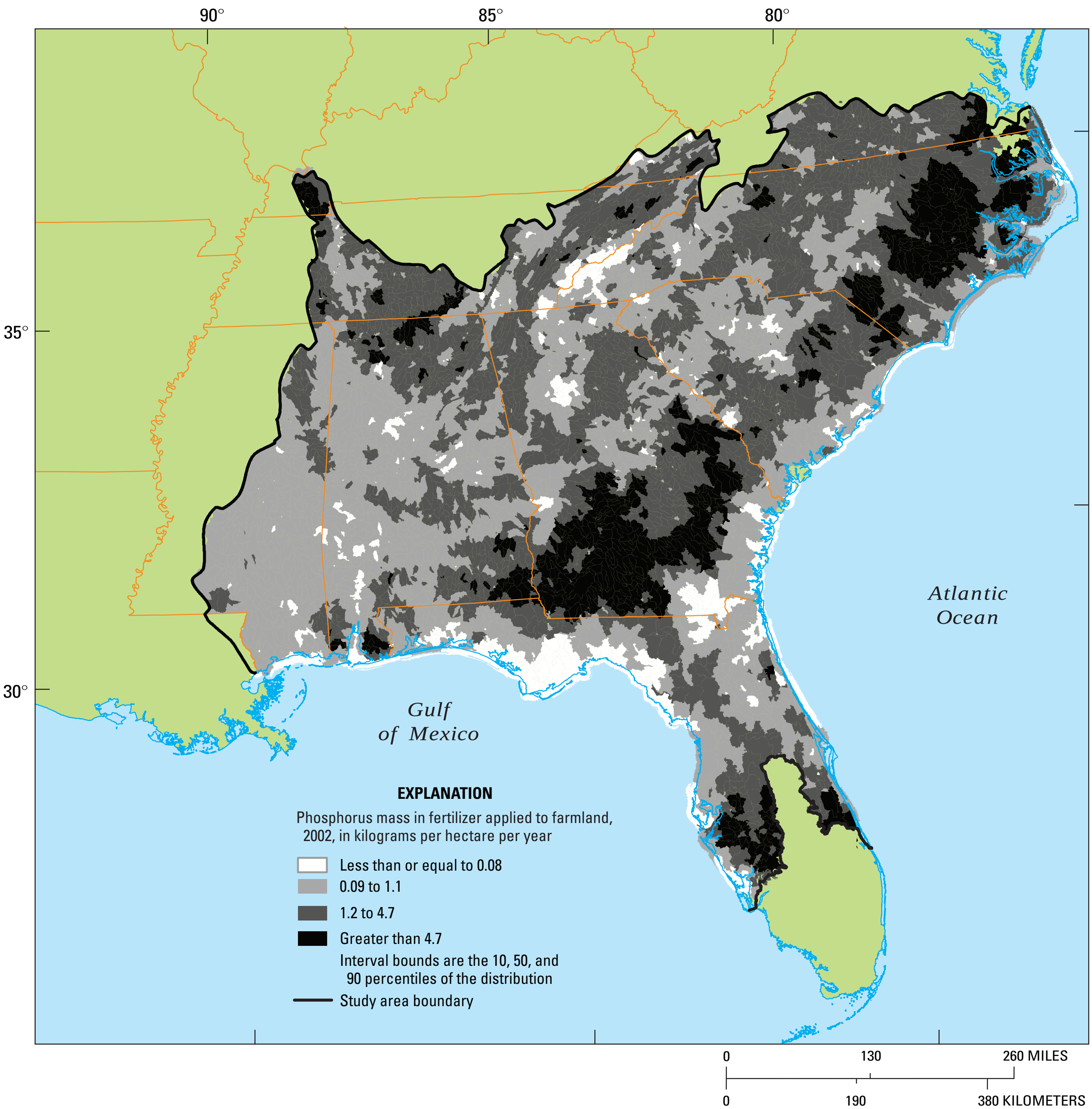


**Figure 4A.** Estimates of phosphorus mass in fertilizer applied to farmland for individual catchments in the SAGT SPARROW model area, 2002.

