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Rainwater Basin Wetland Inundation Decision Support System Guide

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By the Rainwater Basin Joint Venture, Grand Island, NE

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The Rainwater Basin Joint Venture is a collaborative conservation partnership in Nebraska involving state and federal conservation agencies, non-profit organizations, corporations and individuals that work towards conserving habitat for priority bird species and other wildlife.

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System Requirements:

ArcGIS versions 10.0 or 10.1, ESRI, Redlands, CA, U.S.A.

Recommended Projections:

North American Datum 1983 (NAD 1983) Universal Transverse Mercator (UTM) Zone 14

Recommended Citations:

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Uden, D.R. 2012. Agricultural landuse change impacts on bioenergy production, avifauna, and water use in Nebraska's Rainwater Basin. M.S. Thesis. University of Nebraska-Lincoln, Lincoln, NE, U.S.A. 250 pp.

INTRODUCTION

The Rainwater Basin region of south-central Nebraska, U.S.A., is a critical stopover location for migratory waterfowl, waterbirds and shorebirds traveling along the Central Flyway. The ephemeral playa wetlands in the region serve as spring staging areas, providing critical habitat for migrating birds to rest, feed and establish pairs before resuming their northward migration to the breeding grounds. Collectively, the playa wetlands found in the region form the Rainwater Basin Wetland Complex, encompassing a 6,150 square-mile area of rolling loess plains that extend over 21 counties. Analyses of the State's historic soil surveys (1910-1917), National Wetland Inventory (NWI; 1980-1982; U.S. Geological Survey 1999) and the Soil Survey Geographic Database (SSURGO; 1961-2004) indicated that approximately 11,000 individual playa wetlands once existed in the landscape. Since European settlement, however, approximately 90% of wetlands in the region have been destroyed due to land-use intensification. Furthermore, many of the remaining wetlands are severely degraded and may lack functionality altogether. Despite these losses, remnant and restored playas continue to serve as important spring migratory stopover locations for a variety of avian species.

The majority of Rainwater Basin wetlands are ephemeral in nature and the occurrence and degree of springtime playa inundation varies between locations and years. Inundation is believed to be driven by individual wetland characteristics, surrounding land-use and local weather events, but the exact relationships between these constrains and wetland ponding has largely been speculative. Recently, research in the Rainwater Basin Wetland Complex has shed some light on these interactions (*see* Uden 2012), producing a set of statistical models capable of predicting wetland ponding during peak spring migration (Uden et al. *In Prep.*). In an effort to assess how much stopover habitat may be available to spring migratory birds, the Rainwater Basin Joint Venture (RWB JV) developed the Rainwater Basin Wetland Inundation Decision Support System that can be used by wildlife managers to predict the likelihood of springtime ponding for each wetland within the basins based on user-defined weather scenarios.

SYSTEM DEVELOPMENT

The Rainwater Basin Wetland Inundation Decision Support System (*hereafter* Wetland Inundation DSS) combines research findings and statistical models from Uden (2012) with spatially-explicit variables to create an output raster layer capable of predicting the likelihood of inundation for each wetland in the basins. A combination of wetland-specific, land-use and weather-related variables were included in the Wetland Inundation DSS (Table 1). We developed a custom script to calculate model predictions based on a set of user-defined values for weather variables using Python version 2.7 (Van Rossum and Drake 2001). We integrated the Python script into a custom ArcGIS Toolbox, which is capable of running in ArcGIS versions 10.0 and 10.1 (ESRI 2011; ESRI ArcGIS 10.0 & 10.1, Redlands, CA).

Table 1. Wetland-specific, land-use and weather related variables used in predicting wetland ponding in the Rainwater Basin Wetland Complex and their relationships with wetland inundation. The table is modified from its original form in Uden et al. (*In Prep.*).

