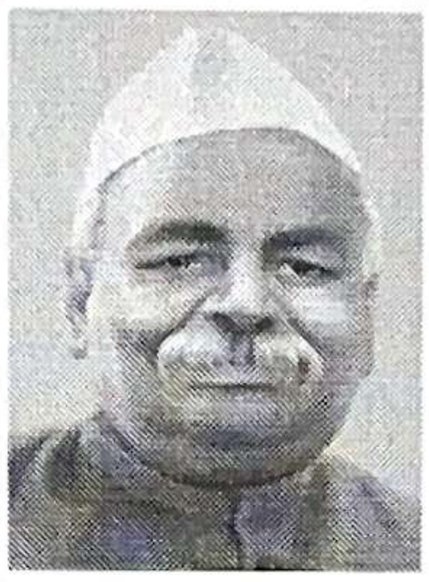
Azadi Ka Amrit Mahotsav

पंचम हिमालयन लोकप्रिय व्याख्यानः लद्दाख श्रृंखला

5th Himalayan Popular Lecture: Ladakh Series



Climate Change & Water Issues in Ladakh

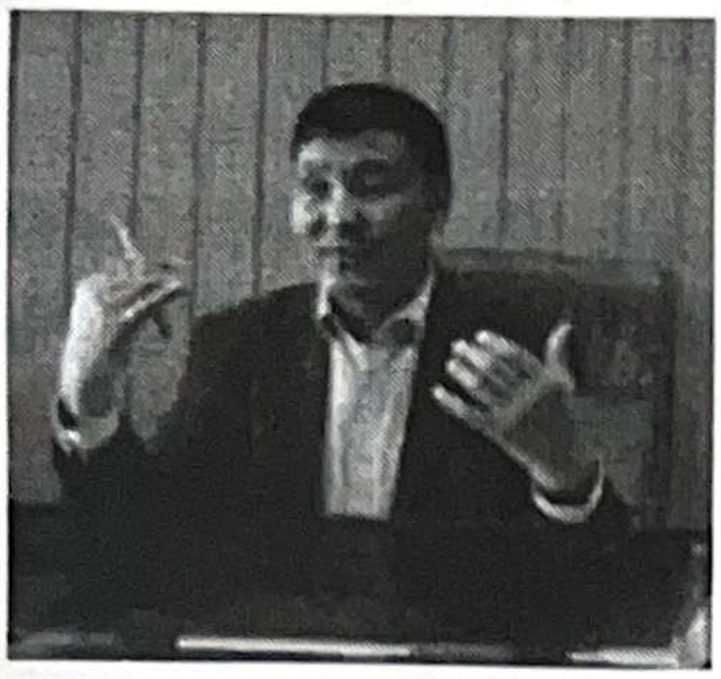
वक्ता: श्री सोनम लोटस वैज्ञानिक ई एवं प्रमुख,
मौसम केंद्र लेह - भारतीय मौसम विज्ञान विभाग, लेह, लद्दाख

Speaker : Shri Sonam Lotus Scientist E & Head, Met Centre Leh –Indian Meteorological Department, Leh, Ladakh

(10 सितंबर 2024 I 10th September 2024)

गोविन्द बल्लभ पंत राष्ट्रीय हिमालय पर्यावरण संस्थान

Govind Ballabh Pant National Institute of Himalayan Environment
लद्दाख क्षेत्रीय केंद्र I Ladakh Regional Centre
लेह लद्दाख (यू.टी.) I Leh Ladakh (UT)



Shri Sonam Lotus
Scientist E & Head, Met Centre Leh
Indian Meteorological Department, Leh, Ladakh

Shri Sonam Lotus was born in Shara Village of Leh, Ladakh. He began his educational journey in Leh, completing his schooling amidst the backdrop of the Himalayas. Driven by a passion for science, he pursued his higher education at Science College in Jammu, where he received his undergraduate degree in Science. His academic pursuits did not stop there; he went on to earn his MSc and MPhil degrees from the University of Jammu, solidifying his expertise in meteorology and atmospheric sciences.

In 2005, Shri Lotus joined the India Meteorological Department (IMD), marking the beginning of a remarkable career in weather forecasting and meteorological research. He underwent rigorous training in meteorology and weather forecasting at IMD's prestigious training school in Pune, where he honed his skills in understanding complex weather patterns and forecasting techniques. After his training, he was appointed to lead the Meteorological Centre in Srinagar, where his leadership and vision played a pivotal role in enhancing the region's weather forecasting capabilities.

One of his most significant achievements was the revival of the "Weather Forecasting and Flood Met Office in Srinagar," which had been dormant for nearly two decades. This revival was a crucial development, significantly enhancing the region's preparedness against natural disasters, particularly floods.

