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WestFAST News

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Chair – Roger Gorke; Federal Liaison Officer – Heather Hofman

Bipartisan Infrastructure Law investments combine science and technology to track biological threats in US waters

USGS 11/9/22

The U.S. Geological Survey announced today it has signed a cooperative agreement with the Monterey Bay Aquarium Research Institute, or MBARI, to develop portable robotic DNA samplers capable of independently monitoring for living threats in the rivers and streams without constant support from researchers.

With new investments from President Biden's Bipartisan Infrastructure Law, the partnership will help advance detection of invasive species, pathogens and parasites which cause ecological and economic damage to aquatic systems. These organisms can wreak havoc on our waterways, threaten commercial and recreational fishing industries and promote the spread of zoonotic diseases that can impact humans.

Researchers with the USGS have also launched a new program, building on earlier work, called Rapid eDNA Assessment and Deployment Initiative and Network, or READI-Net, which tests for DNA fragments in the water known as environmental DNA, or eDNA. READI-Net will enhance early detection and rapid-response methods to help resource managers contain and control aquatic biological threats.

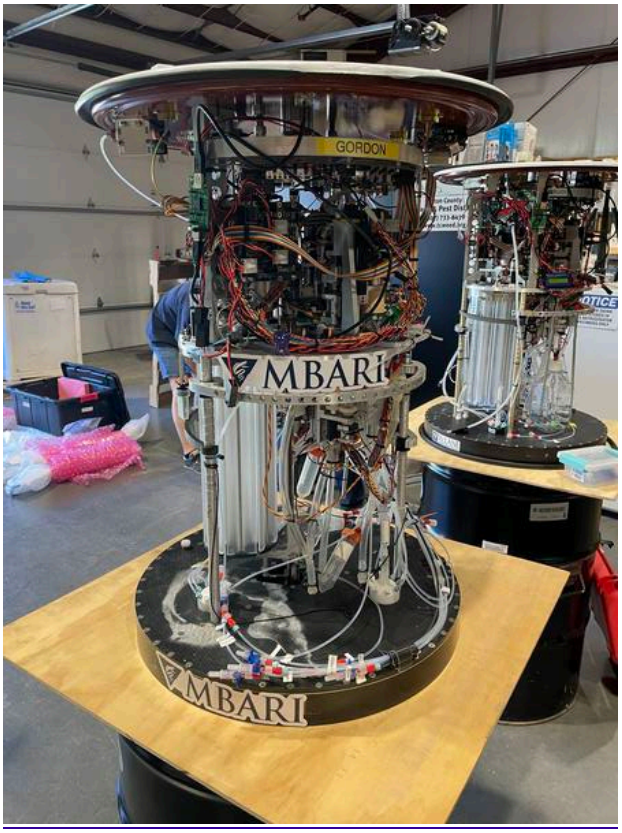
"Freshwater environments are critical for ecosystem health and provide valuable resources for food and recreation," said Adam Sepulveda, a USGS scientist and the project lead. "The USGS has successfully used eDNA methods and robotic samplers as an early-detection strategy for biological threats to important aquatic systems." For example, the USGS has engaged in eDNA survey campaigns for invasive dreissenid mussels, carp, round goby and Burmese python in water basins across the country.

"MBARI will design the eDNA samplers to be roughly the size of a microwave oven so they are easily carried and will fit into USGS streamgages for possible deployment across the nation," said Jim Birch, Director of the SURF Center at MBARI. "These new eDNA samplers will provide high-quality data for scientists, leading to effective monitoring for aquatic biological threats."

Sources/Usage: Public Domain.
MBARI Environmental Sample Processor (ESP) installed in Streamgage

Robotic samplers can help researchers search for hard-to-find organisms by detecting their DNA in the water. The current MBARI-designed sampler, called the Environmental Sample Processor or ESP, was built to be a sturdy 400-pound machine for use in rugged marine environments. Scientists need a more compact and nimble design for easier deployment in freshwater rivers and streams. As part of the new agreement, the USGS and MBARI will design a new robotic eDNA sampler. This new device will be smaller and lighter, with an easy-to-use computer to facilitate deployments and wireless connectivity so researchers can control sampling remotely.

