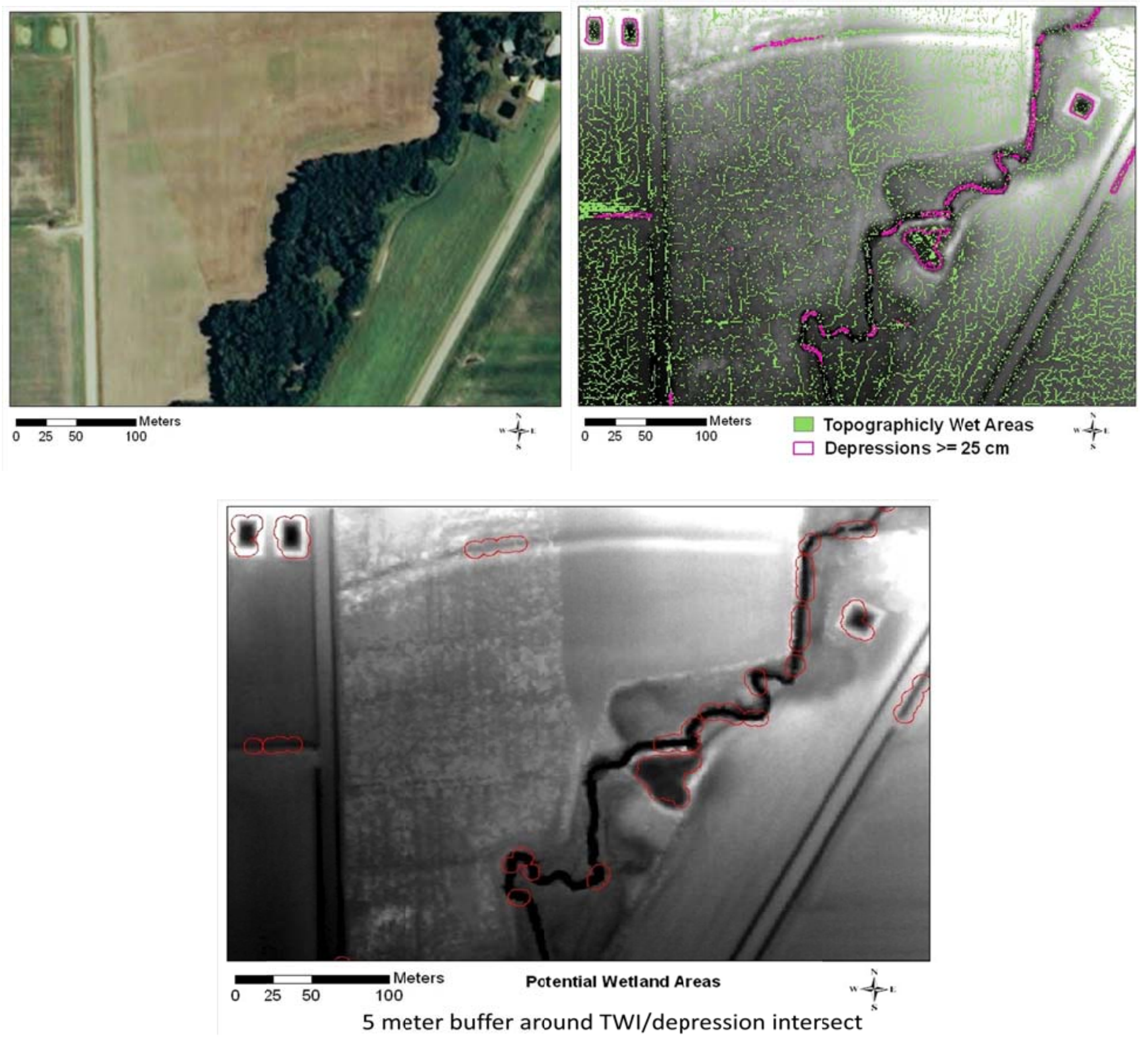
User guide for the
Topographic Wetland Identification Process (TWIP)

An ArcGIS toolbox for using LiDAR and GIS data to identify Potential Wetland Areas



The Topographic Wetland Identification Process (TWIP), a methodology to detect potential wetland areas, was developed as part of an EPA Region 7 Wetland Program Development Grant to the Kansas Water Office.

