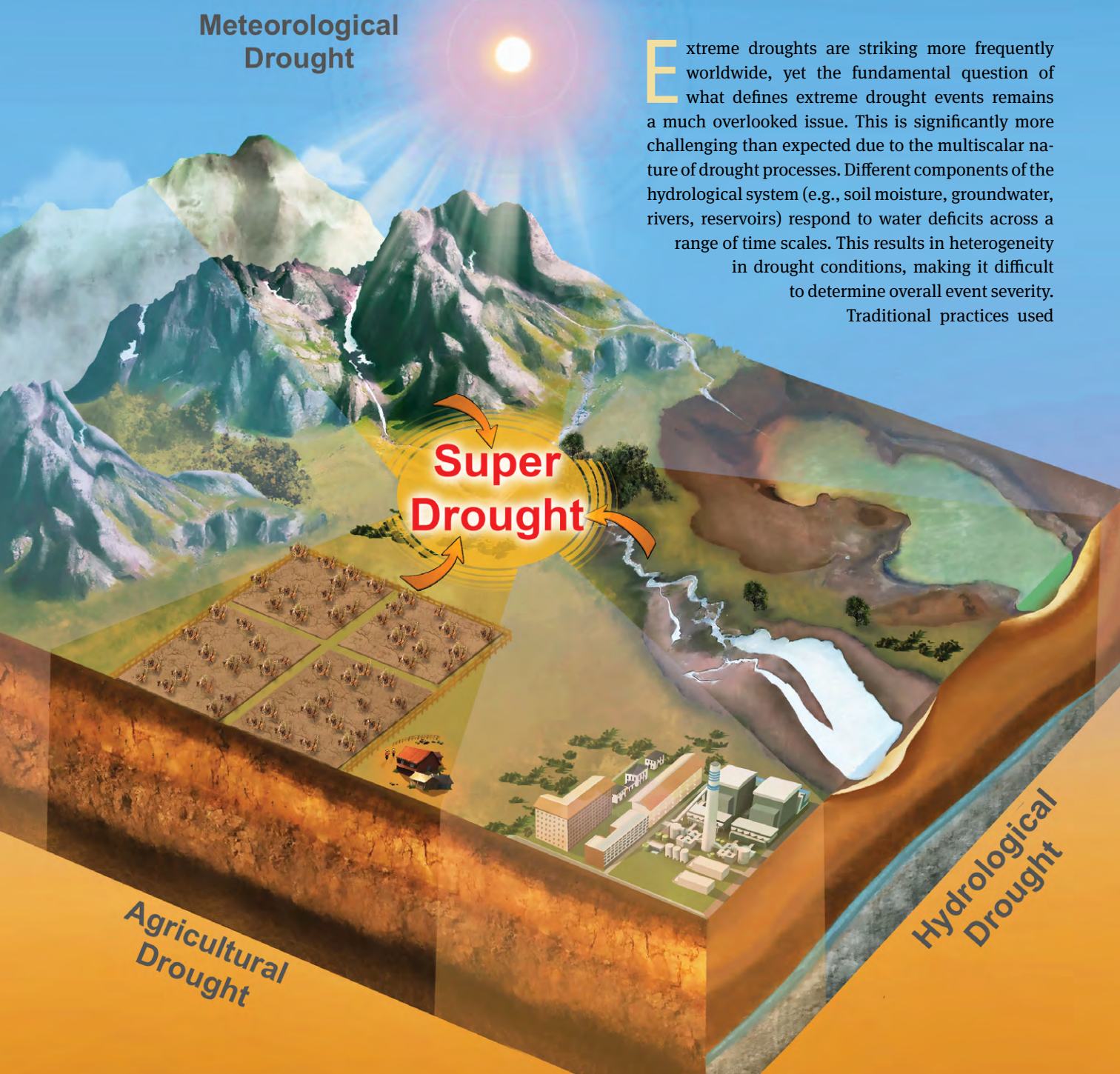
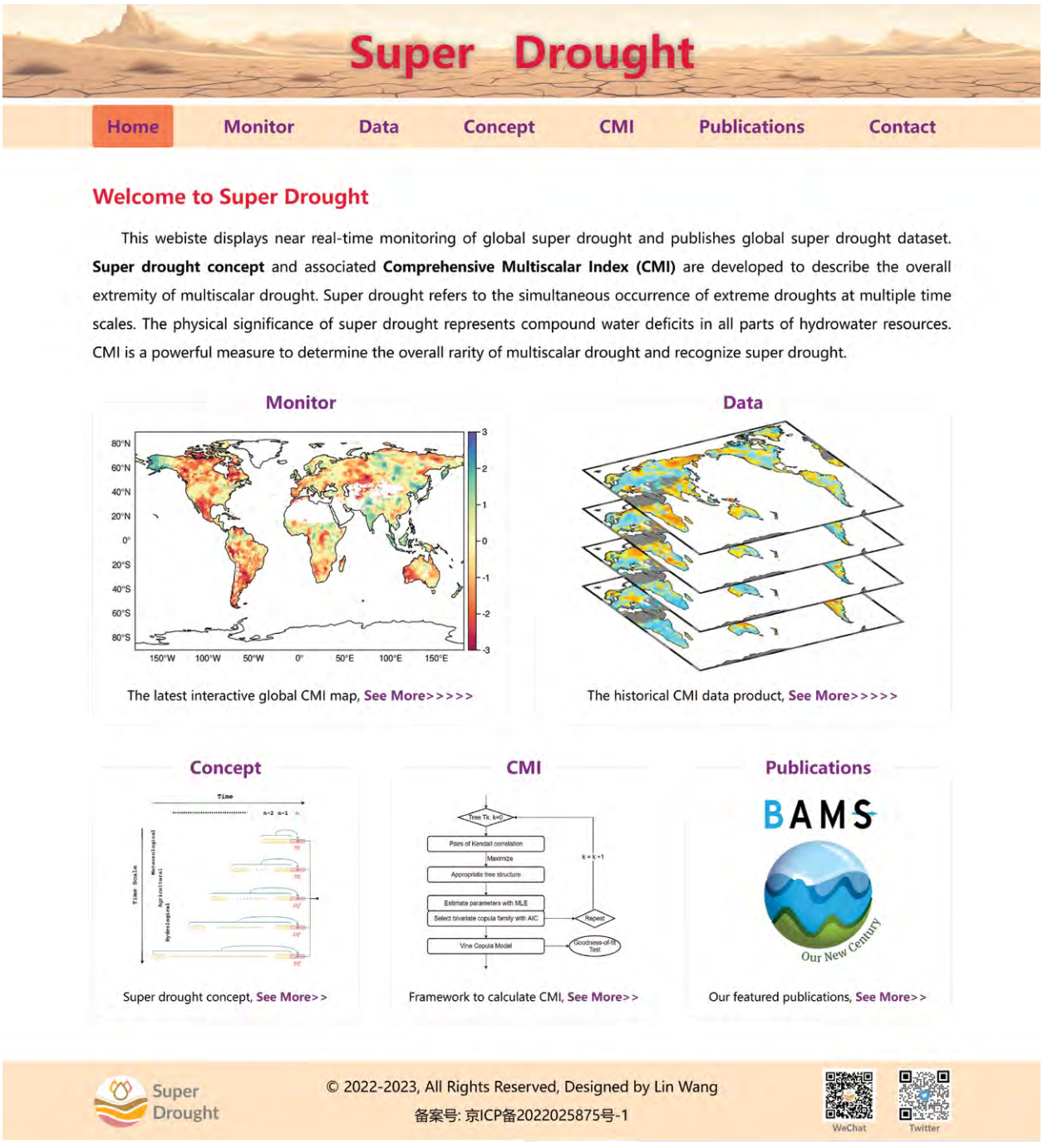
Key messages from "Super Drought under Global Warming: Concept, Monitoring Index, and Validation," by **Lin Wang** (Chinese Academy of Sciences), **Gang Huang**, **Wen Chen**, and **Ting Wang**. Published online in *BAMS*, May 2023. For the full, citable article, see https://doi.org/10.1175/BAMS-D-22-0182.1.

