**Abstract**

Climate change is a complex issue that affects multiple facets of human life, creates multitudes of regionaland context specific outcomes, and exacerbates existing inequalities. As such, this requires precise measurement for appropriate interventions in development practice. This chapter explores the many dimensions of climate change and energy within the SDG indicator framework and addresses definitions and measurement issues. These indicators are examined through an interrogation of other key measurement issues relating to adaptation and mitigation data and existing climate and energy measures.

The chapter begins by disaggregating historic GHG emissions data relative to various historic collection trends thus exploring the consequences of collecting CO2 data versus GHG/CO2e. The chapter will then disaggregate the same GHG emissions data by country, economic sector, and generation technology as it relates to SDG 7. The disaggregation will reveal how different emissions narratives can be generated and skewed based on the subset of data that is being collected and the boundary condition that is assigned to the collection methodology. This analysis will be complemented by the interrogation of x indicators seeking to address the concepts of “adaptive capacity” and “resilience.” Through a similar exploration of the data associated with these specific dynamics through disaggregation, such as those “affected” following natural disasters, the chapter will question the accuracy and utility of available data.

Using this framework of interrogation, this chapter employs a critical lens on current data issues to further assess the degree of alignment within climate and energy priorities in development practice. Ultimately, the reader should understand how data issues reflect the relationships between the key players contributing to the intensification of climate change impacts, the forwarding of the energy transition, and the politics behind the impacts felt disproportionately by specific populations.

**Chapter Outline**

1. Introduction to overarching climate conversation
2. History
   1. Conversation and tracking re: CO2 emissions
      1. Flaws in data; this metric is the foundation of most present and historical framings of climate change and climate action, but is not accurately or coherently tracked across all nations.
         1. GHG / CO2 politics
         2. Difference between GHG and CO2 emissions [(US EPA 2015)](https://www.zotero.org/google-docs/?Hld7Xn)
            1. Carbon Dioxide Information Analysis Center (CDIAC) is the main producer of CO2 emissions data (from 1751; latest 2017 [(Friedlingstein et al. 2020)](https://www.zotero.org/google-docs/?2vHiFa)), whereas World Resources Institute’s (WRI) Climate Analysis Indicators Tool (CAIT) includes other GHG using different sources such as the FAO for land-use emissions [(WRI 2015)](https://www.zotero.org/google-docs/?q0x3Qo) and BP for years not covered by CDIAC [(Friedlingstein et al. 2020)](https://www.zotero.org/google-docs/?qnI4N5)
         3. Producers of measures
            1. GHG [(Friedlingstein et al. 2020)](https://www.zotero.org/google-docs/?RUKfas)
            2. CO2 [(Chen et al. 2020)](https://www.zotero.org/google-docs/?3ecU1B)
         4. By having this limited data as the baseline, it has complicated steps to climate action and allowed imprecise measurements to inform global action processes, including the SDGs, making them difficult to achieve any goals set by countries or other parties.
      2. Relevant actors, politics, and frameworks
         1. 1992 Rio Convention
            1. Establishment of UNFCCC, UNCBD, UNCCD
         2. Arguably the most important of these processes for intergovernmental action on climate change is the UNFCCC.
            1. [This section will be a brief history, mainly focused on concise mentions of key meetings and what they mean historically in the process: bali, copenhagen, warsaw, paris]
         3. Relationship to SDG Process
3. Current State of Play (overview) of climate change in the context of the SDGs
   1. Overview of NDC, SDG Crossover
      1. Nationally Determined Contributions are the current manner by which countries develop and share their climate-related goals within the UNFCCC, both mitigation and adaptation.
      2. Similar to the SDG process, most NDCs have time-bound goals for their commitments. A big difference between the two, however, is that the SDG timeline is based upon 2030, while the NDCs are up to each country to decide independently.
         1. Ex: Examining of China’s NDC vs. their energy generation infrastructure over time (SDG 7.2 & SDG 7.1)
         2. Ex: Climate Watch’s ‘NDC-SDG Linkages’ tool [(ClimateWatch 2016)](https://www.zotero.org/google-docs/?AXmVZX) shows that 145 (of 192) countries are committed to “increase substantially the share of renewable energy in the global energy mix by 2030” (SDG 7.2).
         3. The qualitative nature of the SDG 7.2 does not allow for explicit accountability.
      3. Trade offs and conflicting goals [(Shawoo et al. 2020)](https://www.zotero.org/google-docs/?mylJcV)
         1. “a switch to sustainable energy sources could conflict with economic growth and raises concerns of increased poverty and inequality.”
   2. An Introduction to Indicators
      1. The SDG-related indicators that will be explored in this chapter focus on a few areas where it is possible to measure outcomes. While these measurements are able to be taken, it is important to ask whether or not they are the best indication of the dynamics they are supposed to represent. To this effect, the indicators in this chapter interact with are compared to the current overarching conceptual debates in modern climate change research and political sphere. As the impacts of climate change accelerate and intensify, the available data illustrate the need for a more holistic approach to climate and energy data.
      2. Mitigation
         1. Energy Generation and Emissions
         2. Renewable energy generation (Renewable energy consumption (% of total final energy consumption) vs NDC.
            1. Review NDC for top 5 historic emitters

