CRITICAL COASTAL AREAS PROGRAM

Fitzgerald Marine Reserve, Sonoma Creek and Watsonville Slough Pilot Projects

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Review of Technology Options for Online Access to Coastal Areas Information

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for the Association of Bay Area Governments
in partnership with San Francisco Estuary Institute

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Contents

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SUMMARY

ABAG commissioned GreenInfo Network to conduct a quick, preliminary assessment of technology options for online mapping and other information to support the Critical Coastal Areas (CCA) program.

1. INITIAL SURVEY OF NEEDS

As part of this project, a brief and limited survey of CCA stakeholders was also undertaken, indicating:

- Strongest interest in basic online mapping and related information
- Significant interest in more expanded online information, after core needs are met
- An attitude of “start with existing systems” and make cautious expansions, to ensure best use of resources

2. ONLINE MAPPING TECHNOLOGY

A survey of a wide range of publicly available mapping/information web sites relevant to the CCA program showed the following types of online mapping tools:

- Basic view and browse sites – including commercial applications like Google Earth as well as more traditional GIS-based custom viewers
- Viewing sites with query and selection capacities – these usually are significant extensions of basic view and browse sites, adding more data and advanced user choices
- Sites that allow users to model a natural process by making text-based selections and receiving a text-based report
- Sites that allow users to use GIS tools to model a process and to have returned a map-based outcome as well as a companion report

Technologies that supported these sites were almost always based on one of the following:

- ESRI ArcIMS (Internet Map Serving) software
- Graphics software such as Adobe Flash or SVG
- Open source mapping and database software, coupled with HTML-based design

Based on the review of all these sites, the authors have reached the following conclusions about online mapping as it exists now:

1. **CURRENT TECHNOLOGY:** Technical capabilities for serving geo-data into basic browsers and into those with simple query/selection functions are very strong and fairly widespread.
2. **EXISTING SITES:** There are existing, effective data viewers for water/marine and watershed-related information, many of which have existing information for the California central coast. Some of these are better at being user-friendly than others – many online mapping sites exhibit a severe lack of user-orientation in their design and functions.

3. **GIS MODELING:** No public GIS-based modeling sites currently exist and the technology to do such modeling is just beginning to appear, likely requiring time to mature before it will be widely usable.
4. **USER EFFECTIVENESS:** Most online mapping sites need improvement in their user-friendliness – interface designs are unattractive, choices of function are poorly described, multiple layers of data are hard to understand and the technical assumptions and interactions among data sets are difficult to understand unless one has strong expertise (however, few who have strong expertise seem to use web mapping to perform their work – they instead use their own workstations).
5. **LIMITS ON DATA AND FUNCTIONS:** Technically, the more extensive and complex the information served in a geo-browser, the more likely it was for users to experience delays, crashes and other interruptions in use. These issues began with even relatively simple browsers (e.g., those serving fewer than 10 data layers) and any site with 20 or more layers appeared to have frequent difficulties for users.
6. **DATA ACCESS:** Sites that offer simple and direct options for downloading GIS and other data are very effective, supporting local use of this information by agencies, organizations and persons with technical skill.

