सत्यमेव जयते

Proceedings

of

National Workshop on Heat Wave 2023

Early Planning and Effective Action: Saving Lives

February 13-14, 2023

NATIONAL DISASTER MANAGEMENT AUTHORITY (NDMA)
Government of India
NDMA Bhawan, A-1, Safdarjung Enclave,
New Delhi-110 029

Proceedings of
National Workshop on Heat Wave 2023

Early Planning and Effective Action: Saving Lives

February 13-14, 2023

Venue:
Victor Menezes Convention Centre
Indian Institute of Technology Bombay, Mumbai

Editors

Prof. Parmeshwar Udmale, Assistant Professor, IIT Bombay

Prof. Ravi Sinha, Professor, IIT Bombay

Dr. Swati Sulagna, Senior Consultant, NDMA

Shri Anuj Tiwari, Senior Consultant, NDMA

Dr. Vazeem Iqbal, Consultant, NDMA

Organising Team - NDMA

Shri Kunal Satyarthi, Joint Secretary, NDMA

Smt. Rakhee Sadhu, Deputy Secretary, NDMA

Shri Pankaj Kumar, Under Secretary, NDMA

Dr. Swati Sulagna, Senior Consultant, NDMA

Shri Anuj Tiwari, Senior Consultant, NDMA

Dr. Vazeem Iqbal, Consultant, NDMA

Rapporteurs

Ms. Rutuja Shinde, PhD Student, IIT Bombay

Ms. Megha Mhaskar, PhD Student, IIT Bombay

Ms. Mayuri Gadhawe, JRF, IIT Bombay

Ms. Debdatta Chakraborty, PhD Student, IIT Bombay

Mr. Ankit Kumar Gupta, M Tech Student, IIT Bombay

Ms. Saili Bhoir, Intern, IIT Bombay

This report should be cited as:
National Disaster Management Authority (2023): Proceedings of National Workshop on Heat Wave 2023: Early Planning and Effective Action: Saving Lives, IIT Bombay, Mumbai, 2023.

Table of Contents

1 CONTEXTUAL BACKGROUND

The frequency of climate extremes, such as hot and cold temperature extremes, is expected to increase across the globe (IPCC, 2018)[1]. Over the past decades, the maximum annual average temperature has shown a rising trends across the globe. As a result of this increased temperature, the number of hot days has also shown an increasing trend. The continuous acceleration in global warming has severely increased the exposure of living beings and socio-ecological systems. In 2022, the average surface air temperature of the oceans and land was around 1.15 °C higher than it was before industrialization (WMO, accessed on January 2023)[2]. The continuously increasing temperature trend over the past century and present years is the primary reason for the increasing trend Heat Waves.

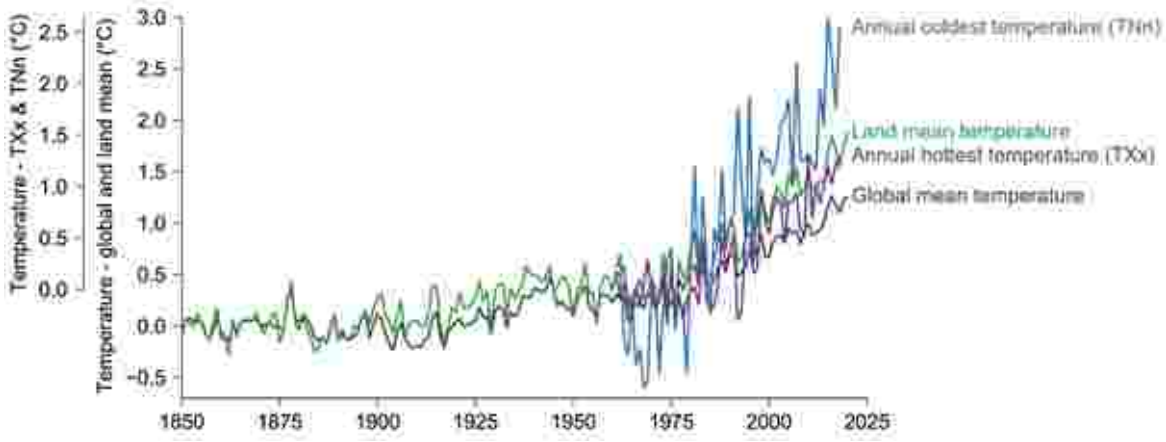

Figure 1 Observed temperature anomalies for global average annual mean temperature (black), land average annual mean temperature (green), land average annual hottest daily maximum temperature (TXx, purple), and average annual coldest daily minimum temperature (TNn, blue) (Source: IPCC Report, 2021)[3]

The increasing temperature and associated heat waves can adversely affect agriculture, ecology, society, public health, and a nation's economy (National Weather Service, 2014[4]; Thamo et al., 2017[5]). Health and society are facing significant impacts due to the disastrous

1. Intergovernmental Panel on Climate Change, (2018), https://www.ipcc.ch/2018/
2. https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate
3. https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-11/
4. NWS,2014.
5. Thamo, T., Addai,D., Pannell, D. J., RobertsonM. J., ThomasD. T., Young, J. M. (2017). Climate change impacts and farm-level adaptation: Economic analysis of a mixed cropping–livestock system. *Agricultural Systems*,

heatwave events (Dubey et al., 2021)[6]. The heat waves have a profound impact on ecosystems, economy and society. The urban climate has been noticeably impacted by rapid urbanization, increasing land and population density, and expanded urban developments (Oleson et al., 2015)[7]. Extreme heatwave events are common worldwide and have developed into major meteorological disasters due to global warming and urbanization (Yang, 2021)[8]. It has caused notable human life loss worldwide. There are a few deadliest heatwave examples, such as the heatwave caused more than 77000 deaths in Europe in 2003, 15,000 deaths in France in 2003, and in Russia, about 55000 were killed in 2010. Forest fires in Portugal and Spain are also a result of heatwave events (Robine et al., 2008[9]; Poumadère et al., 2005[10]; Otto et al., 2012[11]). With the increase in temperature (3-6^{0}C) at the end of the century, the risk of heatwave disaster is one of the greatest threats to humans and the environment (IPCC, 2014)[12]. The hottest temperature in the past 60 years was recorded in the cities of north India (Jacox et al., 2016)[13]. In addition to directly harming human health, heatwave hazards also negatively affect local production and quality of life (Tian et al., 2013)[14]. The vulnerability of the urban man-land composite system is further exacerbated by factors including the overburdened operation of urban water supply and electricity, the disorder of the transportation system, the drop in crop yield, and the change in agricultural production. (Yang et al., 2019)[15]. Unlike other disasters like earthquakes and cyclones, an extreme heat event is a slow onset event and results in unexpected mortality. As a result, it is challenging to pinpoint the event's beginning and end. There is only a small degree of international

6. Dubey, A., Kumar,P., Saharwardi, Md., Javed, A. (2021). Understanding the hot season dynamics and variability across India. Weather and Climate Extremes, 32
7. Oleson, KW., Monaghan, A., Wilhelmi, O., Brusnell,N., Feddema,J., Hu, L., Steinhoff, DF. (2015). Interactions between urbanization, heat stress and climate change, Climate Change. 129(3-4):525-541.
8. Haifeng Yang (2021). Geomatics, natural hazards and risk: spatial assessment of urban heatwave vulnerability of coupling adaptability based on BPNN model: a case study of Xiamen City, China, Geomatics, Natural Hazards and Risk, 12:1, 2654-2675, DOI: 10.1080/19475705.2021.1973119
9. Robine, J., Cheung,S. K., Roy, S., Oyen, H. V., Griffiths,C., Michel, JP. and Herrmann.F. R. (2008). Death toll exceeded 70,000 in Europe during the summer of 2003. Comptes Rendus Biologies, 331(2):171-178
10. Poumadère, M., Mays,C., Mer,S., and Blong,R. (2005). The 2003 Heat Wave in France: Dangerous Climate Change Here and Now. Risk Analysis, 25(6):1483-1494.
11. Otto, F. E. L.,N. Massey, G. J. van Oldenborgh, R. G. Jones, and M. R. Allen (2012). Reconciling two approaches to attribution of the 2010 Russian heat wave. Geophysical Research Letters, 39(4)
12. https://www.ipcc.ch/ar6-syr/
13. Jacox, M.G., Hazen, E.L., Zaba,K.D., Rudnick, D.L., Edwards,C.A., Moore, A M., and Bograd, S.J.(2016). Impacts of the 2015–2016 El Nino on the California Current System: early assessment and comparison to past events. Geophysics Research Letters. 43(13):7072–7080.
14. Tian, Z., Li,S., Zhang,J., andGuo,Y. (2013) The Characteristic of Heat Wave Effects on Coronary Heart Disease Mortality in Beijing, China: A Time Series Study. PLoS ONE 8(9): e77321. https://doi.org/10.1371/journal.pone.0077321
15. Yang, J., Yin,P., Sun,J.M., Wang, B.G., Zhou,M.G., Li,M.M., Tong,S.L., Meng,B.H., Guo,Y.M., and Liu,Q.Y. (2019). Heatwave and mortality in 31 major Chinese cities: definition, vulnerability and implications. Science of The Total Environment. 649:695–702.

consensus regarding the precise criteria to consider when a heat event is classified as a heatwave.

Table 1: Heat wave definitions

Region/Country	Definition	Reference
Africa	For three consecutive days, daily maximum temperature > 90th percentile cantered on a 31-day window.	Ceccherini et al. (2017)[16]
Australia	Three or more consecutive days with unusually high daytime and night-time temperatures in relation to the local long-term climate and recent past. Range: 37°C to 42°C	Bureau of Meteorology, Heatwave assessment and forecast, report
Brazil	"Three or more consecutive days characterized by daily Tmax above the 90th Tmax percentile and daily Tmin above 90th Tmin percentile. Percentiles are computed for each day of the year based on the climatological normal (1961-1990) with a 15-day window."	Oliveira et al. 2021[17]
China	Daily maximum temperature > 35°C daily maximum temperature > 90th percentile threshold of the local daily temperature distribution of the data.	Ding et al., 2010[18]
Europe	"A time interval of at least 2 days with maximum apparent temperature exceeding the 90th percentile of the monthly distribution or a time interval of at least 2 days in which	Awasthi et al. 2022[19]

16. Ceccherini, G., Russo,S., Ameztoy,I., Marchese,A. F., Carmona-Moreno,C. (2017). Heat waves in Africa 1981–2015, observations and reanalysis, Natural Hazards Earth System Science, 17, 115–125, https://doi.org/10.5194/nhess-17-115-2017.
17. Oliveira, A., Lopes,A., Correia,E., Niza,S., Soares,A. (2021). Heatwaves and Summer Urban Heat Islands: A Daily Cycle Approach to Unveil the Urban Thermal Signal Changes in Lisbon, Portugal. Atmosphere, 12(3):292. https://doi.org/10.3390/atmos12030292.
18. Ding, T., Qian,W., and Yan,Z. (2010). Changes in hot days and heat waves in China during 1961–2007, International Journal of Climatology, 30:1452-1462, 10.1002/joc.1989.
19. Awasthi, A., Vishwakarma, K., Pattnayak,K.C. (2022). Retrospection of heatwave and heat index. Theoretical and Applied Climatology, 147, 589–604. https://doi.org/10.1007/s00704-021-03854-z.

	minimum temperature exceeds the 90th percentile and maximum apparent temperature exceeds median monthly value"	
India	It is defined based on the temperature thresholds over a region in terms of actual temperature or its departure from normal. For Plains, if the maximum temperature of a station >= 40°C For Hilly regions, >= 30°C Based on Departure from Normal: i) Departure from normal is 4.50°C to 6.40°C:Heat Wave; ii) Departure from normal is >6.40°C: Severe Heat Wave Based on Actual Maximum Temperature: i) When actual maximum temperature ≥ 45°C: Heat wave; ii) When actual maximum temperature ≥47°C: Severe Heat Wave If the above criteria are met at least in 2 stations in a Meteorological sub-division for at least two consecutive days, it is declared on the second day. In coastal areas, heatwaves are described in India as: When the maximum temperature departure is 4.50°C or more from average, Heat waves may be described if the actual maximum temperature is greater than or equal to 37°C.	India Meteorological Department
Japan	For three consecutive days, daily maximum temperature > 35°C	Noh et al. 2021[20]
Russia	daily maximum temperature exceeds the 90th percentile of the daily Tmax series	Wang and Luo, 2020[21]

20. Noh, E., Kim, J., Jun, S.-Y., Cha, D.-H., Park,M.-S., Kim, J.-H., Kim,H.-G. (2021). The role of the Pacific-Japan pattern in extreme heatwaves over Korea and Japan. Geophysical Research Letters, 48, e2021GL093990. https://doi.org/10.1029/2021GL093990
21. Wang, H., and Luo,D. (2020). Summer Russian heat waves and their links to Greenland's ice melt and sea surface temperature anomalies over the North Atlantic and the Barents–Kara Seas. Environmental Research Letters, 15(11): 10.1088/1748-9326/abbd03

South Africa	In terms of heat stress, a heatwave occurs when the mean UTCI (Universal Thermal Climate Index) for the region exceeds the climate 90th percentile. (i.e., UTCI > 26.1°C for December and January 1981 to 2019)	Brimicombe et al., 2021[22]
USA	A two-day period in which the daily maximum apparent temperature (the actual temperature adjusted for humidity) in a specific city exceeds the 85th percentile of that city's historical July and August temperatures (1981-2010).	United States Environmental Protection Agency
UK	A three-day period with daily maximum temperatures that meet or exceed the heatwave temperature threshold.	https://www.metoffice.gov.uk/
World Meteorological Organization, WMO	Five or more consecutive days of prolonged heat in which the daily maximum temperature is higher than the average maximum temperature by five degrees Celsius (9 °F) or more	Heatwave, Meteorology, accessed on January 2023

Impact of Heatwave on Major Countries

Mbokodo et al. (2020)[23] examined the foreseeable impact of climate change on South Africa's future with a focus on heatwaves using an ensemble of regional climate model downscaling obtained from the Conformal Cubic Atmospheric Model (CCAM) for the durations 2010-2039, 2040-2069, and 2070-2099, with 1983-2012 as the historical baseline. Results showed that the frequency of severe cold events would decline while the frequency of extreme heat events will rise. The highest significant increase in heatwaves occurrences is projected to occur in the north-western region of South Africa. Although it is not predicted

21. Wang, H., and Luo,D. (2020). Summer Russian heat waves and their links to Greenland's ice melt and sea surface temperature anomalies over the North Atlantic and the Barents–Kara Seas. Environmental Research Letters, 15(11): 10.1088/1748-9326/abbd03
22. Brimicombe, C., Napoli,C., Cornforth,R., Pappenberger, F., Petty, C., Cloke,H. L. (2021). Characteristics of Heatwaves in Africa: Morocco 2000 and South Africa 2015/16, Natural Hazards and Earth System Sciences, https://doi.org/10.5194/nhess-2021-242, 2021
23. Mbokodo, I., Bopape, M.-J., Chikoore, H., Engelbrecht, F., & Nethengwe, N. (2020). Heatwaves in the Future Warmer Climate of South Africa. Atmosphere, 11(7), 712. https://doi.org/10.3390/atmos11070712

that the frequency of heatwaves will significantly rise in the central interior, this region's heatwaves are anticipated to last longer as a result of future climate change (Mbokodo et al., 2020)[24]. Future heat waves were predicted by Zittis et al. (2021)[25] using the Heat Wave Magnitude Index and a robust assessment of regional climate projections for North Africa. Results showed that in the second half of this century, previously unknown super- and ultra-extreme heatwave situations will develop. These events will have unexpectedly high temperatures (up to 56 °C and above), last for a long time (many weeks), and could endanger human life. Adeniyi and Oyekola (2017)[26] studied the prevalence of heat and cold waves over the West African regions with homogeneous temperatures. The intensity and occurrence of heat waves over West Africa are influenced by both global warming as well as tropical oceanic oscillations.

