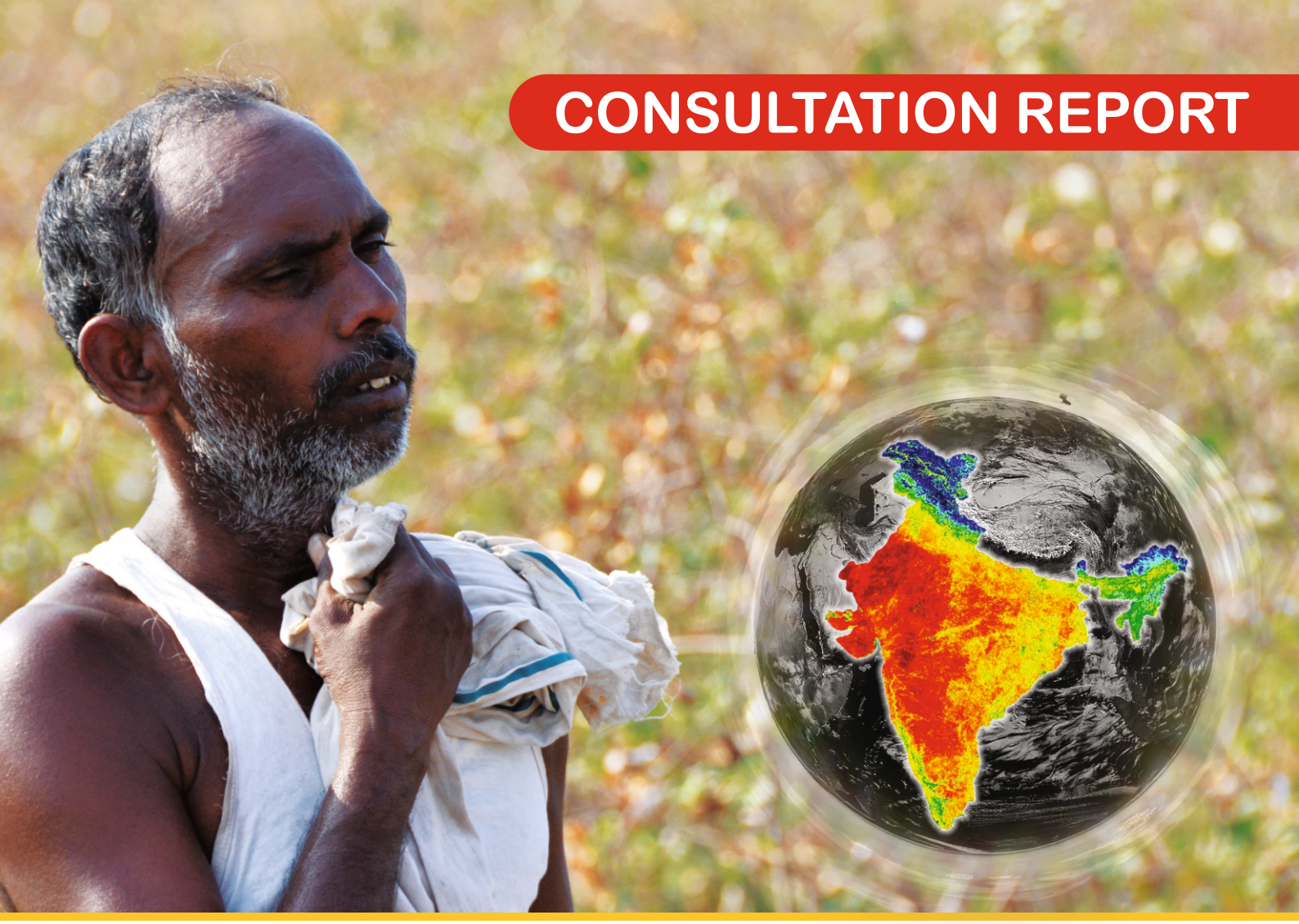

CONSULTATION REPORT

Rising Land Surface Temperature and its Implications on Humans and Natural Ecosystems

