Identifying Key Factors in Decarbonization Policy from India's National Action Plan on Climate Change

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ABSTRACT

Despite the correlation between India's rapid economic growth and rapidly increasing greenhouse gas (GHG) emissions, there has been little research on decarbonization policy in the area. In efforts to reduce carbon emissions, governments tend to utilize market-based tools to promote low-carbon operations and decrease pollution-heavy practices. Despite India's heavy reliance on these market-based tools, these tools have mostly been studied in countries with more stable economies. In 2008, India published the National Action Plan on Climate Change (NAPCC), a document encompassing 8 national missions that focus on different areas related to sustainability. This document also included a range of "ongoing initiatives" that date back to 2001. The NAPCC has received mixed opinions from experts, despite it being proclaimed as a roadmap for climate policy in India. In this factor analysis, I identified and analyzed key features of the NAPCC and the frequency at which they show up in policy from 2001-2023. The results of my analysis showed that the NAPCC mainly focuses on the international distribution of burden, which can be seen as a way to push responsibility for climate action onto higher-emitting countries. My analysis also showed that key features from the NAPCC are minimally included in Indian climate policy.

KEYWORDS

Factor analysis, National Action Plan, India, climate change, policy

INTRODUCTION

Decarbonization policies tackle a variety of areas, such as agriculture, chemical manufacturing, land use, energy use, and transportation. Legislation is an important instrument of collective action as it encourages compliance with issues that do not affect all people in the same way. Governments will often utilize market-based tools to promote low-carbon operations, including incentives for technological advancement, command-and-control instruments, government spending on clean-up and policy enforcement, and demand-side market-based incentives (Briand et al. 2023, Eskeland and Jimenez 1992). Early forms of basic environmental laws mostly originated from the United States in the 1970s, with one of the most notable and successful frameworks at the time being emissions trading schemes (Bell and Russell 2002). European countries quickly followed suit and began implementing economic instruments, such as the effluent charge systems in Germany, France, and the Netherlands (Bell and Russell 2002). After the fall of communism, Western industrialized countries even began promoting market-based instruments in Central and Eastern Europe, although minimal success suggested these methods might only work in "developed" countries (Bell and Russell 2002).

Environmental policies usually rely on economic instruments to successfully enact change, meaning financial barriers faced by the government or consumers can severely limit the success of environmental policy (Eskeland & Jimenez et al. 1992, Kumar et al. 2023, Goyal et al. 2022, Kedia et al. 2016). There are many theoretical barriers and enablers to environmental policy, related to geophysical, environmental, technological, economic, institutional/infrastructural, political, and socio-cultural factors (Briand et al. 2023, Kumar et al. 2023, Kedia et al. 2016, Tarei et al. 2021). For example, environmental policies have historically been disproportionately enacted in countries with large economies, countries that do not face financial barriers when it comes to how much the government can spend on a measure (Bell & Russell et al. 2002, Kedia et al. 2016, Kumar et al. 2023). Subsequently, a majority of research analyzing success in environmental policy has been conducted in countries with financial resources and stable economies, such as Germany, France, the Netherlands, and the US (Bell & Russell et al. 2002).

The last two decades have revealed a significant shift in the global economic landscape, though. Due to increasing populations and significant GDPs, emerging economies such as China and India are now playing a role in global growth, providing domestic employment opportunities

as well as reducing poverty (Kumar et al. 2023). However, these emerging economies are also becoming major greenhouse gas emitters, spurring us towards a global climate crisis unless changes are made (Kumar et al. 2023).

There are many theoretical barriers and enablers to environmental policy, related to geophysical, environmental, technological, economic, institutional/infrastructural, political, and socio-cultural factors (Briand et al. 2023, Kumar et al. 2023). The goal of this study is to fill this research gap and help in creating a new framework to guide environmental policy decisions in India. In the rest of this paper, I aim to answer the following question:

What key factors from India's National Action Plan on Climate Change have shaped the framework of India's policies? To answer this, I identified:

(1) What exploratory factors can be identified from India's NAPCC?

(2) How many times is each theoretical factor addressed or mentioned in each policy? and

(3) Has there been a change in how often these factors show up in policies since the publication of the NAPCC in 2008?

RESEARCH FRAMEWORK

Study Site

For this study, I choose to analyze India, a nation that was one of the ten fastest growing economies of the world in the 1990s (United Nations Framework Convention on Climate Change (Organization) and India 2004). India is also the second most populous country in the world. Despite only encompassing 2.4% of the world's geographic area, it is home to over 16% of the global population (United Nations Framework Convention on Climate Change (Organization) and India 2004). It also features diverse natural conditions: landlocked as well as temperate coastal states, extreme seasons in the North with 180 days of rainfall per year in the Northeast, and a semi-arid belt with parts only receiving 20 days of rainfall per year (United Nations Framework Convention on Climate Change (Organization) and India 2004). Most importantly, India experiences a monsoon season from May to September, a period of concentrated rain (United Nations Framework Convention on Climate Change (Organization) and India 2004). Floods and droughts both occur in India and can affect land use patterns, as do population density,

