How does social vulnerability to climate change spatially correspond to land cover in Ghana, West Africa?

Map Series and Text By:

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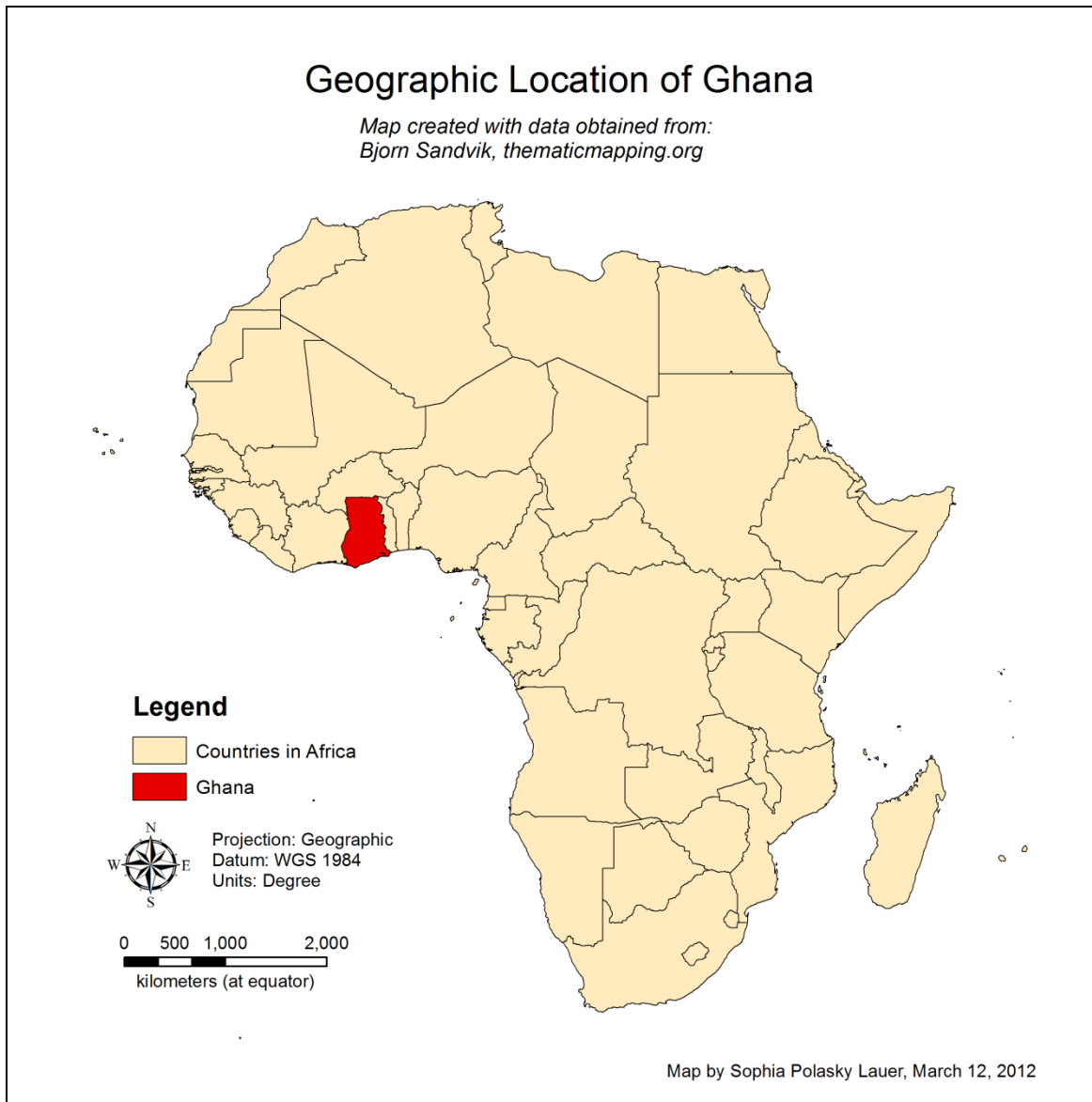Department of Forest Ecosystems and Society

March 20, 2012

Prepared For:
Dr. Jim Graham, Instructor
GIS 565 – Introduction to GIS

Photo by Sophia Polasky Lauer, 2008. Ghanaian children from Sunyani Regional Orphanage pose in front of a world map they helped paint.