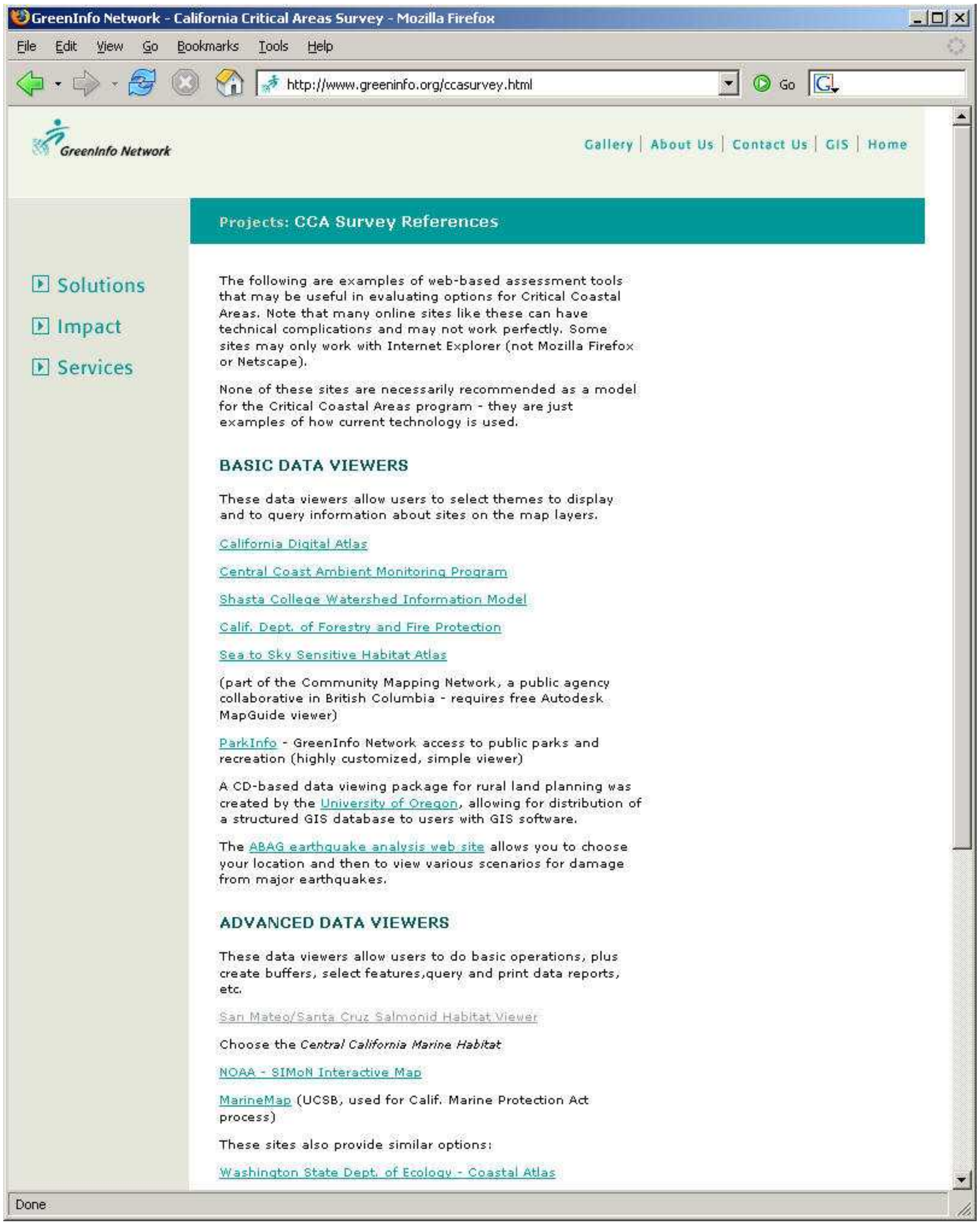
3. NEXT STEPS

We recommend that the CCA process consider the following general strategy at this point:

- **PROFILES:** Develop a design document that profiles CCA user needs more explicitly, and evaluates those needs against current best technology practices for feasibility, prior to developing a specific geo-browsing capacity.
- **STAGING:** Adopt a staged approach to online mapping and data, beginning with easy tasks and doing them well, collecting user feedback to inform next phases, and avoiding newly emerging technologies.
- **DESIGN:** Invest heavily in high quality web and cartographic design from the outset, to ensure excellent customer experiences and program identity, and thoroughly test designs with target audiences before implementing.
- **EXISTING CAPACITIES:** Explore using an existing web mapping/data platform and adapting it to fit the specific needs of CCA, rather than building a new technology platform.
- **EDUCATION:** If functions will go beyond browse data sets and identify features (e.g., including buffer or polygon selections of data), develop an outreach plan to train intended CCA users on how to use functions, after also involving them in testing design options.
- **DATA:** Combine data download functions with online geo-browsing, to ensure a central location for all current, relevant data (this "warehouse" can be virtual, in that it points to where data can be downloaded, versus having all data on a single server).

4. EXAMPLES OF WEB-BASED ASSESSMENT TOOLS

GreenInfo Network created a website that includes links to all mapping tools included in the technology options review. The site is available at: http://greeninfo.org/ccasurvey.html



I. INTRODUCTION

This project was commissioned by ABAG in October of 2006, in order to create a quick overview of options for delivering map and other information over the Internet to key stakeholders in the Critical Coastal Areas (CCA) processes. GreenInfo Network was asked to develop a survey to assess needs and to review major technology options for meeting those needs, in order to inform workshops scheduled for early 2007.

The Critical Coastal Areas in Monterey, San Mateo and Sonoma counties are the main focus for this project. However, its results are also applicable to other CCAs.

The project was overseen by Kathleen Van Velsor, ABAG Senior Environmental Planner and Program Manager for Water and Land Use Planning Studies. Rainer Hoenicke of the San Francisco Estuary Institute also advised on project directions. GreenInfo Network staff who worked on the project consisted of Larry Orman, project director, and Jennifer Strahan, project associate.

This assessment was intended to be an initial overview of options, not a full-fledged user design or technology analysis. A second phase, based on feedback from workshop participants, will develop more specific recommendations.

II. CCAs and STAKEHOLDER NEEDS

In late November and early December, 2006, approximately 25 persons responded to an online survey about key needs for information and mapping. Most respondents were from local public agencies, with others representing state, regional and federal agencies, non-profits and some landowners (affiliation was optional and nine persons did not indicate their associations). Almost every respondent had a good understanding of the CCA process.

The following substantive areas were queried:

1. Overall value of an online tool for the CCA process
2. Priorities for the kind of modeling of best practices and other matters that might be provided online
3. Priorities for the categories of data that might be provided online
4. Concerns about providing online access to listed types of data
5. Approximate cost ranges that seem acceptable for different levels of mapping/analysis provided
6. Web sites that should be evaluated
7. Participant's technical capacities (computer access and skill, etc.)
8. Other comments

It is important to note that this was an initial survey. Some question choices may have had different meanings for different respondents, and some respondents may not have had experience with some choices.

SURVEY SUMMARY RESULTS

What functions overall would be most useful in an online tool?

The following general functions of an online tool were most highly valued (60-70% ranking Critical or Important):

- View natural resource information for a particular CCA
- Download GIS data about a CCA

These functions were strongly valued (50-70% ranking Important or Useful):

- View best management practices (what is being done where)
- Exploring water quality monitoring information
- Capacity to generate reports of data custom selected by a user
- Viewing the mapped outcomes of pre-set water quality management scenarios
- Viewing the outcomes of user selections about water quality management in an online, interactive model
- Add new data or information
- Linking to other sites that have useful information

There were no functions that fell significantly below the level of "Useful", although both the "create buildout scenarios" and the "add new data/information" functions did have a number of respondents who felt they would not be useful.

