GIS and Water Resources II

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Applications of GIS in Water Resources Management

- Remote Sensing
- Watershed management
- Flood management
- Groundwater
- Water quality
- Permitting

Remote Sensing

- Use of aerial photography and/or satellite imagery to assess water resources
- Allows rapid assessment of large areas, and selection of subsets for detailed analyses
- Water has distinctive spectral properties; water absorbs radiation – in infrared imagery, water appears black
- Water quality can also be picked up from remote sensing – turbidity and/or depth

Remote Sensing

- Provides a static ‘snapshot’ of water conditions; not an active system like stream monitoring gauges, etc
  - Strong temporal scale component
- Used for:
  - Flood plain delineation
  - Flood assessment
  - Monitoring changes in stream channels
  - In association with traditional GIS, can provide information for all GIS/Water Resources projects

Watershed Management

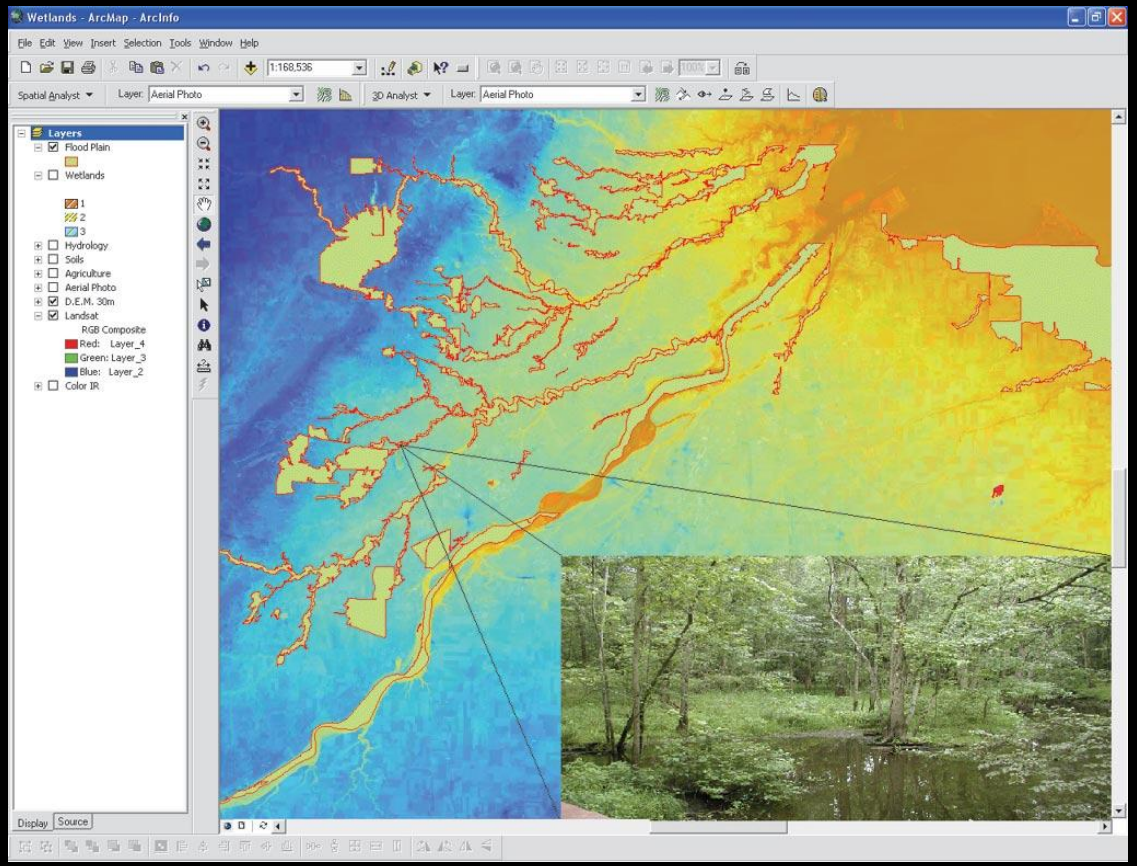
- Terrain modeling
- Flow modeling
- Debris flow probability

