HISTORICAL LANDSCAPE AND ECOSYSTEM SERVICE CHANGE IN POCATELLO, IDAHO

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Introduction

A study investigating the interaction between ecosystem services, landscape change and associated socio-ecological systems in Pocatello, Idaho is currently underway focusing on the Portneuf River which runs through the city. Channelization of the Portneuf River in the 1960's has permanently altered the rivers natural processes. Recently the City of Pocatello has organized a Portneuf River Management Group with the goal of re-envisioning the Portneuf River. The Portneuf River Management Group has identified a need for a historical context of change over time in the river corridor at a local scale. High resolution historical imagery offers a unique opportunity to gain a clear picture of physical landscape change over time and can display this spatial data at a fine scale. This study uses rule-based feature extraction to create valuable input data which consists of urban structures, roads, green spaces, water, and agricultural lands. With the availability of historical aerial photos for many parts of the United States, extracting features from orthomosaics is a cost-effective approach in collection of historical and modern environmental data which can be used as inputs for ecosystem service modeling.

Question

How has land cover changed along the Portneuf River from 1959 to 2013?

Study Area

The study area is situated in urban portions of Pocatello, Idaho. Particular emphasis is placed on the Portneuf River which has gone through a considerable amount of change, especially with measures to enact flood control in the mid 1960's. The Portneuf River Management Group seeks to engage stakeholders of all levels to re-envision the future state of the Portneuf River by reviewing the past conditions of the waterway before these major alterations occurred.

Figure 1. Photograph of the Portneuf river through a residential area. The concrete section spans roughly 1.4 miles. The sides of the channel are 15 feet high and the river itself is 42 feet across.

https://www.idahoecosystems.org/al/blog/thursday

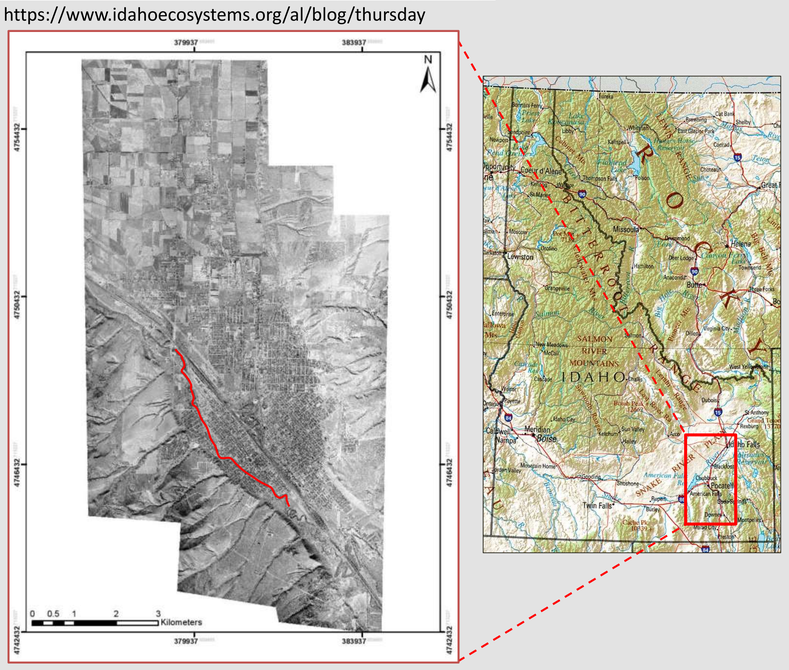

Figure 2. Orthomosaic of Pocatello , Idaho circa 1959. The path of the Portneuf River is shown in red.

Methodology

Aerial imagery on a decadal scale from the late 1950's to the mid 1990's was georeferenced and orthorectified at a 0.5 meter scale using structure-from-motion photogrammetry (SfM). This method uses pixel matching and ground control points to place camera positions for image alignment and stitching resulting in an orthomosaic **(Figure 3)** (Westoby, M. J., et al, 2012). A secondary result from SfM is point clouds that record surface elevation and create digital surface models for each orthomosaic year.

