

Water Quality Modeling and TMDL Development for the Illinois River Watershed

Sponsored by
EPA Region 6
Dallas, TX

EPA Contract EP-C-06-029, WA 3-36

Performed by
AQUA TERRA Consultants (Prime Contractor)
Mountain View, CA

Project Initiation Meeting
November 20, 2009

Arkansas/Oklahoma Illinois River Watershed Modeling

Project Team

- AQUA TERRA Consultants
 - EPA Prime Contractor for BASINS/WQ Modeling Support (Contract No. EP-C-029-06)
- Subs:
 - Eco Modeling – AQUATOX Developer
 - R. Srinivasan, TAMU – SWAT Developer
- Additional Subs available on this contract, as needed:
 - Dynamic Solutions LLC
 - Tetra Tech – EFDC Developer

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Project Tasks

- Work plan development and project management
- Quality assurance project plan development
- Data compilation and assessment Currently authorized, Thru 3/31/10
- GIS/geospatial database development
- Watershed/WQ model selection and development
 - Phase I – Simulation Plan Development
 - Phase II – Model setup and calibration/validation
- Scenario development, simulation, and analyses

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SWAT – USDA’s Soil and Water Assessment Tool

- Physical based, watershed scale model
- Developed to predict impacts of land management practices on water, sediment, and agricultural chemical yields in large complex watersheds
- BASINS 3.1 version closely tied to ArcView’s scripting language; BASINS 4.0 compatible version coming in a future update
- Expedites set-up process for SWAT users, and provides BASINS with another sophisticated watershed model

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EFDC - Environmental Fluid Dynamics Code

- Multi-dimensional (1D, 2D, 3D) hydrodynamic/WQ model
- Represents a multi-order stream network
- Incorporates variable cross-sectional bathymetry
- Simulates out-of-bank runoff events
- Open source, through EPA, since 1990’s

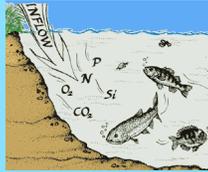
.....one of the most widely used and technically defensible hydrodynamic models in the world.....(EPA, Ecosystems Research Div., Athens, GA)

Links hydrodynamic and sediment transport modeling which more accurately predicts the sediment transport that occurs during a rainfall induced high-flow runoff event.

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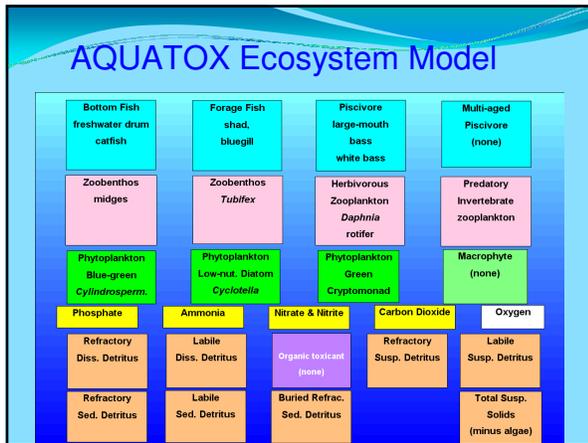
AQUATOX

- A simulation model for aquatic ecosystems
- Predicts the environmental fate and ecological effects of the various environmental stressors
- Fish, invertebrates, and aquatic plants
- Biological effects
 - food consumption
 - growth and reproduction
 - natural mortality
 - acute and chronic toxicity
 - trophic interactions
- Environmental fate
 - nutrient cycling and oxygen dynamics
 - partitioning of organic toxicants to water, biota and sediments
 - toxic organic chemical transformations
 - bioaccumulation through gills and diet
 - impacts of suspended and deposited sediments



“This model [AQUATOX] is a valuable tool for ecologists, biologists, water quality modelers, and anyone involved in performing ecological risk assessments for aquatic ecosystems.”
US EPA