March 18, 2025 | Pune

organized by

WOTR
Rejuvenating Communities & Ecosystems

W-CReS
Building Resilient Futures

supported by

Honeywell

Honeywell Hometown Solutions India Foundation

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Date: April 2025

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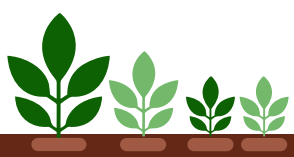


KEY TAKEAWAYS

Rising LST and Climate Change :

- Land surface temperatures are rising rapidly with increased variability in rainfall, leading to higher crop stress, and lower agricultural yields.
- By 2047, mean seasonal precipitation variability will rise, leading to more extreme weather events.
- With rising land and air surface temperatures, the impact is seen on human and livestock health.

Impact on Agriculture and Water Resources :

- The implications of rising LST include loss of soil fertility, altered cropping cycles with threats to food security.
- Water loss through increasing evaporation and evapotranspiration, and greater crop-water requirement will further increase water scarcity.

Need for Immediate Action :

- Long-term interventions such as watershed development, agroforestry, sustainable land and water management mitigate the impacts of LST, as seen in Bhojdari (MH) & Kamsanipalle (TEL).
- Farmer Producer Organisations that aim for financial security, can be capacitated for preventive action against LST rise & climate vagaries.

Collaborative Solutions :

- Multi-stakeholder collaboration, including government, NGOs, donors, scientific institutions, and local communities is vital to address the challenges posed by rising LST and climate change.
- Ecosystem-based adaptation (EbA) approaches are a key strategy to build resilience against climate risks.

SUMMARY

Over the past century, the average earth temperature has significantly increased. The mean temperature in India has shown an increase since 1980, with significant development in the maximum (0.14 - 0.21°C) and minimum (0.1 - 0.23°C) temperatures[1]. Surface temperature over Western India is warming by 0.13°C/decade due to the combined effect of Greenhouse Gases (GHGs) and Land Use Land Cover (LULC) changes.

Between 2000 - 2004 and 2017 - 2021, there was a 55% increase in deaths across India due to heat stress[2], and Land Surface Temperature is one of the main contributing factors. This is of serious concern for the vulnerable populations, as this trend will severely impact Indian agriculture and force farming communities to follow distress migration in cities and nearby areas.

To understand heat and its likely impacts in rural areas, a study on changes in Land Surface Temperature (LST) was conducted by the WOTR Centre for Resilience Studies (W-CReS) between 2022 and 2025 in the semi-arid regions of Jalna & Narayanpet districts of Maharashtra and Telangana respectively, with the support of Honeywell Hometown Solutions India Foundation.

SETTING THE AGENDA

With a focus on enhancing preparedness and resilience in response to escalating climate challenges, Prakash Keskar, Executive Director of Watershed Organisation Trust (WOTR) encouraged the participants to develop practical strategies to deal with climate variability in 2047. He drew insights from research publications relevant to LST and the study of Jalna and Narayanpet that was conducted by W-CReS.

- There are strong indications of a projected rise in temperature in Maharashtra by 1°C and possibly up to 2°C by 2047[3]. It has already touched the 1.5°C mark above the pre-industrial period[4].
- India has lost approximately 11 +/- 2% of large trees (crown size 96 m^2) from farm lands across India between 2010 - 2011 and 2018, and over 5 million trees with crown cover of 67 m^2 between 2018 and 2022[5]. Maharashtra and Telangana saw the largest number of trees disappear from farm lands. Is this contributing to the rising LST in rural India?

OBJECTIVES

To explore insights from the Land Surface Temperature analysis in semi-arid regions of Jalna district, Maharashtra and Narayanpet district, Telangana and identify practical strategies by :

- Understanding the impact of LST on rainfed farming systems
- Discussing practical approaches to mitigate the adverse impacts of LST on farming, on human health and wellbeing, in order to enhance resilience and sustainability.

