Development of a Platform for Wildfire Incident Support and Evaluation of Post-Fire Impacts

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14. ABSTRACT
The two objectives of this project were to 1) create a spatial platform for identifying fires on or threating Reclamation values and assets in near real time to allow for communication with Incident Commanders and Incident Management Teams for operational and tactical considerations, and 2) identify large fires upstream of Reclamation reservoirs which may be vulnerable to post-fire sedimentation or hydrological pulses. Originally the proposal identified the application of the Watershed Erosion Prediction Project model with the Postfire Erosion Prediction interface (WEPP-PEP) model for analyzing post-fire sediment influx to fire affected Reclamation watersheds; however, due to the development of a new model within Reclamation, PFHydro, the scope of the project was truncated to focus on the development of a spatial platform to allow for reevaluation of which model, PFHydro or WEPP-PEP, would be better suited to address Reclamation post-fire sediment and hydrologic needs in the future. The project ultimately succeeded by allowing any employee within Reclamation to access near real-time information on fire location and spread direction, shifting the response of the C-PN Region from a reactive to a proactive position for coordinating during incidents.

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Peer Review

Bureau of Reclamation
Research and Development Office
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Acronyms and Abbreviations

Reclamation   Bureau of Reclamation
AGOL   ArcGIS Online
C-PN   Columbia-Pacific Northwest (Region)
FedRAMP   Federal Risk and Authorization Management Program
FMP   Fire Management Plan
GIS   Geographic Information System
IC   Incident Commander
InFORM   Interagency Fire Occurrence Reporting Modules
IMT   Incident Management Team
MODIS   Moderate Resolution Imaging Spectroradiometer
NIFC   National Interagency Fire Center
O&M   Operations and Maintenance
RGIS   Reclamation ArcGIS Portal
VIIRS   Visible Infrared Imaging Radiometer Suite
WEPP-PEP   Watershed Erosion Prediction Project-Postfire Erosion Prediction (interface)

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Executive Summary

Reclamation's ability to achieve its mission of managing, developing, and protecting water and related resources is inextricably linked to the quality of the terrestrial watershed. This is of particular importance as it relates to the impacts during and after a wildfire incident. The purpose of this project was to develop GIS architecture to 1) quickly and effectively communicate at risk values/assets/infrastructure to the affected office(s), and 2) provide information regarding values at risk and cultural and natural resources information to Incident Commanders (ICs) or Incident Management Teams (IMTs).

The following research questions were the drivers behind the project:
1) What Reclamation infrastructure are vulnerable to wildfires?
2) How can Reclamation effectively and efficiently communicate natural, cultural and infrastructure values to cooperating partners, national IMTs, or other fire management agencies to avoid preventable impacts due to fire suppression or wildland fire management activities?
3) Where are the data gaps across disciplines that need to be addressed to be able to communicate values at risk during an incident and triage regarding post-fire effects on infrastructure or potential deleterious water impacts?

At the onset of this project, Reclamation did not have a "one-stop shop" mapping product for cross-disciplinary reference during or after a wildfire. Myriad layers have, or are being produced for Operation and Maintenance (O&M), Restoration, Cultural Resources, and other Programs; but no adequate interface existed to access them all when incidents occurs that have cross-disciplinary impacts. In a rapidly evolving incident, being able to expeditiously communicate Reclamation values at risk to ICs and IMTs will dramatically reduce preventable impacts to Reclamation interests during fire suppression efforts. Further, the development of this product will empower Reclamation Managers to quickly make necessary preparations for the impact of the incident and communicate those potential impacts to managing partners and/or cooperators.

The Wildfire Platform Web App hosted on ArcGIS Online (AGOL), was available for beta testing during the 2021 fire season in C-PN. Initial feedback of the App was overwhelmingly positive. Reclamation employees across disciplines were able to track the location and growth of specific incidents of interest in near real-time based on the layers' 2-3 hour refresh rate, and provide critical protection information to the C-PN Wildland Fire Coordinator which was then relayed to IMTs and ICs during daily operational planning meetings. The App provided a common platform for discussion of potential post-fire hydrological impacts and a shareable mechanism to have discussions with interagency partners on post-fire emergency stabilization and rehabilitation needs. An additional unintended benefit of the App was the realization that it could provide the base data for the development of a spatial Fire Management Plan (FMP) to replace the maintenance heavy hard copy FMPs currently in place in C-PN.

