Illinois on iPad: Teaching Soil Science via Isee – Integrating Spatial Educational Experiences

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Introduction

In cooperation with adjacent states, as part of a regional project called "Isee," we have developed a method of presenting location-specific soil science information on iPads. This involved preparing geospatial soils information derived from the gridded Soil Survey Geographic (gSSURGO) Database for display with a specially designed mobile app (Isee) that leverages iOS location services to show soils data at the current location. As a teaching tool, the Isee app allows students to interact with soils data and can be used on natural resources/soils field trips and in field-based undergraduate classes to enhance learning outcomes. After a preliminary series of lectures giving an overview of the software and the map layers, the students are taken on field excursions. The maps on their iPads are instantaneously updated as to location thus permitting students to locate themselves on any of the several maps made available to them. A wide range of maps can be produced from pre-existing georeferenced data, including general geology maps, landform, soil taxonomy, drainage class, slope, and parent materials. Also included is a cultural feature map layer showing county boundaries and roads to assist with spatial orientation. The base layer of the GIS is a shaded relief map based on state wide elevation data. In addition to facilitating learning of soil science, using Isee improves students' spatial thinking and problem solving skills.

Objectives

- To develop an interactive teaching tool that increases interest and awareness of soils and landscapes in Illinois.

Materials and Methods

Illinois has a completed soil survey at the original scale of 1:15,840 that was updated to 1:12,000 during the update phase of Illinois soil survey. We utilized the digital records of the 551 soil series and the 10,432 unique soil mapping units (smus) in Illinois as a starting point in assigning attribute classes to each soil mapping unit. Included in those mapping units are 11 miscellaneous landscape units and 11 undifferentiated soil taxonomic classes (Table 1). These are of too limited extent to differentiate on the iPads, so the miscellaneous landscape units were distributed into "Disturbed Lands" or "Water" for the purposes of the IL Isee project, and the undifferentiated soil taxonomic classes were included in the appropriate mapping legends (Table 2).

Table 1. Non-soil series based mapping units.

Miscellaneous Landscape Units	Undifferentiated Soil Taxonomic Classes
Beaches	Arents
Dams	Alfic Udarents
Dumps	Udorthents
Oil-waste land	Aquents
Pits	Orthents
Riverwash	Orthents, very hilly
Rock outcrop	Psamments
Sandstone Rock Land	Udipsamments
Urban land	Fluvaquents
Miscellaneous water	Hapludalfs
Water	Typic Hapludalfs

Table 2. Landform Classes as used in IL Isee.

Landform Classes	SMU Count	Area Ha (10^3)	%
Loess Plain	999	1,583	11
Till Plain	3,562	7,546	52
Moraine	37	31	0.2
Outwash Plain	1,912	1,863	13
Flood Plain	1,683	1,772	12
Lake Plain	340	368	3
Dunes/Aeolian Sands	494	293	2
Bedrock Uplands	662	497	3
Disturbed Lands	572	380	2
Water	171	257	3
Total	**10,432**	**14,591**	**100**

Based on the existing NRCS data base for Illinois soils, which included many of the attributes of interest, we assigned a simplified group of classes for each attribute of interest to each of the individual 10,432 soil mapping units. Areas were calculated by computing the summed pixel count for each class of a given field and multiplying by $100m^2$, which is the resolution of a pixel. Sums were determined using the summarize option available in the attribute table, where the field to summarize is the reclass field, and the data summarized are pixel counts (soil mapping units (smu) count field). For maps that were developed from data outside the NRCS data base, we utilized existing maps from Illinois State Geological Survey such as the Bedrock Geology map (Fig. 1).

Figure 1. Bedrock geology of Illinois.

Table 3. Bedrock geology of Illinois.

Rock Group	Area Ha (10^{-3})	%
Cambrian	31	0.2
Cretaceous	118	1
Devonian	387	3
Mississippian	1,491	10
Ordovician	1,598	11
Pennsylvanian	9,461	65
Silurian	1,470	10
Tertiary	35	0.2
Sum	**14,591**	**100**

Results & Discussion

Because the IL Isee maps would be used on a small screen of the iPads, the legends needed to be simplified. Parent materials in the Soil Survey Geographic (gSSURGO) Database for Illinois include 19 units (Table 4), far too many to show on the small screen. Too much detail can be as bad as too little, cartographically speaking. For IL Isee parent material map, we simplified the legend to 13 units (Table 5, Fig. 2).

