

Spatial Model to Prioritize Wetland Forest Restoration on Private Lands in the Mississippi Alluvial Valley to Enhance Water Quality

Purpose:

The model provides conservation planners, working on a state or regional level, a tool to identify large areas on the landscape where restoration of wetland forests will result in water quality benefits. Land-use/land cover, hydrology, soils, and geology data are combined to derive a ranked index for establishing a viable wetland forest capable of performing water quality functions, such as trapping sediment and filtering nutrients in surface runoff, on lands within the Mississippi Alluvial Valley.

Information generated from this model is designed to be used alone or in combination with other decision-support models/information systems that target reforestation benefits such as habit restoration and carbon sequestration.

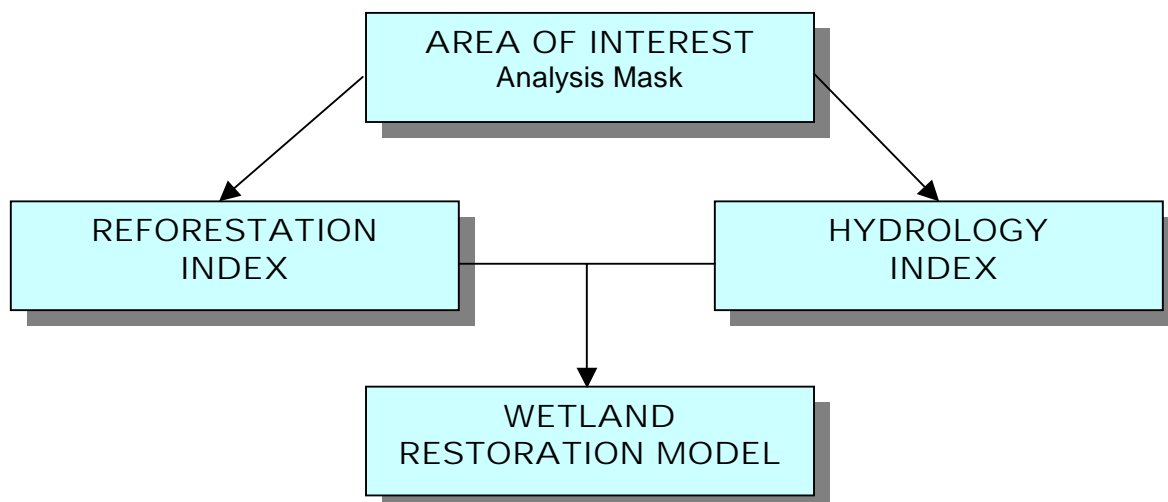
Construction of the Model:

The model is built and run in ESRI ARCINFO Grid and ESRI ArcView Grid Analyst software. All data were converted to a raster format with a 30 meter sized grid cell. The grid cell size was selected because several of the raster data-sets used in the model were already in that scale.

All data layers were projected to a Universal Transverse Mercator Projection (Zone 15, NAD 1927). Each of the six Lower Mississippi River states was modeled separately to accommodate slight differences in the available data sets between states, computational limits, and to facilitate model updating in response to the availability of improved or new data.

The model is comprised of three main components: 1. Area of Interest; 2. Reforestation Index; and, 3. Hydrology Index. The Area of Interest component was constructed first and is a binary mask that is applied in the construction of the other two components.

Model Schematic



Limitations:

The model combines data that vary widely in scale, resolution, precision, and accuracy. While each set of data carries with it a level of error and uncertainty, the limitations of this model arise primarily from the structure, accuracy, and precision of the STATSGO soils database which contributes 40% of the total model weight. Minimum mapping unit size for the STATSGO data which is derived from a generalization of soil series data is 625 hectares. Soil characteristics are expressed as a weighted average of constituent soils that manifest that characteristic. The precision of the flooding characteristics is particularly coarse. For instance, the STATSGO flooding frequency attribute is comprised of 4 classes: 1. Frequent (50 % or more chance of flooding per year); 2. Occasional (5 to 50% chance of flooding per year); 3. Rare (less than 5% chance of flooding per year; and, 4. None. No formal evaluation of the accuracy of the model has been made. Visual examination of the raster overlaid on digital orthophotos seems to indicate that the model behaves well in areas ranked high. Uncertainty increases in those areas that are ranked low or moderate.