The eDNA robot will be programmed to take samples frequently and at any time of day and will collect large amounts of data that must be managed and analyzed. The USGS READI-Net researchers will develop field and laboratory procedures to acquire high-quality data, produce analytical tools to process and validate large volumes of information, and create products for the public and decision-makers, such as resource managers, to easily visualize the results.



Sources/Usage: Public Domain.
An inside look at an MBARI autonomous environmental DNA (eDNA) sampler that is normally in metal housing taking samples in streams to detect aquatic invasive species, pathogens, and parasites. This version weighs about 400 pounds, but future versions will be more portable.

Megadroughts in the Common Era and the Anthropocene

NOAA/NIDIS 11/15/22

Author: Benjamin Cook, NASA, Columbia University

Key Findings

- Megadroughts are persistent, multi-year drought events that stand out as especially extreme in terms of severity, duration, or spatial extent when compared to other droughts of the last two thousand years
- Megadroughts have occurred on every continent outside of Antarctica, often causing major disturbances to ecosystems (e.g., forests in the Southwest U.S.) and societies (e.g., the Maya in Central America, the Ming Dynasty in northern China).
- While many past megadroughts were caused by persistent shifts in tropical ocean temperatures, climate change is likely to increase future megadrought risk through regional declines in precipitation and widespread increases in evaporative demand.
- The impacts of an ongoing megadrought in Southwestern North America (2000–present), amplified by climate change, suggest that these events will significantly strain water resources and present major resiliency challenges in the future.

In recent years, severe droughts have affected many regions around the world, including western North America, Europe, East Africa, and China. In some cases, these events (and others) have been referred to as "megadroughts," a term increasingly used in the media and scientific literature to refer to almost any extreme or impactful drought event. There is little consensus in the scientific community, however, on when a drought becomes a megadrought, nor is there any quantitative or established definition. A recently published paper by a team of international scientists synthesized information from the paleoclimate record, observations, and climate models to summarize our current understanding of megadrought dynamics around the world, from the last two thousand years to the end of the current

century (Cook et al., 2022). What is a megadrought? Where in the world do they occur? And what are the consequences of climate change for megadrought risk and severity?

The term megadrought likely originated from studies of drought in the paleoclimate record over western North America. In this region, records from lake sediments, tree rings, and speleothems revealed major drought events in the years prior to 1600 CE, droughts much more extreme and persistent than even the worst events of the 20th century. In the late 1500s, for example, much of the southwest and central U.S. experienced a multi-decadal drought over twice as long as any drought events observed in recent history. Using these events and this region as a starting point, the researchers suggested the following definition for megadroughts: *persistent, multi-year drought events that stand out as especially extreme in terms of severity, duration, or spatial extent when compared to other droughts over the last two thousand years.*

In recent years, severe droughts have impacted regions around the world, including Poyang Lake in China. Photo credit: Humphery, Shutterstock.

Using this definition and reviewing the paleodrought literature, the researchers found strong evidence for megadrought events over the last two millenia in regions on every continent outside of Antarctica (Table 1; adapted from Cook et al., 2022). These include relatively well known megadroughts that affected ancient societies in Central America and Northern China, as well as more recently discovered events in western Australia and Europe. Recent advances in model-data comparisons and data assimilation have further increased our understanding of what caused these megadroughts, highlighting how many of these events can be linked to shifts in tropical ocean temperatures. Many of the medieval-era megadroughts in North America and southern South America, for example, can be linked to extended cold ocean temperatures in the tropical Pacific (Steiger et al., 2021). These ocean conditions, often associated with La Niña, typically cause drought in these two regions, but the evidence suggests they were especially long-lived during past megadroughts. This review demonstrates that megadroughts are not geographically isolated or incredibly rare events, but rather an intrinsic feature of hydroclimate variability in many regions. But what about the future?