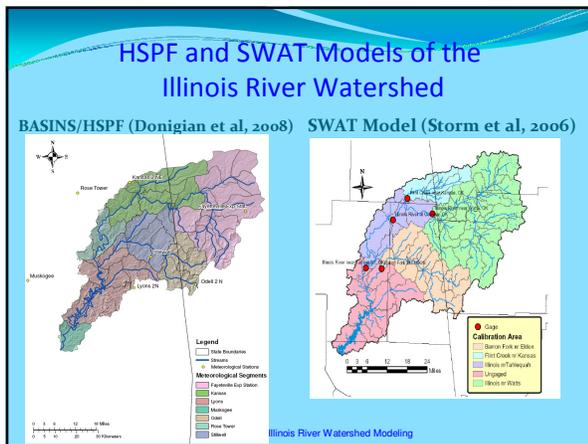
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HSPF/SWAT Comparisons

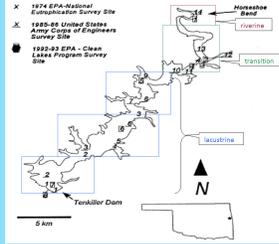
<p>BASINS/HSPF</p> <ul style="list-style-type: none"> • Hourly time step typical • Multi-land use capabilities • Strong hydrology module • Current IL River application uses simplified processes • Detailed AGCHEM available • Detailed instream routing and WQ processes • Moderate spatial resolution with ~40 subbasins 	<p>SWAT</p> <ul style="list-style-type: none"> • Daily time step typical • Multi-land use, but strength is agricultural • SCS CN hydrology • Detailed ag practices included • IL River application includes poultry litter contributions • Simplified instream processes • Moderate spatial resolution with ~90 subbasins
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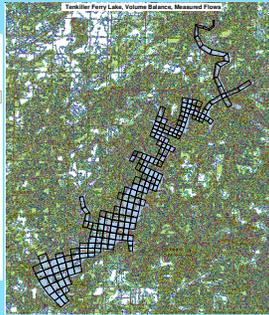


Models of Tenkiller Lake, OK

AQUATOX Model



EFDC Model



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AQUATOX Tenkiller Lake Application

- Linked Model application includes nine segments
 - Riverine segment
 - Vertically stratified transitional segment
 - Three vertically stratified lacustrine segments
- Model linkage to HSPF (watershed) and EFDC (in-lake hydraulics) models
- Model can predict chlorophyll *a* and dissolved oxygen levels and changes in composition of biota based on nutrient loadings (BMPs)

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AQUATOX/EFDC Comparisons

AQUATOX

- Detailed ecosystem model
- Multiple biotic compartments/processes
- Compartmental model with transfers – can be linked to a hydro model
- Limited spatial definition
- Highly efficient run times
- Has been applied to Tenkiller and numerous other lakes

EFDC

- Detailed hydrodynamic, sediment, and WQ model
- Multi-dimensional
- Limited biotic compartments up to algal level
- High spatial definition
- Computationally intensive
- Has been applied to Tenkiller, other lakes in OK, and elsewhere

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Data Needs (Preliminary)

- Precipitation (to extend simulation period thru 2007/8)
- Meteorologic data – to extend simulation
- Flow and WQ data (other than USGS), especially on the AR side of watershed
- Point sources – daily discharge and WQ values preferred
- Poultry litter practices and management
- NPS loadings studies and rates
- SWAT 2009 Report and model files
- Future scenario descriptions

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Quality Assurance Project Plan (QAPP)

Program Authority and Development Procedures

- Work being performed under auspices of EPA OST Contract “Technical Support for BASINS and the Water Quality Standards Program”
- Governed by AQUA TERRA’s contract QMP
- Customized QAPP developed for work effort, reviewed and approved by OST and by Region 6

As part of development process and prior to final approval...

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“QAPP Must be Coordinated with States to Assure Compliance with their Modeling Technical Documents”

ADEQ “State of Arkansas Continuing Planning Process” (2009)

- limited guidance on modeling methods/LOE expected for TMDL effort

OKDEQ “Continuing Planning Process” (2006)

- modeling effort dependent on system complexity, potential for environmental impact, sensitivity to POCs
- SOW corresponds to “Level 2”, or “Calibrated Model” effort

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General Modeling QAPP Requirements: organizational QA, project description, project task organization, model documentation, quality of data, model setup/calibration , project documentation

Custom QAPP Components for this Project:

- Flow & WQ Data (point and NPS characterizations)
- GIS Data Layers
- Model Selection
- Model Development
- Calibration/Validation Procedures
- Performance and Acceptance Criteria

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