Archaeological GIS data in Wildland Fire Situations

Abstract:

Archaeological GIS for land and resource management among land managing agencies is established as an essential technology. Agency archeologists can open ArcMap, choose Add Data>Add ArcGIS Server or ArcIMS Server with other datasets to work. Site and Areas Inventoried locations and tabular data are available. Using Mobile GIS, archaeologists are able to go afield with existing data on their handheld, edit extant data or collect new data that becomes part of the record without need for data re-manipulation so that errors are reduced. Such systems are operational many places. Sources of such data are diverse. Exception to access is in some of the Wildland Fire situations where such capabilities would often save sites, life and property. Discussed are Fire scenarios, such as the Incidence Command during a fire and rehab situations, etc. with discussion of what the challenges are to realize capabilities throughout the Fire system.

For this presentation and paper my target audience for the 2008 ESRI International User Conference will be whomever the Title, the session subject[1], and the abstract will attract. Of course, the concepts advanced go beyond the conference event. I am hoping that in the session some may attend who have had experience in such matters[2]. ESRI notes that giving a presentation connects us with others who may be struggling with something we are working on, have already solved or with those who can offer useful feedback to improve our own methods. Among the State Historic Preservation Officer (SHPO) data centers only one of 12 have adopted ArcGIS Server technology, others have not included site attributes that allow evaluations, not all available data is current, etc. I desire to force the issue to make the Archeological spatial data sets timely, deliverable and meaningful to any Federal Wildland Fire situations that require such information as well as available to other land management situations across the boards.

My overall target audience is the:
1) Community of Archeologists concerned with resource protection (resources are being lost to fire and other events because too many of the Archeological community are overly possessive of the data or are not engaged with GIS),
2) Wildland Fire Community who have a full plate of prioritized tasks, and
3) Fire GISS[3] Community who also has plenty on their plates during an Incident.

I wish to encourage a dialog and enhance cooperation among these three communities. At present access to site location data is inconsistent and my perception is that all locations are treated equally when the GISS obtains information. This "all sites are equal" is

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[1] "Managing Archaeological Resources on Public Land with GIS"
[2] Readers of the published on line 'User Conference Proceedings" may also provide insights in the future.
[3] Geographic Information System Specialist (PMS 311-77 MAY 2008)

wasteful and degrades enthusiasm to be concerned about any of the Archaeological and Historic Sites (hereafter in this report referred to as "Cultural Resources").

My key take home message is that the Archaeological spatial data must be evaluated by Archeologists prior to being passed off to the Fire Community. More specifically our GIS tools and Archeological Spatial data in the hands of Archeologists engaged in Fire activities must be current, and contain the needed tabular data for evaluation[4] To do this not only must locations be available and accurate, but also, attributes must be meaningful and readily at hand via delivery with ArcGIS Server. Analysis of Archeological data without GIS capabilities is onerous or lacks quantitative, qualitative rigor and may be indefensible as being solely subjective.

When Fires occur some sites and site locations are less likely to be seriously damaged whereas other locations will be utterly damaged. Other issues may overshadow concern about a prime Archaeological location and a loss will occur; however, with high, moderate and low ratings about sites, at least, the Incident Command, or rehab, etc. knows what is best to save if all other factors are equal. Further, Archaeological spatial data must ALWAYS be readily available for any category of Fire activities. Analysis and preparation of Cultural spatial data processed in advance, held in reserve, and readily available for delivery to a Fire's location is a best case. Some of this advance preparation has been done by our hard working Fire Archeologists, but too often the GIS tools or data are insufficient[5]. For person's serving as GISS integration of Cultural information is yet another workload and if they receive data evaluated by Archeologists regarding relative sensitivity of locations in formats that may be readily integrated, they may be more receptive to giving Cultural values serious representation to such Heritage/Archeological resources to convey to Fire management and the on-the-ground fire fighters.

