The National Biomass and Carbon Dataset for the Year 2000 (NBCD 2000)

Mapping Zone 39 README

1. NBCD 2000 Project Description

The accompanying dataset was produced as part of a project funded under NASA's Terrestrial Ecology Program and titled "The National Biomass and Carbon Dataset 2000 (NBCD 2000): A High Spatial Resolution Baseline to Reduce Uncertainty in Carbon Accounting and Flux Modeling." The main objective of the project was to generate a high-resolution (30 m), year-2000 baseline estimate of basal area-weighted canopy height, aboveground live dry biomass, and standing carbon stock for the conterminous (lower 48) United States. Development of the dataset is based on an empirical modeling approach that combines USDA Forest Service Forest Inventory and Analysis (FIA) data with high-resolution InSAR data acquired from the 2000 Shuttle Radar Topography Mission (SRTM) and optical remote sensing data acquired from the Landsat ETM+ sensor. Three-season Landsat ETM+ data were systematically compiled by the Multi-Resolution Land Characteristics Consortium (MRLC) between 1999 and 2002 for the entire U.S. and were the foundation for development of both the USGS National Land Cover Dataset 2001 (NLCD 2001) and the Landscape Fire and Resource Management Planning Tools Project (LANDFIRE). Products from both the NLCD 2001 (landcover and canopy density) and LANDFIRE (existing vegetation type) projects as well as topographic information from the USGS National Elevation Dataset (NED) are used within the NBCD 2000 project as spatial predictor layers for canopy height and biomass estimation. Forest survey data provided by the USDA Forest Service FIA program were made available to the project under a national Memorandum of Understanding. The response variables (canopy height and biomass) used in model development and validation were derived from the FIA database (FIADB). Production of the NLCD 2001 and LANDFIRE projects was based on a *mapping zone* approach in which the conterminous U.S. is split into 66 ecoregionally distinct mapping zones. This mapping zone approach was also adopted by the NBCD 2000 project.

2. Description of Data Distribution

This data distribution (NBCD2000_MZ39) contains six raster files in TIFF format (together with associated metadata XMLs) as well as this README document. A brief description of each file is included below.

(1) NBCD_MZ39_README.pdf
(2) NBCD_MZ39_BAW_height.tif
(3) NBCD_MZ39_FIA_ALD_biomass.tif
(4) NBCD_MZ39_NCE_ALD_biomass.tif
(5) NBCD_MZ39_SRTM_datatakes.tif
(6) NBCD_MZ39_averaging_index.tif
(7) NBCD_MZ39_NED_META_SRTM_voids.tif

To view the data in most GIS and image processing software packages, statistics need to be calculated for each raster file. For example, using ESRI's ArcCatalog, right click the geotiff raster image and choose 'build statistics'.

2.1 NBCD_MZ39_README

The document you are now reading. Contains descriptions of the project and the data description, summarizes standard and zone-specific processing methods as well as zone results, and provides a list of relevant publications and contact information where additional details can be obtained.

2.2 NBCD_MZ39_BAW_height

One 16-bit signed raster layer at 30 m resolution. Digital numbers represent the average basal area weighted height in meters * 10. Thus, the average basal area weighted height in meters = <Digital Number> / 10.

2.3 NBCD_MZ39_FIA_ALD_biomass

One 16-bit signed raster layer at 30 m resolution. Digital numbers represent the amount of aboveground live dry biomass present in kg/m^2 * 10. Thus, aboveground live dry biomass in kg/m^2 = <Digital Number> / 10. Values were multiplied by 10 to preserve significant figures yet reduce file size. Units of kg/m^2 were selected to coincide with FIA results/methodology.

It may be preferable to convert the current units to metric tons (tonnes) per hectare. To estimate the number of metric tonnes of biomass in a given region of interest/polygon, sum the values that lie within the polygon of interest and then multiply the result by 0.09 (which accounts for the fractional portion of a hectare present in a single 30 meter pixel).

Tree-level biomass estimates were obtained from the FIADB Tree Table (variable = DRYBIOT).