Climate models project that many of the regions with most robust past megadrought activity (e.g., western North America, the Mediterranean and Europe, southern South America) are also regions where climate change is likely to increase drought severity and risk with warming. In some regions this drying will manifest primarily through reductions in rainfall and snowfall, but for most areas increases in drought risk will be caused by a warmer, more arid atmosphere increasing water losses from the surface. Indeed, for some regions we are already beginning to see these climate change effects manifest. Southwestern North America, for example, has been experiencing an ongoing megadrought since 2000, the driest 22 to 23 year period of the last 1200 years (Williams et al., 2020; 2022). Further, climate change amplified the severity of this megadrought, contributing ~40% of the total magnitude of this event. Consequently, climate change turned what would have otherwise been a modest, if impactful, drought, into one of the worst droughts of the last two millennia.

Frustratingly, there remain some major gaps in our knowledge and uncertainties that need to be resolved to improve confidence in our understanding of megadrought dynamics and their impacts. For example, many areas of the world (e.g., tropical South America, much of subsaharan Africa) lack long-term observational or paleoclimate records of drought. In such regions, it is therefore difficult to understand what the baseline drought and megadrought risks are. Additionally, the climate models we use for projecting future drought risk have significant uncertainties, especially in the representation of vegetation at the land surface. Finally, it is not clear how effective our adaptation and resilience capacities will be in the face of future droughts and megadroughts,

events that will likely be hotter and more intense than anything in recent memory. Given the massive impacts on ecosystems and water resources of the ongoing megadrought in Southwestern North America, however, it is likely that future megadroughts in this and other regions will present substantial challenges.

The lead author for this study, Benjamin Cook with NASA Goddard Institute for Space Studies and Lamont-Doherty Earth Observatory at Columbia University, was supported by NOAA's Modeling, Analysis, Predictions, and Projections (MAPP) program. NOAA's National Integrated Drought Information System (NIDIS) also provided support for this study through MAPP's drought grant competitions.

Table 1. Timing and Location of Major Megadroughts Recorded in the Paleoclimate Record From the Last 2,000 Years

Region/County	Megadroughts
Western North America	Multiple events: ca. 800 – 1600 CE 2000 – ongoing
Central America	Terminal Classic Drought: ca. 800 – 1100 CE
Chile and Argentina	ca. 1050 – 1200 CE ca. 1250 – 1400 CE ca. 1615 – 1637 CE ca. 1684 – 1696 CE 2010 – ongoing
Europe	ca. 1000 – 1200 CE ca. 1400 – 1480 CE ca. 1770 –1840 CE
West Africa	ca. 1450 – 1750 CE late 1700s through early 1800s
East Africa	ca. 1000 – 1200 CE ca. 1880s – 1890s CE
India	Multiple events: 1300s – 1400s CE
Central Asia	ca. 804 – 882 CE ca. 1175 – 1190 CE
Northern China	Multiple events: 1100 – 1600 CE ca. 1634 – 1643 CE
Southeast Asia	Mid-1300s CE Early 1400s CE
Western Australia	Mid-1300s CE ca. 1755 – 1785 CE ca. 1828 – 1859 CE ca. 1889 – 1908 CE
Eastern Australia	ca. 1100 – 1300 CE ca. 1174 – 1212 CE Early 1500s Late 1700s Early 1800s

5 Things to Know About How SWOT Will Look at the World's Water

The international Surface Water and Ocean Topography mission will provide high-definition data on the salt- and fresh water on Earth's surface.

NASA 11/15/22

This illustration shows the Surface Water and Ocean Topography (SWOT) satellite in orbit with its solar panels and KaRIn instrument antennas deployed. *Credits: CNES*

On Dec. 12, NASA will launch the Surface Water and Ocean Topography (SWOT) satellite into Earth orbit from Vandenberg Space Force Base in California atop a Falcon 9 rocket. The mission is a collaborative effort between NASA and the French space agency Centre National d'Études Spatiales (CNES) – with contributions from the Canadian Space Agency (CSA) and the UK Space Agency – that will survey water on more than 90% of the planet's surface.

