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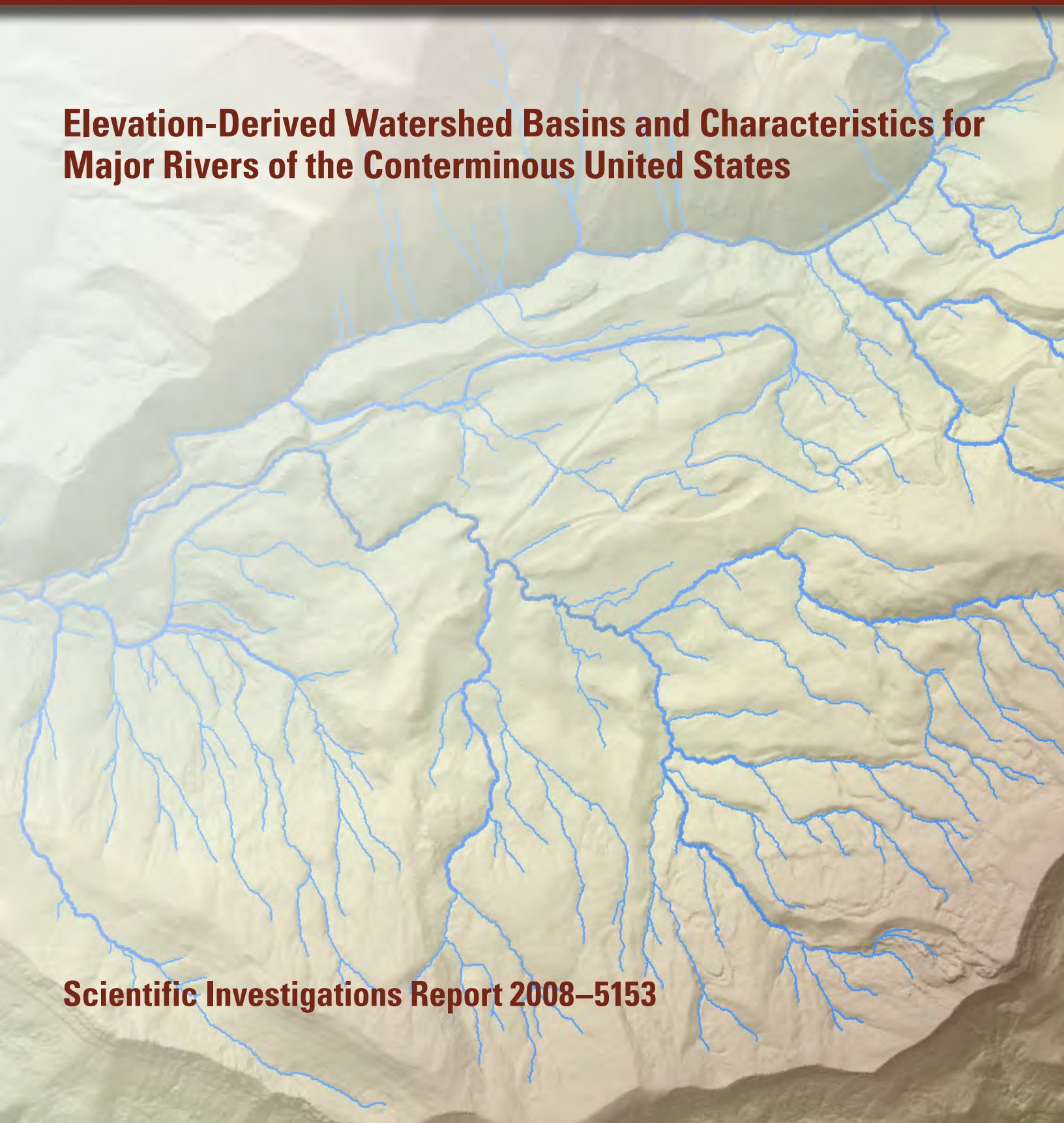
Elevation-Derived Watershed Basins and Characteristics for Major Rivers of the Conterminous United States



Scientific Investigations Report 2008–5153

U.S. Department of the Interior
U.S. Geological Survey

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By S.K. Poppenga and B.B. Worstell

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Conversion Factors

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)
	Area	
square meter (m^2)	0.0002471	acre
square kilometer (km^2)	247.1	acre
square centimeter (cm^2)	0.001076	square foot (ft^2)
square meter (m^2)	10.76	square foot (ft^2)
square centimeter (cm^2)	0.1550	square inch (ft^2)
square kilometer (km^2)	0.3861	square mile (mi^2)
	Flow rate	
cubic meter per second (m^3/s)	70.07	acre-foot per day (acre-ft/d)
cubic meter per second (m^3/s)	35.31	cubic foot per second (ft^3/s)
cubic meter per second per square kilometer [$(m^3/s)/km^2$]	91.49	cubic foot per second per square mile [$(ft^3/s)/mi^2$]
cubic meter per second (m^3/s)	22.83	million gallons per day (Mgal/d)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83). Elevation, as used in this report, refers to distance above the vertical datum.

Elevation-Derived Watershed Basins and Characteristics for Major Rivers of the Conterminous United States

By S.K. Poppenga[1] and B.B. Worstell[2]

Abstract

The U.S. Geological Survey Earth Resources Observation and Science Center Topographic Science Project has developed elevation-derived watershed basins and characteristics for major rivers of the conterminous United States. Watershed basins are delineated upstream from the mouth of major rivers by using the hydrologic connectivity of the Elevation Derivatives for National Applications (EDNA) seamless database. Watershed characteristics are quantified by integrating ancillary geospatial datasets, including land cover, population, slope, and topography, with elevation-derived watershed boundaries. The results are published in an online EDNA Watershed Atlas at *http://edna.usgs.gov/watersheds*. The atlas serves as a framework for evaluating and analyzing the physical, biological, and anthropogenic status of watersheds.

Introduction

In an effort to evaluate and analyze the health of the Nation's watersheds, the U.S. Geological Survey Earth Resources Observation and Science Center Topographic Science Project has developed elevation-derived watershed basins and characteristics for major rivers of the conterminous United States. Watershed basins are derived from hydrologically conditioned digital elevation models (DEMs) because the DEMs are precise, consistent, and unaffected by visual interpretations of cartographic data. Watershed characteristics are selected to provide metrics for land cover distributions, population density, topography, and impoundments for each watershed. This report describes the methods used to develop elevation-derived watershed basin delineations and characteristics and the watershed analysis capabilities within the Elevation Derivatives for National Applications (EDNA) Watershed Atlas (*http://edna.usgs.gov/watersheds)*.

The hydrologic framework that facilitates analyses for the nationally integrated inventory of watershed basins and characteristics is the EDNA database (Franken and others, 2001). EDNA is a nationally consistent, 30-meter resolution, multilayered database in which hydrologic flow representation and stream network connectivity are derived from the National Elevation Dataset (NED) (Gesch and others, 2002). The NED is a DEM of the land surface and is the basis for the EDNA database in that the DEM is a representation of the drainage surface of the United States. A geographic information system (GIS) is used to create hydrologic derivative layers by filling depressions in the DEM (from the NED), calculating flow direction and flow accumulation, and creating synthetic flow channels and reach catchments.

The EDNA is assembled as a seamless database with vertically consistent, hydrologic geospatial layers including hydrologically conditioned DEMs, flow direction, flow accumulation, synthetic flow channels, reach catchments, sinks, slope, aspect, and compound topographic index (CTI; fig. 1). Flow direction in EDNA channels is always from a higher elevation to a lower elevation, and the reach catchments always follow the drainage divide (Verdin and Greenlee, 2003). On the basis of this consistent information available on a national scale, watershed basins are delineated, and watershed characteristics are summarized for land cover, population, drainage area, minimum, maximum, and average elevation and slope for major rivers of the conterminous United States (fig. 2). The ability to access EDNA data layers as a seamless database facilitates the development of elevation-derived watersheds and characteristics.

Methods

An algorithm is written to delineate watersheds (contributing area) from any point in the United States by using EDNA's nationwide hydrologic connectivity. The underlying functionality of the watershed delineation is built on the EDNA reach catchments. During EDNA database development, reaches based on a 5,000-pixel drainage area are created from the DEM, and subsequently a catchment is produced for each one of the reaches (fig. 3). Watershed basins are delineated by selecting an outlet catchment (point) and automatically aggregating the upstream catchments (Kost

[1]U.S. Geological Survey.

[2]SGT, contractor to the U.S. Geological Survey. Work performed under USGS contract 08HQCN0005.

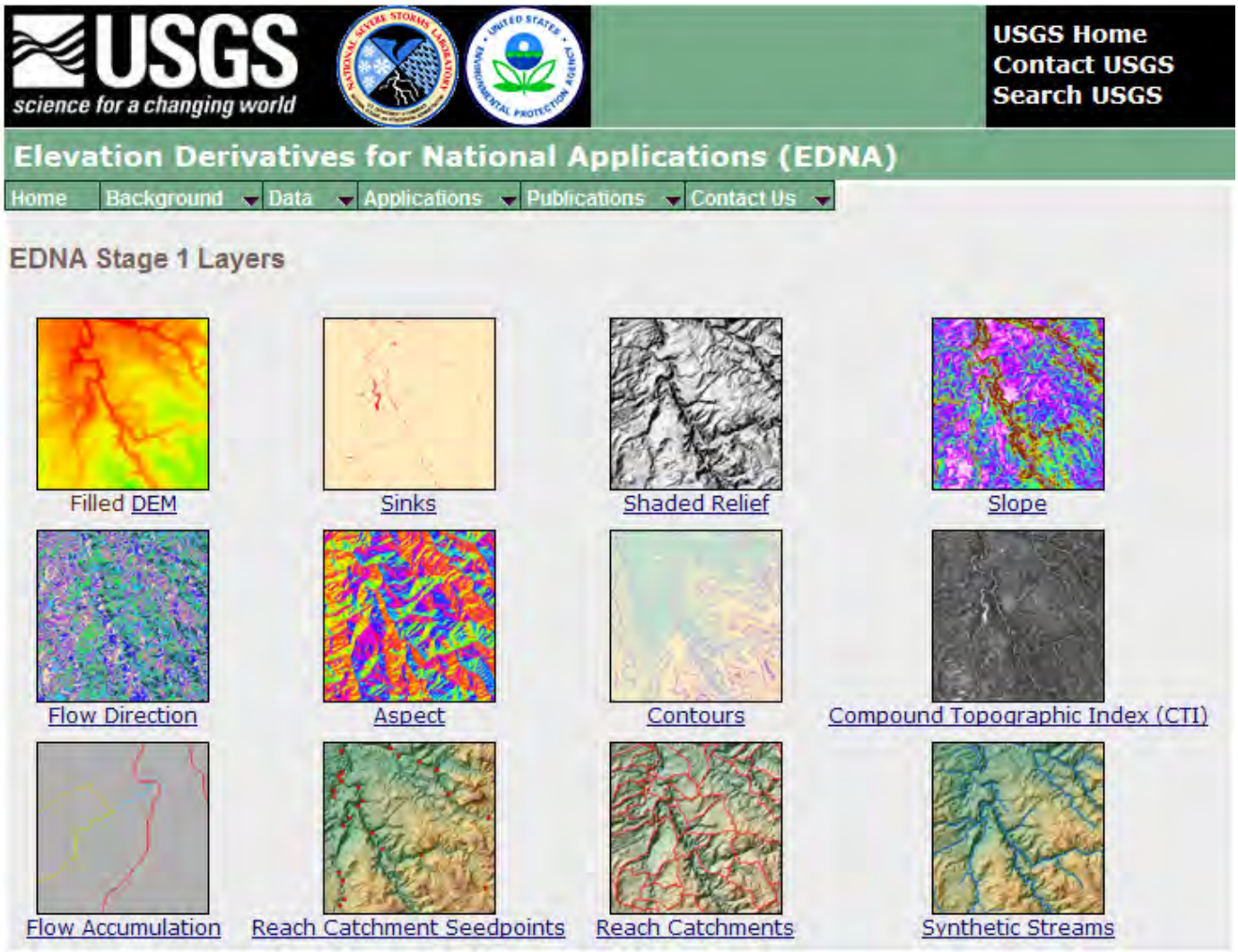

Figure 1. Geographic information system (GIS) layers for Elevation Derivatives for National Applications (EDNA) seamless database (available online at *http://edna.usgs.gov/Edna/datalayers.asp*).

and others, 2001). The output is a polygon that represents the contributing area of a watershed basin.

Elevation-derived watersheds are delineated by using the EDNA watershed tool, which is Web-enabled and contains integration capabilities for placing an outlet point for watershed delineation. The outlet location for each major river is interactively determined by using existing hydrography datasets with named rivers. The corresponding EDNA stream reach is used to seed an outlet point for the EDNA watershed tool, which processes the outlet point to create a delineation for the contributing area upstream from the point. Elevation-derived watersheds are delineated for 77 major rivers of the United States from this tool (table 1 and fig. 2). The combined watersheds for these river systems cover most of the land surface of the conterminous United States. Each watershed delineation serves as a zone mask for computing and summarizing statistics for the watershed.

Watershed characterization includes methods that describe and define the physical, biological, and anthropogenic status of the watershed basin. The watershed characteristics summarized include land cover, population, elevation, and slope. Additional summaries include information about dams in the watersheds. To produce these characteristics, we used ESRI's ArcMap to convert watershed basins (polygons) to rasters (grids). Ancillary geospatial data are overlaid with each watershed grid to extract coincident land cover, population, drainage area, elevation, and slope grids. Watershed characteristics are summarized by quantifying the pixels in each contributing area by using the extracted coincident grids. The derived spatial and temporal characteristics describe the land cover (1992 and 2001), average population density (1990 and 2000, persons per square kilometer), drainage area (square kilometers), minimum and maximum elevation (meters), and minimum and maximum slope (degrees). The methods and

Figure 2. Elevation-derived watersheds for major rivers of the conterminous United States (available online at *http://edna.usgs.gov/watersheds/html_index.htm*).

examples for each of these characteristics are further described in the sections that follow.

Land Cover Characteristics

Distribution of land cover classes are computed for each watershed by using data from the 1992 and 2001 National Land Cover Data (NLCD; U.S. Geological Survey, 2007). These datasets are developed at 30-meter resolution. Each dataset was mapped with different methods and slightly different classes. The 1992 NLCD contains categories of land cover types, which are derived classifications of Landsat Thematic Mapper imagery from the mid-1990s; the 2001 NLCD contains classes, which are derived classifications of multi-season Landsat 5 and Landsat 7 imagery. The percentage of each NLCD category is computed and classified for each watershed on the basis of the Anderson Classification scheme. The 1992 and 2001 land cover characteristics are summarized in tables 2–5.