Fang and Lu (2020)[27] investigated the spatiotemporal variation and variations of summertime heatwave frequency over Northeastern Asia between 1979 and 2017 using both grid-based as well as event-based analyses, based on the ERA-interim reanalysis daily maximum temperature. Using two main blocking indices, the relationship between blocking and heatwave is further investigated in terms their occurrence and properties. The findings showed that heatwaves generally start after or on the day of blocking's beginning and finish after or at that point. Dong et al. (2021)[28] examined heatwaves in Southeast Asia in the current and future warmer climates using the observational dataset SA-OBS and model outputs from the Community Earth System Model Large Ensemble project. The findings showed that increased global warming is linked to significant changes in the characteristics of heatwaves across Southeast Asia, including an increase in their frequency, duration, and extreme temperatures.

From 1950 to 2016, there was a continuous rise in the maximum temperature, number of occurrences, frequency, and severity of heatwaves across Australia (Trancoso et al., 2020)[29]. According to Queensland's future climate estimates that have been downscaled in the study by Trancoso et al., 2020, heatwaves are likely to worsen this century. The estimates also show that

24. Mbokodo, I., Bopape, M.-J., Chikoore, H., Engelbrecht, F., & Nethengwe, N. (2020). Heatwaves in the Future Warmer Climate of South Africa. Atmosphere, 11(7), 712. https://doi.org/10.3390/atmos11070712
25. Zittis, G., Hadjinicolaou, P., Almazroui, M. et al. (2021). Business-as-usual will lead to super and ultra-extreme heatwaves in the Middle East and North Africa. NPJ Climate and Atmospheric Science, 4, 20. https://doi.org/10.1038/s41612-021-00178-7
26. Adeniyi, M., and Oyekola, S. (2017). Assessment of heat and cold wave events over West Africa using three regional climate models. Annals of geophysics, 60(3), A0322. DOI: 10.4401/ag-7039
27. Fang, B., & Lu, M. (2020). Heatwave and blocking in the North eastern Asia: Occurrence, variability, and association. Journal of Geophysical Research: Atmospheres, 125, e2019JD031627. https://doi.org/10.1029/2019JD031627
28. Dong, Z., Wang, L., Sun, Y., Hu, T., Limsakul, A., Singhruck, P., & Pimonsree, S. (2021). Heatwaves in Southeast Asia and their changes in a warmer world. Earth's Future, 9, e2021EF001992. https://doi. org/10.1029/2021EF001992
29. Trancoso, R., Syktus, J., Toombs, N., Ahrens, D., Koon-Ho Wong, K., Pozza, R. (2020). Heatwaves intensification in Australia: A consistent trajectory across past, present and future, Science of The Total Environment, 742, 140521, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2020.140521.

different climate regions within Queensland may respond to heat waves differently under global warming, with tropical and equatorial heatwaves appearing to be more vulnerable to rising atmospheric CO2 concentrations than temperate and desert regions. Williams et al. (2018)[30] evaluated how heatwaves affected morbidity and mortality throughout South Australia's various climate zones. When compared to non-heatwave days, morbidity increased across all locations, and the severity of the heatwave had an even greater impact.

Lhotka and Kysely (2015)[31] assessed combined impact of spatial extent, temperature magnitude and heat waves duration and cold spells durations over Central Europe. The study analysed18 big heatwaves and 24 major cold spells over Central Europe between 1950 and 2012. The two heatwaves that affected Central Europe the most were those in the summers of 1994 and 2006, which were both significantly more extreme than the well-known heatwaves of 2003 and 2010. The harshest cold snaps happened in the winters of 1962–1963, and 1955–1964. Using the seasonal sum of the extremity index, the recent winter of 2011/2012 was revealed to be the sixth coldest since 1950/1951.

Yu et al. (2023)[32] used the ERA5 reanalysis for 1959–2021 and observational data for 1959–2010 to study the North American summertime variability of heat-wave from a climatological aspect. The underlying dynamical as well as thermodynamic mechanisms, and also the anomalies related with substantial atmospheric circulation and surface energy balance during heatwaves, were studied. According to the findings, processes that result in circulation and surface radiation anomalies of the opposite signs would also cause negative heatwave variability. In late June 2021, an unprecedented heatwave stormed across western North America, causing hundreds of deaths, a catastrophic die-off of marine life off the coastline, and devastating wildfires (Wang et al., 2023[33]; H Wang et al., 2022[34]). Wang et al. (2023) identified three atmospheric circulation patterns linked to these heatwaves in western North America using observational data. The daily average highest

30. Williams, S., Venugopal, K., Nitschke, M. et al. (2018). Regional morbidity and mortality during heatwaves in South Australia. International Journal of Biometeorology, 62, 1911–1926. https://doi.org/10.1007/s00484-018-1593-4
31. Lhotka, O., and Kyseľ y, J. (2015). Characterizing joint effects of spatial extent, temperature magnitude and duration of heat waves and cold spells over Central Europe. International Journal of Climatology, 35 (7), 1232–1244, https://doi.org/10.1002/joc.4050
32. Yu, B., Lin, H., Mo, R., & Li, G. (2023). A physical analysis of summertime North American heatwaves. Climate Dynamics, 1-15.
33. Wang, S., Jing, Z., Wu, L., Sun, S., Peng, Q., Wang, H., Shi, J. (2023). Southern hemisphere eastern boundary upwelling systems emerging as future marine heatwave hotspots under greenhouse warming. Nature Communications, 14(1), 28
34. Wang, H., Gao, Y., Wang, Y., Sheng, L. (2022). Arctic sea ice modulation of summertime heatwaves over western North America in recent decades. Environmental Research Letters, 17, 10.1088/1748-9326/ac765a

temperature in the western part of North America has increased over time and will continue to do so, according to CMIP6 climate models, and one of the main causes of this growth is greenhouse gases (Wang et al., 2023)[35]. Whereas the 1980–2021 reanalysis data is examined in another study to understand the mechanism controlling the summer heatwaves in North America (H Wang et al., 2022)[36]. According to the findings, heatwaves in western North America frequently coincide with quasi-barotropic ridges (QBTRs).

Ceccherini et al. (2016)[37] assessed the magnitude as well as frequency of heat waves and cold waves in South America. The findings showed an increase in heat wave frequency and heatwave intensity, particularly over the previous ten years. Cerne and Vera (2011)[38] examined, the impact of intra-seasonal variability on the emergence of heat waves over subtropical South America in austral summer. The results demonstrated the significance of the South Atlantic Convergence Zone activity in causing persistent circulation anomalies at subtropical locations, which can lead to the emergence of persistent heat waves and extremely high daily temperatures.

35. Wang, S., Jing, Z., Wu, L., Sun, S., Peng, Q., Wang, H., Shi, J. (2023). Southern hemisphere eastern boundary upwelling systems emerging as future marine heatwave hotspots under greenhouse warming. Nature Communications, 14(1),28.
36. Wang, H., Gao, Y., Wang, Y., Sheng, L. (2022). Arctic sea ice modulation of summertime heatwaves over western North America in recent decades. Environmental Research Letters, 17, 10.1088/1748-9326/ac765a
37. Ceccherini, G., Russo, S., Ameztoy, I., Romero, C. P., and Carmona-Moreno, C. (2016). Magnitude and frequency of heat and cold waves in recent decades: the case of South America, Natural Hazards and Earth System Sciences, 16, 821–831, https://doi.org/10.5194/nhess-16-821
38. Cerne, S., and Vera, C. (2011). Influence of the intraseasonal variability on heat waves in subtropical South America. Climate Dynamics, 36:2265–2277, DOI 10.1007/s00382-010-0812-4

2 BRIEF NOTE ON THE WORKSHOP

Heat wave has emerged as one of the major extreme weather events around the globe, cities and region in recent years. As per IPCC report 2022 for policy maker and Assessment of Climate Change over the India Region report, (Ministry of Earth Science) indicated that the intensity and frequency of heat waves have increased in recent times with climate change driving temperatures even higher. Eleven out of fifteen warmest years occurred between 2004 and 2019 (WMO). There has been an increasing trend of heat waves in India over past several years whereby a number of States/districts/cities/towns in India have been severely affecting health and livelihood of vulnerable populations.

India's average maximum temperature recorded in March 2022 is the ever highest with 33.10ºC in last 122 years for the period 1901-2022. Similarly, in the month of April 2022, the highest recorded average maximum temperature over Northwest India has been 35.9ºC in last 72 years for the period 1950-2022(Source: IMD, New Delhi).In year 2022, several northern states were severely affected from heat wave. While human health was at the forefront, its cascading effects were felt across all sectors from power, water, and wildlife to agriculture. In the year 2021, 4 deaths were reported, while the government aimed at zero tolerance towards heat wave-related deaths for 2023. There is a need for State governments and stakeholders to take extra measures to ensure that this downward trend of reducing death is maintained.

2.1 Earlier action taken by NDMA, State Governments and other Stakeholders

The NDMA has issued a National Guidelines for 'Preparation of Action Plan – Prevention and Management of Heat Wave' 2016 to provide a framework for implementing, coordinating and evaluating extreme heat wave-related activities in India. Further, NDMA revised the National Guideline on Heat Wave in 20217 and again 2019. This contains, inter – alia, long term mitigation risk management measures for addressing the issues at broader level by undertaking activities by states/local authorities in their respective areas to reduce the adverse impacts of extreme heat-wave conditions. NDMA organized Annual National Workshops on Heat Wave in collaboration with one of the heat wave-prone States to co-ordinate with all the stakeholders since 2019. NDMA issued advisories for managing heat waves to the central Ministries / Department, States, Districts and Municipal Corporations for taking actions. Review of heat wave preparedness was done through Video Conferencing with all heat wave-prone states. NDMA is also focusing on community sensitization and

awareness generation through social media, print/electronic media, advertisements, short TV commercial films on mitigating the impacts and protection from heat waves protection.

India Meteorological Department (IMD)ia nodal agency for early warning and impact-based forecast/alerts of heat-wave spells/events over a particular area, which helps the states to take appropriate measures to mitigate the adverse impacts of heat wave. National Centre for Disease Control (NCDC), Ministry of Health and Family Welfare, monitors and collects data on epidemic prone diseases on weekly basis, builds capacity of medical staff, provides justification of illness and casualty certifications.

The concerned State Governments have taken necessary preparedness and mitigation measures for heat wave. During last few years, many State Governments, districts/cities have prepared Heat Action Plan and are implementing them. Based on these Action Plan's, the State Governments and District administration take all possible measures to prevent mortality due to heat wave.

2.2 Impact of Actions Taken

In the past few years, despite taking Heat Waves becoming a major challenge, the actions taken by the Central /State Governments, NDMA India Meteorological department, health departments, district administrations, and the civil society in a planned way resulted in significant reduction in mortality due to heat waves.

Required early planning and preparedness of Heat wave

This year, various organizations, including the World Bank, have warned India could soon experience Heat wave beyond human survival limit. Therefore, kinds of experience of vulnerability and exposure to Heat wave preparedness and mitigation measures can be shared by the State Governments. Also shared outcome of the two specific research study on “Assessment of Vulnerability and Threshold of Heat – related Health Hazards in four cities of India” and Developing Framework for Heat Vulnerability Mapping and model heat Action Plan for Indian Cities by the expert groups. There is a need to be prepared for the upcoming heat wave season and take timely actions to maintain the reducing trend of the impacts of heat wave.

In the light of the recent progress made and to continue with this momentum, we need to discuss and sensitize the participants about the recent climate change effects and sustainable long term mitigation measures. In order to prepare for the heat waves in the year 2023;

NDMA shall hold a National Workshop on Heat Waves in collaboration with Indian Institute of Technology Bombay (IITB) Mumbai, Visvesvaraya National Institute of Technology (VNIT Nagpur)and State Disaster Management Authority (SDMA) Govt. of Maharashtra (Themes: Early Planning, Early Action for Heat Waves Risk Reduction).

Setting of roles and responsibilities in the National Guidelines and National Disaster Management Plan

The tasks and responsibilities of Central and state government authorities, district authorities, local self-governments, non-profit organizations, civil society groups, and other stakeholders are explicitly listed in the National Guidelines on Heat Wave in a matrix style. A specific chapter titled "Heat Wave Risk Mitigation" in the National Disaster Management Plan (NDMP), which was first created in 2016 and updated in 2019. It also describes the activities and responsibilities of the various stakeholders in a matrix-style structure.

3 OBJECTIVES AND EXPECTED OUTCOMES OF THE WORKSHOP

The broader objectives of the workshop include looking into the state of science (monitoring to early warning), revisiting policies and response strategies, and sharing experiences and lessons-learned for improving the Heat Wave Risk Management in India. The participants, practitioners as well as experts, deliberated on Heat Wave Risk Management (Mitigation, Preparedness, Response and Recovery) for 2023 through the workshop sessions listed in Section 5.

The Workshop aims to help all vulnerable states /districts/ cities in preparation of their Heat Action Plans for 2023. It also aims to discuss the integration of various development plans including long term measures, adapting Cool roof technology, Nature-Based Solutions such as increasing forest coverage and green areas in various states to reduce the risk of heat waves as well as climate change impacts. Moreover, interactions with experts from the different field as well as other stakeholders such as early warning and forecasting agencies, government departments and research institutions would help to figure out appropriate region specific short-, medium- and long- term risk reduction measures most suited for their regions. This platform also aims to provide an opportunity for community capacity building and awareness generation.

