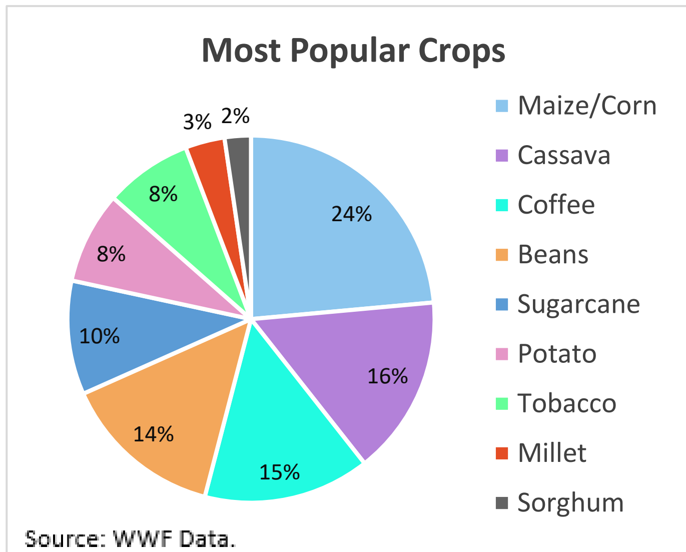
UGANDA: SUMMARY OF FINDINGS

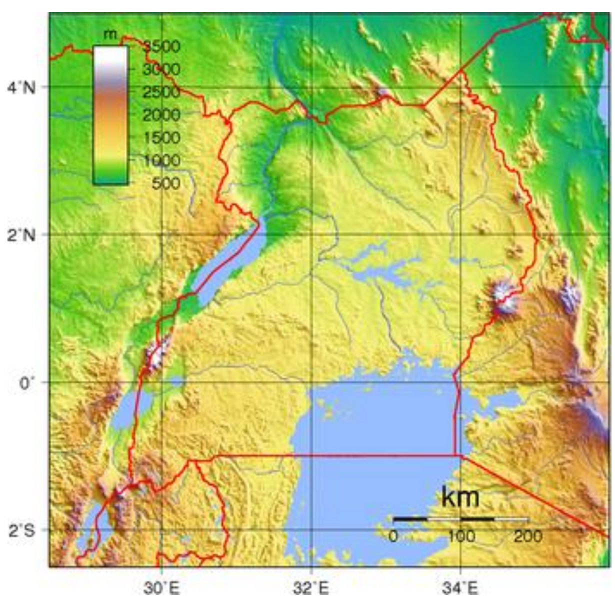
BACKGROUND

Uganda is known to a degree for its social and religious conservatism (particularly for its treatment of members of the LGBTQ community). Despite its generally conservative tendencies, however, the Ugandan government has made groundbreaking commitments towards progressive causes, such as environmental protection and the fight against climate change. It is at the forefront of innovation in African climate change strategies and commitment to sustainability. According to the World Bank (2019), the Ugandan government has taken an active role in reducing climate threats by promoting tree planting, engaging in sustainable soil practices (such as trench construction to mitigate the impact of flooding), developing and endorsing its Nationally Determined Contribution Partnership Plan, hosting sustainability workshops, and developing a national Green Growth strategy. World Wildlife Fund (WWF) interviewees also indicated that the government has dispatched its National Agricultural Advisory Services agency to help communities improve food security and implement environmentally-friendly farming practices.

AGRICULTURE OVERVIEW

Located on the equator, Uganda's average temperatures stay in the vicinity of 70°F year-round. There are two rainy seasons, one starting in April and one starting in September (Levchenko). Uganda is generally considered to have nutrient-rich soil and plentiful rain, making agriculture a major contributor to the economy. According to interviews conducted by the WWF, the most popular crops include maize/corn, cassava, coffee, and beans. The proportion that agriculture has contributed to the economy, however, has been declining in recent years as the service and manufacturing industries have been growing and climate change has created additional challenges for farmers.





GEOLOGY

Uganda has a diverse terrain[1]. To the south rests Lake Victoria, offering some level of protection from drought due to the "lake effect" (a phenomenon whereby warm, moist air rises from the lake and results in precipitation nearby). The south is more mountainous than the north, which also affects precipitation: moisture-rich air gets trapped by the mountains due to the orographic effect, providing a reliable source of water in the south and possibly mitigating some effects of climate change (such as drought and decreased rainfall).

[1] Source: https://commons.wikimedia.org/wiki/User:Sadalmelik

There is a difference of 14,754 feet elevation between the nation's lowest and highest elevation points. The lowest point is in the north at 2,014 feet elevation along the Albert Nile (also called the White Nile) at the border with South Sudan (a low-lying area also called the Sudanese Plain). The highest point is in the south at 16,768 feet elevation at Margherita Peak on Mount "Stanley" (also known as Mount Ngaliema).[2]

SIGNIFICANCE

The condition of the White Nile is significant because it is one of two main tributaries of the Nile River. The Nile River and its tributaries are an invaluable resource to the countries they flow through, with the potential to provide Egypt, Ethiopia, Eretria, Uganda, Sudan, South Sudan, Rwanda, Burundi, Congo, Tanzania, and Kenya with a steady source of both irrigation and hydroelectric power. As discussed in Elsanabary's (2012) research, the Nile River provides a finite supply of such resources. Pollution, erosion, and drought in an upstream country can have disastrous consequences for uses of the Nile River in downstream countries. This, in turn, might contribute to economic destabilization in some areas, as many people rely on the Nile River for their livelihoods. Without cooperative efforts to maintain the Nile River's ecosystem and regulate its use, there is the potential for conflict over water rights between Uganda and neighboring countries. As demonstrated later in this report, the risk of conflict will only increase as climate change intensifies, rainfall patterns become less predictable, and the amount of available water decreases.