If the tool could model according to user choices, what functions would be most important?

The following general functions of an online tool were most highly valued (60-70% ranking Critical or Important):

- Modification of stream beds and banks
- Water and sediment movement and storage

These functions were strongly valued (50-70% ranking Important or Useful) – however, in almost every case, there was a fairly wide spread of opinion:

- Urban planning and development practices
- Agricultural practices
- Other rural land uses
- Infrastructure development
- Transportation
- Recreation and open space uses

The function of modeling marina uses as well as military lands was not strongly valued.

The following (summarized) comments about an online tool were made:

- Functions depend heavily on budget
- Pre-set scenarios depend on the underlying model and the assumptions – they could have some unintended and maybe negative repercussions as well as possible useful information.
- Additions of new data or information need to be quality-checked prior to incorporation.
- Important that data catalog includes linkages back to source agencies/organizations and users have the ability to make sure data is current
- The online tool should both help the general public feel comfortable, while enabling advanced users to get valuable data.
- The ability to look at buildout scenarios for impervious surfaces is not available elsewhere and would be really useful.
- Non-agency users are not likely to have time to run the user-selected information or scenarios
- Tie in to existing efforts rather than starting something new.

Providing online viewing access to what data is most important?

The following data types were <u>most</u> highly valued (60-70% ranking Critical or Important):

- <u>Riparian</u> zones, creeks, wetlands
- Permitted <u>discharge</u> points
- Threatened and endangered <u>species</u>
- <u>Impaired</u> water body segments

These data types were strongly valued (50-70% ranking Important or Useful) – however, in almost every case, there was a fairly wide spread of opinion:

- <u>Urban</u> land uses
- <u>Rural</u> land uses
- Storm <u>drains</u>
- <u>Dams</u> and water impoundments
- Groundwater extraction <u>wells</u>
- <u>Construction</u> zones
- <u>Disposal</u> areas
- Ground water <u>basins</u>
- <u>Timber</u> harvesting areas
- Water <u>monitoring</u> points
- <u>Landslide</u> risks

The following data types had very wide ranges of opinion, from Critical to Useful:

- Urban growth <u>projections</u>
- Areas served by <u>septic tanks</u>
- Watershed management <u>plan boundaries</u>

There were no data types that fell significantly below these levels.

Do you have concerns about providing online access to any types of data?

The only data that raised significant access concerns was property owner data (from already-available assessor records).

Parcel boundaries attracted some concern, as did showing current pollution status/scores, pre-defined scenarios of best management practices and user-defined scenarios of best management practices (modeling).

For each set of functions, what do you see as an acceptable cost range?

- View and explore data - $10-25,000 was the best estimate, with some seeing need for $25-50,000 investment
- View/explore and query data - $25-100,000 was the expected range
- View pre-defined scenarios - $50-100,000 was the expected range, but estimates were fairly evenly distributed across cost ranges
- Set and view user-defined scenarios - $50-200,000 was the expected range

Note: the cost range question was highly speculative, intended only to elicit broad opinion about possible costs. No endorsement of any particular cost/function relationship can be made from the survey responses – however, it is the study consultants' opinion that the cost ranges that emerged were actually fairly accurate.

How do you rank your personal technology capacity?

Over 80 percent of respondents said their technology capacity was satisfactory or strong. This question will need further exploration with a broader number of potential users, however, before design of any online capacity.

General Comments

- Be careful to not just develop a tool, but invest the time and effort to market it to its intended users
- Don't reinvent a technology wheel – use a cautious, low cost approach
- Some respondents are skeptical of the utility of online modeling, in relation to using such resources for other purposes
- Ensure good documentation of any data provided

III. ONLINE TECHNOLOGY OPTIONS

GreenInfo Network conducted a review of existing web sites that provide online access to map and related information. We focused mainly on web sites that provide water-oriented natural resource information. Only web sites that are publicly available were surveyed -- there are a number of internal web sites that serve online information and decision-making for just those in a particular agency or organization, but these were not available to survey.

We grouped sites we reviewed into the following general categories:

1. **Data viewers** (pan/zoom, turn layers on and off)

2. **Data viewers with query/selection** (select items and create reports or other display of data about those items, including ability to set buffers and extract data that occurs within those buffers)

3. **Modeling with text-based selections** (user fills out a form, the responses to which are automatically run through a calculation and a resulting scenario is returned to the user)

4. **Modeling with GIS** (i.e., map) based selections (user sets map and text choices and runs a GIS-based model that calculates results and displays a mapped scenario along with text)

A. DATA VIEWERS

Data viewers are geo-browsers that allow users to choose a specific area and explore it by zooming in and out, turn layers of information on and off, and print maps or lists of information.

Commercial Applications: the most widely known is the Google Earth application, which can be downloaded for free by individual users and allows for browsing layers of information anywhere in the world (a commercial version is required to create and post data, and get higher quality results from browsing). One option is for a serving agency or organization to post a special Google Earth file (a KML) that contains specially formatted information (e.g., the location of all water sampling points and their recent readouts, etc.) on an Internet site, where users can load it into their own Google Earth applications. This approach can work well for limited data sets (one or two variables), but tends to be very cumbersome when creating more complex data sets.