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Updated by Dana Peterson (2013)

Objective:
To develop a standardized methodology for identifying existing wetland locations or locations of potential wetlands that can be used for wetland restoration efforts by all agencies, watershed planning, and stakeholder groups in the state of Kansas.

User manual for TWIP 3.4,

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Introduction:

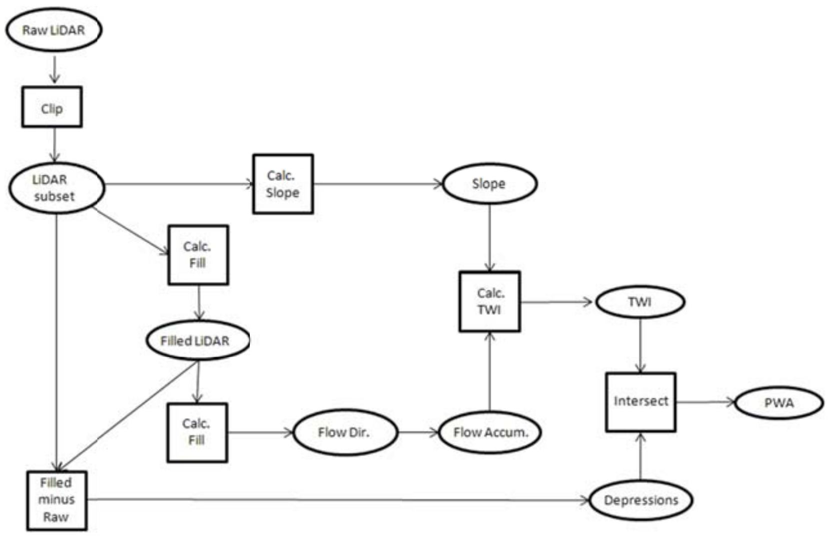
Instead of trying the traditional approach of using imagery to identify wetlands based on the vegetation or the presence of standing water, which can vary greatly depending on the wetland type and current conditions, a new approach was devised that focused on identifying the underlying causes of most wetlands. It was proposed that most wetlands occur in areas where overland water flow slows down and/or rainfall accumulates, and that wetlands are often associated with shallow depressions in the landscape that retain rainfall or surface runoff. As a result, this effort utilized LiDAR-derived datasets to identify areas of co-occurrences between depressions and locations identified using a formula that incorporates flow accumulation and slope to calculate a Topographic Wetness Index (TWI) (Sorensen, 2005, 2007). While most wetlands occur in these areas of intersect (hereafter referred to as Potential Wetland Areas (PWA's), not all identified PWA's are in fact wetlands (false positives). Since the goal of this methodology is to identify new wetland areas not previously mapped, it was decided that it was better to be more inclusive and include false predictions of wetlands, than to underestimate wetlands and miss including them in an inventory altogether.

The methods were created as an ArcGIS toolbox as a simple three step process. In the first step, the user provides an input LiDAR image and a polygon shapefile of the area to be assessed (HUC 12 units are recommended) and the tool outputs a polygon shapefile of PWA's. In the second step, the user inputs in the PWA polygon file and several additional data layers (roads, water bodies…) and the tool adds attributes to the PWA polygons to provide contextual information about the PWA. Users can know if the PWA is located along a stream drainage channel, around a water body, in a roadside ditch, or in an open landscape. Additionally, existing land cover is referenced to provide users information on the vegetation surrounding the PWA, so efforts can be focused on grassland, woodland, or cropland areas depending on the user objective. The third step of the TWIP includes options to match areas identified as "wet" from an ancillary dataset like satellite or NAIP aerial photography. Using this process, PWA areas that were "wet" in these reference images help provide confidence in their identification as a PWA and users can quickly focus on the higher probability Likely Wetland Areas (LWA). It should also be noted that this methodology is focused on empowering the user to make informed decisions and assists with identifying wetland locations and it does not providing an exact delineation of wetlands.

