RECOVER

Rehabilitation Capability Convergence for Ecosystem Recovery

An Automated Burned Area Emergency Response Decision Support System for Post-fire Rehabilitation Management

Application contents:

A. System

1. Name: RECOVER, category: Enterprise System
2. Executive administrator letter (please see attachment A)
3. Summary (please see attachment B)
4. User testimonials (please see attachments C,D, and E)

B. Jurisdiction

1. Name: The state of Idaho
2. Population served: all residents of Idaho benefit from the RECOVER enterprise system (1.6 million residents)
3. Budget: RECOVER was funded by NASA at a cost of $180,000 (year one). Continued funding is under review.
4. Appointed official: n/a
5. Contact person:

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C. System Design

1. **What motivated the system development?**

   Following nearly two decades of scientific research focusing on rangeland ecosystem and the role of fire in land management and rangeland health, it became obvious the post-fire decision process followed by Federal and State agency fire managers was not only critical to successful rehabilitation, but largely a geospatial analysis process. The problem faced by fire managers was the fact their rehabilitation and monitoring plans needed to be completed and submitted within two weeks of each fire and a large amount of time was spent searching for and acquiring the data necessary to assess the fire region and write the plan.

   Keith T. Weber (Idaho State University) and John Schnase (NASA Goddard Space Flight Center) worked together to write a grant proposal to fund what has become known as RECOVER (Rehabilitation Capability Convergence for

Ecosystem Recovery). The RECOVER decision support system stages nearly 24 statewide GIS data layers typically used for post-fire rehabilitation planning. These data are then immediately available to the fire manager following a wildfire through a customized web map client interface within a web browser.

RECOVER has reduced the amount of time needed for data preparation and basic analysis from days to minutes by leveraging web services (Esri image services, map services as well as OGC-compliant WCS and WFS), the cloud (Amazon EC2 through NASA iRODS-based RECOVER Server), process automation using Python, and web map technologies like Flex and ArcGIS on-line.

2. **What specific service or services was the system intended to improve?**
RECOVER improves the decision making process by providing all the necessary geospatial data (including fire-specific datasets requested by a specific fire manager) in one location and within a web browser. Fire managers do not need to use GIS software, they do not need to locate geospatial data, they do not need to manipulate that data prior to analysis (projecting, re-projecting, clipping, etc.), they simply need to use the RECOVER client web map and spend their time analyzing the available data and producing a better informed decision.

3. **What, if any, unexpected benefits did you achieve?**
During the process of developing and deploying RECOVER we learned that most fire managers wanted to start using RECOVER as soon as a fire began instead of waiting until it was contained. We also learned that other agencies are interested in using RECOVER for fire-related management: 1. Idaho Transportation Department will be using RECOVER to assess potential landslide, erosion, and debris flow risks that could impact roads, bridges, and culverts. 2) FEMA has expressed interest in using RECOVER to improve all natural disaster planning (not just wildfire).

4. **What system design problems were encountered?**
RECOVER has been developed for the state of Idaho and we are currently planning to expand its scope to include all the Great Basin state (Utah and Nevada as well as Idaho) and ultimately offer RECOVER nationwide. Problems (or hurdles) encountered during development was 1) deciding upon a standardized naming convention for the data layers (which would allow easy transition into other states), 2) selecting the optimal geographic reference system for Idaho, and 3) leveraging the capabilities of OGC to create GIS data services for both raster and vector data (we are using WCS and WFS as well as Esri services).

5. **What differentiates this system from other similar systems?**
   There actually is no system similar to RECOVER. There certainly are other fire mapping websites but none that provide all the data needed or requested by fire managers within one web map application. RECOVER is also highly responsive and updates submitted by fire managers appear on the web map in a matter of minutes. RECOVER is flexible and no two "fire maps" are identical. Some include high-resolution aerial imagery, others include thermal imagery as RECOVER is designed to provide precisely what the end-user (the fire manager) needs for his/her decision support. The fact that RECOVER is highly automated means these customizations can occur with minimal human interaction.