This paper is testing the water for policy development as well as a stimulus to promote communication among the three above mentioned communities. This presentation ought to be a lightening rod for both positive and adverse reactions among any of the three communities.

The Fire Planning Community evaluates the landscape regarding high, medium, and low risk as well as fire characteristics[6]. Grassland fires burn quickly across the landscape and appear to not damage subsurface remains of certain site types[7]. The "Cultural Site Fire

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[4] "8110 - IDENTIFYING AND EVALUATING CULTURAL RESOURCES – (Public) .4 Categorizing According to Uses."
http://www.blm.gov/wo/st/en/prog/more/CRM/policy_and_guidance/use_on_line_manual.html
[5] Peter Ainsworth and Joe Lally 2008 Personal Communication
[6] See: Natural Resources Modeling 2008 ESRI International User Conference Sean Murphy, David Howes, "Applied Wildland Fire Research in Support of Project Level Hazardous Fuels Planning – Toolkit "at http://forest.moscowfsl.wsu.edu/fuels/tools.html and "Applied Wildland Fire Research in Support of Project Level Hazardous Fuels Planning -- Other Tools and Resources" at http://forest.moscowfsl.wsu.edu/fuels/resources.html
[7] Winthrop, Kate, 2004, "Bare Bones Guide to Fire Effects on Cultural Resources For Cultural Resource Specialists" at
http://www.blm.gov/wo/st/en/prog/more/CRM/fire_and_heritage/fire_effects_on_cultural.html

Risk Evaluations" (CSFRE – my contribution to the world of acronyms) for sites within these Fire high risk zones are the first priority for consideration.

Cultural sites characteristics vary considerably and there are either the negligible or disastrous impacts from fire. Evaluation requires the special professional Archeologist's input and evaluation. A polygon, line or dot indicating a site location is never sufficient to warrant attention and concern. The qualities that make a site valuable are complex and fire impacts upon these valuable aspects vary.

> "**Fire effects are context-dependent. The effects of fire on cultural resources depend upon factors which vary from place to place, including physical factors such as fuels, terrain, site type, and cultural materials present. Managing for fire effects also depends upon the value of the cultural materials at risk. In areas where surface materials have little integrity, for example, due to collecting, erosion, past fires, or other factors, surface effects from fire may be of minimal consideration**."[8]

Some sites may withstand even the most intense Wildland fire conditions while a cool grass fire will utterly destroy the "Euwell Gibbens homestead cabin"[9] or Shoshoni wooden sheep traps[10].

It is a truism that GIS for land and resource management among land managing agencies is an essential technology. On the Public Lands Minerals, Forest, Range, Recreation, Wilderness, Cultural, and Hydrology Resources as well as the land itself have location as a fundamental characteristic. It seems logical to organize information about the land and resources according to their x,y,z coordinates as points, lines or polygons. For land and resource management this makes sense because these resources often will co-exist upon the landscape; therefore, the allocation and use of the resources may be best managed by observing and marshaling spatial information and relationships. No physical entity may be managed successfully unless you know where that entity is, its characteristics, its distribution, and its relationships to its surroundings.

When resources are threatened by catastrophic events such as Wildland Fire a sequence occurs that requires exact spatial information regarding both the location and the nature of the site (site attributes) to be at the finger tips of those who are dealing with the fire and the resource. The first order of business when dealing with Wildland Fire is the safety of lives and property. The Safety of the responders is absolutely primary. Within that caveat the system allows protection of resources and directed reactions toward containment and suppression of the fire, that is, if and only if resource location and attributes are understood by the fire community.

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[8] Winthrop, Kate, Ibid.
[9] Joe Lally 2008 Personal Communication
[10] http://www.npr.org/templates/story/story.php?storyId=92271539

Currently, SOP preplanning is in place where a potential for Wildland Fire exist. Fire "Resource Advisers" have worked with Federal Archeologists to identify generalized "zones". When fire strikes where known identified high value Cultural Resources the

Figure 1 Fire potential is as ubiquitous as lightening strikes

Fire personnel are advised regarding the high value zones.

