

GeoWAX.Net (Geographic Weather and Avalanche eXplorer), An Extension to ArcGIS 9.2

Christopher M. McCollister *
Bridger-Teton National Forest Avalanche Center, Jackson, WY
Jackson Hole Mountain Resort, Teton Village, WY

ABSTRACT: GeoWAX (Geographic Weather and Avalanche eXplorer), which was presented at ISSW 2002, was developed as stand alone software written in Visual Basic 6.0. With the rapid growth in software development, this program is no longer compatible with current Geographic Information System (GIS) software. A new version has been developed using Visual Basic.Net to create an extension to ESRI's ArcGIS 9.2. Extensions provide additional functionality to ArcGIS and can be either commercially developed, such as Spatial Analyst, or privately developed. GeoWAX.Net is such an example. This program will allow GIS users to integrate historic weather and avalanche data into a GIS representation of avalanche paths. Functionality includes: 1) Automatic mapping of avalanche events on a given day or set of days. 2) Nearest neighbor search of weather data and mapping of resulting avalanche events or probabilities. 3) Summary of spatial attributes of avalanches, such as elevation, slope, aspect, etc. This software will be freely available to ArcGIS users. Users need three sets of data: a table of historic weather data, a table of historic avalanche activity, and a set of GIS shape files representing the slide paths where the avalanches occurred.

Keywords: Avalanche, geographic information system, GIS, nearest neighbors, KML

1. INTRODUCTION

Weather and avalanche datasets are increasing in size and complexity due to more data gathering methods, more frequent data recording, and the passage of time (McCollister, 2004). This paper introduces a tool to help alleviate this problem of data overload by linking a variety of data sources to analysis and cartographic programs resulting in better visualize of, and interaction with, avalanche data.

Visualization of geographic data (GVIs) is "the use of concrete visual representations – whether on paper or through computer displays or other media – to make spatial contexts and problems visible, so as to engage the most powerful of human information processing abilities, those associated with vision." (MacEachren et al., 1999). This project uses GIS for analysis and visualization in conjunction with a database program.

GIS has been used for avalanche hazard mapping (Sauer Moser, 2006), analysis of spatial characteristics (McCollister, 2003; Stoffel et al., 1998), and visualization of data (McCollister, 2002, 2003, 2004; Stoffel et al., 2006). Visualization of spatial avalanche data has also been investigated by McNeally (2006).

This project uses the nearest neighbors technique, which is a common search method for weather and avalanche data (Buser, 1983, 1989; Gassner et al., 2000; Purves et al., 2002; McCollister 2002, 2003, 2004). Nearest neighbors can be simply defined as a method to find similar days in a historic weather dataset based on chosen weather parameters.

Visual Studios.Net, a Microsoft product, was used to create GeoWAX.Net, an extension to ESRI's ArcGIS 9.2. Visual Studios.Net is a suite of software programming languages, including Visual Basic, which was used for this project. ArcGIS 9.2 is a common, off the shelf Geographic Information System that integrates well with Visual Studios.

Extensions are add-ons to existing software with the benefit of having all existing functionality available, which include analysis tools such as slope and aspect calculations. By utilizing

* *Corresponding author address:* Christopher M. McCollister, P.O. Box 412, Teton Village, WY, USA 83025; tel: 307-690-6089; email: cmccollister@fs.fed.us

existing technologies it is not necessary to re-invent the wheel.

In addition to analysis, ArcGIS is a powerful cartographic and visualization tool. Geographic data can be displayed in different formats, along with the production of paper maps. Data can also be exported in a format for integration with Google Earth along with text format for analysis using Microsoft Excel.

The rest of this paper will outline the set up GeoWAX.Net and the necessary datasets, the functionality of GeoWAX.Net, the products it can export, and a brief conclusion.

2. SET UP

To set up GeoWAX.Net, users need three sets of data: a table of historic weather data, a table of historic avalanche activity, and a set of GIS shape files representing the slide paths where these avalanches occurred.

Figure 1 shows the configuration dialog box with the Database Connection tab page. Data sources can be either an OLEDB (such as Microsoft SQL Sever) with a connection string or an XML dataset. Multiple weather tables can be integrated which are related to the avalanche table via the date.

