USE OF GROUPWARE-ENABLED GIS FOR LAND RESOURCE ALLOCATION ISSUES

Brenda Faber
William Wallace
Howard Sargent

ABSTRACT
This paper describes the Active Response GIS (AR/GIS) for resource planning and land-allocation deliberation. AR/GIS is an integrated system which combines GIS and electronic meeting software. This combination provides the voting, information organization, and brainstorming of an electronic meeting system, and supports interaction with geographic data sets. The AR/GIS system can improve efficiency of land-resource deliberations, and offers land managers a means to interact more closely with geographic data.

KEYWORDS

INTRODUCTION
The Active Response GIS (AR/GIS) is an integrated system which combines GIS and electronic meeting software. This prototype was developed to support land resource allocation. A description of the AR/GIS prototype is presented, an application of the AR/GIS system for land allocation is described, and future development efforts are discussed.

GIS AND RESOURCE MANAGEMENT
Recent experience has shown that a Geographic Information System (GIS) is a critical tool for enabling effective land-resource management. However, use of GIS technology introduces several significant bottlenecks in the resource management process:

- Resource managers with final authority on land allocations rarely have the time or technical expertise to interact directly with GIS systems. Since they must rely on trained GIS professionals to extract pertinent data and perform spatial analyses, resource managers must anticipate data needs well in advance of a presentation or negotiation session.

- Resource decisions are rarely made by a single person. Most allocation issues require frequent negotiation among land planners, public officials, and affected parties. It is
difficult to insure that all who participate in the negotiations have access to the most recent, consistent, and accurate data. In addition, negotiated changes require subsequent digitization and integration back into the “official” database.

- Analysis of recommended changes can take weeks or months. Thus, it is usually not possible to assess the implications of a suggested approach within the context of its initial recommendation.

- It is difficult to track the rationale justifying various decisions throughout the negotiation process. It is even more difficult to maintain a record of this rationale which is readily accessible for public inquiry and/or regulatory review.

GROUPWARE FOR LAND-RESOURCE NEGOTIATION

TERRA1 (Terrestrial Ecosystems Regional Research and Analysis Laboratory) has developed a prototype system which attempts to address the issues raised above by supporting group deliberation of land allocation issues. TERRA has incorporated GIS capability into a groupware framework using electronic meeting system technology. An electronic meeting system is a type of groupware which is specifically designed to enhance meetings and face-to-face negotiations.

In general, an electronic meeting system captures meeting participants' votes, comments, or positions via an electronic input device, and then summarizes all input for the group. A simple example of an electronic meeting system is demonstrated in the popular USA television show, "America's Funniest Home Videos", where the audience is asked to vote on their favorite video via a hand-held keypad. Figure 1 shows a typical architecture for an electronic meeting system.

---

1 The TERRA Laboratory, located in Fort Collins, Colorado, is an interagency research laboratory sponsored by the US Global Change Research Programs within the US Department of Agriculture and the US Department of Interior. TERRA is a multi-disciplinary consortium concerned with regional-scale studies of terrestrial and human processes related to global change. TERRA develops integrated assessment technologies which incorporate information and models. Contact the authors for additional information.
Figure 1: Electronic meeting system architecture encompasses input devices which are connected via a local area network. The system software has a client/server architecture with a file server collecting all data generated by participants. A special workstation is present to allow the meeting facilitator to control the software. A video display device is connected to the facilitator's computer to display results to the group. Printers, external databases, and other devices can also be included on the network.

TERRA has created a customized electronic meeting system for resource management. The Active Response GIS (AR/GIS) prototype is an integration of GroupSystems V, an electronic meeting system developed by University of Arizona and marketed by Ventana Corporation, and IDRISI, a raster-based GIS system developed by Clark University. The AR/GIS prototype supports face-to-face land-resource negotiations using a PC-LAN configuration of computer laptops (see Figures 2 and 3).
The AR/GIS system introduces geographic interaction tools to the electronic meeting system environment. New electronic meeting tools developed as part of the AR/GIS prototype include:

**Geographic Exploration Tool** -- This tool allows negotiators to interactively explore supporting data via a simple menu interface. Data may include geographic data layers, economic statistics, policy statements, photographs, etc. Participants can customize presentation of the geographic data to fit their own perspective (e.g., overlay selected landmarks, zoom into particular regions, highlight areas of interest, etc.). Thus, the negotiators are no longer dependent on GIS technicians for data review and access.

**Geographic Proposal Tool** -- This tool allows graphical submission, compilation, and tracking of geographic proposals via annotated data layers. Each participant constructs geographic proposals by using a computer mouse to "trace" regions on various data layers. From a technical standpoint, each set of traced regions constitutes a data layer of digitized polygons which graphically captures the participant's perspective or position. It is important to emphasize that the outcome of this activity is a new GIS data layer generated by each participant. Thus, a full array of the analysis techniques can now be applied to combine and analyze this data for display to the group. Negotiators no longer have to wait weeks for analysis results. The implications of various scenarios can be modeled and discussed during the meeting as they are recommended. In addition, the decision rationale behind these scenarios is automatically recorded for later reference.