   RECOVER is deploying a real-time GIS component (using Collector for ArcGIS) allowing geospatial data to be collected in the field and immediately uploaded to the RECOVER database and web map for all agency personnel to access and view.

D. Implementation

1. What phases did you go through in developing the system?
   The first phase of the RECOVER project was considered a feasibility phase. PI, Weber and Co-PI's at NASA Goddard Space Flight Center, as well as students at Idaho State University's GIS Training and Research Center (GIS TReC) created a RECOVER DSS focusing on post-fire rehabilitation planning for Idaho alone, and even more specifically, the needs of the Bureau of Land Management (BLM) and Idaho Department of Lands. The feasibility phase included the development of nearly 24 statewide GIS base layers with sufficient resolution and accuracy to be meaningful and useful for post-fire decision support. Image services were created for each of these layers and made available on the GIS TReC's "AGS" server as WCS services.

   NASA GSFC scientists developed the RECOVER Server as a way of storing various data. One type of data that the Server can store is GIS data. The RECOVER Server is used to automatically extract these 24 base layers using the spatial extent of the each wildfire. The extracted layers are then stored in the Amazon Cloud. This process typically takes less than 2-minutes to complete.

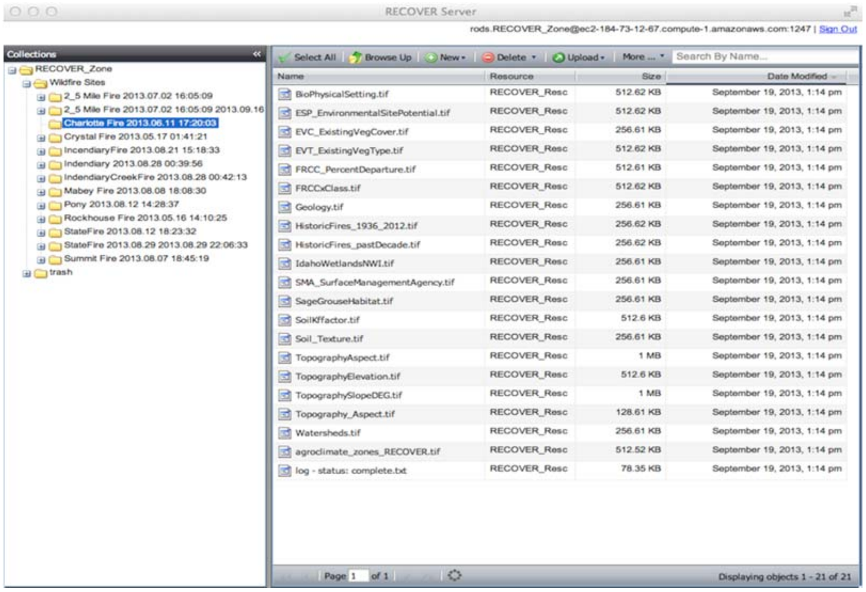

Figure 1. The graphical user interface of the RECOVER server, which uses NASA iRODS technology deployed in the Amazon EC2 cloud.

A second GIS TReC server then harvests the fire specific layers and using a Python automation script, creates a Flex-based web map application for each fire. This process now takes only 4-minutes to complete.