4 SCHEDULE OF THE WORKSHOP

Day 1:

Time	Program	Speakers/Chaired
09.00–09.30	Registration	
09.30-10.30	Inaugural Session – Welcome, Introduction and Objectives	
09.30-09.35	1. Welcome Address	1. Shri AppasoDhulaj, Director (DM), Govt. of Maharashtra
09.35-09.45	2. Special Keynote Address	2. Prof. Subhasis Chaudhuri, Director, IIT Bombay
09.45-09.50	3. Introduction, Objective and Framing of Issues	3. Shri Kunal Satyarthi, Joint Secretary, NDMA
09.50-09.55	4. Special Address	4. Prof. Ravi Sinha, IIT Bombay
09.55-10.05	5. Keynote Address	5. Shri Aseem Gupta, Principal Secretary, Govt. of Maharashtra
10.05-10.25	6. Inaugural Address	6. Shri Kamal Kishore, Member Secretary, NDMA
10.25-10.30	7. Vote of Thanks	7. Ms. Rakhee Sadhu, Deputy Secretary, NDMA
10.30-11.00	Tea Break	
11.00-12.00	Technical Session 1: Climate Change Impact, and Challenges of Heat Wave Adaptation Mitigation (Chair: Dr. Krishna S. Vatsa, Member, NDMA; Co -Chair: Prof. Kapil Gupta, IIT Bombay)	
11.00-11.10	1. NDMA Guidelines and Preparedness Efforts for Heat Waves	1. Shri Kunal Satyarthi, Joint Secretary, NDMA
11.10-11.20	2. Global Threat due to Climate Change and Heat Wave Adaptation	2. Dr.Ajit Tyagi, Former DG -IMD and Member WMO
11.20-11.30	3. Issues and Challenges of Heat Wave Risk Reduction in India	3. Dr. Mahaveer Golechha, IIPH Gandhinagar
11.30-12.00	Discussion & QA	

12.00-13.15	Technical Session 2: Health Impacts of Heat Wave and Preparedness Measures (Chair: Shri Kamal Kishore, Member Secretary, NDMA; Co-Chair: Prof. Ravi Sinha, Professor, IIT Bombay)	
12.00-12.15	1. Assessment of Vulnerability and Threshold of Heat-related Health Hazards	1. Dr. Suresh Kumar Rathi, PHFI
12.15-12.30	2. Impact of Extreme Heat on Health Risk in India	2. Dr. Aakash Shrivastava, Addl. Director, NCDC
12.30-12.45	3. Issues and Challenges on Livestock and Livelihood	3. Dr. Prashant Dhananjay Kamble, MoAH&F
12.45-13.15	Discussion & QA	
13.15-14.00	Lunch break	
14.00-15.00	Technical Session 3: Early Warning, Vulnerability Assessment, and Its Dissemination for Heat Wave (Chair: Lt. Gen. Syed Ata Hasnain (Retd.), Member, NDMA; Shri Harsh Gupta, Jt. Secretary & Project Director, NCRMP)	
14.00-14.10	1. Early Warning and Forecast in Heat-prone Areas	1. Dr. Naresh Kumar, India Meteorological Department
14.10-14.20	2. Multi-dimensional Heat Wave Vulnerability Assessment	2. Prof. Parmeshwar Udmale, IIT Bombay
14.20-14.50	3. Local-Level Forecast Warning Dissemination for Heat Wave	3. Three State Government Presentations (1. Odisha, 2. Karnataka and 3. Maharashtra (DDMA))
14.50-15.00	Discussion & QA	
15.00-16.00	Technical Session 4: National-level Planning and Preparedness for Heat Wave (Chair: Lt. Gen. Syed Ata Hasnain (Retd.), Member, NDMA; C o-Chair: Shri AppasoDhulaj, Director (DM), Govt. of Maharashtra)	
15.00-15.10	1. Heat Wave Impact Study on Agriculture & Allied Sectors	1. Dr Vinay Sahgal, IARI
15.10-15.20	2. Water and Energy Planning for Heat Wave	2. Shri Amit Prothi, Director General, CDRI

15.20-15.30	3. National-Level Capacity Building Initiatives	3. Dr.PasalaEswara Rao, LBSNAA
15.30-16.00	Discussion & QA	
16.00-16.15	Tea break	
16.15 -17.30	Technical Session 5: State -level Plans for Heat Wave Risk Reduction (Chair : Prof. SB Agnihotri, IIT Bombay; Co -Chair: Prof. Anand B. Rao, IIT Bombay)	
16.15-16.25	1. Capacity Building for Climate Adaptive Heat Action Plan	1. Shri Rohit Magotra, Deputy Director, IRADe
16.25-16.35	2. Developing Institutional and	2. Dr Anil Gupta, NIDM

Day 2:

Time	Program	Speakers/Chaired
09.30-10.30	Technical Session 6 : Dealing with Heat Wave in the Urban Context (Chair: Shri Rajendra Singh, Member, NDMA; Co -Chair: Shri Kunal Satyarthi, Jt. Secretary, NDMA)	
09.30-09.40	1. Developing Framework for Heat Vulnerability Mapping and Model Heat Action Plan for Indian Cities	1. Dr.Rajashree Kotharkar, Professor, V-NIT-Nagpur
09.40-09.50	2. Ahmedabad Heat Action Plan – Lessons from Last Decade of Implementation	2. Dr. Mahaveer Golechha, IIPH
09.50-10.00	3. Comparative Study of Heat Action Plans	3. Dr. Chandni Singh, IIHS
10.00-10.10	4. Information Management Issues	4. Shri Amandeep Yadav, Press Information Bureau
10.10-10.30	Discussion and QA	
10.30-11.00	Tea break	
11.00-12.00	Technical Session 7: Mitigation Solutions for Heat Wave (Chair: Dr. Krishna S. Vatsa, Member, NDMA; Co -Chair: Shri Alok, Addl. Secretary, NDMA)	

11.00-11.10	1. Capacity Building for Cool Roof Technology and Adaptation	1. Ms Bijal Brahm Bhatt, Director, Mahila Housing Trust
11.10-11.20	2. Mitigation of Heat Wave at Community and Household Levels	2. Shri Manu Gupta, Director, SEEDS India
11.20-11.30	3. Local Threshold Estimation Study & Effective Preparedness Measures at Local Level	3. Dr.AbhiyantTiwary, NRDC
11.30-12.00	Discussion and QA	
12.00-13.00	Summing up Discussions and Developing a National Programme / Framework on Heat Wave Mitigation (Chair: Shri Kamal Kishore, Member Secretary, NDMA; Co-Chair: Prof. Ravi Sinha, Professor, IIT, Bombay)	
	1. Develop a National Programme / Framework for Heat Wave Mitigation as part of National Adaptation Effort 2. Develop State and City-level Interventions for Heat Wave Mitigation 3. Improve Early Warning and Monitoring of Heat Wave 4. Support Public Awareness Campaigns for Protection against Heat Wave 5. Discuss Various Sources of Financial Resources for Heat Wave Mitigation	All Participants
13.00-13.30	Valedictory Session	
13.00-13.10 13.10-13.25 13.25-13.30	1. Concluding Remarks 1. Shri Aseem Gupta, Principal Secretary, Govt. Of Maharashtra 2. Valedictory Address 2. Shri Kamal Kishore, Member Secretary, NDMA 3. Vote of Thanks 3. Shri Kunal Satyarthi, Joint Secretary, NDMA	
13.30-14.30	Lunch	

5 INAUGURAL SESSION: WELCOME, INTRODUCTION, OBJECTIVES

- **Shri. Appaso Dulaj,** Director of Disaster Management (Government of Maharashtra), delivered the welcome address. He conveyed his gratitude to NDMA and IIT Bombay for conducting the workshop with the Government of Maharashtra. He welcomed the delegates from Government departments, technocrats, policymakers, planners, and consultants from various organizations and requested them to come forward and present their ideas and inputs and contribute to lively discussions throughout the workshop.

Photo 1: Dignitaries at inaugural session

- **Prof. Subhasis Chaudhuri,** the Director of IIT Bombay, welcomed everyone to the IIT campus. He put forth that we need to think of how we can leverage the expertise that IIT Bombay, an institute of excellence, can offer to make our country habitable and sustainable. From generating top-quality human resources for the industries in its early decades, IIT Bombay has been actively investing in creating social impact over the years. Of its 13000 students, nearly 4000 are Ph.D. scholars engaged in research in various fields. Various departments (CPS, CTARA, Climate Studies, Civil, Chemical, Environmental Science, and Engineering) can create a lot of synergistic relationships with state and central government agencies. We need to brainstorm what futuristic action can be taken up collectively through such synergies.

- **Shri Kunal Satyarthi,** Joint Secretary, NDMA, introduced guests and gave a broad overview of all the seven technical sessions and the context under each session. He said the workshop has the participation of 21 out of the 23- heat wave-affected states, eight ministries (power, transport, etc.), and 22 academic institutions and civil society organizations. It has brought together a diverse group of people with on-ground experience and research expertise.

He mentioned that the seven one-hour sessions aim to capture various dimensions of heat waves. The first session deals with the climate change impacts and challenges of the heat wave. The second session is on the health impacts of heat and early warning systems, followed by national and state-level planning sessions—the sessions on the 14th deal with the heat wave in the urban context. The idea is to understand the heat problem, brainstorm mitigation solutions, develop a national program or framework for mitigation, improve state and city-level interventions and early warning systems, and spread public awareness.

- In his address, **Prof. Ravi Sinha,** IIT Bombay, mentioned that the Government of India is committed to reducing heat waves. NDMA has been conducting workshops since 2017 for experience sharing, where we capture the states' best practices and share ground-level ideas of what works and what does not. He spoke about the multidimensionality of heat wave disasters, climate, and weather phenomena. An elevated temperature does not mean a heatwave; many factors make it a disaster. Once we know those factors, we can identify interventions to stop high temperatures from becoming heat wave disasters. He also highlighted the multiple units working on the disaster issues such as CPS, CTARA, Civil Engineering and Climate Studies, who can be longer-term partners for solving problems together with the Government.

- **Shri Aseem Gupta,** Principal Secretary, Govt. of Maharashtra, pointed out the lives are lost due to heat waves and disasters in Maharashtra. He suggested we must aim for zero loss of lives; history repeats itself if you do not learn anything from it, learn from past mistakes, learn from each other, and prepare better for the future. It has been 18 years since we have been planning for disaster management, we have guidelines and processes that are becoming streamlined. Having theme based workshops help shape our common sense, improve multidimensional understanding, and the aim is to become better responders to disasters, while learning and improving HW plans for a better future.

- **Shri Kamal Kishore,** Member Secretary, NDMA, said that, we shall take stock of what has happened during the last season and how prepared we are for the upcoming season. During 2015-16, the mortality was around 2000, and now it has come down to two digits due to the actions taken to manage heat waves. The guidelines for heat wave action planning were formulated by the NDMA in 2016 and revised in 2019. We need to assess what needs to be done further. He also mentioned that all climate change project models indicate that India will be the

worst affected country due to heat waves by 2030. We need to move beyond saving lives to also address productivity losses and livelihoods. He cautioned that the Heat Action Plans has become mechanical exercise; and there is a need to acknowledge the complexity of the problem of heat waves.

He stated that this workshop has three expectations:

(1) To bring science and action together to understand the multidimensionality of heat waves. He stressed to should not oversimplify the problem of heat waves. IMD announces heat waves when the temperature crosses a particular threshold. We need to ask if that threshold works for us and if it is enough to determine heat stress. Heat stress is determined by diurnal variation, humidity, wind movement, and persistence over time (duration). How do we bring all these factors into consideration while announcing heat waves? We need to discuss that with those who study health and climate. We have to bring the best science into practice.

(2) We need to understand the issue of vulnerability. HAPs are mechanical, they use the same vulnerability categories provided in NDMA guidelines for all locations. Vulnerability is context-specific; it can be caused by health conditions or occupation or gender. It is important to understand what makes people vulnerable locally and what actions we can take to reduce such vulnerability.

(3) While government statistics show that heat wave mortality is going down, we need to understand that all heat wave deaths not only happen in hospitals; they may happen at home. How do we address the challenge of attribution? Do we conduct a study on all-cause mortality? Such studies can help us question if our temperature thresholds are relevant to the context.

He added that we must go beyond saving lives to saving livelihoods. We must expand the discussion on heat waves and look at their economy-wide impact on power supply, road, and rail transport. Our built environment is going in one direction and heat in the other; we are building glass buildings with air conditioners leading to Urban Heat Island effect. How can we ensure that building codes and bylaws take heat into account? Our traditional architecture is heat resilient, but we have moved beyond that in the last 30 years. We must consider transforming the built environment and power systems to deal with heat waves. We need to transform our infrastructure for the long-term effects of heat.

Photo 2: Prof. Subhasis Chaudhuri addressing Inaugural Session

Photo 3: Shri Aseem Gupta delivering Keynote Address

Photo 4: Shri Kamal Kishore delivering Inaugural Address

5.1 Technical Session- 1 Climate Change Impact and Challenges of Heatwave Adaptation and Mitigation

After introducing the speakers and their respective topics of presentation by the Chair, Mr. Krishna S. Vatsa, member, NDMA and Co-chair by Prof. Kapil Gupta, Professor, IIT Bombay:

Shri Kunal Satyarthi, Joint Secretary, NDMA, commenced his presentationon Heat Wave Guidelines and Preparedness. The key takeaways are:

- Heat waves have different impacts on diverse regions and states. Different temperature thresholds are followed for the declaration of heat waves in plains, hills, and coasts. The heat wave season begins in March in India and continues till June. The number of states affected by heat waves is rising drastically (from 9 in 2015 to 23 in 2020), and heat-related mortality has come down. The intensity of heat waves has increased exponentially, and their spatial distribution has also changed. On average north India experiences 5-6 heat wave events and south India experiences 8-10 events. IPCC AR 6 projects that India will be the worst affected by Heat waves in the coming decades.

- The effects of heat waves are not immediately felt or visibly experienced. Heat affects people differently. The heat wave is not a stand-alone phenomenon. The socio-economic dimensions of the disaster and other meteorological factors complicate it further. The

local temperature threshold for experiencing heat waves varies across places. While Shimla may feel like a blast furnace at 39 degrees Celsius, Chennai may find the same temperature bearable. Heat adversely affects different sectors like health, water, education, power, and transportation.

- NDMA formulated a set of guidelines in 2016, 2017 for states to manage heat waves by preparing Action Plans, and further revised in 2019.

- NDMA has also supported research programs with VNIT and PHFI. They have developed the: 1. Manual on House Owners Guide to Alternate Roof Cooling Solutions, 2. Assessment of vulnerability and threshold of heat-related health hazards in four cities of India with PHFI (ongoing), 3. Framework for heat vulnerability mapping and model heat action plan for Indian cities with VNIT, 4. Multidimensional Hazard analysis of heat waves with IMD.

- For Heatwave management NDMA ensures inter-ministerial coordination in implementing heat wave action plans; create public awareness and community outreach.

- Ever since heat waves came to be acknowledged as a disaster, the mortalities have come down (however, it is important to analyse how robust the death statistics are).

- Seventeen heat-wave-prone states and 120 districts/cities from 14 states have formulated HAPs, and there has been improved inter-agency coordination among IMD, IDSP, NCDC, and concerned states and ministries. There has also been enhanced awareness of heat waves.

- Previous heat wave workshops have emphasized the need to

  - ❖ Formulate heat action plans at the city/district,
  - ❖ Strengthen early warning and dissemination systems,
  - ❖ Understand local temperature thresholds,
  - ❖ Strengthen institutional mechanisms for the implementation of action plans,
  - ❖ Ensure robust data collection for the formulation of evidence-based policies,
  - ❖ Improve communication and collaboration with research organizations and knowledge centres
  - ❖ Conduct local-level vulnerability assessments by local research institutes

- ❖ Conduct capacity building of SDMA,
- ❖ Build temperature-suitable houses by borrowing traditional knowledge,
- ❖ Ensure build capacity of workers, doctors, paramedics,

- The way forward for NDMA and the key expected outcome from this session is to
  - ❖ To understand the cascading impacts of heat waves along with other interrelated disasters like drought, forest fire etc.,
  - ❖ Develop a framework for capturing loss and damage specific to heat waves,
  - ❖ Design and implement mediumand long-term mitigation measures,
  - ❖ Develop a strong partnership between Government and academia
  - ❖ Build capacities of different stakeholders and improve early warning systems.
  - ❖ Strive towards formulating a national programme for heat wave mitigation.

Dr. Ajit Tyagi, Senior Advisor IRADe, Former DG-IMD and Member of WMO, was the next speaker. He talked on Global threat: climate change and heat wave adaptation. The key takeaways from his speech are as follows:

- A heat wave is not new phenomenon and has been affecting people for decades. However, given the slow- onset nature of the event and lack of preparedness in the beginning, heatwaves were becoming high- mortality events. However, research and understanding the heat waves and the actions by state and non-state actions have resulted in reducing the mortality from heat wave.

- Climate change is affecting all sectors including health, livelihood, and productivity and its impacts are expected to increase, if not mitigated. The last six years have been the hottest years on record. All parts of the globe including Australia, New Zealand, and the Arctic have been affected by heat waves. The WMO monitors the events and has established global surveillance systems and robust early warning systems. Initially, we needed more in-house capacity for forecasting and had to depend on Washington University forecasts, but now IMD has come up with a 7-day weather forecast. There is a need for a multidimensional heat index, including humidity and health indicators. There is a possibility of an exponential increase in death if the temperature exceeds the current thresholds. Hence, we cannot be complacent.

- Regional variations in heat happen due to El Nino and La Nina phenomena, anti-cyclones, and the Urban Heat Island Effect, the cumulative effects of which can give rise to temperatures we have not felt so far. Even a few decades ago, heat waves in Europe and the USA were unimaginable. Nevertheless, in the last 20 years, situations have changed due to climate change. We can only arrest the deadly impacts of heat waves by mitigating global warming.

- Marine heat waves, noticeable since the last decade, have a big impact on monsoons and marine life, particularly in the North Bay of Bengal and West Indian Ocean, and are expected to change local heat wave frequency.

