraprayag districts.



**p. Uttarakhand sheep and wool development board**

The Himalayan state Uttarakhand with great potential of sheep development has established the board with overall responsibilities about the schemes for sheep and wool development.



**q. Govind Ballabh Pant University of Agriculture & Technology Pantnagar**

GBPUAT has role and contributions in bringing agricultural transformation in the country. The University with eight faculties together with 14 research centres on campus (eight off-campus research centres and nine Krishi Vigyan Kendras spread over nine districts) that offer venues for technology generation for agriculture development, and high crop yielding seed generation.



### x. Livelihood based on agriculture, horticulture & floriculture

The total population of Uttarakhand is 100.86 lakh persons as per the last census, 2011. The density of population means number of persons per square kilometre is only 189 in the state. The sparse population is mainly due to large area under mountains. In Uttarakhand, 38.4% of population comprise of workers. Surprisingly, work participation rate of population in the state is lower than the all India level. It could be attributed to relatively low work participation of male population which is 49.7% against 53.3% for all India. Historically, male workers have been migrating to plains in search of employment opportunities and this has reduced the work participation rate of males in hilly Uttarakhand. On the other hand, work participation rate of females in Uttarakhand is above the national level due to their various activities related to agriculture. Latest details of labour/workers engaged in Uttarakhand agriculture is given in Tables 5.15 and Fig 5.9.

**Table 5.15**  
Classification  
of workers in  
Uttarakhand as  
compared to India

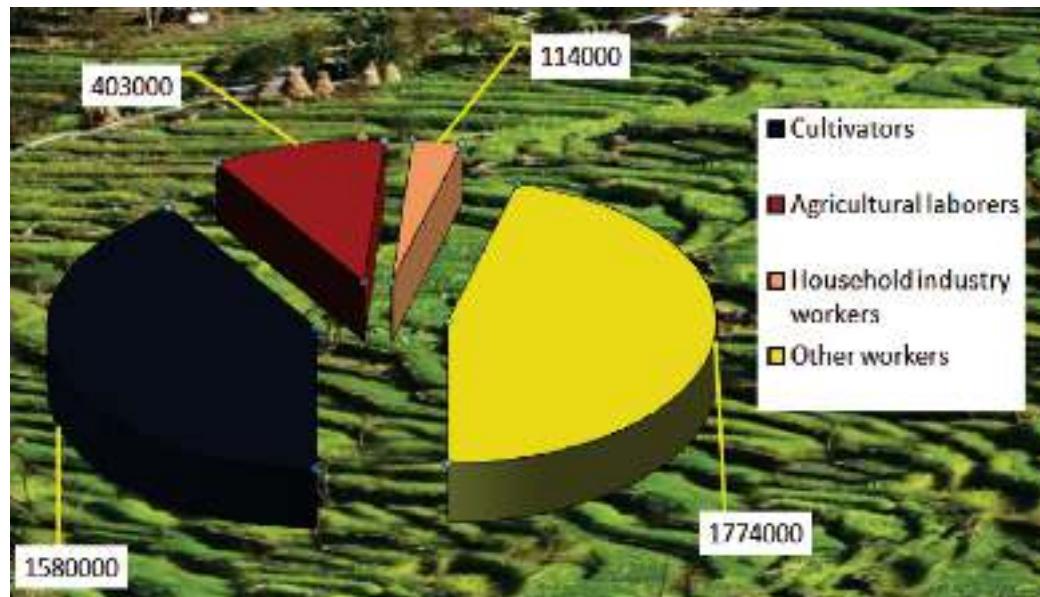
Category	Uttarakhand		India	
Cultivators ('000)	No.	(%) to total workers	No.	(%) to total workers
Male	735	28.82	82700	24.92
Female	845	64.00	35985	24.01
All	1580	40.81	118701	24.64
II. Agricultural Labourers ('000)				
Male	286	11.23	61594	18.56
Female	117	8.84	82747	55.21
All	403	10.42	144330	29.96
III. Household Industry Workers ('000)				
Male	69	2.72	9790	2.95
Female	45	3.41	8558	5.71
All	114	2.95	18354	3.81
IV. Other workers ('000)				
Male	1461	57.24	156640	47.20
Female	313	23.75	43734	29.18
All	1774	45.82	200405	41.60
% of Agricultural Workers to Total Workers		51.23		54.59
% of Cultivators to Total Agricultural Workers		79.67		45.13
% of Agricultural Laborers to Total Agricultural Workers		20.33		54.87
% of Female Agricultural Workers to Total Agricultural Workers		34.09		31.11



### xii. Marketing of agricultural, horticultural and floricultural products

Generally in rural areas of Uttarakhand, the marketing/distribution of agricultural products is done directly by farmers. For smooth marketing, Uttarakhand Agricultural Produce Marketing Board (UKAPMB) came into existence through agricultural produce marketing (development and regulation) act 2011. This Act aims to provide effective regulation in Marketing of agricultural produce, establishment and development of proper and modern marketing system, promotion of agricultural processing and agricultural export, superintendence and control of markets in the state of Uttarakhand. Table 5.16 describes about principal markets, sub-markets and weekly agriculture markets (Haath Painth) of Uttarakhand.

**Fig 5.9**  
Occupational classification of main and marginal workers in Uttarakhand<sup>16</sup>



① <https://www.ukapmb.org>

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- Govt Govt of India
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- Govt of Uttarakhand
- Sou-Moto Disclosures
- samvidhan Uttarakhand
- Other Marketing Board

**INTERNAL USE ONLY**

<sup>16</sup>Tuteja, U. 2015. Agriculture profile of Uttarakhand. Agricultural Economics Research Centre University of Delhi. <http://gbpihedenvis.nic.in; uk.gov.in>.

Sl.No.	District	Principal markets	Submarkets	Weekly markets
1.	Nainital	1. Haldwani	1. Mukhani 2. Lamachod 3. Lal Kuan 4. Bhowali 5. Kaladhungi	1. Kaladhungi
		2. Ramnagar	1. Shankarpur 2. Peerumadara	1. Halduwa 2. Tanda 3. Shankarpur
2.	Udham Singh Nagar	3. Rudrapur	1. Bhurarani 2. Bhamraula 3. Bagwala 4. Bhainsiya	
		4. Kashipur		1. Pratappur
		5. Jaspur		1. Kunda 2. Kundeshwari 3. Mahuwakheda
3	Champawat	6. Sitarganj	1. Bhudiya	1. Shaktifarm
		7. Nanakmatta		
		8. Khatima		1. Satrahmil 2. Melaghat
		9. Kichha		
		10. Gadarpur	1. Chandayan	1. Dineshpur 2. Gularbhoj 3. Gadarpur
		11. Bazpur	1. Sultanpur Patti 2. Kilakheda	1. Kilakheda 2. Sultanpur Patti
		1. Tanakpur	1. Banbasa 2. Champawat 3. Lohaghat	
		2. Dehradun	1. Doiwala 2. Mussorie	1. Selaqui
		3. Vikashnagar		1. Raiwala 2. Chhidarwala
		4. Chakrata	1. Sahiya	1. Rani Pokhari 2. Baniyawala 3. Shyampur
		5. Rishikesh		1. Ganganagar 2. IDPL
4	Dehradun	6. Manglore	1. Jhabreda 2. Narsan	
		7. Lakshar	1. Landora 2. Rayasi 3. Govardhanpur 4. Bheekampur	
		8. Haridwar	1. Bahadarabad	1. Bahadarabad 2. Shahpur
		9. Roorkee	1. Bhagwanpur	-
		10. Kotdwara	1. Dugadda	-
5	Haridwar	11. Karanprayag		-
6		12. Uttarkashi	Not yet functional	-
7		13. Tehri Garhwal	Not yet functional	-
8		14. Almora	Not yet functional	-
9		15. Pithoragarh	Not yet functional	-

**Table 5.16**  
 Principal agricultural markets in Uttarakhand: district wise details<sup>17</sup>

<sup>17</sup>[www.ukapmb.org](http://www.ukapmb.org)



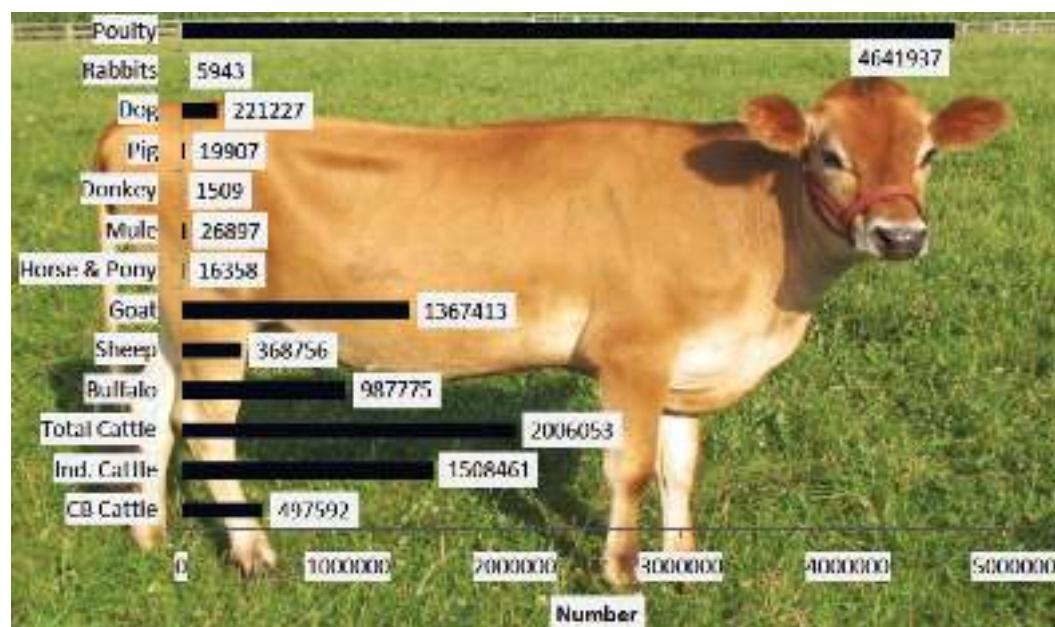
### xiii. Livestock: status and policies

Livestock farming is the second most important occupation of the people, after agriculture. It helps to substitute livelihood of the poor marginal farmers by providing milk, manure, meat and wool. Uttarakhand characterises mixed crop-livestock systems in small holdings. There are two systems – sedentary and migratory. Livestock is kept in a village throughout the year under sedentary system, whereas in migratory system livestock migrates seasonally to highland pastures for grazing. Draught animals also support productivity and sustainability of hill agriculture. Geographic variations have combined to provide a microcosm of the Earth's livestock farming systems. Farmers who are involved in rearing dairy animals also keep bullocks to plough fields and sell them to supplement their incomes. The whole system is

referred to as dairy-manure-draught cattle production system.

Farmers consider cow as a sacred animal and also considered as an economic animal since it provides both milk and manure, and helps substantiate the rural livelihoods. Uttarakhand possesses a huge natural resource base for livestock farming that includes common property resources and extensive grasslands – subtropical, temperate and alpine. In addition, fodder is alternatively managed through stall feedings, the planting of fodder trees and cultivation of grasses on private land. Climatic conditions are suitable, ranging from subtropical to temperate and alpine and provide suitability for livestock farming. Latest status of total livestock population of Uttarakhand based on year 2012 is given in Fig 5.10.

**Fig 5.10:**  
Total livestock population of Uttarakhand<sup>18</sup>



<sup>18</sup><http://www.uldb.org/>

Uttarakhand livestock development board was established for implementing following objectives in livestock development:

- The Board has the rights, powers, privileges and responsibilities, provided by the law of India. The purpose of this board is to promote breeding and development of cows and buffaloes both of indigenous and exotic breeds along with those of economic importance by introduction, promotion and adoption of appropriate technologies for improving their production, and also to arrange, organize and undertake all activities relating to and necessary for

improving livestock production and productivity.

Department of animal husbandry, Govt. of Uttarakhand is also working for intensifying & creating new opportunities in the field of animal husbandry for increasing employment and enterprise development in the state. The strategy adopted by the department is to realize its vision of providing prophylactic and therapeutic veterinary services, doorstep animal breeding facilities and production support activities to the livestock farmers through its vast institutional network to improve animal productivity and employment.

[www.ahd.uk.gov.in](http://www.ahd.uk.gov.in)

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Currently different projects offered by Animal Husbandry Department of Uttarakhand are:

- [\*\*Action Plan-Grassland Project\*\*](#)
- [\*\*Office Memorandum Dairy Venture Capital\*\*](#)
- [\*\*Revised ATMA Guidelines\*\*](#)
- [\*\*State Sector New Scheme\*\*](#)
- [\*\*Ahilyabai Holkar Scheme\*\*](#)
- [\*\*Cow Distribution Scheme for Kedarnath Aapda Widows\*\*](#)
- [\*\*Aajivika Utthan Scheme for Dharchula and Munsyari Block Pashupalak\*\*](#)



### **Constraints for livestock**

- ✓ Shortage of fodder and feed, livestock fodder problem is more acute than the human food problem in the hills.
- ✓ The rangelands and grasslands are operating at one-fourth of their productive potential.
- ✓ Most of the fodder and grazing areas have been infested by non-palatable invasive species, such as lantana, eupatorium and congress grass.

### **xiv Constraints in agriculture, horticulture & floriculture**

Subsistence agriculture is the prime source of livelihood and employment for more than 70% of the population in Uttarakhand. It accounts for about 37% of the Net Domestic Product of the state. Agriculture in Uttarakhand is very complex and is interlinked with crop husbandry, animal husbandry and forestry to form a production system. Inaccessibility, environmental heterogeneity and ecological fragility have favoured evolution of subsistence production system in the hill state. Following are some important constraints for sustainable development of agriculture horticulture and floriculture in Uttarakhand:

- Remoteness and inaccessibility
- Fragility in terms of moisture stress and the poor soil conditions
- Short growing season
- Natural disasters such as floods, earthquake etc.

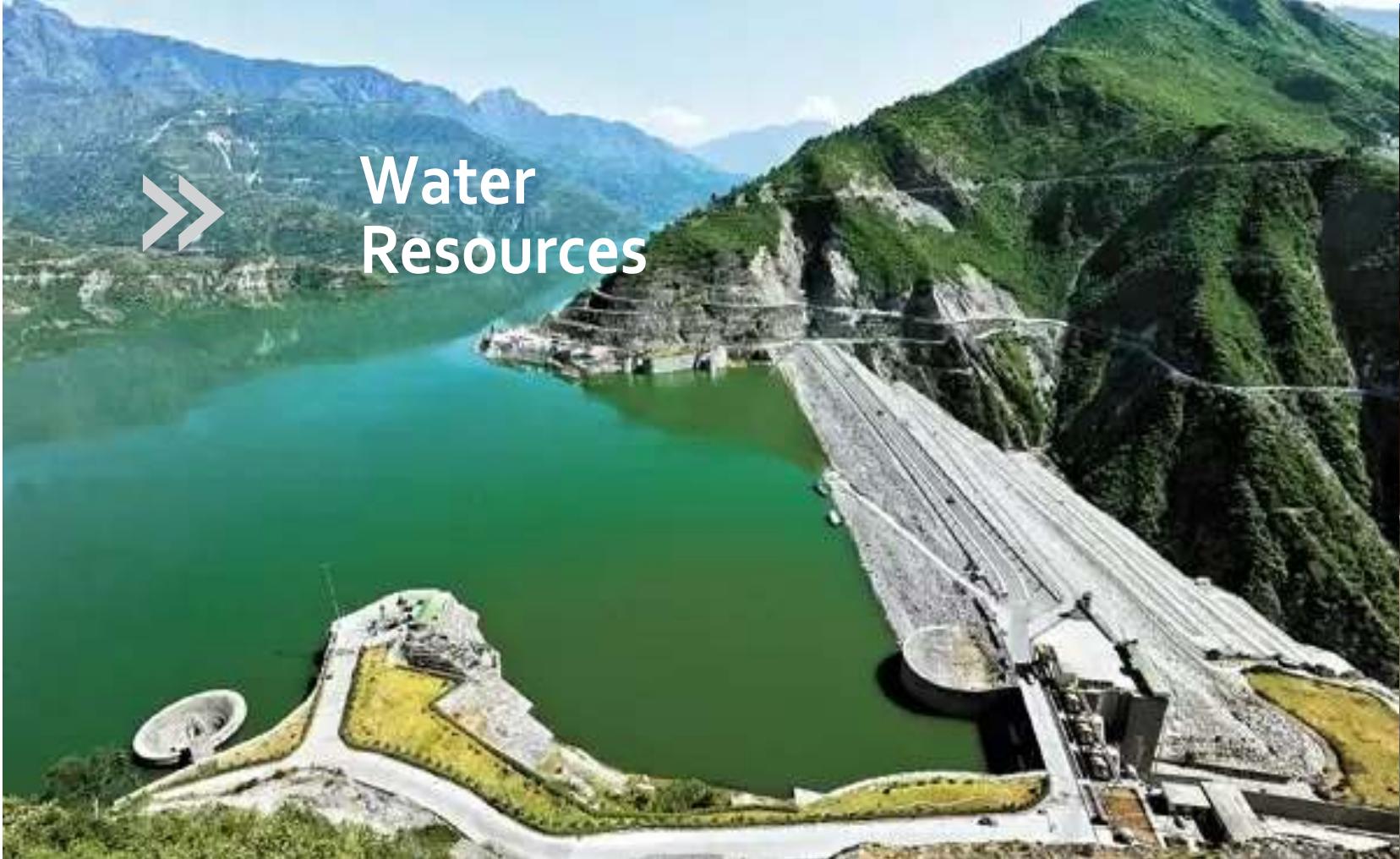


- Small holdings
- Poor productivity
- Poor production management
- Labour shortages
- Poor post-production technology
- Poor marketing and networks
- Lack of entrepreneurship
- Poor orchard management practices
- Quality of planting material
- Seeds and other inputs
- Little access to extension services and marketing
- Problems in accessing market information
- Value addition skills





# Water Resources



- i) Water sources of Uttarakhand.
- ii) Glaciers and recession of glaciers; Hazardous related to glaciers.
- iii) Riverine network.
- iv) Water requirement in Uttarakhand.
- v) Water quality of rivers.
- vi) Traditional Water harvesting systems.
- vii) Status of drinking water: quality and quantity and sanitation.
- viii) Water management system in Uttarakhand.
- ix) Dwindling of perennial water resources.
- x) Development of water resources.
- xi) Recharge of spring water sources.



# 06

## i. Water sources of Uttarakhand

Water on the earth is in motion through the hydrological cycle. The utilisation of water for most of the users i.e. human, animal or plant involves movement of water. The dynamic and renewable nature of the water resources and the recurrent need for its utilisation requires that water resources are measured in terms of its flow rates. Thus water resources have two nature. The dynamic resource, measured as flow is more relevant for most of developmental needs. The static or fixed nature of the reserve, involving the quantity of water, the length of area of the water bodies is also relevant for some activities like pisciculture, navigation etc. A river basin of Uttarakhand is considered as the basic hydrological unit for planning and development of water resources. It has three main river basins as Bhagirathi (Alaknanda basin –

Ganga basin), Yamuna (Tons basin) and Kali.

The state has a long network of perennial and seasonal streams which are drained by number of rivers and local water streams like gad, gadhera naula etc. In state lakes also contribute major role in water supply. Total 118 lakes are present in state in which high altitudinal lake cover 231 ha area. The behaviour of groundwater in Uttarakhand is highly complicated because of diversified geological formation, complex tectonic frame work, different climatic condition etc. The reduction in groundwater recharge over last decades has been reported due to change in rainfall pattern. The estimation of dynamic ground water resources for Uttarakhand done by Central Ground Water Board is given below<sup>1</sup>:

Annual replenishable ground water resources	2.27 BCM
Net annual ground water availability	2.10 BCM
Annual ground water draft	1.39 BCM
Stage of ground water development	66%

\*BCM: Billion cubic meters

In Uttarakhand springs gadheras, rivers, lakes, tube wells, dug wells, koops, chal and khal etc. are the main

drinking and irrigation water sources.

<sup>1</sup> [http://cgwb.gov.in/gw\\_profiles/Uttarakhand.htm](http://cgwb.gov.in/gw_profiles/Uttarakhand.htm)



## ii. Glaciers and recession of glaciers: hazardous related to glaciers

### Glacier

A glacier is a mass of ice consisting of compacted and recrystallized ice on land that flows down under its own weight due to gravity. Glaciers are lying largely or wholly on land and showing evidence of past or present movement. Snowfields that persist throughout the winter, melt in summer season are not remain glaciers because they lack motion.

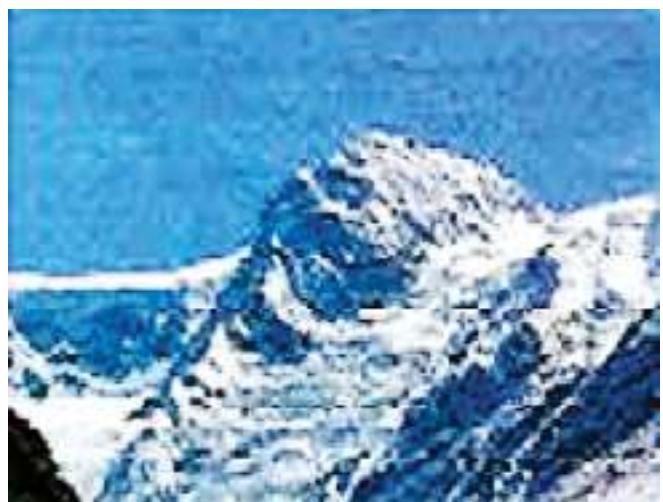
### GLACIER IN GARHWAL:

#### Bandarpooch Glacier

Bandarpooch is an exquisite peak in the Western Himalayas of North India. It stands at the western edge of the High Himalayan range where it turns northwest at an altitude of 6316 m and is easily accessible with a scenic three-day hike. The glacier is about 12 Km long. The Southwest ridge offers a route of moderate difficulty with little technical climbing.



The Uttarakhand Himalaya stretches for about 325 Km between Kali Ganga in the east and Tons-Yamuna valley in the west and covers an area of 53,204 Km<sup>2</sup>. There are 1439 glaciers in Uttarakhand Himalaya covering a total area of 4060 Km<sup>2</sup>. These glaciers have been further sub-divided in the following mountain ranges: Nanda Devi Group, Dhauliganga Group, Kamet Group, Gangotri Group, Satopanth Group and Bandarpooch Group. The following glacier inventory for Uttarakhand Himalaya using remote sensing techniques has been prepared by the Wadia Institute of Himalayan Geology, Dehradun.



#### Gangotri Glacier

Gangotri glacier is located in the district of Uttarkashi in the hill state of Uttarakhand. It is one of the most important glaciers in Garhwal region as it is responsible for feeding the head stream of the holy river Ganga. Gangotri glacier originates at the northern slope of Chaukhamba range. It extends to about 28 Km before terminating at Gaumukh which is 4,000 m above the MSL. This glacier has volume of about 27 Km<sup>3</sup>.

### **Khatling Glacier**

This lateral glacier situated in Tehri district is the source of river Bhilangna. The glacier is surrounded by snow peaks of the Jigin group (6466 m), Sphetic Pristwar (6905 m), Barde Kauter (6579 m), Kirti Stambh (6902 m) and Meru (6672 m). The moraines on the side of the glaciers look like standing walls of gravel mud.



### **Pindari Glacier**

The Kumaon region in the state of Uttarakhand has unimaginable natural beauty. The Himalayan ecology is well conserved here and offers a great retreat for all nature lovers. The Pindari glacier is found in the upper reaches of the Kumaon Himalays, to the southeast of Nanda Devi. The glacier flows to the south for a short distance of about 3 Km, 0.25 Km in breadth and gives rise to the Pindar river which meets the Alaknanda at Kamaprayag in the Garhwal district. The trek to the Pindari Glacier is amongst the most favorite of treks in the Kumaon region of the Himalayas. The trail takes through some of the most spectacular landscape one can ever hope to see. The traditional,

### **GLACIER IN KUMAON:**

#### **Milam Glacier**

Situated on the south facing slope of the main Himalayan range is 16Km long. It originates from the slope of Kohil and Trishul peaks. It acts as the source for the Milam river and a tributary of the pindar river. Milam glacier is spread over 3870 to 5500 m covering 37Km<sup>2</sup> areas.



remote villages make for a special attraction for any visitor. At the final destination, the Pindari Glacier, one is rewarded with a view that will remain etched in the mind for life.



### Sunderdhunga Glacier

Sunderdhunga literally means valley of beautiful stones. Sunderdhunga glacier is situated in the district of Bageshwar within the hill state of Uttarakhand. Other famous glaciers of Sunderdhunga valley are Maiktoli Glacier (6,804 m) and Sukhram glacier and main peaks are Tharkot (6,100 m), Mrighthuni (6,856 m), Maiktoli (6,804 m) and Pawali Dwar (6,663 m).



### Ralam Glacier

Ralam is a beautiful glacier located in Munsyari tehsil of Pithoragarh district within Kumaon region. This magnificent glacier is situated at an elevation of 2,290 m above MSL near Ralam Dhura at Ralam Khal. From Munsyari to Ralam Khal Ralam glacier is 15 Km long.



### Kafni Glacier

Kafni glacier is situated on the left side of pindar valley under majestic mountain Nandakot. This region has its own charm with the solitude it presents. This region is very rich in wildlife. There are no rest houses beyond Dwali and one has to spend nights in tents or caves. Main peaks near the glacier are Nandakot (6860 m) above MSL, Changuch (6322 m), Maiktoli (6803 m), and Mrighthuri (6855 m) etc. It has length of approximately 3 Kms.



### Namik Glacier

The word 'Namik' means a place where saline water springs are present. Namik is a fascinating glacier cradled in the pristine environs of Kumaon Himalayas, within the district of Pithoragarh in the hill state of Uttarakhand. The Namik glacier trek is situated on Kumaon Himalayas at an altitude of 3,600 m. It is 40 Km from Munsyari and situated at the villages of Gogina and Namik. The length of glacier is 3 Km.

### Recession of Glaciers in Uttarakhand

The rate of recession and volume change are irregular for glaciers across the Himalayan arc. This is attributed to the variations in micro-climate and physiography. Out of more than 5000 glaciers in the Indian Himalayas, only 11 glaciers have been monitored for their

mass balance and nearly 100 glaciers have been monitored routinely for shifting of snout position of the glaciers. The recession trends of some the glaciers are given in Table 6.1. The glaciers are receding rapidly with the rate of retreat during the period 1881-2000 being about 20 m/yr. The enhanced rate of retreat is attributed due to the increased anthropogenic interventions.

**Table 6.1**  
Recession  
trends of  
some Himalayan  
glaciers in  
Uttarakhand<sup>2</sup>

Name of Glacier	Duration of observation	Period (in years)	Recession (in m)	Average recession rate (m/yr)
Milam glacier	1848-1996	148	2472	16.7
Pindari glacier	1845-1966	121	2840	23.5
Gangotri glacier	1935-1996 1996-1999	61 3.5	1147 76	18.8 22.2
Tipra bank glacier	1960-1987	27	100	3.7
Dokriani glacier	1962-1991 1991-2000	29 09	480 161.15	16.5 18.0
Chorabari	1992-1997	05	55	11
Shanklup	1881-1957	76	518	6.8
Poting	1906-1957	51	262	5.1
Dunagiri	1992-1997	05	15	3.0
Burphu	1966-1997	31	150	4.8
Chorabari	1992-1997	05	55	11
Bhrigupanth	1962-1995	33	550	16.7
Tipra Bank	1960-1987	27	100	3.7

### Hazards related to glaciers

Glaciers are basically made up of fallen snow which over the years compresses into large thickened masses of ice which have an ability to move. The glacial movement is directed by gravity and high pressure. It is noteworthy that the glacial ice is the largest source of fresh water on earth.

Glaciers of Uttarakhand acts like an important features due to state topography as it is a source of some of the most important river systems of India. While the river Ganga has its origin in the melted water of Gangotri glacier and the melted water of Yamunotri glacier feed the headstream of river Yamuna.

<sup>2</sup> Climate change in Uttarakhand: Central State of knowledge and way forward 2015, Cedarhimalaya.org.



### Flooding caused by glacier

Although it is common for a glacier to have a small lake of meltwater near its terminus, extreme melting or unusually fast melting can cause these lakes to overflow their barriers and cause flooding downstream called glacial lake outburst floods (GLOF). More dangerous is the case when a glacier flows across a stream or river, creating a dam like structure that can trap a large amount of water.

Glacial lake outburst floods (GLOF) avalanches and flash flood can be considered to be primary hazards in the hilly region of Uttarakhand, while rock fall, debris fall and landslide can be considered as secondary hazards.

### GLOF/flash floods

Valley glaciers have supra- glacial ponds and moraine dam lakes. As glacier retreats it leaves a large void. Ponds occupy the depression earlier occupied by glacial ice.

Moraine wall act as dam are structurally weak and unstable and undergoes to constant changes due to slope failures.

GLOF is characterised by sudden release of large amount of lake water that reaches along the stream channel downstream in the form of dangerous flood waves. The flash flood due to sudden burst of a glacial lake produce the violent flow of water and associated debris. Lake outburst and debris flow in Kedarnath in June 2013 was one of the destructive disaster occurred in Uttarakhand and still various potential disastrous lakes exists and are developing in this region. In Uttarakhand Himalaya there are 127 glacial lakes of varying sizes that cover a vast area of Uttarakhand region.

Avalanches – Sudden downward movement of snow, ice block and rock mass when cohesion among the snow particle is decreased is called avalanches. Major avalanches occurred in Uttarakhand in past are as follows<sup>3</sup>:

Date/Year	Location	Remarks
June 2008	Gomukh glacier near Gangotri, Uttarkashi	1 person died and 9 injured
June 2008	Hemkund shahib ,Chamoli	6 died and more than 12 people injured
September 2008	Kalindi- Badrinath track in the Garhwal Himalaya, Chamoli	3 persons were killed
September 2010	Ghastoli, Chamoli	2 army officers were killed
June and July 2013	Kedarkharak, Uttarkashi	1 person killed

Himalayan region valley close to glaciers in district Uttarkashi, Chamoli, Rudraprayag, Pithoragarh, and Tehri which receive winter snow and susceptible to avalanches.

### Damage to Hydropower station

The discharge during Glacier burst floods causes acute erosion which leads to landslides along the valley slopes.

<sup>3</sup> Uttarakhand disaster 2013, NIDM GOI



Saturated discharge can cause destruction of the dam. Uttarakhand has identified capacity of hydropower generation potential of around 18 GW out of which state has developed 2980 MW capacity. Regular monitoring of glacial lakes and glacial retreat are necessary for safeguards of

power projects in the state. Lanco Infratech limited which was building Vyong phata hydro power project (76 MW) in Vyong village of Rudraprayag district has closed down the project for incurring losses especially after a large part of its barrage got washed away in 2013 deluge in Kedarnath.

### iii. Riverine network

Riverine is a landscape formed by the natural movement of a water system. It may also be defined as network of rivers and surroundings land.

Uttarakhand is a state which is known for its hundreds of small and big rivers, the holy places, sacred temples situated on the bank of the rivers. The sources of these rivers are glaciers of the western Himalayas. The following are some river of Uttarakhand which form a riverine network in the state (Fig 6.1).

**Alaknanda-** This river flowing in Uttarakhand is two head network streams of holy river Ganga. The source of Alaknanda river is the confluence of Satopanth. Several river flowing in Garhwal division merges with Alaknanda river at Panch Prayag.

Alaknanda meets with Bhagirathi river at Devprayag where it is officially become Ganga river.

**Bhagirathi** - It is one of the two headstream of pious Ganga river. This river has a length of 205 Km and basin about 6921 Km<sup>2</sup>.



**Fig 6.1**

Riverine network of Uttarakhand



**hilangna** – It is tributary of Bhagirathi river, which is source-stream of Ganga river. The length of this river is 80 Km. It arises from Thatling glacier perched at an elevation of 3717m. Bhilangna meets its major tributaries namely Bal Ganga at Ghyansali about 976m above MSL.

**Dhauliganga** – It rises at an altitude of 5,070 m in the Niti pass at Chamoli district of Uttarakhand. The river is joined by Rishi Ganga river at Raini about 25 Km from Joshimath.

**Ganga** – Ganga emerges form Devprayag and flung at Haridwar in Uttarakhand. The soruce of Ganga river is Gangotri glacier, Satopath glacier, Khatling glacier and the melted water from the snow peaks of Nanda devi, Trishul, Kedarnath and Kamet.

**Gaula** - It is a Himalayan river which flows in Uttarakhand. The source of the river is Pahaspani and the end point is Kichha. The length of this river is about 103 Km.

**Gori Ganga** – Gori Ganga also referred to as Ghori Ganga and Gori Gad is a river in the Munsiyali tehsil of Pithoragarh District in Uttarakhand. The source of Gori Ganga is Milam Glacier.

**Kali** -The Kali River also known as Sharda river, Kutiyangdi or Mauakali river is a Himalayan river which flows through Uttarakhand. The traditional source of Kali River is Lipmpiya Dhura in Pithoragarh District of Uttarakhand which is 3600 m above MSL.

**Tons** - Tons river originated from Rupin Supin Glacier and its length is about 148 Km. It ends at Dak Pathor. It is largest tributaries is Yamuna River. The source of this river is Banderpoonch mountain.

**Yamuna River**- This river originates from Yamnotri Glaciers perched at an elevation of 6,387m on the south western slope of Banderpoonch mountain in the uppermost region of the lower Himalayan in Uttarakhand.

In most of the major cities like Rudrapur, Kashipur, Haridwar and Dehradun area water supply is deficient mainly due to large population size. For sustainable use of water resources and its proper availability to the people, National Rural Drinking Water programme by Department of Drinking Water and Sanitation, Ministry of Jal Shakti, a number of schemes have been started since 2008 in the state. Under this programme present status of water supply schemes handed over to Gram Panchayat in Uttarakhand is given in Table 6.2.

#### iv. Water Requirement in Uttarakhand

Snow covered high altitude area of mountain ranges of the state are perennial source of water for Uttarakhand. From 2001 to 2014, 4.88% of the state population has full access of safe drinking water supply. It is estimated that minimum 70-100 ltr per head per day water is considered to be adequate for domestic needs in urban communities.<sup>4</sup>

**Table 6.2**  
Status of  
water supply  
schemes handed  
over to Gram Panchayat  
in Uttarakhand from  
2008 upto 2019<sup>4</sup>

S.No.	District	No. of schemes handed over to Gram Panchayat
1	Almora	1,558
2	Bageshwar	615
3	Chamoli	722
4	Champawat	445
5	Dehradun	542
6	Garhwal	2,171
7	Hardwar	106
8	Nainital	457
9	Pithoragarh	873
10	Rudraprayag	1,002
11	Tehri Garhwal	1,422
12	Udham Singh Nagar	5
13	Uttarkashi	1,461
total		<b>11,379</b>

<sup>4</sup>[https://indiawater.gov.in/IMISReports/Reports/TargetAchievement/rpt\\_RWS REP\\_HANDED\\_TO\\_COMMUNITY\\_D.aspx?Rep=0](https://indiawater.gov.in/IMISReports/Reports/TargetAchievement/rpt_RWS REP_HANDED_TO_COMMUNITY_D.aspx?Rep=0)



## v. Water quality of rivers

Several Himalayan rivers are the source of water in Uttarakhand. The Himalayan rivers are the life line of majority of population in cities, towns and villages of Uttarakhand. The

assessment of water quality of rivers of Uttarakhand has done by the Central Pollution Control Board. In the year 2018 monitored water quality characteristics is given in Table 6.3. Designated best use classification of water for the assessment of river water by CPCB is also mentioned in Table 6.4.

**Table 6.3**  
Water quality  
characteristics  
of rivers in  
Uttarakhand  
(2018)<sup>5</sup>

Location	pH	BOD mg/L	COD mg/L	Temp °C	DO mg/L	Alkalinity/Visual titration CaCO <sub>3</sub> mg/L	Chlorides mg/L	Calcium as CaCO <sub>3</sub> mg/L	Magnesium as CaCO <sub>3</sub> mg/L	Hardness as CaCO <sub>3</sub> mg/L	TDS mg/L	DBU
River Ganga Canal, Harki Pauri, Haridwar	7.95	<1	4.17	18.75	9.30	73.08	5.17	43.33	38.17	81.50	106.33	A
River Ganga Canal, D/S Rishikul Bridge, Harki Pauri Haridwar	7.93	<1	4.00	18.83	9.20	72.17	5.00	45.00	38.00	83.00	106.33	A
Upper Ganga Canal, D/S Roorkee, Haridwar	7.94	1.00	5.09	18.36	9.04	75.64	5.82	45.82	40.00	85.82	106.64	A
Upper Ganga Canal, Damkoti, Haridwar	8.00	<1	4.00	18.67	9.45	72.17	5.25	44.83	37.17	82.00	104.00	A
Ganga U/S Abindhughat, Dudhiyaban, Haridwar	8.03	1.00	5.00	18.67	9.38	72.67	5.67	44.0	37.67	81.67	105.58	A
Upper Ganga Canal D/S Balakumari Mandir, Ajeetpur, Haridwar	7.88	1.05	5.67	18.58	9.20	78.00	7.33	49.33	40.67	90.00	143.25	B
Upper Ganga Canal, Lal Tao Bridge, Haridwar	7.93	<1	4.17	18.58	9.43	72.33	5.42	44.33	38.00	82.33	108.33	B
River Suwa D/S Mathurawala, Dehradun	7.88	33.17	134.00	18.75	2.42	293.50	32.33	218.83	130.00	348.83	422.83	C
River Ganga D/S Raiwala, Dehradun	7.68	1.05	5.67	18.83	8.87	82.50	7.17	53.33	40.50	93.83	127.75	B
River Ganga U/S Lakshmanjhula	7.55	<1	4.00	18.58	9.92	71.00	5.00	41.83	34.83	76.67	85.50	A
Ganga D/S Rishikesh	7.60	<1	4.00	18.75	9.58	70.33	5.50	42.00	36.67	78.67	94.17	A
River Yamuna U/S Lakwar Dam, Dehradun	7.78	<1	4.00	17.50	9.00	72.50	5.00	45.00	39.00	84.00	93.50	A
River Yamuna U/S Dakpathar, Dehradun	7.63	1.00	4.50	18.25	8.85	64.50	5.75	41.50	33.00	74.50	87.50	A
River Alaknanda A/C Mandakini, Rudraprayag	7.79	<1	4.00	16.50	9.30	64.00	5.25	42.00	32.00	74.00	64.50	A
River Mandakini B/C Alaknanda, Rudraprayag	7.72	<1	4.00	16.75	9.30	62.50	5.25	40.50	32.00	72.50	63.00	A
River Alaknanda B/C Mandakini, Rudraprayag	7.70	<1	4.00	17.00	9.10	65.00	5.00	42.00	33.00	75.00	64.00	A
River Alaknanda A/C Bhagirathi, Devprayag	7.76	<1	4.00	17.50	9.50	61.00	5.50	39.50	31.00	70.50	65.75	A
River Alaknanda B/C Bhagirathi, Devprayag	7.80	<1	4.00	17.50	9.25	65.50	5.50	42.00	33.00	75.00	65.50	A
River Bhagirathi B/C Alaknanda, Devprayag	7.84	<1	4.00	17.50	9.35	59.50	5.25	39.00	33.00	67.00	61.00	A
Nainital Lake Water Intake	7.61	1.47	5.50	13.20	7.30	214.50	21.33	123.33	105.33	228.66	313.00	A
Bhimtal Lake	7.60	1.45	5.42	13.75	7.40	121.50	21.25	83.50	64.33	147.83	142.00	A
Gola River	7.70	1.42	5.67	15.80	7.39	123.66	18.91	120.67	98.00	218.66	152.00	A

\*DBU- Designated Best Use, D/S- Down Stream, U/S- Up Stream, A/C- At the Confluence, B/C- Before the Confluence

<sup>5</sup>[ueppcb.uk.gov.in/](http://ueppcb.uk.gov.in/)



**Table 6.4**  
Designated Best Use  
classification  
for water  
assessment<sup>4</sup>

Designated-Best-Use	Class of water
Drinking WaterSource without conventional treatment but after disinfection	A
Outdoor bathing (Organised)	B
Drinking water source after conventional treatment and disinfection	C
Propagation of Wild life and Fisheries	D
Irrigation, Industrial Cooling, Controlled Waste disposal	E

#### vi. Traditional water harvesting system

Uttarakhand has a glorious tradition of water harvesting and a number of natural water resources are also found here. The traditional structures of water management are similar in the mountainous areas of Kumaon and Garhwal regions of the state. Traditional water collecting system in Uttarakhand comprises a variety of community control methods. Their assortments started from the differences in the local circumstances. Many of these plans were initially made by local leaders, dynasties and kings or by the prosperous

people of the society.

The following are some water harvesting system present in Uttarakhand.

- **Gul**

In hilly regions, cultivation is done largely on terraced fields since ancient times, the problem of irrigating the field was resolved by diverse water resources from nearly streams, rivers and through channel. These channels are called gul.



- **Naulas**

Naulas are designed to collect water from subterranean springs. The flow of springs is very resistive and can be disturbed by seismic activity and human disturbance.



- **Simar**

Simar is also known as gajar. Gajar is a marshy tract of land in an agriculture field and is created by the ground water. It is suited for paddy cultivation. Cultivation of high quality crops like basmati rice, medicinal plants and herbs are a common feature in Gajar.



- **Khal**

Large depression in mountain areas used for rainwater harvesting is called khals. Mostly they are on top of ridges in the saddle between two crests. Sometimes small ponds are also dugged for collecting rainwater.



- **Dhara**

Common source of drinking water and can be compared with a drinking water fountain. Dhara located in mountain crest and in valley are also popular in townships. In Dehradun district Parala Dhara and Sipahi Dhara areas are used.



- **Chuptaula**

These are basically water holes for animals and are found mostly in high altitudes for use of graziers. They are not permanent in nature and water is collected in them from springs or from points where water oozes.





- **Dhaan**

Water collected from small and big streams gives the shape of a lake called Dhaan. The accumulated water is used for bathing of domestic animals and irrigation.

- **Roof top rainwater harvesting method**

Harvesting rainwater from rooftop is an easy and eco friendly method of augmenting household level water availability. Roof top rainwater harvesting (RRH) involves diverting and storage of rain water that falls on the roof of a house.

- **Recharge well/ Dug well**

Large diameter wells and smaller diameter boreholes are used to directly recharge or dilute shallow

aquifers where low permeability strata overlies the aquifers and where other infiltration methods are not effective. The important thing is that only good water quality is used for this purpose. This technique mainly describes recharge at the family level in areas where hand dug wells run dry at the end of the dry season.

### vii. Status of drinking water: quality and quantity and sanitation

In Uttarakhand drinking water is available to the public through lakes, ponds, rivers and in some place through ground water. The lakes found above 3000m elevation termed as high altitude lakes. Total lake covered in the state is nearly about 103882 ha areas including 231 ha of high altitudinal lakes. District wise ground water and surface water based schemes in Uttarakhand (reported as on 13.05.2019) is given in Table 6.5.

<sup>6</sup> <https://indiawater.gov.in> Ministry of drinking water and sanitation (National rural drinking water programme)

S.N.o.	District	Ground Water Based Schemes						Surface Water Based Schemes						Others **					
		PWS		H.P/ Borewell / Tubewell & other spot sources		Other *		PWS		H.P/ Borewell / Tubewell & other spot sources		Other *		PWS		H.P/ Borewell / Tubewell & other spot sources			
		No. of Schemes	No. of Habs covered	No. of Schemes	No. of Habs covered	No. of Schemes	No. of Habs covered	No. of Schemes	No. of Habs covered	No. of Schemes	No. of Habs covered	No. of Schemes	No. of Habs covered	No. of Schemes	No. of Habs covered	No. of Schemes	No. of Habs covered		
1	Almora	226	453	14	15	0	0	2193	4365	1	1	0	0	664	1579	0	0		
2	Bageshwar	50	215	08	08	0	0	406	1326	11	11	0	0	302	1884	0	0		
3	Chamoli	16	66	07	06	0	0	1150	3216	8	8	0	0	9	30	0	0		
4	Champawat	25	77	16	19	0	0	974	2141	13	13	0	0	10	45	0	0		
5	Dehradun	220	677	28	30	0	0	723	2071	3	4	0	0	37	172	0	0		
6	Pauri Garhwal	158	151	47	39	0	0	3340	3644	23	23	1	1	847	2474	2	2		
7	Haridwar	121	123	192	588	0	0	0	0	0	0	0	0	0	0	0	0		
8	Nainital	262	617	08	26	23	16	603	2056	7	7	35	27	56	183	2	2		
9	Pithoragarh	24	108	09	11	0	0	1343	4451	19	19	0	0	51	518	0	0		
10	Rudraprayag	67	136	00	00	0	0	1460	1638	11	11	0	0	20	105	0	0		
11	Tehri Garhwal	138	182	12	11	0	0	2796	4965	4	4	0	0	356	1057	0	0		
12	Udham Singh Nagar	72	81	330	1010	0	0	0	0	0	0	0	0	0	0	0	0		
13	Uttarkashi	28	36	278	162	0	0	1831	1801	7	7	0	0	199	262	0	0		
<b>Total</b>		<b>1,407</b>	<b>2,922</b>	<b>949</b>	<b>1,925</b>	<b>23</b>	<b>16</b>	<b>1,6819</b>	<b>31674</b>	<b>107</b>	<b>108</b>	<b>36</b>	<b>28</b>	<b>2581</b>	<b>8309</b>	<b>4</b>	<b>4</b>		

**Table 6.5**  
District wise  
Ground and Surface  
Water based  
Schemes for  
drinking water in  
Uttarakhand<sup>6</sup>

Note : \*Other than pws and spot source schemes.  
PWS – Piped Water Scheme.

\*\* Other than ground water and surface water source schemes.  
H.P- Hand Pump

In the state drinking water is being supplied and managed mainly by the department of drinking water. The department is basically concern with Uttarakhand Jal Sansthan (UJS), Uttarakhand Payjal Vikas Evam Nirman Nigam (UPJN) and Swajal project. Water is referred to as polluted when it is impaired by anthropogenic contaminants. On site sanitation system, sewage, fertilizers and pesticide,

commercial and industrial discharge, landfill leachate etc are the major factors behind the contamination of water. Hydrochemical study of surface and ground water is performed for determining its suitability for drinking, industrial and agriculture purposes. Regarding this National Rural Drinking Water Programme under Ministry of Jal Sansthan has made district quality profile by Forensic Testing Kit as given in Table 6.6.

S.n.o.	District	Total Sources Tested	Tested Sources Not found Contaminated	No. of Sources with Single Chemical Contaminants						No. of Sources with Bacteriological Contaminants	No. of Sources with Multiple Contaminants	No. of Sources with Other Contaminants
				Iron	Fluoride	Salinity	Nitrate	Arsenic	Other			
1	Almora	4827	4827	0	0	0	0	0	0	0	0	0
2	Bageshwar	3265	3265	0	0	0	0	0	0	0	0	0
3	Chamoli	3144	3144	0	1	0	0	0	0	1	0	0
4	Champawat	2725	2720	0	0	0	0	0	11	0	1	0
5	Dehradun	1934	1934	0	0	0	0	0	0	0	0	0
6	Pauri Garhwal	4724	4724	0	0	0	0	0	0	0	0	0
7	Haridwar	1051	1045	16	0	0	2	0	23	0	0	4
8	Nainital	3884	3884	0	0	0	0	0	0	0	0	0
9	Pithoragarh	2650	2650	0	0	0	0	0	2	1	0	0
10	Rudraprayag	2280	2272	0	0	0	0	0	0	16	0	0
11	Tehri Garhwal	2880	2872	0	0	0	0	0	5	0	0	6
12	Udham Singh Nagar	1728	1705	1	2	0	0	0	21	0	0	13
13	Uttarkashi	1705	1705	0	0	0	0	0	0	0	0	0
<b>Total</b>		<b>36797</b>	<b>36747</b>	<b>17</b>	<b>3</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>62</b>	<b>18</b>	<b>1</b>	<b>23</b>

**Table 6.6**  
District wise Ground  
Water Quality Profile  
by Forensic Test Kit  
(FTK)<sup>6</sup>



Ground water quality of Uttarakhand from the swallow and deeper aquifers is considered as of good quality and it is suitable for drinking, agriculture and for industrial purposes. Central Ground Water Board (CGWB) is engaged in the monitoring of the ground water of Uttarakhand and established ground water monitoring wells for this purpose. The Gangetic Alluvial Plain is a capable zone for groundwater development where as in hilly areas ground water occurs mainly in fissures and fractures. These structures emerge in the

form of water streams like gadheras or springs.

Rainfall plays a key role in the management of ground water. The ground water is a renewable reserve and is recharged annually by precipitation. There are several factors including diversified geological formations, complex tectonic framework, different climatic and hydro-chemical conditions which are responsible for the difficult performance of ground water resources and per hour yields of tube wells in various zones of Uttarakhand state are provided in Table 6.7.

**Table 6.7**  
Active ground  
water scenario  
in Uttarakhand<sup>7</sup>

Dynamic ground water resources in Uttarakhand	
Annual replenishable groundwater resources	2.27 BCM
Net annual groundwater availability	2.10 BCM
Annual groundwater draft	1.39 BCM
Yield of Tubewell in Uttarakhand	
Zone/ Belt	Yield/ hour
Shivalik	50.4- 79.2 m <sup>3</sup>
Bhabhar	upto 332.4 m <sup>3</sup>
Tarai	36 -144m <sup>3</sup>
Indo gangetic	90 – 198m <sup>3</sup>

The predominantly hill state of Uttarakhand has a varied hydrogeological setup and can be divided broadly into two distinct hydrogeological regimes viz. the Gangetic alluvial plain and the Himalayan mountain belt. The former is covered with vast expanse of alluvium and unconsolidated sedimentary material of varying size is promising zone for ground water development. The latter zone being predominantly hilly, offers much less potential for large scale development. Ground water in the hilly regions occurs mostly in fissures/fractures and emerges as spring. The springs are amenable to small scale development of groundwater resources in the state.