While this approach is fine as a "stop gap" measure, a more precise location and attribute system is required and is possible. This is due to the application of the Geographic Information System Specialist (GISS)[11] within the Planning Section of the Wildland Fire Incident Command. Further, opportunities now exist beyond our former dreams as a result of the advance of a growing body of persons with GIS skills as well as a growing body and availability of spatial information about Cultural Resources due to the ten years of effort by a BLM sponsored partnership the "Cultural Resource Data Sharing Partnership (CRDSP)"[12]

While Suppression Operations are the most obvious and dramatic activities in Wildland Fire situations these are only a part of the requirement for a precise location and attribute system for Fire related Cultural Resource work. Included work areas related to Cultural Resources are Wild Land Fire Preparedness, Emergency Fire Rehabilitation, and Hazardous Fuels Reduction work. Each of these requires the ability to know precise location and attribute for sites. Further, for this work the capability to apply Mobile GIS[13]

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[11] "The Geographical Information Systems Specialist (GISS) position is part of the Incident Command System's (ICS) Planning Unit. This group also encompasses the National Incident Management System (NIMS). The GISS group is dedicated to the dissemination of information to the entire GISS community regardless of agency or nationality. The GISS position as it currently stands is regulated by the National Wildfire Coordinating Group (NWCG), an inter agency organization in the United States." http://tech.groups.yahoo.com/group/GISS_group/

[12] The CRDSP (recipient of an ESRI Inc.2008 SAG award) and BLM Archeologist's GIS skills are addressed in other papers in this section.

[13] Mobile GIS (aka integrated GIS/GPS) is subject to special specifications and capabilities for Archaeological Spatial efforts. The Mobile units must be fully capable with field delivery of GIS including

is fundamental. Cultural Resource sites are often subtle and not easily distinguish on the ground even by professionals. For land disturbing Wild Land Fire Preparedness, and Hazardous Fuels Reduction work an archeologist navigating to known site locations derived from an ArcGIS managed Cultural spatial data base with a Mobile GIS may flag sites for ground crews and applications far more efficiently than having to wander around searching for the locations. As soon as firefighters extinguish the fire and abandon the area, immediate collection with Mobile GIS of new sites revealed by the fire as well as visiting known sites is necessary to deal with looting[14].

For the post fire work of Emergency Fire Rehabilitation (EFR) the characteristics of the landscape are often dramatically altered. Navigating with precision to known site locations allows far more time and effort toward the actual rehabilitation work and greatly reduces costs. Also, the landscape alterations of a Fire will reveal unknown resources. With a Mobile GIS in hand that allows location and attributes with data collection formats derived from the data structure of the GIS, the collection of this new data requires a fraction of the time and effort.

For Fiscal Year 2007 BLM Cultural Staff[15] invested 23% of its available work effort in Fire related work! Percent quantification of the total by each activity is in parentheses following the work category:

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Wild Land Fire Preparedness	(6%)
Suppression Operations	(12%)
Emergency Fire Rehabilitation	(16%)
Hazardous Fuels Reduction	(18%)
Wild Urban Interface Fuels	(45%)
Fire Reimbursable	(1%)
Preparedness Assistance Expenses	(0.02%)
Monitor/Apply Fire Rehab Treatments	(2%)

How the creation of Cultural Spatial Data Bases are funded

Efforts to funds these advances and partnerships are as creative as they are diverse. The labor required to pay the bills detracts heavily from accomplishing more by taking away time of dedicated GIS true-believers to beat the drum for funding. Available BLM funds

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multiple layers, as well as the complete tabular data associated with both site locations and areas inventoried that reside with the ArcGIS Geodatabases for the Cultural Resource data. Upload and download from the main Geodatabase to and from the Mobile unit must be straight forward and easy to accomplish.

