How Do Countries Talk about Climate Action?

A Text Analysis of Vulnerability and Responsibility within Nationally Determined Contributions

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1 Introduction

Climate change is one of the most pressing challenges facing the international community today, requiring urgent and large scale actions from every country around the world to rapidly reduce emissions and build resiliency to climate vulnerabilities. However, national responses to climate change vary tremendously country-to-country, due to significant differences in terms of emissions profiles, exposure to physical climate risks, economic structure, and legal-institutional responsibilities, among other determinants. I aim to explore **how this variation as it is reflected in the text of national statements of climate priorities corresponds to the reality of differing climate vulnerability and national responsibilities for decarbonization**.

Since the inception of the United Nations Framework Convention on Climate Change (UNFCCC) during the 1992 Rio de Janeiro "Earth Summit," countries have maintained the practice of publishing national communications stating their positions on the issue of climate change. More recently, the 2015 Paris Agreement established a formal system for the reporting of national climate priorities as embodied in "Nationally Determined Contribution" (NDC) documents. Under the Agreement, NDCs are meant to be issued every five years, describing the steps countries will take to reduce greenhouse gas emissions (i.e., "mitigation") while also building resilience to the impacts of rising global temperatures (i.e., "adaptation") (UN, n.d.).

Relative to this broad mandate, however, the UNFCCC does not provide much specific guidance on what content should comprise an NDC and how such content is meant to be communicated. As a result, within published NDCs, countries are ostensibly able to discuss their climate action

priorities in whatever manner they please. Accordingly, the NDCs constitute an interesting social science corpus, as they reveal how countries choose to state their climate goals and corresponding implementation frameworks when given a blank template to do so.

The remaining sections of this research paper are structured as follows: **(2) Research Motivations & Hypotheses, (3) Data Description, (4) Methodology, (5) Results, (6) Discussion, (7) Appendices, and (8) References**.

2 Research Motivations & Hypotheses

Cross-country variation in climate action ambition and implementation is well-studied, particularly from a quantitative standpoint. Existing research that analyzes the most recent NDC submissions shows that, while most countries set emissions reductions targets and many others match such targets with climate finance commitments, quantifiable levels of ambition (e.g., percentage emissions reductions by a certain date, amounts of committed financing, etc.) reflected in these goals differ tremendously between countries (World Resources Insititute, 2023).

However, qualitative components of NDCs also warrant consideration as they reveal differences in national perspectives on climate change that may not be obvious from quantitative targets. Previous text analysis studies have focused on certain topics contained in NDCs, such as health (Dasandi et al., 2021). My analysis examines two qualitative themes — vulnerability to climate risk and differentiated responsibility for climate action — as they are represented within NDC documents.

I propose that the discussion of these two themes varies across countries' NDC documents. In particular, I test two primary hypotheses: **(I) countries more vulnerable to climate risks discuss this vulnerability more extensively in their NDCs, and (II) countries designated as having greater responsibility to take climate action under the UNFCCC ("differentiated responsibilities") detail this responsibility at greater length in their NDCs**. Lastly, I examine **(III) whether the topical content of NDCs differs according to countries' relative vulnerability to climate risks and differentiated responsibilities**.

3 Data Description

3.1 NDC Corpus

The primary data source used in this analysis are the "first" NDCs submitted by countries to the UNFCCC under the stipulations of the 2015 Paris Agreement, representing countries' initial set of climate aciton priorities. To date, 194 of the world's 197 countries have submitted a first NDC — note that all 27 EU countries have submitted jointly — while Iran and Yemen have further submitted "Indicative Nationally Determined Contributions" (INDCs). Moreover 107 countries have submitted a revised version of their first NDC, elaborating on their targets and supporting policies. NDC documents are stored in the Climate Watch data portal, which is maintained by the World Resources Institute.

From the Climate Watch API, I construct a text dataset by parsing the text of the **latest NDC submission made by a country**, translated into English, which produces a corpus of **169 total documents** (107 revised NDCs, 60 first NDCs, and 2 INDCs). Note that all 27 EU countries are represented by a single document. Submission dates for NDCs in the corpus range from 2015-11-21 to 2023-03-02.