PARTICIPANTS: The consultation brought together 72 diverse participants, including village representatives, researchers, academicians, policymakers, practitioners, media and others.

Session 1: Study on Land Surface Temperature

Ajit Jadhav, researcher in W-CReS, presented the study findings in Jalna (MH) and Narayanpet (TEL) for the period 2001 to 2020. Using RS-GIS, temporal trends of LST were analysed against the respective annual rainfall together with the evaluation of the Land Use Land Cover (LULC) changes. LST for the months of March, April and May were also assessed against the rainfall.

Jalna: Rainfall Variations

- Annual average Rainfall ranges between 650 and 750mm
- Compared to the decade 2001 - 2010, rainfall reduction of 72.5 mm was noted in the following decade 2011 - 2020
- Summer rainfall was also greatly reduced between 2011 - 2020, except for very high rainfall in March and April 2014 and 2015.
- In the decade 2000 to 2010, there was 1 year of rainfall below 600 mm/pa
- In the decade 2011 to 2020, there were 4 years of rainfall below 600 mm/pa, with two consecutive years of low rainfall.

- Land Surface Temperature: Temperatures in the month of May show an increasing trend with a spike shift post 2014. The LST is above 55°C in the months of April and May over the 2 decades.

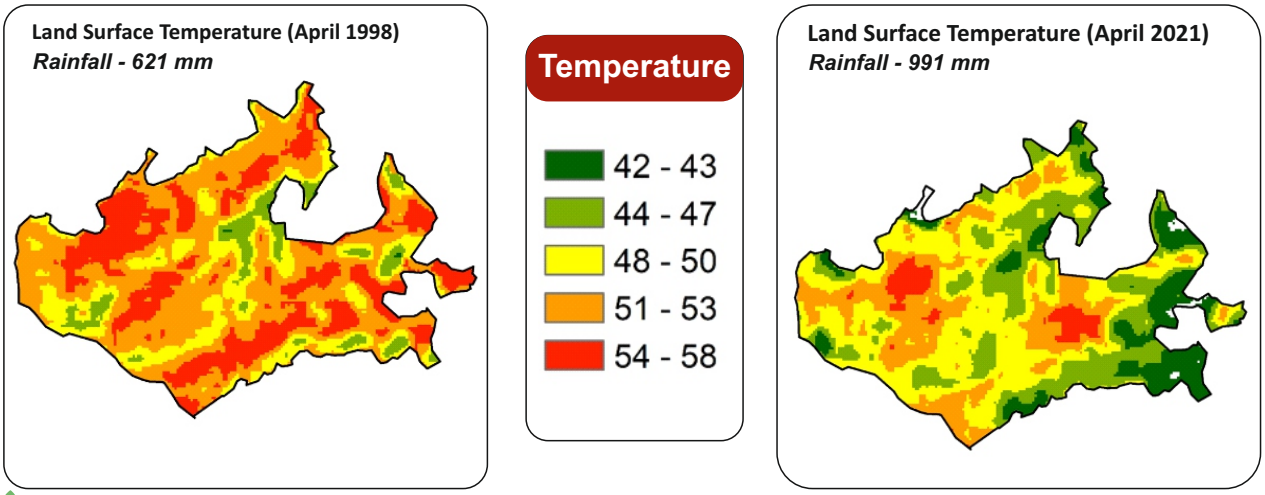
- Air Temperature: Overall a warming trend is observed, especially in April and May with the temperature ranging between 39.9°C to 40.6°C in April and 42.5°C in May.

Session 2: Village-Level Watershed Development and LST

Aparna Yadav from the W-CReS Geoinformatics team presented a case study on Bhojdari and Kamsanipalle.

In Bhojdari, watershed development was implemented between 1998 to 2003 with the active engagement of the local community. Land management, extensive tree plantation, water harvesting measures, and later regenerative agriculture with water use management enhanced incomes of the local communities. Post project implementation, watershed efforts improved water availability, increased vegetation, and enabled summer cropping, reducing LST. Benefits of the implemented interventions have sustained for over 18 years, as noted in 2021.