METHODOLOGY

How do geological differences impact climate change and responses to climate change? Given the significant geological differences between the north and south of Uganda, I wanted to test for statistical differences in how climate change was affecting each region and how responses to climate change differed by region. The WWF conducted a total of 198 qualitative interviews of Ugandan residents, consisting mostly of unstructured dialogue prompted by interview questions. Residents could also choose as many options as were relevant from a selection of types of climate changes and types of responses to climate change. I looked at a map of the locations of the residents, and visually broke the interviews into northern and southern regions (see **Appendix A** for details). The interviews broke down by region as follows: 95 in the north, 99 in the south, and 4 of indeterminant region.

I analyzed the reported types of climate changes, responses to climate changes, and instances of decreases in crop yields. I used chi-square tests (two by two crosstab analyses) and Pearson correlation tests in IBM SPSS Statistics 25 to determine which variables had a statistically relevant association with region, and to determine whether region impacted the likelihood of decreased crop yields. Each of the two by two chi-square tests came up with results consistent with the Fisher's exact test, in terms of level of significance. In order to convert the qualitative data into something easily analyzed by SPSS, I coded affirmative responses "1" and negative responses "0" for various variables or, in the case of region, "1" for north and "0" for south.

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[2] Source: https://en.wikipedia.org/wiki/Geography_of_Uganda

REPORTED CHANGES IN WEATHER/CLIMATE[3]

Interviewees across the whole of Uganda were asked to report on the following types of recent changes in weather/climate: Increased or decreased rainfall, changes in the timing of the rainy seasons, droughts, floods, storms, loss of water sources, heat waves/hot days, wildfires, cold spells, changes in the wind, erosion/landslides, and ice melts. Responses tended to be more numerous/severe for respondents in the north, possibly indicating that the lake effect and orographic effect has a calming effect on climate changes in the south. There were 408 weather changes reported for the 95 interviews in the north and 336 reported for the 99 interviews in the south. After normalizing the responses, it is determined that residents in the north reported approximately **1.3 times** the number of recent changes in the weather as compared to their neighbors to the south.

A statistical test can confirm the relationship between the region and the number of expected climate challenges. Detailed analysis from SPSS is available in **Appendix B**.

- Crosstab Analysis: The low p-value (.002) of the chi-square test of climate changes by region indicates that there is a relationship between region and number of climate challenges. The p-value is below the .05 level of significance needed to reject the null hypothesis and confirm our test hypothesis. We can be 95% confident that geographical region is relevant in determining how many types of climate challenges a Ugandan resident will likely face. Specifically, residents in the north will suffer more types of climate challenges than will residents in the south.

The most statistically significant connections between region and type of climate change are found with the following climate challenges: increased drought, storms, loss of water source, wildfires, and changes in wind. The low p-values of the chi-square tests for these climate changes (ranging from 0.000 to 0.037) indicate that there is a strong relationship between region and these types of climate challenges. Detailed chi-square tests from SPSS are available in **Appendix B**. The associations between region and climate change are confirmed with a correlation test (found in **Appendix C**), where the level of significance is less than 0.05 and the correlation coefficient is greater than 0.100. The correlation coefficients are low (ranging from 0.100 to 0.300), but with such a large sample size, even a modest correlation can be meaningful. Once normalized, the interview responses revealed the following ratios:

- Residents in the north saw the increased occurrence of <u>wildfires</u> 5.7 times more often than did residents in the south
    - 11 out of 95 compared to 2 out of 99
    - Level of significance: 0.008; Pearson correlation coefficient: 0.191

- Residents in the north saw the increased occurrence of <u>changes in wind</u> 3.4 times more often than did residents in the south
    - 26 out of 95 compared to 8 out of 99
    - Level of significance: 0.000; Pearson correlation coefficient: 0.252

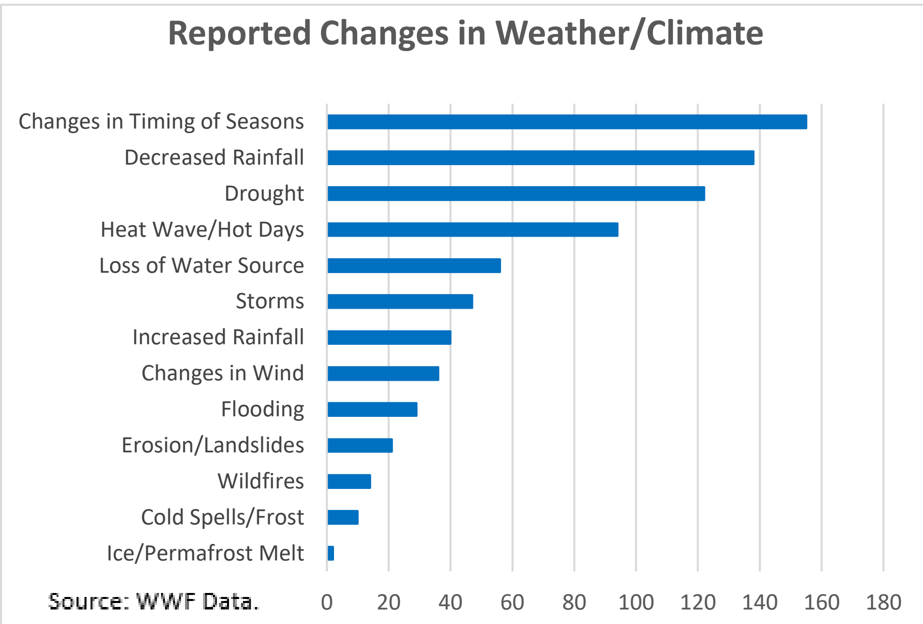
- Residents in the north saw the increased occurrence of <u>storms</u> 2.9 times more often than did residents in the south
    - 33 out of 95 compared to 12 out of 99
    - Level of significance: 0.000; Pearson correlation coefficient: 0.272

[3] Note: The highest frequencies of interviews are clustered at the start of the two rainy seasons (19 conducted in March and 43 conducted in August). Excluding these two months, the average number of monthly interviews was 13.6. The timing of the interviews may have influenced or skewed some people's reporting of their most urgent climate struggles. Right before planting seasons, interviewees might have been most concerned with how the timing of the rainy seasons, droughts, and decreased rainfall would affect their crop yields. Thus, those issues might have had an outsized place in the interviewees' minds, making other climate occurrences feel smaller or less critical.

