Pragmatic GIS: Efficient Resources for Applications

Abstract
Small organizations (e.g. local and regional conservation groups) struggle with the need to incorporate the abundance of geographic information system (GIS) data available and the lack of resources to employ technical professionals and purchase premium software packages. Assembling a workable GIS and associated applications at this level either for office use or for Web interaction has become less a function of a full staff armed with pricey software applications and more a function of assembling practical software, relevant open source applications, and expertise from local professionals.

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Introduction

Assembling a GIS for practical use often focuses on the immediate purchase of commercial software packages to suit the needs of office mapping as well as Web distribution. For purchasers, especially those with financial constraints, a GIS software package cost can be prohibitive. Paradoxically, the organizations most needing the applications a GIS provides lack both the staffing and purchasing funds. Keeping the staff skill and up-to-date software can be tricky if funding is low and turnover is high. Situations arise where the software is purchased and shelved due to lack of dedicated staff. While management may have a need for GIS, even when the skilled personnel is not available, their own schedules do not permit overcoming the learning curve to use the software. Management is critical while support staff is variable; therefore a guaranteed GIS program is not easily arranged.

The recent phenomenon to being spatially active and interactive on the World Wide Web drives many businesses and organizations to capture their audience with such ability. Fortunately, the spatial community experienced an awareness boost over the past few years with the demonstrated ability of open source applications, like Google Earth/Maps and Microsoft's Virtual Earth. For those familiar with dealing in raster data speeds within a traditional GIS environment, impressive is the capability to deliver high resolution aerial/satellite imagery for the entire globe. With this available for a backdrop, custom data can be layered on these massive, easy to use datasets. The fascinating effect of global imagery in turn nurtured an environment which welcomes a variety of users, whether they know it or not, aware of geography and its implications.

In some cases, spatially implications dictate portions of the entity's mission. This is case for the organization in this case study, the Lackawanna River Corridor Association (LRCA). This paper examines the decision making, application architecture, and implementation process for a non-profit watershed organization in northeast Pennsylvania's formerly mined anthracite coal region. Combining the basic editing and analysis capabilities of commercial software (ESRI's ArcView), a free distributable viewer (ESRI's ArcExplorer), and open-source Web controls (Microsoft's Virtual Earth), small organizations like the LRCA obtain a large assortment of opportunities for a multi-level, workable GIS at reduced costs.

Background

The LRCA's origins date back two decades to members of the local community seeking to form a unified front to bring the Lackawanna River's problems to light. Typical of communities whose history involves an industrial emphasis, the river served both purposes of natural resource and outlet, for industrial waste, untreated sewage, etc…

Less than 150 years passed from the region's rise of coal mining in the 1820's to its fall,

accentuated by the infamous Knox Mine disaster of 1959[1]. Following this grand finale regionally for coal mining, industry diversified and grappled to maintain the relevance it had once claimed. While struggling to keep its population from seeping out of the region, today a visit though the Scranton/Wilkes-Barre corridor looks very much like many communities across the country with a sophisticated series of intersecting interstate highways (I-81, I-84, I-380 (short connector to I-80), large commercial complexes at interchanges, and downtowns struggling to once again make themselves attractive for multi-use activities. With other economic matters prevailing, environmental issues simmer, awaiting more lucrative times to surface and secure funding.

The watershed's current condition bears the scars of its mining history as well as the living legacy of outdated infrastructure. In addition to the traditional watershed concerns, the Lackawanna River watershed harbors many pollution points of intrigue. These features include:

- *Mine Pools* - estimated to hold millions of gallons of water underground within the confines once solid with coal, the Northern Anthracite Mine Pool sits beneath the Lackawanna Valley.
- *Bore Holes* - since the accumulation of water in the pools beneath the ground seeks relief from the confines of the mine pool, engineered 'bore hole' locations assist in alleviating this pressure in a controlled manner. Without this mechanism, the water seeks refuge in home basements and valley hillsides.
- *Acid Mine Drainage* - as the water spends time in this underground pool, it becomes a transport mechanism for all the dissolved minerals and metals such as aluminum and iron it can carry. The result is a toxic flow of contaminated water, heavy with iron oxides and other poisons, leaving an orange film in and along the river downstream from the outfall.
- *Combined Sewer Overflows* - the sewer system for over 20 municipalities in the watershed generally operates in a closed environment. When excessive rainfall is introduced to the system, the overflow system allows untreated sewage to bypass treatment and immediately get discharged into the river.

