An Integrated Landslide Management System for Highway Applications

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Outline of the Presentation

- ODOT Landslide Hazard Rating Matrix
- GIS Database
- Database Access via Internet
Landslide Management

GIS DATABASE MANAGEMENT PLATFORM

Landslide Risk Analysis

Landslide Hazard Identification
(data collection)

1. Landslide Observation Report
2. Landslide Reconnaissance Form A
3. Landslide Reconnaissance Form B
4. Landslide Reconnaissance Form C

Landslide Risk Assessment

Landslide Risk Management

Landslide Monitoring

Decision Making

Landslide Rehabilitation
Landslide Reconnaissance Processes

Landslide Observation Report
- Landslide activities are reported to the district highway office

Part A
- CM/TM
  - Collect the site location.
  - Preliminary information of landslide
  - Verify whether it is landslide
  - Determines the significance of the landslide using “rated” and “non-rated” criteria.
  - Collect sketches and photographs
  - Upload the information to database

Part B
- CM/TM
  - Search and report site history
  - Search and report traffic information
  - Send a notification to DGE if “rated”
  - Upload the information to database

Part C
- District Power User
  - Verify the reported information
  - Determine the amount of landslide information to be collected using landslide vulnerability criteria
  - Perform hazard rating
  - Take additional photograph
  - Draw detailed sketches
  - Upload information to database
Landslide Vulnerability Criteria (Part A)

The landslide with low vulnerability is “non-rated” landslide otherwise “rated”.

If landslide is “rated”, notification is sent to DGE for detailed investigation.

<table>
<thead>
<tr>
<th>Probability of additional movement</th>
<th>Probability of significant impacts to the roadway, structures, adjacent property or features</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very High</td>
</tr>
<tr>
<td>Very High</td>
<td>Very High</td>
</tr>
<tr>
<td>High</td>
<td>Very High</td>
</tr>
<tr>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Low</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
Criteria for Data Collection (Part C)

<table>
<thead>
<tr>
<th>Probability of additional movement (A)</th>
<th>Probability of significant impacts to the roadway, structures, adjacent property or features (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very High (4)</strong></td>
<td>Very High (16) High (12) Moderate (8) Low (4)</td>
</tr>
<tr>
<td><strong>High (3)</strong></td>
<td>Very High (12) High (9) Moderate (6) Low (3)</td>
</tr>
<tr>
<td><strong>Moderate (2)</strong></td>
<td>High (8) High (6) Moderate (4) Low (2)</td>
</tr>
<tr>
<td><strong>Low (1)</strong></td>
<td>Moderate (4) Moderate (3) Low (2) Low (1)</td>
</tr>
</tbody>
</table>

Vulnerability score (X) = A × B

- **X ≤ 2**
  - Verify existing information
  - Verify sketches from part A
  - Take additional photographs

- **2 < X ≤ 9**
  - Verify existing information
  - Verify sketches from part A
  - Take additional photographs
  - Fill Form C

- **X > 9**
  - Verify existing information
  - Verify sketches from part A
  - Take additional photographs
  - Fill Form C
  - Provide Detailed Sketches
Six Risk Factors

Composite numerical hazard score of six factors

- Accident History
- Decision Sight Distance (DSD)
- Average Daily Traffic (ADT)
- Maintenance
- Hazard to Traveling Public
- Movement Location/impact
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>RATING CRITERIA and SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Points 3</td>
</tr>
<tr>
<td>1. Movement location/ impact (select higher score)</td>
<td></td>
</tr>
<tr>
<td>Current and potential impact of landslide on roadway</td>
<td>On slope with a low potential to affect shoulder</td>
</tr>
<tr>
<td>Current and potential impact of landslide on area beyond right of way</td>
<td>On slope with a low potential to impact area beyond right of way</td>
</tr>
<tr>
<td>2. Hazard to traveling public (Select higher score)</td>
<td></td>
</tr>
<tr>
<td>Rate of displacement in roadway if known</td>
<td>&lt;1-inch/year</td>
</tr>
<tr>
<td>Evidence of displacement in roadway</td>
<td>Visible crack or dip no vertical drop</td>
</tr>
</tbody>
</table>
# ODOT Landslide Hazard Rating System

## Rating Criteria and Score

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>RATING CRITERIA and SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. <strong>Maintenance</strong> (Select higher score)</td>
<td><strong>Points 3</strong></td>
</tr>
<tr>
<td>Maintenance frequency</td>
<td>None to rare</td>
</tr>
<tr>
<td>Maintenance response</td>
<td>No response</td>
</tr>
<tr>
<td>4. <strong>ADT</strong></td>
<td>&lt;2000</td>
</tr>
<tr>
<td>5. <strong>%Decision Sight Distance (DSD)</strong></td>
<td>≥ 90</td>
</tr>
<tr>
<td>6. <strong>Accident history</strong></td>
<td>No accident</td>
</tr>
</tbody>
</table>
Numerical Hazard Score Criteria

Low Hazard Score < 150

Failure on slope/low potential: 3 points
No failure in roadway: 3 points
Need periodic observation: 9 points
16,000 cars/day: 81 points
DSD > 90%: 3 points
No history: 3 points
Total: 102 points

Failure surface

Failure on slope/low potential: 3 points
No failure in roadway: 3 points
Need periodic observation: 9 points
48,230 cars/day: 81 points
DSD > 90%: 3 points
No history: 3 points
Total: 102 points

Failure surface
Numerical Hazard Score Criteria

Medium Hazard

150 < Score ≤ 250

Failure on roadway shoulder: 27 points
Displacement > 3 in: 81 points
Need periodic observation: 9 points
10,000 cars/day: 81 points
DSD > 90%: 3 points
No history: 3 points
Total: 204 points