Population Characteristics

Population data from the Center for International Earth Science Information Network (CIESIN) are characterized for each watershed. The CIESIN is a nongovernmental organization at Columbia University, New York City. It develops datasets and analysis capabilities for studying a wide range of human and environmental interactions. CIESIN datasets include human population estimates for 1990 and 2000 called the Gridded Population of the World (GPWv3; Gridded Population of the World Version3, 2005). The dataset provides estimates of human population density in units of persons per square kilometer.

Table 1. Elevation-derived watersheds for major rivers of the conterminous United States.

Altamaha	Hudson	Red River
Apalachicola	Kansas	Rio Grande
Arkansas	Kennebec	Roanoke
Atchafalaya	Klamath	Rogue
Biloxi	Lake Champlain	Sabine
Black	Merrimack	Sacramento/San Joaquin
Brazos	Mississippi	Saint John
Calcasieu	Missouri	Saint Johns
Caloosahatchee	Mobile	Salinas
Cape Fear	Navidad	San Francisco Bay
Chehalis	Neuse	San Gabriel
Chesapeake Bay	Nueces	Santa Maria
Cheyenne	Ochlockonee	Santa Ynez
Choctawhatchee	Ogeechee	Santee
Chowan	Ohio	Satilla
Colorado	Pajaro	Savannah
Colorado, Texas	Pamlico	Souris
Columbia	Pascagoula	Suwannee
Connecticut	Peace	Tampa Bay
Delaware	Pearl	Trinity
Edisto	Pee Dee	Umpqua
Eel	Penobscot	Waccamaw
Escambia	Platte	Withlacoochee
Everglades	Puget Sound	Yellow
Great Basin	Rainy	Yellowstone
Great Lakes	Red	

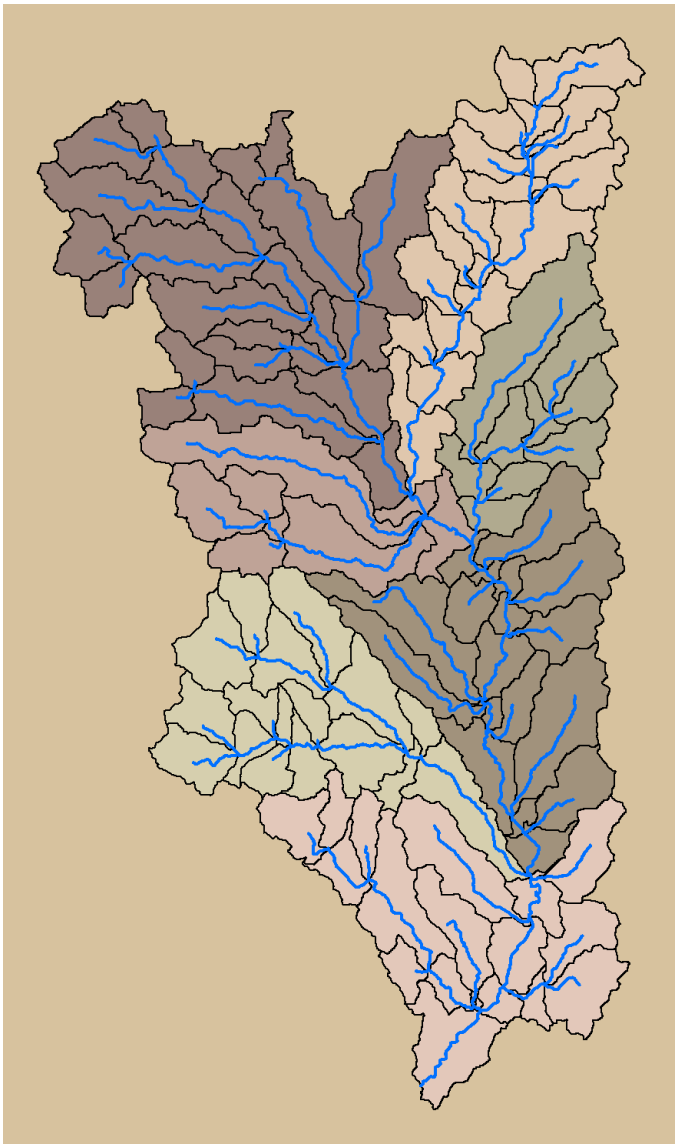

Figure 3. Reach catchments within an elevation-derived watershed.

The GPWv3 dataset is developed globally using census data specific to each country. These country-specific data are converted to a uniform 2.5-arc-minute resolution raster dataset. Population density values for each census unit are developed for each country. These data are overlaid on a 2.5-arc-minute grid to determine proportions of density values per grid cell (Deichmann and others, 2001).

GPWv3 population density datasets for 1990 and 2000 are used for estimating average population density for major U.S. watersheds. These data are projected into the USGS Albers Equal Area projection at a resolution of 3,845 meters by 3,845 meters. Population density samples (cells) for each watershed are summed and divided by the total number of cells in the watershed. The 1990 and 2000 population characteristics are summarized in table 6 and table 7, respectively.

Table 2. Land cover characteristics, in percent, for elevation-derived watersheds, 1992 (National Land Cover Data (NLCD) from U.S. Geological Survey, 2007). NLCD 1992 classification schemes in table 3.

Watersheds	11	12	21	22	23	31	32	33	41	42	43	51	61	71	81	82	83	84	85	91	92
Altamaha	1.2	0	1.7	0.4	0.8	0.1	0.3	5.4	21.9	24.8	10.8	0	0	0	8.1	15.5	0	0	0.5	8.4	0.2
Apalachicola	2.0	0	1.6	.4	.9	0	.1	4.2	21.8	17.5	17.6	0	0	.1	8.6	15.5	0	0	.4	9.1	.4
Arkansas	1.2	0	.6	.2	.4	.3	0	.1	8.7	4.4	1.6	5.6	0	44.6	11.2	6.9	13.0	.2	.1	.5	.3
Atchafalaya	6.2	0	.9	.1	.7	0	0	.2	3.5	3.4	1.4	0	0	.4	10.4	20.5	2.9	0	.7	19.9	28.9
Biloxi	3.1	0	1.6	.5	1.1	0	0	3.3	2.2	40.9	14.3	0	0	0	8.4	2.6	0	0	1.7	18.8	1.5
Black	.4	0	1.2	.3	.7	0	.1	2.9	10.6	23.7	8.8	0	0	0	3.1	28.8	0	0	.3	18.9	.3
Brazos	1.6	0	.5	.2	.5	.5	.1	0	7.2	4.5	.4	14.5	0	26.3	15.5	21.7	5.5	.1	.1	.3	.4
Calcasieu	5.7	0	1.4	.3	1.0	.2	.1	4.2	7.6	28.1	11.3	0	0	.4	9.3	4.2	8.1	0	.2	11.3	6.7
Caloosahatchee	3.0	0	8.9	1.9	1.1	.1	.1	1.0	0	9.5	0	2.1	6.0	14.9	13.6	10.5	0	0	.6	15.4	11.4
Cape Fear	1.5	0	2.6	.8	1.3	.2	.1	1.1	20.4	24.9	9.6	0	0	0	7.3	15.8	0	0	.3	13.9	.4
Chehalis	1.6	0	.9	0	.6	.1	0	6.6	18.9	45.1	16.0	1.0	.2	.5	6.7	.6	.1	0	0	1.0	.2
Chesapeake Bay	7.6	0	2.4	.2	1.1	0	.4	.6	40.7	5.6	11.7	0	0	0	20.7	6.2	0	0	.2	1.7	.9
Cheyenne	.5	0	.1	0	.1	.9	.1	0	.5	10.2	0	12.9	0	65.8	2.7	.5	2.9	1.4	.1	.5	.9
Choctawhatchee	2.9	0	.5	.1	.5	0	0	4.7	13.5	21.8	20.9	0	0	0	8.6	16.2	0	0	.4	9.4	.4
Chowan	1.4	0	.9	0	.6	0	0	2.3	25.4	15.8	15.1	0	0	0	9.9	16.6	0	0	.1	11.5	.4
Colorado	.4	0	.3	0	.2	3.8	.1	0	2.9	19.4	.6	58.9	0	11.0	1.1	.7	.2	0	0	.1	.1
Colorado-Texas	.7	0	.5	.2	.5	.7	0	0	3.1	7.8	0	42.0	0	25.9	3.5	13.1	1.7	0	.1	0	.1
Columbia	1.3	.1	.4	0	.4	1.6	0	1.4	1.3	37.4	1.2	30.3	.3	10.5	4.5	1.5	4.8	2.7	0	.2	.2
Connecticut	2.3	0	3.2	.5	1.7	.2	.1	.6	38.0	14.7	24.0	.2	0	0	2.3	6.4	0	0	.9	3.5	1.3
Delaware	8.2	0	5.6	1.2	1.9	0	.5	.2	35.4	4.1	14.0	0	0	0	16.7	6.7	0	0	.6	2.8	2.0
Edisto	2.9	0	.7	.3	.3	.1	.1	4.5	10.8	26.5	9.3	0	0	0	2.6	23.0	0	0	.1	16.8	1.9
Eel	.4	0	.1	0	.1	.7	0	.3	5.8	50.2	10.0	12.1	0	19.2	1.0	0	0	0	0	0	0
Escambia	.4	0	.3	0	.2	0	.1	4.3	11.2	35.9	25.2	0	0	0	6.9	8.4	0	0	.2	6.6	.3
The Everglades	13.7	0	3.1	.7	.9	.1	0	.7	0	4.3	0	.3	3.3	13.6	5.7	12.9	0	0	.2	15.7	24.6
Great Basin	2.0	0	.2	0	.2	9.3	.1	0	.9	10.2	.3	67.5	0	5.7	2.3	.4	.5	0	0	0	.4
Great Lakes	31.8	0	1.3	.6	.7	0	.1	.2	19.9	3.8	4.6	0	0	.9	9.6	17.2	0	0	.4	7.9	1.1
Hudson	3.2	0	3.5	1.1	1.3	0	.1	0	40.8	10.4	19.4	0	0	0	13.2	3.8	0	0	.7	2.3	.3
Kansas	0.7	0	0.2	0.1	0.3	0.1	0	0	1.9	0.1	0.1	0.6	0	42.8	8.1	25.5	16.7	2.1	0.1	0.1	0.4
Kennebec	6.0	0	.7	.1	.6	.1	0	2.1	30.3	22.3	27.4	.3	0	0	1.9	4.4	0	0	.3	2.5	1.1
Klamath	1.5	0	.1	0	.2	.7	0	.6	1.2	62.2	3.1	14.1	0	8.3	2.8	.5	2.5	0	0	.1	2.1
Lake Champlain	7.7	0	1.0	.3	1.0	.1	.1	.3	38.3	13.1	16.4	.1	0	0	6.6	11.8	0	0	.2	2.1	1.1
Merrimack	4.9	0	6.2	.9	3.0	.1	.1	.4	30.8	17.3	23.6	.1	0	0	1.6	5.0	0	0	1.1	3.1	1.6
Mississippi	1.48	0	.76	.16	.46	.2	.08	.34	16.88	6.10	4.04	4.78	0	25.72	13.0	15.3	6.98	1.22	.2	1.70	.54
Missouri	1.1	0	.3	.1	.3	.3	0	.3	3.2	5.6	.2	8.5	0	42.3	9.0	15.1	8.2	4.1	.1	.4	1.0
Mobile	1.6	0	.8	.2	.5	0	.2	2.3	25.8	19.3	24.3	0	0	0	10.3	7.7	0	0	.3	6.4	.3
Navidad	7.5	0	.4	.2	.4	.3	.1	.1	13.5	7.4	.3	11.0	0	14.0	21.8	17.7	.5	0	.1	.3	4.5
Neuse	3.3	0	2.8	.6	1.3	.1	.1	.9	16.1	19.3	7.0	0	0	0	6.2	23.6	0	0	.4	17.8	.5
Nueces	3.3	0	.6	.5	.6	.5	.1	0	6.9	12.5	.3	38.5	0	13.2	11.4	8.7	1.1	.1	.2	.2	1.3
Ochlockonee	1.6	0	1.6	.2	.4	0	.1	8.9	2.6	23.7	7.3	.3	.3	1.9	3.2	19.2	0	0	.1	26.9	1.6
Ogeechee	1.3	0	.8	.3	.5	.1	0	5.6	10.8	26.9	7.4	0	0	0	3.0	26.3	0	0	.2	16.2	.8
Ohio	1.4	0	1.6	.2	.7	0	.3	.3	43.4	4.2	7.6	0	0	.1	19.2	19.4	0	0	.5	1.0	.1
Pajaro	.1	0	1.5	.2	.6	1.6	0	0	3.7	12.7	7.5	16.6	3.7	40.3	7.4	3.8	0	.1	.2	0	0
Pamlico	1.5	0	1.7	.2	.7	.1	.1	1.4	21.9	20.2	8.3	0	0	0	7.9	21.0	0	0	.3	14.6	.3
Pascagoula	1.1	0	.5	.1	.4	0	0	3.6	11.1	32.6	22.7	0	0	0	11.4	5.4	0	0	.2	10.2	.6
Peace	4.1	0	5.7	1.4	1.4	.5	1.2	.6	0	6.8	0	1.1	10.6	26.9	9.8	6.4	0	0	.3	15.0	8.2

Table 2. Land cover characteristics, in percent, for elevation-derived watersheds, 1992 (National Land Cover Data (NLCD) from U.S. Geological Survey, 2007). NLCD 1992 classification schemes in table 3.—Continued