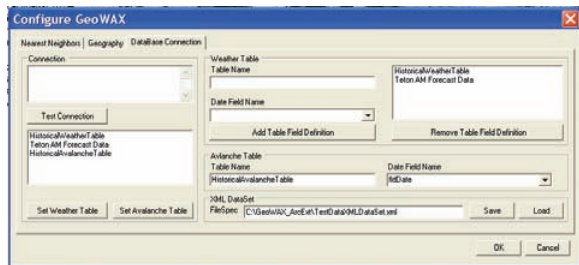


Figure 1. Database Connection Tab for configuring GeoWAX.Net.

Figure 2 displays the Geography tab page of the configuration dialog box. Six shape files are needed which correspond to the starting zones, and class I through class V representations of the avalanche paths in the avalanche dataset. These files also need to have five fields which represent the avalanche path name, a Boolean field to indicating whether or not to display a slidepath, elevation and aspect fields, and finally a field for numeric identification on maps.

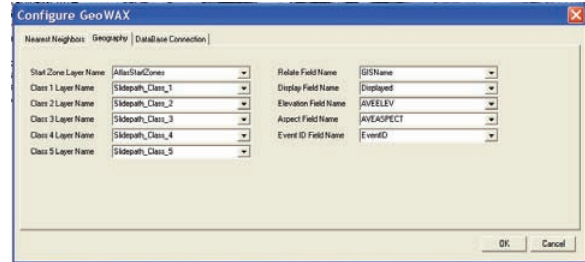


Figure 2. Geography Tab for configuring GeoWAX.Net.

3. FUNCTIONALITY

Current functionality of GeoWAX.Net includes automatic mapping of avalanche events, nearest neighbor search of weather data and mapping of resulting avalanche events or probabilities, and a summary of the elevation and aspect of the slide paths starting zones.

Automatic mapping of avalanches can be performed for either a single day or a set of days. Figure 3 shows a table of avalanche events for Jan. 1-31 of the 2007-08 winter season.

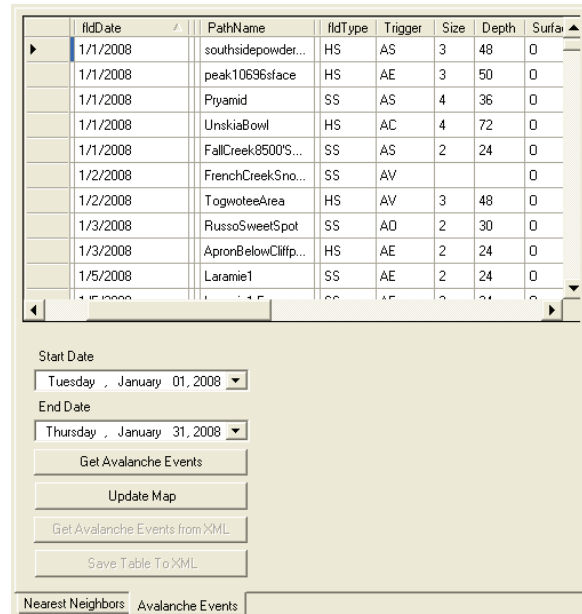


Figure 3. Avalanche Events Form to search for avalanche events based on the date of occurrence.

Using the Update Map function, avalanche events are mapped with the GIS (Figure 4). For each of the five class size shape files, slidepath representations are turned on if they occurred, or turned off if they did not occur. For example if

a Laramie 4 class III event occurred, the Laramie 4 feature in the class III shape file would be turned on, and the Laramie 4 features in the remaining shape files would be turned off.

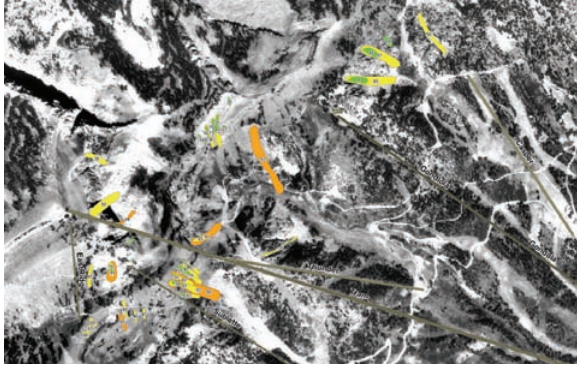


Figure 4. Avalanche Events for Jan 1 – 31, 2008. Class I slidepaths are represented in green, II in yellow, and III in orange.

