

**Proceedings
of
National Webinar
on
Cold Wave Risk Reduction
2020-21**



**National Disaster Management Authority
New Delhi
14th October, 2020**



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**National Disaster Management Authority (NDMA),
NDMA Bhawan, A-1,
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Proceedings of National Webinar on Cold Wave Risk Reduction 2020-21

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Program Schedule
(Date: 14.10.2020)

Time	Program	Speakers
11.00-11.25	Welcome, Introduction and objective	
	Welcome	Sh. Anuj Tiwari, Sr. Consultant., NDMA
	Key note address	Shri. Lt Gen Syed Ata Hasnain, Member, NDMA
	Inaugural address	Shri. G. V. V. Sarma, Member Secretary, NDMA
11.25-12.30	Technical Session I: Early warning dissemination and Sector Specific measures	
11.25-11.35	Early warning forecasting and dissemination of Cold Wave	Dr. M. Mohapatra, Director General of Meterology, India Meteorological Department
11.35-11:45	Management of Cold Wave – Presentation by Nodal Ministry	Dr. M. Prabhakar, Scientist & PI, CRIDA-ICAR, Ministry of Agriculture and Farmers Welfare
11.45-11.55	Impact of Cold Wave on Human Health	Dr. U. B. Das, Chief Medical Officer (SAG) Ministry of Health and Family Welfare
11.55-12.05	Cold wave impact on livelihood and measures	Sh. Bipin Rai, Member, Delhi Urban Shelter Improve- ment Board (DUSIB)
12.05-12.15	Impact of Cold Wave on Ag-riculture and Livestock and measures	Dr. Prabhjot Kaur Siddhu, Punjab Agriculture University, Ludhiana
12.15-12.30	Discussion & QA	
12.30-13.00	Technical Session II: Sharing of experiences and Capacity Building	
12.30-12.40	Managing Cold Wave – State Perspective	Sh. S.A. Murugesan, Secretary, DM, Uttarakhand
12.40-12.50	Capacity Building and Docu-mentation on Cold Wave – Role of NIDM	Major General M.K. Bindal, ED, NIDM
12.50-13.00	Discussion & QA	
13.00-13.15	Concluding Remarks and Road Map	Dr. L.S. Rathore, Former DGM, India Meteorological Department
	Vote of Thanks	Dr. S.K. Jena Joint Advisor, NDMA

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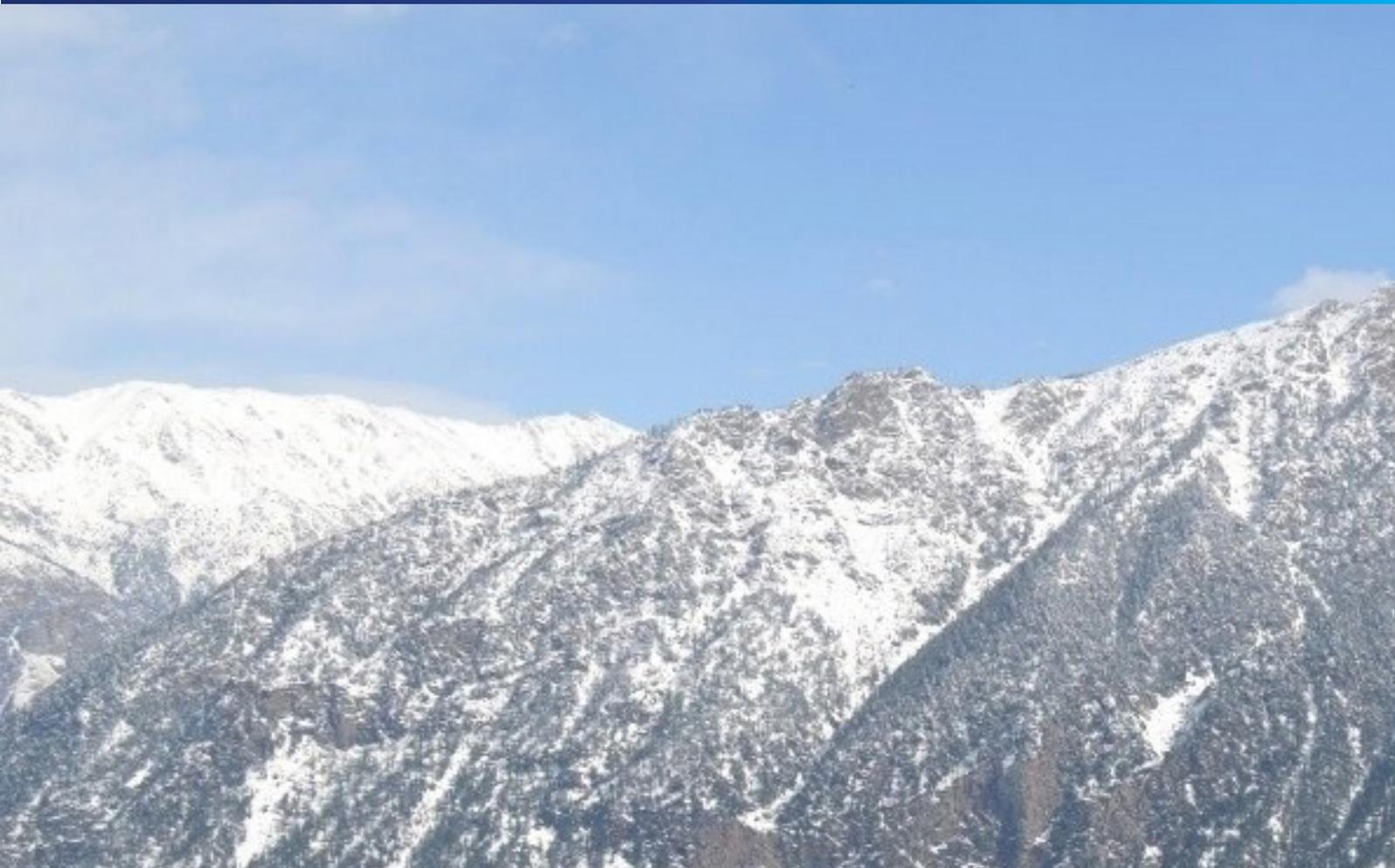


Background

Cold wave is one of the extreme weather event that prominently occurs during the winter season of India (November to February). The cold weather is marked by a well-defined and prolonged period of lower temperatures. The precise criterion for a cold wave is determined by the rate at which the temperature falls and the minimum to which it falls. This minimum temperature is dependent on the geographical region and time of the year.

The India Meteorological Department (IMD) defines a cold wave as a rapid fall in temperature within 24 hours. This is distinguished by a marked cooling of the air, or with the invasion of very cold air, over a large area. The northern parts of India especially the hilly regions and the adjoining plains are influenced by transient disturbances in the mid-latitude westerlies.

As per IMD, cold wave is considered when the minimum temperature of a station is 10°C or less for plains and 0°C or less for Hilly regions. Cold wave and severe cold wave is considered a negative departure from normal i.e. 4.5°C to 6.4°C and more than 6.4°C in hill stations respectively. Similarly, the departure in minimum temperature of $\leq 04^{\circ}\text{C}$ and $\leq 02^{\circ}\text{C}$ for plains is considered a cold wave and severe cold wave respectively. Considering the weather phenomena of India, IMD declared cold wave zones covering several States.



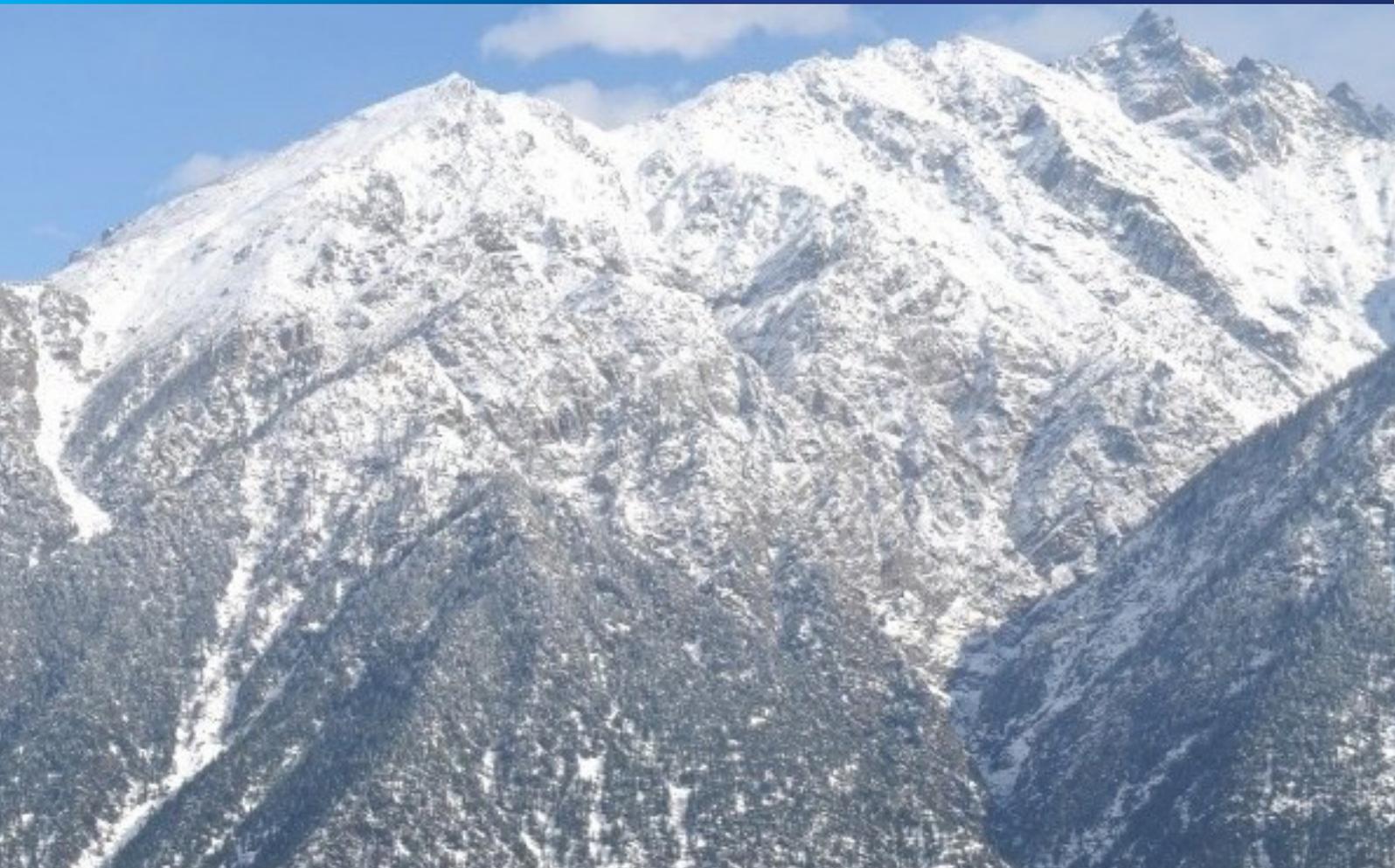
Impact of cold wave

In recent years, occurrences of extremely low temperatures in association with the incursion of dry cold winds from the north into the sub-continent area have been substantial in creating cold wave spells. The impact of the cold wave on human beings can lead to death or injury. The mortality rates show a marked increase in populations exposed to cold wave.