Use and Interpretation:

The end product of the model is a raster where each 30 meter grid cell has a value of 7 to 75. The values have no units and should be interpreted as an indicator of relative probability that a given grid cell will deliver water quality benefits if reforested. Inferences on the magnitude or nature of water quality benefits cannot be drawn from this index.

For a number of reasons, low values do not necessarily indicate that an area will not deliver water quality benefits. First, virtually any reforestation of agricultural lands will result in water quality benefits. Second, an area with a low or moderate ranking may in fact contain significant amounts of land that would be an ideal candidate for wetland restoration but does not manifest itself in the data due to the scale of some of the data sets. For example, an area where only 20 % of the constituent soils are frequently flooded might get a low ranking because the location of those soils cannot be identified. Finally, many areas that have a low ranking may be capable of sustaining a functional wetland with modifications to local hydrology such as filling drainage ditches, land leveling, or removing agricultural levees.

Planners may also find the interim components of this model, the *Reforestation Index* and the *Hydrology Index* useful. The Reforestation Index ranks areas as to their suitability for wetland forest establishment without regard to water quality benefit. The Hydrology Index can be applied to any type of re-vegetation.

Though this model is intended to assist planners at the landscape level, it can in many cases prove useful for planning to the county level, especially in those areas that are ranked highly or where the STATSGO soils database has a relatively low degree of uncertainty.

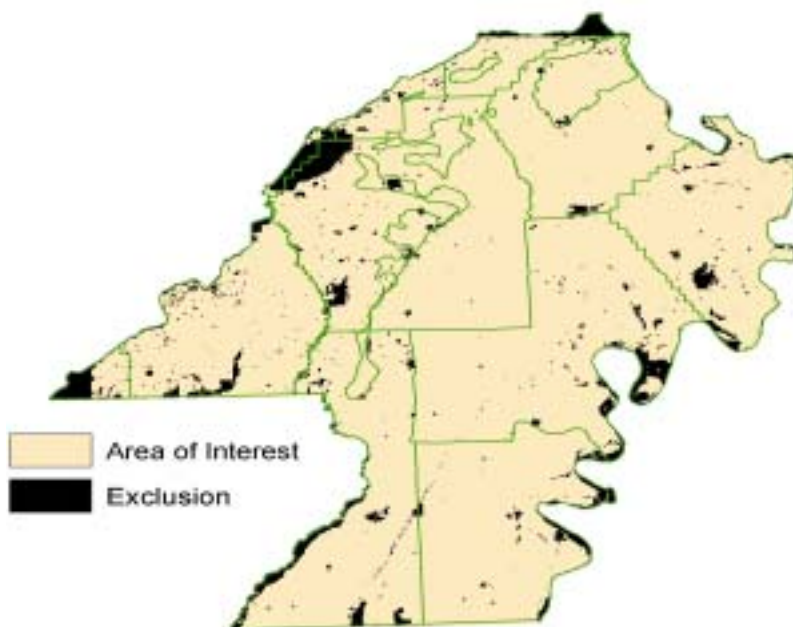
The following pages which provide a discussion of each component are accompanied by graphics illustrating components and constituent layers superimposed over aerial photos of an area west of New Madrid, Missouri.

I. AREA OF INTEREST

This component defines the area of interest created by removing areas and features not suitable for wetland restoration on private lands. The *Area of Interest* layer serves as a mask for subsequent spatial analyses.

