

**REPORT OF BRAIN STORMING SESSION
ON IMPACT OF**

CLIMATE CHANGE

ON HIMALAYAN LIVELIHOOD

ORGANISED BY
UTTARAKHAND STATE COUNCIL FOR SCIENCE & TECHNOLOGY, UTTARAKHAND
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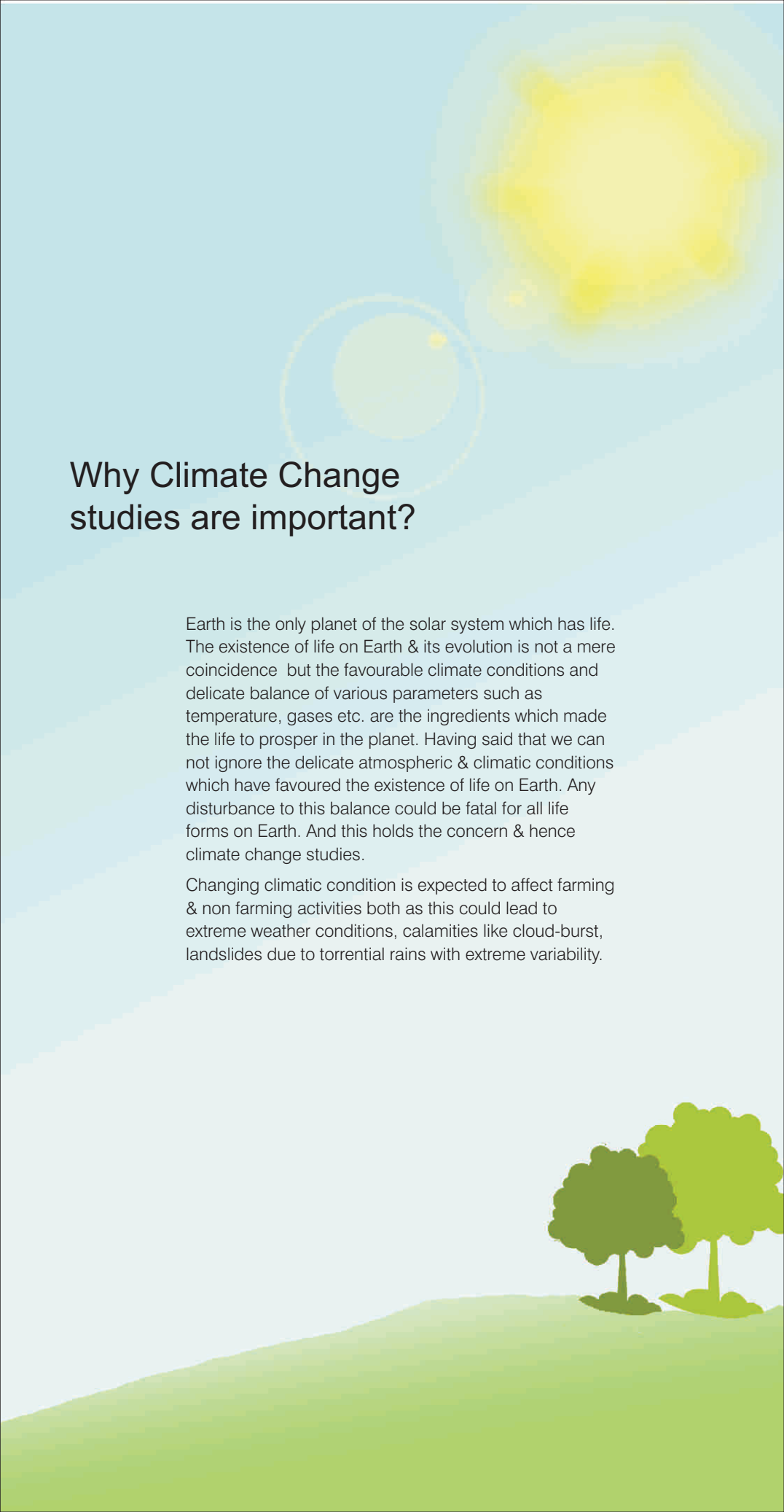
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Why Climate Change studies are important?

Earth is the only planet of the solar system which has life. The existence of life on Earth & its evolution is not a mere coincidence but the favourable climate conditions and delicate balance of various parameters such as temperature, gases etc. are the ingredients which made the life to prosper in the planet. Having said that we can not ignore the delicate atmospheric & climatic conditions which have favoured the existence of life on Earth. Any disturbance to this balance could be fatal for all life forms on Earth. And this holds the concern & hence climate change studies.