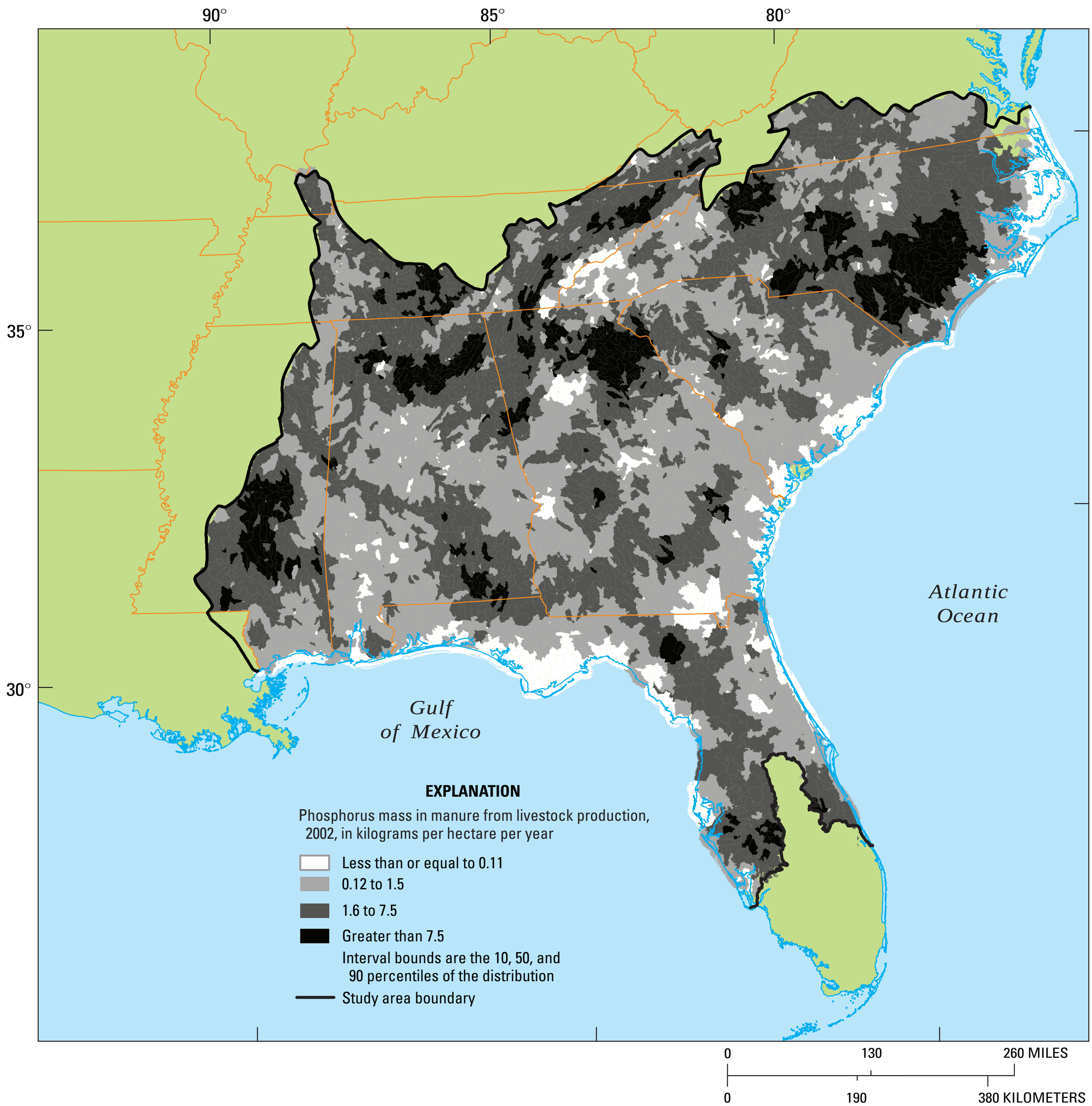


**Figure 4B.** Estimates of phosphorus mass in manure from livestock production for individual catchments in the SAGT SPARROW model area, 2002.