2.4 NBCD_MZ39_NCE_ALD_biomass (Beta Version)

One 16-bit signed raster layer at 30 m resolution. Digital numbers represent the amount of aboveground live dry biomass present in $kg/m^2 * 10$. Thus, aboveground live dry biomass in kg/m^2 = <Digital Number> / 10. Values were multiplied by 10 to preserve significant figures yet reduce file size. Units of kg/m^2 were selected to coincide with FIA results/methodology.

It may be preferable to convert the current units to metric tons (tonnes) per hectare. To estimate the number of metric tonnes of biomass in a given region of interest/polygon, sum the values that lie within the polygon of interest and then multiply the result by 0.09 (which accounts for the fractional portion of a hectare present in a single 30 meter pixel).

Biomass estimates were derived from nationally consistent allometric equations (NCE) developed by Jenkins et al. (2003)[†] and were applied to the FIADB on a tree-by-tree basis.

[†] Source of biomass equations:

Jenkins, J.C., Chojnacky, D.C., Heath, L.S., & Birdsey, R.A. 2003. National-scale biomass estimators for United States tree species. *Forest Science,* 49:12-35.

2.5 NBCD_MZ39_SRTM_datatakes

One 8-bit unsigned raster layer at 30 m resolution. Digital numbers represent the number of SRTM C-band datatakes associated with each 30 m pixel.

2.6 NBCD_MZ39_averaging_index

One 16-bit unsigned raster layer at 30 m resolution. Digital numbers represent an index computed by multiplying the number of SRTM datatakes (see datatake layer) by the size (measured in pixels) of the particular image-object polygon to which the pixel belongs. The averaging index provides a measure of confidence in the estimates of canopy height and biomass as it relates directly to the amount of noise reduction achieved in each image pixel. Hence, the larger the index value, the greater the noise reduction, and the higher the confidence in the canopy height/biomass prediction. For further information see Walker et al. (2007a).

2.7 NBCD_MZ39_NED_META_SRTM_voids

One 8-bit unsigned raster layer at 30 m resolution. Digital numbers identify the locations of (1) low NED quality (i.e., electronic image correlation and manual profiling production methods – see http://ned.usgs.gov/Ned/downloads.asp for more information) and presence of SRTM voids (2) high NED quality and presence of SRTM voids, (3) low NED quality and absence of SRTM voids, (4) high NED quality and absence of SRTM voids, (5) lidar-based DEM and presence of SRTM voids, and (6) lidar-based DEM and absence of SRTM voids.

3. Summary of Standard Processing Methods

A diagram of the general process flow for the NBCD 2000 project is included in Figure 1. Detailed information on the methods employed at each step in the process can be found in Walker et al. (2007a/b) and Kellndorfer et al. (In Preparation).