The satellite will measure the height of water in Earth's freshwater bodies and the ocean, providing insights into how the ocean influences climate change; how a warming world affects lakes, rivers, and reservoirs; and how communities can better prepare for disasters, like floods.

Set for a December launch, the SWOT satellite will help researchers study such ocean features as currents and eddies in places like the Black Sea closer to the coast than previous ocean-observing satellites.
Credits: NASA Earth Observatory

Here are five ways that SWOT will change what we know about water on Earth:

1. SWOT will survey nearly all water on Earth's surface for the first time.

Water is essential for life on this planet. But it also plays a critical role in storing and moving much of the excess heat and carbon trapped in Earth's atmosphere by greenhouse gas emissions. It influences our weather and climate as well. SWOT will help researchers track Earth's water budget – where the water is today, where it's coming from, and where it's going to be tomorrow. This is key to understanding how water resources are changing, what impact those changes will have on local environments, and how the ocean reacts to and influences climate change.

2. SWOT will see Earth's water in higher definition than ever before.

The spacecraft's science instruments will view the planet's freshwater bodies and the ocean with unprecedented clarity. SWOT will be able to collect data on ocean features less than 60 miles (100 kilometers) across, helping to improve researchers' understanding of the ocean's role in climate change. Earth's seas have absorbed more than 90% of the excess heat trapped in the atmosphere by human-caused greenhouse gas emissions. Researchers think that short-lived ocean features, such as fronts and eddies, absorb a lot of that heat – and the extra carbon that produced it.

By providing a high-definition view of freshwater bodies, SWOT will help generate a much more complete picture of Earth's water budget. Many big rivers remain a mystery to researchers, who can't outfit them with monitoring instruments for various reasons, including inaccessibility. The spacecraft's instruments will observe the entire length of nearly all rivers wider than 330 feet (100 meters), viewing them in three dimensions for the first time. Likewise, where ground and satellite technologies currently provide data on only a few thousand of the world's largest lakes, SWOT will expand that number to over a million lakes larger than 15 acres (62,500 square meters).

NASA and CNES (French Space Agency) are collaborating to make the first global survey of Earth's surface fresh water and study fine-scale ocean currents with a new mission called SWOT, or Surface Water and Ocean Topography. SWOT will collect data on the height of Earth's salt and fresh water – including oceans, lakes, and rivers – enabling researchers to track the location of water over time, which will help measure the effects of climate change.

3. The satellite will address some of the most pressing climate change questions of our time.
An important part of predicting our future climate is determining at what point the ocean slows down the absorption of excess heat trapped in the atmosphere and starts releasing it back into the air, where it

could accelerate global warming. SWOT will provide crucial information about this global ocean-atmosphere heat exchange, enabling researchers to test and improve climate forecasts. In addition, the satellite will help fill gaps in researchers' picture of how sea level is changing along coastlines, offering insights that can then be used to improve computer models for sea level rise projections and the forecasting of coastal floods.

4. SWOT data will be used to inform decisions about our daily lives.

Climate change is also accelerating Earth's water cycle, leading to more volatile precipitation patterns, including torrential downpours and extreme droughts. Some communities around the world will thus experience floods while other suffer droughts. SWOT data will be used to monitor drought conditions in lakes and improve flood forecasts for rivers, providing essential information to water management agencies, disaster preparedness agencies, universities, civil engineers, and others who need to track water in their local areas.

5. This mission is paving the way for future NASA Earth missions while also building on a long-standing international partnership.

With its innovative technology and commitment to engaging a diverse community of people who plan to use the mission's data, SWOT is laying a path for future Earth-observing missions. Measurements from SWOT – and the tools to support researchers in analyzing the information – will be free and accessible. This will help to foster research and applications activities by a wide range of users, including those who may not usually have the opportunity to access this knowledge.