Failure on roadway: 81 points
Displacement ≤ 3 in: 27 points
Need routine maintenance: 27 points
9,400 cars/day: 27 points
DSD > 35-49%: 27 points
No history: 3 points
Total: 193 points

Cracks on road
Numerical Hazard Score Criteria

Failure on roadway: 81 points
High displacement: 81 points
Need immediate response: 81 points
120,000 cars/day: 81 points
Limited DSD: 81 points
No history: 3 points
Total: 408 points

Failure Mass

Failure on roadway: 81 points
Displacement > 3 in: 81 points
Need immediate response: 81 points
34,880 cars/day: 81 points
DSD > 90%: 3 points
No history: 3 points
Total: 330 points
# Privileges of Users in Database

<table>
<thead>
<tr>
<th>Privilege</th>
<th>Normal User</th>
<th>County Power User (CM/TM)</th>
<th>District Power User (DGE)</th>
<th>State Power User</th>
<th>Administrator</th>
<th>System Power User</th>
<th>Supervisor</th>
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<tbody>
<tr>
<td>Download</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Add/Edit Parts A and B</td>
<td>X</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Add/Edit Part C</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Delete Parts A, B, and C</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Manage landslide pictures</td>
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<td>X</td>
<td>X</td>
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<td>X</td>
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<td>Manage regional information (County and District)</td>
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<td>Update shape files in GIS server</td>
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<td>User registration</td>
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<td>X</td>
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</table>
Components of Web-enabled GIS Database System

Data Management

ShapeFile Update

Raw File Management
• Upload and Download GIS information in database

Data Query
• Part A, B, and C lists.
• Data Query
• Inspection

File Management
• Adding pictures
• Linking pictures to site

Report (NEW)
• Report Template
• Report Design

System Components

User Forum (NEW)

GIS Query

(Continued in the next page)
Components of Web-enabled GIS Database System

**System Components**

1. **Data Management**
   - Group Manage: authorize new users to some specific functions
   - User Manage: allow add, edit, delete new users to database

2. **File Management**

3. **System Management**
   - Permission Manage: set up function details to users, qualified users have right to see and operate his features.

4. **GIS Query**
   - Show location of landslides on GIS map
   - Perform various types of data query

5. **User Forum**
   - Bug Report
   - Suggestion

6. **User Management**
   - Group Manage: authorize new users to some specific functions
   - User Manage: allow add, edit, delete new users to database

7. **Resource Management**
   - Tab Manage: add, edit, and delete tabs
   - Bar Manage: manage items in bar
   - Item Manage: users could add, edit, delete items in bar

8. **Page Management**
   - Tab Manage: add, edit, and delete tabs
   - Bar Manage: manage items in bar
   - Item Manage: users could add, edit, delete items in bar

9. **Regional Management**
   - County Manage: add, edit, and delete county
   - District Manage: add, edit, and delete district
Resource/Asset management using Web-Enabled GIS Database System

- [http://landslide.ascn3.uakron.edu/gisView](http://landslide.ascn3.uakron.edu/gisView)
- Users login with user name and password
Resource/Asset management using Web-Enabled GIS Database System

Data management
Resource/Asset management using Web-Enabled GIS Database System

ShapeFile Update

Upload needs at least 3 files. (Dbf, Shp, and Shx)
Resource/Asset management using Web-Enabled GIS Database System

System Management

- Can add, edit, and delete user groups.
- Can add, edit, and delete users.
- Can give permission to users.
Resource/Asset management using Web-Enabled GIS Database System
Resource/Asset management using Web-Enabled GIS Database System

System Management

Add, edit, and delete County Information

Add, edit, and delete ODOT district Information
Resource/Asset management using Web-Enabled GIS Database System

GIS Query
Resource/Asset management using Web-Enabled GIS Database System

GIS Query

Identify

slidesite

<table>
<thead>
<tr>
<th>Field</th>
<th>Operator</th>
<th>Value</th>
<th>Get Samples</th>
<th>And</th>
<th>Or</th>
<th>Not</th>
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<tbody>
<tr>
<td>Slide ID</td>
<td>=</td>
<td></td>
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</tbody>
</table>

Distance measurement
Resource/Asset management using Web-Enabled GIS Database System

<table>
<thead>
<tr>
<th>Status</th>
<th>ID</th>
<th>Topic</th>
<th>Views</th>
<th>Replies</th>
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<tbody>
<tr>
<td>Open</td>
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<td>1</td>
<td>0</td>
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<tr>
<td>Closed</td>
<td>32</td>
<td>Part B Data</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Closed</td>
<td>22</td>
<td>Parts- Picture manage</td>
<td>3</td>
<td>0</td>
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<tr>
<td>Closed</td>
<td>23</td>
<td>Data query</td>
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<td>Closed</td>
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<td>0</td>
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<tr>
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<td>GIS map</td>
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<td>0</td>
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<tr>
<td>Closed</td>
<td>17</td>
<td>Post new topic</td>
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<td>14</td>
<td>Topic Re: personal suggestion from YAN</td>
<td>11</td>
<td>1</td>
</tr>
</tbody>
</table>

**User Forum**

**BugReport:** Post new topic and reply a topic

**Suggestions:** Post new topic and reply a topic
Information Collection Process

Part A County/Transportation Manage (CM/TM)
Part B (CM/TM)
Part C District Power User

Landslide Observation Report
Landslide Database

ArcPad 6
Benefits of the Development

1. No paper work
2. Near real time monitoring
3. Centralized information
4. Uniform data collection
5. Shorten work time in office
6. Interchangeable information
Thank You!