OAK RIDGE NATIONAL LABORATORY

Environmental Sciences



The Environmental Sciences Division (ESD) addresses national challenges at the intersection of energy, water, and environmental systems. ESD researchers develop the knowledge, technologies, and decision support tools needed to improve infrastructure planning, enhance energy reliability, strengthen national competitiveness, and secure natural resources for economic prosperity.

BY THE NUMBERS

1,093	160	1.7 billion	1.4 GW	70 years
Publications in the past 5 years	Staff	Tons of potential biomass resources identified	Assessed conduit hydropower potential	Leadership in large-scale field studies

Strengthening Energy, Water Security

ESD is an interdisciplinary R&D organization with more than 70 years of achievement in regional, national, and international environmental research. Scientists combine large-scale experiments and observations, high-performance computing, and next-generation, AI-enabled data systems to deliver actionable scientific insights for the nation.

Researchers develop advanced tools to predict and prepare for disturbances, such as severe weather and flooding, that could disrupt energy generation and delivery throughout the grid. These predictive capabilities are based on extensive study and simulation of how plants, microorganisms, ecosystems, and human activities influence land and water systems across local to global scales. Scientists combine data from extensive field studies, remote sensing measurements, and laboratory experiments with AI-assisted modeling to advance understanding of biological and environmental systems. This work supports planning for national energy systems, including siting, modernization, and long-term reliability of energy operations.

ESD advances the state of water resources science and engineering through data analytics, modeling and simulation, engineering design, decision support, and visualization. Researchers conduct national assessments of biomass feedstocks for the manufacturing of advanced chemicals and materials to support secure, domestic supply chains. They develop novel water power technologies to expand US energy generation.



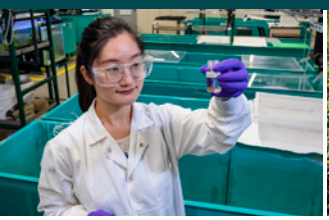
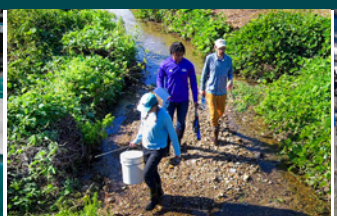
Researchers used the R&D 100 Award-winning Advanced Terrestrial Simulator to model water flow near critical energy infrastructure in Southeast Texas.

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"Our researchers build predictive capabilities to inform decision-making about water availability, energy security, and infrastructure resilience."

— Environmental Sciences Division Director, **Peter Thornton**




Predicting Earth Systems

Predicting future water availability and disturbances such as flooding and wildfire that affect energy generation requires advanced understanding of complex Earth system processes. ESD scientists bring expertise across multiple disciplines to address these challenges. Collaborating closely with colleagues in the Biosciences Division, they leverage ORNL's world-leading capabilities in exascale computing, neutron imaging, physical sciences, and advanced manufacturing. Together, they translate discoveries into decision support tools and technologies that increase energy security, enhance US competitiveness, and drive economic growth.

Recent Impacts

- Developed accurate simulations of the nation's waterways for energy resilience, infrastructure, and human security.
- Observed and modeled Southeast coastal ecosystems to improve understanding and prediction of these critical areas affecting energy infrastructure and communities.
- Developed a robotic system that improves the accuracy and lowers the cost of environmental monitoring around the nation's hydropower facilities.
- Improved land system models for better risk assessment and infrastructure planning in support of national prosperity and well-being..
- Assessed U.S. hydropower potential to strengthen grid security and reliability.
- Profiled U.S. biomass feedstock resources for manufacturing advanced chemicals and materials.
- Developed and modeled data on Arctic land processes to support infrastructure and energy resilience.
- Built and are operating modern data platforms to enable rapid, AI-assisted scientific discovery.



The NGEE Arctic project combines tundra observations with models powered by exascale supercomputing to predict how rapid shifts in the Arctic landscape will impact DOE's energy and national security missions.



Researchers are developing predictive capabilities to inform decision-making for the Gulf Coast region, home to vital resources and strategic energy, transportation, and industrial infrastructure that is crucial to economic and national security.

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