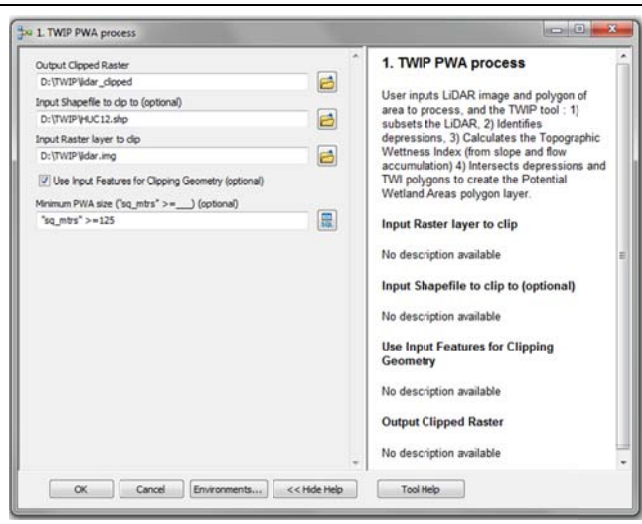
While this manual provides instruction on how to use the ArcGIS TWIP toolbox as well as some general information on the how and why behind the models, users interested in learning more about the process are encouraged to reference one of the more detailed documents describing this project which are contained in the Kansas Water Office Final Report (Field Collection of Wetland Data and Accuracy Assessment of Remote Sensing Data, or Developing a Methodology to Identify Existing & Potential Wetlands Areas in Kansas, for Protection, Enhancement, and Restoration).

1. LiDAR and identify Potential Wetland Areas

While condensed down to a single step in the toolbox, step 1 is a series of many processes and intermediate date steps. Users input a LiDAR image and a polygon shapefile of the area to be assessed. Check the option to "use input features for clipping" to clip the LiDAR to the exact polygon area (unchecked, the process will clip to the minimum bounding rectangle). Define output location and name for the subset LiDAR. A new empty folder is suggested as this will also be the location a number of intermediate files and the final PWA shapefile will be placed. As an additional option, users can define a minimum PWA polygon size threshold. By default this is set to only keep PWA's greater or equal to 125 square meters (or approximately 10 x 12 meters). The intermediate files are kept for user reference, but could be deleted upon completion of the process if desired.



General processes that occur durring step one of the TWIP model. Files created include: LiDAR subset.img, Slope.img Depressions.img, depressions.shp, flowdir.img, flowacc.img, TWI.shp, and PWA.shp. If it is both a depression and topographically wet, then it is a potential wetland area (PWA).

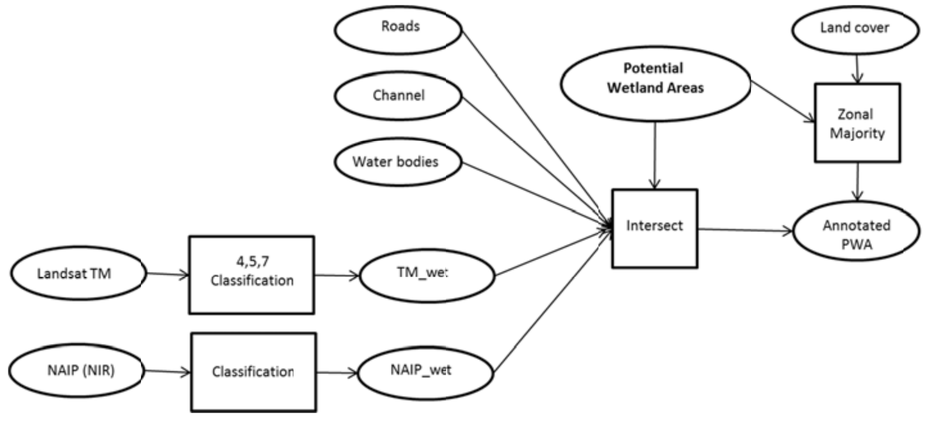


TWIP model dialogue box for step 1.