A cold wave can also cause death and injury to livestock. During a cold wave, the animals require a higher intake of nutrition. Often, if a cold wave is accompanied by heavy and persistent snow, grazing animals are unable to graze hence requiring more fodder to be provided indoors. If the food is inadequate and there is exposure to low temperatures, animals may die of hypothermia or starvation. Similarly, wildlife also experiences challenges during winter for both shelter and food.

Cold waves bring unexpected freeze and frost during the Rabi cropping season affecting crops, horticultural plantations/orchard, and other agricultural allied services. Cold waves impede the vegetative growth of plants/ seedlings and may result in crop failure. As a result, the livelihood of people gets adversely affected. A farmer also needs to acquire food and fodder to feed livestock at considerable cost if there is crop failure. At times cold waves can leave the land in danger of forest fires that consume dead biomass.

The infrastructure is also affected due to extremely cold climate. For instance, specific plumbing is required in colder regions. Similarly, antifreeze needs to be added to the car for it to function.



Cold Wave in India

In 2019, IMD issued a forecast of cold to severe cold day conditions over many States like Punjab, Haryana, Chandigarh, Delhi, northern Rajasthan, Uttar Pradesh, Madhya Pradesh, and Bihar, following which a brutal cold wave swept through northern India, blanketing streets in freezing fog, intensifying pollution, disrupting hundreds of flight and prompting school closures.

These States were highly affected due to lack of preparedness measures and inadequate shelters for the outdoor workers and farmers. Cold waves also caused the death of wild animals, birds, poultry, etc. across the country. Cold wave also affected various service sectors including vegetable vendors, rickshaw pullers, daily wage workers, and roadside kiosk operators etc.

Avalanches in the hilly terrain are also common during a cold wave. In India last year, five people including an army officer, died in an avalanche in Kashmir. Four members of a family were killed in avalanches in the Ganderbal and Bandipora districts of Kashmir. In January 2017 fifteen Indian soldiers died and several soldiers went missing due to three avalanches that hit the Gurez and Kupwara Sectors of Kashmir, Bandipora district near the Line of Control.

Given that centralized heating in buildings is rare in the region and with the night time temperatures dropping fast, many patients suffered from cold and cough symptoms. The homeless, of course, are especially vulnerable. The Delhi government operated 221 winter shelters that accommodated nearly 10,000 people. Similarly, the UP government distributed warm clothing and blankets to the homeless population during 2019.

Keynote address



Lt Gen Syed Ata Hasnain

Member, NDMA

Lt Gen Syed Ata Hasnain, Member, NDMA greeted the dignitaries on the panel, representatives from Ministries/ Departments of Central Government, State Government/ UT Administration, Principal Secretaries of Disaster Management, Health Department, Agriculture Department, Animal Husbandry Department, Municipalities/ NACs, Remote Sensing Organizations, Agricultural Universities, International Organizations, voluntary organizations, various other stakeholders, Advisors/Members of NDMA and former Members of NDMA.

Lt Gen Hasnain informed that NDMA chose the theme of 'Cold Wave Risk Reduction' for this national webinar given that it's one of the major extreme weather events. In the keynote address, he presented the activities carried out by NDMA. He also shared his experience of working with the army in cold wave prone areas for the last 40 years.

He pointed out that timely dissemination of early warning is crucial in managing cold waves. All the sectors vulnerable to lower temperatures are required to devise action plans like health, agriculture, animal husbandry & dairying, power, education, water supply, livelihood, etc. Along with this, the community needs to adopt various preparedness measures. For better community participation, IEC materials need to be prepared and the affected people need to be sensitized. A depository of civil society organizations needs to

be created and involved with the government to carry out the management of cold waves.

During the winters, heavy snow and landslides/ avalanches cause remote villages to be cut off from the mainland. The local authorities need to retain stocks of essential items to tide over the lean period of supply. The dense fog associated with cold wave limits the movement of traffic both road and air. Hence particular attention needs to be provided for traffic management.

With the onset of winter, disaster management authorities at the state and district level should issue advisories for better management of cold waves. All the institutions involved in cold wave management must document their lessons learned and draw upon them to refine the management this year. Hence, for cold wave



management, both change management, as well as knowledge management, are important.

Giving the example of a situation in the valley of Jammu & Kashmir where if the Jawahar tunnel is blocked, then the entire valley comes to a standstill, he emphasised that the government has to be prepared by stocking essential supplies. Similarly, he pointed out that during peak winter season, movement is very limited. People are advised to move in groups and army in convoys. Often, while on foot, it is advised to use the rope for moving between places in hilly regions.

During winters it is a common practice to use coal/wood in chullas and angethis or use other heating devices that result in the build-up of carbon monoxide indoors. This has a deleterious impact on health and in some cases leads to an

increase in mortality. There is limited awareness among people till date using these traditional heating methods.

If snow deposited on roads is left unattended, it may lead to the formation of ice which is extremely difficult to clear. There is a need for a volunteer system such as Aapda Mitras to clear ice and debris for smooth traffic management. Similarly, systems of power supply are vulnerable to vagaries for cold waves. Often during these power failures, communication becomes a difficult task. People have to pay a hefty amount to charge mobile phones. Considering this as a serious problem, charging kiosks were set up alongside all major highways in J&K.



Inaugural Address



Shri G.V.V. Sarma,
Member Secretary, NDMA

There is a common misconception that because of global warming and climate change, the temperature across the globe is increasing, therefore hazards like cold wave, are no longer a threat. However, as per the global data available, cold wave events are also showing an increasing trend especially in specific regions.

Various preparedness measures need to be put in place by disaster management authorities. Cold wave especially, affects the health sector; hence health systems are required to be given more importance. Also, loss of life as well as property damage must be minimised. Cold wave more or less has not been paid adequate attention. This webinar aimed to get views from all the experts cutting across different sectors/fields working on cold wave.

The IMD has laid out conditions to categorise the severity of cold waves. Considering the importance of the cold wave, Government of India notified 'cold wave' as a disaster and the Ministry of Agriculture as the nodal Ministry for cold wave/frost. Accordingly, the Ministry of Home Affairs included cold wave/ frost as an eligible natural calamity in the guidelines for relief assistance under the SDRF / NDRF and the financial assistance is limited to the agriculture sector only.

In order to deal with cold wave related issues, NDMA has taken certain initiatives, as per the following:

- (a) Cold wave has been included in NDMP, 2019 making it mandatory for cold wave-prone states to include cold wave preparedness, mitigation, response, and capacity building in State and District plans;
- (b) Prepared TVCs and Pocket Books containing do's and don'ts on cold wave and shared with States/ UTs for creating awareness among the public;
- (c) Organized a panel discussion 'Aapda ka Samna' on Doordarshan;
- (d) Issues advisory in December to all States/ UTs to undertake precautionary measures for cold wave;
- (e) Publishes print advertisement in English & Hindi and regional languages;
- (f) Runs awareness campaigns on Doordarshan and All India Radio;
- (g) Regular campaigns on social media relating to awareness campaign of cold wave, avalanches, and frostbites;
- (h) Periodically reviews the measures taken by the cold wave prone States/ UTs and Ministries/ Departments on prevention and management of cold wave and review the preparedness measures undertaken by various stakeholders to reduce the casualty.

Many cold wave prone states and Ministries/ Departments of Government of India have done significant work towards managing cold wave, but, it is never documented nor shared with others. The webinar aimed to highlight best practices and lessons learned for preparedness & mitigation measures on cold wave. This will enable the concerned stakeholder to prepare their action plan relating to preparedness and mitigation. Since the webinar was only for two hours, NDMA identified the relevant issues concerned with the cold wave. Based on the issues, various stakeholders were invited to share their experience. The work done by various stakeholders like state government and local boards also shared their experiences/ best practices and lessons learned for preparedness & mitigation of cold wave. This will in turn help to prepare an action plan with a road map.



Technical Session I

Early warning dissemination and sector-specific measures

Forecasting, Early Warning and Dissemination of Cold Wave



Dr. M. Mohapatra,
Director General of Meteorology, IMD

Cold wave is a natural weather phenomenon that is distinguished by the cooling of the air. Qualitatively, cold wave is a condition of air temperature which becomes fatal to human body when exposed. The precise criterion for a cold wave is determined by the rate at which the temperature falls, and the minimum to which it falls. Usually, cold waves are measured by the difference from the normal temperature. The general meteorological event is characterized by a sharp drop of air temperature near the surface, leading to extremely low values, rise of pressure, and strengthening of wind speed, or associated with hazardous weather like frost and icing. Cold waves occur due to large cool air masses that accumulate over certain regions, caused by movements of air streams. It is different from blizzards, snowfall, etc. Like the humidity in the heat wave, the wind speed in case of cold wave further compound the effect of wind chill. The IPCC (2007) noted that cold-waves continue to be a problem in northern latitudes, where very low temperatures can be reached in a few hours and extend over long periods. The temperature may drop both during the day as well as night. Globally, there is still lack of a clear and consistent definition for cold wave events.

Quantitatively, it is defined based on the temperature thresholds over a region in terms of actual temperature or its departure from normal. Based on daily maximum temperature station data, climatology of maximum and minimum temperatures are prepared for the period 1981-2010 to find out normal maximum temperature of the day for particular station. According to IMD, the cold wave detailed conditions are notified based on the criteria listed below.

Cold wave criteria

Cold wave is considered when (i) minimum temperature of a station is 10°C or less for plains and 0°C or less for hilly regions and (ii) the departure of minimum temperature from normal is -4.5°C to -6.4°C . It is called as 'Severe Cold Wave,' if the departure of minimum temperature from normal is more than -6.5°C or less.

The cold wave condition is also declared based on Actual Minimum Temperature for plain stations only. It is said to be a cold wave, if the minimum temperature is $\leq 04^{\circ}\text{C}$ and Severe Cold Wave, if the minimum temperature is $\leq 02^{\circ}\text{C}$.

For a coastal station, when minimum temperature departure from normal is -4.5°C or less 'Cold Wave' may be described if the minimum temperature is 15°C or less.

If above criteria meets at least in 2 stations in a Meteorological sub-division for at least two consecutive days then a cold wave is declared on the second day.

Cold day criteria

It is considered as cold day, if (i) the minimum temperature is 10°C or less for plains and 0°C or less for hilly regions and (ii) maximum temperature departure from normal is -4.5°C to -6.4°C . It is called as severe cold wave, if the maximum temperature departure from normal is $< -6.4^{\circ}\text{C}$.

Cold day/cold wave should be described, if conditions are satisfied simultaneously.

Cold wave season in India

Cold waves are seasonal with more episodes observed from November to March with each of these extreme events mostly experienced during the middle 3-month period. However, the minimum temperatures drop below 8°C over many parts of northern India during the month of November to February. December and January are the coldest months over northern India with normal T_{MIN} less than 8°C over its many parts.