1. Where is Ghana Located?

Geographic Location of Ghana

Map created with data obtained from:
Bjorn Sandvik, thematicmapping.org

Legend

Countries in Africa

Ghana

Projection: Geographic
Datum: WGS 1984
Units: Degree

0 500 1,000 2,000
kilometers (at equator)

Map by Sophia Polasky Lauer, March 12, 2012

2. What is social vulnerability to climate change?

Social vulnerability to climate change is a characteristic of populations, and can be defined as, "the ability or inability of individuals and social groupings to respond to, in the sense of cope with, recover from or adapt to, any external stress placed on their livelihoods and well-being" (Kelly and Adger 2000, p. 328). Within the context of climate change in Ghana, external stresses are assumed increases in average temperatures, and assumed increased variability in rainfall, both predicted outcomes under climate change scenarios that have been generated for the region.

3. How is social vulnerability to climate change measured?

The social vulnerability assessment to climate change in Ghana that was used to create the following maps was generated by Stanturf et al. (2011). The authors measured vulnerability to climate change at a district level, utilizing published data from Ghana's 2000 census. Each district was given a composite vulnerability score (10-110, with 110 representing maximum vulnerability) which was based on 11 equally weighted indicator scores. Composite vulnerability scores are useful only for comparative purposes within Ghana.

The 11 indicators used to construct the index are presented in table 1. For a justification of the relevance of these indicators, or a more detailed description of this approach to measuring social vulnerability to climate change, including a note on the index's uncertainty, please see the author's published findings.

Table 1. Indicators used to measure social vulnerability to climate change

Indicator Title	Description	Data source and year
Ability to survive crisis	The percentage of total households within a district that felt either "somewhat" or "very" insecure about their ability to withstand any crisis	Ghana 2003 Core Welfare Indicators Questionnaire Survey Report: Statistical Abstract, Ghana Statistical Service (CWIQ II)
Agricultural employment	The percentage of the district's total population > 15 years of age that is engaged in agriculture-related employment (including hunting and forestry related activities).	2000 Population and Housing Census, Analysis of District Data and Implications for Planning, Ghana Statistical Service (2000 Census)
Dependent population	The percentage of a district's total population that is < 15 and > 65 years of age	CWIQ II
Distance from drinking water	The percentage of total households within a district that travel ≥30 minutes for drinking water	CWIQ II
Distance from food market	The percentage of total households within a district that travel ≥30 minutes to reach a food market	CWIQ II
Female-headed households	The percentage of total households within a district that are headed by a female	CWIQ II
Illiteracy	The percentage of the district's total population > 15 years of age that is illiterate. Illiteracy is defined as the inability to read or write in English, any Ghanaian language, or any foreign language.	2000 Census
Malnourished children	The percentage of all 0-59 month old children, within a district, that are considered underweight for their age. Children are considered underweight if their weight is	CWIQ II

