National Hydrography Dataset (NHD) Update Project for US Forest Service Region 3

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Acknowledgments

I would like to extend my appreciation to the Water Resources Institute (WRI) at California State University, San Bernardino and USDA National Institute of Food and Agriculture for providing me this incredible internship opportunity. I would also like to thank Joel Osuna and everyone in the Center for Geographical Studies (CGS) for guiding, supporting, and allowing me to work on the National Hydrography Dataset Update Project.

Executive Summary

The purpose of this project was for Center for Geographical Studies (CGS) to update attributes and geometry of the U.S. Geologic Survey's (USGS) National Hydrologic Dataset (NHD) watersheds in the Southwestern region of the United States. CGS is located in California State University, Northridge (CSUN). Geospatial technology such as Geographic Information System (GIS) was used to improve the hydrologic features such as streams, lakes, washes, ponds, and canal ditches. ArcGIS software was used in this project to capture, manipulate, analyze, and present accurate spatial data. The United States Forest Service (USFS) requested to update the existing attributes of the NHD watersheds only within National Forest justifications. The NHD was useful to USFS because it provided improved hydrography. The updates included adding new features, realigning geometry, and changing seasonality. Reference data, such as aerial imagery interpretation, US topographic maps, Google Earth, and specific business rules were utilized to achieve comprehensive updates. Currently, two out of the five Nation Forests have been completed with NHD improvements and were sent back to the USGS National Database, which were Coronado and Coconino National Forests.

Project Objectives

The objective of this project was to improve NHD such as NHD lines, flowlines, points, areas, and waterbody features at a scale of 1:24,000. The NHD editing was done at a scale of 1:12,000 - 1:10,000 in order to match at the resolution scale of 1:24,000. Provisional names of hydrographic feature that did not have approved Geographic Names Information System (GNIS) associated with them were assigned to the NHD geometry features. After finishing the editing stage which was accomplished using custom USGS editing tools within a GIS software know as ArcGIS, the updates were given to the Local USFS hydrologists and GIS managers for further review before being submitted to the national database. CGS was responsible for making NHD edits to hydrography within Coronado, Tonto, Coconino, Carson, and Kaibab National Forests in the southwestern region for USFS.

I want to pursue a career in Geographical Informational Science (GIS) because I want an environment in which I am consistently learning new things from different areas and applying them to different scientific studies. My long term career goal is to work for one of the government branches as a GIS Analyst. I am currently in the GIS Master's program at California State University, Northridge. This internship has been a great learning experience and opportunity for my career.

Project Approach

NHD Training

In order to achieve the completion of the National Forests, training sessions were provided by the USGS. USGS provided tutorials and documents to show how each NHD tool worked and what it was used for. CGS also provided further training in aerial imagery interpretation, topology interpretation, and hands-on practice. This training provided fundamental background on hydrology and NHD editing.

Data Preparation

After the dataset was checked out from USGS, a pre-initial quality control (QC) check was preformed to identify any errors before beginning the editing process. Some of the QC's included checking for pseudo-nodes, invalid geometry, and flow directions. Once the QC errors had been fixed the editing process could begin.

NHD Editing

Each study area (National Forest) was divided into Hydrologic Unit Codes (HUC) which were representations of watershed boundaries made by using Digital Elevation Models (DEM) in a separate process. Editors were working on HUC12 boundaries which were the smallest sub-basins that made up the HUC8 boundaries. Editors were given a job with HUC12s outlined, numbered, and named for easy tracking of updates to the NHD. The number of HUC12s within a HUC8 varied from job to job by the topographical landscape and existing hydrologic features.

The documentation and support data that was used for editing were business rules from CGS, USGS support pages, USFS region three resource photography, Arizona Department of Water Resources data, and current NAIP aerial imagery. Other datasets that were used for decision making in order for the NHD to reflect current conditions were Google Maps/Earth, Bing Maps, USFS region three data (stream line and water point data), and Arizona Spring Institute data.

