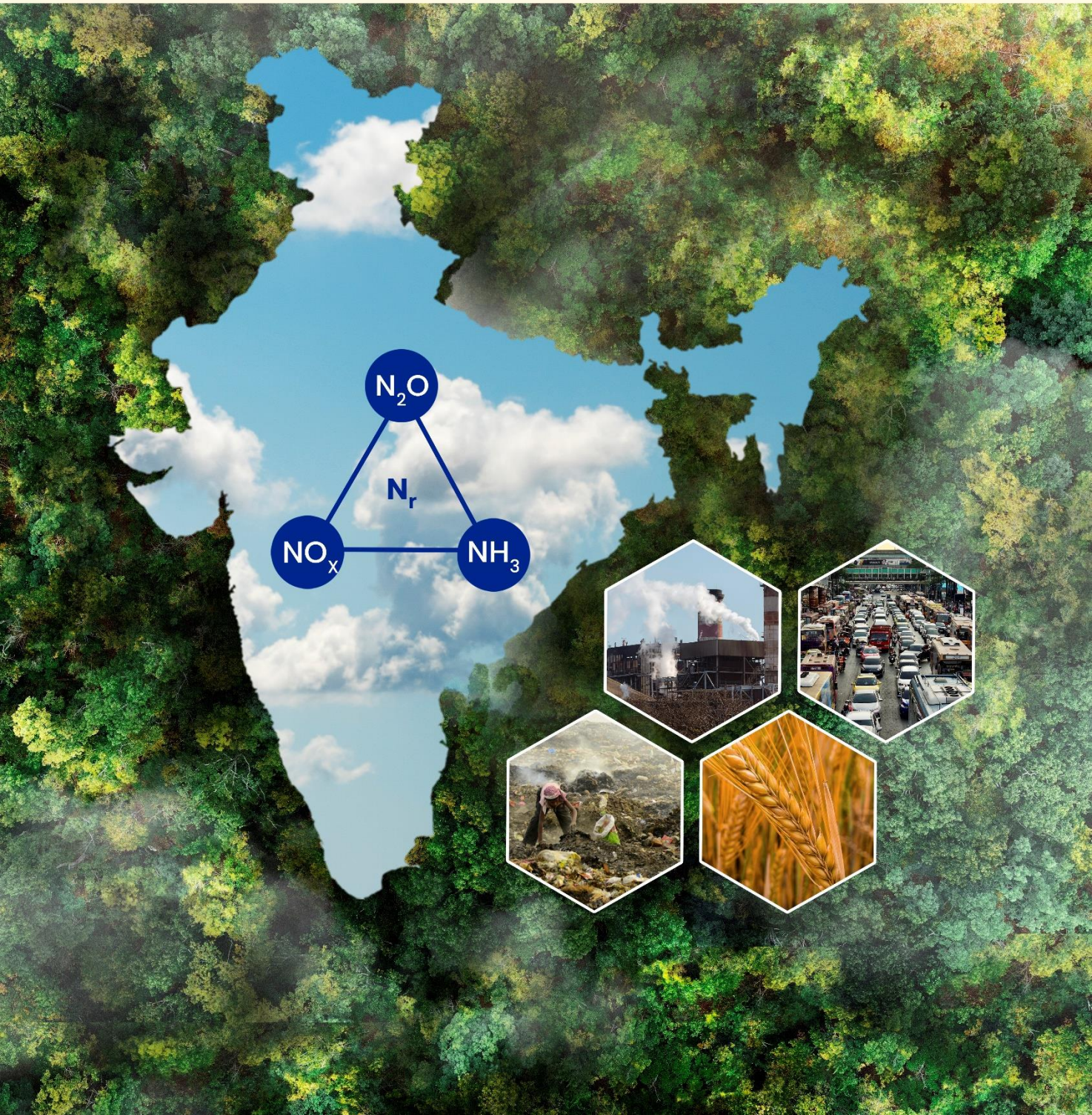
UKRI GCRF South Asian Nitrogen Hub

NATIONAL NITROGEN POLICY REPORT: INDIA



NATIONAL NITROGEN POLICY REPORT: INDIA

2023

SCIENTIFIC EVIDENCE, CURRENT INITIATIVES AND POLICY LANDSCAPE

KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY (DEEMED UNIVERSITY), BHUBANESWAR

INI- SOUTH ASIA NITROGEN CENTRE, NEW DELHI

SUSTAINABLE INDIA TRUST, NEW DELHI

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY, NEW DELHI

UNIVERSITY OF EDINBURGH, EDINBURGH

Scientific Report 2023

Authors

Prof. Tapan K. Adhya
Co-Director (Science) UKRI-GCRF SANH Project Director (Emeritus), South Asia Nitrogen Centre, New Delhi and Professor, School of Biotechnology, KIIT University, Bhubaneswar

Dr. Ananta Narayan Panda
Research Associate, UKRI-GCRF SANH Project KIIT University, Bhubaneswar

Dr. Himadri Kaushik
Communication Specialist, UKRI-GCRF SANH Project KIIT University, Bhubaneswar

Dr. Sangeeta Bansal
Research Associate, Sustainable India Trust, NASC Complex, New Delhi

Prof. Nandula Raghuram
Emeritus Chair INI, Chief Trustee, Sustainable India Trust, and Professor, School of Biotechnology, GGSIPU, New Delhi

Dr Ramesh Ramachandran
Founder Director, National Centre for Sustainable Coastal Management, Chennai

Dr Smriti Das
Professor Department of Policy and Management Studies TERI School for Advanced Studies, New Delhi

Dr Niharika Tyagi
Department of Policy and Management Studies TERI School for Advanced Studies, New Delhi

Dr Annie Yang
Senior Research Fellow, UKRI GCRF South Asian Nitrogen Hub (SANH), School of Social and Political Science, University of Edinburgh

Dr Roger Jeffery
Professorial Fellow in Sociology, Associate Director, Edinburgh India Institute, University of Edinburgh, School of Social and Political Science, University of Edinburgh

External Reviewer(s)

Dr A. K. Singh
Ex-Dy Director General (Natural Resource Management), Indian Council of Agricultural Research, New Delhi, Vice President, National Academy of Agricultural Sciences, NASC Complex, New Delhi

Dr P.D. Sharma
Ex-Asst. Director General (Soils), Indian Council of Agricultural Research, New Delhi

Citation

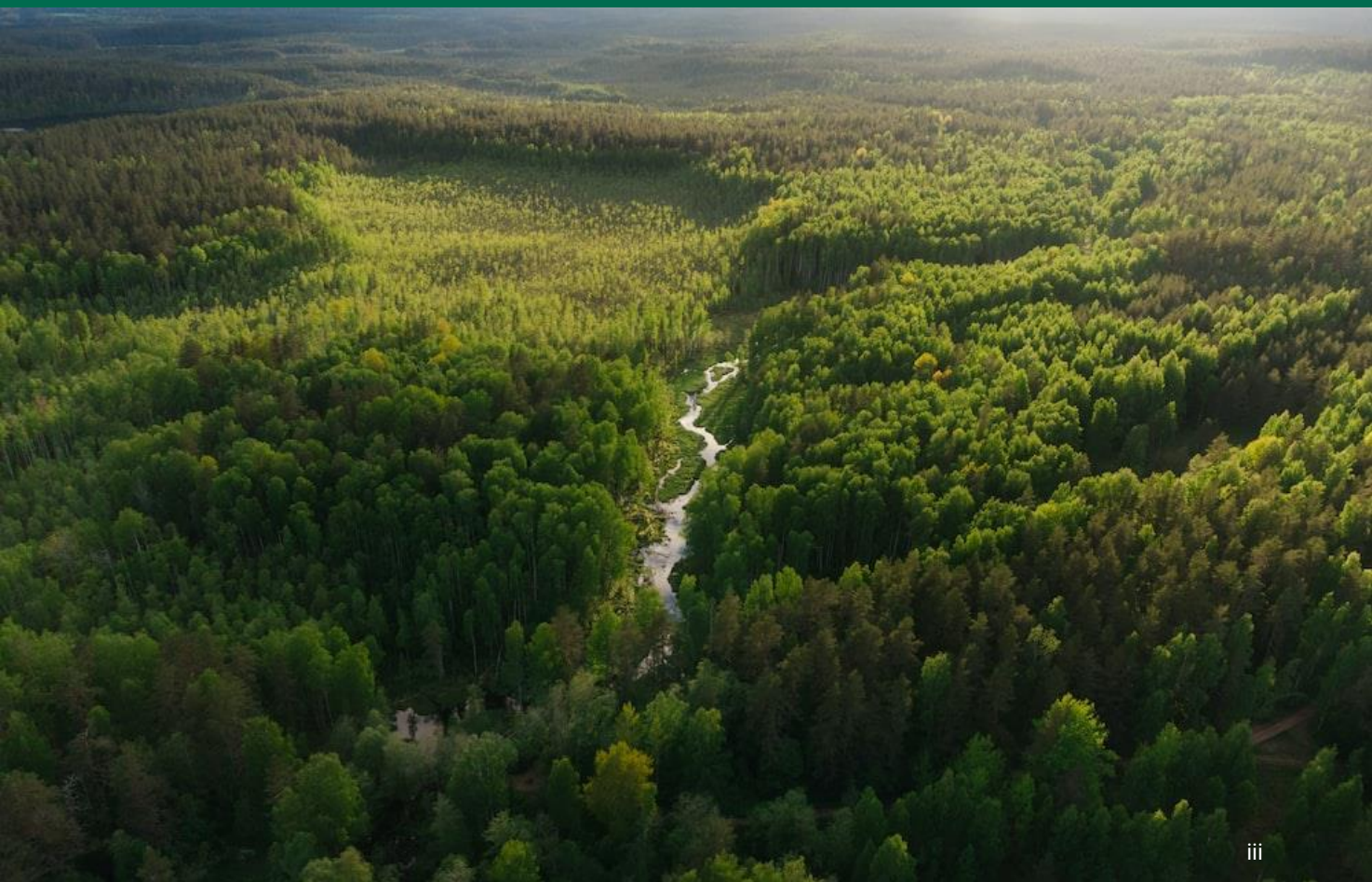
Adhya, T.K., Panda, A.N., Kaushik, H., Bansal, S., Raghuram, N., Ramachandran, R., Das, S., Tyagi, N., Yang, A. and Jeffery, R. (2023) India National Nitrogen Policy Report: Scientific Evidence, Current Initiatives and Policy Landscape. UKRI-GCRF-South Asia Nitrogen Hub, Kalinga Institute of Industrial Technology (KIIT), Deemed University, Bhubaneswar, India.
pp. 100 + XVIII

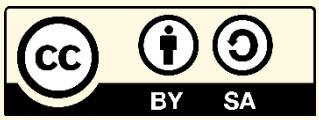
ACKNOWLEDGEMENTS

We gratefully acknowledge funding from UK Research and Innovation (UKRI) through its Global Challenges Research Fund, which supports the GCRF South Asian Nitrogen Hub (SANH) that made this work possible, together with underpinning support from the project “Towards the Establishment of an International Nitrogen Management System (INMS)” supported by the Global Environmental Facility (GEF) through the UN Environment Programme. This report contributes to the work of the International Nitrogen Initiative (INI) and the global Partnership on Nutrient Management (GPNM). The Present report is a part of the output of the SANH Work Package 1.1

We are highly indebted to Prof. Achyuta Samanta, Member of Parliament, Hon’ble Founder, Kalinga Institute of Industrial Technology, KITT-KISS Foundation for kind permission to host the project at the School of Biotechnology, KIIT (Deemed) University. We are grateful to Prof. Dr (Ms.) Sasmita Samanta, Hon’ble Vice-Chancellor, KIIT University for extending all possible administrative support in carrying out the project work without any hindrance and Dr. Mrutyunjay Suar, Director General (Research & Innovation), KIIT University for continued support to the project.

We acknowledge the effective support from the SANH Coordination team especially Dr. Clare Howard, Dr. Bill Bealey and Ms. Madison Warwick. We also acknowledge most valuable contributions and directives of Dr. Mark Sutton, Director UKRI GCRF South Asian Nitrogen Hub. We are grateful to Dr Shailesh Nayak, Director, National Institute of Advanced Studies, Bengaluru and Chair, National Nitrogen Steering Committee, Govt. of India for critically going through the draft manuscript. We further acknowledge our two esteemed external reviewers who critically reviewed the draft document leading to its qualitative improvement. This work would not have been complete without direct (all authors of the report) and indirect support from all our SANH colleagues.





COPYRIGHT & DISCLAIMER

All efforts have been made to ensure the accuracy of this report's information. We believe that use of material from other published or copyright sources falls under fair use and has been properly referenced. Please bring any errors on this front to our attention.

The designation employed and the presentations of material in this publication concerning the legal status of any country, territory, city area or its authorities, or concerning the delimitation of its frontiers or boundaries or the designation of its name, frontiers or boundaries do not imply the expression of any opinion whatsoever on the part of KIIT University, SANH, or contributory organizations, editors or publishers. The mention of a commercial entity or product of this publication does not imply endorsement by KIIT University, Bhubaneswar or SANH.

FOREWORD

Message from the Vice-Chancellor, KIIT University

Nitrogen, as di-nitrogen (N2) is one of the most abundant elements in the atmosphere; but in its reactive form, nitrogen in excess can cause severe harm to people and environment. Excess reactive nitrogen in the environment is an important issue globally and in South Asia too. Agriculture being one of the important vocations of the people of the country, use of nitrogenous fertilizer is the major reactive-N source in India. Apart from agriculture, other sectors including transportation, industry and energy have increased their share of nitrogen pollution and related greenhouse gas (GHG) emissions due to growing demand led by continued economic development. Principal threats to nitrogen pollution are water quality, air quality, greenhouse gas balance, soil quality, ecosystem and biodiversity. Thus, it is essential to manage the nitrogen pollution for a better and safer environment for the future. Both government and non-government measures including policy support can encourage efficient nitrogen management and reduce the negative impacts.

