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Climate change vulnerability assessment in Georgia

Binita KC [a, *], J. Marshall Shepherd [a, 1], Cassandra Johnson Gaither [b, 2]

[a] University of Georgia, Department of Geography, 210 Field Street, Athens, GA 30602, USA
[b] USDA Forest Service, 320 Green Street, Athens, GA 30602, USA

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ABSTRACT

Climate change is occurring in the Southeastern United States, and one manifestation is changes in frequency and intensity of extreme events. A vulnerability assessment is performed in the state of Georgia (United States) at the county level from 1975 to 2012 in decadal increments. Climate change vulnerability is typically measured as a function of exposure to physical phenomena (e.g., droughts, floods), sensitivity to factors affecting the social milieu, and the capacity of a given unit to adapt to changing physical conditions. The paper builds on previous assessments and offers a unique approach to vulnerability analyses by combining climatic, social, land cover, and hydrological components together into a unified vulnerability assessment, which captures both long-term *and* hydroclimatic events. Climate change vulnerability indices are derived for the 1980s, 1990s, 2000s, and 2010s. Climate change exposure is measured as: 1) departure of decadal mean temperature and precipitation from baseline temperature and precipitation (1971–2000) using the United States Historical Climatology Network version 2.5 and 2) extreme hydroclimatic hazards indicated by flood, heat wave and drought events. Sensitivity and adaptive capacity are measured by well-established conceptualizations and methods built derived from socioeconomic variables. Impervious surface and flood susceptibility area are also incorporated to account for place-based vulnerability.

Anomalies in temperature and precipitation with an overall trend towards drying and warming have been observed. The anomalous cooling period in Georgia during the 1970–1980 period as well as the post-1980 warm-up have been captured with a clearly established increase in extreme hydroclimatic events in recent decades. Climate vulnerability is highest in some metropolitan Atlanta and coastal counties. However, the southwestern region of Georgia, and part of the rural Black belt region are found to be especially vulnerable to climate change.

Introduction

Climate change is a departure in the mean state of climate or in its variability that persists for a decadal time span (IPCC, 2007). A differential rate of warming has been observed across the United States since the 1970s (Melillo, Richmond, & Yohe, 2014). According to Karl, Melillo, and Peterson (2009), the average temperature has risen by 1.1 °C in the southeastern United States since the 1970s, with a significant temperature rise during winter and a decline in number of frost days per year. Despite reported increases in precipitation, areas experiencing moderate to severe drought have also increased in recent decades in the region. Similarly, Tebaldi, Adams-Smith, and Heller (2012) report that a warming hole, which is the slow warming of parts of the Southeastern United States including Georgia, has disappeared in recent decade, which is consistent with the warming trend in the Southeast. The Southeast, along with the Southwest and Midwest U.S. could experience more intense heat waves in the future (Kunkel, Liang, & Zhu, 2010; Meehl & Tebaldi, 2004), which would be intensified by urban heat islands at the local scale (Zhou & Shepherd, 2010). Such changes result in decreased crop production and increased heat-related mortality and morbidity (Changnon, Kunkel, & Reinke, 1996). Shepherd and Knutson (2007) also suggest possible increased intensity of hurricanes.

This study focuses on climate change in Georgia, considering both biophysical and socio-demographic indicators of vulnerability.

* Corresponding author. Present address: Resilient Cities Lab, School of Public Policy and Urban Affairs, Northeastern University, 310 Renaissance Park, Boston, MA 02115, USA. Tel.: +1 301 538 6943.
E-mail addresses: leebinita@gmail.com (B. KC), marshgeo@gmail.com (J.M. Shepherd), cjohnson09@fs.fed.us (C.J. Gaither).
[1] Tel.: +1 706 542 0517.
[2] Tel.: +1 706 559 4270.