Again indicative of a poor state of affairs, these compelling scars in the river and watershed certainly induce ideas for resolution to problems on a large scale. With such challenges, the LRCA strives to raise awareness on numerous fronts. As a community organization with members, the LRCA encourages recreational interaction both on and around the river. Being a partner to local and regional agencies, an advocate for the river's well-being as well as an annual funding seeker, the LRCA needs to collect, maintain and distribute data about the river and watershed. GIS provides a solution for the organization as the data is spatially significant. Much of the organization's mission revolves around the spatial relationship of the river to surrounding municipal entities,

[1] On January 29, 1959 miners were illegally mining beneath the bed of the Susquehanna River between Scranton and Wilkes-Barre, just below the confluence with the Lackawanna River. The bed was breached and the river waters tore through the mined voids below the surface for 4 days, killing 12 workers.

adjacent networks of recreational trails, data collection sites, pollution sources, culm piles[2], remediation sites, as well as the features described above.

The Problem

Being a small not-for-profit organization with a real need for GIS does not always make for an easy situation to overcome. Personnel time generally is not available for developing GIS skill sets and such specialized training. Oscillating annual funding sources, recently on a declining trend, have made staffing tasks difficult. The basic arrangement for the LRCA includes a full-time executive director with a part-time administrative staff person for support. Over the years, the organization has employed personnel with GIS skills to operate software on an as needed basis. The day-to-day operations do not warrant management to be an advanced GIS user and the budget precludes seating a GIS professional. Converse to the lack of staff resources, the need for accessible spatial data is of inverse proportions. Meetings, reports, and promotional literature represent a small portion of the daily need for spatial data and associated products.

Fortunately, the organization draws a diverse talent to its membership and volunteer base. Though not as consistent as day to day staff, such talent progresses the LRCA's interest in advancing technology access to GIS and the Web mapping. Several GIS and Information Technology (IT) professionals have made themselves available over the years to keep the organization up to date with industry matters and advancements.

The LRCA acquired a copy of ESRI's ArcView (version 9.0) several years ago. This purchase, while not supported annually with maintenance or upgrades, became a long-term solution for maintaining spatial data. For staff, interns and volunteers familiar with this software package, negotiating the interface, locating data and creating a map does not present a challenge but for those without a fair amount of experience, such tasks are daunting and rarely undertaken.

Beyond GIS in the office, the organization's ability to distribute any spatial data or other map products traditionally has been limited to exported images (.jpg, .pdf) for posting on its website. While having a more modern GIS on the office desktop is desirable, the importance of disseminating spatial information via the Internet has taken more priority. Aside from the obvious need to spatially assess the LRCA's area of interest, the organization strongly favors providing through its website:

- spatial data collections to parties of interest
- website visitors with dynamic alternatives to static maps
- interactive mapping

The separate environments for office and Web GIS connect at the data management level. Regardless of how the each environment gets handled, being able to acquire, edit and maintain reliable datasets adheres to the ubiquitous rules of database management. These

[2] Mounds of coal pieces deemed too small for use and other refused material.

issues all translate to a workable framework for a highly accessible GIS in the office and on the Web.

Office GIS Solution

While a formal GIS skill set would be the argument for a workable office GIS, an accessible GIS seems to be more functional in situations like the LRCA's where the prevailing staff has limited GIS knowledge but a wealth of data and a large need for map products. Even the most standard of desktop GIS software does not suit in this situation for usability. Instead of this heavy software, a lighter application like ESRI's ArcExplorer, downloadable freeware, provides the GIS data display in an easy to use, flashy environment.

A number of characteristics make ArcExplorer appealing for internal desktop use. Firstly, the low disk cost makes the software appealing for use on older machines and platforms. The current build (480 at the time of this writing) for ArcExplorer requires under 70MB of disk space. Secondly, the interface's similarity to other Web mapping applications like Google Earth and Virtual Earth make this product easy to navigate and eliminate the steep learning curve often associated with software packages. Existing local and global datasets of many common formats are easily added to the mapping interface. Lastly, the freeware places no burden on the budget.