Another type of geographic data viewer is the ESRI ArcExplorer program (note: this is not the ArcGIS Explorer – AGX -software mentioned below), which is similar to Adobe Acrobat Reader – a GIS user with special software publishes a map file, which can then be opened by any user who downloads the free ArcExplorer "reader" software. Users can then turn layers on and off, zoom, pan and even do some limited queries. Print maps are very hard to create with this approach, however, and data is limited to what is inserted in the first place.

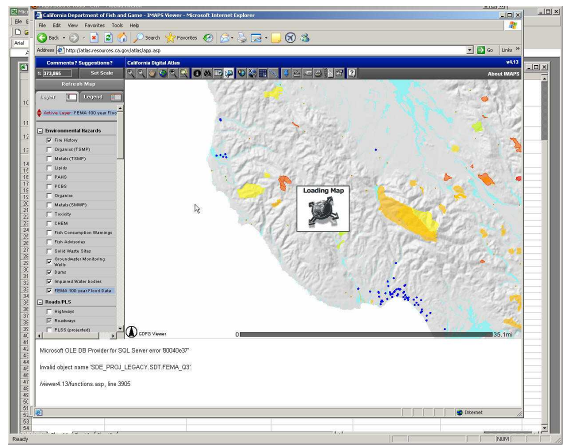
Custom web geo-browers: Most web sites that provide geographic data viewing use one of three basic technology approaches:

1. ESRI's Arc IMS (Internet Map Server) – a very robust software package that requires significant expertise to deploy, but allows for serving very large amounts of data and can perform complex queries.

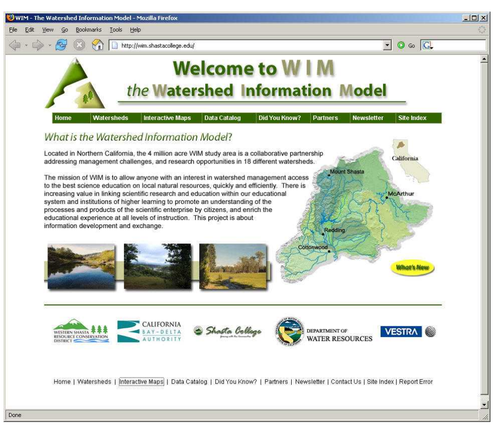
2. Graphics programs that can publish special geographic data – the most well-known of these are Adobe's Flash and SVG software. These programs also allow more extended queries.
3. Open source mapping software (MapServer, Open Layers, etc.) – this software allows users to assemble geographic databases and to publish maps created from them, including user controls like search, pan, zoom and identify, as well as more robust controls.

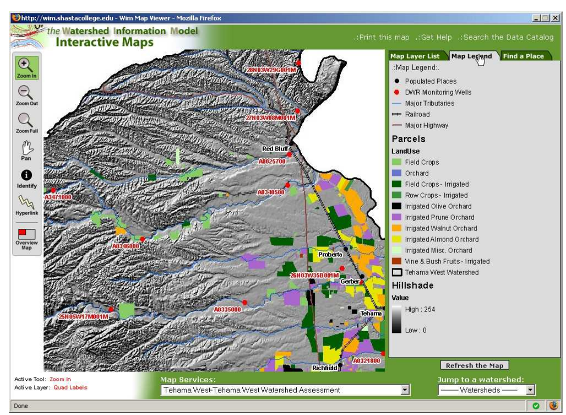
The most useful and relevant data viewer examples that we found were the following:

The **California Digital Atlas** (IMAPS viewer, customized version of ESRI ArcIMS software – http://atlas.resources.ca.gov), developed by the Department of Fish & Game as an overall index of California geographic data. Has some calculation functions, but appears to not always operate correctly (returned a number of operational errors). Map interface is well designed, among the best for ArcIMS products.

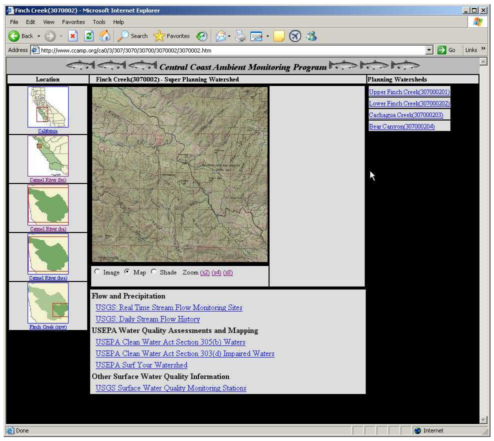


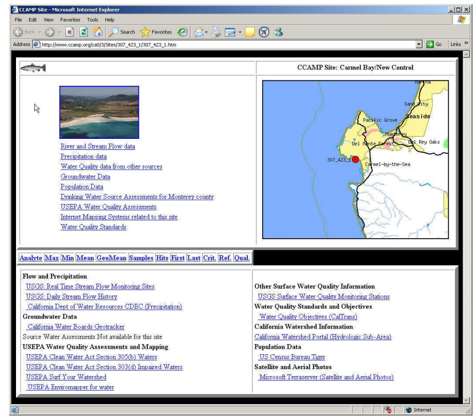
WIN - Watershed Information Network (created by Shasta College, as part of a multi-agency collaborative for mostly northern Central Valley data, using ArcIMS technology – http://wim.shastacollege.edu) - this is a very well designed and functional data viewing site for providing browser based information, integrated into broader information about watersheds and watershed management. In general, this was among the best designed sites we surveyed.