urbanization, agriculture, and irrigation demands (United Nations Framework Convention on Climate Change (Organization) and India 2004). Agriculture, a climate-sensitive sector, is essential for the livelihoods of nearly 64% of the population and any changes to water availability could greatly threaten food security (United Nations Framework Convention on Climate Change (Organization) and India 2004). As of 2004, 61% of CO2 and CO2 equivalent emissions came from the energy sector (United Nations Framework Convention on Climate Change (Organization) and India 2004). Coal, which is abundant in India, is the dominant energy source and makes up 47% of the energy sector (United Nations Framework Convention on Climate Change (Organization) and India 2004). India stands to be greatly affected by the impending climate crisis and yet is faced by the equally important task of supplying energy and work to an ever-growing population. As such, it is extremely important for environmental policy in India to promote a growing economy in order for a green transition to be both successful and ethical (Goyal et al. 2022, Nagdeve et al. 2004).

India has leaned heavily on market-based instruments as a tool for combating climate change (Kedia 2016). For the most part, these past policy instruments for environmental protection have not effectively curbed emissions in India (Kumar et al. 2023, Nagdeve 2004). India historically has lacked in a few key elements needed for environmental regulation, including accurate emissions monitoring, a working legal system, transparency regarding emissions data and environmental requirements, institutional enforcement of regulations, social recognition of environmental policy, resource and renewable energy availability, and consequences for noncompliance (Bell and Russell 2002, Goel et al. 2023, Kumar et al. 2023, Nagdeve 2004). Until early 1994, ambient air quality standards in India were based on 8 hourly average times—now 24 hourly standards are prescribed—and air quality standards were the same across industrial, residential, rural, and other sensitive areas (Nagdeve 2004). Even when environmental requirements are stricter, enforcement may be lax. The automobile sector, a major pillar of India's economy, has been performing well below satisfactory levels when it comes to meeting environmental targets as recently as 2018, likely due to the lenient regulatory framework in place (Kumar et al. 2023). One of the biggest critiques of India’s environmental policy is that policy is too vague and unambitious; enforcement has always been a weak point in policy. When India published its National Action Plan on Climate Change in 2008, it was meant to be a roadmap for stronger and stricter climate policy (Pandve 2009). However, there has been little analysis into the

success or efficacy of this document, despite it still being a central part of India's approach to climate change.

National Action Plan on Climate Change

The National Action Plan on Climate Change (NAPCC) is a document published by the government of India in 2008. It outlines steps for the government to take in order "to simultaneously advance India's development and climate change-related objectives" (Pandve 2009). As a country with a rapidly growing economy, all climate change-related measures have to be carefully considered alongside how these measures may affect economic growth. The NAPCC, published in 2008, describes 8 main missions as well as a number of ongoing initiatives that fall under the umbrella of the NAPCC (Prime Minister's Council on Climate Change 2012). These 8 missions are the national solar mission, national mission for enhanced energy efficiency, national mission on sustainable habitat, national water mission, national mission for sustaining the Himalayan ecosystem, the green India mission, national mission for sustainable agriculture, and national mission on strategic knowledge for climate change (Pandve 2009, Prime Minister's Council on Climate Change 2012). Ongoing initiatives described include power generation initiatives, renewable energy initiatives, energy efficiency initiatives, and proposals for the health sector. The NAPCC also discusses how each mission will be implemented, with direction for dedicated ministries to lead responsibility for each mission and develop objectives, implementation strategies, timelines, and monitoring and evaluation criteria that will then be submitted to the Prime Minister's Council on Climate Change (Pandve 2009). The Prime Minister's Council on Climate Change is then responsible for periodically reviewing and reporting on each mission by developing proper indicators and methods to assess avoided emissions as well as adaptation benefits (Pandve 2009).

The NAPCC has received mixed opinions from different organizations and experts over the years. The director of a Delhi-based ecological foundation, a water expert, called the plan "a compilation of listless ideas that lack depth, vision, and urgency" (Pandve 2009). Many news and media articles claim that the plan is "sticking to the safe path" while the Indian government and its associated institutions insist that the use of market-based mechanisms for energy efficiency are a potential huge driver of savings (Pandve 2009). Greenpeace even commented on the NAPCC,

applauding the focus on solar and renewable energy programs but at the same time stating that targets are too vague and unambitious. Given the vague nature of actual mechanisms within the NAPCC, I was interested in finding out if future policy actually took inspiration from the NAPCC or if the document was more of an empty promise from the government to tackle climate change.

METHODS

I examined a set of policies enacted in India from 2001 onwards, starting with the Energy Conservation Act of 2001. The purpose of choosing this time frame was to only include policies that fall under the umbrella of the National Action Plan on Climate Change, a document published by the government of India in 2008. To ensure I used a comprehensive list of climate-related policies, I used the Climate Policy Database to find all policies and acts carried out on a national level in India. My final list contained 17 policies enacted before the passing of the NAPCC and 35 policies enacted after the passing of the NAPCC. Unfortunately, a few policy documents had to be excluded from this study due to their length. My system was not able to successfully analyze documents that were longer than 150 pages without considerable delay, and so I opted to exclude these documents.