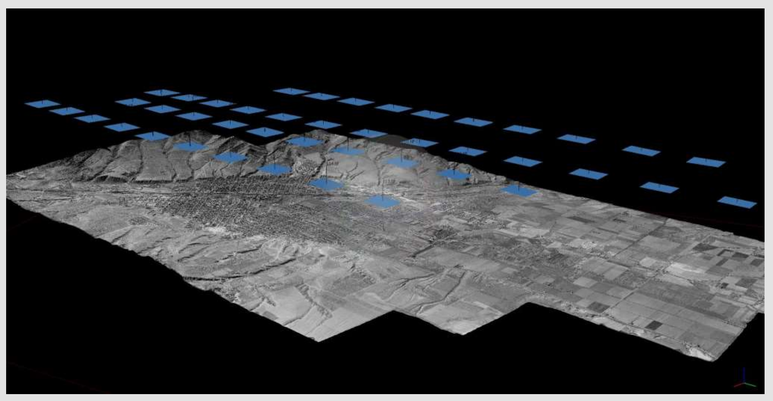

Figure 3, Camera positions of 1959 flight lines

Year	Scale	Images	Scan Resolution	Resolution (m)	Error(m)
11/02/1959	1:12000	44	11432x11241	.5 m	0.045686
10/17/1968	1:12000	42	11432x11241	.5 m	0.227806
9/19/1975	1:12000	209	11240x11240	.5 m	0.313031
7/11/1984	1:12000	122	11432x11241	.5 m	0.234593
7/11/1994	1:12000	60	11432x11241	.5 m	0.506871

Table 1. Date, Scale, Image Count, Original Scanned Resolution, Spatial Resolution and Spatial Error of each orthomosaic.

Historical orthomosaics along with modern NAIP imagery were analyzed on a decadal scale using rule-based classification (Opitz, D., et al, 2008). This method results in groups of pixels that are segmented by intensity and detection perceived of edges in the image **(Figure 4)**.

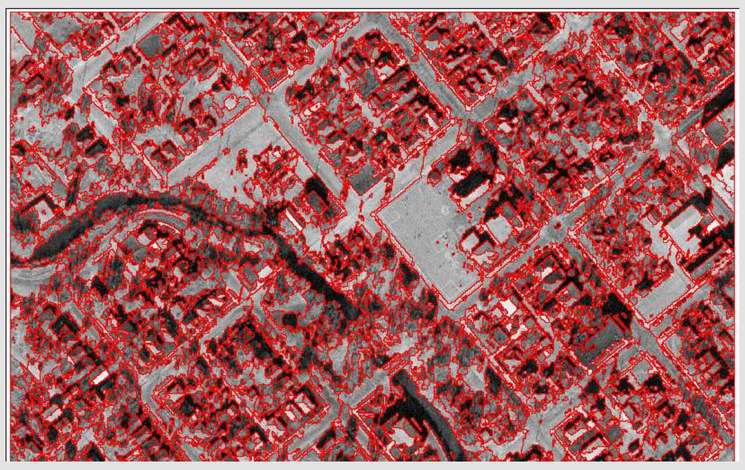

Figure 4. Segmented image of 1959

A spatial subset of these images were chosen based on important areas to be re-envisioned by the Portneuf Management Group. Segmented images are then placed into classes based on rule sets that specifies parameters such as shape, length and area. Extracted features in the form of vector and raster layers are exported to calculate spatial change of class types from 1959 to 2013 using ArcGIS Desktop 10.2. The class types used for this analysis are as follows:

- **Paved Surfaces – roads, sidewalks, concrete channel, parking lots**
- **Structures – residential, commercial, utilities**
- **Vegetation – trees, shrubs, grass, cropland**
- **Surface Water – river, reservoir**