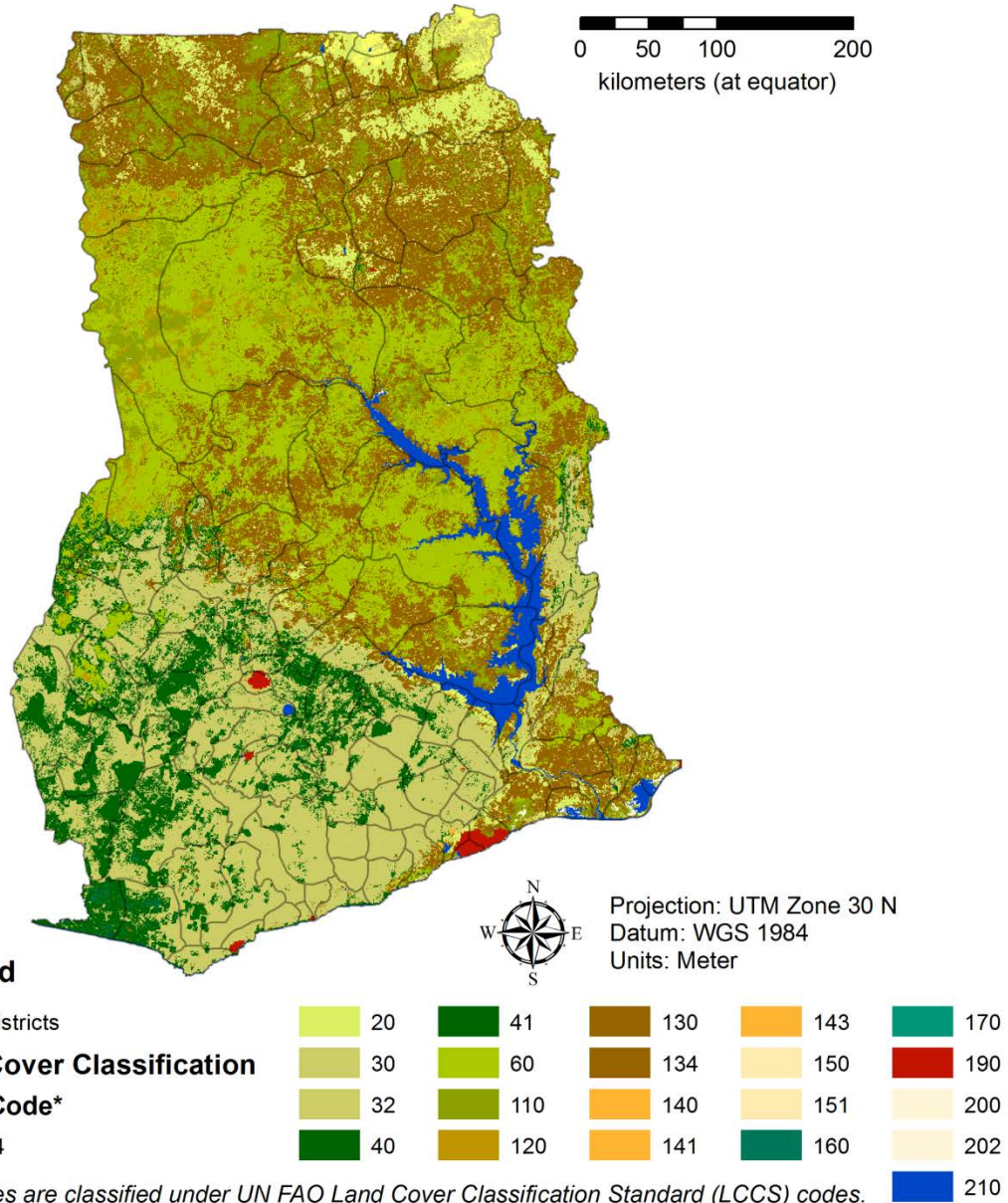| Indicator Title	Description	Data source and year
	more than two standard deviations below the United States National Center for Health Statistics' standard weight for age.	
Poverty Perception	The percentage of total households within a district that self-identified as being either "poor" or "very poor"	CWIQ II
Road Accessibility	The percentage of households within a district that can access their homes by road throughout the year	CWIQ II
Unimproved drinking water source	The percentage of total households within a district that depend on unimproved sources for their drinking water. Unimproved sources include rainwater, rivers, lakes, ponds, and unprotected wells.	CWIQ II

