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Climate Change in Ethiopia: impact, adaptation & mitigation

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The purpose of this presentation is-

"...to share my questions so that there will be a lively discussion ..."



Ethiopia: brief summary



- Between latitudes 3° and 15°N
- Population (2015): 99,465,000
 Population growth rate (2013):
 2.6% (World Bank)
- Total area: 1,104,300 km²
- 80 ethnic groups
- A dry and two rainy seasons (annual rainfall 250 to 2000 mm; average temperature 16 to 27°C)

Ethiopia: brief summary



- Agriculture dominant economy (42% of GDP, 85% employment)
- GDP \$550 per capita (2015)
 - 10% economic growth annually from 2004 through 2009
- Forest cover (FAO, 2010)
 Early 20th century: 35%,
 Current:11.9%
 Annual deforestation rate:1.1%

Q1: Sure about climate change in Ethiopia?



"Ethiopia is frequently portrayed as a drought-stricken country, both in the media and the scientific literature (Bewket 2012)"





'Climate change' in Google



Google.com.et offered in: মলেরে নলরে Soomaali Afaan Oromoo

'Climate change' in Google



'Climate change' in Google



'Climate change' in Google(%)



'Climate change' in Google(%)



nan farmers' assessment of local climate change

Interviewing farmers, Wondo Genet, 2012

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Ethiopian farmers' assessment of local climate change

An increase in temperature & a decrease in annual total rainfall (Deressa et al., 2008; Amsalu and Adem 2009; Bewket 2011 & 2012).

What data tell me....

Automatic weather monitoring station, Wondo Genet, 2013

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What data tells me....

Ethiopian average temperature has increased 0.2 to
 0.28 °C per 10 years over last 50 years (Keller 2009; Eshetu et al. 2014).

- Precipitation decline in southern Ethiopia, during both February–May and June–September (Viste et al., 2013)
- Spring droughts have occurred more frequently in all parts of Ethiopia during the last 10–15 years (Viste et al., 2013)

What climate models tell me....in future





- Temperature is expected to increase: 1°C by 2030 and 2°C by 2050 (compared to 1975) (Eshetu et al. 2014; Aragie 2013)
- Precipitation is expected to increase: 9% over 50 years (compared to 1975) (Eshetu et al. 2014; Aragie 2013)
- Extreme events are expected to increase: e.g., severe droughts in one year, and heavy flooding with erosion and landslides in the next (Aragie 2013)

What data tells me.... what I did not expect

- Precipitation decline in central and northern Ethiopia: no evidence (Viste et al., 2013)
- Consistent changes in the frequency or intensity of extreme events: little evidence (Tessema and Lamb, 2003; Seleshi and Camberlin, 2006; Mekasha et al., 2013).
- Positive trends for maximum temperature, warm days & negative trends for cool days, cool nights: most of the trends were not significant (Mekasha et al., 2013)

Q1. Sure about climate change in Ethiopia?

Q1. Sure about climate change in Ethiopia?

Climate data << Perception ???

May be a hint???

"Governments, aid organizations and local people within East Africa have been **so sensitized to the threat of climate change** that almost any moderately extreme weather event, or even weather that does not conform to a current ideal, is labelled as being a consequence of climate change (Coe and Stern 2011)."

Q2: The impact of climate change on Ethiopia?

Ethiopian farmers' assessment of the impact of climate change

Crop farmers

- Decrease in length of growing period
- Increase in crop damage by insects and pests
- Increase in crop diseases
- Shift in suitable growing areas

Pastoralists

- Shortage of feed
- Livestock disease
- Scarcity of water supply for livestock
- Mass die-offs of livestock

Source: Bewket 2012; Amsalu et al. 2013

How will climate change affect agriculture in Ethiopia?



Source: Evangelista et al., 2013

Rainfall & GDP growth in Ethiopia



World Bank, 2006. Managing Water Resources to Maximise Sustainable Growth: A Country Water Resources Assistance Strategy for Ethiopia. World Bank, Washington, DC.