- Residents in the north saw the increased occurrence of loss of water sources 1.6 times more often than did residents in the south
  - 34 out of 95 compared to 22 out of 99
  - Level of significance: 0.037; Pearson correlation coefficient: 0.150

- Residents in the north saw the increased occurrence of droughts 1.4 times more often than did residents in the south
  - 68 out of 95 compared to 50 out of 99
  - Level of significance: 0.003; Pearson correlation coefficient: 0.217

Across all of Uganda, residents in both regions most often reported challenges with changes in the timing of the seasons, decreased rainfall, and increased droughts:



Out of 198 respondents:

- 78% reported issues with changes in the timing of seasons (155 interviews)
- 70% reported issues with decreased rainfall (138)
- 62% reported issues with drought (122)
- 47% reported issues with heat waves/hot days (94)
- 28% reported issues with a loss of water source (56)

Seventy-eight percent of respondents (155 interviewees) reported noticing changes in the timing of the rainy seasons. There was a slightly greater likelihood that this change affected interviewees in the north, but not to a statistically significant degree. Eighty percent of residents in the north (76 out of 95 interviews) reported issues with changing timing of the seasons, compared to 76% in the south (75 out of 99 interviews). Four responses were of indeterminant region. The changing timing of the rainy seasons tended to affect respondents regardless of geographical area.

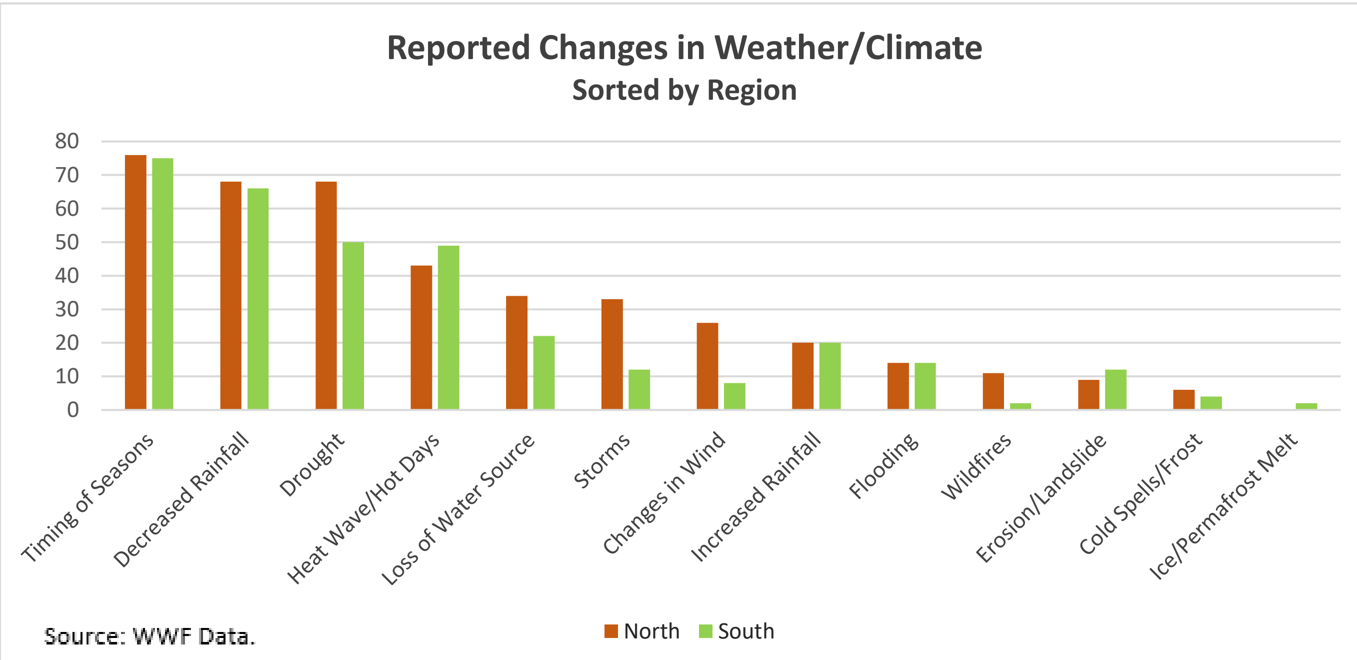
Decreased rainfall was the second most commonly reported issue, showing up in 70% (or 138) of all interviews. Residents in the north were slightly more likely to experience decreased rainfall than were residents in the south (at 72% and 67% of regional interviews, respectively), but the regional differences were not statistically significant.

Drought was a major issue. Sixty-eight interviewees in the north and 50 in the south indicated that they saw an increased occurrence of droughts due to climate change. The normalized responses indicate that residents in the north experienced drought nearly one and a half times more often than did their southern counterparts.