Ground water being a limited resource requires proper management and judicious use of its storage for meeting out demand on long term basis without putting any adverse impact on its regime. To meet this objective, Central Ground Water Board monitors the behaviour of ground water regime through a network of Ground Water Monitoring Wells spread across the country. However the analysis of annual water level fluctuation

rise and decline of ground water level data of existing 75 ground water monitoring wells in 5 districts of Uttarakhand ( Dehradun, Nainital, Champawat, Udhampur and Haridwar) is given in table 6.8. This table represents the data for the period January 2016 versus January 2017. A perusal of the table indicates that the minimum annual rise is 0.10 m at Bandarjud in Haridwar district whereas the maximum annual rise is 17.58 m at Majra in Dehradun district. The minimum annual decline is found to be 0.05 m at Ramgarh in Dehradun district whereas the maximum decline is 20.56 m at Khatbaans in Nainital district. A perusal of the table also reveals that out of 75 monitoring wells, 37 wells (49.33%) have recorded the minimum annual rise in the range 0-2 m whereas 5 wells (6.67% of total wells) had shown higher rise in the range 2-4 m. 4 no. of monitoring wells (5.33% of the total) had recorded the highest annual rise of >4 m during the period January 2016 to January 2017. Lowest annual decline of 0-2 m is recorded by 24 monitoring wells (32% of total) while 2 wells (2.67%) had recorded higher decline in the range of 2-4 m. The highest decline of >4 m is shown by 3 no. of monitoring well (4% of total).

<sup>7</sup>[https://cgwb.gov.in/gw\\_profiles/uttarakhand.htm](https://cgwb.gov.in/gw_profiles/uttarakhand.htm).

<sup>8</sup><http://cgwb.gov.in/Regions/GW-year-Books/GWYB-%202016-17/Uttarakhand.pdf>



District	No. of stations analyzed	Fluctuation (m)				Rise (m)						Decline (m)					
		Rise		Decline		0-2		2-4		>4		0-2		2-4		>4	
		Min	Max	Min	Max	No	%	No	%	No	%	No	%	No	%	No	%
Dehradun	19	0.33	17.58	0.05	12.41	5	26.32	1	5.26	2	10.53	9	47.37	0	0.00	2	10.53
Haridwar	23	0.10	3.11	0.10	3.97	12	52.17	2	8.70	0	0.00	8	34.78	1	4.35	0	0.00
Udham Singh Nagar	26	0.17	2.84	0.15	2.03	18	69.23	2	7.69	0	0.00	5	19.23	1	3.85	0	0.00
Nainital	5	5.20	9.99	1.16	20.56	0	0.00	0	0.00	2	40.00	2	40.00	0	0.00	1	20.00
Champawat	2	0.59	1.88	-	-	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Total	75	0.10	17.58	0.05	20.56	37	49.33	5	6.67	4	5.33	24	32.00	2	2.67	3	4.00

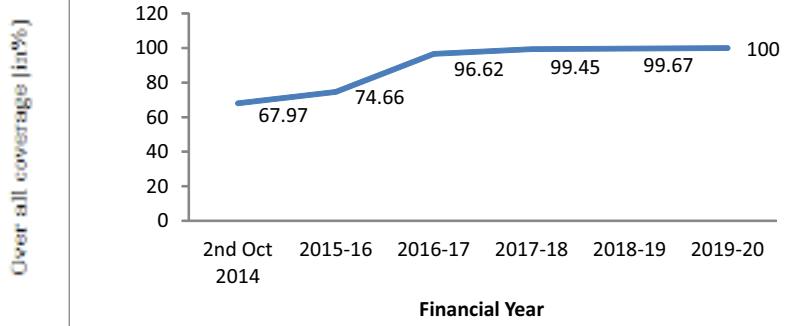
**Table 6.8**  
Annual water level fluctuation Jan 2016 vs Jan 2017<sup>8</sup>

Individuals health and hygiene mainly depends on the availability of potable drinking water and proper sanitation due to the direct relationship between water quality, sanitation and health. Urban sewerage facilities are available only to a small fraction of urban population and lack of proper sewerage facilities causing unhygienic health environment. In urban areas of Uttarakhand sewerage facilities are available only to a small fraction. Lack of proper sewerage system causes adverse effects on environment and local bodies. The state water and sanitation mission for Uttarakhand has been constituted with the participation of Uttarakhand jal sansthan and Swajal project. Under this mission 857 villages of Uttarakhand are covered. The Total Sanitation Campaign (TSC) programme in Uttarakhand was

started on 2 Oct 2014 with coverage of 67.9% of toilets out of total house hold that involved changing traditional mindset of rural communities for construction and usages of latrines for Open Defecation Free (ODF) villages. Due to peculiar geography and poor economical condition of rural masses, promotion of sanitation services in the rural areas of Uttarakhand was quite tough. Still continuous effort made for the promotion and implementation of this campaign and positive output came out which is given in Table 6.9. This mission has shown very significant effect in Uttarakhand and the status of coverage achieved in 2018-19 (as depicted in Fig. 6.2) was 99.6% with 100% coverage in 2019-20.

**Table 6.9**  
District wise Swachh Bharat Mission Target vs Achievement for Sanitation in Uttarakhand as on 16/04/2019<sup>9</sup>

S.No.	District Name	Total detail of HH entered (with & without toilet)	Total House hold detail with Toilet	Coverage of House Hold (HH) for Toilet					
				2014-15	2015-16	2016-17	2017-18	2018-19	Till 2018-19 Coverage (%)
1	Almora	131373	76166	7220	6286	41306	0	395	100
2	Bageshwar	59040	43056	2149	1977	11121	52	133	99.0
3	Chamoli	71561	50882	2161	4897	11027	2428	159	99.0
4	Champawat	47323	33711	3712	2121	7592	0	172	99.9
5	Dehradun	165244	130640	6568	5972	18540	2826	162	99.6
6	Haridwar	245560	135462	5353	3971	68940	28138	2834	99.6
7	Nainital	114563	88256	5502	3986	16113	305	398	99.9
8	Pauri(Garhwal)	144958	97416	4640	7672	31625	3530	6	99.9
9	Pithoragarh	100223	67229	4316	5418	22021	1	0	98.9
10	Rudraprayag	53330	32230	3121	3140	14402	95	329	99.9
11	Tehri Garhwal	119269	82506	4973	6694	23126	788	505	99.4
12	Udham Singh Nagar	207437	131714	4988	7286	57544	4744	1159	99.9
13	Uttarkashi	61270	42549	3189	4551	10742	78	154	94.9
	Total	1521151	1011817	57892	63971	334099	42985	6406	99.7



<sup>9</sup> <https://sbm.gov.in/sbmdashboard/IHHL.aspx>





A provision of a properly planned sewerage system with suitable treatment and safe disposal of treated sewerage has become absolutely essential in the state. There are 31 sewage management projects sanctioned for the state at an estimated cost of Rs 1024.5 Crore, to create 155.45 MLD STP capacity by the Government and to rehabilitate 151.02 Km of sewer network. Out of these, 13 projects have been completed, which have created 24 MLD STP capacity at a cost of Rs 139.5 Crore. Of the remaining 18 projects, 16 have already been awarded, while two are under tendering. The projects for construction of 22 ghats and 22 crematoria amounting to Rs. 161.16 Crore have also been sanctioned and are currently at different stages of progress at Tehri Garhwal, Rudraprayag (Devprayag to Rudraprayag stretch), Haridwar, Uttarkashi and Chamoli districts of Uttarakhand. Haridwar generates an estimated 114 MLD of sewage, but its existing sewage treatment plants at Jagjeetpur and Sarai are able to treat only 63 MLD of sewage. To bridge this gap, another 64 MLD STP at Jagjeetpur (replacing 18 MLD existing plant) and 14 MLD STP at Sarai have

been awarded under Hybrid Annuity based PPP (Public Private Partnership) model to exclusively address the sewage treatment requirements of the city under the National Mission for Clean Ganga and it is expected to complete by Nov. 2019 (Fig 6.3). The total sewage treatment capacity in the city thus will be 141 MLD, adequate to meet the sewage treatment demands of the town for coming years too. Some of the existing STP with their capacity in the state along with its untreated and treated characteristics are given in table 6.1<sup>10</sup>.

However, Nainital town generates total sewage of around 14.38 MLD for which 02 nos. of 05 MLD STP is proposed to be installed at Rishi village. The generation of sewage from Bhimtal is about 1.27MLD and to treat this amount of sewage 1.25 MLD STP is installed at Bhimtal. However about 30.68MLD sewage generation from other towns of Nainital goes untreated besides the provision of septic tanks and soak pits at different places in towns of Nainital. As per Payal Nigam data 2017, total sewage generation from main Almora city is 3.60MLD for which only 2.0MLD STP is existing at Bakh village of Almora.

**Fig. 6.3**  
Sewage Treatment  
Plant at Sarai,  
Haridwar



<sup>10</sup>[ueppcb.uk.gov.in/](http://ueppcb.uk.gov.in/), <https://swachhindia.ndtv.com/clean-ganga-16-sewage-treatment-plants-completed-in-uttarakhand-na-mami-gange-23552>

**Table 6.10**  
**Effluent characteristics before and after treatment by STP at different locations in Uttarakhand**

Sl. No	Sampling date	Name of the treatment plant	Sampling point								
			Inlet of STP				Outlet of STP				
			TSS (mg/L)	pH	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	pH	BOD (mg/L)	COD (mg/L)	FC MPN per 100ml
1.	01.01.2019	3.5 MLD STP Tapovan, Rishikesh	162	6.74	155	276	18	7.35	9.6	32	240
2.	01.01.2019	3 MLD STP at Swargashram, Rishikesh	168	6.92	165	310	16	7.42	10	34	140
3.	01.01.2019	6 MLD Oxidation pond, Lakkarghat, Rishikesh	162	7.78	160	194	58	7.82	32	128	>1600
4.	07.01.2019	20 MLD STP at Mothurawala	162	6.74	155	280	38	7.24	12	36	110
5.	07.01.2019	68 MLD STP at Kargi, Dehradun	168	6.78	160	286	12	7.19	8.8	34	140
6.	07.01.2019	0.42 MLD STP at Vijay Colony, Dehradun	164	6.84	160	298	42	7.58	20	62	500
7.	07.01.2019	0.72 MLD STP at Salawala, Dehradun	160	6.78	155	274	38	7.54	22	64	500
8.	11.01.2019	27 MLD STP at Jagjeetpur, Haridwar	166	6.75	160	288	18	7.58	10	38	280
9.	11.01.2019	18 MLD STP at Jagjeetpur, Haridwar	158	6.72	170	294	24	7.79	11.6	36	170
10.	11.01.2019	18 MLD STP at Sarai, Haridwar	162	6.82	160	278	10	7.47	9.6	34	110
11.	16.01.2019	0.26 MLD STP at Badrinath	168	6.84	160	286	34	7.42	14	38	350
12.	16.01.2019	3.5 MLD STP at Srinagar	162	6.85	165	318	45	7.38	24	68	900
13.	16.01.2019	0.075 MLD STP at Devprayag	172	6.85	160	310	47	7.42	22	64	900
14.	16.01.2019	0.150 MLD STP at Devprayag	168	6.74	160	296	36	7.54	18	62	500
15.	30.01.2019	5 MLD STP at Bhagirathipuram, Tehri Garhwal	168	6.89	160	292	28	7.42	12	32	280
16.	30.01.2019	2 MLD STP at Gyansu, Uttarkashi	160	6.85	155	286	26	7.38	14	34	500



### viii. Water management system in Uttarakhand

State has several natural as well as manmade water resources. River, lakes, springs or gadheras, tube well, dug wells Uttarakhand koops and river bank filtration units etc., are the major drinking and irrigation water resources. The major rivers of north India originate from 917 glaciers of Uttarakhand and spread over 3550 Km<sup>2</sup> area in state.

In Uttarakhand 86% of total water demand is provided by natural resources. Koop are also very popular in Uttarakhand for water harvesting. Koop are formed by small river, rivulets locally called gadhera for taping these sources masonry walls of cement concrete are constructed across the rivulets, which generally get damaged or washed away during heavy rains causing interruption to water supply scheme. Jal Sansthan has innovated "Uttarakhand Koop" to solve this problem. This technique is sustainable, less expensive and helpful in managing the quality water supply. This initiative has been awarded National Urban Water Award for good initiative by Ministry of Urban Development, Govt. of India. The other programme which is initiated by government in state for water management is integrated watershed management programmes now called Pradhan Mantri Krishi Sinchay Yojana is currently implemented by Parvati Jan Kalyan Sansthan in 7 micro watershed in Thalisain and Pabau blocks of Pauri district of Uttarakhand. This programme is also supported by the government of India through state government. This programme covers an area of 9729 ha in 7 micro watersheds including 54 gram panchayats comprising of 122 villages and 6124 household in above blocks with total project cost of Rs. 14.5 crore.

#### **ix. Dwindling of perennial water resources**

Dwindling of water resource means scarcity of water. The Uttarakhand mountain system is dotted with 8 rivers; out of 18 major rivers of the country. It is ironical that these rivers have not been of any use to the local resident, except for the minor utilities in the form of watermill, occasional irrigation not exceeding 2% of the total potential use. The perennial streams of state are diminishing at a faster rate due to the reduction in groundwater recharge and converting into non-perennial streams. The total lengths of perennial streams of Kosi watershed was about 225.6 Km four decades back but at present there length is only around 41.5 Km. These streams are drying up at the rate of about 5.43 Km per year. The rate of diminishing of the length of perennial stream is more in non-glacial fed river watersheds.

Moreover, government scheme of water supply has largely failed due to poor maintenance and distribution system. This has plunged mountain residents to severe water shortage and some places, women and girl have to walk kilometres for potable water in districts like Almora, Pauri, Tehri, Pithoragarh and Chamoli etc.

#### **x. Development of water resources**

Uttarakhand is well known for its forest and water resources. More than 1400 glaciers and 8 major river catchment act as the life line for the hydrological system of the state. The watersheds of Uttarakhand are under constant threat of mass wasting and erosion caused by depletion of forest cover, unscientific agronomic practices, hydrologic imbalances and natural calamities. The ever increasing population need to provide a better quality of life to the people and their pressure on natural resources are major concern of Uttarakhand. A total of around 50 watersheds, 116 sub-watersheds and 1110 micro sheds have been identified in the state which need to focus for development. Moreover, for

the development in these areas integrated watershed development programmes has been started by watershed management directorate. Watershed management directorate is a modal agency work for monitoring and implementation of integrated watershed development programmes in the state. It works on the principles of good governance viz transparency, accountability and responsiveness of administration.

One of the techniques which is adopted for development of water resource is Bank filtration or river bank filtration (RBF). It is a natural, sustainable water treatment and production technique along the banks of rivers or lakes in which the abstraction of water resources take place from wells located near river or lake banks. In this process surface water from river channels and lakes is induced by pumping from nearby production wells to flow through the natural aquifer soil. These infiltration wells have been installed in the foothill area of Haridwar and Rishikesh adjacent to the Ganga river and also in Nainital. 16 RBF wells and tube wells in Haridwar are producing a total 25050 litre/min discharge successfully to the water demand of the city.

Recently, Uttarakhand Jal Sansthan has installed 4 new RBF wells successfully at Srinagar, Karanprayag, Agastmuni and Satpuli on the banks of Alaknanda, Alaknanda, Mandakini and East Nayar rivers respectively.

#### **xi. Recharge of water resources of springs**

Springs are points on the surface of the earth through which groundwater flows. This water is then used as a main source of drinking and domestic purposes in many areas. It also forms a main source of irrigation in many parts of Uttarakhand. The springs in hilly regions originate from seepage water which flow through the shallow weathered and fractured zones. The existence and characteristics of these springs have become essential for their longer sustainability.



It is estimated that 1 million springs support communities of western Himalayan region. They provide safe, perennial drinking water, feed rivers and anchor ecosystems. But these vital resources are under threat and spring discharge is declining due to environmental degradation and changing land use and climate. New efforts are needed to protect springs to help ensure water security. HESCO (Himalayan Environment studies and conservation organisation) is also working for the recharging of drying springs in mountain regions using isotope hydro-geochemical techniques. HESCO has recharged 16 springs of Uttarakhand in association with BARC Mumbai.

Some famous springs of Uttarakhand region Narad kund, Surya kund, Tapta kund, Gauri kund, Tapovan hot spring, Siyansu, Bhinu, Koti etc. Nearabout 12,000 natural springs in Uttarakhand have dried up over a period of time. In order to work towards their revival, a number of NGOs and other organisations have prepared a proposal, which would

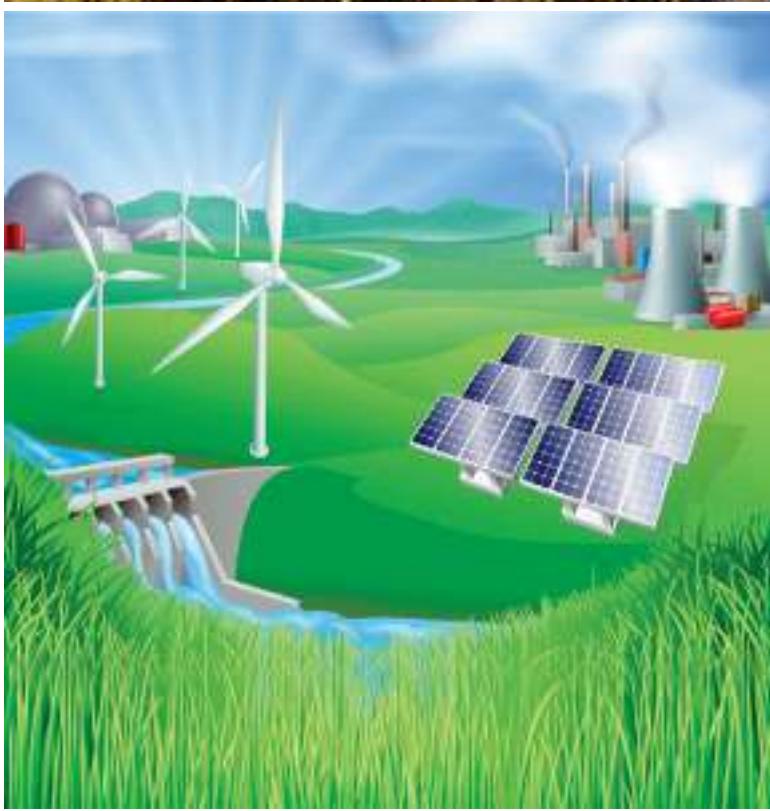
be forwarded through the state government to the union Ministry of Drinking Water and Sanitation, asking for a grant in order to revive these water springs.

To make the efficient use of the available water springs and at the same time increase available water resources from springs following steps can be adopted

1. Water storage structure is essentially required to store spring flow of the non-use periods for domestic uses. Planning is required especially for proper storage and distribution.
2. Water harvesting structures are required over respective springshed to increase infiltration of rainwater in monsoon month in order to increase the flow of springs.
3. A decision support plan required for proper distribution and utilization of water in the spring.
4. Efficient drip irrigation method is highly recommended for crops as to maximise the use of limited spring water potential.



# ENERGY RESOURCES



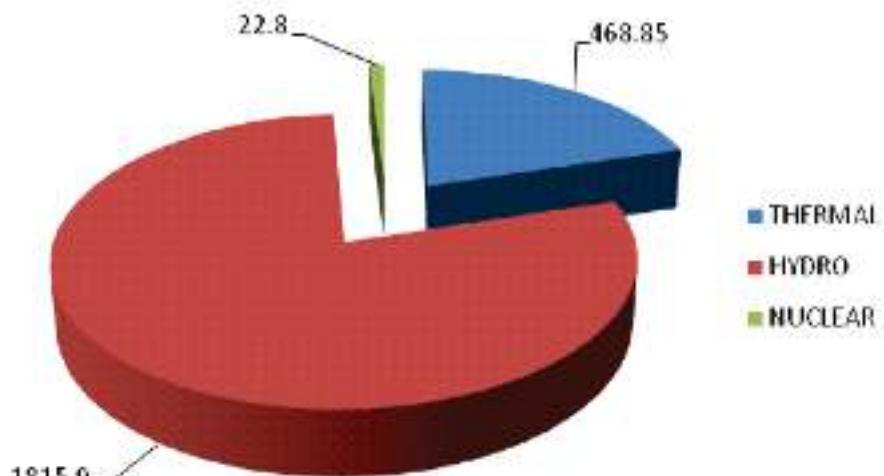
- i. Energy: status in Uttarakhand
- ii. Energy need: status of national and state
- iii. Installed capacity of energy
- iv. Energy resources: hydropower, wind, solar, biomass based power
- v. Renewal energy: govt. policies and potential and utilization.
- vi. Rural electrification
- vii. Hydropower project and its implications



In the modern society, energy affects all aspects of human life. Due to the exponential growth of population, the demand for the energy is increasing with very high rate. The development and utilization of energy resources are an important area which needs to be focused in the modern time to meet the needs of society. However, resource augmentation and growth in energy supply have failed to meet the ever increasing demands exerted by the multiplying population, rapid urbanization and progressing economy. Hence, energy shortages of 221 MU (CEA 2017) continue to plague Uttarakhand, forcing it to rely on imports. Therefore, an urgent need to conserve and reduce energy requirements by demand supply management and adopting more efficient technologies in all sectors. Despite increasing dependency on commercial fuels, a sizeable quantum of energy requirements especially in the rural household is met by non-commercial energy sources, which include fuel wood, crop residue, and animal waste, including human and draught animal power.

#### i Energy Status in Uttarakhand

Uttarakhand has a rapidly growing economy which needs energy to meet its growth objectives in a sustainable manner. The economy faces significant challenges in terms of meeting its energy needs in the coming decade. The increasing energy requirements coupled with slower than expected increase in domestic fuel production has meant that the extent of imports in energy is growing rapidly. Uttarakhand has a population of 1.01 crore (2011 census) with 703694 population living in rural areas. People living in rural area still using firewood for cooking and are mainly dependent on non-commercial energy sources, such as fuel wood, crop residue and animal waste for their energy needs. Uttarakhand is one of the few states in India which not only have high hydro potential of 1815.69 MW but also have higher per capita consumption than the national average of 1000 KWh (Per capita consumption of the state has steadily grown from 1012 kWh in FY 2012 to 1154 kWh in FY 2015). The current scenario of energy capacity of state is given below (Fig 7.1)<sup>1</sup>.



**Fig 7.1**  
Installed capacity of Uttarakhand power utility (in MW).

<sup>1</sup>[https://en.wikipedia.org/wiki/States\\_of\\_India\\_by\\_installed\\_power\\_capacity](https://en.wikipedia.org/wiki/States_of_India_by_installed_power_capacity) and CEA-2017

## ii Energy need: status of national and state

### A) National

During the year 2017 -18 the demand of electricity in India in term of base load energy is 1,229,661 MU against availability of 1,337,828 MU (Table 7.1). The energy need of the country is mostly met by the thermal, followed by hydropower, other renewable resources and nuclear power.

Although India is increasing dependency on commercial fuels, a sizeable quantum of energy requirements (40% of total energy requirement), especially in the rural household sector, is met by non-commercial energy sources, which include fuel wood, crop residue, and animal waste, including human and draught animal power. However, other forms of commercial energy of a much higher quality and efficiency are steadily replacing the traditional energy resources being consumed in the rural sector.

India also has one of the highest potentials for harnessing the renewable energy as it is bestowed with such natural resources and geographical and climatic conditions that support the promotion of renewable energy technologies

like solar, wind, biomass and small hydro. The current scenario of total installed capacity of electricity for different sectors in the country is given in Fig 7.2.

Till year 2016, the share of grid connected solar PV was negligible, most of the government focus was on off grid Solar PV and Residential Solar Thermal. However, due to the new government initiative- Jawaharlal Nehru National Solar Mission (announced in year 2010), the Grid connected Solar PV and the concentrated solar power market is on the boom. Around 440 MW of Solar PV was installed in the 2015 and is expected to increase many folds due to highly lucrative government schemes.

- **Solar Energy**

India has high solar insolation levels with about 300 clear sunny days –most parts of the country receive 4-7 Kwh/m<sup>2</sup>/day with about 1500-2000 sunshine hours per-week (depending upon location), which is far more than current total energy consumption. Ministry of New and Renewable energy (MNRE), Government of India estimates solar potential at over 10000 MW in the western state of India such as Rajasthan and Gujarat that have the highest potential.



To reduce its dependency on the conventional sources, India has launched a solar mission in 2009. The mission has set a target of 20,000 MW using solar panel. Solar Mission stipulates implementation and achievement of the target in 3 phases (first phase from 2012 to 13, second phase from 2013 to 2017 and the third phase from 2017 to 2022 for various components, including grid connected solar power.

- **Grid Parity in India**

The capital cost for solar power has come down by about 16% to 20% in the last two years. It is expected to

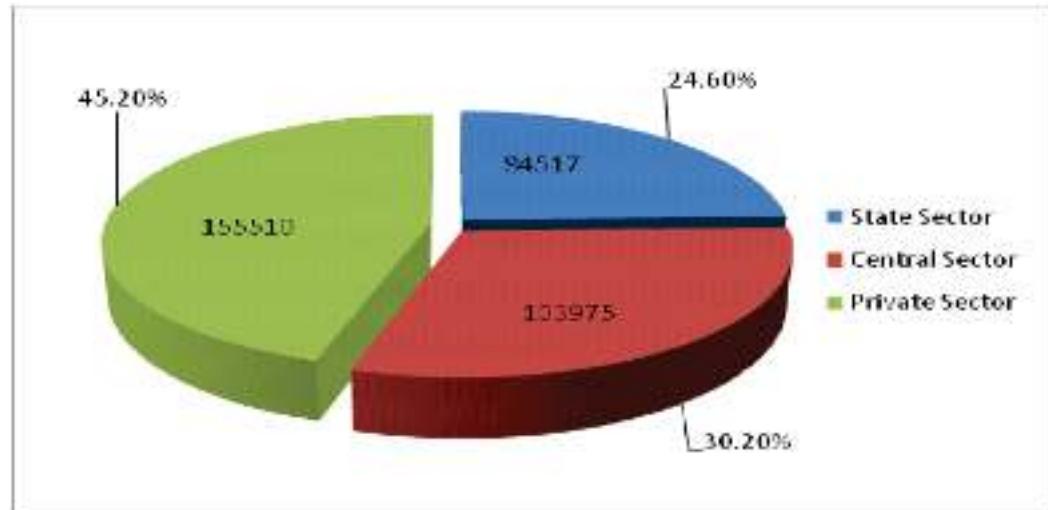
continue the downward trend for the next three years as the manufacturing scale increases and the technology matures. At the same time, the cost for fossil fuels such as coal is expected to increase and subsidies in the power sector in India are expected to fall, thus driving up grid power prices. Given India's high irradiation levels, solar power will soon become a feasible choice for captive generation in the future. So it is expected that India will achieve grid parity in 2018.

Month	Peak				Energy			
	Demand (MW)	Availabil- ity (MW)	Surplus (+)/ Deficit(-)		Requirem- ent (MU)	Availabilit- y (MU)	Surplus(+)/ deficit (-)	
			(MW)	(%)			(MU)	(%)
Apr'17	162817	174832	12015	7.4	102504	107496	4991	4.9
May'17	160009	175522	15512	9.7	106265	115548	9283	8.7
Jun'17	158548	173402	14854	9.4	103841	113958	10117	9.7
Jul'17	162840	179005	16164	9.9	104755	116553	11798	11.3
Aug'17	164191	180486	16295	9.9	105108	117810	12702	12.1
Sep'17	169130	180601	11471	6.8	106552	118241	11688	11.0
Oct'17	163908	174547	10639	6.5	105613	114191	8578	8.1
Nov'17	157426	169758	12332	7.8	96287	104199	7912	8.2
Dec'17	153711	165018	11307	7.4	98698	107512	8813	8.9
Jan'18	154583	166581	11998	7.8	99708	109343	9635	9.7
Feb'18	158189	172355	14166	9.0	94305	101098	6793	7.2
Mar'18	162350	175323	12973	8.0	106023	111879	5856	5.5
Annual	169130	180601	11471	6.8	1229661	1337828	108167	8.8

**Table 7.1**  
Status of electricity requirement in India<sup>2</sup>

<sup>2</sup> [www.cea.in](http://www.cea.in)2017





**Fig. 7.2**  
Total Installed capacity of electricity(MW)  
in India as  
on 31.3.2018<sup>3</sup>

#### A) Uttarakhand state

During the year 2017-18, the base load requirement of the Uttarakhand state is 14,428 MU against availability of

14,207 MU which is 1.5 % deficit (Table 7.2) the energy needs of the state is mostly met by hydropower.

**Table 7.2**  
Anticipated power supply of the energy in Uttarakhand<sup>3</sup>

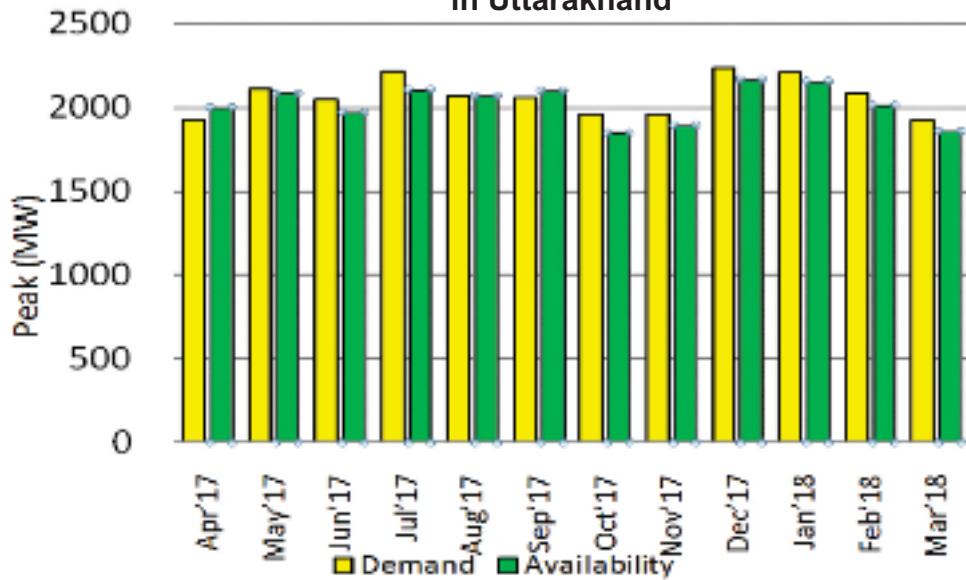
Month	Peak				Energy			
	Demand (MW)	Availability (MW)	Surplus (+)/ Deficit (-)		Requirement (MU)	Availability (MU)	Surplus(+)/ deficit (-)	
			(MW)	(%)				
Apr'17	1930	2002	72	3.7	1136	1122	-14	-1.2
May'17	2110	2082	-28	-1.3	1216	1234	18	1.5
Jun'17	2050	1973	-77	-3.8	1242	1217	-25	-2.0
Jul'17	2220	2107	-113	-5.1	1272	1235	-37	-2.9
Aug'17	2070	2070	0	0.0	1283	1275	-8	-0.6
Sep'17	2060	2101	41	2.0	1261	1191	-70	-5.6
Oct'17	1960	1850	-110	-5.6	1174	1154	-20	-1.7
Nov'17	1960	1895	-65	-3.3	1113	1123	10	0.9
Dec'17	2240	2167	-73	-3.3	1261	1213	-48	-3.8
Jan'18	2210	2156	-54	-2.4	1235	1228	-7	-0.6
Feb'18	2080	2014	-66	-3.2	1099	1094	-5	-0.5
Mar'18	1930	1860	-70	-3.6	1137	1122	-15	-1.3
Annual	2240	2167	-78	-3.3	14423	14207	-221	-1.5

<sup>3</sup> www.cea.in2018

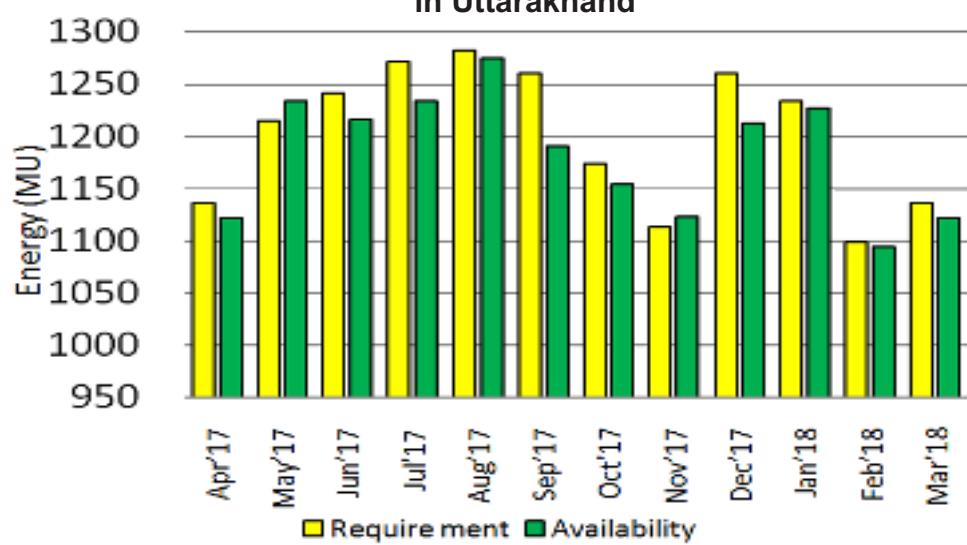




**Peak:Demand v/s Availability**  
in Uttarakhand



**Energy: Requirement v/s Availability**  
in Uttarakhand



### iii. Installed capacity of energy

Installed capacity means production capacity of plant based either on its rated capacity or actual capacity. As of July 2017, the state had total installed power generation capacity of 3,313.45 MW. Hydropower contributed 1,815.69 MW to the total installed power generation capacity, followed by thermal power with a contribution of 950.71 MW and other sources of power generation. Of the total installed power generation capacity, state utilities accounted for the largest share of 1,315.02 MW, followed by 1,089.94 MW under private utilities and 908.49 MW under central utilities. Uttarakhand Jal Vidyut Nigam Limited (UJVNL) controls the state's hydropower generation and the state's power sector is regulated by the Uttarakhand Electricity Regulatory Commission (UERC).

Uttarakhand Power Corporation limited is responsible for the electricity distribution & power transmission within the state. The company consists of 3,487 human capital

workforces, committed to provide 24X7 high reliability and quality power supply to 1.89 million electricity consumers spread across the 13 districts in the state of Uttarakhand. UPCL aims to reduce the AT&C (Aggregate technical and commercial) Losses of the Company for FY 2015-16 to around 17% and set target to further reduction to 14% by March 2020. The company operates and maintains following substations:

- a. 295 Substations of 33/11 KV with capacity - 3122 MVA.
- b. 66/33/11 KV -48 MVA.
- c. 4526 Km -33 KV, 38204 Km -11 KV lines and 59401 Km LT Lines spread across the state periphery.
- d. 60298 Distribution Substations of 11/0.4 KV- 3602 MVA capacity with a Sub-Transmission & Distribution System Network of 211 Km - 66 KV.



**iv. Energy sources: hydropower, wind, solar, biomass based power**

**a) Hydropower**

Hydropower, also known as hydro-electric power, is generated by hydro-electric dams placed on major rivers. These structures divert the flow of the river and harness the force of the water to turn massive turbines that power electricity generators. By virtue of its topographic location, the state has a number of perennial streams where water is available throughout the year. The untapped potential that

could be harnessed before 2020 through Micro/Mini/Small Hydro projects is about 600 MW. The state Government is committed to exploiting this potential. Uttarakhand Jal Vidyut Nigam was formed on 9 Nov 2001 with it main motto of developing and harnessing the hydro potential of Uttarakhand state. The Nigam has 33 projects under operation with an aggregated capacity of more than 1400 MW and more than 14 projects are under different stages of implementation. The hydro project under development in Uttarakhand upto 25 MW is given in Table 7.3

**Table 7.3**  
**Hydro project under development in Uttarakhand upto 25MW<sup>4</sup>**

S.No.	Name of project	Capacity (MW)
1.	Sonegad	3.0
2.	Asingna III	9.0
3.	Suringad II	5.0
4.	Urgam II	3.8
5.	Painagad	9.0
6.	Pilangad II	4.0
7.	Tankul	12.0
8.	Bhilangana-II 2A	24.0
9.	Bhilangana-II 2B	24.0
10.	Bhilangana-II 2C	24.0
	Total	117.8 MW

**b) Biomass/Agro residue and waste**

It is estimated that about 20 million metric tons of agro residues and agro industrial/ processing waste is produced annually in Uttarakhand. It holds promising potential for

generating decentralized power of about 300 MW. The state government would support and facilitate harnessing this potential by 2020.

UREDA has commissioned 2 Institutional biogas based power generation project at village Shyampur and Kalshi of Dehradun under a scheme "Biogas based distributed / grid power generation" of Ministry of New and Renewable Energy (MNRE), Govt. of India with a view to promote biogas based power generation project in the farms where large quantity of animal wastes are available<sup>5</sup>.

<sup>4</sup>[http://www.uttarakhandjalvidyut.com/project\\_under\\_dev.php](http://www.uttarakhandjalvidyut.com/project_under_dev.php)

<sup>5</sup><http://www.ureda.uk.gov.in/pages/display/140-institutional-projects>

S.No.	Project type and location	Biogas generating capacity (m <sup>3</sup> )	Power generation capacity (KW)
1	Biogas based power generation project (Shyampur, Rishikesh, Distt. Dehradun)	25	4
2	Biogas based power generation project (Kalshi, Chakrata, Distt. Dehradun)	60	6

#### b) Biomass/Agro residue and waste

It is estimated that about 20 million metric tons of agro residues and agro industrial/ processing waste is produced annually in Uttarakhand. It holds promising potential for

generating decentralized power of about 300 MW. The state government would support and facilitate harnessing this potential by 2020.



### c) Solar Energy

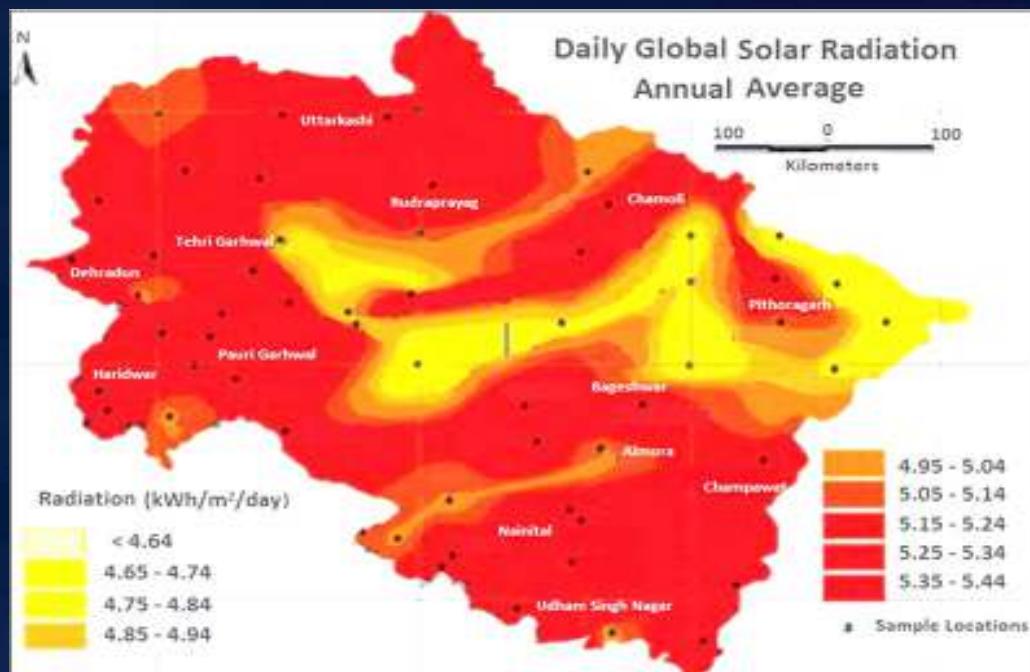
The state is endowed with vast potential of solar energy, some part of hilly region of the state is known for the being cold but has enough sunshine whereas other regions are cold as well as cloudy. The usual weather reported in the valley of Dehradun is average. The non-hilly area of Uttarakhand like Haridwar, Roorkee, Kashipur and Rudrapur also witness average climatic conditions. Hence, the entire state receives solar energy in abundance which is approximately 4.5 – 5.5 kwh/m<sup>2</sup> and the Government of Uttarakhand (GOU) is keen to tap this resource; the state is making supporting efforts for setting up Solar based power projects. Focusing towards solar energy direction. The Jawahar Lal Nehru National Solar Mission was launched on the 11th January, 2010 by the Prime Minister. This mission has set the target of deploying 20,000 MW of grid connected solar power by 2022 with aims to reduce the cost of solar power generation in the country through (1) long term policy (2) large scale deployment goals (3) aggressive R& D and (4) domestic production of critical raw materials, components and products etc. Uttarakhand ranked 15th in the country for generating solar energy. The state has the following installed units for solar power generation

1. Lanterns : 66964
2. Home lights : 3431
3. Street lights : 1604
4. Solar charkha: 290

In an attempt to promote solar power generation UREDA has decided to setup over 2000 units which will produce 44 MW of electricity using solar energy in the state. Fig 7.3 shows annual average daily solar radiation map of Uttarakhand<sup>6</sup>.



**Fig 7.3**  
Annual average  
daily solar  
radiation map  
of Uttarakhand



**d) Wind Power**

Sufficient untapped wind power potential is available in the state. There is an immediate necessity for wind mapping in the state to assess and exploit the available potential. The state is contributing in making support of such programmes. Government of Uttarakhand has approved a wind energy farm on top of the hill of Tehri Garhwal district at

Bachheilikhal area with a capacity of 2.4 MW. At present near about 11 wind monitoring station has been establishing in Uttarakhand in collaboration with UREDA and CWET with potential of 534 MW. A wind power plant is installed at Haldwani is India's first carbon neutral power plant which has a capacity of 3x5 KW.





#### v. Renewal energy- govt. policies and potential and utilization

- **Govt policies:**

Uttarakhand government has made the policies for harnessing the renewable energy from the natural resources and for its proper utilization as follows:

- ✓ The Uttarakhand solar energy policy 2013- this policy aims to provide a comprehensive policy for promotion of solar energy in the state.
- ✓ Uttarakhand solar rooftop policy: Uttarakhand state had about 23 solar plants since 2016 and now mandated to setup another 2000 solar plants that would produce 44 MW electricity.

- ✓ National policies on biofuel: - The policies aim at mainstreaming of biofuels and therefore envision a central role for it in the energy and transportation sectors of the country in coming decades.
- ✓ Suryamitras skill development programmes: National Institute of Solar Energy is the apex body to organise all renewable energy skill development programmes across various states of India, Ministry of New and Renewable Energy has set target of 165 GW of renewable power projects to be installed in the coming few years.

- ✓ Renewable energy government policies bachat lamp yojana: This has started on August 2013. Under this yojana compact florescent lamp is used to promote usage of energy efficient bulbs and thus reduce consumption load at the domestic level.

This yojana promotes replacement of incandescent bulbs with compact fluorescent lamps by certified emission right under the clean development mechanism (CDM) of the Kyoto protocol, the scheme platform for a robust public private partnership between the government of India, private sector CFL suppliers and state level electricity distribution companies and provides the framework to distribute high quality CFLs at subsidized price to the residential households in exchange of an incandescent lamp of the country.

• **Potential:**

In Uttarakhand, the estimated capacity of small hydro power projects is about 1500 MW out of total potential

capacity more than 20,000 MW. Uttarakhand has geographically 8 districts which are completely in the hilly region of the Himalayan having the origin of some of the snow fed rivers like the Ganges, Yamuna, Bhagirathi, Alaknanda, Sarju, Tons, Kali etc. In the foothills the medium and large dams for collecting the water of rain fed rivers for irrigation and flood protection purposes have been built. Thus, the availability of snow fed and rain fed rivers along with the natural incline make this province a state of having a good hydro power potential and a future Energy state. At present all the electric power being generated (except the captive power plants, diesel generators in the factories and commercial places) is the only hydro power with some power from thermal and nuclear plants allocated from power stations situated outside the state. The Table 7.4 shows the present status of power potential in the state of Uttarakhand

**Table 7.4**  
The present status of power potential in Uttarakhand<sup>6</sup>

1.	Hydro power potential	20,000 (plus) MW
2.	Wind power potential	534 MW
3.	Biomass power potential	24 MW
4.	Waste to energy potential	5 MW

**Utilization:**

In order to achieve the objective of 24x7 supply in the state, the state would increase in the demand from 1930 MW at present to 2845 MW in FY 2019. In present conditions, the peak demand of 1930 MW in FY 2015 was fully met owing to the availability of a large hydro-power capacity in the state.

The transmission schemes planned in the state would increase the present transformation capacity by 5180 MVA resulting in an overall transformation capacity of 13698 MVA.

T&D (Transmission and distribution) losses are also projected to be reduced to 13.7% and AT&C (Aggregate Technical and commercial losses) to 14% by FY 2019 from present level of 17.61% and 20% respectively. However, the status of an independent state brought in pressures on Uttarakhand in terms of the development and infrastructure needs of the state and the capital Dehradun to meet the increasing economic and political activities. This lead to an increase in the energy demand of the state too but the current power situation does not seem to be meeting it as given in Table 7.2.

#### vi. Rural electrification

Electrification is one of the most vital requirements for socio-economic development of rural areas. The linkages between renewable energy, sustainable livelihoods and socio-economic development are well recognized.

The state has already completed the RGGVY (Rajiv Gandhi Vidyutikaran Yojana) scheme. However,

according to recent survey undertaken by the state, 100407 households in rural areas are still un-electrified, whereas the state has planned to electrify 54015 identified un-electrified households under DDUGJY (Deendayal Upadhyaya Garjan Jyoti Yojana) scheme of GOI and 2229 households through off-grid solutions. Village electrification under DDUGJY in Uttarakhand is given in Table 7.5.

**Table 7.5**  
Village  
electrification  
under DDUGJY  
in Uttarakhand  
(Status as on  
30.11.2017)<sup>7</sup>.

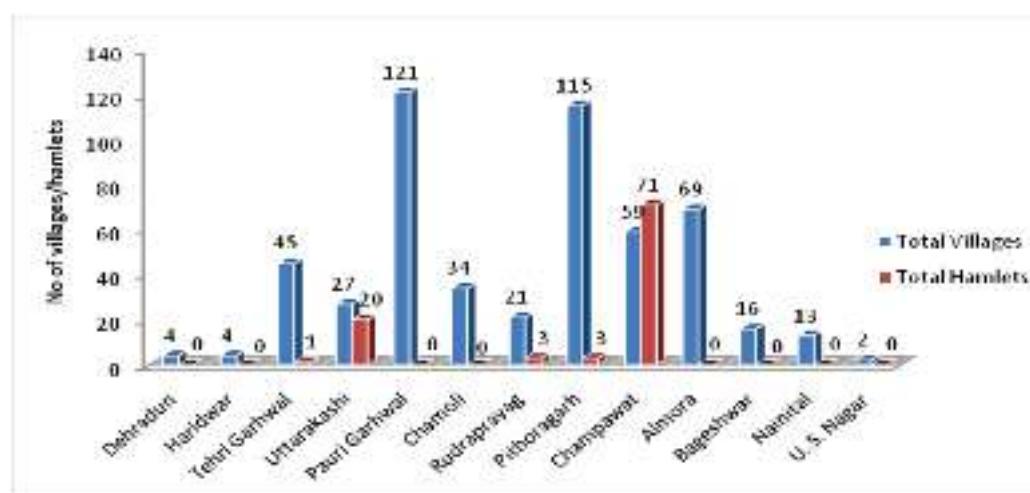
<b>a.</b>	<b>Total inhabited villages (as per Census 2011)</b>	<b>15745</b>
<b>b.</b>	Unelectrified Villages as on 01.04.2015	76
<b>c.</b>	Villages electrified during 2016-17 -	18
<b>d.</b>	Electrified during 2017 -18 (upto 30.11.2017)	23
<b>e.</b>	Un-inhabited villages	02
<b>f.</b>	Balance un-electrified villages as on 30.11.2017 • Through grid • Through off -grid	33 30 03

#### A) Village Electrification Through Solar Energy

Under Village Electrification programme of MNRE (Ministry of New and Renewable energy) through solar energy, UREDA

has electrified 530 remote villages and 98 hamlets in the state of Uttarakhand. District wise number of electrified villages and hamlets are given in Fig 7.4

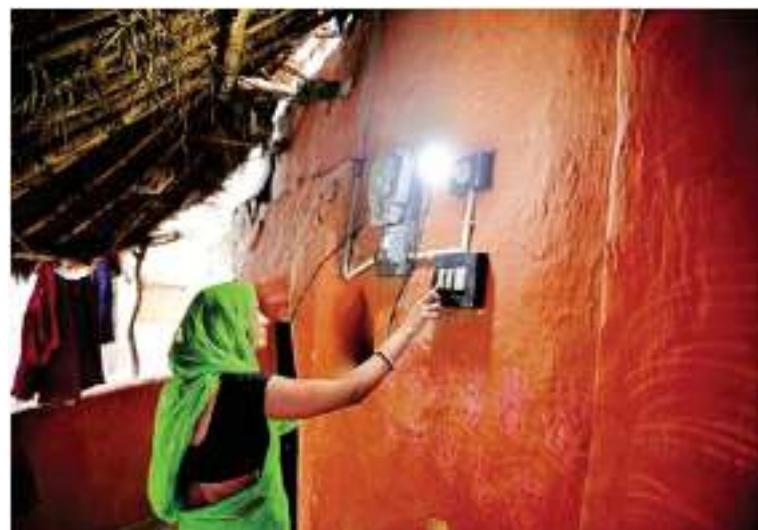
**Fig 7.4**  
Electrification  
through Solar  
in various  
villages and  
hamlets of  
Uttarakhand<sup>8</sup>



<sup>7</sup> <http://garv.gov.in/assets/uploads/reports/statesnaps/Uttarakhand.pdf>

<sup>8</sup> <http://ureda.uk.gov.in>





#### B) Village Electrification Through Micro Hydro Projects:

Micro hydro power (MHP) projects in the remote rural areas of the state of Uttarakhand can provide energy services for sustainable development based on indigenous resources, with minimum expenditure, commitments and exploitation of natural resource base.

UREDA has commissioned large number of MHPs in the remote area of state where the national or state grid

cannot be extended. 44 MHPs of total capacity 4.29 MW has been installed in the remote area. In villages of Uttarakhand another 19 MHPs of total capacity 2.315 MW are under implementation. The details of microhydel projects constructed and under construction are given in Table 7.6 and 7.7 respectively.