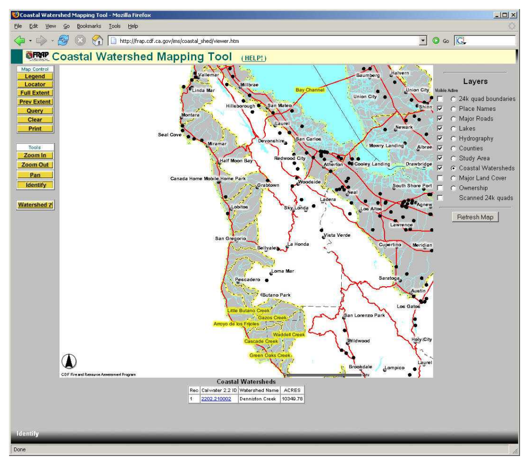


CCAMP (Central Coast Ambient Monitoring Program – http://www.ccamp.org) – This is a very technical site that has large amounts of data on watersheds and monitoring activities, and has extensive links to other information sites related to this. However, the site and map design were among the least effective sites we surveyed – navigation is confusing, maps are very low quality and information returned is often difficult to understand without significant prior knowledge.



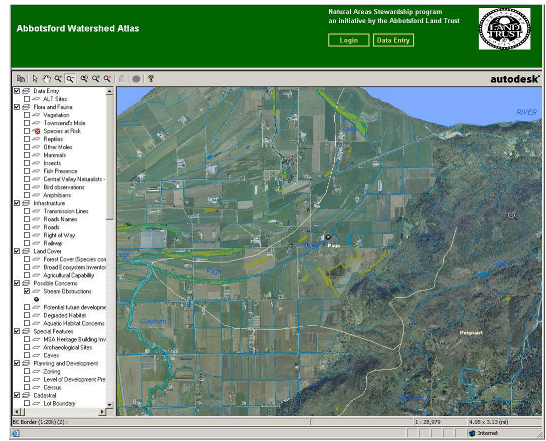


Coastal Watershed Mapping Tool (Calif. Dept. of Forestry and Fire Protection FRAP program, ArcIMS technology – http://frap.ca.gov/ims/coastal_shed/viewer.html) - this is a basic site that allows users to pan and zoom into coastal watersheds and retrieve basic identity information. The site design is not highly effective and the cartography is below average. This appears to be a site created with modest resources and functions effectively at that level.

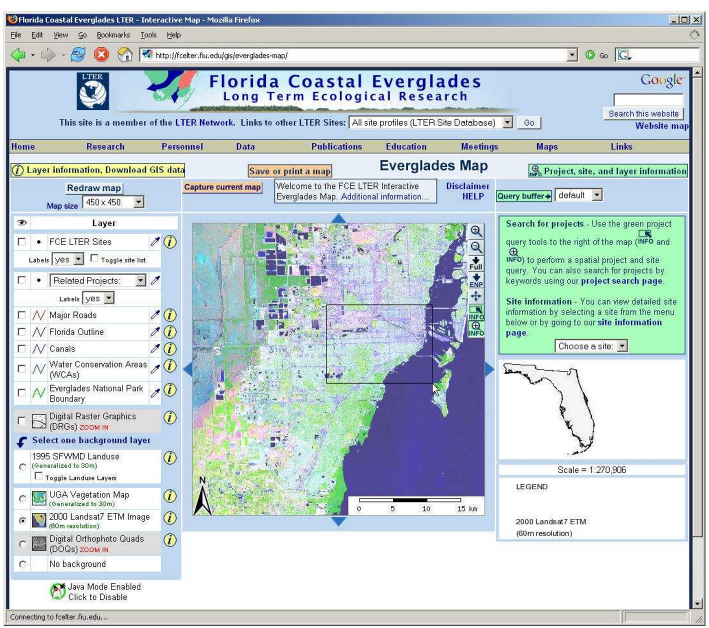


In addition, these sites were valuable options for data viewing approaches:

Sea to Sky Atlas (Univ. of British Columbia - www.shim.bc.ca) – this project has almost 20 atlas sites that it has created, using Autodesk MapGuide technology. These sites allow basic viewing and some data selection.



Florida Coastal Everglades Ecological Research – (Florida Intl. University - http://fcelter.fiu.edu/) – This site is a very robust map viewer and data access point, but suffers from a difficult graphic design. It was built with the open source MapServer software along with related technology.



B. DATA VIEWERS WITH QUERY/SELECT FUNCTIONS

Many data viewers allow users to set up queries that select data out of a particular type of sub-area, extending the functionality of basic data viewers. Most common types of queries are text searches (e.g., "find all locations where x value exists") and geographic searches ("find all records within a certain distance or a user-drawn shape"). These viewers only return underlying data that is selected, they do not process it into new data, as a modeling function would do.

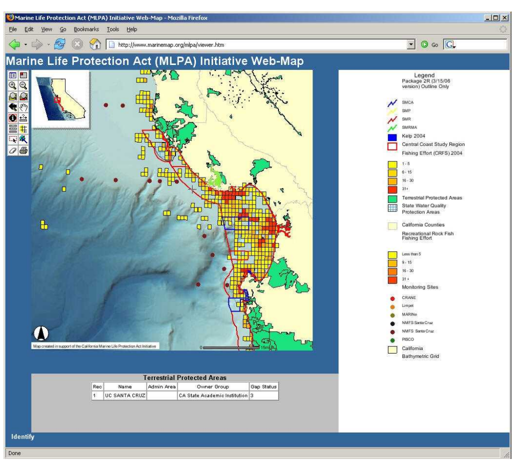
As with the basic data viewers, the same three technology strategies provide most of the capacity for these types of more enhanced viewers:

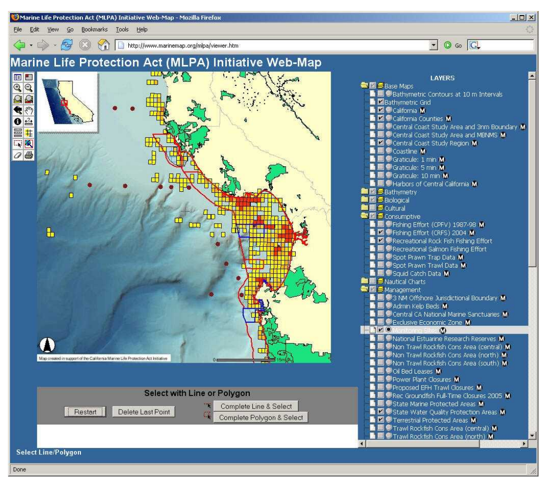
1. ESRI ArcIMS
2. Flash/SVG and other graphics programs
3. Open Source web mapping software

The difference between more robust and simpler data viewers is not so much the technology per se as it is the application that any particular user might develop to showcase the information and allow other users to interact with it.

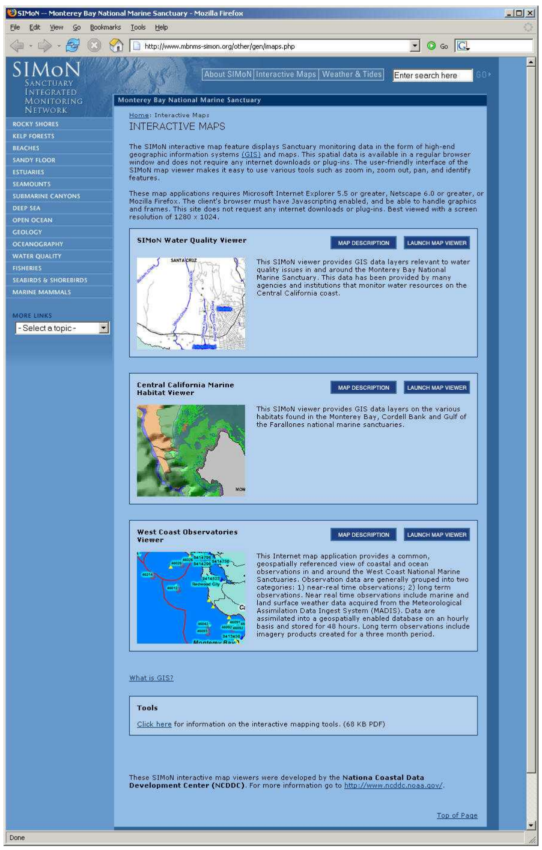
The following three sites offered the best examples of this level of functionality:

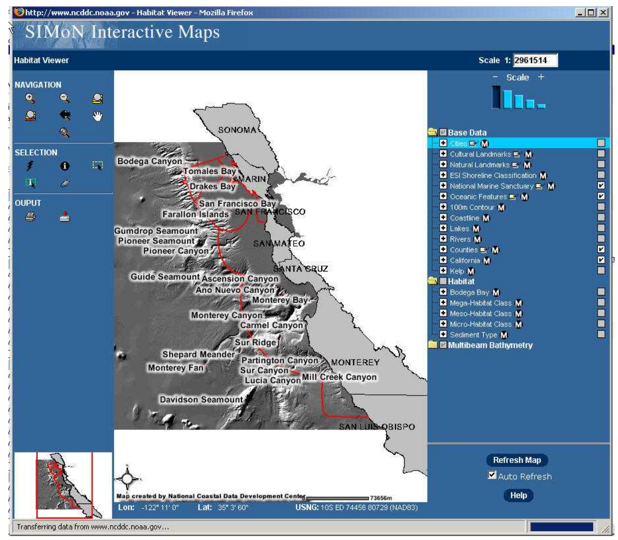
MarineMap (UC Santa Barbara – http://www.marinemap.org) – MarineMap is a generic capacity created by UCSB for a range of ocean and marine projects. The main data on the site comes from the MPA (Marine Protection Act) process data for California, for which this site is a key element. The site has basic buffer and polygon selection features that return places and data within their extents. The amount of data available is extensive and for users without significant understanding of coastal and marine data can be overwhelming. The site allows users to display the results of analyses that have been done prior. Design is generally effective, but tools seem to operate inconsistently, with frequent errors on operations.



