COASTAL & HYDRAULICS LABORATORY

STRATEGY


Vicksburg

1 ▶ MISSION & VISION

Mission

CHL's mission is to deliver solutions to our Nation's most challenging coastal and hydraulics problems through research, development, and application of cutting-edge science, engineering, and technology.

Goals

Vision

The CHL vision is to be a world-class research and development organization that discovers, develops, and delivers coastal and hydraulics science and engineering to make the world safer and better every day.

Here, we define world-class by three elements: making substantial contributions to solving difficult problems, being part of an elite cadre of researchers world-wide, and continually seeking excellence.

2 ▶ HISTORY

The continuous existence of the US Army Corps of Engineers (USACE) dates from the year 1802, and from its inception, the USACE was asked to contribute to both military construction and works "of a civil nature." Throughout the nineteeth century, the USACE supervised the construction of coastal fortifications as well as constructed lighthouses, developed jetties and piers for harbors, and carefully mapped navigation channels.

The great flood of 1927 was the deadliest and most destructive of a series of natural disasters that ravaged the lower Mississippi River valley and heightened the Nation's awareness of the need for a greater understanding of civil engineering problems. Consequently, civil engineer John R. Freeman led a campaign to develop a national hydraulics laboratory at the federal level. The laboratory was envisioned to serve multiple agencies as well as the public. The Flood Control Act of 1928 authorized the Chief of Engineers to establish what became known as the Waterways Experiment Station (WES). The visionary early leaders of the Hydraulics Laboratory (HL) enabled WES to become the first federal facility to apply modern research methods to large, nationally signficant Civil Works projects.

The laboratory quickly became the largest hydraulics research facility in the world due to the continuous need for supporting large-scale Civil Works projects. In 1932, HL expanded into coastal physical modeling by developing the St. Andrews, Florida, Ship Channel Model. Additional coastal physical models followed, and while modeling skill improved with experience, the development of accurate coastal models remained a significant challenge. At the same time, the USACE expanded coastal research into other areas. Coastal research gained national impetus with the formation of the Beach Erosion Board (BEB) in 1930. Both WES and the BEB made significant contributions to military operations during World War II, including the D-Day campaign. The BEB developed a national research facility that included the world's largest wave tank. In 1962, a commission concluded that a center was needed to conduct research to support congressional imperatives for coastal planning and advancing coastal research, including hurricane impacts, as well as to consult and coordinate with USACE districts on specific coastal engineering projects. In response to this, Congress established the Coastal Engineering Research Center (CERC) in 1963 to focus on coastal engineering research, with oversight provided by the Coastal Engineering Research Board, which was the successor to the BEB. The CERC was originally located on the Dalecarlia Reservation in Washington, DC, but was moved to Ft. Belvoir, Virgina, in 1973. In 1977, CERC established the Field Research Facility in Duck, North Carolina, a coastal observatory that became an early focus of coastal experimentation, funded jointly by the USACE, the Office of Naval Research, and the US Geological Society. In 1983, CERC was moved to WES, and in 1996, the Coastal and Hydraulics Laboratory (CHL) was created through the merger of CERC and HL. In 1999, with formation of the US Army Engineer Research and Development Center (ERDC), which encompassed WES, CHL became one of the seven ERDC laboratories. Today, CHL leads coastal, estuarine, and hydraulic water resources research in both Civil Works and military domains.

3 ▶ FUTURE MILITARY & CIVIL WORKS ENVIRONMENT

We live in age of global hyper-interconnectivity where transformational technologies are fueling opportunity while simultaneously disrupting classical governing philosphies and economic trajectories. Global environmental hazards, such as more extreme weather, create additional challenges that may disrupt societies and change population centers and transportation pathways. According to the National Intelligence Council's Global Trend Report, effective responses to these challenges require national investment in infrastructure, knowledge, and alliances/ relationships that are resilient to shock. Resilient nations will be able to preserve security and respond to unexpected change by maintaining technological leadership and awareness of possible future challenges and opportunities.

The future military landscape includes increased global turbulence, accelerated human progress, and rapid technological advancement, creating an increasingly lethal, competitive, complex, and dynamic operational environment. The future operational environment will reveal formidable threats and challenges in every domain: land, air, space, cyberspace, and maritime. Technology development has accelerated from the commercial sector, becoming a global commodity, where the speed of new technological advancements and dissemination of information is futher enhanced through modern communication networks and social media. We must anticipate that emerging adversaries may exploit technologies to include anti-access/area denial strategies designed to impede the ability of joint forces to globally project power and operate in all domains.

