Urbanisation et développement d'une plaine inondable « artificielle » : la rivière South Platte à Denver, Colorado, États-Unis

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RÉSUMÉ

Les plaines inondables comptent parmi les écosystèmes les plus riches de la planète. Pourtant, leur développement est devenu courant pour répondre aux besoins des populations humaines croissantes. De nombreuses études ont montré que l'urbanisation des plaines inondables entraîne une perte drastique de biodiversité ainsi que la dégradation d'autres fonctions écologiques essentielles à l'échelle mondiale. Cependant, peu de recherches ont examiné en détail leur transformation, sur plusieurs décennies, de paysages naturels à des espaces en partie artificiels. Cette étude analyse l'urbanisation rapide de la plaine inondable de la rivière South Platte, au nord de Denver, dans le Colorado (États-Unis), amorcée en 1937. Des analyses historiques par SIG de cartes et d'images aériennes mettent en évidence des changements dans l'usage des terres, passant de l'agriculture à l'industrie, ainsi qu'une réduction significative des zones humides et des habitats riverains. Une analyse par télédétection du nombre croissant de carrières de gravier permet également d'établir une chronologie de leur gestion en tant que réservoirs d'eau. Ces transformations s'accompagnent de changements dans les perceptions locales, étudiées via une analyse textuelle des journaux. Les résultats de cette étude visent à informer les aménageurs, gestionnaires et communautés locales sur les processus d'urbanisation des plaines inondables. Ces conclusions offrent également un cadre de comparaison avec d'autres exemples de plaines inondables en cours d'urbanisation à travers le monde.

ABSTRACT

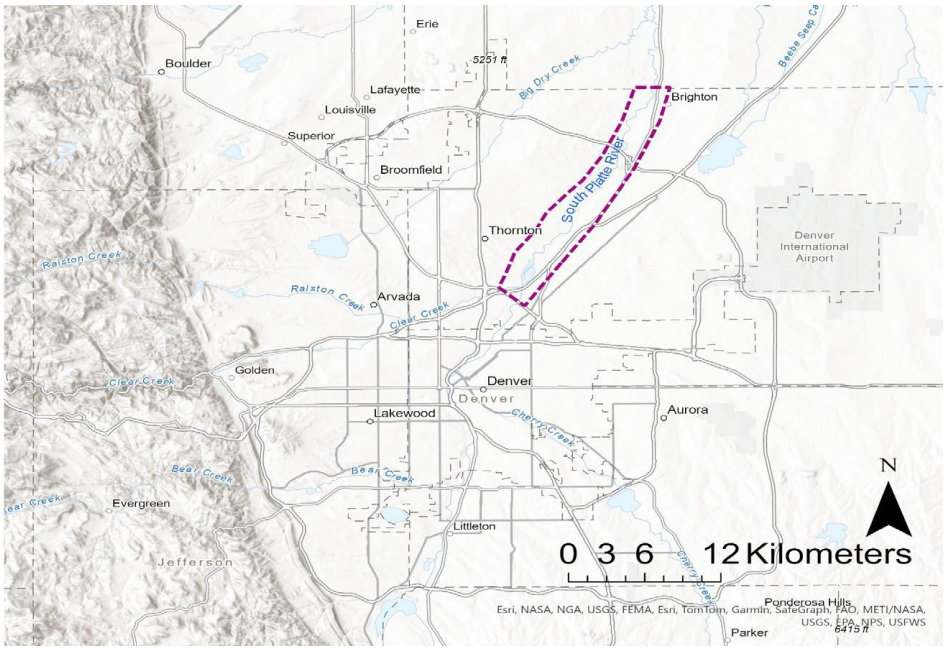
Although floodplains are among the most species-rich ecosystems across Earth's surface, development on floodplains has become common to meet growing human populations. Many studies have shown how urbanization on floodplains has led to drastic loss of biodiversity and other functional aspects of floodplains at global scales. Few have documented, however, the detailed transformation of floodplains over decadal periods from natural to partly artificial features on the landscape. This study follows the South Platte River floodplain north of the Denver area in Colorado (USA) through rapid urbanization since 1937. Historical and GIS analyses of maps and aerial imagery show changes in land use from agricultural to industrial, along with reductions in wetlands and riparian habitat areas. Remote sensing analysis of the growing number of gravel mining pits on the floodplain also produces a chronology of the management of mining pits as water reservoirs. Shifts in perceptions among residents of the area, revealed through text mining from local newspapers, have accompanied such changes. Results contribute toward informing planners, managers, and communities on the process of urbanizing floodplains. Findings also provide a template for comparison with other examples of urbanizing floodplains around the world.