Grouping	Parameter	Relationship to Wetland Inundation	Significant Relationship (*)
Intercept	Intercept	+	*
Wetland Type	Semi-perm ^a	+	*
	Temp ^b	-	*
Irrigation Type	Center-Pivot ^c	-	*
	Gravit ^d	-	
	Dryland ^e	-	*
Wetland Specific	Dist. to Reuse Pit ^f	-	*
	Wetland Shape ^g	-	*
Weather	MajSpringPrecip ^h	-	
	TotSumPrecip ⁱ	+	*
	TotFallPrecip ^j	+	*
	MeanFallTmax ^k	-	*
	MeanWintVpd ^l	-	
	YrFreezTmin ^m	-	

^{a-m} Semi-perm = Semi-permanent wetland; Temp = Temporary wetland; Center-pivot = Center-pivot irrigated field; Gravity = Gravity irrigated field; Dryland = Dryland field; Pit distance = Euclidian distance to nearest irrigation reuse pit; Shape complexity = Hydric footprint perimeter to area ratio; MajSpringPrecip = Number of spring days with > 50.8 mm of precipitation; MeanFallVpd = Mean autumn vapor pressure deficit; TotWintPrecip = Total winter precipitation; WintFreez = Number of winter days with maximum temperature < 0°C; YrThawTmin = First winter/spring date with minimum temperature > 0°C.

SETUP AND USE

Loading the Custom ArcGIS Toolbox into a Map Document

The Wetland Inundation DSS zipped files can be downloaded and unzipped to any preferred system folder (*i.e.*, C:\Users\<username>\Documents\GIS). Extract the compressed files by right-clicking on the folder icon “Wetland_Ponding_DSS_ArcGIS_v10” and select “Extract All...” Browse to the preferred file destination and select the location, select “OK” and click “Extract.” In order to load the Custom ArcGIS Toolbox into ArcMap, open a new or an existing map document (.mxd file) in ArcMap versions 10.0 or 10.1. Open the *toolbox window* if it is not currently open and right-click on the ArcToolbox icon, select “Add Toolbox” (Fig. 1). Navigate to the extracted “Wetland_Ponding_DSS_ArcGIS_v10” folder and open it, select the Wetland Inundation DSS.tbx and click “Open” (Fig. 2).

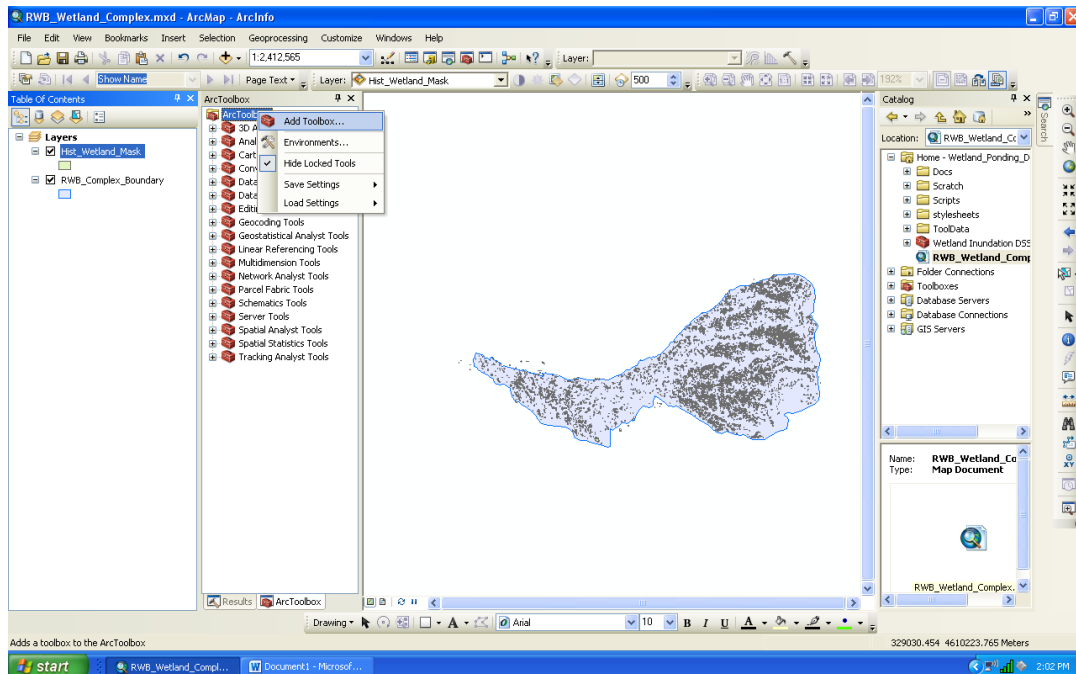


Fig. 1. Load the Wetland Inundation DSS toolbox by right-clicking on ArcToolbox and select “Add Toolbox.”