The NHD editing was mostly focused on realignment and adding new hydrologic features such as streams, lakes, washes, ponds, and canal ditches. The project included a 500 meter flowline densification threshold in both mountainous or semi mountainous areas within USFS boundaries, which meant that editors could not add new flowlines below the threshold. Stream type (ephemeral, intermittent, and perennial) also known as seasonality were also corrected.

Job Submission

An internal QC was done for each job. Once the original editor completed the NHD updates, the job was reviewed by a second editor check. Internal QC went over spring integration, seasonality checks, GNIS Name Continuity, and flow direction/ properties checks. A final QC check was processed to verify all errors were resolved. Once resolved, the updated NHD Job was sent for review to the USFS Local Forest hydrologists and GIS managers. Once CGS received their feedback and made adjustments to the updated NHD job, it was effectively transferred back to the USGS National Database for check-in.

Project Outcomes

Coronado and Coconino National Forests have been completed and sent back to the USGS National Database. Three National Forests remain and CGS is currently working on completing Tonto National Forest. The outcomes from the project demonstrated that the NHD updates were needed for USFS region three. Most of the improvements included modifying existing features and adding new features such as flowlines (Figures 3 and 4). The results indicated that most of the streams that were added were ephemeral which meant that the channel only contained water during or immediately after rainstorm, flooding event, or heavy snowmelt (Figure 5 and 6). Many of the water bodies were classified as intermittent with high water elevation which meant that water was present, but the lake bed was not filled. Originally the threshold for adding flowlines was 1000 meters but as the project progressed, the threshold was adjusted to 500 meters in highly dense areas in order to have the NHD jobs completed with enough detail at the 1:24,000 scale. A reference map of the study area and a legend that demonstrated some of the common features that were updated during the edit process were provided below (Figure 1 and 2).