Taking the top three reported climate changes together, it is evident that Ugandan farmers are facing broad issues with regard to access to water. Being able to predict the timing of the rainy seasons is particularly important to the agricultural sector. Without knowing when the rain is likely to fall, it is impossible to know when it is the best time to plant crops. Regular precipitation promotes predicable crop yields, making farming a tenable profession.

Without that regularity, farming becomes less predictable, less productive, and less profitable. Interviewees indicated that decreased rainfall and unpredictable rainfall had a negative impact on crop yields. These farming challenges directly relate to how access to the White Nile affects the geopolitical stability of the whole region. Residents negatively impacted drought, decreased rainfall, etc. will search for reliable water sources, possibly putting additional strain on the limited resource that is the White Nile. This, in turn, might impact Uganda's relationship with its neighbors, as each country seeks to use the river to mitigate the consequences of climate change.

See the breakdown of reported changes in weather by region in the chart below:



RESULTS OF CLIMATE CHANGE

Among other issues, residents mentioned that the following problems were created directly or indirectly by climate change:

- Drought conditions and increased winds exacerbate the severity of wildfires
- Increasingly violent lightning storms kill people and livestock
- Strong winds and hailstorms destroy property
- Droughts have created friendly conditions for insects and diseases to spread
- Long periods of drought followed by short bursts of intense rainfall cause landslides and flooding
- Increased temperatures and intensity of heat waves cause scorched land, leading to soil infertility
    - Scorched fields leave less suitable grazing land for livestock
- Soil degradation and drought have led people to encroach on wetlands and public forests in search of firewood, fertile soil, and a water source. In turn, this deforestation has led to:
    - Scarcity of firewood and charcoal
    - Wild animals driven from their natural habitats moving to areas populated by people
    - Decreased collection of native edible plants (wild yams and mushrooms), herbs, and medicinal plants

    - Increased hazardous encounters between people and wild animals
    - Decreased biodiversity of wild animals
    - Destruction of endangered mahogany forests and extinction of other tree varieties
- Decreased rainfall means decreased crop yields. This has led to food scarcity, which has led to:
    - Malnutrition
    - Food theft
    - Increased domestic violence as hunger causes tension in homes
- Siltation of waterways (exacerbated by increased drought and erosion) decreases the supply of fish and potable water
- Girls drop out of school to help their mothers look for scarce resources such as water and firewood
- Household conflicts increase due to the amount of time needed to look for firewood

RELEVANCE TO CROPS

Forty-one percent of interviewees saw recent declines in crop yields. Residents in the north saw occurrences of decreased crop yields 1.4 times more often than did residents in the south (there were 45 out of 95 northern respondents as compared to 33 out of 99 southern respondents). There was a statistically significant correlation between decreased crop yields and region, with a level of significance of 0.047 and a Pearson correlation coefficient of 0.143. This means that crops yields are statistically more likely to perform worse in the north than in the south. There were also correlations found between crop yield and changes in wind, and crop yield and wildfires. (Detailed analyses from SPSS are available in **Appendix C**.) Given that so many interviewees across the country indicated issues with drought, decreased rainfall, and changes in the timing of the seasons, it is not surprising that so many farmers experienced problems with productivity.

It would be logical for farmers to invest in drought-resistant crops. Depending on the varieties used, corn, cassava, and beans (several of the most popular crops among farmers interviewed) can be highly drought resistant, according to the De Peyster (2016) and Patterson. (Of the farmers interviewed, about 54% of them indicated that they grow some combination of corn, beans, and/or cassava.) The decision to grow hardy crops increases the likelihood of successful yields even as climate change increases drought conditions.

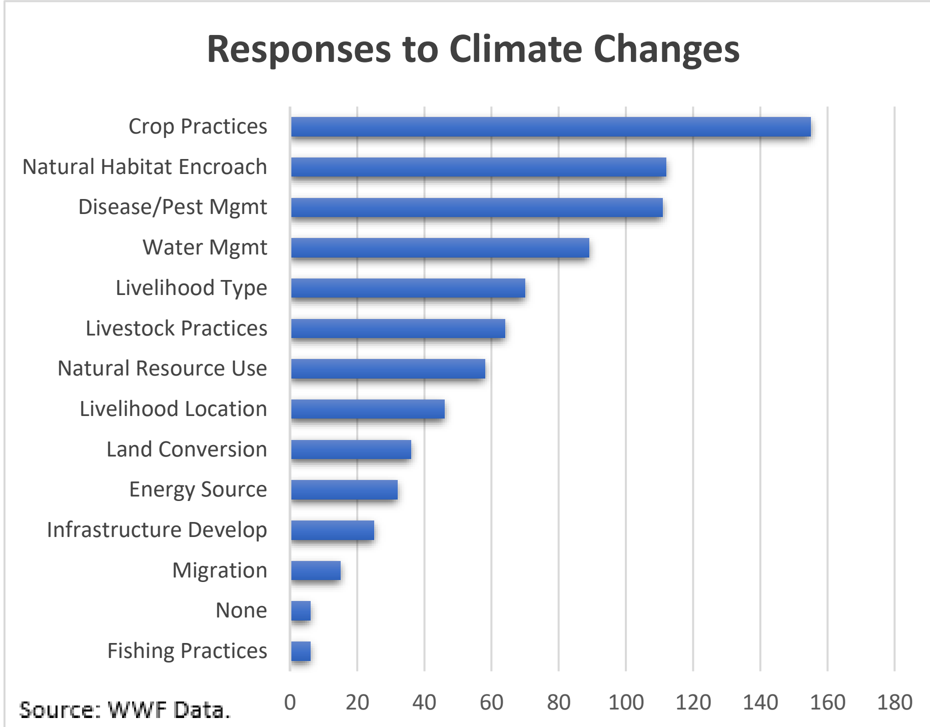
Coffee is grown by approximately 15% of the farmers interviewed. The coffee plant is sensitive and is not particularly hardy against drought conditions, leaving coffee farmers more at the mercy of weather fluctuations and vulnerable to low crop yields. As discussed in Cheserek and Gichimu's (2012) research, the coffee plant is "a highly environmentally-dependent crop and an increase of a few degrees of average temperature and/or short periods of drought in coffee-growing regions can substantially decrease yields of quality coffees." Interviewees indicate that both the planting and harvesting time for coffee has become unpredictable in recent years. In some areas, drought has made coffee growing untenable.