South Asia Nitrogen Hub (SANH), a global research program covering all eight South Asian countries and UK partners, is funded by UKRI-GCRF. SANH has enabled this report and helped collating and analyzing nitrogen related policy issues pertaining to India which is coming up as the hub of heightened economic activity but with related deleterious impacts on the environment, including ones contributed by increased nitrogen use. Emission of the three gaseous nitrogen compounds, ammonia, nitrogen oxides and nitrous oxides, have increased over time in India. It is heartening to peruse that the Government of India is well-aware of the issue as evidenced by the promulgation of 306 policies that might impact reactive-N status of India. However, a continued effort to follow up on the most relevant issues related to nitrogen is essential for a better future. I am sure that this policy analysis report will provide quality input to the policymakers of the country in this direction.

Kalinga Institute of Industrial Technology (KIIT), a deemed University which is celebrating its 25-year of glorious existence and meritorious service to the nation in the area of academics and high-quality research, is continuously engaged in bringing to the fore information of societal impact and importance. I am thankful to the SANH program authorities for hosting this program in this university and supporting our faculty and also academics and research scholars from other centres of India.
I congratulate the authors of this report for such a well-drafted report which will be a source of information to the scientific community, informed public and the policymakers of this country, South Asia and the world alike.

Prof. Sasmita Samanta
Vice-Chancellor, KIIT Deemed to be University
Bhubaneswar – 751024, Odisha, India

FOREWORD

This report, prepared by the UKRI GCRF South Asian Nitrogen Hub in partnership with Indian partners and the South Asia Co-operative Environment Programme (SACEP), without doubt represents a milestone in international cooperation on sustainable nitrogen management. The foundation of the Hub is closely linked to SACEP and nitrogen policy, with a key moment being the joint workshop on Sustainable Nitrogen Management between SACEP and the International Nitrogen Management System (INMS) held in Malé, September 2017. Key outcomes of the meeting included a draft resolution, which was ultimately adopted at the United Nations Environment Assembly's UNEA-4 in March 2019. Agreement to cooperate in a competitive proposal to UKRI ultimately established the GCRF South Asian Nitrogen Hub.

The work in this report represents one fruit of this cooperation between policy makers, and of social and natural science researchers into current nitrogen policies in South Asia providing a foundation to inform future policy development. Apart from its immediate contribution to the SACEP Roadmap for Nitrogen Policies in South Asia, and the GCRF Nitrogen Hub, this document is also an important regional contribution to following up the Resolution on Sustainable Nitrogen Management at UNEA-4, which was led by India.

Actions in this wider policy context have since been accelerated by the Colombo Declaration in October 2019, which highlighted the need for National Roadmaps on Sustainable Nitrogen Management alongside a new ambition to 'halve nitrogen waste' from all sources by 2030. The policies presented in this report provide building blocks for the necessary change, and at the same time the opportunity for cleaner air, water, soil, less climate and biodiversity impacts, healthier lives and stronger economy. Globally, halving nitrogen waste could offer a resource saving worth 100 billion USD per year, which is a strong motivation for action.

The present report will be especially useful as we move forward. In addition to input to SANH, INMS and SACEP, other UN member countries can see comparative data and share lessons. We are celebrating the adoption in February of a new Resolution on Sustainable Nitrogen Management at UNEA-5. This encourages countries 'to accelerate action to substantially reduce nitrogen waste by 2030 and beyond'. Although Member States did not yet agree to "halve nitrogen waste", this new resolution is the first time that such a reduction intent for nitrogen waste has been agreed universally by the UN, and it is therefore a major step forward to the UN Sustainable Development Goals (SDGs). The information and the lessons from the present report are therefore very timely in providing support to turn this ambition into reality.

Prof Mark Sutton
Director UKRI GCRF South Asian Nitrogen Hub
Edinburgh, June 2022

Executive Summary

This report, the first of its kind, provides a necessary step to understand the current nitrogen policy landscape for India within the broader South Asian context. It highlights the issues and challenges around nitrogen pollution and management, with recommendations for action.

INTRODUCTION

- **Nitrogen is essential for life, but nitrogen in its reactive form (N_r) in excess can cause severe harm to people and the environment.** Excess reactive nitrogen (N_r) is a significant issue globally and for South Asia.
- Multiple sectors including agriculture, transportation, industry, and energy sectors have increased their share of nitrogen pollution and related greenhouse gas (GHG) emissions due to growing anthropogenic demands.
- **Five principal threats of nitrogen pollution** are to water quality, air quality, greenhouse-gas balance, soil quality, ecosystem and biodiversity.
- Addressing climate change by reducing greenhouse gas (GHG) emissions is a key priority in international politics. **Managing nitrogen is essential for international climate change mitigation: nitrous oxide (N_2O) has ~310 times[1] more warming potential than CO_2.**
- **South Asia is a global hotspot for N_r emissions** for the main nitrogen compounds: nitrogen oxide, nitrous oxide and ammonia, with emission levels above global averages.
- **Nitrogen pollution can be managed directly or indirectly** by legislation, financial or regulatory measures taken by governments.
- Government and non-government measures can support and encourage efficient nitrogen management, and hence, minimize the negative impacts.
- The **management of nitrogen is a major issue of international policy, yet information about nitrogen policies at national levels is scarce.** There is a limited understanding of the policies, the issues addressed, and the types of instruments used, and how existing policies might impact nitrogen pollution.

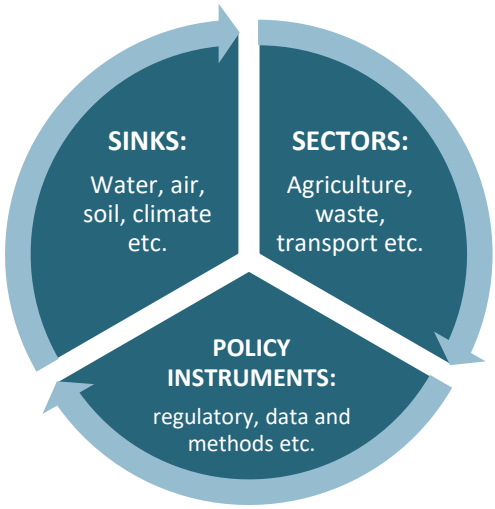
UKRI GCRF SOUTH ASIA NITROGEN HUB (SANH)

- **SANH aims to tackle the nitrogen challenge by bringing together experts from leading research organizations from across South Asia and the UK.** The hub focuses on four main areas: i) building the nitrogen policy arena for South Asia; ii) finding nitrogen solutions; iii) improving understanding and awareness of key nitrogen threats; iv) integrating data on regional nitrogen flows and impacts in south Asia.
- The South Asia Co-operative Environment Programme (SACEP) and SANH undertook an initial **South Asian regional assessment of nitrogen emissions and policy and created a database of 966 nitrogen-relevant policies from South Asia.**
- **The SANH India team conducted a second round of policy search in 2021 with a State and Union Territory level focus collecting an additional 114 policies.** This led to a collection of 306 nitrogen-relevant policies for India, contributing to 28% of the total policy collection for South Asia.
- **Drawing on that database, this SANH national report outlines the implications of these findings for India**. The country report is the first of its kind to provide a national overview on the extent of nitrogen-related policies for India.

[1] In a 100-year time period (IPCC, 2021)

NITROGEN-RELATED POLICY ANALYSIS FOR INDIA

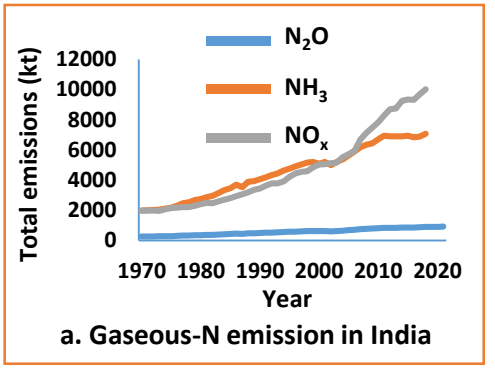
- **All nitrogen-related policies collected were classified** based on certain characteristics. Classifications include: environmental sink; sector; sub-sector; policy type; pollution source type; impact direction; relevance; and impact scope.
- **The policy type classification indicates the type of policy instruments that are incorporated within a particular policy**. A single policy may have multiple policy type characteristics, which indicate a more comprehensive approach. **For India, there were 531 classifications from the 306 policies, 172 policies (56%) of which had more than one policy type identification**.



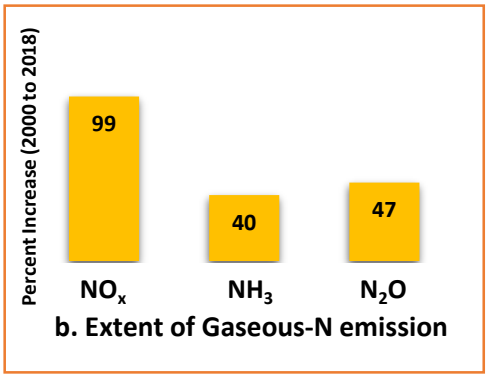
- **In terms of sectors, the most common classification of policies was for 'agriculture' (21%)**. Agriculture is one of the main contributors to GDP of India and also a core contributor to national N-emissions.
- **Another common classification for sectors was for 'multiple sectors' (20%)**. Having multiple sectors within a policy is an advantageous characteristic indicating an understanding that multiple sectors have roles to play in N_r management.
- **For environmental sinks, the most common classification was where 'no sink' had been included in the policy text (40%), and the policy was therefore purely sector oriented**. This could be regarded as an unfavourable policy characteristic, indicating that N_r environmental impacts have been overlooked.
- **Policies classified as having low relevance and/or low impact scope (36%) should, however, not be considered 'irrelevant'**, as such policies still hold potential to have an impact and via amendments, they can mitigate any N_r waste and pollution, if they do not pose a potential risk.
- **Over half the policies (70%) were identified as having a potentially positive impact on N_r management,** as there are mostly environmentally orientated policies. Policies classified as mixed/neutral (20%), indicate to varying degrees' dual goals for economic development and the environment. **Policies with a potentially negative impact direction (2%) include those that risk promoting N_r waste.**
- **To deal with N_r pollution better, it is necessary to have policies that consider multiple sectors and sinks and policy instruments.** Currently 11 policies meet this criterion to some degree. Policy examples include the 'Policy Statement for abatement of Pollution, 1991' and the 'State Action Plan on Climate Change (Haryana)'. Although, not all policies would need to be integrated in this manner, a policy gap is visible.

DRIVERS OF REACTIVE NITROGEN EMISSIONS

- **Emissions of all three nitrogen compounds, ammonia, (NH_3), nitrogen oxides (NO_x), and nitrous oxide (N_2O), have been increasing over time in south Asia and India**[2]. These results highlight that current policy efforts so far have not yet been able to stabilise or reduce N_r emissions.
- **N_r emission levels will continue to increase unless they are arrested further via tight policy actions taken at international, national, and local levels**.
- **Nitrogen oxides (NO_x) in India are the fastest rising N_r compound, particularly** since the year 2000 increasing by 99% from 2000 and 2018.
- **For ammonia (NH_3) the emission levels in India have been increasing steadily,** and at a somewhat similar pace since the 1970's. NH_3 emission grew by 40% in the period 2000 to 2018.
- There was a 47% increase in nitrous oxide (N_2O) emissions. **N_2O emissions are the lowest (in total amount) compared to the other N_r compounds**. The emissions for N_2O, NH_3 and No_x were about 894, 7074 and 10025 Gg/year in 2018, respectively.
- **Agriculture is the largest source for ammonia (NH_3) and N_2O emission.**



a. Gaseous-N emission in India



b. Extent of Gaseous-N emission

- **Industrial combustion (others) and road transportation accounts for other major sources of nitrogen oxides (NO_x)** and their contribution increased to 1211% and 457% respectively from 2000 to 2015.
- **Power, industry and other industrial combustion also contributed to NH_3 emissions**, with the emission increasing by 507% and 361% respectively between 2000 and 2015.

NEEDED ACTIONS

- **Despite the number of policies in India (306) that have relevance for N_r management, and the high number of policies with a potentially positive impact direction, all major N_r compound emissions (ammonia, nitrous oxide and nitrogen oxides) are on the rise.**
- **India is a major contributor to all three N_r compounds in South Asia.** The South Asia region has been identified as a global nitrogen emission hotspot (SACEP-SANH, 2022). This indicates that more has to be done at the international, national and state level to tackle N_r waste.
- **As well as addressing nitrogen management systematically, policies with higher relevance should also be accompanied by direct actions, such as 'core' policies, that contain regulatory and economic policy instruments**. Setting quantifiable and enforceable constraints on N production and consumption in nitrogen-related policy is recommended.
- **Existing policies can also be adapted to deal more directly/effectively with nitrogen management by referring explicitly to nitrogen pollution itself, and ideally to specific relevant N_r compounds**. In order to address nitrogen pollution issues, amendments – ranging from minor to major ones – could be applied to these policies.

