



Platte River Basin Water Resources

Assessing Urban Flood Vulnerability to Select Restoration Sites for Urban Woods and Prairies in the Great Plains

Project Team

Project Team:

Jennifer Mathis (Project Lead)
Jackie Encinas
Olivia Kirkland
Emma Vail

Advisor:

Dr. Marguerite Madden (University of Georgia, Center for Geospatial Research)

Node Lead:

Megan Rich (Georgia – Athens)

Team Contact: Jennifer Mathis, nejeanne@gmail.com

Partner Contact: Melissa Mosier, melissa.mosier@audubon.org

Project Overview

Project Synopsis:

In the Platte River Basin, wetlands are lifelines, offering vital services like flood control and wildlife sanctuaries. However, rapid encroachment of urbanization disrupts this balance, threatening habitats and putting communities at risk. In response, the Audubon Great Plains' UWP Initiative works to restore urban habitats, safeguard birds, and minimize flood risks head-on. Collaborating closely with the NASA DEVELOP project team, we leveraged cutting-edge Earth Observation technologies to track changes in land use land cover from the past decade. Our analysis revealed notable areas of urban expansion, specifically locales like Grand Island, NE. By integrating flood extent mapping from significant events like the 2019 deluge, we are facilitating region-wide efforts aimed at pinpointing hotspots and prioritizing critical wetland restoration sites, building a sustainable future for both wildlife and people.

Abstract:

In the Platte River Basin, wetlands provide ecosystem services such as flood mitigation and wildlife habitat. However, increasing urban development in the area has impacted natural floodplain processes, leading to a decline in wildlife habitat and an elevated flood risk for nearby communities. To address this issue, Audubon Great Plains' Urban Woods and Prairies (UWP) Initiative focuses on restoring vital habitats within urban areas to protect bird species and reduce flood hazards. Our project used remotely sensed data, including Landsat 8 Operational Land Imagery (OLI), Sentinel-2 Multispectral Instrument (MSI), and Sentinel-1 Synthetic Aperture Radar (SAR), to assess land use and land cover from 2013 to 2023, as well as flood extent. Broad-scale analysis of the LULC showed some changes in land use patterns across the Central Platte River Basin, with the most notable being a decrease in Agricultural land coverage and an increase in Vegetation and Grassland coverage. Land use changes varied across 13 focal cities across the entire basin. In particular, developed land in Grand Island, NE, nearly tripled from 2019 to 2023, making it a good possible candidate for restoration efforts. We overlaid a flood extent map with the LULC classifications in Grand Island to identify possible restoration sites under UWP. This data will inform Audubon Great Plains in identifying potential restoration sites in key cities.

Key Terms: Platte River, Basin, land use land cover classification, time series analysis, random forest, Machine Learning, Flood extent, HYDRAFloods

Application Area: Water Resources

Study Location: Platte River Basin in WY, CO, NE

Study Period: April – July 2013 – 2023

Community Concerns:

- Over the past several decades, the natural landscape of the Platte River Basin has been converted for agriculture and urban land use, compromising ecosystem services and driving habitat fragmentation and loss.
- Intense flooding events throughout the basin are a concern for communities along the Platte River floodplain. Local conservation efforts like Audubon Great Plains' Urban Woods and Prairies Initiative aim to implement green infrastructure and other nature-based solutions to mitigate flooding and restore habitat connectivity.

Project Objectives:

- Visualize land use land cover changes in 13 focal cities from 2013 – 2023
- Evaluate flood risk in urban areas
- Pinpoint potential restoration sites under the Urban Woods and Prairies Initiative

Partner Overview

Partner Organization:

| Organization(s) | Contact (Name, Position/Title) | Partner Type | Sector |
|----------------------|--|--------------|------------|
| Audubon Great Plains | Melissa Mosier, Platte River Program Manager | End User | Non-profit |

Decision-Making Practices & Policies:

Audubon Great Plains uses local partner knowledge and several selection criteria, like population size, public access, and proximity to riparian habitat, to select restoration sites under the UWP Initiative. While they currently implement GIS tools to analyze species dispersal and habitat connectivity, integrating remote sensing techniques into their decision-making process is a new endeavor. By integrating Earth Observation techniques into their decision-making process, the Audubon Science team can gain valuable insights into landscape dynamics, habitat suitability, and ecosystem connectivity, enabling a more comprehensive analysis of ecological benefits and community resilience.