In additon to preserving peace through military strength, the US National Security Strategy recognizes that a strong national economy protects the American people, supports our way of life, sustains American influence, and increases US national resilience. A priority action for national security is to improve American infrastructure. These improvements will increase national competitiveness, benefit the environment, and improve our quality of life. The Nation's challenges at home are growing and require an enhanced science and engineering capability to meet the new and changing demands. This includes not only aging and inadequate infrastructure but also impacts of climate change, changing demographics and continued rapid urbanization, mitigation of environmental contamination and degredation, and natural resource conservation on both military and civilian infrastructure and assets.

To meet the challenges, CHL must be adaptive and innovative. Exploiting advanced computational sciences and emerging computing systems for coastal and hydraulics applications will lead to scientific and engineering breakthroughs. Leveraging foundational research in artificial intelligence and machine learning conducted for application to other fields and applying them to problems in the coastal and hydraulics domain will transform how the Nation addresses water challenges and better enable the Nation to adapt to surprise and unanticipated change. Specifically, research and new technologies in the areas of advanced computing, big-data analytics, remote sensing, data assimilation, and autonomous systems applied to water problems will transform the future of complex applications. For issues of water security, climate change, navigation, and watershed analysis, CHL tools must integrate across scales (large and small, space and time scales) and discplines, coupling environmental, geotechnical, arctic, and socio-cultural processes. Decision support tools that provide uncertainty/ risk analysis and studies of resilience in a changing climate are required. Basic research is also required in coastal and hydraulics topics of sediment dynamics, multiphase flow, nonlinear waves, turbulence, and energy dissipation.

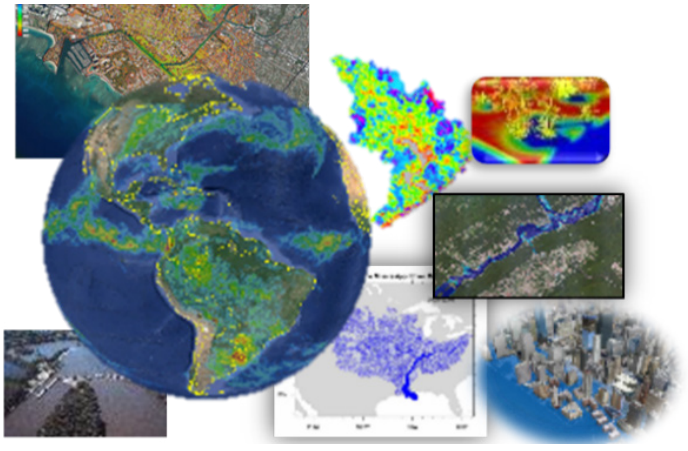
4 ▶ WHAT WE DO

CHL's strength is found in our people, who **solve problems** and **initiate scientific discovery** through a multi-faceted approach that includes field and laboratory data collection and instrumentation development, physical modeling, computational science, and data analytics.

Our researchers, who collaborate on these multi-faceted problems, have strengths in one or several of our core competencies: **hydrology, river and estuarine engineering, coastal science and engineering, fluid structure interaction,** and **maritime operations**. CHL employs these core competencies to discover, develop, and deliver products across our portfolio.