Changing climatic condition is expected to affect farming & non farming activities both as this could lead to extreme weather conditions, calamities like cloud-burst, landslides due to torrential rains with extreme variability.

Climate Change at international theater

Over last two decades climate change has become a major issue confronting the lives of people living across the globe. Temperature data available since 1000 A.D. indicates that the 20th century was unusually warm and 1990s decade was the hottest on record with six of the warmest years in last century.

Erratic weather patterns have been experienced on a regular basis across the world with the Indian subcontinent being part of the global phenomenon. In last two decades, the world has witnessed rapid growth in industrialized nations where fossil fuel based economic development has resulted into an exponential increase in Green House Gases' concentrations in the atmosphere.

All three major global surface temperature reconstructions show that Earth has warmed since 1880. Most of this warming has occurred since the 1970s, with the 20 warmest years having occurred since 1981 and with all 10 of the warmest years occurring in the past 12 years. This is because of increased anthropogenic activities across the globe.



Climate change in Himalayas

Climate change is expected to have serious environmental, economic, and social impacts on Himalaya where livelihood depend on the use of natural resources particularly in the rural areas. Uttarakhand being the most densely populated Himalayan state have high vulnerability to the impacts of climate change.

Improvement of rural livelihood and enhancing adaptive capacity of both natural and human systems to the long-term impacts of climate change therefore constitute the critical components of sustainable development planning in Uttarakhand. Community responses and traditional adaptation practices to climate change are considered highly effective in enhancing the resilience and adaptive capacity of both natural and social system and therefore needs support from all stake holders.

Due to the phenomenon of climate change, livelihood of the people is likely to affect directly. Govt. of India has issued a National Action Plan on Climate Change (NAPCC) along with the National Mission on Climate Change to assess the situation and bring in efforts to minimize its impact. The Action Plan is based on the following Eight National Missions:-

1. National Solar Mission
2. National Mission for Enhanced Energy Efficiency
3. National Water Mission
4. National Mission on sustainable Habitat
5. National Mission for sustaining the Himalayan Ecosystem
6. National Mission for a "green India"
7. National Mission for sustainable Agriculture
8. National Mission on strategic knowledge for Climate Change.

Some Vital Facts

Rio summit in 1992 recognized the crucial role played by mountain ecosystem in sustenance of human life. As part of the activities initiated to ensure sustainable mountain development, the year 2002 was declared as International Year of Mountains (IYM).

Glaciers that sustain many rivers of the world are melting. When they will disappear, rivers will run dry. Uttarakhand has 11 important glaciers in which Gangotri is the longest (30 km) and from 1962-91 (29 years) receded 580 m. Gangotri is the main contributor to the holy river Ganga



About Uttarakhand

Uttarakhand has a glacier area of around 2312 km². The rainfall in Uttarakhand varies from 670 to 2500 mm per annum. The net cultivated area is 5.12 lakh ha with 158.89% cropping intensity. All India ranking of Uttarakhand in terms of food grains is 17 while the area under fruits and vegetables is 54000 ha as per land use.

The climate in general depends on geographical altitude with zones divided as warm temperate (900-1800m), cool temperate (1800-2400m), cold zones (2400-3000m), alpine zone (3000-4000m), glacier zone (4000-4800m) and perpetually frozen zone (above 4800m). The geographical, forest and irrigated area of Uttarakhand is as follows:

Total Area - 53483 sq. km

Forest area - 34662 sq. km-- 4.5% of India's forests

Forest Cover - 23938 sq. km--

Density- 19023 sq. km

Open forest land-- 4915 sq. km

Net irrigated area - 345000 ha

Gross irrigated area - 559000 ha

Net un-irrigated area - 422000 ha

Ground water potential

Total replenish ground water resource - 2.7 BCM/year

Available ground water resources for irrigation - 2.29 BCM/year

Balance ground water potential available for exploitation - 1.47 BCM/year

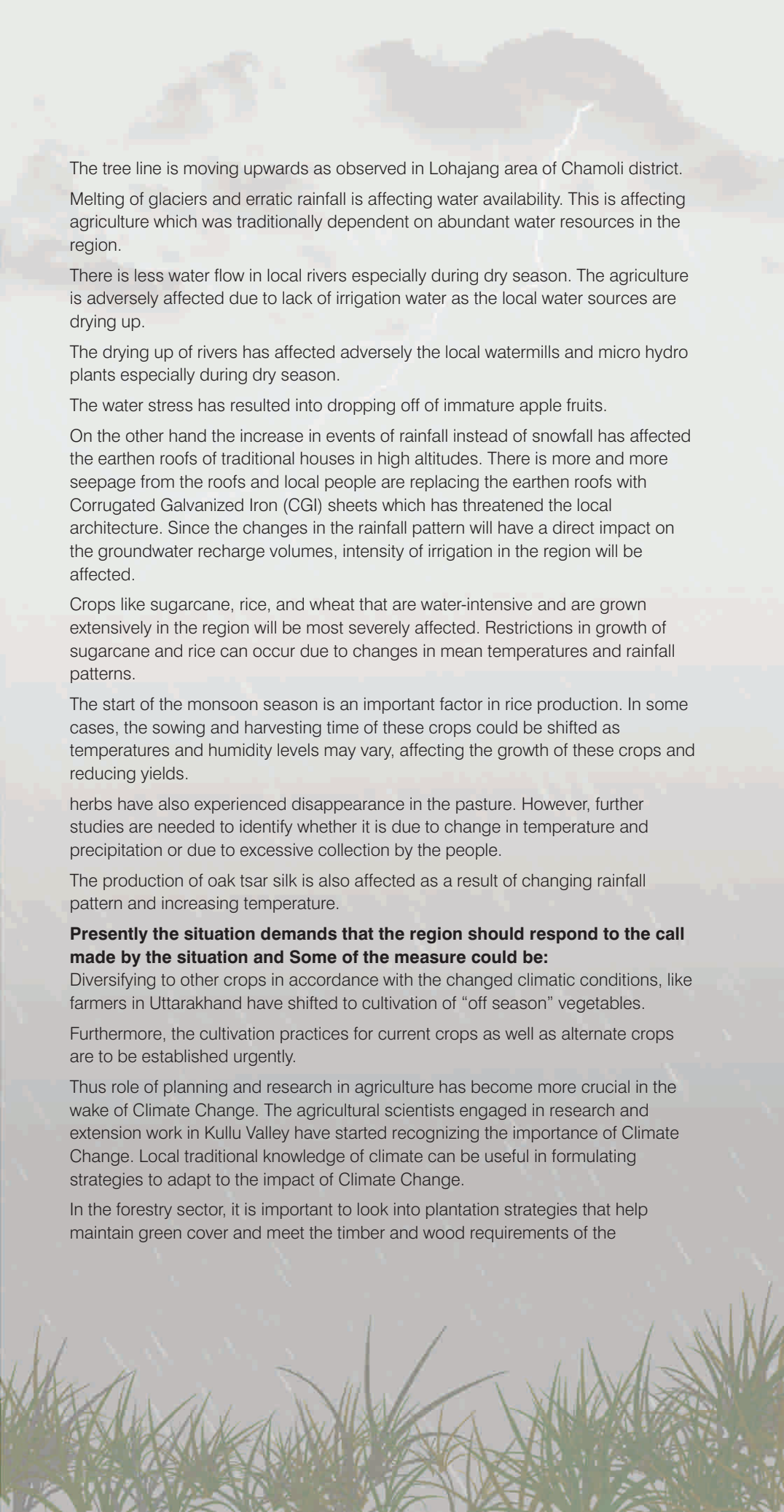
The possible effects of Climate Change in Uttarakhand can be seen amongst the following

It has been observed over the years that monsoon rains **ha** shifted forward from July/August to August/September and winter precipitation from December/January to January/February. These changes are affecting production of Amaranthus (a good cash crop of high altitudinal village of the Uttarakhand) and winter crops like barley and wheat.

Change in average winter temperature has led to early flowering in Rhododendron or Burans in Uttarakhand, affecting availability of flowers for annual rituals.

Horticulture is an important source of income of the Himalayan people. Irregular rainfall and snowfall; change in climatic condition; and rising temperatures affect fruit production.

The Chamba fruit belt in Tehri District of Uttarakhand, once famous for apple orchards has witnessed change in cropping patterns. Due to increase in temperature, invasion of pine forests upwards into oak forests have started affecting the fodder availability for livestock and people's livelihood.



The tree line is moving upwards as observed in Lohajang area of Chamoli district.

Melting of glaciers and erratic rainfall is affecting water availability. This is affecting agriculture which was traditionally dependent on abundant water resources in the region.

There is less water flow in local rivers especially during dry season. The agriculture is adversely affected due to lack of irrigation water as the local water sources are drying up.

The drying up of rivers has affected adversely the local watermills and micro hydro plants especially during dry season.

The water stress has resulted into dropping off of immature apple fruits.