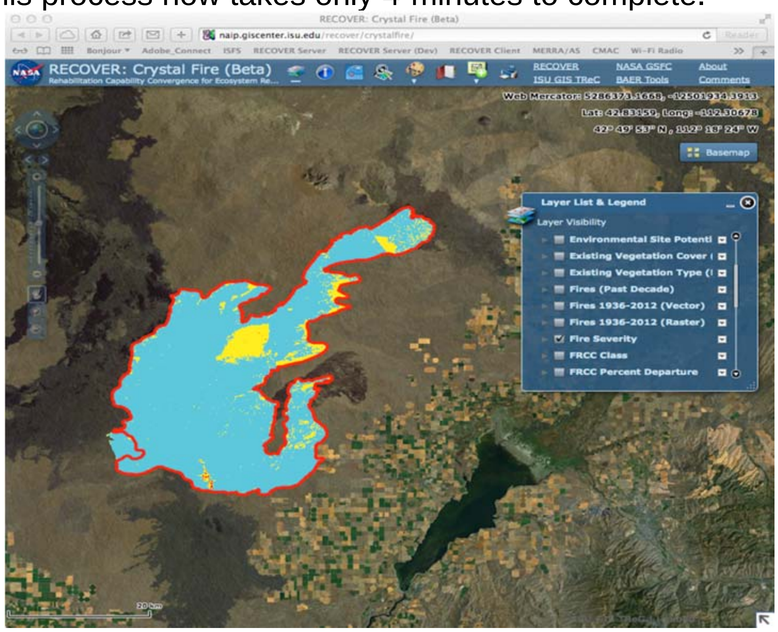

Figure 2. The web-map interface developed for each wildfire is similar to the one shown above. Indeed, the functionality and layout is identical allowing the land manager to learn one system and readily apply it to all fires within their responsibility.

The second phase of the project will begin in 2014 (contingent upon availability of funding) and will complete the development of RECOVER as well as provide RECOVER across the Great Basin states, and ultimately, nationally.

2. Were there any modifications to the original system design? Why? What?
   Yes. We changed the "event trigger" of RECOVER from wildfire containment to wildfire ignition. This added an urgency to RECOVER processing but also provided the analysis capabilities of RECOVER to both the BLM and IDL immediately.

   As a result of this change, RECOVER needed to perform very quickly and requiring 4-8 hours of preparation by ISU students for each web map was not acceptable. The solution was the development and use of Python process automation (written and completed by ISU students) which reduced this time to 4-minutes.

E. Organizational Impact

1. What user community does the system serve and how?
   RECOVER was intended to serve the wildfire community. By that I mean those involved with post-fire management and rehabilitation as well as long-term post-fire monitoring. When RECOVER was put into use it was quickly adopted by those managing and fighting active fires and more recently, has been applied to transportation management. More specifically, Idaho Transportation Department will use RECOVER to manage for debris flows and mudslides that could potential impact the roads and transportation network of Idaho. RECOVER users are primarily interacting with RECOVER via the web map interface while others are consuming the image services and map services within Esri's ArcGIS.

2. What are the ultimate decisions/operations/services being affected? If appropriate, provide a few examples including, but not limited to: screen input/output forms, paper products, or other descriptive graphics.
   Ultimately, the RECOVER DSS impacts the post-fire emergency stabilization and rehabilitation (ESR) plans (and similar products) authored by the BLM and Idaho Department of Lands, etc.

3. What were the quantitative and qualitative impacts of the system?
   Both quantitative and qualitative impacts of the RECOVER DSS are difficult to calculate. However, it is known and quantified that prior to RECOVER, fire managers would often require 4 days to assemble the geospatial datasets and related soil/ecotype reports necessary to develop a post-fire recovery plan. That time has been reduced by RECOVER to approximately 5 minutes and this includes all the same geospatial datasets as well as immediate access to the same soil/ecotype reports.

   RECOVER has also delivered a less tangible benefit; the land manager or fire manager no longer needs to be concerned about finding the best or most current GIS data but simply needs to use the data available in RECOVER. The geographic information scientists at Idaho State University's GIS Training and Research Center and scientists at NASA's Goddard Space Flight Center have ensured the most current and authoritative geospatial data is available within the RECOVER DSS.

In addition, a qualitative impact of RECOVER is the ability for a district fire manager to discuss a given fire (and his/her draft management plans) with a regional or statewide leader using a webinar approach where the RECOVER web map is actively used to discuss the management plan. This again saves time and truly allows for an improved decision making process. This same approach has been used to discuss a fire and post-fire plans with members of the community that may have been impacted by a given fire.

4. What effect has the system had on productivity?
   Productivity has been greatly enhanced by RECOVER in that land managers and fire managers can devote their time to evaluation, assessment, and analysis of a fire instead of data acquisition, formatting, projecting/re-projecting, etc. As managers are given14 days to prepare their post-fire management plan and as RECOVER has saved managers approximately 4 days of effort, it is arguable that RECOVER has improved productivity by 28%. While managers may still use 14 days to complete a plan that time is used far more effectively.