KEYWORDS

floodplains, gravel mining, land use, newspapers, urbanization
carrières de gravier, journaux, l'usage des terres, plaines inondables, urbanisation

1 STUDY AREA

This study investigates an urbanized portion of the South Platte River (drainage area 13,061 km^2) along the foothills of the Rocky Mountains in Colorado, USA. We focus on the floodplain north of Denver with a total length of ~22.5 km and width of ~3.2 km. This stretch of the floodplain is somewhat open compared to the area within Denver, which is narrow, heavily developed, and channelized. Because development occurred in this area more recently, transformation of land uses and vegetative cover is more easily detectable in the available data.

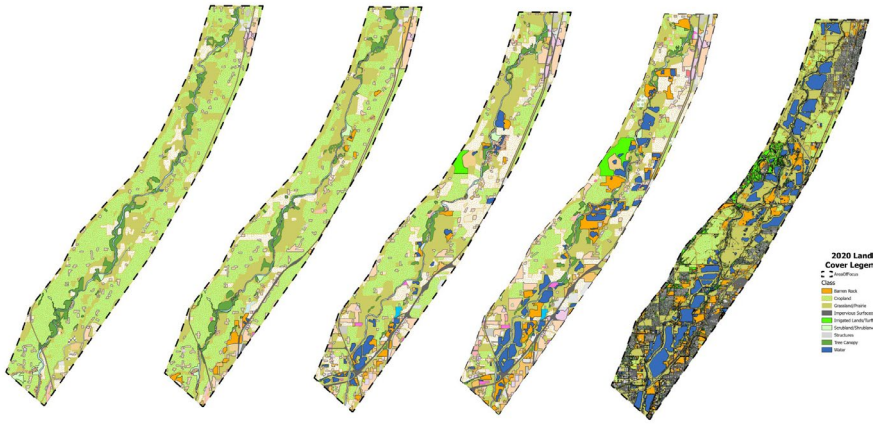


Study Area: The city of Denver was founded on the banks of the South Platte River. Growth has radiated outward from the city center covering the floodplain. Population has increaed 6% annually since the 1950s, with a current population of ~ 3.25 million.

EVOLUTION OF THE FLOODPLAIN

1.1 Land Use Change

GIS data on land use (1937-1997) were available from the United States Geological Survey in 20-30-year increments. Denver Regional Council of Governments provided the GIS data for land cover in 2020. We used ArcGIS Proto to quantify percentages of land cover in the specified time periods. The data were sorted by the given classifications for land use.



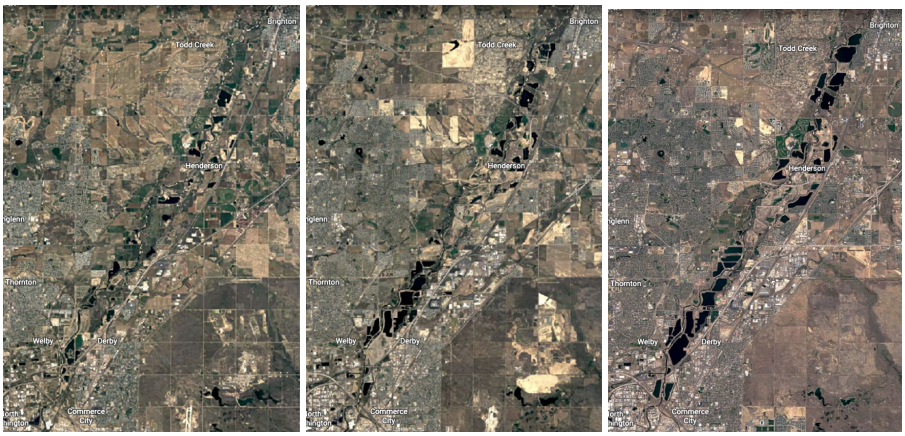
1937-97 Land Use Legend

2020 Land Cover Legend

Within the time periods analyzed, residential land use in the floodplain more than doubled, with multi-family housing appearing in the 1997 data. Quarry area increased by 3500% between 1937 and 1997 with a total area of 0.44 km in 1997. Riparian Forest decreased by 50% between 1937 and 1997. The increase in 2020 is due to the inclusion of urban forest. Shrubland decreased slightly while Wetland, herbaceous reduced from 1% in 1937 to 0.1% in 1997 and no measurable quantity in 2020.

