

### I. GREENHOUSE EFFECT, GLOBAL WARMING AND CLIMATE CHANGE

**GREENHOUSE EFFECT:** Process by which the atmosphere traps solar radiation and warms the planet's surface.

**GREENHOUSE GASES:**

- CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, H<sub>2</sub>O vapor and Chlorofluorocarbons.

### I.2. EFFECTS ON THE ENVIRONMENT

**UNMANAGED SYSTEMS**

- Oceans:
  - Sea-level rise.
  - Carbonisation and Acidification.
- Wildlife Reserve and Species Loss.
- Hurricanes.

**MANAGED SYSTEMS**

- Agriculture and Livestock Farming.
- Health.

**ANOTHER CONCERN: TIPPING POINTS**

- Non-linear reactions to stresses.

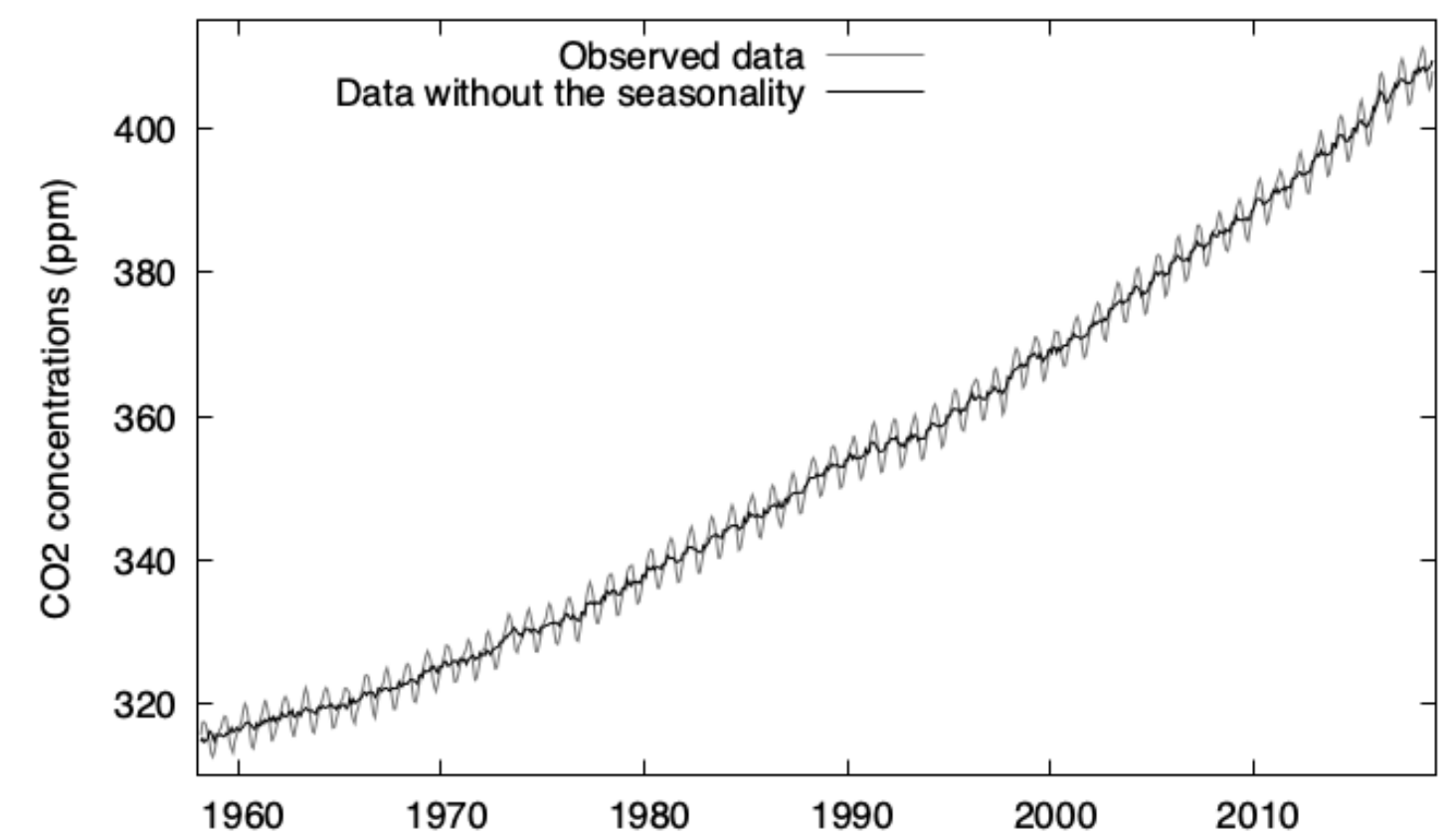
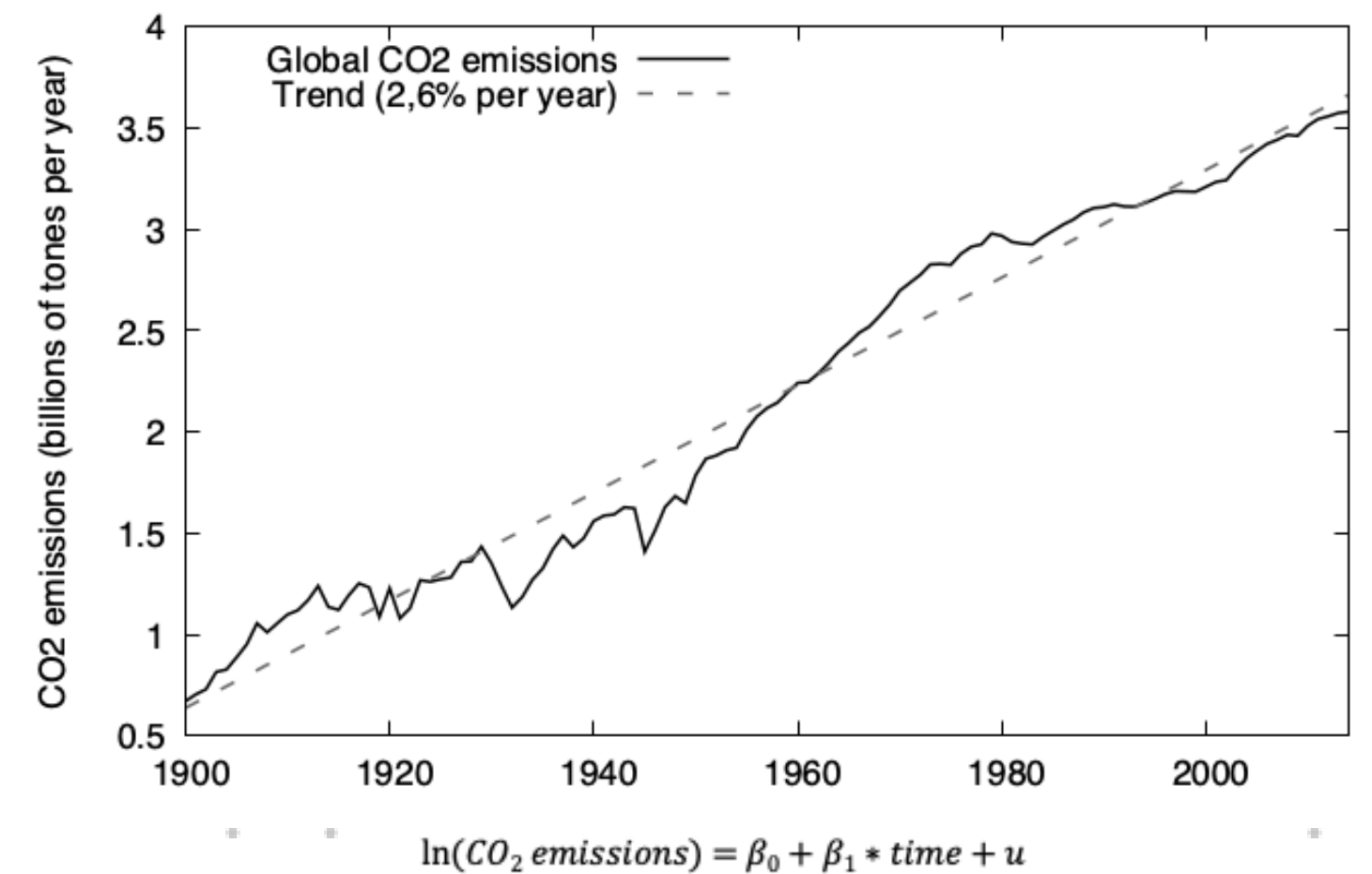
### I.3. EVIDENCE AND GENERAL CONSENSUS

**EVIDENCE**

1. Increase of 0.9°C of the Earth's surface.
2. Melting of the Arctic and Antarctic's ice sheets.
3. Sea level has increased about 20cm since 1990.
  - a. Increase on the frequency of extreme events (more hurricanes, ...).

**GENERAL CONSENSUS**

97% consensus, among the scientific community, that anthropogenic emissions are the cause of global warming.



## 2. LINKING CLIMATE CHANGE AND CONFLICT

**THE ROLE OF UNDERDEVELOPED COUNTRIES**

- More than 1 out of 2 people live off agricultural activities.
- Climate change can affect harvests and reduce the availability of basic needs.
- Political instability.