Compare with the lowest historic emitters (data permitting)

* + 1. Adaptation
       1. In modern day climate politics, the term “Resilience”is frequently cited. Much like, adaptation, despite this term being hard to define it is ubiquitous across sectors and processes.
          1. The politics of defining said metrics and its current use as an adaptation and mitigation bridge buzz term despite there being no solid way to measure what “resilience” is

This term serves as a key connection between mitigation and adaptation; for instance the term is used to describe how renewable energy generation is movement toward “resilience” within an adaptation context

* + - 1. Vulnerability
         1. Those who have not caused the problem are facing the brunt of impacts;

[this portion will serve as a space to delineate what exacerbation of existing inequalities means in the climate context at a high-level]

1. Mitigation
   1. “According to the Intergovernmental Panel on Climate Change’s (IPCC’s) Special Report Global Warming of 1.5°C, a near-total reduction in the use of coal and other fossil fuels for electricity generation replaced by renewable energy generation by 2050 is necessary if the temperature goal of the Paris Agreement is to be reached, with reductions of approximately two-thirds by 2030'' [(Climate Transparency 2019)](https://www.zotero.org/google-docs/?bV7U9U). Understanding climate mitigation thus means understanding existing and planned energy infrastructure.
      1. Dissaggerate GHG Emissions data per sector [(Ritchie and Roser 2020)](https://www.zotero.org/google-docs/?Qiqjx7).
      2. Dissagerate power sector GHG emissions data per technology (sector responsible for the largest volume of GHG emissions)
         1. Dig into how a change in energy infrastructure relates to decline in GHG emissions
            1. Share of renewable energy generation (and percent change) [(IEA 2019)](https://www.zotero.org/google-docs/?fFHK0E)
            2. Share of Coal generation (and percent change) [(IEA 2020)](https://www.zotero.org/google-docs/?TXBhn0)
            3. Countries mitigation commitments VS Existing Energy Infrastructure VS Planned Energy Infrastructure
   * Lack of planned infrastructure data makes it hard to understand countries decarbonization pathway and thus hard to know if we will be within IPCC's recommended 1.5℃ range
   1. Where is the data located?
   * Who collects the data: International Energy Agency
   * How does the data get collected and distributed?
2. Adaptation

