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BUILDING COASTAL RESILIENCE

As the economic, environmental, and human costs of sea-level rise begin to mount, VIMS' cutting-edge research provides essential tools for communities to adapt and thrive.

The Wave of the Future

VIMS' flooding forecast models
break new ground

"All ocean processes are interrelated, from the small-scale, like turbulence, to large-scale," says VIMS Research Professor Joseph Zhang. "If you want to simulate these processes in a holistic fashion, it's a huge challenge."

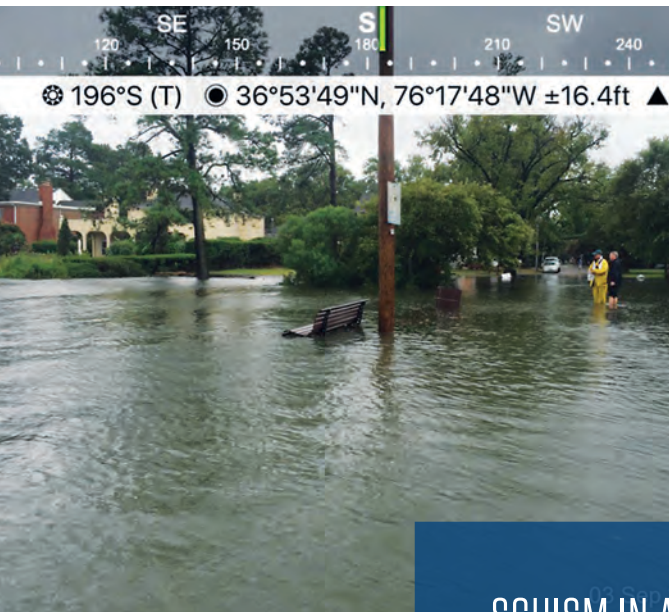
Zhang is the lead developer of the SCHISM cross-scale computer modeling system, a suite of models designed to more precisely forecast the movement of the world's waters, from tsunamis to storm surge. It is fast and highly accurate, simulating how waters flow through time and three-dimensional space. "SCHISM occupies a unique place," he says. "It's one of the few models that accommodates creek to ocean. We know by talking to researchers and managers, that's exactly what they want."

In addition to physical processes, SCHISM can simulate biological processes such as the life cycle of vegetation. Its broad applications include EPA water-quality studies to mitigate hypoxia and future predictions of the impact of Antarctic ice melt.

Zhang worked with an international team for two decades to develop the modeling system. "One of the things that we pride ourselves on is our open attitude. We never walk away from a suggestion," Zhang says. "It's a collaborative — that's the beauty of open source."

Today, SCHISM is widely considered the best of its kind in the world. Zhang regularly travels to sites in the U.S.

Virginia's Hampton Roads region is experiencing the highest rates of sea-level rise on the East Coast.



VIMS Research Professor Joseph Zhang is the lead developer of the SCHISM modeling system.

and abroad to provide training in the modeling system's use. Closer to home, Research Assistant Professor Derek Loftis Ph.D. '14, who applied elements of the SCHISM modeling system in his dissertation research, now focuses on regional forecast modeling in his work with Zhang at VIMS' Center for Coastal Resources Management (CCRM). Loftis leads the StormSense project, a research initiative to enhance emergency preparedness for coastal flooding utilizing SCHISM. StormSense has installed more than 40 ultrasonic water-level sensors throughout Tidewater Virginia.

"We are expanding the frontiers of science very rapidly because of the superior capabilities of this particular modeling system."

"We take data from the sensors and feed the information into our model, but we also use the sensors to validate the accuracy of our model after major storm surge events" Loftis says.

StormSense has garnered nine national awards thus far. Loftis also was an inaugural winner of a Dean and Director's Innovation Fund Award in 2019, which he is using to commercialize a video camera system capable of detecting water-level data in real time. *"We plan to integrate the sensor into our StormSense sensor network,"* Loftis says.

SCHISM IN ACTION

When VIMS completed a recent pilot project on flooding hazards for NOAA using the SCHISM modeling system, the agency's personnel knew they were looking at something unique. *"It really opened their eyes,"* says Joseph Zhang. *"They are fully convinced that our model is truly different from other models."*

As a result, NOAA has signed a long-term agreement with VIMS as part of its initiative to develop next-generation forecasting models. As Zhang explains, because of its holistic design, SCHISM not only is applicable to flooding and storm surge, it also addresses NOAA's co-mission of safe navigation with superior forecasting of water currents — providing great economic benefits to major U.S. ports. Private companies are employing SCHISM as well. Mike Sapnar '88, P '20, president & CEO of TransRe, has been a critical advisor to the program on industry relations. At the start of this year, Zhang became one of two external advisors to the Silicon Valley start-up One Concern, which consults on disaster forecasting and resilience. *"We are really breaking new ground,"* Zhang says.



Taiwan is using the SCHISM modeling system to enhance forecasts for ocean flooding.