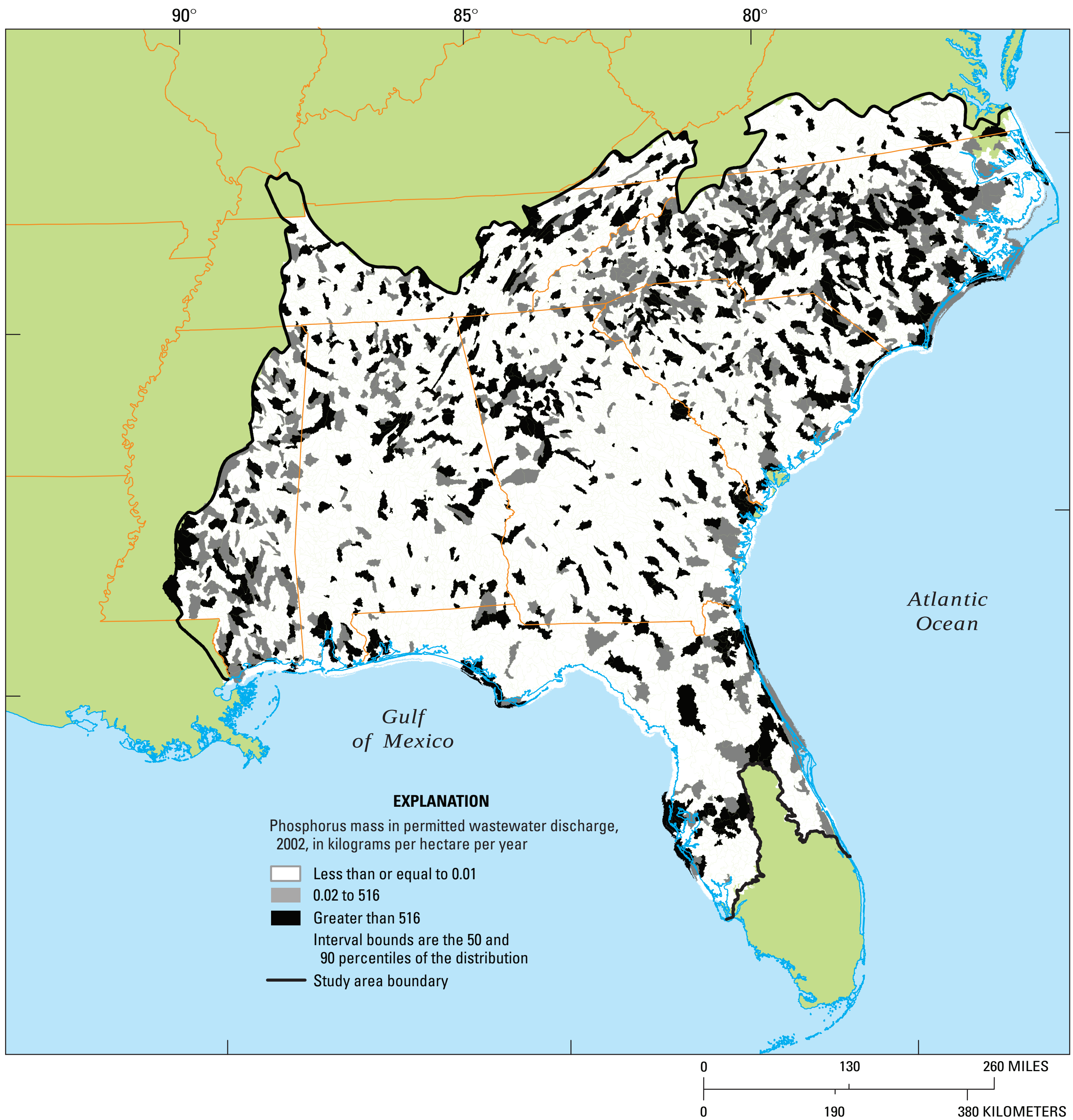


**Figure 4C.** Estimates of phosphorus mass in permitted wastewater discharge for individual catchments in the SAGT SPARROW model area, 2002.

## Nutrient Mass in Atmospheric Deposition

Atmospheric deposition of nitrogen has been shown to contribute substantially to instream nitrogen loads in streams (for example, Moore and others, 2004; Potter and others, 2006). Inorganic forms of nitrogen are released into the atmosphere as byproducts of many human activities, such as combustion of fossil fuels, livestock production, and fertilizer application, and from natural processes, such as volatilization of decomposing soil organic matter; these compounds are transported by wind before re-deposition on the land surface with precipitation (wet deposition) or as dry deposition. Observations of wet deposition of inorganic nitrogen during 1990–2005 (National Atmospheric Deposition Program, 2006) were used to estimate mean annual wet deposition for each of 186 measurement stations in the United States. A detrending procedure was applied to the wet deposition record (1990–2005) at each station to produce a detrended estimate of annual load to the base year 2002 (K. Savvas, U.S. Geological Survey, written commun., July 2006). Two models, a precipitation and deposition model, were developed to detrend the record for each station. The precipitation model ($precip_M$) and the detrended estimate of precipitation ($precip_{DT}$) take the form:

$$precip_M(i,t) = a0(i) + a1(i) * year(t), \text{ and}$$

$$precip_{DT}(i,t) = precip(i,t) + a1(i) * (base\_year - year(t));$$

where

| | | |
|---|---|---|
| i | is | the station index, |
| t | is | time, and |
| a0 and a1 | are | coefficients to be estimated in the analysis. |