[14] http://www.npr.org/templates/story/story.php?storyId=92271539

[15] Such statistic for the FS, NPS, as well as other Federal Agencies may reflect similar efforts and would increase the quantity of effort. The Fire Community includes these Federal Agencies
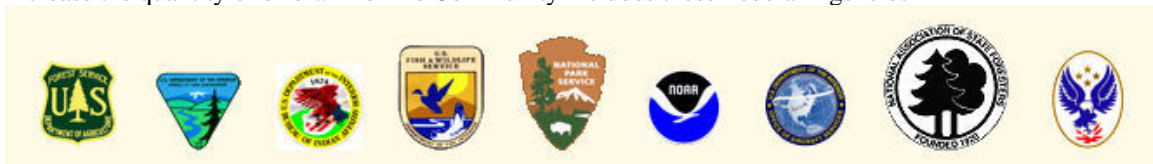
are supplemented greatly by SHPO in-kind contributions. Grants are sought, but base reliable programmatic funding in adequate amounts is required. There is not a "Sugar Daddy". All who have labored so very hard to get this far hope that the value and success thus far will attract investment from the many benefactors of these capabilities[16].

How we have helped federal managers, staff and the public understand and use Cultural GIS

Implementing and using a Cultural Resource Spatial System imposes some fairly unique conditions. Locations and tabular data is "privileged" and "protected" from general public release due to potential for site looting and vandalism. Cultural sites and data are subject to an elaborate system that causes professional Archaeologists to process and interpret the fragile remains of past civilizations for the public. Such a procedure was instituted in 1906 in Federal Statute[17] due to foreign collecting and removal of exquisite Anasazi ceramics to overseas Museums as well as private collections. Also, during the late 1800s local citizens spent Sunday afternoons exploring and unfortunately removing and destroying important contextual information for interpretation of the past. These mandates dictate that professional archeologists must regulate public access to the sites and data while at the same time providing interpretation and access to the information for the public.

Of course, this does not mean simply denying access to sites, and data, but instead is a responsibility to provide necessary access to information for site protection as well as public enjoyment of our Heritage, and especially the interpretation and explanation of Archeological work[18]. Cultural Resources are subject to destruction in fire suppression situations as well by erosion and other forces of nature. Specific location information if in the hands of a Bulldozer operator may enable missing a site while still accomplishing an effective 30' fire break line. An antidote regarding the dilemma of "protection" versus "common sense" is a fire situation wherein a mechanized fire crew ordered to place a fire break and move across country encountered an 1870 era barbed wire fence intact and in excellent condition. The archeologist on hand refused to allow the fire crew to cut a ten foot section of the fence to take a direct path to the location for the new fire break. The time lost in going around the fence led to the fire sweeping across the whole fence so that the entire historic fence was destroyed. In the right circumstances a sensible Archaeologist knows when to make judgments involving minimal loss as well as that release of raw site location via the GISS to a fire crew will lead to preservation and not to looting.

This overall situation suggests implementation of a situation diagramed below at the Incident Command Center.

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[16] Other papers in this session may address funding issues more fully.

[17] The 1906 Antiquity Act is reinforced by at least 8 follow-on Federal mandates and regulations over the next century.
http://www.blm.gov/wo/st/en/prog/more/CRM/policy_and_guidance/historic_preservations.html

[18] See http://www.blm.gov/heritage/adventures/research.html

Relationships & Integration
Suppression
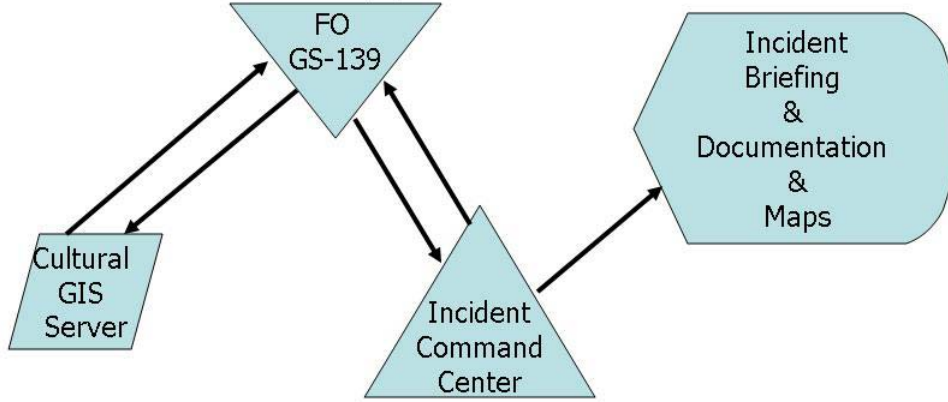
In suppression situations the potential for site damage is most urgent, demands immediate data access, and offers the best chance to avoid site damage.