The climate changes specific to Uganda may force farmers to abandon coffee as a cash crop, in favor of more hardy plants. Another possibility is that the nation would see more farming operations move from the north to the south, where drought is less likely and the impacts of climate change are slightly mitigated (due to the lake effect and orographic effect, as discussed earlier). Of the interviewees who mentioned growing coffee, 21% were in the north and 76% were in the south. (Three percent were of indeterminant region.)

COMMUNITY RESPONSES TO CLIMATE CHANGES

Out of 198 respondents:

- 80% reported changing crop practices (159 interviews)
- 59% reported changing natural habitat encroachment (116)
- 58% reported changing disease/pest management practices (115)
- 46% reported changes in water management practices (92)
- 36% reported changes in livelihood type (72)



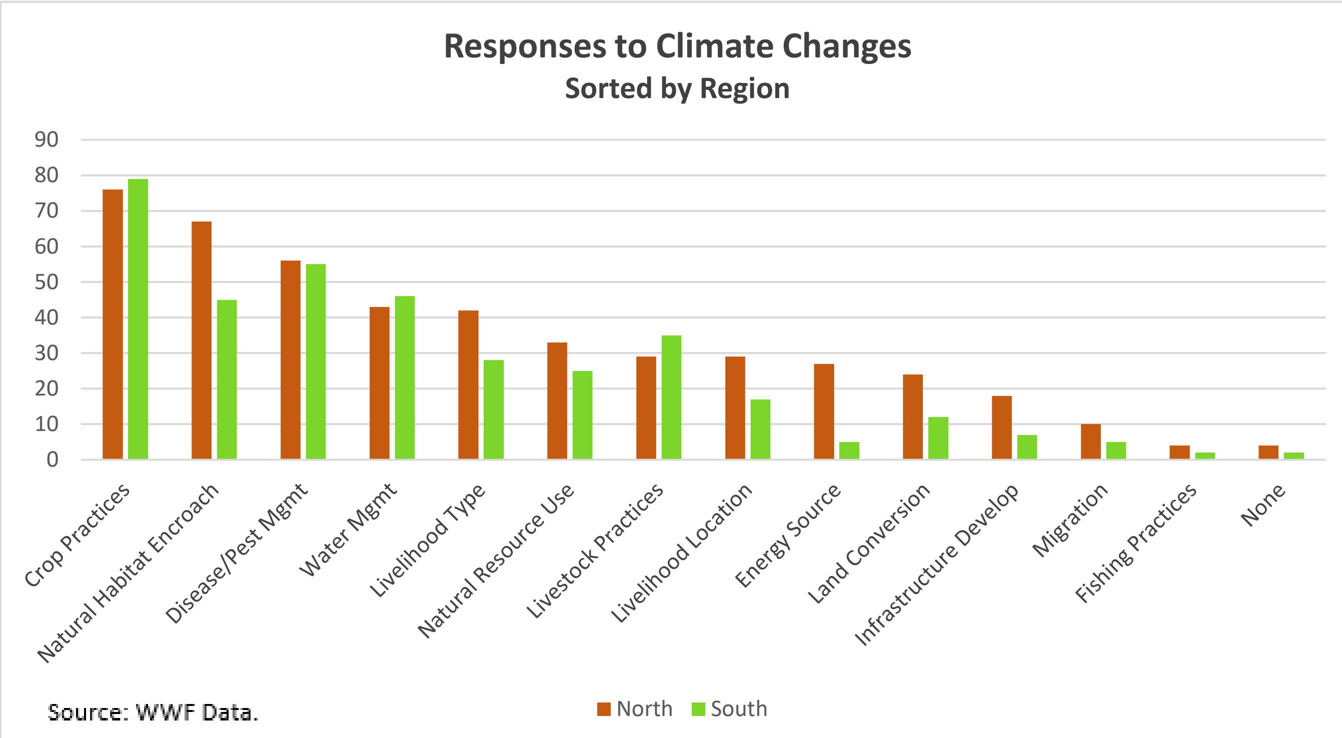
In an effort to curb crop losses and tackle the rising consequences of climate change, residents of Uganda have responded in a number of ways. They were asked to select as many ways as were relevant among the following potential changes: crop practices, disease/pest management, natural habitat encroachment, water management, livelihood type, livestock practices, natural resource use, livelihood location, land conversion, energy source, infrastructure development, migration, and fishing practices. (Six of 198 interviewees said that they made no changes whatsoever.)