Reframing Extreme Drought Characterization

The Super Drought Concept, Index, and Web Services



Extreme droughts are striking more frequently worldwide, yet the fundamental question of what defines extreme drought events remains a much overlooked issue. This is significantly more challenging than expected due to the multiscalar nature of drought processes. Different components of the hydrological system (e.g., soil moisture, groundwater, rivers, reservoirs) respond to water deficits across a range of time scales. This results in heterogeneity in drought conditions, making it difficult to determine overall event severity. Traditional practices used



Home page of the superdrought.com website.

to identify extremes overlook this multiscalar complexity.

To address this challenge, we introduce the concept of "super drought" to describe the synchronous occurrence of extreme drought across multiple time scales. Super drought represents concurrent water scarcity in all components of the hydrological cycle, equivalent to substantial total water storage deficits. This distinguishes high-impact events from mild ones.

Then, a new comprehensive multiscalar index (CMI) based on vine copula modeling is proposed to quantify super drought. CMI probabilistically links drought risk across time scales into a multivariate distribution and determines an integrated metric to represent the joint rarity of observed multiscalar conditions. Evaluation against Gravity Recovery and Climate Experiment (GRACE) terrestrial water storage data demonstrates CMI's skill

in capturing variability and extremes in integrated water resources. It outperforms widely used indices limited to individual time scales or components. Moreover, CMI enables accurate estimation of real water scarcity, avoiding false alarms that occur when only one time scale exhibits extreme drought.

To enhance the accessibility and real-world utility of this research, we are proud to highlight the development of the website superdrought.com to facilitate end users and policymakers. This online platform provides a repository of the high-resolution CMI dataset spanning from 1960 to near present. More critically, it features near-real-time global maps updated monthly to support early warning of emerging super drought events based on the latest data. We encourage the community to utilize this resource.

In summary, the super drought framework offers a new paradigm for drought monitoring and research by accounting for the multiscalar nature of drought impacts on water resources, the CMI shows promise as an operational index for assessing overall drought extremity, and the monitoring and data capabilities at superdrought.com promote the accessibility and practical utility of the super drought framework and index for researchers and policymakers.

METADATA

BAMS: What would you like readers to learn from this article?

Lin Wang (Chinese Academy of Sciences): *Overall, this research highlights the need to revolutionize extreme drought characterization and risk management by adopting interconnected and multivariate thinking. The introduced "super drought" concept represents systemic water deficits across processes and time scales, and the proposed comprehensive multiscalar index (CMI) metric demonstrates the power to quantify overall drought severity. Most importantly, the online platform superdrought.com represents a valuable effort to transform the novel theory into an operational tool for application, adaptation, and preparedness. In summary, the super drought framework offers new insights into drought impacts, drivers, and responses in a changing climate.*

BAMS: How did you become interested in the topic of this article?

LW: *As the lead author of this article, I have been involved in drought research for over a decade and have analyzed many major drought events worldwide. I became increasingly aware of the limitations of conventional theory and drought indicators, based on single time scales or components, in capturing the true severity of multiscalar drought and its impacts. Additionally, the intensification of droughts around the world due to climate change made improving drought assessment even more critical. Hence, I was motivated to pursue this work because of gaps I observed in existing drought-monitoring theories and tools. It became my passion to develop more holistic approaches like super drought and CMI to advance drought research and provide better tools for managing drought risk.*

BAMS: What surprised you the most about the work you document in this article?

LW: *Above all, the significant skill improvement in capturing integrated drought severity and extremes with CMI compared to traditional methods exceeded my initial expectations. In addition, I was also impressed by how flexible and adaptable the proposed algorithm was across diverse climate regions worldwide.*

BAMS: What was the biggest challenge you encountered while doing this work?

LW: *The biggest challenge encountered with this research was constructing the novel CMI to quantify overall drought severity. First, converting the conceptual idea of interconnected drought processes into a quantitative algorithm was difficult. Extensive testing was needed to find the right way. Second, we had to carefully tailor the vine copula framework to the specific requirements of joint drought representation. Third, making CMI accessible to end-users via superdrought.com also took considerable effort. But overcoming the obstacles produced an innovative tool with the potential to transform monitoring and prediction capabilities. The effort to develop CMI, though difficult, was extremely worthwhile.*