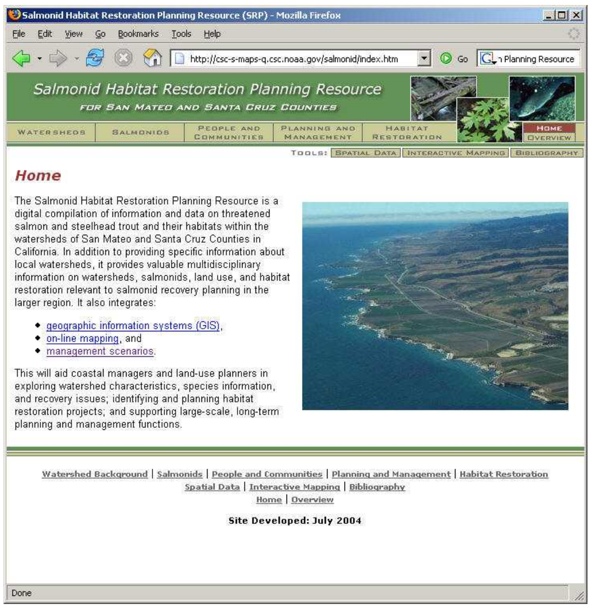


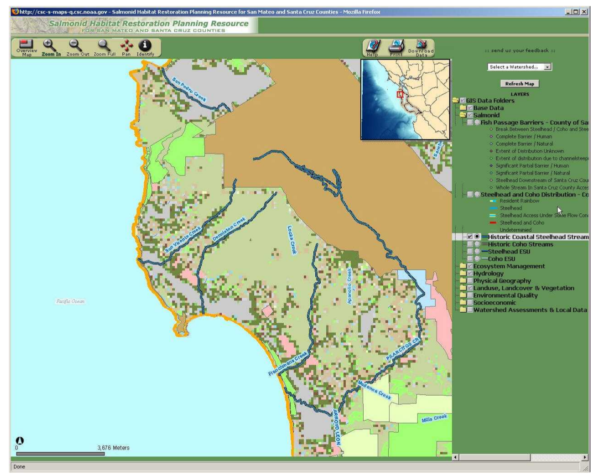
SIMON Interactive Maps (NOAA, based on ArcIMS software – http://ncddc.noaa.gov) – SIMON is part of a national system of web mapping tools created by NOAA. We reviewed the SIMON site for the Monterey Bay National Marine Sanctuary. The site has extensive data sets and provides basic data browsing, but also allows users to select map features by drawing shapes and then return data on the selected features. It also allows users to clip out and download particular data sets, a nice feature. The SIMON web framework also has a number of pre-defined mapping sites, so that rather than placing all functions and data in one viewer (likely to be very confusing to users), users can choose which subject they want to delve into. Modules include a Marine Habitat and a Water Quality viewer.





Salmonid Habitat Restoration Planning Resource (Created by NOAA and Circuit Rider Productions for Santa Cruz and San Mateo counties – http://csc-s-maps-q.csc.noaa.gov/salmonid/) – This is a hybrid site, mostly allowing for viewing and browsing, but with a well-designed and extensive set of information about salmonids and planning for their conservation. It also has the beginnings of management scenario planning – currently it depicts detailed technical steps in a particular management plan, using the Ecosystem Management Decision Support (EMDS) system coupled to GIS. However, users cannot set parameters and return runs of their choices, and the site is clear that this information is for educational purposes, not to make actual management recommendations.



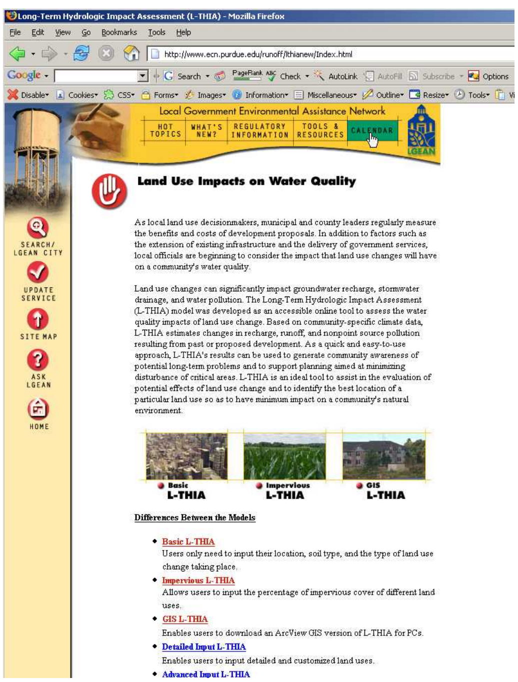


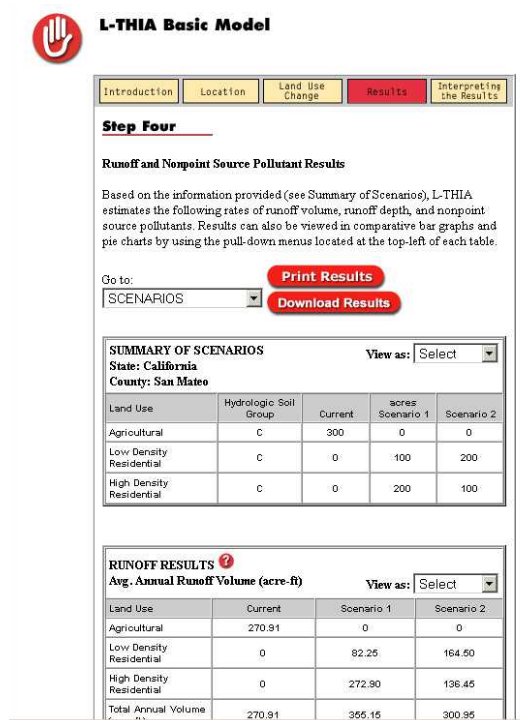
C. MODELING – TEXT-BASED

Text-based modeling uses formulas embedded into a web site application to analyze user input of particular variables, with the result being a text-based report. This kind of modeling is different from user selected parameters (e.g., buffer distance) in that the user input activates a full model of interactions rather than defining a single transaction.

There were relatively few of these types of models that we found – the two sites that seemed to offer good examples were concerned with projecting either soil erosion or sediment loads (including impervious surface analysis). Both were based at mid-west universities, and created in conjunction with the USDA Natural Resources Conservation Service (NRCS). Soil loss is known process and can be modeled fairly exactly, if a user knows certain soil and land use parameters.