Watersheds	11	12	21	22	23	31	32	33	41	42	43	51	61	71	81	82	83	84	85	91	92
Pearl	16.3	0	1.9	.5	.7	.1	0	.9	11.8	21.3	12.3	0	0	.1	14.1	4.7	0	0	.4	6.8	8.0
Pee Dee	.9	0	2.3	.4	1.1	.1	.1	1.2	23.7	17.3	10.8	0	0	0	10.2	20.7	0	0	.3	10.8	.1
Penobscot	5.7	0	.3	.1	.4	.1	0	2.4	21.3	27.8	34.2	.3	0	0	.4	1.8	0	0	.2	4.4	.8
Platte	.9	.1	.6	.1	.4	.2	0	.1	1.7	6.2	0	11.8	0	50.0	4.6	14.5	3.6	3.0	.1	.2	1.8
Puget Sound	16.3	.9	3.6	0	1.2	2.5	0	4.1	8.7	45.1	7.9	2.6	.2	2.4	3.4	.3	.2	0	.2	.3	0
Rainy	9.6	0	.1	0	.3	0	.2	1.1	17.0	10.8	12.4	1.8	0	0	2.4	1.7	.4	0	0	38.7	3.4
Red	2.1	0	.6	.1	.4	.2	0	.7	14.0	11.3	7.9	5.2	0	16.8	12.3	15.2	7.8	.1	.1	4.8	.4
Red River	3.1	0	.2	.1	.4	0	0	.1	6.7	.2	.1	.2	0	3.4	9.4	57.1	8.3	0	.1	4.9	5.9
Rio Grande	.7	0	.2	.1	.3	1.7	0	0	.5	9.8	.1	48.8	0	34.1	1.2	1.9	.1	0	0	0	.3
Roanoke	2.3	0	1.8	.1	.7	0	.1	1.3	39.1	14.2	12.7	0	0	0	16.3	6.0	0	0	.1	5.1	.2
Rogue	.4	0	.5	0	.3	.2	0	.8	2.1	69.1	11.5	2.9	0	6.4	5.0	.2	.4	0	.1	0	.2
Sabine	4.6	0	.9	.3	1.0	.1	.1	2.3	17.6	15.8	21.9	0	0	.5	20.9	2.1	1.8	0	.1	6.5	3.4
Sacramento/San Joaquin	1.6	0	1.6	0	0.6	2.2	0	0.1	3.0	29.3	4.0	13.1	6.0	20.7	6.4	6.3	4.3	0	0.1	0.1	0.6
Saint John	3.3	0	.3	0	.3	0	0	3.3	23.8	26.2	33.2	.5	0	0	.3	5.7	0	0	.2	2.4	.5
Saint Johns	7.6	0	6.8	2.0	1.7	.2	.1	3.7	0	29.9	0	1.3	3.1	9.7	2.7	7.6	0	0	.3	15.7	7.4
Salinas	.2	0	.6	.1	.4	3.4	0	0	1.3	12.4	3.7	16.0	.8	47.9	4.9	7.1	.9	.1	.3	0	0
San Francisco	12.3	0	18.	.4	4.9	1.0	.1	0	4.7	10.4	8.5	7.5	.4	26.5	1.4	.6	.3	0	1.5	0	.5
San Gabriel	.6	0	14.4	2.9	5.0	1.7	0	0	.8	13.6	3.2	38.4	.9	9.5	1.4	5.0	.9	.1	1.3	.1	.1
Santa Maria	0	0	.6	.2	.3	5.0	0	0	2.1	14.7	3.8	28.3	1.0	36.3	3.9	3.1	.5	.1	.1	0	0
Santa Ynez	.4	0	.7	.2	.3	1.3	.3	0	1.3	15.4	8.3	35.0	.6	29.2	2.9	3.3	.4	0	.3	0	0
Santee	2.8	0	3.5	.9	1.6	.2	.1	2.1	26.9	24.6	14.2	0	0	0	7.8	10.3	0	0	.6	4.1	.2
Satilla	1.2	0	.4	.1	.3	0	0	7.6	4.3	37.0	5.5	0	0	0	4.0	21.2	0	0	.1	16.0	2.3
Savannah	3.1	0	1.4	.3	.7	.1	.2	4.7	21.4	29.7	13.1	0	0	0	7.2	10.5	0	0	.4	6.5	.7
Souris	1.3	0	.2	.1	.4	.4	.1	0	3.2	0	0	1.2	0	26.9	2.0	10.4	42.4	7.4	.1	.1	3.9
Suwannee	.9	0	1.1	.2	.4	.1	.2	6.7	2.2	32.8	2.6	.5	.1	4.9	4.7	20.3	0	0	.1	19.9	2.5
Tampa Bay	14.6	0	12.3	6.2	4.0	.4	1.1	.9	0	6.5	0	.6	5.7	15.8	4.2	6.6	0	0	1.1	15.1	4.9
Trinity	5.4	0	3.8	2.0	2.3	.2	.1	.5	12.4	5.5	9.8	1.4	0	8.7	35.3	5.6	2.6	0	.7	2.0	1.7
Umpqua	.6	0	.2	0	.3	.2	0	1.4	3.3	71.0	11.4	2.0	0	4.9	4.5	0	.1	0	0	0	.1
Waccamaw	1.4	0	.9	.2	.7	.1	.1	1.7	4.1	32.9	5.8	0	0	0	3.7	17.0	0	0	.5	30.7	.2
Withlacoochee	2.2	0	7.7	.8	.9	.2	.2	3.0	.3	21.9	0	2.3	2.2	16.5	2.5	15.0	0	0	.2	17.9	6.1
Yellow	2.0	0	.4	.1	.7	0	0	6.2	10.5	34.3	18.7	0	0	0	6.6	10.4	0	0	.4	9.2	.4
Yellowstone	.6	.1	.1	0	.1	.5	.1	1.1	.8	12.8	.1	27.0	0	46.9	1.9	.6	3.2	3.4	0	.3	.4

Table 3. National Land Cover Data classification schemes, 1992 (from U.S. Geological Survey, 2007).

	Classification
11	Open Water
12	Perennial Ice / Snow
21	Low Intensity Residential
22	High Intensity Residential
23	Commercial / Industrial / Transportation
31	Bare Rock / Sand / Clay
32	Quarries / Strip Mines / Gravel Pits
33	Transitional
41	Deciduous Forest
42	Evergreen Forest
43	Mixed Forest
51	Shrubland
61	Orchards / Vineyards / Other
71	Grasslands / Herbaceous
81	Pasture / Hay
82	Row Crops
83	Small Grains
84	Fallow
85	Urban / Recreational Grasses
91	Woody Wetlands
92	Emergent Herbaceous Wetlands

Elevation and Slope Characteristics

Elevation statistics are computed by using the EDNA filled elevation layer, a hydrologically conditioned DEM that contains no depressions. Zonal statistics are derived for each watershed drainage area and include minimum, maximum, and average elevation. Statistics for EDNA slope are computed in the same manner. The elevation and slope characteristics are summarized in table 8 and table 9, respectively. Watershed basin characteristics derived from EDNA are among the most time-consuming to generate because of the size of the nationwide elevation and slope grids, each exceeding 55 gigabytes.

Other Ancillary Characteristics

The National Inventory of Dams (NID) database contains an inventory of more than 79,000 dams in the United States. The database is maintained by the U.S. Army Corps of Engineers and used for inspection, safety, and other applications by Federal and State agencies. A dam is included in the NID database if it is a potential hazard or exceeds a height of 25 feet with 15 acre-feet of storage, or exceeds a height of 6 feet with 50 acre-feet of storage. Because dams can be used for multiple purposes, they are categorized as such in the NID database with a "Purposes" attribute (table 10). For each "Purpose" category assigned to each dam in a watershed, the percentage of dams used for each category is computed. Because some dams have multiple purposes, the percentages for the number of dams in a watershed do not always equal 100 percent. For example, a watershed with 100 dams might have 100 percent used for recreation, 60 percent used for flood control, and 1 percent used for hydroelectric generation.

The EDNA Watershed Atlas

The elevation-derived watershed basins and characteristics for major rivers of the conterminous United States are published in an online EDNA Watershed Atlas. The atlas serves as a framework for geographic analyses of watershed basins and characteristics and is a valuable tool for evaluating change within watersheds. The atlas is published in a standard Web browser and in a three-dimensional (3D) environment, such as Google Earth. The EDNA Watershed Atlas portal is at *http://edna.usgs.gov/watersheds/* (fig. 4) and is accessible through the EDNA Web site at *http://edna.usgs.gov* (fig. 5).

The Hypertext Markup Language (HTML) Option (Web browser)

By selecting the *HTML* link on the EDNA Watershed Atlas portal (fig. 4), the elevation-derived watershed basins and characteristics can be accessed exclusively in a standard Web browser. Each watershed name is a Web link to that watershed's characteristics. For example, selection of the Chesapeake Bay watershed (link) redirects to the watershed characteristics for the Chesapeake Bay (fig. 6). Additional Chesapeake Bay watershed characteristics, such as land cover, population, elevation, slope, or dams can be accessed by selecting one of the *EDNA watershed characteristics* links (left side in fig. 6). Selection of the *Slope* link redirects to the Chesapeake Bay watershed slope characteristics (fig. 7). Other watersheds can be accessed by selecting the *Return to Watershed Index* link to return to the EDNA Watershed Atlas portal.

The 3D Option (Google Earth)

The EDNA Watershed Atlas can be accessed in 3D by selecting the *KML* link from the Watershed Atlas portal at *http://edna.usgs.gov/watersheds/* (fig. 4). The 3D atlas portal looks similar to the Web portal; however, selection of the 3D links will result in a Keyhole Markup Language (KML) file loaded into Google Earth. There are two options in Google Earth: *Watershed Layers and Watershed Characteristics.*

Table 4. Land cover characteristics, in percent, for elevation-derived watersheds, 2001 (National Land Cover Data (NLCD) from U.S. Geological Survey, 2007). NLCD 2001 classification schemes in table 5.

Watersheds	11	12	21	22	23	24	31	41	42	43	52	71	81	82	90	95
Altamaha	1.2	0	5.9	2.6	0.7	0.3	0.7	20.0	24.8	5.1	0.9	9.7	10.6	6.4	10.5	0.7
Apalachicola	1.9	0	5.5	2.6	.7	.4	.3	19.7	24.0	3.9	4.0	5.5	9.0	12.3	9.6	.4
Arkansas	1.2	0	3.2	.9	.3	.1	.3	8.9	5.4	.6	7.1	41.8	8.6	20.7	.8	.2
Atchafalaya	5.5	0	.5	2.9	.4	.2	.2	0	2.3	.6	1.3	1.1	6.8	23.8	45.8	8.6
Biloxi	3.1	0	7.7	4.2	1.3	.4	.4	0	37.9	1.2	13.2	2.8	4.6	.3	21.0	1.8
Black	.4	0	4.8	1.2	.3	.1	.1	3.8	20.6	1.5	5.0	8.4	8.6	16.2	28.5	.5
Brazos	1.0	0	3.4	.8	.3	.1	.2	5.4	4.9	.7	19.8	30.0	8.9	22.2	2.0	.3
Calcasieu	5.2	0	2.3	4.5	.5	.3	.2	.1	26.7	2.8	14.2	6.6	7.8	6.1	16.5	6.1
Caloosahatchee	2.1	0	8.2	5.8	1.1	.3	.1	0	3.4	0	12.8	1.3	17.5	16.9	21.6	8.8
Cape Fear	1.4	0	6.0	2.9	.9	.3	.3	15.6	19.0	4.1	3.7	9.1	9.2	12.8	13.9	.5
Chehalis	1.4	0	4.6	1.6	.5	.2	2.3	4.1	51.1	6.0	11.2	5.2	4.8	.9	4.4	1.7
Chesapeake Bay	7.3	0	4.5	2.3	.9	.3	.6	42.2	6.5	5.4	.6	.3	17.7	8.8	1.6	.9
Cheyenne	.6	0	.7	.2	.1	0	1.3	.3	11.5	.1	16.3	62.8	1.0	3.5	1.0	.5
Choctawhatchee	2.9	0	5.0	1.0	.3	.1	.2	8.1	29.6	5.9	13.8	1.6	8.6	11.0	11.4	.5
Chowan	1.1	0	2.0	.5	.1	0	1.6	25.1	26.5	3.2	.7	1.6	11.0	16.1	9.9	.6
Colorado	.5	.1	.7	.5	.2	0	3.3	3.4	19.8	.4	61.1	7.1	1.3	.9	.5	.2
Colorado-Texas	.5	0	2.1	.5	.2	.1	.2	2.8	5.2	.3	57.5	15.6	2.5	11.9	.5	.1
Columbia	1.2	0	1.4	.7	.3	.1	.9	.5	36.5	.5	35.8	8.9	2.1	10.2	.5	.5
Connecticut	2.0	0	4.5	2.7	1.4	.3	.2	37.2	17.7	21.2	1.4	.2	5.1	2.1	3.6	.3
Delaware	7.9	0	6.8	4.4	2.2	1.0	.9	38.5	3.5	4.4	.2	.1	11.7	12.5	4.0	1.9
Edisto	2.6	0	4.1	1.1	.2	.1	.1	8.1	25.4	2.6	2.9	11.7	7.9	11.6	19.9	1.8
Eel	.5	0	3.1	.1	.1	0	.4	5.2	48.8	7.1	24.4	9.6	.6	0	.1	0
Escambia	.7	0	3.9	.6	.1	0	.2	14.7	32.5	10.0	11.3	1.0	8.8	6.6	9.3	.3
The Everglades	12.0	0	4.1	1.8	.6	.2	.1	0	2.0	0	3.9	.9	11.7	15.8	18.7	28.2
Great Basin	1.8	0	.7	.5	.2	0	6.9	1.6	10.9	.2	69.5	4.1	1.8	1.1	.2	.4
Great Lakes	34.0	0	3.5	2.3	.8	.3	.3	17.8	4.4	2.4	1.1	2.1	6.0	15.1	8.7	1.1
Hudson	3.1	0	5.5	2.1	1.0	.4	.1	39.2	10.0	9.9	2.0	.6	10.8	5.6	9.2	.4
Kansas	.7	0	3.5	.7	.2	.1	.1	2.4	0	0	0	39.1	3.4	49.1	.7	.1
Kennebec	5.6	0	2.3	1.1	.4	.1	.5	23.9	20.3	28.2	6.3	.8	2.5	1.3	5.8	.9
Klamath	1.7	0	1.7	.3	0	0	.9	.8	55.2	1.8	21.4	8.9	2.3	3.4	0	1.5
Lake Champlain	7.4	0	3.1	1.4	.6	.1	.1	33.1	15.8	14.8	1.7	.6	10.4	5.1	5.1	.5
Merrimack	4.4	0	5.4	5.0	3.6	0.8	0.4	28.4	19.2	20.1	1.3	0.3	4.6	1.0	4.8	0.9
Mississippi	1.6	0	3.5	1.3	.4	.1	.3	15.6	5.2	1.1	6.8	24.9	9.5	26.7	2.1	.8
Missouri	1.2	0	2.3	.6	.2	.1	.5	3.2	5.9	.1	10.6	41.5	6.8	25.1	1.0	.9
Mobile	1.9	0	4.9	1.4	.4	.2	.3	26.8	19.9	9.5	7.3	2.3	12.2	4.4	7.9	.4
Navidad	6.9	0	4.4	.5	.2	.1	.2	7.6	4.7	.5	9.4	2.6	33.3	22.8	4.7	1.9
Neuse	3.4	0	7.6	2.7	1.0	.3	.1	12.9	14.7	4.0	1.8	7.9	7.3	21.6	13.9	.7
Nueces	2.7	0	3.3	1.5	.5	.2	.5	4.0	6.8	.2	45.3	9.0	13.9	8.8	2.0	1.2
Ochlockonee	1.0	0	4.6	1.1	.2	.1	.2	8.0	26.1	7.8	.3	6.1	3.9	13.6	25.6	1.5
Ogeechee	.6	0	4.7	1.5	.4	.1	.3	11.8	24.3	4.6	1.4	11.2	5.9	15.0	16.3	1.9
Ohio	1.5	0	5.8	2.1	.7	.3	.2	46.2	2.5	2.1	.9	2.3	15.3	19.3	.6	.1
Pajaro	.2	0	6.2	2.0	1.5	.3	.2	0	7.0	14.1	24.9	34.1	1.1	8.1	.3	.3
Pamlico	1.5	0	5.6	1.4	.5	.2	.1	17.9	18.8	4.4	2.4	7.9	9.2	20.1	9.8	.4
Pascagoula	1.3	0	4.4	.9	.3	.1	.1	6.8	30.2	14.6	13.1	1.0	10.3	1.9	14.5	.6
Peace	3.6	0	7.2	2.7	.9	.3	1.5	0	2.0	0	2.6	4.9	26.5	17.2	25.3	5.4

