H-GAC Ecological Land Cover Data Development

The Houston-Galveston region is one of the largest and fastest growing metropolitan areas in the United States and home to a diverse array of environmental resources such as forests, grasslands, wetland and prairies. These critical ecological resources are being lost as a result of rapid and sustained urban growth. The Houston-Galveston Area Council (H-GAC) developed an Eco-Logical Tool for the 8-County region (Harris and surrounding Counties) to identify and safeguard these valuable ecosystems from future development. The tool allows to measure the impacts associated with future transportation projects in the early stages of planning process. Thus, helps in preserving the critical ecological resources that are necessary for maintaining and improving the quality of life in the region.

The Eco-Logical tool was developed under the guidance of H-GAC's Ecological Advisory Committee. In 2018, H-GAC convened an Ecological Advisory Committee (EAC), which consisted of environmental professionals from federal and state resource agencies, as well as organizations and institutions with knowledge of the region's major environmental systems and resources. This committee came together to help identify high-priority environmental resources in the region, with the goal of building a regional Ecological Geospatial Base Map dataset to use for environmental and transportation planning purposes. The committee identified top priority ecosystems for environmental conservation at a regional scale. Furthermore, building of an interactive Geographic Information Systems (GIS) web application was in the plan based on the ecological data and related other data and information for visualization and analysis.

One of the first tasks undertaken by the EAC was the identification and verification of the ecotypes that exist within the region. Although this may appear to be a simple task, common terminologies had to be agreed upon as the literature review revealed a variety of typologies and sub-typologies used for different ecotypes throughout the region. The following section identifies the key ecotypes identified within the region and the methodology used to map each ecotype through aerial imagery.

Ecological Land Types

Based on the recommendations from the committee, H-GAC identified seven different ecological land types. Naming of these land types was selected to represent generalized nature of various ecotypes and to have consistency with the previous version (2010 version) of the regional ecological dataset. Furthermore, seven non-ecological land types were also included in the final dataset in order to display the other surrounding land types including various developments. Following is the list and the description of each seven ecological land types and seven non-ecological land types.

LC CODE	Ecological Land Type	LC CODE	Non-Ecological Land Type
1	Upland Forest	8	Barren Lands
2	Bottomland Forest	9	Row Crops
3	Prairies	10	Open Water
4	Tidal Prairies	11	Developed High Intensity
5	Non-Prairie Grasslands	12	Developed Medium Intensity
6	Freshwater Wetlands	13	Developed Low Intensity
7	Tidal Wetlands	14	Developed Open Spaces

1. Upland Forests

This vegetation type represents the canopy expressions of the overall systems that includes, Mixed Forests, Deciduous Forests, Evergreen Forests, and Shrub/Scrub lands in the region that occur in upland landforms. Delineation of "Upland Forest" is based on spatial separation of all above canopy producing vegetation that are located outside of 100-year floodplain boundary. Since the consideration of elevation, slope, and precipitation distribution such as Atlas 14 are included in the process of developing floodplain boundaries, it was considered to use floodplain as the delineation boundary for spatial separation of upland forest from bottomland forest.

2. Bottomland Forest

This vegetation type represents the canopy expressions of the overall systems that includes, Mixed Forests, Deciduous Forests, Evergreen Forests, and Shrub/Scrub lands that occurs in the lowland landforms. Delineation of "Bottomland Forest" is based on spatial separation of all above canopy producing vegetation that are located within the 100-year floodplain boundary.

3. Prairies

This land type is also generally named as Coastal Prairies that occurs in the non-tidal areas of the region. This type circumscribes a variety of grasslands across a relatively large area and under various past and current management regimes. The coastal prairie ecotype, once covering the majority of the region, is now highly fragmented. This fragmentation is a result both of urbanization and agriculture. Presently, only a small portion of unaltered prairie remains, including segments of the Katy Prairie, Damon Prairie, and prairie in Chambers County.

This herbaceous land primarily occurs on upper slopes and broad uplands in gently undulating landscapes. Circumneutral to moderately alkaline, vertic soils such as Ferris, Houston Black, or Wiergate clays. A variety of grasslands are circumscribed by this mapped

type, and species such as Bermudagrass, King Ranch bluestem, bahiagrass, deep-rooted sedge, rat-tail smutgrass, broomsedge bluestem, little bluestem, bushy bluestem, and brownseed paspalum may be dominant.

4. Tidal Prairies

This herbaceous land type mostly occurs at the level or very gently undulating landform, typically near the coast. They are also generally considered as Coastal Prairie types that occur near the coastline with tidal influence. These sites are located in uplands and may be inundated by saltwater during storm surges. Pimple mounds may lend some local topographic variation to the otherwise level surface. This system occupies saline soils, generally near-coast, on level topography of the Beaumont Formation. Sites may be nearly monotypic stands of *Spartina spartinae* (Gulf cordgrass). Small areas within deep coastal sands may be dominated by shrub species. These lands may be saturated from local rainfall or, occasionally from storm surges.

5. Non-Prairie Grasslands

This vegetation type represents the herbaceous expression of the overall system, which is a mosaic of woody and herbaceous cover types that falls into savanna land types. These grasslands are often dominated by mid- and tallgrass species often present in the understory of woody expressions of the system. Also, very little intact Blackland prairie remains within the region, so grasslands that are mapped in the region are assumed to primarily consist of disturbance or tame grasslands. Furthermore, the lands that are herbaceous dominated sites occupying bottomland soils and lacking significant shrub or overstory canopy cover. They are mostly managed grasslands.