1.Introduction

1.1.　　Project Background

In 2017, the United States Geological Survey published a study predicting wildfires could double the amount of sediment in a third of the largest Western watersheds by 2050, with some watersheds having a 1,000 percent increase. The 2009 Hayman fire in Colorado resulted in the precipitous decline of the South Platte River trout fishery and hundreds of tons of sediment filled lakes and reservoirs inside and downstream of the fire perimeter. Following fires in the American River headwaters in California, the Placer County Water Agency experienced significant damage to its water supply and hydropower infrastructure, including costly impacts from increasing sediment and debris. Modeling post-fire effects on watersheds is rapidly developing. However, without a spatial framework to focus the model outputs on Reclamation lands and values, the existing modeling programs provide little applied utility to the Bureau. Further, without having an integrated map to share with managing partners, fire suppression agencies do not have complete information to help them protect values at risk during the incident response. The creation of this product helps protect natural and cultural resources, O&M infrastructure, and allow for triaging the need for post-fire mitigation and emergency stabilization.

1.2.　　Previous Work

This project was the first of its kind, developed in support of the C-PN Fire Program, with the goal of providing a framework for adoption by other Regions or at the Bureau-level.　This project incorporated existing spatial layers from different divisions and agencies within the C-PN Region. These disconnected layers are only useful for those that know how and where to access them. When combined they would be vastly more useful. Once these layers are organized, methods of identifying the gaps in prudent information will become clearer.

1.3.　　Problem the Study Addresses

In the C-PN Region, when a fire is reported, there is no single map to immediately reference for communicating values at risk that should be addressed when developing suppression tactics. Waiting hours or days on return calls from the Field Office (in the case of fires that start on weekends) after suppression actions begin greatly reduces the window of opportunity to prevent suppression-related damage to cultural and natural resources and infrastructure. A single spatial product would allow anyone to communicate directly to an IMT or IC regarding necessary protection needs within minutes of a fire being reported. An AGOL mapping application is delivered over the Internet and requires no special software, allowing managers and those in the field to visualize the situation when they are away from the office. Preventing suppression-related impacts to Reclamation values saves Reclamation's money repairing damage to O&M infrastructure and incalculable hours of staff's time documenting and communicating damage to tribal values and may prevent damage to paleo or historical sites.

1.4.   Project Objectives and Approach

Initially, there were multiple objectives for the final product. The primary objective was to create an online web map that overlays reported fire locations and perimeters alongside all mapped Reclamation infrastructure, values, and assets. The second objective was to share the information collected via an AGOL App with other agencies that have wildland fire response responsibilities on Reclamation land. The resultant C-PN Wildland Fire App is hosted on the AGOL platform, however many of the Reclamation asset data sets are published on the Reclamation ArcGIS Portal (RGIS) platform due to the sensitive nature of the asset inventories. The RGIS platform is hosted on internal Reclamation servers that operate behind Reclamation's IT firewall system. Because the asset data is published to servers behind the firewall, outside agencies are unable to access it, eliminating the ability to incorporate Reclamation's data into their fire management response protocols. Upcoming changes to the Federal Risk and Authorization Management Program (FedRAMP) status of the AGOL platform will make it possible to publish Reclamation's asset inventories to AGOL instead of RGIS, enabling collaborator access to the C-PN Wildland Fire App and required data to protect Reclamation assets. In the meantime, the required data can be exported as a geodatabase and shared with agencies that have wildland fire response responsibility on Reclamation land. The last objective was to identify large fires that are upstream of Reclamation reservoirs that may trigger detrimental sedimentation issues in a post-fire environment. Often, Reclamation is not included in larger interagency fire conversations when Reclamation jurisdictional land is not included within the footprint of the fire. Identifying fires off Reclamation jurisdiction that may have impactful debris flow, erosion and accompanying sedimentation issues provides an opportunity for Reclamation to enter post-fire interagency restoration discussions.
Because this was the first effort of its kind to combine almost all known and mapped values and assets of Reclamation in one map, there was initial trepidation on taking the "kitchen sink" approach for fear of having a map too cluttered with assets. However, once the layers were added for the mapped resources, it became apparent that on the scale of individual fires, the amount of assets were highly manageable for interpretation and communication.

