River Pyle

This is a fantastic start and a really well thought-out methodology. I'm very impressed by all of the thought and research you've put into this.

Dr. Brian Burke

SD 4405 – 101

02/27/2022

03/05/2022

Remote sensing and Water Quality:

Applications of GIS in environmental impact assessment and water resource management strategies for human development projects

Abstract

By utilizing the institutions created by the Federal Water Pollution Control Act of 1972 (FWPCA 1972), the Clean Water Act amended in 1977(CWA 1977), and the North Carolina Environmental Policy Act of 1971 (NCEPA 1971), actors involved in local/regional development can assess impacts of a proposed land or waterway disturbance and provide feedback to mitigate harm to adjacent environmental and human systems. The definitions and characteristics outlined in many ' waterways and pollution control acts' written into both federal and state legislature provide open interpretation to include anthropologic, ecologic, geologic, and hydrologic as factors when assessing a development project, i.e., proposed action, as referenced in the NCEPA. Additionally, these documents stand the test of time through the allowed use and optimization of technological advancements as each field evolves (FWPCA 1977, §101. A. 6. 7). This report will utilize various programs, definitions, and descriptions listed within the FWPCA, CWA, and NCEPA as the framework for a water resource and ecological impact analysis for the proposed action 'Project Ranger' in Asheville, NC. Project Ranger is an ongoing economic development project involving a land parcel directly adjacent to the Blue Ridge Parkway (BRP), with limited road access requiring the addition of a 5-lane bridge to connect the proposed action to a primary roadway. However, discrepancies between the proposed action notification plans submitted to the NC Department of Environmental Quality (NCDEQ) and impact assessments from biologists, spatial analysts, and historical landmark surveyors indicate a need for further research on the site as well as the implementation of water control policy to prevent significant impact.

Introduction

Although publicly available documents regarding ‘Project Ranger’ provide significant insight into the timeline of a proposed action in NC, the large scale of land/waterway disturbance outlined in the Pre-Construction Notification form submitted to the Water Resource division of the NCDEQ indicates a need for water and soil quality monitoring at regular intervals throughout the action. Fortunately, the capabilities of water resource monitoring allow spatial analysts to build flood models, delineate waterways, and understand potential impacts to topography encroached upon by the proposed action. Using elevation data and aerial imagery provided by the USDA’s Natural Resource Conservation Service (NRCS), current project boundaries and land/water disturbance can be compared to the initial Pre-Construction Notification (PCN) form to assess how well the developer (Biltmore Farms LLC. and Pratt & Whitney of Raytheon Tech.) has adhered to their plan as well as suggestions made by environmental scientists (ClearWater 2019).

This comparison can provide insight into observable impacts made by active construction upon the local waterways and topology, aided by the high resolution of the NRCS’s LiDAR elevation dataset. In contrast to the 30-, 10-, and 3-meter Digital Elevation Models (DEMs) often used by water resource analysts to delineate watersheds and streamlines, the LiDAR Model requires a resolution of 1 to 5 meters specifically for “terrain mapping and conservation planning and analysis activities” and is the product for the 3D Elevation Program (3DEP), wherein the USGS is authorized to create a shared pool of high-resolution elevation data. The NRCS specifically lists applications for this dataset that align with the goals of this report including floodplain delineation, watershed evaluation, hydrologic modeling, and “fast and accurate stream cross-section acquisition and geomorphology mapping” (NRCS 2022). The purpose and accuracy of this data can aid to demonstrate variances between project and stream locations in the PCN for Project Ranger, as well as understanding where the site lies relative to precise and updated floodplain models. The primary resource to create these floodplain models is HEC-RAS, the Hydraulic Engineering Center’s River-Analysis System which utilizes the resolution of newly captured elevation data to create flow and floodplain models (HEC-RAS 1995). In this report, HEC-RAS modeling can also provide an understanding of potential impact from streambank changes, then referenced to the initial Project Ranger PCN that describes the stormwater management plan during and upon completion of the bridge (ClearWater 2019). Lastly, a dataset necessary to understand the ecology of the area surrounding Project Ranger is the USDA’s Web

Soil Survey (WSS), a large geospatial soil database system that uses queries to produce information about soil characteristics, native vegetation specific to use (wind-break, canopy, erosion control), and historic/present land use; the origins of the soil survey are rooted in conservation, pioneered by David Rice Garner's 1957 "The National Cooperative Soil Survey of the United States" that set the standard for soils mapping, classification, interpretation of data, as well as the capabilities of the assertions made from the data ("Web Soil Survey" 2022; Gardner 1957).