[2] The image 'a' shows Ammonia, (NH_3), Nitrogen oxides (NO_x), and Nitrous oxide (N_2O) emissions for India, 1970 – 2018/2021. Image 'b' shows the extent of percent change in the emission of gaseous reactive-N emission. Source: Crippa et al., (2021) derived from EDGAR v7.0. and EDGAR v6.1 air pollutants, https://edgar.jrc.ec.europa.eu/dataset_ap61

- **For policies with high nitrogen management relevance, amendments to specify pollution source type and the risk of nitrogen waste would be advantageous**. Only a small number (27%) of directly nitrogen-relevant policies (from a total of 197) determined if pollution sources were 'point source' locations or 'non-point source' or both. Such policies indicate potentially useful examples for N_r management as there are different challenges involved according to the different pollution source types.
- **Sector-based policies would benefit from ensuring that they directly, or via other connected policies, consider the potential risks, or options to mitigate negative N_r impacts referring to one or more environmental sink.** A large proportion (40%) of India's nitrogen relevant sector-based policies have not referenced any sinks.
- **To deal with N_r pollution better, it is necessary to have policies that consider multiple sectors and sinks and policy instruments.** Currently, 11 policies meet this criterion to some degree. Although not all policies would need to be integrated in this manner, a policy gap is visible.
- **Agriculture is one of the main contributors to national N_r emissions**. Fertilizers play a vital role but much of the inputs are wasted. Sustainable alternatives are available. Such methods, that would increase crop-N use efficiency (NUE) and simultaneously reduce N waste, have the potential to save considerable revenue, maintain soil and human health.
- **Action is needed in emerging sectors, considering relative changes in N_r emissions.** Different sectors contribute to the emission of N_r compounds in various ways and are growing at different rates. Currently, NO_x is one of the fastest rising and most abundant N_r compound in India, sourced mostly by the energy, transport and other forms of industrial combustion sector activities. The overlap in contributing sectors to different compounds, such as No_x , indicates areas where integrated policies are necessary to avoid pollution swapping and promote coordinated actions.
- **The development of National Action Plans is advised in the United Nations Environment Assembly (UNEA-5) new resolution on sustainable nitrogen management**. India has the ability to strengthen regional/international commitments such as support of UNEA-5.2 and preparing for UNEA-6 to manage nitrogen sustainably.
- **Further in-depth research on these N_r relevant policies is necessary, to assess, amongst other aspects, their impact**. SANH will continue to analyse N-relevant policy, increase the evidence base, and engage with SACEP member states to broker a better understanding.
- **Science-based decision-making is crucial to move towards N_r sustainability and SANH is supporting this journey to create the scientific evidence of the sources and causes of emissions, and ways to mitigate their impact**. SANH will improve the scientific and technical base and help strengthen India's contributions to address N_r both nationally, regionally and beyond.

Funders

UK Research and Innovation

GCRF Global Challenges Research Fund

The South Asian Nitrogen Hub (SANH) is a UKRI GCRF funded research partnership that brings together 32 leading research organisations and project engagement partners from South Asia and the UK. SANH is working towards enabling South Asia to 'adopt and champion a strategic approach to nitrogen management as a key step towards the Sustainable Development Goals'. SANH aims to provide relevant scientific insights identify barriers to change and demonstrate the economic benefits of tackling nitrogen.

CONTENTS

01 INTRODUCTION

02 COUNTRY LEVEL PROFILE AND PRIORITIES

03 NITROGEN-RELATED POLICY ANALYSIS

CONTENTS

List of Tables

List of Figures

List of Figures

Abbreviations and Acronyms

- % - Percentage
- ^{o}C - Degree Celsius
- ^{o}F - Degree Fahrenheit
- ADRTC - Agriculture Development and Rural transformation centre
- BU - Billion Units
- BTU - British thermal unit
- cm - Centimetre
- C&C - Command and control
- CCA - Climate and Clean Ai r Coalition
- CCEA - Cabinet Committee on Economic Affairs
- CFQCTI - Central Fertiliser Quality Control and Training Institute
- CIL- Coal India Limited
- CO_2 - Carbon dioxide
- CPCB - Central Pollution Control Board
- ECOLEX database - Ecolex is an information service on environmental l aw, operated jointly by FAO, IUCN and UNEP
- EDGAR - Emissions Database for Global Atmospheric Research (EDGAR), provided by the European commission, Joint Research Centre (JRC)/Netherlands Environmental Assessment Agency (PBL)
- EEZ - Exclusive Economic Zone
- EPA - Environmental Protection Agency
- EU - European Union
- FAI - Fertiliser Association of India
- FAO - Food and Agricultural Organization.
- FCO - Fertilizer Control Order
- FICCI - Federation of Indian Chambers of Commerce & Industry
- FY - Fiscal Year
- GCRF - Global Challenges Research Fund
- GDP - Gross Domestic Product
- GEF - Global Environmental Facility
- Gg - Gigagram
- GHG - Greenhouse gas
- GPNM - Global Partnership on Nutrient Management
- GRAP - Graded Response Action Plan

- GVA – Gross Value Added
- GW – Giga Watt
- ICAR-IARI - National Agriculture Research System including Indian Council of Agricultural Research
- IFFCO- Indian Farmers Fertiliser Cooperative
- INDC - Intended Nationally Determined Contribution
- INI - International Nitrogen Initiative
- INMS - International Nitrogen Management System
- IPCC - Intergovernmental Panel on Climate Change
- IUCN - International Union for Conservation of Nature
- IVA - Information and voluntary action
- Kg – Kilogram
- KIIT- Kalinga Institute of Industrial Technology
- KISS - Kalinga Institute of Social Sciences
- Km – Kilometre
- KRIBHCO - Krishak Bharti Cooperative
- KVKs - Krishi Vigyan Kendras
- Lha- Lakh hectare
- Lt - Litre
- MBR - Market-based regulation and governmental expenditure
- M&E - Monitoring and evaluation
- mi – miles
- mg- milligram
- MFL - Madras Fertilizers Limited
- MMT - Million metric tonnes
- MSME – Micro Small and Medium Scale
- MoAFW – Ministry of Agriculture and Farmers Welfare
- M/O CAFPD - Ministry of Consumer Affairs, Food and Public Distribution
- MoCF - M/o Chemicals & Fertilizers
- MoEFCC – Ministry of Environment Forest and Climate Change
- MoF - Ministry of Finance
- MoPNG - M/o Petroleum & Natural Gas
- MT – Million tonnes
- MW – Megawatt
- N, P, K - Nitrogen (N) Phosphorous (P) Potassium (K)
- N - Nitrogen

- N_2- di-nitrogen
- N_20 - Nitrous oxide
- NA - Not applicable
- NABARD - National Bank for Agriculture and Rural Development
- NAMP - National Air Quality Monitoring Program
- NASA- SRTM - National Aeronautics and Space Administration -Shuttle Radar Topography Mission
- NAQI - National Air Quality Index
- NBS - National Bureau of Statistics
- NCAP - National Clean Air Program
- NCOF - National Centres of Organic Farming
- NDC - National Determined Contributions
- NFL - National Fertiliser Ltd.
- NGOs - Non-Governmental Organisation
- NH_3 - Ammonia
- NH_4 – Ammonium
- NO – Nitric Oxide
- NO_2 - Nitrites
- NO_3 - Nitrates
- NOx - Nitrogen oxides
- NPS - Non point source
- N_r - Reactive Nitrogen
- NUE - nitrogen use efficiency
- PM - Particulate matter
- P&K – Phosphorus and Potassium
- R&D - Research and development
- RCFL- Rashtriya Chemicals & Fertilizers Ltd
- RE- Renewable Energy
- SA - South Asia
- SACEP- South Asian Regional Cooperative Environmental Programme
- SANC- South Asian Nitrogen Centre
- SANH- South Asia Nitrogen Hub
- SAUs - State Agricultural Universities
- SC - Supreme Court
- SCON – Society for conservation of nature
- SDG – Sustainable development goal

- SIT – Sustainable India Trust
- SO_2- Sulphur dioxide
- STPs - Sewage treatment plants
- TERI- The Energy and Resources Institute
- UFP - Uniform Freight Policy
- UKCEH- UK Centre for Ecology and Hydrology
- UKRI- UK Research and Innovation
- UNSDGs- United Nations Sustainable Development Goals
- UNDP- United Nations Development Program
- UNEA- United Nations Environment Assembly
- UNEP- United Nations Environment Program
- UNFCCC- United Nations Framework Conservation on Climate Change
- UNICEF- United Nations Children's Fund
- URA- Utility Regulatory Authority
- WHO- World Health Organisation

1 INTRODUCTION

1.1 Lead institution and SANH

The South Asian Nitrogen Hub (SANH) is a collaborative research program funded by the United Kingdom Research and Innovation under its Grand Challenges Research Fund (UKRI-GCRF). It brings together 32 research organisations and project partners from South Asia and the UK. SANH is working towards enabling South Asia to 'adopt and champion a strategic approach to nitrogen management, as a key step towards the Sustainable Development Goals'. SANH aims to provide relevant scientific insights, identify barriers to change, and demonstrate the economic benefits of tackling nitrogen pollution in South Asia.

SANH includes eight south Asian countries: Afghanistan, Pakistan, India, Nepal, Bhutan, Bangladesh, Maldives and Sri Lanka. These eight countries are also partners in the South Asia Co-operative Environment Programme (SACEP), which outlines a shared vision for a 'healthy environment, resilient society and regional prosperity for the present and future generations' for the 2020 - 2030 decade.

SANH research programmes focus on the following four key areas:

a. Building the nitrogen policy arena for South Asia;
b. Testing options for improving N management, from agricultural practices to technological recapturing;
c. Studying the impact of nitrogen pollution on the key ecosystems, corals and lichens;
d. Building an integrated framework to look at nitrogen flows between land, water and atmosphere across the region.

1.2 What is the purpose of this report?

This report is part of SANH actions towards building the nitrogen policy arena for South Asia. It is specifically focused on the evaluation of current policies, progress and barriers across different scales within each of the eight countries. Our approach firstly looked at the regional scale[1] and now aims to focus on the individual country scale.

This report provides a necessary step to understand the current nitrogen policy landscape for India within the wider ambit of South Asia. National level reports of this kind are being prepared for each of the eight SACEP member countries but being a large country, Indian action is expected to have impact on regional trends.

The report is structured in the following way:

1. Issues and challenges around nitrogen pollution and management in India.
2. Nitrogen related policy analysis for India using SANH nitrogen policy dataset.
3. The drivers of emissions of reactive N and policy trends in India.
4. Stakeholder analysis
5. Case study overview into some significant nitrogen control policies.
6. Emerging issues
7. Recommendations
8. References
9. Supplementary material

[1] A joint publication by SACEP and SANH provides a regional overview of the nitrogen policy in South Asia (SACEP-SANH Report, 2022). A regional policy analysis on nitrogen has also been published (Yang et al., 2022). South Asia case studies on nitrogen will form part of a chapter in an International Nitrogen Assessment being prepared by the International Nitrogen Initiative (INI) to be published by Cambridge University Press, U.K.

1.3 Why focus on nitrogen pollution?

Utilising nitrogen, in its reactive form (N_r), has been essential for human development. Non-reactive elemental nitrogen predominant in the air we breathe, has been altered to reactive form (N_r) to produce chemicals, fertilisers, and other useful products. Agriculture depends heavily on N_r, with fertilisers, largely synthetic, making it possible to fulfil global food demands (FAO, 2021), but most of them are leaked as N_r into the air and water. Likewise, energy, transport and wider industry depends heavily on fossil fuels but emitting N_r as a by-product. It has been estimated that "global reactive nitrogen production has more than doubled during the last century as a result of human activity" (Galloway et al., 2008; Sutton et al., 2009).

Nitrogen pollution is the result of environmental accumulation of N_r compounds from human activities involving fossil fuels, fertilizers, and others beyond nature's capacity for restoration. They disrupt the natural nitrogen cycle, causing environmental damage. N_r compounds occur as gaseous air pollutants and include ammonia (NH_3), nitrogen oxides (NO_x), and nitrous oxide (N_2O), a potent greenhouse gas with up to 310 times higher global warming potential than carbon dioxide over 100-year period (IPCC/TEAP, 2005; Forster et al., 2007). N_r further causes water pollution in the form of nitrites (NO_2^-), nitrates (NO_3^-), and ammonium (NH_4^+).

The growing demands of sectors such as agriculture, transport, industry, and energy have given rise to sharp increases in the levels of nitrogen pollution and related greenhouse gas (GHG) emission (Sutton et al., 2019).

Figure 1. Threats from nitrogen pollution Source: Sutton et al., 2011

Five principal threats of nitrogen pollution are to water quality, air quality, greenhouse-gas balance, ecosystems and biodiversity (see Figure 1). The growing intergovernmental concern about these threats led to the first ever UN resolution on 'sustainable nitrogen management' from South Asia, initially led by India (UNEP, 2019) and followed up by Sri Lanka (UNEP, 2022).

Reductions in greenhouse gas (GHG) emissions are key to combating climate change, and a key area in international collaboration in the United Nations Framework Convention on Climate Change (UNFCCC). The Paris agreement, in 2015, is a legally binding international commitment to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels (UNFCCC, 2015). These concerns were reiterated in COP 26 with 'net zero' emission commitments by different countries. Nitrogen management is essential for international climate change mitigation actions. It is scientifically well-known but less recognized in policy matters that nitrous oxide (N_2O) produced by industry and combustion, is the third most important GHG after carbon dioxide and methane in terms of global warming potential.

1.4 How does reactive nitrogen (N_r) impact the environment and human health?

Environmental accumulation of reactive nitrogen (N_r) is not only a waste of a useful resource worth over $200 billion globally (Sutton et al., 2019, 2021), but also affects ecosystems, biodiversity, health and climate change (Figure 1). For example, the combined cost to ecosystems, climate and health was estimated at over €70 billion per year to the EU alone (Brink et al., 2011). Most of these costs were attributed to the direct/indirect impacts on human health.

