

Outcome of the initiative of Multi hazard Early Warning Decision Support System (MHEW-DSS) of IMD

1. Introduction

The Multi-Hazard Early Warning Decision Support System (MHEW-DSS), implemented by the India Meteorological Department (IMD) under Mission Mausam, represents a comprehensive digital transformation of India's weather forecasting, early warning, and dissemination framework. The initiative has significantly strengthened public awareness, preparedness, and resilience by delivering timely, accurate, and impact-based weather and climate information to nearly 80% of India's population through automated, digital, and multi-channel platforms and covering entire Indian region and neighbouring countries.

2. Enhanced Public Awareness and Risk Understanding

The MHEW-DSS has enabled timely, accurate, and impact-based weather warnings to reach the general public and stakeholders by significantly improving public awareness of hazards such as cyclones, floods, heavy rainfall, heat waves, cold waves, thunderstorms, and lightning. By shifting from generic forecasts to impact-based and location-specific warnings and forecast (Mausamgram), the system allows citizens to clearly understand *what the weather will do*, rather than just *what the weather will be*.

The use of WebGIS based MHEW-DSS portal, mobile applications Mausam, SMS alerts, WhatsApp dissemination, Common Alerting Protocol (CAP), and media platforms ensures that warnings are accessible to diverse population groups, including rural, coastal, remote, urban communities and all other central and state government stakeholders. The data and warning is also being shared through API to various stakeholders.

3. Awareness through Digital and Community-Level Engagement

Extensive awareness programs, workshops, webinars, exhibitions, and stakeholder meetings are being conducted to familiarize the public, local authorities, and sectoral users with the new system. Continuous engagement through training programs, demonstrations, surveys, and feedback mechanisms ensured that beneficiaries could interpret forecasts correctly and act on them effectively.

4. Transparency, Trust, and Responsiveness

Automation and digitization have made the warning system transparent, faster, and more reliable, reducing forecast preparation time by 50% and improving accuracy by 30%. The seamless, faceless, end-to-end digital delivery of services has enhanced public trust in official warnings and increased compliance with advisories during extreme events.

5. Sector-Specific Outcomes:

The outcomes of the initiative span multiple sectors, including environment and water conservation, energy, education, health, women and child welfare, sustainable farming, livelihood promotion, economic growth, good governance, and international collaboration. The following sections present the details of the impact of this initiative on various sectors.

- **Environment Conservation**

IMD's MHEW-DSS products have contributed to environment conservation by monitoring climate and air quality, issuing forecasts and early warnings for extreme weather, and supporting water and natural resource management, which has aided renewable energy growth and reduced disaster-related environmental damage. Long-term climate data helps formulate environmental policies and promote sustainable development.

Before implementation of the project, 40 IMD forecasting offices were printing 16 weather charts (A0 size and 100 GSM) daily for forecasting. With the implementation of MHEW-DSS, chart plotting has been completely stopped in all IMD forecasting offices. This has resulted in both cost savings and environment conservation. Taking Rs. 20/- as the cost of one A0 chart paper (233,600 numbers or 23.4 tonnes) of 100 GSM and Rs. 40/- as the cost of printing one A0 chart, the total saving for chart paper amounts to Rs. 46.72 lakhs per year and for printing Rs. 93.44 lakhs per year. In addition, the cost of stationery (pen, pencil, eraser, etc.) used for plotting and analysing charts was around Rs. 32,000/- per year.

If all three components are combined, the total saving is approximately Rs. 1.40 crore per year. In terms of carbon emissions, this amounts to a saving of 2.57 tonnes of CO₂ per year.

- **Water Conservation**

MHEW-DSS contributes to water conservation by providing products for accurate rainfall forecasts, monsoon predictions, drought and flood early warnings, and long-term climate data. These support efficient reservoir management, irrigation scheduling, groundwater protection, and watershed planning. IMD's agromet advisories guide farmers to use water efficiently, reducing wastage and supporting sustainable water resource management.

The system supports water management including: (i) reservoir management, (ii) flood management, (iii) groundwater management, (iv) agricultural planning, and (v) drought management. MHEW-DSS helps IMD provide desired products and data for these purposes by comparing, comprehending, analysing, and developing products through a fully digital, paperless workflow.