Factor identification and principal component analysis (PCA)

To answer my first subquestion, I had to identify a list of theoretical factors from India's NAPCC. I found the best software for me to use for this task was Python, which has many well-established libraries created for the purpose of text processing (Inoue et al. 2023). For document parsing, I followed the same set of steps to parse the NAPCC as well as all policy documents.

Using a versatile open-source text parsing library called spaCy, I first extracted the text from the document and then tokenized it, meaning each word was assigned a part of speech (Meaney et al. 2023, Inoue et al. 2023). I then lemmatized the text, which reduces words to their base root words. I then removed all stopwords (Inoue et al. 2023). Filler words, such as conjunctions and pronouns, are called stop-words and can be removed as they are not related to the concept of the text (Uğuz 2011). After filtering to remove all stopwords, of which a list is already stored in the spaCy library, I used a noun-chunking function to separate chunks of text

from the document (Inoue et al. 2023). These chunks of text were parsed left-to-right and derived in a top-to-bottom fashion.

After the document parsing provided me with a list of text chunks pulled from the NAPCC, I used multiple tests to reduce this list to only contain relevant phrases and unique pieces of information. The first test I ran was for multicollinearity, which checks if variables are correlated with each other along multiple dimensions. In order to run this test, I had to create a matrix with all the text phrases and all the words used in all the text phrases. The matrix contained counts of how often words showed up in text phrases. I combined duplicate phrases and increased counts to account for that information. Bartlett's test of sphericity was then used to ensure the categories were all equally correlated with each other. If the variance inflation factor was greater than 5, the tolerance was lower than 0.2, and the R^2 value was above 0.8, the results showed that multicollinearity existed and I dropped the variable from the study. I then ran a Kaiser-Meyer-Olkin measure of sampling adequacy to validate the component analysis. Phrases with small values of communality (<.79) were dropped from the study as this result showed that the phrase did not have enough data to be included in the analysis.

After reducing this list of factors down to a total of 220, I then ran a PCA using the XLSTAT add-on in Microsoft Excel to reduce and summarize this list of factors with minimal loss of information (Inoue et al. 2023, Liu 2014). PCA does this by sorting variables into different categories according to which dimensions overlap with each other (Uğuz 2011). After cutting factor groups with 2 or less factors in them, the overall factor count was 180. The PCA results provided me with 9 factor groups that contained over 3 factors in them.

Identifying and storing factor frequencies

Now that I had my list of factors, I needed to answer my second subquestion: how often does each theoretical factor show up in India's policies? My objective here was to create a table showing how often each factor is mentioned in each policy. I first used the same document parsing method described above to tokenize, lemmatize, and filter stop-words out of each policy document. I then utilized the Natural Language Tool Kit on Python to create a dictionary of all factors sorted by word length and wrote an algorithm to read each document and display the number of occurrences of each factor (Arnold 2017, Inoue et al. 2023). I collected this data from each policy

document and consolidated it into a spreadsheet containing all policies for further analysis. I split this table in two, based on if policies were passed before or after the publication of the NAPCC (Table 1, Table 2).

My objective for this subquestion was to identify which factors and categories were most prevalent, and the count data that I collected directly displayed which factors and which categories appeared most frequently. For each policy document, I was able to add up the count data for all factors in a category and then sum up all the total category counts across policy. Then, I ranked the categories based on which categories had the highest counts. I was able to use the same method for identifying the prevalence of individual factors, ranking them by overall counts (Table 3, Table 4).