S. No.	District	Name of Project	Capacity (KW)	Electrified	
				No of Villages	No of Hamlets
1	Bageshwar	Gogina	100	5	7
2		Badiyakot	100	4	6
3		Sorag	50	1	5
4		Baichham	100	7	3
5		Bagar	50	2	6
6		Liti-I	50	1	7
7		Karmi-I	50	1	4
8		Toli	100	3	8
9		Kanolgad	100	1	9
10		Karmi-II	50	1	3
11		Dokhtigaun	20	1	3
12		Ratmoli	50	4	-
13		Kunwari	50	1	4
14		Jagthana	100	1	4
15		Karmi-III	50	1	7
16		Liti-II	50	3	7
17		Lamabagar	200	4	4
18		Lathi	100	7	9
19		Borbalda	25	1	3
20		Gogina -II	50	4	2
21		Lamchula	50	2	2
22	Chamoli	Gulari	200	7	1
23		Milkhet	100	4	1
24		Bursol	200	6	2
25		Ghesh	100	6	2
26		Wan	50	1	3
27		Choting	100	6	2
28		Sarma	100	2	4
29		Bank	100	5	3
30		Ghgariya	100	1	-
31		Niti	25	1	-
32		Gamsali-Bamba	50	2	-
33	Uttarkashi	JankiChatti	200	2	6
34		Istergad	200	4	6
35		Gangotri	150	Gangotri Dham	-
36		Taluka	20	-	1
37	Rudraprayag	Kadernath	100	Kadernath Dham	-
38	Pithoragarh	Bhikoriyagad	500	24	Grid feed
39		Satteshwar	50	2	4
40		NamiK	50	1	-
41	Nainital	Ramgad	100	5	Grid feed
42	Pauri Garhwal	Kanwashram	100	Grid feed	-
43	Tehri Garhwal	Jakhana	100	3	-

**Table 7.6**  
The details  
of recent  
micro hydel  
project  
constructed<sup>9</sup>

<sup>9</sup> <http://ureda.uk.gov.in/pages/display/129-village-electrification>



**Table 7.7**  
The details of under construction micro hydel projects

S. No.	District	Name of Project	Capacity (KW)	To be Electrified	
				No. of Villages	No. of Hamlets
1	Bageshwar	Wachham	500	2	6
2	Chamoli	Hafla	200	Grid feed	-
3	Chamoli	Nigolgad	100	Grid feed	-
4	Pithoragarh	Rotan	50	3	2
5		Kutty	50	1	-
6		Naplchyou	50	2	6
7		Nagling	50	3	2
8		Sela	50	1	-
9		Dugtu	25	2	-
10		Bundi	50	1	-
11		Rongkong	50	2	-
12	Tehri Garhwal	Kotijhala	200	4	1
13		Pinsward	50	2	-
14		Gangi	200	2	5
15	Pauri Garhwal	Gainichhira	250	Grid feed	Grid feed
16	Uttarkashi	Chiludgad	100	3	1
17		Khapugad	40	1	-
18	Rudraprayag	Kedarnath -II	200	Kedarnath Dham	-
19		Gaundar	100	2	-

#### vii. Hydropower projects and its implications

The development of small hydropower around the world is on the increase. Much of the world has huge potential to further develop this resource. Small hydropower offers a wide range of benefits-especially for rural areas and developing countries. Efforts also being made to improve the exchange of ideas and technology related to small hydropower. In India, small hydropower up to capacity of 25 MW also includes the mini-and-micro hydropower projects which are usually confined strictly to local use. Uttarakhand

has a large network of rivers and canals which provides an immense scope for hydro-power energy. In India, the development of Micro, Mini, and Small Hydro Power Projects started in the year 1897. One of the first hydro-power stations in India was commissioned at Galogi near Mussoorie in 1907 after that more power stations were subsequently developed over a period of time. In Uttarakhand, the estimated capacity of Small hydro power projects is about 1500 MW out of total potential capacity of more than 20,000 MW. The status of hydropower potential in different sector and their capacity in Uttarakhand reported in Table 7.8 and 7.9.

**Table 7.8**  
Status of hydropower project in different sectors<sup>10</sup>.

1	State sector under UJVNL Uttarakhand Jal Vidyut Nigam Ltd.	304 MW
2	Central sector under THDC- Tehri - Hydroelectric Develop. Corpn. Ltd	1000 MW Stage I 400 MW Stage II 1000 MW Stage III
3	Private sector (Vishnuprayag Project)	400 MW

<sup>10</sup> Joshi, M. C. (2007). Hydro power potential in Uttarakhand. In International Conference on Small Hydropower-Hydro Sri Lanka (pp. 22-24).]



**Table 7.9**  
Capacity of hydro electric project in Uttarakhand<sup>11</sup>

Capacity	2015	2016
<b>Identified capacity total (MW)</b>	18175	18175
<b>Above 25 MW</b>	17998	17998
<b>Capacity Developed</b>		
<b>Mega Watts</b>	3756.4	3756.4
<b>Percent</b>	20.87	20.87
<b>Capacity under construction</b>		
<b>Mega watts</b>	1310	1430.0
<b>Percent</b>	7.28	7.95
<b>Capacity development and under construction</b>		
<b>Mega watts</b>	5066.4	5186.4
<b>Percent</b>	28.15	28.82
<b>Capacity yet to be development</b>		
<b>Mega watts</b>	12931.7	12811.7
<b>Percent</b>	71.85	71.18

At present, the following projects are working for harnessing the hydropower from rivers of Uttarakhand<sup>12</sup>.

Sl.No.	Project details	Installed capacity (MW)
1	Projects in Alaknanda River Basin	
	Total	455.45
	Projects in Bhagirathi River Basin	
	Total	1850.9
3	Projects in Ganga River sub basin downstream of confluence of Bhagirathi and Alaknanda Ganga sub basin	
	Total	173.7
4	Project in Ramganga basin	
	Total	210.5
5	Projects in Sharda River Basin	
	Total	426.15
6	Projects in Yamuna River Basin	
	Total	478.15
<b>Grand total</b>		<b>3594.85</b>

#### Small Hydro Programme in Uttarakhand

The energy-development relationship has numerous social and political implications in Uttarakhand, where about 69.77% of the population lives in rural areas and most of them belong below the poverty line.

Geographical conditions of the state differ at a short distance. Most of the area is hilly and forest coverage is about 45.43%. Villages are in scattered manner and household coverage in a village is short. In this situation, either it is not possible to lay grid lines due to forest laws or due to high cost of coverage. Operation and maintenance is also an issue in this pattern. As a solution of this problem- Decentralized Distributed Generation (DDG) Micro & Mini Hydro Projects are suitable and best way to provide electricity facility to the forest fringe and scattered villages. Operation and maintenance of standalone MHPs can be done in easy manner by local community after a formal training.

In the state of Uttarakhand, UREDA is constructing MHPs for remote village electrification as well as for grid feeding. Earlier the projects were constructing on turn-key basis but from year 2005, Govt. of Uttarakhand has decided to construct MHPs for village electrification on community participation. For construction of MHPs, tripartite agreements have been signed between UREDA, Alternate Hydro Energy Centre (AHEC), IIT Roorkee and concern User Energy Committee (UEC). As per tripartite agreement AHEC, IIT Roorkee is providing technical specialized services for construction of MHPs, preparation of DPR (Detailed Project Report) etc. and UREDA is providing its services for monitoring, funding and guidance to UECs.

MHPs are being constructed with the financial support from Ministry of New and Renewable Energy (MNRE), Govt. of India. The financial support from MNRE is available as per the relevant guidelines of MNRE.

<sup>11</sup> <https://ureda.gov.in>

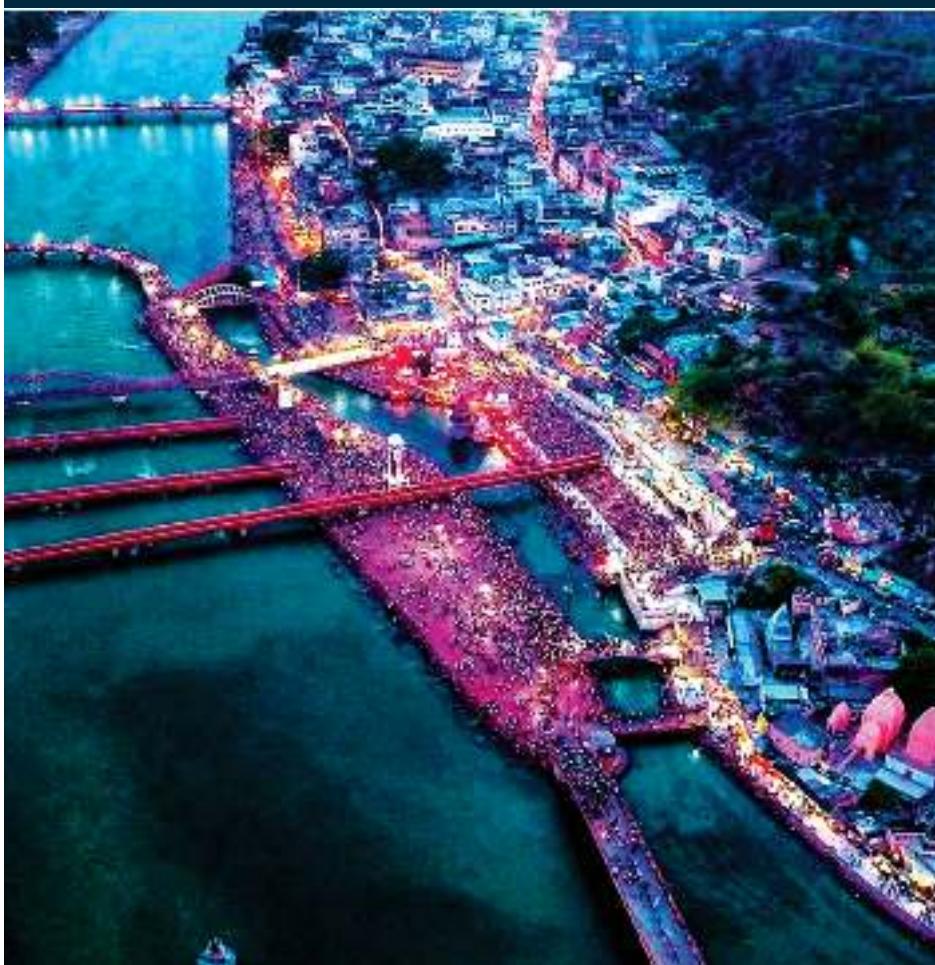
<sup>12</sup> <https://www.elctricalindia.in>



# Urbanization



- i. Urbanization in Uttarakhand
- ii. Urbanization centres and urban agglomeration: Its trend and possible impacts
- iii. Housing
- iv. Urban slums
- v. Water supply and sanitation
- vi. Air quality of urban settlement
- vii. Status of solid waste management
- viii. Status of Bio-medical Waste management
- ix. Non-sustainable urbanization: Its impact on environment
- x. Balancing urbanization: Need of integrated planning



There are many evidences of urbanization in Uttarakhand throughout history. Most of the towns were originally rural settlements converted into urban settlements in the later stages. The main reason for this is tourism, as the state is the heart of famous pilgrimages. Originally these small towns were the stoppage centres of the pilgrims during Yatra

season. With time as a result of a number of commercial activities, these stoppage places transformed from, small to medium towns. These town/cities later converted into bigger cities. This has been the regular pattern of urbanization in the state. Few cities settled because of some natural calamities and constructions of large dams i. e. Tehri dam.

### i. Urbanization in Uttarakhand

The rapid urban growth has been observed in Uttarakhand after attaining statehood. Due to population increase, transport development, growth of rural areas, tourism development, and improvement in market, urbanization is continuously increasing in Uttarakhand. Lack of various important facilities in villages and ineffective land use policy are also some of the factors that increase urbanization in the state. Besides the rise in population and growth of a large number of new urban centres, these towns are increasing both in size and area. With the recent trend of urbanization, small towns are growing faster than the big towns, especially the cities and towns which are situated in the valley regions along the roadside. Administrative buildings, offices, commercial complexes and hi-tech institutions are the main benefits of urbanization. Therefore, these developmental activities are responsible for migration of peoples from the remote areas toward the urban areas. Moreover, better opportunities of employment have also lead

to migration from hilly areas. The heavy migration toward the urban areas is also a serious threat to the environment.

With urbanization, the rate of population growth increases in cities. According census report, the urban population in Uttarakhand has increased from 7.8 percent to 30.55 percent between 1901 to 2011 census (Fig 8.1). Especially after statehood, a significant increase in urbanization was noticed in the state by increase of 4.96% from year 2001 to 2011. Along with population increment, redistribution of population has also been observed.

Before creation of Uttarakhand state, this region was having only 10 districts. The new districts Rudraprayag (initially part of Chamoli), Champawat (part of Pithoragarh), Bageshwar (part of Almora) were formed later. Uttarakhand is a hill dominated state in which Haridwar, Udhampur Singh Nagar, Dehradun and some part of Nainital are plain. As reported in Fig 8.2, the urban population is continuously increasing in each district of the state. With this growth, many problems

**Fig 8.1**  
Decadal growth of urbanization in Uttarakhand<sup>1</sup>

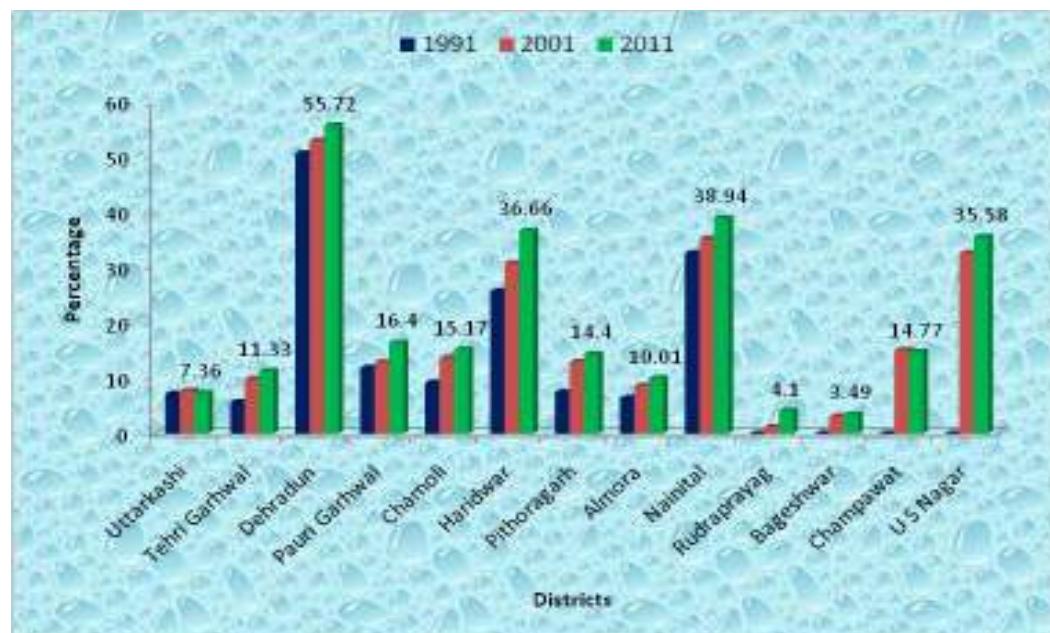


<sup>1</sup>censusindia.gov.in/

regarding sanitation, drinking water availability, traffic, degradation of agricultural land due to unorganised construction, etc., have emerged. Maximum degree of urbanization has occurred in plain districts such as Dehradun, Haridwar, U S Nagar, and Nainital. Other important fact about urbanization in Uttarakhand is its changing nature. In winters the urban population shrinks whereas it increases in summers.

It is because most of the tourist places and temples of international importance like Kedarnath and Badrinath are closed in winters and open for public only in the summer season. Dehradun is the most urbanised district of Uttarakhand with 55.72% urban population out of its total population.

**Fig 8.2**  
District wise percentage of urban populations in Uttarakhand<sup>1</sup>



Badrinath and Kedarnath temples during winter season



Badrinath



Kedarnath

## ii. Urbanization centres and urban agglomeration: Its trend and possible impacts

Uttarakhand Urban Sector Development Investment Program (UUSDIP) conceives the support of central and state governments in their policy of balanced regional, socio-economic development and poverty reduction through improvements in urban governance, management, infrastructure and service provision throughout the urban

sector in Uttarakhand. It is responsible to deliver sustainable development in the urban areas of Uttarakhand by improving the quality and availability of water, waste management systems, water drainage system for reducing flooding and soil erosion, transportation system, improving traffic management, proper sewage drainage system, preservation of the heritage structures and places of historical interest and facilitating improvement in tourism potential.



The Uttarakhand housing and Urban Development Authority is also involved in development and planning of

housing and urbanization in Uttarakhand state.



Urban Development Directorate (UDD) is the administrative department for local self governments in the state, the Uttarakhand Housing and Urban Development Authority plays similar role for the Urban Development

Authorities, and the Town & Country Planning department are responsible for urban planning and development control in the state.



Further, the Drinking Water (Pey Jal) Department is the administrative department of Uttarakhand Pey Jal Nigam (UPJN) and Jal Sansthan (UJS) which ensures water supply, and sewage and drainage services to the project towns. Moreover, there are organisations such as the Uttarakhand Environment Protection and Pollution Control Board (UEPPCB), Public Works Department (PWD), and other agencies functioning in the urban areas. The vision of all the departments is to achieve integrated development of urban areas thereby making the cities vibrant, clean with a strong infrastructure and to bring about improvement in the service delivery, with two main objectives:

- To improve the quality of life of all towns and cities with an emphasis on preservation of their heritage.
- To provide gainful employment to the urban unemployed or underemployed poor by

encouraging setting up of self employment ventures or provisions of wage employment.

Uttarakhand is a rural centred state. The state has few old urban settlements like- Dehradun, Nainital & Mussoorie. As per the report of Census of India (2011), total number of urban settlements/ agglomerations in Uttarakhand is 86. However, this number has now reached in 2018 to 144 (Table 8.1). In 2011, Dehradun was the only municipal corporation and rest were nagar palika parishads (31) and nagar panchayats (31), together with 09, 12, and 2 cantonment boards, census towns, and industrial townships respectively. Now the state has 8 municipal corporations, 41 nagar Palika parishads, 43 nagar panchayats, 09 cantonment boards, 41 census towns, and 02 industrial townships. Being a hilly state, most of the towns have uneven topography.

**Table 8.1**  
Town/ Urban  
agglomeration  
in Uttarakhand<sup>2</sup>

Town/ Urban agglomeration	Census 2011	Current data (2017-18)
(a) Municipal corporation	01	08
(b) Nagar palika parishad	31	41
(c) Nagar panchayat	31	43
(d) Cantonment boards	09	09
(e) Census towns	12	41
(f) Industrial township	02	02
<b>TOTAL</b>	<b>86</b>	<b>144</b>

Urban agglomeration is a continuous urban spread constituting a town and its adjoining outgrowths, or two or more physically contiguous towns together with or without

outgrowths. The constituents of Urban Agglomerations in Uttarakhand with a population of 1 lakh or above are presented in Table 8.2.

<sup>2</sup>censusindia.gov.in/; <https://www.usdip.org/>



**Table 8.2**  
**Constituents of**  
**Urban**  
**Agglomerations**  
**in Uttarakhand**  
**(with a population**  
 $\geq 1$  lakh)

1. Dehradun Urban Agglomeration	i) Dehradun	Municipal corporation
	ii) Bharuwalla Grant	Out growth
	iii) Dehradun Cantonment	Cantonment board
	iv) FRI and college area	Census town
	v) Raipur	Census town
	vi) Nathanpur	Census town
	vii) Nathuwala	Census town
	viii) Clement Town	Cantonment board
2. Haridwar Urban Agglomeration	i) Haridwar	Municipal corporation
	ii) BHEL Ranipur	Industrial township
	iii) Gurukul Kangri	Part out growth
	iv) Jwalapur Mahavidyalaya	Part out growth
	v) SIDCUL Haridwar	Part out growth
	vi) Rawai Mahdud	Census town
	vii) Jagjeetpur	Census town
3. Haldwani-cum-Kathgodam Urban Agglomeration	i) Haldwani	Municipal corporation
	ii) Kathgodam	Municipal council
	iii) Damua Dhunga Bandobasti	Out growth (ward no 26)
	iv) Byura	Out growth (ward no 27)
	v) Bamori Talli Bandobasti, Amrawati Colony, Shakti Vihar, Bhatt Colony	Out growth (ward no. 28)
	vi) Manpur Uttar (Palika Yatayat Nagar)	Out growth (ward no 29)
	vii) Haripur Sukha (Van Cancer Hospital)	Out growth (ward no. 30)
	viii) Gaujaji Uttar (Shishu Bharti Vidya Mandir)	Out growth (ward no. 31)
4. Roorkee Urban Agglomeration	ix) Kusumkheda	Out growth (ward no. 32)
	x) Bithoria no. 1	Out growth (ward no. 33)
	xi) Korta (Chanmari Mohala)	Out growth (ward no. 34 part)
	xii) Bamori Malli	Out growth (ward no. 35 part)
	xiii) Mukhani	Census town
	xiv) Haldwani Talli	Census town
	i) Roorkee	Municipal corporation
5. Rudrapur urban agglomeration	ii) Roorkee Cantonment	Cantonment board
	iii) Landhaura	Municipal council
	iv) Sunhaura	Census town
	v) Shafipur	Census town
	vi) Khanjarpur	Census town
6. Rishikesh urban agglomeration	vii) Padali Gujar	Census town
	viii) Nagla Imarti	Census town
	ix) Dhandera	Census town
	x) Mohanpur Mohammadpur	Census town
5. Rudrapur urban agglomeration	i) Rudrapur	Municipal corporation
	ii) Jagatpura	Out growth
	iii) SIDCUL Rudrapur	Out growth (part)
	iv) Rampura	Out growth (part)
6. Rishikesh urban agglomeration	i) Rishikesh	Municipal council
	ii) IDPL Virbhadra	Industrial township
	iii) Rishikesh	Census town
	iv) Gumaniwala	Census town



Population pressure on the cities is not only causing unbearable burden on the available infrastructure facilities but also hinders the social and economic development of the cities. Although tourism is one of the important factors that contribute greatly in the economy of the state. Due to urbanization, cities are now becoming a hub of industries, important facilities, transport, tourism, population of different, religions/castes/localities, colleges, Universities, etc. Therefore, the urban growth in Uttarakhand is affecting the society and environment both positively & negatively.

Because of the recent statehood of the state, the unplanned development, combined with rapid urban growth and the inflow of tourists and pilgrims has made critical impact on the urban environment of Uttarakhand. Most of the towns in Uttarakhand have grown in an unplanned manner causing immense pressure on the urban infrastructure and services resulting in degradation of the urban environment and of the natural resources. Major environmental concerns associated

with such unplanned urban development are different types of pollutions and landslides. Some of the major rivers which are sources of drinking and irrigation water for the states as well as are of religious significance, are silted and polluted due to the unplanned urban development and industrial activities. Lakes and water bodies which are also source of attraction for tourists are polluted due to uncontrolled discharge of wastewater and disposal of solid waste. This is a need for the government to assess and examine the root cause of the problems and to identify the strength of the state by means of balanced systematic planning in consensus with urban local bodies and citizens of the places to solve all these issues.

### iii. Housing

Traditional house making system in hilly part used mostly the wood work and stones and soil. Based on earthquake resistance among the available building materials at that time, wood was preferentially used (Fig 8.3 a).

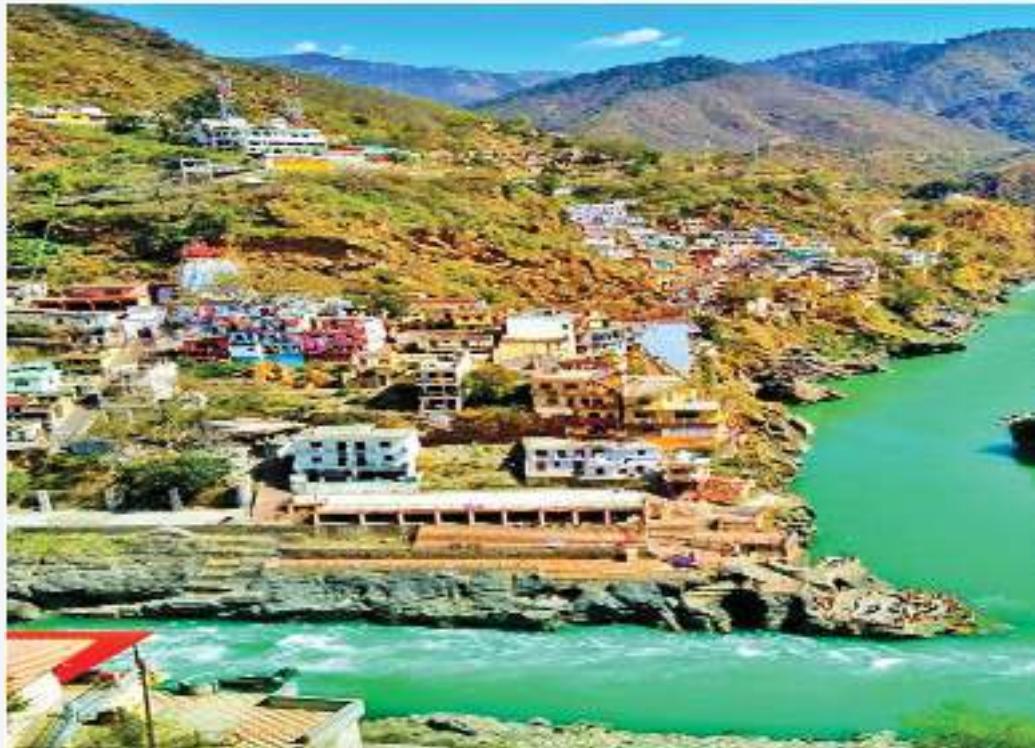


**Fig 8.3**

(a) Traditional house constructions in Uttarakhand utilised most of the work of wood and stone, and soil.

**Fig 8.3**

(b) New housing practices in hilly areas utilize cement, iron and new technology.



**Traditional Uttarakhand**



Now, cement, iron and new advanced materials are used in plain regions as well as hilly areas of Uttarakhand (Fig 8.3 b). The Uttarakhand housing and urban development authority is engaged in preparation of rules and regulation for

a planned and environmentally safe urbanization practices. Various laws are published by the authority which are strictly being in use in all urban sectors.

Rules of housing are formulated according to type of area either hilly or plain. Uttarakhand building BYE-LAWS and Regulation -2011 (Amendment 2016) is the latest rule book utilized for construction purposes. The book consists of different regulations and rules regarding various parameters such as height of the building, exterior open spaces, distance between two houses, distance from the tree, parking area, walking area, gardening area, tree plantation area, necessity of balcony, boundary, safety related to fire/earthquake, fire escapes, rain water collection area, constructed area, group housing and many more important factors. Separate schemes are defined for official/commercial constructions, school construction, University/college constructions, hospital construction, hotel constructions etc. all details regarding housing schemes can be accessed using official webpage of UHUDA<sup>3</sup>.

#### **iv. Urban Slums**

A slum is a highly populated urban residential area consisting mostly of closely packed, decrepit, housing units in a situation of deteriorated or incomplete infrastructures, inhabited primarily by impoverished persons. Improvement in slum colonies is a major challenge for the government of Uttarakhand. Uttarakhand Urban Sector Development Board is engaged in slum improvement practices in the state. Interventions include providing bulk water supply and sewerage at the entry of slums, improving solid waste management, improved access to roads, street lighting, and drainage in poor communities and slums. The slum improvement program of UUSDB aims to cover around 300,000 poor people (about half the state slum population). Slum up-gradation sub-projects are also in implementation.

These sub-projects are generated through a participatory planning process by communities with the assistance of community-based and non-government organisations (CBOs and NGOs) as applicable. Support will be provided to urban local bodies (ULBs) and communities for effective joint functioning in developing, implementing and sustaining community based urban upgrading schemes. The schemes are also helpful in poverty reduction. Initially based on the slum policy of the state and upgrading strategy, basic infrastructure will be improved in 69 slums in Dehradun, 20 in Haridwar, 10 in Nainital and 16 in Rudrapur.

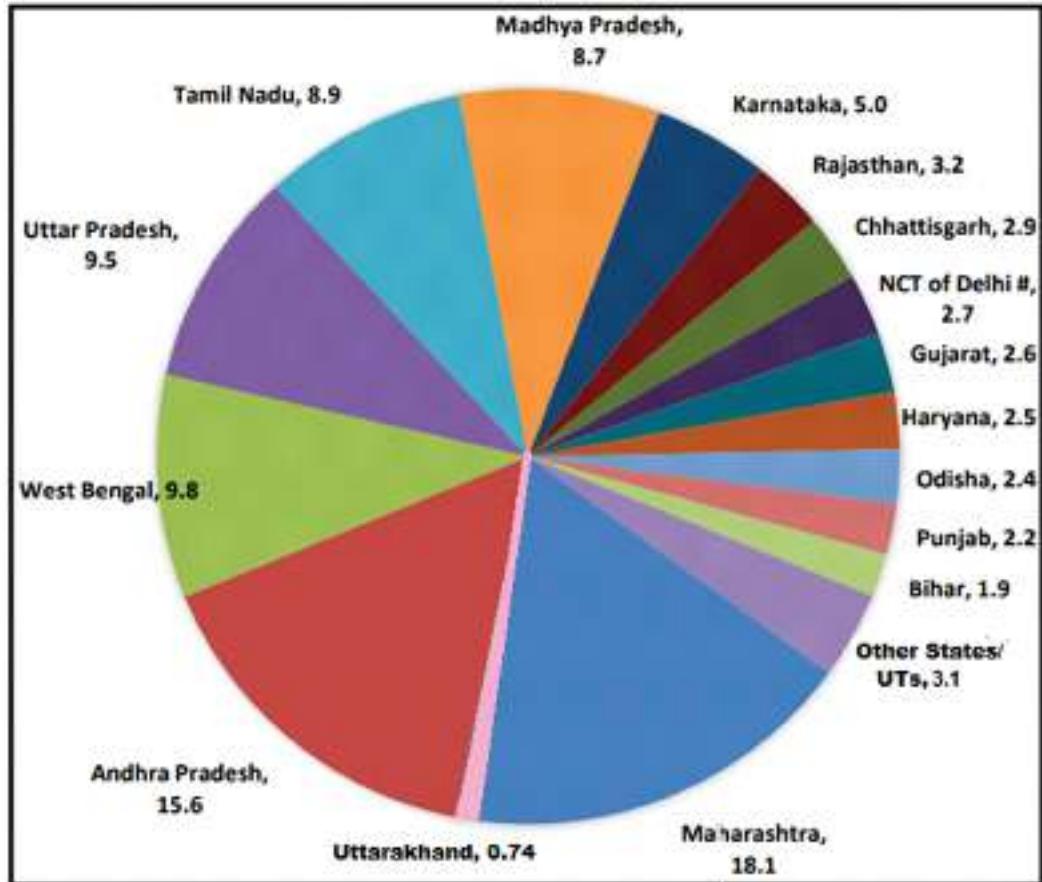
In the capital Dehradun, the total area under slums is now more than 279.65 acre. Out of the 113 slums, nearly 90 are near the Bindal and Rispuna rivers and cover a major part of river side. It is also explored that 23 slums are away from the river side and have developed near the railway station, railway lines and both side of major roads. Claiming that the state government is seriously addressing the problems faced by slum-dwellers in the city. State government has also planned to develop river fronts along the banks of the Rispuna and Bindal rivers where slums abound and shops will be allocated to poor sections. The state government has also expressed its thinking earlier about slum areas on occasion of "Nirbal Varga Diwas" that the slum areas will be developed as clean residential areas but fresh encroachments will not be allowed.

Uttarakhand state has a very small slum population of 0.74% of total slum population as compared to the other states of India. The percent state share of slum population of all the states to total slum population of India is given in Fig 8.4.

<sup>3</sup>[www.uhuda.org.in](http://www.uhuda.org.in)



**Fig 8.4**  
State share  
of slum  
population to  
total slum  
population  
of India<sup>4</sup>



#### v. Water supply and sanitation

The Major government organizations and departments in water supply and sanitation (WATSAN) sector are Uttarakhand Jal Sansthan (UJS), Uttarakhand Pey Jal Nigam (UJN), and the Swajal-Project Management Unit (PMU). The Swajal Project although started on November 2006 and completed in Dec 2015, but it had a significant role in water supply and sanitation systems development in Uttarakhand.

Uttarakhand Jal Sansthan was constituted by amalgamation of "Garhwal Jal Sansthan" and "Kumaun Jal Sansthan". The Sansthan is basically responsible for operation and maintenance of the water supply schemes. It extends in the whole of Uttarakhand excluding cantonment areas. Broad functions of Jal Sansthan Uttarakhand are to plan,

promote and execute schemes and operate an efficient system of water supply sewerage, sewage treatment and disposal and to take such measure as may be necessary to ensure water supply in times of any emergency. Moreover, Pey Jal Nigam Uttarakhand is also a functioning organization which is basically responsible for formulation of water supply schemes. Broadly the major objective behind the establishment of the Pey Jal Nigam was to have a responsible body for supplying water in the state of Uttarakhand. The major function or work performed by the Nigam is supplying water to the people residing in the state of Uttarakhand. Again the Nigam is responsible for planning, survey, design and execution of urban as well as rural water supply and sewage schemes in the state. The Swajal-Project Management Unit (PMU) was basically involved in community managed water supply and sanitation systems.

<sup>4</sup>Primary Census Abstract for Slum, 2011 Office of the Registrar General & Census Commissioner, India.

Prior to Swajal Project (also called Swajal II), other community based initiatives in Uttarakhand were also in operation such as Swajal-I, Sector Reforms Project, Swajaldhara etc. Swajal I was implemented as a pilot project from 1996 to 2003 with a number of 1146 various schemes, Sector Reforms Project was implemented in district Haridwar from 2002 to 2005 with a number of 103 schemes.

Swajaldhara initiated in 2002 with a reported number of more than 100 schemes and some are currently in operation.

The block wise schemes that are implemented by Uttarakhand Jal Sansthan are listed in Table 8.3. The data regarding all schemes and the site map of each district can be accessed using the official webpage of Jal Sansthan<sup>5</sup>.



**Table 8.3**  
Number of Implemented schemes by Uttarakhand Jal Sansthan<sup>6</sup>

S. No.	District	Block	No. of Schemes
1	Dehradun	Kalsi	11
		Raipur	1
		Doiwala	1
2	Pauri	Dwarikhali	30
		Jaiharikhali	5
3	Tehri	Thauldhar	31
		Jaunpur	20
4	Rudraprayag	Augustmuni	23
5	Chamoli	Gairsain	3
6	Almora	Dwarahat	26
		Chaukhutia	42
		Sult	12
7	Bageshwar	Bageshwar	7
8	Pithoragarh	Gangolihat	5
		in	3
		Munakot	1
<b>Total</b>			<b>221</b>

#### vi. Air quality of urban settlement

Increase in technology, development of industries, agricultural advancements coupled with population growth has triggered the deterioration of quality of environment throughout the world. In India and in

Uttarakhand, rapid urbanization, increasing traffic on roads, growing waste production, energy consumption, inadequate mass transport etc. are increasing the emission of pollutants into ambient air.

<sup>5</sup><http://uj.s.uk.gov.in/pages/display /60-list-of-schemes-221uj.s.uk.gov.in>

<sup>6</sup>[uj.s.uk.gov.in](http://uj.s.uk.gov.in)



#### ❖ Common ambient air pollutants

The air we breathe can become contaminated with pollutants viz. Sulphur dioxide ( $\text{SO}_2$ ), Nitrogen oxide (NOx), Carbon monoxide (CO), Ozone ( $\text{O}_3$ ) and particulate matter from various natural and manmade sources. A brief account on above pollutants is given here:

**Carbon monoxide (CO):** Carbon monoxide is a colorless, odourless and tasteless gas remains chemically inert under normal conditions. However, higher concentrations can effect human aerobic metabolism, owing to its high affinity for haemoglobin, the component of the blood responsible for transport of oxygen. CO sources are both natural and anthropogenic. The absorption of CO by the body increases with CO concentration, exposure duration and the activity being performed. High concentration of CO mainly reported in congested urban areas where traffic is heavy and slow moving.

**Sulphur Dioxide ( $\text{SO}_2$ ):** Sulphur dioxide is a colourless gas readily soluble in water. Natural sources such as sulphur bacterial activities, volcanoes, forest fires etc. contribute to the environmental levels of  $\text{SO}_2$ . Manmade contributions include the containing use of sulphur containing fuels for transportation, domestic purposes and power generation. Fuel consumption in stationary sources and industrial processes are the principal contributors of  $\text{SO}_2$  from anthropogenic sources.

**Nitrogen Oxides (NOx):** The two oxides of nitrogen are primarily concern in air pollution are nitric oxide (NO) and nitrogen dioxide ( $\text{NO}_2$ ), the only two oxides of nitrogen that are emitted in significant quantities to the atmosphere. Some oxides of nitrogen are produce naturally and others are anthropogenic in source. Primary origins of human induced NOx are fuel combustion in stationary sources and in transportation.

**Particulate Matters:** Air pollutants can be in the form of particulate matter which can be very harmful to our health. The level of effect usually depends on the length of time of exposure, as well the kind and concentration of chemicals and particles exposed to. Short-term effects include irritation to the eyes, nose and throat, and upper respiratory infections such as bronchitis and pneumonia. Others include headaches, nausea, and allergic reactions. Short-term air pollution can aggravate the medical conditions of individuals with asthma and emphysema. Long-term health effects can include chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys. Continual exposure to air pollution affects the lungs of growing children and may aggravate or complicate medical conditions in the elderly.

## ❖ Health effects of ambient air pollutants

### **Carbon Monoxide (CO)**

- Fuel combustion from vehicles and engines.
- Reduces the amount of oxygen reaching the body's organs and tissues; aggravates heart disease, resulting in chest pain and other symptoms.
- Other health symptoms are-Headache, Dizziness, Nausea, Breathing difficulties, Drowsiness, Reduced work capacity.

### **Oxides of Nitrogen (NO<sub>x</sub>)**

- Fuel combustion (electric utilities, big industrial boilers, vehicles) and wood burning.
- Worsens lung diseases leading to respiratory symptoms, increased susceptibility to respiratory infection.

### **Particulate Matter (PM)**

- This is formed through chemical reactions, fuel combustion (e.g., burning coal, wood, diesel), industrial processes, farming (plowing, field burning) and unpaved roads or during road constructions.
- Short-term exposures can worsen heart or lung diseases and cause respiratory problems. Long-term exposures can cause heart or lung disease and sometimes premature deaths.

### **Sulfur dioxide (SO<sub>2</sub>)**

- SO<sub>2</sub> come from fuel combustion (especially high-sulfur coal); electric utilities and

industrial processes as well as and natural occurrences like volcanoes.

- Aggravates asthma and makes breathing difficult. It also contributes to particle formation with associate health effects.

## ❖ Air pollution prevention, monitoring and

### **solution:**

#### **Government or community level prevention**

- Governments throughout the world have already taken action against air pollution by introducing green energy. Some governments are investing in wind energy and solar energy, as well as other renewable energy, to minimize burning of fossil fuels, which cause heavy air pollution.
- Governments are also forcing companies to be more responsible with their manufacturing activities, so that even though they still cause pollution, they are a lot controlled.
- Companies are also building more energy efficient cars, which pollute less than before.

Dehradun city, Haridwar, Rishikesh, Kashipur, Rudrapur and Haldwani areas are enjoying rapid urbanization. It was observed that in above cities a lower or moderate concentration of gaseous pollutants (SO<sub>2</sub> and NO<sub>2</sub>) and a higher concentration of particulate matter (PM10) was found. The average urban air quality data of these places for last three years (2016-2018) are reported in Table 8.4. National Ambient Air Quality standards (NAAQS) are given in Table 8.5 for its comparison.



**Table 8.4** Urban ambient air quality ( in  $\mu\text{g}/\text{m}^3$ ) of selected cities in Uttarakhand<sup>7</sup>



**Table 8.5**  
National ambient air quality standards (NAAQS)

Sl.No.	Pollutant	Time weighted average	Standards (schedule VII Rule 3 (3B))	
			Concentration in ambient air	
			Industrial, rural and other areas	Ecologically sensitive areas (Notified by Central Govt.)
1.	Oxides of Sulphur ( $\text{SO}_2$ )*	Annual Avg.	50.00	20.00
		24 hrs.	80.00	80.00
2	Oxides of nitrogen as ( $\text{NO}_2$ )*	Annual Avg.	40.00	30.00
		24 hrs.	80.00	80.00
3	Particulate matter ( $\text{PM}_{10}$ )*	Annual Avg.	60.00	60.00
		24 hrs.	100.00	100.00
4	Particulate matter ( $\text{PM}_{2.5}$ )*	Annual Avg.	40.00	40.00
		24 hrs.	60.00	60.00
5	Lead ( $\text{Pb}$ )*	Annual Avg.	0.50	0.50
		24 hrs.	1.00	1.00
6	CO ( $\text{mg/m}^3$ )	Annual Avg.	2.00	2.00
		1 hour	4.00	4.00
7	Ammonia ( $\text{NH}_3$ )*	Annual Avg.	100.00	100.00
		24 hrs.	400.00	400.00
8	Benzene*	Annual Avg.	5.00	5.00
9	Arsenic <sup>†</sup>	Annual Avg.	6.00	6.00
10	Nickel <sup>†</sup>	Annual Avg.	20.00	20.00

(\*in  $\mu\text{g}/\text{m}^3$ , <sup>†</sup>in  $\text{ng}/\text{m}^4$ )

#### vii. Status of solid waste management

Any substance that is discarded is designated as waste. In any human society, bulk solid wastes are produced as by-products of the normal and fundamental activities of living. The solid material such as household garbage (both recyclable and non-recyclable), food wastes, yard wastes, demolition or construction debris are main solid wastes and also considered as municipal solid waste (MSW). These

include discarded items like commercial and residential appliances, furniture, scrap metal, machinery, vehicle parts and abandoned or junk vehicles. Improper disposal of MSW can create unsanitary conditions that in turn can lead to pollution of the environment and outbreaks of vector-borne diseases (diseases spread by rodents and insects). Categorization and characterization of MSW is given in Table 8.6 and Fig 8.5.

In Uttarakhand, growth of population, industrialization and urbanization has resulted in generation of large volumes of solid waste. The total waste generation in the state is continuously increasing with growth in population, urbanization, high per capita income, increase in construction, commercial activities and shift towards western lifestyles. However, urbanization is the key driving factor amongst all for environment sustainability. In Uttarakhand, the

ULBs are mainly governed by the Urban Development Directorate therefore financial as well as infrastructural assistances are issued through the Directorate. In case of MSW Rules-2016, the Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) is responsible for implementation of provisions of said rules through the concerned ULBs.

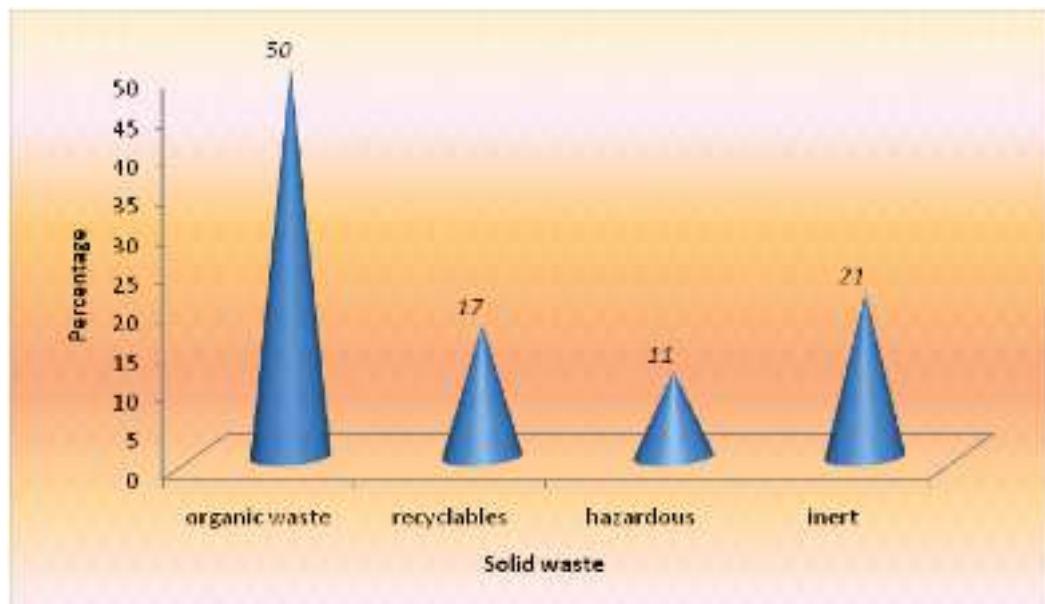
S.No.	Source	Typical waste generators	Types of solid wastes
1.	Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g., bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes).
2.	Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants.	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes.
3.	Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes.
4.	Institutional	Schools, hospitals, prisons, government centres.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes.
5.	Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Roofing & Sheathing scrapes, Wood, steel, broken concrete, dirt, plaster, pipe, wire, insulation etc.
6.	Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants.	Street sweepings; landscape and tree trimmings; general wastes from parks, beaches, and other recreational areas; sludge.
7.	Process (manufacturing,etc.)	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing.	Industrial process wastes, scrap materials, off-specification products, slag, tailings.
8.	Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms.	Spoiled food wastes, agricultural wastes, hazardous wastes (e.g., pesticides).
9.	Sewage Treatment Residues	Sewage treatment plants, septic tanks	Coarse screening, grit, septic tank sludge, dewatered sludge
10.	Other Wastes	Households, hospitals, institutions, stores, industries, etc.	Hazardous wastes: pathological wastes, explosives, radioactive material security wastes : confidential document, negotiable papers etc.

**Table 8.6**  
Categorization  
of municipal  
solid waste<sup>8</sup>

<sup>8</sup> <http://utrenvis.nic.in/msw%20categorization.html>. Environment status report Uttarakhand, TOR#1 Plastic Waste Mgt.



**Fig 8.5**  
Solid waste  
characterization



The MSW Management and Handling Rules (2000) and Solid Waste Management Rules (2016) are notified by the Ministry of Environment Forests and Climate Change for management of MSW. According to rules, solid waste management is one of the important obligatory functions of the municipal authorities. The waste characterization showed in Fig 8.5 indicates that MSW typically contains about 50% of organic waste, 17% recyclables, 11% hazardous and 21% inert materials. However, about 40% of all generated MSW is not collected at all and hence lies littered in the city/town and finds its own way to nearby open areas, drains and water bodies, causing clogging of water percolation and choking of drains, therefore pollute surface water. Un-segregated

waste collection and transportation leads to dumping in open, which generates leachate and gaseous emissions besides causing nuisance in the surrounding environment. Leachate contaminates the groundwater as well as surface water in the vicinity and gaseous emissions pollute environment and contribute to global warming. status of solid waste and plastic waste generation and its treatment method in Uttarakhand is reported in Table 8.7. Moreover by the judgement given by Uttarakhand High Court on Dec 20, 2016; the state government has imposed a ban on sale and use of plastic and thermocol products from Jan 11, 2017. From the date those who will use or sell plastic or thermocol things will have to pay a fine of Rs. 5000/-

**Table 8.7 Municipal solid waste generation status in Uttarakhand<sup>9</sup>****a) Nagar Palika Parishads**

SI. No.	District	Town	Population (census 2011)	MSW Status (TPD)		Plastic waste based on assumption of 17% avg. composition of MSW	
				2017	2041 (Projected)	2017	2041 (Projected)
1	Pauri Garhwal	Pauri	25440	21.5	28.000	3.66	4.76
		Srinagar	20091	14.8	13.059	2.25	2.22
		Kotdwar	33031	23.8	30.000	4.05	5.10
		Dogadda	2423	1.3	1.575	0.22	0.27
2	Dehradun	Mussoorie	28897	19.3	26.000	3.28	4.42
		Vikasnagar	13927	7.7	14.000	1.31	2.38
		Rishikesh	70499	41.4	91.000	7.04	15.47
3	Haridwar	Manglore	52994	27.4	34.446	4.66	5.86
4	Tehri Garhwal	Tehri Garhwal	24012	16.0	15.608	2.72	2.65
		Narendra nagar	6034	3.3	6.000	0.56	1.02
5	Uttarkashi	Uttarkashi	17480	9.0	11.362	1.53	1.93
6	Rudraprayag	Rudraprayag	9313	5.0	7.500	0.85	1.28
7	Udham Singh Nagar	Gadarpur	19289	10.0	12.538	1.70	2.13
		Bazpur	25513	13.2	16.583	2.24	2.82





### c) Nagar Nigam

1.	Dehradun	Dehradun	583679	327.9	584.051	55.74	99.29
2	Roorkee	Roorkee	118188	79.3	113.000	13.48	19.21
3	Haridwar	Haridwar	231139	236.5	368.363	40.21	62.62
4	Rudrapur	Rudrapur	154514	99.2	273.000	16.86	46.41
5	Kashipur	Kashipur	121610	71.6	158.000	12.17	26.86
6	Haldwani – Kathgodam	Haldwani	171351	88.5	111.378	15.05	18.93

It is estimated that about 900 MT/day solid wastes is being generated from the Urban local bodies(ULBs) in the of Uttarakhand, currently there are two waste management plants are working in Haridwar (Sarai) and out of which about 50% of wastes is being lifted and dumped at unidentified locations. In plain areas of the state, dumping of solid wastes along the motor road is very common, which is causing aesthetic as well as environmental threats to surface water, ground water and ambient air quality. In the hilly areas, solid wastes after its collection is disposed of simply by dumping from the top of hills or disposed of in a valley along the riverside. As a result, a clean water streams are chocked with garbage resulting in water contamination. No ULBs has defined collection, segregation, transportation and disposal mechanisms to comply with the MSW Rules, 2000. Even most of the ULBs are not aware of provisions of the MSW Rules. The ULBs have neither any capability of implementing the MSW Rules, nor have the resources for implementing the same. However, under JNNURM three ULBs namely Nagar Nigam, Dehradun; Nagar Nigam, Haridwar and Nagar Palika Parisad, Nainital are under the process of getting environmental clearances for setting up waste processing plant for respective cities.

#### Problems faced by Municipal Bodies:

- The local bodies which are responsible for proper disposal of urban waste are over-burdened with

other responsibilities of much higher priorities such as street sweeping, maintenance of existing roads, street lights, immunization etc. and waste disposal is downgraded to the end of the list.

Manual collection and disposal of wastes is the most widely practiced system of waste disposal. Lack of an established system for collection, transportation, treatment, disposal and complete networking of the system is the major drawback in the proper management of wastes.

- Waste management is least priority subject to ULBs.
- Inadequate financial support;
- Inadequate training of personnel;
- Lack of performance monitoring;
- Inadequate emphasis on preventive maintenance

#### and recycling waste

For effective waste management stress is given on three 'R's i.e. Reduce, Reuse and Recycle before storage and safe disposal of wastes.

1. Reduction in use of raw materials- Reduction in the use of raw materials will correspondingly decrease the production of waste. Reduced demand for any metallic product will decrease the mining of their metal and cause less production of waste.