Table 4. Soil parent materials as mapped in Illinois.

Illinois Soil Parent Materials
Loess (>80 in.)
Loess (10 - 80 in.) on Illinoian Drift
Loess (0 - 40 in.) on Loamy Wisconsinan Till or Lacustrine Deposits
Loess (0 - 40 in.) on Loamy Wisconsinan Till
Loess (0 - 20 in.) on Clayey Wisconsinan Till or Lacustrine Deposits
Loess (40-80 in.) on Loamy or Clayey Wisconsinan Till or Lacustrine Deposits
Loess (20 - 60 in.) on Sandy Wisconsinan Eolian Deposits
Loess (20 - 80+ in.) on Loamy Wisconsinan Outwash
Loess or Loamy Deposits (10 - 60 in.) on Limestone
Loess or Loamy Deposits (10 - 60 in.) on Sandstone, Siltstone, or Shale
Loamy or Silty Wisconsinan Drift (20 - 60 in.) on Sandy and Loamy Outwash
Sandy, Loamy, Silty, and Clayey Wisconsinan Lacustrine Deposits
Sandy Wisconsinan Outwash and Eolian Deposits
Sandy, Loamy, or Silty Drift (10 - 40 in.) on Gravelly Wisconsinan Outwash
Sandy to Clayey Alluvium
Miscellaneous Deposits - Mine Spoil or Fill
Organic Deposits
Miscellaneous Soils
Water

Table 5. Soil parent materials as used in IL Isee.

Parent Materials	SMU Count	Area Ha (10^{-3})	%
Deep Loess	1,660	3,695	25
Loamy Wisconsinan Till	879	1,393	10
Clayey Wisconsinan Till	424	1,064	7
Illinoian Till (pre-Wisconsinan)	1,695	3,086	21
Outwash	1,716	1,711	12
Lacustrine Deposits	313	311	2
Eolian Sand / Sandy Sediments	697	471	3
Limestone Residuum	271	200	1
Sedimentary Rock Residuum	370	292	2
Alluvium	1,546	1,689	12
Organic Deposits	97	37	0.3
Disturbed Areas/Urban Lands	593	385	3
Water	171	257	2
Total	**10,432**	**14,591**	**100**

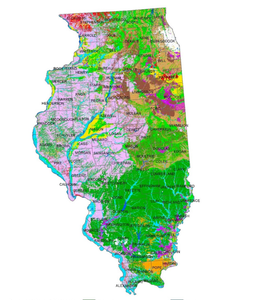

Figure 2. Dominant soil parent materials in Illinois.

The complication of selecting dominant parent materials when there is commonly a layer cake such as loess over outwash over till, requires some judgment on assigning smus to parent material classes. Likewise, soil series are often allowed to exist on various landforms, so it too requires judgment in making a useful landform map (Table 2; Fig. 3). Because many soils in Illinois have some loess cover, it is difficult to assign a loess thickness class to them therefore a generalized map based on Illinois Geological Survey data was developed (Fig. 4).

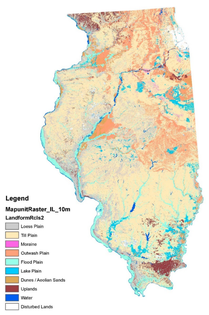

Figure 3. Dominant landforms in Illinois.

Figure 4. loess thickness classes in Illinois.

Illinois is known as the Prairie State and the remnants of the native vegetation is reflected in the topsoil color (Fig. 5; Table 6), which shows a close correlation to the dominant soil orders (Fig. 6; Table 7).

Figure 5. Surface soil color in Illinois.

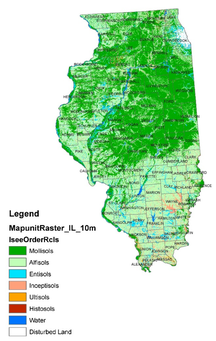

Figure 6. Soil orders in Illinois.

Results & Discussion

Table 6. Surface soil color in Illinois.

Surface Soil Color	SMU Count	Area Ha (10^{-3})	%
Light	4,439	5,926	41
Dark	5,364	8,141	56
Disturbed	361	37	0.3
Water	171	230	2
Organic	97	257	2
Total	**10,432**	**14,591**	**100**

Table 7. Soil orders in Illinois.