The Wildland Fire Scenario and how Cultural Resources will Relate and Integrate

At first light the Incident Command Center will receive the benefit of the Planning Section's GIS section that labors around the clock. The crews assemble for the morning briefing.

Figure 2 Out of the sleeping bags, dress, breakfast, and morning briefing

Figure 3 Assembling at the briefing point.

Figure 4 A large format map is used for the briefing.

For the Cultural Spatial Data to be effective it must be accessible on the Archeologist's ArcGiS desktop via an"Add Data"
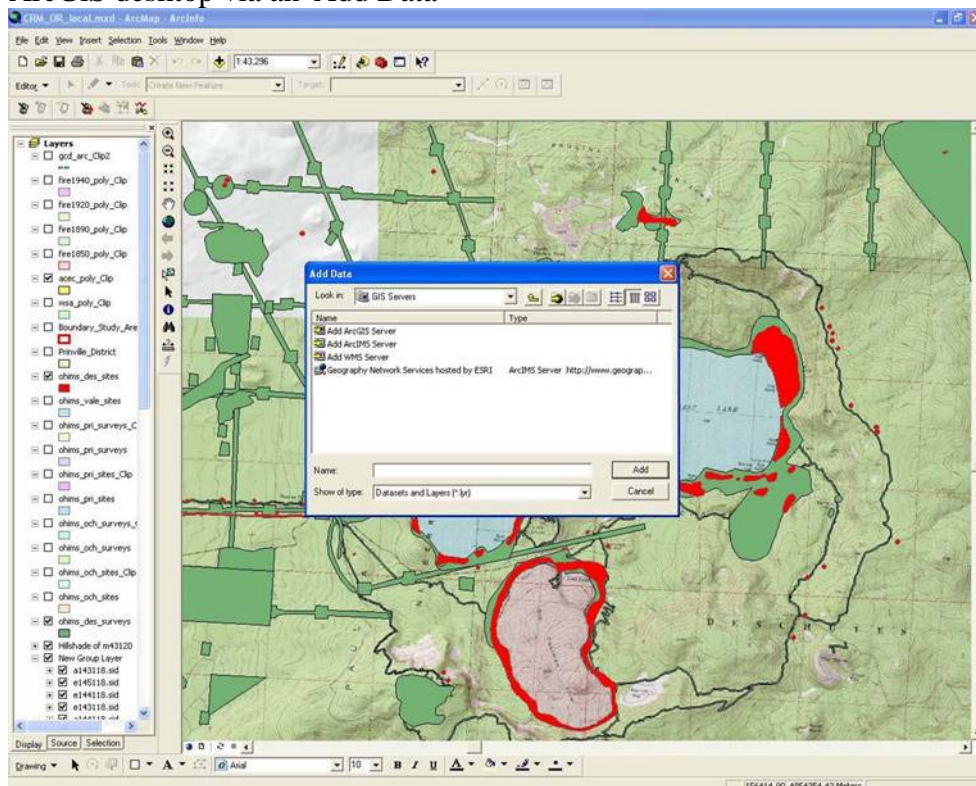