**Geographic Prioritization Tool** -- This tool uses electronic voting/prioritization utilities to establish land management priorities as weighting factors for subsequent geographic analysis and modeling. Participants first use a groupware voting application. For instance, they might use the electronic meeting software to rank the importance of land...
characteristics, or they might score objectives based upon a multicriteria land-use objective. The resulting combined scores from this exercise are then applied as weighting factors for any of a number of GIS analysis techniques.

**Geographic Negotiation Tool** -- This tool makes use of a whiteboard to encourage participant interaction and collaboration. Data layers are first projected on a whiteboard. Then, in a method similar to the Geographic Proposal Tool described above, participants are asked to work together to construct land-use proposals by interactively tracing/erasing areas with marker pens. This exercise encourages the group to collaborate verbally to generate a group proposal. Once the group agrees on a proposal, the meeting facilitator can digitize the pen marks overlaying the projected display. A full array of analysis techniques can now be applied to combine and analyze this data for further discussion.

All AR/GIS geographic interaction tools were implemented within the context of an electronic meeting system environment:

- input is simultaneous (except for the Negotiation Tool) allowing everyone to state their position or opinion at once;
- input is anonymous (if desired), minimizing impediments to group interaction such as dominant personalities, pre-established group hierarchies, and personal rivalries;
- participant input is compiled and summarized for group display; and,
- meeting documentation is generated automatically and is available for review at any time.

It is important to note that none of the AR/GIS tools described above replaces the verbal interaction critical to any negotiation process. Rather, the AR/GIS methods can be used to provide a snapshot of the group's perspective at any point during the deliberations. The visual display of analysis results allows the group to quickly assess which issues are already agreed upon, as well as identify issues which need further debate. The AR/GIS tools are best used to stimulate discussion and focus the group on critical issues.

**APPLICATION OF AR/GIS FOR RESOURCE ALLOCATION**

The AR/GIS prototype is currently being applied in a project with the Arapaho-Roosevelt National Forest. The Forest is nearing completion of its 1995 Forest Plan Revision. The revision must incorporate a number of management strategies and land-use alternatives. Public response to initial revision proposals has been collected through a variety of mechanisms including open houses, field trips, and individually submitted forest plans.

District rangers and their staffs must now respond to the public comment by making final alterations to the Forest proposal. The districts will use the AR/GIS prototype to explore district priorities, review the database of public comment, and respond by suggesting changes to management prescriptions, usage boundaries and/or general policy. All current
data will be available for review at any time. The district staffs will debate possible changes using the AR/GIS Geographic Proposal and Negotiation tools described previously. Changes agreed to in the meeting will be automatically digitized and saved using the AR/GIS system. All changes will be tracked and linked to the comments database, making decision rationale available for subsequent forest use, public inquiry, and regulatory review.

Next, Forest Leadership will make use of the AR/GIS system to develop an integrated Forest Plan based on the district proposals. Each district ranger will present the district's recommendations resulting from the sessions described above. The AR/GIS system will be used to highlight the spatial changes made, indicate comment(s) which prompted each change, and review the documented rationale associated with each change. After examining all district proposals, Forest Leaders will then use the AR/GIS system tools to establish overall Forest priorities, resolve inconsistencies between the district proposals, and integrate any differences in district approaches. This session will result in an integrated Forest Plan Proposal.

Finally, allocation changes and rationale used to develop the Forest Plan Proposal will be made available for public review and inquiry. The AR/GIS system's role in this process will be to allow the public, within a workshop environment, to explore alternatives and environmental effects information at their own pace, suggest additional allocation changes, and leave comment for Forest officials. This has advantages over typical public presentation formats because it allows individuals to review the information they are most interested in and it provides a dynamic means to make suggestions and/or work out compromises. Project completion of all phases is scheduled for Spring of 1995.

FUTURE WORK
While the AR/GIS prototype is designed specifically for face-to-face negotiations, a demand is growing for a similar mechanism to support distributed land-resource negotiations. For example, a land management plan may require public input from local land managers, coordination support from regional agency representatives, and policy input from governing bodies at the state or national level.

TERRA is working on a demonstration of a distributed land-resource negotiation tool. This tool will encompass many of the capabilities of the AR/GIS prototype, but will be customized to operate in a distributed mode using an Internet framework.

SUMMARY
The AR/GIS prototype provides a new environment for teams of resource managers to debate land allocation issues. All participants have direct access to consistent and accurate datasets. Participants work individually or in groups to construct potential geographic scenarios. The implications of these scenarios are modeled and discussed as the scenarios are generated. Decision rationale for final recommendations are recorded automatically. All generated data are linked to original geographic datasets. In summary,
the AR/GIS prototype is a unique system which can improve efficiency of land-resource deliberations, and offers land-managers a means to interact more closely with geographic data.

SELECTED REFERENCES


AUTHOR CONTACT INFORMATION

Brenda Faber
Senior Spatial Systems Research Analyst
CIESIN/TERRA
315 West Oak Street, Suite 101
Fort Collins, CO 80521
(303) 490-8388
bfaber@terra.colostate.edu

Bill Wallace
Senior Systems Analyst
CIESIN/TERRA
315 West Oak Street, Suite 101
Fort Collins, CO 80521
(303) 490-8380
wwallace@terra.colostate.edu

Howard Sargent
Forest Planner
Arapaho & Roosevelt National Forest
240 West Prospect Road
Fort Collins, CO 80526
(330) 498-1201