Emerging Environmental Solutions Using GIS for the Transportation Industry

Kimberly Majerus, nationwide FHWA-Resource Center, at the Olympia Fields, IL office
GIS-T 2006: Presentation Topics

Environmental Solutions using GIS:
- Approach
- Developing Technology Solutions
- Example Solutions
- Analyses and Integrated Methods
- Factors for Success
- Questions?
Approach: Environmental Solutions

GIS Solutions are being used for:
- Long-range planning cycles (every 4 to 5 years)
- Project delivery cycles
- Environmental Commitments and Mitigation
- Interagency coordination/Public involvement
- Construction and Maintenance and Operations
- Improved decision-making
Environmental Solutions: Examples

IL Dept of Trans, (IDOT) District One

Integrated Environmental Survey Request

GIS Solutions to fulfill IL DOT BDE Manual
I80/94: EA Environmental Inventory Map

Integration of Environmental Studies in One Map
IDOT District One and GIS for the Environmental Survey Request (ESR) Cycle

Information needs:

- What, where, when, why, who, how, many
- In-house study aerial photos, maps, sources and GIS
- If needed, field studies, GPS, and GIS
Environmental Solutions Using GIS for the Transportation Industry

Example:
Development of Data and Technologies
Use of Technology – How do we get there?

Technology Life Cycle to Match User Needs

Step One:
Identify Users & User Needs

Assess Data Needs and Scale (spatial & temporal)

Identify Available Data, Methods, Tools & also Gaps

Select Existing Data & Tools & Eval Need for New Ones

Life Cycle to Match User Needs

Design & Develop Data and Tools & Maintenance Plan

Deliver Solutions & Tools & Measure Benefits
National Spatial Data Infrastructure: Available Data

Sources of free, downloadable data from the web-

National Atlas: nationalatlas.gov

GeoSpatial OneStop www.geospatialonestop.gov

National Map: www.nationalmap.gov
Develop, Manage, Use - Data at Various Levels

Regional & National

County/Parish

Local Data & Uses

Available for:
- Data exchange,
- Aggregation,
- Multi-level,
- Multi-purpose Analyses
- Metadata use

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Free Imagery Solution: Orthophotographs

Geographically referenced to the earth

*black/white or color of various scales*

Presence of

- Wetlands?
- Agriculture?
- Displacements?

Download from IL Geospatial Data Clearinghouse

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Free, downloadable data used with GIS, Computer Maps & Documentation

Geographic Information System (GIS)

Arc Explorer - FREE

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Free, downloadable data used with GIS, Computer Maps & Documentation

Geographic Information System (GIS)
IL I80/94: EA Environmental Inventory Map (could have been done with GIS)
Example

For Individual Topic:
Endangered Species and Wildlife
“Suddenly, Bobby felt very alone in the world.”
Before GIS:
- Paper maps
- Hand written notes

Legally protected species and wildlife habitats

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DCR-DNH Conservation Sites and Stream Conservation Units

VA with GIS & can integrate further
GIS Example for Legally Protected Species and Wildlife Habitat and 4 (f)

Downloadable - National Spatial Data Infrastructure

Source: US Fish and Wildlife Service (US FWS)
- US FWS National Data Sets
- Internet Map and Data Server (IMADS)
- National Wildlife Refuge Boundaries
- Wetlands Mapper (NWI maps)
- Public Roads – Wildlife refuges

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Environmental TEMPORAL dynamic

Example: Migratory Wildlife from web search

Peregrine falcon

Activities & Location Changes with seasons

Source: www.natureserve.org
Example

For Individual Topic:
Wetlands and 404 Permits
GPS to GIS & CADD

Wetland Delineations, Wetland Impact Assessments, & 404 Permits

Clean Water Act, Section 404:
Sequence as hierarchy of steps:

1. Avoid - first, then
2. Minimize impacts, then
3. Compensatory mitigation
Question: What happens to wetland info and boundary delineations in your organization?
Integrate with
NWI Wetlands, & Floodplains
Free, downloadable GIS & Computer Maps
Wetland GPS data to GIS & CADD Project Delivery Cycle

Can use Global Positioning Systems (GPS) to delineate wetland boundaries in the field
(check Corps of Engin & state requirements)

- Prepare and deliver GPS data for -
- Download GPS data to use in GIS and CADD
- For project delivery cycle

Available: Example language for delivery of geospatial data by private sector and in-house staff

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Approach: Natural Environment, Natural Foundation

IL, Glaciers – 10,000 yrs ago - then Landforms

Weathering through time

Existing: Oak Savanna

Natural Environment

- Topography
- Slope
- Soils
- Parent Material & Geology
- Hydrology & Drainage
- Vegetation (example, wetlands)
Natural foundation for projects: stream and road locations (example)
GIS for site selection for wetland bank sites and mitigation sites
Environmental Solutions Using GIS for the Transportation Industry

Example

For Individual Topic:

Special Waste

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GIS Solutions for Special Waste Issues

IL DOT contracted with the IL State Geological Survey.