On the other hand the increase in events of rainfall instead of snowfall has affected the earthen roofs of traditional houses in high altitudes. There is more and more seepage from the roofs and local people are replacing the earthen roofs with Corrugated Galvanized Iron (CGI) sheets which has threatened the local architecture. Since the changes in the rainfall pattern will have a direct impact on the groundwater recharge volumes, intensity of irrigation in the region will be affected.

Crops like sugarcane, rice, and wheat that are water-intensive and are grown extensively in the region will be most severely affected. Restrictions in growth of sugarcane and rice can occur due to changes in mean temperatures and rainfall patterns.

The start of the monsoon season is an important factor in rice production. In some cases, the sowing and harvesting time of these crops could be shifted as temperatures and humidity levels may vary, affecting the growth of these crops and reducing yields.

herbs have also experienced disappearance in the pasture. However, further studies are needed to identify whether it is due to change in temperature and precipitation or due to excessive collection by the people.

The production of oak tsar silk is also affected as a result of changing rainfall pattern and increasing temperature.


Presently the situation demands that the region should respond to the call made by the situation and Some of the measure could be:

Diversifying to other crops in accordance with the changed climatic conditions, like farmers in Uttarakhand have shifted to cultivation of "off season" vegetables.

Furthermore, the cultivation practices for current crops as well as alternate crops are to be established urgently.

Thus role of planning and research in agriculture has become more crucial in the wake of Climate Change. The agricultural scientists engaged in research and extension work in Kullu Valley have started recognizing the importance of Climate Change. Local traditional knowledge of climate can be useful in formulating strategies to adapt to the impact of Climate Change.

In the forestry sector, it is important to look into plantation strategies that help maintain green cover and meet the timber and wood requirements of the



community and other dependents. Promoting bamboo plantation as a coping mechanism to Climate Change by organizations like Uttarakhand Bamboo and Fiber Development Board (UBFDB) is an effort in that direction.

While bamboo can be used as construction material, its use as & for Carbon **sequestration** **fodder** reduce can props, fodder etc to reduce dependence on trees and conventional materials.

A new review has found that changing weather conditions are threatening the existence of some species of medicinal plants, which could have a knock-on effect on supplies and prices of extracts used in dietary supplements.

According to an article published by the American Botanical Council (ABC) in its issue of HerbalGram, some key species could have been already lost as a result of climate change.

Traditionally local people are not prepared for some of these events which expose them to potential disasters. The farmers should be educated with the potential hazard the change in climate can bring about and awareness about this to be generated.



The initiative

Climate change is a phenomenon that is enhancing some of the prevalent hazards like drought, floods, etc. Although local people are aware of climate disturbances and their impacts in their area, they are not fully aware of global and local climate change, its potential impacts and needs for adaptation.

The issue of climate change has to be integrated into local development activities for which the local institutions need reorganization to accommodate climate change issues.

For this Uttarakhand State Council for Science and Technology (UCOST), Dehradun and Uttarakhand Science Education and Research Centre (USERC) has initiated a step and taken lead in setting-up the Uttarakhand Centre on Climate Change (UCCC) in Kumaun University, Nainital.

The centre will take the Uttarakhand State as a natural laboratory for developing a Web based Geoportal of climate change data. The Uttarakhand Geoportal would be constituted of six sub-portals namely -agro-informatics, geo-informatics, hydro-informatics, weather-informatics, bio-informatics and socio-informatics.



Discussions

Based on Brain Storming sessions on "Impact of Climate Change on Himalayan Livelihood System" the deliberations highlighted the impact of climate change and possible suggestions for sustainable farming and non-farming practices, which could provide blue print for Himalayan livelihood systems.

In view of the tropical interest in the subject of climate change and likely societal impact, the session attracted good response from the participants. At the brainstorming session, 12 invited experts presented their opinion on the subject and more than 50 experts participated in the open discussions.

Presentation by experts covered wide spectrum of topics including the likely nature and sources of climate change, changes in mountain meteorology, rainfall pattern, glacier health, hydrological cycles, fluctuations in tree line/vegetation pattern especially the impact on plant life, cultivation of medicinal and aromatic plants, eco-tourism etc.

Experts in their presentation were unanimous that there are strong evidences in the form of increment in global average temperature, rising level of green house gases, change in precipitation pattern, frequency of extreme events etc suggesting that climate change is a reality, although many questions needs to be answered, particularly whether the change can be solely attributed to global warming due to anthropogenic factors.