Figure 3. The RECOVER DSS has effectively eliminated data acquisition and preparation tasks for the land manager.

5. What, if any, other impacts has the system had?
   The impacts of RECOVER have been fairly well described above. It is important to note however that while RECOVER was designed to be a post-fire decision support system that would be built upon containment of a fire, it has rapidly evolved into a wildfire DSS that is built upon fire ignition and updated throughout the duration of the fire. Since the 2013 fire season, RECOVER has again evolved by broadening its scope and encompassing transportation planners as well as the much broader emergency management field.

6. How did the system change the way business is conducted with and/or service delivered to clients? Give specific examples comparing the old way with the new.
   Before RECOVER fire maps and ancillary data required to make rehabilitation decisions were delivered in disparate pieces and frequently in a format "for GIS professionals only" (the data would need to be viewed in ArcMap or other similar GIS software). RECOVER has now empowered the fire managers and land managers by giving them access to the data they need to make better informed decisions and they are indeed using it. The GIS professional still plays an important role by conducting more advanced geospatial analyses consuming the same web services used in the RECOVER client within ArcMap. This new approach better leverages the skills and abilities of each person involved in fire management.

F. System Resources

1. What are the system's primary hardware components? Give a brief list or description of the hardware configuration supporting the system.
   RECOVER follows a distributed web-centric design. The GIS TReC at ISU employs two production servers and one development server to support RECOVER. All RECOVER servers run Windows Server 2012 OS and a fault tolerant RAID-5 architecture with redundant, hot-swappable hard drives, and power supplies. Primary power is supported through a redundant line feed and a pair of APC enterprise-grade uninterruptable power supplies.

   NASA Goddard Space Flight Center has deployed the RECOVER Server in the Amazon EC2 cloud. As described below, this deployment runs an instance of the iRODS database in support of RECOVER.

2. What are the system's primary software components? Describe the primary software and, if a commercial package, any customizations required for the system.

   RECOVER data is prepared using Esri's ArcGIS 10.2.1. Web services are delivered using Esri map service/image service format as well as OGC WFS and WCS services, respectively. Adobe Flex is used to create the RECOVER client web map applications, development of which is highly automated using Python scripting. No customizations (third party extensions or add-ons) are used in RECOVER.

3. What data does the system work with? List and briefly describe the database(s).

   RECOVER uses the Esri file geodatabase. In addition, an innovative aspect of this work is our use of the integrated Rule-Oriented Data System (iRODS) to implement the RECOVER Server. iRODS is data grid middleware that provides policy-based control over collection-building, managing, querying, accessing, and preserving large scientific data sets. The RECOVER Server can use iRODS's federation capability to integrate data products from a variety of sources. Federation allows collections that are under iRODS control to easily share data through cross-registered servers.

4. What staff resources were required to implement the system? (i.e., report approximate staff and consultant time as FTE's)

   RECOVER funding is provided by NASA (NNX12AQ78G) for GIS TReC Director and staff (Keith T. Weber (0.20 FTE) and two graduate assistants (1.00 FTE)) and NASA Goddard Space Flight Center personnel (John Schnase (0.10 FTE), Mark Carroll (0.10 FTE), and Roger Gill (1.00 FTE). In addition, the GIS TReC System Administrator (Kindra Serr) was assigned RECOVER tasks equivalent to 0.20 FTE.

   In total, RECOVER required 2.60 FTE during its initial development. It is anticipated that FTE requirements will reduce as additional automation is implemented. RECOVER will not become an entirely automated process however as some system administration will always be required as will project oversight and improvements.

5. Comment on anything unusual about the resources used to develop your system, such as data, software, personnel and financing.
   The success of RECOVER is attributable to many talented and dedicated people. RECOVER could not have succeeded without:
   - A solid, pre-existing relationship between ISU's GIS TReC and partner agencies (BLM and IDL). This relationship had been fostered through numerous collaborations and joint-efforts since 1999.
   - The skill, dedication, and resources from GSFC scientists
   - Well prepared, geospatially-trained, and talented students at ISU.