2. Reuse of waste materials- The refillable containers (such as glass bottles, plastic containers) which are discarded after use can be reused, villagers make casseroles and silos from waste paper and other waste materials.
3. Recycling of materials- In recycling used and discarded items are collected, melted and reprocessed into new products. For example iron scraps, aluminium cans etc. can be melted and recorded into new products.

Currently solid waste management plants are working in Haridwar (at Sarai) and Dehradun (at Sheeshambada). The working plant of Sarai has a treatment capacity of 300 ton/day out of which machines treat 150 ton/day and rest 20 to 50% is recycled manually (Fig 8.6). The plant at Sheeshambada, Dehradun recycles 500 ton waste/day (Fig 8.7).

#### viii. Status of bio-medical waste management

Biomedical waste, also known as infectious waste or medical waste, is defined as solid waste generated during the diagnosis, testing, treatment, research or production of biological

products for humans or animals. Biomedical waste may also include waste associated with the generation of biomedical waste that visually appears to be of medical or laboratory origin (e.g., packaging, unused bandages, infusion kits, etc.), as well as research laboratory waste containing bio molecules or organisms that are restricted from environmental release.

Examples of infectious waste include discarded blood, sharps, unwanted microbiological cultures and stocks, identifiable body parts, other human or animal tissue, used bandages and dressings, discarded gloves, other medical supplies that may have been in contact with blood and body fluids, and laboratory waste that exhibits the characteristics described above. Waste sharps include potentially contaminated used (and unused discarded) needles, scalpels, lancets and other devices capable of penetrating skin.

#### Sources of bio-medical waste

Hospitals produce waste, which is increasing over the years in its amount and type. The hospital waste, in addition to the risk for patients and personnel who handle them also poses a threat to public health and environment.

**Fig. 8.6**

- a) Solid waste management plant at Sarai, Haridwar
- b) Manure production from solid waste after treatment



(a)

(b)

**Fig 8.7**

- a) Solid Waste Management plant at Sheeshambada
- b) Processing of solid waste



(a)

(b)

Major sources	Minor sources
Hospitals	Clinics
Labs	Dental clinics
Research centres	Homecare
Animal research	Cosmetic clinics
Blood banks	Paramedics
Nursing homes	Funeral services
Mortuaries	Institutions
Autopsy centres	
Production Units	

#### Problems related/associated with bio-medical waste:

A major issue related to current bio-medical waste management in many hospitals is that the implementation of bio-waste regulation is unsatisfactory as some hospitals are disposing of waste in a haphazard, improper and indiscriminate manner. Lack of segregation practices, result in mixing of hospital wastes with general waste making the whole waste stream hazardous. Inappropriate segregation ultimately results in an incorrect method of waste disposal.

Inadequate bio-medical waste management thus causes environmental pollution, unpleasant smell, growth and multiplication of vectors like insects, rodents and worms and may lead to the transmission of diseases like typhoid, cholera, hepatitis and AIDS through injuries from syringes and needles contaminated with human.

The bio-medical waste scattered in and around the

hospitals invites flies, insects, rodents, cats and dogs that are responsible for the spread of communicable disease like plague and rabies. Rag pickers in the hospital, sorting out the garbage are at a risk of getting tetanus and HIV infections. It becomes primary responsibility of Health administrators to manage hospital waste in most safe and eco-friendly manner. Various diseases and their causative agents relate to biomedical waste are reported in Table 8.8.

The problem of bio-medical waste disposal in the hospitals and other healthcare establishments has become an issue of increasing concern, prompting hospital administration to seek new ways of scientific, safe and cost effective management of the waste, and keeping their personnel informed about the advances in this area. The need of proper hospital waste management system is of prime importance and is an essential component of quality assurance in hospitals.

**Table 8.8**  
Diseases and  
their causative  
agents related to  
biomedical  
waste<sup>8</sup>

ORGANISM	DISEASES CAUSED	RELATED WASTE ITEM
VIRUSES: HIV, Hepatitis B, Hepatitis A and C, Arboviruses, Enteroviruses	AIDS, infectious hepatitis, dengue, Japanese encephalitis, tickborne fevers, etc.	Infected needles, body fluids, human excreta, soiled linen, blood, body fluids,
BACTERIA: <i>Salmonella typhi</i> , <i>Vibrio cholerae</i> , <i>Clostridium tetani</i> , <i>Pseudomonas</i> spp., <i>Streptococcus</i> spp.	Typhoid, cholera, tetanus, wound infections, septicaemia, rheumatic fever, endocarditis, skin and soft tissue infections	Human excreta and body fluid in landfills and hospitals wards, sharps such as needles, surgical blades in hospital waste.
PARASITES: <i>Wuchereria bancrofti</i> , <i>Plasmodium</i> spp.	Cutaneous leishmaniasis, kala azar, malaria	Human excreta, blood and body fluids in poorly managed sewage system of hospitals

#### Biomedical waste management in Uttarakhand

Uttarakhand Environment Protection & Pollution Control Board (UEPPCB) is taking various steps to ensure that bio medical waste generated from various hospitals/nursing homes and other health care units are disposed off in safe and scientific manner in order to prevent disease and infections. State board has identified 2429 health care facilities (HCF) in year 2018. 5169.44 kg/day waste is being generated by these HCF's. Details of biomedical waste generated in the hospitals

are given UEPPCB regional office wise is given in Table 8.9 (a). There are following incinerators operational in Uttarakhand:

1. Sushila Tiwari Government Hospital, Rampur Road Haldwani
2. Medical Pollution Control Committee (MPCC), Mandawar, Roorkee, Distt. Haridwar
3. Global Environment Solution, Lamba Khera, Khanpur, Gadarpur
4. BHEL, Hospital, Ranipur, Haridwar



M/s Global Environment Solutions, Khasra no 560, Lambakhera, Khanpur, Gadarpur (Fig 8.8) and M/s Medical Pollution Control Committee (MPCC), Mandawar, Roorkee-Dehradun road, Roorkee, Distt Hardiwar are functioning as the Common Bio-medical waste treatment facility in Uttarakhand. HCFs of Uttarakhand has provided various facilities at the hospital for waste disposal like provision of needle destroyer and different coloured bins for collection of different kind of waste for segregation at source. Small nursing homes and Indian Medical Association has engaged service providers i.e. MPCC and Global Environment Solution to transport their incinerable waste. These service providers collect the waste from each nursing home/hospital/clinic and other health care units to ensure proper handling and disposal of bio-medical waste in scientific manner, in compliance to the Bio-Medical Waste Rules, 1998. State board has prosecuted CHC( Common Health Center), Vikasnagar and Jwala Nursing Home, Dehradun into special designated court because these hospitals are not complying BMW Rules since a long time.

Different methods have been developed for rendering biomedical waste environmentally innocuous and aesthetically acceptable but all of them are not suitable due to different conditions. Incineration is most convenient and quick method of solid waste disposal by burning of waste at very high temperature. Autoclaving and microwave treatment shall not be used for cytotoxic, hazardous and radioactive wastes, contaminated animal carcasses, body parts and large metal items. For such wastes, deep burial systems for their natural microbial degradation could be adopted. For deep burial system, a pit or trench should be dug about 2 meters deep. It should be half filled with waste, and then covered with time within 50 cm of the surface, before filling the rest of the pit with soil. On each occasion, when wastes are added to the pit, a layer of 10 cm of soil shall be added to cover the wastes. Burial must be performed under close and dedicated supervision. Categorization of biomedical waste and its proper disposal techniques are given in Table 8.9 b. Colour coding and type of container used for disposal of such biomedical wastes is also recommended

**Fig 8.8**

- (a) Biomedical waste management by M/S Global Environmental Solution near Gadarpur U S Nagar
- (b) Biomedical waste treatment unit
- (c) Installed Incinerator



b



c

by the government. The categories of container are discriminated by its colour. The colour coding is based on the hazardous effect and process of disposal of the biomedical

waste. The colour coding and type of container used for disposal of different biomedical wastes are reported in Table 8.9 c.

**Table 8.9**  
(a) Biomedical waste status in Uttarakhand<sup>8</sup>

Year wise	Total no. of Hospitals	Total no. of beds	Total no. of waste generated (Kg/day)	Total no. of waste Treated (Kg/day)
Year 2016				
<b>Dehradun</b>	277	7672	1401.66	1401.66
<b>Roorkee</b>	127	3124	216.34	216.34
<b>Haldwani</b>	91	3233	614	614
<b>Kashipur</b>	145	1565	450	450
<b>Total</b>	640	15594	2682	2682
Year 2017				
<b>Dehardun</b>	434	8101	1516.38	1516.38
<b>Roorkee</b>	174	3398	438	438
<b>Haldwani</b>	103	3358	717	717
<b>Kashipur</b>	416	3297	1600	1600
<b>Total</b>	1127	18154	4271.38	4271.38
Year 2018				
<b>Dehradun</b>	958	8686	2692.22	2692.22
<b>Roorkee</b>	195	3490	454	454
<b>Haldwani</b>	756	4321	423.22	423.22
<b>Kashipur</b>	520	3380	1600	1600
<b>Total</b>	2429	19877	5169.44	5169.44

**Table 8.9**  
(b) Categories of biomedical waste and its disposal technique<sup>8</sup>

Cat. No.	Waste type	Treatment
1.	Human anatomical waste	Incineration/ deep burial
2.	Animal waste	Incineration/ deep burial
3	Microbiological/ biotechnological waste	Incineration / autoclaving / microwaving
4	Waste sharps (needle, syringes etc)	Disinfection / autoclaving
5	Discarded medicines / cytotoxic drugs	Incineration/ disposal in municipal land fills
6	Solid wastes contaminated with blood	Incineration / autoclaving / microwaving
7	Other solid waste	Chemical treatment/ autoclaving/ microwaving/ shredding
8	Liquid waste	Disinfection and discharge
9	Incineration ash	Disposal in municipal land fills
10	Chemical waste	Chemical treatment and discharge



**Table 8.9**  
(c) Colour coding and type of container for disposal of biomedical wastes.<sup>8</sup>

Colour coding	Type of container	Waste category*	Common treatment
Yellow	Plastic bag	1,2,3,6	Incineration/ deep burial
Red	Plastic bag/ disinfectant container	3,6,7	Autoclaving / microwaving / chemical treatment
Blue	Plastic bag/ puncture proof container	4,7	Autoclaving / microwaving / chemical treatment etc.
Black	Plastic bag	5,9, 10 (solid)	Disposal in secured land fill

\*waste category according to Table 8.9 (b).



#### Recommendations to lower down hazards from biomedical waste:

- i. Training should be given to the staff of health department for the proper implementation of rules.
- ii. Bio-medical waste should not be allowed to mix with other MSWs.
- iii. Housekeeping staff must wear protective devices such as gloves, face masks, gown, while handling the waste. Staff should be trained for proper waste disinfection techniques.
- iv. There must be biomedical waste label on waste carry bags/waste carry trolley and also poster should be put on the wall adjacent to the bins (waste) giving details about the type of waste that has to be disposed in the baggage as per biomedical waste management rules. Carry bags should also have the biohazard symbol on them.

#### ix. Non-sustainable urbanization: its impact on environment

Increase in human population in urban areas is becoming a powerful environmental force over the last many years. With the industrial revolution, it began to affect our

environment. The recent increase in the population has magnified the effects on agricultural and economic activities. According to an estimate, within the next few years, more than half the world's population will be living in urban areas. Moreover, with unplanned and rapid urbanization, the

number of people living in slums are lacking access to basic infrastructure and services such as sanitation, electricity, and health care. However, increased urban populations

interact negatively with their environment also. Therefore, the polluted urban environment affects the health and quality of life of the urban population.



Moreover, urban development occurred in Uttarakhand significantly in unplanned manner which has resulted in lack of civic amenities in accordance with the population density. Population pressure on the cities is not only causing unavoidable burden on the available infrastructure facilities but also hinders the social and economic development process of the cities. On the other hand, tourism is contributing much in the state's economy. Cities have now become the hub of capitalization of the state as well. Thus the urban growth in Uttarakhand is having both positive and negative aspects. Major environmental concerns associated with such unplanned urban development are:

- Unwanted depletion of forest area

- Loss of bio-diversity
- Potential urban pollution in the form of air pollution
- Water pollution
- Noise pollution
- Solid and liquid waste discharges
- Landslides
- Human and other animal health problems
- Increase in slums.

Some of the major rivers in the state and having religious significance are silted and polluted due to the unplanned urban development and industrial discharges. These rivers also act as major drainage outlets for the towns, and are often used as a convenient method of solid/liquid waste disposal. Lakes and water bodies which are also an attraction for tourists are also getting polluted due to uncontrolled discharge of wastewater and disposal of solid wastes. There is a need to assess and examine the root cause of the problems and identify the strength of the state by means of balanced systematic planning in consensus with ULBs and citizens of the native towns to get rid of all these issues.

#### x. Balancing urbanization: need of integrated planning

The negative impacts of urbanization on environment, health of human, etc. are briefly discussed in prior section. But urban area development is also very important for boosting the economic and infrastructural development of the state. Cities are at the forefront of global socio-economic change. The urban population living in Uttarakhand is increasing day by day at very faster rate and population living in non-urban areas are also depend on cities for economic, social cultural and political progress. The urbanization should be balanced and always sustainable. It should be planned in such a manner that the negative exploitation of natural resources such as water, soil, air, plants etc. can be avoided.



Not only the Uttarakhand but also India's other mountainous states lack the master planning of urbanization. Unplanned development of housing, urban transport, basic necessities (like drinking water, sewerage, drainage & solid waste management), population growth, outpacing development of physical infrastructure, disaster prone development near hazardous areas, lack of ULB's resources and capacity and delays due to centralized planning implementation are major points to concern. Therefore, to alleviate these concerns, conceptualisation of bottom-up solutions is required.

#### **Key areas identified for sustainable urban development framework**

- City master plans
- City aesthetics, public space planning & management

- Building by-laws with mountain specificity and disaster management focus
- City services
- Water & sanitation issues
- Drinking water
- Drainage, sewerage & waste water management
- Solid waste management
- Urban transport
- Governance & finance



# >> Health



- i) Health status
- ii) Health indicators
- iii) Health infrastructure
- iv) National programs and schemes
- v) Ayurvedic and alternative healthcare system



# 09

Over the years of human development, it has been recognized that a healthy society can lead to overall growth and self fulfilment of the individuals. Therefore, health must take centre stage of all developmental agenda. The environment and the changes in it are also reflected in the health of the people. Therefore, review of the health status of the population is an integral part of any environmental report.

If we consider the approach towards health, it has undergone various stages of change from curative to preventive, preventive to social and social to community based, where the whole community is involved in the process. It has now been recognized that the community as a whole should be mobilized and involved in order to attain the goal of "health for all" set up by WHO. Public health care originated

from this concept and is considered the key strategy to achieve the goal. In Uttarakhand, there is a complex climate change environment. It has significantly increased respiratory related diseases and hospitalization. Besides heat stresses and respiratory distress from poor air quality due to fine wood burning for cooking in hilly and rural area, changes in temperature, precipitation and contaminated water, lead to water borne diseases and create conditions for disease outbreaks. Climate change is responsible for imparting mixed effects of increase and decrease in transmission potential of different diseases. Climate change also alters social environment resulting in important impact on various social and economic activities.



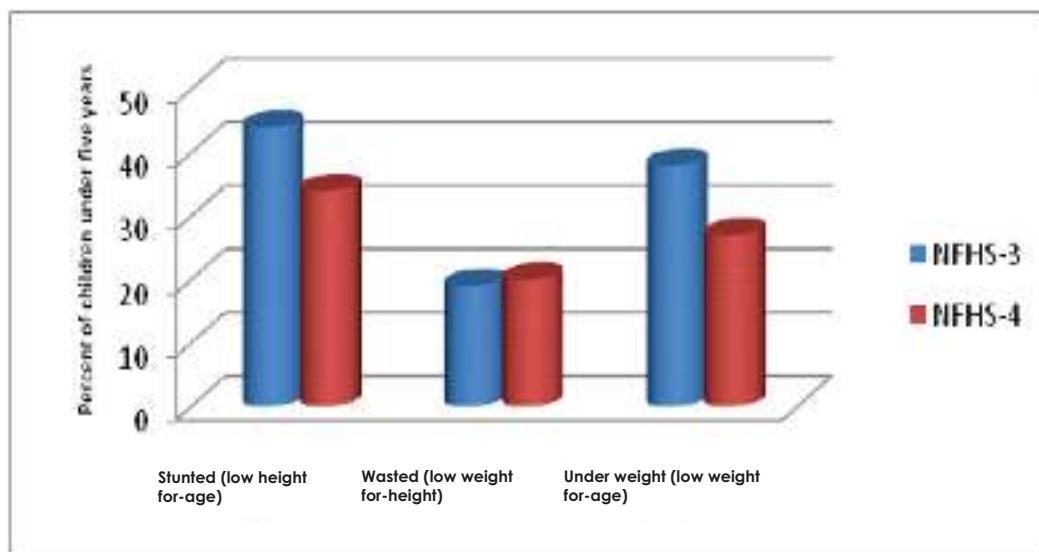
## i Health status

### Children's nutritional status

Children's nutritional status in Uttarakhand has improved since 2006-2007 as per National Family Health Survey (NFHS-3). Stunting decreased from 44% to 34% in 10 years between NFHS-3 and National Family Health Survey

(NFHS-4) which was carried out during 2016-17, and the percentage of children who were underweight decreased from 38% to 27%. However, in the same period, wasting increased slightly (from 19% to 20%). Despite the gains in stunting and underweight, child malnutrition is still a major problem in Uttarakhand. Fig 9.1 shows the status of nutrition in children of Uttarakhand.

**Fig 9.1**  
The status of nutrition in children of Uttarakhand



### Adults' nutritional status

Overall, more than one-third of women (39%) and men (34%) are either too thin or overweight or obese. 18% of women and 16% of men in Uttarakhand are too thin and 20% of women and 18% of men are overweight or obese as per NFHS-4. This is quite different from the pattern in NFHS-3; where a substantially larger proportion of men and women were thin than overweight or obese.

Women of the hills are known for their hard work

which is generally taken for granted. She pervades all aspects of hill life but rarely talked or thought about for problem and issues of health and nutrition. The health status of girls in hilly areas are more affected by generally deteriorating conditions of nutritional value of food. Drudgery of hill women is the most important reason for their undernourishment.

Indian Council of Medical Research (ICMR) recommended standard diet criteria for health status of women in Uttarakhand which is given in Table 9.1.

Food Items	Quantity as prescribed by ICMR	Quantity actually consumed
Cereals	575 gm	75 gm
Pulses	50 gm	40 gm
Green leafy veg.	100 gm	40 gm
Other Veg.	50 gm	20 gm
Milk	200 gm	50 gm
Oil or Ghee	40 gm	20 gm
Sugar & Jaggery	40 gm	20 gm

**Table 9.1**  
Standard diet required by females as recommended by ICMR vis a vis what females are getting<sup>1</sup>.

#### Disease status

Among children between the ages of 6 and 59 months in the state, more than half (55%) are anaemic. This includes 26% who are mildly anaemic, 27% who are moderately anaemic and 2% who suffer from severe anaemia. Girls are slightly more likely to have anaemia than boys. Although anaemia levels vary somewhat according to background characteristics, anaemia among children is widespread in every group. Almost half of children (49%) are anaemic despite their mothers have 12 or more standard of education. The prevalence of anaemia among children decreased from 61% in NFHS-3 to 55% in NFHS-4. 42% of women in Uttarakhand have anaemia, including 31% with mild anaemia, 10% with moderate anaemia, and 1% with severe anaemia. Anaemia exceeds 40% for almost in every group of women and 14% of men between ages 15-49 years.

In Uttarakhand, 244 persons per 100,000 are estimated to have medically treated tuberculosis, based on reports from household respondents. The prevalence of medically treated tuberculosis is higher among men (307) than among women (182) and is higher in urban areas (344) than in rural areas (189). Most respondents have heard of tuberculosis (94% of women and 97% of men), but even among those who have heard of tuberculosis, only 64% of women and 70% of men know that it is spread through the air by coughing or sneezing. More than 61% of women and 77% of men have misconceptions about how tuberculosis is spread. Almost all women (93%) and men (97%) know that tuberculosis can be cured, and only 10% of women and 9% of men say that if a family member had tuberculosis, they would like to keep it a secret.

<sup>1</sup><https://icmr.nic.in/>

According to self-reports, 1,382 women and 634 men ages 15-49 years per 100,000 have diabetes. The diabetes rate is much higher among women and men aged 35-49 years than among younger women and men. Overall, 983 women and 763 men per 100,000 suffer from asthma. The prevalence of asthma among women is again notably higher among those aged 35-49 years than among younger individuals. Goitre or any other thyroid disorder is somewhat more common than asthma among women (1,601 per 100,000) but less prevalent than asthma among men (116 per 100,000). The prevalence of any heart disease is higher among men (1,283 per 100,000) than among women (898 per 100,000). Among the five diseases, cancer is the least common, with 94 persons per 100,000.

On calculation of availability of health workers and health facility per lakh population in each district of the state from district health action plan it was found that Pauri Garhwal has maximum number of government health facilities per lakh of population followed by Chamoli, and Pithoragarh. However, Chamoli has maximum number of health workers per lakh population followed by Uttarkashi, Tehri Garhwal and Rudraprayag. It has been observed from Table 9.2 that the plain districts of the state which are considered to be well equipped with the health facility and infrastructure are very low on this scale.

**Table 9.2**  
Status of health facility and health workers<sup>2</sup>.

District	District wise population	No. of health facilities	No. of health workers	Health facility/lakh population	No of health workers/lakh population
<b>Almora</b>	622506	325	412	52.20	66.18
<b>Bageshwar</b>	259898	106	150	40.78	57.71
<b>Chamoli</b>	391605	222	725	56.68	185.13
<b>Champawat</b>	259648	105	126	40.43	48.52
<b>Dehradun</b>	1696694	275	570	16.20	33.59
<b>Haridwar</b>	1890422	206	295	10.89	15.60
<b>Nainital</b>	954605	248	383	25.97	40.12
<b>Pauri Garhwal</b>	687271	413	572	60.09	83.22
<b>Pithoragarh</b>	483439	264	307	54.60	63.50
<b>Rudraprayag</b>	242285	115	217	47.46	89.56
<b>Tehri Garhwal</b>	618931	336	559	54.28	90.31
<b>U S Nagar</b>	1648902	226	436	13.70	26.44
<b>Uttarkashi</b>	330086	172	339	52.10	102.70

<sup>2</sup><http://mohfw.nic.in/NRHM/DHAP/DHAP.htm#UT>, 2012, Uttarakhand SOER 2012, UCOST Dehradun

## ii. Health indicators

The health indicator viz. Crude Birth Rate (CBR), Crude Death Rate (CDR), Total Fertility Rate and Infant Mortality Rate (IMR) of the state is less than the national values. Immunization percentage of children below 23 month is higher than national values. Maternal mortality ratio is lower

than the national values and percentage of institutional deliveries is less than the national average. Therefore, these two areas needs due attention and proper development of health related facilities. According to the Uttarakhand health and family welfare society, the status of health indicators is given in Table 9.3

**Table: 9.3**  
Status of health indicators in India and Uttarakhand<sup>3</sup>.

S. No.	Indicator	Current Status of Health Indictors (India)	Current Status of Health Indicator (Uttarakhand)
1	Infant Mortality Rate (IMR)	47	32/1000 (AHS)
2	Complete Immunization	43.5%	63%(NFHS )
3	Maternal Mortality Ratio	359	212 (AHS)
4	Total Fertility Rate	2.5	2.5 (NFHS)
5	Crude Birth Rate (CBR)	22.1	18.8(AHS)
6	Crude Death Rate (CDR)	7.2	6.1 (AHS)
7	Institutional Delivery	40.8%	36% (NFSH)

NFHS: National Family Health Survey

AHS: Aboriginal Health Services

## iii. Health infrastructure

Public health infrastructure provides communities, states, and the nation the capacity to prevent disease, promote health, and prepare for and respond to both acute (emergency) threats and chronic (ongoing) challenges to health. Uttarakhand has a good network of hospitals and health centres. As on August, 2017 the state had 293 primary health centres, 21 district hospitals, 27 sub district hospitals and 23 blood bank centres.

To function at an optimum level and to improve the quality of healthcare services in all the 13 districts of the state, in March 2017, the World Bank signed US\$ 100 million credit agreement with the government. According to Uttarakhand health and family welfare society (report 2017) the health infrastructure data is given in Tables 9.4 and 9.5

<sup>3</sup>[www.ukhfw.org](http://www.ukhfw.org) , Uttarakhand health and welfare society



**Table 9.4**  
Health infrastructure in Uttarakhand<sup>4</sup>.

S.No.	Health Facility	Number of Institutions
1	District Hospitals	12
2	Female Hospitals	06
3	Base Hospitals	03
4	Combined Hospitals	15
5	CHC including identified FRUs	55
6	PHC's	239
7	Sub Center	1765
8	State Allopathy Dispanseries	322
9	Ayurvedic Hospitals &Dispensaries	543
10	Homeopathic Dispensaries	107
11	Unani Hospitals	03
12	Blood Banks	23
13	T.B. Clinic	13

**Table 9.5**  
Details of health centres<sup>5</sup>.

Five year plan	Sub centres	Primary health centres (PHCs)	Community health Centres (CHCs)
<b>Tenth plan (2002-2007)</b>	1765	232	49
<b>Eleventh plan (2007-2012)</b>	1848	257	59
<b>Twelfth Plan (2012-2017)</b>	1918	293	64

#### iv. National programmes and schemes

National programmes and schemes related to Health in Uttarakhand are as follows.

##### a) National AIDS control programme

The national AIDS control programme phase III is being launched with the objective to halt and reverse the spread of the HIV/AIDS epidemic in India. During this phase the national AIDS control organisation will strengthen

capacity. Formulate policies and facilitate proper implementation to enable decentralized responses focused on local needs. As per WHO, report AIDS epidemic update.

Uttarakhand State AIDS Control Society (USACS) has established 48 integrated counselling and testing centres, ten sexually transmitted infection centres. In 2016-17 following HIV/AIDS cases are reported in different districts of Uttarakhand<sup>6</sup>.

<sup>4</sup>[www.ukhfw.org](http://www.ukhfw.org) , Uttarakhand health and family welfare society 2017

<sup>5</sup><http://gbpihedenvis.nic.in/uttarakhand.html>

<sup>6</sup>The Tribune Nov 30, 2017



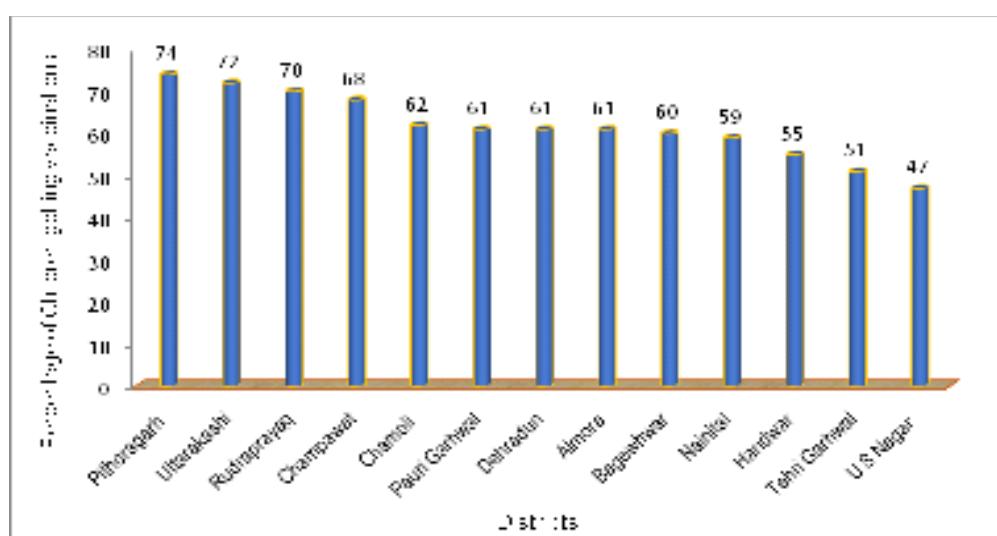
District	Number of affected persons
Dehradun	367
Haridwar	139
Nainital	120
Rudraprayag	0
Pithoragarh	16
Tehri Garhwal	7
Almora	15
Bageshwar	4
Chamoli	4
Pauri Garhwal	23
Uttarkashi	3
U.S. Nagar	47
Champawat	0

### b) Immunization programme

As per National Family Health Survey (NFHS -4, 2017) in Uttarakhand 58% of children age 12-23 months are fully vaccinated against 6 major childhood illnesses- tuberculosis, diphtheria, pertussis, tetanus, poliomyelitis and

measles. Coverage with all basic vaccinations is higher among Hindu than Muslim children (61% versus 48%) and is highest for children whose mothers are educated (66%). There is not much difference in vaccination coverage by urban-rural residence or the sex of the child (Fig.9.2)

**Fig 9.2**  
Coverage of  
all basic  
vaccinations in  
different districts  
of Uttarakhand



### c) Integrated disease surveillance project

Government of India is initiating a decentralized state based integrated disease surveillance project in the country in response to a long felt need expressed by various expert committees. The project would be able to detect early warning signals of impending outbreak and help to initiate an effective response in a timely manner. It is also expected to provide essential data to monitor progress of an ongoing disease more optimally. In Uttarakhand, the integrated disease surveillance project was launched on 5th July 2005 with World Bank assistance.

### d) National Polio Surveillance Project

The objective behind this project is to ensure that no child will ever again infected by polio virus. Polio is a highly infectious disease caused by polio virus. This project was launched in 1997, provides technical and logistics assistance to the goal and works closely with state government. India achieved the milestone of having no polio case for more than 1 year since 13 Jan 2011 and has been removed from the list of polio endemic countries.

**Table 9.6**  
Status of vector borne diseases in Uttarakhand<sup>7</sup>.

Disease	2011		2012		2013		2014 (Upto November)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
<b>Dengue</b>	454	5	110	2	54	0	1	0
<b>Malaria</b>	1277	1	1948	0	1426	0	1120	0
<b>Japanese Encephalitis</b>	0	0	1	0	0	0	0	0
<b>Kala-Azar</b>	0	0	7	1	0	0	4	0

### g) National Blindness Control Programme

In 1974, prevalence of blindness in India was 1.4%. In 1976, national programme for control of blindness was launched as 100% centrally sponsored scheme with the goal of reducing the prevalence of blindness to 0.3% by 2020. At present its prevalence is 0.56% in Uttarakhand.

### e) National Leprosy Elimination Programme

National leprosy eradication programme phase II is running from April 2001. The main objective of the project is to achieve the targets set by the GOI of bringing down the leprosy prevalence rate to 1 or below 1 per 10000 population. The prevalence rate of leprosy in Uttarakhand state was 28.77 per 10000 in the year 1986, which has been brought down to 0.38 per 10000, as of March 2016 and hence the state has achieved the target of leprosy elimination programme.

### f) National Vector Borne Disease Control Programme

The national vector borne disease control programme has been started as an initiative for prevention and control of the vector borne diseases i.e. Malaria, Dengue, Lymphatic, Filariasis, Kala-azar, Japanese Encephalitis and Chikungunya in India. In Uttarakhand most of these diseases are found in plain areas and the hill district does not face the wrath. The status of vector borne diseases in Uttarakhand is tabulated in Table 9.6.

### h) Rashtriya Swasthya Bima Yojana

Rashtriya Swasthya Bima Yojana has been launched by Ministry of Labour and Employment, Government of India in April 2008 to provide health insurance coverage for Below Poverty Line (BPL) families. The objective of the programme is to provide protection to BPL households from financial

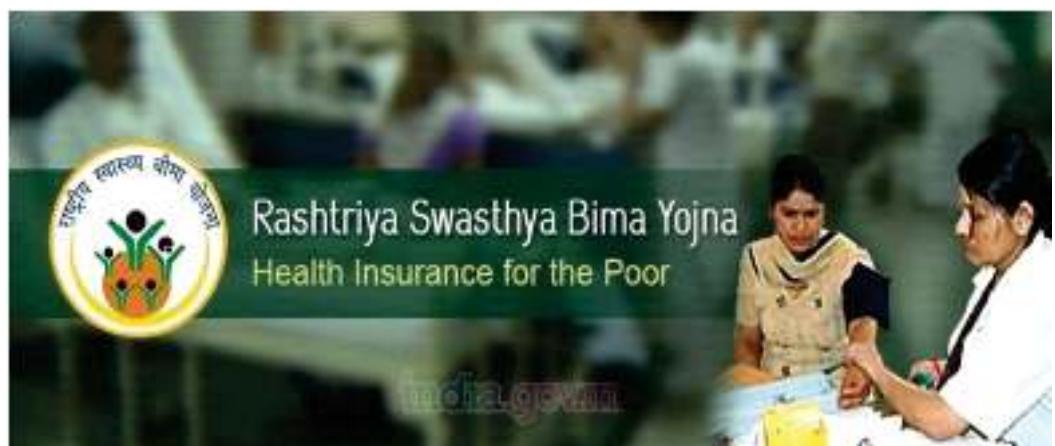
<sup>7</sup><http://nvbdcp.gov.in/Doc/Annual-report-NVBDCP-2014-15.pdf>



liabilities arising out of health shocks that involve hospitalization. The scheme provides hospitalization coverage up to Rs. 30,000 for most of the diseases. The scheme will cover at most five members of BPL family including the head of the family, spouse and up to three dependents. The benefits of the scheme can be availed by registering with a meager amount of Rs.30. In Uttarakhand, RSBY Scheme was launched on 1st December 2008 and the nodal agency was Uttarakhand state labour department. However, the scheme was transferred to Uttarakhand Health and Family Welfare department in September 2009.

Health insurance despite the emergence of a number of health insurance programmes and health schemes, only 20% of households in Uttarakhand have any

kind of health insurance that covers at least one member of the household. Health insurance coverage is as common in rural areas (20%) as in urban areas (19%). In Uttarakhand, four types of programmes dominate. More than two fifths of the households with at least one covered member report coverage from the Rashtriya Swasthya Bima Yojana (RSBY), 26% from the state health insurance scheme, 14% from the Central Government Health Scheme (CGHS), and 9% from the Employees' State Insurance Scheme (ESIS). Only 12% each of women and men aged 15-49 years in Uttarakhand are covered by any health scheme or health insurance. Health scheme or health insurance coverage is higher among women and men with 12 or more years of schooling than among those with less schooling or no schooling.

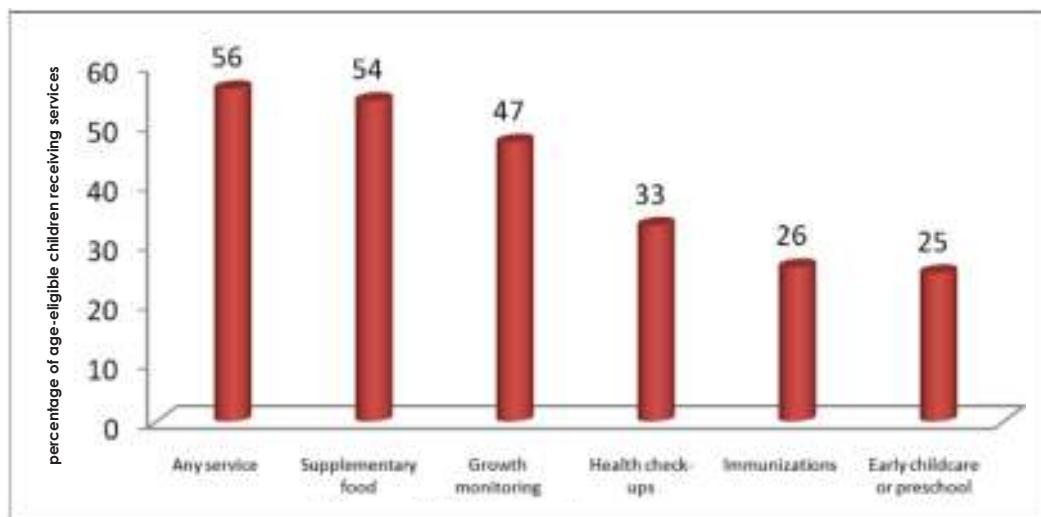


#### i) Integrated Child Development Services (ICDS)

The ICDS programme provides nutrition and health services for children under the age of 6 years and pregnant or breast feeding women, as well as preschool activities for children age 3-5 years. These services are provided through community-based anganwadi centres. 56% of children under

6 years receive some kind of services from an anganwadi centre. The most common services that age-eligible children receive are supplementary food (54%), growth monitoring (47%), health check-ups (33%), and immunizations (26%). The service that is least likely to be accessed is early childhood care or preschool (25% of children age 3-6 years) Fig. 9.3.

**Fig 9.3**  
Children receiving anganwadi centre services in Uttarakhand



#### v. Ayurvedic and alternative healthcare system

Ayurveda is a system of medicine with historical roots in the Indian subcontinent globalized and modernized practices derived from ayurvedic traditions are a type of complementary or alternative medicine. Ayurveda developed significantly during vedic period and later some of non-vedic system such as Buddhism and Jainism also developed medical concept and practices that appear in the classical ayurveda texts. According to the report published in "Healthcare in India" upto 80% of people in India use some form of traditional medicine a category which include ayurveda.

In 1970, the Indian medical council Act which aimed to standardise qualification for ayurveda practitioners and provide accredited institution for its study and research was passed by parliament of India. In 1971 the Central Council of Indian Medicine (CCIM) was established under the department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy Ministry of health and family welfare, Govt. of India, to monitor higher education in Ayurveda in India. The Indian Government support research and teaching in ayurveda through many channels at both

the national and state levels and helps institutionalise traditional medicines so that it can be studied in major town and cities. The State Council for Research in Ayurvedic Science is designed to do research work on ayurveda. Many clinics in urban and rural areas are run by professionals from who qualify for these institute.

With the advent of National Rural Health Mission (NRHM), attempts have been made to bring AYUSH into the mainstream of health care services across the country. From the year 2008-2009, the Uttarakhand state has been pursuing the activities for mainstreaming of AYUSH under NRHM. Efforts have been made to strengthen AYUSH health care facilities by co-locating them to CHCs (Community health centres), PHCs (Primary health centres)and Additional PHCs. Appropriate functioning of these units under the mainstreaming component needs to be ensured by various factors, one of them being the availability of adequate infrastructure and logistics. Blood pressure measuring apparatus and stethoscope were found in majority (81%-88%) of the Ayurvedic units. It is suggested that the district and the block-level stakeholders be made well-versed with the vitality of the AYUSH system for smooth functioning of this system under the state at large.

Yoga is a science as well as an art of healthy living physically, mentally, morally and spiritually. The ancient science of yoga which was discovered by the ancient seers centuries ago traces its origin in Uttarakhand. Since then, yoga and meditation in Uttarakhand has been in constant practice. Uttarakhand is home or land of Yoga and Ayurveda. It has many destinations for learning yoga and meditation which helps people live a peaceful and happy life. Parmarth Niketan, Yogpeeth, Divya Yog Mandir (Trust) and other yoga organization have given a fresh impetus to yoga not only in India but throughout the world.

Naturopathy or Nature Cure treatment primarily stresses on the curing of the body in the most natural manner i.e. give the body time to heal on its own. The five main modalities of treatment are air, water, heat, mud and space.

Homeopathy has been practiced in Uttarakhand for more than a century and a half. It is recognised as one of

the national systems of medicine and plays an important role in providing health care to a large number of people. Its strength lies in its holistic approach towards the sick individual through promotion of inner balance at mental, emotional, spiritual and physical level.

Unani system of medicine was originated from Greece. It is a form of traditional medicine practiced in Middle East & south asian countries. In India, Unani system of medicine was introduced by Arabs. An outstanding physician Hakim Ajmal Khan (1868-1927) made indispensable contribution to Unani System in India and initiated systematic research in the field of Unani medicine. Unani System of medicine in fact is the "Science of life" provides practical knowledge about function and structure of human physiology, the cause of disease and the action of herbal drugs. In Uttarakhand, Unani Medical College and Hospital at Haridwar provides the facility of Unani medicine treatment.



# >> Transport



- i) Road development in Uttarakhand
- ii) Vehicular population
- iii) Energy and transport
- iv) Road network: Its environmental implications
- v) Alternative mode of transport: rail, air, ropeway etc.
- vi) Future transport options





For every state, region or country, roads play a vital role in their economy and development. Uttarakhand is mostly a hilly state and therefore maintenance charges of the roads are very high because they often get damaged in harsh weather conditions such as during landslides and flash floods (Fig 10.1). After Independence the process of construction of roads in Uttarakhand was very slow but the 1962 Indo-China war and extreme weather conditions gave a much attention towards boosting to the construction of roads, as the state shares a wide range of border with China. Initially, the Transport Department was constituted in 1945 according to the Motor Vehicles' Act 1939 and headed by Transport Commissioner Uttar Pradesh. Then it was transferred to the Transport Commissioner Uttarakhand, after November 09, 2000. The State Road Transport Corporation (SRTC), which has also been reorganized in Uttarakhand as "Uttarakhand Transport Corporation" is main constituent of the Uttarakhand transport system.

According to the latest update, more than 1000 buses are being plied by "Uttarakhand Transport Corporation" on 35 nationalized routes along with many other non nationalized routes. Approximately 3000 buses are being plied by the private transport operators on non-nationalised routes along with a few inter-state routes of Uttarakhand and Uttar Pradesh. Majority of the roads of Uttarakhand are covered by hilly routes and being plied by the buses of 166 inches wheel base with not more than 50 percent overhang, whereas the buses plying on plain routes have wheel base larger than 166 inches and more seating capacity and up-to 60 percent overhang<sup>1</sup>.



**Fig 10.1**  
Road  
destructions  
are very  
common  
during harsh  
weather  
conditions  
in Uttarakhand.

<sup>1</sup>[kmvn.gov.in/](http://kmvn.gov.in/); [gmvnl.in/](http://gmvnl.in/)

### I Road development in Uttarakhand

Developing the physical infrastructure is very important for the overall development of state. The Government of Uttarakhand has identified physical infrastructure as one of the thrust areas that has potential to generate large scale employment, revenue and promote a favourable business environment. The state has given continuous priority to develop roads in order to improve connectivity. In the last ten years, the length and quality of the roads has improved. Along with the hill road development, drainage and parapet facilities have also been provided, therefore most of the roads have been widened, safe and beautified. All these activities have improved the travel conditions and thus increased tourism activities in the state. However, there is a lot to be done to improve hilly and rural regions.

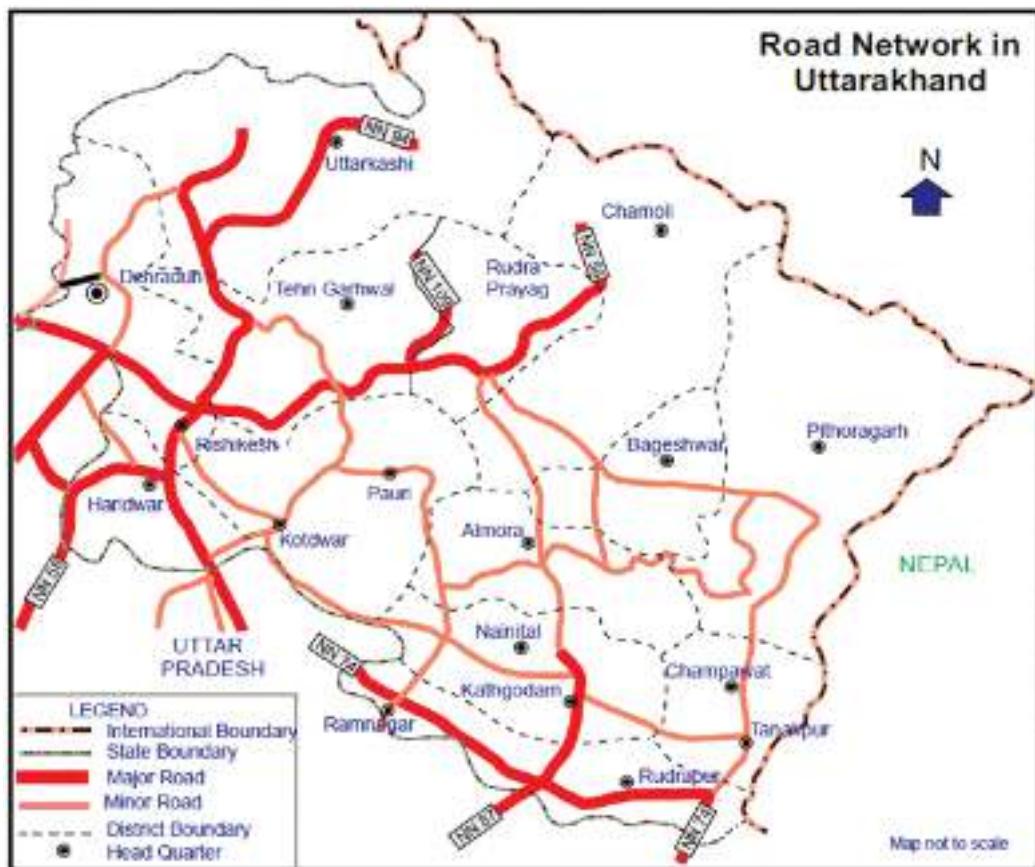
Uttarakhand Transport Corporation (UTC) was incorporated on 31-10-2003 under the provisions of the Road Transport Act, 1950 with the basic objectives of the road transportation sector development, coordination of the road transport services with other modes of transport, and providing an adequate, economical, efficient and coordinated road transport services to the residents of the state. UTC is a public sector passenger road transport corporation with a fleet size of around 1143 buses and operates over 3.50 lakh kilometres catering to the travel needs of over one lakh people every day.

Today, Uttarakhand proudly exhibits 14 National Highways, having a length of about 2108 kilometers. Following is the list of National highways of Uttarakhand and their route (Fig 10.2).

S. No.	N. H.	Route
1	NH 108	Dharasu-Uttarkashi-Gangotri Dham
2	NH 109	Rudraprayag-Guptkashi-Gauri Kund (near Kedarnath).
3	NH 119	Junction with NH -58 near Meerut and connecting Bijnor - Najibabad - Kotdwar - Pauri and terminating at its junction with NH-58 near Srinagar at Takoli Challannsyun, Uttarakhand.
4	NH 121	Junction with NH -74 near Kashipur connecting Ramnagar - Dhumakot - Thalisain - Tripalisain and terminating at NH 119 near Bubakhal.
5	NH 123	Junction with NH 72 connecting Vikasnagar - Kalsi- Barkot and terminating at junction with NH94 near Barkot band.
6	NH 125	Junction with NH -74 near Sitarganj and connecting Khatima - Tanakpur and terminating at Pithoragarh.
7	NH 58	Ghaziabad- Meerut- Haridwar-Rishikesh-Badrinath - Mana village.
8	NH 72	Ambala- Nahan- Dehradun - Rishikesh.
9	NH 72A	Chhutmalpur-Biharigarh-Dehradun.
10	NH 72B	The highway starting from Paonta at the junction of NH -72 connecting Rajban, Shillai and passing through Minus, Tuini in Uttarakhand and terminating at Hatkoti in Himachal Pradesh.
11	NH 73	Roorkee-Saharanpur-Yamunanagar-Panchkula.
12	NH 74	Haridwar-Nazibabad-Kashipur-Kiccha-Bareilly
13	NH 87	Rampur-Pantnagar-Haldwani-Nainital-Bhowali -Almora - Ranikhet. Dwarahat - Chaukutia-Gairsain-Adbabri and terminating at its junction with NH 58 near Karnaprayag.
14	NH 94	Rishikesh - Ampata - Tehri - Dharasu - Kuthnaur - Yamnotri.



**Fig 10.2**  
Major roads  
in Uttarakhand



Recently, the government of India launched ambitious 'Char Dham Highway Development Project' or 'Chardham Mahamarg Vikas Pariyojna' on 27th Dec 2016<sup>2</sup>. Prime Minister Shri Narendra Modi also cleared that this project is a tribute to those who lost their life during 2013 Kedarnath disaster. The project is a dream project of central govt. that will upgrade and develop the roads of all four 'Dhams' (Gangotri, Yamunotri, Kedarnath and Badrinath). Rs. 12,000-crore dream project will turn 1100 km damaged

highways of Uttarakhand into all weather roads. The project is divided into 7 packages which involves Tanakpur to Pithoragarh highway too. On the other hand more accidents have been observed to be occurred in the year 2016, but the level of deaths is low in year 2017 than that of year 2016. The data can be correlated with the good infrastructure development of roads in Uttarakhand and proper medical facility for timely treatment of injured persons.

**Table 10.1**

Length of  
national  
highways in  
Uttarakhand<sup>3,4</sup>

The length of national highways in Uttarakhand is reported in Table 10.1.

S. No.	Year	Length (in km.)
1	2013	2,042
2	2015	2,042
3.	2017	2,108

<sup>2</sup> Press Information Bureau, GOI, Ministry of Road and Transport

<sup>3</sup> euttaranchal.com

<sup>4</sup> <http://gbpihedenvis.nic.in>; euttaranchal.com

Uttarakhand Rural Roads Development Agency (URRDA) acts for sole purpose of implementation of the Pradhan Mantri Gram Sadak Yojana under the guidance and norms as fixed by the National Rural Roads Development Agency. The Pradhan Mantri Gram Sadak Yojana (PMGSY) in India has essentially a rural-oriented program as 74% of state's population living in villages.

#### **ii. Vehicular population**

More than 1000 buses are being run by Uttarakhand Transport Corporation (UTC). Furthermore, the private transport system operates nearby 3000 buses. The buses are

being plied in nationalized routes, non-nationalized routes and the neighbouring states. For local travelling, auto rickshaws including electrically operating E-rickshaws, manually pedalled rickshaws, tempo, matadors etc. are widely used. In addition, remote towns and villages in the hills are connected to important places by buses and a vast network of private jeeps. The data of registered motor vehicles in Uttarakhand from the year 2010-11 is given in following Fig. 10.3, and Table 10.2. Number of vehicle registration in Uttarakhand is continuously increasing during the preceding years.