Impact of Watershed Development on Land Surface Temperature, Bhojdari Village, Sangamner block, Ahilyanagar district, Maharashtra



Breakout Session

Based on the research presentations and discussion of findings, participants were divided into four thematic groups: Land (LULC), Water, Agriculture, and Health. They were then tasked with analyzing how rising surface temperatures would impact their respective sectors. They were also required to identify the causes of increasing LST, its consequences, and propose actions to reverse the negative impacts.

FINDINGS FROM GROUP DISCUSSIONS

Each group presented their findings, and the key points are summarized below.

1. Land Use Changes and LST

Cause	Consequences	Proposed Solutions
Deforestation	• Soil erosion • Increase in heat absorption leads to further rise in both LST and air temperature • Consistent high temperatures cause soil structure destruction and loss of soil microbiomes • Reduced water infiltration with the consequent loss of soil humidity, reduction in streams and base flows (see impacts on the water sector) • Biodiversity Loss	• Motivate and mobilize farmers and the rural communities to understand the importance of tree cover (native forest varieties) in stabilizing the land and ensuring water flows • Soil conservation measures (watershed development) across the landscape • Protect forest land through restoration and conservation of natural ecosystems
Expansion of agricultural land by cultivating on shrub, grass and forest lands	• Loss of grassland and forest ecosystems, affecting rural livelihoods.	• Prevent cutting of trees on farm lands and promote re-plantation in fields • Promote region-specific agroforestry, silvopasture systems, and balanced agriculture-livestock integration. • Restore native plants, grass, shrubs and trees.
Burning of Crop Residue & Biomass	• Burning destroys soil microbiomes, making the soil more prone to LST rise, besides releasing harmful gases (CO_2 , CH_4 , and N_2O) and particles.	• Promotion of crop residue mulching, residue incorporation, composting along with good management practices.
Urbanization & Concretization	• Higher LST due to the Urban Heat Island effect has a cascading impact on the nearby rural areas.	• Sustainable urban planning / green city solutions by increasing urban green spaces, rooftop gardens, and pavements that allow water percolation into ground in order to reduce heat effects.

2. Agriculture and LST

Cause	Consequences	Proposed Solutions
Reduction in Tree Cover	• Disruption of local climate.	• Farm Tree Plantation - Promote tree-based farming to enhance biodiversity, provide shade, and improve soil health.
Excessive Use of Chemical Fertilizers	• Increased soil degradation, reduced water infiltration capacity.	• Integrated Nutrient Management (INM)- Encourage balanced fertilizer use, add organic manure, crop residues and use soil conservation practices.
Agricultural Intensification & Unsustainable Practices	• The use of agrochemicals with continuous cropping, aggravated by use of heavy machinery disrupts the soil's natural balance.	• Sustainable agriculture and conservation practices- Encourage use of organic fertilisers, precision farming to maintain and improve soil health.