Dr. Mahaveer Goleccha, Professor and Lead- Heat Action Plan, IIPH Gandhinagar spoke about his learnings and experiences from the implementation of South Asia's first heat wave action plan in Ahmedabad. He talked about the issues and challenges of heat wave reduction in India. His presentation is summarized below:Most states are yet to assess the real impact of extreme heat on humans, livelihoods, and the economy. Heat kills people. Even if there are no direct deaths, heat can aggravate pre-existing morbidities leading to death.

- Data in Indian cities are insufficient regarding recording and analysing total daily/weekly deaths and causes of death in cities or districts. This hampers the effort to estimate heat wave mortalities accurately. Even big cities do not report daily deaths or all-cause mortality. Municipal corporations do not have heat-related death data

.

- Cases of death from direct sun exposure and heat strokes (exertional deaths) are widely reported. In contrast, non-exertional deaths (which account for 90 percent of the mortality) and may happen indoors or in less visible situations are not recorded or reported.

- There is also an understanding of environmental impacts on public health among municipal, state, and national administrators and political leaders. There are no well-developed environmental health divisions with qualified officers in the city or state governments.

- Poor urban planning and design accentuate heat in cities. Temperature is higher in cities due to the urban heat island effect; sustainable passive cooling technologies can help reduce temperatures. Heat resilience should be an important component in the municipal building code, and corporations should promote passive cooling through traditional techniques.

- Heat waves are not notified as disasters at the national level under the existing disaster relief policy. Several state governments have declared heat waves as local disasters. However, there needs to be more research at the local level to identify vulnerable populations and study the impact of heat on them. Heat action plans should focus on local realities and should be able to adapt to changing situations.

- According to ILO, India will tremendously lose labour hours, productivity, and GDP by 2030 due to heat. There needs to be more AWS spread across more districts, and heat health information systems are not functional everywhere. There are no heat-related work standards. Heat Health nodal officers are only appointed in some places. There is a lack of inter-agency coordination in heat action. There is a lack of dedicated personnel for climate change and health-related activities in Municipal Corporations.

- Cool roof technologies have not penetrated widely across states due to lack of awareness and funds.

Question and Answers in Session 1

Q. How to assess heat wave mortality?
Dr. Goleccha suggested that heat wave mortality can be accessed through an analysis of all-cause mortality during summer. For example, if, on an ordinary 100 people die daily and on a particular day in May, 300 people die, then that excess mortality can be attributed to heat.

Q. How to create awareness about mitigation funds?
Fund has just been set up, plans and programs are in the pipeline.

Q. Why is the real feel of temperature different from the actual temperature?
It happens due to humidity, and the wet bulb temperature measures the composite effect of temperature and humidity.

Q. When will we acknowledge heat waves as a notified disaster at the national level?
The acknowledgment is there, and action is underway. So, a formal notification does not make much difference.

Comments/Suggestions:

- Heat action plans currently focus on outdoor vulnerability. There is a need to consider the indoor impacts of heat. Gender dimensions need to be taken into account in measuring impacts.

- Karnataka has successfully collected local-level weather data by installing AWS in all villages.

- Indian Railways face a unique problem in summer months when tracks to heat disproportionately (particularly when a derailment occurs in heat wave-affected areas) temperature of the tracks sometimes increase to 59 degrees Celsius, making it difficult for workers to work on them. There was a suggestion that IIT could develop a technology to measure the temperature of tracks and design gloves or heat-resistant equipment for workers.

Summary:

The session discussed the impact of climate change on rising heat waves worldwide. It highlighted NDMA's contribution to heat wave management in India through the formulation of guidelines for action, the creation of heat wave action plans in association with state governments, support in research and development, and the generation of public awareness about heat waves. It also highlighted NDMA's future goals of developing a national framework for mitigating heat and strengthening collaboration between academia and Government. IMD's role in heat forecasting was emphasized, followed by a discussion on the challenges in heat governance in India derived from a lack of understanding of heat wave impacts and vulnerability undercounting of deaths, poor planning, and coordination by state agencies.

Photo 5: Technical Session 1: Climate Change Impact, and Challenges of Heat Wave Adaptation Mitigation

Photo 6: Technical Session 1: Climate Change Impact, and Challenges of Heat Wave Adaptation Mitigation

5.2 Technical Session- 2 Health Impacts of Heat waves and Preparedness Measures

The second technical session was chaired Shri. Kamal Kishore member secretary, NDMA and co-chaired by Prof. Ravi Sinha, Professor, IIT Bombay.

Dr. Suresh Kumar Rathi, from PHFI, Hyderabad, was the first speaker of the second technical session. The talk Dr.Rathi was on the research project of heat wave vulnerability and threshold assessment in 4 different cities of India, funded by NDMA, India. The key takeaways from the talk are:

- Tracking temperature alone is not important to identify the risk areas. There are several other factors. Humidity, heat index, and temperature. We need a Heat Vulnerability Index, which accounts for landscape, demography, and socio-economic factors. With this background, they conducted a study in 2020-21 for four cities. (Names provided by NDMA)(Ongole, AP, Karimnagar, Telangana, Kolkata, WB, and Angul, Odisha). It was found that almost ⅔rd to ¾th households are vulnerable to heat.

- Objectives of the study were 1) to conduct the vulnerability assessment of the four cities and 2) to conduct threshold assessment. Tool development, questionnaire development, and a survey were the methodology applied. About 500 households were surveyed in each city. Collected mortality data from Municipal Corporation and temperature data from IMD. Mortality data from Kolkata is not available. Therefore, restricted study for threshold assessment for three cities only.

- Total of 21 exposure, sensitivity, and vulnerability indicators were used to describe the questionnaire. After data collection, the rescaling of the raw data, transformation of the direction of the variable, and normalization of rescaled data have been done. The score of each variable is combined to get the overall Household Vulnerability Index. Mean HVI scores were used as the cut-off for identifying 'low' and high HVI.

- Based on HVI, highly vulnerable cities are: Ongole>Karimnagar>Kolkata>Angul.
  For threshold assessment outcome variable is all-cause mortality.

- Answered the research question, what is the excess risk of all-cause deaths on days with higher maximum temperature compared to days with lower maximum temperature?
  City-wise and year wise number of heat wave days obtained from IMD data. Descriptive statistics of temperature and humidity. Every 1-degree rise in temperature

- Above the threshold raises mortality by 24, 16, and 20 % for Karimnagar, Ongole, and Angul, respectively.

- **Policy Recommendations:**

  - ❖ Recommended VA at least every three years. Help in developing a framework for a city-specific heat action plan. Humidity and minimum temperature need to be included in the heat-warming system. Every city must carry out a heat threshold assessment at a regular interval of at least five years.

  - ❖ The most important policies will impact the quality of life of vulnerable people; hence policymakers should work with researchers on some aspects, like temperature forecasts becoming meaningful only with threshold assessment at the city level. Vulnerability assessment contributes to developing heat wave action plans at city/state levels. Every HAP is to be evaluated independently by third-party researchers to understand how better they have served and how they can be improved.

  - ❖ Heat waves are a common occurrence in India, and can cause significant health risks for residents.

  - ❖ There is a lot of research that needs to be done to better understand the effects of heat waves on different populations, and to develop effective mitigation strategies.

  - ❖ The thresholds at which different populations are vulnerable to the effects of heat waves need to be better understood, so that appropriate interventions can be put in place.

Dr. Aakash Shrivastatva, Additional Director, and Dr.Poorvi Patel, from NCDC, were the second speakers of the session, and presented how the health ministry has been responding to the heatwave and health. The topic of presentation was impact of extreme heat on health risk in India. Key takeaways from the session are:

- **Dr. Poorvi Patel** started the seminar and explained how heat is important for the context of health. Moreover, she highlighted some critical aspects of heat and health.

- Climate change is increasing the frequency and intensity of heat waves over India. An early heat wave occurred in 2022 and was 30 times more likely to impact the population.

- The health outcomes of extreme heat on a population differ depending upon the population's exposure level, size of the exposed population, and population sensitivity. The vulnerability of the population depends upon age, occupation, and socio-economic conditions.

- As time progresses and heat increases, indoor conditions are also becoming necessary for consideration of heat wave impacts. It depends upon how we communicate and how we plan for the event. A study was conducted on patients, measured the temperature of the location from which patients were picked up, and found that the affected area had comparatively more temperature than the station, which measures weather data.

- Direct impacts of heat on health are heat illnesses that directly cause deaths, and indirect impacts are on health services, power, water transmissions, change in disease distribution, change in the food system, and increase in accidents and transport. The spectrum of health impacts starts from mild heat rash and progresses to severe impacts such as heat stroke. Our body temperature has a very narrow range at which we feel comfortable, but if we are exposed to heat severely, even a healthy person can become a patient.

- Quantity of different physiological factors that affect one person's health outcomes when exposed to heat. Epidemiological factors were studied. With those factors, there are 27 pathways leading to health outcomes such as different diseases.

- Heat can cause many other illnesses than heat strokes which we do not recognize particularly by heat.

- Understanding of how heat stress works. The Allahabad plot shows that the number of deaths is increasing with an increase in temperature. Heatstroke and cardiovascular diseases due to heat cause mortality.

- The National program on Climate change and Human Health is addressing the issue of heat waves in India. Prime Minister's Council on Climate Change (PMCCC) was established with a new mission in 2015. The five key objectives of NPCCHH are generating awareness, capacity building, strengthening health sector preparedness, collaborative partnership, and research and development. It has a three-level operational framework: National Level, State Level, and District Level.

Discussed awareness activities such as public health advisories, IEC: audio-visual, print, media, use of local language, and campaigns. Capacity building in the form of training modules, strengthening the health sector by preparedness such as national and state action plans related to heat illnesses. Heat-related surveillance of deaths, emergency OPD visits, and all-cause deaths was discussed. Under this, suspected heat-related illness death investigation forms and guidelines were discussed. The plot of 2022 surveillance reporting heat-prone states. Most heatstroke deaths are unreported due to complex diagnoses. The application of IMD's forecast helps to plan for heat waves at the local level properly. Heat-resilient health facilities such as

green and climate-resilient measures for adaptation and mitigation. Recent developments include integrating HRI surveillance on IHIP and IMD guidelines and model heatstroke room development. In trying to digitalize the existing surveillance system, A dashboard is developed on the IHIP platform.

Photo 7: Technical Session 2: Health Impacts of Heat Wave and Preparedness Measures

Dr. Prashant Dhanajay Kamble, Regional Joint Commissioner, Department of Animal Husbandry and Dairying, MOAH&F, focused on the issues and challenges of livestock and livelihood in the third talk of the session. The key notes from his talk are:

- Animal husbandry is a state subject, and the state government has various schemes for managing animals during a heatwave. All the states and UTs have set up disaster management authorities and have definite plans to meet their specific needs in the context of various disasters. Guidelines and SOPs are formed and circulated at the state level.

- Purpose and scope for DMP in the animal sector are to provide rapid assistance to animal owners, to protect livestock assets, to rebuild livestock assets, create awareness of veterinary care, management, and care during natural disasters, and to build disaster-resilient infrastructure.

- Risk assessment and measures are available human resources assessment, preparedness review of veterinary hospitals and mobile units, adequate disease diagnostic and control measures, and assessment of existing animal handling search and rescue capacity at state and district level.

- Measures for heat wave risk reduction are conducting animal camps and awareness programs, rehabilitation of animals, creation of safe locations such as cool sheds, feed and fodder stocking supply, emergency channels, and contacts. Heat wave is mentioned Pashu Palak Calendar, which is month-wise veterinary care, management, and good practices.

- Heat management in the animal sector depends on animal species. The temperature tolerance is 24-26 degrees C for exotic and 33 degrees C for local breed cattle. Animals show extreme panting, irregular pulse rate, and increased water intake due to heat. The economic losses in the animal sector are in the form of less milk production, reduced breeding efficiency, and loss of life.

- The animals at high risk are the young ones, dark-coloured, sick animals with respiratory disease history, pigs, new-borns, and lactating animals.

- Heat disorders in animals are heat burn, cramps, heat exhaustion/stress, and heat strokes.

- The department advises to follow updates on local weather, salt/electrolyte mixture with feeds, milking 1-2 hrs later in the evening, use of sprinklers and shade on animals, and supply of cool water for drinking at least four times per day.

- Animals should not be tied in the sun; pets should not be left in parked vehicles; avoid overcrowding of animals in the shade and milking during hot hours.

- More cooperation between sectors is needed. Liaison of state AHDs and SDRF, training to AHD officials by SDRF, involvement of local youth, Pradhan, school teachers, and children with regular awareness, creation of RRTs, and use of MVUs are also needed.

- Improve regulatory oversight of schemes that provide assistance to the farmers.

- Increase the funding available to schemes that provide assistance to the farmers.

- Encourage the use of state-level schemes as a model for implementing schemes that provide assistance to the farmers.

Summary:

The primary concern of the session was about human and animal health. The NDMA's heath and heat project in 4 heat-prone cities of India and the HVI calculation are based on indicators. The planning of heat wave action plans at national and state levels. The risk assessment, planning, and mitigation of heat wave disasters and Animal heat stress-bearing capacity based on species and the temperature range of heat stress they can sustain were discussed under the heat health in the animal sector. The requirement and success of inter-agency cooperation and collaborations for impact management and formation and working of various emergency services are also discussed during this session. Need for more extensive research and development in risk assessment and mitigation.

Questions and Answers in Session 2:

Question regarding the threshold and the study showed that the maximum temperature is being discussed as a threshold. However, we also observed that a HI, a combination of temperature and humidity, is also one of the significant indexes that can lead to higher mortality. All-cause mortality and minimum temperature also, so the minimum temperature increase, there is a high all-cause mortality. Whether they have explored other indices other than the maximum temperature?

Here they considered the heat index more important than the temperature index. Around six deaths per day increase when heat is considered, and three deaths per day when the temperature is considered—18% excess deaths with humidity and heat index. Published paper. They tried for Surat.

Question for the animal husbandry department, considering that we have talked about how to mitigate the plans regarding the heat waves and how the animals can be rescued. There is a growing concern among people that animal husbandry contributes to an increase in carbon footprint and climate change and increases the temperature. So, do we have any brainstorming, or do we have any steps to mitigate that challenge, and can we control that?

There are around 536 million livestock our country has, which adds to the carbon footprint but at the same time, I said that when we go for Cross breeding with exotic breeds, which are highly producing. We can reduce our Desi breeds; that was what the department was going on before 25 to 30 years, but it can come up with all those aspects like our breed are more sturdy and more

resistant to all the climatic changes and whatever we are coming up with new diseases also. In that case, we should not see only carbon footprint in that respect, but our breed can also be upgraded so that we can solve the purpose of our milk demand. However, many more brainstorming sessions must be conducted to develop amicable solutions.

Do we also have to consider air pollution control and management when discussing the heat wave Action Plan and its correlation?

In our action plans, we are addressing how the health sector needs to respond regarding heat. But our heat health-related sector-related health plan is part of a larger sector climate change plan, and that plan has got multiple chapters, one of which is on air pollution and health. So, the entire focus of the Climate Change-related Action Plan has been developed under this program. NPCCHA addresses not only heat but also air pollution and other climate outcomes and their composite action plan as far as accounting for air pollution in heat in terms of exposure that's not part of our work and is addressed by the climate change ministry.

5.3 Technical Session 3: Early Warning, Vulnerability Assessment and its Dissemination for Heat waves

This session was chaired by Shri. Aseem Gupta, Principal Secretary, Relief and Rehabilitation, Maharashtra and co-chaired by Shri. Harsh Gupta, Jt. Secretary and Project Director, NCRMP.