Currently, Shri Sonam Lotus serves as the Head of the Meteorological Centre in Leh, Ladakh, where his expertise and dedication continue to benefit the community. Beyond his official duties, Shri Lotus is deeply committed to popularizing meteorology among the general public. He authored a book on the '**Climate of Srinagar**,' providing invaluable insights into the region's unique weather patterns and climate challenges.

As a founding member of the Indian Meteorological Society (IMS) Chapter in Srinagar, Shri Lotus has been instrumental in strengthening the meteorological community in the region. His contributions have been widely recognized, and he has received numerous awards for his work, including the prestigious **Best Employee Award** presented by the **Prime Minister of India** in July 2018.

In Ladakh, Shri Sonam Lotus is fondly known as the "**Saint Lotus**" and "**Weatherman**," titles that reflect his deep connection with the people and his commitment to serving the community through his expertise in meteorology. His story is one of dedication, resilience, and a lifelong commitment to understanding and predicting the weather in one of the most challenging environments in the world.

Climate Change & Water Issues in Ladakh

Shri Sonam Lotus
Scientist E & Head, Met Centre Leh
Indian Meteorological Department, Leh, Ladakh

The Himalayas are the highest mountain range/landmass of the world having huge deposits of snow cover after the Antractic & Arctic regions and is one of the great source of fresh water in the world. This region is characterized by a complex topography with different land-cover/land-use patterns. Heterogeneous topography is a characteristic feature of mountainous regions and shows large variety of climatic conditions over a comparatively smaller gradient (Bhutiyani et al., 2007). Amplified variations in temperature and precipitation patterns are noted in such regions (Jhajharia and Singh, 2011). As these regions are most vulnerable to climate change (IPCC, 2007), they are used as indicators of climate change with focus on trends and consequences (UNEP, 2009). Mountains over the world are highly sensitive to climate change and are natural indicators of a changing climate regime of a region. Over the Himalayan region, changes in temperature and precipitation patterns and it impacts on water resources, glaciers, ecology and agriculture etc. are being attributed to the changing climate (Dimri and Dash, 2012). Higher sensitivity of mountainous regions towards the impacts of extreme variation in the climate makes such studies even more important.

Ladakh lies on the Western Himalayan Range and is a region bounded by the Karakoram range in the north and the Great Himalayan range in the south. Within its boundary it has two parallel ranges - the Ladakh range and Zanskar range - extending from north-west to south-east with the Indus River flowing in between them (Dimri et al 2018). Despite, little annual precipitation of 105mm at LEH, the fragile ecology of Ladakh experiences various kinds of adverse weather events especially Flash Flood, Mudslide, Landslide, Glacial Lake Outburst (GLOFs) and poses serious threat to safety of lives & property.

This needs urgent attention of the govt. and the people to mitigate the challenges posed by such extremes. Some of the recent such events are:

Table 1. The list of adverse weather events in Ladakh (2005 to 2024)

Stream/Catchment	Year
Leh Nalla (Ganglass) Stream overflow	23/24 June 2005
Phyang Nalla Stream overflow	July 2005
Leh Nalla(Gyalung Nalla) Stream overflow	July 2006
Phyang Stream overflow	1st August 20062006
Leh Nalla (Ganglass) Stream overflow	31st July& 1st August 2006
Igoo Nalla Stream overflow	31st July 2006
LEH, Choglamsar, Sabu and many other streams (Cloudburst/Flash Flood/Mudslide)	4 to6 August 2010
GLOF at Gya	Aug 2018
Mudslide Kargil	27th Aug 2021
Outburst of an artificial lake near Rumbak	Aug 2021
Flash Flood Near LAMDON School, Leh	21st July 2024
Flash Flood Lamayuru, Neyraks	29th July 2024

The Monsoon 2023, especially July remained very active during 2-3rd week of July as a result of which Ladakh received above normal Rainfall. Heavy Rainfall was also recorded at some places. There was mainly two good Rainfall spells. One during 7-10th & other 20-22nd July. Fig.(i).

The first rainfall spell was widespread in nature, (rain occurred at most places of Ladakh). Meteorological Centre at Yourtung Leh received 27mm of rain in 24hrs during 8-9th July which is very rare for a place like Leh. This spell caused widespread Flash Flood across Leh district and also snowfall at Abran Zanskar. Seepage of water from roofs are reported from across Ladakh. Good thing is that there was a timely and authoritative early warning by the local Meterological Centre.

Rainfall during the 2nd spell was lesser than the first one and concentrated more in Leh district that Kargi. However, the damage was almost similar to the 1st spell. This time, a severe thunderstorm occurred at upper catchment area of Lamdon School Leh during 21:30-22:00hrs (IST) and it triggered Flash Flood at Main city of Leh where Flood water entered Chokhang Vihara and damaged various homes, road etc. Fortunately, no loss of lives occurred.