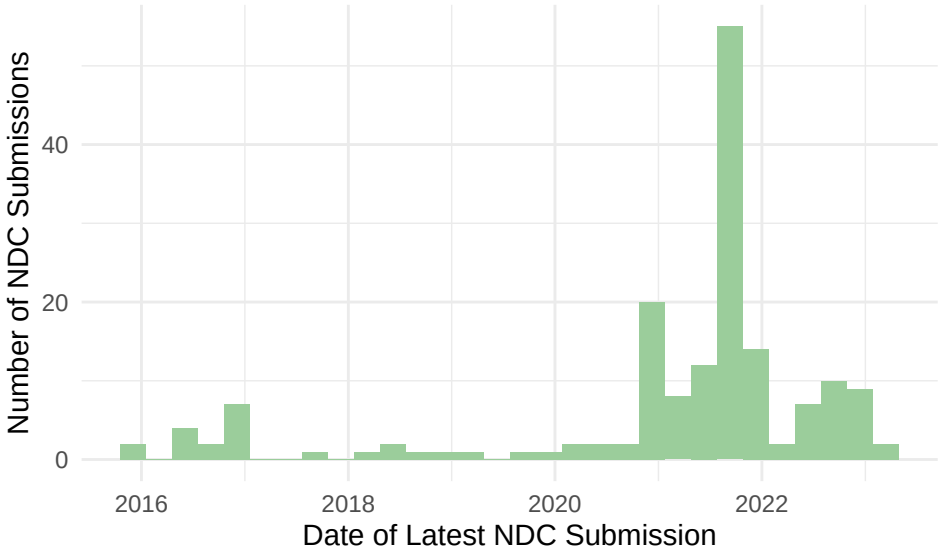

Figure 1: NDC Submissions Over Time

Before examining the semantic content contained in the documents, it is interesting to note that

NDC text varies dramatically between countries just in terms of structure. The shortest NDC document contains 634 characters (Kazakhstan), while the longest contains 290300 characters (Albania), and the overall corpus average is 59248.8 characters.

From the corpus of NDC documents, I construct a pair of Document-Feature Matrices (DFM), **one with uni-gram features** (for supervised analysis) and **another with bi-gram features** (unsupervised analysis). Pre-processing steps are fairly standard, I remove numbers, punctuation, URLs, and symbols from the NDC body text. I also implement "stemming" and remove all stop words. Additionally, I remove the names of countries. For the bi-gram DFM, I trim features that appear more than 1500 times (e.g. "climat_chang") or less than 50 times. Finally, there are a series of commonly used technical terms (e.g., "high-high," "high-medium," "medium-high," etc.) that would seem to correspond to climate modeling, but do not provide much independent semantic value, which I also remove from the bi-gram DFM.

The resulting uni-gram DFM dimensions are 169 documents by 21769 features. Bi-gram DFM dimensions are 169 documents by 1319 features. My rationale for constructing two separate DFMs is that the supervised analysis methods I employ largely assume a "bag of words" documents structure, which I assess to be best represented by uni-grams, while unsupervised topic modeling reveals a document's latent topic structure, which I believe is best represented by bi-grams. See the Methodology section for greater detail.

3.2 Metadata

3.2.1 ND-Gain Index of Climate Vulnerability

To complement the textual data contained in countries' NDC documents, I include a measure of national vulnerability to climate risk as document metadata. The particular measure I select is the University of Notre Dame Global Adaptation Initiative country index of climate vulnerability ("ND-GAIN index"), which ranges from values of 0 to 100, with **lower values indicating greater national vulnerability to climate risk**. I match these values by the year of NDC submission.

Index values are assessed as a composite of two sub-dimensions: **vulnerability** (i.e., exposure, sensitivity, and adaptive capacity to the physical effects of climate change) and **readiness** (i.e.,

Figure 2: NDC Bi-Gram Word Cloud

economic, governance, and social resources available to respond to climate risks). The inputs that compose these dimensions are a variety of country specific indicators, ranging from cereal crop yields to rule of law (ND-GAIN, n.d.). For a more complete overview of the ND-GAIN index, see the accompanying technical document.

3.2.2 "Annex I" Differentiated Responsibilites

The second metadata feature that I include is countries' "Annex I" status, which is a formal designation under the UNFCCC that assigns more economically developed (i.e., Annex I) countries with greater climate action responsibilities (UNFCCC, n.d.). Generally speaking, the list of countries assigned Annex I responsibilities corresponds very closely to OECD member countries (OECD, n.d.). A full list of Annex I countries is found in Appendix I.

Within the 2015 Paris Agreement, Annex I and non-Annex I status correspond closely to the principle of "common but differentiated responsibilities" (UNFCCC, n.d.). Stated generically, this principle stipulates that countries all have an obligation to take action on the issue of climate change, but are flexible to do so in the manner that best suits their national circumstances. As such, there is a general expectation within the international community that Annex I countries take on more ambitious climate action responsibilities under the Agreement, relative to non-Annex I peers.