Dr. Naresh Kumar, IMD, spoke on IMD's role in weather forecasting. His presentation on early warning system of IMD for heat wave over India is summarized below:

- IMD has an extensive network of surface observatories covering the entire country to measure various meteorological parameters like temperature, relative humidity, pressure, wind speed, and direction.

- The maximum temperature threshold for heat waves is calculated based on 30 years of climate data.

- Heat waves occur between March-June; maximum heat waves are experienced in May in the northern peninsula, North West, and central India. Heat waves are mostly experienced in interior plains with clear skies. Heat waves generally develop over northwest India and spread eastwards and southwards.

- In 2022 we started experiencing heat waves in March. Rajasthan experienced 13 days of heat waves in March, which is quite unusual in North India. The reason for this is rising temperatures at the North Pole where temperatures were 4-6 degrees Celsius above normal. North Pole temperature controls the jet stream. Whenever the North Pole is warmer, the jet stream shifts towards the north and does not affect northern India. But when polar temperatures are normal or below normal, jet streams come towards 30 degrees south over the Indian region. The jet stream controls the western disturbances. Last March due to rising polar temperatures and a shift in the jet stream away from India there were feeble western disturbances that caused light rainfall, (less than 80 percent below normal). The plains of northern west India have not experienced any rainfall around that time. This led to clear skies favourable to the formation of heat waves. Another causal factor was the anti-cyclonic flows over Pakistan leading to a spike in temperatures over the country. Westerly and north-westerly winds blowing from Pakistan to India led to heat wave conditions in northwest India.

Since 2022, IMD has issued daily weather bulletins between 1st March and 30th June, which contain colour-coded heat wave warnings determined by temperature,

- humidity, and wind speed. Seasonal 15 days five days forecasts are also available. Warm night warnings are also given.

- Warnings are disseminated through WhatsApp, Twitter, and press releases. There is a dedicated web page for warnings on the IMD website. There are interactive maps for the country's maximum temperatures, relative humidity, heat wave events, and warm nights. One can get the weather forecast for a region just by selecting it on the map.

- IMD also conducts heat wave hazard analysis for four months (March, April, May, and June) considering Maximum, and minimum temperature, wind speed, and relative humidity. These analyses can later be used as thresholds to generate heat wave impact-based alerts for specific locations.

- For the use of disaster managers, the IMD website contains climatological thresholds of maximum temperature considering the percentiles 90, 95, and 98 based on 30 years of data collected over 300 stations.

Professor Parmeshwar Udmale, Assistant Professor, CTARA, IIT Bombay, spoke on multidimensional disaster risk assessment. The summary of the presentation is below:

- There are four components of risk assessment -

  - ❖ Risk identification and early warning, which includes hazard and vulnerability assessments and early warnings

  - ❖ Preparedness and mitigation, which include the implementation of effective and affordable practices to minimize impacts,

  - ❖ Awareness and education, which requires a well-informed public and participatory processes in disaster preparedness

  - ❖ Policy and Governance aspects for which institutional responsibilities and commitments are the most important.

  - ❖ Another hidden dimension is local-level disaster risk management through community participation, sustainability context, and local reality, which may not match with whatever number crunching we are doing on the reports we are planning for heat wave action.

- Steps followed in disaster risk assessment:

- ❖ Conceptualization of hazards (identification of linkages between exposure, sensitivity, and adaptive capacity of socio-ecological systems). It also includes stakeholder consultation.
- ❖ Literature review and categorization of indicators
- ❖ Expert inputs on indicatorsidentification, measurement scales, and assignment of weights
- ❖ Toolkit development to assess heat impacts (statistics, geospatial analysis.)
- ❖ Stakeholder inputs to ascertain
- ❖ Knowledge dissemination

- There are multiple dimensional indices for risk assessment. Multidimensional indices are followed at the national level for example the poverty index based on health, education, and the standard of living. The Aspirational District Program also talks about indicator-based approaches. Then there are also the SDGs. In multidimensional risk assessment, we combine all these frameworks adopted at the national level with disaster risks management indicators like hazard exposure, sensitivity, and adaptive capacity. This framework can be applied at the national or local level and different temporal scales.

- It is important to come up with a hazard-specific ScienceManagement and Policies (Sci-MAPs), which starts with the science of hazard, then data collection and vulnerability assessment, and includes stakeholder consultations which will go into designing mitigation and adaptation strategies.

- The researcher faces several challenges and dilemmas in terms of
  - ❖ Dynamic nature of risks, which are difficult to quantify,
  - ❖ Data limitations, identification of spatial scale for finer level analysis,
  - ❖ Subjectivity in methodological assessments,
  - ❖ Trans-disciplinary research which focuses on stakeholders' engagementin different phases of research (co-design, co-produce and co-manage)Adoption of advanced technology for disaster risk reduction including heat wave disasters

This was followed by the presentations on local-level actions by the representatives from Odisha, Karnataka, and Maharashtra.

Odisha :

- Heat discomfort is caused by meteorological, social/cultural, physiological factors.
- Coastal areas of Odisha experience humid heat, and the western part of Odisha has dry heat from power plants and coal mines.
- In 1998, 4042 deaths were recorded due to heat waves. Since it was declared a disaster in the state, people have been getting an ex-gratia amount as compensation. A Post-mortem has to be conducted to determine the cause of death to be eligible for compensation. If a post-mortem is not possible, a special committee is formed to investigate the cause of death.
- Odisha has conducted capacity-building awareness programs by disseminating IEC materials and safety tips, maintained the mortality record, provided emergency medical services through mobile health units with special attention to high-risk patients, changed working hours for workers and school timings, and provided drinking water on streets and bus stops.
- Long-term measures include afforestation drives, maintaining parks and water bodies, and promoting heat-resistant buildings.
- All activities are performed through cross-department coordination.
- Forest fire is not a nationally declared hazard, but the Government of Odisha has taken steps to limit forest fires during summer.

Karnataka :

- Karnataka has not experienced any major spike in temperature or mortality recently, but the Government keeps updating the heat wave action plan.
- 15 out of 31 districts in Karnataka are prone to high temperatures. There are state and district-level action plans.
- Dissemination of early warning till the last mile connectivity is ensured through IMD, and KSMDNC forecasts through SMS, email, social media, and Varunamitra call centers.

Karnataka's public alert system provides reliable, effective, and rapid communications to vulnerable panchayats.

- As short-term measures for heat wave preparedness, mass awareness programs are conducted to communicate clearly defined dos and don'ts to be followed during heat wave seasons; training and capacity building of health workers and paramedics are conducted; school and MGNREGA timings are rescheduled, community cooling centers are opened, water facility is provided in work sites and markets, the situation is monitored in control rooms by the nodal officer at the district and taluka level, weekly review meetings are also conducted.

- Long-term plans include green roofing, green building, and increasing forest cover.

Maharashtra :

- The presentation on Maharashtra focused on Chandrapur city, an industrial city and one of the hottest cities in India due to the existence of coal mines; Chandrapur has implemented heat action plans since 2015.

- Meetings are conducted with line departments, community organizations, PHCs, and Urban PHCs before the beginning of the heat wave season.

- Warnings from IMDs are disseminated through news, television, hoardings, and awareness campaigns.

- The Municipal Corporation identifies vulnerable local populations like hawkers, thermal power plants, cement factories, brick kilns, and mine workers; an appeal is made to the industries to change work timing and allow workers to take rest in shade, school timings are altered, uninterrupted supply of clean drinking water is ensured.

- The district administration has made cool roofs mandatory while sanctioning building plans. They are encouraging residents to paint buildings white; people who work on roads are vulnerable to disasters; hence more trees have been planted on roadsides, and parks have been created to cool down the local microclimate.

Question and Answer in Session 3 :

Q. Deaths caused by direct exposure to the sun are easy to identify and attribute to heat. But non-exertional deaths are not that easy to trace. How does Odisha ascertain the actual cause of death while granting compensation?

Post-mortem is mandatory to ascertain the cause of heat waves, and claims must be made online.

Summary:

This session highlighted IMD's role in heat wave forecasting. It also emphasized the significance of multidimensional disaster risk assessment followed by presentations by the states of Odisha, Karnataka, and Maharashtra on state/city-level heat wave planning and action.

Photo 8: Technical Session 3: Early Warning, Vulnerability Assessment, and Its Dissemination for Heat Wave

5.4 Technical Session- 4 National Level Planning and Preparedness for Heat waves

This session was chaired by Lt. Gen. Syed Ata Hasnain, Member, NDMA and co-chaired by Shri. AppasoDhulaj, Director, Governmentof Maharashtra.

Dr. Vinay Sahgal Head and Principal Scientist, Division of Agricultural Physics, IARI started by recalling NDMA in Bangalore 4 years ago, where a discussion was done on the heat wave, forest fires, and related events. The topic of presentation was extreme temperature and heatwave impacts on agricultural crops. The key points from the talk are:

- India carries over 16 percent of the global population, and how significant it is to bring food to the table. Over 80 percent of the farmers are small and marginalized but hold only 36 percent of cultivable land. He stressed that we couldn't stop agriculture or reduces it with the heat wave and associated scenarios. With the changing climatic conditions, we have to develop plans and strategies to cope with it.

- IPCC missed our 1.5-degree Celsius target, and we might be more than around 2 degrees Celsius. It needs an hour to identify the reason and reduce the same. He said on the criteria set up by IMD, which raises alerts based on the temperature limits. WMO has not put any temperature limit as such.

- Plants have an optimum temperature range which is required for proper growth. Winter crops can bear temperatures between 22 to 27 degrees Celsius. Whereas the summer Crops can't survive over 38 degrees Celsius. Hence there is a need to define different criteria and temperature limits approaches that can be changed with a percentile-based approach and develop a better heat wave magnitude index which takes in 3 days of continuous data in 90 percent over 31 days.

- In India, over 42% of areas have experienced significant rise in temperatureover recent years, both temporally and spatially, and extremes are increasing at a higher rate. He said 56% of India shows an increased heat wave magnitude index. A few analyses of the crop loss were discussed where he said that carbon loss in soil, reduced microbial activities, and increased water requirements occur with increased temperature. These affect the crops and, eventually, the economy. Physiological impacts discussed include a decrease in the photosynthesis rate, a slowdown in CO2 diffusion, decreased transpiration, and loss of membrane integrity.

Later, he talked about the Morphological systems of the heat wave in plants which leads to necrosis, browning, photo-oxidation, and sunburns, leading to crop damage.

- For example, he talked about the rice crop, which is sensitive even to night time temperatures.

- As concluding remarks, he discussed adaptation measures by utilizing the agro advisory system, which is then sent to every farmer weekly for them to take precautionary actions. He stressed that we need to get climate-smart villages to tackle climate change in the coming years.

The next speaker was **Shri Amit Prothi,** Director General of CDRI, who started talking about water and Energy planning for the Heat Wave. The key takeaways from the talk coalition for disaster resilient infrastructure, impact of extreme heat on power and water are:

- **Shri Prothi** citing the example of Fatehpur Sikri which lost its tourism industry due to a lack of water, stressed that water is critical to economic well-being.

- Nowadays, every sphere of life is dependent on power. Life and livelihood are interdependent and rely on an uninterrupted power/energy supply, but this power generation infrastructure becomes unpredictable due to heat waves. The supply side must stay stable.

- He talked about how countries like China and Brazil face heat waves and drought, leading to an energy crisis. He talked about developing long-term investment over a long-term support system. He gave an example of how the US faced a major blackout in 60's led to the development of new strategies for sharing power to different regions via newer governance mechanisms. He said not only the supply side but also the demand side has to be looked upon with the same responsibility. He also skimmed through topics on how heat waves affect water supply, sanitation, and reservoirs. Cape Town was in dire need of water after its water reservoir was on the verge of drying out.

- National-level capacity-building initiatives should be of utmost priority and should include elements of human resources development. Identification of Key Capacity gaps is required in policy, management, and operations. Department projects and policies should be national and include elements of policy and planning, operation and communication, mitigation, administration, and coordination. Initiative towards strengthening state and district level institutions.

Summary:

Public infrastructure like water supply and power generation systems need to be robust to tackle heat waves. It is important to remember that supply and demand are equally important regarding power. Experiences of other countries in the past should be taken up as learning.

Question and Answers in Session 4:

Q : How can plant health be monitored by satellite?

We are utilizing the geospatial technologies available. There is more work required to be done. There has been 5-6 % loss in wheat production last year due to heat. Due to the late onset of rains, there was a delay in the sowing of rice and, eventually, in the sowing of wheat.

Photo 9: Technical Session 4: National level Planning and Preparedness for Heat Wave

5.5 Technical Session 5: State-Level Plans for Heat waves Risk Reduction

The session was Chaired by Prof. S. B. Agnihotri, IIT Bombay and co-chaired by Prof. Anand Rao, IIT Bombay

Speaker 1 : Shri Rohit Magotra, Deputy Director, IRADe, Capacity Building for Climate Adaptive Heat Action Plan. He talked about climate adaptive heat stress action plans to manage heat stress in Indian cities. The takeaways from his speech are:

- The speaker gave his insights about designing & developing of climate adaptive detection plan, which is initiated concerning developing heat action plans. These plans are adapted to climate requirements and direct comprehensive methodology. The speaker also addressed the need for climate-adaptive heat action plans to identify heat hotspots and shifts in heat centres.

- The climate adaptive heat action plans are essential to manage the heat stress in Indian cities and to address climate change concerns. These plans are essential to identify urban heat islands, focus and target intervention, heat spot identification, and vulnerability analysis at the ward level. The speaker emphasized on inclusion of a gender-sensitive Heat Action Plan in south Asian cities for indoor heat management.

- The views expressed by the author were explained further using the study of 3 cities based on the Climate Adaptive Heat Action Plan. These plans involved processing evidence-based information and sharing this information with stakeholders. The speaker also summarized identifying ward-level heat spots and vulnerabilities and future impact assessment.

- Development of a climate adaptive heat action plan can be effectively achieved by building modules for capacity building and stakeholders training. The speaker also emphasized the importance of developing effective communication strategies and knowledge dissemination.

- Designing a climate adaptive detection plan involves developing heat action plans that are adapted to climate requirements.

- Identifying heat hotspots and shifts in heat centres is essential for effective climate adaptation.

Speaker 2 : Dr. Anil Gupta, Professor and HoD, NIDM. He talked about Developing institutional and technical capacities for developing and implementing state-level heat Action Plan

- The speaker spoke about introducing a climate action plan, integrating disaster risk reduction plans at gram panchayat levels, and developing institutional and technical heat action plans. The speaker spoke about the involvement of sectoral, sectional, jurisdictional, and local bodies and the need for their linkage to disaster management and CCAP.

- The author gave insights about addressing non-climatic factors such as socio-economic, cultural, environmental, and cause-effect relationships. He further spoke about the physical effects and impacts of heat waves and about developing dynamic and flow-based plans for heatwave management.

- The speaker emphasized introducing capacity-building interventions and dynamic planning, developing state resilience. Using multiplier effect models, heat wave action plans are prepared dynamically in synergies with other assessment plans. Toward the end of the presentation, the speaker expressed the necessity of having an assessment and audit mechanism.

- To reduce carbon emissions, a climate action plan might involve measures to reduce energy consumption, such as installing solar panels or retrofitting buildings to become more energy-efficient.

- The speaker emphasized another key element of a climate action plan is adaptation, or preparing for the effects of climate change. This could involve developing plans to deal with floods, droughts, or other extreme weather events, as well as developing plans to protect vulnerable populations from the impacts of climate change. Improving heat management infrastructure, such as installing air conditioning in schools or hospitals, could also be included in a climate action plan.

3. State Level Heat Action Plans, State Government Presentations

A. Dr. Fatima Kaneez, UPSDMA

Dr. Fatima Kaneez spoke about the State Action Plan for Resilience, Planning, and implementation. She gave a compelling summary of the implementation of unified development for the framework of the Heat Action Plan throughout the Districts in UP state. Further, the state has been developing a Heat Action Plan framework with UNICEF & IIPH. The speaker spoke about the district-level use of AAPDA MITRA for capacity building and the effective use of social media to disseminate information and outreach.