Table 4. Land cover characteristics, in percent, for elevation-derived watersheds, 2001 (National Land Cover Data (NLCD) from U.S. Geological Survey, 2007). NLCD 2001 classification schemes in table 5.—Continued

Watersheds	11	12	21	22	23	24	31	41	42	43	52	71	81	82	90	95
Pearl	16.2	0	4.3	2.2	.7	.3	.2	5.2	17.3	6.3	10.0	1.1	10.9	2.5	17.4	5.4
Pee Dee	.8	0	6.4	2.0	.5	.2	.1	22.7	14.5	2.7	2.2	8.2	14.4	11.9	13.1	.2
Penobscot	4.6	0	1.4	.6	.2	.1	.5	16.1	22.5	33.1	7.0	.7	.9	1.1	9.9	1.4
Platte	.8	.1	2.2	.8	.3	.1	.4	.9	7.0	.1	15.5	46.8	1.3	21.3	1.2	1.3
Puget Sound	15.0	.9	4.1	4.2	1.6	.7	3.2	2.6	43.8	6.6	7.6	3.1	2.9	.6	1.7	1.2
Rainy	9.1	0	.8	.2	0	0	.2	31.4	21.2	.3	3.2	1.0	1.4	1.2	21.5	8.6
Red	2.0	0	3.3	1.4	.2	.1	.2	10.4	14.7	3.6	14.0	19.6	7.4	16.5	6.3	.2
Red River	4.1	0	3.9	.5	.1	0	0	7.7	.9	0	.2	4.5	8.3	59.9	2.8	6.9
Rio Grande	.5	0	1.0	.6	.2	.1	1.0	.8	10.0	.1	63.7	18.2	1.1	2.0	.4	.3
Roanoke	2.0	0	4.6	1.7	.4	.2	.3	41.8	13.0	3.9	2.0	3.5	18.4	3.9	4.1	.1
Rogue	.3	0	2.7	.9	.3	.1	.5	.2	65.5	2.6	18.6	3.6	3.0	.9	.5	.1
Sabine	4.1	0	3.7	3.1	.5	.2	.1	5.9	21.7	6.6	8.4	5.7	15.6	2.2	18.9	3.1
Sacramento/San Joaquin	1.5	0	2.9	1.2	1.1	.2	2.6	1.4	27.1	1.5	17.8	20.5	2.8	18.0	.2	1.0
Saint John	2.8	0	.8	.4	.1	0	.5	15.9	20.9	33.0	10.1	.8	1.0	4.7	8.4	.6
Saint Johns	6.7	0	9.0	4.2	1.3	.4	.2	.7	24.1	.7	2.2	8.3	10.3	4.8	22.0	5.1
Salinas	.3	0	5.0	.7	.5	.1	2.4	0	5.2	8.8	29.4	37.4	1.3	7.9	.6	.3
San Francisco	12.0	0	8.1	7.7	14.0	4.2	0	0	4.6	17.7	11.5	18.2	0.2	0.6	0.2	1.0
San Gabriel	.6	0	11.6	11.9	13.6	2.1	.6	0	10.0	1.6	31.1	12.2	1.5	2.7	.3	0
Santa Maria	0	0	2.6	.8	.4	0	2.6	0	8.7	8.4	51.2	17.3	1.7	5.6	.3	.4
Santa Ynez	.5	0	4.1	1.0	.6	0	.3	0	15.8	13.5	41.4	15.7	1.8	4.1	.4	.7
Santee	2.9	0	7.8	3.5	1.0	.5	.6	31.3	19.8	2.0	1.3	6.9	15.4	1.5	5.4	.2
Satilla	.8	0	4.3	1.5	.3	.1	.1	3.6	30.5	2.7	1.5	11.3	4.9	14.3	21.0	3.0
Savannah	3.1	0	5.3	1.9	.5	.2	.9	25.6	25.5	2.6	1.2	10.1	12.0	2.9	7.6	.8
Souris	3.2	0	4.2	.5	.1	0	.1	2.3	0	0	0	20.9	8.4	54.1	.5	5.7
Suwannee	.6	0	4.6	1.1	.2	.1	.2	4.0	26.8	5.0	.8	11.7	7.8	13.3	22.3	1.3
Tampa Bay	13.4	0	13.2	9.5	5.9	1.9	1.6	0	3.8	0	2.3	3.8	10.4	5.5	25.3	3.3
Trinity	5.1	0	6.5	5.5	3.2	1.5	.4	7.5	6.2	3.5	3.9	21.7	19.6	6.2	7.9	1.3
Umpqua	.5	0	2.2	.4	.2	.1	.6	.5	66.8	5.8	12.3	4.6	5.1	.3	.6	.2
Waccamaw	1.3	0	4.8	1.7	.4	.1	.1	1.2	21.2	1.8	3.4	11.7	.8	17.7	33.0	.9
Withlacoochee	1.4	0	9.8	2.6	.8	.1	.3	.1	19.6	0	3.0	3.0	21.6	1.7	30.7	5.2
Yellow	2.3	0	6.3	.9	.2	.1	.3	2.4	44.5	4.9	10.0	3.9	7.3	6.6	9.7	.6
Yellowstone	.5	0	.6	.2	.1	0	1.0	.2	12.6	0	34.5	42.2	1.6	4.5	1.3	.6

Table 5. National Land Cover Data classification schemes, 2001 (from U.S. Geological Survey, 2007).

	Classification
11	Open Water
12	Perennial Ice / Snow
21	Developed, Open Space
22	Developed, Low Intensity
23	Developed, Medium Intensity
24	Developed, High Intensity
31	Barren Land
32	Unconsolidated Shore
41	Deciduous Forest
42	Evergreen Forest
43	Mixed Forest
51	Dwarf Shrub
52	Scrub/Shrub
71	Grasslands/Herbaceous
72	Sedge Herbaceous
73	Lichens
74	Moss
81	Pasture/Hay
82	Cultivated Crops
90	Woody Wetlands
95	Emergent Herbaceous Wetlands

Watershed Layers (Google Earth)

In Google Earth, *Watershed Layers* contains folders with integrated characteristics similar to a GIS (including transparency). The *Watershed Layers* folders include watershed boundary, elevation, land cover, and EDNA synthetic channels (streams). The *Boundary* is a polygon generated by the watershed tool by using the EDNA database and represents the watershed basin in that it follows the drainage divide. The *Elevation* folder provides topographic information and is derived from the EDNA database. The *Land Cover* folder contains 1992 and 2001 land cover distributions. The *Streams* folder contains mean annual streamflow in cubic meters per second for the EDNA synthetic streams. Some of the channels in larger watersheds are generalized because of software limitation of vertices. The *Population* folder contains 1990 and 2000 average population densities. The *Watershed Layers* folders that contain temporal data, such as *Population*, can be independently toggled to determine change within the watershed (fig. 8).

Watershed Characteristics (Google Earth)

In Google Earth, *Watershed Characteristics* is a gateway to the elevation-derived watershed summary statistics. Selection of the link (either under the *Temporary Places* folder or the placemark in the center of the display window) accesses a Web link where the characteristics are available for analysis (fig. 9).

Results

Elevation-derived watershed basins and characteristics for major rivers of the conterminous United States contain characteristics for 77 watersheds. We have chosen to discuss the results of the elevation-derived watershed characteristics for the Chesapeake Bay only.

Land cover (1992) characteristics summarized for the Chesapeake Bay watershed indicate that the elevation-derived watershed basin primarily consists of forest, cropland, and pasture (fig. 10). Located in the highly urbanized eastern part of the country, the Chesapeake Bay watershed is composed of 3.9 percent urban land cover. Transitional and barren land account for a small percentage of this watershed area. Land cover (2001) characteristics generated from NLCD (U.S. Geological Survey, 2007) indicate the watershed still primarily consists of forest, cropland, and pasture (fig. 11).

In 1990, the average population density for the Chesapeake Bay watershed was 86.3499 persons per square kilometer (fig. 12). In 2000, the average population density had increased to 95.0975 persons per square kilometer (fig. 13). This direct spatial and temporal comparison is valuable for determining population change within a watershed and for evaluating population effects on watersheds.

The drainage area for the Chesapeake Bay watershed is 174,590 square kilometers with the minimum elevation at sea level and a maximum elevation of 1,481.10 meters (fig. 14). The minimum slope for the Chesapeake Bay watershed is 0 degrees, and the maximum slope is 69.3009 (fig. 15).

Discussion

The EDNA watershed delineation tool provided an avenue to delineate 77 watersheds that constitute the EDNA Watershed Atlas. The watershed delineation tool, however, is designed to create a watershed from any point within the conterminous United States. Therefore, additional watersheds and their characteristics can be added to the EDNA Watershed Atlas.

The number of watershed characteristics was limited by time and budgetary constraints. Those characteristics included in the EDNA Watershed Atlas are land cover, population, drainage area, elevation, slope, and other ancillary data including dams. After the development of the EDNA Watershed

Table 6. Population characteristics for elevation-derived watersheds, 1990 (persons per square kilometer; from Gridded Population of the World, Version 3, 2005).

Watershed	Minimum	Maximum	Mean	Watershed	Minimum	Maximum	Mean
Altamaha	2.444	1,999.390	50.3785	Ohio	0	3,816.750	48.5199
Apalachicola	1.165	1,999.390	53.6451	Pajaro	.540	1,252.090	50.1417
Arkansas	.094	1,623.850	14.1808	Pamlico	6.936	993.684	39.8028
Atchafalaya	2.086	781.483	24.4898	Pascagoula	2.805	1,069.560	19.6377
Biloxi	6.484	1,608.420	87.9239	Peace	3.082	1,023.800	54.9626
Black	5.371	691.320	30.1817	Pearl	1.365	4,599.430	57.1864
Brazos	.150	1,571.540	15.9799	Pee Dee	5.371	1,368.370	47.4044
Calcasieu	2.073	870.525	22.4073	Penobscot	0	320.941	7.4835
Caloosahatchee	1.824	1,256.530	71.6347	Platte	.032	3,225.680	14.7907
Cape Fear	4.607	1,490.400	60.3852	Puget Sound	.087	9,272.470	108.6190
Chehalis	.555	601.184	21.4743	Rainy	.001	375.450	1.4961
Chesapeake Bay	0	7,016.260	86.3499	Red	.150	1,463.610	12.4867
Cheyenne	.063	739.655	2.7312	Red River	.498	1,663.220	5.1237
Choctawhatchee	3.110	656.003	22.3388	Rio Grande	0	2,481.360	10.9320
Chowan	3.259	356.272	15.2804	Roanoke	3.324	1,280.440	34.9882
Colorado	0	2,869.010	7.9348	Rogue	.553	759.116	16.2251
Colorado-Texas	.162	2,014.810	12.4362	Sabine	1.231	1,323.530	23.6667
Columbia	0	2,943.600	9.3127	Sacramento/ San Joaquin	.227	10,889.100	42.8452
Connecticut	.380	4,322.990	71.0533	Saint John	0	276.292	5.3935
Delaware	1.515	7,773.130	220.7280	Saint Johns	1.318	1,846.690	99.2333
Edisto	3.116	595.132	23.7199	Salinas	.454	2,187.560	22.6844
Eel	.398	150.419	4.4740	San Francisco	0	10,889.100	768.4640
Escambia	2.924	818.100	13.7091	San Gabriel	.767	5,295.070	607.0420
The Everglades	.034	1,813.480	30.8146	Santa Maria	.383	1,536.200	26.0551
Great Basin	0	2,558.150	6.2571	Santa Ynez	.384	965.969	26.0654
Great Lakes	0	8,365.610	75.4810	Santee	.628	1,560.800	69.1434
Hudson	.302	29,048.100	124.8820	Satilla	2.065	477.399	13.8041
Kansas	0	2,632.060	8.1808	Savannah	0	1,120.280	33.6838
Kennebec	.006	1,064.340	16.9063	Souris	.323	938.823	3.1468
Klamath	.112	685.914	2.6981	Suwannee	.560	867.353	15.4862
Lake Champlain	1.058	1,755.680	28.7681	Tampa Bay	0	2,328.500	334.3530
Merrimack	3.596	3,942.030	135.1700	Trinity	0	3,035.130	122.9840
Mississippi	.025	18,495.500	21.4810	Umpqua	.553	241.142	7.2061
Missouri	0	3,225.680	7.6948	Waccamaw	5.385	851.236	33.0933
Mobile	1.786	1,592.850	31.7039	Withlacoochee	9.231	702.942	44.4995
Navidad	2.971	1,166.390	11.7183	Yellow	2.924	418.485	16.6305
Neuse	6.691	1,420.200	70.5708	Yellowstone	.032	1,109.990	1.7943
Nueces	.047	2,908.900	24.8054				
Ochlockonee	1.165	1,359.490	22.7346				
Ogeechee	.232	2,021.140	26.2869				

Table 7. Population characteristics for elevation-derived watersheds, 2000 (persons per square kilometer; from Gridded Population of the World, Version 3, 2005).

