Creating a Distributed NATional CARB on Sequestration Database and Geographic Information System (NATCARB)
An Incomplete Author List

• Timothy R. Carr, Jeremy D. Bartley, Azif Iqbal  
  – Kansas Geological Survey, University of Kansas
• James J. Dooley, Robert T. Dahowski  
  – Pacific Northwest National Laboratory
• David S. Cheng  
  – Massachusetts Institute of Technology
• Christopher P. Korose, Damon Garner  
  – Illinois State Geological Survey
• Richard Nelson  
  – Engineering Extension, Kansas State University
• Barry V. Biediger  
  – State of Utah Automated Geographic Reference Center (AGRC)
• Joseph Wells  
  – Ohio Geological Survey
• And Many Others
Goals

• Distributed National Database of Carbon Sequestration
  – MIDCARB ==＞ NATCARB

• Federation of Map Servers
  – Distribute the management
  – Distribute the computer resources/activity
  – Distribute the metadata

• Intelligent Portal
  – Interoperability through web mapping services
  – Tools to access and analyze the distributed data

• Partners
  – Increased synergy and communication among regions
The MIDCARB (Midcontinent Digital Carbon Atlas and Relational DataBase) Carbon Sequestration Project

www.midcarb.org
MIDCARB Project Goals

• Characterize Major CO₂ Sources
  – Quantity, Quality, Location
• Characterize Potential Sequestration Sites
  – Geology and Reservoir Characteristics
• Develop Relational/Spatial Databases
  – Local and Regional Reporting Levels
• Supply this data to the public
  – For use as tools in cost/feasibility analyses, etc.
Carbon Sequestration Database

Background
Carbon Sequestration Database

Background
Carbon Sequestration Database

Background
Carbon Sequestration Database

Background

ColdFusion Data Pathways:

Query RDBMS

Return Results

RDBMS

Illinois (Oracle)

Indiana (SQL Server)

CF Server

Kansas (Oracle)

Kentucky (SQL Server)

Ohio (SQL Server)

ArcIMS

ColdFusion Request

ColdFusion Report

Web browser
Carbon Sequestration Database

Background

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Carbon Sequestration Database

Background

• 125 different layers from five different databases.
• No background database of metadata. The database was the AXL file.
• Hard to incorporate dynamic tools:
  – Table of contents, Graphing
  – Built on lists of codes in javascript parameters file.
• Requests to multiple onsite databases for spatial data can be a performance bottleneck!
  – Performance heavily dependent on the off-site network speed for each server.
• SDE/ODBC Connections through a firewall problematic.
National Database For Carbon Sequestration

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Federation of Web Mapping Services

What are the advantages of a distributed national database?

- De-centralization of metadata and data
- Local control over data layers (maintain, enhance, add)
- Portal is easily customized
- Data requests & structures are driven by XML (IMS-XML)
- Server Resources are split among different computers
- Portal can request data in a multithreaded fashion
- Portal can be interoperable with different databases in different formats
- Interaction among GIS/IT personnel across partnerships
- By incorporating and cooperating now we can answer national scale questions in the future
Metadata

• Portal serves as a central metadata repository and catalog:
  – Spatial information and data types are driven by local IMS servers
  – Repository allows for detailed information about models/datasets/calculations to be entered by the user and stored in the portal

• Regional partner requirements:
  – Publish data through ArcIMS
    • or Open GIS Consortiums (OGC) Web Mapping Service (WMS) and Web Feature Service (WFS)
  – Metadata publishing is pushed to the partnerships

• Distribute the management of the system to each partnership
Metadata: Map Service Application

MIDCARB Mapservice data entry

Add Server | Add Layer | Add Column | View Server | View Layer | View Column

Please Enter name and port of server you want to add

Server Name: ims-dev.isgs.uiuc.edu
Port: 5300

submit
Metadata: Map Service Application

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Metadata: Map Service Application

Please enter information below to complete the addition of drysdale.kgs.ku.edu to the server list:

- Server Name: IMS-dev.isgs.uiuc.edu
- Service Name: M300
- Map service Name: NG_Logs
- Region: Other
- States Served: Illinois, Indiana, Iowa
- Can portal access Map Server?: Yes
- Contact Person: Chris Korose
- Contact Number: 111-111-1111
- Contact Email: korose@ui.edu
- Username for contact person: korose

Submit
Metadata: Map Service Metadata Application

Add Layer Page - Microsoft Internet Explorer

MIDCARB Mapservice data entry

| Add Server | Add Layer | Add Column | View Server | View Layer | View Column |

21 server(s) found in database
Please select server to which you want to add a layer and click next

