Use of Floodscape Mapping to Assess Changes in Inundation Frequency of the Upper Mississippi River

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Introduction

The Mississippi River and its floodplain are part of a dynamic natural system. This system creates changes in both topography of land masses and hydrology of water in the river system.

This research was aimed at mapping and explaining the changes in flooding of Blackhawk Island over about 70 years of natural change as well as human river management impact.

Research Objectives:

1. Create three floodscape maps; Pre-dam Floodscape (1908-1937), Post-dam Floodscape (1939-1968), and Modern Floodscape (1986-2015).

2. Conducting analysis between the floodscape maps to see how the floodscape of Blackhawk Island has changed.

3. Create a new way to conceptualize frequent flooding changes by floodscape mapping.

Methods

The methods for creating the floodscape maps follows those from De Jager (2015). Hydrologic and topographic data were obtained for Blackhawk Island, then cross analyzed to give average number of days of inundation.

This research broadened the concept by adding a historical component and creating floodscape maps for three distinct time periods and averaging days of inundation over a year for the periods. This project was carried out almost entirely within Geographic Information Systems (GIS) software ArcMap 10.4.1, ESRI 2017.

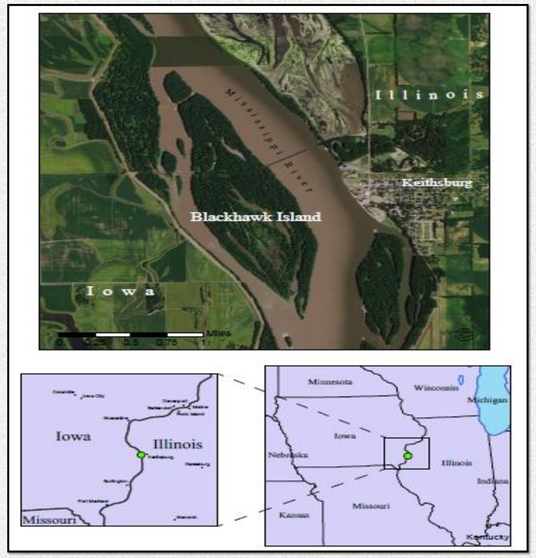

Figure 1. Study area map of Blackhawk Island with inset maps for context. Base map from ESRI base map within GIS- User CommunityGetmapping, Aerogrid, IGN, IGP, swisstopo, and the GISGeographics, CNES/Airbus DS, USDA, USGS, AEX,Source: Esri, DigitalGlobe, GeoEye, Earthstar

Study Area

The Study area of this project is Blackhawk Island, in pool 18 of the Mississippi River near Keithsburg, Illinois.

Hydrologic Results

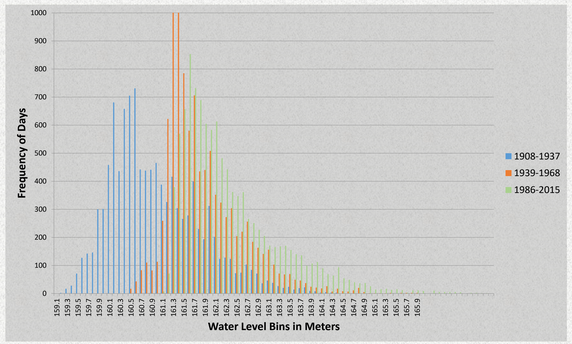

Figure 5. Histogram showing the frequency of days that reached corresponding water levels within the flood stage bins.

Results

The following map is representative floodscape maps to show the average number of days of inundation of Blackhawk Island over the 1986-2015 30 year period. There is a clear increase in the average number of days of inundation, with some areas of the island showing more drastic changes than others.

The bottom map is a map displaying the representative change in the number of days of inundation over the last ~70 years. Areas of the island have experienced different changes in the average number of days of inundation.

