

Development of an Integrated Watershed and Surface Waterbody Decision Support Systems to Support DoD Civil Works and Military Programs

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The U.S. Army Corps of Engineers (USACE) Engineering Civil Works and Military Missions

Civil Works

- **Serve the public by providing quality, responsive service to the Nation**
- **Development and management of the Nation's water resources**
- **Support of commercial navigation**
- **Restoration, protection and management of aquatic ecosystems**
- **Flood risk management**
- **Engineering and technical services in an environmentally sustainable, economic, and technically sound manner with a focus on public safety and collaborative partnerships**

Military

- **Provide programmatic policy and management of the worldwide military construction programs assigned to USACE as a designated DoD construction agent with responsibility for delivery of facilities and infrastructure supporting the Army, Air Force, and Defense Agencies.**
- **Support Overseas Contingency Operations.**



Integrated Decision Support System (IDSS) for Water Quality Management (IDSS-WQ) – Civil Works

Problem Statement

Harmful algal blooms are a major environmental problem in all 50 states.

Significant increases in algae harm water quality, food resources and habitats, and decrease the oxygen that fish and other aquatic life need to survive.

Large growths of algae can severely reduce or eliminate oxygen in the water, leading to illnesses in fish and the death of large numbers of fish.

Some algal blooms are harmful to humans because they produce elevated toxins and bacterial growth that can make people sick if they come into contact with polluted water, consume tainted fish or shellfish, or drink contaminated water.



Integrated Decision Support System (IDSS) for Water Quality Management (IDSS-WQ) – Civil Works

Technical Approach

Texas A&M will work with the USACE-ERDC and LimnoTech Inc. to integrate the hydrologic watershed and landscape modeling capabilities of the Soil and Water Assessment Tool (SWAT) with ERDC's CE-QUAL-W2 Reservoir Model and the Clearwater 1D/2D Riverine Water Quality Model to provide a systems wide approach to water quality management.

Research will be done in order to model complex water quality cycles, with emphasis on Harmful Algal Blooms (HABs), as well as other historic and emerging contaminants of concern.

Use of the integrated modeling system will be greatly facilitated by incorporation into an advanced version of the HAWQS user interface/platform, which will facilitate its use by EPA and state and local environmental agencies.



System Wide Analysis



Integrated Decision Support System (IDSS) for Water Quality Management (IDSS-WQ) – Civil Works

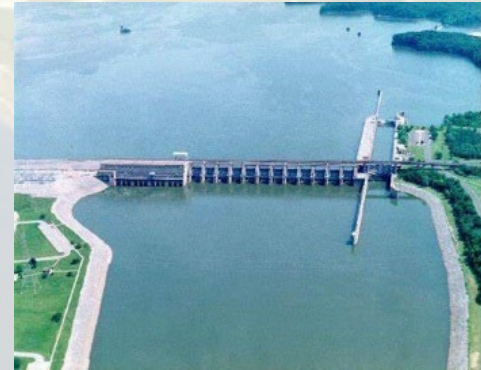
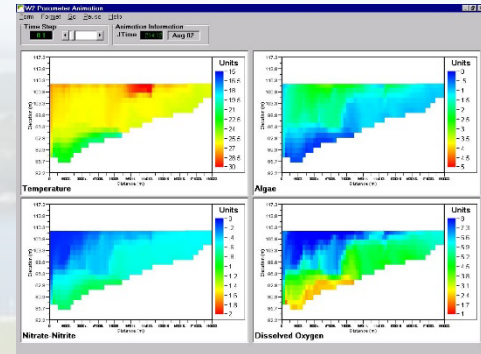
CE-QUAL-W2

CE-QUAL-W2 is a water quality and hydrodynamic model in 2D (longitudinal-vertical) for rivers, estuaries, lakes, reservoirs and river basin systems. W2 models basic eutrophication processes such as temperature-nutrient-algae-dissolved oxygen-organic matter and sediment relationships.