B. Shri Rishikesh Tiwari, Joint Collector, Chhattisgarh.

- The speaker spoke about the state's capacity to identify heat-prone areas. Most heat-generating activities, industries, and urban areas lie in the state's central region. Most Central Districts of the state are prone to heat waves, and their most critical time is during March – June. The state assesses health impacts due to heat waves. The speaker noticed that the death rates reported are low though the rate of hospitalization rises with a rise in temperatures. The state experiences decreased water levels along the rain shadow region with the onset of heat waves. The speaker stated structured and standardized frameworks and guidelines for Districts. Managing manpower is a framework for the health sector to follow treatment protocols during heat waves. The speaker gave insights into the implementation of mandatory solar power systems and passive cooling in the state.

C. Shri Shreedutt Kamat, State Project Officer, Maharashtra.

- The speaker gave information about identifying heat wave-prone Districts by SDMA. Thereby identifying 13 districts most heat prone in the state. The speaker focussed on early forecasting of Heat Waves and Heatwave management through IRS dissemination with the least human intervention through color-coded warnings. The speaker spoke about the necessity for creating awareness amongst the masses through media, information distribution for symptoms of the heat wave, protocols to follow, and use of the healthcare system. The speaker spoke about implementing regulatory methods and taking measures to combat heat waves. And successful implementation of passive cooling methods in certain districts. The speaker emphasizes coordination with other agencies for long-term effective mitigation plans and adapting mitigation measures for sustainability.

Questions and Answers in Session 5 :

Q. How is the framework for vulnerability analysis designed, and what are its parameters?
The use of several multidimensional approaches is used in the analysis of vulnerabilities. Parameters depend on various factors—use of secondary data and framework provided by NDMA. The study mainly focused on vulnerability, the least affected, adaptability, and capacity.

Q. Are state disaster management plans evaluated, and how?
No systematic studies are available at present. The evaluation is mainly through state performance. General assessment reports for 2016-2018 for the states of Telangana and Odisha. The emergence of other indicators and cost-benefit analysis is required.

Summary:

The last Session of the day focused on using a multidimensional approach towards a heat wave action plan to identify vulnerabilities and the need for capacity building at grass root levels to develop a long-term mitigation plan achieved through coordinating with various agencies' implementation of current mitigation steps by the states.

Photo 10: Technical Session 5: State-level Plans for Heat Wave Risk Reduction

5.6 Technical Session 6: Dealing with Heat waves in the Urban Context

The present session was Chaired by Shri. Rajendra Singh, Member, NDMA and co-chaired by Shri. Kunal Satyarthi, Joint Secretary, NDMA.

Dr. Rajashree Kotharkar, Professor, VNIT, presented a research study conducted by her team in association with NDMA. The study had two components. The first goal of the research was to develop a framework for heat vulnerability mapping, and the second was to create a model heat action plan for Indian Cities. The city of Nagpur was identified as a case study for the project.

- Cities are a problem and a solution. Every heat wave action plan should have a spatial framework in the background of any study. One needs to identify the context and the population the plan would cater to. For the vulnerability assessment in Nagpur, a local climate zone classification was used to study the Urban Heat Island Effect. Within cities, there are areas with different levels of heat stress and energy consumption due to micro-climate, which is a function of urban morphological parameters like building surface fraction and vegetation density ratio. The LCZ classification was mapped onto the ward boundaries and correlated with exposure, adaptive capacity, and sensitivity indicators to map the heat vulnerability of the city.

- **Professor Kotharkar** also contended that the maximum threshold to withstand heat depends on how adapted we are to a specific climate. They conducted an outdoor thermal comfort study to understand the heat stress level in Nagpur. The threshold will be different in different areas. Her team has also studied the heat risk perception of informal workers. She claimed that unless people identify heat as a threat, no amount of government effort can yield any result.

- Talking about mitigation efforts, Professor Kotharkar said that different kinds of mitigation strategies are effective in different microclimates- cool roofs are suitable in densely built areas without much variation in the heights of the buildings. At the same time, planting trees can be a better strategy along streets than having one patch of green. Roadside plantation protects against prolonged exposure to solar radiation and from the heat reflected by concrete surfaces like pavements. Mitigation should match the LCZ.

- Professor Kotharkar identified the shortcomings of the existing HAPs. Those are:

  - ❖ Lack of clarity on the definition and scientific understanding of heat waves
  - ❖ Definition and identification of threshold are unclear
  - ❖ Lack of dynamic alert systems and action plans

- ❖ Integration of HAP in national planning policies and development plans
- ❖ Limited coverage of HAP
- ❖ Lack of proper spatial vulnerability mapping
- ❖ Lack of monitoring and evaluation of HAPs
- ❖ Limited weather stations
- ❖ Lack of trained human resources to implement heat-related efforts

- Heatwave action plans are internationally accepted as a standard to reduce mortality and morbidity. They should cover four key domains:
  - ❖ meteorological (heat health warning systems),
  - ❖ epidemiological (establishing a relation between thermal environment and health),
  - ❖ public health (robust health system providing support to vulnerable groups),
  - ❖ built environment (long-term urban planning design to reduce exposure)
- The model HAP as recommended by their study, is based on eight core elements:
  - ❖ Agreement on a lead body and clear definition of roles and responsibilities
  - ❖ Accurate and timely alert systems
  - ❖ Health Information Plan
  - ❖ Reduction in Indoor Heat Exposure
  - ❖ Particular care for vulnerable groups
  - ❖ Preparedness of the health/social care system
  - ❖ Long-term urban planning
  - ❖ Real-time surveillance

- Professor Kotharkar suggested shifting from heat management to heat planning. Through her research, she has tried to devise explicit medium and long-term plans to tackle the heat. She feels that research and policy must come together to address this problem. If we start working on the medium and long term, the short-term crisis will be taken care of independently.

Dr. Mahaveer Goleccha, Professor and Lead-Heat Action Plan, IIPH, Gandhinagar, gave the second talk in this Session and highlighted the lessons learned from the last decade of Heat Action Plan Implementation by IIPH, Gandhinagar in India. The key points from the Session are:

- IIPH, Gandhinagar, in collaboration with the local city Government, NRDC, USA, and the University of Washington in 2013, developed India's first Heat Action Plan. This HAP was a significant impetus for heat health-related works in India.

- NDMA became the key agency and took this journey forward by organizing national-level workshops and supporting SDMA and state government.

- IIPH Gandhinagar has supported many state and city governments and district administrations in heat-related plans about preventable morbidity.

- Most important lesson they learned in 2013 is that political and administrative leadership is essential for prioritizing heat-health. The Mayor of Ahmedabad city had played a significant role in the implementation of the heat Action Plan for preventable deaths and morbidity in Ahmedabad. E.g., The Mayor of Ahmedabad did cool roofing, which impacted the population and enhanced the administrative department to work on HAP.

- The second lesson was that we have to enhance our understanding of the environment, Public Health, climate change, and the health of our administrative and political leaders. Because until and unless they understand the relationship between the benefits of the heat Action Plan, they will not implement this plan at the district or city level.

- Institutions play an important role in the continuation of services. There is an urgent need to define inter-agency coordination roles and responsibilities with accountability at National and state-level disaster management organizations or institutions. Outcomes should be defined in advance.

- Localized action and stakeholder engagement should be there in implementing HAP. HAP is implemented in cities, but all the areas in the same city do not need the same attention. Ward-wise heat stress management can be applied in such cases. Actions taken at the micro level should be regularly monitored. Engagement with religious leaders and NGOs

to implement action plans to ensure their involvement in small things like water in hot hotspots and vulnerable areas. In Ahmedabad with the help of religious communities such as Swaminarayan sampradaya, Jain community, and Bohra Muslim community. They have implemented such a plan. They helped establish water points across the city where they were needed. Distribution of buttermilk at all bus stops during a red alert with the help of NGOs.

- In most cities, the urban planning department is not on board. While passing the plan, they are not considering whether the building is heat resistant.

- 30 to 40% of our population lives in urban areas, so there should be a division for the Urban environment in the forest department. The Forest Department should also be part of the plan.

- For increasing the availability of all-cause mortality data, we must improve heat health surveillance. Five hospitals in a city should be made available for more mortality data.

- The NDMA has developed a city-specific threshold for heat.

- A study in collaboration with IRADe IIPH found 15 vulnerable wards in Rajkot city with very high temperatures. The city temperature varies within a radius of 10 km by 5 to 7 degrees. Many cities have implemented the heat wave Action Plan, but only Ahmedabad city has evaluated the impact of the heat wave Action Plan in reducing mortality and morbidity.

- Economic evaluation of the heat action plan needs to be studied. What cost benefit is it giving to you? Suppose you invested Rs 100000 in HAP; how much benefit in terms of quality-adjusted life did you gain? How many deaths have been avoided?

- We should have one special call for heat health research in India, where 10-15 Institutes can call, operate and do different studies. One special call for heat health research in India should be from ICMR DST, or any competent authority should be there so more research would be done.

- Since implementing the heat wave action plan in Ahmedabad in 2013, morbidity and mortality have been reduced. In Ahmedabad, if the night minimum temperature is below 40 degrees C, more mortality was observed. So, night temperature has also played a vital role, and if a city has the same problem, this will be understood through research.

- NDMA and NHM should fund education programs in India. Every year ten officers for environmental public health should be assigned. IIPH will develop a course in collaboration with IIT Bombay. The Environmental public health master should be there.

- Implemented rural area HAP in Rajasthan.

- 60% of patients are treated in private hospitals; therefore, the private sector should be on board in providing various services.

Dr. Chandni Singh, from IIHS, and **Shri Aditya Pillai,** Centre for Policy Research talked on how is India adapting to Heatwaves? The key takeaways are:

- India is getting hotter. We will hit the limits of heat and humidity by the end of this decade. Dr. Singh and her team reviewed 37 heat wave action plans across 16 states. They found that the HAPs suggest a wide range of solutions to the problem of heat. The solutions are Infrastructural, nature-based, institutional, technological, informational, and behavioural.

- HAPs provides an extensive suite of solutions across states with a good mix of long-term and short-term solutions. However, more emphasis is on preparatory and relief measures and less on long-term measures.

- There is a need for capacity building in Government departments; one needs to incorporate transformational capacity through inter-agency cooperation, state-state learning, and sharing best practices. One needs to consider the maintenance and funding of nature-based solutions.

- Heat risk as a function of hazard, exposure, and vulnerability. We need to identify who is being exposed and to what extent? How are the Heat Action Plansaddressing these components? How is hazard defined? 24 of the 37 HAPs recognize local thresholds, but only five explicitly do so. 21 out of 37 plans acknowledge cascading impacts of heat, but how they incorporate them into their solutions is unclear. Only 2 out of 37 plans take into account long-term temperature projections. Only 2 out of 37 HAPs incorporate extensive vulnerability assessments, HAPs do well in identifying vulnerable groups, but there is limited policy targeting. There is a need to target intersectional vulnerability, which can be the cumulative function of age, gender, caste, and livelihood.

- **Mr. Pillai** added that there is insufficient information on the financing mechanisms of the plans; sources of legal authority are not discussed.

- **Dr. Singh** suggested the following recommendations:

  - ❖ Need for localized heat hazard assessments

  - ❖ Use of climate projections and past temperature trends in planning

- ❖ Acknowledgement of changing nature and cascading effects of heat
- ❖ Shift from vulnerability assessments to holistic risk assessments
- ❖ Establish accountability for the implementation of HAPs
- ❖ Develop institutionalized systems to monitor and evaluate HAPs and make the data available to the public
- ❖ Link HAPs to existing centre and state scheme
- ❖ Create a centralized repository of HAPs and their updates for knowledge sharing
- ❖ Set up an expert committee to assess and notify heat wave as a disaster
- ❖ Clarify funding sources (Create a central fund or harness the national fund on climate adaptation
- ❖ Clarify legal foundations and link HAPs to sectoral laws
- ❖ Implement recurring capacity building for actors
- ❖ Facilitate intra and inter-state sharing of knowledge and best practices

Shri Amandeep Yadav from Press Information Bureau talked about media, communication, and related aspects. The key notes from his talk are:

- During natural disasters, we should have a proper communication plan because we have different target groups, so different communication plans are required. We cannot have a straight-jacketed approach toward everyone.
- Depending on the DGs, the target groups have to devise different capsules of information for them and package it accordingly so they can grasp it properly. For rural and urban areas, the information communication plans and media should be different based on the availability of sources. In rural areas, people cannot get information through social media; therefore, more interpersonal communication methods should be applied.
- Information mechanism through the AASHA workers; through the ANM, we have to devise the Panchayat representatives in rural areas. People must be kept prepared for disasters like heat waves. However, the information should be delivered through a proper mode of communication based on the acceptability of communication modes.

- Newspapers are the best feedback mechanisms we have. Authorities, officers of DPR, and information department officers must be ready with press conferences and all sorts of information that should be published through the media.

- In electronic media, the information related to dos and don'ts in disaster situations should be directly discussed in such cases.

- Role of social media is crucial today with different types of utility. Complex information should be told in layman's language so everyone can understand. Correct information in the right amount; this should be the approach.

- Success stories can help understand people more effectively and increase acceptability in people.

- With the help of Google, the hotspots for heat are accessed, and precise information dissemination can be done in that area to get the results.

Question and Answer in Session 6:

Q. Where do heat waves stand in the loss and damage paradigm?
Attributing loss and damage to heat is complex. Quantitative assessments on tangible impacts are available, but it is challenging to consider intangible effects like women's increasing work burden at home, mental health concerns, and diminishing workers' comfort.

Q. What is the best mechanism to disseminate information?
In rural areas, interpersonal communications and audio-based dissemination work well. For youths, Instagram reels by influencers can convey the message.

Q. How to implement heat action in slums?
One of the significant concerns in slums is the indoor environment. Cool roofing and modifying the walls and roofs can help. Scientific knowledge is one of many forms of knowledge; we have a lot to learn from the local communities, which have their adaptation mechanisms.

Summary:

This Session covered the academic assessments of HAPs across India, including implementation challenges, financing, and communication. Based on a case study of Ahmedabad and Nagpur; a model HAP was presented for cities to adopt.

Photo 11: Technical Session 6: Dealing with Heat Wave in the Urban Context

5.7 Technical Session 7: Mitigation Solution for Heat waves

The Chair **Dr. Krishna S. Vatsa**, Member, NDMA began the Session by talking about mitigation solutions required for heat waves. The session was co-chaired by Shri. Alok, Addl. Secretary, NDMA. The first speaker was **Ms. Bijal Brahmbhatt,** Director of Mahila Housing trust. She talked on climate change and slum dwellers: key issues identified.

The Chair began the Session by talking about mitigation solutions required for heat waves. The first speaker was **Ms. Bijal Brahmbhatt**, Director of Mahila Housing trust.

- The speaker presented their work withwomen in the informal sector. She talked about the objectives of the Mahila Housing Trust, especially the housing & development sector and building capacity.

- Targeted training and localized communication are key strategies for behavioural change. She also talked about piloting community-based validation on technical solutions related to heat stress.

- Design and incubate financial products to help communities in addressing the problem of heat wave. She also stressed how developing strong institutional partnerships can help us in the long term in mitigation of heat wave.

- At ground level the NGO engaged with women by designing innovating games like the snake and ladder to identify the impact matrix and understand the intensity and frequency. A toolkit has been developed, which helps identify and connect the root cause. Piloting technical solutions is also required. As an example, she presented ten climate-resilient solution demonstrations.

- Modular roofing system was discussed. There has been an increase in investment practices over the modular roofing system over time. She talked about how the community can take on the measure of temperature with and without modular roofing and then understand the importance of solar reflective paint.

