Landslide Mapping & Modeling (use of GIS technology)

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What are landslides?

... the movement of a mass of rock, debris or earth down a slope due to the action of gravity
Mapping susceptible slopes
Distribution of toposheets

~ 0.42 million km² (12.6%)

National Landslide Susceptibility Mapping (NLSM) Project
to generate...

Seamless thematic maps on 1:50k

Landslide inventory repository

Landslide susceptibility maps

target: 2020
deliverables…

Seamless landslide susceptibility maps

Detailed landslide inventory

Thematic maps

LULC
GEOM
SFM
etc…
Planning & initiation…

90 officers with GIS knowledge in NLSM

NLSM initiation: 2014

GIS application

Interactive Orientation Programmes

Specialised Training Module

Brain-storming sessions
**Thematic maps data source**

1. **Slope, Aspect and Curvature Map**: Aster DEM of 30m
2. **Drainage**: Aster DEM of 30m (auto generated)
3. **Distance to structures**: GSI’s Geology (1:50k), Aster DEM of 30m
4. **Slope Forming Material**: mainly field based
5. **Land use/cover**: LISS III/IV, Google, Toposheet
6. **Regolith Depth**: mainly field based
7. **Geomorphology**: NGLM data, Google, Toposheet
8. **Landslide Inventory**: LISS III/IV, Google, Toposheet
Landslide mapping...

GIS facilitates mapping using multiple sources of varying resolution

Basemap in ArcGIS 10.2

Cartosat

LISS IV

Toposheet
More than 10,000 landslides mapped
Thematic maps...

19,000 km² area mapped.
Methodology...

Data integration in GIS

Step 1 (Data collation)
- RS (Google Earth, LISS-IV), NGLM
- Aster DEM
- 1:50k Geology Map

Pre-field (visual interpretation) and field validation

Step 2 (Thematic map preparation)
- LULC, GEOM, SFM, Fault/fracture
- Slope, Aspect, Curvature
- Landslide

Spatial association analysis

Step 3 (Calculation of Yule's coefficient)
- Determination of weights for LULC, GEOM, SFM, Fault/fracture, Slope, Aspect, Curvature maps

Conversion to LOFS map & Multiclass index overlay method

Step 4 (LOFS maps & Landslide score map)
- LULC, GEOM, SFM, Fault/fracture, Slope, Aspect, Curvature
- Landslide Score map

Step 5 (Classification)
- Classified Landslide Susceptibility map (High, Moderate, Low)

Success rate curve
Methodology.....Yule’s Coefficient

- $O$ = known geo-object of interest
- $I$ = indicator (or evidence) pattern
- $T$ = study area

\[
egin{align*}
T &= 2945; 
O &= 727 \\
I &= 486
\end{align*}
\]

- $T_{11}$ → derived from cross operation
- $T_{12} = O - T_{11}$
- $T_{21} = I - T_{11}$
- $T_{22} = T - T_{11} - T_{12} - T_{21}$

Note: an example of $I$ is a slope aspect class
GIS application... ModelBuilder

Step-3: spatial analysis

Polygons to Raster

- Cells size
- Enter the field use
- Name clipped theme
- Enter output raster name

Add Field

Clipping with boundary

Adding of Field
Step-3: spatial analysis

Getting summary statistics

Adding to Field (T)
GIS application... ModelBuilder

Step-3: spatial analysis

Using Combine Function for combining landslide with thematic class

Adding to Field (T11)
GIS application... ModelBuilder

Step-3: spatial analysis

Joining with raster map

Getting summary statistics

Adding to Field
Step-3: spatial analysis

Generating Attribute map using Lookup Function

Naming output as LOFS map
GIS application...

**Step-4: integration of LOFS maps**

Integrating LOFS maps using Map Algebra Function

\[
\bar{S} = \frac{\sum_{i}^{n} (LOFS_{ji} \times W_{i})}{\sum_{i}^{n} W_{i}}
\]

Success rate curve generated in ILWIS using ‘script’

**Classified Susceptibility Map**

**Legend**

<table>
<thead>
<tr>
<th>SuscScore Value</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>High : 0.945456</td>
<td>High</td>
</tr>
<tr>
<td>Low : 0</td>
<td>Low</td>
</tr>
</tbody>
</table>
Conclusions…

- GIS technology is very useful in landslide studies
- Modeling for LSM for UK takes ‘one hour’
- Saves time
- Enhances output – quality & presentation
Uploading in GSI web for Public viewing
Thank you