**Fig. 10.3**  
Registered  
motor vehicles  
in Uttarakhand<sup>4</sup>



**Table 10.2**  
Registered  
motor vehicles  
per 1000  
population in  
Uttarakhand<sup>4</sup>

Sl. No.	Year	Registered motor vehicles (per 1000 population)	% share
1	2010	85	0.7
2	2011	99	0.7
3	2012	123	0.8
4	2013	143	0.8

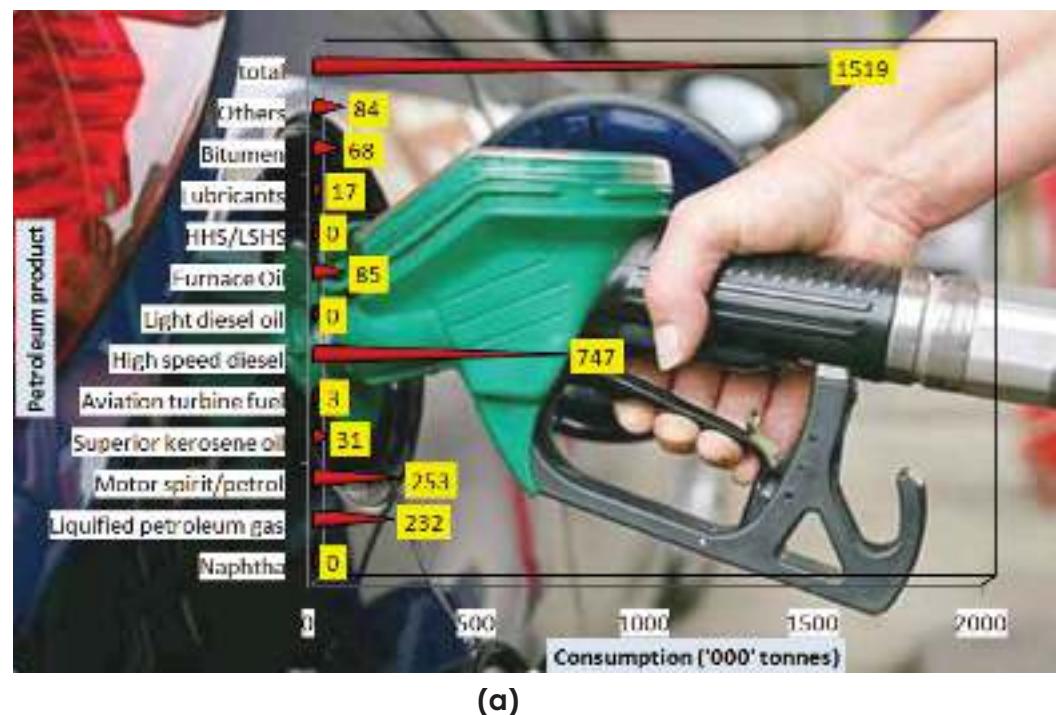
#### **iii. Energy and transport**

Energy being a strategic commodity plays a significant role in transport and infrastructural development of a state. Ever increasing demand of energy has posed tremendous pressure on its limited resources and has necessitated optimum use of resources and renewable

energy production. Energy systems in India have evolved over last six decades along with country's economic development, supporting the aspiration of 1.2 billion people, within the framework of democratic polity, globally integrated economy and environmentally sensitive regime.

The Petroleum Ministry (Govt. of India) has thrown up interesting data about use of diesel and petrol sold across various states. The all India study reported that 70% of diesel and 99.6% petrol is consumed in the transport sector alone. Of the total diesel sale, the highest consumption of 28.48% is by cars, utility vehicles (UVs) and 3-wheelers. It was also revealed that private cars & UVs account for 15.13%, commercial cars &

UVs 10.29% and 3-wheelers 7.36% of the diesel sold in the country. In case of petrol, about 99.6% is consumed in the transport sector. Of this majority consumption of 61.42% is accounted for by Two-Wheelers while cars use 34.33% followed by 3-wheelers at 2.34%. Consumption and per capita sale of major petroleum products during the year 2015-16 in Uttarakhand is given in Fig 10.4 a and b, respectively.



(a)



(b)

**Fig 10.4**  
Consumption  
(a) and per  
capita sale  
(b) of major  
petroleum  
products in  
Uttarakhand



#### iv. Road network: Its environmental implications

Ministry of Road Transport & Highways, GOI is primarily involved in road development all over India. The Ministry is primarily constructing and maintaining National Highways

(NHs) in the Uttarakhand. Connectivity Improvement Program for Char-Dham (Kedarnath, Badrinath, Yamunotri & Gangotri) in Uttarakhand is also specially considered. The details of funds (expenditure up to February, 2016) used for development and maintenance of NHs in Uttarakhand are given below<sup>5</sup>:

State	NH (Rs. in Crore)		Maintenance and Repair (Rs. in Crore)	
	Allocation	Expenditure	Allocation	Expenditure
Uttarakhand	189.24	184.99	82.93	45.34

Uttarakhand exhibits 14 National Highways, having a length of 2108 kilometers. The details of all National highways in Uttarakhand with their route is defined earlier section i. Further detailed data regarding the roads maintained by various functional bodies are described here (Fig 10.5-10.7). The task forces/projects of BRO (Border Roads Organization) in

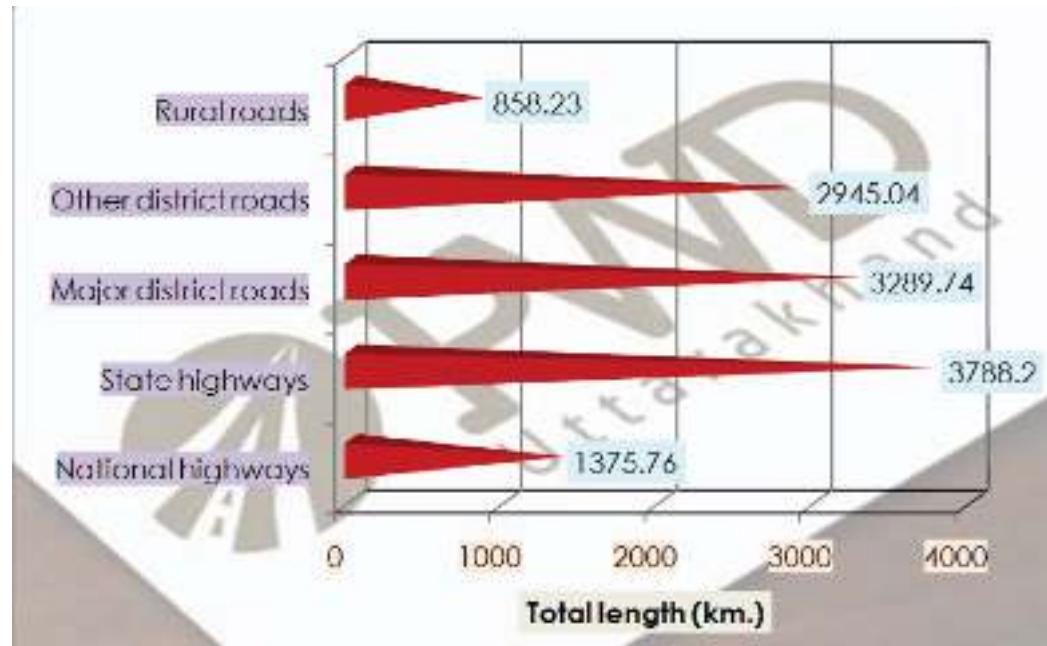
state are Arunank, Beacon, Brahmank, Chetak, Deepak, Dantak, Himank, Hirak, Pushpak, Sampark, Setuk, Sewak, Shivalik, Swastik, Udayak, Vartak, and Vijayak. Therefore, BRO's roads are maintained by Border Roads Task Force (BRTF).

*Total length of the roads maintained by BRTF= 1281.32 Km*



<sup>5</sup> Ministry of Road Transport & Highways, Govt. of India

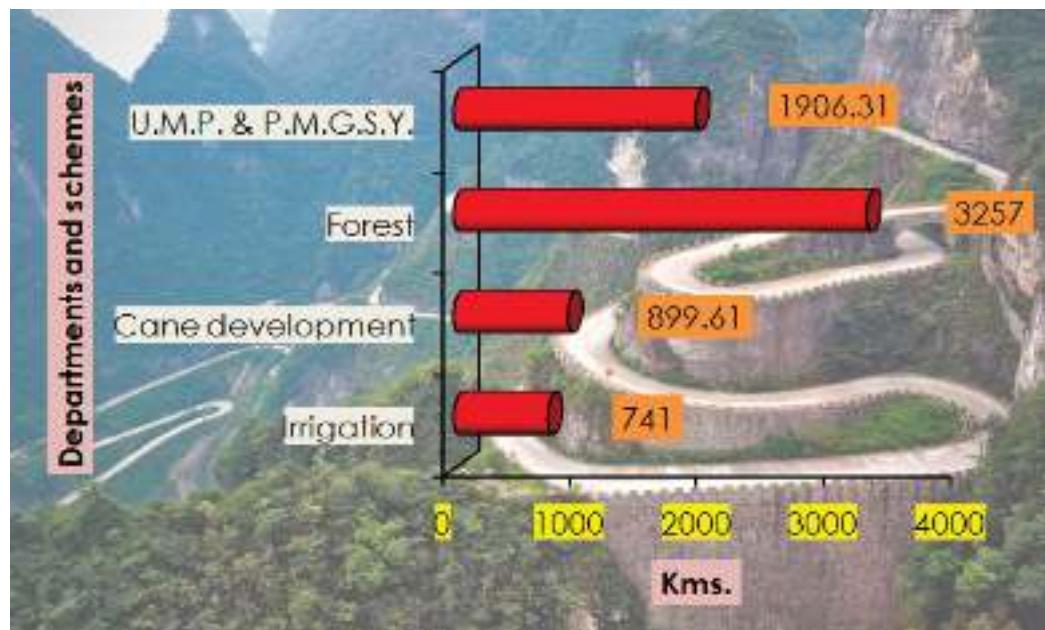
**Fig 10.5**  
Motor road  
lengths  
maintained  
by PWD in  
Uttarakhand



**Fig 10.6**  
Motor road  
lengths  
maintained  
by local  
bodies in  
Uttarakhand



**Fig 10.7**  
Motor road lengths maintained by other departments in Uttarakhand



Road construction also causes various environment related problems. The problems are generated because of damage to hills, trees and water resources etc., during construction. Furthermore, there is no other alternative transport system such as railways, city buses, rickshaws, auto rickshaws in most of the areas of the state. Thus, identification of impacts of natural resource, their screening, and suggesting mitigation measures for road development are very important. Following are some important and notable impacts of road development in Uttarakhand:

#### ❖ Impacts during planning and design phase

There are no significant adverse environmental impacts during the planning and designing for road networks. Although following post-road construction environmental impacts must be considered during design or preconstruction phase:

- i) Loss of land
- ii) Loss of properties

- iii) Loss of livelihood due to acquisition of properties
- iv) Diversion of forest land and tree felling
- v) Off-site environmental impacts associated with the road construction are related to material sourcing from quarries, pollution with hot mix plant and stone crushers.

#### ❖ Impacts during construction phase

Majority of the negative impacts are being observed during the construction phase. Increase in soil erosion at construction site and increase in sedimentation in water stream lead to alteration of surface water hydrology. Furthermore, erosion is expected to intensify due to vegetation removal, soil disturbance and exposure of bare soil surface. Soil erosion is anticipated at bridge and culvert construction sites. Problem will be more pronounced if the construction is taken up in rainy season. Moreover, road construction decreases available water to the local host community because of its requirement for processing, dust suppression, and domestic use of camps.

Further, risks of contamination to both surface and groundwater from untreated camp sewage also impacts availability of water to most beneficial users. Cutting of hill slope and trees, filling, and stone quarrying will disfigure the landscapes. Loss of productive and fertile soil is a serious problem with the road construction both in hilly and plain areas. Most of the roads in Udhampur, Jammu, and Srinagar districts are located in very productive agricultural lands. Moreover, soils of the area are compacted due to the movement of heavy equipment, transport vehicles, and storage of construction materials.

Other major environmental problems are increase in local air/water pollution (due to rock crushing, filling works, and production of asphalt processing chemicals) noise pollution and vibrations from civil works (Fig 10.8). Gaseous emissions like oxides of sulphur ( $\text{SO}_2$ ), oxides of nitrogen ( $\text{NO}_x$ ), carbon monoxide (CO), and hydrocarbon (HC) are emitted from hot mix plants, batching plants and diesel generator sets and causes negative impacts on environment.

**Fig 10.8**  
Air pollution  
to near by  
area due  
to road  
construction



*Exposure to episodes of air pollution causes numerous health problems like pulmonary, cardiac, vascular, and neurological impairments. High-risk groups such as the elderly, infants, pregnant women, and sufferers from chronic heart and lung diseases are more susceptible to air pollution. Children are at greater risk because they are more active outdoors and their lungs are still developing. Exposure to air pollution can cause both acute (short-term) and chronic (long-term) health effects. Acute effects are usually immediate and often reversible when exposure to the pollutant ends. Some acute health effects include eye irritation, headaches, and nausea. Chronic effects are usually not immediate and tend not to be reversible when exposure to the pollutant ends. Some chronic health effects include decreased lung capacity and lung cancer resulting from long-term exposure to toxic air pollutants.*

Tree cutting and encroachment to the forest land is also a major problem. In PMGSY a number of 58 of the 89 roads have sections located inside forestland. The wildlife problems such as human-animal conflicts are also very common problems to emerge after road construction in forest areas.

Noise pollution affects both workers and nearby communities. Impacts of exposure are hearing loss and sleep disruption. Sleep disruption in turn can cause poor concentration and performance, weight changes, and a general decrease in health and overall well being.

#### ❖ Socio-economic impacts

Some socio-economic impacts are also in consideration such as encroachment on historical and cultural areas and occupational health and safety. Employers are required to implement precautions to protect the health and safety of workers. Road construction exposes workers to various physical hazards that may result to minor, disabling, catastrophic, or fatal injuries. Workers close to rotating and

moving equipment like hot mix plant operation, other materials, motorpool repairs/machining etc. are at big risk. Exposure to loud noise can cause temporary or permanent hearing impairment.

#### v. Alternative mode of transport: Rail, Air, Ropeway etc.

Due to the hill area dominancy, other modes of transport such as railways are not much developed in the state. Railway networks are only limited to some parts of Champawat, Nainital and Pauri Garhwal districts. U. S. Nagar, Haridwar, and Dehradun districts are well connected to railways as compared to other districts. Although the air transport sometime looks feasible but weather conditions and costs are major constraints. Almost 90% of the geographical area is dependent only on road transport. However, the state has planned to increase the share of railways in cargo and passenger transport so that railways can be strategically

**Fig 10.9**  
Railways network in Uttarakhand



placed as an alternative to reduce the transportation cost for industrial development including tourism. The state has 345 kms of rail route, out of which 283.76 kms constitute as broad gauge and 61.15 kms as small gauge. Some of the main railway stations are Dehradun, Haridwar, Roorkee, Kotdwar, Kashipur, Rudrapur, Haldwani, Rishikesh, Ramnagar, Tanakpur and Kathgodam. Efforts are planned on to start monorails in the inter-city linkage routes at Dehradun, Haridwar and Rishikesh. The railway network in Uttarakhand is showed in following Fig 10.9.

**Fig 10.10**  
Dehradun  
railway  
station



Kathgodam railway station is also well connected to major cities of Uttarakhand and other states of India. The major cities that are connected by trains are Lucknow, Gorakhpur, Asansol, Jalandhar, Ambala, Moradabad, Bareilly, Haridwar, Amritsar, Chandigarh, Durgapur, Samastipur, Ghaziabad, Delhi, Jaipur, Jodhpur and many other small stations. The Haridwar station also runs the trains to most of the major cities of India. Importance of Haridwar Jn. is much more than others because of its religious recognition to whole world.

Several important trains are scheduled from Dehradun station (Fig 10.10). The station is well connected to all the major cities of India such as Lucknow, Gorakhpur, Delhi, Bareilly, Bhopal, Vijaywada, Saharanpur, Kanpur, Aligarh, Meerut, Varanasi, Gaya, Dhanbad, Ujjain, Gwalior, Haldwani, Jhansi, Gonda, Surat, Rajkot, Dwarka, Ludhiana, Ambala, Ernakulam, Mangalore and many others also.

Currently two operating domestic airports one at Jolly Grant (Dehradun) and another at Pantnagar (Udham Singh Nagar) are well connected with the national capital. To facilitate operations for international flights, up-gradation work is under way at Jolly Grant airport. Additionally, the state government is also maintaining the airstrips located at Naini Saini (Pithoragarh), Guacher (Chamoli) and Chinyalisaur (Uttarkashi).



**1. Aerial Ropeway, Nainital**

Ropeways are popular means of transport at hill stations and ski resorts around the world. The cable cars provide a panoramic view of the valley below as well as the majestic hills and mountains. At ski resorts, these airlifts help in taking skiers to the higher elevation of the ski slope. Ropeways are very popular and highly time saving means of transport at hill stations of Uttarakhand. Following are the best ropeways tourist destinations in Uttarakhand.

**1. Aerial Ropeway Nainital-** Cable car or aerial ropeway in Nainital is a major attraction that used for breathtaking view of Naini lake and complete Nainital hill station. It takes less than 3 minutes to reach in a direction. The ropeway is developed by swiss- technology and considered as one of the safest ropeways in India.



**2. Auli Ropeway, Chamoli**

**2. Auli** – Auli is considered among the best skiing destinations in India and situated at Chamoli district. Asia's longest and one of the world's highest cable car covering a distance of 4 km. It also has a chair lift and ski-lift. The ropeway of Auli connects Auli to Joshimath in a cost around Rs. 500/-

**3. Haridwar Ropeway** - The Haridwar city (meaning the gateway of lord Vishnu) has its religious significance. The holy

river Ganga enters the Indo-Gangetic plains of North India at Haridwar by completing its course of 310 km (from Gomukh). Haridwar is also a popular destination of ropeway travelling activity by connecting the main Haridwar market to Mansa Devi Temple and Chandi Devi Temple at a cost around Rs. 100.



3. View of Auli during winter



4. Ropeway at Haridwar



5. Ropeway at Mussoorie



6. Sahastradhara ropeway, Dehradun

# Vedini Bugyal





### Proposed Funiculaire in Uttarakhand

**4. Mussoorie-** The queen of hills located at a distance of 35 kms from Dehradun and it's a wonderful hill station situated at the foothills of Himalayas in Uttarakhand. The ropeway is situated on Gunhill, the second highest peak of Mussoorie. It gives a bird's eye view of town. The panoramic view of Himalayan ranges can also be viewed from the ropeway. Mussoorie is also known as gateway to Yamunotri and Gangotri.

**5. Sahastradhara Ropeway-** Sahastradhara (meaning thousands of water spring) is a famous tourist place at Dehradun. The major attractions in Sahastradhara are its beautiful waterfalls, sulphur water pools and a number of caves. It also has an ropeway providing an airy ride to the mountain top.

Therefore, the ropeways are other type of very good modes of transports in Uttarakhand that can experienced by

tourists. All the ropeways are providing a very good birds eye view of the beauty of natural places of state. Apart from these the state government is also planning to install more ropeways to Kumaun & Garhwal Himalayas. The Hemkund –Ghaghariya ropeway is planned by the government as the highest ropeway of Asia. At same place Ghaghariya to Gobindghat ropeway is also planned. Various funiculaires (a car moves on hill by a track) from Panchkoti to Baurari, Chopta to Tungnath, Bhimtal to Kharkotak, Purukul Gaon to Hathi Paaw and Massoorie, Van to vedini Bugyal, Goi Barnala to Dayara Bugyal, Snow view to Naini Peak, Ranibagh to Nainital, Ulka Devi to Chandika Devi and Asurchula, etc. are also planned to implement very soon. Government is also planning a ropeway for Kedarnath Yatra because of the negative environmental impacts of helicopters in these holy areas.

#### **vi. Future transport option**

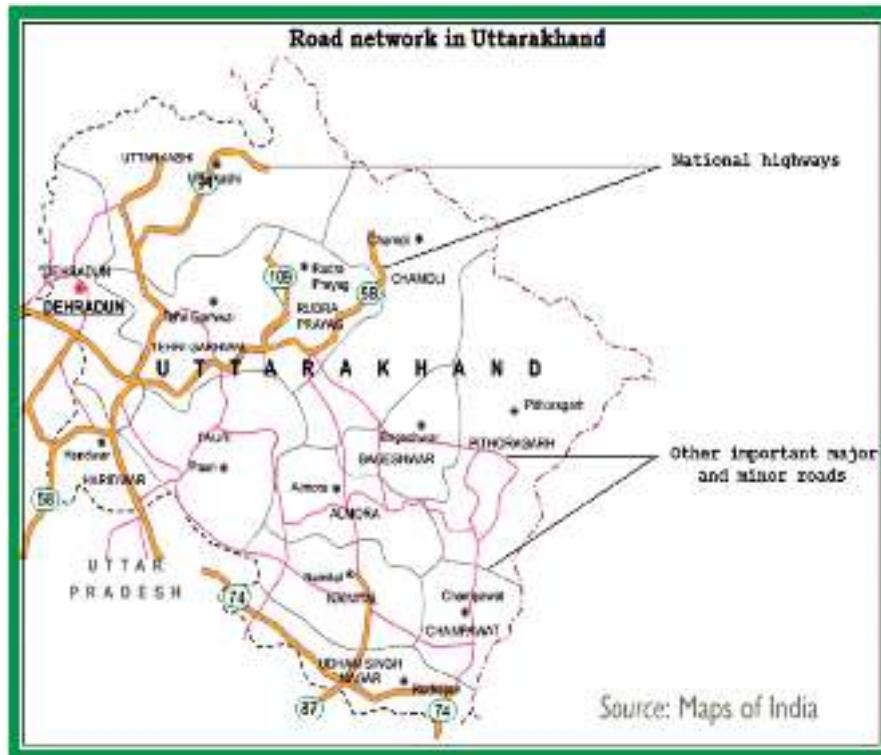
Tourism/ecotourism is one of the most important thrust industry of Uttarakhand for economy up-liftment. Tourism in Uttarakhand is a well growing sectors as both of Kumaun and Garhwal regions are well blessed with the natural beauty. Moreover various important places like Char Dham, Mussoorie, Dehradun, Haridwar, Valley of Flowers, Tehri dam lake etc. in Garhwal region and Jageshwar, Nainital, Patal Bhuvaneshwar, Pindari, Ranikhet, Almora etc. in Kumaun regions increase the tourist attractions towards the state. Increase in tourism can ultimately demand the good and safe transport facilities in the affordable prices. Therefore, continuous upgradation of roads is required as most of the part is connected only by the roads (Fig 10.11).

According to the road network requirement, climate of state, increasing tourism, up-gradation of transport vehicles etc. are also very important tasks. As described earlier, a few railway networks are present in Uttarakhand. Some initiatives have been made to start monorails at Dehradun, Haridwar, and Rishikesh on the inter-city linkage routes. The central government has sanctioned Rs. 9700 Crore for development of five roads covering 570 km under Bharatmala Project in the state. The project will build highways from Gujarat and Rajasthan, move to Punjab and then cover the entire string of Himalayan states - Jammu and Kashmir, Himachal Pradesh, Uttarakhand. The sanctioned projects under Bharatmala in Uttarakhand include 94 km long Baijnath- Tharali- Karanprayag road, 147 km long Askot- Dharchula- Malpa- Lipulekh road, 216 km long Baijnath- Bageshwar- Kapkote- Munsiyari- Joljivi road, 51 km long Mana- Musa Pani- Mana pass road and 63 km long Joshimath- Malari road and Rs. 50,000 crore for making All Weather Roads in Uttarakhand up to 2019.

The two working domestic airports are at Jolly Grant and Pantnagar are only used for air transportation (Fig 10.12). The upgradation work for both of the airports is underway so that they can facilitate the most national and international flights. Airport Authority of India has allocated Rs. 1000 crore and Rs. 370 crores for Pantnagar and Jolly Grant (Dehradun) airports respectively for their expansion and modernization as international airports. Moreover, for future air transport upgradation various existing old helipads such as Haldwani, Nainital, and Almora are now proposed along with Ramnagar to work as heliports; and Dharchula, Pithoragarh, Chinalisaur, and Gauchar are going to be operational airports by the end of 2018. The air transport development in Uttarakhand seems time saving, more reliable and all weather supportive for the hills.

Ropeway development for transport purpose has the great potential in Uttarakhand. Construction of new ropeways seems to be one of the safest and time saving transport method for the hilly areas. More ropeways and funiculaires have been planned by the state government using European technology. Although 8-10 ropeways are currently in work but further long distance ropeways are also in plan. The work of various ropeways and funiculaires will be started soon for Kedarnath, Bhimtal, Mussoorie, Purkul Gaon, Ulka Devi Chandika Devi, Asurchula, Corbett landscapes, some Bugyals and Nainital etc.

**Fig 10.11**  
Road  
network in  
Uttarakhand



**Fig 10.12**  
Domestic  
airports in  
Uttarakhand





# Climate Change and its Impact



- i) Temperature and Rainfall
- ii) Snow and Glaciers
- iii) Biodiversity
- iv) Streams and Rivers
- v) Agriculture
- vi) Health





11

Climate change may refer to a change in average weather conditions of a particular area or region. Climate change is caused by factors such as biotic and abiotic processes, variations in solar radiation received by earth, plate tectonics and volcanic eruptions etc. Certain human activities have been identified as primary causes of ongoing climate change, often referred to as global warming. In 1966, the World Meteorological Organization (WMO) proposed the term "climatic change" to encompass all forms of climatic variability on time-scales longer than 10 years, regardless of cause. When it was realized that human activities had a potential to drastically alter the climate, the term climate change became the dominant term to reflect an anthropogenic cause. Climate change was incorporated in the title of the Inter governmental Panel on Climate Change (IPCC) and the UN Framework Convention on Climate Change (UNFCCC).

Uttarakhand mainly has two different climatic regions, namely, the hilly terrain and the plain area of tarai and bhabar region. The weather conditions within state are also varying depending on the location of particular place. The climate of Himalayan region in general and of Uttarakhand in particular depends on the summer monsoon currents and associated cyclone system, westerly disturbances and local orographic and conventional thunder storms that occur in the afternoon during pre and post monsoons. In Uttarakhand a large variation of relief exist from 200 m in south to more than 7,500 m in the north. It has been observed that for every 1,000 m ascend, there is a decrease in temperature by 6.5°C. The slope and aspect also play an important role in determining the climate, as north facing slopes are much cooler and damp as compared to south-facing slope due to insolation effect.

Summers in the plain region of Uttarakhand have similar climate as other surrounding plain regions of different states i.e. the maximum temperature can cross the 40°C mark and there can be considerable humidity. Warm temperate conditions prevail in the middle Himalayan valleys with the temperature around 25°C making it an idle gateway for people of the plains to beat the heat. However, in the higher areas of middle Himalayas, the temperature is around 15 to 18°C, still pleasant. The summer season extends from April to June.

The climate of Uttarakhand during winters in the plain region can be chilly with temperatures going below 5°C mark. The winters in the middle Himalayan valleys are very cold and in the higher areas, the temperature can drop below the freezing point. The upper Himalayan peaks of Uttarakhand remain snow-capped during the year and many places receive regular snowfall. Throughout the state, the temperature ranges from sub-zero to 15°C during winter and the season lasts from November to February.

The monsoon is the most pleasant season and temperature differs from 15 to 25°C at most places which reign from July to September. The state receives 90% of its annual rainfall in this season.

#### i. Temperature and rainfall

Uttarakhand is climatologically very sensitive and ecologically fragile. During recent years the state has recorded a significant increase in climatological disasters and for that the humanogenic enhancement of regional atmospheric entropy is being seen as the cause.



The analysis mainly based on the district temperature and rainfall series of 102 years obtained from India Meteorological Department, reveals that the state has recorded a significant increase in temperature while the volume of rainfall it receives annually, has declined during the course of the last century. The monthly changes show that the state is losing its seasonal contrast, and while winter months are becoming warmer, monsoon months are losing their heat and also the quantum of rainfall.

Uttarakhand is considered to be highly sensitive for climate related changes due to its varying topography and rich glacier mass. Intensifying human activities like deforestation, urbanisation, mining etc, may affect the regional climo-balance adversely and, thus, may change the pace and fate of the ongoing geomorphic processes.

The state of Uttarakhand, which has witnessed a notable increase in climatological disasters during recent years, highlights the need of a precise estimation of changes that are taking place in climate.

A study analyses of past 102 years (1911-2012) temperature and rainfall data of Uttarakhand obtained from IMD, Pune and India water portal. The changes at annual and monthly scales were identified by regression analysis. The anomalies were computed from an averaged values of a 30 years' reference period (1961-1990). The two major considerations for favouring this base periodic: the observational climate data coverage and availability are

better for this period as compared to earlier ones; and, the years after 1990 are likely to have larger anthropogenic trends embedded in the climate data owing to the intensified human activities following the 1990s economic reforms.

#### **Temperature Changes**

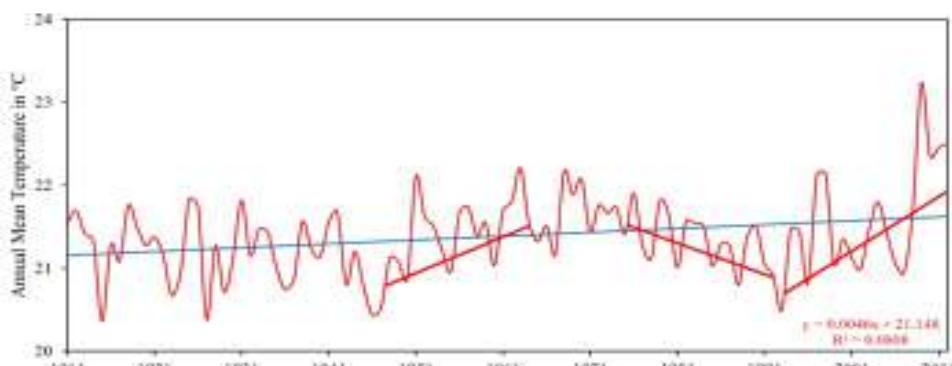
Temperature is the key factor that determines climatic properties of a place. The distribution of temperature condition over Uttarakhand varies greatly from -1.7°C at Mukteswar to 42°C at Pantnagar. This large variation conveys state's sensitivity for climate change. Fig. 11.1 demonstrates temperature variability over Uttarakhand during last century. In all the course of temperature profile, a 4-5 year normal cycle is quite evident, however, as far as trend is concerned, no significant change was recorded till 1950. However, after this, the temperature started rising, but 1970 onwards it started declining. Nevertheless, the rising trend resumed after 1990 and is continued till present. Amid these fluctuating phases, the state, however, registered 0.46°C increase in mean annual temperature during the last century.

Table 11.1 shows the changes in temperature at district level. Evidently all the 13 districts of the state have recorded a notable increase in temperature. Fig 11.1 and 11.2 showing the spatial distribution of warming over the state clearly demonstrates that the hill regions are warming more prominently than the plains like Haridwar which is entirely a plain district, is at the lowest rung in the warming table.

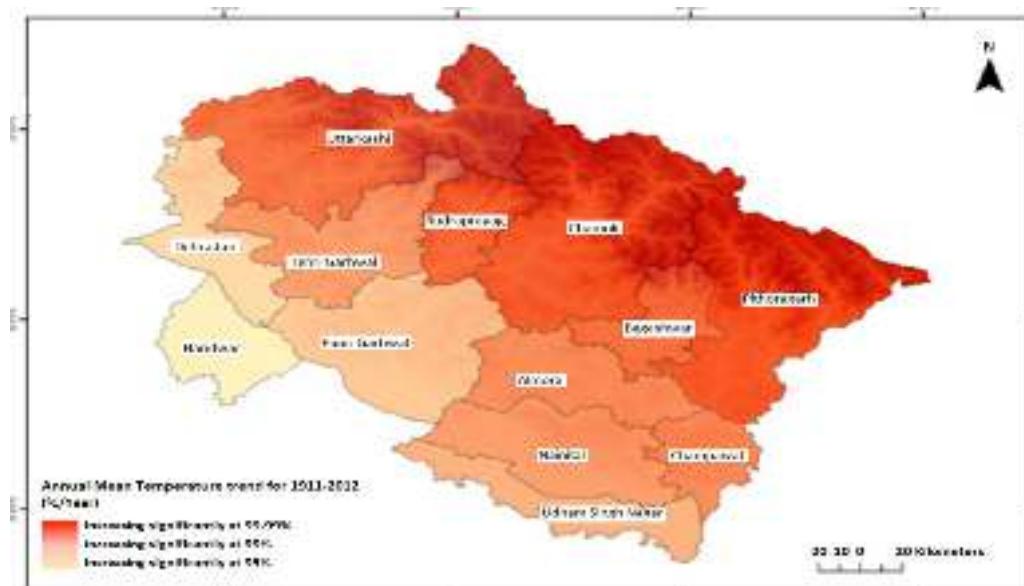
**Table 11.1**  
Annual mean  
temperature  
changes  
in Uttarakhand<sup>1</sup>.

Districts Where Temperature is Increasing Significantly at 99%	Annual Mean Temperature Trend in °C/100 Years	Districts Where Temperature is Increasing Significantly at 95%	Annual Mean Temperature Trend in °C/100 Years
Pithoragarh	0.58	Garhwal	0.41
Chamoli	0.54	Dehradun	0.37
Rudraprayag	0.53	Haridwar	0.34
Bageshwar	0.52		
Uttarkashi	0.51		
Champawat	0.49		
Almora	0.46		
Nainital	0.44		
Tehri Garhwal	0.43		
Udham Singh Nagar	0.42		

**Fig 11.1**  
Annual mean  
temperature  
trend of Uttarakhand  
(1911-2012)<sup>1</sup>.



**Fig 11.2**  
Annual mean  
temperature  
changes<sup>1</sup>.



### Rainfall Changes

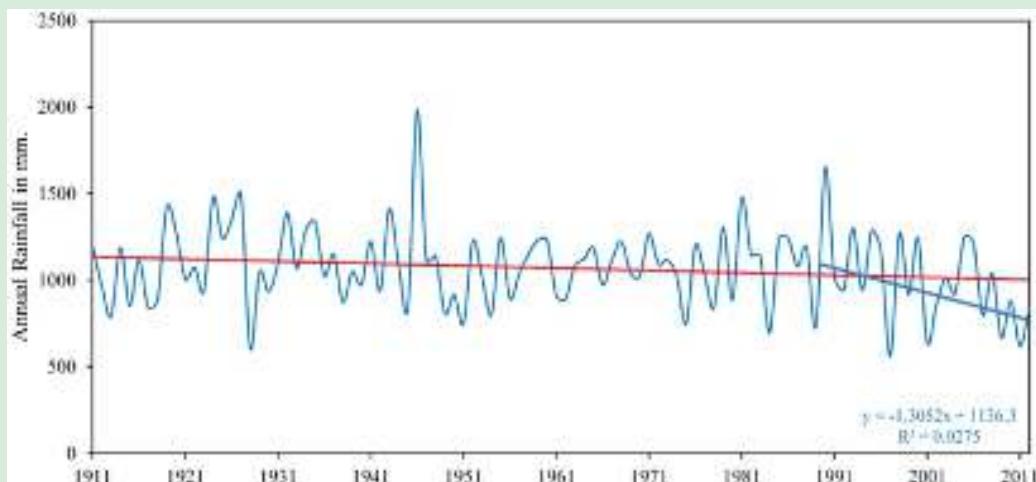
Rainfall is the most critical element of climate that determines the nature of life at a place Fig11.3 shows the pattern of rainfall in Uttarakhand during 1911-2012. The fluctuation in quantum of rainfall is quite evident, however, the slope of trend line suggests a declining trend that has become more prominent after 1990, and on an average the state has recorded a rainfall deficit of 13.05 cm, (insignificant although) in last 100 years. The changes in annual rainfall at

the district level during last century have been shown in Table11.2. It is noteworthy that besides Haridwar, which has witnessed a slight increase, all the districts are in rainfall deficit, Fig 11.4 shows the spatial distribution of these changes. It is quite revealing that the hill regions of the state are becoming drier while the rainfall is declining from south to north and from west to east. The monthly changes in the rainfall has been summarised in Table11.3. It is noteworthy that except the months of March, May and November, other months are rainfall deficient Fig11.5.

District Witnessing Increasing Rainfall	Trend of Annual Rainfall in cm./ 100 Years	District Witnessing Decreasing Rainfall	Trend of Annual Rainfall in cm./ 100Years	District Where Rainfall is Decreasing Significantly at 95%	Trend of Annual Rainfall in cm./ 100Years
Haridwar	1.37	Chamoli	15.30	Champawat	24.22
		Udham Singh Nagar	12.97	Pithoragarh	21.16
		Rudraprayag	12.48	Bageshwar	20.67
		Garhwal	9.25	Almora	19.01
		Tehri Garhwal	8.53	Nainital	17.60
		Uttarkashi	7.56		
		Dehradun	2.31		

**Table 11.2**  
Changes in annual rainfall<sup>1</sup>.

**Fig11.3**  
Annual rainfall trend of Uttarakhand<sup>1</sup>.

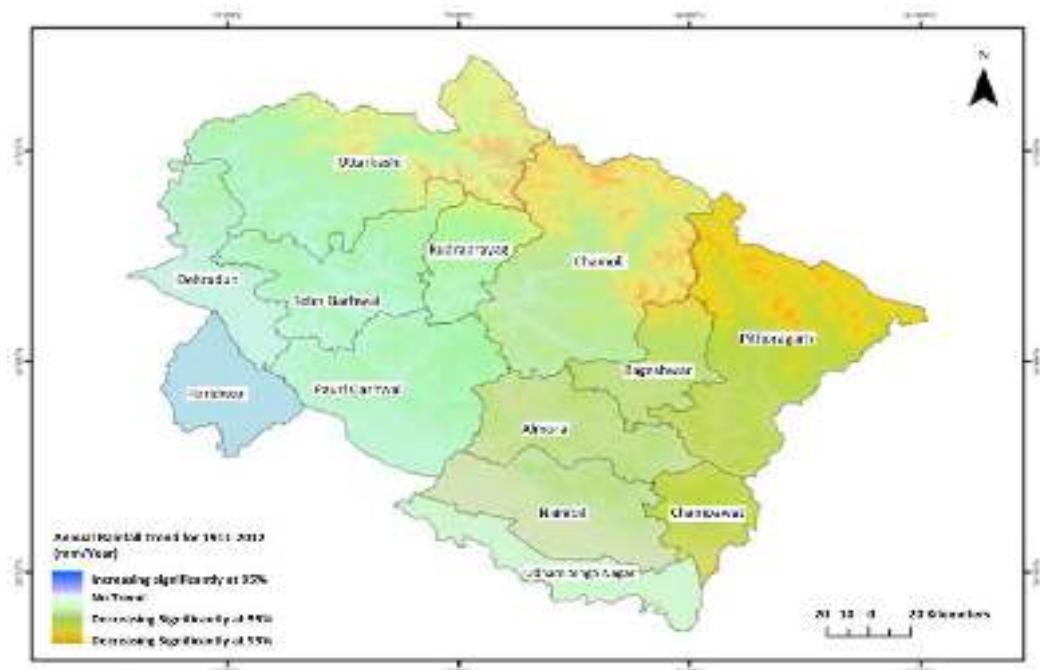


**Table 11.3**  
Monthly rainfall changes (cm/100 Year)<sup>1</sup>.

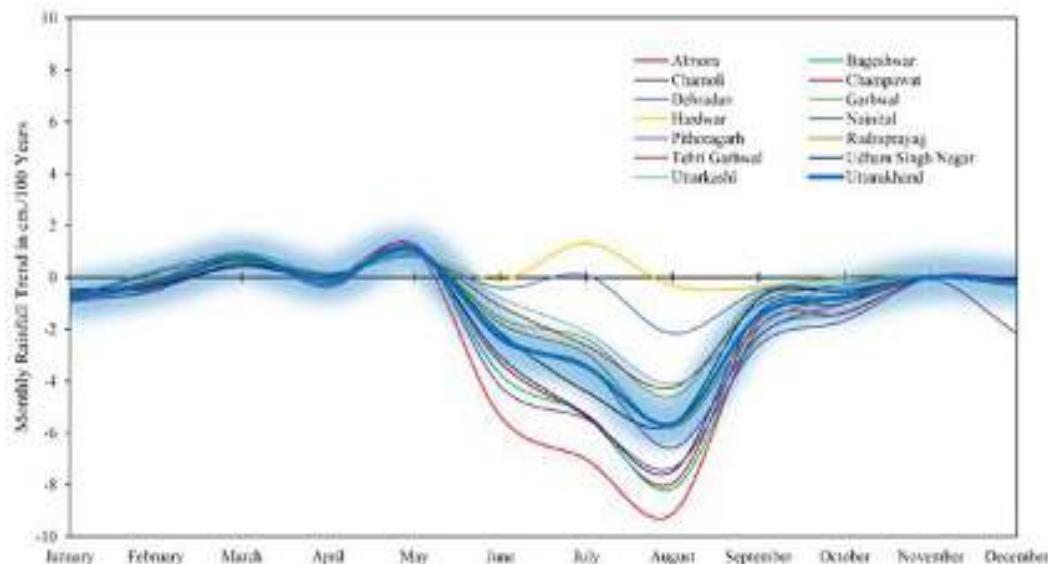
District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Almora	-0.85	-0.31	0.66	-0.10	1.10	-3.29	-5.39	-7.95	-1.68	-1.00	-0.02	-0.19
Bageshwar	-0.95	-0.44	0.82	-0.23	1.28	-3.75	-5.31	-8.16*	-2.33	-1.36	-0.03	-0.21
Chamoli	-0.88	-0.30	0.91	-0.27	1.17	-2.43	-3.40	-6.58	-2.27	-1.00	-0.04	-2.17
Champawat	-0.52	-0.42	0.53	-0.06	1.11	-5.36	-7.03	-9.12*	-1.96	-1.39	0.03	-0.04
Dehradun	-0.80	0.19	0.71	0.14	0.80	-0.41	0.07	-2.17	-0.55	-0.01	0.05	-0.35
Garhwal	-0.75	-0.10	0.62	-0.07	0.98	-1.57	-2.38	-4.61	-0.71	-0.44	0.00	-0.22
Haldwani	-0.57	0.01	0.51	0.08	0.94*	-0.10	1.32	-0.32	-0.39	0.05	0.06	-0.22
Nainital	-0.62	-0.33	0.52	-0.02	1.01	-3.05	-5.30	-7.49	-1.38	-0.83	0.01	-0.11
Pithoragarh	-0.91	-0.52	0.92	-0.40	1.28	-4.20	-5.47	-7.36*	-2.63	-1.67	-0.01	-0.20
Rudraprayag	-0.86	-0.07	0.90	-0.13	1.04	-1.79	-2.96	-5.79	-1.91	-0.73	0.00	-0.19
Tehri Garhwal	-0.85	0.16	0.77	0.09	0.87	-1.11	-2.65	-4.25	-1.06	-0.28	0.03	-0.25
Udham Singh Nagar	-0.49	-0.30	0.42	0.02	1.03*	-2.13	-4.41	-5.66	-0.84	-0.55	0.03	-0.08
Uttarkashi	-0.78	0.29	0.96	0.18	0.86	-0.80	-2.13	-4.12	-1.61	-0.26	0.04	-0.20
Uttarakhand	-0.76	-0.17	0.71	-0.06	1.04	-2.31	-3.46	-5.66	-1.49	-0.73	0.01	-0.19

\*Trend is significant at 95% confidence level

**Fig 11.4**  
Annual rainfall changes in Uttarakhand<sup>1</sup>.



**Fig11.5**  
District wise monthly rainfall changes in Uttarakhand.<sup>1</sup>



The analysis reveals that the state of Uttarakhand is experiencing a significant warming and the temperature in hilly areas is rising more prominently than the plains.

The month wise temperature trend analysis, show that the state is losing its seasonal contrast as winters are becoming warmer and the rainy season is missing its heat. The decrease in rainfall and especially during rainy months- June-September, indicate that climate of the state is changing notably. Although, the pangs of climatic change may not be visible at this stage, but the scenario, that is emerging, warns that these changes may alter the regional energy balance and, thus, may change the pace of ongoing geomorphologic processes. Undoubtedly this will impact the physical, social as well as cultural settings of the state.

Himalayan vulnerability is of striking importance in the context of Uttarakhand due to highly vulnerable zone and the actual nature of the climate change effect has

been spelt out. This consists of effects due to a higher rate of melting of glaciers and increased variability and irregularity of the monsoon. It means that there will be more frequent incidences of very high and concentrated rainfall in some years, and low rainfall in others. The high rainfall will of course cause flash flood and landslides, as experienced in Uttarakhand in 2013.

## ii. Snow and glaciers

Snow is a form of ice crystals that precipitate from the atmosphere (from clouds) and undergo changes on the Earth's surface. It pertains to frozen crystalline water throughout its life cycle, starting under suitable conditions, the ice crystals form in the atmosphere, increase to millimeter size, precipitate and accumulate on surfaces, then metamorphose in place, and ultimately melt, slide or sublimate away. Snowstorms organize and develop by feeding on sources of atmospheric moisture and cold air.

<sup>1</sup>Mishra. A. 2017. Changing temperature and rainfall patterns of Uttarakhand. Int J Environ Sci Nat Res 7(4), p 1-5.

Snowflakes nucleate around particles in the atmosphere by attracting supercooled water droplets, which freeze in hexagonal-shaped crystals. Snowflakes take on a variety of shapes, basic among these are platelets, needles, columns and rime. As snow accumulates into a snowpack, it may blow into drifts. Over time, accumulated snow metamorphoses, by sintering, sublimation and freeze-thaw. Snow cover is a highly sensitive factor for climate change impact. Uttarakhand Himalaya consisting one of the most important snow cover and glacier regimes stretches for about 325 km between Kali Ganga in east and Yamuna

Valley in the west. There are 968 glaciers found in sub-basin of Ganga, 52 in Yamuna basin with 12.2 Km<sup>3</sup> ice volume, 238 in Bhagirathi, 407 glaciers with 90.75 km<sup>3</sup> ice in Alaknanda and 271 glaciers in the Kaliganga basin with 43.77 km<sup>3</sup>ice.

Due to climate change with an increase in annual temperature the process of advancement and recession of glaciers has been observed.

There are some images of the Himalayan glacier in Uttarakhand which clearly indicate the recession of glacier due to climate change.



(a) Snout retreat of Gangotri Glacier (1965-2006)<sup>2</sup>



(b) Change in Snout of Gangotri glacier<sup>2</sup>

<sup>2</sup>[www.cdn.cseindia.org/userfiles/D.P.Dobhal.pdf](http://www.cdn.cseindia.org/userfiles/D.P.Dobhal.pdf)

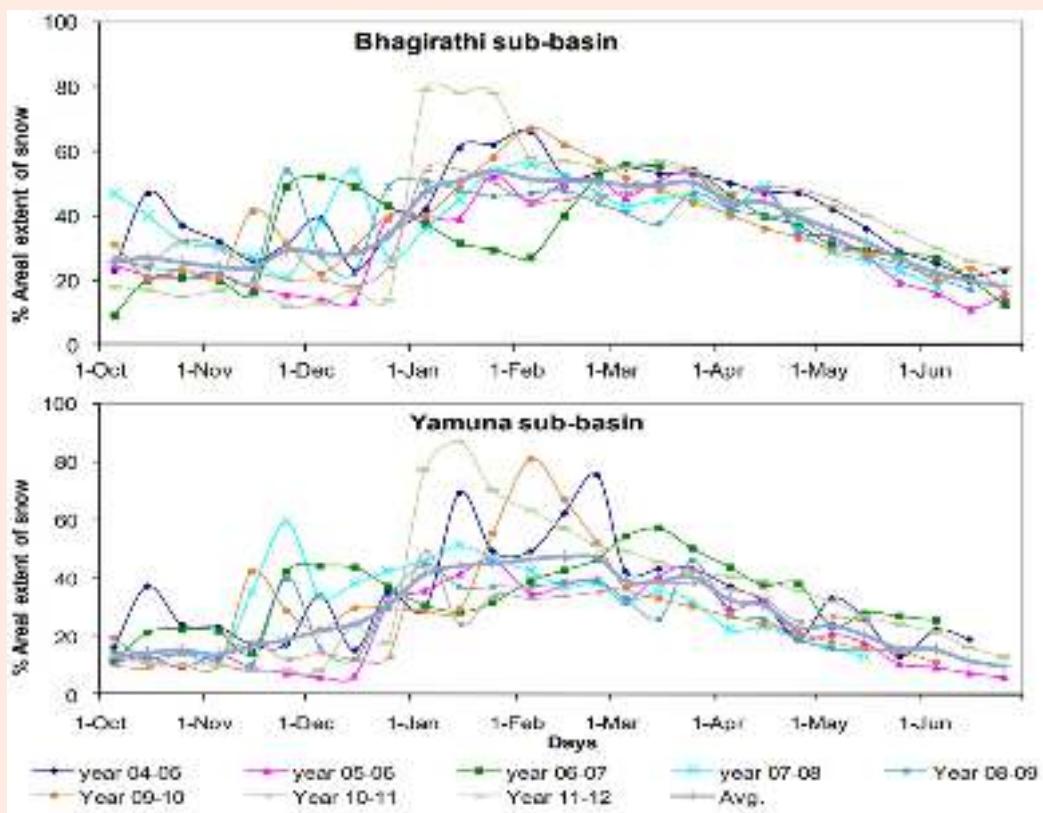


(c) Change in Chaurabari Glaciers in Uttarakhand

In Bhagirathi Basin, there is consistency in accumulation pattern. The snow cover varies between 20% to 80% during accumulation period is quite uneven indicating precipitation and heavy melting. The maximum melting of snow cover indicates a gradual rise in temperature. In the Yamuna, sub-basin snow cover varies

from about 10% to maximum 90% during October to June. The decline in snow cover has steep slopes indicating depleting snow cover. The peak of maximum snow cover is sharper in Yamuna sub-basin than in Bhagirathi basin (Fig11.6).

**Fig 11.6**  
Accumulation and ablation pattern of snow cover for Bhagirathi sub-basin (Ganga basin) and Yamuna sub basin between 2004 and 2012<sup>3</sup>



<sup>3</sup>[www.vedas.sac.gov.in](http://www.vedas.sac.gov.in).

### **Development of pro-glacier lake**

Due to the impact of global warming, the melting of glaciers is taking place at the much higher rate, which is causing origin of proglacial lakes.

#### **Pro-Glacial unnamed lake in Dhauli Ganga Valley**

At the mouth of the terminal moraine of the Kamet glacier in Pithoragarh district a proglacial lake ( $30^{\circ}54'4''$  latitude and  $79^{\circ}45'21''E$  longitude) has been developed in the north of village Niti and due to warming, the size of this lake is increasing.

Similarly, a proglacial lake has developed in Bhagirathi watershed ( $31^{\circ}16'12''$  latitude and  $78^{\circ}56'22''E$  longitude) at an elevation of 4700 m. In 1990 there was no lake at this place but in October 1999 the aerial extent of this lake was about  $0.025 \text{ km}^2$  which increased to  $0.031 \text{ km}^2$  after 11 years in October 2010.