Model Capabilities: Longitudinal-vertical hydrodynamics and water quality in stratified and non-stratified systems, nutrients-dissolved oxygen-organic matter interactions, fish habitat, selective withdrawal from stratified reservoir outlets, hypolimnetic aeration, multiple algae, epiphyton/periphyton, zooplankton, macrophyte, CBOD, sediment diagenesis model (Version 4), and generic water quality groups, internal dynamic pipe/culvert model, hydraulic structures (weirs, spillways) algorithms including for submerged and 2-way flow over submerged hydraulic structures, dynamic shading algorithm based on topographic and vegetative cover.

Model Limitations: Well-mixed in lateral direction (but can be used in a Quasi-3-D mode by use of additional model branches), hydrostatic assumption for vertical momentum equation.

Model Training: The next W2 workshop is scheduled for July 18-20, 2023, Denver, CO.



Integrated Decision Support System (IDSS) for Water Quality Management (IDSS-WQ) – Civil Works

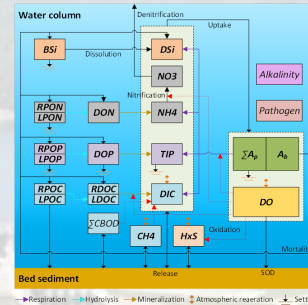
Clearwater (Corps Library for Environmental Analysis and Restoration)

Clearwater is a library of environmental simulation software that leverages the capabilities of existing water resource simulation models to assess environmental impacts and design solutions to manage and restore aquatic ecosystems.

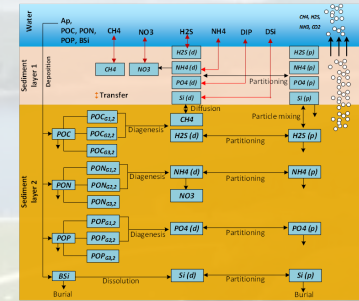
Environmental Modules:

- NSM – Nutrient Simulation Module
- TSM – Temperature Simulation Module
- MSM – Mercury Simulation Module
- CSM – Contaminant Simulation Module
- SSM – Solids Simulation Module
- RVSM – Riparian Vegetation Simulation Module

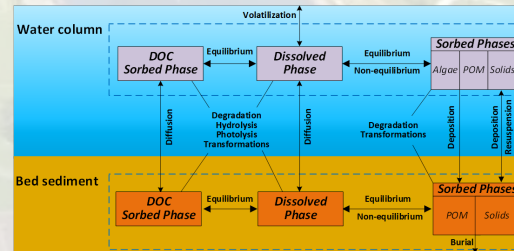
NSM



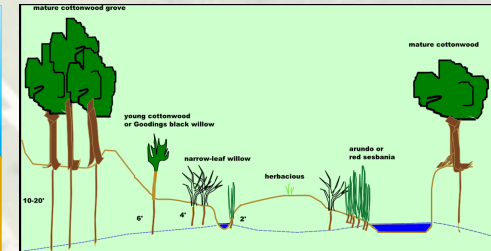
Sediment Diagenesis



CSM



RVSM



Integrated Decision Support System (IDSS) for Water Quality Management (IDSS-WQ) – Civil Works

Payoff

The payoff from this research and development will be an analytical tool (the IDSS-WQ) that can be used by the USACE districts/division offices, states and EPA to identify sources of many of these impairments and develop cost-effective remediation plans, including for HABs.

In addition, the IDSS-WQ will provide information needed by water managers to protect raw drinking water supplies, reduce costs of drinking water treatment, avoid or manage HABs, and protect commercial and recreational fisheries.