Global Nitrogen emission maps reveal South Asia as one of the hotspots and India as the region's major contributor (Figure 2 to 5). Figure 2 illustrates the hotspots for nitrogen dioxide (NO_2), the main component of atmospheric NO_x pollution. Figure 3 illustrates the extent of nitrogen oxide (NO_x)

emissions across South Asia in 2015[2]. Direct and indirect exposure to NO_x can lead to respiratory issues including lung damage; the incidence of asthma attributable to NO_2 in children is growing globally, including in South Asia and India (Anenberg et al., 2022). These emissions are mainly from coal and diesel burning for power generation, industry, and transport. These activities also contribute to particulate matter (PM) emissions (Kegl, 2007). NO_x and ammonia are precursors of $PM_{2.5}$. Concentrations of NO_x and NH_3 further affect the chemical reactions that lead to $PM_{2.5}$ formation (Gu et al., 2021). A global study calculated NH_3 contributed to 32% of $PM_{2.5}$ pollution in 2013, and NO_x to 28% (Gu et al., 2021).

Rises in ammonia and nitrogen oxides were linked to global increases in deaths caused by $PM_{2.5}$. Reducing fertiliser inputs was identified as one of the key mechanisms to abate ammonia emissions (Gu et al., 2021). According to the World Health Organisation (WHO), many of the world's worst affected cities in terms of $PM_{2.5}$ pollution are in South Asia, accounting for the largest number of deaths and disabilities due to air pollution. Particle size is directly related to their potential for causing health problems. Fine particles ($PM_{2.5}$) can cause the greatest health risk (Goodkind et al., 2019). PM concentrations are argued to be higher in areas of growing populations undergoing fast urbanization and industrialization (Ji et al., 2018).

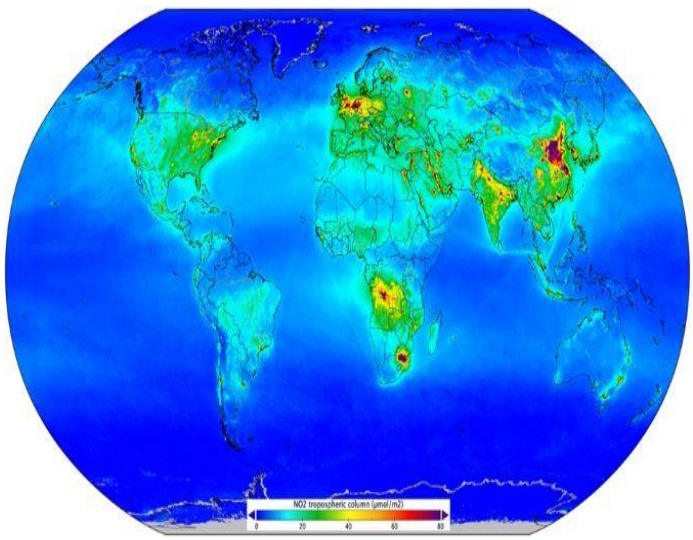


Figure 2: Global map of nitrogen dioxide (NO_2) atmospheric pollution
Source: European Space Agency (2019)
Note: Low levels of pollution are dark blue running to dark red for highest levels.

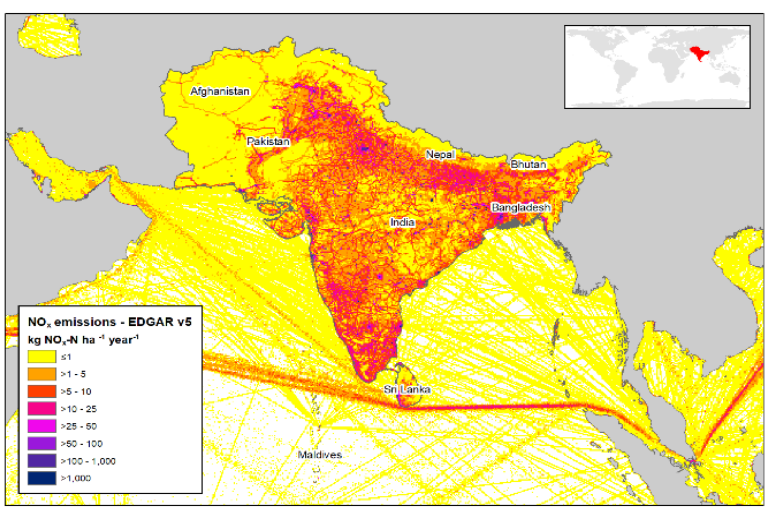


Figure 3: Nitrogen oxide (NO_x) emissions across South Asia, 2015
Source: SACEP-SANH (2022) p.17, Data sourced from Crippa et al., (2019a; 2019b) EDGAR v5.0 Note: The darker purple to blue colours indicate high concentrations of NO_x per hectare per year.

[2] Data sourced from EDGAR v5. https://data.europa.eu/doi/10.2904/JRC_DATASET_EDGAR

N_r can enter surface water and groundwater as a consequence of agricultural activity and the excess application of synthetic fertilizers and manures. In addition, wastewater treatment, diffuse pollution, discharges from industrial processes, and motor vehicles also contribute to N_r found in water systems. Exposure to nitrates in drinking water can be particularly harmful to infants.

Nitrogen pollution, in its reduced form, can occur in the air as ammonia (NH_3) and in the water as ammonium (NH_4^+). Ammonia (NH_3) is increasingly seen as problematic. The deposition of ammonia, both wet and dry, can lead to soil acidification, nutrient leaching, eutrophication, and ground water pollution (Erisman et al., 2013). Agricultural activities reportedly account for approximately 80%–90% of the overall anthropogenic ammonia emissions (Giannakis et al., 2019; Ma et al., 2021; Klimczyk et al., 2021). Ammonia (NH_3) is considered to be more harmful to ecosystems than nitrogen oxides (NO_x) especially when deposited in its dry form (Hicks, 2011). South Asia is a global hotspot for NH_3 emissions (Hicks et al., 2011), indicated in Figure 4. The extent of NH_3 emissions in South Asia are illustrated in further detail in Figure 5.

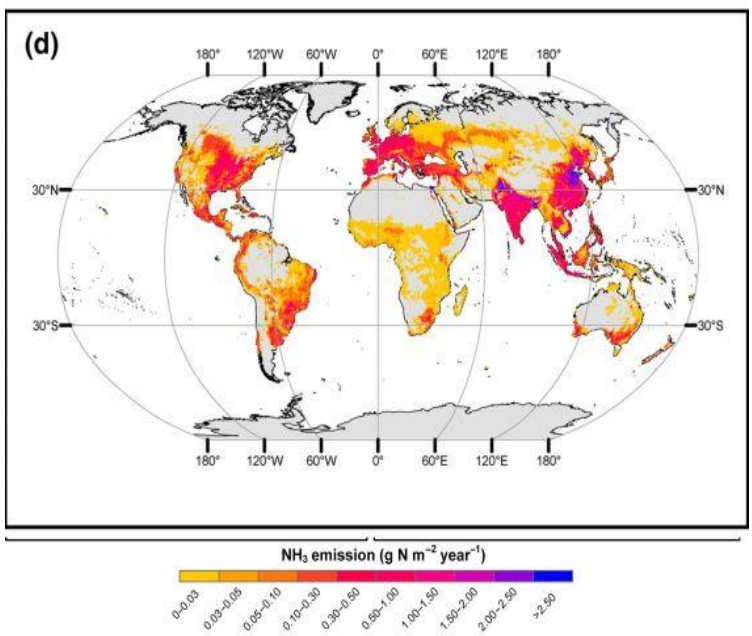


Figure 4: Global map of Ammonia (NH_3-) emissions
Source: Xu et al., (2019)
Note: this map is based on simulated ammonia emissions in response to application of synthetic nitrogen (N) fertilizer in the 2000s. Spatial resolution of 0.5 by 0.5 degree.

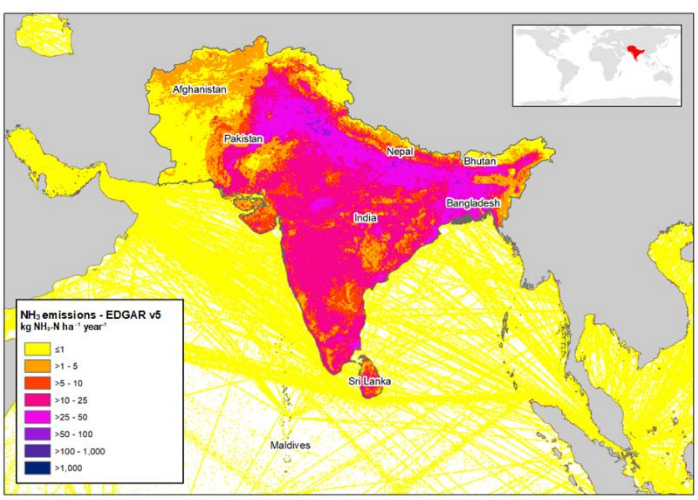


Figure 5: Ammonia (NH_3) emissions across South Asia, 2015
Source: SACEP-SANH (2022) p.24. Data sourced from Crippa et al., (2019a; 2019b) EDGAR v5.0

For nitrous oxide (N_2O) pollution, agriculture & wastewater have been identified as the source of the largest anthropogenic contributions globally. South Asia is one of the global hotspots (Tian et al., 2020).

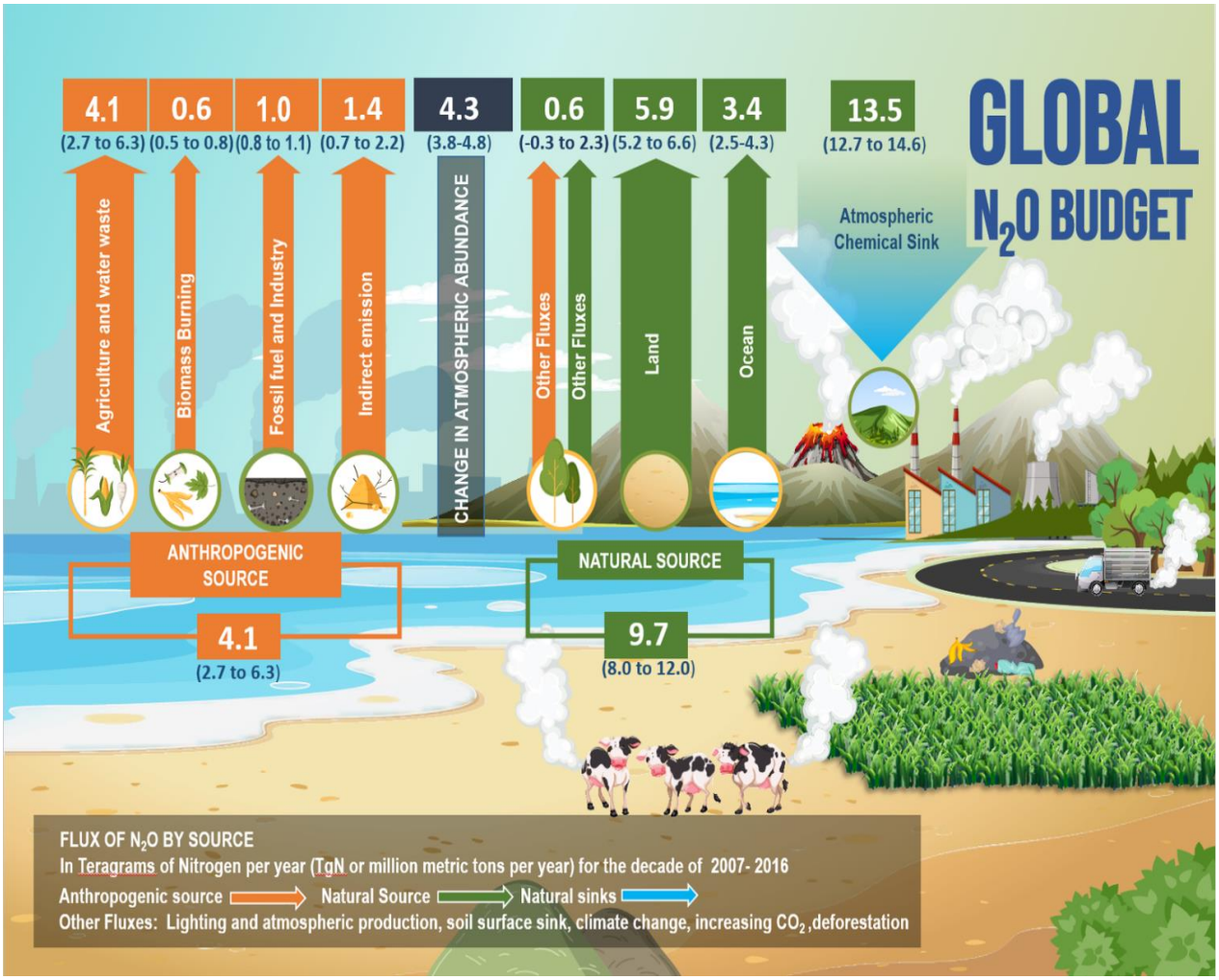
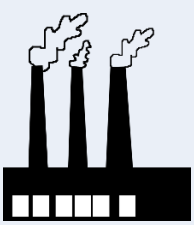


Figure 6: The global nitrous oxide budget with segregation of anthropogenic contribution. Adopted from Tian et al., (2020) and modified by the authors.