3. Water Resources and LST

Cause	Consequences	Proposed Solutions
Unregulated Over-Extraction of Groundwater	• Exploitation of groundwater by a few affects neighbouring smallholding farmers. • Declining water table, soil moisture depletion, and increased vulnerability to drought.	• Encourage community-led water stewardship. • Groundwater Recharge — Promote rainwater harvesting, and implement aquifer recharge structures (check dams, percolation ponds). • Regulation and monitoring of water extraction and banning deep borewells.
Groundwater Lifted onto Surface Water Bodies for Irrigation	• Loss of groundwater through evaporation when stored in plastic lined surface tanks; losses will be greater with the rising temperatures.	• Farm ponds to be filled with surface runoff only, and without plastic lining. • Promotion of micro-irrigation and mulching to reduce water loss while protecting agriculture
Increasing Water -Intensive Agriculture Including Monoculture	• Excessive demand for water in agriculture lowers water tables, and reduces water availability for other sectors.	• Crop diversification and Micro-irrigation- Encourage adaptive cropping patterns, water-efficient crops and drip irrigation, based on local water availability.
Pollution Of Surface Water Bodies (flow Of Excessive Nutrients From Agriculture / Dumping Of Wastes)	• Eutrophication of surface water bodies increases invasive plant growth such as water hyacinth, algae. This causes very high evapo-transpiration with rapid depletion of surface water. • Water bodies covered with water hyacinth facilitates the breeding of mosquitoes. • water contamination of nearby subsurface wells affects human health • Soil degradation in farmlands close to such water bodies affects soil health, reducing agriculture productivity	• Regular removal of water hyacinth to prevent both water loss as well as reduction of vector borne diseases is necessary (see Human Health table below). • Waste management is urgent. • Soil testing and the appropriate use of fertilizers for crops and good management practices will reduce costs and also increase productivity.

4 . Human and Livestock Health and LST

Cause	Consequences	Proposed Solutions
• **Outdoor Heat Exposure (working in agriculture, MGNREGS activities, other outdoor labour)** • **Indoors (tin & concrete roofs, poor ventilation)**	• Mild Heat-Related Illness (HRI)- Intense thirst, headache, cramps, sunburn, rashes, heavy sweating. • Severe HRI- Hallucination, fainting, heat stroke, nausea.	• Heat Adaptation Strategies, hydration awareness, light cotton clothing, work schedule adjustments, provision of drinking water facilities at work; rest under trees or vegetation shade. • Health advisories and emergency medical services. Distribution of IEC materials. • Use cool/green roofs, cover tin/ concrete roofs with crop residues; traditional cooling methods; good ventilation.
Vector-borne diseases due to stagnating water bodies (see point above	• Spread of malaria, and other vector borne diseases.	• Public Health Interventions - Early warning systems for heat and health advisories, health awareness outreach, mosquito control measures.
Lack of water purification for human consumption	• Spread of water-borne intestinal diseases when water for consumption is not purified.	• Awareness on the need for water purification.
Impact of Livestock (Poultry & Hybrid Breeds)	• Decreased productivity, increased mortality & morbidity, higher calf mortality, and fertility issues.	Livestock Cooling & Health Management - Provision of cooling infrastructure, supply of green fodder, regular veterinary health camps, and disease surveillance programs.

SUMMARY

Summarizing the discussions of the four groups, Swapnil Vyas, Assistant Professor, Savitribai Phule Pune University, identified the thread that connected the factors driving rising Land Surface Temperature and ecological degradation. The key components-land, water and green cover are rapidly changing, driven by uncontrolled deforestation, agriculture and industrialization. Aggravated by rising temperatures and climate change, land productivity, water quality and availability, livestock and human health are affected. Traditional sustainable practices, once a way of life, can help address current environmental challenges.

Swapnil further explained that changes are inevitable, particularly triggered by population growth and developmental aspirations. However, sustainable solutions must balance progress with conservation.

Rising LST with the consequent decline in soil moisture, cannot be resolved only by water harvesting. Expanding tree and vegetative cover and the choice of native species over exortic ones is essential for groundwater recharge and moisture retention. Sustained impacts and tangible benefits of integrated watershed development with community involvement as visible in the Bhojdari case study, even 18 years post implementation. Thus, long-term, well-planned steps are crucial to effectively reduce LST and build resilience to the projected climate change.

IMPACT OF LST ON FARM PRODUCTIVITY & ROLE OF FPOs AS THEY FACE CLIMATE RISK

Sandip Jadhav, Director of WOTR, shared his views on the impact of LST on farm productivity and the role of FPOs in addressing climate risks.

He emphasized that rising LST is altering soil structure and depleting soil microbial life, a trend already observed in regions like Jalna and Aurangabad. Since temperatures and the lengthening of summers LST affects the natural balance, it is essential to find solutions to address these.