Climate change will make the prospect of **economic development harder** in at least two ways:

- first, by reducing agricultural production and output in the sectors linked to the agricultural sector (reduce Ethiopia's GDP by about 10% from its benchmark level)
- second, by raising the degree of income inequality (increases by 20%), which is likely to further decrease economic growth and fuel poverty.



The impact of climate change on health?



Climate Change and Public Health

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Sample



CLIMATE CHANGE

Source: Patz, 1998

Urban Heat Island Effect

Air Pollution

Vector-borne Diseases

Water-borne Diseases

Water resources

& food supply

Environmental Refugees

Heat Stress Cardiorespiratory failure

Respiratory diseases, e.g., COPD & Asthma

Malaria Dengue Encephalitis Hantavirus Rift Valley Fever

Cholera Cyclospora Cryptosporidiosis Campylobacter Leptospirosis

Malnutrition Diarrhea Toxic Red Tides

Forced Migration Overcrowding Infectious diseases Human Conflicts

Altitudinal Changes in Malaria Incidence in Highlands of Ethiopia and Colombia



A. S. Siraj,¹* M. Santos-Vega,²* M. J. Bouma,³ D. Yadeta,⁴ D. Ruiz Carrascal,^{5,6} M. Pascual^{2,7}†

The impact of global warming on insect-borne diseases and on highland malaria in particular remains controversial. Temperature is known to influence transmission intensity through its effects on the population growth of the mosquito vector and on pathogen development within the vector. Spatiotemporal data at a regional scale in highlands of Colombia and Ethiopia supplied an opportunity to examine how the spatial distribution of the disease changes with the interannual variability of temperature. We provide evidence for an increase in the altitude of malaria distribution in warmer years, which implies that climate change will, without mitigation, result in an increase of the malaria burden in the densely populated highlands of Africa and South America.

Source: Science 343, 1154 (2014)

Are women differentially affected?

Women carrying fuel woods, Wondo Genet, 2013 ©Sepp Böhme

Women are more affected than men by the impacts of climate change related problems

Drought

- Increasing extra work load
- Targets of attacks/sexual violence
- No right for decision making in critical condition
- Discrimination from husband and family

Survey results from Southern Ethiopia (Aklilu and Alebachew, 2009; Amsalu et al. 2013)

The impact of climate change on Ethiopia!



"Scientific truths of global climate change may have turned into myths about environmental change at the local level." (Osbahr et al. 2011) "There is also evidence that multiple causes of changes are confounded, so farmers who observe decreasing crop production may not be distinguishing between rainfall change and **declining soil fertility or other conditions**"(Coe and Stern 2011).

Ethiopian forest Early 20th century: 35%, current: 11.9% Annual rate of deforestation is 1.1% (FAO 2010)

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Continuous conversion of forests to crop lands since the 1970's

A ROMAND

Agricultural expansion: 4 million ha (2000-2008) (Brown et al. 2010)
Overgrazing....

Increased from 54.5 million to over 103.5 million in 1995-2013 (Lepta and Mesele 2014)

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Energy issues in Ethiopia

68%

of the Ethiopian population has no access to electricity (Moge, 2011; Dawit 2010)

92%

of energy comes from biomass (fuel wood, char coal) (IEA ,2008)

The per capita annual consumption of fuel wood: 1025 kg in rural areas & 240 kg in urban areas (Kalumiana, 1996)



Indigenous agroforestry in Ethiopia: Various ecosystem services including drought resilience & soil fertility



Currently converting to mono-cropping: Lowering drought resilience & soil fertility



Is it all climate change fault?

How about us?

to Part Lat. 1 'm.

Q3: How to adapt climate change in Ethiopia?