4 Methodology

At a broad level, my methodology aims to assess **how variation in NDC document content corresponds to real measures of vulnerability to climate risk (i.e., ND-GAIN Index) and common but differentiated responsibilities (i.e., Annex I/non-Annex I status).**

This methodology contains two primary components — **supervised analysis** and **unsupervised analysis** — which each provide a unique approach to mapping document content against measures of vulnerability and responsibility.

4.1 Supervised Analysis Methodology

The supervised component of the methodology utilizes **key word dictionaries** to analyze the **proportional usage of features relating to themes of vulnerability and responsibility** within NDC documents. The computational steps underlying this analysis are simple. First, for each NDC document, I sum the frequency at which key words are used. Then, I divide that sum by the sum of total features contained in the document, which essentially returns the proportion at which key words appear in the document relative to all features. Measurement of key word usage can be represented by the equation below:

$$key\ word\ usage_i = \sum^{k} frequency_{ki} \div \sum^{j} frequency_{ji}$$

where $frequency$ is the count of feature appearances of k key word features in the key word dictionary and j total features in the NDC DFM, in document i. **In simplest terms, this measure represents how often key words appear in each country's NDC document.**

Finally, I measure the extent to which **proportional key word usage relating to vulnerability and responsibility in NDC documents corresponds to actual measures of national vulnerability to climate risk (i.e., ND-GAIN Index) and formal UNFCCC designation of responsibility (i.e., Annex I/non-Annex I)**.

To construct a key word dictionary for vulnerability, I self-select terms commonly used to describe adaptation, resiliency, and disaster management measures in NDCs and other formal climate documents. Given the arbitrariness of this step — basically predicated on my personal expertise working as a climate policy analyst — I select as conservatively as possible, only including terms used exclusively in the context of vulnerability to climate risk. That said, within this methodological approach, the dictionary comprehensiveness is secondary to its ability to provide a straightforward measure of vulnerability discussion within NDC documents — which then can be analyzed against the ND-GAIN index. Key words included in the dictionary are listed in Appendix II.

For the responsibility key word dictionary, I also self-select terms, which are descriptors for collective obligations and assistance efforts as detailed in NDCs. My selection process again tends towards parsimony, resulting in a fairly narrow dictionary that is only meant to capture "common

but differentiated responsibility" within the context of NDC documents, rather than a broader sentiment of responsibility. Key words for this dictionary are also available in Appendix III.

As a final methodological note, this **supervised approach** is only applied to the **uni-gram DFM**. My reasoning is that a key word dictionary analysis essentially represents documents as a "bag of words" — that is, feature counts are the primary measure for evaluating content, and features are not assumed to be interrelated. In this representation, I believe a key word dictionary approach is most efficiently paired with uni-gram features, allowing for simplest dictionary construction. For example, uni-gram features such as "adapt" could be extended as "climat_adapt" under a bi-gram construction, but it is not apparent that this would improve measurement of document content.

4.2 Unsupervised Analysis Methodology

The unsupervised component of the methodology aims to fit a **structural topic model (STM)** to the NDC documents, in order to assess whether **the latent topic structure of NDCs differs according to ND-GAIN index scores and Annex I/non-Annex I status.** STM is a sub-method of topic modeling that utilizes metadata, in addition to textual content represented by a DFM, to identify clusters of "topics" that appear throughout a corpus of documents. In addition to identifying topics, STMs measure how topic prevalence varies according to metadata dimensions ("prevalence covariates"). This latter inferential capacity underpins the unsupervised portion of this paper's methodology — **using two separate STMs, I measure how the topical content of NDCs varies with countries ND-GAIN index scores and Annex I status**.

A key parameter choice underpinning STM results is the k number of topical clusters that the model is directed to identify. To define an "optimal" k value, I run a validation test for k values ranging 2 to 20, using the `searchk()` function from the `stm` R package. The diagnostic results of this test allow me to assess which particular k value provides topic clusters that maximize tuning parameters, namely exclusivity (i.e., how unique topics clusters are), semantic coherence (i.e., how internally consistent topic clusters are), held-out likelihood (i.e., how predictive topic clusters are over iterations), and residuals (i.e., how well topic clusters explain the distribution of document features). In evaluating these results, I select an optimal k value for each STM using the machine learning rule-of-thumb "Elbow Method" which essentially stipulates that the optimal k value is

located at a local maxima or minima for each tuning parameter (or as many as possible).

Validation tests return an optimal k value of 13 topic clusters for the vulnerability STM and 14 topic clusters for the responsibility STM.