Sandip also pointed out that humans are both the villains and the heroes in this situation. While human activities contribute to rising LST, humans can also bring the solution if given the right motivation, such as financial incentives. One possible solution is to make sustainable lifestyles economically viable. If people see economic benefits in protecting the environment, they are more likely to participate.

Can we marry the economy and natural ecosystem health?

The idea of resilient incomes is important, and farmers and businesses need to work together to realize this. Many agricultural businesses may not even be aware of the environmental consequences of their products, but farmers understand the impact. If farmers are involved in businesses that protect natural ecosystems, there is a greater chance of ecosystems surviving.

Some sustainable practices are already in place, such as micro-irrigation, organic formulations, better seed management, capital availability, and crop insurance. Soil and water resources are further enhanced where watershed development has been implemented. This is where Farmer Producer Organizations (FPOs) play a critical role. FPOs can teach the farmers about these practices and at the same time also connect them to consumers, promote awareness about residue-free produce, and create a market for sustainable products so that their livelihoods are not compromised.

Sandip further discussed the significance of the entire agricultural value chain, from farm to table, and the role of FPOs in marketing, organizing farmer field schools, and training farmers to adopt ecosystem-friendly farming methods. Weather-based agro-advisories further help farmers protect their produce and sell it effectively.

In conclusion, he emphasized that reducing LST is not just about planting trees, it's about smart planning, sustainable business models, and ensuring that farmers and consumers are connected in a way that benefits both the economy and the environment.

RECOMMENDATIONS GOING FORWARD

The consultation underscored the urgent need to address rising Land Surface Temperature (LST) and its far-reaching impacts on agriculture, water resources, and human health. Important next steps include:

1. Ecosystem-based Adaptation Framework: A Key to Mitigating rising LST

The consultation strongly advocated for the adoption of the **Ecosystem-based Adaptation (EbA)** framework as a critical strategy to mitigate the impacts of rising LST and reduce its increasing trend. EbA focuses on restoring and enhancing biodiversity, which not only builds resilience against climate risks but also helps regulate land temperatures. Key actions include:

- **Restore Natural Ecosystems:** Promote afforestation, watershed development, and sustainable land management to enhance canopy cover and reduce LST.
- **Enhance Biodiversity:** Protect and restore natural habitats to improve ecosystem services, such as water retention and soil health.
- **Build Resilience:** Strengthen the adaptive capacity of communities by integrating EbA into climate adaptation plans at national and state levels.

The EbA framework is essential for addressing the interconnected challenges of land degradation, water scarcity, and climate variability. While it brings in immediate returns, it also ensures long-term sustainability for both ecosystems & communities.

2. Engaging Local Communities through Farmer Producer Organizations (FPOs)

Local communities must be at the heart of any intervention to address rising LST. Farmer Producer Organizations (FPOs) can play a pivotal role in engaging and empowering these communities. By capacitating FPOs, we can ensure that farmers not only secure their livelihoods but also become stewards of their environment. Key actions include:

- **Capacity Building:** Train FPOs in sustainable agricultural practices, water resources management, and ecosystem restoration and conservation.
- **Financial Security:** Provide FPOs with access to financial resources and markets to ensure the sustainability and scalability of interventions.
- **Community-Led Initiatives:** Encourage FPOs to lead watershed development, afforestation, aquifer management and other EbA activities, fostering a sense of ownership and responsibility.

By leveraging FPOs, we can create a network of climate-resilient communities that actively contribute to reducing LST and building sustainable ecosystems.

Additional Recommendations

1. Integrate LST Mitigation Strategies into Policy:

- Incorporate LST mitigation strategies into national and state-level climate adaptation plans.
- Provide financial incentives for nature-based solutions and ecosystem restoration.

2. Strengthen Multi-Stakeholder Collaboration:

- Foster collaboration between government, NGOs, research institutions, donors and local communities to coordinatedly address the diverse challenges posed by rising LST.
- Develop a centralized database for monitoring LST trends and their impacts.

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