Figure 1: This map demonstrated the study area of the national forests that were selected to be updated specifically within National Forest justifications for this project.
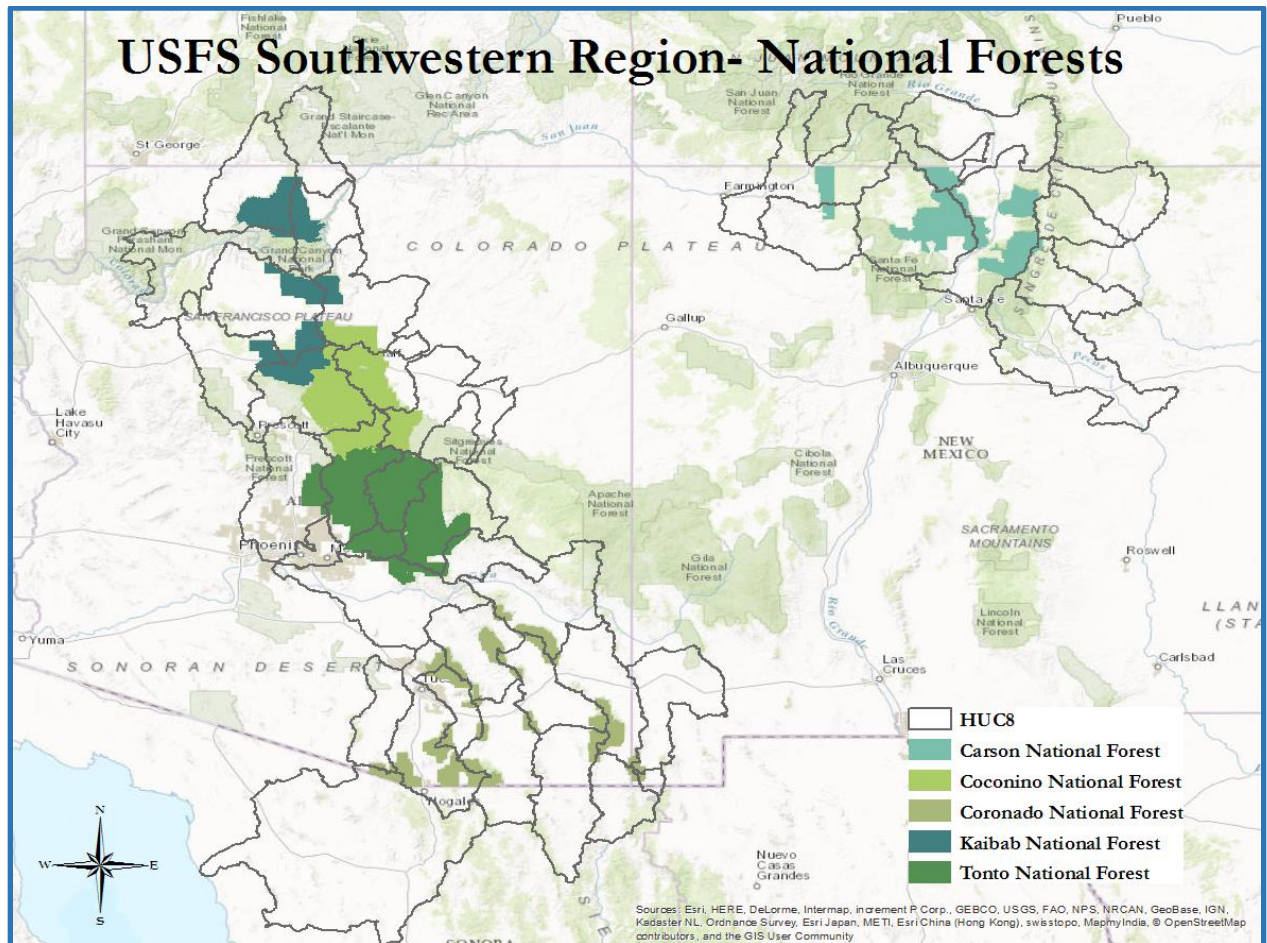
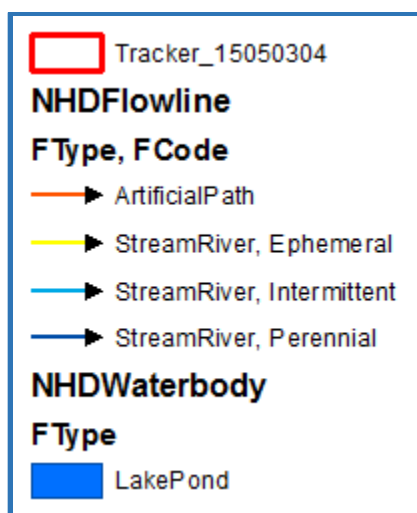