There are a number of ways that the north and south have differed in their responses to climate change. Statistical analysis of the interviews finds that the many types of responses are statistically more likely to occur in the north than in the south: changes in livelihood type, changes in livelihood location, natural habitat encroachment, land conversion, infrastructure development, and energy source. The low p-values of the chi-square tests for these types of responses (ranging from 0.000 to 0.029) indicate that we should reject the null hypothesis (that there are no differences between responses in the north and south) and accept the test hypothesis that region and responses are associated: Specifically, that these responses to climate change are statistically more likely in the north. (Detailed analyses from SPSS are available in **Appendix D**.) After normalizing the responses, the following ratios emerge:

- Residents in the north responded to climate changes with 5.6 times more changes in energy source than did residents in the south (27 out of 95 compared to 5 out of 99)
- Residents in the north responded to climate changes with 2.7 times more instances of infrastructure development than did residents in the south (18 out of 95 compared to 7 out of 99)
- Residents in the north responded to climate changes with 2.1 times more instances of land conversion than did residents in the south (24 out of 95 compared to 12 out of 99)
- Residents in the north responded to climate changes with 1.8 times more changes in livelihood location than did residents in the south (29 out of 95 compared to 17 out of 99)
- Residents in the north responded to climate changes with 1.6 times more changes in livelihood type than did residents in the south (42 out of 95 compared to 28 out of 99)

- Residents in the north responded to climate changes with 1.6 times more instances of <u>natural habitat encroachment</u> than did residents in the south (67 out of 95 compared to 45 out of 99)

See all of the responses to climate change broken down by region below:



Responses to the consequences of climate changes have included:

- Planting of drought-resistant crops
- Digging more boreholes wells to collect water
- Walking longer distances in search of drinking water and firewood
- Attempting to domesticate rare varieties of plants to preserve them
- Using organic fertilizer to improve soil fertility
- Receiving training in climate-smart practices by non-profit organizations
- Adopting energy-saving technologies
- Having other sources of income to fall back in the event of poor crop yields (i.e., economic diversification)
- Switching from water-reliant livestock to drought-resistant crops
- Moving livestock further away to find fertile grazing pastures
- Cultivating wetlands and encroaching on forest land to find fertile soil for farming
- Hunting wild game as an alternative source of meat
- Increasing the use of chemical sprays in places to combat pests and weeds
- Staying single longer, if a farmer's livelihood has been affected and they cannot afford to support a family
- Planting fruit trees around homes as a windbreaker
- Installing energy-saving stoves due to scarcity of firewood/charcoal

The most common response, being mentioned by about 80% of the interviewees, was changing crop practices. (At 76 and 79 responses, respectively, there was not a statistically significant difference between the number of northern and southern responses for changing crop practices.) This common response to climate change could potentially be an environmentally-friendly way to make farming more robust in a future without reliable water. Switching to drought-resistant crops (and away from water-dependent crops like coffee) could preserve farming as a tenable profession in drought-prone areas. With environmentally-friendly farming practices, farmers in the north might be better equipped to stay on their current lands, maintain their livelihoods, and avoid overusing the White Nile - thus reducing the risk of local and international conflicts over water rights. During their WWF interviews, farmers specifically mentioned eschewing coffee in favor of drought-resistant varieties of cassava and yams during their interviews. Many have already started implementing farming practices to protect against current and future climate changes.

The Ugandan National Agricultural Advisory Services (NAADS) is a government program aimed at improving agricultural practices and increasing food production by encouraging environmentally-friendly farming. Some interviewees mentioned that the organization has had a role in helping farmers change their crop practices, assisting farmers with switching to drought-resistant crop varieties. Aside from providing hardier seedlings, NAADS has also been training farmers in the latest sustainable farming techniques.

Natural habitat encroachment was the second most common response to climate change, according to interviewees. This response, statistically more likely in the north than the south, is not an environmentally friendly one – and it brings with it a host of dangerous consequences. Encroaching on public forests leads to loss of habitat for wild animals, leading them to move closer to areas populated by people. Increased encounters with wild animals lead to transmission of disease between livestock and native fauna. According to the interviews, residents have found that their herds are catching diseases (and sometimes dying off) at an increased rate. Deforestation also means the destruction of native medicinal herbs, along with the extinction of endangered plants and animals. The destruction of forests also means less firewood and charcoal, which are commonly used for fuel. Many interviewees indicated that lack of firewood was a significant problem, necessitating that residents walk longer distances in search of firewood sources. This, in turn, has led to increased strife in the home as families grapple with the large amount of time it now takes to find firewood.

The third most common response to climate challenges was changes in pest management and disease control. Farmers have found that droughts make the land more habitable for pests, and they have had to use more pesticides to control insect outbreaks than in the past. The harsh chemicals are killing off the native pollinators, which in turn hurts crop yields. Pest management responses were not statistically different between the north and south. The increased need for pesticides might continue to grow in the near future, as a historically large swarm of locusts has been sweeping through East Africa in recent months. According to Blandy (2020), "[b]illions of locusts swarming through East Africa are the result of extreme weather swings and could prove catastrophic for a region still reeling from drought and deadly floods." Blandy's statement leads one to conclude that the unusual size of the swarm might itself be an indirect consequence of climate change. This swarm is ravenous and will have a devastating impact on the Ugandan farming industry. Even accounting for expected decreases in yields due to climate changes, 2020's crop yields will probably be significantly worse than previously anticipated due to the swarm.

Disease control has needed to increase because changing rain patterns have caused an increase in incidence of certain diseases. In the rainy seasons, waterborne diseases such as diarrhea, hepatitis, typhoid, cholera, and malaria have been on the rise, according to interviewees. In the dry seasons, cases of eye infections, measles, chest infections, colds, and flus have increased. The government has responded by providing residents with mosquito nets in an effort to control the spread of malaria, and residents have been drinking filtered water to cut down on waterborne diseases.

CONCLUSION

Interviewees mentioned a number of dire indirect consequences of climate change. According to residents, there are connections between climate change and cases of domestic violence, girls dropping out of school, and increased incidence of various diseases. Any solutions seeking to mitigate the effects of climate change in a systemic and holistic way should also address these concomitant events.