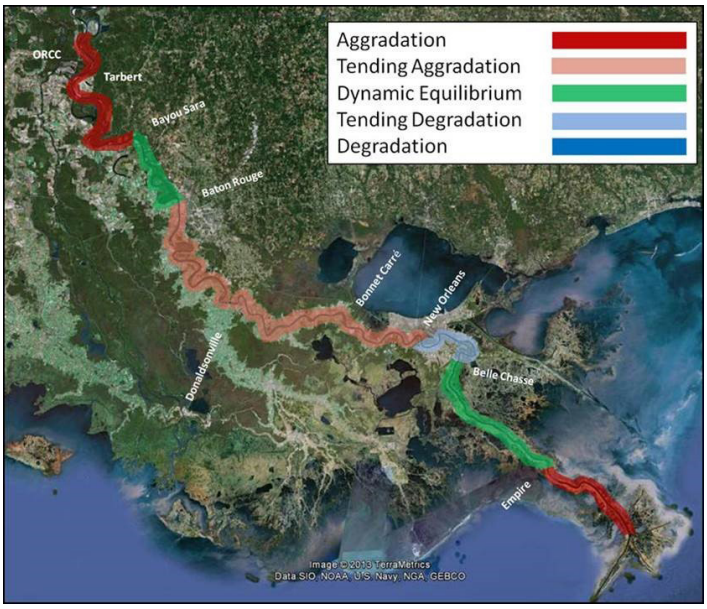
Hydrology

CHL supports Military and Civil Works missions with hydrologic analysis, providing sensing equipment, data collection methodologies, modeling tools, integration of large data sets, and analysis for a variety of purposes related to flood analysis and control, water supply and availability, hydrologic forecasting, troop mobility, facility siting, watershed management, and sediment transport. In conjunction with ERDC's Environmental Laboratory, CHL provides hydro-environmental modeling, tools and analysis for environmental compliance, and other water quality analysis. To accomplish diverse missions, CHL develops, maintains, applies, and transfers to the field a variety of generally applicable hydrologic technologies relevant to wide-ranging environments around the world (temperate, tropical, and arctic regions). CHL analyzes and simulates surface and subsurface hydrologic systems and coupled groundwater and surface water systems. Tools cover a large range of applications requiring differing levels of fidelity, from quick analysis to high-fidelity solutions. To provide complete solutions to complex problems, such as coastal flooding, hydrologic forecasting, and structure operations, CHL hydrologic tools are integrated with other simulation capabilities, such as weather and storm surge forecast models and systems.



River and Estuarine Engineering

Due to the numerous demands placed on our Nation's rivers, waterways, and estuaries, CHL's river and estuarine engineering expertise remains as important today as it was over nine decades ago when it formed the foundation of the first federal hydraulics research facility. CHL



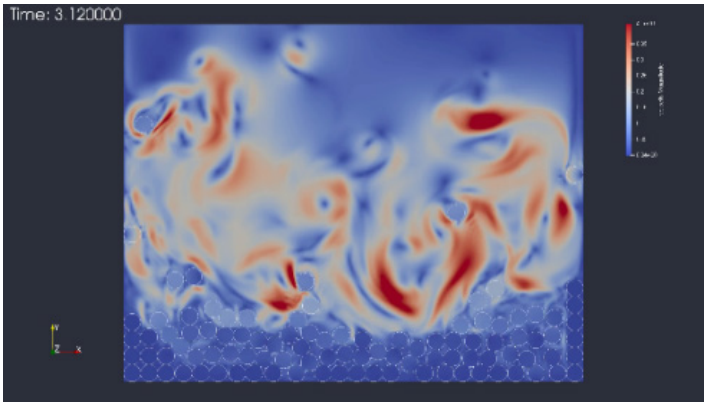
continues to leverage its proximity, knowledge, and experience of the Mississippi River and coastal Louisiana to solve the most complex river and estuarine problems across the Nation. These core competencies include the development and application of advanced instrumentation and sensing equipment, field data collection techniques, numerical models, and physical modeling to solve problems related to river and estuarine hydraulics, sediment transport, geomorphology, salinity intrusion, and marsh evolution.

Coastal Engineering

Coastlines are dynamic landscapes that respond to a variety of meteorlogical and hydrodynamic forces at a range of spatio-temporal scales. Short-term hazards such as storms, which result in extreme coastal erosion, flooding, and infrastructure damage, are particularly challenging problems to prepare for and typically require billions of dollars for restoration and recovery efforts. Long-term hazards such as sea-level rise create challenges that aggregate in time and threaten large-scale communities and low-lying critical infrastructure. Sand resources are at a premium, and their effective management is critical to the long-term resilience of our Nation's coastlines. CHL advances a range of measurement and modeling expertise, tools, and databases to characterize the relevant coastal forcing climatology. To quantify the coastal response, CHL develops advanced field measurement techniques and modeling/analysis tools for coastal sediment transport and morphology response to support integrated coastal zone management and resilient coastlines. To support the design of engineering measures to manage coastal risk related to navigation, flooding, and coastal erosion, CHL develops and executes physical and numerical modeling of coastal protection strucuture response.