2.2 Legacy of Gravel Mining

Gravel mining has occurred actively on the floodplain of the South Platte River near Denver since 1906. Before 1976, all mines in Colorado had been abandoned once activity was complete. With the passage of the Colorado Mined Land Reclamation Act in 1976, all exhausted sand and gravel pits in the state were transitioned to “public and environmental beneficial use”. Therefore, many became water reservoirs.

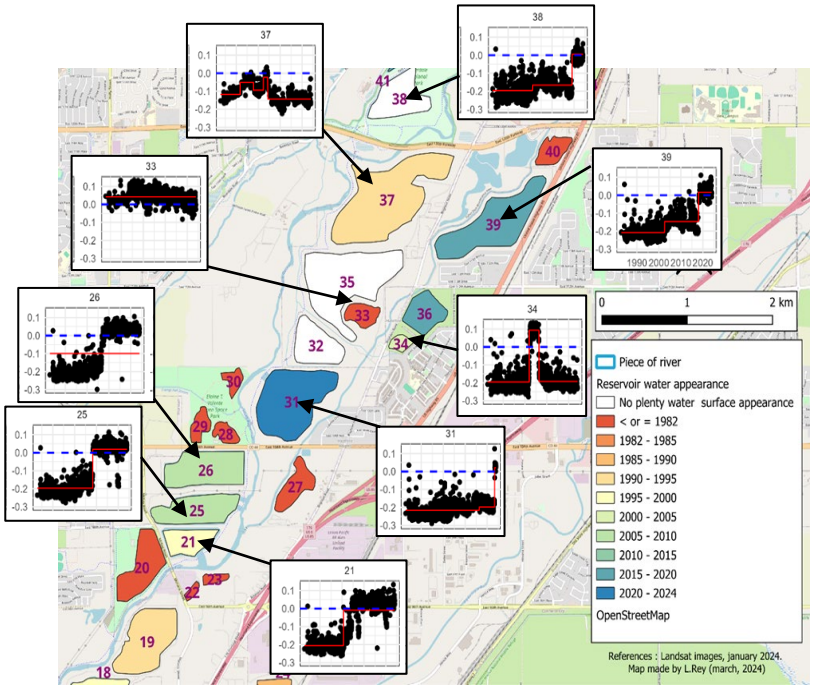


1990 **2005** **2020**

Presence of gravel mining pits and reservoirs over time

2.3 Water Levels in Reservoirs Over Time

The increasing prevalence of reservoirs on the South Platte floodplain led to the question of variations in the presence of water in the reservoirs. Landsat remote sensing data enabled extraction of the mean MNDWI (Modified Normalized Difference Water Index) series. This index revealed the date when the water appeared and disappeared in the reservoir. A MNDWI equal to 0 represents the pure water surface. The analysis was performed at Laboratory EVS in Lyon for Landsat images from 1983 to January 2024.



A set of representative reservoirs and the water levels over time. The x-axis represents years from 1982 to 2023. The y-axis represents the mean of all pixels of the MNDWI index in a whole reservoir. The colors show the years with water in the particular reservoirs.

2.4 Changing Public Discourse

The research team also examined the extent to which the transformation of the urbanizing floodplain through the Denver area may be reflected in public discourse. For example, is the public aware of such changes? How has the media portrayed the South Platte River through the decades of urbanization?

We examined two key newspapers in the region from 1859-2023, available at the Denver Public Library: *Denver Post*, which provides digital access from 1989 to 2023 and *Rocky Mountain News* from 1859 to 1954 and 1989 to 2023. We extracted articles through searches with key words and date filters and compiled them into .txt files. Using Python, we applied text mining techniques including text analysis and visualization for content analysis.

Clustering the corpus produced several patterns over time. First, the themes of government (0.40%), community (0.34%), and development (0.31%) appeared most frequently across time periods. Second, the theme of environment (0.23%), though less dominant overall, appeared more frequently in recent decades. Third, more even coverage across the themes is evident in recent decades. These patterns suggest how the public discourse surrounding the river has changed over time. Continuing work aims to clarify the significance of these changes.