The direct and indirect environmental and health impacts of different nitrogen molecules are illustrated in Table 1. The table indicates where there are some overlaps between Nr emission sources and impacts, and unique different

Table 1. Overview of reactive nitrogen emissions and related environmental and health impacts.
Source: adapted from Erisman et al., (2013) and UNEP (2019)

Emission	Source	Benefit	Environmental and Health impacts
Nitrate (NO_3) 	Wastewater, agriculture and oxidation of NOx.	Widely used in fertilizer and explosives.	NO_3 forms particulate matter (PM) in air and affects health. In water it causes eutrophication.
Nitric oxide (NO) and nitrogen dioxide (NO_2)– collectively known as NO_x (nitrogen oxides) 	Combustion from transport, industry, and energy sector.	NO is essential for human physiology but NO_2 has no known benefit.	NO and NO_2 (or NO_x) are major air pollutants, causing heart disease and respiratory issues, e.g. asthma, respiratory disorder, inflammation of airways, reduced lung functions, bronchitis, and cancers.
Ammonia (NH_3) 	Manure, urine, fertilizers, and biomass burning.	NH_3 is the foundation for amino acids, protein and enzymes. Ammonia is commonly used in fertiliser.	NH_3 causes eutrophication and affects biodiversity. It forms particulate matter (PM) in air affecting health (See NO and NO_2 above). - modest odour contribution
Nitrous oxide (N_2O) 	Agriculture, industry, and combustion.	Used in rocket propellants and in medical procedures as anaesthetic.	Health impact due to global warming, often enhanced by eutrophication health impact due to loss of stratospheric ozone depletion. In addition, the enhancement of vectors for infectious diseases (e.g. malaria) and frequency of infestations (e.g. algae blooms, insects etc.

Ecosystem services[3] can be directly and indirectly affected by Nr. Impacts are further intensified via interactions with other anthropogenic changes, such as land use and climate change, along with other pollutants. For example, fertilizer runoff can cause freshwater eutrophication, leading to harmful algal blooms and dead zones, killing fish stocks, as visible in Figure 7.

Figure 7. Dead fish (white) floating in the Ganga River at Kanpur, UP, India.
Source: Prasad and Prasad (2019)

Whilst local sources of nitrogen pollution, such as air emissions and run off, contribute to local effects, they also can contribute to accumulations at regional o global scales (Erisman et al., 2013, Sutton et al., 2019). Nitrogen pollution does not respect country boundaries. Therefore, tackling nitrogen pollution requires trans-national cooperation. European countries took the early lead following the European Nitrogen Assessment (Sutton et al., 2011). This was followed by South Asian cooperation following the Indian Nitrogen Assessment (Abrol et al., 2017).

1.5 How can policy support sustainable nitrogen management?

Governments may take several legislative, financial or regulatory measures in order to manage nitrogen pollution directly and indirectly. Additionally, measures both through government and non-government can support and incentivise the management of nitrogen more effectively, minimising negative impacts. Multiple scales and actors also need to be considered in deciding how to target specific actions.

Traditional policy interventions that deal with nitrogen management can include (Dalgaard et al., 2014):

1) Command and control (C&C) i.e., the classic regulation type, where an action or pollution practice is forbidden by law, controlled by the authorities, and fined if in violation.

[3] Ecosystem services are defined as the ecological and socio-economic value of goods and services provided by natural and semi-natural ecosystems (Erisman et al., 2014)

2) Market-based regulation and governmental expenditure (MBR), for example, when the management of pollution behaviour is regulated via market incentives, typically via a green tax (e.g. N-taxation) under the 'polluter pays' principle (Carter, 2007) or when funds are provided to promote environmentally friendly behaviour.

3) Information and voluntary action (IVA); the promotion of sustainable N-management practices via knowledge production, communication, technologies as well as research and extension services. These actions may also be subsidised or funded by government(s).

Other measure for reducing nitrogen pollution requires the efficient use of nitrogen, particularly in agriculture (see box 1). Improving nitrogen use efficiency (NUE) in agriculture is becoming increasingly vital as global food demands are set to grow by 50% – 100% by 2050 (Connor et al., 2011; FAO, 2017).

Box 1. Nitrogen Use Efficiency (NUE) in agriculture

Agriculture is the economic sector with the highest nitrogen use; and the main source of Nr pollution (Van Grinsven, 2013). Nitrogen use in agriculture is often extremely inefficient; the global NUE of cereals decreased from ~80% in 1960 to ~30% in 2000' (Erisman et al., 2007). Highlighting that the majority of fertiliser applied globally is wasted, with NUE decreasing over time. NUE is further reduced when widened out to the entire food system.

Sutton et al., (2009) stated that:
"The global food chain has a mean nitrogen use efficiency of 14% for plant products and 4% for animal products (meat, dairy, egg). The remainder is dissipated into the environment … to air, and … to groundwater and surface waters."

By addressing NUE could provide a 'win-win scenario' argues Sutton et al. (2009). Studies have shown it could be both environmentally and financially beneficial. Improving NUE is focused on minimising damaging emissions of nitrogen whilst maximising the benefits gained (European Commission, 2013).

Improvements to NUE require changes to agricultural practices. Scientists argue that sustainable agriculture practices, especially those closer to the natural systems as the way forward. Such practices can include "reduced tillage, intercropping, broad crop rotation, cover crops, catch crops, green manures (including legumes), animal manures, effective use of crop residues, and landscape planning" to reduce Nr waste and increase NUE (Jarvis et al., 2011; Sutton and Billen, 2010; Van Grinsven, 2013). Yet any intervention can have drawbacks and the suitability will be site specific. Policy itself plays a crucial role in guiding actions towards more efficient and effective nitrogen management. Scientists are increasingly developing research and policy agenda to support sustainable nitrogen management (Udvardi et al., 2021, Yang et al., 2022; Raghuram et al., 2022).

Focusing measures can also be limited. Globally, most policies that aim to reduce N pollution in agriculture targeted only one scale, i.e., farm level (Kanter et al., 2020a). However, such policies on their own are inadequate, because N_r loss also happens beyond the farm. There are opportunities for intervention along the value chain, from fertilizer manufacturers, transportation, retailers, consumption, and wastewater treatment (Kanter et al., 2020a). One approach that takes this into account is 'the nitrogen circular economy'. This concept was adopted by the EU in 2015, aiming to maximise resource efficiency at all steps along the value chain (Sutton et al., 2019). Recently, nitrogen-related policies in South Asia have been analysed in the light of these findings (Yang et al., 2022).

Nitrogen pollution is not just an issue for agriculture. Addressing other sectors such as energy, waste, industry, transport, urbanisation, tourism, and more, are also vital for addressing the global N challenge. For example, tackling emissions of air pollutants from transport. National measures can include setting of limits or target values for ambient concentrations of pollutants, limits on total emissions (e.g., national totals) and regulating emissions from the traffic sector by setting emissions standards or by setting requirements for fuel quality (European Environment Agency, 2020). Localised measures may include low-emission zones in cities and congestion charges.

Figure 8 gives some examples of other measures that can promote clean air practices to reduce PM pollution. These are the 25 'most effective' measures listed by the Climate and Clean Air Coalition (CCA). Figure 8 indicates some existing measures, those with recent legislation, and those with further potential being implemented in Asia and the Pacific. Post combustion controls, clean cooking, industrial process emissions, along with emission standards for road vehicles are the measures indicated to have the most impact in reducing $PM_{2.5}$.

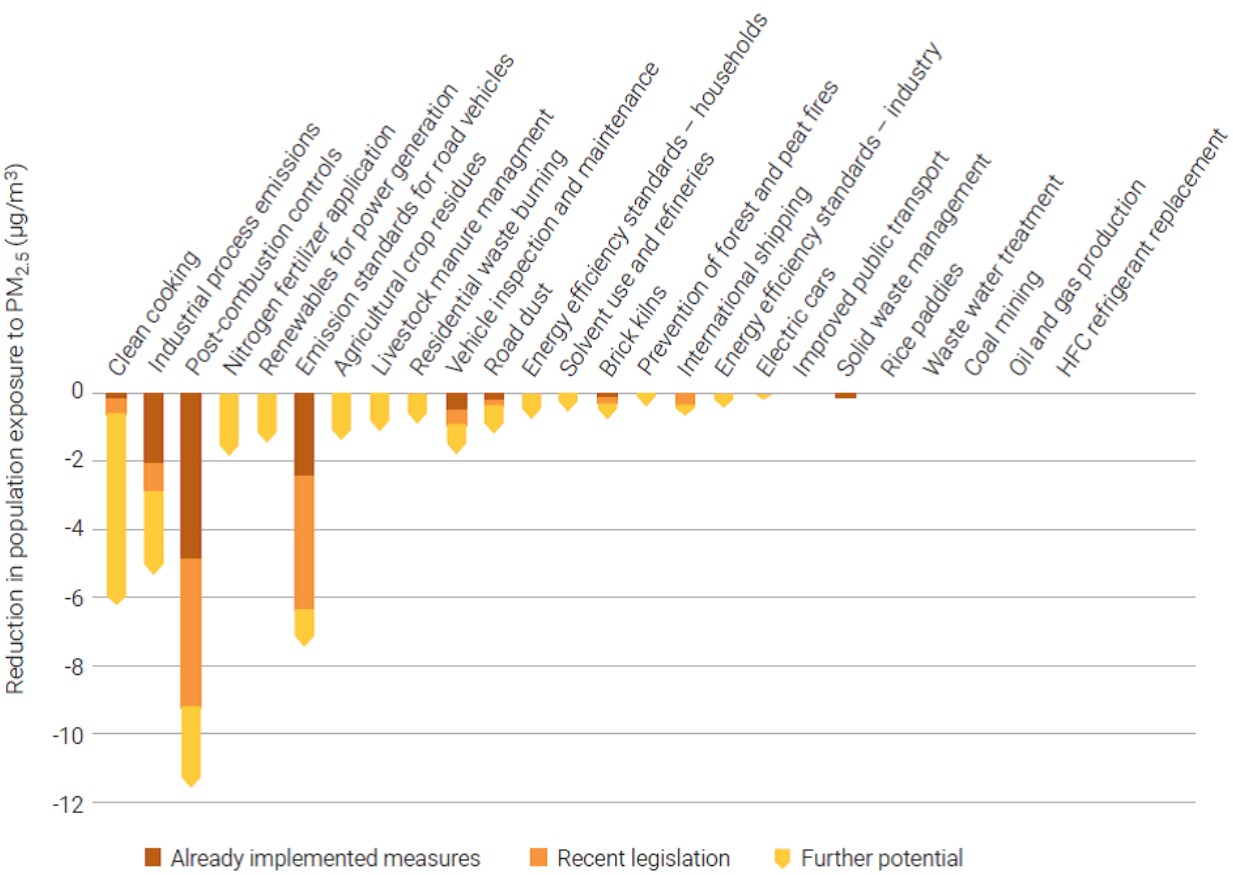


Figure 8: Impacts on population-weighted exposure to $PM_{2.5}$ in 2030 from implementation of 25 clean air measures, ranked by further potential.
Source: United Nations Environment Programme & Climate & Clean Air Coalition (2018)

1.6 Global and South Asia Policy events

The UNEP report (Sutton et al., 2019; UNEP, 2019) on 'emerging issues of environmental concern' states that nitrogen policies are fragmented, which is apparent, for example, in the Sustainable Development Goals (SDGs). The SDG indicators reveal that nitrogen is ''relevant almost everywhere but barely visible anywhere''. The exception is for the nitrogen related indicator associated with the SDG 14.1 on life below water. Proposals to adopt NUE or N losses into the SDGs have yet to be implemented.

Several international policy events in relation to nitrogen can be linked to activities in South Asia (Figure 9). They closely paralleled events led by the International Nitrogen Initiative (INI), established in 2003. INI's main goal has been to optimize nitrogen's beneficial role in sustainable food production and minimize nitrogen's negative effects (Raghuram et al., 2020, 2021). Collaborative efforts to tackle N_r have already been underway among scientists of the region with the efforts of the Indian Nitrogen Group since 2006, initially under the Society for Conservation of Nature, New Delhi, which hosted the 5th INI Conference in New Delhi and spearheaded the Indian Nitrogen Assessment (Abrol et al., 2017). In 2008, the South Asian Nitrogen Centre (SANC) was established as one of the seven INI centres in the world. It is currently hosted under the Sustainable India Trust (SIT), New Delhi, a UNEP-accredited NGO under the S&T Major Stakeholder Groups.

SANC is also a part of the Global Partnership on Nutrient Management (GPNM) involving governments, scientists, policy makers, private sector, NGOs and international organisations to respond to the 'nutrient challenge'. The GPNM is currently chaired by India and its secretariat is hosted under the UNEP Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (UNEP/GPA). This partnership has facilitated further international cooperation for research and policy on nutrients in general and nitrogen in particular, leading to the ongoing GEF-UNEP-INI project 'towards the establishment of an International Nitrogen Management System (INMS)' and led to further initiatives, including the formation of the UKRI-GCRF funded SANH. Several regional activities under these projects are co-led by the SIT in association with the SANC of the INI.

SANH works across the eight south Asian counties to reinforce and support effective nitrogen management through a coordinated and integrated approach in the region. Together with the intergovernmental South Asian Cooperative Environment Programme (SACEP), they facilitated the first ever resolution on Sustainable Nitrogen Management in the 4th UN Environment Assembly (UNEP/EA.4/L.16) piloted by the Indian government in 2019 (Raghuram et al., 2021). This was followed by the 'Colombo Declaration' (Sutton et al., 2021) and another resolution on 'Sustainable Nitrogen Management' led by the Sri Lankan government in the 5th UN Environment Assembly in 2022. They promoted the ambition to 'halve nitrogen waste by 2030' whilst highlighting the multiple benefits across all the UN SDGs.

Prior to these events in 1982, SACEP was established with the mission to promote regional co-operation in South Asia in the context of sustainable development. SACEP, amongst other actions, commissioned UNEP funded research on; ''Nutrient loading and eutrophication of coastal waters of the South Asian seas'' from the Society for Conservation of Nature, New Delhi. SACEP serves as another key mechanism for regional intergovernmental cooperation to tackle nitrogen waste.