Finally, unlike the dictionary analysis, I fit both STMs to a **bi-gram DFM.** I utilize a bi-gram DFM for unsupervised analysis because I believe bi-gram features provide a better representation of document semantic content than uni-grams, and thus provide more coherent topic clusters. In particular, I conjecture that the increased specificity of paired tokens will assist topic clusters in grouping features that have semantic relation. Moreover, after trimming, bi-gram features reduce the dimensional complexity of the NDC DFM, which is helpful for unsupervised computation.

5 Results

I report results on from both supervised and unsupervised analysis. **Broadly, results from both approaches support the hypotheses that NDC content varies in accordance with vulnerability to climate change and, to a lesser extent, differentiated responsibilities.**

However, these results are subject to limitations, which are specified in the Discussion section.

5.1 Supervised Analysis Results

5.1.1 Key Word Dictionary Analysis of Vulnerability

Key word dictionary analysis provides **evidence that countries more vulnerable to climate risks** (i.e., low ND-GAIN scores) **discuss this vulnerability more frequently** in their NDCs.

As shown in Figure 3, **the proportion of total features used (i.e., uni-gram counts) dedicated to vulnerability key words increases with lower ND-GAIN index scores (i.e., greater actual vulnerability)**. Overall, the estimated correlation between proportion of vulnerability key word use and ND-GAINs index is -0.34 and is statistically significant at basically all levels (p-value = 1.6926228×10^{-5}). This result conforms with my research hypothesis that more vulnerable countries discuss vulnerability more extensively in their NDCs.

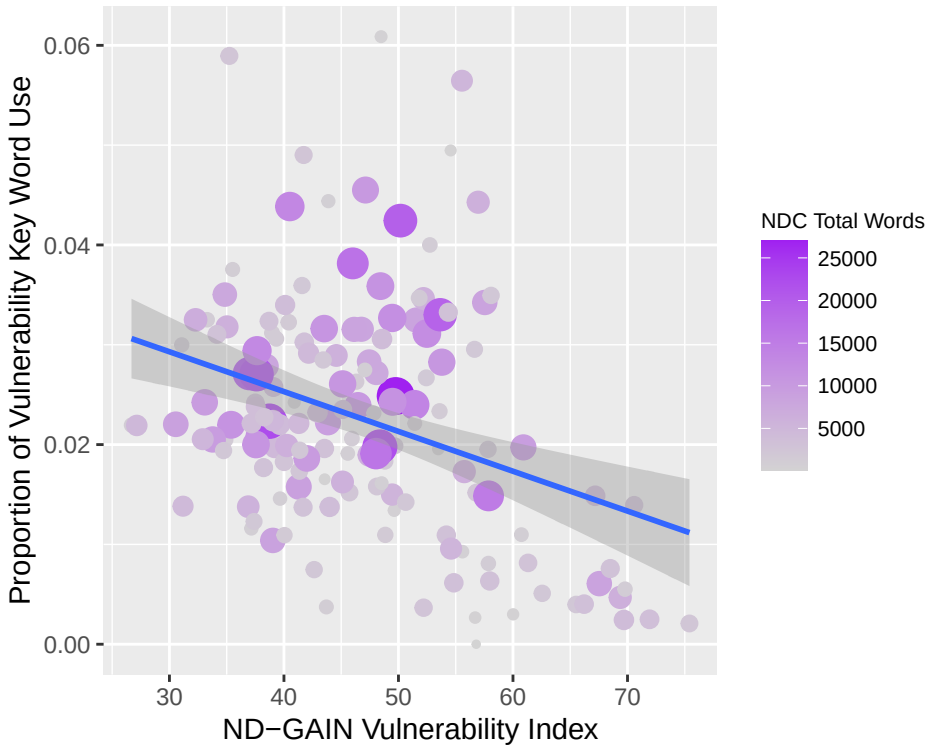

Figure 3: Use of Vulnerability Key Words by ND-GAIN Index

This relationship is robust to weighting by the total features (i.e., words) contained in each NDC document, with a word-weighted correlation of -0.23 (p-value = 0.005). This suggests that vulnerability discussions are not simply "tacked on" to lengthier NDCs, and are instead actually reflective of countries' climate realities.

5.1.2 Key Word Dictionary Analysis of Responsibility

In contrast, key word dictionary analysis provides **minimal evidence that countries with greater climate action responsibilities under the UNFCCC** (i.e., Annex I) **discuss responsibility more frequently** in their NDCs.