* How adaptation is measured is in itself an inherently political question. In that data collection is dependent upon how adaptation is understood, it is nearly impossible to separate the question of who data benefits from and who is left out by said data from the definitions used to measure key aspects of adaptation. In this section, we explore examples of high-level concepts mobilized within the adaptation frame, resilience and vulnerability, to illustrate the point and to dissect current measures and the politics behind them.
* Just as with mitigation, adaptation is a contentious topic but for different reasons. While mitigation largely explores ideas about how to innovate to limit emissions, adaptation seeks to prepare, avert, and minimize the impacts felt by people and systems when confronted with climate change dynamics, such as climate change-induced disasters.
  1. The state of adaptation metrics and indicators
     1. Adaptation as a concept remains a hyper-localized and multi-sectoral issue, which exacerbates issues of metric standardization particularly for comparability. [We will leave this section as a high-level discussion on metrics just so students understand the current debates]
        1. Because there are no clear measures for adaptation, having access to financing becomes an even more complicated process. [This will be a discussion about how finance is key to understanding how numbers may look one way, but they don’t quite tell the whole story. A narrative throughline here will also be that the lack of clear metrics for adaptation is hindering much needed progress on any adaptation related goals: exL Given that it is easier to define mitigation, the 50/50 funding for mitigation/adaptation as committed to in UNFCCC processes is made difficult to achieve. Can a mitigation project be framed as an adaptation project without reducing vulnerability or increasing resilience?]
           1. Tie to SDG 13.A.1: Finance [(Our World in Data 2021)](https://www.zotero.org/google-docs/?7LJKb0)

Adaptation Aid vs. Climate Finance that include adaptation, specifically within the Green Climate Fund (GCF)

GCF history and mandate

"The core of the Green Climate Fund’s (GCF) mandate comes from Article 2(c) of the Paris Agreement, which “aims to strengthen the global response to the threat of climate change ... by making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development”" [(Green Climate Fund 2019)](https://www.zotero.org/google-docs/?NLmHDO)

Adaptation Fund history and mandate

Funding is project-based, meaning impact metrics are context-specific and funding impact is measured by expenditures.

* + - * 1. The politics of tracking contribution data

Commitments vs. Contributions

What has been pledged, what has been mobilized?

What is needed to mitigate climate impacts vs. how much is projected to be raised?

Where is the data located?

Who collects the data: Green Climate Fund

How does the data get collected and distributed?

Self reported by countries within their NDC’s or specific pledges made to the GCF

* + 1. Climate-Impacts (Vulnerability subtext)
       1. Intro: Why is there urgency around climate change in the development sector? Beyond ecological collapse, such as coral bleaching and loss of keystone species, there are vast impacts on humanity as well.
       2. Climate change impacts vary by sector and it is important to note that not all climate impacts are felt the same by all people. Whether it be geographically, coastal communities vs. inland communities, or by personally held identities, such as race, caste, gender, ability, climate change serves as an amplifier of existing inequalities and intensifies social problems.[(Cuomo 2011; Benevolenza and DeRigne 2019; Moosa and Tuana 2014)](https://www.zotero.org/google-docs/?zDEAE7).
          1. Example: power outages from extreme weather events affect multiple sectors, which in turn impact human activity and well-being disproportionately.
       3. Mortality
          1. Tie to SDG 13.1.1: Mortality

One of the most measured metrics on disaster dynamics, but there are flaws including inconsistencies in measurement, missing countries, and disasters being defined in a general sense that includes ones not influenced by climate change.

How does this miss the bigger picture?

It’s overly simplistic and doesn’t take into account impacts on livelihoods.

In doing so, how does this framing and imprecise measurement hinder the international response to emerging dynamics such as climate change and related-displacement and/or migrations

Case-study on climate change-related human movement

Where is the data located?

Who collects the data: UNISDR houses data from external sources [(Prevention Web n.d.)](https://www.zotero.org/google-docs/?URGFCG)

How does the data get collected and distributed?

* + - * 1. Disasters

Not the only climate events that increase mortality rates

Cumulative effects of air pollution

Crude deaths (direct)

DALYs from respiratory illnesses (indirect)

What is and isn’t measured

Livelihoods lost from climate change impacts

1. Conclusion

* Historically, Climate Change indicators have been limited to a focus on mitigation, with resulting attention centered on cemissions. However, the indicators that explain the complex issues of climate change are more complicated than they are presented and previously thought. There is a clear need for standardized resilience measures and comprehensive energy- related data to aid in a rapid and equitable shift in development and beyond to meet the challenges of a planet facing rapidly intensifying climate impacts.
* Having accurate, clear, and transparent data is essential to creating the policy interventions to protect people's livelihoods now and in the future.

