Developing Tools forWatershed-based Analysis in Support of City-Region Planning

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Abstract

Nationwide and globally, watershed management has become increasingly pivotal in urban and regional (city-region) planning. We will use elements of a prototype watershed planning and decision support system developed by the members of the UCSD Regional Workbench Consortium and the SALT lab at the San Diego Supercomputer Center to demonstrate improved city-region planning methodologies. We call the prototype we are developing, WET, Watershed Exploration Tool.

The prototype includes a project and mitigation database with query and mapping features useful for a wide range of stakeholders that need to understand various aspects of watershed management and its impact on city-region planning. Construction project spatial layers were derived in a semi-automatic way using ArcScan. This paper explores ways the data can be used to expose students to principles of sustainable city-region development and compliance challenges, changes in habitat, and cumulative impact of development in a particular watershed.

City-Region Planning and the Regional Workbench Consortium

Increasingly efforts to promote economic development and quality of life must embrace a broad metropolitan and regional scale. Yet many barriers stand in the way, including difficulties associated with integrating, sharing, and managing information across jurisdictionally fragmented regional landscapes **[1]**. In recent years, embracing the watershed as a unit of environmental analysis has allowed the debate to crystallize around holistic regional planning in a manner that transcends political boundaries.

Figure 1: RWBC's 3D Regional Canvas of the Region

Figure 1, shows a solid terrain model, integrating both elevation and bathymetry data, and representing our integrated view of the region. These kinds of models combine the worlds of flat maps, satellite imagery and 3-dimensional physical terrain models. They help people see and understand topography in a direct and reliable way. The extents of the model are transboundary in nature and in this particular instance are meant to encompass the traditional Kumeyyay ancestral American Indian boundaries (from the Pacific to the Sea of Cortez – see Mike Connolly) **[2]**. Our approach builds on a foundation laid by the Regional Workbench Consortium (RWBC), a "knowledge-action collaborative" geared to linking science and technology to policy and planning for sustainable city-region development, http://regionalworkbench.org. Funded in large part by the Outreach Core of UCSD's Superfund Basic Research Program since 2000, the RWBC takes a forward-looking perspective by focusing on the Southern California-Northern Baja California transborder region - especially the San Diego-Tijuana city-region and coastal zone. The RWBC is affiliated with the Association of Collegiate Schools of Planning (ACSP), the Global Planning Education Association Network (GPEAN), and the Sustainability Science Initiative. It is a member of the *Forum*

on Science and Technology for Sustainability, one of the world's most significant global networks and forums dedicated to sustainability science: http://sustsci.harvard.edu/

The SALT laboratory (Sustainable Archives & Library Technologies) at the San Diego Supercomputer has teamed up with the RWBC to advance the notion of "the digital watershed" by way of a prototype called **WET** (Watershed Exploration Tool), which integrates various types of data in a data grid environment (a framework which allows for distributed management of data collections).

The SALT lab, in collaboration with Sparkers Inc and Jyo Purohit, is exploring ways of providing more effective access to legacy data in ways that can further policy development. We are currently working on information extraction, digitization, digital library and archive creation techniques that can facilitate this. . The WET prototype initially focuses on construction permits . A longer term goal of the effort is to enable the process of holistic city-region planning by "creating a detailed GIS record of the watersheds and rivers".

Watershed Management and Planning

National goals of vibrant economic development with simultaneous progress in environmental restoration and preservation emphasize the need to bring together the public, decision-makers, and scientists in effective strategies. The attainment of these goals is not mutually exclusive, but can be assured only with the integration of ecological, social, and economic approaches to environmental management problems. .Watershed management is one method for addressing these needs for integration**.[3].**

From the perspective of watershed planning and management, the penalty for failing to address these issues in advance will result in expensive mitigation in the future, placing real financial burdens on the future generation that are dramatically larger than many of the positive economic impacts projected for other university/industry partnerships. The California Resources Agency (CRA) and State Water Resources Control Board (SWRCB) estimated in 2002 that $14.8 billion is needed to combat point source and non-point sources of water pollution in the California **[4].**

The lesson here is clear; major economic benefits can be realized from effective watershed planning and management. In a major study by the National Research Council (1999), titled New Strategies for America's Watersheds **[5],** the authors examined the utility and limitations of the watershed-based policy-making and management. The report, as is the case with this proposal, grew out of recognition of the emerging trends toward integrative watershed management and the need to

improve communication between scientists and decision makers. One of the report's conclusions was that any effort to sustain economic prosperity while preserving environmental quality will require management approaches that integrate human and natural systems. Yet the capacity to do this is limited. In a benchmark work on this subject, Kenney, et al. (2000) **[6]** underscore the need for the engineering and scientific communities to .develop better, more user-friendly **decision support systems** to help decision makers understand and evaluate alternative approaches..