Figure 5 Add Data - Sites and Areas Inventoried
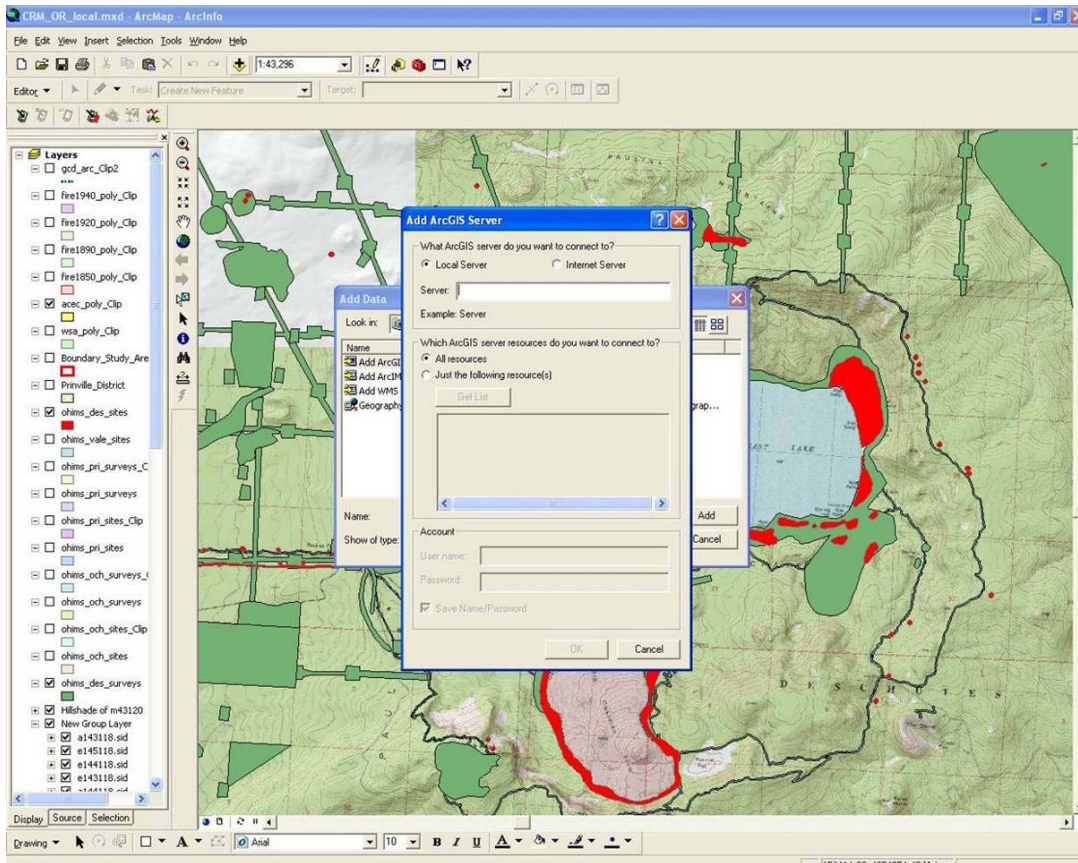
as a choice from an ArcGIS server.
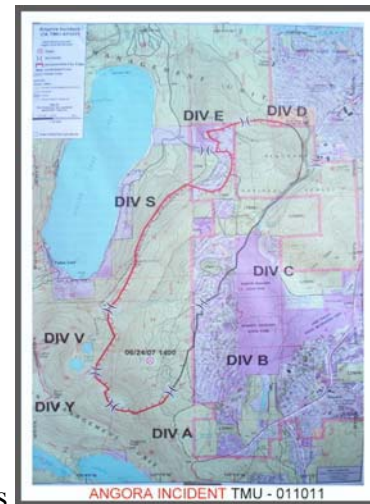

Figure 6 Add the Cultural Spatial Server

The Archeologist may then compare the mapped Firelines

Figure 7 Fire perimeter map

as well as potential impact areas, directions and potential rates of advance, that are transmitted by the GISS at the Incident Command Center against the location and attributes of Cultural Resources that may be impacted the next day. Then the Archeologist must transmit the assessment and locations and scaled comparative value of the Cultural Resources to the GISS so that it arrives prior to midnight for processing for the next days morning briefing. This type of participation by the Archeologist will most

likely be from the Archeologist's office location and not at the Incident Command Center. The internet must be relied upon. Of course, in the best of all worlds, such work by the Archeologist would have been done for areas with high potential for fire well in advance and be ready to transmit to the GISS as required.

