CCST EXPERT BRIEFING SERIES:
Toward a Disaster Resilient California

REMOTE SENSING TECHNOLOGIES
and Water Resilience

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Briefing held **DECEMBER 2021**

One Pager

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Shasta Lake, California. NASA Earth Observatory image by Lauren Dauphin, using Landsat data from the U.S. Geological Survey.

SUMMARY

Satellite based measurements offer a cost-effective way to generate high resolution data on groundwater resources across a wide geographic area. As California continues to grapple with frequent drought and overdrafted aquifers, data from satellites in conjunction with other ground-based monitoring can help inform sustainable groundwater management.

Looking to the Sky to Address
CALIFORNIA'S WATER CHALLENGES

California faces escalating threats to its water resources. The State has experienced several significant droughts in the last two decades and scientists estimate that this period has been one of the driest in the last 1200 years. Already a drought prone state, the effects of climate change are expected to exacerbate future drought events.

At the same time, many of California's groundwater aquifers, which provide anywhere from 40 to 60 percent of the State's water supply in a given year, are critically overdrafted. Groundwater depletion can cause soil subsidence, which threatens vital infrastructure, negatively impact water quality, and increase pumping costs. Sustainable water management requires accurate data on the amount of groundwater extracted from a system.

Remote sensing refers to techniques that use aerial sensors, such as satellites, to measure details about the Earth's surface. Satellite monitoring is a cost-effective method of generating groundwater data over a large geographic area.

The Many Ways to
MEASURE WATER FROM SPACE

Satellites can be used in a variety of ways to directly measure or infer important information about groundwater on earth. Different techniques measure specific aspects of groundwater and offer differences in spatial or temporal resolution. Some methods include:

LANDSAT

Landsat satellites collect high resolution images and temperature data of the surface of the earth. The **OpenET project** (see back) uses Landsat data to estimate the total amount of water lost from a system due to evapotranspiration.

InSAR (Interferometric Synthetic Aperture Radar)

InSAR detects changes in the height of the ground by measuring the time it takes radar signals to reflect off the surface. Computer models can calculate changes in groundwater levels from surface deformation.

GRAVITY

JPL's Gravity Recovery and Climate Experiment (**GRACE**) mission uses a pair of satellites to detect small changes in Earth's gravitational field as they orbit, which correspond to the movement of water on the planet's surface (see back illustration).

About the
CCST Disaster Resilience Initiative:

Ongoing, complex, and intersecting disasters—including climate change, extreme heat, power outages, and the COVID-19 pandemic—are radically disrupting the ways in which Californians live and work. CCST is committed to delivering science and technology advice to improve our resilience to disasters, reduce harm, and improve the lives of all Californians.

SELECT EXPERTS

The following experts can advise on remote sensing and water management.

Moderator:

TARA MORAN, PhD
President and CEO
California Water Data Consortium
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Expertise: Data requirements for sustainable groundwater management

Panelists:

FORREST MELTON
Senior Research Scientist
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Expertise: Remote sensing and evapotranspiration

PETER NICO, PhD
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Expertise: Soil Chemistry, Groundwater motion

JT REAGER, PhD
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Expertise: Space based observation of the Earth's water cycle

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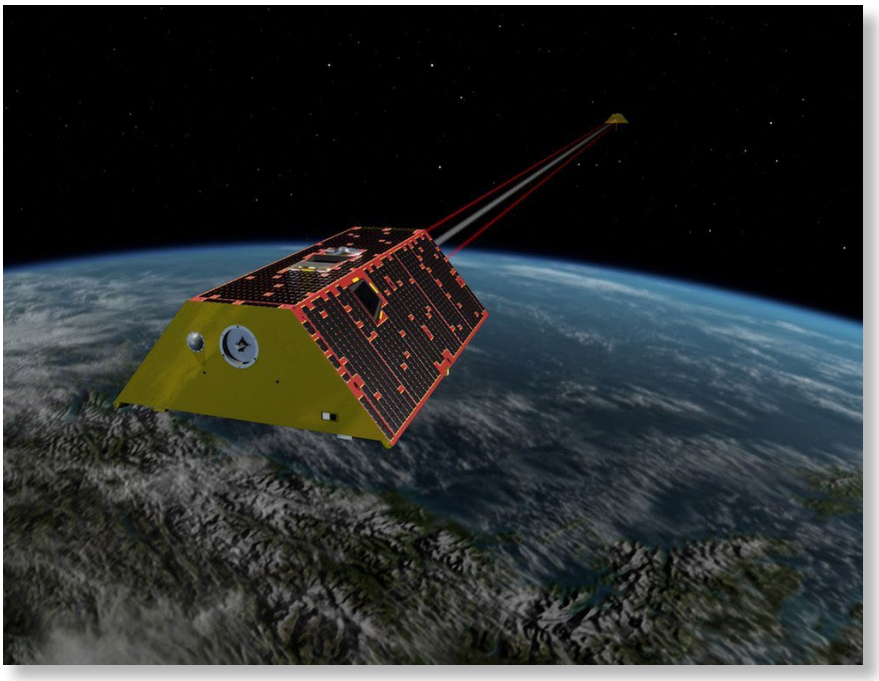
Data Needs for **GROUNDWATER MANAGEMENT**

In 2014, California passed the **Sustainable Groundwater Mgmt. Act (SGMA)**, which requires local water regions to develop sustainability plans to mitigate groundwater depletion and soil subsidence.

Many regions lack continuous groundwater monitoring data and different methods for measuring water use can lead to disagreements on the accuracy of data between different jurisdictions. Water planners need access to consistent, reliable, and accessible data to inform management strategies.



An illustration of the GRACE Follow-on mission in orbit.
NASA/JPL-Caltech

Sharing Water Data: **OpenET**

Evapotranspiration (ET) is the process by which water leaves a system and re-enters the atmosphere. It combines evaporation—surface water changing into a gas—and transpiration—water released from plants as vapor. ET measurements can be used to approximate how much water is consumed in a system and cannot be recovered or reused.

The OpenET project combines Landsat images with computer models to provide accessible ET data for improved water management across the Western United States.

In the Sacramento-San Joaquin Delta region, farmers use OpenET to comply with State regulations that require accurate reporting of measurements of water diversions.

Given the complex nature of water movement in the delta, ground-based measurements are expensive and prone to error—OpenET offers a more reliable, convenient and timely method for achieving compliance.

Intersecting **DISASTERS**

As climate change further stresses California's water resources, escalating drought events will intersect and compound with other disasters. The same remote sensing techniques used for groundwater monitoring can offer important insights into these effects.

For example, data on soil moisture obtained via satellites can be used to inform predictions of fire danger across large areas during wildfire seasons. Additionally, measurements of soil subsidence can provide valuable insight into potential impacts on local infrastructure and water quality.