Fluid-Structure Interaction (FSI)

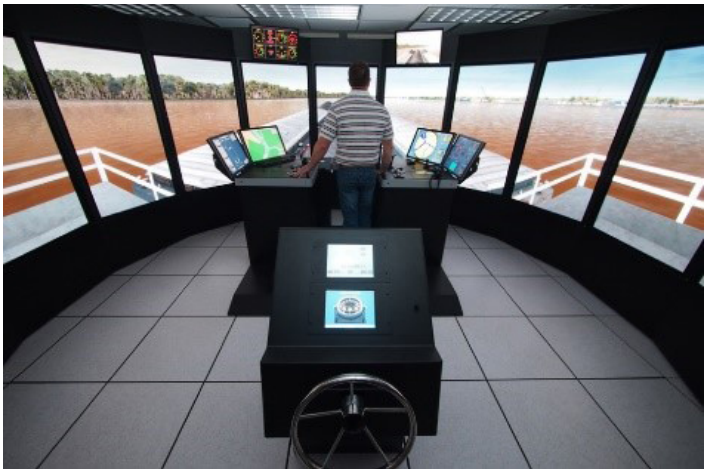
Understanding how currents and waves exert force on solid structures is at the heart of many engineering problems CHL faces. More generally, we must understand coupled fluid-structure systems where momentum and energy are exchanged along moving interfaces between the solid structures, water, and air. CHL develops and maintains advanced computational modeling tools for FSI and conducts research in a range



of areas that support continued advances in FSI modeling: numerical analysis, scientific computing, engineering mechanics, and mathematical modeling. Since computational modeling is not sufficiently reliable in many cases, especially those involving complex fluid-structure systems, CHL also develops and maintains an array of experimental facilities (flumes and basins) and field data collection capabilities, which are used to study processes, validate computational models, and design structures and vessels. In support of FSI simulation, we also conduct specialized research and development into experimental methods, data acquisition, and field data collection to advance our capability to measure more complex processes and achieve higher accuracy with new measurement techniques.

Maritime Operations

CHL delivers analytic tools and predictive capabilities in direct support of the USACE Civil Works Navigation mission as well as for military logistic operations around the world. Navigation research and development at CHL applies the Ship Simulator, an immersive technology for evaluating the impacts to navigability of proposed design changes to channels, anchorages, and berthing terminals. CHL combines advanced data analytics derived from integration of large datasets from waterborne cargo records, hydrographic surveys, marine vessel position reports, and dredging vessel diagnostics to determine critical needs within the vast USACE Navigation portfolio of projects and to direct limited operations and maintenence resources accordingly. The USACE spends in excess of $1B annually on maintenance dredging of navigation channels, and CHL directly supports this mission with research and development focused on dredging operations performance monitoring, dredged material management best practices, and optimization strategies for dredge project budgeting and scheduling. CHL is modernizing the real-time flow of relevant information to marine operators througout the national waterway network for safer and more efficient marine transportation. CHL also develops capabilities to inform both strategic and tactical decision making for military transport and force projection, with emphasis on evaluations of austere port environments throughout the globe for logistics over the shore and route planning for deployments and related activities.



5 ▶ WHY WE DO IT

CHL works collaboratively across ERDC and the USACE, and with other government agencies, industry, and academic partners, to deliver world-class products that advance coastal and hydraulics science and engineering in the service areas of navigation, flood risk management, water resources management, sediment management, and military engineering. Through CHL's research, development, and applications, we seek to leverage advancements to support Military and Civil Works requirements.

Navigation

We discover, develop, and deliver solutions to enhance safe, reliable, efficient, and environmentally sustainable waterborne transportation systems for movement of commerce, national security needs, and recreation.

Flood & Coastal Risk Management

We discover, develop, and deliver products to quantify the risk-based performance of natural, engineered, and hybrid systems threatened by long-term changes including extreme drought and flood and storm-induced hazards.

Water Management

We discover, develop, and deliver hydro-environmental capabilities and tools to support decision making considering the spatial and temporal distribution of water and to optimize hydropower generation in an environmentally sustainable manner.

Sediment Management

We discover, develop, and deliver tools to beneficially manage sediment resources, including use of natural processes to solve engineering problems and enhance natural resources while balancing national security and economic requirements.

Coastal & Hydraulics Military Engineering

We discover, develop, and deliver capabilities to provide advantage in multi-domain operations against adversaries, providing the warfighter with advanced capabilities in the area of force projection and maneuver support in complex riverine, estuarine, and coastal environments.

