

# Automatic delineation of river banks using aerial photographs

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## Abstract

Aerial photographs are used by river scientists and engineers in studies related to river channel morphology, channel migration, habitat classification and flood inundation mapping. All these studies involve manual digitization of river banks using aerial photographs. Although human judgment is required in the overall process, manual digitization of river banks is a tedious task often prone to human errors. Using ArcObjects, a GIS tool is developed that uses aerial photographs in conjunction with stream lines from the National Hydrography Dataset to delineate river channel banks. The tool uses multivariate analysis to classify aerial photographs based on pixel statistics. The tool is applied to the lower Brazos River in Texas to delineate river banks for instream flow studies. Although developed primarily for delineating river banks, the tool can be easily modified to delineate other waterbodies in a watershed.

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## Introduction

Delineation of river boundary is one of the key inputs in hydraulic modeling, floodplain mapping, channel migration studies, habitat classification, hydraulic geometry relationships, etc (Mount et. al., 2003; Tate et. al., 2002; Merwade et. al., 2004). In most cases, the river banks are manually delineated using aerial photographs. The manual delineation of river banks is often tedious, subjective, and prone to human errors. In this paper an automatic geographic information systems (GIS) approach for delineating water bodies from aerial photographs is presented. The proposed approach is based on supervised classification, which is a process of extracting features from a photograph for representing different land cover types (Lillesand and Kiefer, 1994). The water body is extracted through a series of raster and vector operations in GIS using the following two inputs: aerial photographs; and a polyline feature from the National Hydrography Dataset (NHD).

## Study reach and data

The study reach is located along the Brazos River in Texas as shown in Figure 1. The input data used for the study include Digital Orthophoto Quadrangles (DOQQ) and NHDFlowline feature class from NHD. The DOQQs for Brazos River were downloaded from the Texas Natural Resources Information System website (<http://www.tnris.state.tx.us/>), and the 1:100000 NHD for the Brazos River reach were obtained from the NHD website.

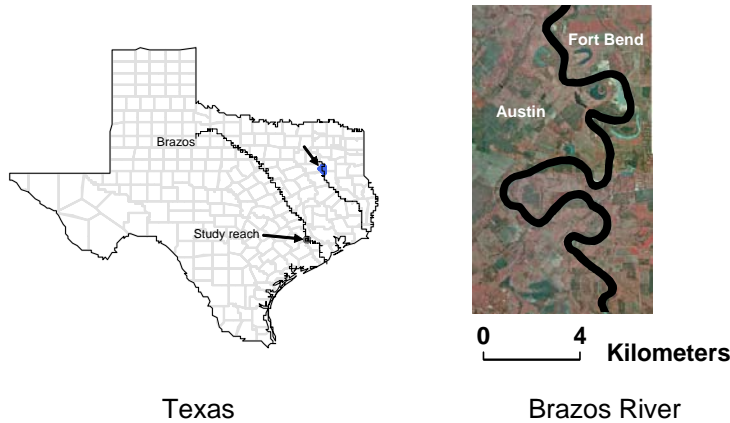


Figure 1. Study Reach along the Brazos River in Texas.

## Methodology

The methodology for delineation of river channels presented in this paper requires aerial photographs and NHD data as input. The input data are processed through a series of raster and vector operations in GIS to produce a polygon representing the boundary of the required river reach. The methodology is automated by creating a custom tool for ArcGIS using Visual Basic and ArcObjects. The custom tool is compiled as a dynamic link library (DLL) file, which can be used with the ArcGIS 9.0 environment. A flowchart of the operations involved is shown in Figure 2. Following steps are involved:

1. Using the NHD layer, create training areas for the river channel. This is done automatically by creating buffers around the NHDFlowline feature. The training area for river channel has a ClassID of zero, and the training area for other areas has a ClassID of one.
2. Perform supervised classification on the aerial photograph to classify the photograph into water and non-water areas.
3. The output from the supervised classification, which is a raster is converted to vector features (classified polygons). All polygons will have a ClassID attribute to distinguish between water (ClassID = 0) and non-water areas (ClassID = 1).
4. Classified polygons are processed to remove unwanted features to extract the boundary for the river channel. This is accomplished by an attribute query (remove polygons with ClassID = 1), and a spatial query (remove polygons that do not intersect with NHDFlowline).

Steps 2 and 3 are raster operations, while steps 1 and 4 are vector operations. Steps 1- 4 are repeated if the river reach covers more than one aerial photograph, and the resulting polygons are merged to get the final boundary.

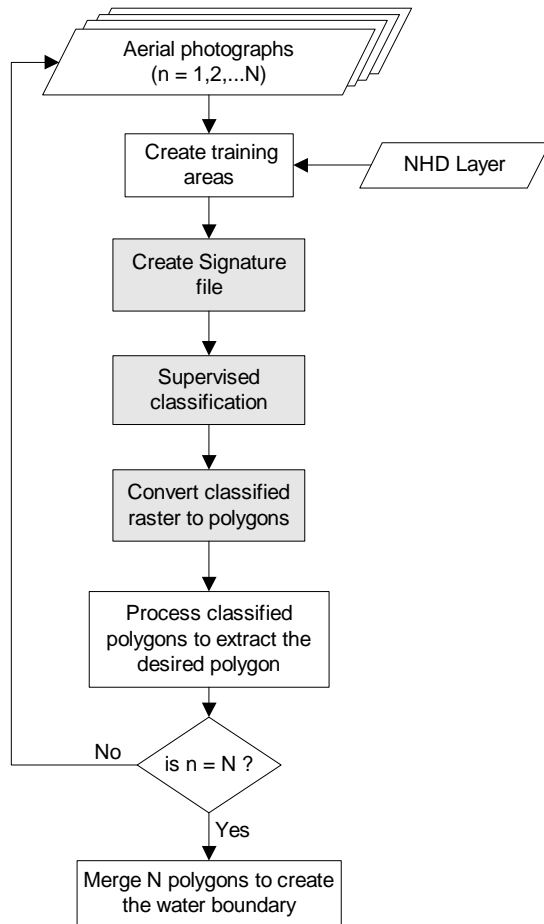


Figure 2. Methodology for automatic delineation of river banks using aerial photographs.