Climate changes have had a negative impact on crop yields and have created or exacerbated food scarcity throughout Uganda. Based on statistical analysis of the WWF interviews, it is evident that the north of Uganda is dealing with harsher/more frequent consequences of climate change than is the south. Efforts to mitigate the effects of climate change should focus on changing farming and water management practices in the north, or perhaps should focus on encouraging farming operations to move to the south. Decreasing farming in the north would put less strain on the limited water resources there (such as the White Nile), and the south might be better geologically equipped to cope with the worsening effects of climate change.

LIMITATIONS OF THE STUDY

Many interviews were highly informative. For future interviews, it might be useful to add questions specifically addressing changes in crop yields and types of crops grown. Many interviewees included these pieces of information but, without an explicit question, some people did not mention it. This might leave gaps in the collection of data. Also, with many of the responses in the form of qualitative, free-form conversation, it was difficult to quantify much of the data to make apples-to-apples comparisons for statistical analysis.

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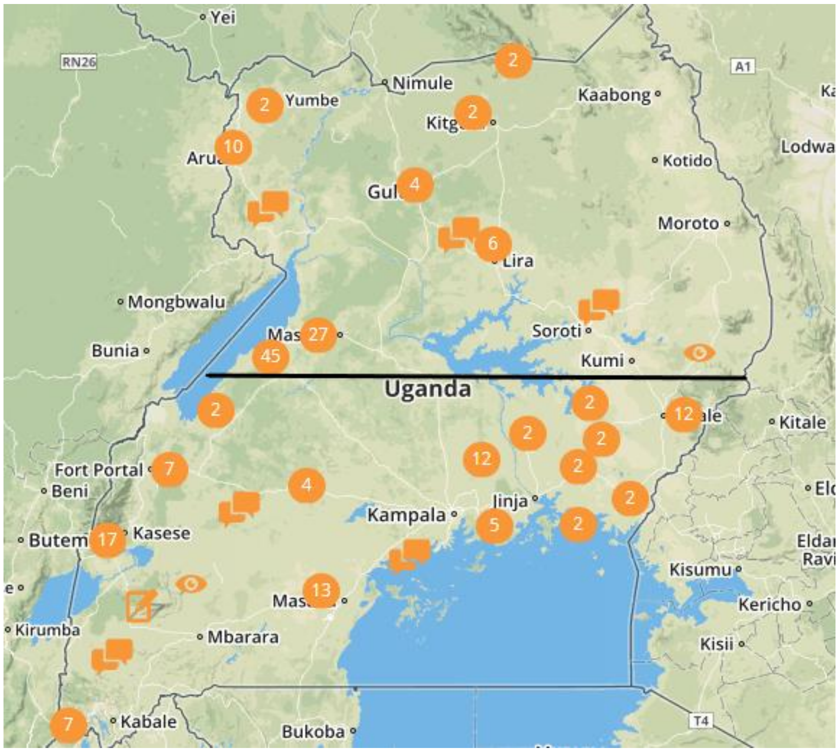
Appendix A: Interview locations broken down by region



NORTH

Amura
Arua
Bulambuli
Gulu
Hoima
Kadukuru
Kapchorwa
Karongo
Kaseeta
Kigaaga
Kinyara
Kitgum
Koboko
Kyakatemba
Kyempunu
Lamwo
Lira
Maracha
Masindi
Nebbi
Nyabeya
Nyakafunjo
Oyam
Soroti
Yumbe

SOUTH

Bududa
Bushenyi
Iganga
Kabarole
Kalangala
Kaliro
Kamuli
Kanyegaramire
Kapeeka
Kasese
Kayunga
Kibale
Kisoro
Kyenjojo
Luweero
Lwengo
Manafwa
Masaka
Mayuge
Mbale
Mbarara
Mubende
Namutumba
Pallisa
Rukungiri
Sironko

APPENDIX B: Statistical comparisons between northern and southern effects of climate change

CHANGES IN CLIMATE BY REGION

Total Changes * N/S Crosstabulation

		N/S		
		0	1	Total
Total Changes	0	0	1	1
	1	9	10	19
	2	21	8	29
	3	28	14	42
	4	21	23	44
	5	13	10	23
	6	1	14	15
	7	3	9	12
	8	2	4	6
	9	1	1	2
	10	0	1	1
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	27.892[a]	10	.002
Likelihood Ratio	31.289	10	.001
N of Valid Cases	194		

a. 8 cells (36.4%) have expected count less than 5. The minimum expected count is .49.

DROUGHT

Crosstab

		N/S		
		0	1	Total
Drought	0	49	27	76
	1	50	68	118
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	9.036[a]	1	.003		
Continuity Correction[b]	8.173	1	.004		
Likelihood Ratio	9.135	1	.003		
Fisher's Exact Test				.003	.002
N of Valid Cases	194				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 37.22.

b. Computed only for a 2x2 table

STORMS

Crosstab

		N/S 0	N/S 1	Total
Storms	0	87	62	149
	1	12	33	45
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	13.918[a]	1	.000		
Continuity Correction[b]	12.678	1	.000		
Likelihood Ratio	14.323	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	194				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 22.04.

b. Computed only for a 2x2 table

LOSS OF WATER SOURCE

Crosstab

		N/S 0	N/S 1	Total
Loss of water source	0	77	61	138
	1	22	34	56
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.346[a]	1	.037		
Continuity Correction[b]	3.710	1	.054		
Likelihood Ratio	4.368	1	.037		
Fisher's Exact Test				.041	.027
N of Valid Cases	194				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 27.42.

b. Computed only for a 2x2 table

WILDFIRES

Crosstab

		N/S 0	N/S 1	Total
Wildfires	0	97	84	181
	1	2	11	13
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.085[a]	1	.008		
Continuity Correction[b]	5.639	1	.018		
Likelihood Ratio	7.711	1	.005		
Fisher's Exact Test				.009	.007
N of Valid Cases	194				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.37.