Watershed	Minimum	Maximum	Mean	Watershed	Minimum	Maximum	Mean
Altamaha	2.696	2,441.900	65.44810	Ohio	0	3,684.090	52.40120
Apalachicola	1.337	2,441.900	67.20760	Pajaro	.564	1,608.660	64.00870
Arkansas	.079	1,743.370	16.01490	Pamlico	7.370	1,063.420	44.97360
Atchafalaya	2.425	772.262	25.56950	Pascagoula	3.431	1,014.820	21.99150
Biloxi	8.840	1,299.060	103.67000	Peace	3.160	1,071.340	64.46690
Black	6.483	666.800	31.80700	Pearl	1.136	4,313.740	62.30830
Brazos	.150	1,822.000	19.53970	Pee Dee	6.008	1,556.430	56.24530
Calcasieu	2.380	809.783	23.73720	Penobscot	.008	315.609	7.44283
Caloosahatchee	3.160	1,341.640	85.85530	Platte	.023	3,666.890	18.46410
Cape Fear	5.590	1,555.880	75.80190	Puget Sound	.037	9,101.530	128.78000
Chehalis	.670	592.890	23.91700	Rainy	.003	365.339	1.47902
Chesapeake Bay	.149	6,239.380	95.09750	Red	.150	1,512.980	13.20550
Cheyenne	.068	748.516	3.01630	Red River	.466	1,701.230	5.44082
Choctawhatchee	2.523	790.303	25.62640	Rio Grande	.023	2,646.880	13.96650
Chowan	6.350	342.324	16.68420	Roanoke	3.146	1,268.650	37.73600
Colorado	.002	4,015.190	11.53630	Rogue	.642	997.680	19.94330
Colorado-Texas	.114	2,147.970	15.24740	Sabine	1.284	1,459.920	26.19910
Columbia	.018	2,916.290	11.49250	Sacramento/ San Joaquin	.197	10,671.700	50.48020
Connecticut	.398	3,593.310	72.39410	Saint John	0	272.974	5.01735
Delaware	1.498	7,355.590	234.08400	Saint Johns	1.428	2,150.190	124.12300
Edisto	3.576	673.075	27.78680	Salinas	.485	2,548.500	28.40280
Eel	.387	171.819	4.79963	San Francisco	0	10,671.700	862.94100
Escambia	3.062	905.974	14.97530	San Gabriel	.809	5,856.650	692.49800
The Everglades	0	2,150.190	43.63280	Santa Maria	.315	1,875.480	31.26730
Great Basin	0	2,618.190	8.07698	Santa Ynez	.368	1,029.880	27.52100
Great Lakes	0	8,782.440	78.87440	Santee	.717	1,556.430	82.23850
Hudson	.328	29,680.500	130.59300	Satilla	2.334	420.262	15.89490
Kansas	.238	2,234.420	8.52539	Savannah	0	1,048.880	38.86540
Kennebec	.012	964.501	17.07390	Souris	.254	952.576	3.03534
Klamath	.126	730.727	2.88294	Suwannee	.517	900.537	18.93570
Lake Champlain	1.040	1,765.680	30.19020	Tampa Bay	3.659	2,616.070	390.53700
Merrimack	4.205	3,958.670	148.07200	Trinity	0	3,834.090	156.37000
Mississippi	.029	19,389.77	23.6513	Umpqua	.642	302.227	7.66179
Missouri	.023	3,666.890	8.73752	Waccamaw	6.503	832.239	42.76250
Mobile	.252	1,577.930	36.10900	Withlacoochee	12.014	705.034	60.97490
Navidad	3.188	1,231.130	12.76340	Yellow	2.523	514.013	22.44070
Neuse	7.409	1,555.880	90.49390	Yellowstone	.041	1,135.230	1.96221
Nueces	.113	2,942.550	29.68300				
Ochlockonee	1.337	1,491.550	27.31190				
Ogeechee	0	1,894.220	29.16240				

Table 8. Elevation characteristics for elevation-derived watersheds (EDNA).

Watershed	Area (square kilometers)	Minimum (meters)	Maximum (meters)	Watershed	Area (square kilometers)	Minimum (meters)	Maximum (meters)
Altamaha	36,969.2	0	508.12	Ohio	525,924.0	86.99	2,035.83
Apalachicola	50,579.3	0	1,348.87	Pajaro	3,371.4	0	1,597.36
Arkansas	405,274.0	34.35	4,411.43	Pamlico	8,908.9	0	219.54
Atchafalaya	14,369.3	0	79.80	Pascagoula	24,562.6	0	216.96
Biloxi	1,803.7	0	111.42	Peace	6,247.2	–.33	89.88
Black	4,598.4	.05	131.96	Pearl	44,357.5	0	220.06
Brazos	11,917.4	0	1,446.24	Pee Dee	37,183.6	.53	1,255.77
Calcasieu	9,914.0	0	142.75	Penobscot	21,641.5	0	1,599.24
Caloosahatchee	4,695.2	–.35	48.74	Platte	220,529.0	288.16	4,344.37
Cape Fear	23,501.0	0	332.90	Puget Sound	43,046.8	0	4,390.53
Chehalis	6,039.0	0	1,530.49	Rainy	52,850.2	323.39	669.19
Chesapeake Bay	174,590.0	0	1,481.10	Red	241,261.0	5.80	1,515.60
Cheyenne	65,489.3	492.47	2,205.44	Red River	104,877.0	232.13	720.81
Choctawhatchee	13,669.1	0	210.88	Rio Grande	302,550.0	0	4,361.49
Chowan	12,739.0	0	214.21	Roanoke	25,216.4	0	1,282.29
Colorado	625,052.0	24.72	4,361.41	Rogue	13,376.2	0	2,887.44
Colorado-Texas	109,703.0	0	1,384.99	Sabine	55,122.6	0	234.96
Columbia	542,635.0	0	4,391.03	Sacramento/ San Joaquin	158,164.0	0	4,410.10
Connecticut	27,714.9	0	1,911.87	Saint John	37,349.5	31.86	852.84
Delaware	35,504.2	0	1,265.87	Saint Johns	24,569.9	0	94.50
Edisto	9,792.0	0	207.04	Salinas	11,373.7	0	1,787.82
Eel	9,387.3	0	2,309.04	San Francisco	5,351.7	0	1,322.45
Escambia	11,013.6	0	205.06	San Gabriel	8,182.2	0	3,479.37
The Everglades	23,160.2	–.43	91.43	Santa Maria	4,733.9	0	2,636.60
Great Basin	546,922.0	–69.32	4,415.28	Santa Ynez	2,324.0	0	2,082.83
Great Lakes	328,737.0	32.31	1,401.25	Santee	39,584.5	0	1,802.80
Hudson	34,920.5	0	1,622.57	Satilla	8,988.3	0	112.57
Kansas	155,489.0	220.27	1,817.78	Savannah	27,852.0	0	1,672.74
Kennebec	25,492.5	0	1,912.33	Souris	43,557.2	430.20	821.00
Klamath	41,135.9	0	4,301.61	Suwannee	25,549.0	0	158.74
Lake Champlain	21,325.4	28.87	1,623.40	Tampa Bay	5,149.0	0	80.20
Merrimack	12,845.4	0	1,597.49	Trinity	60,672.3	0	460.78
Mississippi	3,171,588.0	0	4,411.43	Umpqua	12,104.7	0	2,786.40
Missouri	1,325,810.0	119.06	4,344.37	Waccamaw	4,186.0	.53	41.46
Mobile	113,316.0	0	1,280.37	Withlacoochee	5,384.3	0	91.49
Navidad	10,897.7	0	180.70	Yellow	6,126.9	0	160.15
Neuse	14,335.9	0	268.99	Yellowstone	181,388.0	564.45	4,198.78
Nueces	91,967.9	0	740.12				
Ochlockonee	6,773.5	0	137.84				
Ogeechee	12,118.1	0	225.66				

Table 9. Slope characteristics, in degrees, for elevation-derived watersheds (EDNA).

Watershed	Minimum	Maximum	Mean	Watershed	Minimum	Maximum	Mean
Altamaha	0	56.723	2.4034	Ohio	0	85.539	6.9332
Apalachicola	0	45.048	2.5798	Pajaro	0	54.621	12.8251
Arkansas	0	82.012	2.8716	Pamlico	0	18.985	1.4050
Atchafalaya	0	16.073	.3291	Pascagoula	0	30.056	2.4426
Biloxi	0	12.781	1.4203	Peace	0	13.165	.3133
Black	0	13.755	.4348	Pearl	0	29.891	1.3236
Brazos	0	39.087	1.5709	Pee Dee	0	51.816	2.9126
Calcasieu	0	12.533	.7617	Penobscot	0	67.428	3.4281
Caloosahatchee	0	5.738	.0781	Platte	0	78.849	3.8316
Cape Fear	0	39.303	1.6845	Puget Sound	0	84.655	13.1218
Chehalis	0	65.953	10.3737	Rainy	0	46.885	1.3063
Chesapeake Bay	0	69.301	6.1317	Red	0	56.000	1.9979
Cheyenne	0	60.039	4.3215	Red River	0	53.478	.6381
Choctawhatchee	0	29.008	2.3003	Rio Grande	0	79.878	4.3820
Chowan	0	21.775	1.4813	Roanoke	0	55.101	4.6593
Colorado	0	88.926	8.3710	Rogue	0	68.504	16.7673
Colorado-Texas	0	48.181	1.6211	Sabine	0	28.208	1.6643
Columbia	0	85.397	11.6346	Sacramento/ San Joaquin	0	84.760	9.4769
Connecticut	0	65.914	7.2958	Saint John	0	76.402	3.4405
Delaware	0	66.791	4.4139	Saint Johns	0	20.819	.4986
Edisto	0	16.575	.9905	Salinas	0	64.031	12.0949
Eel	0	65.226	17.7757	San Francisco	0	53.465	9.9823
Escambia	0	28.151	2.6659	San Gabriel	0	66.466	11.3324
The Everglades	0	12.432	.1044	Santa Maria	0	63.399	15.6017
Great Basin	0	85.113	7.2859	Santa Ynez	0	63.553	16.1116
Great Lakes	0	59.533	1.7116	Santee	0	71.043	4.2782
Hudson	0	64.788	6.6372	Satilla	0	12.781	.6199
Kansas	0	33.065	2.0485	Savannah	0	71.033	3.4455
Kennebec	0	70.301	5.5723	Souris	0	49.881	.6561
Klamath	0	74.085	12.4504	Suwannee	0	19.328	.6775
Lake Champlain	0	67.814	6.7859	Tampa Bay	0	12.005	.3874
Merrimack	0	60.644	5.5055	Trinity	0	29.430	1.3535
Mississippi	0	85.539	3.8619	Umpqua	0	68.545	18.0453
Missouri	0	81.309	4.0302	Waccamaw	0	11.697	.3336
Mobile	0	54.426	4.0093	Withlacoochee	0	15.294	.5734
Navidad	0	12.464	.5591	Yellow	0	18.128	1.8890
Neuse	0	22.512	1.1622	Yellowstone	0	81.309	7.6615
Nueces	0	58.237	1.8513				
Ochlockonee	0	24.734	1.5247				
Ogeechee	0	22.280	1.2536				

Table 10. National Inventory of Dams (NID) "Purposes" attribute categories.

"Purposes" Attribute	"Purposes" Attribute Categories
C	Flood Control and Storm Water Management
D	Debris Control
F	Fish and Wildlife Pond
H	Hydroelectric
I	Irrigation
N	Navigation
P	Fire Protection/Stock or Small Farm Pond
R	Recreation
S	Water Supply
T	Tailings

Atlas, the NLCD Retrofit Land Cover Change Data were released (*http://www.mrlc.gov/multizone.php*). Had these data been available during this research, they would have been included in the summarized statistics because they provide a more direct comparison with the 1992 NLCD (U.S. Geological Survey, 2007) categories.

Conclusions

Elevation-derived watersheds and characteristics for major rivers in the United States are developed to quantify EDNA hydrologic footprint characteristics so that researchers can evaluate the health of the Nation's watersheds by analyzing biological, physical, and anthropogenic change within watersheds. The watersheds are derived from the EDNA database by using the watershed generation tool to delineate watershed basins, or contributing areas, upstream from the mouth of major rivers of the conterminous United States. Watershed characteristics are selected to provide metrics for land cover distribution, population, drainage area, elevation, slope, and other ancillary data such as dams. The compilation of watershed basins and their characteristics are documented in an EDNA Watershed Atlas at *http://edna.usgs.gov/watersheds/*.

The EDNA Watershed Atlas is a valuable resource for analyzing watershed characteristics and evaluating change within major river basins of the conterminous United States. This new database is broadly useful in landscape change modeling and subsequent monitoring activities in future years.

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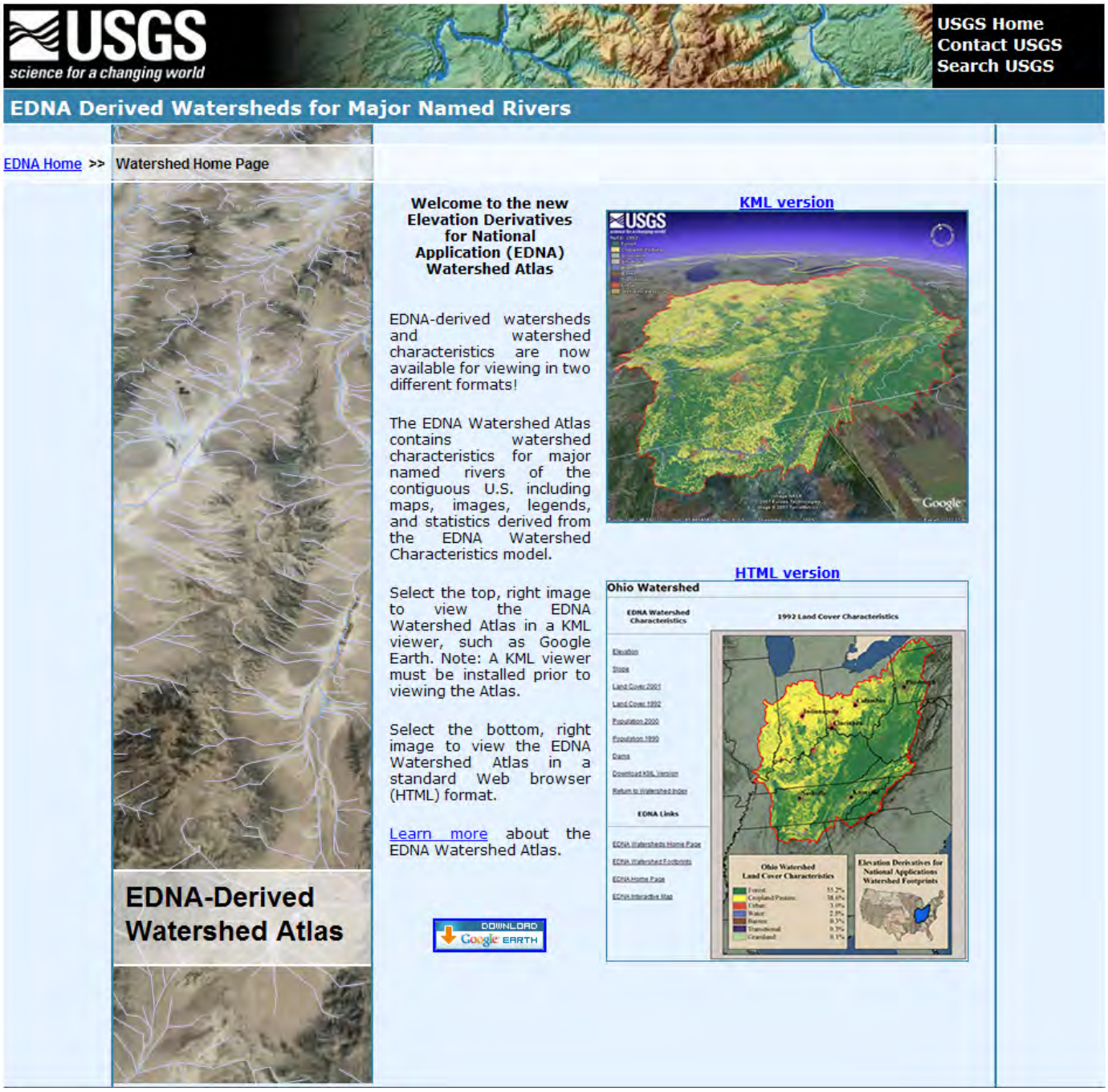

Figure 4. EDNA Watershed Atlas Web portal (*http://edna.usgs.gov/watersheds*) is accessible in a standard Web browser (HTML link) or with a three-dimension option, such as Google Earth (KML version link).