Another impact of global warming was felt in the form of melting of Gourikund which is situated on the eastern side of the Kailash peak. It was a small beautiful oval-shaped lake covered with ice almost all the year but in, 1948 it completely melted away.



**Ice melted form of Gauri Kund**

### **iii. Biodiversity**

Due to climate change the habitat of many species is moving towards pole from their current locations and vegetation development, regeneration are getting affected. Alpine ecosystems are particularly vulnerable to warming as species occurring near the mountain top has no space for their upward movements. Some species are dependent on monsoon rain for regeneration like Sal, Oak, Telonj oak. Due to fluctuation in monsoon period and changes in temperature their regeneration and flowering time is getting affected. Lichens are the species which shows

the shifting of vegetation line very fastly in Uttarakhand.

#### **Upward shifting of vegetation species**

The xerophytic plant *Euphorbia royleana* is gradually invading upward specifically in the tectonic valley of Kakarighat valley in district Almora. Due to increase in temperature the aridity of the place rises which causes shifting in vegetation.



***Euphorbia royleana***

The palm tree a native flora is gradually invading towards higher altitude and has started developing colonies specifically on steep fault scarps constituted of highly deformed rocks having very thin and biologically poor soils. Such growing palm colonies are particularly discernible in the southern part of district Nainital.

Upward invasion of such colonies of the palm tree is a sharp signature of aridity and beginning of the process of desertification in the region being accelerated by the climate change.

Lichens are also gradually shifting towards higher elevation due to the warming in the Chopta-Tunganath landscape, which comes under Kedarnath wildlife sanctuary protected area.

Shifting in vegetation is a universal phenomenon in the Alpine Zones. Annual observations represent that Alpine Ermanni Birch has moved towards the tundra ecosystem over the last twenty years.

Rainfall and temperature are responsible for phenological events of many species particularly the dominant Oak which is very sensitive to climate change. Early ripening of Kafal with a change in their taste and early flowering of Rhododendron species are the result of a change in climate. To maintain the variation in phenological events of many species the phenological calendar should be developed especially for evergreen species like, Oak, Rhododendron and some important shrubs.

#### **iv. Streams and rivers**

Uttarakhand Himalaya is one of the most sensitive zones of the world with respect to climate change and water stress. Anthropogenic activities, advancement of technology and climate changes have disturbed the hydrological cycle in Uttarakhand. This imbalanced hydrological cycle causes an adverse impact on water availability in streams and river.

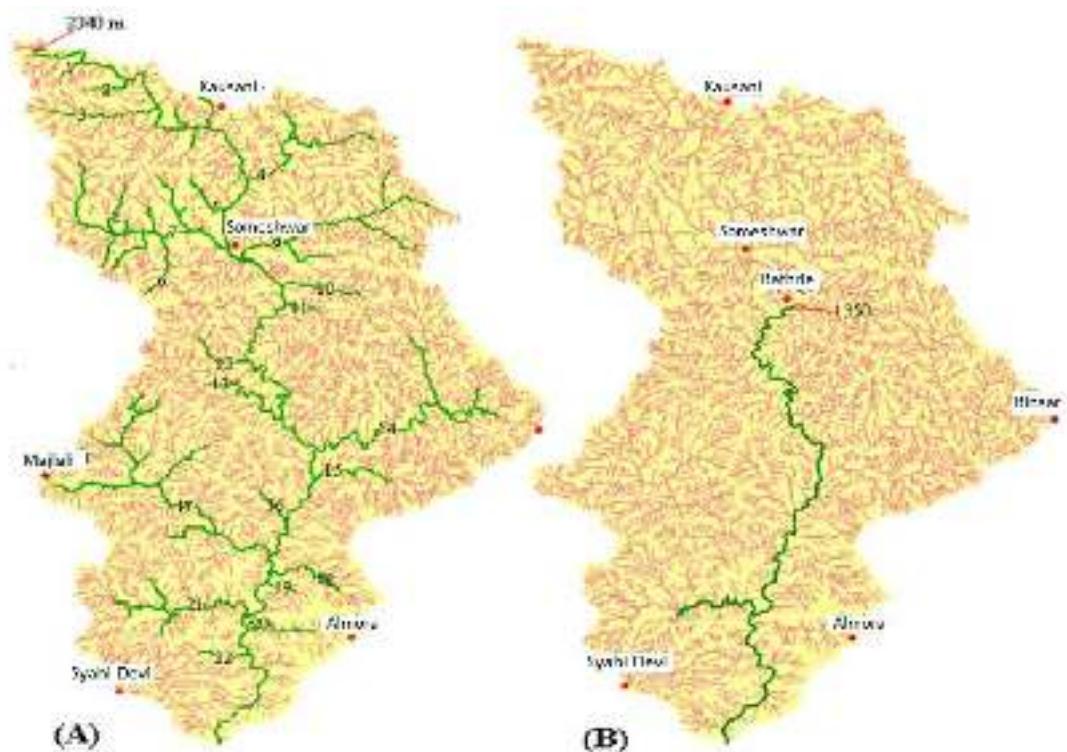
It has been observed that despite melting of glaciers due to global warming, the discharge of the snow-fed river is decreasing continuously. There are 3 reasons behind the decrement of discharge of rivers: i) Reduction in snow cover in the catchment areas of snow-fed rivers during last 3 to 4 decades and some snowfall glaciers completely disappeared which used to contribute water to the main river, ii) Decreasing length of the time the snow remains on the mountain, iii) Glacial fed river system network have thousands of tributary streams which are groundwater fed and the groundwater storage has drastically reduced due to change in rainfall behaviour. Due to above-mentioned reasons, the flow of water into the major glacial fed rivers during the dry session has declined. The reduction in summer water discharge in glacial-fed rivers is a warning for the production of hydroelectricity and for irrigation facility for crops in hills as well as plains areas.

Due to the climate changes the groundwater table has been affected. Groundwater storage is a renewable resource, which is recharged annually by the hydrological cycle through precipitation. During last 3 decades, a drastic change in rainfall pattern has been observed. The most important change is very rare or absence of snowfall events in the lesser Himalayan region and complete absence of the 'Satzlar' i.e. low-intensity rain of continuous seven days in mid-July when Herela festival is celebrated. This geographic phenomenon was responsible for groundwater restage in hills and parched regions. However, the scenario has changed now and the entire hilly region is characterized by frequent heavy rainfall and cloudburst followed by very high surface runoff resulting in drastic reduction in groundwater recharge. Due to decreasing groundwater Pauri Garhwal and Dehradun are currently facing the shortage of surface water and groundwater availability and high crop water stress in the non-monsoon Rabi season. Bageshwar and Pithoragarh are relatively least vulnerable on the scale of better availability of surface and groundwater recharge.

The process of transformation of perennial stream into non-perennial streams is resulting in reduction of the total length of perennial stream network. Kosi watershed in district Almora reveals that about four decade back the total length of perennial streams in the watershed was about 225.6 Km and at present their length is only 41.5 Km due to the disappearance of perennial streams from the headwater regions. These data indicate that the perennial streams in the

region are drying up at the rate of about 5.43 Km/year in the Kosi watershed in district Almora due to anthropogenically accelerated processes of climate change. The process of diminishing length of perennial streams is relatively faster in the watersheds of non-glacial fed river catchments compared to the glacial fed river catchments because all the perennial streams of this region are groundwater fed (Fig11.7).

**Fig 11.7**  
Kosi watershed in  
district Almora:  
(a) about 40 year  
back  
(b) at present<sup>4</sup>

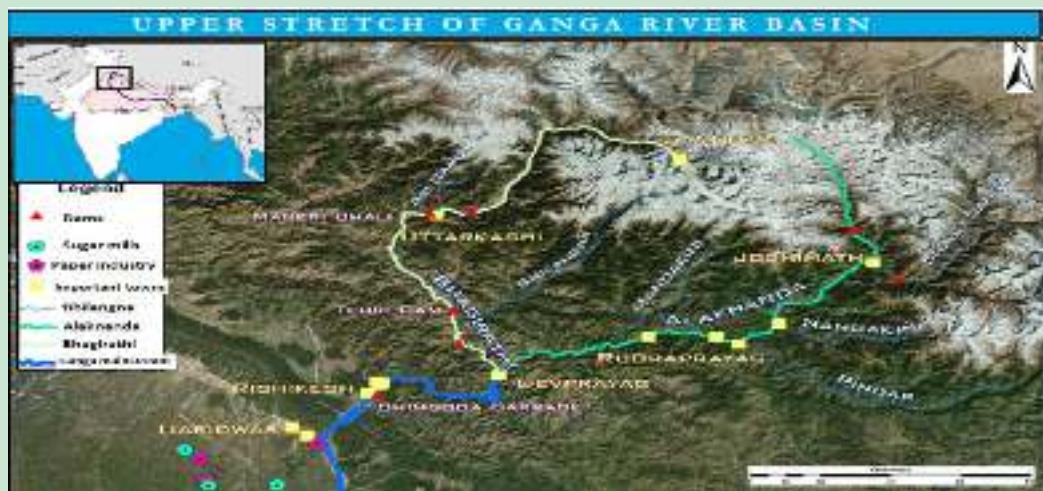


<sup>4</sup>Uttarakhand SoER 2012, UCOST, Dehradun

Gomukh, the Gangotri glacier is a source of the Ganga river -extended as far as Gangotri town, located almost 18 km away. However, uncontrolled development activities including deforestation, rampant construction and unregulated flow of tourists (and the pollution caused by their vehicles) has negatively affected the glacier, which is around 30 Km long and between 0.5 to 2.5 km wide. The glacier is not just receding but this condition also raised worries over the continuing health of the source of the country's most revered river. Gangotri glacier has been constituted with several tributaries. These tributary glaciers melt faster due to increase in temperature and thus, water generated from them flow down and seep into the crevasses of Gangotri glacier. This is resulting in a situation where the glacier is melting from the bottom, the water melting from the

glacier bottom has not increased the water flow emanating from the glacier which shows that the water is evaporating due to temperature increase. Since the tributaries situated on the right side of Gangotri glacier are hitting its right bottom, therefore its right side corner has receded the most. This ultimately means breakage and loss of storage of water.

Scientists have warned that if the situation continues like this, there will be a severe water shortage for the Ganga at its source. The process of Gangotri glacier receding has been ongoing for last 250 years at a gradual pace but has picked up pace in the last few decades. If it continues like this, it will soon lead to a situation when there will be serious scarcity of water. Hence, it is very important to strike a balance with the environment. Following picture shows the upper stretch of Ganga river basin<sup>5</sup>



Deterioration of water quality in source and springs due to heavy rainfall has been reported by many villages in the study including Chamoli, Tehri Garhwal and Kami Guth (Champawat) which is expected to worsen under the extreme precipitation events. Soil erosion is one of the major hazards affected by climate change particularly the

increasing intensity of rainfall resulted in increasing erosion apart from other factors like land quality, temperature change etc. Change in climate has an adverse effect which is being felt in terms of increasing rainfall and soil erosion. In a study future rainfall has been generated downscaling the Global Circulation Model data of Mandakini river basin,

<sup>5</sup>[http://indpaedia.com/ind/index.php/Ganga\(Ganges\).river](http://indpaedia.com/ind/index.php/Ganga(Ganges).river)

a hilly catchment area in the state of Uttarakhand to obtain future impact on soil erosion within the basin. The Universal soil loss equation is a erosion prediction model designed to predict the long-term average annual loss from specific field

slopes in specific land use and management system. The study concluded that the soil erosion will increase in the years to come (Table 11.4).

**Table 11.4**  
Area under different classes of soil erosion<sup>6</sup>.

Sl.No.	Time	Mean rainfall (mm)	Sediment Load (tonnes/year)
1	1980s(1961-2001)	1071.41	586,337
2	2020s(2011-2040)	1549.63	711,328
3	2050s(2041-2070)	1595.21	824,050
4.	2080s(2071-2099)	1977.89	999,746

The climatic projections exhibit that rainfall will increase in future, therefore, rainfall intensity will also increase. This will result in the higher sediment load in the river water. A comparison shows that changes in sediment in the year 2080s is higher than 2020s and 2050s.

#### v. Agriculture

Climate change has adversely affected the agricultural production. Rising temperature, erratic rainfall, delay in monsoon onset, drying up of irrigation water sources

such as streams and rivers are the factors behind the low agricultural production due to climate change.

Delay onset in rainfall is causing the delay in sowing and maturity of crops, which in return have caused significant loss in crop production. The production of various kharif crops in the year 2018-19 based on provisional estimates has been reported to decrease as compared to the year 2015-16 except sugarcane. Change in the climatic conditions might be the possible reason for decrease in production and the crop production data is reported in the Table 11.5.

**Table 11.5**  
Crop production in Uttarakhand<sup>7</sup>.

Crops	Production ('000 tonnes)			
	Year 2015-16	Year 2016-17	Year 2017-18	Year 2018-19
<b>Rice</b>	585.921	572.963	605.606	562.465
<b>Maize</b>	39.370	37.219	44.041	38.447
<b>Tur</b>	3.341	2.668	3.639	2.520
<b>Ground nut</b>	1.504	0.947	1.312	1.219
<b>Soyabean</b>	18.036	13.355	12.173	9.726
<b>Sugarcane</b>	5885.755	5504.562	6303.656	6345.570
<b>Finger millet</b>	150.572	159.606	140.655	109.809
<b>Barnyard millet</b>	68.044	78.477	68.120	63.009

<sup>6</sup><https://link.springer.com/article/10.1007/s13201-016-0419-y>

<sup>7</sup><http://shm.uk.gov.in/agriculture.uk.gov.in/> /directorate of agriculture, Uttarakhand



The production of crops from irrigated land is directly related with the surface and ground water available for irrigation purposes. A large part of the rain inputs runs off from hills and very little amount of rainwater percolates deep into rocks to recharge groundwater storage moreover a very little or no water flow in most of the hill streams during the summer season has also been observed. The irrigation guls and canals remain dry due to lack of water. Hence the irrigation land in hills is being transformed gradually into non-irrigated land and production of crops is drastically reduced year by year.

Shifting temperate horticulture belts is a common phenomenon due to increase in temperature towards high latitude. The apple cultivation belt is observed to shift towards higher altitude. Moreover mango which is cultivated in many warm valleys of Uttarakhand is being threatened due to disturbance in their ripening period.

Delay in snowfall and early snowmelt may encourage people to cultivate crops in alpine meadows both legally and illegally. Sporadic cultivation of potato in alpine meadows can be seen at present.

It is also reported that the peak rainfall time is gradually shifting from July - August to August – September and winter precipitations are extending till February, whereas cloud bursts have become a regular phenomenon in the recent past. The 2013 cloud bursts destroyed 30% of the crops in Uttarakhand. Some changes based on people's perception of climate change are given below:

- 1) Increased warming events in snowfall period, lower periods of snow on the ground.
- 2) A decline in apple yield and upward shift of apple zone due to less snowfall.
- 3) Successful cultivation of cabbage/pea/tomato in higher elevation.
- 4) Shortening of maturity periods of winter crops
- 5) Increased pest infestation
- 6) Less rain during March-May may abandon millets like *Panicum miliaceum* and decline yield of Amaranthus

**Positive and negative effects of climate change on crops**

Positive	Negative
CO <sub>2</sub> fertilization, productivity enhancement of C3 crops- wheat and soya bean marginal enhancement in productivity of C4 crops - millets, maize, sugarcane etc. Suitability of crops to grow in higher altitudes	Increased evapotranspirational losses may severely affect rain-fed agriculture- particularly important when moisture limits productivity. Increased mortality of crops due to pests and diseases, intensified heavy droughts and heavy precipitation may lead to crop damage, frequent climate hazards may lead to loss of agricultural land and development of fear psychology.

Climate change also impacts badly on horticultural crops. Rainfall patterns and increasing solar radiation also impact agriculture by changing the geographical distribution of areas suited to different crops. An upwards altitudinal shift in cropping has been reported in cash crops like apple, rajma, potato and carrot. Some projection speculate or an increase at night time temperature which may not only lead to decrease in production of some crops such as rice but also reduce the winter killing of pest hereby decreasing crop fields high temperature increased humidity and milder winter provide favourable condition for Coleoptera which damage the crops.

#### vi. Health

Changes in temperature patterns disturb many natural ecosystems. Frequent floods and droughts will cause the shortage of food in many developing countries causing several million deaths due to malnutrition and starvation. Weather disasters end up in causing overcrowding in resettlement areas, which are poorly planned with poor

sanitation.

The 5<sup>th</sup> IPCC (Intergovernmental panel for climate change) report has mentioned in year 2014-15 that the impacts of climate change will fall disproportionately upon developing countries and the poor thereby exacerbating inequities in health status and access to adequate food, sanitation, and clean water. World Health Report 2002 estimated that 2.4% of worldwide diarrhea and 6% of malaria in 2000 was because of climate change. Climate change is expected to have major health impacts in India-increasing malnutrition and health related disorders such as child stunting - with the poor likely to be affected most severely. Child stunting is projected to increase by 35% by 2050 compared to a scenario without climate change. Malaria and other vector-borne diseases, along with and diarrheal infections which are a major cause of child mortality, are likely to spread into areas where colder temperatures are prevalent and had previously limited transmission of diseases.

#### Health concerns and vulnerabilities due to climate change

Health Concerns	Vulnerabilities due to climate change
Temperature-related morbidity	<ul style="list-style-type: none"> <li>• Heat and cold -related illness</li> <li>• Cardiovascular illnesses</li> </ul>
Vector-borne diseases	<ul style="list-style-type: none"> <li>• Changed patterns of diseases by region and by climate parameter</li> <li>• Malaria, Filaria, Kala- azar, Japanese Encephalitis, and Dengue caused by bacteria, viruses and other pathogens carried by mosquitoes, ticks, and other vectors.</li> </ul>
Health effects of extreme weather	<ul style="list-style-type: none"> <li>• Diarrhea, Cholera and intoxication caused by biological and chemical contaminants in water.</li> <li>• Injuries and illness</li> <li>• Social and mental health stress due to disasters and displacement</li> </ul>
Health effects due to insecurity in food production	Malnutrition, hunger particularly in children



**Major health effects due to climate change:**

- Extreme weather-related health effects
- Air pollution-related health effects
- Water and food-borne diseases
- Vector-borne diseases
- Effects on food and water shortages
- Psycho-social impacts on displaced populations
- Health impacts from conflicts over access to vital resources



Uttarakhand has complex climate environment. Climate change impacts show the significant increase in respiratory-related diseases and hospitalization. Besides heat stress and respiratory distress from poor air quality in plain areas of the state, changes in temperature, precipitation and humidity effect environment for water-and vector-borne diseases and create conditions for disease outbreaks. Climate-change related exposures are likely to affect the health status of people particularly to those with low adaptive capacity, through increase in malnutrition and consequent disorders with implications for child growth and development, increase in deaths, disease and injury due to floods, storms, fires and droughts, the increased burden of diarrheal diseases, increased frequency of cardio-respiratory diseases due to higher concentrations of green house gases related to climate change and the altered spatial distribution of some of infectious disease vectors.

Climate change is expected to have some mixed effects, such as a decrease or increase in range and transmission potential of different diseases. Studies have shown that climate change is projected to bring some benefits, such as fewer deaths from cold exposure. Overall it is expected that these benefits will be outweighed by the negative health effects of rising temperatures. The balance of positive and negative health impacts will vary from one location to another and will alter over time as temperatures continue to rise. Critically important factor that will directly shape the health of populations such as education care, public health initiatives and infrastructure and economic development. The state often faces severe heat wave that has been a spurt in the cases of fever, diarrhoea and typhoid, especially in children. In Uttarakhand, 244 persons per 100,000 are estimated to have medically treated tuberculosis. 983 women and 763 men per 1,00,000 suffer from asthma.

## vii. Policy and governance

To mitigate the impacts of climate change there is a need of new policies and some effective changes in our existing policies. Some of the vulnerable areas which need urgent intervention is a policy on forest. Uttarakhand state is working on some plan and policies to combat this climate change. Some initiatives are taken by the government are as follows.

### **1. National Forest Policy -**

Ministry of Environment, Forest and Climate Change (MoEF &CC) recently released the draft National Forest Policy 2018. However The previous National policy was launched in 1988. The objectives of newly drafted policy are

- Forest management
- It aims at bringing a minimum of one-third of India's total geographical area under forest or tree cover.
- It seems to address the concern of decline in forest productivity.

The draft has introduced some new concepts such as:

- Economic valuation of ecosystem services
- Forest certification
- National forest ecosystem management information system

### **2. Namami Gange National action plan-**

Ganga action plan phase 1 was started in 1985 with the original cost of 256.26 Crore rupees. However the 2nd phase was started in 1996. In Uttarakhand state government is claiming that all drains flowing into the river with untreated sewage will be stopped and the rivers will be made clean by



2020. A sum of Rs 273 crores has been sanctioned for the 28 STPs (Sewage treatment plant) and so far a meagre amount of Rs. 12 Crores has been spent.

### **3. Uttarakhand Action Plan On Climate Change -**

This plan was launched under National Action Plan on climate change (2008). The objective of this plan to prepare strategy to mitigate climate change impact on environment. The climate response strategy of Uttarakhand has key elements such as accelerating inclusive economic growth, promoting sustainable development, securing and diversifying livelihoods and safeguarding ecosystem services.

Further, the strategy envisaged as it should not be viewed as a standalone action; instead it should be integrated into the regular developmental planning process. Similarly, while it is important to pursue both mitigation and adaptation measures, considering the overall socio-economic and ecological contexts and vulnerabilities, it would be of importance to give priority to adaptation options including disaster risk reduction. In accordance to the sector wise strategies identified for the state over a period of five years (2014-19) has estimated an expenditure of Rs. 8832.62 Crore in the plan. The sectoral breakdown of the expenditure outlay has been given below<sup>8</sup>:

SI. No.	Sector	Rs in Lakhs
1.	Agriculture	7,991.75
2.	Forests and Biodiversity	97,101.65
3.	Animal Husbandry and Livestock	19,274.73
4.	Disaster Management	37,125.00
5.	Human Health	10,400.00
6.	Urban Development	41,465.70
7.	Water Resources	9,825.00
8.	Tourism	4,100.00
9.	Energy	15,838.50
10.	Roads	6,23,000.00
11.	Industries	4,260.00
12.	Transport	12,880.00
	<b>Total</b>	<b>8,83,262.33</b>

<sup>8</sup><https://www.moef.gov.in/sites/default/files/uttarakhand%20SAPCC.pdf>



#### **4. Jawaharlal Nehru National Solar Mission –**

The National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change. The Mission has adopted a 3-

phase approach, spanning the remaining period of the 11<sup>th</sup> Plan and first year of the 12th Plan (up to 2012-13) as Phase 1, the remaining 4 years of the 12<sup>th</sup> Plan (2013-17) as Phase 2 and the 13<sup>th</sup> Plan (2017-22) as Phase 3. The target of this mission is the deployment of 20,000 MW of solar power by 2022 in India. Under this mission government has given approval for development of solar parks in Uttarakhand with the capacity of 50 MW<sup>9</sup>.

<sup>9</sup><https://mnre.gov.in/filemanager/userfile/solarpark.guidlines.pdf>





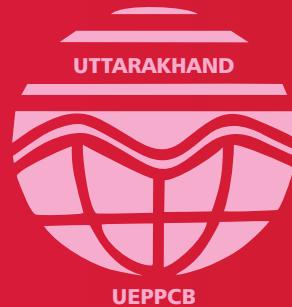
# Disaster



# Disaster



- i. Vulnerability of Uttarakhand
- ii. Disaster scenario and management
- iii. Major disaster: flood; landslides; earthquakes; forest fires; road activities
- iv. Disaster mitigation and response
- v. Disaster management: structure in Uttarakhand
- vi. Policies and legal framework



The whole Himalayan region including Uttarakhand is exposed to a range of natural hazards mainly due to its unique geo-climatic conditions. Environmental degradation due to unplanned development and increasing population pressure are leading to high level of disaster risks. The state faces major threat of a devastating earthquakes, landslides and floods. Despite having experienced major earthquakes in the recent past in Kashmir and Nepal, several segments of the Himalayan belt are identified as possible sources of a much larger earthquake. Furthermore, with the existing scientific techniques and knowledge, the disasters clearly cannot be predicted in space, time and in their magnitude.

While the Himalayan region of Uttarakhand faces a plethora of natural hazards. The region also has its own developmental challenges and inevitably require investment in new infrastructures such as planned roads and dam constructions etc. If developed properly, then these new infrastructures have potential to reduce disaster risk and bring forth sustainability in the socio-economic systems of the state. But sometime potential risks from these infrastructures are not properly understood and not taken into account while developing the new infrastructures. Therefore, it could seem to be hard to manage and might lead to disproportionately high losses in future.

#### i. Vulnerability in Uttarakhand

Uttarakhand by virtue of its geographical setting is vulnerable to minor ecological changes. Hence any activity disapproved by mountain ecosystem triggers a disaster. Disasters are synonymous to damage of property, life and psyche of the people. If disasters cannot be averted, then

reduction of losses of any type caused by disaster becomes a focal point of the policy for disaster management. So far, in the recent years (1990 onwards) Uttarakhand has experienced two major earthquakes (magnitude >6) in Uttarkashi(1991) and Chamoli (1999) and a series of landslides/cloud burst such as Malpa(1998), Okhimath (1998), Fata (2001), Gona (2001), Khet Gaon (2002), Budhakedar(2002), Bhatwari(2002), Uttarkashi (2003), Amparav(2004), Lambagar(2004), Govindghat(2005), Agastyamuni(2005) Ramolsari(2005), Kedarnath (2013) and many more. Therefore, Uttarakhand is a disaster prone state.

Landslides, forest fires, cloudbursts and flash-floods are seasonal in nature and these strikes are prominent at a certain period of the year with high frequency. Earthquake is the most devastating disaster in the mountains of Uttarakhand and is unpredictable. Moreover, in the month of June (2013) very large part of the state has suffered its worst disaster with huge loss of lives and a wide spread destruction. It was the peak time of tourists and pilgrimage season that enhanced the number of the casualties with adverse impact on the immediate rescue and relief operations. At that time the entire state was hit by very heavy rainfall resulting into flash floods and landslides over a wide area.

Main districts that were worst affected are Chamoli and Rudraprayaga in Garhwal region; and Pithoragarh and Bageshwar in Kumaun region. Moreover, a large population in several areas were cut off across the state and suffered due to shortage of essential commodities. The Madakini valley in Rudraprayag district was observed most vulnerable for the cloud bursting and floods. Torrential rain in monsoon



season resulted with the collapse of Chorabari lake (Gandhi Sarover) led to flooding at the Kedarnath along with Rambara, Gauri-Kund, Agastyamuni, Tilwara, and Guptkashi. Other pilgrimage areas like Gongotri, Yamunotri and Badrinath were also severely affected. This disaster also termed as Himalayan Tsunami by media that resulted a wide

loss of lives, damage to infrastructure property and environment and a great economic loss to the state government. The vulnerability of this disaster is too huge that it had affected more than nine million people. The statistics about total damage during flood is given in Table 12.1.

**Table 12.1**  
*Damage during  
Himalayan Tsunami  
in year 2013<sup>1</sup>*

<b>Reported human death</b>	169
<b>Missing (presumed to be dead)</b>	4,021
<b>Affected villages during flood</b>	4,200
<b>Lost livestock</b>	11,091
<b>Completely damaged houses</b>	2,513
<b>Damaged forest roads (km)</b>	1,000
<b>Damaged bridle path (km)</b>	2,500

The Himalayan mountain range covers wide spread geographical area of India from Jammu and Kashmir to some parts of west Bengal. It extends from Hindukush in North West to Myanmar in the South East, covering a distance of about 2400km (Fig 12.1). The Himalaya mountains are the youngest mountain systems in world and due to this most of the rocks are rudimentary, metamorphic and tectonically very active, therefore the whole Himalayan region is highly vulnerable to natural disasters.

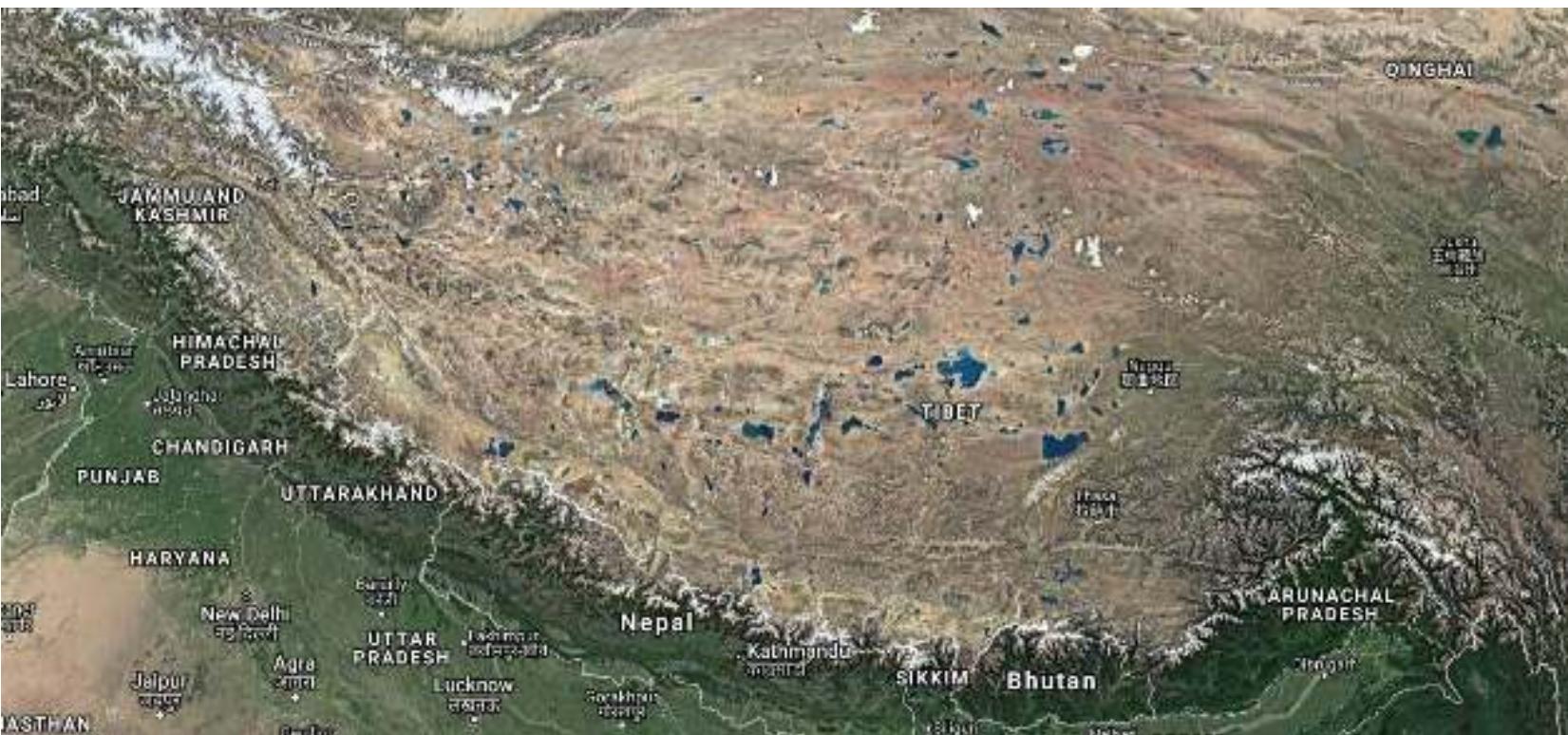
Due to such features, the hill area of the state is highly sensitive towards mass wasting. These areas are the birth places for major rivers of India, therefore, in the foothills, the Tarai and Bhabhar area are highly prone to flooding and water logging. Therefore, natural hazards in Uttarakhand are highly pronounced due to the Himalayan region. The tectonic activities, lithological/structural/ecological settings, topography, and changing landscapes owing Uttarakhand state to be vulnerable to various natural and anthropogenic activities.

#### Features responsible for high vulnerability of Uttarakhand towards disasters

<b>Geomorphic features</b>	<b>Cliffs, rocky, slopes, waterfalls, major and minor ridges, river valleys, highly moderate and low dissected denudational hills, river terraces.</b>
<b>Fluvial geomorphic features</b>	<b>Point bar, meandering scars, natural levees.</b>

<sup>1</sup>Uttarakhand disaster 2103, NIDM, GOI





**Fig 12.1 Geographical location of Himalayan region of India and other neighbouring countries**

### Earthquakes

- ❖ Uttarakhand has two earthquake zones IV and V (Fig. 12.2)
- ❖ Zone V covers the highest risk of earthquakes
- ❖ Zone IV is called the High Damage Risk Zone.
- ❖ Pithoragarh, Chamoli, Bageshwar, and Rudraprayag are in Zone V
- ❖ Uttarkashi, Tehri-Garhwal, Pauri, Almora and Champawat are partially in Zone V and partially in zone IV.
- ❖ Other districts are in Zone IV earthquake risk levels.

\*State's vulnerability to earthquake is characterized by the fact that during the last century, the state has experienced more than 10 earthquakes of magnitude greater than 6.0 on the Richter scale. According to India Meteorology Department, more than 65 earthquakes of varying intensities had been experienced since 1803 in the state and nearby regions.

### Landslides / slope failures, land subsidence

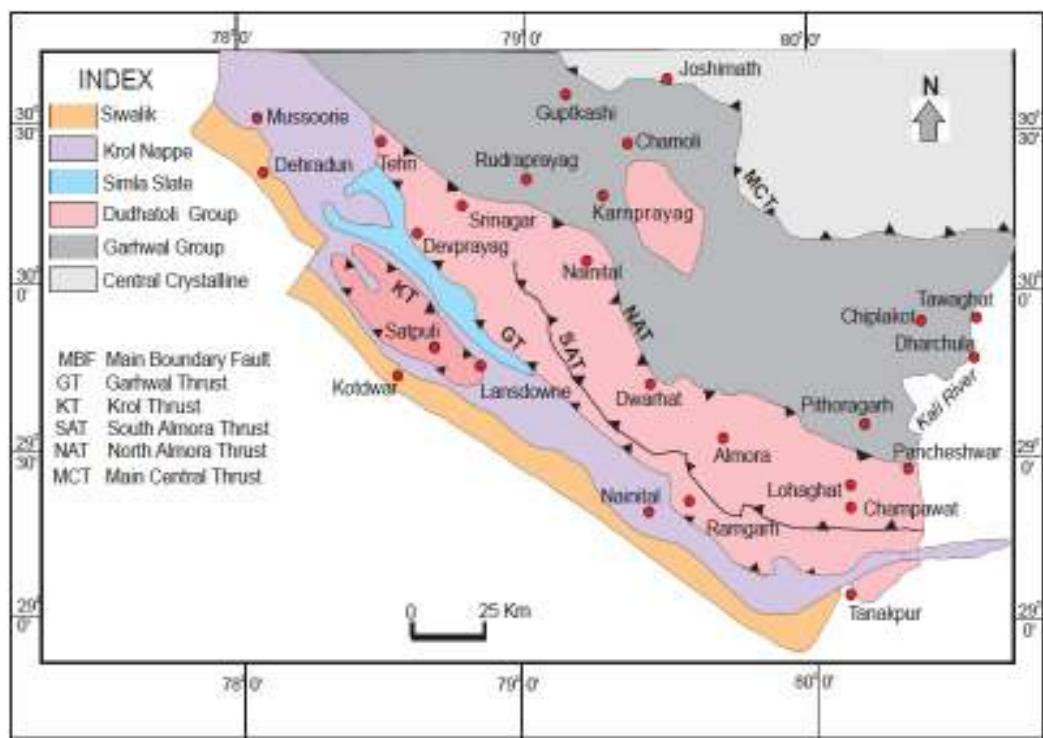
- Loss of human and animal lives, damage to infrastructure (roads, buildings) destruction of agriculture and ecosystems.
- The possibilities can be avoided or reduced by proper implementation of catchment area treatment plan including stabilizing of landslides/ slips prone areas, reservoirs, RIM treatment works, plantations etc.
- These are common along two zones lying in close proximity of two major tectonic discontinuities main boundary thrust (MBT) and main central thrust (MCT) (Fig 12.3 a). Landslide hazard zonation map of the state is given in Fig 12.3 b.
- From the year 1867 to 2016 twenty seven major landslides occurred in various regions of Kumaun and Garhwal.



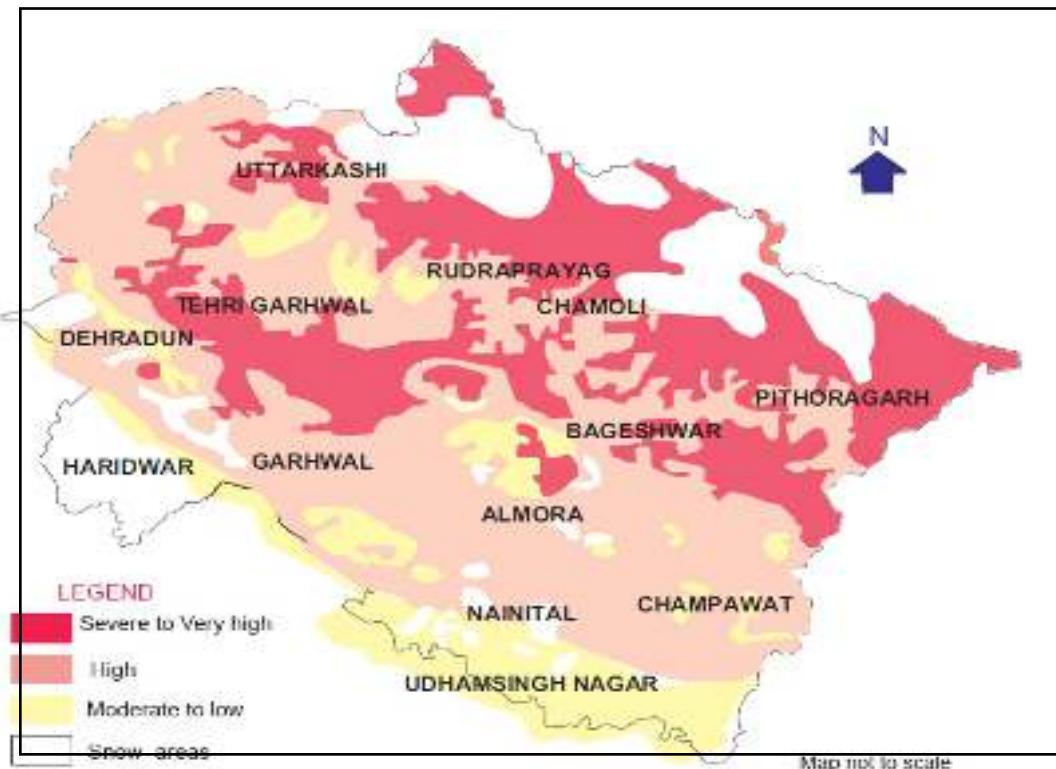
**Fig 12.2**  
Earthquake  
zonation  
map of  
Uttarakhand



**Fig 12.3 (a)**  
Geotectonic map of Kumaun and  
Garhwal Himalaya  
of Uttarakhand



**Fig 12.3 (b)**  
Landslide zones  
of Uttarakhand



Avalanches are also more common in Himalayan region of Uttarakhand at altitude more than 3500 m and slope more than 30 degrees. Hemkund, Badrinath, Kedarnath, Yamunotri and Gangotri are under avalanche prone areas.

In rainy season, the average rainfall of the state is 1229 mm. Months from July to September are high rainfall periods that resulted in soil erosion and destruction of lives and property. Therefore, flash floods are very common in Uttarakhand that combines with rapid snow melting, cloudburst etc. results in destructions.

Besides all above mentioned disasters, the forest fires in summer season are also very prominent disasters in Uttarakhand. The state is badly affected by forest fires almost every year. The direct damage to forest species, loss of soil nutrients and fertility, soil erosion, water resources drying and loss of biodiversity are major results of forest fires. The hills are more prone to forest fires and the fire incidences are usually occurring between the months of April to June.

## **ii. Disaster scenario and management<sup>2</sup>**

With the great mountainous lines of Himalaya, divine river systems, glaciers, forests, valleys, the state is beautified by nature. These all makes a wide range of geomorphic features that are very sensitive to natural disasters. With the previous knowledge, it is cleared that the earthquakes, landslides, and floods are most common disaster events in Uttarakhand. Besides these, avalanches, forest fires and some time soil erosions are also prominent. The part disaster scenario of Uttarakhand is briefly given in following Table 12.2 a-e.

These tables indicate vulnerability of the Uttarakhand state towards various kinds of disaster events. It seems that the state is more prone to earthquakes followed by landslides and floods. Various natural causes are deep rooted within the earth's crust. The natural geological settings of the region makes it more susceptible and prone to

disasters. Various human induced causes such as population growth, tourism pressure, poor socioeconomic conditions, road constructions, deforestation, large dam constructions etc. are also responsible for these natural hazards in Uttarakhand, various management practices such as community based disaster management can be a good practice. Community preparedness, disaster management programme, awareness generation in various places like schools/villages/ communities, capacity building programmes for disaster management, incorporation of trained manpower's in disaster management authorities, collaboration with NGOs, involvement of media to give an early warning system together with during and after the disaster, print media, report publications, use of geographical management information system for emergency management, maintenance of hazard safety cell like PWD and irrigation department, nagar palika/other town agencies etc. The final and most important management practices are medical preparedness in hospitals to give immediate responses after the disasters to save human/animal life. This includes on site and off site emergency plans, disaster trained staff, ambulance services, blood bank availability etc. Various other official staff such as finance officer (for immediate funding during/after disaster) security officers, fire officers, store related officials are also very important.

<sup>2</sup>Uttarakhand disaster 2103, NIDM, GOI



**Table 12.2 (a)**  
Reported  
major earthquakes  
in Uttarakhand

S.No.	Year	Magnitude (at Richter scale)	Affected areas
1.	1803	9.0	Badrinath
2.	1809	9.0	Garhwal
3.	1816	7.0	Gangotri
4.	1869	6.0	Nainital
5.	1916	7.5	Dharchula
6.	1937	8.0	Dehradun
7.	1966	6.3	Kapkot, Dharchula
8.	1968	7.0	Dharchula
9.	1980	6.5	Dharchula
10.	1991	6.6	Uttarkashi
11.	1999	6.8	Chamoli
12.	2006	*a	Indo-China Border
13.	2006	3.8	Bageshwar
14.	2006	3.1	Chamoli
15.	2006	*b	Indo-Nepal Border
16.	2007	3.5	Indo-Nepal Border
17.	2007	*c	Uttarkashi
18.	2008	3.5	Rudraprayag
19.	2008	3.6	Bageshwar
20.	2008	5.1	Indo-Tibet Border
21.	2009	3.7	Whole Uttarakhand
22.	2009	3.3	Uttarkashi
23.	2009	4.5	Chamoli
24.	2009	*d	Whole Uttarakhand
25.	2009	4.7	Uttarkashi
26.	2009	4.3	Bageshwar
27.	2010	3.9	Pithoragarh
28.	2010	4.7	Bageshwar
29.	2010	3.5	Whole Uttarakhand
30.	2010	*e	Almora
31.	2010	4.7	Pithoragarh
32.	2011	*f	Chamoli
33.	2011	3.2	Indo-Nepal Border
34.	2011	3.4	Chamoli & Almora
35.	2011	*g	Uttarkashi
36.	2011	3.8	Indo-China Border
37.	2012	*h	Uttarkashi
38.	2012	*i	Chamoli
39.	2012	3.0	Pithoragarh & Bageshwar
40.	2012	2.8	Bageshwar
41.	2013	2.6	Bageshwar
42.	2013	*j	Uttarkashi
43.	2013	*k	Indo-Nepal Border
44.	2013	4.3	Rudraprayag

\*a: Two earthquakes of 5.2 & 5.0 magnitude  
 \*b: Two earthquakes of 5.0 & 4.1 magnitude  
 \*c: Four earthquakes of 3.2, 5.0, 3.5 & 2.7 magnitude  
 \*d: Two earthquakes of 3.9 & 3.4 magnitude  
 \*e: Two earthquakes of 3.6 & 4.1 magnitude  
 \*f: Three earthquakes of 3.3, 4.6 & 3.2 magnitude  
 \*g: Three earthquakes of 3.1, 3.0 & 3.2 magnitude  
 \*h: Three earthquakes of 5.0, 2.5 & 4.8 magnitude  
 \*i: Three earthquakes of 3.5, 3.7 & 3.5 magnitude  
 \*j: Four earthquakes of 4.3, 3.2, 3.1 & 3.5 magnitude  
 \*k: Two earthquakes of 3.2 & 2.9 magnitude





**Table 12.2 (b)**  
Reported major landslides in Uttarakhand

S.No.	Year	Location
1.	1867-1880	Nainital
2.	1893	Alaknanda
3.	1868	Rishi- Ganga
4.	1970	Patal Ganga
5.	1971	Kanauldia gad
6.	1978	Uttarkashi
7.	1920, 1952, 1963, 1964, 1965, 1968, 1969, 1970, 1971, 1972, 1985	Kaliasaur
8.	1998	Okhimath
9.	1998	Malpa, Kali river
10.	2003	Varunavat Parvat Uttarkashi
11.	2004	Badrinath, Chamoli
12.	2005	Govind Ghat, Chamoli
13.	2007	Baram/ Sialdhar Villages, Dharchula, Pithoragarh
14.	2008	Amru Band
15.	2009	Berinag- Munsiyari road, Pithoragarh
16.	2010	Ganga- Alaknanda Valley
17.	2012	Rudraprayag

**Table 12.2 (c)**  
Reported major avalanches in Uttarakhand

Sl.No.	Year	Location
1.	2008	Gomukh Glacier, Near Gangotri, Uttarkashi
2.	2008	Hemkund Sahib, Chamoli
3.	2008	Kalindi- Badrinath track in Garhwal Himalaya, Chamoli
4.	2010	Ghastoli Chamoli
5.	2013	Kedarkharak, Uttarkashi.

**Table 12.2 (d)**  
Reported major floods and flash floods in Uttarakhand

S.No.	Year	Location
1.	1989	Karnprayag, Chamoli
2.	1991	Uttarkashi
3.	1994	Chaukhutia, Almora
4.	1997	Near Neelkanth, Haridwar
5.	2001	Near Meykunda, Rudraprayag
6.	2003	Didihat, Pithoragarh
7.	2004	Kapkot, Bageshwar
8.	2005	Vijayanagar, Rudraprayag
9.	2007	Didihat, Pithoragarh
10.	2009	Joshimath, Chamoli
11.	2009	Munsiyari, Pithoragarh
12.	2010	Kot, Pauri



13.	2010	Khatima & Rudrapur, U.S. Nagar
14.	2010	Dehradun
15.	2010	Dhari, Nainital
16.	2010	Jaspur, U. S.Nagar
17.	2010	Karnprayag Chamoli
18.	2010	Nyalgarh, Pauri
19.	2010	Belbandgoth, Champawat
20.	2010	Jwalapur Kasim, Haridwar
21.	2010	Dhari, Nainital
22.	2011	Raipur, Dehradun
23.	2011	Tuneda, Bageshwar
24.	2012	Asi Ganga Valley Uttarkashi
25.	2013	Kedarnath

**Table 12.2 (e)**  
Reported major  
cloud bursts  
in Uttarakhand

Sl.No.	Year	Location
1.	2002	Khetgaon
2.	2004	Ranikhet
3.	2007	Pithoragarh & Chamoli
4.	2008	Pithoragarh
5.	2009	Munsiyari, Pithoragarh
6.	2010	Kapkot, Bageshwar
7.	2010	Almora
8.	2012	Chwanni, Mangoli & Kimana Villages of Okhimath Block in Rudraprayag

### iii. Major disaster: flood; landslides; earthquakes; forest fires; road activities

In Uttarakhand, floods are very common due to its most hilly area. The excessive rainfall, construction of natural dam and their bursting, rapid melting of snow and glaciers, cloudbursts areas are main reason behind the floods and

flash floods in Uttarakhand. Apart from it, bursting of constructed dams or dams under construction and immediate release of excess water from these dams sometimes causes human induced floods. Description of few most hazardous floods in the state is given below:



- ⇒ In July 17, 2001, twenty seven people died during the flash flood at Rudrapryag district near Meykunda.
- ⇒ Forty three people died due to massive cloudburst induced flash floods in 2009 at Munsiyari, Pithoragarh district.
- ⇒ Aug 18,2010; thirteen people died and 3 injured at Dhari, Nainital flash flood.
- ⇒ At Tuneda, Bageshwar district, twenty people died and one severely injured on Aug. 15, 2011.
- ⇒ Asi Ganga valley at Uttarakhand district was worst affected by flash floods on Aug 03, 2012. About 7,389 people from 1,159 families in 85 villages were affected during this fold. Nearly 28 people died in this flash flood/induced landslides.
- ⇒ 2013 multi-day cloudbursts centred at Kedarnath in Uttarakhand caused devastating floods and landslids becoming the country's worst natural disaster since the 2004 tsunami. The reason the floods occurred was due to rainfall received was on a larger scale than the regular rainfall the state usually received (Fig 12.4). The total 169 people died and 4021 were missing and presumed to be dead.

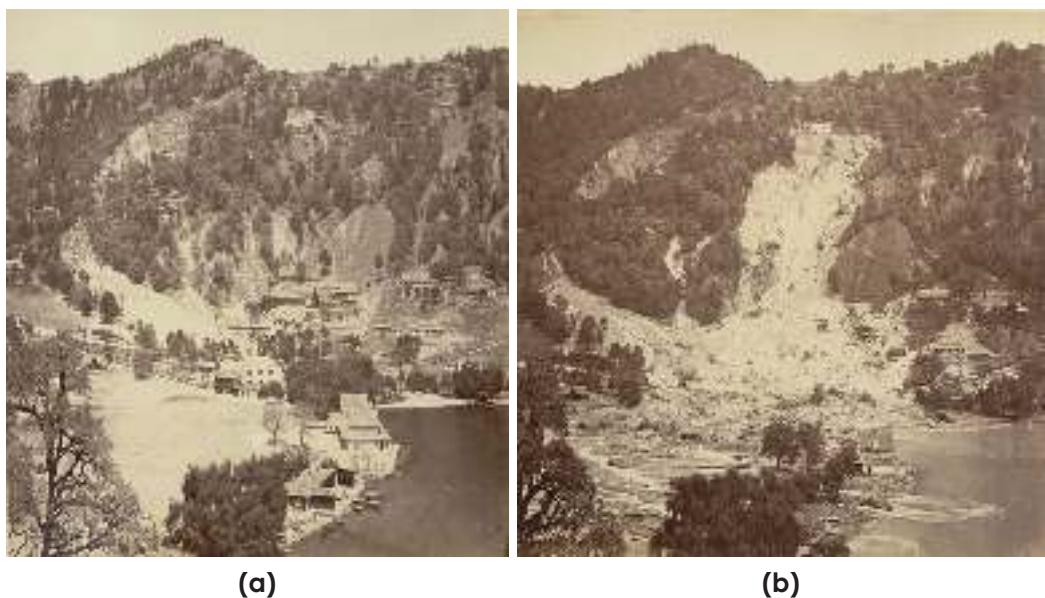
**Fig 12.4**  
Remaining marks  
of Kedarnath  
disaster after 2013



The landslides, slope failures, and land subsidence's are again very common in Uttarakhand. Rainfall and cloudburst are most common reason behind landslides. Some of them with high hazardous profile are described briefly in following section.