Statement of Purpose

In essence, this report aims to identify discrepancies, changes, and unforeseen impacts resulting from the Project Ranger development in Asheville, NC. The initial research will primarily use updated elevation, hydrologic, and soil data in combination with purpose-designed modeling and spatial analysis software to delineate watersheds, streams, and floodplain models. Additionally, aerial images showing the site during active construction may be used to digitize updated building foundations and roadway boundaries represented by cleared trees and bare earth. These products may then be referenced to relevant site documents submitted to the NCDEQ to understand the difference between proposed and actual/in progress proposed action. Ideally, this report will provide a process/framework for future impact assessors to identify errors throughout the timeline of a proposed action. These results may be most useful as arguments for or against CWA permits (required for developers before construction) and permits listed in the PCN form, as well as provide greater information about the site to the local/regional public. Lastly, the utilization of datasets and tools designated specifically for conservation and hydrologic monitoring will help to maintain a standardized language throughout the explanations of methods, processes, and research within the report. By combining GIS, water resources, and impact assessment processes this report intends to design a framework for monitoring both the ultimate success of mitigation strategies applied to a proposed action, as well as monitor impact and changes during construction.

Plan/Timeline

The first section of research into the Project Ranger site will comprise mostly of data collection on elevation, soils, hydrologic, and land use, as well as available information on water quality for the area. This research will also include sourcing documents related to the site submitted to the NCDEQ, in addition to any other available impact reports or assessments, e.g.,

Historic Structures Survey Report, Benthic Macroinvertebrate surveys, to use in comparison. The bulk of data may be derived from sources and government agencies listed in the introduction and their respective sub-divisions, however, many of the assessments were completed by firms contracted directly by the developers and although are required to work within state and federal water quality standards, the role of these assessments in the context of this report is for comparison. Once initial elevation and aerial imagery of the site have been gathered, the first 'updated' delineation of the watershed, floodplains, and proposed action boundaries can be created. The purpose of this initial analysis is to establish a local database for new delineations and identify any errors or conflicts within the analysis before comparison to available site data. The first series of models will include the centerlines of 1st, 2nd, and 3rd order streams within the watershed immediate the proposed action, as well as drainage systems adjacent to access roads or land disturbances nearby. The French Broad River encapsulates the site from due West 270 degrees clockwise due East and is cordoned off on the southern side by the Blue Ridge Parkway, limited to access from a gravel road (ClearWater 2019, pg. 18). Thus, any wastewater produced during construction, or the ultimate operation of the facility will drain into the French Broad, its hyporheic zone, or the aquifer beneath the site. This section of research is primarily to build a greater understanding of the hydrologic characteristics of the site and identify gaps within local data.

Once the initial delineations have been produced, a review of historic and proprietary analysis methods used in similar assessments will be done to ensure the results are valid. In this context, health standards for safe chemical concentrations (human, bio-, and ecologic) may be compared to data from sample stations along the French Broad River. During this section, observations about the record-keeping process in this region can be noted, e.g., are there enough water quality monitoring stations at regular intervals away from storm/wastewater pipes to assess the impact of site operation and active construction? This section of research is primarily to develop quantitative data about pollutants, native species, soils, and sociologic systems nearby the proposed action, and discern what data may aid in future mitigation and conservation management strategies for the site. Language and requirements listed in sections of the FWPCA and CWA may be referenced and applied to the initial delineations to develop a baseline for the site impact. In this case, section 404 of the CWA "Permits for Dredged or Fill Material" has explicit guidelines for how the land of various amounts can be moved, as well as the process for

approval (CWA 1972, §404). Section 404 is also specifically called in the NCDEQ's PCN form and is the first type of approval sought by developers during a proposed action in NC. Thus, it can be used to assess the degree Project Ranger developers are adhering to guidelines.
As quantitative data is linked to delineations and models produced in the first section of research, boundaries, and disturbances indicated in the Project Ranger PCN submitted in 2019 and other reports about the site must be digitized into a local database before an accurate comparison can be made. Footprints of the proposed structures, roadways, storm/wastewater management ponds, discharge pipes, and parking lots are all portrayed within the site PCN, however, these boundaries must be digitized and processed within a local database before any calculations can be made. This section of research will prioritize clear filesystem organization to show a clear contrast between delineations created from 'updated' data and digitized boundaries from reports submitted to the NCDEQ for Project Ranger. Additionally, new methodologies for water resource analysis and tools within modeling software may be implemented to include detail.