The role of the Field Office Archaeologist is:

> Isolates and evaluates location & tabular data
>   For Areas inventoried and site locations
>   For fire trends and directions
> Forwards analysis to GISS for the IC

The GISS's role is:

> Provides Fire information to Archeologist (GS-193)[19]
> Integrates GS-193's information for IC
> Provides Cultural data integrated with other data to folks who need to know

Cultural values location and attributes must be known, analyzed, and communicated to the folks on the ground or we must accept the consequences and

losses.

Figure 8 Fire break creation
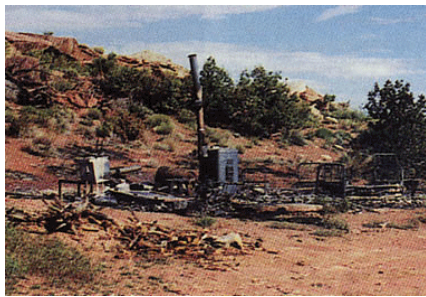
Figure 9 Wildland Fire storm

Figure 10 Historic cabin lost forever

Bonuses to having this Cultural GIS support system

One of the most exciting aspects of these capabilities for me since the mid-1980s when I "discovered" GIS aside from all of the natural disaster utility is in cultural spatial

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[19] GS-193 is the Federal designation for the Archaeologist job series.

analysis[20]. I allude here to the work of Kenneth L Kvamme[21], Lynne Sebastian, Jeffrey H. Altschul[22], and others. This aspect is stated as well as I have stated often in the past by Bradley L. Garrett:

> "The new working database will assist archaeologists at BLM in two very important ways. First, the ability to statistically analyze large amounts of data may lead to new research possibilities and interpretation of land use in history. Geospatial data also allows broad cultural patterns to emerge, as population dynamics, temporal use patterns, and habitation centers begin to "pop off" the map.
>
> Second, the construction of the database facilitates quick reference when creating reports on area impacts, such as environmental assessments, or when making quick decisions on potential resource impacts, such as in the case of fire-line bulldozing in areas of potential cultural sensitivity."[23]

For some exquisite examples of combinations of modeling and fire impacts upon Cultural Resources see Joe Lally's work that discusses (potential) heat of combustion of a given fuel load, heat release rate, or the amount of heat flux that impinged on any given artifact[24].

Lessons learned to implement these solutions

Our colleague, Bradley L. Garrett, in spring of 2007 cites "the resource database has seen limited use within BLM due to reluctance to shift to digital formats."[25] The use of GIS is improving continually although not nearly rapidly to suit some of us. I perceive a wide spread failure to embrace many Information Technology (IT) productivity tools, and I am searching for explanations. For years the mantra of the "non-user" was "ease-of-use"[26].

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[20] Fire operations are a tremendous symbiotic relationship for Cultural with such data and modeling developments as LANDFIRE http://www.landfire.gov/

[21] 2006 There and Back Again: Revisiting Archaeological Location Modeling, In GIS and Archaeological Site Location Modeling, M.W. Mehrer and K.L. Wescott, eds., CRC-Taylor & Francis, Boca Raton, pp. 3-38.

[22] http://www.srifoundation.org/index.html

[23] http://www.esri.com/news/arcnews/spring07articles/blms-california-cultural.html

[24] See: Man, John 2007 "The Terracotta Army" for Lally's model of the fire(s) in the underground chamber of the Terracotta Army that devotes several pages to Lally's analysis of the fire.
See also: "Scientific Investigation and Modeling of Prehistoric Fire at Chevelon Pueblo in Arizona" a paper that was presented at the 10th Biennial International Symposium of Fire Science and Investigation and that is being cited in the British Journal, "Antiquity".