Cold wave prone areas in India

The north and central India are prone to cold wave. The states of Rajasthan, Uttar Pradesh and Bihar are more prone to cold wave followed by Punjab, Haryana, Delhi, Madhya Pradesh, Kutch & Saurashtra, Jharkhand and adjoining areas of West Bengal and Odisha. These are highest over plains of northwest & adjoining central India with annual average numbers 6-8 days (data during 1971-2019) as shown in Figure 1. Many times northwest India experiences both cold day conditions as well as cold wave conditions.

Climate Change and cold wave in India

Climate change studies highlight the increasing temperature around the globe. However, across the globe, the incidents of intense cold waves vary from region to region. Over India, the trend of the cold wave observed across 86 weather stations during the December-January-February season for the period 1971-2020 is shown in Figure 2. It shows falling/rising (blue/red arrows) trends in frequency of cold wave days in different parts of the country as shown in Figure 2.

Formation of cold wave:

The formation of a cold wave is characterized by an influx of unusually cold air into middle or lower latitude (Figure 3). The center of this formation is characterized by a strong high-pressure center that develops over the winter season in high latitudes. The cold polar or Arctic

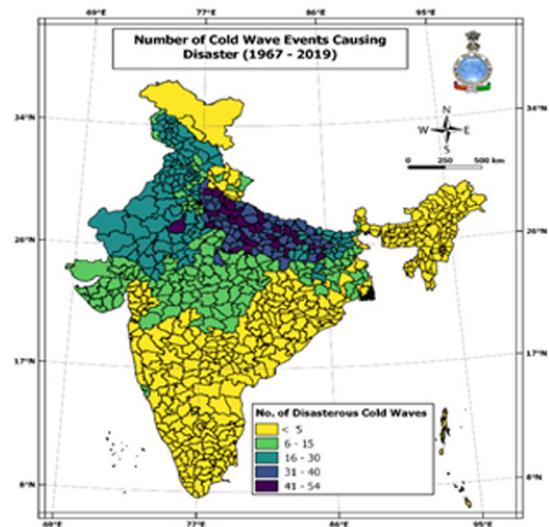


Figure 1: Cold wave prone areas of India

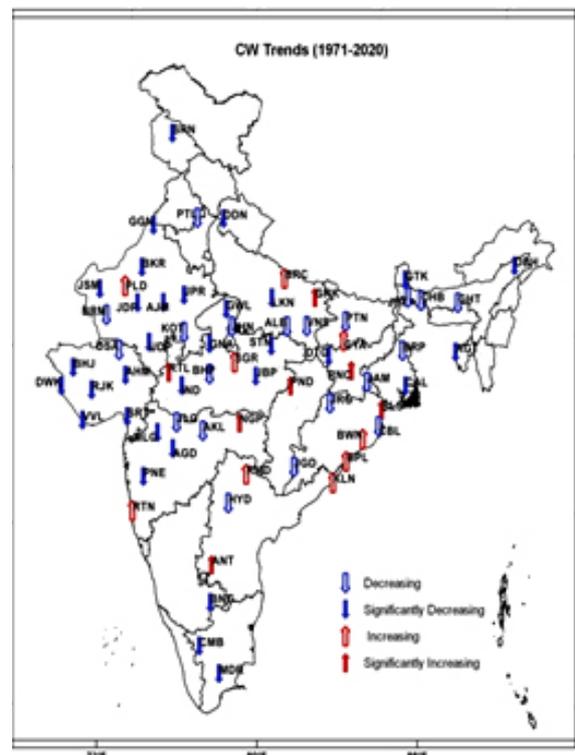


Figure 2: Trend in Cold wave conditions 1901-2016

air masses are relatively shallow, extending one to several km above the surface. The formation of cold waves can be understood from the upper-level flow pattern and equator-ward motion of cold air masses.

The surface high-pressure centre of the cold air is accompanied by an upper-level

convergence. An upper-level ridge to the west of the surface high pressure can intensify the surface high-pressure centre. In the Northern Hemisphere, cold waves occur when very cold, dense air near the surface moves out of its source region in northern Canada or northern Asia. The 'wave' in the cold wave is apparent in the upper-air flow (the jet stream), which is usually amplified into a strong ridge-trough pattern during a major cold outbreak. The most extreme area of all is northern Asia (Siberia), where the formation of cold surface air is enhanced by the large distance to the nearest unfrozen ocean, isolating the area from warmth and moisture, and the presence of mountains to the east and south, serving as barriers to trap and further isolate the cold surface air once it has formed.

Two factors contribute to the equator-ward motion the movement of cold dense air towards warm light air and upper-level steering winds. To the east of the upper-level ridge, the upper-level flow has an equator-ward component that steers cold air masses equator-ward.

Formation of the cold wave over India:

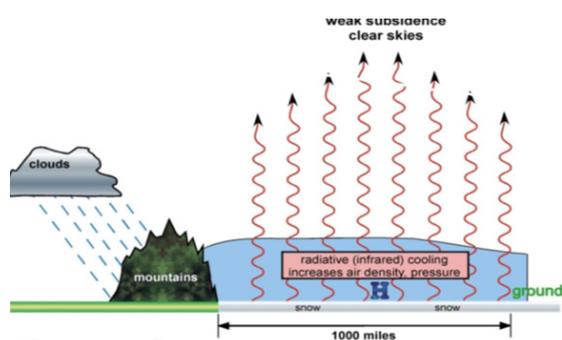


Figure 3. Formation of Cold wave

Cold waves over the country are generally experienced during December-February. The frequency of occurrence of cold waves is maximum over the north-western parts of India. The occurrence of cold wave is associated with the inflow of very cold air from extreme north-western parts of the Indian-sub-continent or even beyond. The following weather situations

are favourable: i) Passage of a well-marked low-pressure system in the upper air westerlies and for a low-pressure system at sea-level and aloft across north India and/or adjoining regions. The system generally causes widespread rainfall activity over the plains and-snowfall over the hills. ii) In the rear of the rainfall/snowfall activity, north-westerly winds may set over the region and cause an inflow of cold air mass from higher latitudes and from mountain regions. Occasionally, in the absence of western disturbances and persistent clear sky conditions, intense nocturnal radiation cooling may also cause night temperatures falling below normal and result in cold wave conditions.

The following are the weather situations for cold outbreaks over India:

- The buildup of a ridge in the jet stream over NW Asia;
- Formation of a surface high-pressure center over north and central India;
- Movement of cold air masses in response to steering by upper-level winds;
- Triggering mechanism like a strong westerly wave approaching NW India to enhance transport of cold air southeastward;
- Extensive snow covers the north of India and the Northwest Himalayas.

El Niño/ La Niña conditions and cold wave in India

Looking at the inter-annual variability, Ratnam et. al., 2016¹ pointed out the processes causing and maintaining cold waves over India. As per the study, based on the standard deviation of the T_{min} and following the criteria of IMD, a total of twenty-nine cold wave events were identified from November to February 1982 to 2013. Interestingly, it is found that of the twenty-nine identified events, twenty-one events occurred during La Niña years and eight events during El Niño years indicating

¹ <https://www.nature.com/articles/srep37657>

that La Niña conditions are favourable for the occurrence of cold waves over India. During the La Niña years, cold days were observed to a larger

spatial extent and caused cooler temperatures over most parts of India. In contrast, in El Niño years the events caused cooler temperatures only

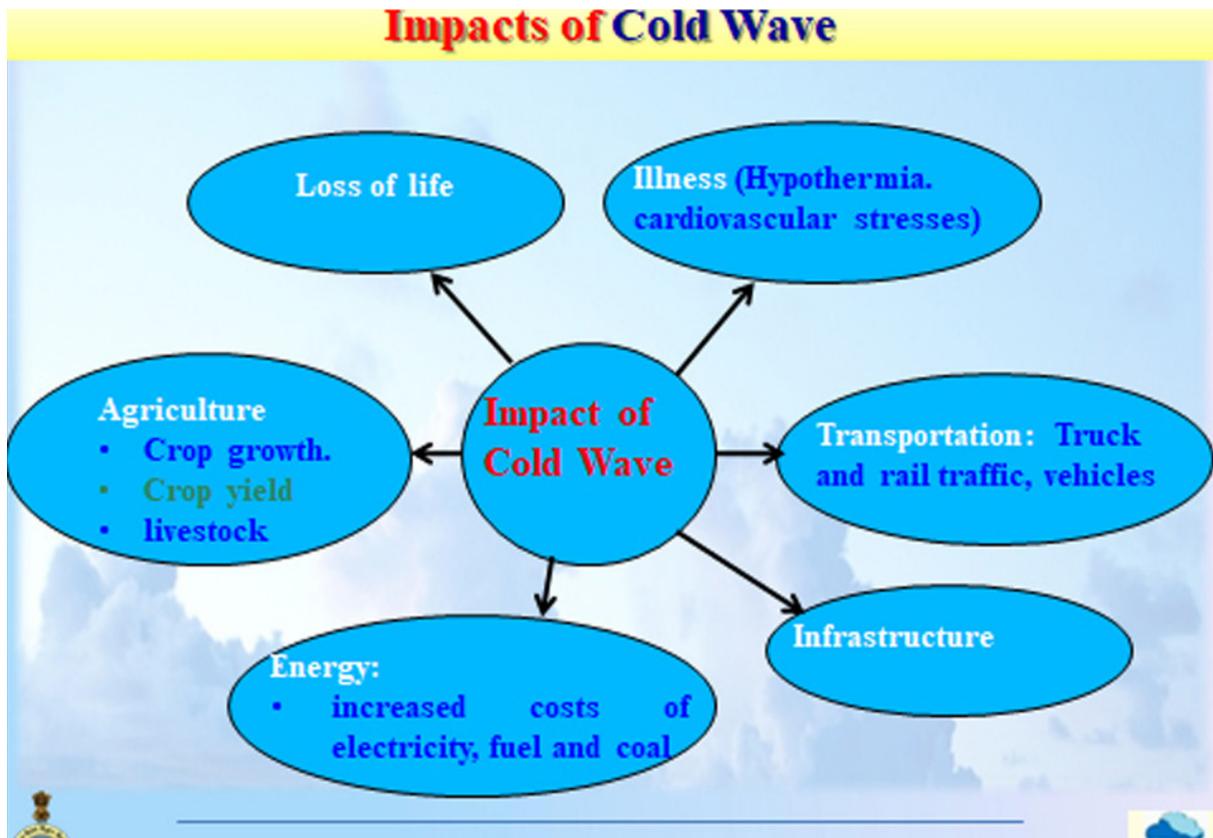


Figure 4 Impacts of cold wave

confined to northwest India.

Impacts of cold wave:

The cold waves affect health, agriculture, and infrastructure in India (Figure 4). Some of the impacts of the cold waves include detrimental effects on the health of human beings. An unexpected cold wave can cause frostbites, hypothermia, or other serious medical ailments. A lot of damage is caused to agriculture, animal husbandry, and wildlife. The damage to infrastructure is well evident e.g. damage when water pipelines freeze and burst. The impact on the energy sector is well marked with a rise in the demand for fuels and electricity.

