Oxbow Lakes as Geological Archives of Historical Changes in Channel Substrate, Swan Creek Metropark, Toledo, Ohio

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Abstract

Urbanization significantly impacts hydrologic systems, including changes in flow magnitude and frequency, sediment input and channel stability, and channel morphology. At attempts are made to restore urban areas, a complicating factor is understanding human-caused changes in channel substrates. Therefore, it is necessary to understand the effects of urbanization on sedimentary archives. The study area is focused on approximately 1.5 km reach of Swan Creek (a tributary of the Maumee River) that contains 4 oxbow lakes of various ages and in different areas. The study area has changed over historical times from open forest to agricultural fields to suburban housing areas and light industry. Photographs from 1934 and 2011 and topographic maps from 1935, 1941, 1951, and 1994 were collected from the USGS. These were georeferenced using control points, original ArcGIS, and the 2011 error was calculated to be 0.3 meters using a comparison of each historical image to the 2011 image acquired from the USGS and used as a base map. The difference, which was limited to historical and photo interpretation, was identified as three channels, two pre-1930 oxbows, and one likely the youngest oxbow in the study area. The stratigraphic sections were input into ArcGIS, and the RMS error was calculated to be 5.7 meters when comparing each historical image to the 1994 image acquired from the USGS and used as a base map. The study area was divided into five different sections based on the presence of pre-1930, 1930, and 1940 cut-off oxbows.

Study Area

Swan Creek flows through the city of Toledo, before joining the Maumee River shortly before flowing into Lake Erie. This study focuses on a 2.2 km reach flowing through Swan Creek Metropark.

Oxbow Lake Stratigraphy

Channel at time of cut-off

Lacustrine/estuarine sequence with interbedded fossil deposits

Above: In contrast to the fining-upward sequence seen in point bars, cut-offs show an abrupt transition to fine-grained lake and wetland deposits interbedded with occasional coarse-grained flood deposits decoupled from the adjacent active channel.

Anthropogenic Activity & Landuse

Post-glacial moraine terraces and a lower ‘fill terrace’ probably related to anthropogenic changes in sediment budgets.

Within the past 150 years, the region has changed from forest to agricultural fields (pre-1930) to urbanized areas (historical image from Clark Waggoner). These land-use changes had major impacts on sediment and water budgets, potentially affecting channel migration and cut-offs.

Meandering River Behavior

Rivers meander due to bank erosion and resulting channel shifts. Lateral accretion deposits form at the bends, as shown below. The characteristic flaring-upward sequences can be used to identify these point bar deposits. In contrast, channel cutoffs, produce deposits which have a channel base, but are then filled in by lake deposits.

Sediment Budget

It is important to consider sediment budget when studying the impact of human activity on alluvial deposits. Changes in channel substrate often contribute to changes in sediment erosion and deposition. An additional factor is storage. Sediments need a basis to be stored in order to leave a deposit. As a result, changes in sediment input and output will cause changes in storage, leading to depositional events.

Results

- The impacts of urbanization can be recognized within the differences between the oxbow lakes. Pre-urbanization oxbow lakes appear to be characterized by fine-grained channel substrate, while post-urbanization oxbow lakes appear to have an armored pavement.
- There is an asymmetric distribution of oxbow lakes within the park. All oxbow lakes within the metropark are located along the North side. There are oxbow lakes along the South, but not within the reach that runs through the park.
- Much of the modern migration of Swan Creek includes lateral shifts.
- The ages of the oxbow lakes are older than initially suspected, which may correlate to major land use changes in its history.
- Major land use changes would have changed the sediment budget, potentially influencing the channel abandonment events.

Methods

This project involves three main research components: field work, analytical work, and laboratory work. The field work will consist of the data collection process, which includes trenching, push cores, and lab work. The laboratory work will mainly take place at Bowling Green State University, excluding carbon dating, which will be contracted out to a laboratory. Finally, analytical work includes work done using historical imagery and ArcGIS software.

Image on the right is a sample out for carbon dating. The data collected will aid in stratigraphic conclusions. Other carbon samples include large pieces of ballest wood.

Results

- Grainsize data for this project, as well as another project have yet to be measured. In addition, there is one more planned day to collect obect ratio data. It is expected that within the coming weeks, paleoecology data will arrive from the laboratory. Vibrance and trace data will be compiled into stratigraphic sections.