[25] http://www.esri.com/news/arcnews/spring07articles/blms-california-cultural.html In addition to the outstanding training opportunities offered by ESRI Inc,. the Principles of Modeling, course number 1730 - 55 offered by BLM National Training Center or the U.S. Fish & Wildlife
National Conservation Training Center in Shepherdstown, WV taught by Dr. Tony Starfield this June 2-6 at NCTC

[26] ArcGIS has evolved to be a joy to use in the "ease of use", efficient and effective context help area. However, many software products supplement GIS itself such as on-line training, Forums addressing technical issues such as to interface with an OS and security issues, and a variety of Office Automation

The IT community has come a long way with GUI interfaces, and accommodating the general public. The exciting aspects of "ease of use" has a negative side that I have experienced and is stated well by my friend and colleague, Kenneth L. Kvamme, Professor, Department of Anthropology, University of Arkansas, Fayetteville, AR:

> **"There is a generational component where "older" people are more fearful of or resistant to using or adopting IT solutions. It comes naturally to the current younger generation and they adapt to it quickly, but I also see problems with them (since I regularly teach them). They are quick to "point and click" and they can rapidly navigate through menus, but increasingly, and alarmingly, I'm finding that they don't understand how things really work. This is probably the failure of our educational system where contemporary students have poor math skills, but many, surprisingly (and distressingly), don't have a clue about how computers work. So Bill Gates & Apple might be applauded for getting the computer to the masses, but once you get the students past the internet and Facebook, there are some real educational issues to confront. At least they don't fear trying things with computers as older generations do."[27]**

As we all know, it is possible to create some perhaps very pretty and impressive appearing products or results that are, in fact, utter nonsense.

Some IT products are quite popular regardless of user's demography. How then may the rejection of tools that offer to make our lives more productive, effective and, efficient be explained? I reject such explanations as "too busy", or "too old to learn". If realistic explanations for not using IT are understood, the situation may be improved. Many "solutions" come to my mind, but these may be addressing the wrong explanations for people who do not use these tools.

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productivity tools. Users failure to embrace these supplemental tools that will aid coming up to speed with GIS is an area that I see as a weakness to advancing spatial knowledge and success.

[27] Kvamme, Kenneth 2008 Personal Communication

REFERENCES

Ainsworth, Peter 2008 Personal Communication

Altschul, Jeffrey H., Sebastian, Lynne, and Heidelberg, Kurt 2004 "Predictive Modeling in the Military: Similar Goals, Divergent Paths" at http://www.srifoundation.org/library.html

2004 BLM 8100 BLM Manual of 12/03/04

Garrett, Bradley L. 2007 "Bureau of Land Management's Cultural Resource Database Goes Digital: California Field Offices Unlock Data for Archaeology Program " at http://www.esri.com/news/arcnews/spring07articles/blms-california-cultural.html

U.S. Congress 1906 forward "Protection and Preservation Laws" http://www.blm.gov/wo/st/en/prog/more/CRM/policy_and_guidance/historic_preservations.html

Kvamme, Kenneth 2006 There and Back Again: Revisiting Archaeological Location Modeling, In GIS and Archaeological Site Location Modeling, M.W. Mehrer and K.L. Wescott, eds., CRC-Taylor & Francis, Boca Raton, pp. 3-38.

Kvamme, Kenneth 2008 Personal Communication

Lally, Joe 2008 Personal Communication

Wheatley, David, and Mark Gillings 2002. Spatial technology and archaeology : the archaeological applications of GIS. London:Taylor & Francis.

Winthrop, Kate, 2004, "Bare Bones Guide to Fire Effects on Cultural Resources For Cultural Resource Specialists" at http://www.blm.gov/wo/st/en/prog/more/CRM/fire_and_heritage/fire_effects_on_cultural.html

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