Such an ambitious mission is possible because of a decades-long collaboration between NASA and CNES that started in the 1980s to monitor Earth's ocean. This partnership pioneered the use of a space-based instrument called an altimeter to study sea level with the launch of the TOPEX/Poseidon satellite in 1992. The NASA-CNES partnership has continued uninterrupted for three decades and has expanded to encompass work with other agencies, including the CSA and the UK Space Agency for SWOT, as well as ESA (European Space Agency), the European Organisation for the Exploitation of Meteorological Satellites, and the European Commission for the Sentinel-6 Michael Freilich satellite, which launched in November 2020.

Data from the SWOT satellite will help people monitor freshwater resources and aid communities prepare for the consequences of a changing climate.

More About the Mission
SWOT is being jointly developed by NASA and CNES, with contributions from the CSA and the UK Space Agency. JPL, which is managed for NASA by Caltech in Pasadena, California, leads the U.S. component of the project. For the flight system payload, NASA is providing the Ka-band Radar Interferometer (KaRIn) instrument, a GPS science receiver, a laser retroreflector, a two-beam microwave radiometer, and NASA instrument operations. CNES is providing the Doppler Orbitography and Radioposition Integrated by Satellite (DORIS) system, the dual frequency Poseidon altimeter (developed by Thales Alenia Space), the KaRIn radio-frequency subsystem (together with Thales Alenia Space and with support from the UK Space Agency), the satellite platform, and ground control segment. CSA is providing the KaRIn high-power transmitter assembly. NASA is providing the launch vehicle and associated launch services.

To learn more about SWOT, visit:
https://swot.jpl.nasa.gov/
SWOT media reel
SWOT press kit
SWOT lessons for students and educators

Upcoming Meetings and Webinars

WestFAST Webinars: WestFAST is hosting a series of webinars to discuss the importance of water resources and community engagement related to wildfire prevention, reduction, recovery, and rehabilitation

Western State's Perspectives on Wildfire Management and Water Resource Impacts - State Panelist Presentations and Discussion
December 7, 2022 10:00 am – noon MT

Other Federal News

USBR 11/9/22. Biden-Harris Administration announces $20 million for environmental projects in five states

BLM 11/10/22. Bipartisan Infrastructure Law to Fund up to $9 Million to Advance Wildfire Science

DOI 11/10/22. Biden-Harris Administration Joins National Fish and Wildlife Foundation, Private Partners to Announce $91 Million in America the Beautiful Challenge Grants

USFS 11/15/22. USDA Forest Service Launches Interactive Map Showcasing Wildfire Reduction Projects

USDA 11/15/22. FACT SHEET: One Year of the Bipartisan Infrastructure Law at USDA

EPA 11/15/22. EPA Celebrates Year One Accomplishments Under the Bipartisan Infrastructure Law

USFS 11/16/22. USDA Forest Service, Trout Unlimited invest up to $40 million to restore watersheds on America's national forests

FWS 11/17/22. U.S. Fish and Wildlife Service Seeks Project Applications for $38 Million in Fish Passage Funding

USFS 11/17/22. Biden-Harris Administration Announces $20.5 Million in Grants to Protect Water, Increase Wood Processing Capacity

DOI 11/28/22. Inflation Reduction Act Funds Landmark Agreements to Accelerate Salton Sea Restoration

USBR 11/29/22. Reclamation selects nine projects to receive $1.69 million to test innovative and new water treatment technologies

USFS 11/30/22. USDA Forest Service signs 11 new agreements to advance tribal co-stewardship of national forests

DOI 11/30/22. Interior Department Announces New Partnerships and Offices to Leverage New Resources for Indian Country

DOI 11/30/22. Biden-Harris Administration Announces News Steps to Strengthen Tribal Co-Stewardship of Public Lands and Waters

DOI 11/30/22. Biden-Harris Administration Makes $135 Million Commitment to Support Relocation of Tribal Communities Affected by Climate Change

EPA 11/30/22. EPA Announces Proposal to Protect Tribal Reserved Rights in Water Quality Standards and Best Practices for Tribal Treaty and Reserved Rights

USDA 11/30/22. At the White House Tribal Nations Summit, USDA Announces Continued Commitment to Indian Country