- ❖ In September 1880 "The Landslip of 1880" occurred at the north end of Nainital town, burying 151 people. The photographic view is given in following Fig. 12.5.
- ❖ In July 1970, the Patal Ganga (tributary of Alaknanda river) was choked and after bursting of this reservoir resultant flood triggers many landslides to the area.
- ❖ Kaliasaur is one of the most regularly occurring landslide area is located along the Rishikesh – Badrinath road. Frequent landslides were reported in this area during 1920, 1952, 1963, 1964, 1965, 1968, 1969, 1970, 1971, 1972 and 1985.
- ❖ Sixty nine people were killed by several landslide near Madmaheshwar valley at Okhimath in August 1998.
- ❖ On August 18, 1998, more than 210 people were killed at Malpa. 15 m high heap of debris created and the village was wiped out.
- ❖ On July 5, 2004 sixteen persons were killed 200 pilgrims stranded, 800 shop keepers and 2300 villages trapped as cloudbursts triggered massive landslide and washed away nearly 200 m of road on the Joshimath-Badrinath road.
- ❖ In 2008 Amruband landslide killed seventeen people with a very huge damage to roads and houses.
- ❖ Due to the landslide of Ganga –Alaknanda valley on 18-21 September 2010, nearly 220 people died and caused severe damage of 170 major and minor roads.
- ❖ On Sept 14, 2012 at Okhimath, Rudraprayag, sixty eight people were killed in landslides with extensive damage to buildings, agricultural lands and roads.

**Fig. 12.5**  
Nainital landslip:  
(a) before and  
(b) after



According to the India Meteorological Department (IMD), nearby 65 earthquakes of varying intensity since 1803 occurred in Uttarakhand. It is observed that eleven destructive earthquakes have occurred with Ritcher scale measure 6.0 or above in Uttarakhand.

Due to huge diversity of forest plant species, coverage of a large land by specific plant species (such as pine), changeable climate such as temperature, in adequate fire mitigation equipments techniques and

manpower etc., the Uttarakhand forests suffering the forest fire disaster in every year. Direct damage to plants and animals, drying of area and water resources, nutrient loss, erosion are common incidences in Uttarakhand (Fig 12.6). In hills of Uttarakhand the fire incidences occur between the months of April to June. In every year forest fires have been noted in numerous places of Uttarakhand forests. Majority of pine forests are much vulnerable to fires due to their wax/resin content and their dry leafy layer on ground surface.

**Fig 12.6**  
Forest fires  
in Uttarakhand



Blasting for construction of roads and buildings, hydro energy projects and tourist infrastructure development, and some other development activities also triggers the disasters. Kedarnath disaster might have happened due to such development activities nearby the temple (Fig 12.7).

In the hilly terrain construction of roads is disturbing the ecological balance. The removal of debris while constructing roads in hilly areas disturbs both the underground and surface pattern of the drainage. The road

construction is very necessary for development of hilly areas but if it is carried out without taking geological, geomorphological and ecological aspects into the consideration it can cause the hazardous effects to human and other biodiversity, increase in soil erosion and mass movement of soil and rocks. According to NIDM report the most of the roads in Uttarakhand are constructed without giving much attention to above mentioned issues, which results into increased instability and thus the area become vulnerable to landslides.



**Fig 12.7**  
Public interference and destruction of Kedarnath during 2013 flood disaster

#### iv. Disaster mitigation and response<sup>3</sup>

The disasters nullify the efforts of several years in a time period of hours or even in a minute or in few seconds. Human lives and infrastructure loss are two common consequences of the disasters even though it is not always possible to prevent occurrence of natural hazards, but due to proper effort and planning it is possible to prevent and reduce the effect of these natural hazards. Both pre and post

disaster management plans are required to overcome disaster problems.

State disaster management authority of Uttarakhand has published state disaster management plan that envisaged to standardize pre and post disaster practices and protocols for disaster effect mitigation in the state. Following mitigation measures are very important:

<sup>3</sup> dmmc, Uttarakhand; nidm GOI.



The pre-disaster mitigation method that operated by state emergency operation centres is early warning. Early warning of any sort of disaster that is given by national agencies such as India Meteorological Department (IMD), Central Water Commission (CWC), Geological Survey of India (GSI) etc. Key responsibilities to early warning systems /agencies are coordination with local technical agencies responsible for forecasting different hazards, establishment of a reliable communication system and alternative communication system method development to coordinate to media and mainly bringing forth awareness among communities under risk zones for effective use of early

warning system. Example of early warning include stopping the vehicles at safe places by police and administration after receiving the information of any type of disaster in sensitive areas on the path. Evacuation is also a precautionary method that is undertaken on warning prior to disaster. Evacuation is rapid removal of people in order to move persons from a disaster stricken area into safer, good surrounding and condition. The district disaster management authority is also responsible for preparing /practicing / rehearsing/ updating and enhancing the evacuation plan in case of any emergency. Various components of evacuation plans are as follows:

- (a) Identification of vulnerable areas**
- (b) Communication of risk to nearby or other sensitive area**
- (c) Identification of safe places.**
- (d) Information exchange (for officials and disaster management authorities/ agencies)**
- (e) Disaster warning dissemination**
- (f) Air evacuation and alternate route development.**
- (g) Traffic regulation**

Various places on famous Char Dham Yatra route where traffic is to be stopped in case of any emergency are given in following Table 12.3.



**Table 12.3**  
Places on Char Dham Yatra route where traffic is to be stopped in case of any emergency.

Sl.No.	Route	Places
1	Rishikesh – Badrinath-Kedarnath	Rishikesh, Srinagar, Rudraprayag
2	Rishikesh – Badrinath	Gauchar, Gwadham, Gopeshwar, Joshimath
3	Rudraprayag- Kedarnath	Agastyamuni, Gupt Kashi
4	Rishikesh - Gangotri	Chamba, Suakholi, Chinyalisaur, Dunda , Uttarkashi, Harsil
5	Rishikesh –Yamunotri	Nangaon, Barkot

#### v. Disaster management: structure in Uttarakhand

As earlier reported, the DMMC (Disaster Mitigation & Management Centre) is working under Department of Disaster Management Government of Uttarakhand. The center is most functional and important center in the field of Disaster Mitigation & Management in Uttarakhand. It having the responsibilities to protect the community and the environment from the obliteration caused by disasters, offer an extensive range of training programs to combat with disasters, provide advance information about disaster using latest technologies, maintaining a network of experienced experts working in the field and institutions of excellence, etc.

The following are some of the steps that can be taken toward framing a disaster management plan.

##### **The pre-disaster stage:**

This stage focuses on minimizing the damage to life, property and environment. Various schemes are drafted for controlling the losses to lives and property to minimize the effects of disaster. Following are two main components of the pre-disaster stage:

##### (a) Preparedness

It refers to the readiness, on the governmental, social and personal levels, to effectively face the disaster that has already visited and it includes practical disaster-layouts. Here, the local residents along with the state officials need to be sensitized regarding the measures to be taken when faced by a crisis, such as landslides, floods, earthquakes etc. So in case of such emergencies they can take necessary action.

##### (b) The warning of disaster

It is very crucial that immediately after receiving slightest hint of a disaster, the information about its advent reaches the entire danger-prone area. In the case of Uttarakhand it was seen that the State Disaster Management Authority did not have a scheme so as to curtail the disaster nor were the warnings issued by the meteorology department taken seriously.

##### **The post-disaster stage:**

While restoring the state to normalcy, it is also equally necessary to ensure that if, unfortunately, the disaster revisits, the extent of damage is lesser. Restoration includes assistance, rehabilitation and reconstruction.

##### **Some important activities in DMMC**

k Consultancy: DMMC is also closely linked with several other ATIs, Research Institutes, Universities, Organizations, NGOs, experts of Uttarakhand and other states and shares data/information with them.

\* GIS database: Database on the various critical infrastructure/satellite data is an important resource for quick decision making and better manages the disaster situation. DMMC has prepared a detailed database of all critical resources for the entire state of Uttarakhand using Geographic Information System (GIS) environment. Besides the disaster management work this database is also being utilized by different departments for their planning and resource mobilisation related needs.





- \* **Documentation:** It is a routine practice at DMMC to prepare detailed reports of the various disasters and these are being utilized for experience sharing, seeking information regarding the particular event as also database creation.
- \* **Communication:** DMMC has police wireless connectivity at State Emergency Operation Centre, video conferencing facility with all the 13 districts Ministry of Home Affairs (GOI). Satellite phones have been set up in ten districts and also in the DMMC and State Emergency Operation Centre (SEOC) for providing alternative communication. DMMC is currently using SMS gateway service for emergency alerts. A HAM (Home Amateur Mechanic) radio club has been formed in DMMC for providing alternative communication.
- \* **Value added services:** DMMC is providing various advisory technical inputs to the various state government departments. DMMC has completed the projects for demarcating landslide prone areas in the reservoir rim of Tehri dam and road master plan of Uttarakhand, GIS based health infrastructure mapping, besides preparing district disaster management plans for the downstream districts of Tehri dam.
- \* **Research:** The DMMC however focuses on the

management aspects of response and relief activities mounted by the Government of Uttarakhand and the role of state and central government agencies, armed forces, non-government organisations and others supporting these activities so as to minimize the miseries of the masses exposed to these events.

Therefore in the Uttarakhand DMMC is routinely involved in pre and post disaster management practices and surveys of the areas affected by disasters.

#### **vi. Policies and legal framework**

Disaster Mitigation & Management Centre (DMMC) Uttarakhand is responsible for making all the policies, plans, development framework of disaster prone area, disaster mitigation scheme development, management of the disaster etc. Various schemes are building up for the disaster management practices according to the past disaster incidences or sometimes formed according to the occurrence of the disaster at any area. Kedarnath temple reconstruction sometime seems to be the best example of disaster induced policy (Fig 12.8).

<sup>4</sup>Uttarakhand disaster, 2013, nidm, GOI; State disaster management plan, Uttarakhand;





**Fig 12.8**

A three-tier wall is being built to save the Kedarnath town from any flood in the future

Following are some important protective measures/plans/activities of the DMMC before/during/after the disaster.

- Identification of hazards
- Prevention and mitigation includes enactment of executive and legislative measures and ensuring enforcement of the same.
- Human resource development: It would then be the responsibility of the concerned departments to plan and undertake capacity building of their manpower.
- Mass awareness
- Risk transfer mechanism, e.g. personal insurance, and cover of agriculture, horticulture, housing and other losses.
- Review of departmental schemes and plans as per disaster risk reduction norms.
- Departmental plans; in accordance with the provisions of the Disaster Management Act, 2005 every department is mandated to prepare its disaster management plan.
- Landuse planning, preparation of zonal plans especially

for growing urban habitations and vulnerable areas is the responsibility of the housing department together with enactment of the same.

- Ensuring structural and non-structural safety measures
- Preparation of village, district and state disaster management plans
- Mock drills; organizing mock drills and table top exercises at different levels and testing the efficacy of the disaster management plans prepared at that level.
- In view of fragile ecology and environment, all the departments are to ensure that their infrastructure is as per actual requirements and in keeping with environmental and disaster resilient norms.
- Media; it is to be the responsibility of the information department to i) organize timely media briefings, ii) update the media, iii) organize visits of media representatives to disaster affected area and the like. Apart from others this is to include providing specific information to relatives, dependents and next of kin of dead, missing and injured persons.

- Warning; generation of accurate, authentic and reliable warning and its timely communication in a decipherable manner to the population likely to be affected and critical to saving human lives during disaster.
- Furthermore, following are the some other functionalities of the disaster management and mitigation scenario that might be very helpful to prepare various policies and plans as well as framework for the development of the infrastructures related to the disaster.

#### \***Disaster Risk Reduction (DRR)**

A close analysis of the development process with its six aspects namely i) policy, ii) strategy, iii) programming, iv) project / program cycle management, v) external relations and vi) institutional capacity; clearly calls for the need of systematic and more conscious ways of integrating disaster risk reduction (DRR) into development process.

#### \***Risk Knowledge**

Risk Knowledge forms the basis for DRR. Risk Knowledge includes collection and compilation of economic data, demographic data, land use planning, social data, hazard and vulnerability assessments, preparation of hazard and vulnerability maps, etc.

#### \***Role of Media**

Media is an effective medium for the dissemination of information during all the stages of disaster management cycle.

#### \***Pre-disaster performances**

- Awareness and information to people on various disaster related aspects.
- Promoting information on various trainings being organized.
- Monitoring the activities of various agencies involved in pre disaster activities.

- Planning and to encourage people to face the situation.
- Removing fear of unknown.
- Dwarfing images of all false perceptions.
- Building partnerships between media and other organizations

#### \***Performances during disaster**

- To help in organizing relief and rescue.
- Providing information on the measures being taken.
- Providing latest information and updates on the disaster situation.
- Broadcast for the assistance of the medical, police, civil defense, NGOs, fire department and others involved in response operations.
- Providing information on the preventive measures to be taken.
- Providing information pertaining to food, water, medicines and other immediate needs and issuing appeals for assistance.
- Providing information regarding sanitation and hygiene in the affected area and in relief camps.
- Assisting in damage assessment.
- Help in identifying grey areas and advising the affected population to adhere to certain do's & don'ts.

#### \***Post-disaster performances**

- Monitoring re-settlement and rehabilitation.
- Technical and material aid in reconstruction.
- Mustering financial and other assistance for disaster victims.
- Arresting panic by providing information regarding the true picture.
- Mobilization of state, national and international resources.





# Industry



- i) Industrial development in Uttarakhand.
- ii) Present status of industries in Uttarakhand: large, medium and small scale.
- iii) Khadi and village industries.
- iv) Resource based industrialization in Uttarakhand.
- v) Industrial Policies.
- vi) Environmental impacts of industrialization.
- vii) Waste management.





### i. Industrial development in Uttarakhand

The state had few resources for upliftment of the economy. Initially the state was known as zero industry region. Banking on the strength of the states in terms of good connectivity, perfect location, cheap and abundant power and highly educated human resources, the state was able to develop the industrial infrastructure in a very short span of time. The State Infrastructure and Industrial Development Corporation of Uttarakhand Limited (SIIDCUL) came into existence in 2002 and successfully developed industrial areas at Haridwar, Pantnagar, Selaqui and Sitarganj.

The Uttarakhand economy shows diversity with adverse geographical conditions ranging from the allied activities to small concentration of industries. Allied activities include traditional crafts and skills, causal labour employment in the fruit processing industries, tea gardens and tourism. Wheat, millet, barley, sugarcane, tea, oilseeds and potatoes are some of the major crops. A wide variety of

fruits are grown in the state. Moreover, tourism has emerged as a major industry in the state ranging from eco-tourism, pilgrims, adventure, sports and mountain climbing as tourist attraction centres. The state is gifted with rich ecosystem which is responsible for the tremendous biodiversity of the region. Industrial sector of Uttarakhand mainly confined to plain areas like Udhampur Singh Nagar, Dehradun and Haridwar. These areas are the hub of large rural out-migrated population who mainly work as semi-skilled and unskilled labours.

During 2016-17, Government of Uttarakhand has planned to establish an industrial park for women, across 200 acres of land. Moreover, in order to boost the industrial infrastructure and create employment opportunities in Uttarakhand, the Chinese Chamber of Commerce has proposed investment to the tune of US\$ 743.71 million in the state. Table 13.1 shows different industrial parks in Uttarakhand.





**Table 13.1**  
Industrial Estates  
in Uttarakhand<sup>1</sup>

Industrial Estates	Location	Area (Acre)
IT Park Dehradun	Dehradun	98.38
Pharma City, Selaqui Industrial Area	Dehradun	207.12
Integrated Industrial Estate	Haridwar	2038.00
Integrated Industrial Estate	Pantnagar	3233.52
Integrated Industrial Estate (Escort farm)	Kashipur	310.96
SIIDCUL Phase II, Integrated Industrial Estate	Sitarganj	1762.50
Sigaddi Growth Centre IIE	Kotdwar	102.62
Integrated Industrial Estate Bhimtal	Bhimtal	103.00
Eldeco Siidcul Industrial Park Ltd. (ESIPL) Sitarganj	Sitarganj	1093.00

As per 2016-17 budgets, the state government proposed to establish a food park in Kashipur city of Udhampur district of Uttarakhand. In November 2014, the Uttarakhand government approved the new Micro, Small and Medium Enterprises (MSME) policy for the state. Under the policy, capital subsidy of 40% will be given for backward hill districts such as Pithoragarh, Uttarkashi, Chamoli, Champawat, Rudraprayag and Bageshwar (Category A); and 30% for other hill districts like Tehri, Pauri and Almora (Category B). Power and transport subsidies will also be provided in a graded manner. State Infrastructure and Industrial Development Corporation of Uttarakhand Limited (SIIDCUL) is the organization responsible for development of

Integrated Industrial Estates (IIEs) in Uttarakhand. The IIEs covered land area of 8949.10 acres with investment reaching up to US\$ 497.6 billion and generated about 2,00,000 employment opportunities.

#### ii. Present status of industries in Uttarakhand: large, medium and SSI

The state of Uttarakhand has 206 heavy industries as per available data. The state has registered an increment of industries after its formation. According to the Micro, Small and Medium Enterprises Development act 2006, which came into effect from October 2, 2006, the enterprises are classified according to Table no. 13.2.

**Table 13.2**  
Classification of  
industries according  
to micro, small  
and medium  
enterprises  
development  
act 2006

Type of enterprise	Engaged in manufacture of production of goods	Engaged in providing or rendering of services
	Investment in plant and machinery	Investment in equipment
<b>Micro enterprise</b>	Does not exceed 25 Lakh rupees	Does not exceed 10 Lakh rupees
<b>Small enterprise</b>	More than 25 Lakh rupees, but does not exceed 5 Crore rupees	More than 10 Lakh rupees, but does not exceed 2 Crore rupees
<b>Medium enterprise</b>	More than 5 Crore rupees, but does not exceed 10 Crore rupees	More than 2 Crore rupees, but does not exceed 5 Crore rupees

<sup>1</sup><http://www.doiuk.org.in>; uk.gov.in



Uttarakhand has several enterprises. There is an increase in number of Small, Medium and Large scale industries registered after the formation of state. Upto 2019

total 6323 industries are reported in Uttarakhand (Table 13.3). The numbers of industries are maximum in Haridwar followed by Udham Singh Nagar and Dehradun.

**Table 13.3**  
District wise different existing industries in Uttarakhand (upto 2019)<sup>2</sup>

S. No.	District	Small scale	Medium scale	Large scale	Total
1	Almora	64	4	1	69
2	Bageshwar	88	2	0	90
3	Chamoli	91	0	2	93
4	Champawat	31	1	1	33
5	Dehradun	504	106	152	762
6	Pauri Garhwal	310	10	9	329
7	Haridwar	2110	247	377	2734
8	Nainital	335	33	47	415
9	Pithoragarh	61	0	1	62
10	Rudraprayag	41	0	0	41
11	Tehri Garhwal	198	4	13	215
12	Udham Singh Nagar	913	178	342	1433
13	Uttarkashi	44	0	3	47
	<b>Total</b>	<b>4790</b>	<b>585</b>	<b>948</b>	<b>6323</b>

Some traditional and other industrial thrust areas are in progress in Uttarakhand:

#### Traditional Industries –

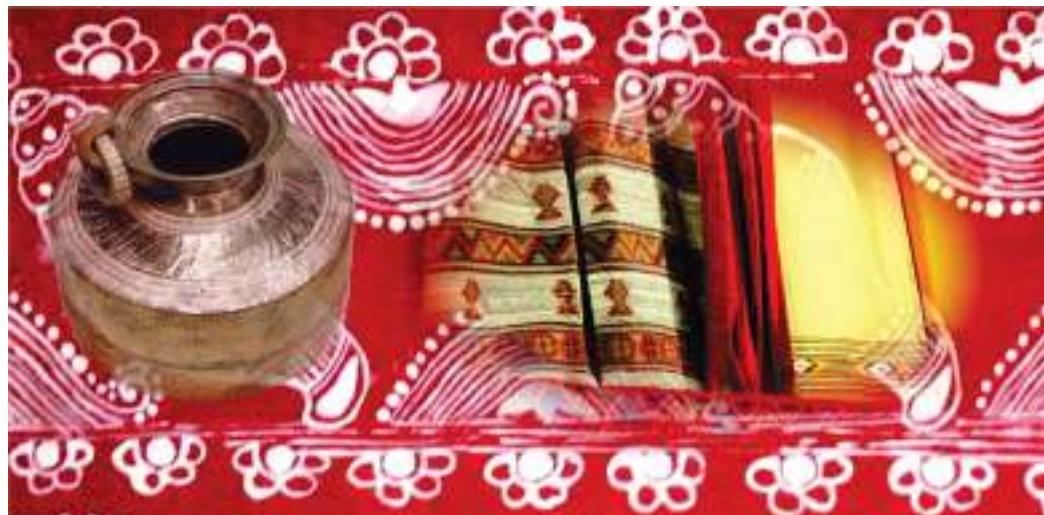
❖ **Handicrafts:** There are several handicraft industries in Uttarakhand such as carpet weaving, wood carving, brassware and other copper-based industries. For revival of these industries Government is playing the role as facilitator in ensuring adequate backward and forward linkages. Training by Master Craftsmen will be organized in situ and these villages will be developed as "Shilp Grams". For the marketing of handicraft products, action will be taken to develop outlets in tourist centres and provide increased access to markets outside the state. In addition, assistance will be sought under the Government of India's Baba Saheb

Ambedkar Hastshilp Vikas Yojana which aims at developing the handicrafts sector through an integrated cluster approach and by making the artisans self-sustainable.

❖ **Handlooms:** This industry is of vital importance for employment generation in rural areas. Under the Deen Dayal Hathkargha Protsahan Yojana action will be taken to benefit cooperative societies or registered groups. Members of these groups would be imparted training as well as be provided with modern looms and designs. Action will be taken for facilitating the marketing of their products. Establishment, expansion and modernization of Design Centres will also be undertaken. Further, state Government also proposes to develop an integrated handloom complexes where facilities for dyeing, carding, development of designs. etc., will be provided.

<sup>2</sup>ueppcb.gov.in





♦ **Wool-based industry:** A large section of the population is involved in sheep breeding and production of wool. However, wool industry has not been developed in an integrated manner. It is proposed to pay special emphasis on improving availability of good quality raw material, wool processing, grading, quality and design improvement, strengthening of marketing arrangements and mobilise institutional finance for development of this industry. Non-traditional animal wool fibres will also be encouraged and developed. Efforts will similarly be made to develop vegetative fibres. A wool bank and wool auction yards will also be established.

♦ **Khadi and village industries:** Special emphasis will be paid to the development of khadi and village industries, cottage industries and tiny industries. Common facility centres for packaging and marketing will be developed. Following the efforts of the state government, the government of India has declared "Gharats" as a cottage industry. These "Gharats" will serve as a nucleus for the development of tiny industries in the rural areas.

♦ **Wax based industry:** This is an important handicraft industry in the hill regions of the state. The main problem facing this industry is lack of availability of good quality raw material. Institutional arrangements will be made to overcome the

same. Also, proper arrangements for marketing of finished products will be accorded due priority.

#### **Other Industries**

♦ **Biotechnology:** After information technology, biotechnology is the emerging thrust area at the global level. Uttarakhand is well known for its vast and rich diversity of flora and fauna. A MOU has already been signed between Rabo India Finance Company, Infrastructure Development Finance Company and the G.B. Pant University of Agriculture and Technology in order to forge strategic cooperation to jointly pursue initiatives in the sphere of research in food and agriculture sectors.

♦ **Industry based herbal and medicinal plants:** Uttarakhand is a storehouse of a rich variety of species of herbs, medicinal and aromatic plants. This massive potential has remained largely unexploited in the absence of a well planned and coordinated strategy for commercial cultivation and integrated arrangements for processing and marketing. An integrated action plan will be drawn up for this purpose in coordination with the Government of India and specialized agencies all over the country. Strategic linkages and connectivity will also be forged between this industry and tourism. Special emphasis will be given to arrangements for marketing both within the country and abroad.

★ **Tea industry:** Recently, intensive efforts have been commenced in the state to significantly expand the plantation of tea with the involvement of a large number of small and marginal farmers and landless labour. Already 560 acres of new plantations have been covered and it is proposed to bring an additional 22000 acres of land under tea plantation over the next few years. Action will be taken to encourage the setting up of tea processing and packaging units and thus establish Uttarakhand as a major tea producer in the country.

★ **Forest-based industry:** With the vast forest coverage in Uttarakhand, there is excellent potential for the development of forest resources based industries. Some such industries could include paper and paper products, plywood/flush boards, furniture, wood carvings, sports goods, toys, educational aids (pencils), matchsticks, katha, bamboo-based products, etc.

★ In addition, there is ample scope to develop industries based on forest and agro-wastes such as lantana, pine-needles and vegetative fibres such as Ramban, etc. Action will be taken in an integrated manner and in cooperation

with specialised agencies for research and development, product development and promotion of industries based on such materials.

★ **Information technology:** With its clean environment, proximity to the national capital, high literacy rate, concentration of high quality educational institutions, particularly in Dehradun, Nainital, Roorkee and Pantnagar and the presence of a large number of national institutions, Uttarakhand has the potential to develop as a major Information Technology centre in the country. In view of this and the large area of hilly terrain and dispersed habitations, Information Technology has been identified as a major thrust area of development in the state.

### iii. Khadi and village industries

Khadi is a type of fabric that breathes "warm in winter and cool in summer". Khadi is a hand spun and hand woven cloth which acquired patriotic status during Indian freedom struggle and it gave as swadeshi spirit. Moreover, village industry is an industry located in a rural area producing goods or rendering services per head investment of an artisan or worker doesn't exceed Rs. 1.00 Lakh in plain areas and Rs. 1.5 Lakh in hilly areas.





To keep vigilance in Khadi and village industry a Khadi and Village Industries Commission (KVIC) has been established. It is a statutory body established by an act of

parliament (No. 61, of 1956) as amended by act 2006. In April 1956, it took over the work of former all India Khadi Village Board.

**The main objectives of KVIC are as follows:**



#### iv. Resource based industrialization in Uttarakhand

Uttarakhand has abundant natural resources because of its hills and forest. It has abundant water resources, favouring hydropower generation. The agro-climatic condition is also favourable for horticultural and medicinal and aromatic plant. There are various medium

and small scale industries which are based on different resources. There is also, some potential for development of small cottage industries if imaginatively linked to tourist circuits. This will add value to locally available raw material mainly of plant and animal origin, as well as some items that have use of mineral wealth to provide dispersed employment in the state.

## v. Industrial policies

Uttarakhand adopted the new industrial policy in 2003 for encouraging industrial development in the state and to offset the obstacles that hampered this process. The aim of the policy is to provide a comprehensive framework to enable a facilitating investor-friendly environment for ensuring rapid and sustainable industrial development in Uttarakhand and through this to generate additional employment opportunities and to bring about a significant increase in the state domestic product and eventual widening of the resource base of the state.

A special policy has been implemented by the government in 2008 for hill and remote areas of Uttarakhand to promote the industrial development. The period of the policy is from 1st April 2008 to 31st March 2018. This policy has been further extended its benefits beyond 2018 to 2025 and decided to setup 11 new industrial hubs. The State Infrastructure and Industrial Development Corporation of Uttarakhand Limited (SIIDCUL), which is created for heavy industrialization in the plains, has been roped into develop these 11 new industrial hubs in the hills. All these hubs will be set up at the district headquarter of the respective districts. In the new amendments, Sahaspur and Raipur areas of Dehradun district and Haldwani and Ramnagar areas of Nainital district have been included in hill area category, where all the promotional benefit will be available. The main objective of the policy is to accelerate the pace of industrial development in backward and remote areas of hilly regions. This policy also focuses to generate employment opportunities for the local people of the remote areas. In this policy following activities are identified.

1. The manufacturing industries classified under green and orange categories which are of non-polluting in nature.
2. The industrial activities included in the thrust industries declared by Government of India under the special industrial promotion package for the states.
3. Protection of agriculture and polyhouse, cold storage and like activities.
4. Petrol and diesel pumping and filling gas godowns.

<sup>3</sup>Status of E-Waste Generation and Management in Uttarakhand, ueppcb2017.



## Environmental impacts of industrialization

Industrialization offered gains in efficiency that affected almost every facet of life in society. Industrialization increased agricultural and manufacturing output, allowing people to take jobs in other sectors and increasing the amount of consumer goods and food available to the populace. Industrialization created significant population growth, as well as increases in economic output. It also spurred technological development, enabling scientific advances that changed the socio economic aspect of state.

However, Industrial estates, infrastructural development sites and its surrounding areas in Uttarakhand are also affected by industrialization. Its requires land acquisition in different parts of the state that converts agricultural land into an industrial and development plots, especially multi-crop land that usually creates a stir among the peasants. Thus, it deprives the farmers of their basic and traditional source of income which leads to social discontent and endangering socio-economic status and bring about social problems.

The Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) is discharging its duties assigned under the provision of different acts for environmental protection in the state.

In Uttarakhand most of the approved SEZ (Special economic zone) are in the regions of Dehradun, Haridwar and Sitarganj, it is creating imbalanced development. Thus, the pattern of development creates pockets of affluence and it aggravates the divide between the haves and have-nots.

Industrial growth, urbanization and the increasing use of synthetic organic substances have serious and adverse impacts on freshwater. Waterborne diseases have a major public health and socio-economic impact. Contaminated drinking water causes the problem to health and leads to water-borne diseases. The major water-related diseases are diarrhoea, hepatitis, roundworm, hookworm infection, trachoma, guinea worm, schistosomiasis, leishmaniasis, lymphatic filariasis, cholera, and malaria. Moreover, industrialisation is responsible for depletion of natural resources and leads to air pollution, soil pollution and degradation of land quality etc.

#### vii. Waste management

Industrial development is very necessary for the development and well-being of the state. Economic growth of any state or country depends on the industrial sector of that state or country. On the other side, the emissions and effluents from them are of environmental concerns. The effluents from the industries are discharged into the water bodies making them polluted, so to reduce the water pollution, the wastewater should be first treated by treatment plants before discharging into the other water bodies. Investment in industrial sector have to be regulated in order to protect the fragility of the region. Only limited areas, it is advisable to set up industries so that the adverse effect on the terrain and the water regime can be accepted if not countered. The Central Pollution Control Board has introduced several air and water quality standards and guidelines in order to regulate the environmental quality.

Following the National Green Tribunal (NGT) guidelines, the SIIDCUL office has been asked to make the water potable so that it can be reused for irrigation, washing or fit for drinking by animals. At present SIIDCUL has installed CETP in first phase 4MLD Pantnagar (fig. 13.1), 4 MLD Sitarganj and 4.5MLD at Haridwar with an advanced technology to combine the sewage treatment plant and effluent treatment plant (CETP) targeting for zero liquid discharge. A common facility is available for hazardous waste disposal at Bharat Oil and Waste Management Pvt. Ltd. at Mauza Mukimpur, Roorkee, Haridwar and Global Environment Solutions, Lambakhera, Gadarupur, US Nagar.

E-Waste includes a wide and increasing variety of electronic devices like television, computers, refrigerators, air conditioners, and mobile phones etc, which consist of different types of toxic material that can create occupational as well as environmental health hazards apart from polluting the adjacent atmosphere severely. Given the volumes of E-Waste being generated and the content of both toxic and valuable materials in them, E-Waste, is also emerging as a business opportunity of increasing significance. E-waste management plant in the state is also working at Attero Recycling Pvt. Ltd, Bhagwanpur, Roorkee; Anmol Parivar Sanrakshan Samiti, Banwala, Haridwar, and Resource E-Waste Solutions Daulatpur, Haridwar. Considering average increment of 21% in two years; the projected E-Waste in 10 years time period for Uttarakhand state would be<sup>3</sup>:

Year	2013	2015	2017	2019	2021	2023	2025	2027
<b>Quantity of E-Waste Generation (MT)</b>	3518	4256	5150	6232	7541	9124	11040	13359





(a)



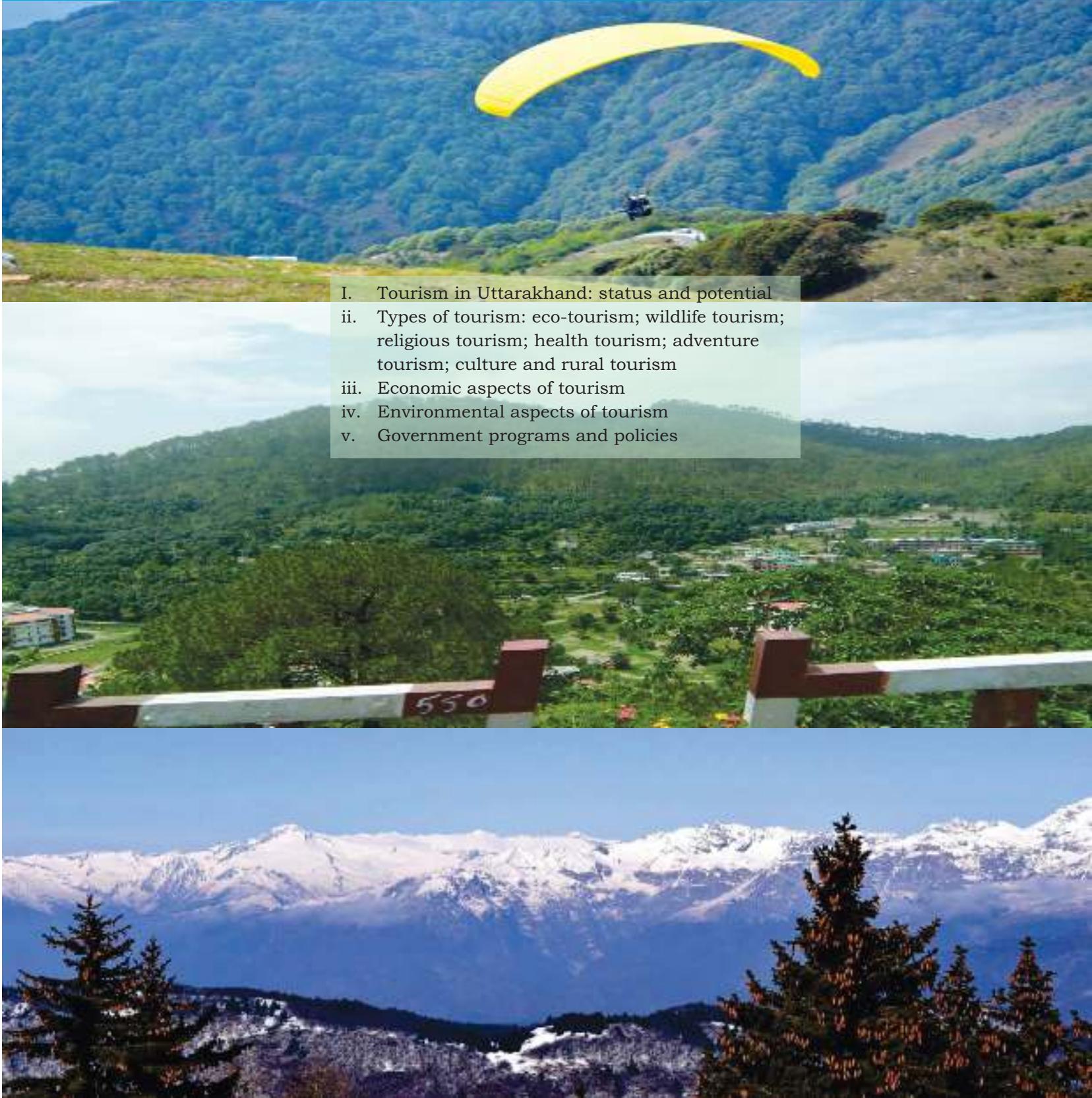
(b)

**Fig. 13.1**

a) Installed CETP at SII DCUL, Pantnagar  
b) Secondary treatment of wastewater in CETP



# Tourism

- 
- I. Tourism in Uttarakhand: status and potential
  - ii. Types of tourism: eco-tourism; wildlife tourism; religious tourism; health tourism; adventure tourism; culture and rural tourism
  - iii. Economic aspects of tourism
  - iv. Environmental aspects of tourism
  - v. Government programs and policies



14





### i. Tourism in Uttarakhand: status and potential

Uttarakhand state is popularly known as Devbhoomi (the land of Gods) due to the presence of numerous Hindu pilgrimage sites such as Haridwar, Badrinath, Gangotri, Kedarnath etc. Because of such holy sites, religious tourism forms a major part of tourism in the state. Furthermore, the state is home of rich natural resources especially water and forests along with many glaciers. These all specialities are making the state an ideal destination for adventure leisure

and ecotourism. Besides all these, adventure tourism is also a speciality of Uttarakhand. Adventurous tourism includes various forms of trekking, skiing, paragliding, camping, angling, mountaineering, rock climbing etc. The economy of the state largely depends on tourism sector due its contribution over 51% of the total GSDP.

Following five are important tourist circuits that have been identified and developed in the state:

- 1. Haridwar – Rishikesh – Muni Ki Reti**
- 2. Dehradun – Mussoorie- Dhanaulti – Kanatal – Rishikesh – Haridwar – Dehradun**
- 3. Corbett – Nainital – Corbett**
- 4. Adibadri – Simli – Karnprayag – Chamoli – Pipalkoti – Urgam – Vrashbadri – Joshimath – Bhavishya Badri- Yogdhyana Badri (Pandukeshwar) Tapovan – Malari – Niti Village.**
- 5. Nanakmatta – Tanakpur- Purnagiri- Champawat – Lohaghat – Abbotmount – Pithoragarh – Jauljibi – Madkot – Munsiyari – Shyama- Kapot- Bageshwar – Takula – Almora**



The diagrammatic representation of major important tourist destinations across Uttarakhand is given in Fig. 14.1. The major themes in which various famous destinations across Uttarakhand can be divided are as follows:

- **Adventure & water sports**
- **Pilgrimage and festivals**
- **Nature and wild life**
- **Sightseeing**
- **Health (as in Rishikesh) and rejuvenation**
- **Rural tourism.**



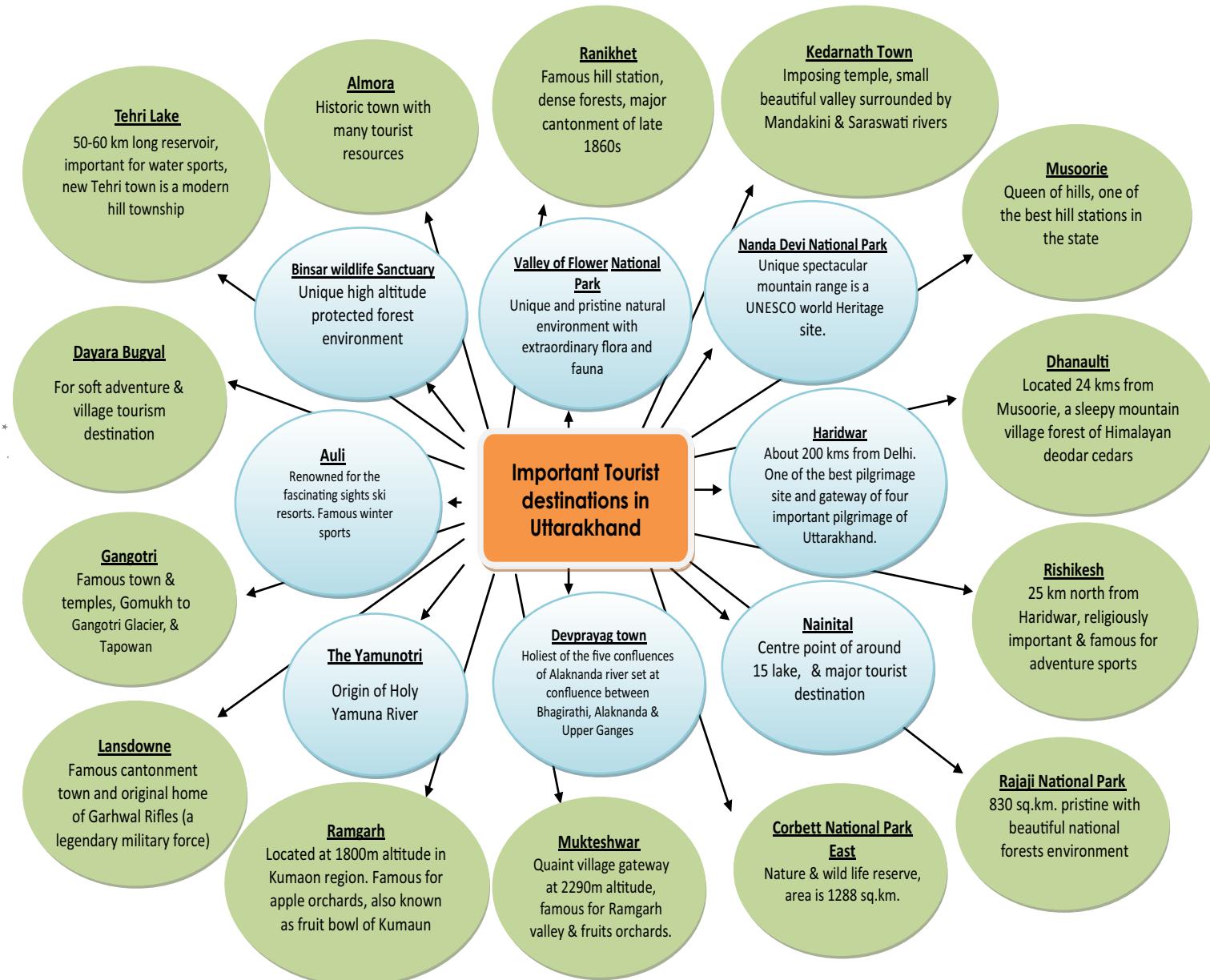
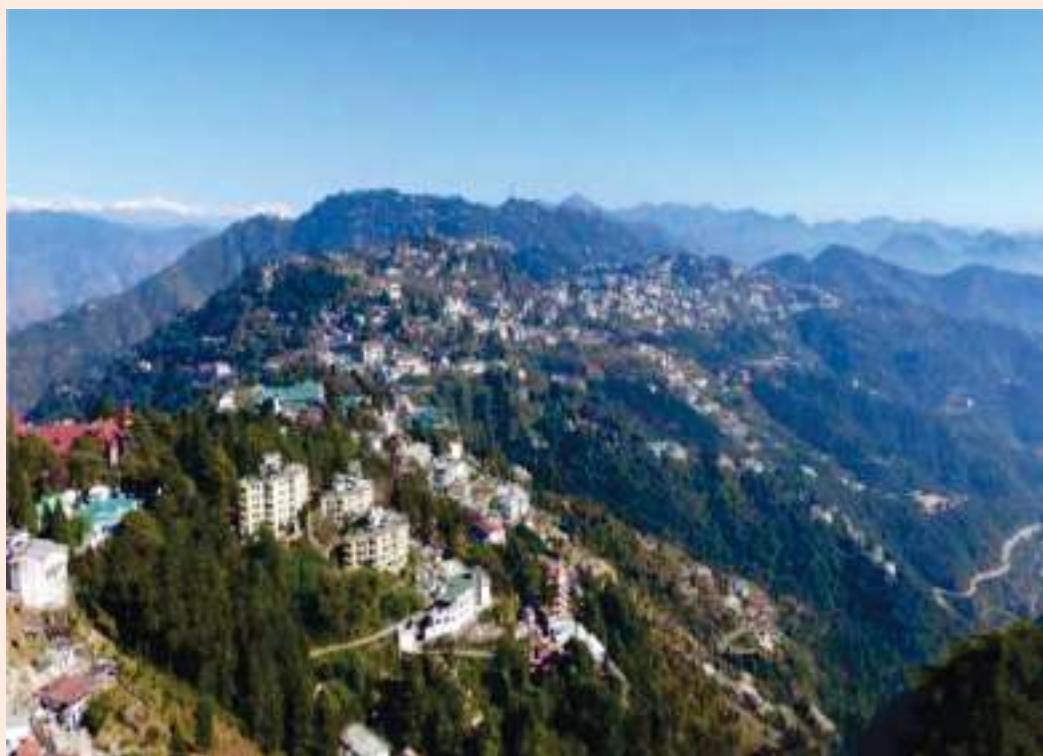


Fig 14.1 Major tourist places of Uttarakhand



(a) Tehri lake



(b) Mussoorie



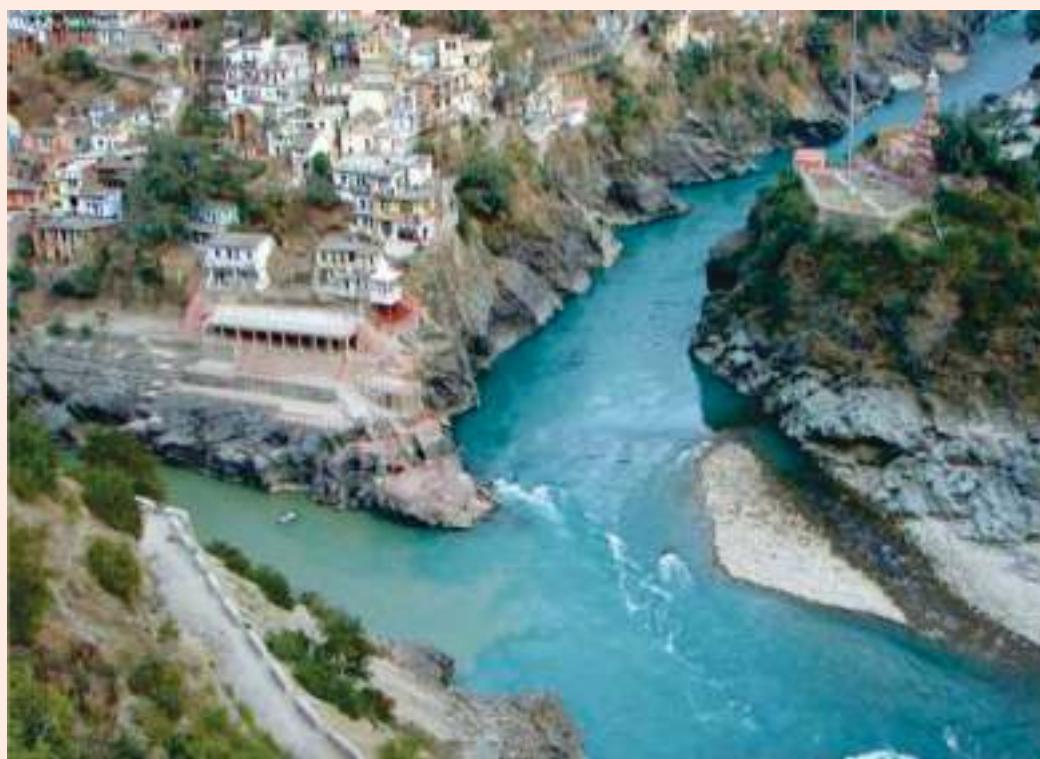
(c) Rishikesh



(d) Auli



(e) Nainital



(f) Dev-Prayag



(g) Lansdown

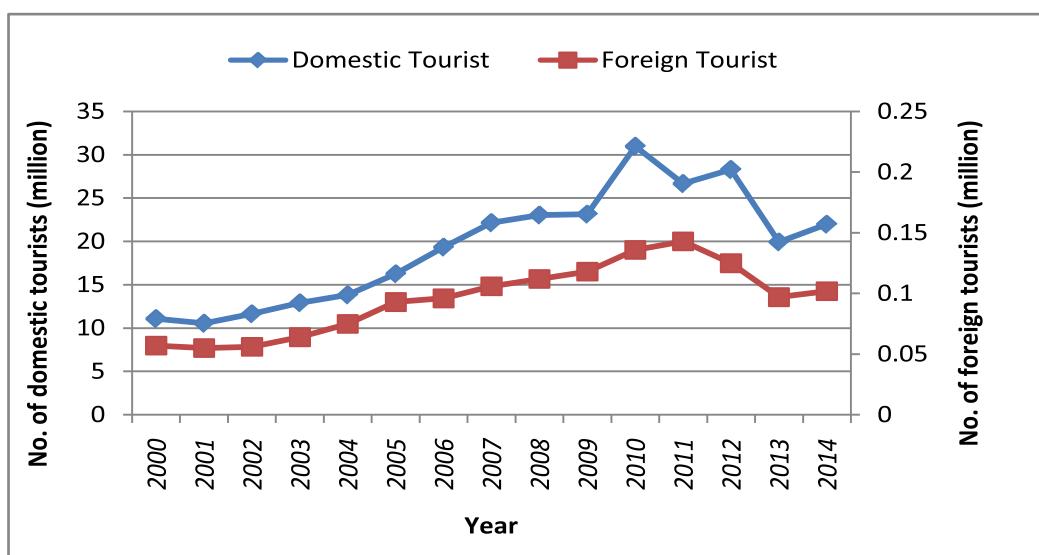


(h) Gangotri

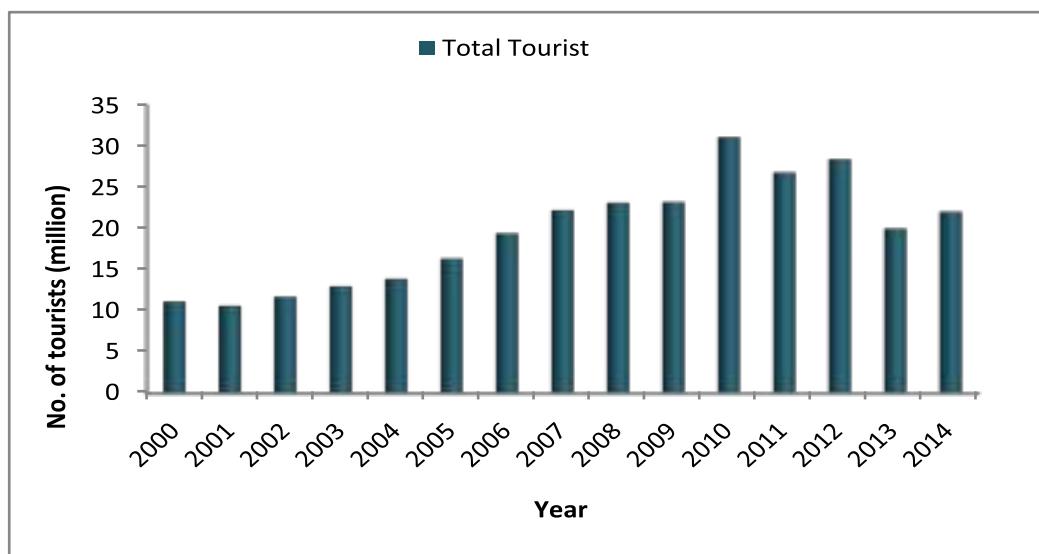
According to the current status of tourism, the visit to these tourist places has consistently increased around 11 million in the year 2000 to 28 million in the year 2014. Following the 2013 flood disasters in Uttarakhand a 30% decline in tourist visits have been observed (Fig 14.2, 14.3), but in 2014, the state regained its tourism with 10% growth in total tourist visits. All over 58.2% of the foreign tourists visits were observed for holidays and sightseeing while 21.9% were for health improvement or yoga/meditation and 19.4% visits were

observed specifically for religious pilgrimage functions. Furthermore, about 59% of the holiday tourists were attracted by the beauty of Uttarakhand followed by 51.3% for trekking facilities and 52.1% for spiritual centres. Nepal, Germany, Italy, Australia, Israel, America, etc. are major source countries of tourists. Inflow of foreign tourists into the state increased from 101.97 thousand in 2014-15 to 105.88 thousand in 2015-16. All most popular destinations were reported in Fig. 14.1.

