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Climate vulnerability mapping in the Horn of Africa

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Abstract

Climate change is expected to have severe consequences on the lives and livelihoods of millions of people around the world, but its effects will not be evenly distributed. Africa is thought to be especially vulnerable, given both high exposure to climate change and relatively low community resilience and governance capabilities. In this paper, we systematically review the literature on climate vulnerability in the Horn of Africa in searching transparency, coherence, and comparability. We describe the development of vulnerability maps for the Horn of Africa, specifically for Djibouti, briefly presenting the data, methods and results. We show the complementary satellite data and gauge data in the context of scarcity of data. . Results suggest that vulnerability maps are a useful boundary object for discussions among stakeholders with different portfolios and technical backgrounds, and that they provide useful guidance for targeting development assistance.

Keywords: Vulnerability mapping, climate change, Satellite data, decision support tools, spatial assessment

Introduction

Spatial vulnerability assessments and allied methods such as spatial impact assessment are useful tools for understanding patterns of historical vulnerability and risk to climatic factors, as well as likely future vulnerability under climate change. The demand for vulnerability maps among development agencies and governments is increasing as greater emphasis is placed on scientifically sound methods for targeting adaptation assistance (de Sherbinin 2013 and 2014a, Preston et al. 2011). Mapping is useful because climate variability and extremes, the sensitivity of populations and systems to climatic stressors, and adaptive/coping capacities are all spatially differentiated. The interplay of these factors produces different patterns of vulnerability. Often spatial vulnerability assessment involves data integration in which georeferenced socioeconomic and biophysical data are combined with climate data to understand patterns of vulnerability and, in turn, inform where adaptation may be required (e.g., de Sherbinin et al. 2014a and 2014b, Midgely et al. 2011, Busby et al. 2011). Maps have proven to be useful boundary objects in multi-stakeholder discussions, providing a common basis for discussion and for deliberations over adaptation planning (Preston et al. 2011). Maps can help to ground discussions on a solid evidence base, especially in developing country contexts where geographic information may not be easily accessible for all stakeholders.

The power of spatial assessment is that it presents a large amount of information in a simplified and visually attractive manner. Yet this strength is also a weakness, insofar as uncertainties in the data and important analytical assumptions may be hidden from the user. The article presents a brief overview of the methods used and the results before turning to demand for the maps and their use by end users and its development partners, assessing the map products in terms of their credibility, salience and legitimacy among stakeholders (Cash et al. 2003). This article seeks to contribute to the literature on climate vulnerability 'hotspots' mapping by developing vulnerability map for the Horn of Africa, specifically for Djibouti.

Data and Methodology

As a framework for the vulnerability mapping we utilized the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) conceptual framework, which separates vulnerability to climate stressors into three components: exposure, sensitivity, and adaptive capacity (Parry et al., 2007). This framework and variants thereof are commonly used in vulnerability mapping exercises in Africa and globally (e.g., BMZ 2014, Midgley et al. 2011, Yusuf and Francisco 2009, Thow and De Blois 2008). Our approach was to map the general vulnerability of the population rather than to develop separate vulnerability layers for individual systems (e.g., ecosystems); sectors (e.g., water or agriculture); or population sub-groups (e.g., pastoralists). We used a spatial index approach, in which each data layer is converted to an indicator with a range of 0-100 (with 100 representing most vulnerable). The indicators are then averaged to produce sub-indices for exposure, sensitivity, and adaptive capacity, which are then combined into an overall vulnerability index. For Djibouti, we experimented with Principal Components Analysis (PCA) as an alternative aggregation method.

Data has been provided by various partners who include the national agency of meteorology od Djibouti (ANM), Ministry of agriculture and International Research Institute for climate and Society of Columbia University. For the analysis of recent trends of extreme precipitation and temperatures, data were made available by the synoptic station of Djibouti City (Lat: 11.55 N; Long: 43.15 E; altitude: 13 m) located near the international airport of Djibouti (Ozer et al.2012) . Data for the sensitivity and adaptive capacity are from the national report on “Djibouti accelerated growth strategy and employment promotion 2015-2019”. We had reasonably high confidence in the validity and reliability of each of the data sets included, though limitations were explored in technical Djibouti reports. The eighteen spatial indicators we utilized in Djibouti are found in **Table 1.**

Table 1. Indicators used for the Djibouti climate vulnerability mapping exercise

Component	Indicator Code	Data Layer
Exposure	PRCP	Average annual precipitation
	IACV	Inter annual coefficient of variation (CV) in precipitation (1980-2011)
	DCVAR	Percent of precipitation variance explained by decadal component (1980-2011)
	NDVICV	CV of the Normalized Difference Vegetation Index (NDVI)(1980-2011))
	TTREND	Long-term trend in temperature in July-August-September (1966-2011)
	FLOOD	Flood frequency (1966-2011)
Sensitivity	HHWL	Household wealth (2006)
	STNT	Child stunting (2006)
	IMR	Infant mortality rate (IMR) (2006)
	POVI	Poverty index by commune (2006)
	CARB	Soil organic carbon/soil quality
	MALA	Malaria stability index
Adaptive Capacity	EDMO	Education level of mother(2006)
	MARK	Market accessibility (travel time to major cities)
	HEALTH	Health infrastructure index (2012)
	ANTH	Anthropogenic biomes (2000
	IRRI	Irrigated areas (area equipped for irrigation) (1990–2000)

Results

The preliminary results show how the three components for the Djibouti vulnerability mapping are rolled up into an overall vulnerability index. The exposure map depicts the generally southeastern to north gradient of exposure indicators, with lower rainfall, higher temperatures, and higher rainfall variability in the north. The sensitivity map shows highest sensitivity in the densely settled of the country, and the adaptive capacity component generally shows highest adaptive capacity near Djibouti capital and closest area .The resulting vulnerability map also includes uncertainty maps for the most important indicators: the FEWSNET-derived climate exposure indicators and those derived from the DHS survey.

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