Identifying potential changes in policy framework using Welch's T-test

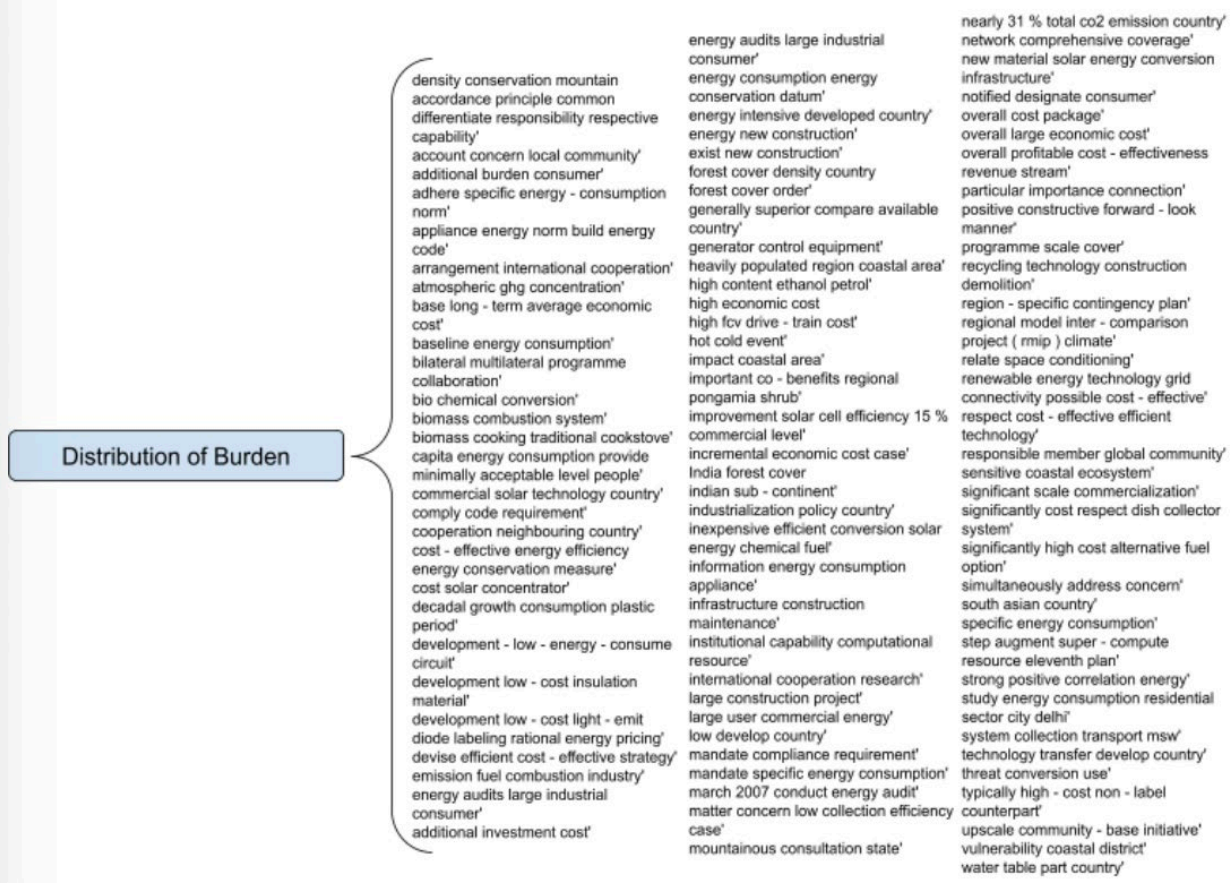
To see if I could identify a change in policy framework due to the NAPCC, I decided to look at three criteria: overall factor frequency, number of policies published, and policy page length. Since I am trying to identify if there is a statistically significant difference between two groups, I thought T-tests would be best. However, since the NAPCC unevenly divides the time period I am examining, this means my sample size will be different for pre-NAPCC policies and post-NAPCC policies. I used Welch's T-test, which accounts for unequal sample sizes and differences in variance while allowing me to compare two groups.

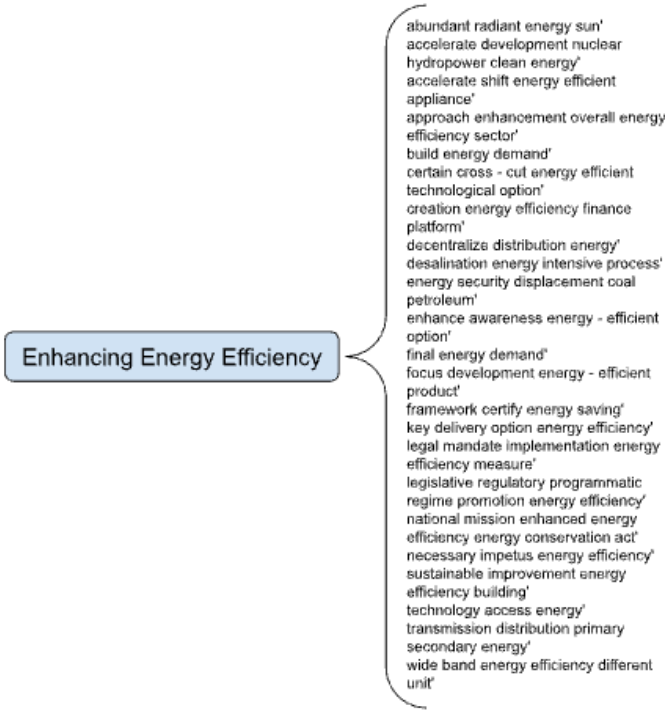
To investigate if there was a change in how overall factor frequency, I split up my list of policies into those that were passed before the NAPCC and those that were passed after. Since I already had collected data on individual factor frequency per policy, I added up all factor counts for each policy. I was then able to run Welch's T-test to see if there is a significant difference in the number of overall factors identified pre- and post-NAPCC. To compare the number of policies published, I compared the number of policies published per year with a T-test, splitting the policies into pre-NAPCC and post-NAPCC. For policy page length, I again used Welch's T-test.