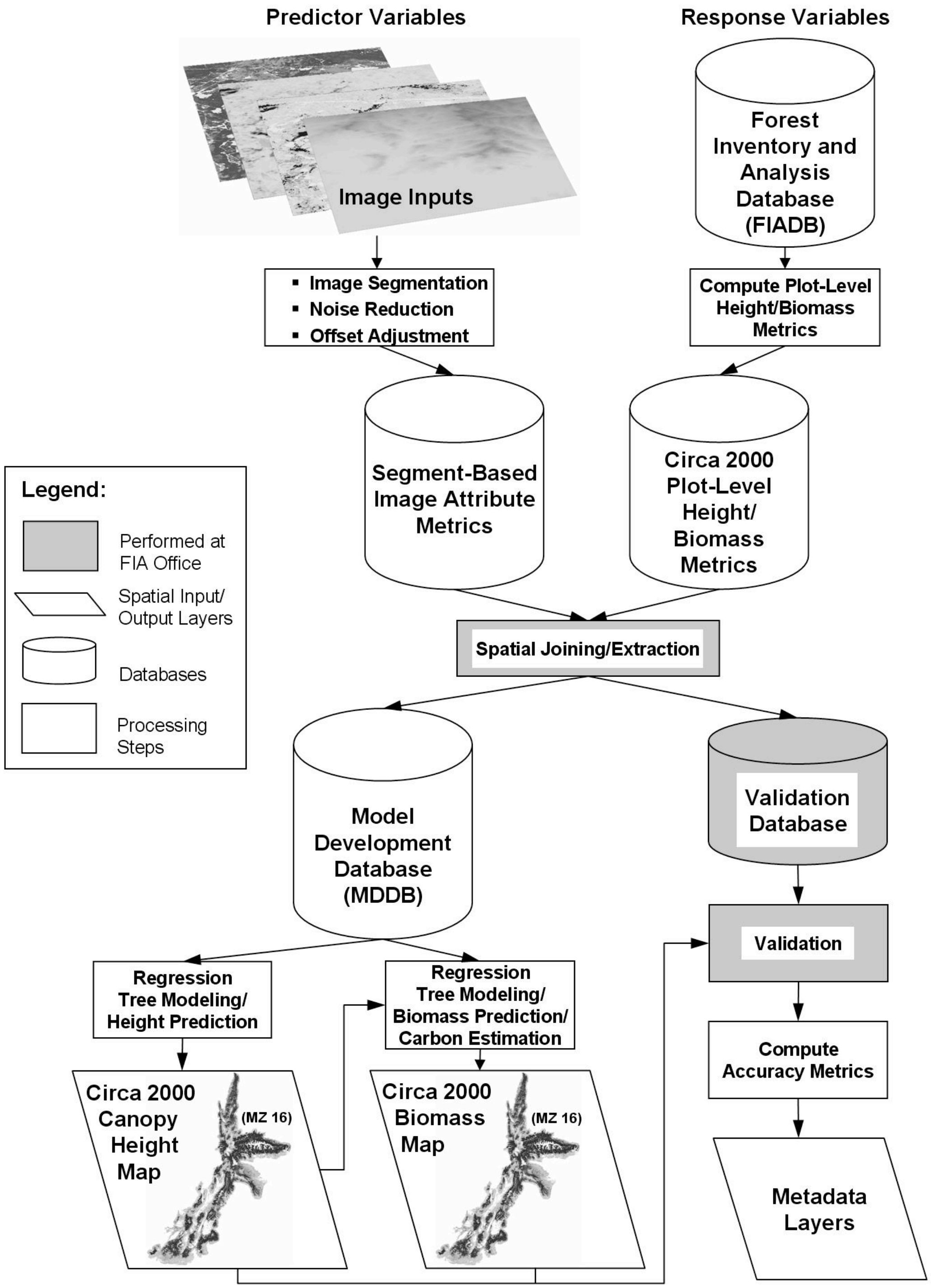

Figure 1. Process flow diagram for the NBCD Project

4. Summary of Mapping zone-specific Deviations from Standard Processing

FIA-field plots from adjacent zone 31 were used in addition to FIA-field plots from zone 39 to develop the model for zone 39.

5. Summary of Mapping Zone Results

5.1 Mapping zone accuracy assessment

The following figures include (1) variable importance (VI) plots (2a, 2b, 2c) and (2) validation (one-to-one) plots (2d, 2e, 2f) for basal area weighted height and aboveground live dry biomass (FIA and NCE). VI plots provide a graphic view of the relative importance of a spatial predictor layer used in each regression-tree model. For further information on VI plots see Liaw and Wierner (2002) or Walker et al. (2007a). Validation plots are based on a bootstrap approach described in Kellndorfer et al. (Submitted).