Major reasons for such extreme events are:

- Climate Change triggered by global warming.
- Active Monsoon activity
- Orography (the Western Himalayan regions)
- Land Use Land Cover Future Projections:

Most recent studies indicate that these increasing trends in extreme rainfall likely to continue. So we need to be prepared.

Mitigation Strategies:

As extreme events like Flash Flood, Mudslide is likely to increase, there is a need for a multi-pronged approach that includes both proactive and reactive strategies.

- **Authoritative & timely early warning system:** Improved weather models, Dense network of Observatorries etc.
- **Flood risk maps:** Map that consider factors such as topography, historical flood data, and hydrological modelling to assess vulnerability, identify high-risk zones, and guide targeted actions.
- **Climate-resilient infrastructure:** Proper drainage systems and channels, to prevent water logging paving way for smooth flow of water.
- **Land use planning and zoning regulations:** Proper implementation of land use planning and zoning regulations, designating areas prone to flash floods as non-residential or restricted areas to minimise human exposure to flood risks.

- **Awareness campaigns:** Conducting awareness campaigns to educate and influence people to take appropriate actions during floods, including evacuation procedures, first aid provision, and obtaining information from reliable sources.

Lesson Learnt from past events:

It is heartening to observe that the people of Ladakh have become weather conscious. They consider whether an important input in day-to-day life. During severe weather events, they remain cautious and that is one of the good lessons that they have leant and I hope in coming years we will be more proactive & follow govt. norms to make Ladakh more weather & climate re-salient.