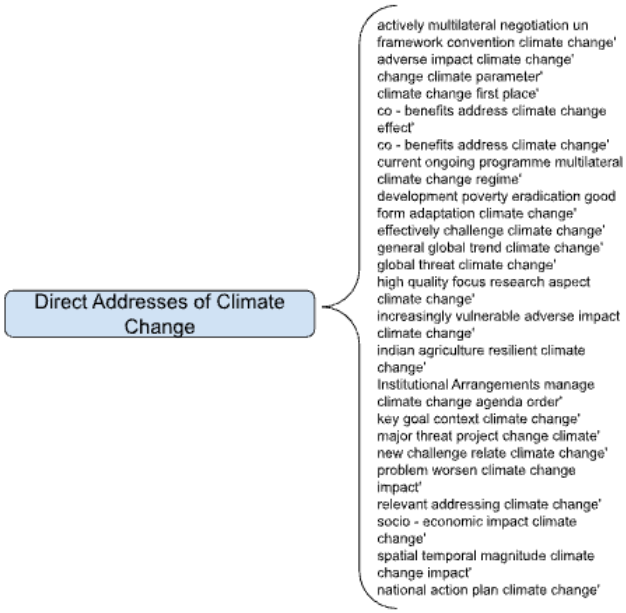
RESULTS

Factor identification and categorization

After analyzing the PCA results, I ended up with nine categories of factors. The largest category had 95 factors while the smallest category had 3. I chose the names, as seen below, based on the general theme of most of the factors (Figure 1). Some factors in each category do not fit neatly under the category name, which suggests there may be underlying connections that I have not identified.




Enhancing Energy Efficiency
abundant radiant energy sun'
accelerate development nuclear hydropower clean energy'
accelerate shift energy efficient appliance'
approach enhancement overall energy efficiency sector'
build energy demand'
certain cross - cut energy efficient technological option'
creation energy efficiency finance platform'
decentralize distribution energy'
desalination energy intensive process'
energy security displacement coal petroleum'
enhance awareness energy - efficient option'
final energy demand'
focus development energy - efficient product'
framework certify energy saving'
key delivery option energy efficiency'
legal mandate implementation energy efficiency measure'
legislative regulatory programmatic regime promotion energy efficiency'
national mission enhanced energy efficiency energy conservation act'
necessary impetus energy efficiency'
sustainable improvement energy efficiency building'
technology access energy'
transmission distribution primary secondary energy'
wide band energy efficiency different unit'


Direct Addresses of Climate Change
actively multilateral negotiation un framework convention climate change'
adverse impact climate change'
change climate parameter'
climate change first place'
co - benefits address climate change effect'
co - benefits address climate change'
current ongoing programme multilateral climate change regime'
development poverty eradication good form adaptation climate change'
effectively challenge climate change'
general global trend climate change'
global threat climate change'
high quality focus research aspect climate change'
increasingly vulnerable adverse impact climate change'
indian agriculture resilient climate change'
Institutional Arrangements manage climate change agenda order'
key goal context climate change'
major threat project change climate'
new challenge relate climate change'
problem worsen climate change impact'
relevant addressing climate change'
socio - economic impact climate change'
spatial temporal magnitude climate change impact'
national action plan climate change'