Once the base calculations for the site have been made a brief write-up on each component of the analysis can begin. This will include the methods used in the delineation, e.g., tools used in raster analysis, description of how flow direction and accumulation are used to calculate stream centerlines, as well as definitions of various actors, systems, and technology used in the analysis. Formulas for the various hydrologic and flood modeling analysis algorithms may be included provided it adds to the audience's understanding of the tool being used. Mapping products and visual descriptions of the site will be added to the writeup during this stage to maintain relevancy in the comparison. It is important to reevaluate this report at various stages to ensure accuracy, as well as include notes and observations during data and methods research. To create the final report, the draft will be revised to standardize language within each field, and general formatting can be completed. The last stage of research will be used to gather input from various audiences, i.e., those in related fields versus the general public, as well as highlight any significant findings from the comparison.

Similar Works

Related works to this type of assessment include both submitted impact assessments for Project Ranger as well as reports written primarily for water quality control policy. Wetland research also includes many of the processes found in these reports, as Kelly outlines the change in North Carolina wetlands after the amendment of the Clean Water Act, using buffer zones

relative to the type of Section 404 permit issued (2001, 9). This assessment also provides background that “remotely sensed satellite data combined with GIS have proved to be an approach successful in measuring broad-scale landscape patterns and correlating such patterns with ecological functional changes” (as qtd. In Kelly 2001, 14). Highfield supports this assertion through an analysis of the impact of CWA Section 404 on peak streamflow and wetland status in coastal Texas and adds that the permitting process focuses primarily upon mitigating losses to wetland and water resources and generally minimizing the amount of disturbance for each proposed action (2012, 894). Highfield’s analysis includes flooding as a factor of wetland degradation, and most importantly hypothesizes that the 404 permitting process is necessary to maintain wetland health, and subsequently mitigate abnormal peak annual streamflow values (2012, 894). Highfield and Kelly’s assessment aligns more closely with the proposed research herein than the PCN and environmental impact assessments, as this comparison will evaluate the effectiveness of current mitigation strategies for Project Ranger rather than an additional impact assessment.

Works Cited

Clean Water Act of 1972. 33 U.S.C § 1344 et seq. (1972). Plain Text Web Node.

ClearWater Environmental Associates. "Pre-Construction Notification Form". Project Ranger, Biltmore Farms LLC. Web PDF Archive. November 2019. Accessed 2022. https://edocs.deq.nc.gov/WaterResources/DocView.aspx?id=1030041&dbid=0&repo=WaterResources&cr=1.

Evans, Parthenia B. "State water quality certifications in Section 404 permitting." *Natural Resources & Environment* 7, no. 1 (1992): 22-63.

Federal Water Pollution Control Act. 33 U.S.C § 1251 et seq. (1972). PDF File.

Highfield, Wesley E. "Section 404 permitting in coastal texas: a longitudinal analysis of the relationship between peak streamflow and wetland alteration." *Environmental management* 49, no. 4 (2012): 892-901.

Hydrologic Engineering Center, US Army Corps of Engineers. "HEC-RAS". USACE Software. WebPage. First Version 1995. Accessed 2022. https://www.hec.usace.army.mil/software/hec-ras/.

Kelly, Nina M. "Changes to the landscape pattern of coastal North Carolina wetlands under the Clean Water Act, 1984–1992." *Landscape Ecology* 16, no. 1 (2001): 3-16.

Natural Resources Conservation Service, USDA. "Web Soil Survey ". Web Page. Accessed 2022. https://websoilsurvey.sc.egov.usda.gov/App/HomePage.html.

North Carolina Environmental Policy Act of 1979. “G.S. § 113A, Article 1”. Markdown on Web. NCLeg.net.

NRCS, USDA. "LiDAR Elevation Dataset". Bare Earth Digital Elevation Model (DEM). Plain Text. (2022). https://gdg.sc.egov.usda.gov/Catalog/ProductDescription/LIDAR.ht.

Rice Gardner, David. "The National Cooperative Soil Survey of the United States". Thesis presented to the Graduate School of Public Administration, Harvard University. PDF File Download. May 1957. https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd1402410&ext=pdf.

Richard Grubb and Associates. *Historic Structures Survey Report.* “The Biltmore West Tract for Project Ranger Site”. PDF File. December 2019. NC-Gov-Historic-Preservation-Office.

USDA. "Geospatial Data Gateway". *Natural Resource Conservation Service*. URL Link. Accessed 2022. https://datagateway.nrcs.usda.gov/GDGOrder.aspx