Fortunately for the LRCA, having the ArcView 9.0 software renders the organization a data editor and analyzer as much as a viewer. Though outdated, the software remains capable of handling the basic, yet technical tasks, of data entry, editing, and analysis. At present, most available freeware applications like ArcExplorer provide a slick viewing environment, with limited analysis possibilities. Even the older versions of software and associated extensions/tools can be stretched to assume the higher-level analysis freeware cannot currently provide.

The ArcExplorer application allows, as well as encourages, lower-level GIS user access to owned datasets on high-resolution imagery provided. Access to the streamed imagery is made possible through high-speed Internet connectivity, a certain prerequisite for this application's use. Easy access to the application as well as ease of adding existing datasets leads to ease of creating those mapping products for presentations and publications.

Internet GIS Solution

The availability of Web mapping applications helps stretch the capabilities of organizations like the LRCA without, again, placing excess emphasis on cost. Since spatial implications run deep with environmental organizations like this, having map products available to members and other persons of concern is critical to interest in the mission. While seemingly simple, items like watershed boundaries, water levels, stream extents, and recreational points of interest are best represented with visual content. While prepared map products are suitable (preferably at higher resolution – i.e. higher disk

cost), viewers prefer interactive mapping applications, especially those with aerial photography.

With open source options from Google and Microsoft, pricey Internet-capable mapping software is not required for organizations primarily concerned with just displaying map data. Additionally, these open source applications manage to further alleviate the pressure to have higher level GIS, database, and specialized programming professionals on staff. Many programming needs for these applications can be addressed with HTML (HyperText Markup Language) as opposed to proprietary programming languages and objects. Since many professionals in technology industries are more versed with HTML, as is the case here, rectifying problems and maintaining the mapping control within the website is much easier for the site managers and developers.

Choosing the Web mapping control for development was the first step. Following research on both open source applications, the choice favored Microsoft Live Virtual Earth. The decision was based solely on the available aerial imagery for the watershed at the time.

Once the Web mapping application was functional on a standard HTML page utilizing Microsoft Visual Web Developer 2008 (Express edition), progress could be made toward customizing the interface and publishing existing data. As previously mentioned, the LRCA utilized ArcView software to create and maintain spatial data, primarily in the shapefile format. This requires conversion of these files into a Web-ready format such as XML (Extensible Markup Language), GeoRSS (Geographically Encoded Objects for Really Simple Syndication), or KML (Keyhole Markup Language). Based on its simplicity within browsers as well as proprietary GIS software, KML was the converted file type for mapping. The KML Home Companion extension for ArcMap (available as an ArcScript), among other trial software, has been used to make this conversion. Layers are quickly converted and added to the existing map on request by the user. Some of the more important layers include the watershed boundary and parcels owned and/or managed by the LRCA.

The development for this sort of Web mapping application rests on the IT committee and the GIS and IT professionals it draws. The organization's staff can direct the needs and the volunteer committee can implement the necessities remotely. Management of the application does not exert excessive burden either as the main controls are called directly from the vendor. Overall, the fusion of GIS concepts and the Web environment works well for quick deployment of live mapping.

Going Forward

Organizations like the LRCA will continually have a need to transform either old or new data into a Web format for distribution. The workflow for posting under the current arrangement is fairly simple. Data is created (or retrieved) with ArcView, converted to KML, and incorporated onto the Web mapping control. These controls are constantly

under revision and being upgraded for a more sophisticated mapping experience on the Web.

While these aforementioned Web controls offer access to global imagery and data, the need for analysis tools for projects involving spatial implications cannot be met with such Web controls at this point in time. Fortunately, the LRCA's ownership of an ArcView license accomplishes these needs. Since annual maintenance costs for software like ArcView can be cost-prohibitive for small organizations, the cost burden can be drawn out over several years, sacrificing updates and upgrades, but allowing for smarter use of funds.

The Web mapping controls and applications open doors for GIS data entry by website visitors who would like to post observations about the river or trails. Again, this activity does not demand constant updating by a Webmaster or in-house GIS personnel but instead allows an open, yet moderated, environment for timely spatial information to be displayed. Interaction promotes website use as well as ongoing interest in issues related to the LRCA's mission.