Towards Building a WET Prototype

In our initial Watershed Exploration Tool (WET) prototype, we explore the environmental impacts of construction projects over a period of time**.** Environmental impact mitigation is required when a developer impacts sensitive habitat and/or the beneficial use of a water body.

For the WET prototype, data for projects that included documents, spatial information and records were compiled in an integrated data base. Another componentg of WET is a navigation scheme that will allow for easy access to diverse data. With this information put it into multiple forms for access and visualization, it will be possible to examine the pattern of past required mitigation, and the types of BMPs (Best Management Practices) implemented. We can also show, how, over the longer term, such an approach will enable us to determine: (i) whether the mitigation was carried out, (ii) whether it was successful, and (iii) whether it was efficiently carried out given other options. This will enable us to think about how to change the current policy to achieve "better" results and to better understand what additional sources of data are needed to better make policy decisions. A mitigation-centric access to environmental data is also of great interest to the public and citizen-monitoring groups.

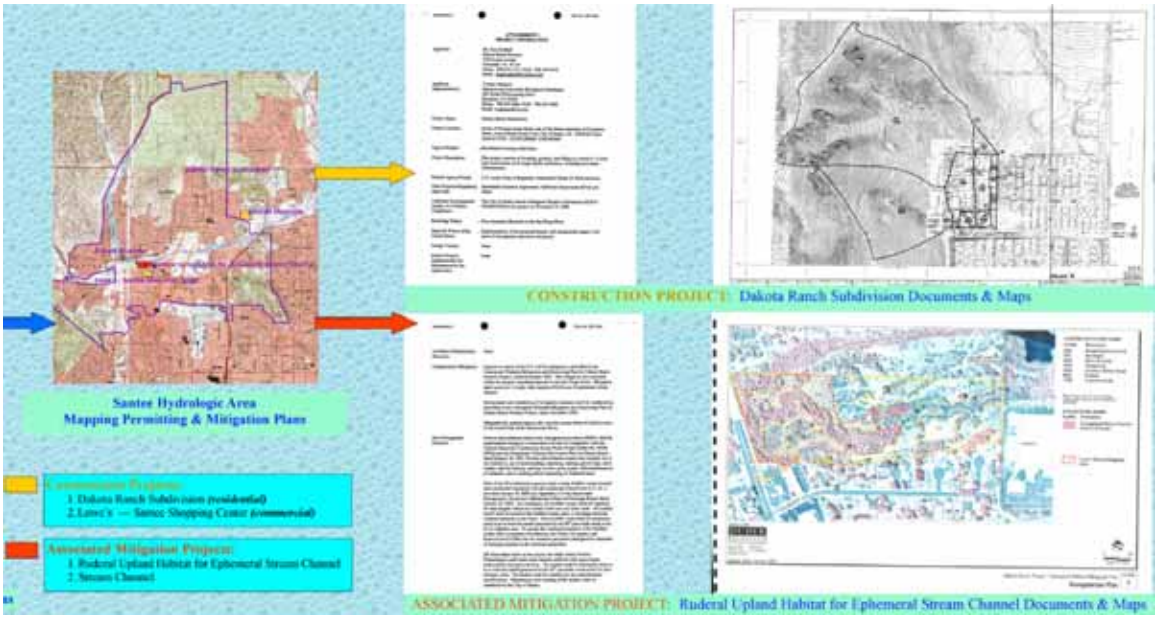

Figure 3: Linking Maps and Documents

Figure 3, shows an example of a topographic map on the left with two projects (red polygons) and associated mitigation projects (orange polygons). In this case the mitigation polygons overlap. To the immediate right are samples of the permit documents filed by applicants and to the far-right samples of maps (showing one of the project sites at the top, and showing the mitigation area at the bottom). A typical project file can consist of a few small documents (dozens of pages in total) or many linear feet of documents of all sorts (e-mail, environmental impact reports, photos, etc.).

In an memo titled, .Committing EPA's Water Program to Advancing the Watershed Approach,. the EPA states .multi-stakeholder efforts within hydrologically defined boundaries to protect and restore our aquatic resources and ecosystems, offers the most cost-effective opportunity to tackle today's challenges **[7].** To be effective, watershed partnerships, including water authorities as well as industry and community-based stakeholders need good Watershed Planning Support Systems (WaPSS).

A fully developed WaPSS would include an entire suite of computer programs with components consisting of databases, simulation models, decision models, and user interfaces that assist a decisionmaker in evaluating the economic and environmental impacts of competing watershed management alternatives.