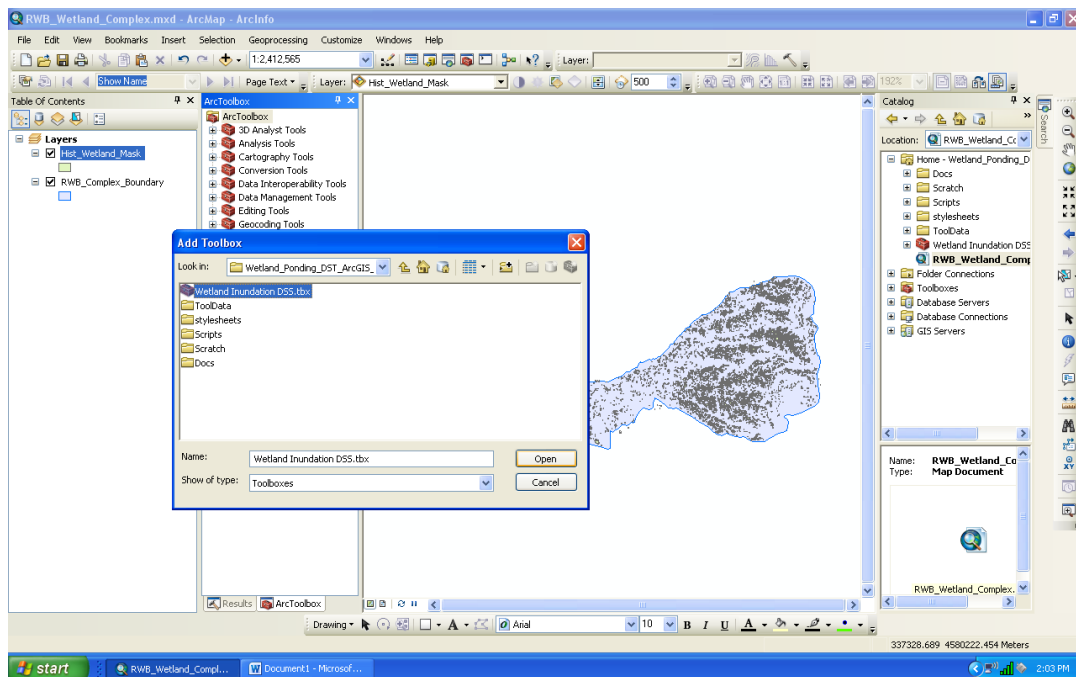


Fig. 2. Navigate to the Wetland Inundation DSS.tbx and select “Open.”

Running the Wetland Inundation DSS

In order to run the Wetland Inundation DSS, the *Spatial Analyst Extension* must be available and selected by the user. Click the “Customize” tab at the top of the ArcMap window and navigate to Extensions. Select the box labeled “Spatial Analyst” and then exit the

“Extensions” window (Fig. 3). For more information on using the *Spatial Analyst Extension* go to the ArcGIS Resource Center ([ArcGIS Resource Center: Spatial Analyst Extension](#)). Double-click the Wetland Inundation DSS toolbox icon in the *ArcToolbox Window*. To open the user interface, double-click the RWBJV Wetland Inundation Decision Support System script inside the Wetland Inundation DSS toolbox (Fig. 4).