Data used to define the Area of Interest Layer

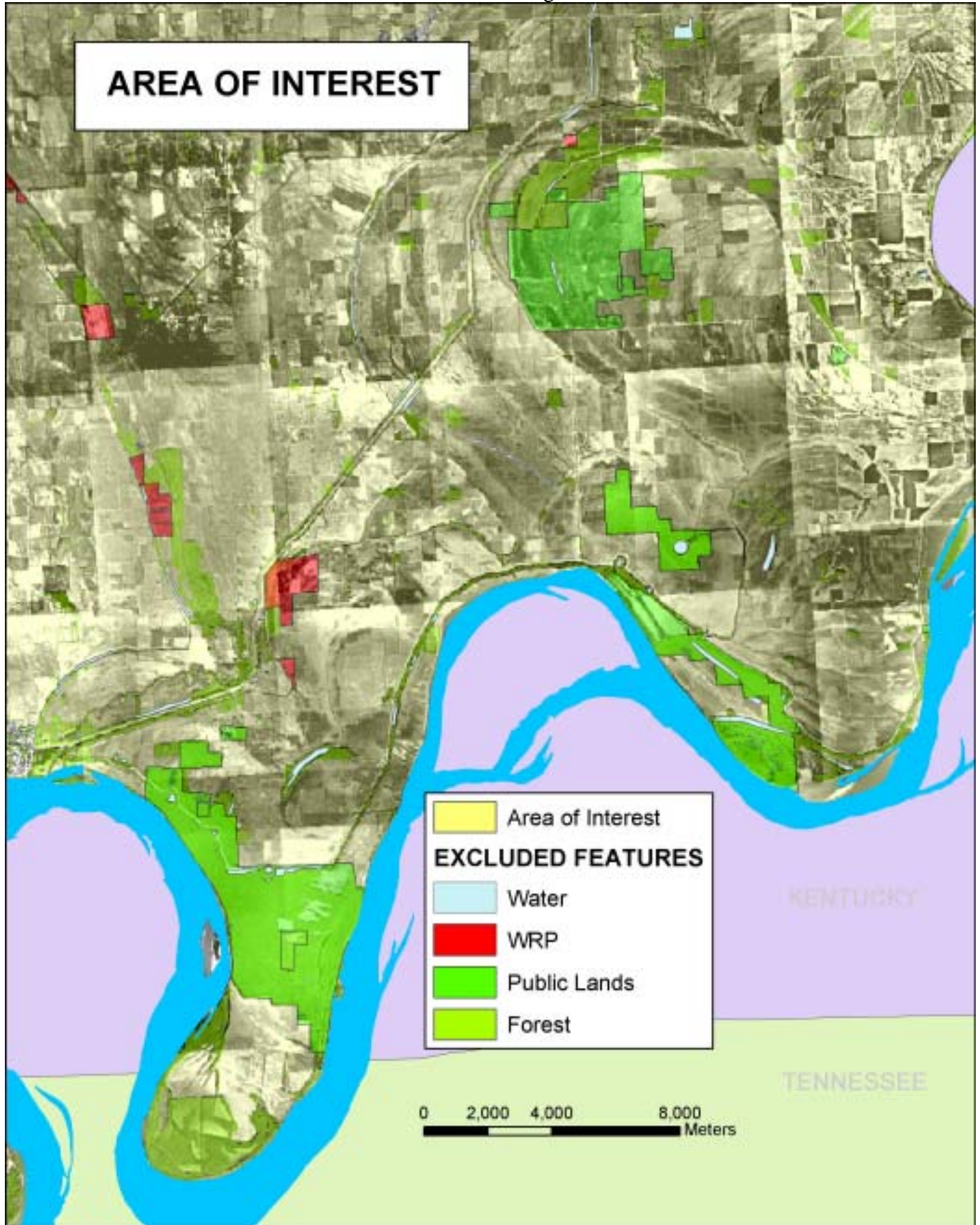
Feature	Components	Source Data Description
Forest Cover	Single Coverage	Interpreted from 1999 TM Satellite Imagery, Ducks Unlimited, Inc.
Urban Land-use	Single Coverage	USGS NLCD 1992 TM Imagery
Water	Lakes, river polygons, catfish ponds	USGS 100,000 DLG, DU, TIGER
Public Lands	WMAs, NWRs, National Forests, State Parks	LMVJV, State agencies
Conservation Easements	WRP, CRP, EWP,	LMVJV, Ducks Unlimited, Inc., National Resource Conservation Service