Shown in Figure 4, **Annex I countries do indeed use responsibility-related key words at a higher proportion in their NDCs than non-Annex I countries**. However, this difference is **not statistically-significant** (p-value = 0.74). As such, although this result follows the direction of my original hypothesis — that countries with greater formal responsibilities for climate action discuss responsibility more extensively in their NDCs — it ultimately is not substantial evidence.

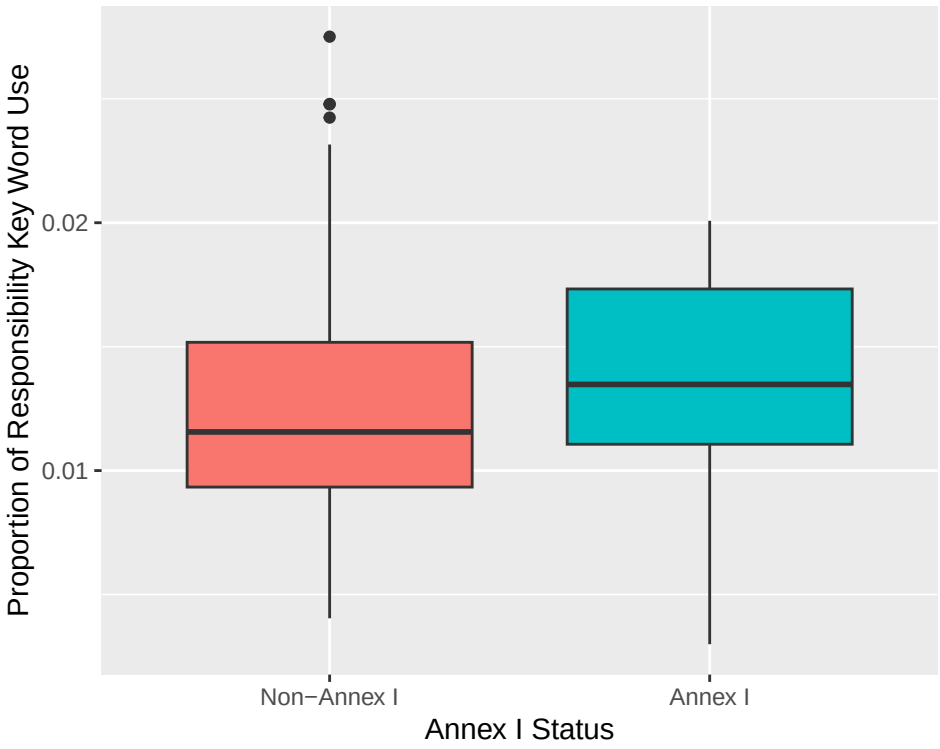

Figure 4: Use of Responsibility Key Words by Annex I Status

5.2 Unsupervised Analysis Results

5.2.1 Structural Topic Model Analysis of Vulnerability

Fitting a structural topic model to the NDC bi-gram DFM using ND-GAIN index values as the prevalence co-variate, I find clear differences in topical structure of NDCs, corresponding to variation in national vulnerability to climate risks.

In particular, the topics "Emissions Targets," "Paris Agreement," and "NDC Goals" are more prevalent (i.e., associated at the 95% level) in the NDCs of countries with higher ND-GAIN index scores (i.e., low vulnerability), while the topics "Scenario Model I" and "Financing" are more prevalent in the NDCs of countries with lower ND-GAIN index scores (i.e., high vulnerability). These results are fairly intuitive, less vulnerable countries tend to be high emitters, and with lower vulnerability, would have a greater focus on reducing greenhouse gas emissions (i.e., setting emissions targets, meeting Paris Agreement temperature goals, accomplishing NDC emissions goals) than more vulnerable peers.