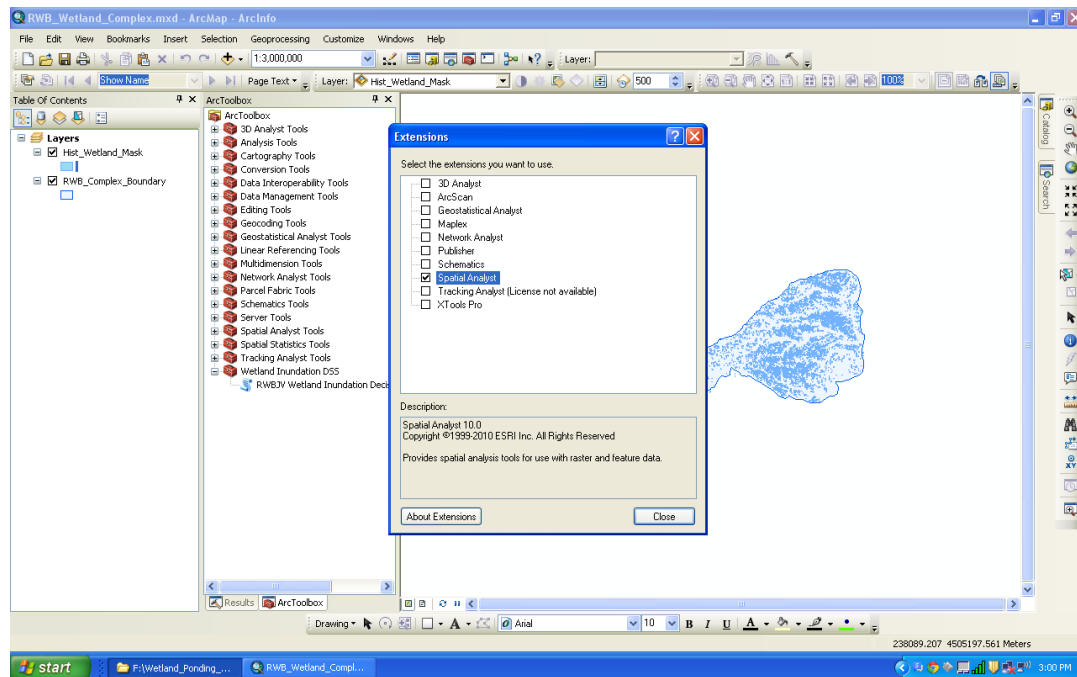


Fig. 3. Select the “Spatial Analyst” box in the Extensions window.