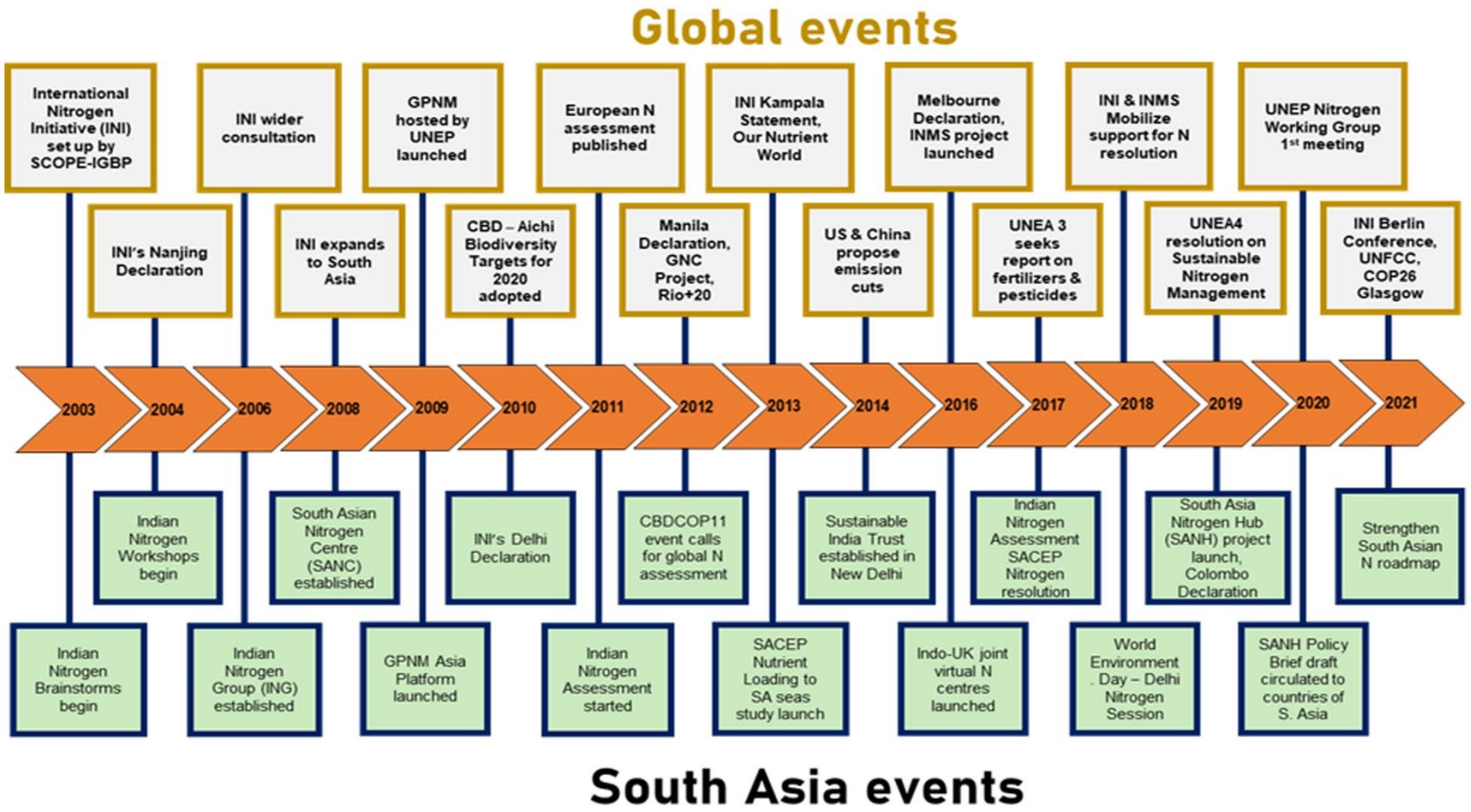


Figure 9: Timeline of global and South Asian developments toward global cooperation on sustainable nitrogen management
Source: Raghuram et al., (2021)

Prior to these events in 1982, SACEP was established with the mission to promote regional co-operation in South Asia in the context of sustainable development. SACEP, amongst other actions, commissioned UNEP funded research on; ‘‘Nutrient loading and eutrophication of coastal waters of the South Asian seas’’ from the Society for Conservation of Nature, New Delhi. SACEP serves as another key mechanism for regional intergovernmental cooperation to tackle nitrogen waste.

1.7 What do we know about nitrogen policies?

Nitrogen management is a major international policy issue and international policy actions are easier to track. Less is known about the nitrogen policy landscape at national levels (Kanter et al., 2020b). A limited understanding remains of how many nitrogen-related policies there are, what issues they address, and what types of instruments are used. In addition, how existing policies may inadvertently lead to increases in nitrogen pollution is also poorly understood.

An initial international assessment attempted to address this knowledge gap by creating the world’s first nitrogen pollution policy database. Kanter et al., (2020b) identified 2,726 policies across 186 countries derived from the ECOLEX database. Aiming to identify the gaps and opportunities in N policy around the world. Overall, their analysis revealed policy integration was limited and ill-equipped to deal with the cross-cutting nature of the global N challenge. Investigating the regional and country level implications of the N policy database has yet to be examined for South Asia and remains a core aim of SANH.

Policy fragmentation, and the lack of understanding on nitrogen-related policies and their trade-offs are barriers to being able to tackle the nitrogen challenge. This is one of the challenges that SANH aims to examine.

The present report is the first of its kind to provide a national overview on the extent of nitrogen-related policies for India. Included in its analysis are indirect policies that may not consider nitrogen in their formulation but potentially have implications anyhow for nitrogen management. By building a better understanding of the current nitrogen policy landscape both at the national and region level will support efforts to develop effective nitrogen management policies for the future.

2 COUNTRY LEVEL PROFILE AND PRIORITIES

2.1 Biophysical characteristics

India is located above the equator between 8°4' north to 37°6' north latitude and 68°7' east to 97°25' east longitude. With an area of 3,287,263 sq. km (1,269,219 sq. mi), it is globally the seventh-largest country. India measures 3,214 km (1,997 mi) from north to south and 2,933 km (1,822 mi) from east to west. It has a land border of 15,200 km (9,445 mi) and a coastline of 7,516.6 km (4,671 mi) (Supplementary Table, ST 1). Those long borders are shared with eight countries including China, Pakistan, Afghanistan, Nepal, Bangladesh and Myanmar through land border and Sri Lanka and Maldives through its maritime border.

The physical features of India can be grouped under the following physiographic divisions: (1) The Himalayan Mountains, (2) The Northern Plains, (3) The Peninsular Plateau, (4) The Indian Desert, (5) The Coastal Plains and (6) The Islands. Figure 10 illustrates the land cover of India. The country is administratively divided into 28 states and 8 union territories. These states and union territories are further subdivided into districts and smaller administrative divisions. New Delhi is the National Capital of India.

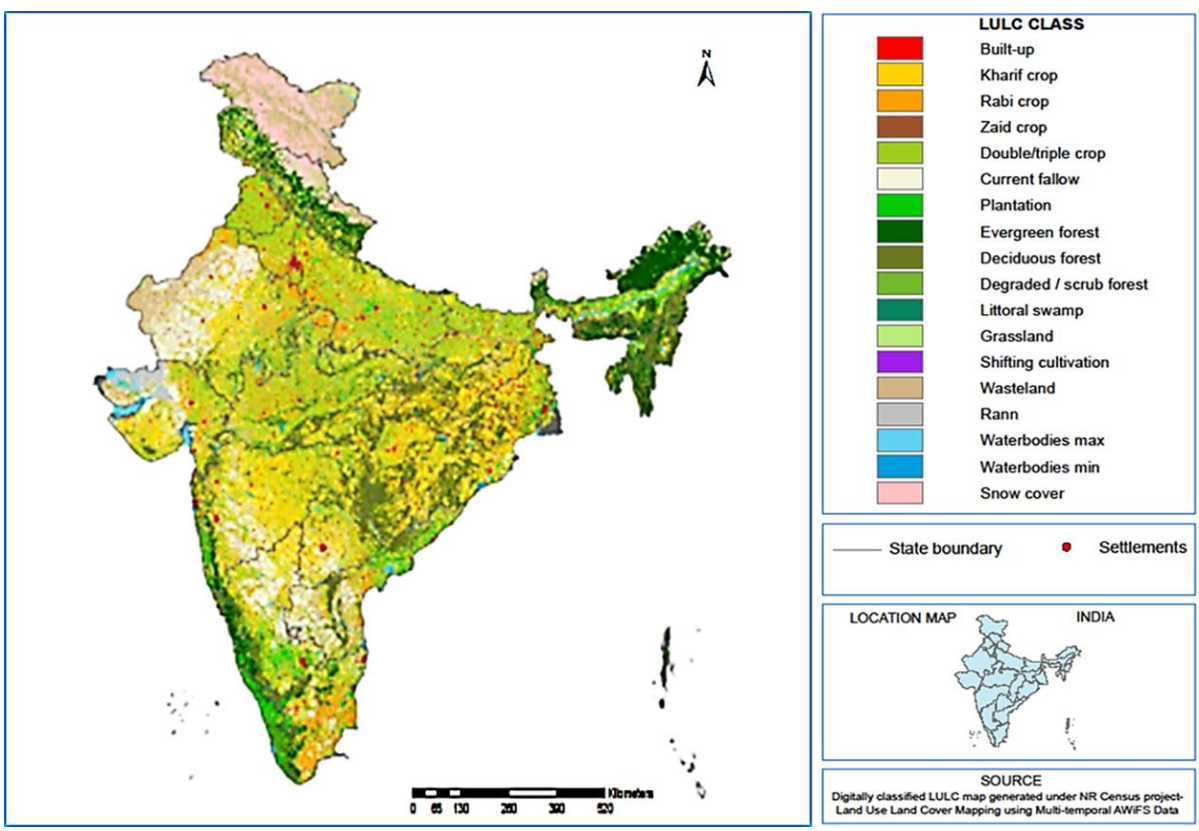


Figure 10: India Land cover map of 2018-19[4]

[4] Source: https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php

2.1.1 Climate

India's climate ranges from humid and dry tropical in the south to temperate alpine in the northern regions (Chang, 1967). Climate in the southern region is usually hotter and more humid than that of North India, due to South India's coastal areas. The southern half of the country does not experience temperatures below 10 °C (50 °F) in winter, and the temperature usually tends to exceed 40 °C (104 °F) during summer. The average rainfall in India is 120 cm per annum. The South-west monsoon constitutes 75% of the total rainfall between June to September, 13% of the rain by north-east monsoon from October to December, 10% of the rain by the pre monsoon cyclonic storms which occurs mostly in April and May and rest of the 2% by western disturbances from December to February. The North-Eastern India and the western coast annually receive over about 400 cm of rainfall, but it is less than 60 cm in the western Rajasthan, Haryana, adjoining parts of Gujarat and Punjab.

India's climate varies from humid and dry tropical in the south to temperate alpine in the northern reaches and has a great diversity of ecosystems. Four out of the 34 global biodiversity hotspots and 15 of the World Wildlife Fund's global 200 eco-regions fall fully or partly within India (Venkataraman and Sivaperuman, 2018). Having only 2.4 % of the world's land area, India harbours around 8% of all recorded species, including over 45,000 plant and 91,000 animal species.

India has the second-largest arable land resources in the world. With 20 agri-climatic regions, all the 15 major climates in the world exist in India. The country also has 46 of the 60 soil types in the world. India is the largest producer of spices, pulses, milk, tea, cashew, and jute, and the second largest producer of wheat, rice, fruits and vegetables, sugarcane, cotton, and oilseeds (Srinivasarao et al., 2021). Further, India is second in the global production of fruits and vegetables and is the largest producer of mango and banana. During 2019-20 crop year, food grain production reached a record of 296.67 million tonnes (Singh et al., 2020).

2.1.2 Topography

India is bordered by the mountains in the north and ocean in the south. The northern regions of India are defined largely by the Himalayan Mountain range. India's territorial waters extend into the sea to 12 nautical miles (13.8 miles, 22.2 km) from the coast baseline. India has the 18th largest Exclusive Economic Zone of 2,305,143 km^2 (890,021 sq. mi).

India has been divided into 25 Major River Basins and 103 sub-basins by the NASA-Shuttle Radar Topography Mission (https://earthdata.nasa.gov) (Supplementary Table ST 2). The total catchment area of these rivers is 25.3 lakh km^2, covering about 81% of the total geographical area of the country (Prasit et al., 2009). The Ganga-Brahmaputra-Meghna is the major river basin of India with the largest catchment area of about 11.0 lakh km^2 which is 43% more than the catchment area of all the major rivers in the country. The other major river basins including Indus, Mahanadi, Godavari and Krishna consist of catchment area of more than 1.0 lakh km^2. While the total catchment area covered by 46 medium river basins is about 2.5 lakh km^2.

2.2 Socio-economic background

India -- the world's second most populous country (population of 141.71 crore as of 2022) -- ranks as the fifth-largest economy by nominal GDP and the third-largest by purchasing power parity (PPP). As per World Bank data from 2022, its per capita GDP (nominal) is $2,466 and per capita GDP (PPP) is $8,293, and ranks 142nd and 125th, respectively, in these two categories[5]. 23% of the GDP is attributed to agriculture, which is the primary source of livelihood for 70% of the rural households, and 82% of the farmers' holdings are small and marginal.

Statistics in this paragraph come from the International Monetary Fund's (IMF) World Economic Outlook Database, Source: https://www.imf.org/en/Publications/WEO/weo-database/2022/October.