When developers are required to do mitigation, they must identify suitable locations which can be either on or off-site. This can be a lengthy and, therefore, expensive process. Currently, each project is done on an individual basis. In cases involving water, California resource agencies issue discretionary permits to

applicants to modify, fill or dredge streams, wetlands, rivers, lakes, bays, sloughs, or vernal pools. The environmental analysis for these discretionary permits require a thorough and fundamental understanding of the fluvial-habitat systems to be impacted, the historical context of what the particular system used to be, and the proposed mitigation for the anticipated impact. One of the most tangible ways of addressing these problems is by building a watershed-based planning support system using an integrated Geographic Information System.

Document Management and GIS Integration

The ability to navigate document spaces and GIS spaces and access data in a data grid environment is a distinguishing feature of WET. We intend to use data grid technology to manage the underlying documents themselves. Data grid technology, through the use of the Storage Resource Broker software **[8],** allows for integration of heterogeneous networked storage to manage distributed data.

There are many successful examples of GIS and document management integration at the city and county levels. Managing documents independently offers many advantages over traditional GIS systems where you may have static links to specific documents. The Storage Resource Broker software (SRB) at SDSC will also allow for the independent management of documents and linking to GIS interfaces through layers of abstraction. Examples of city/county document to GIS integration include:

- Los Angeles County's Land Information Website integrates the FileNET document management system and the county's GIS database engine in ArcSDE and provides a web-based document retrieval interface. Documents have been georeferenced and are linked through an SVG Server map viewing tool.
- Orange County has developed a web-based public records retrieval and viewing system based on 266,000 public records scanned, georeferenced and loaded and linked to a web map.
- San Diego County has developed a the Survey Record Imaging (SRI) system with 350,000 documents and georeferenced 100,000's of Assessor's Office records (parcel maps, subdivision maps, records of survey) and integrated a Documentum document management system and GIS database. Their interface allows for searching of documents by location and type (25 types including: historical data, old survey, record of survey, subdivision map, old survey, etc.).
- Richardson, Texas has deployed an integrated ArcGIS/document management system on top of a FileNET-based system.
- Indianapolis has scanned 100,000s of permits since 1995 and is developing the City of Indianapolis Integrated Information System (CIIS), integrating GIS, permits, and document management systems.

- Montrose, Colorado is exploring the integration of ESRI's ArcIMS with Hummingbird's document management system. (see: http://www.farragut.com/GISandDOCS.htm and DOC-Locator suite).

Lessons Learned

This work is partly funded by the Superfund Basic Research Program (SBRP) and the National Archives (NHPRC/NARA). Over the longer term, we are interested in lessons learned from the WET prototype with a particular emphasis on "smart achives" and the notion of multifaceted electronic records that require the development of infrastructure allowing the same records to represent multiple points of view / perspectives **[9]**. It is increasingly clear that such environments require the exploration of novel information technology frameworks and we hope that this study will contribute to the further development of these themes.

Acknowledgments

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References

[1] Pezzoli, Keith, Ilya Zaslavsky and Richard Marciano (2001) "Transborder City-Regions and the Quest for Integrated Regional Planning: Challenges posed by disarticulated infrastructures, fragmented ecologies of knowing, and uneven development." Paper presented at the WPSC in Shanghai China, July 2001.

[2] Connolly, Mike. Communication from the Honorable Mike Connolly, Tribal Council Treasurer, Campo Band of Kumeyaay Indians (see Maps link of ancestral Kumeyaay lands, created by Mike Connolly), http://www.campo-kumeyaay.org/.

[3] National Research Council, New Strategies for America's Watersheds. Committee on Watershed Management , Water Science and Technology Board, Commission on Geosciences, Environment, and Resources. Washington, D.C.: National Academy Press, 1999.

[4] California Resources Agency and State Water Resources Control Board, Addressing the Need to Protect California's Watersheds: Working with Local Partnerships, Report to the Legislature (As Required By Ab 2117, Chapter 735, Statutes Of 2000), April 11, 2002.

[5] National Research Council, Board on Sustainable Development (1999) Our Common Journey: A Transition Toward Sustainability. Washington D.C., National Academy Press, http://www.nap.edu.

[6] Kenney, Douglas S., et al. (2000) The New Watershed Source Book: A Directory and Review of Watershed Initiatives in the Western United States. Boulder, CO: Natural Resources Law Center, University of Colorado School of Law

[7] Mehan, G. Tracy III, A policy memo of the Environmental Protection Agency, *"Committing EPA's Water Program to Advancing the Watershed Approach,"* issued Dec. 3, 2002.

[8] Marciano, Richard, See Persistent Archive Testbed project (PAT), http://www.sdsc.edu/PAT.

[9] Marciano, Richard, Bertram Ludaescher, Ilya Zaslavsky, Reagan Moore, and Keith Pezzoli (2002) "Multi-level Information Modeling and Preservation of eGOV Data," Presented at: First International Conference, EGOV 2002, Aix-en-Provence, France, September 3, 2002. Published at: Lecture Notes in Computer Science, LNCS, No. 2456, pages 93 - 100.