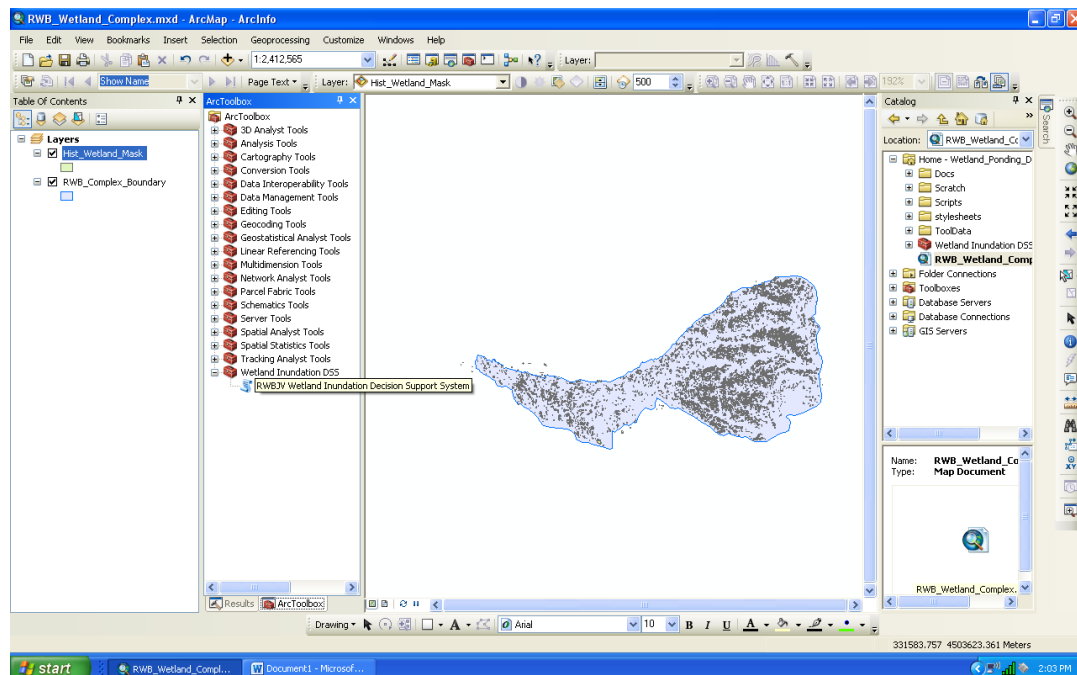


Fig. 4. Double-click the RWBJV Wetland Inundation Decision Support System script inside the Wetland Inundation DSS Toolbox.

The Wetland Inundation DSS user interface requires the user to specify eight arguments to successfully run a wetland inundation scenario for the Rainwater Basin. Details regarding the tool's purpose and functionality can be displayed in the user interface by clicking on the "Show Help>>" button in the lower right corner of the toolbox window (Fig. 5). The first six inputs are weather-related and can be entered as "min", "max", or "avg." These arguments are related to the minimum, maximum, or average values for the corresponding weather variable observed between 2004 and 2009. Alternatively, the user can specify a numeric value that falls within the ranges of weather values observed from 2004 to 2009. If specified, the numeric value is added to an intermediate averaged deviation raster layer, which is created by taking the averaged values (2004 to 2009) from the associated weather data (*i.e.*, the "avg" layer) and subtracting them from the mean averaged value. All intermediate raster layers are only temporary and will not be provided as an output. Since weather variables are not uniformed throughout the basins, the averaged deviation raster layers are used to create a continuous gradient of values across the basins based on the value specified by the user. To see the range of allotted values for each numeric input, select the box corresponding to the weather variable of interest and open the help by clicking the "Show Help>>" button in the lower right corner of the toolbox window (Fig. 6). The final two required inputs are the "specified output folder" and "output file name." All output file names must not exceed 13 characters in length. The file extension (*i.e.*, .grid, .tif, etc.) should not be included with the output file name.