Variable (Layer) acronyms:

hspc	Mean SRTM-NED height difference (i.e., scattering phase center height)
bawht	FIA plot basal area weighted height
cd	NLCD 2001 canopy density
lc	NLCD 2001 land cover
ned	Elevation from the USGS National Elevation Dataset (NED)
slp	Slope derived from the NED
asp	Aspect derived from the NED
spB	Landsat ETM+ Tasseled Cap transformed brightness from a spring acquisition
spG	Landsat ETM+ Tasseled Cap transformed greenness from a spring acquisition
spW	Landsat ETM+ Tasseled Cap transformed wetness from a spring acquisition
lonB	Landsat ETM+ Tasseled Cap transformed brightness from a leaf-on acquisition
lonG	Landsat ETM+ Tasseled Cap transformed greenness from a leaf-on acquisition
lonW	Landsat ETM+ Tasseled Cap transformed wetness from a leaf-on acquisition
loffB	Landsat ETM+ Tasseled Cap transformed brightness from a leaf-off acquisition
loffG	Landsat ETM+ Tasseled Cap transformed greenness from a leaf-off acquisition
loffW	Landsat ETM+ Tasseled Cap transformed wetness from a leaf-off acquisition
tcpc1	First principal component derived from the nine Tasseled Cap image layers