b. Computed only for a 2x2 table

CHANGES IN WIND

Crosstab

		N/S 0	N/S 1	Total
Changes in wind	0	91	69	160
	1	8	26	34
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	12.477[a]	1	.000		
Continuity Correction[b]	11.179	1	.001		
Likelihood Ratio	12.986	1	.000		
Fisher's Exact Test				.001	.000
N of Valid Cases	194				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 16.65.

b. Computed only for a 2x2 table

APPENDIX C: Correlations between types of climate change, region, and decreased crop yield

Correlations

		Decreased Crop Yield	North/ South	Increased rainfall	Drought	Storms	Loss of water source	Wildfires	Changes in wind
Decreased Crop Yield	Pearson Correlation	1	.143*	.154*	0.098	0.072	0.011	.159*	.175*
	Sig. (2-tailed)		0.047	0.032	0.173	0.316	0.876	0.027	0.015
	N	194	194	194	194	194	194	194	194
North/South	Pearson Correlation	.143*	1	0.011	.216**	.268**	.150*	.191**	.254**
	Sig. (2-tailed)	0.047		0.884	0.003	0.000	0.037	0.008	0.000
	N	194	194	194	194	194	194	194	194
Increased rainfall	Pearson Correlation	.154*	0.011	1	.174*	0.112	-0.072	0.118	0.033
	Sig. (2-tailed)	0.032	0.884		0.015	0.119	0.321	0.101	0.646
	N	194	194	194	194	194	194	194	194
Drought	Pearson Correlation	0.098	.216**	.174*	1	.191**	.278**	.215**	.203**
	Sig. (2-tailed)	0.173	0.003	0.015		0.008	0.000	0.003	0.004
	N	194	194	194	194	194	194	194	194
Storms	Pearson Correlation	0.072	.268**	0.112	.191**	1	.216**	0.097	.293**
	Sig. (2-tailed)	0.316	0.000	0.119	0.008		0.003	0.179	0.000
	N	194	194	194	194	194	194	194	194
Loss of water source	Pearson Correlation	0.011	.150*	-0.072	.278**	.216**	1	-0.034	0.065
	Sig. (2-tailed)	0.876	0.037	0.321	0.000	0.003		0.636	0.365
	N	194	194	194	194	194	194	194	194
Wildfires	Pearson Correlation	.159*	.191**	0.118	.215**	0.097	-0.034	1	.310**
	Sig. (2-tailed)	0.027	0.008	0.101	0.003	0.179	0.636		0.000
	N	194	194	194	194	194	194	194	194
Changes in wind	Pearson Correlation	.175*	.254**	0.033	.203**	.293**	0.065	.310**	1
	Sig. (2-tailed)	0.015	0.000	0.646	0.004	0.000	0.365	0.000	
	N	194	194	194	194	194	194	194	194

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

APPENDIX D: Statistical comparisons between northern and southern responses to climate change

CHANGES IN LIVELIHOOD LOCATION

Crosstab

		N/S		
		0	1	Total
Livelihood location	0	82	66	148
	1	17	29	46
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.780[a]	1	.029		
Continuity Correction[b]	4.070	1	.044		
Likelihood Ratio	4.818	1	.028		
Fisher's Exact Test				.042	.022
Linear-by-Linear Association	4.755	1	.029		
N of Valid Cases	194				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 22.53.

b. Computed only for a 2x2 table

CHANGES IN LIVELIHOOD TYPE

Crosstab

		N/S		
		0	1	Total
Livelihood Type	0	71	53	124
	1	28	42	70
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.333[a]	1	.021		
Continuity Correction[b]	4.664	1	.031		
Likelihood Ratio	5.359	1	.021		
Fisher's Exact Test				.025	.015
Linear-by-Linear Association	5.305	1	.021		
N of Valid Cases	194				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 34.28.

b. Computed only for a 2x2 table

NATURAL HABITAT ENCROACHMENT

Crosstab

		N/S 0	N/S 1	Total
Natural habitat encroachment	0	54	28	82
	1	45	67	112
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	12.488[a]	1	.000		
Continuity Correction[b]	11.482	1	.001		
Likelihood Ratio	12.655	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	12.424	1	.000		
N of Valid Cases	194				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 40.15.

b. Computed only for a 2x2 table

LAND CONVERSION

Crosstab

		N/S 0	N/S 1	Total
Land conversion	0	87	71	158
	1	12	24	36
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.540[a]	1	.019		
Continuity Correction[b]	4.705	1	.030		
Likelihood Ratio	5.618	1	.018		
Fisher's Exact Test				.026	.015
Linear-by-Linear Association	5.512	1	.019		
N of Valid Cases	194				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 17.63.

b. Computed only for a 2x2 table

INFRASTRUCTURE DEVELOPMENT

Crosstab

		N/S		
		0	1	Total
Infrastructure Development	0	92	77	169
	1	7	18	25
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.091[a]	1	.014		
Continuity Correction[b]	5.079	1	.024		
Likelihood Ratio	6.260	1	.012		
Fisher's Exact Test				.018	.011
Linear-by-Linear Association	6.060	1	.014		
N of Valid Cases	194				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.24.

b. Computed only for a 2x2 table

ENERGY SOURCE

Crosstab

		N/S		
		0	1	Total
Energy source	0	94	68	162
	1	5	27	32
Total		99	95	194

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	19.224[a]	1	.000		
Continuity Correction[b]	17.564	1	.000		
Likelihood Ratio	20.732	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	19.124	1	.000		
N of Valid Cases	194				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 15.67.

b. Computed only for a 2x2 table