1.5.   Reclamation Involvement

This project was a cross disciplinary product spanning the C-PN Wildland Fire Program and the C-PN GIS group. The CPN Wildland Fire Coordinator facilitated searching out and identifying the appropriate fire related open-source data while the GIS group collected Reclamation asset data, then designed and built the resulting App.

2. Methods

2.1.   Fire Data Sets

This project coincided with a significant effort at the National Interagency Fire Center (NIFC) to create an open-source data set for integration into user-driven online platforms. As different

datasets are made available it is likely that the fire datasets within the C-PN Wildland Fire App will be updated as well. It is recommended that any reproduction or further development of the App utilizes the layers available through NIFC. The most current national open-source geospatial data for fire can be found at https://data-nifc.opendata.arcgis.com/. In addition, Moderate Resolution Imaging Spectroradiometer (MODIS) imagery was included to assist in determining the spread direction of the fire. The MODIS Rapid Response layer and the Visible Infrared Imaging Radiometer Suite (VIIRS) equivalent dataset both provide products for mapping heat signatures, however the MODIS data was ultimately selected due to its more accurate spatial coverage and faster refresh rate. The MODIS Rapid Response layer utilized in the App can provide refreshed satellite imagery approximately every five hours on any heat signature pattern in the United States.

2.2.   Reclamation Datasets

As described earlier, the initial foray into data visualization was the "kitchen sink" approach. To that end, all mapped assets that were deemed vulnerable to fire or post-fire hydrologic impacts that were available at the C-PN Regional level were added to the App. One data set that was initially planned to be included and ultimately wasn't was cultural data. Due to the sensitivity of cultural data, there was no way to incorporate it into AGOL without limiting access to the App via individual accounts or password protection. Establishing individual accounts or managing password security for an App that is designed to be as accessible as possible for all employees in the region was deemed too burdensome.

3. Results

The C-PN Wildland Fire App went live at the beginning of the 2021 C-PN fire season. The season was particularly active and provided multiple opportunities for utilizing and advancing the capacity of the App.

3.1.   Muckamuck Fire (Conconully, WA)

The Muckamuck Fire west of Conconully, WA started, as most fires do, off Reclamation land. The fire appeared in the open source NIFC data on the Reclamation web app a few hours after resources got on scene and was identified early as a potential threat to Reclamation infrastructure. Recognizing the fire threat well in advance allowed for proactive communication with the Ephrata Field Office (EFO) staff about preparing for potential fire impacts. The fire reached Reclamation lands a few days after it began, and the EFO staff were well prepared to consider what impacts may occur, consult with cultural resources staff regarding the existence of any sensitive sites in the area, and reach out to Operations and Maintenance staff about the location of any Reclamation values and assets.
The C-PN Wildland Fire App is also central to the C-PN Region's weekly fire report that is produced for awareness of large fires with threat or impact potential. The report is emailed to a Regionwide recipient list that includes Regional leadership and supervisors of different programs. The report highlighted the ignition of the Muckamuck fire and identified it as a threat to

Conconully, allowing the Geology Program Supervisor to utilize the App to pinpoint the location of the Muckamuck fire and communicate to the C-PN Fire Coordinator that an active drilling operation was occurring at the south end of Conconully Lake. The Fire Coordinator and the Geology Supervisor were able to establish a potential impact and evacuation plan with the crew on-site ahead of the fire reaching them. They also coordinated moving expensive and difficult to replace drilling equipment to a more secure location. This ability to be proactive during a rapidly evolving incident not only increases employee safety, but also provides enough lead time to carefully shore up vulnerable and expensive equipment rather than waiting until mandatory evacuation orders are eventually put in place when it is likely too late to do so.

3.2.   Schneider Springs Fire (Bumping Lake, WA)

As the Muckamuck fire was emerging, the Schneider Springs Fire, near Bumping Lake, WA also ignited. While the Schneider Springs Fire did not threaten any Reclamation fee or withdrawn land, critical Reclamation infrastructure including the Bumping Lake Dam at Goose Prairie and the Tieton Dam and Diversion along the Tieton River were in the direct path of the fire. Like Muckamuck, the early spatial identification of the fire in relationship to the mapped infrastructure allowed for early communication with C-PN O&M staff about potential threats to assets/infrastructure and impacts to manual operation of the facilities during the scheduled flip-flopping of the releases. With the advanced warning of potential impacts, O&M staff were able to ensure that the Goose Prairie facility was not staffed and could be put in stasis while the fire moved through. Last minute site visits during the fire's most substantially threatening period were also eliminated, greatly reducing the risk to employees.