The sites we examined required fairly exacting knowledge about the land use conditions in a particular area, in order to return accurate values from the model. We judged that the general public would be challenged to use these sites, while knowledgeable agency profession staff, consultants and some landowners might be able to use them well. However, these sites just focused on one aspect of land management – water runoff and its associated soil load. Expanding these sites into a more robust model of best management practices could create significant user challenges.



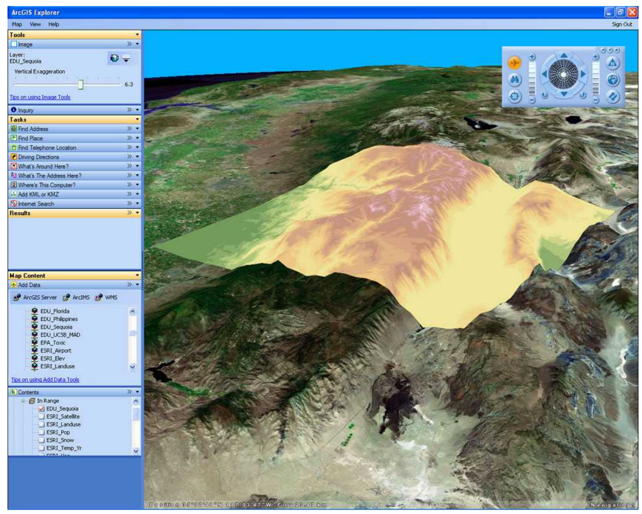


D. MODELING – GIS-BASED

GIS-based modeling means placing a customized GIS application online, allowing a user to set map and text parameters, then to run a model that returns both a map and text information about the scenario that has been created.

We found no accessible natural resources web sites that had actual GIS-based modeling capacities. Our experience is that the technology for this capacity is just beginning to appear and is not likely to be mature enough to be reliable for a least one more year and perhaps not for severeal years.

The leading candidate technology for such capacity is the **ESRI ArcGIS Explorer** (AGX). AGX at the user level is a downloadable application that refers back to a serving site, where special GIS programming makes available information and analytical functions. The routine use of AGX will allow users to pan, zoom and identify geographic features anywhere on the globe. Customized uses are expected to allow serving sites to actually place key elements of GIS functions found in the ESRI ArcGIS software into their interface – users would not have to have ArcGIS, but would use elements of it chosen for and implemented on a particular AGX web site.



AGX has just been released in its first public version and ESRI software often takes a substantial time to mature after initial releases. There may also be significant speed issues at present, as well as no track record of more complex applications having been developed.

There are complex models that run on individual or networked computer workstations (e.g., NatureServe's VISTA habitat modeling program, Community VIZ, the PLACES 3 urban planning model or the UC Davis UPLAN program), allowing user definition of input variables and output of scenario reports – there appears no feasible route, however, for these to be placed in an online environment and made available to many people.

IV. CONCLUSIONS

The following are our overall conclusions about the existing state of web-based mapping and information browsing, as it applies to the Critical Coastal Area process:

1. **CURRENT TECHNOLOGY:** Technical capabilities for serving geo-data into basic browsers and into those with simple query/selection functions are very strong and fairly widespread.

2. **EXISTING SITES:** There are existing, effective data viewers for water/marine and watershed-related information, many of which have existing information for the California central coast. Some of these are better at being user-friendly than others – many online mapping sites exhibit a severe lack of user-orientation in their design and functions.

3. **GIS MODELING:** No public GIS-based modeling sites currently exist and the technology to do such modeling is just beginning to appear, likely requiring time to mature before it will be widely usable.

4. **USER EFFECTIVENESS:** Most online mapping sites need improvement in their user-friendliness – interface designs are unattractive, choices of function are poorly described, multiple layers of data are hard to understand and the technical assumptions and interactions among data sets are difficult to understand unless one has strong expertise (however, few who have strong expertise seem to use web mapping to perform their work – they instead use their own workstations).

5. **LIMITS ON DATA AND FUNCTIONS:** Technically, the more extensive and complex the information served in a geo-browser, the more likely it was for users to experience delays, crashes and other interruptions in use. These issues began with even relatively simple browsers (e.g., those serving fewer than 10 data layers) and any site with 20 or more layers appeared to have frequent difficulties for users.

6. **DATA ACCESS:** Sites that offer simple and direct options for downloading GIS and other data are very effective, supporting local use of this information by agencies, organizations and persons with technical skill.

NEXT STEPS

We recommend that the CCA process consider the following general strategy at this point:

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- **STAGING:** Adopt a staged approach to online mapping and data, beginning with easy tasks and doing them well, collecting user feedback to inform next phases, and avoiding newly emerging technologies.

- **DESIGN:** Invest heavily in high quality web and cartographic design from the outset, to ensure excellent customer experiences and program identity, and thoroughly test designs with target audiences before implementing.

- **EXISTING CAPACITIES:** Explore using an existing web mapping/data platform and adapting it to fit the specific needs of CCA, rather than building a new technology platform.

- **EDUCATION:** If functions will go beyond browse data sets and identify features (e.g., including buffer or polygon selections of data), develop an outreach plan to train intended CCA users on how to use functions, after also involving them in testing design options.

- **DATA:** Combine data download functions with online geo-browsing, to ensure a central location for all current, relevant data (this "warehouse" can be virtual, in that it points to where data can be downloaded, versus having all data on a single server).