2.3 Environmental & health impacts of nitrogen pollution in India

As per the Indian Nitrogen Assessment (Abrol et al., 2017) published by the Society for Conservation of Nature (SCoN), agriculture is the primary source of nitrogen pollution in India, with cereals being the largest contributor[6]. Rice and wheat form the highest cropped area in India at 36.95 million hectares (ha) and 26.69 million ha respectively. According to Fertiliser Association of India's data, 20 million tonnes of nitrogen fertiliser were consumed in the country in 2020-21[7]. But only 33% of the nitrogen applied to rice and wheat through fertilisers is taken up by the plants in the form of nitrates (NO_3). The remaining 67% remains in the soil and seeps into the surrounding environment causing a cascade of environmental and health impacts.

N pollution adversely impacts soil health by reducing its carbon content in the long run, thereby defeating the very purpose of fertilisers. While fertilisers are the major emitters of N_2O in India, vehicular pollution (55.53 Gigagram), industrial and domestic sewage (15.81 Gigagram) are also causing the rise of the GHG in the atmosphere, according to a 2007 study[8]. Further, vehicular pollution is also a major contributor of NO_x, accounting for 32 % of the total emissions in India, out of which 28% is from road transport.

[5]Statistics in this paragraph come from the International Monetary Fund's (IMF) World Economic Outlook Database, Source: https://www.imf.org/en/Publications/WEO/weo-database/2022/October.
[6]Source: https://cdn.cseindia.org/userfiles/pollution.pdf
[7]Source: https://www.faidelhi.org/general/con-npk.pdf
[8]Source: https://www.iitr.ac.in/wfw/web_ua_water_for_welfare/water/WRDM/MOEF_India_GHG_Emis_2010.pdf

2.3.1 Nitrogen Emissions change and status in India

Gaseous N_r emission in India from 1970 to 2018, illustrated in Figure 11, shows that Ammonia, (NH_3), nitrous oxide (N_2O) and nitrogen oxides (NO_x) in India have been increasing from 1970 to 2018/2021. The rate of increase differs between the compounds as seen in Figure 11 and Table 2. Between 2000 and 2015 there was an emission increase of 40% for N_2O emission, 37% for NH_3 emission and 85% for NO_x. The EDGAR data reveals that for India NO_x is the most abundant N_r compound at 10,025Gg compared to NH_3 at 7,074Gg, and N_2O at 895Gg in 2018. The sector sources of nitrogen emissions are discussed further in section 6 of this report.

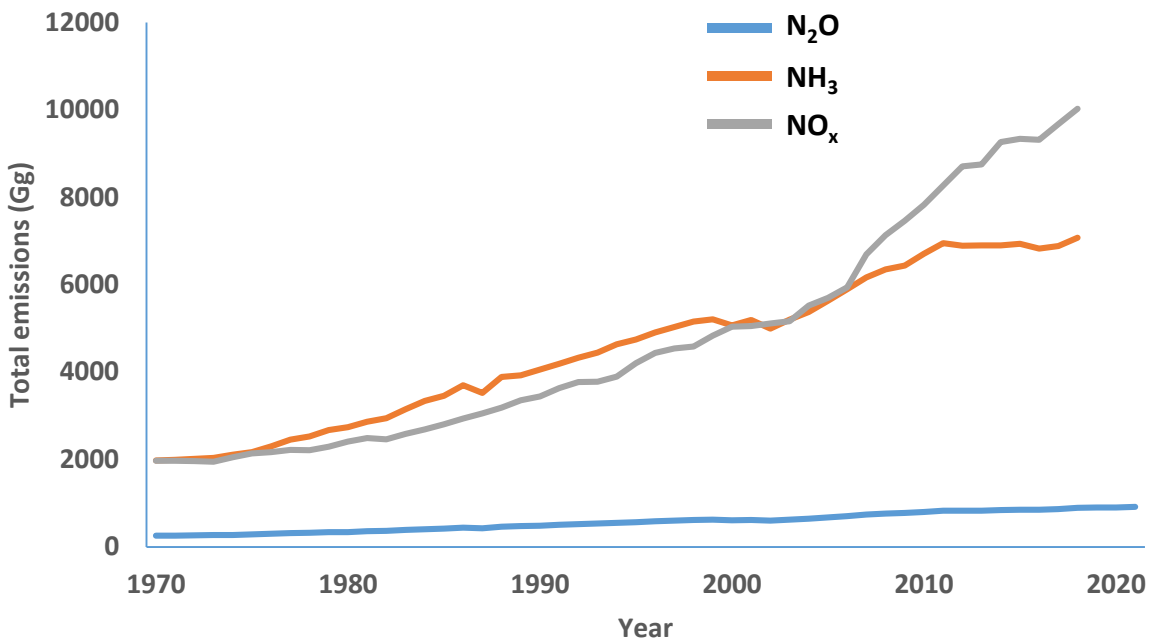


Figure 11: Reactive nitrogen emission trends for ammonia, (NH_3), nitrous oxide (N_2O) and nitrogen oxides (NO_x) in India from 1970 to 2018/2021
Data sourced by: Crippa et al., (2021) derived from EDGAR v7.0, and EDGAR v6.1 air pollutants, https://edgar.jrc.ec.europa.eu/dataset_ap61

Table 2: Changes in emissions of key reactive nitrogen compounds for India (2000-2015)

Reactive-N Compounds	2000	2015	2018	% Change (2000-15)	% Change (2000-18)
Ammonia - NH_3 emission (Gg/year)	5065	6934	7074	37	40
Nitrogen oxides - NO_x emission (Gg/year)	5040	9339	10025	85	99
Nitrous oxide - N_2O emission (Gg/year)	608	851	894	40	47

Data source: Crippa et al., (2021) derived from EDGAR v7.0, and EDGAR v6.1 air pollutants, https://edgar.jrc.ec.europa.eu/dataset_ap61

2.3.2 Air quality

India's most pressing problems in recent years is worsening air pollution due to the rising atmospheric burdens of various reactive nitrogen species. India's air quality has been deteriorating due to rapid urbanisation, industrialisation, and population growth. India is ranked third amongst all countries in the world with the worst air quality. 13 of the 15 cities from northern regions of India were the most polluted cities in the World (Dahiya et al., 2017).

The air pollution in India is not only a massive health and environmental concern, but also takes a huge economic toll. According to the Health Effects Institute, in 2015, over 1.1 million premature deaths in India were caused by air pollution (Lelieveld et al., 2015). In 2019, air pollution led to about 18% of all deaths in the country. In the same year, it resulted in an economic loss of approximately 1.4% of GDP. Air pollution has a severe negative impact across multiple sectors, including labour productivity and crop yields (Clean Air Fund, 2021).

The agriculture sector also contributes to air pollution. India has the second largest agro-based economy with year-round crop cultivation, which generates a large amount of agricultural waste, including crop residues. In the absence of adequate sustainable management practices, approximately 100Mt of a total 500Mt of crop waste is burned, as a quick disposal technique, every year in India, causing excessive particulate matter (PM) emissions and air pollution (Lan et al., 2022). In India, Lan et al., (2022) estimated 69,000 premature mortalities, were caused by crop residue burning, resulting in ambient $PM_{2.5}$. Crop residue burning has become a major environmental problem causing health issues as well as contributing to global warming (Bhuvaneshwari, 2019).

2.3.3 Water quality

Water quality in India as affected by pollution is a serious issue. India is currently rankest 120 out of 122 countries in the water quality index (Water Aid, 2019). It is estimated that 70% of India's drinking water is contaminated (Water Aid, 2019; National Institute for Transforming India, 2018). Water scarcity is also exacerbated by water pollution, as well as intensive agriculture, climate change and expanding populations (Jadeja et al., 2022). It has been projected that by 2030 40% of India's population will have no access to drinking water (Water Aid, 2019). Key sources of water pollution include domestic effluents and sewerage, inadequate sanitation facilities, and poor septage management. The treatment capacity for sewage, was extremely low in 2015, only 37% of the 62,000 MLD (million litres per day) of human waste that is generated in urban India being processed (Ministry of Urban Development, 2017). In 2017 the National Policy on Faecal Sludge and Septage (FSSM) Management was introduced to address issues of sanitation and septage management in India's cities and towns.

The agriculture sector also contributes to India's water scarcity issues through irrigation activities. Wheat and rice are recognised as being water resource heavy for their growth, rice is noted as the least water efficient grain and wheat has been a driver in increasing irrigation water stress (Water Aid, 2019). An alarming percentage of groundwater reserves are contaminated by various organic and inorganic pollutants. Agricultural activities generally degrade the quality of soil and groundwater due to extensive seepage and percolation of water containing pesticides and fertilizer residues (Srivastava 2020). They increase the nutritional content of water, thereby allowing organisms to flourish such as algae and other disease-causing microorganisms.

The Indian Nitrogen Assessment (Abrol et al., 2017) also noted that in parts of Punjab, Haryana and western Uttar Pradesh the nitrate (NO_3) concentration in dug well water and shallow bore-well water had exceeded the limits prescribed by the World Health Organization (WHO) by several times due to enhanced use of fertilizers. This was the worst in Haryana, where the average NO_3 content in well water was 99.5 mg/litre while the WHO limit stands at 50 mg/litre. Overall, in India, ground water nitrate

levels in 387 districts of 21 states have been found above the safety units of 50 mg/l and 45 mg/l prescribed by the WHO and Bureau of Indian Standards (BIS) for potable water. Further, contamination of coastal waters by organic wastes and nitrogenous fertilizer leads to coastal eutrophication causing hypoxic zones affecting aquaculture (mass killing of fish) as well as due to tourist traffic as has been noted in areas of Bay of Bengal and Arabian sea.

Annual water quality Data[9] is collected by the Ministry of Urban Development, Census 2011 and the Central Pollution Control Board (CPCB). as part of these measurements nitrate levels are also recorded. The Water (Prevention and Control of Pollution) Act was enacted in 1974 (amended in 1988 and 2003) to prevent and control water pollution.

2.3.4 Climate quality

India is reported to be the 48th most vulnerable country in the world to climate change (University of Notre Dame, 2019). Nitrogen emissions, via nitrous oxide (N_2O) are the third largest contributor to climate change after CO_2 and methane (Dunne et al., 2020; Tian et al, 2020). Reactive nitrogen species including nitrogen oxides (NO_X=NO+NO_2) and N_2O regulate greenhouse balance and contribute to global climate change on earth. N_2O is emitted from agriculture, land use, industrial activities and combustion of fossil fuels and solid waste. N_2O is the most important gaseous nitrogen having highest global warming potential with a CO_2 equivalent of 310 for a hundred-year timescale (IPCC/TEAP, 2005; Forster et al., 2007). N_2O has a long atmospheric lifetime, and it is estimated that it takes around 120 years to remove 63% of its initial emissions (Prather, 1998; Lassey and Harvey 2007; Wuebbles et al., 2009; Pauleta et al., 2019)

As per the current report of Ministry of Earth Sciences (2020), Government of India, India's average temperature has increased by about 0.7° C and the frequency of summer heat waves (April-June) over India is projected to be 3 to 4 times higher by the end of the twenty-first century. This may lead to amplified heat stress across the India particularly, over the Indo-Gangetic plains and Indus River basins. On the other hand, there is 6% decline in the summer monsoon precipitation (June to September) over India from 1951 to 2015 with notable decreases over the Indo-Gangetic Plains and the Western Ghats. A shift toward more frequent dry spells (27% more during 1981-2011 as compared to 1952-1980) and more intense wet spells has also been observed in the recent period during the summer monsoon season. The frequency of daily precipitation extremes with rainfall intensities exceeding 150mm per day increased about 75% during 1950-2015 over central India. Further, propensity of droughts has also exaggerated due to overall decrease in seasonal summer monsoon rainfall during the last 6-7 decades.

Temperature and rainfall are the two important elements of climate and play an important role in sustainable agriculture. Therefore, this fluctuating pattern of temperature and monsoon induced by climate change can have detrimental effects on crops in India. The whole of India climate is influenced by the monsoon. About 64% of the people of India depend on agriculture for their livelihood and the monsoon rains. Agriculture itself is largely based on southwest monsoons. Regional variations in monsoon climate help in growing various types of crops. Agricultural prosperity of India depends very much on timely and adequately distributed rainfall. If it fails, agriculture is adversely affected particularly in those regions where means of irrigation are not developed. Sudden monsoon bursts not only create a problem of soil erosion over large areas in India but can cause severe damage to crops. Unseasonal rainfall and hailstorms experienced in January 2022 impacted a lot the rabi crops like mustard, wheat, gram and potato in Northern states of India including Punjab and Uttar Pradesh. Significant damage was also noticed in the yield of potato crop due to late blight disease caused by waterlogged conditions because of unseasonal excessive rains in Rajasthan and Uttar Pradesh.[10]

[9]CPCB Water Quality Data: https://cpcb.nic.in/nwmp-data-2021/
[10]Source: The Economic Times, 23 January 2022;
https://m.economictimes.com/news/economy/agriculture/unseasonal-rains-and-hail-affect-rabi-crops-in-north-india/articleshow/89076956.cms)

The agriculture sector, with Fertilizers are the major N_2O emitters in India, but emissions are also contributed by energy production (57 Gg), and waste (16 Gg) in 2007, as reported by the Indian Network for Climate Change Assessment (2010). As per the recent study (Bansal et al., 2022) conducted under International Nitrogen Management Systems (INMS), N_2O emissions from direct fuel combustion in different energy sectors in India have also increased by more 100% from 1990-2017. This can produce enhanced radiative forcing affecting both temperature and rainfall patterns over time.