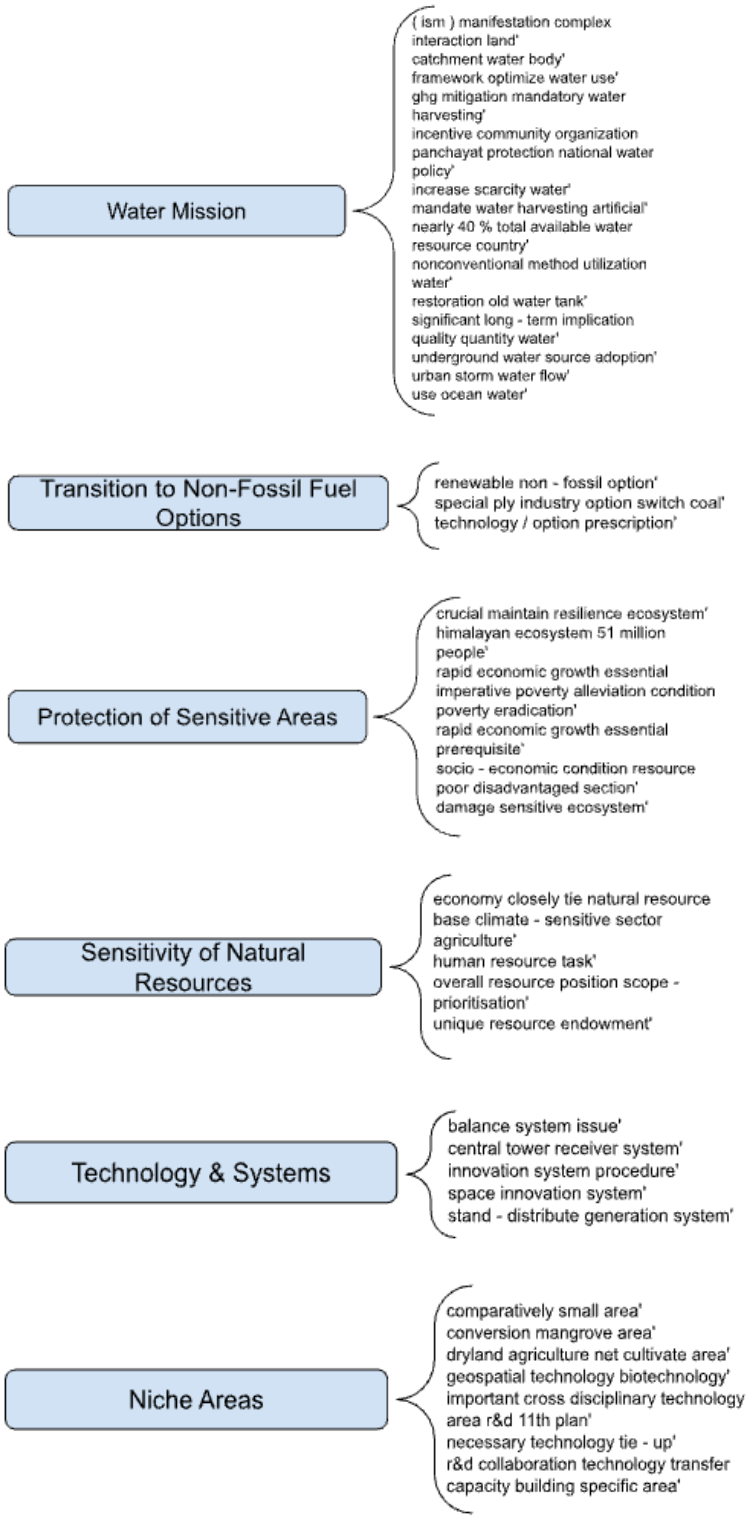


Figure 1. Conceptual framework of factors.

Factor frequencies in policy

When looking at factor frequency in policy, I noted that there were very few matches with factors within policies. This made some sense, as for phrases to match it requires the language to be very similar. Policies that were longer in page length were more likely to have more counts of factors. The factor counts per policy ranged from 0 to 127.

I then prioritized the overall factor categories by adding up the factor counts within each category. Due to the fact that many factors were not mentioned in any policy, there were some factor categories that had no data. These were all ranked at the same lowest priority of all the categories (Table 3). The category of 'Direct Addresses of Climate Change' contained the highest factor counts, with 'Distribution of Burden' factors showing up at the second-highest frequency in policy.

After adding up all counts for each factor across all policy, both pre- and post-NAPCC, I noted there were a handful of factors that appeared at high frequencies, with a portion of factors only appearing once or twice. I compiled a list of factors and their counts, excluding factors that only appeared once (Table 4).

Table 1. Factor counts in policy pre-NAPCC.

Policy pre-NAPCC	
National Electricity Policy	rapid economic growth (2), public private partnership, national action plan, bureau energy efficiency (2), energy conservation act (2), energy efficient technology, energy service companies, potential energy saving, 11th 12th plan period, research development (2), efficient technology (2)
Electricity Act	0
Energy Conservation Act	bureau energy efficiency (5), energy conservation act (4), energy conservation building code (5), research development
National Auto Fuel Policy	old pollute vehicle, research development (2)
Charter on Corporate	ministry environment forest, state pollution control board

Responsibility for Environment Protection (CREP)	
Integrated Energy Policy	atmospheric ghg concentration, adverse impact climate change, gdp growth rate (2), impact climate change, energy conservation act (3), indoor air pollution (5), geological survey india (2), india initial national communication, solar thermal power plant, research development
National Urban Transport Policy	rapid economic growth, public private partnership (3), research development
Biofuel Purchase Policy	degraded forest land, research development (2)
Tariff Policy	Clean development mechanism
The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act	diversion forest land (3), ministry environment forests
National Environment Policy	particular unique mountain scape entity (2), public private partnership (14), future climate change (2), national water policy (2), degraded forest land (2), impact climate change (2), sea level rise (6), national environment policy (57), environment management plan (2), renewable energy technology (4), small scale sector (4), small medium enterprise (2), indoor air pollution (4), clean development mechanism (2), relevant urban area (2), cultivation traditional variety (2), sustainable tourism adoption (2), norm tourism facility (2), joint forest management (2), zoological survey india (2), india initial national communication (2), research development (2), multistakeholder partnership (4)
Energy Conservation Building Code	Energy conservation building code (24)
National Policy for	public private partnership (2), impact climate change, rise sea

Farmers	level, aromatic medicinal plant, joint forest management, research development (2)
Land Acquisition (Amendment) Act	0
National Policy on Biofuels	Public private partnership, research development (3)
National Policy of Disaster Management	Public private partnership, ministry home affairs, research development

Table 2. Factor counts in policy post-NAPCC.

Policy post-NAPCC	
BEE Star Rating for Buildings	Bureau energy efficiency (4)
RE Tariff regulations	renewable energy technology (5), solar thermal power plant (4)
S&L Tubular Fluorescent Lamps	bureau energy efficiency (15), energy conservation act
National Mission on Agricultural Extension & Technology	0
Energy Conservation Amendment Act	energy conservation act (2), energy conservation building code
Clean Energy Cess Rules	0
The National Green Tribunal Act	State pollution control board
Clean Environment Cess	0
Strategic Plan for New and Renewable Energy	solar thermal system water heating, national solar mission (2), integrated energy policy, renewable energy technology (10), public private sector, research development
Solar cities development programme	National solar mission (3)
National Food Security Mission	Research development