- She said people are aspirational, and it is a challenge to ask them to invest money on roofs other than RCC or Concrete. But, still, the trust could put together 10 thousand houses impacting 50 thousand people.

- She stressed on the requirement for a joint workshop with the municipal corporation for better implementation.

At last, she pointed out that it is equally important to address residual risk after implementing mitigation solutions. They started heat health insurance to take care of any losses after these investments were made to mitigate heat-related losses. She also brought up the issue that IMD does not have forecasting based on Web Based Training(WBT), which significantly impacts human comfort.

The second speaker was **Shri. Manu Gupta** (Director, SEEDS) from SEEDS India. He spoke on community driven heat wave action.

- He emphasised that indoor temperature also is a determinant for impacts due to heat wave. A study in Delhi presented the increasing problem of heat experienced in low-income settlements. They are working on developing a hyper-local warning system based on the heat insulation from the roof system, which will benefit the low incomes settlement and help develop advisory to bring change for the better.

- Challenges exist and they are concerned about the size, urgency, and complexity of the problem. He explained what works at scale Vs. Scaling what works. Making sense of what exists. Identifying innovation and partnership and, at last, enabling an ecosystem that links Samaj, Sarkar, and Bazaar. The speaker suggested unilateral approaches and multiple stakeholder models for building partnership ecosystems.

- He stated that the approach of the government in developing the Heat Wave Action plan is unilateral and it impairs the ability to implement them. He also stated that developing the ability to transfer the Action plan to the ground should be given due consideration. He discussed about Dhaka in Bangladeshon how they have followed proper adaptive measures to various disasters. The use of various practices is seen as a result of adaptation to climate change in local communities. Learning from them can be used as ways to mitigate and reduce the risk. He then focussed on increasing the heat wave resilience on a larger scale.

- He pressed on understanding real losses and, in conclusion, spoke on identifying gaps in enacting policy at the local level and scale. New thresholds should be defined for temperature, and a household approach should be followed.

The third speaker was **Shri Abhiyant Tiwari**, Lead- Climate Resilience and Health, NRDC talked about local threshold estimation and the study of effective preparedness measures at the local level.

Speaker spoke on available options and best in-use methods of estimation. He reiterated that there is no universal temperature threshold for heat waves. It is the need of the hour to understand why threshold estimation is necessary. The speaker then discussed the need developing local thresholds as it will play an essential role to trigger early warning systems.

- He talked about various parameters important to identify the threshold for heat. E.g., Tmax, Tmin, and Tmean. Epidemiological and study methods as a factor to consider while designing threshold were also talked upon. The percentile-based study is already being used in a few Indian cities, and these are performing quite well.

- Assessing vulnerability is important as a decision-making dilemma is a major hurdle and can be solved when acted upon collectively.

Question and Answer in Session 7:

Q. Which parameters are used to set the threshold values for a heat wave?
The parameters used to define a heat wave threshold can vary depending on the specific climatic conditions of a region. Some variables that may be considered include the minimum and maximum temperature, wet bulb globe temperature, heat index, and relative humidity. It is important to account for these variables to accurately assess the risk and impact of heat waves in a given region. Local threshold values need to be considered for ground action plans.

Q. For policy formation, how to work out a workable framework with governance for communities?
The first step in identifying a focused community is to conduct a needs assessment to understand the community's characteristics and vulnerabilities to heat waves. Once the community has been identified, guidelines for heat wave management can be developed and presented to the community. Authorities can intervene by providing incentives and implementing building codes to reduce the impact of heat waves. It is important to utilize existing solutions and traditional knowledge while also innovating new solutions. Building partnerships is crucial to reducing the overall impact of heat waves.

Suggestions:
It is essential to equip women with the necessary means to adapt to society and manage the impact of heat waves. This can be achieved by making technological solutions available in the market and implementing them with community input. It is also important to provide a range of solutions, allow communities to have choices based on their aspirations, and analyse cost-benefit relationships. Long-term policies and solutions should also be developed to reduce the impact of heat waves. It is necessary to create an inventory of resources with NDMA for easy access and good governance.

Photo 12: Technical Session 7: Mitigation Solutions for Heat Wave

5.8 Session 8: Summing Up Discussions and Developing a National Programme/ Framework on Heatwave Mitigation

Professor Ravi Sinha drew attention to the five outcomes that the workshop aimed to achieve

- Developing a national program or framework for heat wave mitigation as a part of a national adaptation plan,
- Develop state and city-level interventions for heat wave mitigation focusing only on mitigation and not on response,
- Improve early warning and monitoring of heat waves,
- Support public awareness campaigns for protection against heat waves, and
- Discuss various sources of financial resources for Heat Wave Mitigation.

Shri Alok, Additional Secretary, NDMA, suggested a framework should be made based on the objective elaborations made by several speakers related to heat waves. Also, added that we need a group of people working on the recommendations suggested by the speakers because we can identify future disasters.

Dr. Krishna S. Vatsa, Member NDMA, gave a presentation on the key outcomes of the workshop and suggested the way forward. His speech has been summarized below:

- We have been proactive in heat wave planning and action since 2016. We started quite early, developed the guidelines for heat wave planning, and asked the states to frame HAPs. Much work has been done in last 4 to 5 years, but considering the severity of the situation at present, we need to accelerate the efforts.
- Extreme heat is catching up with us, and it destroys quietly. Its effects are not dramatic, like earthquakes or floods. 2022 was a tipping point when we had the hottest March in more than a century. Experienced crop failure, wheat and rice production came down at the national level.
- The Prime Minister monitored the heat wave situation in the country; the heat caught people's attention at the highest policy-making level. The situation and the intent for action are serious. Impact of heat is experienced more in the urban areas, and Urban Island Heat Effect augments it. We need to understand how we are creating UIHE through our activities. In the height of summer, cities seem to be burning, and we see

exhaustion everywhere (buses, trains, public places). The infrastructure we have created is suited to a particular climate which is now changing.

- We need to take cognizance of the socio-economic dimensions of heat. The health impacts are diverse and are experienced more by the energy-poor and housing poor. The elderly, pregnant women, young children, and manual workers are far more affected.

- So far, we have approached the heat wave problem in a campaign mode. We have developed the guidelines, and following the guidelines, states have developed HAPs. They applied a lot of thought and effort in preparing the action plan. HAPs have become a standard tool for interventions. They consist of instructions, dos and don'ts, and administrative measures regarding school hours, work hours, and manual workers. It has generated positive impacts; mortality has come down (such statistics can be misleading too, which can result from suppression of activities). We need to go beyond campaign mode and adopt a more programmatic one.

- The presentations here have given us a lot of material to take to the programmatic mode. In collaboration with early warning agencies, we need to set up better metrics, thresholds, and heat index, which should not be only in the instruction format. Heat actions like public health preparedness measures, energy, and changing school and work timing should be calibrated to these metrics. We need more sophistication in HAPs than we have been seeing so far.

- It is time to think about heat wave mitigation and move beyond preparedness. Mitigation interventions in diverse fields like environment, health, water, energy, and animal husbandry are needed. Interventions should be done at the local level with the involvement of municipalities and panchayats, who have to play a much greater role in local planning and implementation. Even a small investment in mitigation can bring a big difference.

- Financing- States need to contribute to heat action from SDRF and state disaster mitigation funds and from the preparedness and capacity building window of SDRF and SDMF. All the states have access to these funds. Local, state, and national allocations can be made for heat wave preparedness and mitigation. At the national level, NDMF can support planning and mitigation.

- We must go beyond energy efficiency and carbon emissions and rethink and redesign cities. We must propagate cool roofs, vegetation covers, urban forests, cooler urban spaces, water conservation measures, and architectural reforms like placing windows higher in the wall, improving animal shelters, and using environment-friendly housing materials suited to the local context.

Photo 13: Summing up Discussions and Developing a National Programme / Framework on Heat Wave Mitigation

Photo 14: Summing up Discussions and Developing a National Programme / Framework on Heat Wave Mitigation

Discussion:

- There is a need for institutional changes, clear role definitions among agencies at different levels; appointing heat officers at the level of cities, inter-agency coordination structure at the level of the state as well as cities, national level monitoring mechanism to evaluate heat wave action plans, research and data support for better monitoring, advisories for health.

- We need a heat index for India. Because we are still depending upon some agencies, and some institutions are developing their heat indices which cannot be interoperable. There is an urgent need for projects under NDMA to develop the national heat index for India, which would incorporate temperature and humidity and be correlated with health and other socio-economic sector data. Future studies on heat thresholds will depend on the heat wave index. We need many more research projects and funding for heat. NGOs are doing beautiful jobs, but they also need funding. Based on the temperature projections for the next one decade, we need to be prepared for adaptation and mitigation. We need to be prepared for future emergencies to prevent thousands of deaths. Along with the heat advisories for health and agriculture, we can also have animal health advisories.

- The state representatives from Arunachal Pradesh added that in the north-eastern part, palm tree leaf is used for roofing, but nowadays, people are switching to CGS sheets for roofing. It generates more heat, reflects the heat, and the whole area gets heated up. Palm leaves are flammable; they catch fire, so people switch to CGS sheets. Can we develop a technological solution for roofing based on locally sourced materials?

- **Dr. Mahaveer Goleccha** from IIPH, Gandhinagar, also made some points, such as making a best practices book and including whatever is planned on heat health. It should be in the form of a compendium. NDMA guidelines should go to every state, and in every state, at least three cities should implement and evaluate heat action plans properly using the data-driven approach, like what is the impact of HAP on all-cause mortality or IPD/OPD. Under NHM, lots of funds are available, and states cannot utilize 30% of funds. In that fund, 2-3 cities should appoint a heat health officer.

Since NDMA is preparing for a mitigation program, could there be support for developing a centre similar to the US, a System called the national heat health information system, which is co-funded by NOAA and CDC? NDMA can fund such centres of excellence or institutions, and they can work together under this centre for NDMA to develop national action programs.

- Concerning this, we should launch a national heat health information network to become a peer-to-peer study network for cities and districts to share the learning.

- We need a compendium of best practices done by districts and states and a compilation of research activities done on heat. We need a proper evaluation of plans.

- Suggestion was made for a national centre dedicated to health information systems with a specific focus on health and environment that can work with NDMA to develop mitigation frameworks. Like the global heat health information network, can there be a national heat health information network that will promote peer-to-peer learning?

- The DM of Bhandara district in Maharashtra spoke about their initiative on rainwater harvesting. They conducted rainwater harvesting for public buildings in gram panchayats. Waterproofing was done to the buildings, and heat-resistant paint was applied. GPs were encouraged to use the 15th pay commission fund for this project. Sarpanch in villages is told to encourage rich people to adopt this model.

- Solutions need to reach people at the ground level. Hence, we need an inventory of local practices and resource institutions to share each other's best practices systematically.

- CSR activities can be dedicated to heat action.

- How can we have inclusive plans to cover informal settlements?

Photo 15: Valedictory Session

Photo 16: Valedictory Session

5.9 Session 9: Concluding Session

Shri Kamal Kishore, Member Secretary, NDMA, made the concluding remarks. He said that it is very optimistic that we are taking heat waves seriously. The conversation has broadened in the last one and a half days, from saving lives to livelihoods. Many sectors have been involved; impacts of heat on infrastructure, energy, and water, railways have been discussed. Honest reflections on HAPs have been presented. Suggestions were made on what a model plan should look like; the impact of city morphology on heat was discussed. The conversation is moving forward. There is 100 percent agreement that heat affects everyone, and we will be the worst country affected by heat. The HW season starts from March onwards, and hopes for zero mortality. Even if there has been a poor representation of women among the panelists, research on heat is mainly led by women researchers.

Professor Ravi Sinha added that a synthesis document would be prepared and shared with all, including presentations in the workshop. The inputs from many states will further enrich the compendium of sound practices. The compendium preparation is still in progress. Heat is a slowly building disaster, and knowledge will be beneficial to be better prepared. The workshop brought together knowledge institutions that could further collaborate to make a difference.

Shri Kunal Satyarthi, Joint Secretary, NDMA, gave the vote of thanks. He said we had completed 20 presentations by 20 institutions and six by states in the workshop. He thanked the director of IIT Bombay, Professor Ravi Sinha, and the team at IIT Bombay for hosting the workshop. He thanked the participants, academic institutions, the government of Maharashtra, the state governments, district collectors, and ministries for their participation and efforts.

Photo 17: Group photograph of participants at VMCC, IIT Bombay

Photo 18: Group photograph of participants at VMCC, IIT Bombay

5.10 Action Points from Technical Sessions

	Name	Department/Designation
Technical Session 1	**Climate Change Impact, and Challenges of Heat Wave Adaptation Mitigation**	• Scientific studies for understanding the cascading impacts of heat waves along with other interrelated disasters like drought, forest fire, environmental health etc. may be undertaken. • While the heat wave phenomenon is well understood over land, heat waves over the sea and its impact on monsoon/marine life should be studied in detail. • Build capacities of different stakeholders and improve early warning systems dissemination by designating a heat officer at local level. • Cool roof technologies needs to be promoted widely by increasing awareness and marking dedicated funds to support cool roof programs/ projects. • Heat action plans currently focus on outdoor vulnerability. There is a need to consider the indoor impacts of heat. Gender dimensions need to be taken into account in measuring impacts. • Heat resilience should be an important component in the municipal building code, and local authorities should promote passive cooling through traditional techniques. • Develop a evidence based framework for capturing loss and damage specific to heat waves.
Technical Session 2	**Health Impacts of Heat waves and Preparedness Measures**	• Heat Vulnerability Index, which accounts for landscape, demography, and socio-economic factors along with meteorological indicators like temperature, humidity and wind directions, needs to be developed. • Urban areas must carry out a heat threshold assessment at a regular interval of at least five years.

		• Every HAP needs to be evaluated independently by third-party researchers to understand how better they have served and how they can be improved. • The health facilities across the country needs to have a stringent heat-related surveillance of deaths, emergency OPD visits for heat related illness, and all-cause deaths to understand impact on human health. • Risk assessment measures and preparedness of veterinary hospitals and mobile units, adequate disease diagnostic and control measures, and assessment of existing animal handling search and rescue capacity at state and district level must be strengthened by animal husbandry.
Technical Session 3	**Early Warning, Vulnerability Assessment and its Dissemination for Heat waves**	• Robust heat wave hazard analysis for four months (March, April, May, and June) considering Maximum, and minimum temperature, wind speed, and relative humidity should be further improved to assign temperature thresholds for issuing impact-based alerts for specific locations. • Local-level disaster risk management through community participation, sustainability context, and local reality needs to be promoted. • Trans-disciplinary research which focuses on stakeholders' engagement in different phases of research (co-design, co-produce and co-manage) needs to be incorporated into mainstream policy. • Adoption of advanced technology for monitoring disaster risk reduction including heat wave disasters needs to be undertaken. • Some of the best practices to manage heat wave are training and capacity building of health workers and paramedics; school and MGNREGA timings reschedule, opening of community cooling centers, water facility at

		work sites and markets etc may be incorporated into heat action plan in all the heat wave prone states. • Make cool roofs mandatory while sanctioning public building plans.
Technical Session 4	**Early Warning, Vulnerability Assessment and its Dissemination for Heat waves**	• National-level capacity-building initiatives should be of utmost priority and should include elements of human resources development. • Define different criteria and temperature limits for crops based on their optimum temperature range for growth, considering both winter and summer crops. • Implement adaptation measures, such as utilizing agro-advisory systems, to provide timely information and guidance to farmers, enabling them to take precautionary actions against heat wave impacts. • Strengthen power generation infrastructure to withstand the impact of heat waves, ensuring an uninterrupted energy supply and minimizing disruptions to life and livelihoods.
Technical Session 5	**Early Warning, Vulnerability Assessment and its Dissemination for Heat waves**	• Incorporate local evidence-based information and stakeholder engagement in the development and implementation of climate-adaptive heat action plans. • Establish capacity-building modules and training programs for stakeholders to effectively implement climate adaptive heat action plans and enhance knowledge dissemination. • Consider non-climatic factors such as socio-economic, cultural, and environmental aspects when developing heat action plans, and understand the cause-effect relationships related to heat waves.