**DIFFICULTIES IN MEASURING CAUSALITY**

When the data is observational:

- Selection bias.
- Measurement errors.
- Confounding.

**MOST COMMON ECONOMETRICAL APPROACHES**

**CROSS-SECTIONAL**

- How the conflict variable evolves across sites.
- Use of control variables.

**PANEL DATA**

- How the a certain group of population respond to different climatic conditions that vary over time.

### 2.1. THE DEBATE

BURKE-HSIANG-MIGUEL

"Climate breeds conflict"

Channels:

- Economic incentives.
- Psychological pathway (serotonin).

BUHAUG

"There's no strong evidence to support a causal relationship between climate and conflict"

Channels:

- Decline on agriculture productivity.
  - Technological progress can prevent it.

### 2.2. EMPIRICAL EVIDENCE

MIGUEL ET AL. (2004)

Sub-Saharan Africa, 1979-1999.  
IV approach (exogenous rainfall as an IV for income growth).  
Dependent variable: 1 if at least 1,000 deaths in civil war. Country fixed effects.  
Findings: when rainfall decreased, the likelihood of civil war arose on the following year.

BURKE ET AL. (2009)

Adjusted the study of Miguel to control simultaneously for temperature and rainfall changes (both variables are correlated over time).  
Findings:  
• Same as Miguel et al (2004).  
• When temperature increased, civil war incidence was more likely to happen.

BUHAUG (2010)

Changed the dependent variable (e.g. all conflicts that generated at least 25 battle deaths).  
Added a lagged conflict incidence indicator and a variable that took into account interactions between temperature and poverty.  
Findings: no causal implications of climate variations on civil war.

## 3. DROUGHTS AND POLITICAL VIOLENCE: AN EXERCISE

A) TESTING THE ASSOCIATION BETWEEN DROUGHTS AND POLITICAL VIOLENCE

1. **Contingency tables:** observed and expected
2. **Hypothesis test**
  1. H<sub>0</sub>: no association between Political Violence and Droughts
  2. H<sub>1</sub>: not H<sub>0</sub>
3. **Pearson's Chi-square statistic**

$$\chi^2 = \sum_{i=1}^4 \frac{(f_{oi} - f_{ei})^2}{f_{ei}} \sim \chi^2(1) \text{ (under } H_0)$$

**4. Decision rule:**

P-value:  $1,00668e^{-14} < \text{Significance level of } 1\% \text{ , and } 59.88 > 6.63$

**REJECT THE NULL HYPOTHESIS**

B) CONFLICT AND CLIMATE VARIABLES: LOGIT MODEL

$$(4) p = \text{Prob}[\text{Political Violence} = 1] = \frac{e^{\beta_0 + \beta_1 \cdot \text{Drought} + \beta_2 \cdot \text{Flood} + \beta_3 \cdot \text{Age} + \beta_4 \cdot \text{Gender} + \beta_5 \cdot \text{Urban} + u}}{e^{\beta_0 + \beta_1 \cdot \text{Drought} + \beta_2 \cdot \text{Flood} + \beta_3 \cdot \text{Age} + \beta_4 \cdot \text{Gender} + \beta_5 \cdot \text{Urban} + u} + 1}$$

$$(5) \ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 \cdot \text{Drought} + \beta_2 \cdot \text{Flood} + \beta_3 \cdot \text{Age} + \beta_4 \cdot \text{Gender} + \beta_5 \cdot \text{Urban} + u$$

	Coefficient	Std. Error	z	Slope*
Constant	-3.61075	0.0517136	-69.82	0.0118025
Drought	0.346438	0.0452633	7.654	-0.00493187
Flood	-0.171053	0.168502	-1.015	-0.000221837
Age	-0.00712996	0.00135585	-5.259	0.0112764
Gender	0.361012	0.0417542	8.646	0.00588202
Urban	0.192534	0.0430710	4.470	

**Findings:**

1. Climate variables:
  - Drought and Urban positively associated with political violence
  - Floods: not significant (critical value of z: 2.575)
2. Other variables:
  - Gender positively associated
  - Age negatively associated

## 4. CONCLUSIONS

- Human-induced climate change is a major challenge for humanity.
- Despite of having found a positive association between political violence and droughts, no causal relationship can be inferred.

## 5. SELECTED BIBLIOGRAPHY

- Buhaug, H. (2010). Climate not to blame for African civil wars. Proceedings of the National Academy of Sciences. 107(38) 16477-16482.
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- Nordhaus, W. (2013). The Climate Casino: Risk, Uncertainty, and Economics for a Warming World. Yale University Press.