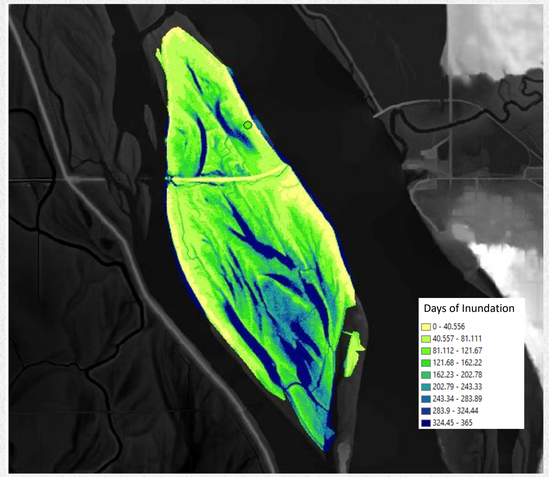

Figure 6. Representative Floodscape map for the modern (1986-2015) period. Labels represented in average days of inundation per year. View 1:24,000

Discussion

Results of this study point to a floodscape that is overwhelmingly wetter for Blackhawk Island. Even in areas where the topography of the island has increased and raised in height, the hydrology has become elevated to a point that it overwhelms any topographic aggradation. In general, the created floodscape maps and the corresponding analyses show an increase in the number of days of inundation.

Such implications could have significant impact on island ecology. Rapid changes in an island's floodscape may impact species colonization and survival rates. This study also offers an alternative way to map and understand frequent flooding within a floodplain environment.

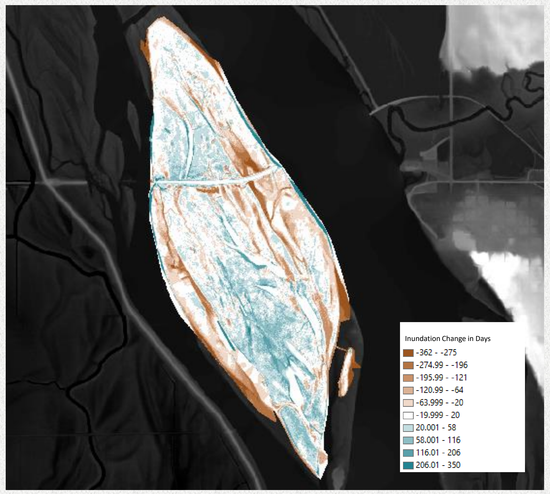

Figure 7. Representative degree of difference map showing amount of change in floodscape between the post-dam (1939-1968) and modern (1986-2015) floodscapes. Labels representing number of days of inundation changed per year with negative values representing dryer and positive values representing wetter.

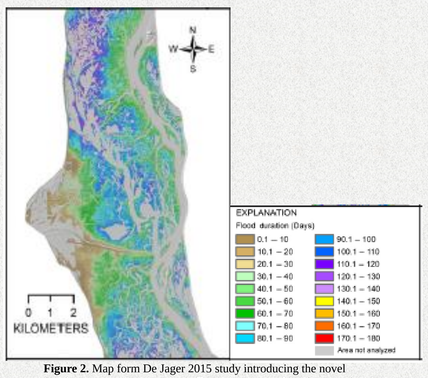

Figure 2. Map form De Jager 2015 study introducing the novel floodscape mapping technique. Colors representative of range of days of inundation. (De Jager 2015).

Topographic Data

Modern topographic Data was obtained through modern LiDAR 2011 data and historic topographic data was digitized through the 1938 Plane Table Maps (U.S. Army Corps).

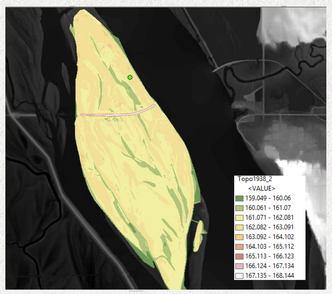

Figure 3. Topographic map representing Blackhawk Island in 1938 labels in meters above sea level [Topo1938_2]. View 1:20,000

Topographic Difference

The degree of difference (DoD) between the topography of historic and modern Blackhawk Island. Areas of land have either increased in elevation through aggradation or decreased due to erosion, between 1938 and 2011.

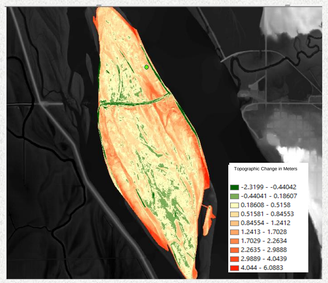

Figure 4. Difference in elevation of Blackhawk Island represented through a DoD map with labels in units of meters. Negative values representing areas of erosion with positive values representing areas of deposition.

Acknowledgements

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