Earth Observations & End Products Overview

Earth Observations:

| Platform & Sensor | Parameter(s) | Use |
|-------------------|--------------------------------------|--|
| Landsat 8 OLI | RGB True Color, NDVI, NDBI, and NDWI | Surface reflectance was used to create training data for the Central Basin-scale LULC Time Series and calculate NDVI, NDBI, and NDWI |

| | | |
|-------------------------|----------------------------------|--|
| Sentinel-2 MSI | RGB True Color, NDVI, NDBI, NDWI | Surface reflectance was used to create training data for the city-scale LULC change detection and calculate NDVI, NDBI, and NDWI |
| Sentinel-1 C-SAR | Backscatter | Backscatter was used in HYDRAFloods to map flood extent of March 2019 flood event |

Ancillary Datasets:

- United States Geological Survey (USGS) National Landcover Database (NLCD) – Reference data for LULC Time Series training data
- United States Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) – Reference imagery for LULC Time Series training data
- Google Earth Basemap Imagery from Maxar Worldview-3 (WV3) – Reference for LULC Time Series training data
- Joint Research Centre (JRC) Historical Surface Water Classification – Permanent surface water classification for HYDRAFloods
- USGS 3DEP 10-meter DEM 2020 – elevation input data for HYDRAFloods
- Multi-Error-Removed Improved-Terrain (MERIT) Hydro 90-meter DEM – Hydrological flow and elevation input data for HYDRAFloods

Models:

- HYDRAFloods (Contact: Ashutosh Limaye, ashutosh.limaye@nasa.gov) – Create surface water and flood extent maps derived from remotely sensed data

Software & Coding Languages:

- Google Earth Engine – Landsat 8 and Sentinel-2 derived LULC Time Series
- Google Earth Engine Python API – HYDRAFloods to create flood extent map
- ArcGIS Pro v.3.1 – Format LULC Time Series and change detection maps, format flood extent map, overlay city-scale LULC classification with flood extent map

End Products:

| End Product(s) | Earth Observations Used | Partner Benefit & Use |
|---|-------------------------|--|
| LULC Time Series of the Central Platte River Basin | Landsat 8 OLI | Audubon Great Plains can employ this time series as a preliminary examination of broad-scale land use changes across the Central Platte River Basin in 2013, 2018, and 2023. |
| LULC Change Detection of Focal Cities | Sentinel-2 MSI | Audubon Great Plains will use this time series data to prioritize cities experiencing urban development for restoration efforts as part of the UWP Initiative. |
| 30 m Flood Extent Map of Grand Island, NE | Sentinel-1 C-SAR | Audubon Great Plains can use the Grand Island flood extent map to verify if highlighted areas are prone to flooding and identify potential sites for restoration. |

Product Benefit to End User:

Audubon Great Plains can use the end products in local outreach efforts aimed at identifying potential restoration sites as part of the UWP Initiative. As Audubon Great Plains forges partnerships within cities,

they can leverage the Central Basin LULC time series for storytelling purposes, illustrating general land cover changes over time. The analysis of the LULC in the focal cities can guide prioritization efforts, particularly in areas experiencing rapid urban growth.

After evaluating, the DEVELOP Team determined that HYDRAFloods using Sentinel-1 C-SAR imagery, lacked the necessary temporal and spatial resolution for effective flood mapping in the region. Although a flood extent map was successfully generated for Grand Island as proof of concept, Audubon Great Plains may explore alternative flood mapping methodologies using techniques such as stormwater-runoff modeling, flood hazard mapping with InSAR, LiDAR backscattering, and remote sensing and GIS –based hydrological models.

Project Continuation Plan:

We provided Audubon Great Plains with a preliminary LULC time series for the Central Basin, a LULC change detection for focal cities, and a flood extent map of Grand Island, NE. We also provided text and figures describing the project for use in an Audubon Society Story Map.

The Summer 2024 DEVELOP team can fine-tune the LULC classification to create a more accurate time series of the basin. They can also prioritize identifying wetlands using SAR, the USFWS Wetland Inventory dataset, or the Wetland Intrinsic Potential tool, as well as explore using a land change model to forecast urban development.

References

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