6 ▶ STRATEGIC GOALS

GOAL 1:

Inspire a World-Class Workforce

People are our number one resource and are key to CHL's ability to successfully support the Nation by solving tough coastal and hydraulics challenges. We will recruit, develop, and train a world-class work force to discover, develop, and deliver coastal and hydraulics engineering expertise and tools. The workforce culture will nurture respect, excellence, transparency, and teamwork while emphasizing the importance of family. We will encourage a balance of research autonomy and connection, striving to create opportunities to safely take risks in the development and testing of new ideas and providing space for curiosity while working around a shared organizational vision. We will grow coastal and hydraulics science and engineering enterprise capabilities worldwide through collaborative development and sharing of knowledge and technology, leveraging our collective strengths. To ensure our continued success, we will continually strive to provide development opportunities and access to technical and career mentoring to all of our people and provide training and guidance to the entire enterprise.

GOAL 2:

Develop and Deliver Innovative Solutions

We will provide state-of-the-art coastal and hydraulics solutions to fundamental science questions and engineering problems that encompass the entire watershed. CHL will prioritize **(1)** understanding the partner needs; **(2)** developing collaborative teams that fully comprehend existing capabilities as well as present and future strategic needs; and **(3)** engaging with our partners to quantify impact and value of solutions. Product development will emphasize innovation and rigor, encouraging our scientists and engineers to push the state of the possible while maintaining reliability and fidelity in our solutions. CHL will encourage collaborative solutions that leverage and incorporate the best technological advances from other ERDC laboratories, USACE districts, academia, private industry, and government research. Product delivery will emphasize sustainable, adaptive, cost-effective, and integrated solutions seamlessly linked to supporting data and customized to meet existing and future user needs. CHL will grow and maintain the appropriate workforce with surge capacity to develop and deliver these innovative solutions.

GOAL 3:

Advance World-Class Research Facilities

Cutting-edge research facilities and data collection technologies are central to increasing knowledge and innovation in research, development, and engineering, and engaging partners. We will collect and deliver critical coastal and hydraulics data to inform discovery and engineering innovation, and inspire collaborative opportunities. We will advance laboratory and field facilities in collaboration with other ERDC laboratories to deliver comprehensive observations, analysis, and data sharing. We will make data available to the larger community through data portals. Data quality, timeliness, efficiency, ease of data access, and documentation are essential. We will collaborate with ERDC's Information Technology Laboratory and others to incorporate the latest advancements in data analytics and machine learning to translate data to solutions and shape desired outcomes.

GOAL 4:

Connect to Strengthen the Enterprise

Collaboration expands opportunities for new research and leverages resources to strengthen the entire water resources enterprise. We will reach out to the global R&D and technology communities to discover new opportunities for innovation and partnering. We will engage stakeholders early and often with a united message of CHL capabilities, building on existing relationships, and transitioning knowledge, data, and tools. Partnering with agencies, academics, and industry on topics of joint interest takes advantage of team excellence to develop world-class solutions in a transparent, open manner. Partnering with universities opens opportunities to build relationships and cultivate the next generation of water resources professionals and connects us to the basic research community and the world of new ideas. In collaboration with other ERDC laboratories, we will establish an integrated, open-source modeling framework to unite technology capabilities and provide consistency in experience across tools. A central web presence will link tools, documentation, and assistance and provide a portal for interaction with USACE districts and partners on requirements, alternative approaches to meet needs, coordination of delivery, and guidance.

GOAL 5:

Anticipate and Discover Transformational Technology

We will explore, plan, and execute strategic research and development to meet future requirements. Areas of focus will include simulation of systems integrated across scales and disciplines, focusing on issues of water security, climate change, navigation, sediment management, and watershed analysis, including risk and uncertainty; analysis and modeling of heterogeneous sediment dynamics; methods to assess infrastructure degradation that are integrated with process tools to assess impacts, improve maintenance and repairs, revolutionize designs, and provide adaptive capability; improving our ability to monitor and assess critical coastal and watershed landforms and structures at sufficient resolution to inform future engineering decisions through development and application of remote sensing technology; quantifying engineering performance of natural and nature-based features; and performing basic research and development on a broad range of coastal and hydraulics topics. We recognize the value of far-sighted, high-payoff, high-risk research that provides the basis for technological progress and the advancement of our fundamental understanding of broadly applicable phenomonea within coastal and hydraulics science and engineering. We will bring together collaborative teams that reach out to the larger community to develop strategies to tackle interdisciplinary problems.

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