Considering the conservation achieved by discontinuing A0 size 100 GSM chart paper (233,600 numbers), the total water saved is 63 kilolitres per year ($233,600 \times 0.27$ litres), assuming one A0 size 100 GSM chart paper requires 0.27 litres of water for production. This saving is equivalent to the annual drinking water requirement of 60 persons, assuming a consumption of 3 litres per day per person.

- **Energy**

MHEW-DSS has significantly contributed to the energy sector by providing products to issue solar radiation, wind, rainfall, and temperature forecasts essential for solar, wind, and hydropower generation. It offers extreme weather warnings that protect power infrastructure and supports grid management through demand forecasting. IMD's climate data also aids renewable energy planning and national energy policies.

Additionally, MHEW-DSS has eliminated the need for plotters and printers for chart printing, reduced IT infrastructure for bulletin preparation and printing, and removed dependence on

tele-printers and fax systems for data and forecast dissemination. Annual maintenance costs have also been reduced by automating all processes into a single system.

Assuming 1200 watts of power consumption per office per day for these purposes, the energy saving is approximately 210,240 kWh ($1200 \text{ W} \times 40 \text{ offices} \times 365 \text{ days} \times 12 \text{ hours per day on average}$), equivalent to Rs. 10,51,200/- per year at Rs. 5/- per unit.

- **Education and Capacity Building**

The project included extensive capacity building, awareness, and communication initiatives to ensure effective adoption and utilization of the automated system. Training programs were conducted for IMD personnel on WebGIS-based forecasting, automated decision-making tools, and AI-based quality control systems.

Awareness campaigns were launched for stakeholders including farmers, disaster management teams, aviation authorities, and other sectoral users to ensure effective utilization of real-time weather data. Digital literacy programs were introduced to help users interpret WebGIS visualizations and automated outputs for improved decision-making.

User manuals for the public and forecasters, as well as administrative manuals, were prepared. IMD also contributes to the education sector by promoting weather and climate literacy through bulletins, maps, and reports, conducting awareness programs, providing disaster warnings to ensure school safety, and supporting higher education by offering climate data for research. IMD's online tools and weather resources help students understand meteorology and environmental sciences.

- **Health**

IMD plays an important role in protecting public health by providing weather-based early warnings, climate information, and specialized services that help reduce disease risks and support health planning. The innovation covers the health sector under the "One Health Mission" of the Government of India by providing services to the Indian Medical Association (IMA).

Deaths due to timely issuance of early warnings and health advisories for severe weather events such as cyclones, heat waves, cold waves, heavy rainfall, thunderstorms, and lightning have reduced considerably. IMD weather data and forecasts are crucial for predicting outbreaks of vector-borne diseases such as malaria, dengue, chikungunya, and Japanese encephalitis. Based on IMD inputs, actions taken by civic agencies have reduced cases of vector-borne diseases.

Forecasts generated using MHEW-DSS cover human health, animal health (livestock, fisheries, poultry), agricultural health, and environmental health (air, water, soil). IMD issues heat-wave forecasts, temperature advisories, and Heat Action Plans for states, helping prevent heat-stroke cases, guide hospitals in emergency preparedness, and support public awareness campaigns. AQI and pollution forecasts help vulnerable populations take preventive measures. Early warnings also enable timely evacuation, pre-positioning of medical teams, and disease-prevention measures during disasters.

- **Women and Child Welfare**

Women and children benefit significantly from timely IMD forecasts and warnings. During cyclones and other severe weather events, IMD warnings help authorities safely shift women, children, and pregnant women to cyclone shelters. Alerts support schools, hospitals, and families in protecting children and ensuring continuity of essential services.

Air quality reports, agromet advisories, and climate information strengthen nutrition programs, rural livelihoods, and community resilience. Alerts are regularly communicated to Krishi Sakhis, Pashu Sakhis, Sarpanch, ward members, and Panchayat Secretaries, ensuring last-mile preparedness and timely local action for the protection of women and children.