4. How does social vulnerability to climate change vary throughout the country of Ghana?
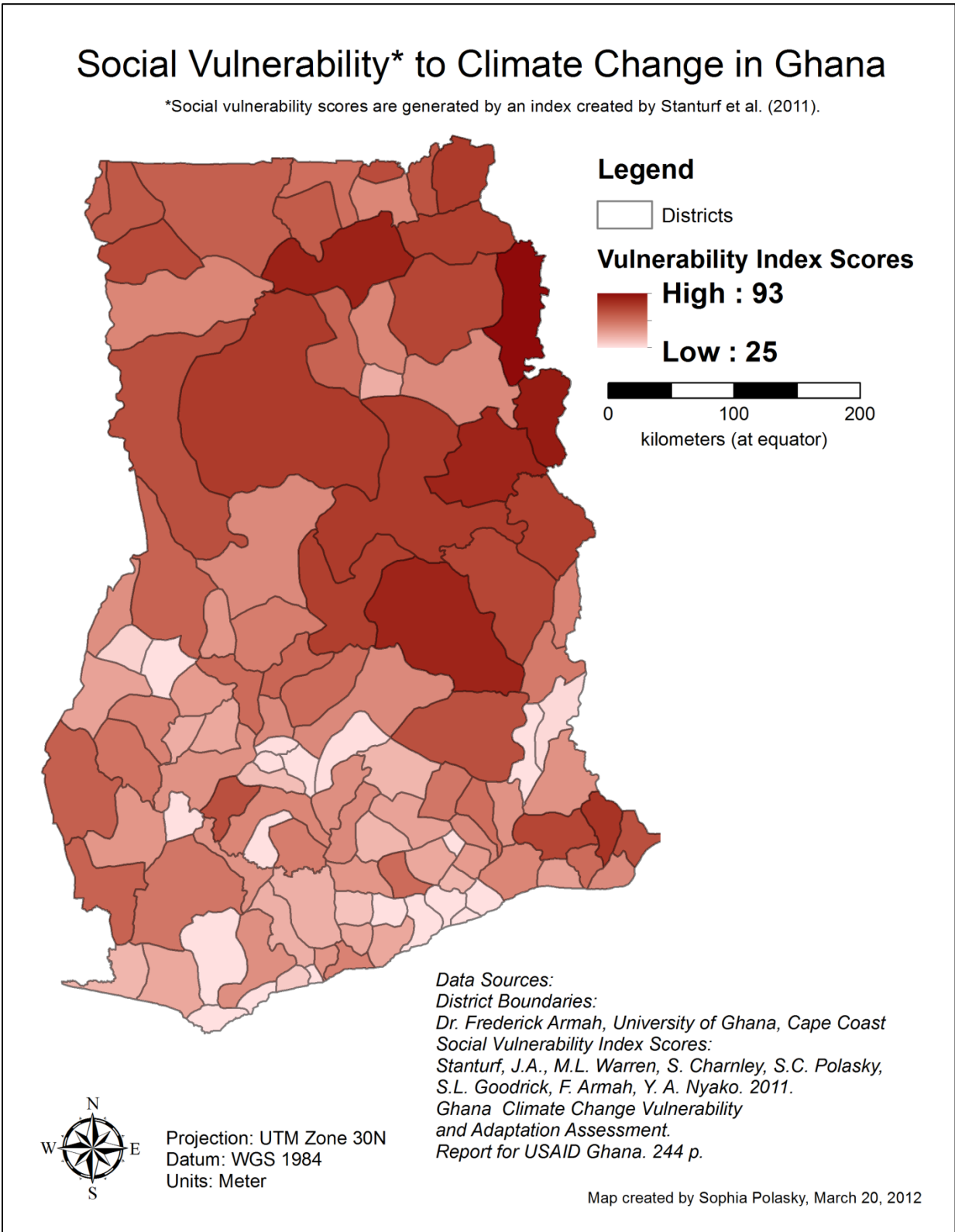
5. How does land cover vary throughout the country of Ghana?

Land cover (at 300 m resolution) in Ghana

Land cover data provided by:
Food and Agriculture Organization of the United Nations 2005 Global Land Cover Network Database
District boundaries provided by:
Dr. Frederick Armah, University of Ghana Cape Coast

0   50   100   200
kilometers (at equator)

Projection: UTM Zone 30 N
Datum: WGS 1984
Units: Meter

Legend

Districts

Land Cover Classification

LCCS Code*

14			
20	41	130	143	170
30	60	134	150	190
32	110	140	151	200
40	120	141	160	202
				210

*Land types are classified under UN FAO Land Cover Classification Standard (LCCS) codes.
Please see Table 2 for a descriptions of codes used for Ghana.