Figure 2: Legend of NHD features

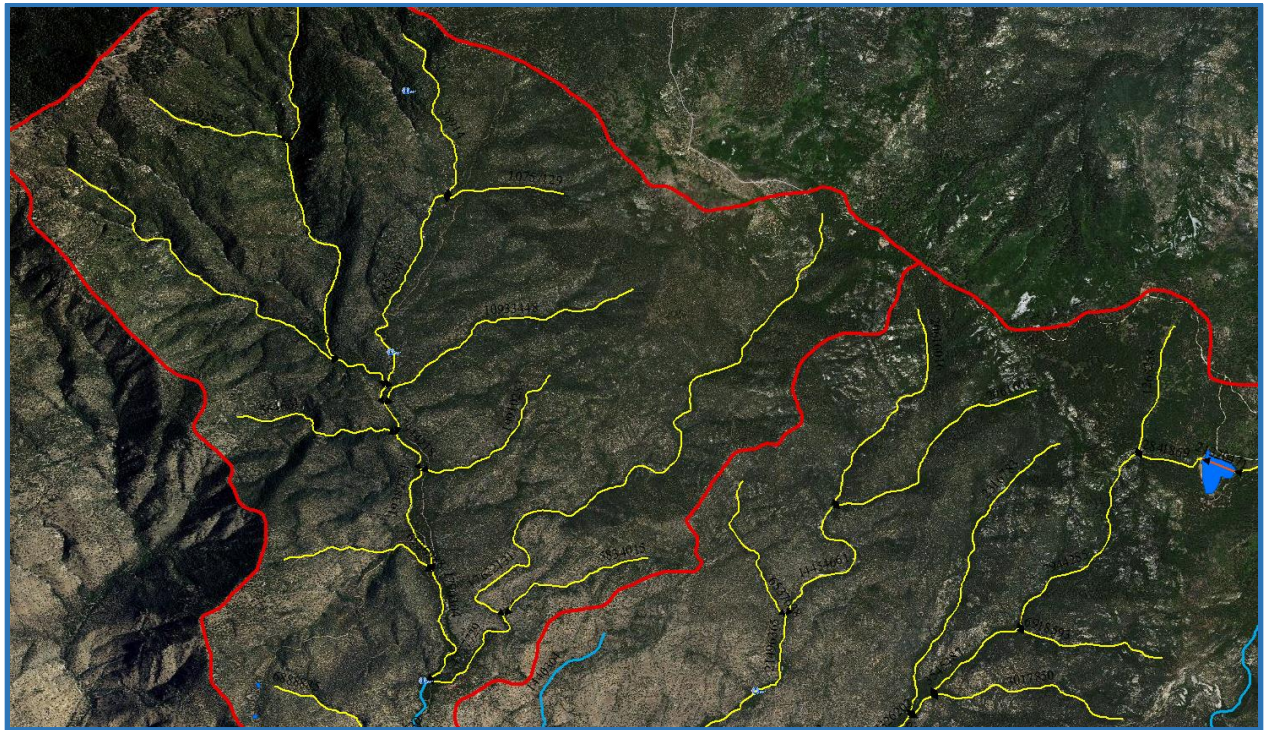*Figure 3: Before NHD Updates in Willcox Playa, Coronado National Forest*

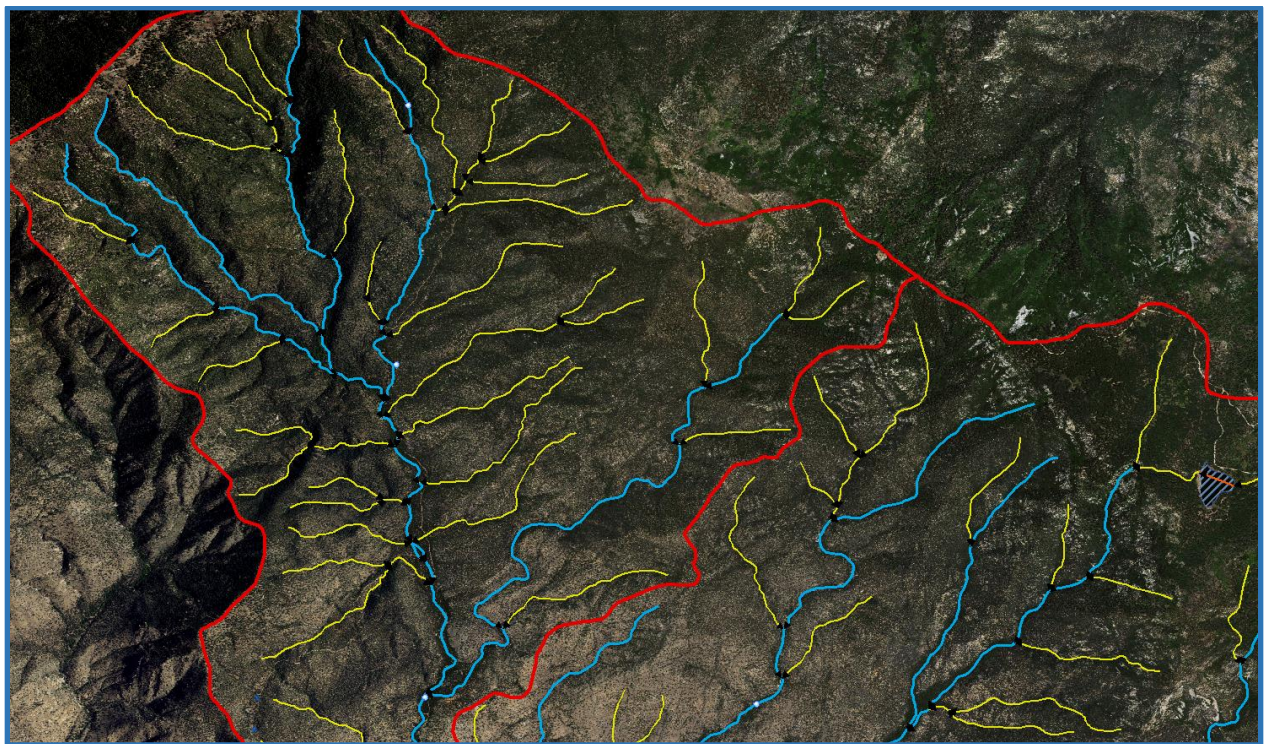*Figure 4: After NHD Updates in Willcox Playa, Coronado National Forest*