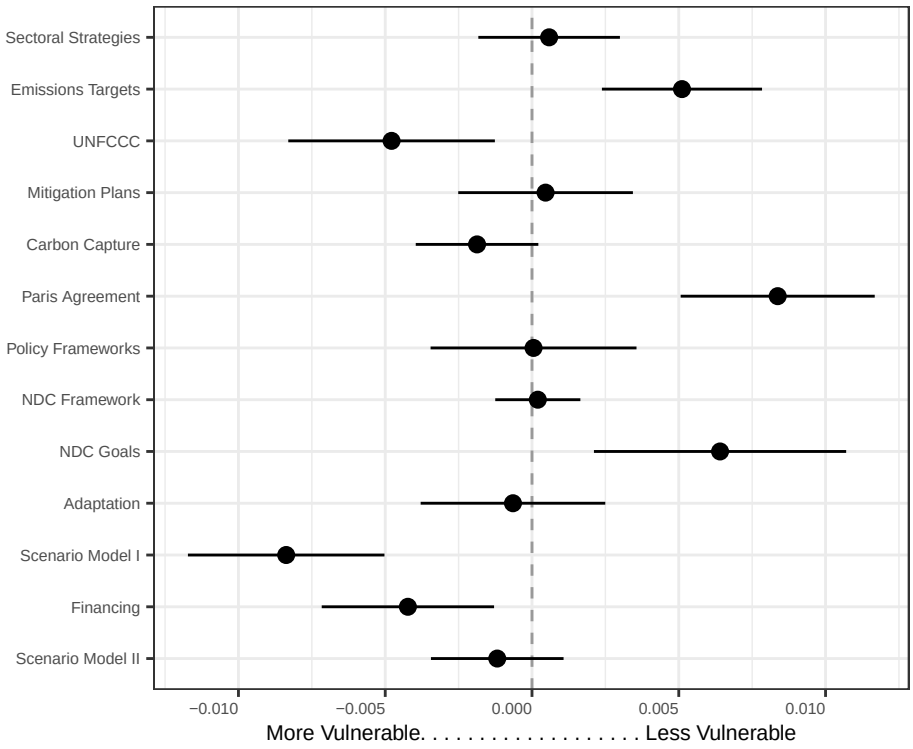

Figure 5: Topic Prevalence by Climate Vulnerability

The set of topics more prevalent among more vulnerable countries are a bit less intuitive — "Financing" and "Scenario Modeling I" would seem to be relevant to both reducing emissions and managing the adaptation risks of rising temperatures. However, it could just be the case that countries with higher levels of vulnerability discuss these topics at greater length, as discussions of financing needs and scenario modeling exercises are extended in NDCs to address the challenges posed by greater vulnerability.

See Appendix IV for the list of topics identified by the vulnerability STM and the most frequent terms within those topics.

5.2.2 Structural Topic Model Analysis of Responsibility

Similarly, a STM fitted to the NDC bi-gram DFM using Annex I status as the prevalence co-variate reveals clear differences in topical structure of NDCs corresponding to UNFCCC delegated national responsibility for climate action.

Among the NDC documents of Annex I countries, the topics "Paris Goals" and "Paris Agree-

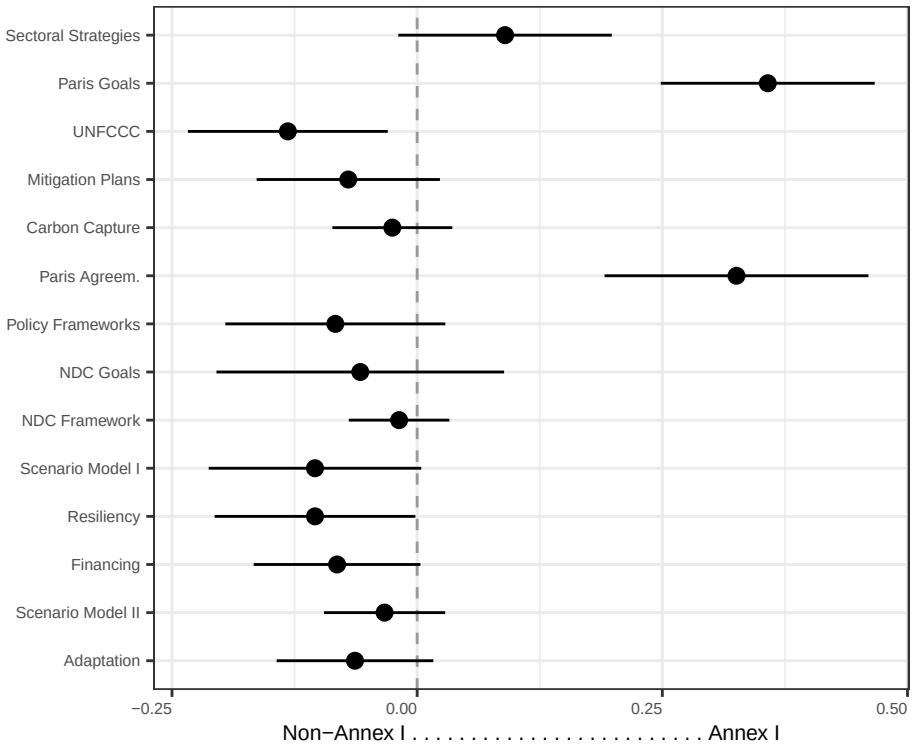

Figure 6: Topic Prevalence by Annex I Status

ment" are strongly prevalent, relative to the NDCs of non-Annex I countries. To a lesser degree (i.e., close to 95% level association), the "Sectoral Strategies" topic is also associated with Annex I country status. Among non-Annex I countries, the topics "UNFCCC" and "Resiliency" are prevalent (95% level association), while the topics "Scenario Modeling I" and "Financing" are also relatively prevalent (close to 95% level association).