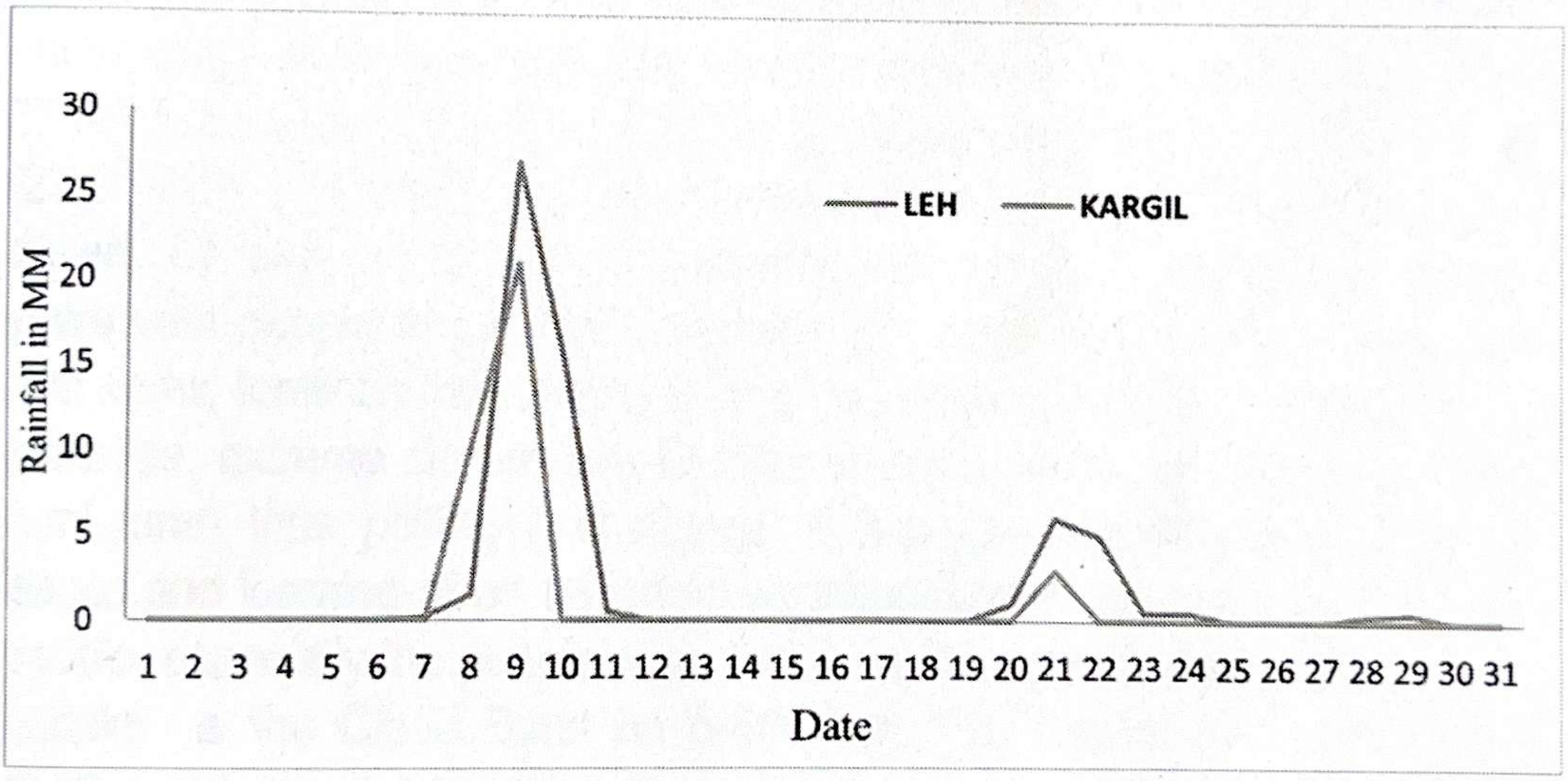


Fig 1. Rainfall pattern of Leh and Kargil district of Ladakh (July 2023)

General Observations:

Like any other city, Leh is also changing and changing rapidly and the region continue to expand and develop, and if this development is not properly planned, the region is exposing itself to damages due to potential natural adverse weather events especially the flash flood, mudslide etc. mainly during summer months.

Another very important issue is the over exploitation of already scare water availability for various purposes like plantation, hotels etc. leading gap in demand and supply of water. As such, it is pertinent to map out mitigation strategies to prevent and minimize losses due to such weather triggered disaster and proper supply and management of water on scientific lines.

Weather & Climate of Leh:

Being in the rain shadow area of the lofty greater Himalayan mountains, the region receives little precipitation with mean annual precipitation of only 105.1mm, rain from (May- Oct.) and snow (Nov-April) (IMD climatological data (1951-1980) Table(i). The general weather condition of LEH is that due to rarefied atmosphere, the weather is normally harsh and on a normal day, Ladakh experiences warm hot day & cold night leading to a high di-urinal range of temperature. The recent extreme temperature ranges from 37.5(8.8.2020) to -28.6 ºC (2.2.2008) and heavy snowfall of 1.8ft. in 12hrs (22.2.2019). Ladakh, having a semi-arid climate often known as cold desert. Of late, the region is confronted with lots of challenges in recent years with people in general complaining of erratic precipitation, less and less snow, torrential rain mainly during July-August leading to Flash Flood, Mudslide, extreme stream flow of local streams, water scarcity (mainly in April-June) thus posing a challenge of management/mitigation of these issues and looming of an uncertain weather pattern. An event that made people, especially the people of Ladakh and the govt. weather conscious in Ladakh is the Cloud Burst on 5-6th Aug.2010 which left hundreds of deaths and caused lots of damaged to properties. I have come across people who says that Ladakh used to get heavy snow in winter and less rainfall in summer and that monsoon cloud doesn't reach Ladakh due to a barrier caused by the Himalayan Mountains and that we are witnessing torrential rain in summer due to climate change. The fact is that yes, being a mountainous region, Ladakh is one of the place where impact of climate change is visible in the form of retreating glacier, rapid warming in temp., frequent Flash Flood, Mudslide triggered by extreme hot days and torrential

rain in July-Aug and GLOFS, various kinds of pests and diseases on plants, crops etc. but we can't blame everything on climate change as weather has its own cycle of highs and lows.

Table 2. Climatology of Leh, Ladakh (1951-1980)

Month	Mean Temperature (°C)		Mean Total rainfall (MM)	Mean Number of Rainy Days	Mean Number of days with			
	Daily Minimum	Daily Maximum			HAIL	Thunder	Fog	Squall
Jan	-14.4	-2.0	9.5	1.3	0.0	0.0	0.1	0.0
Feb	-11.0	1.5	8.1	1.1	0.0	0.0	0.0	0.0
Mar	-5.9	6.5	11.0	1.3	0.0	0.0	0.0	0.0
Apr	-1.1	12.3	9.1	1.0	0.7	0.1	0.0	0.1
May	3.2	16.2	9.0	1.1	0.5	0.5	0.0	0.1
Jun	7.4	21.8	3.5	0.4	0.0	0.2	0.0	0.0
Jul	10.5	25.0	15.2	2.1	0.0	1.2	0.1	0.0
Aug	10.0	25.3	15.4	1.9	0.0	0.9	0.0	0.0
Sep	5.8	21.7	9.0	1.2	0.0	0.1	0.0	0.0
Oct	-1.0	14.6	7.5	0.4	0.0	0.0	0.0	0.0
Nov	-6.7	7.9	3.6	0.5	0.0	0.0	0.2	0.0
Dec	-11.8	2.3	4.6	0.7	0.6	1.9	0.0	0.0