corona.isgs.uiuc.edu - natcarb_ib_co2fac_test

going
### MIDCARB Mapservice data entry

Showing Layers for natcarb_ib_co2fac_test on corona.isgs.uiuc.edu

<table>
<thead>
<tr>
<th>select</th>
<th>layernname</th>
<th>ID</th>
<th>minscale</th>
<th>maxscale</th>
<th>minx</th>
<th>miny</th>
<th>maxx</th>
<th>maxy</th>
<th>layertype</th>
<th>featuretype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add Layer</td>
<td>IL Basin clipped</td>
<td>3</td>
<td>2491256.47309166</td>
<td>1269576.77737318</td>
<td>4188522.84051957</td>
<td>3166026.65101285</td>
<td></td>
<td></td>
<td>featureclass</td>
<td>polygon</td>
</tr>
<tr>
<td>Add Layer</td>
<td>MGSC Counties</td>
<td>2</td>
<td>2410933.67901281</td>
<td>1269576.71084634</td>
<td>5202522.67537691</td>
<td>3532124.38279832</td>
<td></td>
<td></td>
<td>featureclass</td>
<td>polygon</td>
</tr>
<tr>
<td>Add Layer</td>
<td>MGSC States</td>
<td>1</td>
<td>2410933.72643623</td>
<td>1269576.65043692</td>
<td>5202522.63177404</td>
<td>3532124.40924466</td>
<td></td>
<td></td>
<td>featureclass</td>
<td>polygon</td>
</tr>
<tr>
<td>View Layer</td>
<td>CO2 Facilities</td>
<td>0</td>
<td>2574462.53726404</td>
<td>1375722.71209232</td>
<td>5003409.25302528</td>
<td>3471730.51466225</td>
<td></td>
<td></td>
<td>featureclass</td>
<td>point</td>
</tr>
</tbody>
</table>
Metadata: Map Service Metadata Application

Adding Information for layer MGSC Counties for natcarb_ib_co2fac_test on corona.isgs.uiuc.edu

- List of layer types: CO2 Sources
- Display Name: MGSC Counties
- Layer Group: None
- Is layer queryable?: Yes
- Layer Source: None
- Can Layer be identified?: Yes
- Column to use for rendering: OBJECTID
- Layer Authentication: Full access
- Is Layer Visible on Viewer?: Yes

Detailed Metadata

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Metadata: Map Service Metadata Application

MIDCARB Mapservice data entry

Choose the Mapservice containing the layer to which you want to add columns and click submit

drysdale.kgs.ku.edu - KS_MIDCARB

Showing layers for drysdale.kgs.ku.edu
Select layer for which you want to add columns and click next

KS - Weir-Pitt Structure
### MIDCARB Mapservice data entry

**Showing columns for layer KS - Weir-Pitt Structure of KS_MIDCARB on drysdale.kgs.ku.edu**

<table>
<thead>
<tr>
<th>Add data</th>
<th>Name</th>
<th>Precision</th>
<th>Size Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add Column</td>
<td>MIDCARB.STRCT_WPIT_UTM15_83.ID</td>
<td>featureclass</td>
<td></td>
</tr>
<tr>
<td>Add Column</td>
<td>MIDCARB.STRCT_WPIT_UTM15_83.GRIDCODE</td>
<td>featureclass</td>
<td></td>
</tr>
<tr>
<td>Add Column</td>
<td>#SHAPE#</td>
<td>featureclass</td>
<td></td>
</tr>
<tr>
<td>Add Column</td>
<td>MIDCARB.STRCT_WPIT_UTM15_83.OBJECTID</td>
<td>featureclass</td>
<td></td>
</tr>
</tbody>
</table>
Metadata: Map Service Metadata Application

Adding Information for column MIDCARB.STRCT_WPIT_UTM15_83.ID for KS_MIDCARB on drysdale.kgs.ku.edu

Display Name: ID
Column Units:
Sequestration Column? ◯ Yes ◯ No
Is Visible? ◯ Yes ◯ No
Detailed Metadata

save
Interoperability Through Web Mapping Services

How does the portal communicate in real-time with the other Regional Partnerships?

1. A series of requests are generated based on the client input to the map portal. For example, the client would like to see the following:
   - Potential CO₂ storage in petroleum fields in Kansas,
   - Kansas and Illinois CO₂ sources,
   - Illinois net coal thickness

2. The portal simultaneously issues a request to the regional map servers to create an image of the data.

3. The portal stores the requested images locally and creates a world file for each image (so that the images can be georeferenced).

4. The portal IMS server creates a national map with the stored georeferenced images.
NATCARB

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NATCARB

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NATCARB

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NATCARB

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Intelligent Portal

• Use the metadata catalog to build “Intelligent” requests (XML) to the federation of loosely coupled map services.

• The map table of contents is a dynamic system that runs off the metadata catalog.
NATCARB Intelligent Portal

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NATCARB Intelligent Portal

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NATCARB Intelligent Portal
National Sequestration Database

• Tools help answer technical and policy questions.
• Provides tools to access non-spatial data in a spatial way.
  – Emissions analysis for one power plant (identify) or many power plants (select all in a region).
  – Sequestration potential over multiple depths and datasets within a particular region (buffer around a power plant).
• Integrated but Distributed
  – Across Regions
  – Across Data Types
Partners

- DOE
- DOE-EIA
- EPA (Database on Emissions)
- Department of Agriculture
- USGS
- Partnerships
- Industry
- Universities

National Databases - Partnerships can correct, update, enhance and pass corrections back to the source.
Conclusions

• Distributed National Database of Carbon Sequestration
  – National databases and local databases

• Federation of IMS Servers
  – Distribute management
  – Distribute computer resources
  – Distribute metadata

• Intelligent Portal
  – IMS Interoperability
  – Tools that can access/analyze/display distributed data

• Partners
  – Increased synergy and communication

Online at the Booth