U.S. AND GLOBAL PARTNERS

The SCHISM modeling system has been adopted worldwide. Sponsors and collaborators include:



Government

NOAA National Ocean Service and National Tsunami Program; EPA Chesapeake Bay Program; California Department of Water Resources; Oregon Department of Geology & Mineral Industries; Texas Water Development Board; Virginia Department of Transportation; Virginia Port Authority.



Business

BGS IT&E, an engineering company in Germany working on urban flooding; Moffatt & Nichol; GRI, a geotechnical engineering company; PIVOT Architecture; MetOcean Solutions, a New Zealand consulting firm.



International Organizations

Joint European Research Centre, Italy; International Center for Advanced Studies on River-Delta-Sea Systems (DANUBIUS-RI); Laboratório Nacional de Engenharia Civil, Portugal; German Federal Institute of Hydrology; Helmholtz Association of German Research Centers; Second Institute of Oceanography, Hangzhou, China; Central Weather Bureau, Taiwan.

FELLOWSHIP SUPPORTS SEA-LEVEL RISE RESEARCH

A decade ago, Phyllis Cothran and her husband, Dr. Arnold Stolberg, bought a riverfront home in Gloucester. From that vantage point, the couple gained a close-up view of encroaching sea-level rise. Their desire to learn more resulted in a sustained partnership with VIMS. In fiscal years 2109-20, Cothran has served as president of the VIMS Foundation.

Wanting to make an impact for the future, the couple created the Phyllis L. Cothran and Arnold L. Stolberg Fellowship Endowment to provide support for graduate students studying sea-level rise — giving young scientists the opportunity to work with VIMS researchers like Joseph Zhang and Derek Loftis to develop new insights into global coastal change. *"It is so stimulating to see that really smart, excited people are working on these very real problems that the world has to figure out,"* Cothran says.

ACTIONABLE
SCIENCE

Today in Virginia's Hampton Roads region, water levels are a foot and a half higher than they were a century ago. They are expected to rise another 5 feet by the year 2100, while the land sinks as much as 7.5 inches.

VIMS is at the forefront of research on coastal resilience, deploying experts across a wide range of disciplines from wetland ecology to data and modeling to help communities adapt to sea-level rise. This consulting is delivered through VIMS' unique advisory service mission, which grounds the Commonwealth's marine policy decision-making in the best science. This connectivity positions VIMS and Virginia as global leaders in deploying science in partnership with communities, and makes Hampton Roads a cutting-edge testing ground for adaptation solutions.

"Thanks to our advisory service mission, VIMS translates science into solutions in Virginia, which uniquely positions us for national and global leadership on community planning for coastal resilience."

— MARK LUCKENBACH, ASSOCIATE DEAN OF RESEARCH AND ADVISORY SERVICES



'A ONE-STOP SHOP' FOR VIRGINIA

In 2016, the Virginia General Assembly formalized the ongoing collaboration among the state's top experts on coastal resilience, creating the Commonwealth Center for Recurrent Flooding Resilience. The Center's affiliated partners include:

VIMS, with the Center for Coastal Resources Management in the lead.

OLD DOMINION UNIVERSITY, including faculty in Economics, Engineering, Geography, and Ocean, Earth and Atmospheric Studies.

THE VIRGINIA COASTAL POLICY CENTER, which integrates the expertise of VIMS and the W&M Law School and Public Policy Program to provide science-based legal and policy analysis on coastal resource issues.

The Center conducts interdisciplinary studies and provides scientific and technical support to government agencies, businesses, and private citizens. "It's a 'one-stop shop' for scientific, socioeconomic, legal, and policy analyses aimed at building Virginia's resiliency against flooding," says Mark Luckenbach.

COASTAL RESILIENCE
TOOLBOX

Over the last five years, VIMS has introduced new and enhanced tools to help the public understand climate adaptation and reduce risk.



SEA LEVEL REPORT CARDS

In 2018, VIMS introduced new web-based "report cards" to monitor changes in sea level at 32 localities from Maine to Alaska, projected out to the year 2050. The reports offer a key advantage by using relative sea-level measurements — changes in water level relative to the land surface. Local rates of relative sea-level rise give a direct indication of the extent to which homes, buildings, and roads are at risk of flooding.



TIDEWATCH MAP[®]

Tidewatch is a 36-hour tidal forecasting system originally developed by emeritus professor John Boon. Using SCHISM and other modeling systems, VIMS scientists have now introduced the Tidewatch Map, which provides coastal Virginia residents with visual representations of water levels in their own neighborhoods. "You literally can see whether or not particular roads are going to be flooded," says Mark Luckenbach.

ADAPTVA

Launched in 2017, AdaptVA provides a single point of access for comprehensive information about climate adaptation. Designed for a wide range of users, the web portal includes links to legal and policy resources, risk assessment tools, forecasts, diagrams of building modifications, and much more. The project development team was led by the Center for Coastal Resources Management.



SHORELINE STUDIES PROGRAM

This VIMS program, directed by Professor Scott Hardaway, provides information and recommendations to localities and landowners for shore stabilization, applying cutting-edge science. The program's models are currently being applied in Gulf Coast localities as well as the Chesapeake Bay region.