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I think the chapter needs a pretty thorough reorganization. The sections needs to parallel those of other chapters and the framing needs to be much more around climate change in the context of development goals. Key questions to answer:

1. When did we start thinking critically about climate change and its effects on socioeconomic and human development? When and how did this arise in international development theory and practice? What were the key questions, arguments, debates?
2. Unpacking climate change - definitions and dimensions
   1. What is CC?
   2. What do we do about CC to minimize its negative impact on development?
      1. Mitigation
      2. Adaptation
      3. Resilience
3. Who are the key actors working on these issues?
4. What are the key data variables and indicators/metrics that we use in this work?
5. Politics of data: how well does our current menu of metrics really get at all of the dimensions of climate change and its impact wrt development?
   1. What are the key technical/empirical challenges in collecting data for existing metrics or developing new metrics to to measure progress in mitigation, adaptation and building resilience?
   2. What are some ways in which the data around CC and Development is subject to political contestation, manipulation, misuse, etc?

Conclusion: Where are we now in the CC and Development data revolution? Where are we developing new ways to measure mitigation, adaptation and resilience? What challenges still remain?

# D**ata Module**

# Student learning objectives and activities

This chapter aims to achieve the following student learning outcomes:

1. Understand the difference between climate change mitigation and adaptation.
2. Understand the types of indicators used to measure these concepts.
3. Recognize the key players in data collection and dissemination.
4. Explore how different sources measure the same concept differently.
5. Understand issues of data reliability and availability and how that affects policy-making at a global level.

In terms of data management, wrangling, and analysis, we believe that students should achieve the following learning outcomes:

1. Learn how to organize data projects in terms of directory hierarchy.
2. Understand the importance of metadata files and codebooks.
   1. Exercise example: create a new codebook from transformed data, such as changing units, or creating a new variable that’s per capita or percentage of total.
3. How to merge datasets, such as learning the difference between left/right joins, and inner/full joins using tidyverse and fuzzyjoin (for datasets with different country names)
4. Create a map visualization for indicators such as GHG emissions or mortality rates due to natural hazards.

# Practice Problems & Module Outline

* 1. CO2 emissions as base-
     1. Who is emitting the most now? Historically (accumulated)?
     2. Which sector of the economy is emitting the most now? Historically (accumulated)?
     3. How has the historic GHG emission data been collected? (CO2 vs CO2equ) and has this impacted the story that emissions data can tell?
     4. Does the change in generation technology (renewable vs coal) correlate with historic GHG emission volume?
     5. How are fossil fuel exports being accounted for? How does this skew the narrative for GHG emissions per country?
     6. How do historic GHG emissions data compare to who is giving the most in terms of climate finance?
     7. How does this compare to which countries are facing the most severe impacts of climate change?
     8. How are the boundary conditions for the climate events defined? How does this impact the data narrative being told?

This Module will explore indicators from the Sustainable Development Goals that are interrogated in this chapter. Students will be able to compare and disaggregate historic CO2 emissions data with the following:

## Mitigation

7.2 Renewable Energy Generation Shares

7.1 Coal Fired Generation Shares

7.1 & 7.2 Change in generation of each technology over time

The associated change in GHG emissions and how that relates to NDCs

## Adaptation

13.A.1 Green Climate Fund Pledges (GCF)

13.1 Disaster Mortality Rates (UNISDR vs. WHO)

13.1 Post-disaster Displacement Rates (IDMC)

**Grade:** in Canvas Gradesheet

**Peer Review Feedback:** [**https://drive.google.com/drive/u/0/folders/1dbPqgdBKdPO5MzL6davRVsxxXGmt6bBQ**](https://drive.google.com/drive/u/0/folders/1dbPqgdBKdPO5MzL6davRVsxxXGmt6bBQ)