6. Freshwater Wetlands

This land category includes a long range of land types consists of herbaceous and wooded vegetation that are in low lands, relatively broad flat at low topographic positions, valleys and drainages along headwater and large streams where alluvial deposition dominates, internally draining depressions typically on the tablelands of the High Plains occupying Vertisols with a clay layer of reduced permeability, Riparian sites lacking overstory or shrub canopy but retaining herbaceous cover, marsh landcover that occurs on bottomland soils, swamps and marshes.

7. Tidal Wetlands

This category consists of land types that occupy relatively low-lying, coastal situations on level landforms influenced by tidal fluctuations. Some land types are only influenced by storm tides, or tides resulting from extreme wind events. The composition of some of the marshes is primarily influenced by the frequency and duration of tidal inundation. Also,

herbaceous system occupies coastal sites with mucky soils and salinities less than 4 ppt. Some land types can be alternately wet and dry (due to seasonal rainfall events) and generally lack tidal influence but may contain halophytic species due to the influence of salt spray and repeated inundation and evaporation.

8. Barren Lands

This type includes areas where little or no vegetative cover existed at the time of image data collection. Large areas cleared for development in rural areas. Stream beds with exposed gravel or bedrock, rock outcrops, quarries, and mines may be mapped as this type. Fallow fields or areas within cropland blocks that remain barren throughout one growing season or heavily grazed pastures where bare soils are dominant may also be mapped as barren. Unvegetated or very sparsely vegetated flats affected by tidal fluctuations. Unvegetated to sparsely vegetated sandy shoreline adjacent to the Gulf of Mexico and bays.

9. Row Crops

This category includes land areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. This class also includes all land being actively tilled. Some fields may rotate into and out of cultivation frequently, and year-round cover pasture lands are generally mapped as grasslands or prairies.

10. Open Water

Areas of open water, generally with less than 25% cover of vegetation or soil. In addition to large lakes, rivers, and marine water, ephemeral ponds may be mapped as open water.

11. Developed High Intensity

Highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.

12. Developed Medium Intensity

Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.

13. Developed Low Intensity

Areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.

14. Developed Open Spaces

Areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

Data Development Approach

The objective of this basemap data development effort was to create a new ecological dataset with most up-to-date information and higher resolution. The improved spatial resolution of the data allows for a more accurate representation of the ecological and non-ecological land types. The format of the basemap GIS dataset is a raster data type with a resolution of 5 meters pixel size.

There were primarily three sources of information/data used in development of this H-GAC version of Ecological basemap dataset.

1. The 2016 National Agricultural Imagery Program (NAIP) 4 band aerial imageries of the region. They are 1-meter resolution imageries with Infrared band included as the 4^{th} band.
2. Texas Park and Wildlife Department (TPWD) Ecological Mapping Systems of Texas data 2014
3. H-GAC Land Use Land Cover dataset 2018

The ecological forest lands were delineated based on 2016 NAIP imagery. The 4-band tiled NAIP imagery was mosaic into one imagery in county basis. Each mosaiced image was run for Normalized Difference Vegetation Index (NDVI) using following formula in Image Analysis extension in ArcGIS 10.6 environment.

$$NDVI = (Infrared - Red)/(Infrared + Red)$$

The resulting output provided a raster image with values ranging from -1 to +1. -1 being the purely non-vegetation pixels, such as water features and +1 being the healthy vegetation pixels. Then a threshold value for canopy representing pixels was recognized by overlaying the natural color version of the aerial image and making visual observations. Using the

threshold values the NDVI imagery was reclassified to represent all forest/canopy area as one feature. The reclassified image was then resampled into 5-meter resolution. In order to make a spatial separation of forest pixels into upland and bottomland forests, the raster version of 100-year floodplain was overlaid with the forest/canopy area image. The forest pixels that overlapped with the floodplain were recognized as bottomland forest and the pixels that are outside of the floodplain were named as upland forest.

The TPWD ecological data layer consisted of 125 land types in the 8 county H-GAC region. Based on the advisory committee recommendations and the information from TPWD documentations (see reference) the dataset was reclassified into above mentioned ecological land classes. The land types such as Prairies, Tidal Prairies, Freshwater Wetlands, Tidal Wetlands and Non-Prairie Grasslands were extracted from the reclassified TPWD data. Eventhough this land types extracted from this data is not very recent (last revision is 2014), we overwrite the pixels that are converted into developed lands using H-GAC 2018 land use land cover dataset. Since it is considered that majority of the Prairies and Wetlands were fragmented due to the expanding developments in the region, overwriting with 2018 land information will update the extent of the remaining areas of prairies and wetlands.

H-GAC 2018 Land Use Land Cover dataset consists of 10 land classes that includes Open Water, Developed High Intensity, Developed Medium Intensity, Developed Low Intensity, Developed Open Spaces, Barren Lands, Forest, Grasslands/Pasture, Cultivated lands, and Wetlands. Out from these 10 classes 6 land types, that includes Open Water, Barren Lands and 4 Developed land types were selected and merged with the resulted image of NAIP based forest data and TPWD reclassified data. In the merging process the H-GAC land cover data was set as the priority layer and NAIP forest as the second priority layer. The output raster dataset was assessed to confirm that in the resolution of 5 meters and with no empty pixels.

Link to the Eco-Logical Application https://datalab.h-gac.com/EcologicalGIS/

Eco-Logical Application User Guide

https://datalab.h-gac.com/EcologicalGIS/EcoLogical_UserGuide.pdf

Eco-Logical Data Download

https://www.h-gac.com/eco-logical/gis-data-request.aspx

Reference:

Elliott, Lee F., David D. Diamond, C. Diane True, Clayton F. Blodgett, Dyan Pursell, Duane German, and Amie Treuer-Kuehn. 2014. Ecological Mapping Systems of Texas: Summary Report. Texas Parks & Wildlife Department, Austin, Texas.