Monitoring and Forecasting Cold wave/ day in India:

The IMD’s multi-institutional initiative for cold wave/ cold day monitoring and forecasting was introduced in 2016 in collaboration with NCMRWF, IITM, ISRO, and IAF. Presently IMD issues Seasonal Outlook: 1-3 months ahead for sub-divisional level; Extended Range Outlook: 15 days ahead for sub-divisional level; Watch: 5 days ahead for the district and Sub-Divisional level; Alert: 3 days ahead for sub-divisional and district level and Warning: 2 days ahead for the district, block and local level. Various numerical prediction models and techniques are used to arrive at these alerts like IMD GFS, WRF, NCMRWF NCUM, NCUM-R, GEFS, UMEPS, and various international models. The forecasting methods take into consideration various meteorological conditions like the past 24 hrs observed weather (RH, T_{min} wind, and its tendency & departure from normal). Several causative weather systems including Troughs,

Ridges, Cyclonic Circulation (CC) and anti-CC, Jet stream, low-pressure systems, and high-pressure systems and dynamical parameters like divergence, convergence, and vortices at different levels, lower & upper-level winds are taken into

a rapid drop in temperature as indicated in the extended range forecast. The extended range forecast is presently accurate with standardization over the last decade and can predict temperature changes up to 2 weeks with very good accuracy.

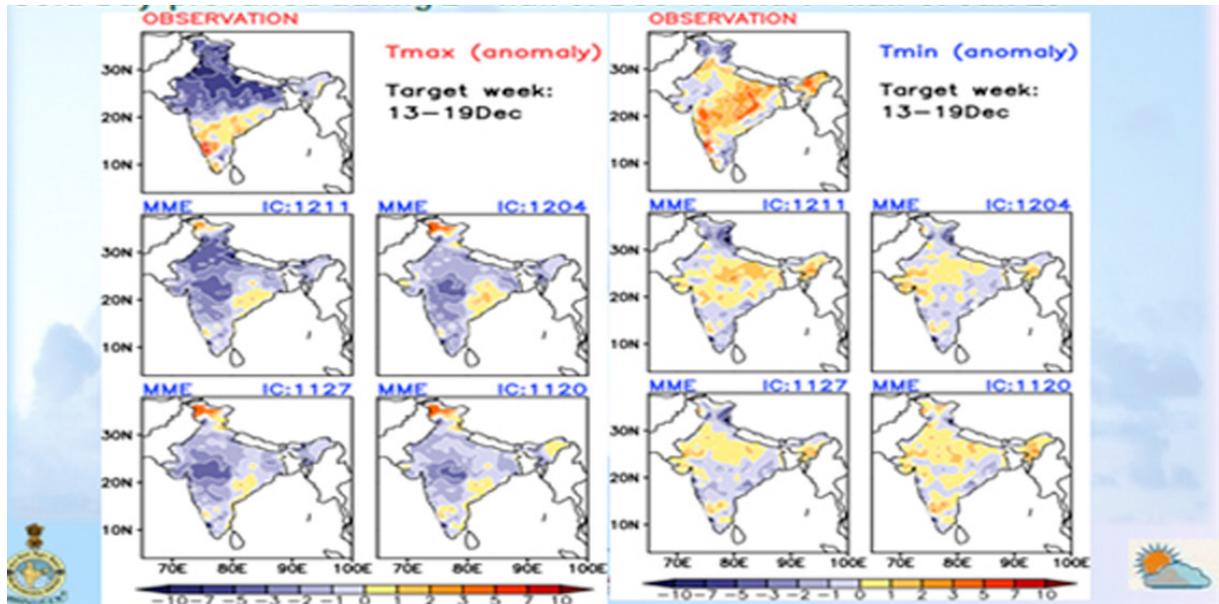


Figure 5 Extended Range Forecast of cold wave

The 2nd half of December; cold wave prevailed, Cold Day prevailed during 2nd half of Dec 19 and 1st half of Jan 20

account before issuing forecast and warnings.

For instance, IMD issued an extended range forecast of Cold Wave during 2019 as shown in Figure 5. It is issued every Thursday and valid for next 4 weeks. The second fortnight observed

Table 1 Colour coded alerts issued by IMD

Green(No action)	Normal night	Minimum temperatures are near normal
Yellow Alert (Be updated)	Cold Alert	Cold wave conditions at isolated pockets persist on 2 nights
Orange Alert (Be prepared)	Severe Cold Alert for the night	(i) Severe cold wave conditions persist for 2 days (ii) Though not severe, but cold wave persists for 4 nights or more
Red Alert (Take Action)	Extreme cold Alert for the night	(i) Severe cold wave persists for more than 2 nights (ii) Total number of cold/severe cold wave nights exceeding 6 nights.

with earmarked actions to be undertaken (Table 1).

The cold wave warnings are provided for various sectors including health, energy, water resource, disaster management and agriculture. The operational Agro-meteorological Services of IMD issues advisories under the Gramin Krishi Mausam Seva in collaboration with Ministry of Agriculture on cold waves/ frost to save cereal crops (eg. wheat), cash crops (eg. cotton), oilseeds (e.g. mustard), vegetables (e.g. potato, tomato), horticultural crops (grapes), livestock and poultry.

Cold Wave Warning Dissemination system:

IMD makes use of mass media like Radio/ TV, News Paper network (AM, FM, Community Radio, Private TV), Prasar Bharati, and private broadcasters for effective dissemination of advisories on the cold wave. IMD also holds and shares a weekly weather video during cold wave season. In order to reach citizens, the IMD has developed various apps like Mausam/ Meghdoot/ DAMINI/RAIN ALARM. For wider dissemination of warnings, IMD uses social media like Instagram/ Facebook/ Twitter extensively. All these can be found on the public website of the IMD. The States as well as local IMD centers issue warnings and advisory in local vernacular language.

Way ahead:

Still, there are gaps in technology vis-a-vis capability. The scientific gaps in understanding meteorological phenomenon in Indian region especially due to lack of data in West Asia needs to be addressed through better international collaboration. Though observational and modeling systems over the Himalayan Region have gaps, IMD is taking every step to fine-tune models to improve in forecast skills. This year's actual impact in different sectors will be issued with Impact based forecasting and risk-based warning for cold wave. Similarly, Common Alert Protocol is developed for warning dissemination





Management of Cold Wave – Presentation by Nodal Ministry (Ministry of Agriculture and Farmers Welfare)



Dr. M Prabhakar,
Principal Scientist and Principal Investigator- National Innovations in Climate Resilient Agriculture (NICRA), ICAR-Central Research Institute for Dryland Agriculture (CRIDA), Department of Agriculture Research & Education (DARE), MoA&FW, Hyderabad, India

During cold wave period, frost may pose a risk to the Rabi crops. If the cold wave condition prevails more than 5 days continuously, it will cause considerable damage to crops. Among several crops, horticulture crops are badly



Figure 6 Mango crop damage due to frost



Figure 7 Damage to Brinjal

affected (Figure 6 & 7). Crops which are in reproductive & seedling stages are more susceptible to cold wave. Crops like papaya, banana, pomegranate, mango, amla, sapota, pineapple, chickpea, and mustard are more susceptible to cold injury. Crops like apple, peach, plum, cherry, cauliflower, cabbage, broccoli, sugar beet, radish, and turnip benefit from cold waves. Hence, in areas where cold waves are frequent, cultivation of such crops can be recommended.

Frost can affect crops in various ways. It can form ice crystals on stems, leaves, and fruits, causing the plant cells to rupture. Similarly, ground frost limits the availability of soil oxygen and moisture to plants. The physical damages due to frost on various parts of plants, makes them vulnerable to diseases and pest invasions. Some examples are provided in figure 8.

Technological Options (Preventive) for Cold Injury

In order to reduce damages due to the cold, various resilient practices can be introduced like high density, multilayered fruit plantations, intercropping in orchards, etc. The mixed cropping of vegetables in fruit crops provides shelter against the cold and mutually benefit each other. Similarly, light and frequent surface irrigations can help overcome cold injury due to high specific heat of the water. Also sprinkler irrigation is considered one of the effective means of reducing cold injury as

Plant Diseases



Crop	Disease
Wheat	Black Rust
Mustard	White rust, aphid
Tomato	Late blight
Barley	Brown rust
Potato	Late blight



Figure 8 Plant Diseases in cold wave season

'water condensation of water droplets-release heat into surrounding'. Similarly, plastic mulching or organic mulching which increases absorption of radiation, creates thermal insulation is advisable. Other technologies like air mixing by running fans, creating a blanket of smoke to trap long wave radiation and creating windbreaks and shelterbelts around the field to reduce wind speed provide effective management of crops during the cold wave.

Technological Options (Curative) for Cold Injury

Some of the curative means to address cold injury involve pruning the affected plants and apply Bordeaux paste. The spray of Bordeaux mixture (2:2:250) or copper oxo chloride 1.5 kg/500 L water is also suggested. It is advisable to apply Nitrogen-based fertilizers and irrigate the field immediately after pruning. Additionally, the application of Phosphorous & Potassium will activate better root growth.

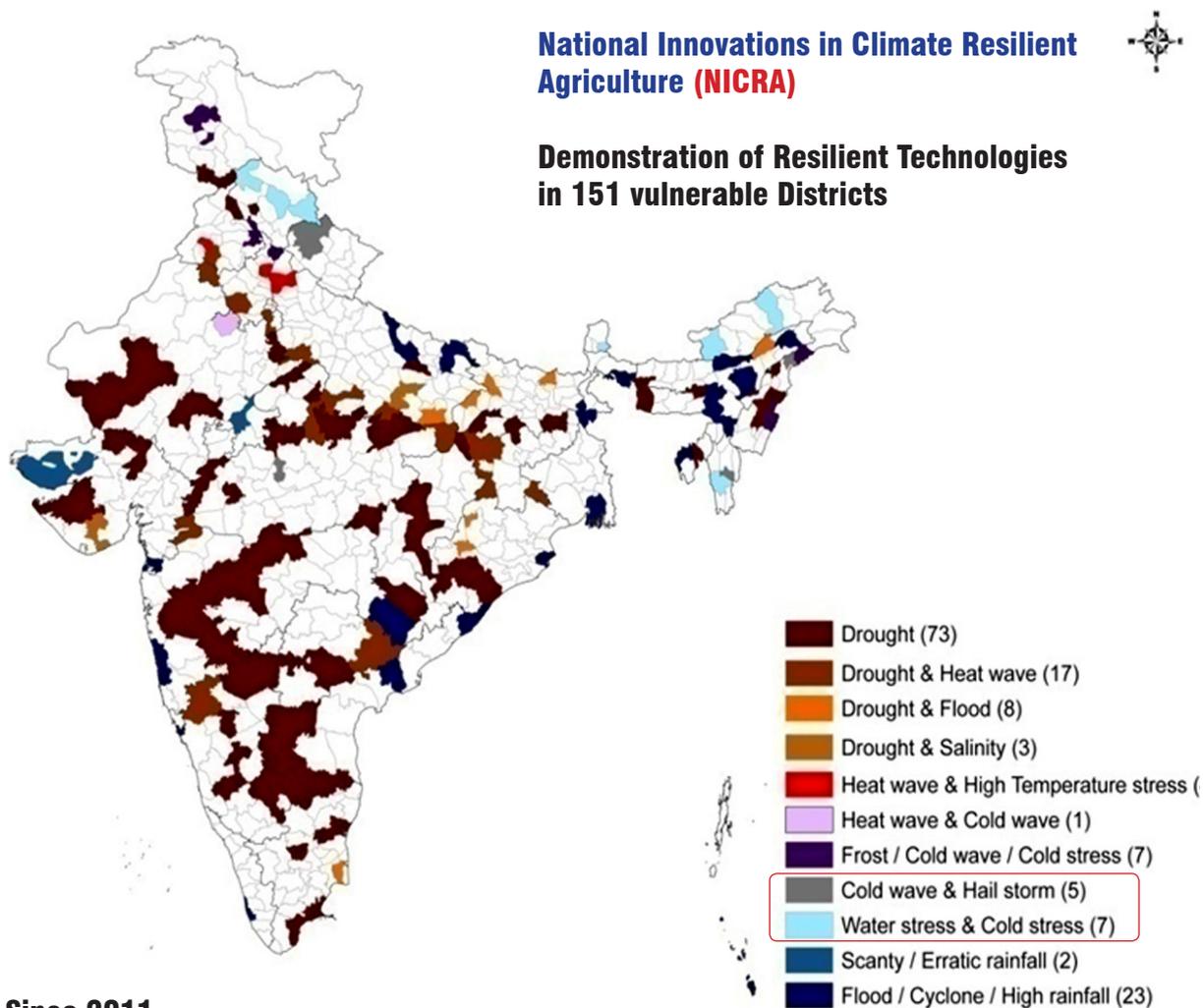
National Innovations in Climate Resilient Agriculture (NICRA):