Area of Interest: Missouri

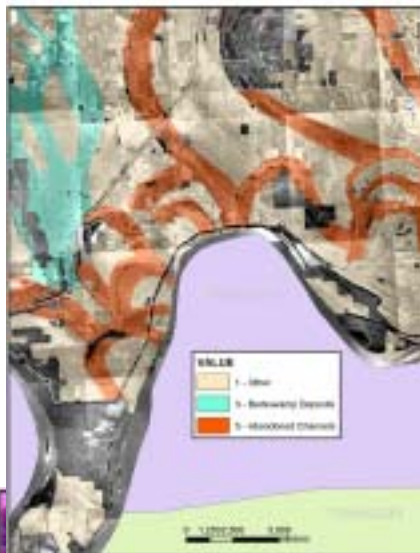
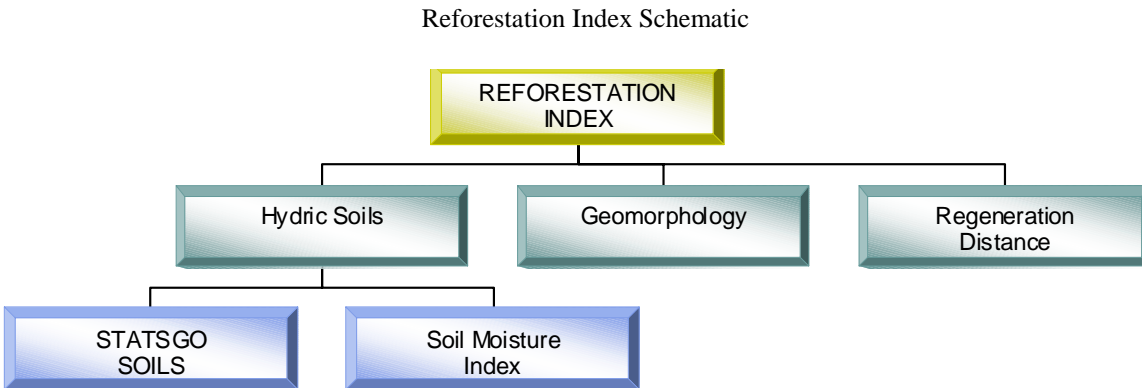
A single binary raster is created where *Area of Interest* has a value of 1 and areas not suitable for reforestation or outside the Missouri portion of the Mississippi Alluvial Valley have a no-data value.

Area of Interest: Large Scale



II. REFORESTATION INDEX

The reforestation index is a combination of biological and physical landscape characteristics that predict an area's ability to sustain a functional wetland forest. This index, which is comprised of geomorphology, soils, and natural seed source layers, contributes 26.67% of the total weight of the model.



A. Geomorphology: This layer is derived from the digital version of Quarternary Deposit Maps in Saucier's *Geomorphology and Quarternary Geologic History of the Lower Mississippi Valley*. Scale 1:250000. Abandoned Channel Deposits have a weight of 5, Backswamp Deposits 3, and all other Deposition 1. Geomorphology comprises 25% of the reforestation index and 6.67% to the entire model.



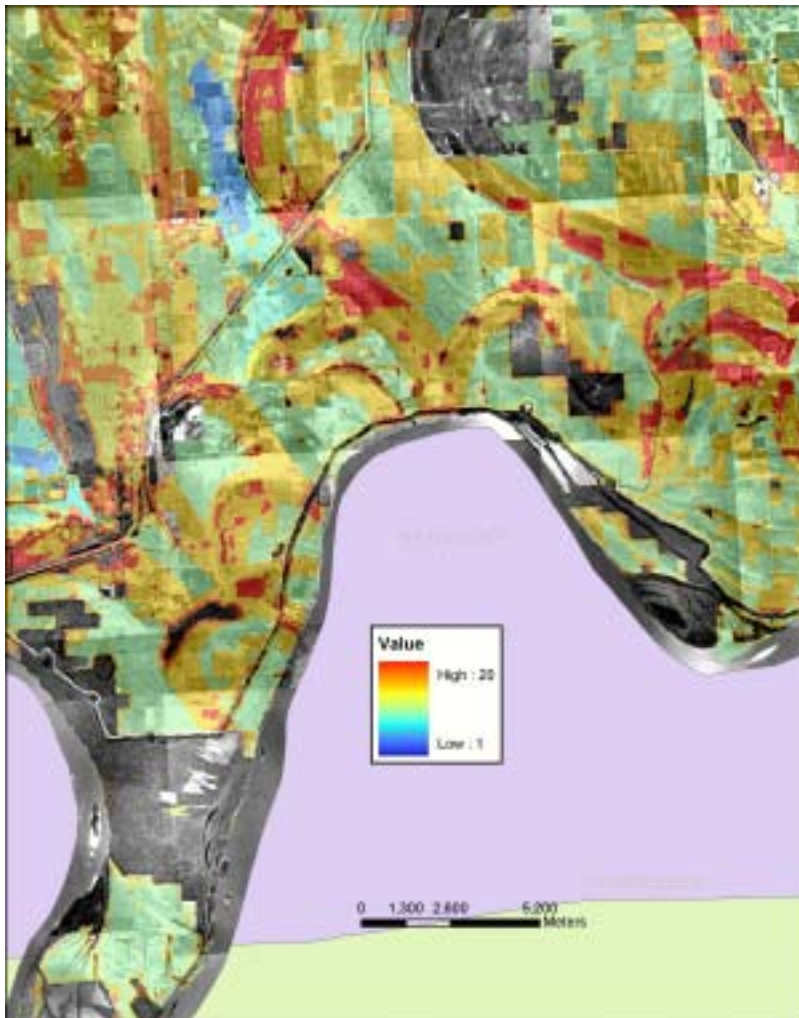
B. Hydric Soils: This layer derived from a combination of the STATSGO database and a Soil Moisture Index (SMI) developed by Ducks Unlimited. Cells have a value from 1 to 10 indicating the probability of containing hydric soils. Cells from STATSGO soil mapping units were replaced with corresponding SMI cells and assigned a value of 10 where the SMI indicated a strong probability of hydric soils. Soils comprise 50% of the Reforestation Index and 13.33% of the entire model