4. EXPORTS

Google Earth is a free geographic program that is quickly becoming a standard method of visualizing and transferring geographic data. Expanding on existing functionality of ESRI's 3-D Analysis extension, KMZ files can be created and exported. These are zipped Google Earth's KML files, which seamlessly integrate into Google Earth (Figure 5). Data files, either of avalanche events, or summaries of aspect and elevation can also be exported in text format, which can then be uploaded into analysis programs such as Microsoft's Excel.

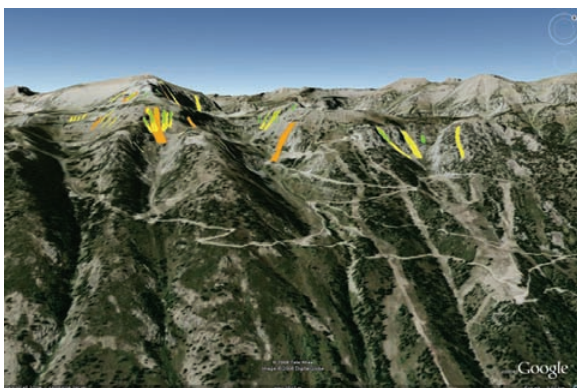


Figure 5. 3-D Google Earth representation of the same data as in Figure 4.

5. CONCLUSION

GeoWAX.Net is a tool to integrate many different analysis and cartographic programs which include ArcGIS, Google Earth, database

programs, and Microsoft's Excel. This program will be freely available to ArcGIS users and can be downloaded from JHAvalanche.org.

References

- Buser, O., 1983. Avalanche forecast with the method of nearest neighbors: an interactive approach. *Cold Regions Science and Technology* 8 (2), 155– 163.
- Buser, O., 1989. Two years experience of operational avalanche forecasting using the nearest neighbors method. *Annals of Glaciology* 13, 31– 34.
- Gassner, M., Etter, H.-J., Birkeland, K., Leonard, T., 2000. NXD2000: an improved avalanche forecasting program based on the nearest neighbor method. *Proceedings of International Snow Science Workshop 2000, Big Sky, MT*, 52– 59.
- MacEachren, A.M., Wachowicz, M., Edsall, R., Haug, D., Masters, R., 1999. Constructing knowledge from multivariate spatiotemporal data: integrating geographic visualization and knowledge discovery in database methods. *International Journal of Geographic Information Science* 13 (4), 311– 334.
- McCollister, C.M., Birkeland, K., Hansen, K., Aspinall, R., Comey, R., 2002. A probabilistic technique for exploring multi-scale spatial patterns in historical avalanche data by combining GIS and meteorological nearest neighbors with an example from the Jackson Hole Ski Area, Wyoming. *Proceedings of International Snow Science Workshop 2002, Penticton, BC, Canada*, 109-116.
- McCollister, C.M., Birkeland, K., Hansen, K., Aspinall, R., Comey, R., 2002. Exploring multi-scale spatial patterns in historical avalanche data, Jackson Hole Mountain Resort, Wyoming. *Cold Regions Science and Technology* 37 (3), 299-313.
- McCollister, C.M. 2004. *Geographic Knowledge Techniques for Exploring Historical Weather and Avalanche Data*. M.S. Thesis, Department of Earth Sciences, Montana State University. 106 pp.

McNeally, P.B and Miller, H.J., 2006. Holistic Geographical Visualization of Spatial Data with Applications in Avalanche Forecasting. Proceedings of International Snow Science Workshop 2006, Telluride, CO, 478-482.

Purves, R., Morrison, K., Moss, G., Wright, B., 2002. Cornice— development of a nearest neighbors model applied in backcountry avalanche forecasting in Scotland. Proceedings of International Snow Science Workshop 2002, Penticton, BC, Canada, 117– 122.

Sauermoser, S., 2006. Avalanche Hazard Mapping – 30 Years Experience in Austria. Proceedings of International Snow Science Workshop 2006, Telluride, CO, 314-321.

Stoffel, A., R. Meister and J. Schweizer, 1998. Spatial characteristics of avalanche activity in an alpine valley – a GIS approach. *Ann. Glaciol.*, **26**, 329-336.

Stoffel, A., Foppa, N., Raderschall, N., 2006. Mapping Snow Depths in the Alps. Proceedings of International Snow Science Workshop 2006, Telluride, CO, 322-329.