Topic prevalence in NDCs corresponding to **Annex I status** is largely intuitive. Given that Annex I countries are nominally more responsible for taking climate action, it would follow that they would make more common reference to Paris Agreement stipulations and goals. A — relatively weaker — association with "Sectoral Strategies" is also straightforwardly explained by the fact that Annex I status corresponds closely to OECD membership, and thus a more complex economy, which requires the devotion of more topic space in NDCs to discussing sectoral climate action.

Topic prevalence towards **non-Annex I status** is also fairly clear-cut. Given that Annex I status is a UNFCCC principle, non-Annex I countries may reference the UNFCCC and related features more frequently in their NDCs to support decisions to advance other policy priorities (e.g., economic

development) concurrent, or even priority, to climate action. Non-Annex I status is also strongly correlated with vulnerability to climate risk (0.53, p-value = $8.3172388 \times 10^{-13}$), which would explain the prevalence of the "Resilience" topic towards non-Annex I status. Similarly, "Finance" and "Scenario Modeling I" topics are prevalent to vulnerability to climate risk, so the (weaker) prevalence of these topics to non-Annex I status could also be explained by the vulnerability-responsibility correspondence.

See Appendix V for the list of topics identified by the responsibility STM and the most frequent terms within those topics.

6 Discussion

6.1 Limitations

The strength of evidence provided by my reported results should be considered against a few key limitations, specified below.

General data limitations correspond primarily to two issues: missing ND-GAIN index values for 14 countries (largely small states and islands such as Monaco, Tuvalu, Cook Islands) and consolidation of the climate action priorities of all 27 European Union states into a single document. Lack of data across these two dimensions potentially introduces sampling bias to the estimates of the relationship between NG-GAIN index and Annex I status with NDC content.

Furthermore, methodological choices for both supervised and unsupervised analysis also create unique limitations. In the key word dictionary analysis, key word selections are subjective and thus results should be interpreted narrowly to those selections. In particular, the key words that comprise the responsibility dictionary fail to identify a recipient of responsibility actions. That is to say, to the extent that countries express "responsibility" in their NDCs, it is unclear if that responsibility is directed towards UNFCCC co-parties (which would correspond to the concept of common but differentiated responsibilities) or towards other stakeholders (e.g., their own citizens or vulnerable populations). In light of these limitations, the precision of these findings should be considered fairly weak, particularly for the responsibility dictionary analysis (which already lack

statistical significance).

To a lesser degree, STM results are also affected by subjective methodological choices. In addition to k parameter selection (discussed in Methodology), labeling of topic groupings is subjective and simply based on my own judgement of how the features appearing most frequently in each group qualitatively align with a particular concept or theme. Moreover, from a purely mechanical standpoint, topic groupings for are inherently unstable, with particular sensitivity to pre-processing steps. Specifically, these results are heavily conditioned on my methodological choice to utilize bi-gram features for STM fitting.

Lastly, it must be stated again that measures of vulnerability and responsibility (i.e., ND-GAIN index scores and Annex I status) are quite correlated, so results attributed to one measure may be somewhat confounded by the other.

6.2 Conclusions

Overall, my analysis supports the conclusion that countries more vulnerable to climate risks do indeed discuss this vulnerability more extensively in their NDCs. Evidence that countries designated greater climate action responsibility under the UNFCCC ("differentiated responsibilities") actually detail this responsibility at greater length in their NDCs is much weaker. However, text analysis results also do suggest that the topical content of NDCs differs according to both countries' relative vulnerability to climate risks and differentiated responsibilities, in a manner that is largely intuitive to those characteristics.

For policy makers and researchers, these findings indicate that NDC text content is indeed reflective of national-level differences in climate vulnerability and climate action responsibilities. Thus it would appear that countries are at the very least taking these issues into serious consideration, if not enacting concrete measures to address them. Further research utilizing this corpus can analyze how NDC content corresponds to other thematic interests (e.g., climate migration, climate justice, etc.), as well as actual policy implementation.