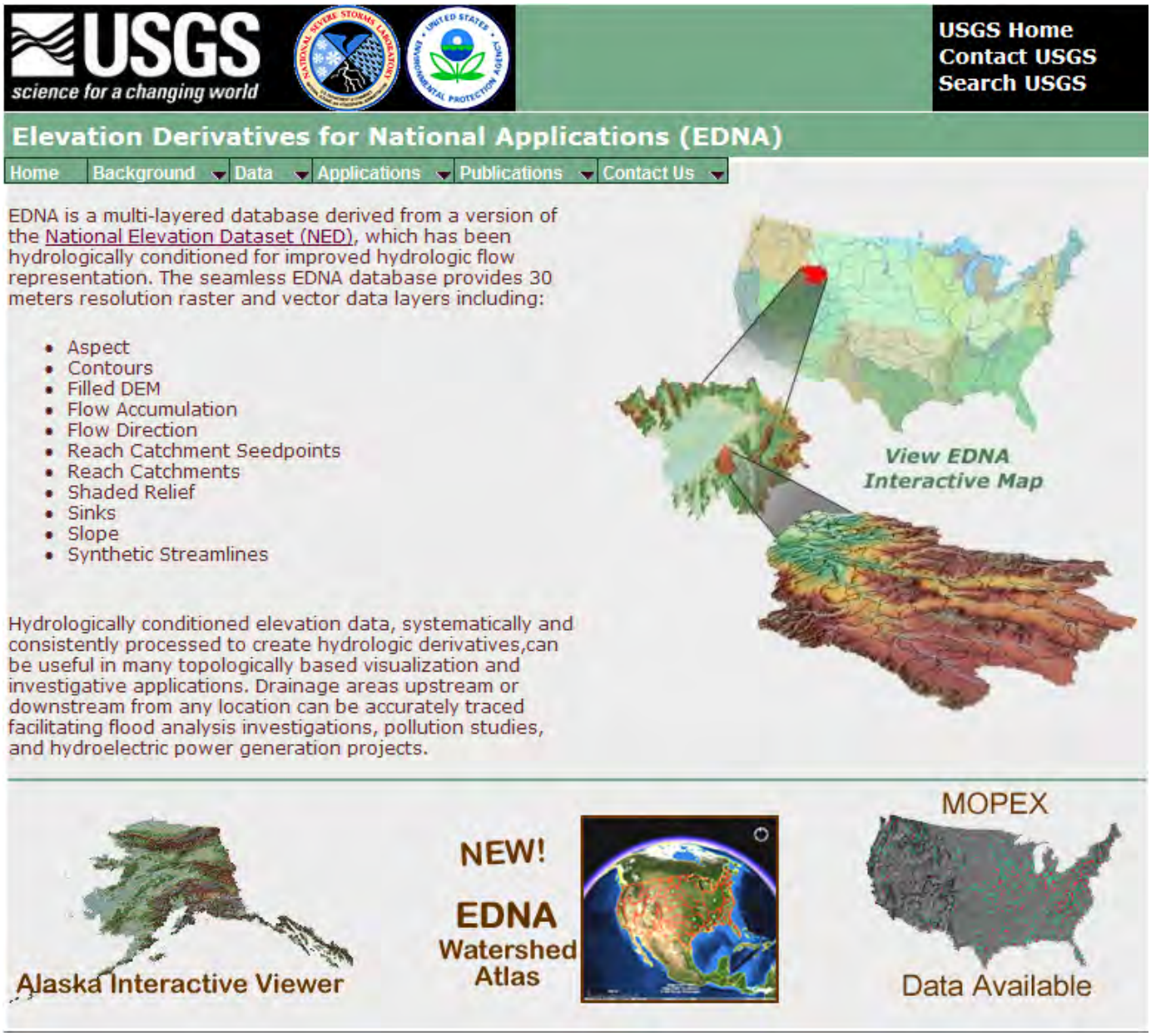

Figure 5. The EDNA Watershed Atlas is accessible from the EDNA Web site at *http://edna.usgs.gov*.

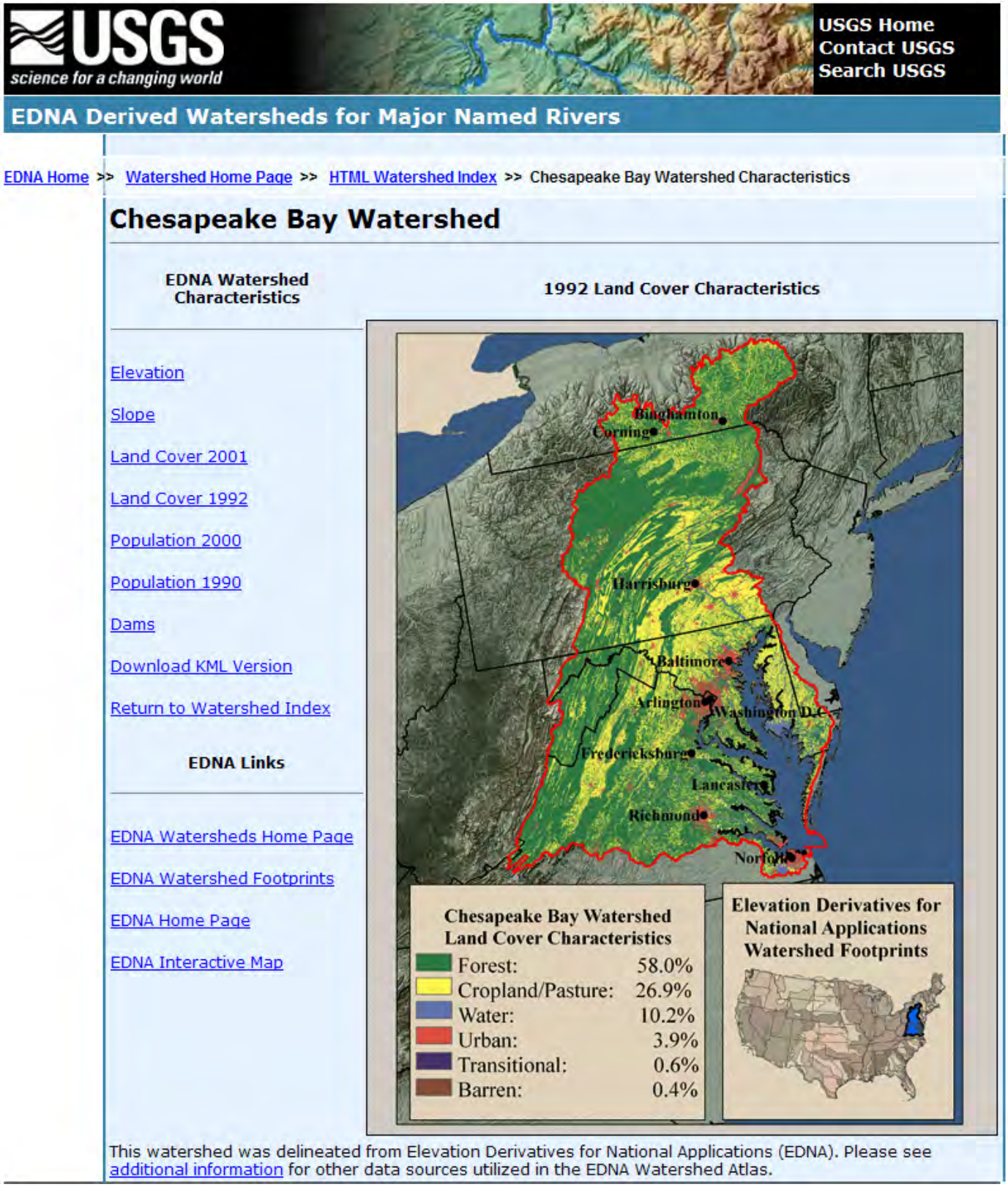

Figure 6. Land cover characteristics for the Chesapeake Bay watershed (U.S. Geological Survey, 2007).

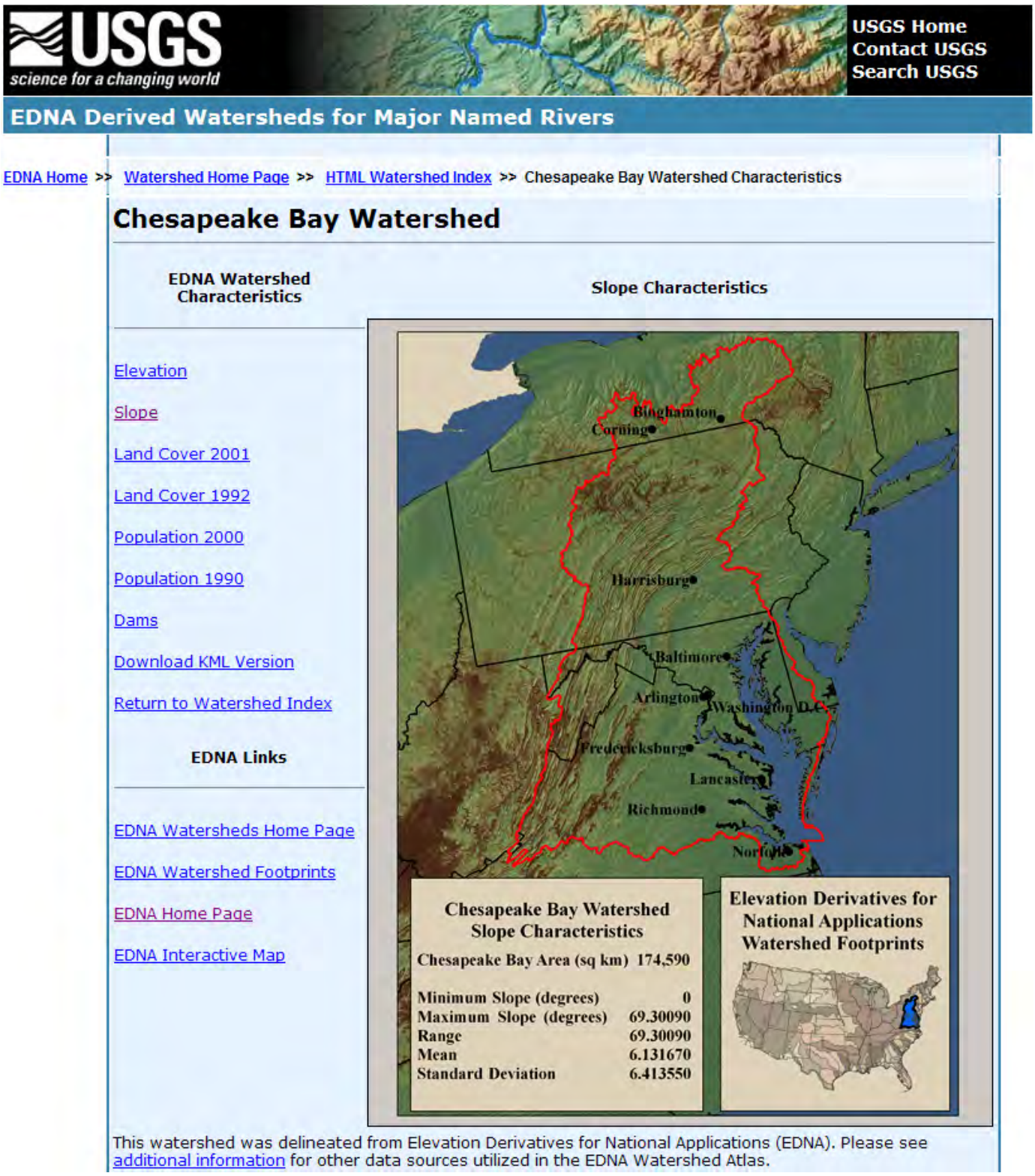

Figure 7. Slope characteristics for the Chesapeake Bay watershed (EDNA).

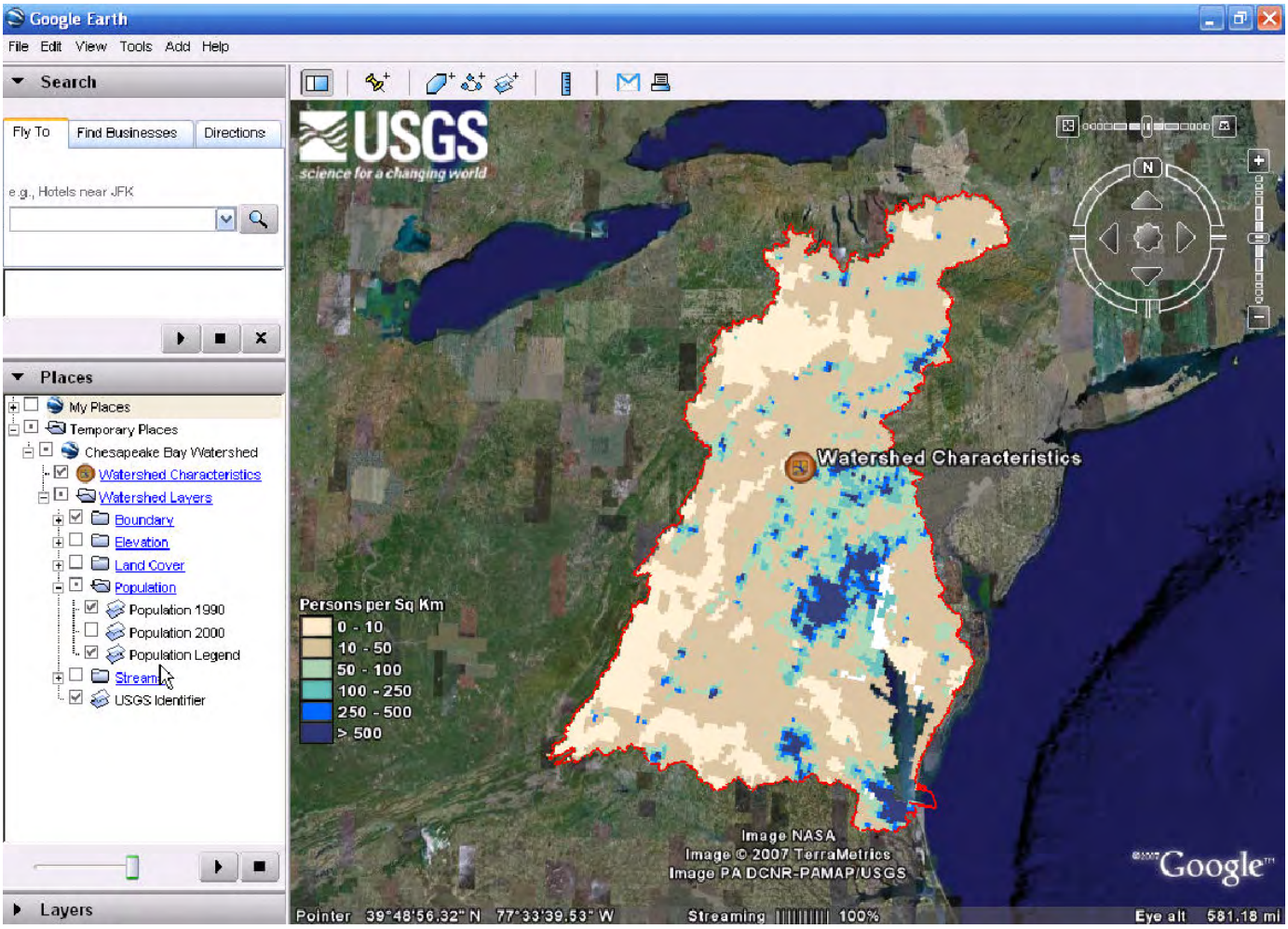

Figure 8. Population characteristics for the Chesapeake Bay watershed (Gridded Population of the World, Version 3, 2005).