**Fig 14.2**  
Number of total domestic and foreign tourists visited Uttarakhand



**Fig 14.3**  
Number of total tourists visited in Uttarakhand



As per the Uttarakhand Tourism Policy 2017 the domestic tourist visits are expected to increase by around 2.5 times in next ten year. Foreign tourist visits are expected to increase by around 2.0 time in upcoming period. Therefore it is predicted that the total tourist visits in Uttarakhand are expected to reach around 67 million by 2026.

From the above data it is clear that the Uttarakhand state of northern India has the great tourism potential because of its most beautiful and enchanting nature. It is blessed with breathtaking natural beauty, rivers and many famous and beautiful mountains. The state has been considered as heaven for people seeking solace in spirituality and a paradise for adventure and nature lovers. Nestled in the lap of the Himalayas, Uttarakhand can rely upon tourism which can bring upon environmental, societal, economic sustainability if managed and operated sustainably. The problems such as vulnerability to various disasters are common in Uttarakhand that affect tourism. Although various government policies and plans related to infrastructure development are very much helpful to minimize such problems.

**ii) Types of tourism: eco-tourism, wildlife tourism, religious tourism, health tourism, adventure tourism, cultural and rural tourism**

Tourism is a travel by domestic or foreign people to enjoy/appreciate/study the scenic or natural/man-made beauty of nature and thereby contributing to the development of concerned state/country together with the other developmental factors. As earlier reported the Uttarakhand has a vast potential regarding tourism, thereby increasing state's income to improve economy. Because of its fresh, beautiful and safe environment, tourist attraction is common for Uttarakhand. Due to Hindu/Sikh pilgrimage sites (Badrinath, Hemkund Sahib, Reetha Sahib, Gangotri,

Haridwar, etc.) the place attracts large communities not only of the country but also of the world. This increasing number of tourists has led pollution and degradation of its environment. Therefore, for protection of environment along with promotion of tourism, the Uttarakhand tourism industry and many environmentalists developed concept of different types of tourisms such as eco-tourism are religious tourism to develop the eco-friendly, sustainable and economic tourism in the state. Various types of tourisms are briefly described in following Table 14.1.



**Cultural tourism: Nanda Devi Raj Jaat Yatra**



**Religious tourism: Shri Hemkund Sahib**



**Religious tourism: Jageshwar Dham**

**Table 14.1**  
Various types  
of tourisms

Sl. No.	Type of tourism	Description
	<b>Ecotourism</b>	<p>The concept of ecotourism is one of ambiguity and dispute. As per name it seems just nature based tourism, but it is now elaborated by adding ecofriendly uses, economic development and income of local people. Therefore, ecotourism is a responsible travel to natural area that conserves the environment and also sustains the wellbeing of local people<sup>1</sup>. Ecotourism is one of the fastest growing sectors of tourism industry of Uttarakhand and has spawn a variety of new terms such as sustainable tourism, pro-poor tourism, and responsible tourism.</p>
	<b>Wildlife tourism</b>	<p>Due to a major forest part in the state there is a great opportunity of wildlife tourism in Uttarakhand. It refers to the non-competitive interaction to the wildlife, such as observation, photography &amp; travel between flora and fauna in their natural habitat. With the 12 national parks and wildlife sanctuaries covering 13.8 percent of the total area, the wildlife lovers /travellers can see or capture various animals/birds etc. Apart from these, Jim Corbett National Park, Asan Barrage and Jhilimil Tal Conservation Reserves, Neeldhara Pakshi Vihar, Nanda Devi Biosphere Reserves and Valley of Flowers National Park (last Two are the world heritage sites) are also good destinations for wildlife tourism.</p>
	<b>Religious tourism</b>	<p>The state has various pilgrimage site (especially related to Hindu religion). The state is also referred as abode of gods due to uncountable ancient temples. Every mountain, each rock, each river and stream of Uttarakhand is somewhat associated with mythological background of India. These attractive places make the state very common and important sites for religious tourism. Haridwar, Badrinath, Kedarnath, Gangotri, Yamunotri, etc. are most famous pilgrimage sites in Uttarakhand. Other important religious places include Rishikesh, Devprayag, Chital Golu, Chorabari Tal, Tarkeshwar Mahadev, Bhavishya Badri Temple, Tungnath, Gomukh, Binsar Mahadev Mandir, Rudranath, Tapowan, Nandprayag, Kalpeshwar Temple, Santopath lake, Swargarohini, Neelkanth peak, Pandukeshwar, Joshimath, Vishnuprayag, Saptrishi Kunal, Kainchi Dham, Jageshwar Dham, Bhadraj Temple, Lakhmandal, Baijnath, Bagnath Temple, Piran Kaliyar, Hemkund Sahib, Nanda Devi, Sri Neelkant Mahadev, Vasuki Tal, Chandrashila, Patalbhuvneshwar cave, and Poornagiri Temple, etc. All the places are well connected with appropriate tourists facilities.</p>

<sup>1</sup>[www.ecotourism.org/](http://www.ecotourism.org/)

	<p><b>Health tourism</b></p>	<p>The health tourism, ayurveda tourism, wellness tourism, medical tourism are some important and health improving tourisms of Uttarakhand. Population health status improvement is the basic component of human development. Health tourism therefore focus on medical treatment and healthcare services. The Family Welfare Department in Uttarakhand works towards improving the accessibility and quality of healthcare services in Uttarakhand. Furthermore efforts are being taken to strengthen health infrastructure and promote public private partnership. Various programmes such as National AIDS Control Programme, National Family Welfare Programme, National Leprosy Elimination Programme, National Blindness Control Programme, Integrated Disease Surveillance Project, Accredited Social Health Activist (ASHA), Rastriya Swasthya Bima Yojna, U Health Scheme etc. are undertaken by the department. Moreover, with more awareness of the benefits of age old art yoga, meditation, and Ayurveda there could no place other than Uttarakhand where one can experience all these. Rishikesh is referred as the 'Yoga Capital' of the state. Ayurvedic colleges and hospitals at Haridwar and Dehradun, Chandra Yoga International (Rishikesh), Himalayan Yoga Retreat (Rishikesh), Parmarth Nature Cure &amp; Yoga Centre (Rishikesh), Patanjali Yogpeeth (Haridwar), etc. are some important institutions for this old and effective science. Furthermore, Doon Hospital, Max Super Speciality Hospital, Himalayan Institute Hospital Trust, Shri Mahant Indresh Hospital, Sushila Tiwari Govt. Hospital etc. are some famous and important hospitals of Uttarakhand state. Due to such kind of medical facilities (especially in yoga/Ayurveda) Uttarakhand has a great potential for health tourism. Other places for health tourism include Champawat, Pithoragarh, Ramgarh, Jageshwar, Almora, etc.</p>
	<p><b>Adventure Tourism</b></p>	<p>Uttarakhand state has shot to fame among adventure lovers because of its perfect topography for thrilling adventures like trekking, river rafting, camping, etc. Rishikesh, Corbett National Park Nainital, Tehri, Sitlakhet, Auli, Shri Hemkund Sahib, Jharipani, Maldevta, Tons valley, Dhanaulti, etc. are various adventure sites in Uttarakhand. Rafting, camping, bungee jumping, zip - line, wildlife safari, air safari are common adventure sports in Uttarakhand. Following are details of some destinations and activities for adventure tourism in Uttarakhand:</p> <ul style="list-style-type: none"> <li>• <b>Trekking Trek in Garhwal Himalayas:</b> <ul style="list-style-type: none"> <li>*Chandrashila Summit, Dodi Tal, Dehradun Mussoorie, Gangotri - Gomukh Valley, Kedar Tal, Kedarnath – Vasuki Tal, Kempty fall, Nanda Devi, Panch Kedar, Roop Kund, Gopeshwar, etc. are famous treks.</li> </ul> </li> </ul>



<b>Culture and Rural Tourism</b>	<ul style="list-style-type: none"> <li>• <b>Trekking trek in Kumaun Himalaya:</b> *Pancha Chuli base camp, Sinla pass, Devi Kund – Nag Kund, Nanda Devi base camp, Adi Kailash, Milam glacier, Pindari glacier etc. are famous treks of Kumaun Himalaya.</li> <li>• <b>Wildlife tours in Jim Corbett National Park, Rajaji National Park, Binsar Wildlife Sanctuary are major area of attraction.</b></li> <li>• <b>Jeep safari in Rajaji National Park &amp; Jim Corbett National Park.</b></li> <li>• <b>Paint ball adventure and rock climbing activities in Rishikesh.</b></li> <li>• <b>Mountain biking at Rishikesh, Ramnagar, Nainital, Ranikhet, and other Kumaun &amp; Garhwal mountains.</b></li> <li>• <b>Paragliding at Nainital &amp; Ranikhet.</b></li> <li>• <b>Elephant safaris in National parks of Uttarakhand</b></li> <li>• <b>Zip-line activities in Nainital, Ranikhet &amp; Mussoorie.</b></li> <li>• <b>Paddling the rapids (in Rishikesh &amp; Nainital)</b></li> </ul>
	<p>Uttarakhand has a well cultured and colourful society. The state has everything that any tourist could want. Along with state's natural beauty, the most significant factor for giving mass appeal to tourism in Uttarakhand is the state's rich culture, an excellent intermingling of exoticism as well as the simple way of life. Culture of Uttarakhand is undoubtedly one of the most vital tourist attractions. The main Uttarakhand cultures are its history, people, religion, dances and singing. The major music and dance, foods, arts and crafts, lifestyle, festivals attraction to tourists are detailed as follows:</p> <p><b>Fairs:</b> Devidhura Mela, Ardh Kumbh Mela, Nanda Devi Mela, Kumbh Mela, Poornagiri Mela, Gauchar Mela etc. are main fairs that gather people.</p> <p><b>Festivals:</b> Basant Panchami, Olgia/Ghee Sankranti, Ganga Dussehra, Hill Jatra, Janau purnima, Chhipla Jaat, Kandali, Nanda Devi, Makar Sankranti, Phool Deli, Vat Savitri, Khatarua, Kumauni Holi are some major festivals.</p> <p><b>Food:</b> Kafuli, Fannah, Baadi, Ras, Bhatt Ki Chutkani, Arsa, Gulgula, Singal, Poori, Kheer, Various foods of Urad and beans etc. are main foods.</p> <p><b>Music &amp; Dance:</b> Chhopati, Chaufula, Jhumeilo, Chholia Nritya, Basanti, Mangal, Pooja Folk song, Jhoda, Chanchari, Kumauni Song, Garhwali Songs, Jaunsari Songs, Langvir Nritya, Barada Nat, Pandav Nritya etc. are the various types of music and dance.</p> <p>With the development of infrastructure in rural areas, the rural tourism is increasing day by day. With the rural tourism, one can learn about the rural life art, culture and heritage of</p>



		<p>a particular region. The village tourism or rural tourism in Uttarakhand is unique and treasured heritage and improves the economy of the region. Important village destinations for rural tourism are Bigul Charekh Danda, Jeolikot, Kalimat, Kanda, Kasar Devi, Khirsu, Kuflon, Malaria, Mana, Martola, Chakrata, Deora, Pallyu, Shaukiyathal, Nainidanda, Nathuakhan, Raithal, Sankri, Sitalkhet. Rural tourism is very helpful to reverse migration and can be able to revive rural economy.</p>
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Camping in Uttarakhand



Nainital



Snow climbing



Health tourism: Rishikesh



**Elephant safari**



**River rafting**

Hence, Uttarakhand has enormous tourism potential due to its beautiful nature, mountains, forests, and culture. All the tourist destinations are well connected by appropriate transport facility. One can travel by air, rail or road to visit various sites. Furthermore, helicopters and ropeways are other modes of transportation according to the need.

Apart from the above mentioned tourisms, various other kinds of tourisms are also documented. These are either a type of tourism or a part of pre-described tourisms, therefore have a great importance.

**Mountaineering:** Uttarakhand Tourism Development Board (UTDB) also promotes the adventure mountaineering, both

for Indian & foreign nationals. Kumaun Mandal Vikas Nigam (KMVN) and Garhwal Mandal Vikas Nigam (GMVN) also provide the support for such activities.

**Angling/Game- Fishing:** Numerous rivers (e.g. Ramganga, Ganga, Kosi, Yamuna, Alaknanda etc.) and various water bodies (Tehri Dam, Nanaksagar dam) etc. are extremely good for angling /sport fishing.

**Homestays:** It is also promoted by the Government. It is a form of tourism that allows visitors to stay at houses of local people. This tourism gives the special opportunity to learn and study the life style of the particular region.



**Home stays in Uttarakhand**

**MICE tourism:** (Meetings, Incentives, Conferencing, Exhibitions) tourism is also a kind of tourism. Uttarakhand Government is also planning to promote it.

**Film tourism:** Due to numerous picturesque film shooting locations e.g. Nainital, Bhimtal, Tehri Dam, Himalayan area, there is a tremendous potential for film tourism.

### iii. Economic aspects of tourism

Uttarakhand's economy mainly relies on tourism industry. Numerous tourist destinations of Uttarakhand make state's recognition globally, hence bringing money to the state. Other contributors to the Uttarakhand economy are its agriculture, mineral resources, some small scale industries (such as Gramodhyog) and other industries, real estate, fishing, foreign investments, etc. Tourism is one of the fastest growing sectors for state's economy. All different tourisms can generate a great economic support to Uttarakhand. Uttarakhand hill stations, wildlife tourism & religious tourisms etc. are having great importance to generate revenue for government. The income earning from tourists is by providing various services such as transportation, food and beverages, pony and porter services, local transport services, hotel services etc. It also helps in sustaining the livelihood of several villages near the tourist places. Both positive and negative impacts of tourism in state's economy are presented in Fig. 14.4.

Tourism is now viewed as one of the key sectors of economic growth and development in the state both from the point of view of income and employment generation as well as a source of revenue. Therefore, the state government must strive hard to make tourism an instrument of economic growth, poverty eradication and generation of prosperity in Uttarakhand. In Himalayan region increasing potential and demand of tourism is being higher labour intensive with a range of career option that also helps in increasing income of the local people. According to the PHDCCI (PHD Chamber of

Commerce & Industry) Uttarakhand has lost a revenue earning of about Rs. 12,000 Crore from its tourism sector alone in the fiscal year 2017-18 due to rains, floods and other disaster of 2013. Close to about 11% of state's GSDP has been ruined on account of the flood in all its riverbeds. According to it, the reconstruction of damaged tourist destinations is expected to burden the state government with huge amount in wake of rising input costs such as mounting prices of cement, iron, labour costs etc. The share of tourism in the GSDP of Uttarakhand is estimated at around 25-30% in the recent years. Blessed with enormous natural beauty and resources, the state also endowed with about 175 rare species of aromatic and medicinal plants. This further increase the ability to boost Uttarakhand economy by health tourism/ayurveda tourism.

### iv. Environmental aspect of tourism

Tourism is the movement of people from one place to another famous place for relaxation, enjoyment, religious/natural cultural and social attributes. As reported earlier, tourism is a vast dimension that supports socio-economic and infrastructural development. As most of the tourist attraction sites in Uttarakhand are in hilly terrain, sometime infrastructure development can cause various harms to nature (Fig 14.5). Moreover, extensive wildlife tourism can also affect the normal lifestyle of wild animals. The tourist attraction places are being observed to face serious problems such as encroachment, over- constructions, rapid urbanization etc. These problems, are leading to many consequences such as whether or climate change, deforestation, pollution of rivers and lakes, solid municipal waste generation, damage by disasters, human- animal conflicts etc. Excessive emission of green house gases can lead to air pollution and melting of glaciers. Therefore, these are some of serious issues emerging at the cost of development related to the tourism industry.



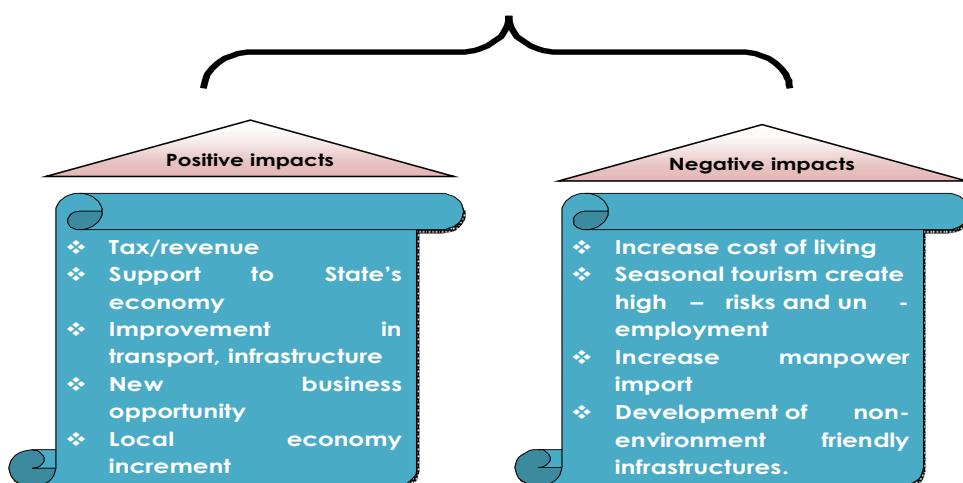
Following are some major environmental impacts of tourism to be considered seriously.

- Depletion of natural resources is a common problem that has occurred due to uncontrolled conventional tourism. The fresh water is one of the most critical resources. The over tourism generally overuse the water for hotels, swimming pools, and for personal use by tourists. Although water crises are not much common in Uttarakhand, but this huge water use by tourism industry also generate large volume of the waste water.
- The land degradation by the pressure on land resources such as minerals, fuel, fertile soil, forests, wetlands and wildlife is due to increased construction of tourism. Forests often suffer negative impacts of tourism in the form of deforestation due to constructions and fuel wood collection.
- Various kinds of environmental pollutions such as air emissions, noise, solid waste, liquid waste, other litterings, sewage, oil & chemicals are reported.
- Generation of solid waste is a more serious problem in tourist places. Especially polyethylene compounds are more harmful for environment. The disposal of solid waste ultimately pollutes the rivers, roads or other scenic areas and creates

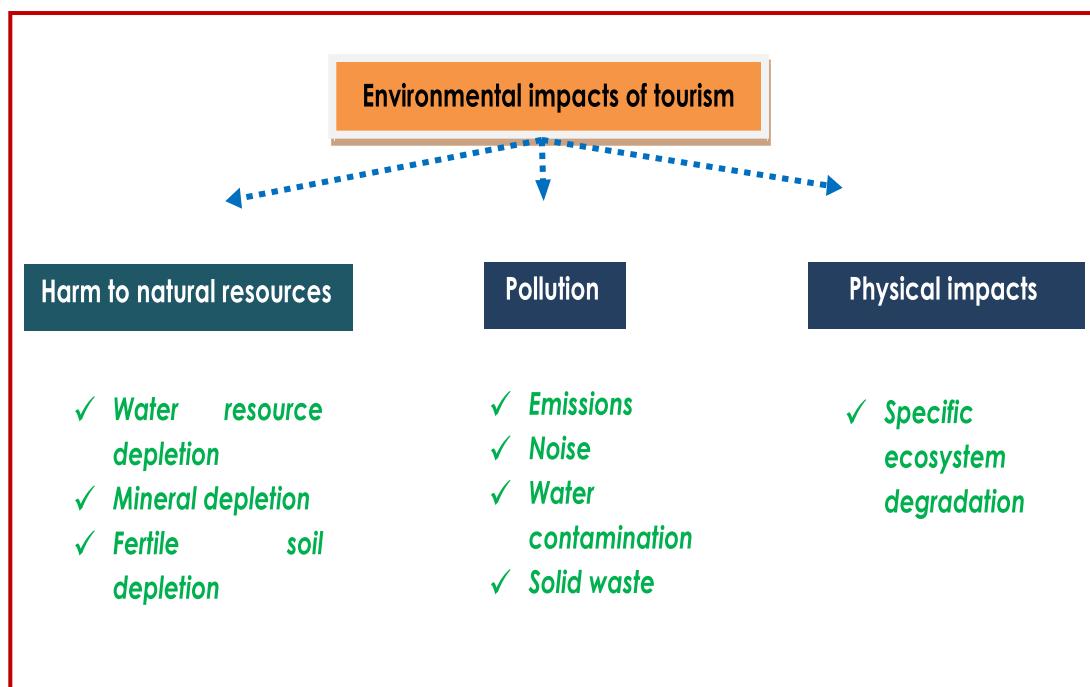
more environmental problems. Trekking tourists creates problem as they leave behind all solid garbage and it is impossible to dispose it because such sites are dangerous for normal municipal worker.

- Due to population increase, sewage production and its release to rivers /water streams is leading to most dangerous situation. Wastewater pollutes its surrounding areas and disturbs the natural flora and fauna. Sometimes disease dispersion can occur as any disease carrier person come to such sites.
- Attractive landscape sites, river sites, mountain tops and slopes are characterized by rich species ecosystems. The degradation of such ecosystems due to tourism induced activities is the typical physical impact on the environment. The construction and infrastructural development activities such as accommodation, water supplies, and restaurants, can involve mining, blasting, erosion etc. which creates serious physical damage to the environment. These are some key factors that need to be considered by citizens and the government of Uttarakhand for the development of eco-friendly and sustainable tourism in Uttarakhand.

### Economic impacts of Uttarakhand tourism



**Fig. 14.4**  
Uttarakhand tourism:  
economic impacts



**Fig 14.5**  
Adverse environmental impacts of tourism

Following are the challenges faced by Uttarakhand tourism:

- ➲ Disaster prone areas – There are numerous instances where development is on disaster prone high risk zones.
- ➲ Unplanned infrastructure development in and around hill areas. Destinations like Mussoorie, Nainital etc. are overcrowded and need urgent interventions in terms of sustainable planning and management strategies.
- ➲ Unplanned tourism development is severely damaging the fragile ecosystem of the state. There is a need to involve local communities in the tourism sector to ensure conservation of natural resources through proper framework.
- ➲ Visitor management during Char Dham Yatra.
- ➲ Parking and traffic management at major hill station.
- ➲ Availability of potable drinking water at all destinations.
- ➲ Solid waste management at destinations.
- ➲ Availability of clean and adequate public convenience facility.
- ➲ Lack of sufficient quality accommodation across all categories.
- ➲ Inadequate rail and air connectivity.
- ➲ Lack of proper regulation and safety standards for development of niche tourism products like adventure tourism, health and rejuvenation in the state.
- ➲ Tourism in Uttarakhand is seasonal in nature. Thus, there is a need to develop innovative and niche tourism products to ensure continuous flow of tourists across the year.
- ➲ Lack of trained guides at major tourism destinations (presently availability is limited at National Parks).

### v. Government programmes and policies

Tourism policies in Uttarakhand are made by government experts to analyse the tourism potential and strengths along with weaknesses and challenges. This is done on the basis of the analysis of various sites and destinations related to the tourism. The analysis then used form a road map for all round development of the state. The pilgrimage, natural beauty, adventure tourism, wildlife tourism, ecotourism etc. are the strengths and assets of Uttarakhand. Other kinds of tourisms are also having great scope in the state. The govt. should take steps to promote its growth in a judicious and eco-friendly manner.

The Uttarakhand Tourism Development Master Plan (2007-2022) is an important policy that collaborates with Govt. of India, United Nations Development Programme, and World Tourism Organization. The master plan is to support government of India in their endeavour to promote high quality sustainable tourism infrastructure, facilities, and products in various tourism zones of the state.

Apart from this, the Uttarakhand Tourism Development Board (UTDB) Department of Tourism (Govt. of India) has reported some other acts and policies such as Home Stay Policy, (Atithi Home – Stay – Yojna), Tourism Policy, Industrial Policy 2003, Amended Hill Policy 2011, and UTDB acts to promote tourism in the state. Details of policies and acts related to tourism in the state is presented in Table 14.2:

1.	Atithi Home - Stay Yojna- 2015	It is for the development of such tourist places where tourists want to stay for a time, but these places are lacking for some important facilities for the tourists. There are two amendments: Uttarakhand Home Stay First Niyamawali Amendment- 2016 & Uttarakhand Home Stay Second Niyamawali Amendemt- 2017 in this policy.
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**Table 14.2**  
State tourism  
policies  
and acts

2.	Uttarakhand Tourism Policy-2017	Vision of the Uttarakhand tourism policy 2017 is "to create a world class tourist destination which is safe, sustainable, and inclusive leaving a mark of peace and tranquillity ". It concludes all tourism strengths of Uttarakhand major challenges and their proper solutions for sustainable tourism development.
3.	Industrial Policy, 2003 <sup>1</sup>	<p>Published in 2003 with the various objectives and visions of overall sustainable development involving tourism also. Following are some important visions of industrial policy 2003 in perspective of tourism development in Uttarakhand:</p> <ul style="list-style-type: none"> <li>• To create high quality world class infrastructure facilities in the state.</li> <li>• To provide single window facilitation in the state to expedite project clearances and provide an investor friendly climate.</li> <li>• To promote and encourage private sector participation in the development and management of infrastructure projects such as theme parks, tourism infrastructure, development of new tourist destinations, airports/helipads/airstrips, roads, generation, transmission and distribution of power .</li> <li>• To promote tourism as a focus area and develop Uttarakhand as a premier global tourism destination.</li> </ul>
4	Amended Hill Policy 2011	It describes the agenda for incentives and facilities, concessions and easiness of procedures, increasing and enhancing employment opportunities etc.
5	UTDB Act 2001 and UTDB Act 2001, Amendment 2004	These acts are for the development of tourism activities in a regular manner.

To give impetus to the tourism development in the state the present tourism organizational structure needs to be strengthen and efforts should be made to open tourism offices in every divisions and districts.

Furthermore other departments such as Rural Development, Town & Country Planning, Transports, Uttarakhand Rural Road Development Agency; directorates such as Directorate of Industry, Urban Development; other

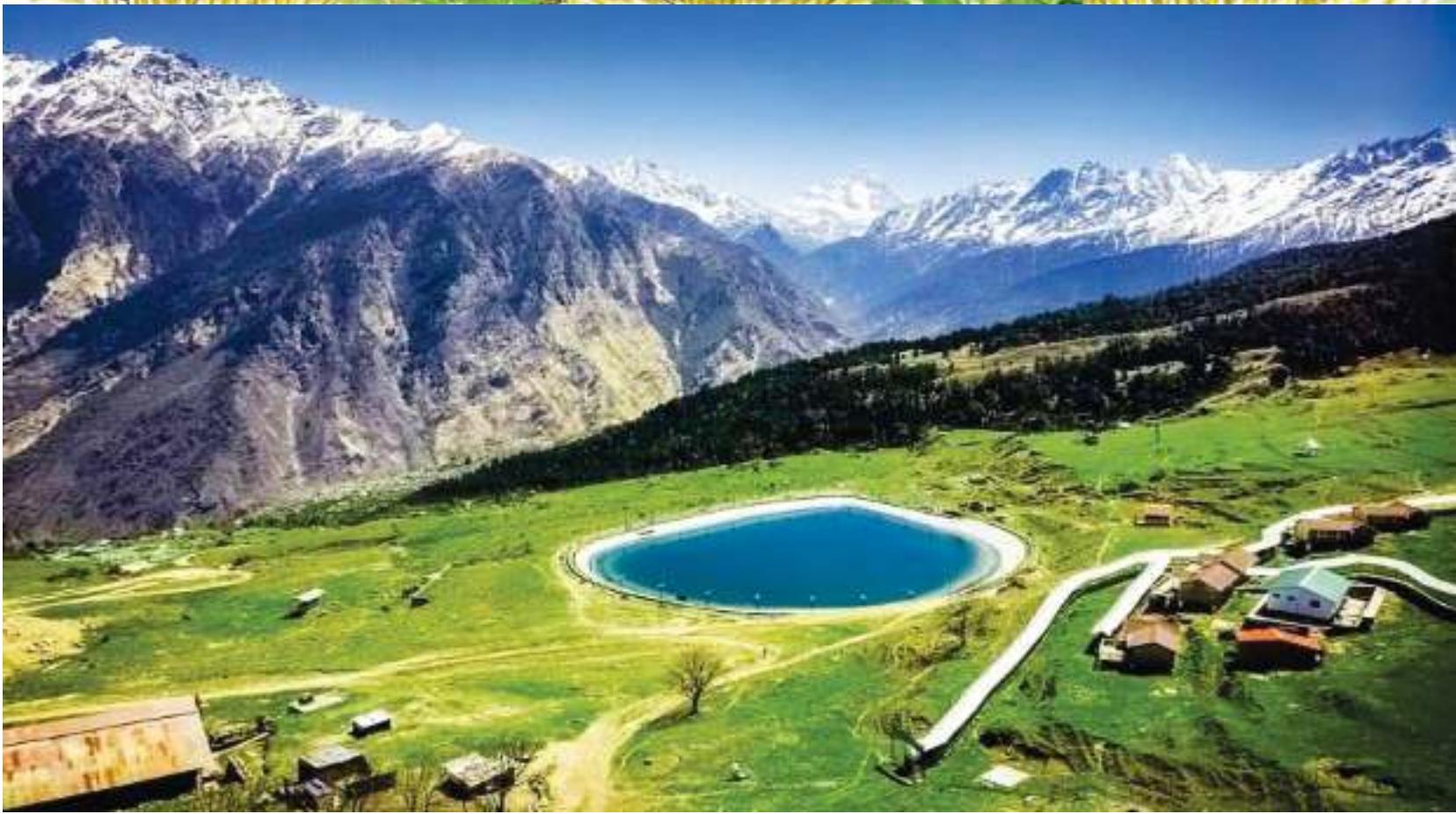
organizations/boards such as Bhagirathi River Valley Development Authority, Environment Protection and Pollution Control Board, State Biodiversity Board, State Water and Sanitation Mission, Swajal, BRIDCUL (Bridge, Ropeway, Tunnel and other Infrastructure Development Corporation of Uttarakhand Limited) Uttarakhand State Rural Livelihood Mission & Uttarakhand Transport Corporation are directly or indirectly involved in tourism and infrastructure development in Uttarakhand.

<sup>1</sup>Uttarakhandtourism.gov.in





# Sustainable Development and Environmental Security





# 15

*"Few threats to peace and survival of the human community are greater than those posed by the prospects of cumulative and irreversible degradation of the biosphere on which human life depends. True security cannot be achieved by mounting buildup of weapons (defence in a narrow sense), but only by providing basic conditions for solving non-military problems which threaten them. Our survival depends not only on military balance, but on global cooperation to ensure a sustainable environment."*

Brundtland Commission Report, 1980

*"Sustainable development is a compelling moral and humanitarian issue, but it is also a security imperative. Poverty, environmental degradation and despair are destroyers of people, of societies, of nations. This unholy trinity can destabilise countries, even entire regions."*

Colin Powell, 1999

Sustainable development is a development that meets the needs of the present without compromising the ability of future generation to meet their own needs. The principal goal of development policy is to create sustainable improvement in the quality of life for all people. The sustainable development is the key to a social order based on equality, prosperity and security. It is a process in which development can be sustained for many generations to come.

Uttarakhand was carved out from Uttar Pradesh on November 9, 2000 with two divisions: Garhwal and Kumaon. Out of its 13 districts, four districts (Nainital, Haridwar, Dehradun and Udham Singh Nagar) have large areas in the plains hence more potential for developmental aspects, whereas remaining nine districts are in hill region and sustainable development is complicated in these areas. Although, formation of the new state has fulfilled the high expectations of people related to development and better

living standards, but the hilly districts are far ahead on various developmental indicators as compared to plains. Uttarakhand is India's newest Himalayan state and is growing very rapidly due to efforts of central and state government. Although natural disasters are serious problem to concern but its natural beauty and tremendous economy generation potentials through its God gifted natural resources also present the chances for sustainable growth and development. The average economic growth of Uttarakhand has been increased from 3% per annum to about 11% per annum after year 2000. Therefore, Uttarakhand is one of the fastest growing states in India as state's GSDP increased at a compound annual growth rate (CAGR) of 16.03% during 2004-05 to 2015-16. Although, most of the time these growth indicators are the causes for disturbance in environmental and ecological balance. Therefore Uttarakhand government has made 'sustainable development' which is an important element for the development of the state.



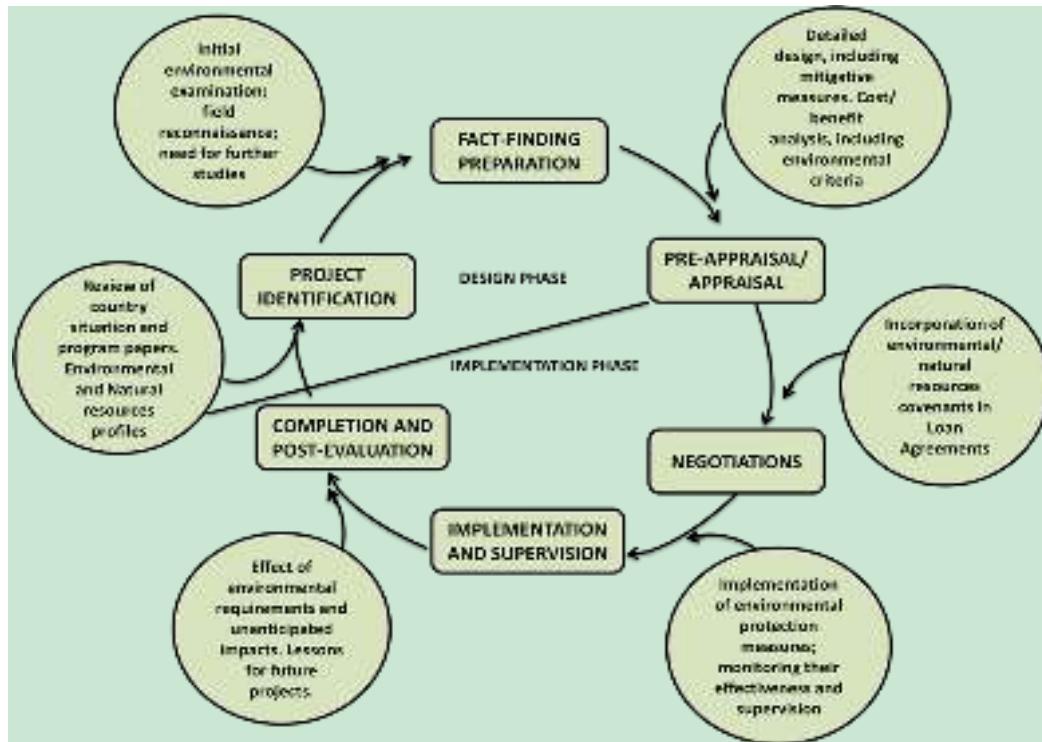
Uttarakhand is also called as 'The Dev Bhoomi' because of its remoteness and pristine environment that is suspected as adobe of Gods. The remoteness declined after the 1962 Indo-China war with national highways being pushed right up to the China occupied Tibetan border to facilitate movement of troops (Fig 15.1). Naturally beautified Uttarakhand has various natural resources. With average to high rainfall (average is 1550 mm and high more than 2000 mm annually) and snow in Himalaya Mountains, the state is blessed with thousands of rivers and streams. Therefore

various kinds of sustainable developmental aspects can be fulfilled by the nature of Uttarakhand. Tremendous potential of hydropower generation, tourism development, forest abundance and many other resources push Uttarakhand to sustainable development. Moreover, for disaster prone state the effects of disasters can be reduced by government reported proper mitigation systems. Proper environment planning and management is needed for protection of environment as depicted in Fig 15.2.

**Fig 15.1**  
Road map,  
hill stations and  
borders of  
Uttarakhand



**Fig 15.2**  
Project cycle  
for environmental  
planning and  
management<sup>1</sup>



Agriculture sustainability is again a prominent challenge for sustainable development of Uttarakhand. More than 70% of state's working population is involved in agriculture even though the cultivable area is less than 15 %. Improvement in fertility of poor to moderate soil in mountain region is another challenge to government. Awareness programmes, production of high crop yield and good variety seeds, fertilizer distribution programmes and promotion of organic agricultural practices are some important aspects for sustainable development of agriculture in the state. Agriculture Department, Department of Animal Husbandry, Fisheries Department Uttarakhand, Uttarakhand Jal Sansthan, Uttarakhand Sheep and Wool Development Board, Uttarakhand Tea Development Board and various central and state Institutions such as ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan (Almora), G. B. Pant

University of Agriculture and Technology (Pantnagar), Uttarakhand University of Horticulture and Forestry (Bharsar), etc. are involved directly to the agriculture development of Uttarakhand state.

Economic growth of Uttarakhand is largely dependent on its natural resources. Although development of industrial areas is a big factor for economic growth of the state. In newly formed Uttarakhand state, government put the faith in the conventional model of development but also is working with a single-minded goal of increasing monetary wealth through industrialization. The major constraint of this goal is that it does not recognize the industrial development in mountainous regions of Uttarakhand. Although it is quite obvious that the development of industries in hills is very challenging that requires development of new techniques to remove these constraints.

<sup>1</sup>Asian Development Bank (1986)

Industrialization in the western and southern plains of state has been the engine of economic development after statehood in 2000. It has generated wealth in Uttarakhand, but the development is neither equitable nor sustainable as underlined by the impacts of the June 2013 disaster. A majority of the working population in the state is engaged in agriculture, whose income growth, however, is the slowest of all the sectors since statehood. It has impoverished mountain farming families, with the SC community in the mountain areas being the least benefitted. Impoverishment has led to heavy out-migration from the mountain districts. Therefore, it is needed to implement the indigenous sustainable development vision emphasized during the statehood agitation. Expanding forest cover with livelihood enhancement has to be the first priority. People are more likely to enhance forest cover if they are assured of tangible benefits. New legislation must be passed to give villagers ownership of their local forests. Community based institutions like the Van Panchayats and Mahila Mangal Dals (MMDs) can expand and manage village forests (Gram Vans). Compensatory Afforestation Fund Management and Planning Authority (CAMPA) and Green India Mission funds should be spent through these institutions.

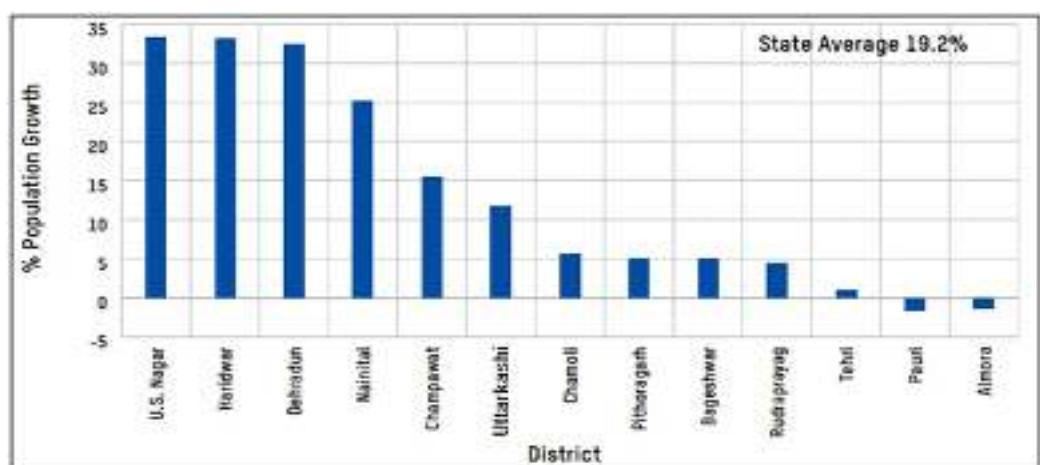
The state government also needs to take a proactive approach to the implementation of the Scheduled Tribes (Recognition of Forest Rights) Act, 2005. Ensuring remunerative ecological livelihoods for mountain dwellers must be the second priority of economic development in Uttarakhand. Mountain agriculture needs to be revived in a sustainable manner. It can be done by integrating high value crop cultivation, basic agro-processing at the farm level, dairying, horticulture and floriculture with adequate market linkages. 'Voluntary Organizations' (VOs) can provide value chains development support to community based

organizations. The Agro Vision Uttarakhand 2020 plan needs to be reviewed, modified and implemented. Funds and activities under schemes like Rashtriya Krishi Vikas Yojana, Agricultural Technology Management Agency, and National Food Security Mission should focus more on promoting integrated farming systems development to yield significant results. Major rural development schemes like Mahatma Gandhi National Rural Employment Guarantee Act, National Rural Livelihood Mission, and Integrated Watershed Management Programme can enhance the productivities of common pool resources and help improve food and livelihood security for the rural people.

Along with natural disasters, out migration is also most prominent development constraint for state. According to earthquake zonation map of India, the zone IV and V (most earthquake prone zone of India) is present in the state. Uttarakhand also witnesses landslides, flash-flooding and forest fires in almost every year. Some rain shadow areas are also prone to droughts. Mitigation of such conditions is highly required for sustainable development in the state. Out migration of youth of state is also a big problem. Many of the villages (more than 1,000) are now called ghost villages because hardly anyone lives there. An absolute decline of 17868 persons in the population of Almora and Pauri Garhwal districts between 2001 and 2011 points towards an out flux of people from many hill regions of the state (Fig. 15.3). From recent data by Uttarakhand Rural Development and Migration Commission, over 700 villages in Uttarakhand have been deserted and a total of 3,83,726 people have migrated from their homes in Uttarakhand villages over the last 10 years with 50 per cent of them going out in search of livelihood and the rest due to poor education and health facilities. Therefore, out migration is a major challenge for sustainable development in the state.



**Fig 15.3**  
District-wise  
decadal (2001–11)  
population growth  
rate in Uttarakhand



Following are some desired thrusts required for sustainable development in Uttarakhand

**➤ Ecologically sensitive development by afforestation**

In a mountain region forests are the backbone of healthy ecosystems as well as source for livelihood and daily used fuel, fodder etc. Dense and moderately dense forests survive on only half of Uttarakhand's forest lands. Therefore, the first priority must be given to expand and maintenance of current forest cover. Forests also sustain rivers and other water ecosystems in Uttarakhand. This will ultimately lead to protection of wildlife and wilderness.

**➤ Sustainable and safer infrastructure development**

In disaster prone areas, post-disaster relief mitigations and infrastructure reconstruction are very expensive. Therefore complete understanding and advisements from experts can be taken into consideration for conceptual shift in the old disaster mitigation processes to modern disaster management processes. Furthermore, hydropower development and tourism are major sources of revenue but can also imperil large populations. Therefore, for safe and sustainable hydropower production and tourism development in Uttarakhand, the entire approach from planning to approvals, constructions and regulation needs to be reviewed.

**➤ Safer tourism**

Among various types of tourisms, religious one is in its peak in Uttarakhand. The religious tourism generates big revenues for the government. Haridwar, during major festivals attracts millions of pilgrims. Moreover, about a million people also visit the five major shrines in eco-sensitive Inner Himalaya. Each location has a potential disaster risk due to the congregation of very large numbers in limited spaces. Hence, the state needs to prepare an effectively managed and disaster emergency plans at these locations. Efficient disaster management systems have to be put in such places. Furthermore, many local families also depend on the annual Char Dham Yatra season for their annual cash income.

Moreover, the adventure sports in the form of river rafting, rock climbing, para-gliding etc. have also picked up. Adventure tourism, however, needs to be regulated to prevent accidents and protect environment.

**➤ Safer green roads**

Road construction in Himalayan region is good for economic growth but is hazardous in context of eco-friendliness. Deforestation and increases slope instability are major consequences from road construction. Hence, there is a need to develop safe trekking routes as alternatives. Ropeways are useful alternatives to roads, particularly in short stretches that are steep.

**➤ Disaster preparedness**

The prediction and warning systems, risk-avoidance action, hardware, emergency plans and immediate activation of emergency plans are very important factors for disaster mitigation. These factors minimize losses when they work together.

**➤ Good governance**

The good governance is a pre-requisite for sustainable development of Uttarakhand. It needs implementation of disaster management plans for various disasters. Promotion of earthquake/fire/ flood/landslide safe housing constructions, safe road constructions, safe infrastructure developments, etc. by taking good governance with experts is mandatory for sustainable development.

**➤ Climate change**

Climate change is also responsible for Uttarakhand's existing vulnerabilities towards disasters. The June 2013 disaster could be a harbinger of the onset of climate change as increased variation in temperatures and precipitation. Growth and yields of crops, fruits and flora will also be affected. Several developmental opportunities that may result to combat with unavoidable consequences of climate change are reported below:

<b>Agriculture</b>	Revitalization of rain-fed agriculture; development of integrated farming systems for different agro-ecological conditions; relocation to more productive areas or cultivation in new warmer areas; better pest surveillance; greater insurance coverage; improved information systems on climate changes and adaptation options.
<b>Animal Husbandry</b>	Animal husbandry has been a traditional coping strategy to deal with the vagaries of weather. The opportunities include improved disease surveillance, animal health and breeds; resilient technologies and institutions for better livelihood opportunities, for example, fodder development, dairy production, backyard poultry and women's SHGs.
<b>Forestry</b>	Strengthening decentralized forest governance institutions like the Van Panchayats, Mahila Mandal Dals and the Biodiversity Management Committees proposed under the Forest Rights Act; better measures to control forest fires; increased forest cover and livelihoods options including agro-forestry and biodiversity conservation.
<b>Disaster Mitigation</b>	Research and documentation of local climate change impacts; preparation of disaster management plans at all levels; monitoring of hazardous impacts; relocation of threatened communities and critical infrastructure; establishment of local quick response teams; retrofitting of lifeline infrastructure; promotion of multi-purpose insurance schemes.

#### ➤ Advocacy

Civil society must advocate lessons learnt from the Uttarakhand disasters. To effectively advocate a people-centric mountain development agenda, the people of the Himalayan states have to come together on a common platform. Some of the important advocacy issues are:

- Following new model of green development that is ecologically sustainable
- Such development model will have control the natural resources from degradation
- All the mountain states need to act together on important demand.

#### **Environmental security:**

Environmental security is the relation between the environment and the security of human and nature which

has the object of much research and the subject of many publications in recent decades. A recent comprehensive overview of the environmental security observes that:

- ✓ The environment is the most transnational issues, and its security is an important dimension of peace, national security, and human rights that is just now being understood.
- ✓ Over the next 100 years, one third of current global land cover will be transformed, with the world facing increasingly hard choices among consumption, ecosystem services, restoration, and conservation and management.
- ✓ Environmental security is comprising the dynamics and interconnections among the natural resource base, the social fabric of the state, and the economic engine for local and regional stability.



- ✓ While the precise role of the environment in peace, conflict, destabilisation and human insecurity may differ from situation to situation and as such are still being debated in relation to other security and conflict variables, there are growing indications that it is increasingly an underlying cause of instability, conflict and unrest.

#### **Importance of environment security**

- ✓ To the extent humankind neglects to maintain the globe's life-supporting eco-systems generating water, food, medicine, and clean air, current and future generations will be confronted with increasingly severe instances of environmentally induced changes. Such events will test our traditional concepts, boundaries, and understandings of national security and alliance politics and, if taken for granted, may lead to conflict including violent conflict from the global to regional, national, local or human level.
- ✓ Environmental security is also determined by environmental change, population size and growth, and unequal distribution or access to resources. Of these factors, unequal access to resources is not bound by physical limits alone. It is also a reflection of societies' preferences, beliefs and norms. Leading examples of emerging environmental change are: depletion and pollution of fresh water supplies, depletion of fisheries, degradation and disappearance of biodiversity, degradation and loss of agriculture lands, food and health safety, stratospheric ozone depletion, and global warming. Of these major environmental changes facing humankind, the first five are now or will likely be growing threats to environmental security in the near term, the

latter two will increasingly affect human security in the coming 50 years. Our ability or lack thereof to make innovative institutional arrangements and/or technological advances for managing the environmental security challenges we face, will increase or decrease global environmental security.

- ✓ The basic framework for understanding the relationship between environment and security is the Millennium Ecosystem Assessment which looks at all the functions of ecosystems and the services they deliver to people and nature. Conceptually one may make a difference between environmental services and natural resources such as minerals, oil and gas. They also may lead to conflicts - and very often do. But then it is not scarcity, but abundance, and the motives are not need, but greed.

#### **Environment Conflict and Cooperation**

- ✓ Another important aspect in the relationship between environment and security is the impact of conflict on the environment. Violent conflict, war, displaced persons, etc. may lead to a decrease of environmental security and spiral up a vicious circle of scarcity and further conflict.
- ✓ On the other hand "the sustainable use of natural resources and joint efforts to protect the environment across national borders and social divisions can contribute to conflict prevention and peace building. For example, the predictions of future wars over access to water have thus far failed to come true. On the contrary, various forms of cross-border water cooperation are contributing to stability and peace in regions of latent conflict".



All this means that national security is no longer about fighting forces and weaponry alone. It relates increasingly to watersheds, forests, soil cover, crop lands, genetic resources, climate and other factors rarely considered by military experts and political leaders, but when taken together deserve to be viewed as equally crucial to a nation's security as military

prowess. The situation is epitomized by the leader who proclaims he will not permit one square metre of national territory to be ceded to a foreign invader, while allowing hundreds of square kilometres of topsoil to be eroded away each year.