Developed a special waste database and GIS tool for IL DOT.
Special Waste: US EPA GIS

CERCLIS Sites Map from USEPA Web Site Source

Dynamic: Contamination moved downstream from release point
Examples:

Analyzing and Integrating Individual Topics/Map Themes
Integrated Solutions and Decisions

Transportation Safety

Congestion Management

Intermodal solutions

Air Quality and Noise and other Issues

Biological and Wetland Resources

Special Waste Issues

Cultural Resources

GIS

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GIS to Integrate Maps, Data, Tools, Decisions, People

- Spatial and Temporal Analysis
- Predictive Modeling
- What-if scenarios
- Calculate cumulative geospatial “surfaces”
- “Least-cost” analyses
- Integrated analyses and outputs
Texas Integrated GIS Results: Conduct calcs for “Scored Map (cost surface)”

Integrated results merged by priority for Quantm analysis

Cumulative results based on specified fields

Quantm cumulative results classified

Zones merged by selected priority for Quantm analysis from 15-22 as defined by planning team
Texas Integrated GIS Analysis:
Finds lowest values/lowest scored values on Calc’d map

Merged polygons exported to Quantm

Merged and imported GISST zone (Avoid)
### Scenario Evaluations for Transportation Planning and Alternatives Analysis

**NatureServe**

#### FHWA HQ Initiative With Pilot States

#### Scenario Evaluation: Proposed Wilderness Plan

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Proposed Wilderness</th>
<th>Policies considered to offer “Protection”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell sizes</td>
<td>500 square meters</td>
<td>Land use Compatibility and Protection Policies</td>
</tr>
</tbody>
</table>

- Legally mandated land use
- Statutorily mandated land use plan
- Individually managed easement or holding
- Land use restricted by regulations

#### Summary

<table>
<thead>
<tr>
<th>Goals Met For</th>
<th>% of Goals Met</th>
<th>Goals Unmet</th>
<th>% of Goals Unmet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected and Compatible</td>
<td>24 elements</td>
<td>65.16%</td>
<td>14 elements</td>
</tr>
<tr>
<td>Compatible</td>
<td>29 elements</td>
<td>89.71%</td>
<td>13 elements</td>
</tr>
</tbody>
</table>

#### Results by Scientific Taxonomy

<table>
<thead>
<tr>
<th>Name</th>
<th>Protected and Compatible</th>
<th>Goal Met For</th>
<th>Goal Met For</th>
<th>Compatible</th>
<th>Goal Met For</th>
<th>Goal Met For</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown (38 elements)</td>
<td>24 elements (65.16%)</td>
<td>14 elements (34.84%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Element details

<table>
<thead>
<tr>
<th>Name</th>
<th>Area (hectares)</th>
<th>Percent</th>
<th>Goal Met</th>
<th>Area (hectares)</th>
<th>Percent</th>
<th>Goal Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>unknown</td>
<td>6,629,000</td>
<td>100%</td>
<td>6,629,000</td>
<td>100%</td>
<td>6,629,000</td>
<td>100%</td>
</tr>
</tbody>
</table>

Abbreviations & Icons

- "Goal has been met (100%)
- "Goal has almost been met (90% - 99.9%)
- "Goal has not been met (less than 90% has been met)
GIS Predictive Modeling: Atmospheric Deposition Deicing of Roads with Salt (NaCl)

GIS Model Simulations: Baseline
Salt deposition before construction of I-355 South Extension

Predicted Model Results: After construction

New I-355 Extension
Environmental Solutions Using GIS for the Transportation Industry

Factors for Success
Use of Technology – How do we get there?

Technology Life Cycle to Match User Needs

**Step One:**
- Identify Users & User Needs

*Deliver Solutions & Tools & Measure Benefits*

*Assess Data Needs and Scale (spatial & temporal)*

*Design & Develop Data and Tools & Maintenance Plan*

*Identify Available Data, Methods, Tools & also Gaps*

*Select Existing Data & Tools & Eval Need for New Ones*
Formula for Success: Using GIS for In-House and Contracted Work

- Determine - how will data and GIS be used

- Measure benefits of GIS: before and after

- Can focus on one topic but keep the door open for integrated analyses and decisions
Formula for Success (cont): Using GIS for In-House and Contracted Work

- Match scale & complexity to the decision
- Include flexibility and scalability
- Pursue consistency in data development & delivery
- Useful data is available and downloadable for free
TRB DISCUSSION OF DATA AND GIS: SAFETEA-LU
Conference on Data Implications

Topic White Paper for SAFETEA-LU Provisions for Planning, Policy, and Environment

Downloadable at:
http://www.trb.org/Conferences/ReauthorizationData/Planning-Policy-Environment.pdf
Questions ?