C. Distance from Seed Source: Distance classes generated from 1992 forest cover where:

- 1 = more than 120 meters
- 3 = 61-120 meters = 3
- 5 = less than 60 meters

Distance from seed source comprises 25% of the Reforestation Index and 6.67 % of the entire model



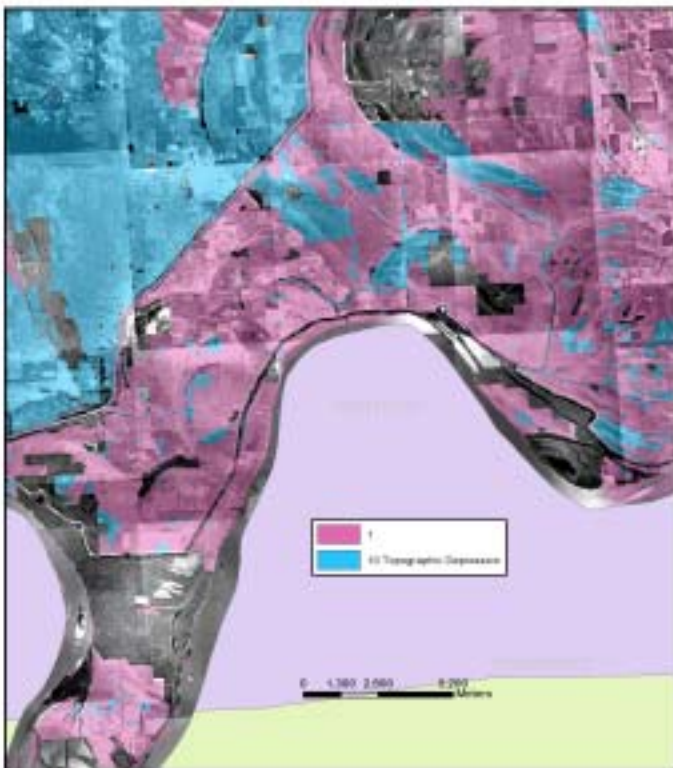
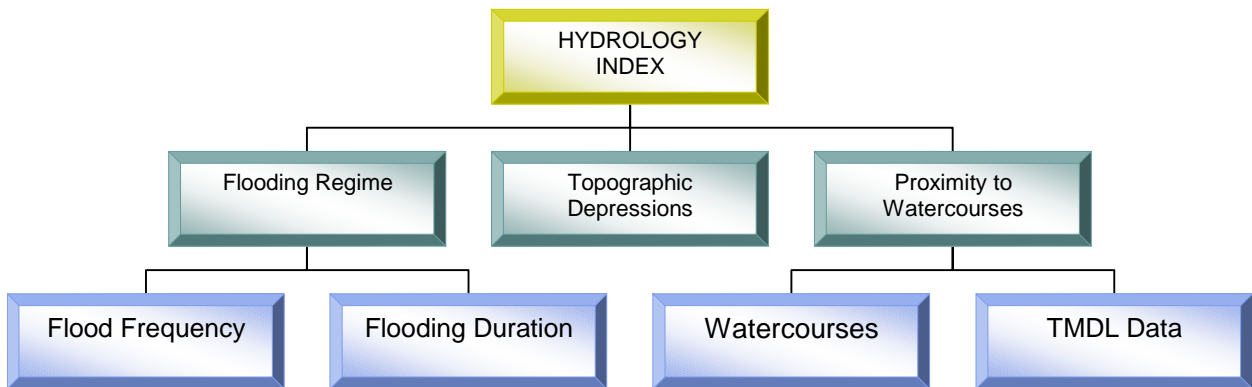
Reforestation Index: Result