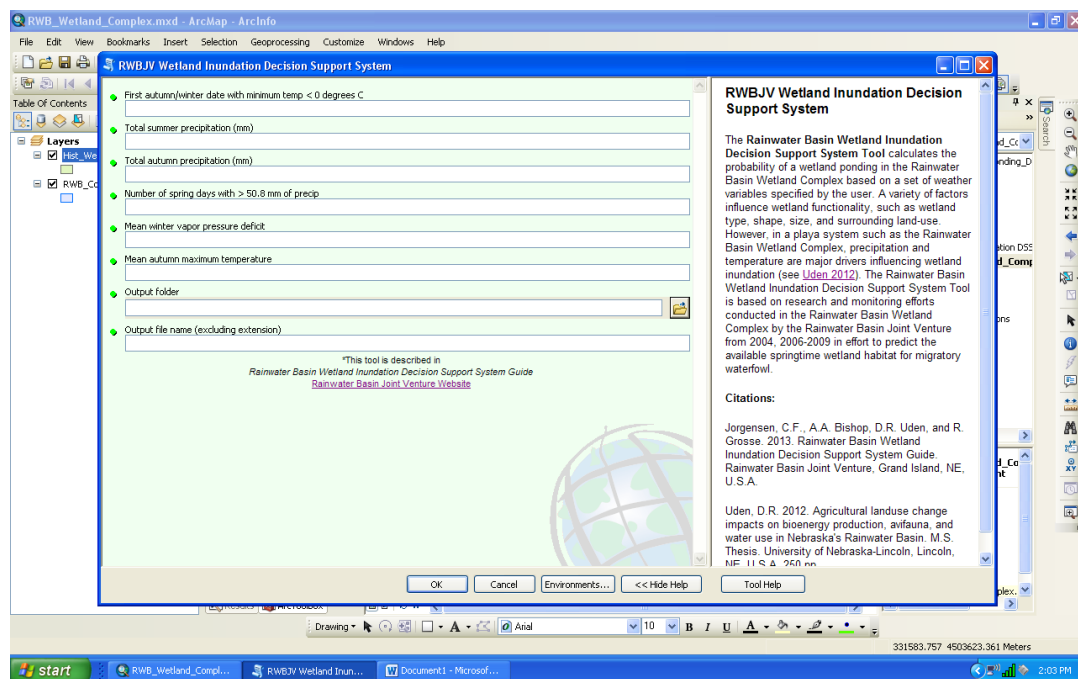


Fig. 5. An example of the RWBJV Wetland Inundation DSS user interface and the help document displayed when the "Show Help>>" button in the lower right corner of the window is selected.

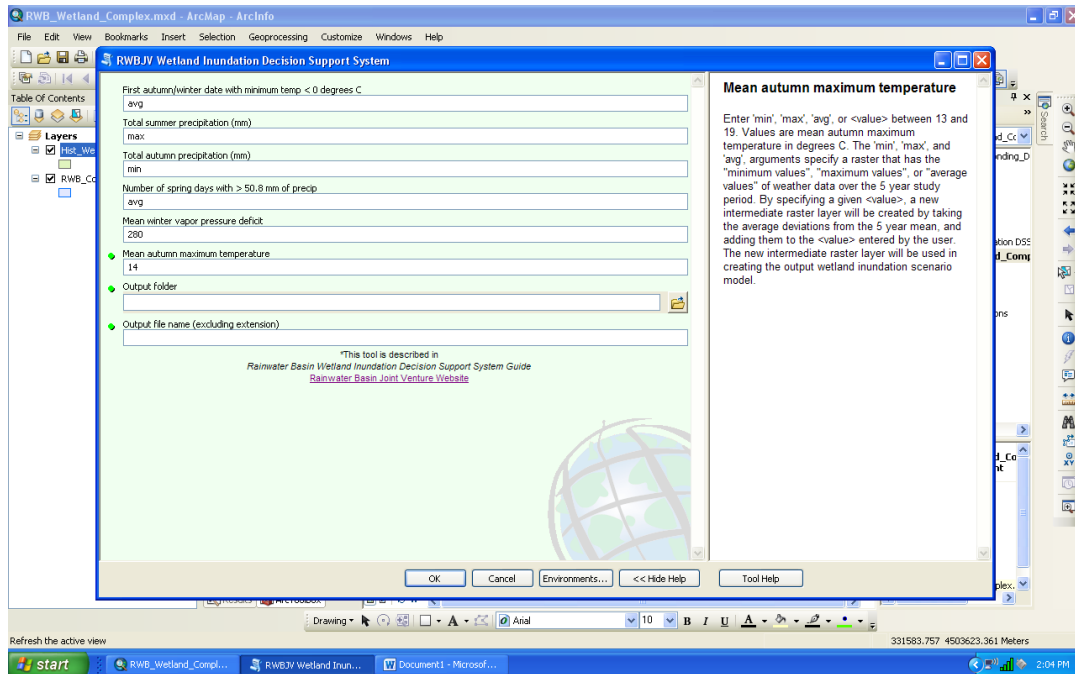


Fig. 6. An example of the Help description for the Mean autumn maximum temperature argument. The Help for each variable is displayed when the input box corresponding to the name of the input is selected (in this case, the Mean autumn temperature box is selected and the “Show Help>>” button was clicked on).

Once all input values are specified, click “OK” to run the weather scenario. It will take one to five minutes to calculate the output raster depending on the processing speed of the machine. If any errors occur while running the wetland inundation scenario, messages will be displayed in the *message window* and the tool will fail to complete the output raster. Make note of the error and make corrections in the toolbox user interface. If no errors occur, the final wetland inundation scenario raster output will automatically be loaded to the current ArcMap document (.mxd document) and saved to the output folder specified by the user (Fig. 7). Output values will range from 0.00 to 1.00 representing the predicted probability of a wetland ponding based on the specified weather scenarios. The output layer’s symbology (e.g., color ranges) can be specified to the user’s preference by right-clicking on the layer, select “properties” and navigate to the “symbology” tab.