The deposition model ($dep_M$) and the detrended estimate of deposition ($dep_{DT}$) take the form:

$$dep_M(i,t) = b0(i) + b1(i) * precip_M(i,t) + b2(i) * year(t), \text{ and}$$

$$dep_{DT}(i,t) = dep(i,t) + b1(i) * a1(i) * (base\_year - year(t)) + b2(i) * (base\_year - year(t));$$

where

b0, b1, and b2 are coefficients to be estimated in the analysis (G. Schwarz, U.S. Geological Survey, written commun., June 2006).

The detrended estimates of wet deposition of inorganic nitrogen (in kilograms per year) were interpolated to a 5-kilometer grid using an inverse-distance weighting method, and an estimate of wet deposition for each catchment was computed from the gridded values using the ZONALMEAN function. The catchment level estimates (variable name nadp_kg) are presented in the file *SAGT_ERF1_input.xls.zip* (2.1 MB). Spatial distribution of wet deposition, normalized by catchment area and expressed as kilograms per hectare, is illustrated in figure 3A.

Atmospheric deposition of phosphorus may contribute substantially to instream phosphorus loads (Kuntz, 1980; Redfield and Efron, 2007). In contrast with nitrogen, however, releases of phosphorus to the atmosphere from combustion or other industrial sources are minor (Murphy, 1974); the major source (comprising about 90 percent) of particulate phosphorus in the atmosphere are soil particles containing both naturally occurring and fertilizer-derived phosphorus (Graham and Duce, 1979). The spatial distribution of atmospheric releases and deposition of fertilizer-derived particulate phosphorus may be adequately represented by the catchment estimates of phosphorus mass in applied fertilizer, hence inclusion of both atmospheric deposition and fertilizer application as source predictors could amount to double accounting of agricultural sources of phosphorus. For this reason, and because phosphorus deposition data are not widely available for the SAGT area, atmospheric deposition of phosphorus is not considered as a source predictor for the SAGT phosphorus SPARROW model.

## Land Cover and Impervious Surface

Land cover classes of urban, agriculture and forested land were summarized by catchment. The 2001 National Land Cover Dataset (NLCD) is classified using an Anderson scale with 8 major classes (level 1) and 21 total classes (level 2) of land cover types (Homer and others, 2007). Level 1 classes are defined as water, developed, barren land/unconsolidated shore, forest, scrub/shrub, grassland/herbaceous, agricultural land (pasture/hay/crops), and wetlands (U.S. Geological Survey, 2001). The sources used for classification are primarily Landsat 5 and 7 imagery, as well as ancillary datasets appropriate for the mapping zones used to develop the final product (Homer and others, 2004). NLCD is distributed as a 30-meter raster dataset, with each pixel assigned a value for the corresponding land cover type (U.S. Geological Survey, 2001). The NLCD zones were merged to create a seamless dataset for the SAGT area, and each land cover class was summarized by catchment zone. Estimates of land cover area (in square kilometers) for each SAGT ERF1_2 catchment for level 1 classes of developed (urban), agriculture, and forested lands (variable names lc2_sqkm, lc8_sqkm, and lc4_sqkm, respectively) are listed in the file *SAGT_ERF1_input.xls.zip* (2.1 MB). Spatial distributions of land cover classes are illustrated in figures 3B–D; each catchment-level estimate is normalized by the total area of the catchment and expressed as percent.

Increases in the percent impervious surface within a watershed have been linked with increases in stream nutrient loads in numerous studies (Driver and Tasker, 1990; Brabec and others, 2002; Yong and Chen, 2002). The estimates of percent impervious surface area included in the NLCD raster dataset for each 30-meter cell (U.S. Geological Survey, 2001) were summarized by catchment zone to derive estimates of impervious surface area (in square kilometers) for the SAGT ERF1_2 catchment dataset. The catchment-level estimates (variable name impsurf_sqkm) are listed in the file *SAGT_ERF1_input.xls.zip* (2.1 MB). The spatial distribution of impervious surface is illustrated in figure 3E; each catchment-level estimate is normalized by the total area of the catchment and expressed as percent.