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## Visualizing Landscape Change

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### Abstract

Visualization of landscape change at multiple scales can help communicate complex information in a clear way. This promises to help bridge existing divides between different technical disciplines and specific publics affected by issues related to combined sewer overflows specifically, and hydraulic infrastructure more generally. This project develops analytical visualizations and spatial interpretations of the data sets and performance standards in the 2011 Albany Pool *Combined Sewer Overflow Long-Term Control Plan*. It also creates a new data set through collection and analysis of historical aerial photographs of the Capital Region from 1952 to 2011, specifically focusing on changes in forest cover and paved areas in the study area. Simultaneously, a field technique is developed and tested at pilot sites for capturing actual sewer overflows into the Hudson River in action. Conclusions are drawn about the relative importance of forest cover change and impervious surface area in contributing to combined sewer overflows in Troy. In addition, potential implications for continued use of the new field technique to better understand the extents and impacts of sewer overflows in Troy specifically in conjunction with chemical and spatial analysis is identified.

## Visualizing Landscape Change

### Three Summary Points of Interest

- Forest cover within the combined sewer overflow area has increased from 21.6% to 27% of the urban area from 1951 to 2011, even as beach closures and ecosystem degradation due to combined sewer overflows has become a larger problem. It appears that this is a result of additional suburban development within the combined sewer service area, in particular the drainage systems being implemented there.
- Low altitude aerial photography can be used to document and analyze the morphological characteristics and performance effects of specific events, including actual combined sewer overflows. While this method generates a lot of useless data because of the necessity and difficulty of photographing in storm conditions that accompany CSO events, it can be done effectively and safely with kites and balloons. Additionally, the field work itself tended to engage surrounding community members, including kids, and interest them in the process and issues. This could be an interesting engagement aspect that was not initially anticipated.
- The design of landscapes in the sewershed, both in the uplands and at the end of the pipe, can have major implications for human and ecosystem health along urbanized riverbanks and should be informed by this type of multi-scalar analysis.

### Keywords

Landscape change, combined sewer overflows, public space, low-altitude aerial photography

### Introduction

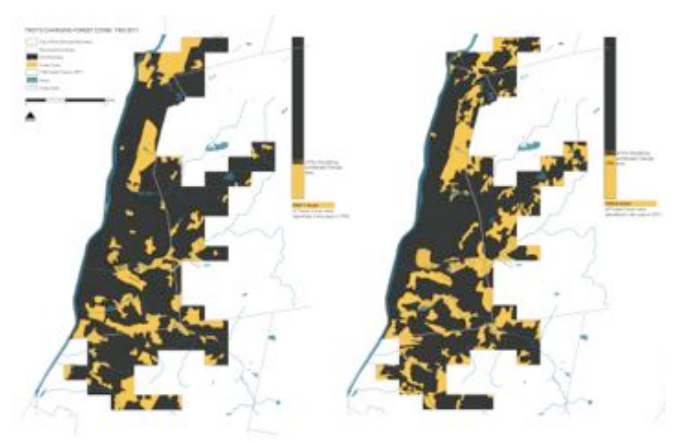
In 2011 the joint-venture team of the Albany Pool (comprised of the cities Albany, Cohoes, Rensselaer, Troy, Watervliet, and the Village of Green Island) submitted a *Combined Sewer Overflow Long-Term Control Plan* to the NYS DEC and CDRPC (Capital District Regional Planning District). That report provides important data sets, including the mapping of existing sewer systems in a GIS, and comprehensive data on outfall discharge frequency, type, and location as well as downstream effects, and establishes strategic goals related to combined sewer overflows.

While a powerful tool, GIS has a tendency to present landscapes as static systems. Infrastructures operating at large temporal and spatial scales can be difficult to represent, and misalignments between life spans of related landscape elements and the aggregate effects of changes over time can be particularly difficult to comprehend. In addition, reducing environmental effects to abstract data, which is often necessary, can nonetheless make impacts on water quality, public health, or ecological performance difficult to understand. Visualization and contextualization of this data within appropriate timescales (such as infrastructural life spans, or shifts in climate, or population growth patterns) may help to make it more useful for public outreach efforts, and for bridging disciplinary divides. The use of high-resolution aerial

photography deployed to capture specific events, when complimented by the use of GIS offers a powerful and intelligible way of understanding landscape change.

### Results & Discussion

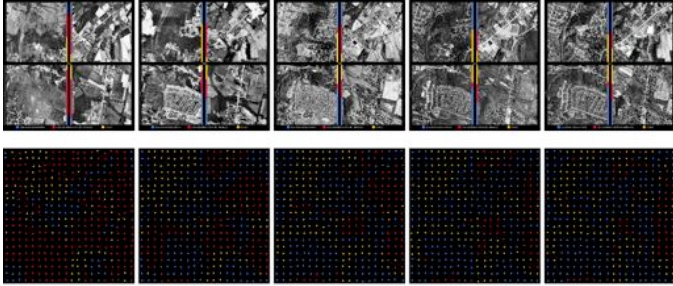
Growing impacts on the health of human and ecological communities along the riverfront from combined sewer overflows in the City of Troy are not caused by changes in land use or design within the city itself. In fact, urban forests areas excluding street trees -- those that contribute most to contribute to stormwater retention (Ordóñez and Duinker, 2012) -- increased significantly from 1952 to 2011.



[forest cover change in Troy, 1952 (left), 2011 (right)]

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While urban sub-sewersheds do contribute to CSOs, the growing negative effects appear to be caused primarily by changes in landscape use and form at the edge of the city, specifically the conversion of farmland to residential.