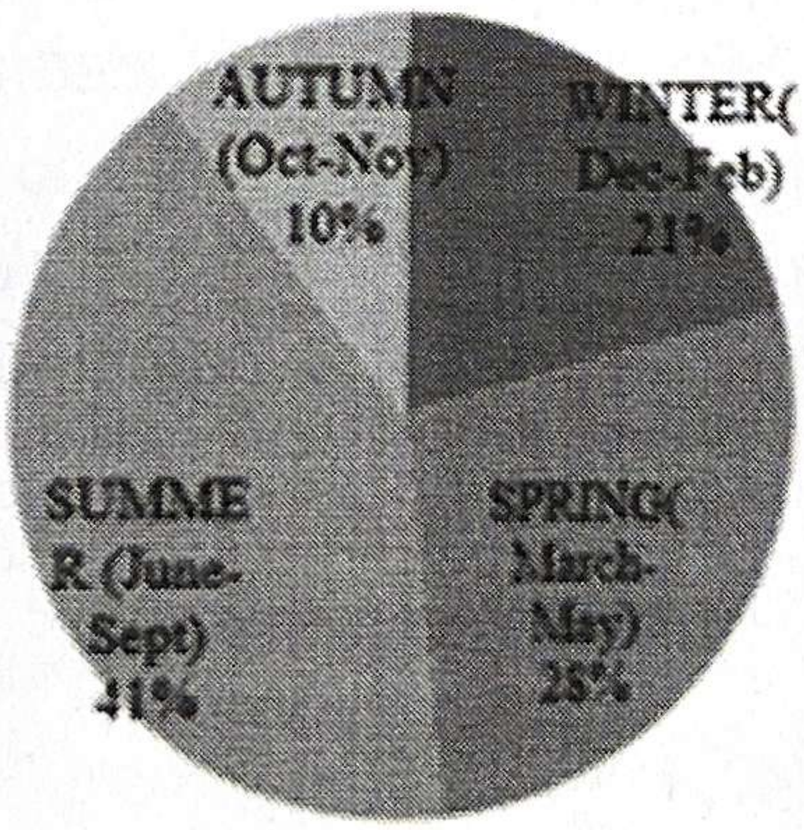


Fig 2. Percentage of total annual precipitation of (105.1MM)

The two main weather systems that are responsible for rain and snow in Ladakh are (i) Western Disturbances (a weather system in which moisture is usually carried out by westerly winds from the Caspian sea, Mediterranean Sea and on certain occasion Arabian sea) and (ii) The South West Monsoon (Moisture usually carried out from Bay of Bengal & on certain occasion Arabian Sea). As can be seen in fig.(i) Leh receives 41% of rainfall during Monsoon (June-Sept.) and 59% due to Western Disturbances and it continues to be so but people start feeling the heat only recently when recent summer rain led to flash flood, Mudslide in many area, recent being that of Mudslide on 27th Aug.2021 at some villages of Kargil.

In agreement with the recent report/assessments of IPCC (Intergovernmental Panel on Climate Change), like other mountains of the world, Ladakh too is experiencing frequent weather extremes like Mudslide, flash flood, torrential rain, GLOFs. Since increased extreme rainfall cannot be avoided we need to adopt mitigation strategies and learn to live with it.

Another burning issue is the change in cropping pattern. Wheat, barley, peas, potatoes were traditional crops for most villages of Ladakh but now farmers grows variety of vegetables like capsicum, cucumber, cauliflower, tomatoes, onion, besides of varieties of horticulture produces etc. and many people including our farmers attribute it to global warming but the fact is that this is possible also due to introduction of newer seeds suitable to the area, more economic benefits which made farmer work smarter and opt for these cash crops and not only the climate change, although its impact is also there as well.

Mitigation & Early Warning of severe weather:

On 5-6th Aug 2010, many lives were lost due to absence of an effective early warning of the severe storm but post 2010, due to combined efforts of weather consciousness of people, administration and affective, timely and reliable weather warnings from India Meteorological Department, many precious lives were saved.

Since sudden severe weather has become common these days as a manifestation of a changing climate, challenges of further improvement in mitigating adverse impacts of flash flood, mudslide is necessary which is both structural and non-structural measures. Structural measures include the construction of flood ways, channelization of water bodies, widening and improving water carrying capacity of streams whereas on-structural measures include forecasting, capacity building of people, etc. Keeping in view the vulnerability of Ladakh to such frequent events, GOI has established a Meteorological Centre at LEH in Dec. 2021 for providing effective early warning to the people and the administration of Ladakh. Since than, the local Met Centre is delivering the services effectively and daily weather information can be accessed online at https://mausam.imd.gov.in/ and http://aws.imd.gov.in:8091/ respectively. The correct & timely forecast of recent Mudslide at some villages of Kargil (27-28th Aug.2021) has helped all the stake holders like the Ladakh Disaster Management authority and the govt. The very close synergy among all stake holders ensured that no precious lives were lost and is a great success story. To provide accurate early warning against such torrential rain, storms, etc. a state-of-the-art Doppler Weather Radar has already procured by IMD and will be operational before commencement of winter 2022.