## Results

Figure 3 shows results of the automatic boundary delineation for the study reach along the Brazos River. Although the procedure classifies the water and non-water areas satisfactorily, the final result is affected by the presence of bridge and the shadow of trees along the river banks. For example, Figure 3c shows a gap in the final result due to presence of a bridge at that location. A bridge gets classified as a non-water feature creating this gap. Similarly, the shadow of trees along the channel bank gets classified as non-water area creating irregularities in the final result at few locations as shown in Figure 3d.

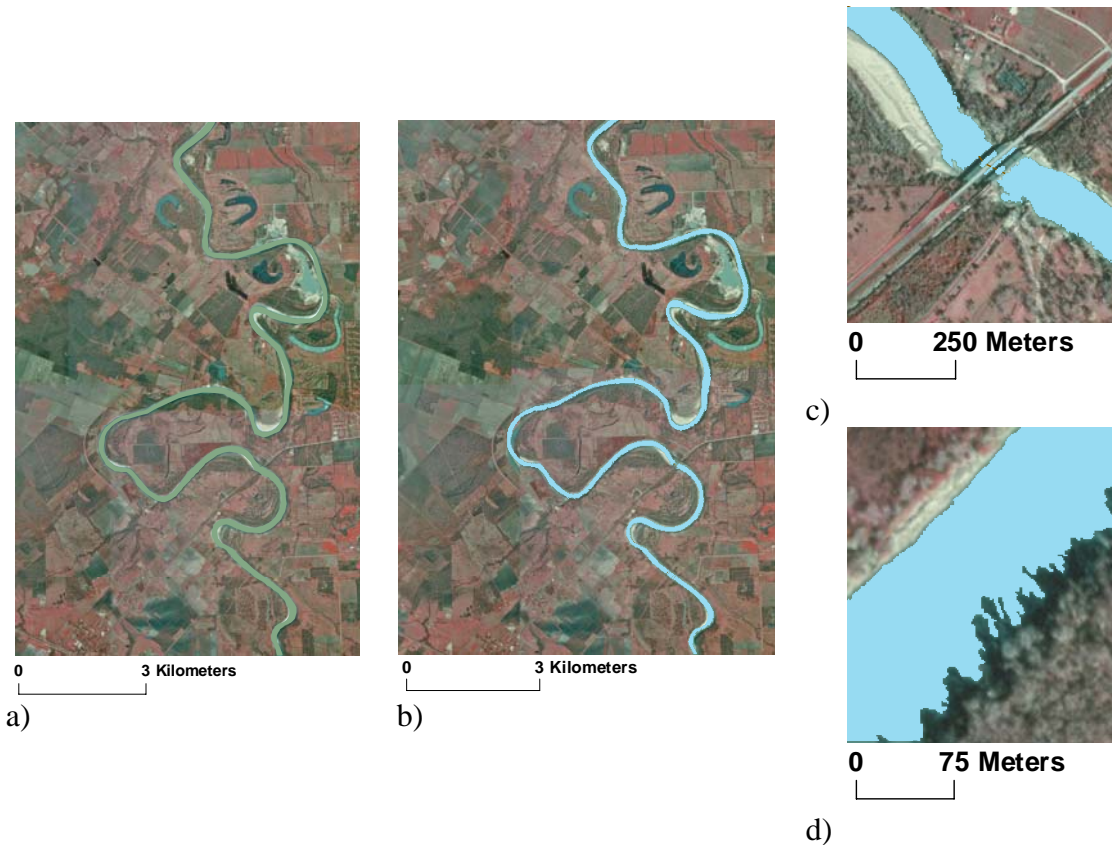


Figure 3. Automatic boundary delineation for Brazos River reach. (a) Aerial photographs showing the Brazos River reach; (b) Boundary delineated by the automatic procedure; (c) Existence of a bridge creates a gap in the final boundary; (d) Shadow of trees creates irregularities in the final boundary.

## Conclusions

In this paper, an automated GIS approach for delineating river channels from high resolution aerial photographs is presented. The approach is based on classification of aerial photographs into water and non-water classes. The training areas for water and non-water classes are defined by using the vector features (NHDFlowline) from the National Hydrography Dataset (NHD). Although NHD data are not available globally, the procedure presented in this paper can be easily adopted by using other vector data or by digitizing a polyline on aerial photographs. The output from this procedure is a polygon outlining the boundary of the required water body. The boundaries of river channels are useful in hydraulic modeling, floodplain delineation, water budgeting, habitat classification, etc.

Although the automatic delineation procedure saves manual labor, some of its shortcomings to deal with bridges and shadow of trees along the bank need to be addressed. Future work includes addressing these issues and implementation of the procedure to delineate lakes.

## **References**

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