National Innovations on Climate Resilient Agriculture (NICRA) is a network project of the Indian Council of Agricultural Research (ICAR) launched in February 2011. The project aims to enhance the resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstrations. The research on adaptation and mitigation covers crops, livestock, fisheries, and natural resource management. The project intends on demonstrating Resilient Technologies in 151 vulnerable Districts across India. These districts include 7 districts prone to cold wave and hail storm and 5 districts prone to water and cold stress (Figure 9).

Some of the technologies used are like plastic mulching in Kulu, Himachal Pradesh to support apple farmers. Protected cultivation methods like innovative low-cost

poly houses to stabilize the temperature and protect crops in seedling stage was very effective. Similarly to support farmers and orchard owners intercropping systems have been demonstrated with crops like Pea, Mustard, Toria Buckwheat, Rajmash, and

different types of fodder crops. In order to protect small ruminants from cold stress, light weight portable incubators are used that help maintain a temperature of 15 °C as against 5-6 °C during night. Similarly felt jacket to keep the animals warm are also introduced. A



Since 2011

Figure 9 National Innovations in Climate Change

pilot-scale Re-circulatory Aquaculture System (RAS) for cold water fisheries unit has been established for climate-resilient coldwater fish farming under a controlled environment and minimum water usage. It will serve as a training and demonstration unit for farmers.

Way Forward

Mapping of vulnerable regions using historical & projected climate change data sets, for cold wave prone region is required.

The timely availability of weather forecast & agro-advisory is important. Similarly, crop-wise climatic thresholds for claims under PMFBY needs to be determined. The capacity building & awareness programs need to be further strengthened. There must be emphasis for the large scale adoption of resilient technologies & their up scaling through various ongoing schemes (NMSA, NHM, NLM, PMKSY, RKVY).

Impact of Cold Wave on Human Health



Dr. U. B. Das

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Extreme cold weather events have a profound impact on human health. Overexposure to cold temperatures may cause the body to lose heat faster than it is produced. The cold weather-related injuries may include both freezing and non-freezing injuries. While the non-freezing injuries include hypothermia, chilblains, and trench/ immersion foot, the freezing injuries are frostnip and frostbite.

Hypothermia: A person is supposed to be experiencing hypothermia when the core body temperature is of less than 35°C (95°F). The classification includes Mild- (35°-32°C/95°-90°F), moderate (32°-28°C/90-82°F), and Severe (<28°C/82°F). The reason behind suffering from hypothermia is when exposed to cold; the body loses heat faster than it is produced. With prolonged exposure to cold, the body's stored energy will eventually get used up. A drop in core body temperature of just 1°C causes the muscles to shiver, which in turn can lead to low blood sugar levels (hypoglycemia) and reduced energy and performance. The highest risk is, if one is intoxicated or suffers from an underlying psychiatric illness or dementia, or is of old age people (> 65 years), or neonates. The symptoms may include shivering or a halt in shivering, lack of coordination, slurred speech, weak pulse, slow and shallow breathing, confusion, and

drowsiness. The geriatric population is more prone to hypothermia given the lack of ability to shiver, thinner epidermis, lack of cardiovascular reserve for compensation, a tendency toward baseline dehydration, movement impairment, or effects of concurrent illnesses and medications.

Similarly, significant morbidity & mortality is observed in neonates due to cold weather. The main reason being the larger surface area per unit body weight and limited heat-generating mechanism and high vulnerability of exposure while traveling or wet clothes. This can be easily addressed with awareness among healthcare providers and chief care giver.

The cold weather also exacerbates respiratory problems. Respiratory problems are higher in women than in men. Besides this, hypothermia may lead to increased oxygen consumption and pulmonary vasoconstriction, increased respiratory distress, and reduced surfactant release. People with coronary heart disease often suffer angina pectoris (chest pain or discomfort) when they're in cold weather. Mortality in patients hospitalized for heart failure having hypothermia (body temperature less than 95° F) at the time of admission is four times higher than patients who are having normal temperatures during admission.

Frostbite: Frostbite is an injury caused by freezing of the skin and underlying tissues. First, your skin becomes very cold and red, then numb, hard, and pale. Frostbite is most common on the fingers, toes, nose, ears, cheeks, and chin. Exposed skin in cold, windy weather is most vulnerable to frostbite.

Chilblains: Skin sores or bumps that occur after exposure to very cold temperatures. Chilblains may be an abnormal blood vessel response. Women, underweight people, and those with Raynaud's phenomenon are at increased risk. Common symptoms include itching, bumps, and red to violet-coloured patches on the hands or feet. The skin usually clears up on its own within one to three weeks, although it may recur for

years. Medication and proper dress can reduce the overall risk of cold weather. The treatment involves passive warming at room temperature, no rubbing, and protection from trauma and secondary infection.

Trench foot or immersion foot syndrome is a serious condition that results from your feet being wet for too long. The condition first became known during World War I, when soldiers got trench foot from fighting in cold, wet conditions in trenches without the extra socks or boots to help keep their feet dry. Trench foot is caused by feet that get wet and don't dry off properly. It's also most common in temperatures of 30°F to 40°F.

With trench foot, visible changes to feet can be observed. These changes include pale waxy skin, numbness, and swelling, blisters, numbness, persistent itching, and tingling. These symptoms of trench foot may only affect a portion of the feet. But in the most severe cases, these can extend over the entire feet, including your toes.

The first line of treatment involves rest and to elevate the affected foot to encourage circulation. The feet may be wrapped in a loose dressing. The feet are allowed to passively re-warm at room temperature. The feet should not be rubbed or massaged and should be air-dried only.

Prevention of Cold Weather Health Impacts:

The victim may be covered with dry insulating materials in a warm environment (blankets, sleeping bags, and space blankets). Block any source of cold wind and keep the victim dry. Also, hot water bags, warmed rocks or heat packs may be applied to high circulation areas. Immersing the victim in a hot water bath at 104°C and sharing body heat from another person helps to manage cold weather-related health impact.

In order to minimize cold weather health impacts high risk groups like senior citizens (>65 yrs) /young children (0 to 5 yrs), homeless citizens, chronic illness (cardiac/respiratory), and psychiatrically debilitated should be given extra

care. Also, extra effort needs to be given to the sick, injured, and wounded individuals as they are very susceptible to cold injuries.

Principles of Care- Need to maintain body heat

- Wear several layers of loose clothing. Tight clothing reduces blood circulation.
- Frequent sock changes.
- Cover head and neck: exposed head and neck causes 80% of body heat loss.
- Use synthetic fibers as natural fibers retain moisture.
- Avoid overexertion
- Take frequent rest/ breaks while performing physical activities outside

Modification of Risk Factors

- Adequate nutrition: 2500 to 3000 cal/day.
- Adequate hydration and rest.
- Adequate clothing: loose, layered, windproof, and changed often (Figure 10).
- Buddy system and patrol leader checks. Never go out alone
- Don't drink alcohol. While alcoholic drink seems to warm you up, it narrows your blood vessels, particularly those in the hands, which can increase your risk of hypothermia

General measures :

- ABC's first; oxygen always.
- Support ventilation.
- Obtain an accurate temperature by the low reading thermometer.
- Start re-warming measures.
- Rehydrate; need to rehydrate with caution in elderly patients.
- Foley / NG tube.
- Continuous core temperature & cardiac monitoring.
- Assess for & treat associated illnesses & injuries.
- Consider ICU admission.

Dressing for the C O L D

- **Keep Clothing Clean**
Dirt and grease block up the air spaces in your clothing and reduce the insulation value.
- **Avoid Overheating**
Sweat can freeze on outer layers. Stay dry, moisture will decrease the insulating ability of your clothing.
- **Wear Clothing in Layers**
Loose clothing allows air spaces to help trap warm air without restricting blood circulation. Good blood circulation helps to prevent frostbite.
- **Keep Clothing Dry**
You've got to keep your clothing dry, from the outside as well as from the inside.

Figure 10 Dressing for the cold wave

Various First Aid measures

- Suspicion is vital!
- Measure core temperature (low reading thermometer /clinical signs).
- Removal of wet clothing.
- Gentle insulation of the patient with blankets etc.
- Provision of warm fluids.

Neonatal Care

Kangaroo Mother Care (KMC) is a special method of care of low birth weight (<2500gm) babies but is also found to be relevant in cold weather conditions. As the name suggests Kangaroo Mother Care consists of keeping the baby in close skin-to-skin contact with his/her mother as practiced by female kangaroo for their babies. It benefits the baby by keeping the baby warm, promoting and sustaining breastfeeding, decreasing the risk of infection and promoting bonding between baby and mother (Figure 11).

Prevention of hypothermia: Warm chain

1. Warm delivery room (>25° C)
2. Warm resuscitation
3. Immediate drying
4. Skin-to-skin contact
5. Breastfeeding
6. Bathing postponed
7. Appropriate clothing
8. Mother & baby together
9. Professional alert
10. Warm transportation

Kangaroo Mother care

Figure 11 Prevention of Hypothermia

Cold weather and COVID-19: Though there is no concrete evidence associating cold weather and increased spread of COVID-19, extra precautions especially in terms of logistics need to be undertaken. Especially, the hospital premises need to be logistically supported to meet COVID-19 challenges and cold weather health issues. Clinically, further data is awaited.