3.3.   Additional Unanticipated Benefits

Though individual fires provide excellent case studies, there were other unanticipated benefits that manifested throughout the continued utilization of the C-PN Wildland Fire App during the 2021 fire season. Reclamation leadership could access near real-time information regarding any fire in the Region without having to route questions through the C-PN Wildland Fire Coordinator. Field staff were empowered to look at fires currently burning nearby and adjust their anticipated inspection schedules, or at least communicate regarding specific incidents and ask the Region Wildland Fire Coordinator for potential impacts.

As the App evolved, it became apparent that AGOL could provide an excellent platform for the migrating to a spatial FMP product. Interest in a move to spatial FMPs has grown across DOI Agencies due to the ability to perform FMP maintenance easily, and they have been deemed the path forward for FMP development. Should policy or guidance be developed for the conversion of hard copy to a digital and spatial form, the AGOL App architecture will allow for relative ease of meeting new standards.

Lastly, though many fires are reported directly to the C-PN Wildland Fire Coordinator as per the Annual Operating Plans in place with the suppression agencies across the C-PN Region, there are some that are not. The overlay of recorded fires in the open source NIFC InFORM database in combination with mapped Reclamation fee and withdrawn lands greatly enhanced the ability to locate fires that may have not been reported to the C-PN Wildland Fire Coordinator. The ability to have a more comprehensive understanding of the true fire load, in incident number and acreage, on

the Reclamation landscape is augmented by the ability to quickly identify fires that the Coordinator had not been made aware of initially through the App.

4. Data

The App can be accessed via https://usbr.maps.arcgis.com/apps/webappviewer/index.html?id=cfeab6fcc6a642d6a9009f2e351cc15d. Access to the fire layers does not require users to be on the DOI network or logged into VPN; however, many of the specific Reclamation layers will only load properly when connected to the DOI Network or through VPN, thus currently limiting the ability for other agencies to access Reclamation specific layers (see section 1.4) No new data were developed for this project. All data utilized for this App was sourced through existing Reclamation data sources. Please contact the Reclamation GIS program manager for further information regarding the data utilized.
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Keywords: wildland fire, GIS, AGOL

5. Discussion

In all, the project was very successful at achieving the initial overarching objectives in addition to some ancillary benefits that were discovered as the project evolved. However, there were certain areas worth highlighting for future development of this C-PN specific product, and for consideration if this product is adopted by other Regions or at a Bureau-level.

The most significant issue in the utilization of this product was the accuracy or existence of mapped Reclamation lands. The use of existing national jurisdictional layers (e.g., Surface Management Agency [SMA] or Protected Areas Database of the United States [PAD-US]) are inadequate for accurate representation of Reclamation jurisdictional land and the use of these layers were never considered for integration into the App. Therefore, the only ands layer available was the C-PN regional lands layer which is continually being updated as GIS staff continues their effort in digitizing plat books. Due to the constant lands data updates, metrics associated with fire load (acres and incident numbers) are likely somewhat inaccurate. Providing information to ICs and IMTs about the location of Reclamation land boundaries is based on the most recent information available.

There are many layers that were initially listed for inclusion that were not available in geospatial form. At the time of App development, there was not a reliable spatial database for a variety of small assets (e.g. repeater sites, AgriMet, HydroMet, and weather stations). These assets have been burned in the past, amounting to tens of thousands of dollars in replacement costs. Having these assets mapped and included in the App would likely provide them an opportunity for protection during a fire when their locations could be shared with suppression agencies.

Archaeological information sharing is a difficult situation to navigate regardless of the agency or incident. Originally, having archaeological data integrated into the App was a top priority; ideally attributed with information on appropriate suppression tactics (e.g., "no ground disturbance", "protect from fire/ground disturbance allowable"). However, as some of this information is highly sensitive, and the App didn't provide a layer of security to protect the exact location and details of these resources. The App did allow for expedited communication of threats and conveyed fire perimeter information for Region Archaeologists to use for reference in their databases to respond back with site specific recommendations for protection or mitigation measures for suppression action.

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