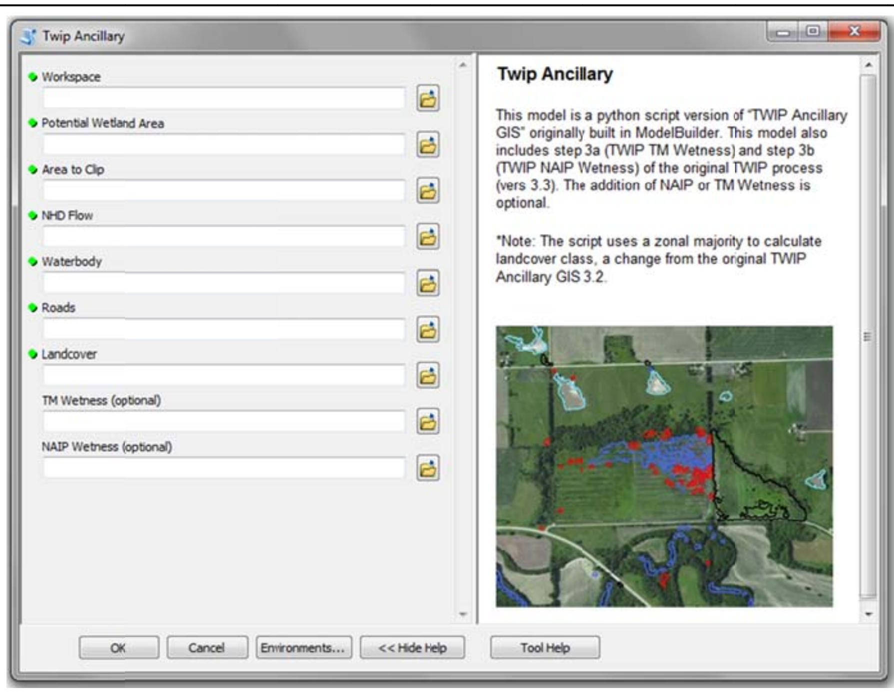
2. Adding landscape context to the Potential Wetland Areas

The addition of contextual landscape information to describe the location of identified PWAs can be very useful information. This landscape context can help users sort the PWAs by creating associations that help indicate the probability of the PWA being an actual wetland (roadside locations are often not actual wetlands due to drainage culverts), focus on specific wetland types (water body wetlands), or identify the dominant land cover type (woodland, grassland, cropland) for PWAs using a zonal majority function.

Like step 1, step 2 in the TWIP is actually many smaller steps combined.



General processes that occur durring step two of the TWIP model where ancillary GIS layers are intersected with PWA's to provide contextual information to assist with user interpretation. Landscape context provides clues toward wetland probability.



TWIP model dialogue box for step 2.

The ancillary GIS base data used in step 2 includes:

Water bodies – From the National Hydrography Dataset (NHD). The “water” attribute is added to the PWA.shp and any PWA polygons that intersect the water body areas are labeled “yes” for being in a lake or pond area and therefore likely exhibit some wetland characteristics. Users should be aware that while the NHD identifies most water bodies, many of the smallest or newer water bodies are not represented.

Roads – All Kansas roads (local and highways) from KDOT 2010. The input roads are buffered by 10.0 meters. The “road” attribute is added to the PWA.shp and any PWA polygons that intersect the buffered roadside areas are labeled “yes” for being in a roadside area and therefore potentially in a ditch or other impoundment created by the road. Users should be aware that these roadside areas are often not really wetlands as there are often culverts under the roads that allow the water to drain.