Watershed Management

- Terrain modeling
  - Creation of DEMs
  - Automated watershed extraction from topography
  - Flow determination – direction and accumulation

Watershed Management

- Flow modeling
  - Flow direction and accumulation
  - Contributing area analysis
  - Stream-ordering



A transport digital elevation model (DEM) helped determine detailed drainage patterns. Green with red outline represents 100- and 500-year floodplains. Riparian picture insert is a common display of vegetation along stream banks examined. A color infrared image below all data layers provides land cover references. Erie, PA, from ArcUser Summer 2004 Issue

Watershed Management

- Debris flow probability
  - Saturation and viscosity calculation

Flood Management

- Flood plain delineation
- Channel characteristics
- Inundation modeling
- Infrastructure analysis
- Risk modeling and mitigation

Flood Management

- Flood plain delineation
  - Use of satellite imagery
  - Assessment/modeling of topography
  - Soil
  - Hydrology

Flood Management

- Channel characteristics
  - Channel cross-section
  - Channel length
  - Channel shape
  - Changes over time
  - Channel erosion and depositional features

Flood Management

- Inundation modeling
  - Prediction of return periods
  - Simulation of models on contemporary situation
  - Assessment of potentially flood-prone sites
  - Implementation of mitigation measures
    - Large-scale and small-scale mitigation

Flood Management

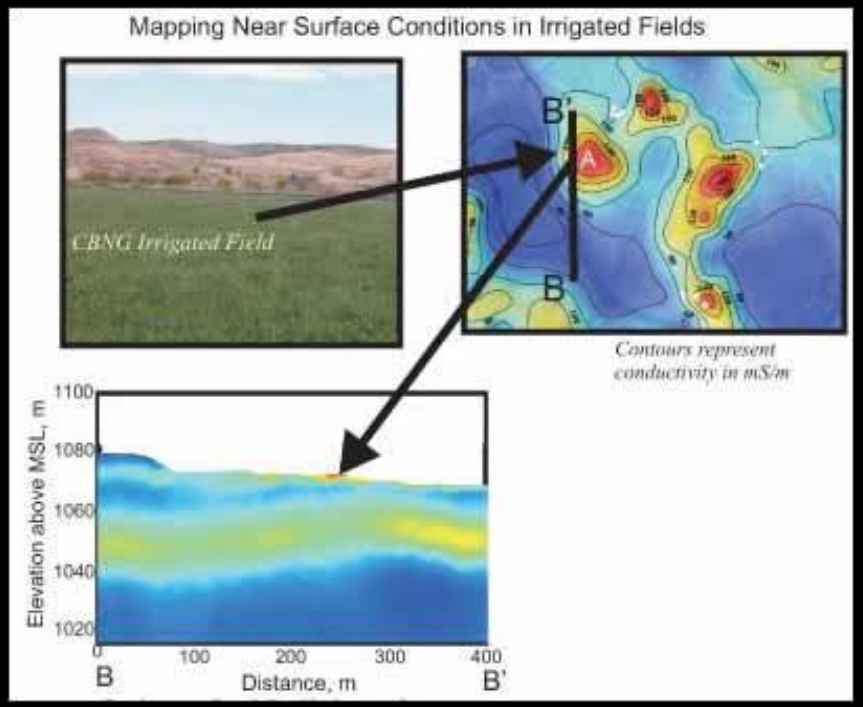
- Infrastructure analysis
  - From analysis of inundation models, determine effects on infrastructure
  - Assessment of bridge and other structures that span river channels
  - Assessment of dykes and other mitigation structures that run parallel to channel
    - Effects of these on sedimentation and erosion processes downstream
  - Assessment of road and other critical networks and facilities with respect to flood hazards

Flood Management

- Risk modeling and mitigation
  - From inundation models and infrastructural analyses, can compute risk factors, and determine probabilities, return periods, and acceptable risk
  - Can begin planning appropriate engineering mitigation plans
  - Mitigation can range from legislation (zoning) to engineering
  - All have to consider socio-economic realities with respect to:
    - Demand for land for development
    - Cost of implementing mitigation
    - Environmental impact of mitigation downstream