The resulting index in the map sidebar has a value range of 3 to 20. High values (reds and yellows) indicate higher probabilities for establishment of functional wetland forests and low values (blues and greens) represent lower probability. Low values do not indicate that an area cannot be reforested.

III. HYDROLOGY INDEX

The *Hydrology Index* is a combination of landscape characteristics that indicate an area's ability to perform water quality functions if reforested. Layers representing flooding regime, proximity to watercourses and topographic depressions are included. The hydrology index contributes 73.33% of the total model weight.

Hydrology Index Schematic



Topographic Depressions: Areas of internal drainage were identified by Ducks Unlimited using the National Elevation Database, which is a thirty meter digital elevation model. Depressions are given a weight of 10. Areas that are externally drained are given a weight of 1. Topographic depressions comprise 18.2% of the Hydrology Index and 13.3% of the total model.



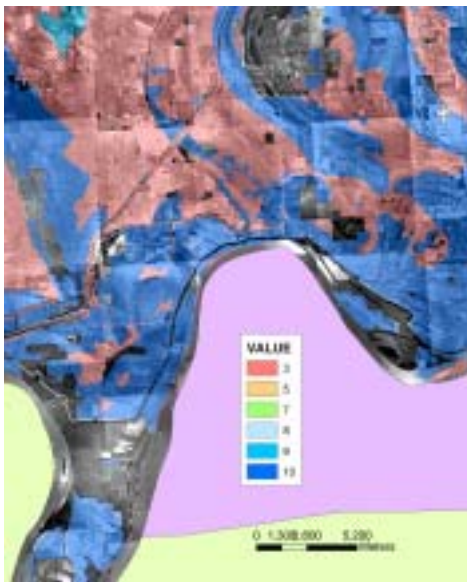
Proximity to Watercourses and Polluted Waters: Variable width buffers around watercourses were assigned weights:

- 1 = outside buffer
- 15 = inside buffer
- 25 = inside buffer around polluted water

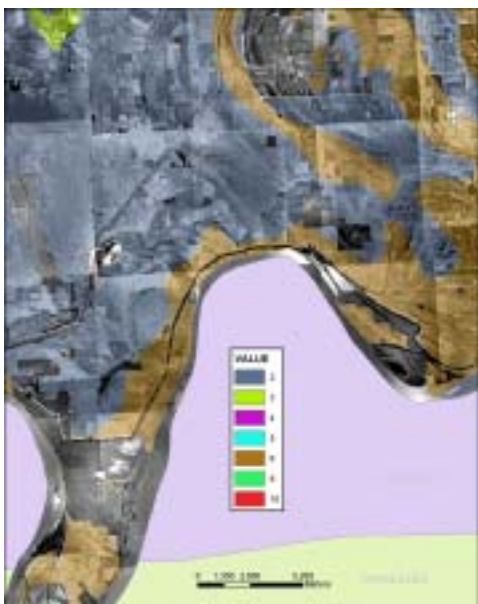
Buffer sizes:

- 150 meters around the Mississippi River
- 90 meters around major rivers,
- 60 meters around perennial streams, canals or aqueducts,
- 30 meters around intermittent streams canals or ditches

This layer contributes 45.4 % to the *Hydrology Index* and 33.3% to the total model.