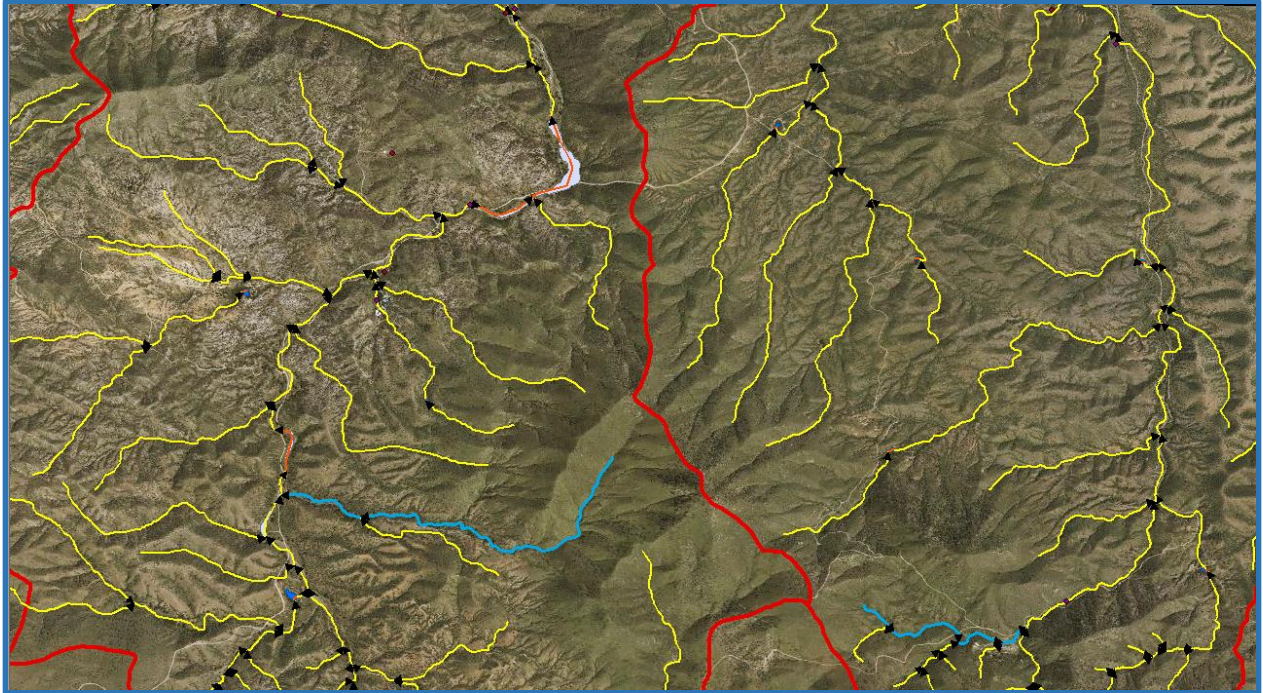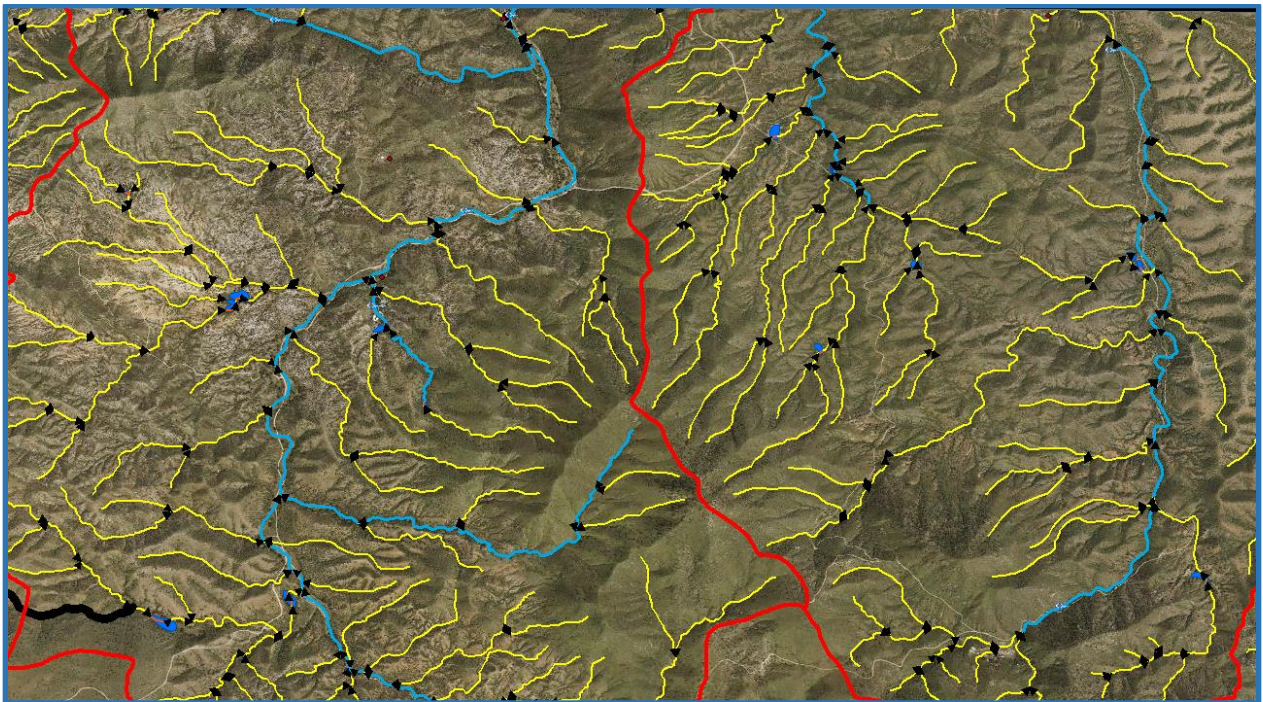*Figure 5: Before NHD Updates in Brawley Wash, Coronado National Forest*

Figure 6: After NHD Updates in Brawley Wash, Coronado National Forest

Conclusions

This project delivered improvements to the NHD which could then be used in the USFS program for applied research, spatial planning and reporting. Once the project is completely finished with all five national forests, it will then have accomplished accurate surface water maps to support land management decisions. This project gave me the opportunity to apply geospatial skills such as hydrography interpretation, GIS editing rules, and following a structured workflow into desert environments in the southwestern region. The WRI internship provided me with a professional and technical learning experience. This experiential learning internship has furthered my career by expanding my skills in GIS and NHD editing. It has also helped me get familiar with USGS and USFS processes, standards, and needs.