Some key points of the discussions --

1. Black carbon is major component in Greenhouse gases influencing the climate. In addition to the regional characteristics, the black carbon can have strong influence in small pockets. Policy needs to check it.
2. There is a need for decoupling the natural vis-à-vis anthropogenic factors, as highlighted by many researchers and it as noted that national program being developed to quantify the climate forcing parameters cover this critical planning. Governance of the hill states of the Himalaya Eco-System-(G-SHE) is one such initiative. It was emphasized that in quantifying the climate forcing parameters, the solar forcing parameter need to be looked. The space age data shows the solar wind pressure and temperature has decreased by 15-20 percent in last 50 years allowing larger injection high energy cosmic rays to earth's environment.
3. Large variability in snow pattern within the Himalayan zone have been noticed and effects of local warming need to be looked into as an independent research problem.
4. There are varied claims related to the rate of recession of the Himalayan Glaciers, due to highly variable nature of the proxies used. Methodology adopted need to be validated.
5. Caution need to be exercised in generalizing the results from couple of glaciers to entire Glacier domain of the Himalaya, particularly ignoring climate-tectonic setting of the Himalaya.
6. Effect of climate change on agriculture productivity is more useful index for evaluating the impact of climate change on livelihood
7. One of the most significant observation highlighted that increase of CO₂ does not have negative influence on plant productivity. It was emphasized that it is not correct to draw equivalence of the Himalayan eco-system with Europe and other continental mountain belts.
8. Often the use of varied terminology is misleading, e.g. the tree line fluctuation should not be mixed with changes in vegetation cover. The tree line fluctuation in response to climate change could be tracked on decade scale only.
9. Himalaya plays an active role in the global climate system modulations, therefore it is expected that the Himalayan ecosystem is most likely to be affected by the anthropogenic modifications of regional climate. Strong opinion thus emerged that research for comprehensive data on impact assessment, education awareness and remedial measure requires big boost which includes coordinated efforts from scientific community and support from the policy makers.
10. The role of remote sensing data in quantifying the glacier cover, GLOF, extreme events and temporal changes in vegetation pattern was highlighted and readiness of the data for sharing amongst researchers was solicited by stakeholders.

11. Some success stories of implementing the local knowledge technology, e.g. artificial glacier impounding, trapping of water in fracture matrix in hard rocks during rainy season as a reserve for use in dry periods were discussed. The need for merging strategic rural technology with modern scientific technology should be encouraged by Government agencies.
12. New system of Rice Intensification should be adopted for enhanced production.
13. Despite the selection of specific session theme "Impact of Climate Change on Himalayan Livelihood System", perhaps controlled by the current trend of research to quantify the different climate forcing, much of the discussion focused on the nature and sources of climate change. However, every experts recognized the need go beyond the scientific research issues to address and make precise impact of climate change on the livelihood of the Himalayan eco-system. Given this fact all experts divulged on this issue and some specific recommendations emerged which are listed.

Recommendations

1. To minimize the effect of black carbon resulting from wood fuel, alternative cooking energy source should be made available to Hilly region
2. Effects of changing precipitation pattern should be communicated to farmers to adopt new strategy for sustained agriculture product and implement new crop sowing and harvesting pattern.
3. While there is urgent need to launch new campaigns for collecting multi-disciplinary data sets on mountain meteorology, rainfall, hydrology, vegetation patterns and yield etc, the compilation and validation of past available data, however meager, would be rewarding to test emerging hypothesis and questions. It was recommended that since such data sets are available in various isolated pockets, UCOST may initiate or launch a special project to collate data from data sources for Uttarakhand region so that homogeneous data become available to researchers for developing and validating unresolved issues of climate change.
4. Recognizing the livelihood in entire Himalayan fore-deep depends on river originating from the Higher Himalaya, the water management, including creation of artificial glacier lakes and water filled rubber dam technology, should be taken up on priority basis.
5. Herbal Garden should be established at strategic locations to generate data base information of climate change on Medicinal and Aromatic Plants particularly to evaluate impact of bioactive chemical constituents of high altitude species. This will develop new opportunities for rural masses and encourage eco-tourism.
6. A state-of-the-art bio dome facilities may be created to undertake laboratory experiments to simulate impact of climate change on the glaciers and plant life.
7. Special field base studies may be launched to quantify the effects of erosion and drainage on the soil productivity.
8. Need to introduce Natural hazard management at village level.
9. Periodic organization of stakeholders meeting for disbursing new information on climate change and devising new strategy for sustaining Himalayan eco-system.
10. Any strategy developed to combat or to adopt the effects of climate change on the habitants, human as well as plant life should be as friendly as possible to conflict with the socio-economic development of the region.



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