Groundwater

- Modeling subsurface flow – rate, advection, concentration
- Well and spring models



Water Quality

- Management of surface and subsurface water
- Use of GPS and photographic tie-points
- Use of passive and active water quality monitoring systems

Water Quality

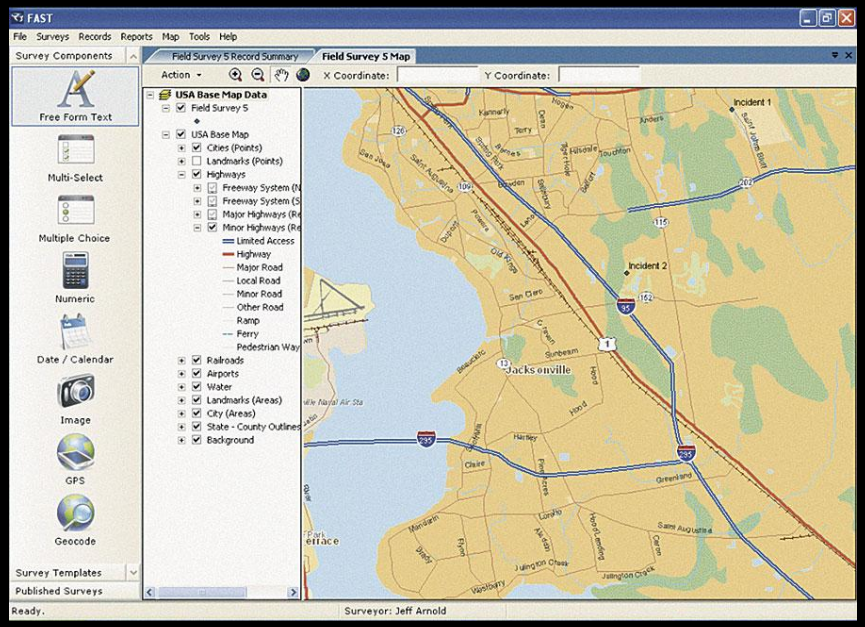
- Management of surface and subsurface water
  - Instrument-based assessments
  - Used in conjunction with GIS/GPS, ties location of sample collection to map to show patterns and distributions
  - Water quality measurements of oxygen, pH, bacterial content, etc
  - Measures flow rates and turbidity

Water Quality

- Use of GPS and photographic tie-points
  - Hot-linking functions relate pictures, reports, and tables for each location within a single system
  - GPS transmission can relay real-time information on water flow and quality

Water Quality

- Use of passive and active water quality monitoring systems
  - Depends on costs and risk; may not need advanced active system on a river that floods often, but is far from any settlement or developments
  - Need to consider quantity of measuring stations; more stations equal greater detail and accuracy but greater cost



Permitting

- Population and consumption demand analyses and forecasts
- Water quality modeling
- Flow analyses
- EIA and development review and approval
- Engineering

Permitting

- Population and consumption demand analyses and forecasts
  - Consider population and consumption characteristics as end users of water resources
  - Includes domestic, commercial, industrial and civil uses
  - Need to know the location and distribution of these

Permitting

- Water quality modeling
  - Level of quality monitoring is a function of the use of the resource
  - Water may be used for:
    - Generation of hydro-electricity
    - Agricultural irrigation
    - Human consumption

Permitting

- Flow analyses
  - Looks at:
    - Rate of flow of water for downstream flood control
    - Content and concentrations of dissolved and suspended particles for pollution control and sedimentation analyses

Permitting

- EIA and development review and approval
  - Important when considering major infrastructural development within watersheds and along rivers or flood plains
  - Downstream impacts important
  - Range from major capital development projects, such as dams, to smaller activities such as sand-mining
  - Implications may extend to other jurisdictions, locally and internationally

Permitting

- Engineering
  - For:
    - Generation of hydro-electricity
    - Agricultural irrigation
    - Human consumption
    - Flood control
    - Transport
    - Extraction of resource
  - Consider topography and other natural physical elements, and population/demand centres to determine means to supply resource from source

SITE LOCATION MODEL FOR CBNG IMPOUNDMENTS