Conclusion

Due in large part to open source applications, light freeware, access to high-speed data transmission, and Web accessibility, the high expectations for a well constructed, easy to use office and Web mapping applications can be easily met at a lower than historically-prescribed cost. In addition to making such a GIS available online without hefty software packages in need of constant management, Web controls offered by Google and Microsoft embody a lightweight solution with excellent output. This sensible approach to maintaining a business GIS component without a large staff or budget burden is functional for small organizations (Figure 1). A significant component in orchestrating a functional, inexpensive, multi-faceted GIS draws on the capitalization of available GIS and Web-programming talent, often donated or provided at a lower cost for non-profit organizations. Each situation requires different needs and time spent on creatively designing a GIS to suit can reduce the costs by bypassing the immediate urge to purchase the most robust software package on the shelf.

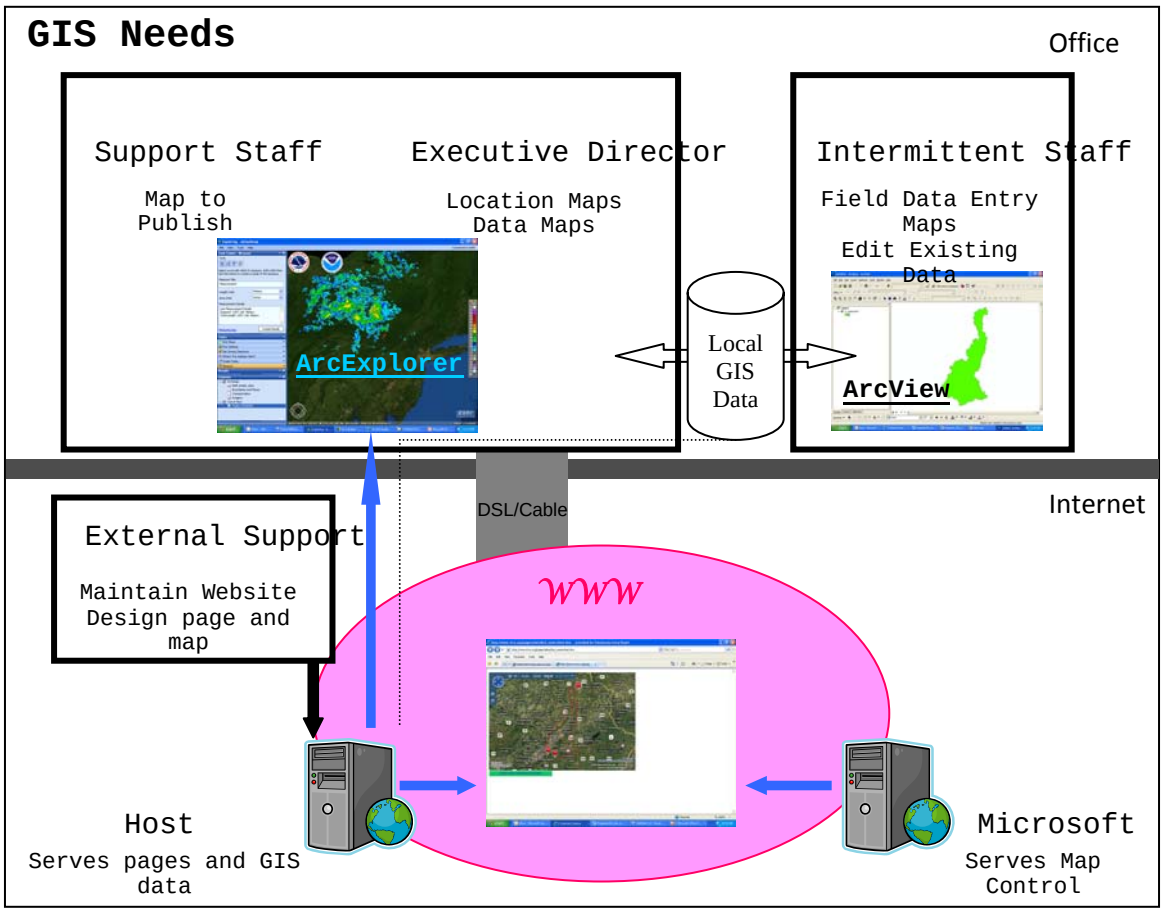
GIS Needs
Office
Support Staff
Map to Publish
Executive Director
Location Maps
Data Maps
Intermittent Staff
Field Data Entry
Maps
Edit Existing Data
ArcExplorer
Local GIS Data
ArcView
DSL/Cable
Internet
External Support
Maintain Website
Design page and map
WWW
Host
Serves pages and GIS data
Microsoft
Serves Map Control

Figure 1