7 Appendices

7.1 Appendix I — List of Annex I Countries

Table 1: Annex I Countries

Country
Switzerland
Japan
Monaco
Ukraine
United States of America
Belarus
Canada
United Kingdom
Iceland
Liechtenstein
New Zealand
Russian Federation
Australia
European Union

7.2 Appendix II — Key Word Dictionary for Vulnerability

Table 2: Vulnerability Key Word Dictionary

Words
adaptation resilience risk loss damage
hazard insecurity vulnerability disaster

Words
destruction harm suffering weather
cyclone flooding drought salination
desertification contamination hurricane
typhoon wildfire erosion landslide mudslide

7.3 Appendix III — Key Word Dictionary for Responsibility

Table 3: Responsibility Key Word Dictionary

Words
responsibility obligation duty commitment
assistance support cooperation aid
partnership sharing collaboration helping
justice fairness commensurate

7.4 Appendix IV — Vulnerability STM: Most Frequent Words by Topic

Table 4: Vulnerability STM — Top 5 FREX Words by Topic

Topic	Word 1	Word 2	Word 3	Word 4	Word 5
Sectoral Strategies	sector_economi	strategi_climat	emiss_per	temperatur_rise	nation_strategi
Emissions Targets	unit_state	net_zero	just_transit	decis_cma	zero_emiss
UNFCCC	unfccc_pari	second_nation	nation_director	advers_impact	develop_countri
Mitigation Plans	million_ton	carbon_emiss	green_low-carbon	energi_conserv	chang_respons
Carbon Capture	uc_us	million_uc	us_million	c_us	million_tco2e
Paris Agreement	member_state	enhanc_ndc	per_cent	reduct_target	carbon_neutral
Policy Frameworks	public_polici	line_action	specif_object	trend_scenario	mean_implement

Topic	Word 1	Word 2	Word 3	Word 4	Word 5
NDC Framework	address_ndc	ndc_commit	economy-wid_reduct	type_inform	mitig_action
NDC Goals	year_s	s_refer	includ_applic	agreement_applic	point_s
Adaptation	loss_damag	risk_reduct	disast_risk	build_resili	blue_economi
Scenario Model I	taken_account	condit_scenario	mitig_scenario	uncondit_scenario	refer_scenario
Financing	usd_billion	mitig_target	condit_uncondit	revis_ndc	ndc_implement
Scenario Model II	ndc_scenario	high_veri	kt_co2e	adapt_prioriti	climat_proof

Note: Within the "Carbon Capture" topic, I have assumed that features "uc_us" and "c_us" correspond to the "CCUS" acronym, which abbreviates "Carbon Capture Use and Storage". I am also not entirely confident in the labeling of the "Scenario Model II" topic, it could just be a "junk" grouping of loose but commonly appearing terms.

7.5 Appendix V — Responsibility STM: Most Frequent Words by Topic

Table 5: Responsibility STM — Top 5 FREX Words by Topic

Topic	Word 1	Word 2	Word 3	Word 4	Word 5
Sectoral Strategies	per_capita	sector_economi	strategi_climat	gas_emiss	nation_strategi
Paris Goals	unit_state	net_zero	natur_disturb	kyoto_protocol	zero_emiss
UNFCCC	unfccc_pari	second_nation	nation_director	least_develop	mitig_object
Mitigation Plans	million_ton	green_low-carbon	carbon_emiss	energi_conserv	low-carbon_develop
Carbon Capture	uc_us	million_uc	c_us	us_million	million_tco2e
Paris Agreem.	member_state	enhanc_ndc	per_cent	carbon_neutral	reduct_target
Policy Frameworks	public_polici	line_action	trend_scenario	specif_object	strateg_object
NDC Goals	year_s	s_refer	includ_applic	c_parti	articl_paragraph
NDC Framework	address_ndc	ndc_commit	economy-wid_reduct	type_inform	mitig_action
Scenario Model I	taken_account	fight_climat	condit_scenario	mitig_scenario	uncondit_scenario
Resiliency	loss_damag	small_island	level_rise	island_develop	chang_disast

Topic	Word 1	Word 2	Word 3	Word 4	Word 5
Financing	mitig_target	ndc_partnership	ndc_implement	revis_ndc	usd_billion
Scenario Model II	ndc_scenario	high_veri	kt_co2e	coastal_area	climat_proof
Adaptation	adapt_prioriti	condit_target	resourc_manag	climat_risk	mainstream_climat

Note: Within the "Carbon Capture" topic, I have assumed that features "uc_us" and "c_us" correspond to the "CCUS" acronym, which abbreviates "Carbon Capture Use and Storage". I am also not entirely confident in the labeling of the "Scenario Model II" topic, it could just be a "junk" grouping of loose but commonly appearing terms.

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