Soil Order	SMU Count	Area Ha (10^3)	%
Mollisols	3,137	6,234	43
Alfisols	5,438	6,619	45
Entisols	888	870	6
Inceptisols	446	433	3
Ultisols	27	12	0.1
Histosols	93	36	0.2
Disturbed Land	232	130	1
Water	171	257	2
Total	10,432	14,591	100

Because Illinois was repeatedly glaciated, it is an area of low relief with the exception of the unglaciated areas in the NW and S (Fig.7; Table 8). Consequently, given the humid climate, the soils tend to be wet (Fig. 8; Table 9).

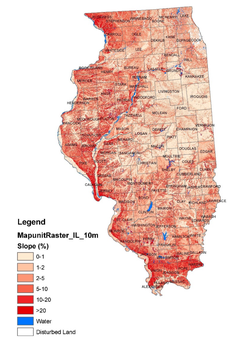

Figure 7. Soil slope classes in Illinois.

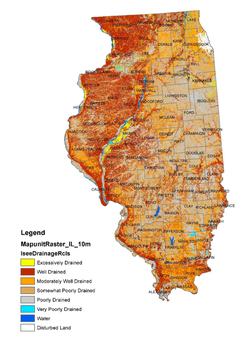

Figure 8. Soil drainage classes in Illinois.

Table 8. Soil slope classes in Illinois.

Soil Slope Classes (%)	SMU Count	Area Ha (10^3)	%
0-1	2,013	4,804	33
1-2	1,994	2,741	19
2-5	2,330	3,373	23
5-10	1,713	1,579	11
10-20	1,144	808	6
>20	843	938	6
Disturbed Land	224	92	1
Water	171	257	2
Total	10,432	14,591	100

Table 9. Soil drainage classes in Illinois.

Drainage Classes	SMU Count	Area Ha (10^3)	%
Excessively	344	222	2
Well	4,140	3,875	27
Moderately Well	1,584	2,066	14
Somewhat Poorly	2,175	4,401	30
Poorly	1,547	3,483	24
Very Poorly	242	157	1
Disturbed Land	229	129	1
Water	171	257	2
Total	**10,432**	**14,591**	**100**

Another glaciation consequence is seen in the rejuvenation of base status in the glaciated north, which has higher soil pH (Fig. 9; Table10). Fragipans are found only in the older landscapes, as are, surprisingly, Natric soils (Fig. 10; Table 11).

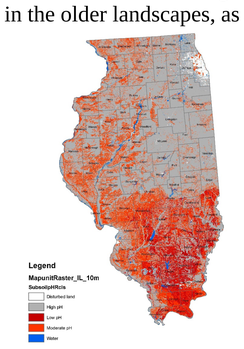

Figure 9. Subsoil pH classes in Illinois.

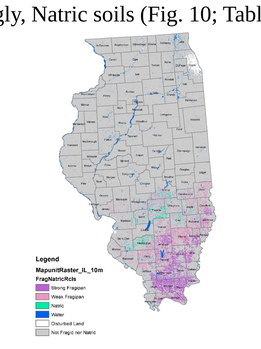

Figure 10. Special soil properties in Illinois.

Table 10. Subsoil pH classes in Illinois.

Subsoil pH	SMU Count	Area Ha (10^3)	%
Low pH	631	1,040	7
Moderate pH	2,656	3,486	24
High pH	6,570	9,555	65
Water	171	257	2
Disturbed land	404	254	2
Total	**10,432**	**14,591**	**100**

Table 11. Special soil properties in Illinois.

Special Soil Property	SMU Count	Area Ha (10^{-3})	%
Strong Fragipan	308	535	4
Weak Fragipan	202	418	3
Natric	51	83	1
Not Fragic nor Natric	9,468	13,168	90
Disturbed Land	232	130	1
Water	171	257	2
Total	**10,432**	**14,591**	**100**

Conclusions

- **Transforming gSSURGO data to the Isee format and scale requires simplification of the complex real world, and experienced pedologists to make a useful legend.**
- **Today's students are fully engaged with digital media and the dynamic properties of the software/hardware adds a new dimension to field trips and enhances pedagogic objectives.**
- **Utilization of iPads to teach about soils, landscapes, geologic history, and land use is effective in maintaining student interests.**

References

Soil Survey Staff. 2014. Gridded Soil Survey Geographic (gSSURGO) Database for Illinois. USDA, Natural Resources Conservation Service. Available online at: https://gdg.sc.egov.usda.gov/. 2/2/2015.

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