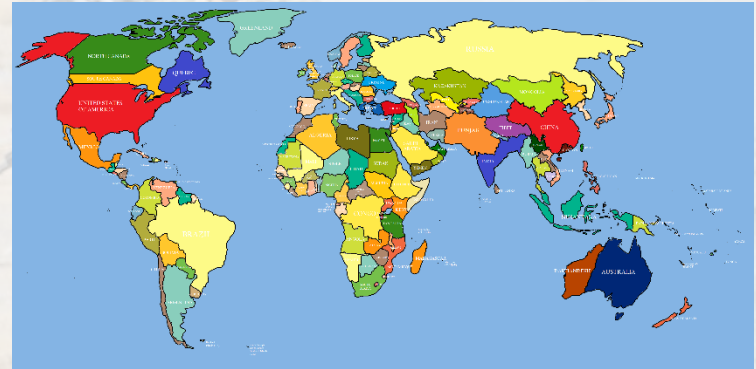
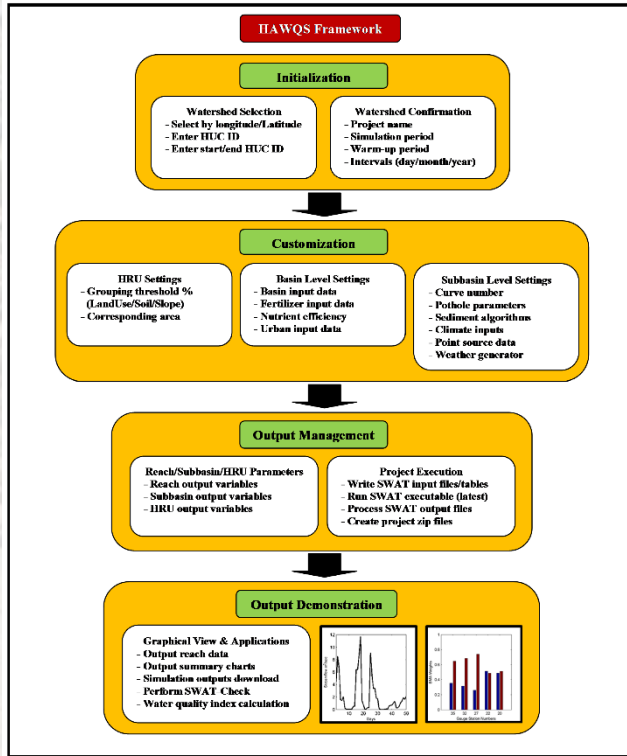
The project also addresses community interests in environmental protection and health, consistent with the AgriLife Strategic Plan.



Weather Risk Assessment Tool (WRAT) - Military

Problem Statement

For military planners, broad hydrologic awareness is needed to support various joint capability areas (e.g. battlespace awareness, protection from natural hazards by mitigating exposure and risk, ensuring logistics, and facilitating partnership building) by utilizing decision aids related to environmental features.



Global Analysis

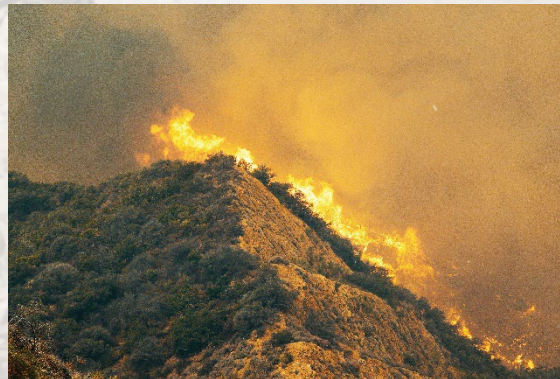
Weather Risk Assessment Tool (WRAT) - Military

Technical Approach

The WRAT will address the US Military's need to have an easily used tactical (days to weeks) and strategic (years to decades) decision support system to assess extreme weather and climate risks (including floods, droughts, hurricanes, anomalous monsoons, extreme temperatures, water pollution, soil trafficability, dust storms, wildfires, and other weather-related phenomena) that could affect military training and other operations on US military bases and other areas of interest in the United States, Africa, the Middle East, and South Asia.

We will build on our previous research in the United States, Middle East, Africa and South Asia to implement and transfer the WRAT to the US Military. This easily used decisions support system will combine the capabilities of:

- the Soil and Water Assessment Tool (SWAT+) hydrologic, water quality, and agricultural production model,
- the CE-QUAL-W2 reservoir water quality model
- the Clearwater 1D/2D riverine water quality model, and
- the Hydrologic and the Water Quality System (HAWQS) user interface and data management platform.



Weather Risk Assessment Tool (WRAT) - Military

Payoff

The payoff from this research and development will be the integrated Weather Risk Assessment Tool (WRAT) for use by the US Military and other government and non-governmental agencies to predict the risks of extreme weather-related events and climate change on hydrology (floods and droughts), water quality, soil trafficability, dust storms, wildfires, extreme temperatures, and other weather-related phenomena.

We anticipate that wise use of the WRAT will save lives and improve operational capabilities of US Military personnel and their collaborative partners.



Questions

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