Map created by Sophia Polasky, March 20, 2012

Table 2 – LCCS codes used to classify Ghana's land cover

Code	Description
14	Rainfed croplands
20	Mosaic cropland (50-70%) / vegetation (grassland/shrubland/forest) (20-50%)
30	Mosaic vegetation (grassland/shrubland/forest) (50-70%) / cropland (20-50%)
32	Mosaic forest (50-70%) / cropland (20-50%)
40	Closed to open (>15%) broadleaved evergreen or semi-deciduous forest (>5m)
41	Closed (>40%) broadleaved evergreen and/or semi-deciduous forest (>5m)
60	Open (15-40%) broadleaved deciduous forest/woodland (>5m)
110	Mosaic forest or shrubland (50-70%) / grassland (20-50%)
120	Mosaic grassland (50-70%) / forest or shrubland (20-50%)
130	Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)
134	Closed to open (>15%) broadleaved deciduous shrubland (<5m)
140	Closed to open (>15%) herbaceous vegetation (grassland, savannas or lichens/mosses)
141	Closed (>40%) grassland
143	Closed (>40%) grassland
150	Sparse (<15%) vegetation
151	Sparse (<15%) grassland
160	Closed to open (>15%) broadleaved forest regularly flooded (semi-permanently or temporarily) - Fresh or brackish water
170	Closed (>40%) broadleaved forest or shrubland permanently flooded - Saline or brackish water
190	Artificial surfaces and associated areas (Urban areas >50%)
200	Bare areas
202	Non-consolidated bare areas (sandy desert)
210	Water bodies

6. How does vulnerability correspond with land cover?

Landcover (at 300 m resolution) and social vulnerability to climate change in Ghana

0   62.5   125   250
kilometers (at equator)
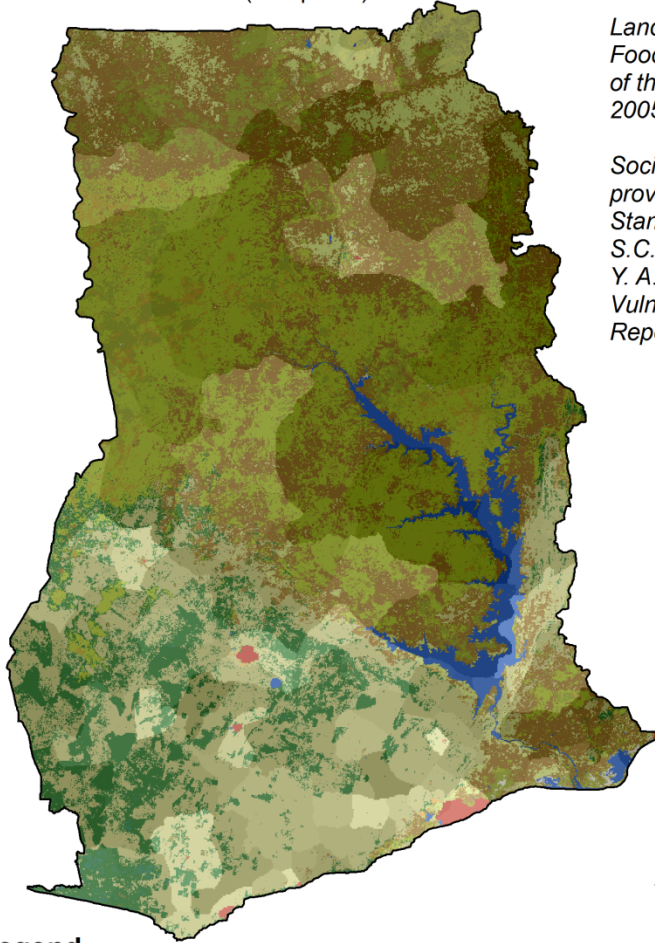
Land cover data provided by:
Food and Agriculture Organization
of the United Nations
2005 Global Land Cover Network Database

Social vulnerability data based on index values
provided by:
Stanturf, J.A., M.L. Warren, S. Charnley,
S.C. Polasky, S.L. Goodrick, F. Armah,
Y. A. Nyako. 2011. Ghana Climate Change
Vulnerability and Adaptation Assessment.
Report for USAID Ghana. 244 p.