Life of rural & urban poor during cold wave



Shri Bipin Rai,
Member, Delhi Urban Shelter Improvement Board, New Delhi

The urban poor and migratory labours that are homeless are especially vulnerable to cold waves. In that, the subgroups of old age, children, drug addicts are especially vulnerable to cold wave spells. Cold waves in rural areas may affect agriculture livelihood, education, health, labours etc. The poor often are not able to meet the calorific requirements needed for cold wave.

Though there are plans and policies to address cold wave preparedness and mitigation, the challenge remains to design a policy exclusively addressing the needs of the urban poor with respect to cold wave impact. Over the years, the gaps in understanding the impact of the cold wave remain elusive. Also, there is a lack of focused attention. Even with increased donations and religious/ cultural activities, the suffering of the urban poor during a cold wave remains high. As the migration from rural to urban areas increases each year there is an overall deficit in housing and shelters for the urban poor.

Mitigation Measures:

Following activities are undertaken to mitigate cold weather impacts on urban poor:

- To provide shelter to the homeless in Rain Baseras/ Vishram Grah throughout the year;

- To provide a comfortable stay with basic facilities for homeless residents;
- To put up shelters at a strategic potential location for meeting the requirement of shelterless;
- To make additional arrangements during the winter season under "WINTER ACTION PLAN";
- To make arrangements to shift homeless from open area roadsides to nearest shelter during winter season under rescue program;
- Collaborate with different Ministries Departments / Agencies to deal with cold wave (Table 2).

Table 2: Roles and responsibility of various Departments/Agencies

Agency	Roles
Delhi Police	For safety, law & order in the shelter homes and help in rescue operations
Divisional Commissioner (Revenue Department)	For rescue and law & order
Delhi Jal Board (DJB)	For water supply
Health Department	For medical facilities
MCD (SDMC, NDMC, EDMC)	For sanitation and cleanliness around shelter homes
New Delhi Municipal Council	For sanitation and cleanliness around shelter homes
DISCOMs	For electric supply

The Shelter Homes are equipped with drinking water, water coolers, electricity/emergency lights, televisions. In all Shelter Homes, first aid box, fire extinguishers, storage facility, etc. are provided. In order to address the safety and security of women & children, CCTV cameras are installed on the premises, and security guards are employed. Basic utilities like bed/durries, blankets, jute mats, mattresses, bed sheets, pillows, etc. are provided

at the shelter. During the peak cold weather season i.e. from November to March entry to Rain Baseras are made free. The food at lunch and dinner is served for the residents. Regular visit of Doctors/ Health Check-up and free distribution of medicines are ensured.

The Board comes out with an action plan every year. The following are the main measures included in the action plan:

- 24 X 7 Control Room to receive complaints from the Public/ Homeless to rescue homeless (Control Room landline numbers 011-23378789, 011-23370560);
- 16 Rescue teams with one vehicle deployed through Shelter Management Agencies (SMAs) to rescue homeless to nearby Night Shelters from 10 PM to 4 AM;
- An awareness campaign for Rescue Operations through mobile App, Appeal to Public, Media advertisement & SMA's/NGOs;
- 62 new Pagoda Tents of water-proof & fire retardant quality to accommodate more homeless during winter;
- 10 teams of doctors from Mobile Health Scheme, GNCTD visiting all Night Shelters twice a week, to extend medical facilities to the Homeless persons;

- Rescue Teams linked with CATs Ambulance to facilitate transportation of needy persons to hospitals;
- Number of Homeless rescued from 19-11-2018 to 30-01-2019 – 12,756.

A night shelter app to track & rescue the homeless has been developed by the Board that can be downloaded by giving a missed call on 8826-400-500 or from Google Play Store (Rain Basera App). The app requires a photo to be submitted. The message is geo-tagged providing the location of the person automatically which is monitored by the Control Room. The rescue team stationed at various strategic points will spot and shift the homeless to the nearest shelter homes. Additional features of the app are for tracking nearest shelter homes from the spot, to get one's complaint status on App, to donate and lodge complaints/ suggestions about services at the Shelter Homes (Figure 12).

The pagoda tents of water-proof & fire retardant quality are installed in different locations provide extra shelters during winters.

New Initiatives

- Two new shelter homes under NULM Scheme are constructed in Geeta Colony and Sector 3, Dwarka (under progress) (Figure 13);



Figure 12 : Rain Basera in Delhi

RECOVERY SHELTER & MOHALLA CLINIC



Figure 13 Measures taken for Cold Wave Management

- Skill Training to Homeless: The first list of 38 interested homeless person with details has been shared with Transport Department, GNCTD for imparting motor driving skill training along-with issuance of Driving Licence to them.

ers for continuous monitoring and evaluation of specific plans needs to be mainstreamed.

In view of COVID-19 previous plans may not work given the social distancing norms. The extra requirement of space will be met by roping in schools and adding more temporary shelters.

Way forward:

A clear policy at the National / State/ District and local level needs to be developed to address urban poor needs during the cold wave. Institutional mapping with a clear role and responsibility at all levels needs to be formalized. A specific action plan for cold wave with focused intervention in housing and shelter needs to be developed. The capacity building of the state and district level offic-



Impact of the cold wave on Agriculture & Livestock and measures



Dr Prabhjyot K Sidhu,

Principal Scientist & Head, Dept. of Climate Change & Agricultural Meteorology, PAU, Ludhiana

The Cold wave conditions in north India are common during the winters. In 2020 too, the cold wave conditions were observed across North

India. Each year due to the cold wave there is a huge loss to the agriculture sector. The low temperatures cause two types of injuries to crop plants:

- **Chilling injury:** This type of injury is caused during low temperatures but not freezing of water. This causes a variety of physiological disruptions in germination, growth, flowering, and yield and storage life (Table 3).

The injuries observed in various crops/vegetable are as given below at low temperature:

Freezing injury: This type of injury occurs when the external temperature drops below the freezing point of water. It results from untimely frost or extremely low temperatures in the mid-winter. If water freezes in a plant cell, the sharp ice crystals can cut cell membranes, resulting in

Crops	Damage symptoms
Broccoli	The youngest florets in the center of the curd are most sensitive to freezing injury. They turn brown and give off a strong odour.
Cabbage	Leaves become water-soaked, translucent, and limp. Upon thawing the epidermis separates.
Carrot	Blistered appearance, jagged length-wise cracks. Interior becomes water-soaked and darkens upon thawing.
Cauliflower	Curds turn brown and have a strong off-odor when cooked.
Garlic	Thawed cloves appear greyish yellow and water-soaked.
Onion	Thawed bulbs are soft, greyish yellow, and water-soaked in cross-section. Damage is often limited to individual scales.
Potato	Freezing injury may not be externally evident, but shows as grey or bluish-grey patches beneath the skin. Thawed tubers become soft.
Raddish	Thawed tissues appear translucent and the roots soften and shrivel.
Tomato	Water-soaked and soft upon thawing. In partially frozen fruits, the margin between healthy and dead tissue is distinct, especially in green fruits.
Turnip	Small water-soaked spots or pitting on the surface. Injured tissues appear tan or grey and give off an objectionable odour.

Table 3 Damage to crops due to cold wave

fluids leaking from the cell, leading to cell and plant death. Freezing injury symptoms include tissue browning, blackening, wilting, or curling of leaves and stems. For example in wheat

for different growth stage, different damage are observed i.e. Vegetative (Seedling death), Anthesis (Sterility), and Grain filling (shriveled grains)(Figure 14).

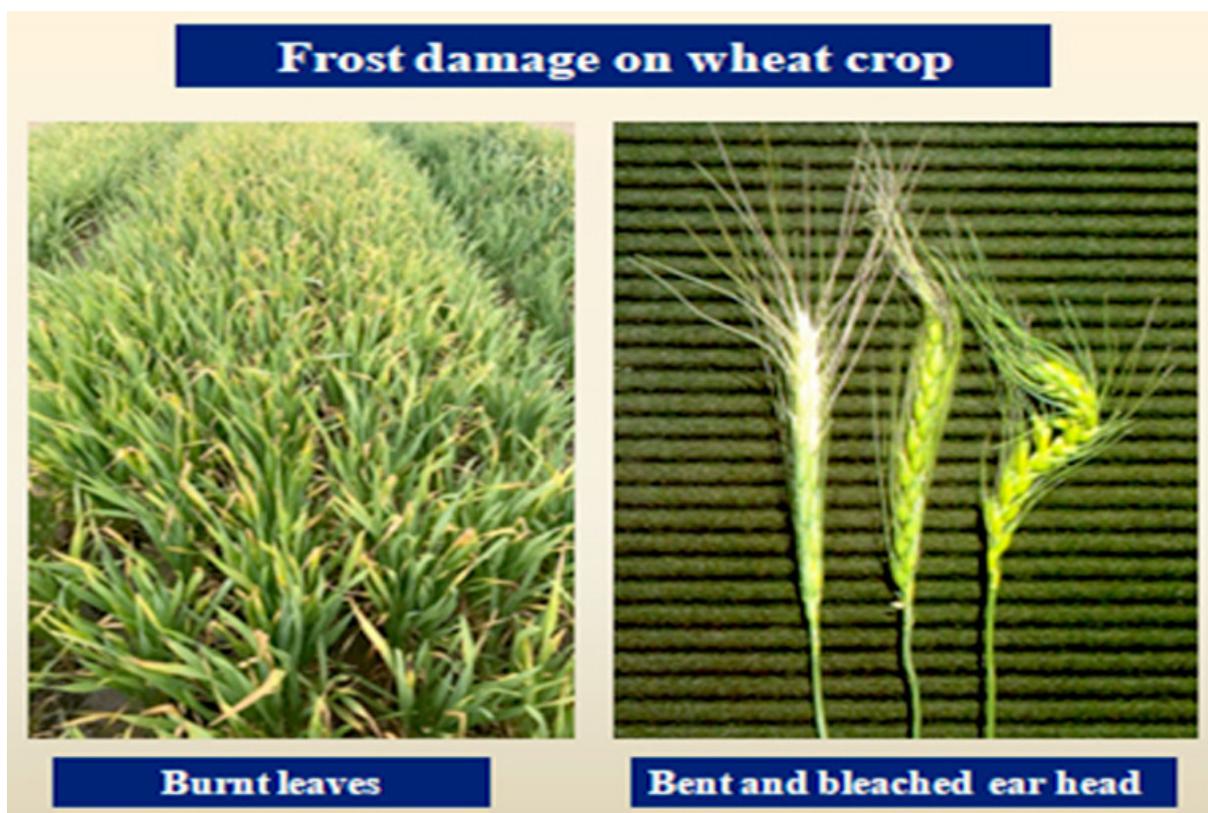


Figure 14 Damage to the wheat crop

Crop cold-tolerance

Cold stress is one of the prevalent environmental stresses affecting crop productivity, particularly in temperate regions. Numerous plant types of tropical or subtropical origin are injured or killed by non-freezing low temperature and display a range of symptoms of chilling injury

such as chlorosis, necrosis, or growth retardation. To thrive under cold stress conditions, plants have evolved complex mechanisms to identify peripheral signals that allow them to counter varying environmental conditions. However, for each crop the threshold temperatures are different. Optimum temperatures for different crops are given in table 4).