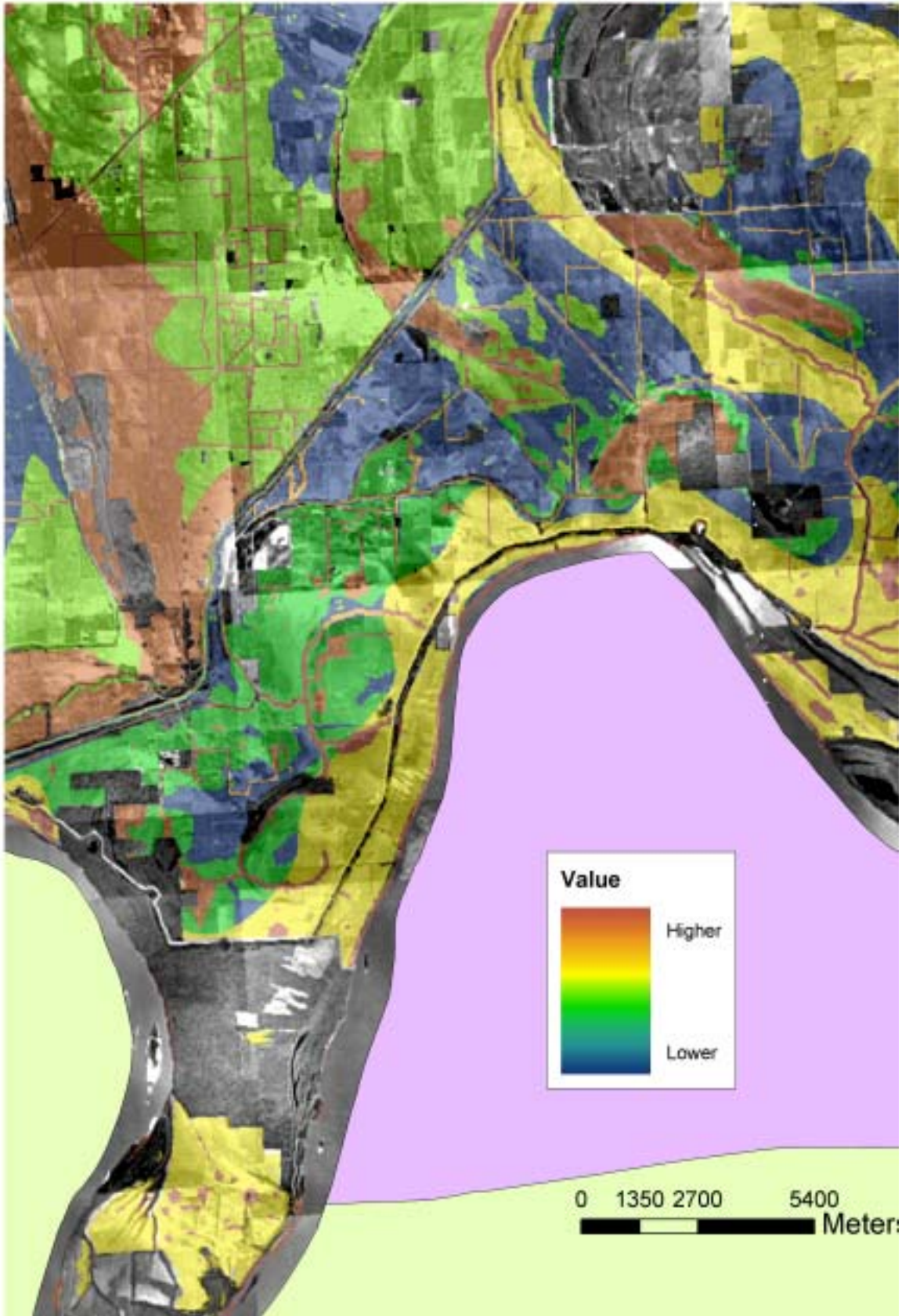


Flooding Frequency: This data layer derived from the STATSGO data base. Values range from 1 to 10. *Flooding Frequency* is comprised of two layers: A frequently flooded soils or soils flooded at least once every two years and A occasionally flooded soils or soils that have a 5 to 50 percent chance of flooding each year. The summary_pct attribute was used to assign weights to the grid cells. Summary_pct is a weighted average of the soil mapping unit-s constituent soils classified as frequently or occasionally flooded. This layer contributes 18.2 percent to the *Hydrologic Index* and 13.33 percent to the total model.