Results

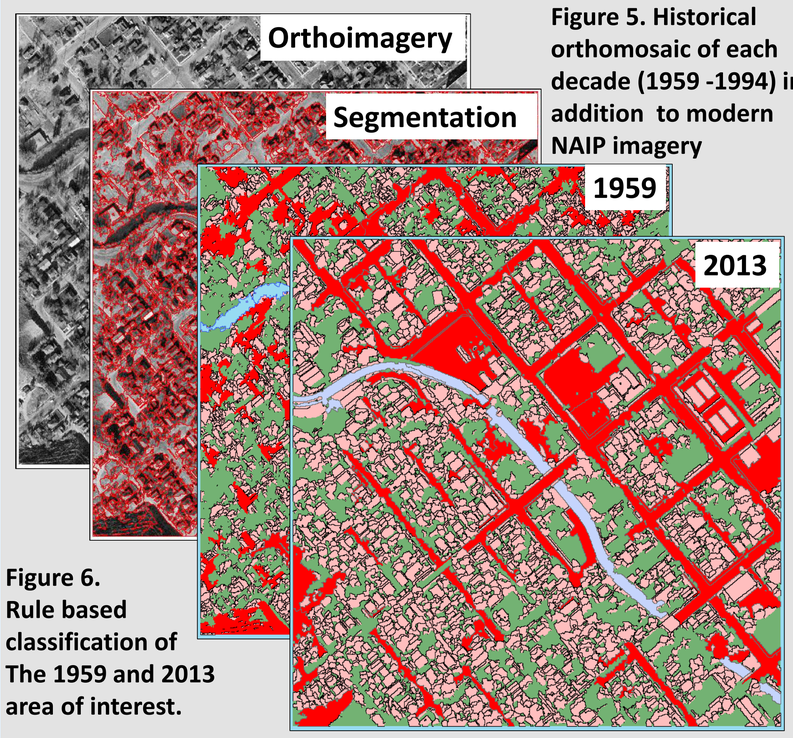

Figure 5. Historical orthomosaic of each decade (1959 -1994) in addition to modern NAIP imagery

Figure 6. Rule based classification of The 1959 and 2013 area of interest.

The subset analyzed between 1959 to 2013 showed an overall area of change by class type as shown in **Table 2.**

Year	Paved Surfaces	Structures	Vegetation	Surface Water
1959-2013	+ 10%	+ 20%	- 30%	- 10%

Table 2, Approximate change of class types

Land cover change from 1959 to 2013 showed and overall increase in both paved surfaces and structures and an overall decrease in both vegetation and water. Preliminary results presented here serve as a basis to fine tune rule based classification techniques and to test for accuracy using ground-truthed data. Additionally, the project seeks to gain more specificity in classes to further differentiate between vegetation, structure and road types.

Conclusion and Future Work

Using object-oriented feature extraction paired with high resolution historical imagery assists in understanding landscape use and land cover change over time, and contributes to the planning process of the Portneuf River Management Group. Initial results of feature extraction and GIS analysis indicated an increase in paved surfaces and structures and an overall decrease of vegetation and surficial water. Based on this data, more meaningful questions can be answered regarding the drivers of landscape change and effects on ecosystem services. Furthermore, The derived high resolution data sets are ideal for future scenario modeling of ecosystem services on a local scale not generally possible with national spatial data. Additionally, these outputs can be used for visualization of cityscapes to enhance decision making and community outreach (Grêt-Regamey et al., 2013).

References

- Grêt-Regamey, Adrienne, et al. "Understanding ecosystem services trade-offs with interactive procedural modeling for sustainable urban planning." Landscape and Urban Planning 109.1 (2013): 107-116.
- Lucas, Richard, et al. "Rule-based classification of multi-temporal satellite imagery for habitat and agricultural land cover mapping." *ISPRS Journal of photogrammetry and remote sensing* 62.3 (2007): 165-185.
- Westoby, M. J., et al. "'Structure-from-Motion'photogrammetry: A low-cost, effective tool for geoscience applications." Geomorphology 179 (2012): 300-314

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