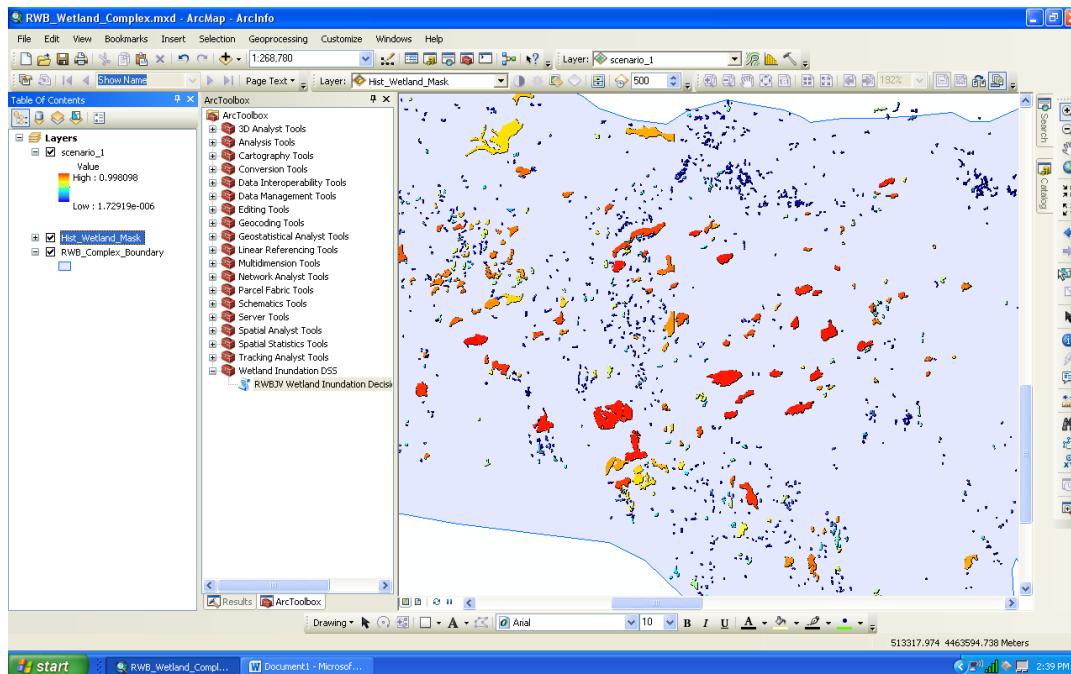


Fig. 7. An example of the output raster layer labeled “scenario_1” which was calculated using weather scenarios specified in the Wetland Inundation DSS toolbox user interface. In this example, wetlands indicated in red have a high probability of inundating, whereas wetlands indicated in blue have a very low probability of having any water present during spring waterfowl migration.

DECISIONS SUPPORT SYSTEM USES

The Wetland Inundation DSS provides wildlife biologists, habitat managers, and policy makers a means to identify which wetlands in the Rainwater Basin Wetland Complex have the highest potential to pond during spring bird migration based on various spring, summer, and fall weather conditions. In addition, the decision support system can provide some indication of how sensitive wetlands in the basins are to particular weather events, such as the mean winter vapor pressure deficit. Although managers cannot control weather events, by predicting which wetlands may pond and how many through the use of scenarios, biologist and habitat managers can potentially use the outputs to help form decisions on where to conduct fall and spring pumping. Given the abundance of water resources in the area (e.g., the Ogallala Aquifer), spring and fall pumping may be a viable option for managers to fill certain wetlands, particularly when the basins experience dry falls and warm winters. Even when pumping ground water into wetlands is not an option, the Wetland Inundation DSS can be used to predict the number of wetlands in the basins containing functional stop-over habitat during spring migration. Nevertheless, all of the potential uses of the Wetland Inundation DSS can assist scientists in making more informative management decisions in the Rainwater Basin Wetland Complex.

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