		• Implement assessment and audit mechanisms to monitor and evaluate the effectiveness of heat action plans. • Emphasize the use of social media and information dissemination platforms to create awareness among the public about heat waves, their symptoms, and the appropriate protocols to follow.
Technical Session 6	**Dealing with Heat Waves in the Urban Context.**	• Develop a spatial framework for heat vulnerability mapping in urban areas, considering factors such as local climate zone classification and micro-climate variations. • Address the shortcomings of existing Heat Action Plans (HAPs), including the lack of clarity on heat wave definition, thresholds, dynamic alert systems, spatial vulnerability mapping, monitoring and evaluation, and integration into national planning policies. • Ensure that HAPs cover key domains, including meteorological aspects, epidemiological relations between thermal environment and health, robust health systems for vulnerable groups, and long-term urban planning to reduce heat exposure. • Shift focus from heat management to heat planning by devising explicit medium and long-term plans to tackle heat issues, combining research and policy efforts.
Technical Session 7	**Mitigation Solution for Heat waves**	• Design and incubate financial products to help communities in addressing the problem of heat wave. • Addressing residual risk after implementing mitigation solutions is equally important like heat health insurance to take care of any losses after these mitigation projects.

		• A Web Based Training (WBT) may be created by IMD for understanding Impact Based Forecasting of common people. • Robust framework for capturing loss and damage due to heat wave needs to be developed. • Support a hyper-local warning system based on the heat insulation from the roof system to benefit the low incomes settlement. • Steps to enhance leadership role for women to manage the impact of heat waves.
Technical Session 8	**Summing Up Discussions and Developing a National Programme/ Framework on Heat wave Mitigation**	• Studies may be conducted to understand the Urban Island Heat Effect and its relation to heat wave. • A model plan on heat wave management should be made taking into account the impact of city morphology may be developed. • Need to set up better metrics, thresholds, and heat index in collaboration with early warning agencies. Heat actions like public health preparedness measures, energy, and changing school and work timing should be calibrated to these metrics. • A heat index needs to be developed for India taking into account local climate conditions and topography.

Annexure I
Local Organising Committee

- Shri Aseem Gupta, Principal Secretary, Disaster Management, Relief & Rehabilitation Dept., Govt. of Maharashtra
- Prof. Ravi Sinha, (Member, MSDMA), Professor, Civil Engineering, IITB
- Shri Appaso Dhulaj, Director, Disaster Management Unit, Disaster Management, Relief & Rehabilitation Dept., Govt of Maharashtra
- Shri Sanjay Dharurkar, Deputy Secretary
- Shri Hintendra Dufare, Under Secretary, DMU
- Prof. Parmeshwar Udmale, Assistant Professor, CTARA, IITB
- Prof. Satish Agnihotri, Professor, CTARA, IITB
- Prof. Kapil Gupta, IITB
- Prof. N. C. Narayanan, IITB
- Prof. Anand Rao, Professor and HOD, CTARA, IITB
- Ms. Falguni Bannerjee, IITB
- Shri Nayan Dabholkar, IITB
- Prof. Arpita Mondal, IITB
- SDMA officials (DM)

Annexure II

Volunteers

Sr. No.	Name	Department/Designation	Affiliation	Category
1.	Nikhil Pisal	Civil Engineering	IIT Bombay	Volunteer
2.	Rutuja Shinde	CTARA	IIT Bombay	Volunteer
3.	Mayuri Gadhawe	CTARA	IIT Bombay	Volunteer
4.	Megha Mhaskar	CTARA	IIT Bombay	Volunteer
5.	Arka Majhi	CTARA	IIT Bombay	Volunteer
6.	Namrata Sankhla	CTARA	IIT Bombay	Volunteer
7.	Akshay Raut	CTARA	IIT Bombay	Volunteer
8.	Harshit Agrawal	CTARA	IIT Bombay	Volunteer
9.	Ankit Kumar Gupta	CTARA	IIT Bombay	Volunteer
10.	Pranit Chute	CTARA	IIT Bombay	Volunteer
11.	Anuj Sharma	CTARA	IIT Bombay	Volunteer
12.	Mohammad Rafiq Joo	Civil Engineering	IIT Bombay	Volunteer
13.	Roshan Jha	Climate Studies	IIT Bombay	Volunteer
14.	Srijon Pal	Civil Engineering	IIT Bombay	Volunteer
15.	Debdatta Chakraborty	Climate Studies	IIT Bombay	Volunteer
16.	Dewashish Tiwari	Climate Studies	IIT Bombay	Volunteer
17.	Umar Iqbal Teli	Mechanical Engineering	IIT Bombay	Volunteer
18.	Mohammad Ibrahim	Civil Engineering	IIT Bombay	Volunteer
19.	Arjun Chandra Biswas	Civil Engineering	IIT Bombay	Volunteer
20.	Sanjay Kumawat	Civil Engineering	IIT Bombay	Volunteer

21.	Ravi Jangid	Civil Engineering	IIT Bombay	Volunteer
22.	Samarth Bhatia	Civil Engineering	IIT Bombay	Volunteer
23.	Suvil Mahagaonkar	Civil Engineering	IIT Bombay	Volunteer
24.	Debaparna Mukherjee	Humanities and Social Sciences	IIT Bombay	Volunteer
25.	Himali Mhatre	CTARA	IIT Bombay	Volunteer
26.	Rohit Kumar Prince	CTARA	IIT Bombay	Volunteer
27.	Kamlesh Mali	MEMS	IIT Bombay	Volunteer
28.	Gaurav Kapse	CTARA	IIT Bombay	Volunteer
29.	Saili Bhoir	Yashada, Pune	IIT Bombay	Volunteer
30.	Sashwat Ghai	CTARA	IIT Bombay	Volunteer
31.	Tarun Negi		IIT Bombay	Volunteer
32.	Mahesh Gadi		IIT Bombay	Volunteer
33.	Sugandh Sawant		IIT Bombay	Volunteer
34.	Adarsh Birare		IIT Bombay	Volunteer
35.	Sanjay Mohite		IIT Bombay	Volunteer
36.	Bapu Rasam		IIT Bombay	Volunteer
37.	Mahesh Chavan		IIT Bombay	Volunteer
38.	Shri. Prasad Dalvi	MCRO	Govt. of Maharashtra	Volunteer
39.	Shri. Sagar Valanju	MCRO	Govt. of Maharashtra	Volunteer
40.	Shri. Sanket Ghanekar	MCRO	Govt. of Maharashtra	Volunteer
41	Shri. Santosh Konekar	MCRO	Govt. of Maharashtra	Volunteer

Annexure III
Participants

Sr. No.	Name	Designation
1.	Shri. Naresh Pal Gangwar	Addl. Secretary MoEF&CC
2.	Mr. Aveek Ghosh	Student VNIT-Nagpur
3.	Mr. Parikshit Dongarsane	Student VNIT-Nagpur
4.	Dr. Abhiyant Tiwary	NRDC
5.	Shri. Naresh Kumar	Scientist FDGM - IMD New Delhi
6.	Shri. Akhil Shrivastava	Scientist C, IMD New Delhi
7.	Ms. Fatima Amin	Young Professional ECDRM NIDM
8.	Ms. PratijnaPoonacha	IIHS
9.	Shri. Aditya Pillai	CPR India
10.	Shri. Devenvder Chapekar	EE -Ministry of Road transport & Highways
11.	Shri. Sachin K. Gautam	DGM- Ministry of Road transport & Highways
12.	Smt. Purvi Patel	Sr. Consultant NCDC
13.	Shri. Suresh Ram	Scientist F,MoES
14.	Shri. K. P. Yadav	Executive Director, Ministry of Railways
15.	Shri. Rajneesh Singh	Director, Ministry of Women child Development
16.	Shri. Vijay Kumar	RO, Dept. of Animal husbandry & Dairying
17.	Md. Riyazuddin	Programmer- BSDMA
18.	Shri P. N. Roy	Member BSDMA
19.	Shri. Thiru. R. Sakthivel	District Revenue officer- TNSDMA
20.	Tmt. M. Manimegalai	District Revenue officer- TNSDMA
21.	Shri. Thiru. C. Mutthukumaran	Joint Director- TNSDMA
22.	Shri. Sushil Singh	CEO, DDMA- Delhi
23.	Dr. Chetana Anand	Sr. Scientific Officer-NCT Delhi

Sr. No.	Name	Designation
24.	Ms. Kaneej Fatima	Project Director- UPSDMA
25.	Dr. Bimlesh Joshi	Health &Pyscho-social Specialist- UKSDMA
26.	Shri. Bijendra Singh	Special Officer-RJSDMA
27.	Shri. KomkarDulom	Director-Arunachal Pradesh SDMA
28.	Shri. Pradeep Singh	Monitoring and Evaluation Officer- PSDMA
29.	Shri. Vivek Sharma	Sr. Consultant-PSDMA
30.	Shri. Sunil Manohar Gavaskar	Senior Scientist- KSDMA
31.	Shri. Rishikesh Tiwari,	Joint Collector, Chattisgarh SDMA
32.	Shri. Surjit Kumar Singh	Add. Collector- JSDMA
33.	Dr. Dillip Kumar Singh	Deputy Director, MPSDMA
34.	Shri. AmarjeetChorpagar	DDMC Amravati
35.	Shri. Sachin Patil	DDMC Nashik
36.	Shri. Chandrakant Bankar	DDMC Aurangabad
37.	Shri. Nitesh Bambhore	DDMC Nagpur
38.	Shri. Rajendra Shelke	SDO Dharmabad
39.	Dr. Mirza baig	DMO Municipal Corporation Nanded
40.	Shri. Kishore Kurhe	DDMO Nanded
41.	Shri. Dinesh Gite	RDC Buldhana
42.	Shri. Ganesh Rathod	SDO Buldhana
43.	Shri. SambhajiPawar	DDMO Buldhana
44.	Shri. Rahul Patil	RDC Jalgaon
45.	Shri. Prashant Waghmare	DM Consultant Jalgaon
46.	Dr. Harsha Meshram	ADHO ZP Nagpur
47.	Dr. Vijay Joshi	MO Nagpur MC
48.	Smt. Chaitali Sawant	Tehsildar (Nagpur)

Sr. No.	Name	Designation
49.	Shri. NivrutiiUike	Tehsildar Chandrapur
50.	Shri. Jitesh Surwade	DDMO Chandrapur
51.	Shri. Shailesh Hinge	RDC Washim
52.	Shri. Shahu Bhagat	DDMO Washim
53.	Shri. Sanjay Khadase	RDC Akola
54.	Shri. Sandeep Sable	DDMO Akola
55.	Shri. Sakeb Osmani	DDMO Latur
56.	Shri. Rahul Kardile	DC Wardha
57.	Shri. Chinmay Gotmare	DM Gondia
58.	Shri. RajanChoube	DDMO Gondia
59.	Shri. Yogesh Kumbhejkar	DM Bhandara
60.	Shri. Deepak Shinde	DDMO Mumbai Suburban
61.	Dr. Anita Javanjal	DDMO Thane
62.	Ms. Nalini	Add. Director,Palledium Consulting
63.	Shri. Sarat Panda	Consultant, Palledium Consulting
64.	Shri. Adarsh Pandey	Consultant, Everbridge
65.	Shri. Atanu Ghosh	Consultant, Everbridge
66.	Shri. Brijesh Sharma	Consultant, Prutech
67.	Ms. Samriddhi Saraswat	Consultant, Everbridge
68.	Ms. Ambika Dabral	Program Manager, RIKA
69.	Sandhya Garware	DGPIR
70.	Shraddha Meshram	DGIPR
71.	Photographer	DGIPR
72.	Arvinder Pal Singh	Distt revenue officer
73.	Shyama Mishra	DD News

Sr. No.	Name	Designation
74.	Praveen chavar	DD News
75.	Mukund Thakur	IAS SDM, Kollam
76.	Sona Seth	KVS
77.	Mrs. Shaheeda Parveen	ZIET KVS
78.	Dr. AmulDundur	
79.	Dr. Suresh Reiu	PHET
80.	Gayatri B. Gohain	R and R
81.	Adesh Mhatre	Revenue Department
82.	Sunil Kumar Nalath	
83.	Vipin Suresh Palival	
84.	Dr. Deepak V Salunkhe	
85.	Dr. KamlaParkar	
86.	Hemlata Chappariya	
87.	Amandeep Yadav	Ministry of Information and Broadcasting
88.	Irfan Ahmed	CE Ministry of Power
89.	Pasala Eswar Rao	
90.	Laxmikant Sethi	Add Commissioner
91.	Padmanava Behera	Member, Odisha
92.	Manikanandan	Kerala
93.	Lekha Chacko	
94.	Vamsi Y	GISE Hub, IIT Bombay

Annexure IV

Liaison Officers from Revenue and Forest Department, Govt. Of Maharashtra

Sr. No.	Name
1.	Satyajeet Chavan
2.	Avinash Raut
3.	NarusbaTugve
4.	Vijay Jadhav
5.	Madan Shelar
6.	Nilesh Kambre
7.	Sunil Patil
8.	Mahesh Chaudhari
9.	Ankush Chaugule
10.	Dinesh Dharath
11.	Ramesh Jadhav
12.	Nilesh Bhangre
13.	Krishna Sawant
14.	VD Dalvi
15.	Amol Sawant
16.	Vaibhav Jhapade
17.	Rohan Shelar
18.	Manoj Surve
19.	Mahendra Patil
20.	Uttam Rao Shedge
21.	Roshan Mehar
22.	Suresh Mahala
23.	Nitin Sawant
24.	Kiran Jadhav
25.	DM Adsule
26.	Ganesh Lohar
27.	Nilesh Kamble
28.	Nitin Salunkhe
29.	Nilesh Sawant
30.	Suresh Utekar

Sr. No.	Name
31.	Vikas Pawar
32.	Lalit Gurukude
33.	SS Kshirsagar
34.	Jayram Valve
35.	Shivaji Chaure
36.	Amol Gavane
37.	Rahul Jadhav
38.	Mahesh Ghode
39.	Balasaheb Mane
40.	Kiran Thabe
41.	Ganesh Lohar
42.	Bhushan Karkari
43.	Vinod Dhotre
44.	Praful Ingale
45.	Naresh Ahirrao
46.	Sagar Nadankar
47.	Mukesh Patil
48.	Rajendra Shelke
49.	Sunil Chauhan
50.	Rupesh Palve
51.	Sopan Khedkar
52.	Sanjay Kokare
53.	Avanti Mayekar
54.	Sujata Kale
55.	Madhura Taralkar
56.	Vaibhav Haldankar
57.	Rajashekhar Kothawale
58.	Savita Pavde
59.	Kishor Marathi
60.	Vijay Patil

Sr. No.	Name
61.	Amit Patil
62.	Atul Kate
63.	Pramod Sawant
64.	Yogesh Patil
65.	Sunil Kapdnis
66.	Sandeep Thorat
67.	Kavita Deshmukh
68.	Neha Hileka
69.	Archana Bobe

Sr. No.	Name
70.	Sumedh Kamble
71.	H. A. Sonandkar
72.	Swati Patil
73.	Satish Bhagwat
74.	Amol Sawant
75.	Rahul Chitte
76.	Jayshree Thakre
77.	Ramdas Dound
78.	Ashish Kumar Biradar

Proceedings of

National Workshop on Heat Wave

2023

Early Planning and Effective Action:

Saving Lives

PRINTED BY: CREATIVE OFFSET PRESS #9136-43-4848