Adaptation to perceived temperature and rainfall changes in Ethiopia



Adaptation to perceived temperature and rainfall changes in Ethiopia



Bryan et al., 2009

Barriers to adaptation in Ethiopia





Adaptation of climate change in Ethiopia: crop farming



Increasing the number of crops type; Changing the type of

crops produced; Adjusting date of planting and harvesting; Use of early maturing crop varieties; Use of pest tolerant crop varieties; Planting high value fruit trees (e.g.,Bewket 2012)



Adaptation of climate change in Ethiopia: livestock



Reducing the number of animals kept; Keeping improved animal breeds; Changing the type of animals kept; Introduce mixed farming system; Promote traditional range conservation and management systems (ex. resource sharing) (e.g., Bewket 2012)

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Adaptation of climate change in Ethiopia: water resources



Water harvesting, improved water use efficiency, spring & wells development, river diversion; Improve the under ground water resources potential and management; Building upon the existing traditional irrigation systems by the local communities (e.g., Tadege 2007)

Water harvesting pond, Wondo Genet, 2013 ©Dong-Gill Kim

Adaptation of climate change in Ethiopia: institutions

US Peace Corps Camp GLOW meeting, Wondo Genet, 2013 ©Dong-Gill Kim

Adaptation of climate change in Ethiopia: institutions

A fundamental shift in thinking across key institutions in Ethiopia

Environmental issue

Broad sustainability issue that affects all sectors

Disaster-focused shortterm view Transient food insecurity

Long-term perspective

livelihood security, vulnerability reduction & chronic poverty

Source: Conway and Schipper 2011

Information, no problem! How to implement?



Q5: Beyond adaptation of climate change? Mitigation opportunities?

An inspiring story from Humbo carbon sequestration project (since 2004, Southern Ethiopia)

Regeneration of 2,728 ha of degraded forests Anticipate carbon revenues \$726,000



Source: Brown et al. 2011

Agroforestry (agriculture + forestry)



Home garden agroforestry

- Grow crops with various tree species & animals
- Provide food, fuel & cash income
- Protect soil & biodiversity



Source: Kim et al., 2016

Unit: t CO₂ eq ha⁻¹ yr⁻¹

Potentials of agroforestry

Reforestation & food production

Carbon trading schemes

ex. Reducing Emissions from Deforestation and forest Degradation (REDD)



Beyond adaptation of climate change?

Can we use as an opportunity?



Take home questions

- Sure about climate change globally, but climate change in Ethiopia? Why perception is so strong?
- Impact of climate change is significant, but is it all climate change fault?
- Adaptation of climate change is urgently needed (e.g., sharing information), but beyond it? Any mitigation opportunity?

Wondo Genet College of Forestry and Natural Resources, Climate Change MSc & Ph.D program

Looking forward collaboration with you!

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One more!

The most important thing is not to stop questioning -Albert Einstein (1879 – 1955)

Basic Climate Change Science



http://news.stanford.edu/2015/10/21/climate-change-cost-102115/

Sun

NATURAL WARMING

(1) Sunlight brings energy into the climate system; most of it is absorbed by the oceans and land.

(2) Heat (infrared energy) radiates outward from the warmed surface of the Earth.

(3) Some of the infrared energy is absorbed by greenhouse gases in the atmosphere, which re-emit the energy in all directions.
(4) Some of the infrared energy further warms the Earth.
(5) Some of the infrared energy is emitted into space.

Source: Marian Koshland Science Museum of the National Academy of Sciences

NATURAL WARMING

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Sun

2

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AMPLIFIED WARMING

(6) Higher concentrations of CO_2 and other "greenhouse" gases trap more infrared energy in the atmosphere than occurs naturally. The additional heat further warms the atmosphere and Earth's surface.

Greenhouse N₂O^eenhouse CO₂ Seeses CH₄ Sesses

Source: Marian Koshland Science Museum of the National Academy of Sciences

Indicators of the human influence on the atmosphere during the Industrial era









Source: IPCC 2007

Variations of the Earth's surface temperature for...



Departures in temperature in °C (from the 1961-1990 average)















The overall losses from weather- and climaterelated disasters worldwide (in 2010 US\$)



IPCC 2012

Any quick questions?