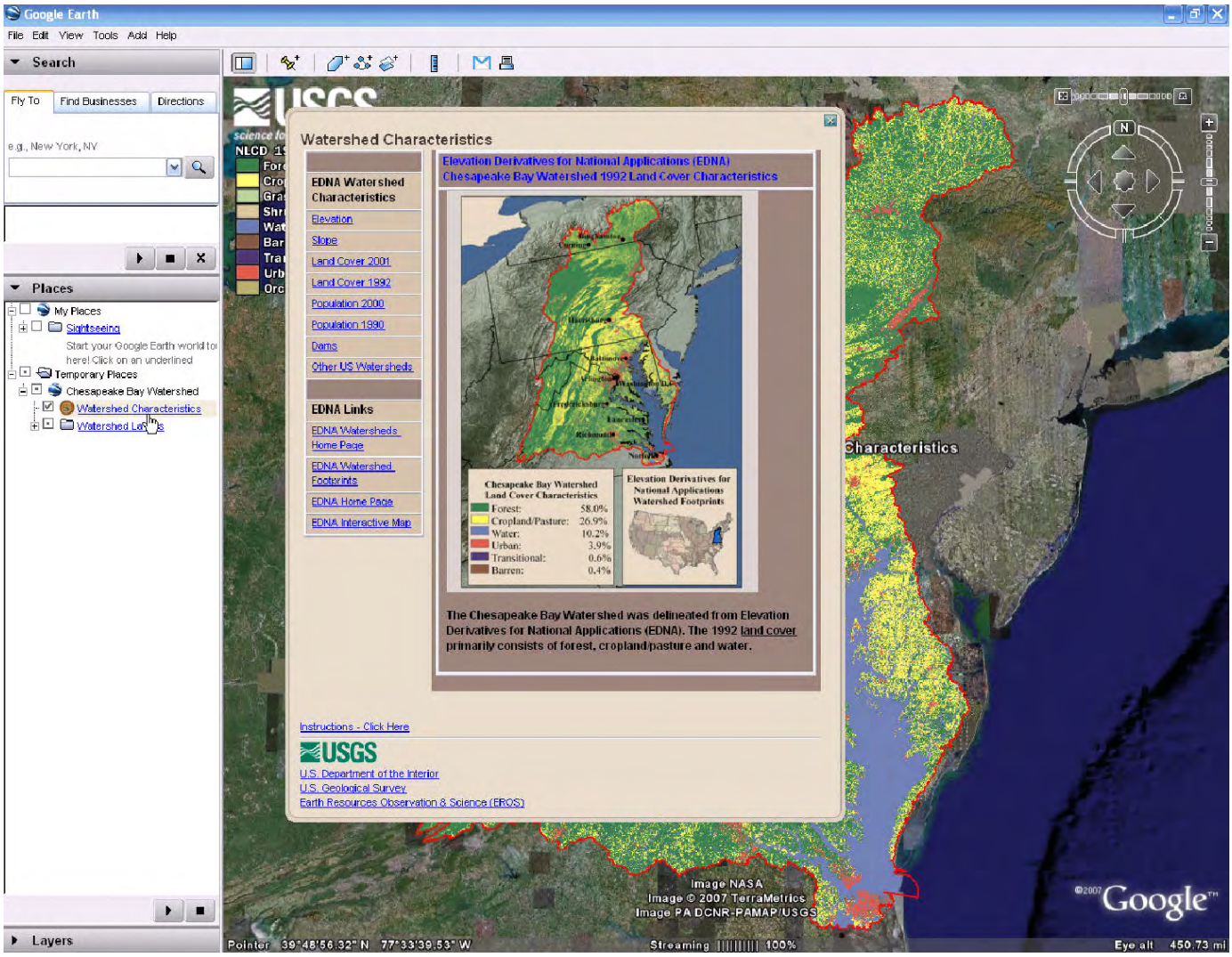

Figure 9. Characteristics for the Chesapeake Bay watershed accessible in Google Earth.

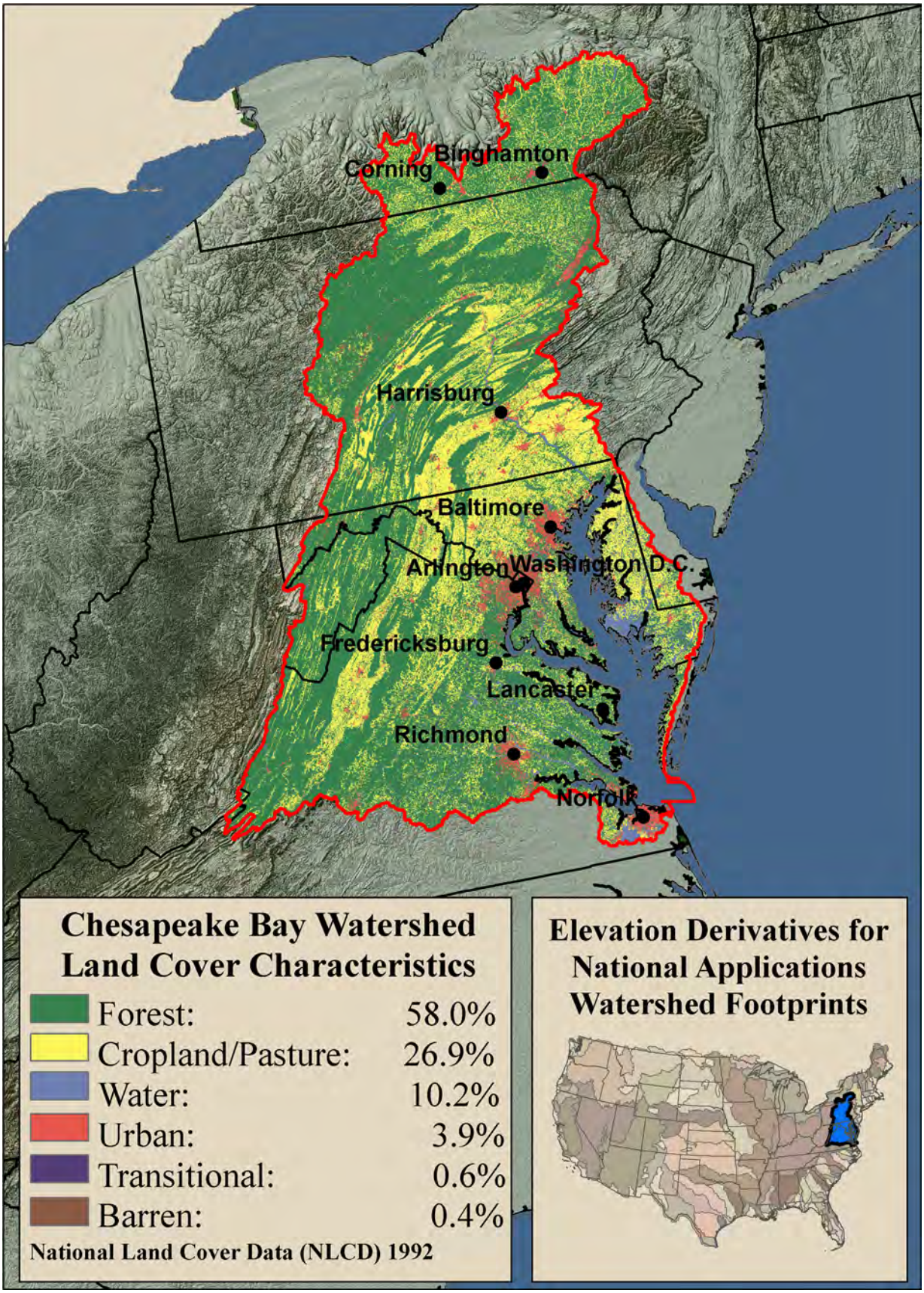

Figure 10. Land cover characteristics for the Chesapeake Bay watershed, 1992 (U.S. Geological Survey, 2007).

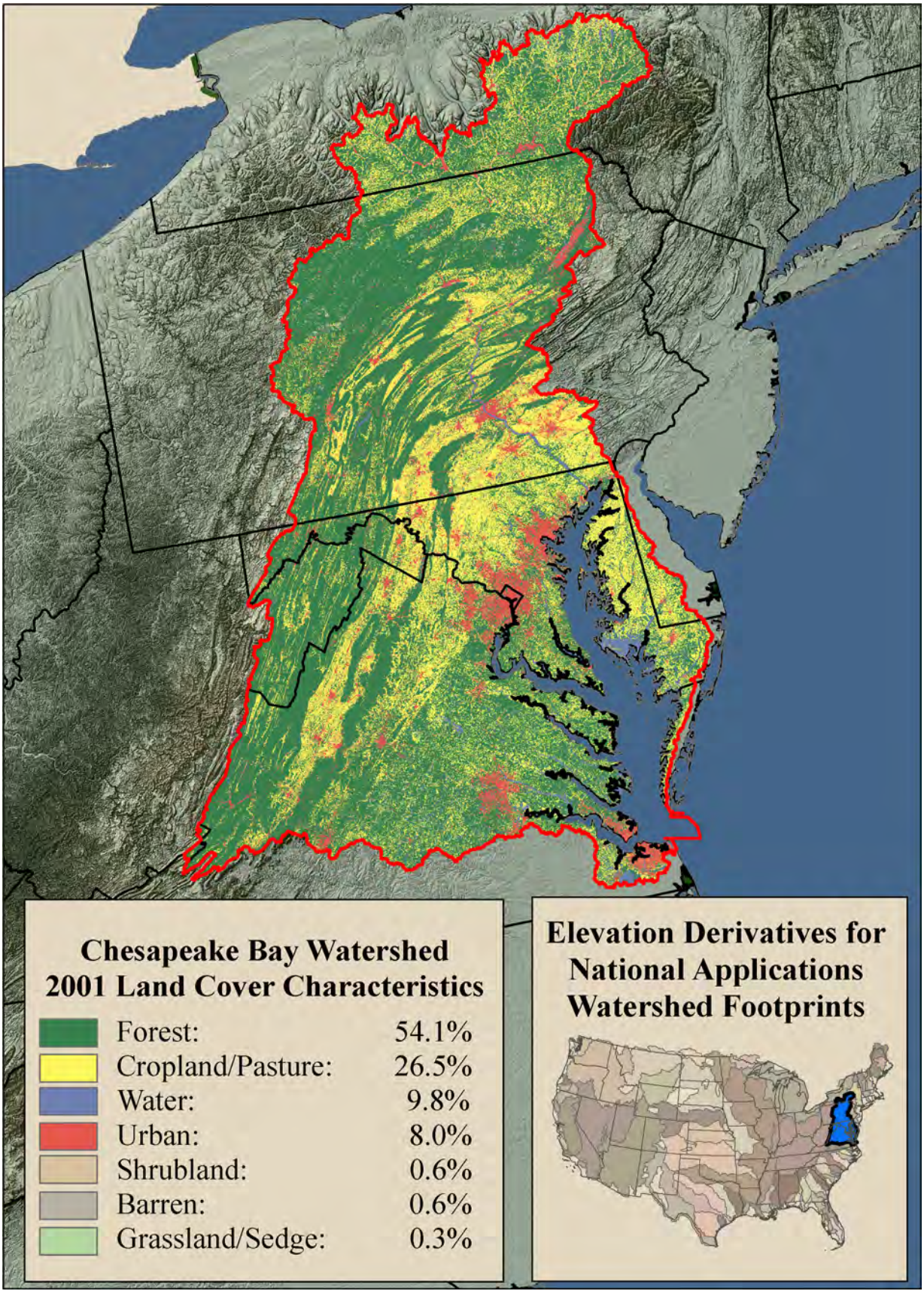

Figure 11. Land cover characteristics for the Chesapeake Bay watershed, 2001 (U.S. Geological Survey, 2007).