Temperature limits for crops in Northern plains

Table 4 Temperature tolerance of various crops

Crops	Optimum temperature (°C)	Limits of lower temperature (°C)	Higher limits of temperature (°C)
Wheat	25.0	3 to 4	30-32
Barley	20.0	3 to 4.5	38-40
Chickpea	20-25	5.0	>30.0
Mustard	17-22 .	3.0	32-35

Mitigation strategies for agriculture during cold weather:

Some of the practices/techniques are listed below:

- i. Application of light and frequent irrigations during December and January wherever it is possible.
- ii. Increasing radiation absorption and providing warmer thermal regime through the covering of nursery and young fruit plants during winter by plastic or by making thatches (jhuggies) of straw or sarkanda grass etc.
- iii. Thermal insulation by the application of locally available organic mulches will reduce the cooling rate of the soil surface and keeps the soil warm.
- iv. The mixing of air by running fans in orchards will help in breaking inversion layers and allow free mixing of cold air with warm air.
- v. The provision of heat through heaters/fire between the rows and creating an air blanket of smoke particularly in orchards shall trap the outgoing long wave radiation and the fall in temperature is reduced to a great extent (green house effect).
- vi. Sprinkler irrigation releases the latent heat of fusion by releasing heat into the surrounding air through condensation of water droplets.
- vii. Cultivation of cold/frost resistant plants/crops/varieties
- viii. Planting of windbreaks/shelterbelts.
- ix. Mixed cropping of vegetables, viz., tomato, brinjal with a tall crop like mustard / pigeon pea will provide necessary shelter against cold winds.
- x. Other agronomic practices such as raising nursery under the partial shade of trees or in between trees rows, multi-storey/mixed plantations and pruning of undesirable twigs/branches for in-situ use as mulch.

Impact on Livestock:

Cold stress results in some hormonal and adaptive changes in livestock, which affect the animal's level and efficiency of production. Some of the effects like an increased energy requirement for maintenance as a result of increased resting metabolic rate can be observed in many livestock. It is also common due to the increased rate of passage of digesta, the digestion efficiency reduces in the animals. The optimum breeding season for buffaloes/cattle under north Indian conditions is between October to February. Extreme variations in temperature may affect the fertility rate of animals. A cold environment increases the whole-body glucose turnover and glucose oxidation thus resulting in less production of ketones.

Mitigation strategies to manage cold wave in Animal Husbandry:

Some of the mitigation strategies that can help reduce the impact of cold weather include:

- i. Improving livestock feeding practice and dietary additives
- ii. Selecting animal breeds especially fit for cold weather conditions
- iii. Use of high-quality forage or pastures
- iv. Fat supplementation in ratios
- v. Construction of Climate-smart sheds that allow maximum sunlight during winters and low radiation during summers.
- vi. Covering the animals especially smaller ruminants during cold days
- vii. Cover the animal habitat from all sides during the night to avoid direct exposure of animals to cold winds
- viii. Using some bedding materials such as dry straw under animals during winters.



Technical Session II

Sharing of experiences and Capacity Building

Managing Cold Wave – State Perspective



Shri S.A. Murugesan,
Secretary (DM), Uttarakhand State
Disaster Management Authority (USDMA)
Dehradun, Uttarakhand

Cold waves are common in the plains of north India with foggy conditions that prevail during the winter season for several days or weeks at stretch. It affects the day to day life of local people. The weather during the winter season can be chilly with an average minimum temperature in between 5°C to 10°C in most of the places. Besides, some high altitude destination like Auli touches the mark of sub-0°C.

During a cold wave, common issues like electricity failures, roadblocks, health issues, etc are reported commonly in media. A cold wave with heavy and persistent snow fall causes crop damage and a shortage of food for grazing animals. Fire incidences are also common during the winters.

Along with the above issues, the Uttarakhand administration faces other unique challenges during the cold wave. Tourism is one of the main sources of income for local communities. During the winter season, Uttarakhand state attracts a surge of tourists.. During the winter months state organised various adventure, sports and cultural cativites, which includes the Food Festival during Winter Carnival, Nainital, winter line Carnival Mussoorie; Ganga Kayak Festival, Devprayag and National Skiing Championship, Auli. This

requires efficient administrative and resource management.

IMPACT:

The State of Uttarakhand has a unique biodiversity and is divided into three zones. The cold wave has a strong impact on the day to day life of local people. The cold wave in the state may lead to death and injury to human beings, livestock, and wildlife. If a cold wave is accompanied by heavy and persistent snow, there may be a shortage of food for grazing animals. If the duration of a cold wave is more along with frost formation damage to crops is observed. Using traditional heating systems increases fire incidences during winters. However, cold wave may also have a beneficial impact as it restores glacier and also improves local income sources by attracting more tourists.

Addressing the problem of Cold Wave:

The Government of Uttarakhand takes into consideration various international agreements like SFDRR and SDGs to mitigate, prepare, and respond to disasters including cold wave. Some of the actions initiated before the beginning of the cold wave are:

- i. Identify vulnerable areas of severe cold in the state.
- ii. Hydro met network facilities have been developed across the state which includes a large number of all-weather stations, automated rain gauge, automated snow gauge, surface field observatories, etc to capture rainfall, temperature, humidity, snow depth, etc. in real-time.
- iii. Meeting with District Officers through Video Conferencing regarding measures being taken for prevention or mitigation of severe cold as may be necessary
- iv. Timely Review of the preparedness measures and provide directions to the concerned departments at the state level as well as

district level and concerned authorities.

- v. Ensure the adequate quantity of supplies of food, drinking water, fuel, and medicines to be stored till the end of January and arrangements to be made for the far-flung areas by February.
- vi. Maintain, review, and upgrade the mechanism for early warnings and dissemination of proper information to the public. Various means (like e-mail, WhatsApp, radio) are used to disseminate

the cold wave warnings. The flow of information is shown in Figure 16.

- vii. India Meteorological Department (IMD) provides an early warning regarding cold spell/ snowfall.
- viii. Snowfall and Snow and Avalanche Study Establishment (SASE) provides an early warning regarding snowfall and Avalanche
- ix. The State also has formulated an action plan on the cold wave which is yet to be finalized.

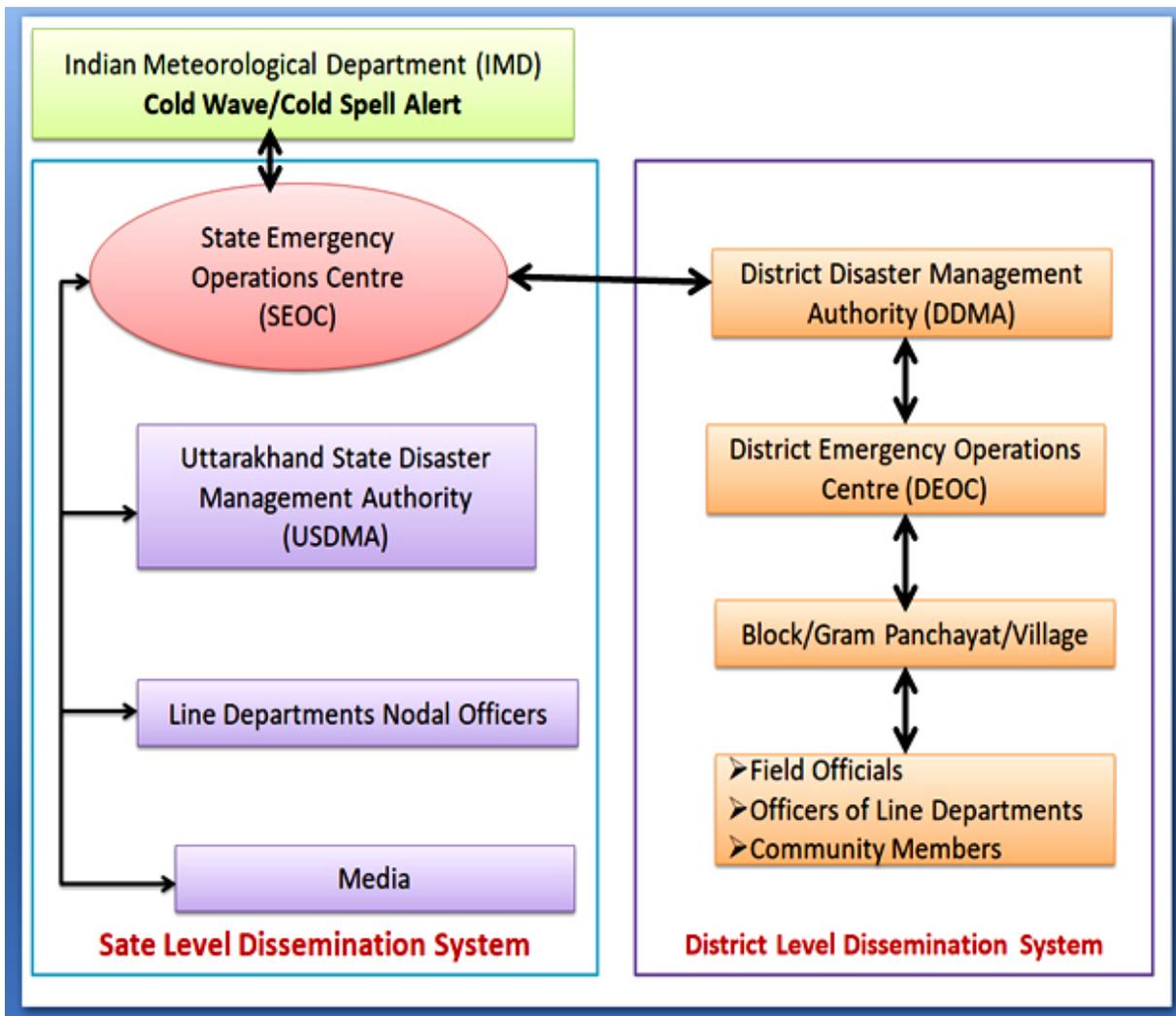


Figure 15 Early Warning Mechanism in Uttarakhand

Actions and Measures during a cold wave:

Addressing needs of shelter less and urban poor: Various buildings and places are identified by the local administration which could, in the event of any threatening severe cold situation, be used as shelter homes (rain basera) (Table

5). Make arrangements for essential supplies like food, water supply, allow health facilities, and sanitation in shelter homes (rain basera) (Figure 16).

Providing warm clothes/ blankets: Blanket has been distributed to the poor and homeless

Table 5 Number of Shelter homes in Uttarakhand during Winter Season 2019.

Shelter Homes (rain basera) during Winter Season 2019	
District	No. of Shelter Homes (rain basera)
Chamoli	03
Rudraprayag	04
Uttarkashi	03
Pithoragarh	06
Bageshwar	04
Almora	03
Champawat	05
Nainital	07
Dehradun	09
Haridwar	06
Pauri	08
Tehri	04
Us Nagar	05
Total	67



Figure 16 Shelter homes in Uttarakhand

people as per the need to safeguard them from low temperatures due to the cold waves. Various arrangements for burning “alaav” (bonfires) in public are arranged.