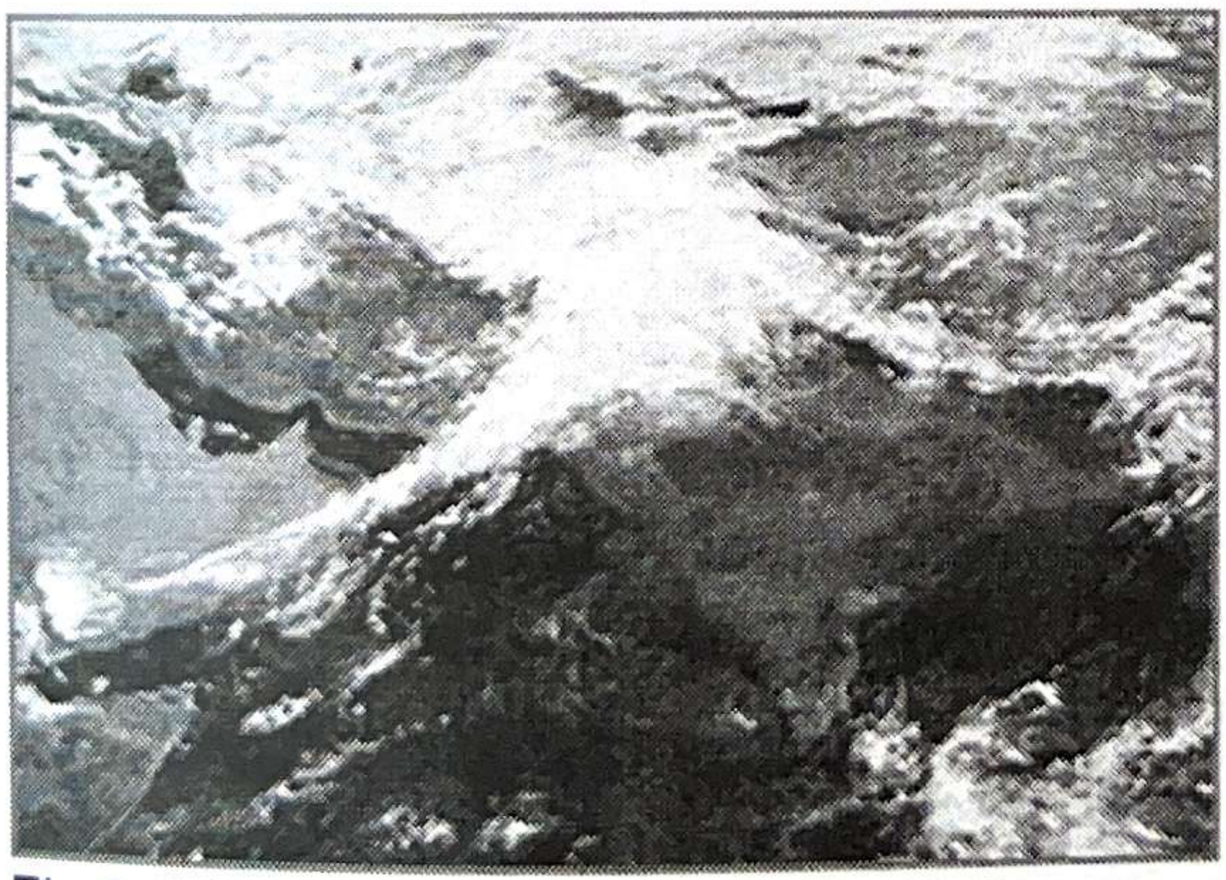


Fig 3. Western Disturbance

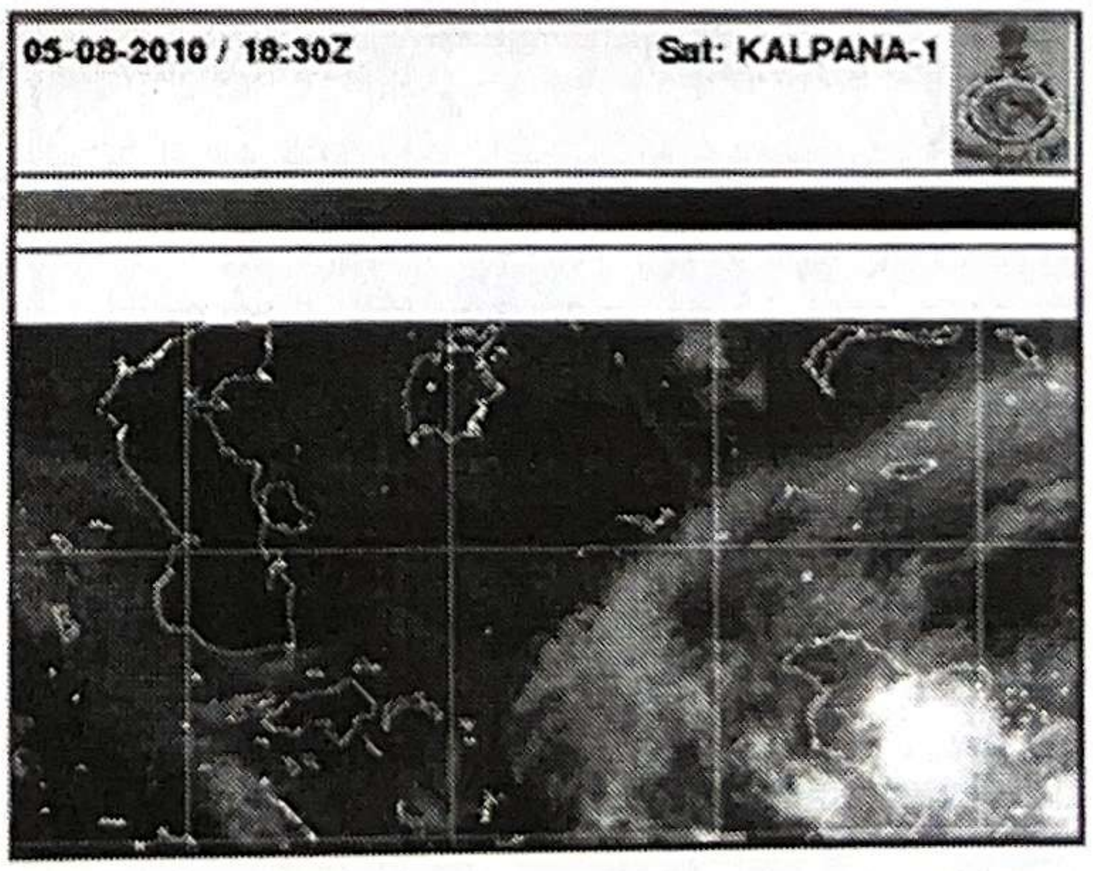


Fig 4. The Cloudburst of 6th Aug.2010

Issues of Water:

Except those on the banks of the river Indus, most villages of Ladakh fed on water from the glaciers which depends on snowfall. It is observed that, many glaciers are retreating at an alarming rate but it is also observed that snowfall pattern especially the winter snow is showing high variability in terms of space, time, intensity and distribution. It is not that such events did not happened earlier. Such events happened earlier also like (1901, 1917,1949,1991,2011 etc.). The reasons for this erratic & high inconsistent winter snowfall could be complex to explain. Due to increase inplantation on otherwise barren land, growing of varieties of vegatables, horticulture produces, increase in populations, increase in tourist influx mainly post 2010 & presence of huge population of army, the demand for water has increased whereas the supply remains the same and even decreasing. So there is a huge gap between demand and supply. To ensure ever availability of water, one thing is sure that we need to respect nature & make judicious use of available resources and come up with various mitigation and management strategies like introduction of water Tax beyond certain limit, creation of more articial glacier and may be other innovative methods.

Conclusion:

The extreme weather events in Ladakh like flash flood, mudlside etc. is not new, such events happened earlier also but it is a fact that such events are increasing and the damages due to it is being felt and seen recently mainly due to lose of human lives & damage to property and also due to faster communication, like Internet, mobile, TV,Radio etc.

- Due to combined efforts of weather consciousness of people, administration and affective, timely and reliable weather warnings from India Meteorological Department, many precious lives were saved and will continue to be so in future with better forecasting skills & technology.

- The general perception that Monsoon doesn't affect Ladakh is wrong. Monsoon does affect Ladakh mainly during July-Aug. and ocassionally in Sept.like the one during 22-23rd Sept.2018 which casued widepsread rain across Leh dist.
- Scientific evidences shows that weather triggered disasters are likely to increase and we must put in place a robust disaster management system which is a combination of science and management.
- To balance gap in demand and supply for water in Ladakh, govt. should come up with various mitigation and management strategies like introduction of water Tax beyond certain limit, creation of more articial glacier and introduction of other innovative methods

Thank you.