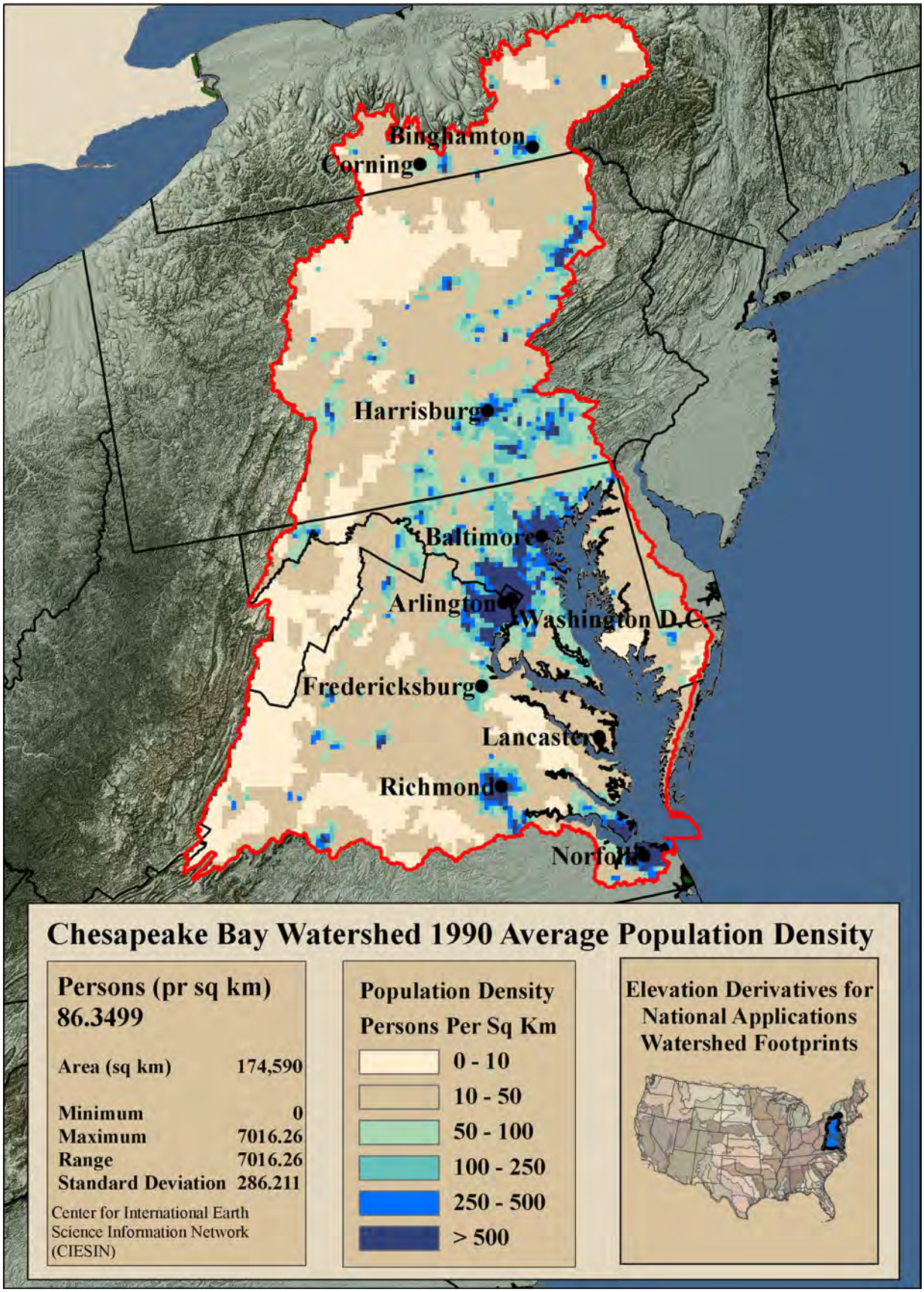

Figure 12. Population characteristics for the Chesapeake Bay watershed, 1990 (Gridded Population of the World, Version 3, 2005).

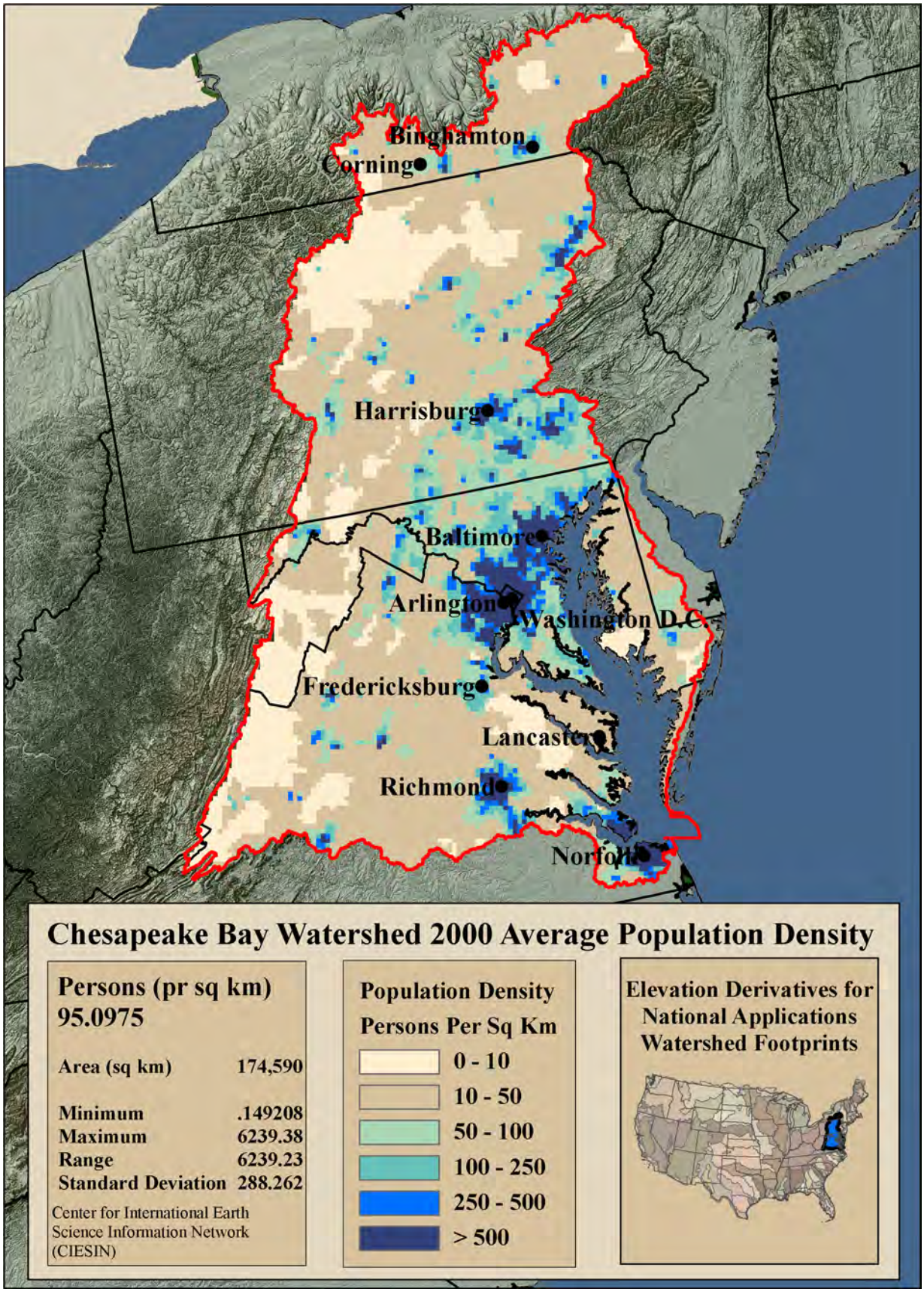

Figure 13. Population characteristics for the Chesapeake Bay watershed, 2000 (Gridded Population of the World, Version 3, 2005).

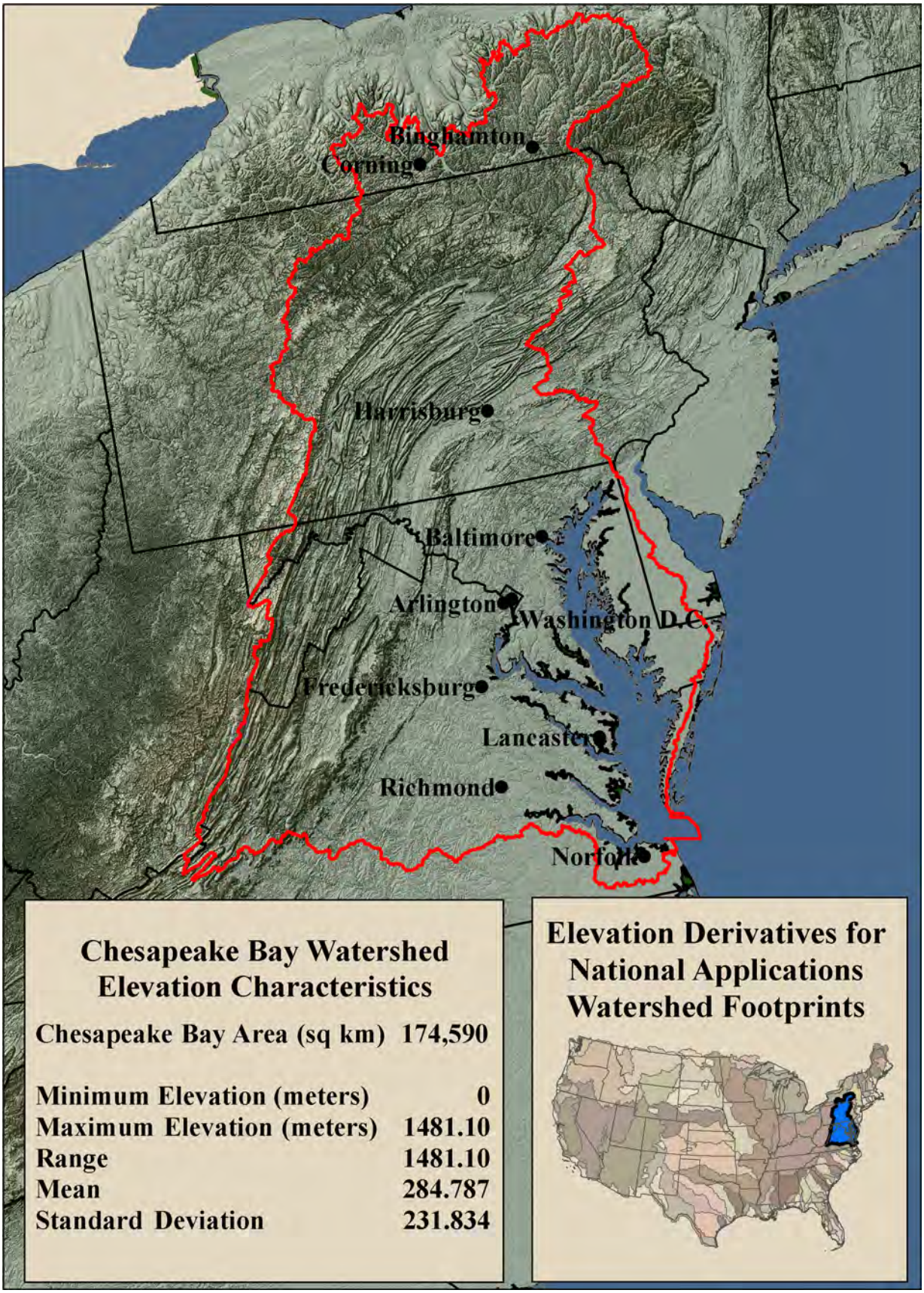

Figure 14. Elevation characteristics for the Chesapeake Bay watershed (EDNA).

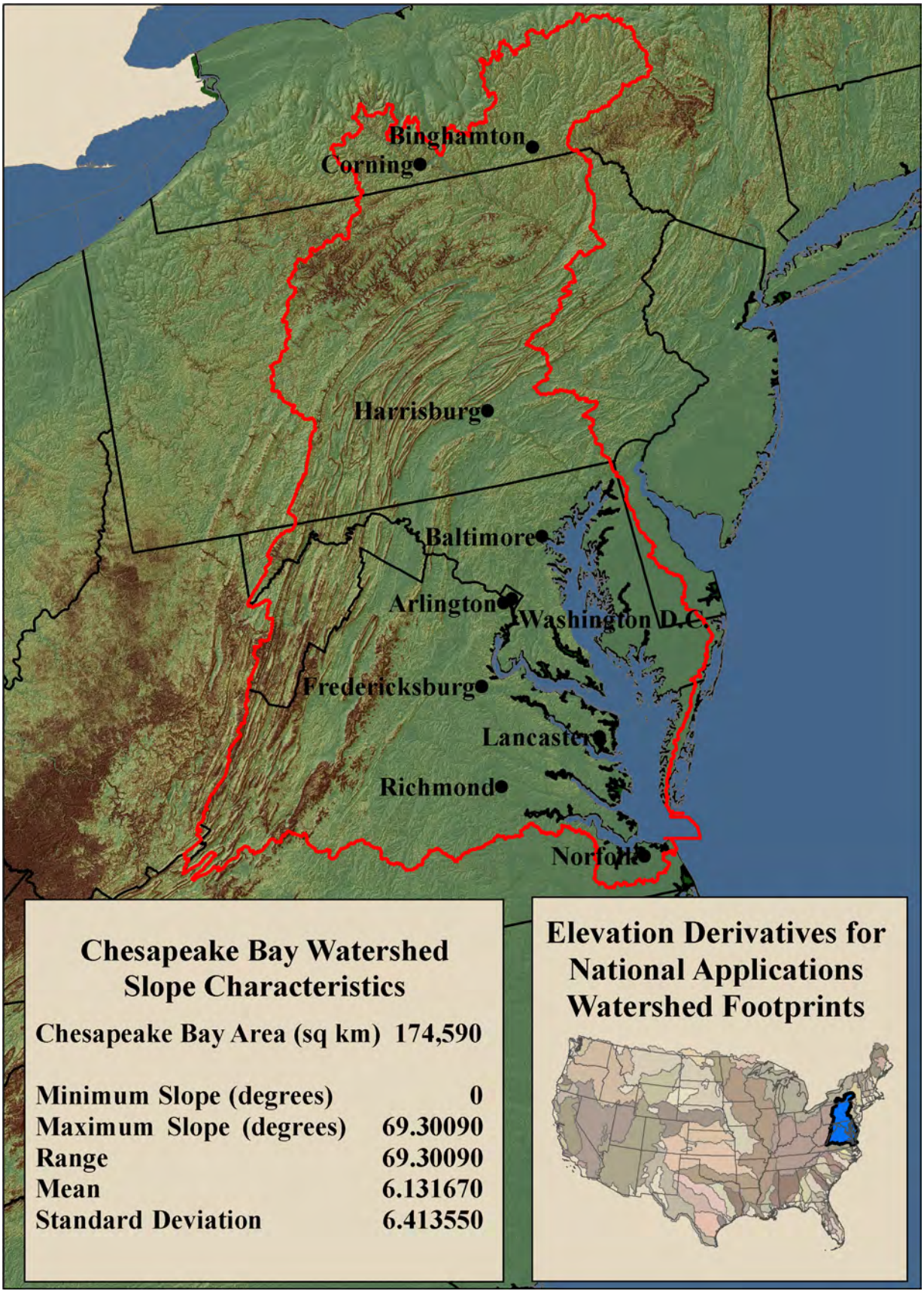

Figure 15. Slope characteristics for the Chesapeake Bay watershed (EDNA).

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For more information concerning this publication, contact:
U.S. Geological Survey
Center for Earth Resources Observation and Science (EROS)
47914 252nd Street
Sioux Falls, SD 57198–0001
(800) 252–4547

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