Clearance of Roads: In order to clear the road the PWD department deploys manpower at the vulnerable sites along with required resources such as JCB machines, cutters, trucks, etc. The PWD officers coordinate with the concerned department (like forest department) to remove fallen trees that block the roads and uses its

manpower as a first response team (Figure 18).

Restoration of electricity: The Power infrastructure damaged due to the Cold Wave and Icing is repaired/ changed quickly by the Power department. The power supply is restored on a priority basis for emergency services like hospitals, fire services, and disaster management cells (Figure 18).

Health measures: The Health Department carries out awareness campaigns and IEC activities for communities using different means



Figure 17 Clearance of roads



Figure 18 Management of power supply during the cold wave

of information dissemination mediums. They also keep adequate stock of medicines and other supplies in case of any road blocks. In case, there is a heavy surge of patients, the Department of Health networks work with the medical centres to share the patient load. All cases of cold-related illnesses are reported to the IDSP (Integrated Disease Surveillance Programme) unit of the district.

Stocking Food and Essential Supplies: The Food & Civil Supplies Department makes necessary arrangements for assuring a steady supply of food and relief materials. In consultation with the State Disaster Management Authority, severely prone districts are marked and storage, packaging, and supply of food grains during the winter season are ensured.

Advisory on Agriculture and Animal Husbandry: The farmers from time to time are advised on how to protect crops against cold wave periodically like irrigate, mulch, fumigate, make a roof over small crops, use Organic and chemical drugs to protect the crops from frost/fog (dithane-M045, copper oxychloride, and trichordama.). In the year 2019-20, the roof over

the newly planted fruit plants were built under the MNREGA scheme to protect them from cold. The farmers are also advised to grow cold-resistant crops - radish, turnip, carrot, fenugreek, spinach, peas, mustard, spinach, coriander, rye, fenugreek, etc.

Animal husbandry, vaccination for susceptible animals keeping in mind the diseases is carried out. A systematic deworming of animals is carried out to improve the health and immunity of the animals. The farmers are provided with energy-rich feed supplements and mineral-rich compounds to overcome nutrition deficiency in winters. Various information dissemination campaigns for the wise use of warm water and scientific rearing of animals is carried out. In case of non-availability of fodder due to roadblocks/ bad weather, the Fodder Banks are institutionalized into the block level to provide compact feed blocks to tide over the crisis. Multiple Rapid response teams are formed at block level to combat any unforeseen calamity.

Water Supply: The District nodal officer in the disaster-affected district will ensure the presence of all staff during any disaster. The staff is supposed to carry out immediate repair and are provided with essential equipment like pipes, HDPE pipes, sodium hypochlorite/bleaching powder, and labourers, etc. The quality of available drinking water is checked and chlorinated. Since cold wave especially has a high impact on water supply infrastructure, the department regularly replaces damaged pipelines from time to time

Children: Schools in the affected districts are closed during the cold spell /snowfall period.

Role of NDRF and SDRF: The SDRF is trained for relief and rescue especially during the roadblocks. They also help in the clearance of debris/ snow on road. Besides these, the SDRF is also employed to help in tracking, escorting the victims, and support in the relief operation.

Capacity Building and Documentation on Cold Wave – Role of NIDM



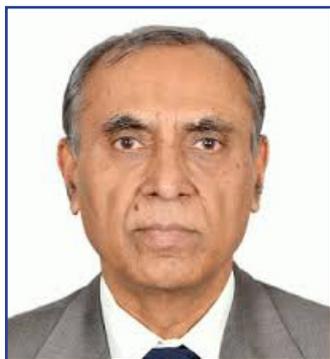
Major General Manoj Kumar Bindal, ED, NIDM

Cold waves can have a deleterious effect on health, even death due to carbon monoxide poisoning, blocking of roads, impact on water supply, and electricity. Till date the preparedness measures are more or less state-driven, but there is a huge scope for building capacity through training so that preparedness measures are taken up by all stakeholders. Most of the preparedness and mitigation is focused on known sectors like agriculture, health, and infrastructure. New areas like measures for stray and wild animals are very limited even today.

India recognized cold wave as a disaster in 2012; however, action plans are yet to be prepared in many of the Cold Wave prone states. NIDM can play a significant role in building capacity and conducting training in cold wave prone states. NIDM can also develop various IEC and awareness programs to create awareness for cold wave management.



Concluding Remarks and Road Map



Dr. L.S. Rathore,
Former DGM, Indian Meteorological
Department

Dr. Rathore highlighted 5 aspects to formulate the road map for cold wave action plan i.e. Early warning, impacts of cold wave, the current level of preparedness to fight the cold wave, Common Alerting Protocol, and improve cold wave management mechanism for the road map.

Early warning: He highlighted the contribution of IMD in cold wave forecasting as well as prediction, dissemination, and consumption of warning. He mentioned that IMD already has an existing infrastructure system in place for the forecast of cold wave. Significant improvement has been made in the accuracy of forecasting and improvement in dissemination mechanisms. This needs to be further strengthened. The priority is to standardize and issue the next level of impact-based forecasts which have already been initiated by IMD. In order to standardize impact-based warnings, we need to analyze impacts on sectors specific and issue warnings. While in certain sectors the impacts of cold waves are well understood, in others it needs to further characterize the impacts. The precise information and output from various research studies also need to be mainstreamed into the planning process especially the vulnerability aspect. The hazard mapping, vulnerability assessment, and

impact assessment for sectors and spatially need to be further standardized.

Presently, we are comfortable using the short and medium-range of forecasting provided by IMD. However, it is important to take into account the extended and seasonal forecast and incorporate it into the planning process. Both at the local and state level how to use this forecast and institutionalize it into local planning, needs to be looked at.

In the Himalayan region, data deficiency is mentioned by DG IMD. Organizations like SASE are already working on avalanches. The IMD and SASE need to work closely to monitor cold wave in the northwestern Himalayas.

The interrelationship of pollutants and cold wave needs to be further explored. Air pollution has an impact on the cold wave by increasing the average fog hours thus reducing the temperature during the day and night. Health issues as well as mortality hikes due to pollution during cold ways. A cold wave's impact factor through a new rating (Wind-Chill-AQI) may be developed based on temperature, wind direction, and air quality.

Development of Common Alerting Protocol (CAP): Keeping the impact-based warning in mind, the impact of the cold wave is different in mountains, hills, and the Terai region. Therefore, any combating cold wave strategy needs to consider this. Different states/ districts have to develop different action plans depending on the level of cold wave conditions previously experienced by the states. Advisories are required for military and paramilitary forces that can be developed with help of SASE.

Impacts of cold wave: The understanding of the impact of the cold wave on different sectors is at various levels. For instance, the impact of cold temperatures on agriculture is fairly well understood. But on orchards/ horticulture is limited in the study.

At the same time, the forest ecosystems response to cooler temperatures is very limited. Similarly, wild life's requirement during a cold wave is limited.

The impact of cold wave on human beings is well documented. But the impact on infrastructure like housing, power, water supply, etc. needs to be further delved into. Managing impacts on the Health sector is very critical as deaths due to cold wave are higher than heat wave. More people die in plains and urban areas. Hence more data is required to make the road map robust.

Level of preparedness: The Government of India notified cold wave as a disaster in 2012 in the agriculture sector only. We need to move beyond the agriculture sector and include all sectors. Guidelines need to be further developed. Like heat wave action plans, cold wave plans need to be prepared and propagated across cold wave prone states. Detailed guidelines are required to lay down action plans. Pilot projects may be developed in a cold wave plan along with vulnerability assessment.

Insurance plans need to be improved and implemented regarding cold waves. Building codes need to be further evaluated and developed taking into consideration ventilation, thermal insulation, regulation of Carbon Monoxide, indoor pollution, etc. in a cold wave. The state has to take into consideration the needs of the community like industry labour, nutrition. Tourism needs should be considered while designing a cold wave action plan.

Future action and road map:

- As the country is passing through COVID-19 Pandemic, there is a need to be prepared for the upcoming cold wave season as a concurrent disaster with COVID-19 and take timely actions to reduce the adverse impacts of cold wave.

- The hazard mapping, vulnerability assessment, and impacts assessment for various sectors and different regions spatially need to be further standardized.
- The impact on various sectors like wildlife, buildings, water systems, industry, etc needs to be further studied.
- Standardize and issue the impact-based forecasts, early warning/forecasting/alerts. The existing dissemination systems may be further strengthened.
- The interrelationship of pollutants and cold wave needs to be further explored.
- Prevention and preparedness measures for Cold wave must aim at reducing the impact on human health, agriculture and food security, livestock & livelihood, etc.
- The IMD and SASE need to work closely to monitor cold wave in the northwestern Himalayas.
- Advisories are required for military and paramilitary forces that can be developed with help of SASE.
- A cold wave's new rating may be developed based on temperature, wind direction, and air quality.
- Pilot Action Plan on cold wave may be prepared and implemented at state/ district level.
- Creating awareness: Educate people through IEC materials (Pamphlets/ Posters/ Advertisements) and dissemination of Dos and Don'ts.
- Projects/ programs to improve the coping capacity of the local community to deal with cold wave situations may be initiated.
- Building capacity at all levels (local people, local administration, community-level organizations like NGOs, CBOs, etc.)
- Develop a Building Code for thermal insulation: Offices, Homes, Public Buildings, Industries etc)

Vote of Thanks



Dr. S. K. Jena,
Joint Advisor, NDMA

It is my privilege to propose a Vote of Thanks on behalf of the National Disaster Management Authority.

First of all, I take this humble opportunity to thank Lt Gen Syed Ata Hasnain, Member, NDMA for giving keynote addresses and Shri. G. V. V. Sarma, Member Secretary, NDMA for an inaugural address. On behalf of NDMA, I express my sincere thanks to all key speakers representing from IMD, Ministry of Agriculture, Health and Family Welfare, Delhi Urban Shelter Improvement Board, Punjab Agriculture University, DM Department, Uttarakhand, and NIDM. Also, my sincere thanks to Dr. L.S. Rathore, Former DGM, IMD for concluding the Webinar.

I am also thankful to all the participants representing from Ministries/ Departments of Central Government and State Governments and particularly Agriculture department, Health department, Animal Husbandry department, Municipalities/NACs, Remote Sensing Organizations, Agricultural Universities International Organizations, voluntary organizations, various other stakeholders, Advisor Members of NDMA and Former Members of NDMA.

As the National Webinar is organized with the broad objective to share experiences/ best practices for preparedness & mitigation of Cold wave, I hope all the participants have learned the issues relating to cold wave risk reduction and it is expected that they suitably modify their action plan for ensuing cold wave season in 2020-21.

Lastly, I would like to extend sincere thanks to Dr. V. Thiruppugazh, Additional Secretary, NDMA for his timely guidance to organize this event and his team for making this event a successful one on short notice.

I once again thank you all for attending the National Webinar in different capacities. Thank you.

National Webinar on Cold Wave Risk Reduction 2020-21

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