*[land use change analysis of different representative study areas in Troy, moving from 1952 (left) to 2011 (right)]*

At the site scale, these effects are evident very near publicly accessible and ecologically important areas. Initial field tests using balloon aerial photography found sewer outfall plumes very near a public boat dock in northern Troy and we suspect a similar patterns will be found at outfalls along the riverfront.



## Policy Implications

The design of landscapes in the sewershed, especially in the uplands and at the “end of the pipe” along the riverfront, can have major implications for human and ecosystem health along urbanized riverbanks and should be informed by multi-scalar landscape analysis. The Albany Pool region is upgrading sewer infrastructure according to the LTCP to lessen the recurrence of CSO events in the Hudson. As part of this

effort, measures should be taken to ensure that the design and use of public and private lands contribute to the mitigation of negative health and aesthetic impacts, such as elevated nutrient and parasite levels, or increased turbidity. In particular, initial research suggest efforts along the riverfront in public spaces should be coupled with an effort to work with homeowners in the suburban areas to redesign stormwater systems through landscape interventions that can be socially and ecologically resilient, low maintenance and attractive.

## Methods

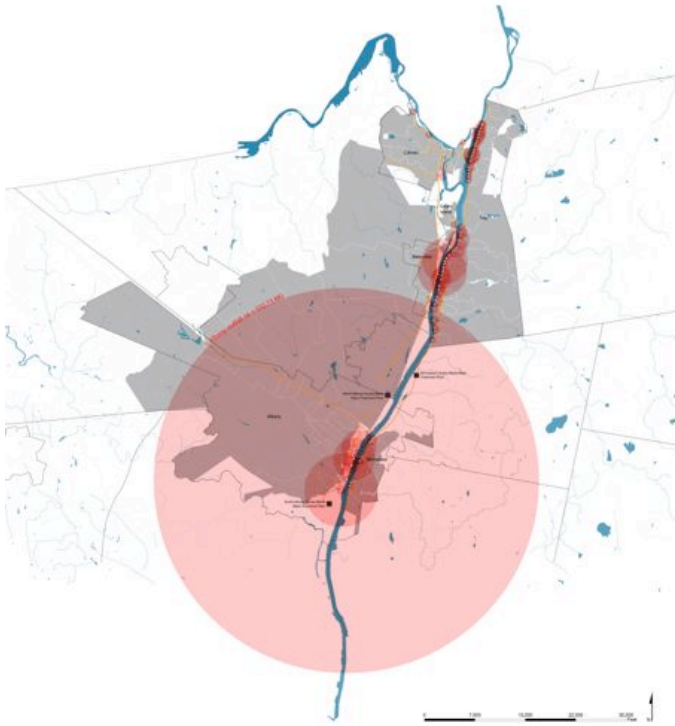
Representational methods that work on both decades-long timelines and highly variable, event-specific temporal scales of a few hours or days were developed to examine combined sewer infrastructure with an emphasis on overflow events and their effects on surrounding areas. Special attention was paid to the way these systems and their outputs intersect with landscapes that are part of the social, public life of the area (such as the closing of a beach or flooding of a neighborhood).

Data sets of historical aerial photography for this period in Troy region were examined and compiled using geo-referencing and layering to create a composite image of the landscape over the period of significance. These images were then analyzed to highlight changes in important landscape resources, such as forest cover, or the construction of a new road or subdivision. These were also turned into an animation, allowing for large scale visual projections that focuses on *trajectory* of change.

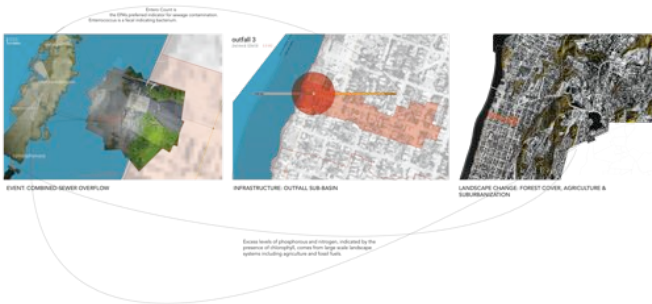
In addition a GIS was created to map the urban landscape morphology of the Capital Region. The study area began with the Albany Pool Communities of Albany, Cohoes, Rensselaer, Troy, Watervliet, and the Village of Green Island. This was then used as a spatial reference for visualizing the overflow data for specific outfalls in the Capital Region (LTCP).

*This report was prepared for the New York State Water Resources Institute (WRI) and the Hudson River Estuary program of the New York State Department of Environmental Conservation, with support from the NYS Environmental Protection Fund.*

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The study was then focused on the city of Troy, and waterfront sites were identified through mapping and analysis as characteristic of the larger CSO landscape for more detailed fieldwork. Event-specific high-resolution aerial photography employing balloons and kites and an accompanying log of environmental data was used to capture specific events along the waterfront in Troy, including a combined sewer overflow.



### Outreach Comments

Initial outreach efforts included contacting local arts (the Arts Center of the Capital Region) and community organizations (Honest Weight Food Co-op and the

Sanctuary for Independent Media) as well as touring the Rensselaer County Sewage Treatment Facility.

In the second year, relationships with these and possibly other organizations (such as Riverkeeper) will be developed with the hope of having a dialogue about the work and the final form that it might take in relation to local communities in the Capital Area. In addition, contact with local municipal authorities in the City of Troy will be important going forward.

### Student Training

Two graduate students worked with me on the project over the summer. Through the project work they were trained in ArcGIS, geo-referencing and analyzing historical aerial imagery, analyzing land use and forest cover analysis, literature review, as well as field work including low altitude aerial photography. One of them, a dual degree student between Landscape Architecture and City and Regional Planning, is currently completing her Exit Project based on the work done, training received, and ideas developed through this project. The other is currently developing a thesis proposal that builds on the analytical and documentation methods learned over the course of this project.

### References

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