National Agro-forestry Policy	public private partnership, threat climate change, joint forest management, ministry environment forests, research development (2)
National Renewable Energy Law	economic environmental objective, national solar mission, renewable energy technology (3), research development (5)
Zero Defect Zero Effect (ZED)	0
National Policy on Biofuels	public private partnership, research development (3)
Solid waste management rules	greenhouse gas emission, residential commercial building, ministry environment forest (10), concern local body, state pollution control board (21), research development
Pradhan Mantri Ujjwala Yojana	indoor air pollution (2), ministry home affairs
National Energy Policy (NEP)	simultaneously address concern, national action plan climate change**,** rapid economic growth, national action plan, future energy saving, future energy source, gdp growth rate, integrated energy policy (2), national environment policy, bureau energy efficiency, renewable energy technology (2), public private sector, energy conservation act, energy efficient technology, energy service companies, especially rural area, indoor air pollution, residential commercial building, address air quality, research development (2), efficient technology (3)
National steel policy	public private partnership, energy efficient technology, efficient technology
Auction of Solar Corporation (SECI)	National solar mission
Metro Rail Policy	public private partnership (7), increase number project
Pradhan Mantri Sahaj Bijili Har Ghar Yojana (Household electrification programme)	0
National Wind-Solar Hybrid Policy	public private partnership (2), public private sector, research development (2)
National E-Mobility Programme	small medium enterprise, research development

Proposed Methodology for Estimation of Electricity Generated from Biomass in Biomass Co-fired Thermal Power Plants	0
Steel Scrap Recycling Policy	old pollute vehicle, ministry environment forest, informal recycling sector
Scheme for Faster Adoption and Manufacturing of Hybrid and EV (FAME) II	Register motor vehicle
Kisan Urja Suraksha evam Utthaan Mahabhiyan (KUSUM)	0
Charging Infrastructure for Electric Vehicles - Revised Guidelines and Standards	Bureau energy efficiency (6)
Removal of mandatory requirement of coal washing	increase water use, ministry environment forest (6), expert appraisal committee
Notification S.O. 4259(E) creating the Apex Committee for Implementation of Paris Agreement	prime minister council climate change, ministry environment forest (5)
Proposed NDC targets	information energy consumption appliance, adverse impact climate change (3), national action plan climate change (2), national mission sustaining himalayan ecosystem, sustainable production process, challenge climate change (2), national action plan (2), national solar mission, national water mission (3), venture capital fund, extreme weather event, threat climate change, impact climate change (4), adverse impact economy, sea level rise, diversion forest land, integrated energy policy, national environment policy, bureau energy efficiency, thermal power generation, public private sector, small scale industry, energy conservation act, substantial energy saving, ministry environment forest, energy conservation building code, information energy consumption appliance, mass rapid transit system, national state

	district level, national mission sustainable agriculture (3), research development (2)
Green Hydrogen Policy	public private partnership, industry civil society (2), public private investment, ministry environment forests, research development (3)
Long Term growth trajectory of Renewable Purchase Obligations (RPOs)	0
Energy Storage Obligation	0

Table 3. Factor categories in descending frequency.

Categories	Priority Level
Direct Addresses of Climate Change	1
Distribution of Burden	2
Enhancing Energy Efficiency	3
Sensitivity of Natural Resources	4
Niche Areas	4
Technology & Systems	6
Protection of Sensitive Areas	6
Water Mission	6
Transition to Non-Fossil Fuel Options	6

Table 4. Factors in descending frequency.

Factors	Total # of counts
National environment policy	59
Research development	39

Public private partnership	35
Bureau energy efficiency	34
Energy conservation building code	31
Ministry environment forest	27
Renewable energy technology	24
State pollution control board	23
Energy conservation act	14
Indoor air pollution	12
Impact climate change	8
National solar mission	8
Sea level rise	8
Efficient technology	5
Public private sector	5
Small scale sector	5
Solar thermal power plant	5
Adverse impact climate change	4
Diversion forest land	4
Integrated energy policy	4
Joint forest management	4
Multistakeholder partnership	4
National action plan	4
Rapid economic growth	4

Clean development mechanism	3
Degraded forest land	3
Energy efficient technology	3
Gdp growth rate	3
India initial national communication	3
National action plan climate change	3
Small medium enterprise	3
Cultivation traditional variety	2
Energy service companies	2
Environment management plan	2
Future climate change	2
Geological survey India	2
Ministry home affairs	2
National water policy	2
Old pollute vehicle	2
Relevant urban area	2
Residential commercial building	2
Threat climate change	2
Sustainable tourism adoption	2

Analyzing changes in policy framework

All three T-tests I ran returned p-values higher than 0.05, which meant I found no significant change in policy framework since the passing of the NAPCC. The two-tailed p-value

obtained from the Welch's T-test I ran to examine overall factor frequency was 0.3051 (df=16). My t-value was 1.0594 and the standard error of difference was 8.012. These values showed that there was not a significant change in the average number of factors per policy before and after the passing of the NAPCC. In looking at policies published per year, my two-tailed p-value was 0.5581 (df=13). My t-value was 0.6012 and the standard error of difference was 0.861. This result showed no significant change in average number of policies published per year after the passing of the NAPCC. My third test, looking to find if there was a significant difference in average page length for policy, returned a two-tailed p-value of 0.1862 (df=19), which is not significant. The t-value I collected was 1.3716 and the standard error of difference was 11.42.