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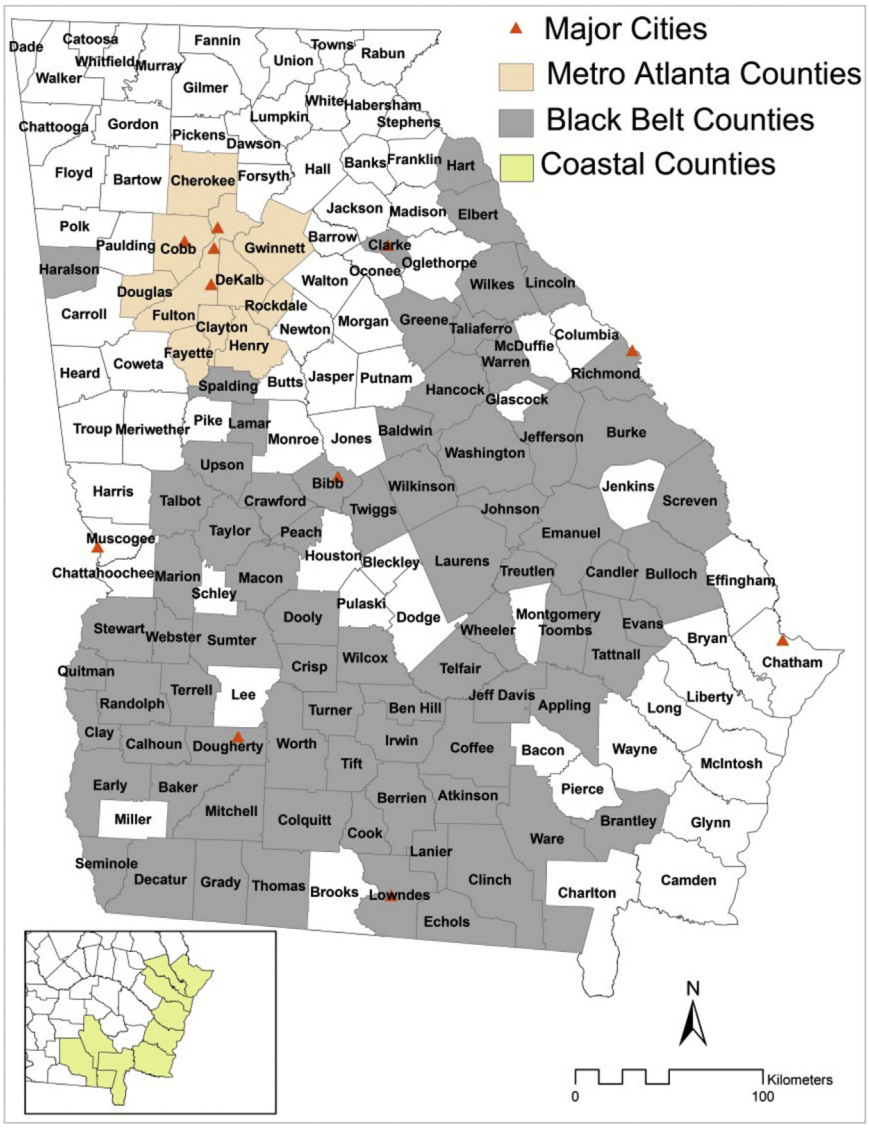

Fig. 1. State of Georgia with 10 Metro Atlanta counties, Black Belt counties (shown here as counties with poverty >20%), and coastal counties (>40% of land in Federal Emergency Management Agency (FEMA) designated flood zones).

In terms of biophysical measures, we propose a vulnerability index that captures both longer-term changes in precipitation and temperature as well as episodic events such as floods, heat waves and drought events. The index includes pertinent socio-demographic and topographical variables indicating humans' abilities to absorb or withstand biophysical manifestations of climate change. A number of studies have considered both the biophysical and social dimensions of climate change, but ours is one of the first to include both those background or longer-term indicators of climate change with measures of episodic events (Azar & Rain, 2007; Emrich & Cutter, 2011; Gbetibouo & Ringler, 2009).

Georgia is one of the fastest growing states in the nation. From 2000 to 2010, Georgia's population increased by 18.3 percent (compared to a national population increase of 9.7 percent for the same period) (U.S. Census Bureau, 2011); and Georgia ranked tenth in terms of percent change in population from 2010 to 2012 (U.S. Census Bureau, 2012b). Much of the state's population growth and economic expansion in recent decades has centered in and around metropolitan Atlanta counties in the north part of the state (Hartshorn & Ihlanfeldt, 2000); but Georgia still contains a substantial number of rural, "Black Belt" counties (Fig. 1), mostly in the southern part of the state, with resource-based industries as an economic mainstay (Wimberly & Morris, 1997).[3] Importantly, the historically-rooted, racial bifurcation of the state's population into "black" and "white" subcultural groupings has given way to a significant third force, manifested as the unprecedented growth in immigrant/migrant populations of both Hispanics and Asians across Georgia (Yarbrough, 2007; Zúñiga & Hernández-León, 2001). Between 1990 and 2000, Georgia's Hispanic population increased 324 percent and 96.1 percent from 2000 to 2010; Asians increased 155 percent and 82 percent, respectively, during these decades (U.S. Census Bureau, 1990, 2000a, 2000b, 2002, 2012a).

[3] The Black Belt is a band of mostly rural counties stretching from southern Virginia down through the Carolinas, Georgia, Alabama, Mississippi, and over to east Texas which have higher than average percentages of African-American residents (McDaniel & Casanova, 2003; Wimberly & Morris, 1997). African Americans residing in this region have relatively higher poverty compared to the rest of the United States (Falk & Rankin, 1992; Falk, Talley, & Rankin, 1993; Hoppe, 1985); and a notable gap persists in social well-being of African Americans in this region compared to Whites and African Americans outside this region (Doherty & McKissick, 2002; Webster & Bowman, 2008).