Land cover – Level 4 landcover patterns of Kansas. Created from Landsat imagery by the KARS program. KARS 2005. The “LC” attribute is added to the PWA.shp and the land cover map is subset to the project area and converted to a shapefile. PWA polygons are then intersected with the LC raster, and the dominant LC attribute is populated with the land cover “gridcode” that is calculated using the zonal majority function. Users should be aware that the Kansas land cover map has a minimum mapping unit and minimum scale of detection and therefore it is likely that there will be some generalization.

Area to subset – HUC 12 polygon layer for Kansas

NHD_flow – The stream segments in the National Hydrography Dataset. The tool buffers channels by 1.0 meters. The “channel” attribute is added to the PWA.shp and any PWA polygons that intersect the buffered stream channels are labeled “yes” for being in/along a stream channel.

PWA.shp - The Potential Wetland Area file created instep 1. Additional attributes will be added to this layer indicating the presence/absence of the ancillary GIS layers.

Optional--Using Classified imagery to identify “Likely” wetland areas

To identify wet areas, the user needs to obtains or create a classification of a satellite and/or NAIP aerial image focused on identifying areas with standing water or saturated soils. The “wet” class should be extracted and converted to a polygon shapefile representing just those areas believed to be wet. The “wet” polygons with the PWA polygons and those that are identified as intersecting are labeled as “Likely” wetland areas, while those that do not intersect a “wet” area remain “potential” wetland areas. Due to the intermittent presence of water in many wetlands, the likelihood of acquiring imagery when water is present, and image classification challenges such as riparian wetlands being obscured by tree canopies or inaccuracies in the water classification, it should be remembered that PWA’s are also reasonable candidates for actual wetland locations.

TM wet.shp – Optional. Recommend classifying a Landsat scene from the spring (March-May) using bands 4,5,7 to identify water and wet areas. Once water areas are classified, the pixels of this “wet” class should be recoded to a single class and subset out to create a new rater layer “TM_wet” which then needs to be converted to polygons. PWA's intersecting the "TM_wet" polygons are then labeled as "Likely" in the newly created probability attribute. Users should be aware that even with the best choice of Landsat imagery and classification results, because of the 30 meter pixel size, many smaller wetlands and waterbodies will remain undetected even though they are indeed wet.

NAIP wet.shp – Optional. Recommend classifying a NAIP image that has a near infra-red band included to increase water identification. For Kansas, NAIP imagery from 2008 has the NIR band and is available tiled by county from the Kansas Data Access and Support Center (DASC). Once water areas are classified, the pixels of this "wet" class should be recoded to a single class and subset out to create a new rater layer "NAIP_wet" which then needs to be converted to polygons. PWA's intersecting the "NAIP_wet" polygons are then labeled as "Likely" in the newly created probability attribute. Users should be aware that even though the aerial imagery has a higher spatial resolution than the Landsat option, this data may still not identify all wet areas due to several factors including the timing of the imagery (could be dry or hidden under tree canopy). Despite these possible limitations, some comparisons indicate that the NAIP imagery identified many more of the smaller water bodies and wetlands than the Landsat TM imagery, but also missed some actual wetland depressions that happened to be dry due to the later acquisition time of NAIP imagery (typically early summer).

A Potential Wetland Areas Database web mapping service is under construction and was developed using funding from the Kansas GIS Policy Board. The web mapping service will allow display of the data processed using the TWIP tool and serve as a data portal for interested parties to retrieve the TWIP toolbox or any of the archived PWA shapefiles already created. Additionally, to help standardize the results of the TWIP process when run by different users, steps have been taken to make the ancillary GIS input data readily available for people using the TWIP in Kansas. A zip file containing the HUC 12 boundaries, roads, NHD water bodies, and land cover are available by contacting the TWIP authors, and will also be available on the forthcoming TWIP website. The web mapping service is available at: http://kars.ku.edu/maps/pwa/ and data will be made available in January, 2014. Data will also be made available through the Data and Access Support Center: http://www.kansasgis.org/.

The TWIP methodology and toolbox are subject to updates, it is recommended that users check for updates before beginning a new project if your current version was not obtained recently. To help the TWIP remain a useful tool, please notify the authors if you find problems with the process or have suggestions for improvements.

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