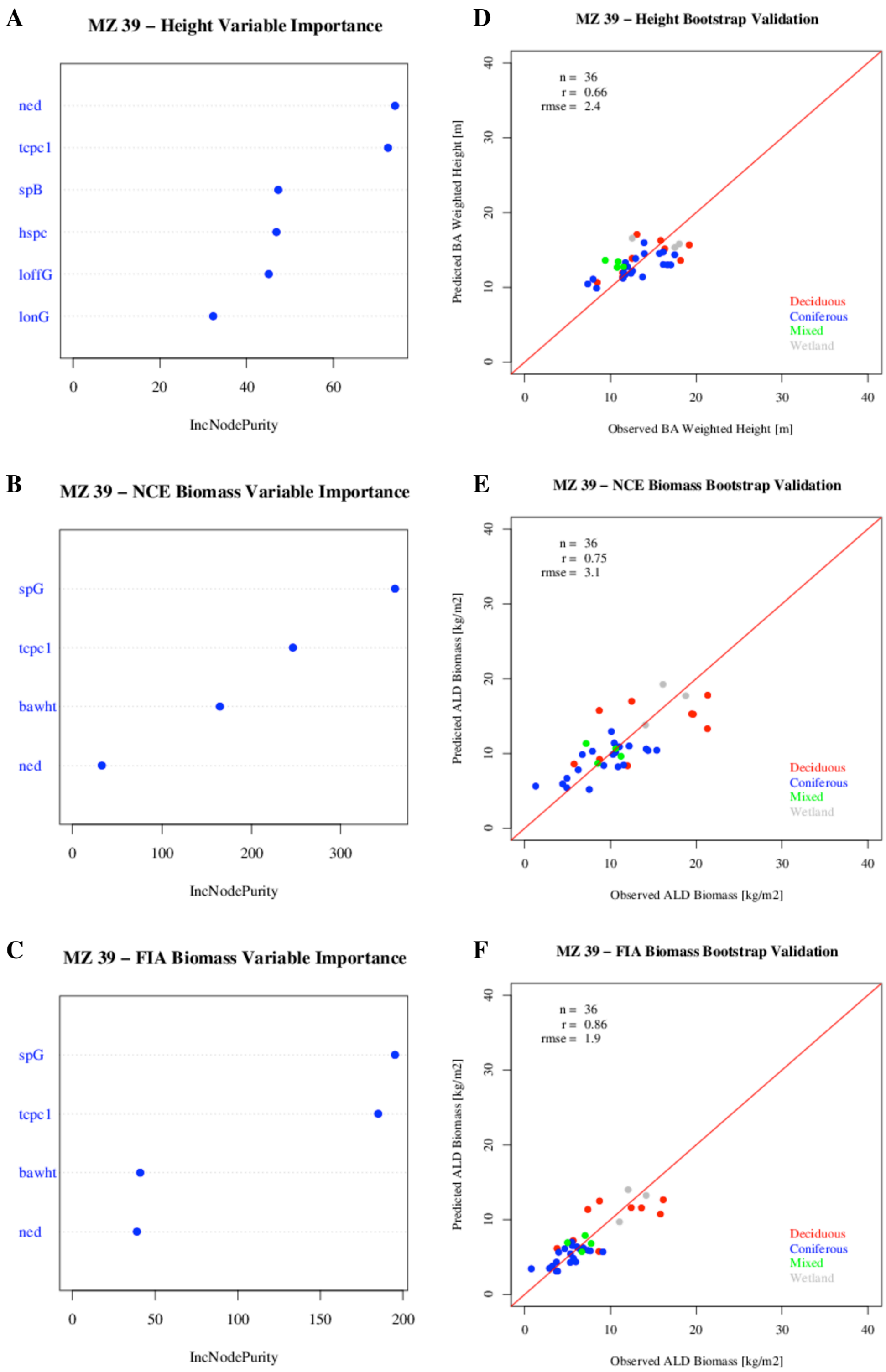

Figure 2. Mapping zone results

5.2 Zone-level biomass and carbon estimates

Estimates of the amount of aboveground live dry biomass and aboveground carbon in each mapping zone are provided below. Aboveground carbon is calculated as 50% of the total aboveground live dry biomass.

Total FIA ALD biomass in mapping zone 39: 0.02 Pg
Total NCE ALD biomass in mapping zone 39: 0.02 Pg
Total FIA-based aboveground carbon in mapping zone 39: 0.01 Pg
Total NCE-based aboveground carbon in mapping zone 39: 0.01 Pg

Total area in mapping zone 39: 158908.01 km^2
Total area mapped (i.e. forest area) in mapping zone 39: 2121.0 km^2
Area mapped/total area in mapping zone 39: 1.0%

6. Relevant Publications/References

Kellndorfer, J.M., Walker, W.S., Kirsch, K.M., Fiske, G., Bishop, J., LaPoint, E., Hoppus, M, & Westfall, J. The National Biomass and Carbon Dataset 2000 (NBCD 2000): A high resolution baseline for the conterminous U.S. *Remote Sensing of Environment,* In Preparation.

Kellndorfer, J., Walker, W., Pierce, L., Dobson, C., Fites, J., Hunsaker, C., Vona, J., & Clutter, M. 2004. Vegetation height estimation from Shuttle Radar Topography Mission and National Elevation Datasets. *Remote Sensing of Environment,* 93:339-358.

Liaw, A. & Wierner, M. 2002. Classification and regression by randomForest. *R News*, 2/3, 18-22.

Pierce, L.E., Kellndorfer, J.M., Walker, W.S., & Barros, O. 2006. Evaluation of the horizontal resolution of SRTM elevation data. *Photogrammetric Engineering and Remote Sensing*, 72(11), 1235-1244.

Walker, W.S. 2006. Toward Regional- to Continental-Scale Estimates of Vegetation Canopy Height: An Empirical Approach Based on Data from the Shuttle Radar Topography Mission. Ph.D. Dissertation. The University of Michigan, School of Natural Resources and Environment, Ann Arbor, MI. 263 pp.

Walker, W.S., Kellndorfer, J.M., LaPoint, E., Hoppus, M., & Westfall, J. 2007a. An empirical InSAR optical fusion approach to mapping vegetation height. *Remote Sensing of Environment,* 109:482-499.

Walker, W.S., Kellndorfer, J.M. & Pierce, L.E. 2007b. Quality Assessment of SRTM C-and X-Band Interferometric Data: Implications for the Retrieval of Vegetation Canopy Height. *Remote Sensing of Environment,* 106:428-448.

When referencing the NBCD 2000 dataset, please use the following citation:

Kellndorfer, J., W. Walker, K. Kirsch, G. Fiske, J. Bishop, L. LaPoint, M. Hoppus, and J. Westfall. 2013. NACP Aboveground Biomass and Carbon Baseline Data, V. 2 (NBCD 2000), U.S.A., 2000. Data set. Available on-line [http://daac.ornl.gov] from ORNL DAAC, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/ORNLDAAC/1161

Acknowledgements

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For further information, please contact:

Dr. Josef Kellndorfer
The Woods Hole Research Center
149 Woods Hole Road, Falmouth, MA 02540-1644
Email: nbcd2000@whrc.org