- **Sustainable Farming**

IMD provides Agromet Advisory Services to farmers twice a week, along with crop-specific advisories. Weather-based agro-advisories help prevent crop loss, reduce water scarcity, and address food insecurity. Farmers who implemented IMD-recommended practices reported an average annual household income of Rs. 3.02 lakh, compared to Rs. 1.98 lakh for those who adopted none, indicating a 52.5% increase in income due to optimal utilization of advisories.

Among agricultural households in rain-fed areas below the poverty line, adoption of weather advisories resulted in an additional income of Rs. 12,500 per household annually. The overall economic benefit across rain-fed districts was quantified at Rs. 13,331 crore per annum, highlighting the role of advisories in supporting climate-vulnerable farming systems.

Warnings and advisories are disseminated through WhatsApp groups, SMS, Common Alerting Protocol, and mobile applications such as Mausam and Meghdoot ensuring timely delivery to farmers.

- **Promoting Livelihoods**

MHEW-DSS supports livelihoods by providing weather forecasts and warnings to the general public, including rickshaw pullers, daily labourers, fishermen, and informal sector workers. IMD promotes livelihoods by reducing weather-related risks, increasing productivity, and safeguarding income across agriculture, fisheries, tourism, transport, and renewable energy sectors. Timely information enables better planning and protection of assets, ensuring livelihood security for millions.

- **Boosting the Economy**

The initiative has reduced economic losses through better preparedness in agriculture, transport, infrastructure, and other sectors. Government agencies save significant resources in relief and rehabilitation through proactive mitigation. For example, cyclone warnings during Phailin (2013) and Hudhud (2014) helped the power sector save around Rs. 500 crore each.

Additionally, Rs. 590 crore in ex-gratia payments and Rs. 32 crore in evacuation costs are saved for each landfalling cyclone, compared to Rs. 437 crore towards the cost of IMD's modernisation programme during 2007–10. These outcomes demonstrate the strong economic returns of investment in early warning systems.

- **Improving Governance / Good Governance**

The manual decision-making process of IMD has been reengineered with digital transformation as the main objective of this project. All processes of the Multi-Hazard Early Warning System, including data collection, data analysis, identification of weather systems, study of the evolution of weather systems, and forecasting of weather systems in terms of lifespan, characteristics, and associated weather conditions valid for up to five days, have been reengineered and established through this DSS via digital transformation. This has enabled better visualization, accessibility, accuracy and seamless warning dissemination to all stakeholders for efficient data sharing. Additionally, it has facilitated the standardization of data and information, enhancing interoperability across systems. The MHEW-DSS has brought (i) interoperability, (ii) improved quality, accuracy, consistency and delivery of services, (iv) reduced computational infrastructure and (v) reduced manpower. The manpower optimization after the introduction of MHEW-DSS has saved 3 Manpower one for manual plotting the weather charts, one for manual analysing and one for manual chart movement per 6 hours at each forecasting station. The total saving for manpower is four persons for each role per station per day which comes to around Rs. 57.6 Cr. per year (4 persons X 12 months X 40 forecasting offices X (Rs. 1.5 lakh per person per month salary for manual analysis + Rs. 1 lakh per person per month salary for plotting + Rs. 50,000 per person per month salary for manual chart movement)).

6. International and Regional Collaboration

MHEW-DSS supports international cooperation by providing severe weather warning assistance to neighbouring countries including Bangladesh, Maldives, Myanmar, Oman, Pakistan, Qatar, Sri Lanka, Thailand, UAE, and Yemen. IMD's Regional Specialized Meteorological Centre (RSMC) functions are strengthened through real-time data sharing, training, and coordinated warning dissemination. This collaboration enhances regional disaster preparedness, supports global meteorological cooperation, and positions India as a leader in multi-hazard early warning services.

Through integrated technology, automation, capacity building, and community engagement, MHEW-DSS has significantly enhanced public awareness and resilience across sectors. The initiative has empowered citizens, strengthened governance, protected vulnerable groups, conserved natural resources, boosted economic efficiency, and reinforced India's leadership in disaster risk reduction and international collaboration.