DISCUSSION

Factor categorization

The theoretical factors that I identified through this study were grouped into nine different categories. I named these categories based on the more general phrases that encapsulated the theme of most of the factors (Goyal et al. 2022, Inoue et al. 2023, Kumar et al. 2023). The largest category, which I named 'Distribution of Burden', contains a lot of language around international cooperation as well as common but differentiated responsibilities. I had expected the categories to more closely follow the missions outlined in the NAPCC, but only 3 categories were closely aligned with missions. The 'Water Mission' category is aligned with the National Water Mission, the 'Enhancing Energy Efficiency' category is aligned with the National Mission for Enhancing Energy Efficiency, and the 'Protection of Sensitive Areas' category is aligned with the National Mission for Sustaining the Himalayan Ecosystem. Other categories, like 'Direct Addresses of Climate Change', are broader and do not focus on one specific aspect of climate change. The results of my analysis grouped factors in a different way than many other studies, so the more established factor category names could not be utilized (Tarei et al. 2021, Goyal et al. 2022, Kannan et al. 2022, Goel et al. 2023, Kumar et al. 2023).

Factor frequency in policy

Overall, factors showed up in policy a lot less often than I thought they would. In fact, it is likely that if I had been able to use the PhraseMatcher tool in spaCy to search for similar words and hadn't been restricted by the exact vocabulary of the NAPCC, there would have been more occurrences of factors in the policies I looked at. However, I did note that many factors that I had removed for multicollinearity showed up frequently across policy. I thought this was interesting as it shows the way language is mirrored in the NAPCC and climate policy, and yet the language that is mirrored is not related to the core of the NAPCC.

The factor categories that showed up most often were the largest category, 'Distribution of Burden', and the 'Direct Addresses of Climate Change' category. I expected 'Distribution of Burden' to show up most often because of how much larger this category is than the others, so it was surprising to see 'Direct Addresses of Climate Change' had a higher overall factor count across policy than 'Distribution of Burden'. Factors that fell under the 'Distribution of Burden' category have been shown to be critical success factors in the promotion of sustainable consumption and production in India, specifically factors focused on international policies and flow of technology/resources (Goyal et al. 2022). The category of 'Direct Addresses of Climate Change' had factors show up most often in the introduction of policy. This makes sense as the introduction is where the problem is outlined and would be an apt place to address that climate change is an issue. 'Enhancing Energy Efficiency' was the third highest ranking category, with a factor count similar to the 'Distribution of Burden' category. These three categories appeared in policy very consistently, with the other categories combined making up less than 50% of the counts. The only one of these categories with factors directly relating to climate solutions was the 'Enhancing Energy Efficiency' category. The other factors tend to be more descriptive of the general impacts of climate change without addressing how to solve the issues.

Changes in policy framework

The results of my T-tests did not show there to be any significant change in policy framework around the passing of the NAPCC. There was no significant change in how often climate policy was passed or how detailed these policies were. The factors of the NAPCC that I extracted did not show up at different frequencies in policy after the passing of the NAPCC. These results imply to me that the NAPCC did not have an impact on climate policy in India.

Limitations and Further Research

One limitation of this research is that I was not able to measure success or efficacy. Since the list of factors only come from one document source, the NAPCC, and aren't validated by experts, I can only use these results to discuss how the NAPCC has shaped framework. In limiting my scope to one document, I could not consider other potentially influential sources on policy such as the media or later public statements issued by the government. It is also important to note that natural language processing methods work best with a large sample size, so pulling all factors from a single document may have resulted in an incomplete list of themes that appear in policy (Inoue et al. 2023). Another limitation is that I was not able to reduce my list of factors to just factors that are correlated with success. In the future, I would like to validate these factors with extensive expert input. I think it would be interesting to engage with policy-makers and stakeholders in the industry and understand how the efficacy of policy might correlate with some of these factors (Tarei et al. 2021, Goyal et al. 2022, Kannan et al. 2022, Kumar et al. 2023).

Conclusion/Broader Implications

In conclusion, my research sought to address a significant gap in the literature by examining the impact of India's NAPCC on the country's climate policy framework. My study employed factor analysis to identify key features of the NAPCC and analyzed the frequency of their incorporation into Indian climate policies from 2001 to 2023. My findings suggest that while the NAPCC outlines ambitious missions and ongoing initiatives aimed at addressing climate change, its impact on shaping actual policy implementation appears limited. Despite India's heavy reliance on market-based instruments for climate action, the study revealed that these tools, as outlined in the NAPCC, are minimally reflected in Indian climate policy (Bell & Russell et al. 2002, Briand et al. 2023).

Furthermore, my analysis indicated that there has been no significant change in the frequency or detail of climate policies following the publication of the NAPCC in 2008. Factors extracted from the NAPCC, such as those related to the international distribution of burden and direct addresses of climate change, were found to be inconsistently reflected in policy documents.

While my study sheds light on the disconnect between the NAPCC's objectives and their translation into policy action, it also underscores the complexity of environmental policy-making in a rapidly developing economy like India. Moving forward, it is essential to engage policymakers and stakeholders to understand the efficacy of climate policies and identify factors correlated with success. By addressing these gaps, future research can contribute to the development of more effective and impactful climate policies in India and beyond, crucial for mitigating the impacts of climate change on both the environment and society.

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