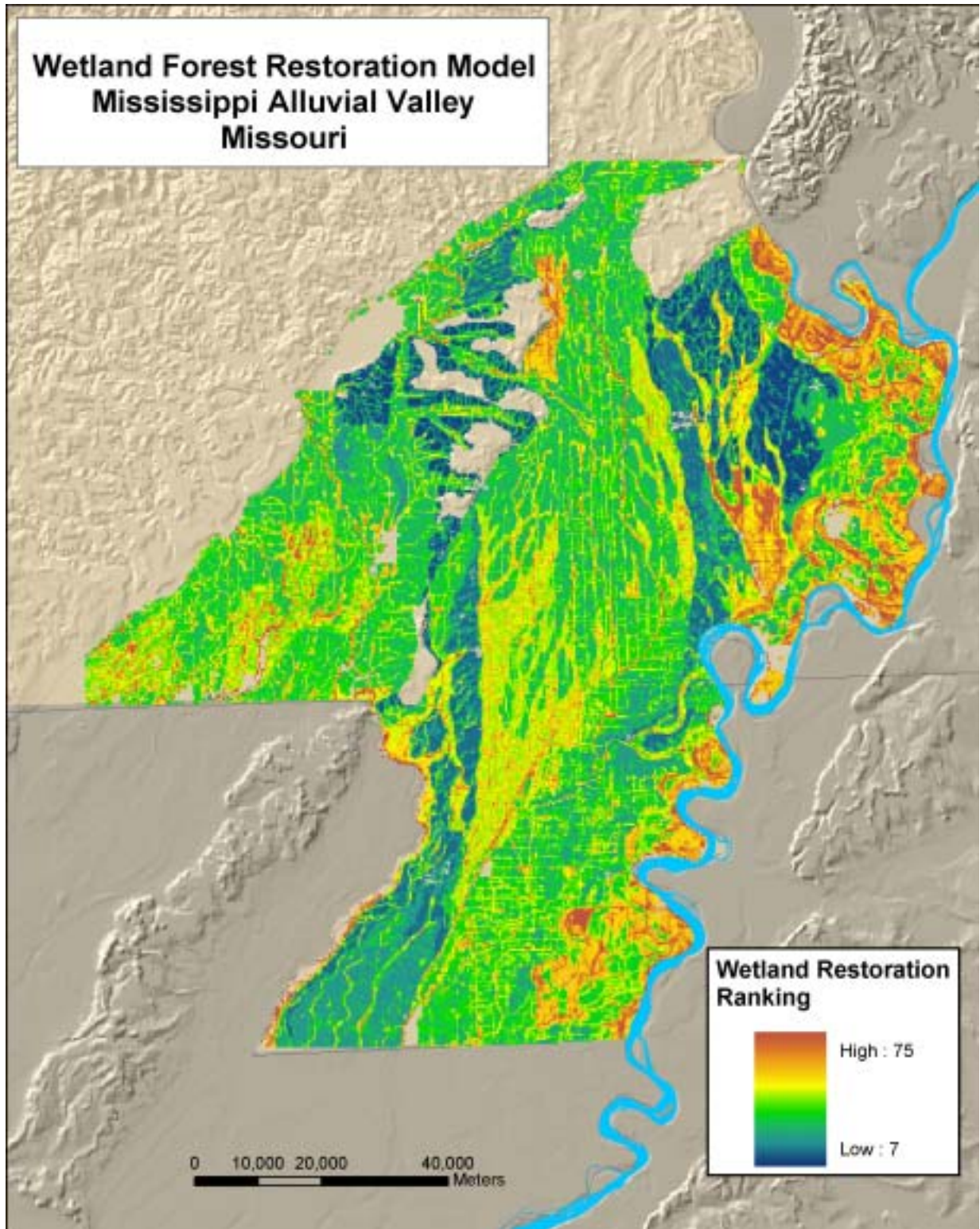
Flooding Duration: This layer is derived from the STATSGO data base. Values range from 1 to 10. *Flooding Duration* is comprised of two layers: Soils flooded for “very long duration” (at least 30 days per flood) and Soils flooded for “long duration” (7 to 30 days per event). The summary_pct attribute was used to assign weights to the grid cells. Summary_pct is a weighted average of the soil mapping unit-s constituent soils classified as flooded for long or very long duration. Flooding duration layer contributes 18.2 percent to the *Hydrology Index* and 13.33 percent to the total model.

Hydrology Index



Wetland Restoration Model: Mississippi Alluvial Valley in Missouri

The final composite index ranges from 7 to 75. Reds and yellows represent areas ranked highly. Highly ranked areas occur mainly in the east.



Wetland Restoration Model: Large Scale