Projection: UTM Zone 30 N
Datum: WGS 1984
Units: Meter

Legend

Classification Codes

LCCS Code

32	120	143	190	**Social vulnerability**
14	40	130	150	200	**Index Value**
20	41	134	151	202	High : 93
30	60	140	160	210	Low : 25
	110	141	170		

Land types are classified under UN FAO Land Cover Classification Standard (LCCS) codes.
Please see Table 2 for a descriptions of codes used for Ghana.

Map created by Sophia Polasky, March 20, 2012

Interpretation

As the sequence of maps show, social vulnerability to climate change is highest, according to the index created by Stanturf et al. (2011), in the northeastern region of Ghana. Vulnerability is lowest along the coast, and generally throughout the southwestern portion of the country. Interestingly, as the land cover data shows, the southwest is also the region with the most remaining forest cover. The north is dominated by grasses and shrub lands. When the two datasets are overlaid, it becomes evident that the remaining forest lands exist in regions of the country with the lowest vulnerability scores, while regions with high vulnerability tend to be covered with shrubs and grasses. Thus, based on the data considered, there seems to be a loose relationship between social vulnerability to climate change and land cover, whereby areas with less forest cover are experiencing highest social vulnerability. These maps alone do not serve as sufficient evidence to document a causal relationship; they are intended to start conversations amongst policy makers, and suggest potential areas for future research.

7. Documenting Uncertainty

Uncertainty in the Vulnerability Index

The index is built using data from two different surveys, both produced by Ghana Statistical Service. Although survey data was collected at the local/village level, it was aggregated into district averages. Thus, districts are treated as homogenous units when in fact there is likely a great degree of variance within each district. Furthermore, there are presently 170 districts in Ghana. However the survey data used for the index was generated in 2000, when there were only 110 districts. Redistricting since 2000 will have altered the distribution of vulnerability at a district level throughout the country. For information regarding uncertainty specifically contained within the survey data, including sampling procedures and methods, please see the Ghana 2003 Core Welfare Indicators Questionnaire Survey Report, and the 2000 Population and Housing Census, Analysis of District Data and Implications for Planning.

Uncertainty in land cover data

As new land cover datasets emerge, they are accompanied with a growing debate among data users about the accuracy of each new dataset. Land cover data in this report was generated from the UN's FAO 2005 Global Land Cover Network (GLCN) Database. Metadata for the dataset can be viewed at http://www.fao.org/geonetwork/srv/en/metadata.show?id=37186. The GLCN has been reprocessing data from their Globcover archive for the continent of Africa. The data sets produced are vector based shapefiles, human coded according to Land Cover Classification Standard (LCCS) classes, and topologically corrected so that they are compatible with GLCN's Advanced Database Gateway software (GLCN 2012). Presumably this processing increases the uncertainty, but to what extent is not documented. Fritz et al. (2011) present a discussion of disagreements found between the Globcover data and other popular global land cover datasets. Their paper, "Highlighting continued uncertainty in global land cover maps for the user community" can be found online at: http://iopscience.iop.org/1748-9326/6/4/044005.

8. References

Fritz, S., L. See, I. McCallum, C. Schill, M. Obersteiner, M. van der Velde, H. Boettcher, P. Havlik, and F. Archard. 2011. Highlighting continued uncertainty in global land cover maps for the user community. Environmental Research Letters. 6(2011): 1-6. [online] http://iopscience.iop.org/1748-9326/6/4/044005.

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Kelly, P. M. and W. N. Adger. 2000. Theory and practice in assessing vulnerability to climate change and facilitating adaptation. Climatic Change. 47(4): 325-352.

Sandvik, Bjorn. World Borders Dataset. Thematicmapping.org. [online] www.thematicmapping.org/downloads/world_borders.php (March 20, 2012).

Stanturf, J.A., M.L.Warren, S. Charnley, S.C. Polasky, S.L. Goodrick, F. Armah, and Y. Atuahene Nyako. 2011. Ghana Climate Change Vulnerability and Adaptation Assessment. Accra, Ghana. United States Agency for International Development Ghana.143 p. [online publication forthcoming].

United Nations Food and Agriculture Organization. 2005. Global Land Cover Network Database. Ghana. Computer file. [online] http://www.fao.org/ geonetwork?uuid=1b7e39c1-f777-4e4a-80c4-b4bb7a3115ab.