(Sonam Lotus)

G.B. PANT 'NATIONAL INSTITUTE OF HIMALAYAN ENVIRONMENT' (NIHE)

(An Autonomous Institute of Ministry of Environment, Forest & Climate Change, Govt. of India)

Ladakh Regional Centre, Leh, Ladakh

Himalayan Popular Lecture: Ladakh Series

1st Lecture: Shri C. Phunsog, IAS-Retd. (Vice Chancellor, University of Ladakh), Impact of Climate Change on India's Trans Himalayan Region (2020)

2nd Lecture: Prof. S.K. Mehta (Vice Chancellor, University of Ladakh), Water: Pollution and Remediation (2021)

3rd Lecture: Dr. O.P. Chaurasia (Director DRDO-DIHAR, Leh), Medicinal Plants Biodiversity of Cold Arid Ladakh Himalaya (2022)

4th Lecture: Shri Jigmet Takpa, IFS [Principal Chief Conservator of Forest (Retd.)], Ladakh, Exploring the Marvels of Himalaya and Shaping the Future Environmental Research (2023)

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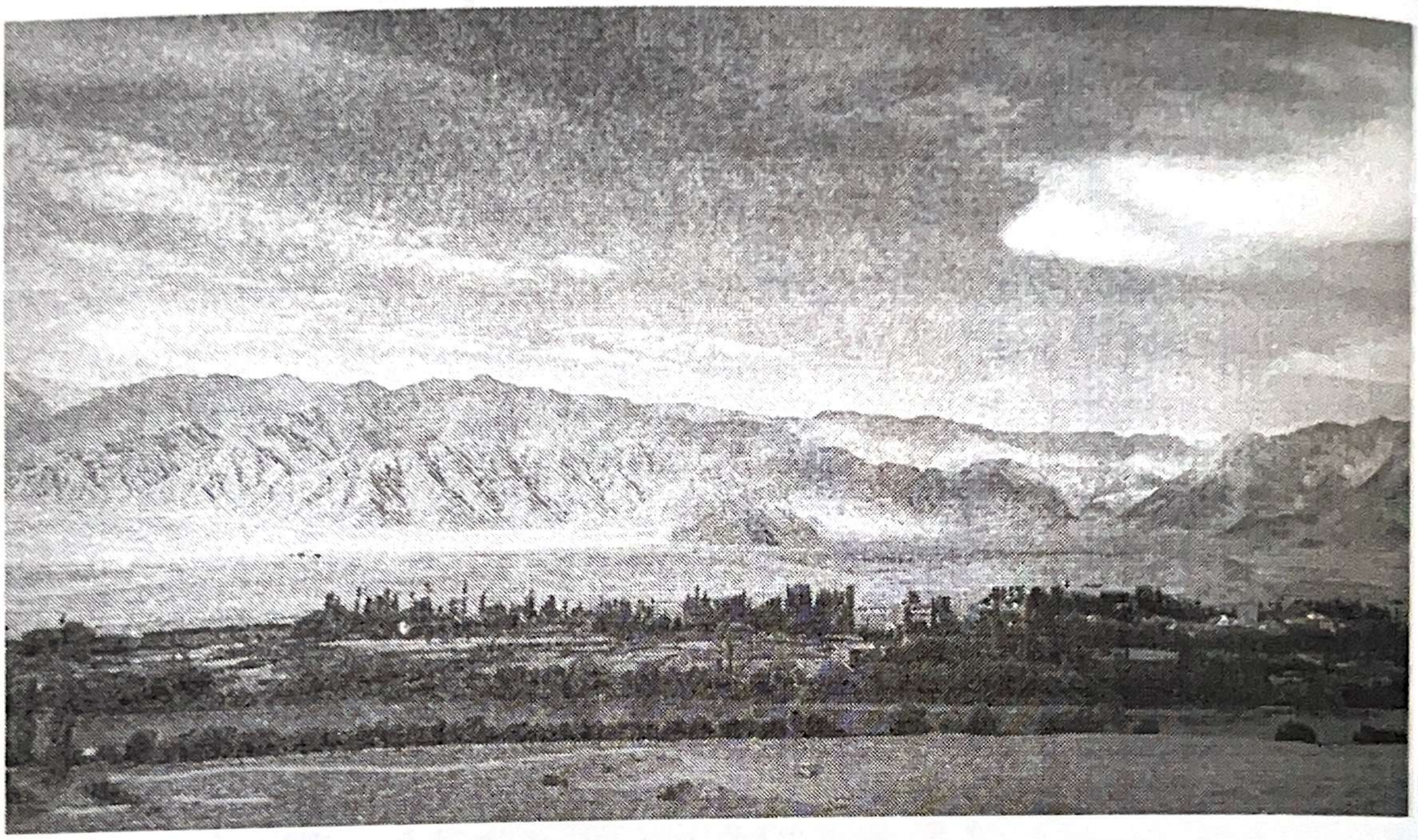

RESEARCH PRIORITIES

- Watershed services (management land use policy)
- Ecological and Economic viability of Himalayan farming systems
- Conservation and sustainable use of biodiversity
- Climate change vulnerability assessment, mitigation, and adaptation
- Disaster mitigation and management (database development and knowledge products

Developmental Options/Plans

- Sustainable natural resource management
- Propagation packages of high value plants
- Mountain specific developmental policies
- Eco-restoration and conservation models
- Livelihood options
- Capacity building and skill development
- Networking