2.3.5 Soil

India represents a land of paradoxes due to the large variety of soils. The first soil map of Indian soils was prepared by Biswanath and Ukil in 1943. Subsequently, based on the soil classes using the US soil classification, a soil map of India indicates 11 major soil groups (Bhattacharyya et al., 2013). The largest soil groups were alluvial soils (30%) followed by red soils (27%) and black soils (17%). Under humid tropical environments, Indian soils, including the highly weathered soils, are potentially productive in terms of food production as evidenced by the growing self-sufficiency in food production and food stocks since independence. However, after the beginning of Green Revolution in 1960s, nitrogen imbalance in Indian soils (Abrol et al., 2017) due to the overuse of synthetic fertilizers to increase yield has degraded the soils physically and chemically by altering the natural microflora and increasing the alkalinity and salinity of the soil (Eliazer Nelson et al., 2019). In addition, due to excess nitrogen or nutrient input to recoup the nutrients removed from the soil during crop harvest, negative soil nutrient balances have also been reported for each of the 15 agro-climatic regions of India (Bhattacharyya et al., 2007).

2.3.6 Ecosystems

India has some of the world's most biodiverse ecozones and hosts three biodiverse hotspots: the Western Ghats, the Himalayas and the Indo-Burma region. These hotspots have numerous endemic species. More than 17,000 species of flowering plants have been recorded in India, which account for 6% of the total plant species in the world (Chitale et al., 2014). Augmented nitrate and ammonia levels in the atmosphere and their deposition over land surface affects the ecosystem to a great and increasing extent. One common change has been in the species diversity in the grasslands due to invasion of dicotyledonous weeds (Verma and Sagar, 2020).

Nutrient-rich water stimulates growth of aquatic plants and algae resulting in eutrophication. Indian ecosystems are, under severe threat due to rising nitrate and ammonia levels in the atmosphere and their deposition over land surface and in the water. Increased nitrate concentration in inland and marine waters can stimulate the growth of aquatic plants and algal blooms leading to eutrophication and hypoxia (lack of oxygen) causing the mortality of fish and other aquatic animals (Prasad and Prasad, 2019). There are many studies reporting algal blooms in inland waters of India including Udaisagar lake in Rajasthan (Vijayvergia, 2008), Dal Lake in Jammu and Kashmir (Ul Solim and Wanganeo, 2008), Upper Lake (Bhojtal) in Bhopal in Madhya Pradesh (Kundu et al., 2015), Chilika lake in Odisha (Sengupta et al., 2017) and in River Ganges at Varanasi (Singh and Choudhary, 2011). Triggered by algal blooms fish mortality has also been observed in many places in India. For example, large scale fish mortality has been reported in Usuru lake, Karnataka in 2005 and 2016 and in Kukurhalli and Karanji lakes in 2001 and 2014. Thousands of fish also died in Zoo lake and Sher Shah Suri Lake of Kanpur in 2016 and 2017 respectively. Recently, dead fish were also found floating at Kannauj and Bilhaur's Nanamau ghat and at Chaubeypur's Andimata and Pratapgarh ghats of the Ganges River at Kanpur (Prasad and Prasad, 2019). Martin et al. (2011) reported that anthropogenic nutrient loading (a six-fold increase in nutrient and chlorophyll levels during the last few decades) caused a change in the benthic diversity of the Cochin estuary, India followed by an invasion of opportunistic polychaetes under eutrophic conditions. The eutrophication in river Yamuna has also been accelerated due to enhanced nitrate loadings from industrial and agricultural run-off varying from 1.38-2.9 mg/l in summers and 1.51-3.1 mg/l in winters (Kaur and Singh, 2012).

3 NITROGEN-RELATED POLICY ANALYSIS

3.1 Brief methods overview

As part of the actions towards building 'the nitrogen policy arena for South Asia', nitrogen-related polices from South Asia were collected and analysed by SANH (Yang et al., 2022). For India, assessing nitrogen-related policies helps to identify the gaps and opportunities for managing nitrogen in the region. An analysis of this kind provides an initial starting point to understanding what policies are in place to help determine what is needed for the future to effectively and efficiently manage N_r. The policy assessment identifies what sectors of environmental sinks are focused on and what policy instruments are suggested and/or in place amongst other indicators for performance.

This regional work builds on from an initial global nitrogen policy assessment conducted by Kanter et al., (2020b). Their global database had a collection of 2,726 policies from across 186 countries derived from the ECOLEX database. We adjusted the data collection approach and used multiple online data sources. We added to the 61 policies from South Asia identified by Kanter et al., (2020b), from ECOLEX and created a new SANH policy database with a total of 966 mostly national based policies for South Asia. The policies were collected during 2020-2021. Policies collected and classified in this first round were mostly national level policies and those active as of 2019, resulting in a total of 192 policies.

For India a second policy collection was conducted in 2021, which focused on state level policies, and national level policies published post 2019. This second collection round led to an additional 114 policies, therefore a total of 306 policies for India. See Table 3 for the overview of nitrogen-relevant policies collected per country. Indian nitrogen-related policies contribute to 28% to the overall policies collected for South Asia. The additional policies collected for India increased the total number of South Asia nitrogen-related policies to 1,080.

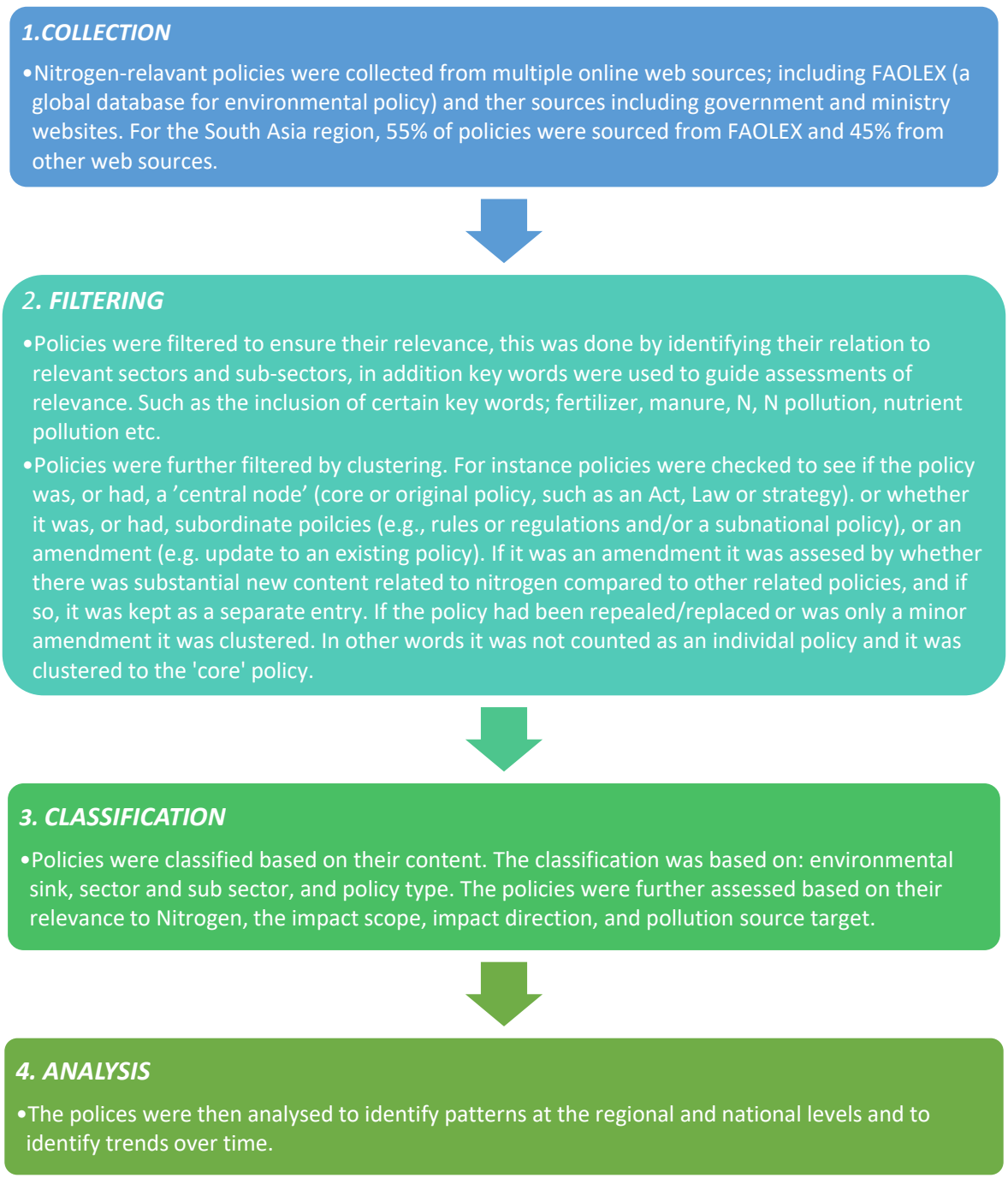
Table 3. Total Number of policies and percentage per country in the SANH database, breakdown by policy data source, and relevance and impact scope

Countries	SANH database 2019 & India database 2021 total No. of policies	% of total database	SANH database 2019 & India database 2021		SANH subset policies high-medium relevance and large-medium scope
			Source		
			Policies sourced from FAOLEX	Policies sourced from national websites	
Afghanistan	89	8	79 (7%)	10 (1%)	58 (5%)
Bangladesh	187	17	67 (6%)	120 (11%)	119 (11%)
Bhutan	60	6	31 (3%)	29 (3%)	38 (4%)
India	306*	28	173 (16%)	133 (12%)	197 (18%)
Maldives	40	4	20 (2%)	20 (2%)	29 (3%)
Nepal	108	10	63 (6%)	45 (4%)	65 (6%)
Pakistan	175	16	136 (13%)	39 (4%)	98 (9%)
Sri Lanka	115	11	61 (6%)	54 (5%)	106 (10%)
South Asia Total	**1080**	**100**	**630 (58%)**	**450 (42%)**	**710 (66%)**

Source: SANH Database 2019 which includes policies from FAOLEX listings (http://www.fao.org/faolex/en/) and other policy sources (total 966).
Note: An additional 114 policies were collected for India in 2021. These have been added to those from the SANH database 2019 (to a total of 1,080).

The policy documents collected include Legislation, Acts, Laws, Ordinances, Plans, Strategies, Regulations, Statute, Standards, Rules, Orders, Codes, Frameworks, and Guidelines. To ensure coverage of all nitrogen-related policy documents, relevant sectors and sub-sectors were identified: agriculture, land use, environment, human health, marine, urban development, water and waste management, transport, energy, and industry. Within each country the responsible ministries and commissions for these sectors were also identified to assist the policy searches. For instance, not only Ministries such as Chemicals and Fertilizers but also the less obvious Ministries such as Health. The policies were then filtered, classified, and analysed. The nitrogen policy assessment methods adopted by SANH is outlined in Figure 12.

Figure 12: An overview of the nitrogen policy assessment methods adopted by SANH.



3.1.1 Policy Classification

The nitrogen-related policies collected were classified based on certain characteristics to identify patterns in the types of polices in place for each country. Policies were classified by *environmental sink, sector, sub-sector, policy type, pollution source type, impact direction, impact scope, relevance* and *impact scope*. The classifications list is provided in Table 4. The classification approach followed closely to the global study approach used by Kanter et al., (2020b), with additional classifications and some modifications. For classification definitions see supplementary table ST 3.

Table 4. SANH nitrogen–relevant policy classifications

Categories	Classification	
Sink	Air; water; soil; climate; ecosystem; multiple; no sink included	
Sector	**Main sector**	**Sub sector**
	Agriculture	Synthetic fertilizer Manure management Crop residues Organic farming Livestock Aquaculture Agriculture other
	Waste	Municipal waste Industrial/ commercial waste Flood water Medical waste Organic waste
	Food	Food safety Food security Food waste
	Energy	Low carbon and renewable Non-renewable energy Biofuel and bioenergy
	Transport	Road transport Aviation Rail Maritime & inland water transport Transport other Biomass burning
	Land use change	Forestry Other land use and land use change
	Industry	
	Urban development & tourism	
	Other	
	Multiple	
	No sector included	
Policy type	Regulatory; economic; framework; data & methods; research & development (R&D); commerce; pro-nitrogen	
Pollution source type	Point source; non-point source; both; unspecified; non-applicable	
Impact direction	Positive; negative; mixed / neutral	
Impact scope	Large; medium; small	
Relevance	High; medium; low	

3.2 India nitrogen-related policy analysis

In this section all the collected Indian nitrogen-related policies, a total 306, are analysed according to the classifications outlined (listed in Table 4). For access to the India policy 2021 database, that all the results in section are derived (Appendix 3).

3.2.1 Relevance & scope

The nitrogen-related policies were classified according to their relevance and impact scope. These classifications were helpful for filtering policies with direct and indirect relevance to N_r management. Table 5 illustrates the number of policies and percentage classified as high, medium, and low relevance for N_r management. We defined directly relevant policies (those with 'high' relevance) by whether they featured one or more of the 29 key words in the policy text.

Table 5. Number and percentage of nitrogen-related policies in India for policy relevance and impact scope

Relevance			Impact scope		
Relevance	Total No. of policies	% of policies	Impact scope	Total No. of policies	% of policies
High (direct)	205	67	Large	150	49
Medium (indirect)	29	9	Medium	73	24
Low (indirect)	72	24	Small	83	27
Total	306	100	Total	306	100

A total of 205 policies (67%) were classified with direct and 'high' relevance for India. Such policies included, for example, the 'New Urea Policy 2015' which promotes the use of neem coated urea and the 'Nutrient based subsidy regime (NBS Policy) 2010 -2019' which promotes the provision of subsidy on the fertilizers fortified with secondary and micronutrients. It should be noted however that whilst there is a high number of policies that have high relevance to N_r management, by relating to water quality, air pollution or climate change for example, it was rare for policies to include an explicit reference to nitrogen (or its related compounds) itself. The majority of policies do not explicitly state an awareness of the direct role nitrogen plays in contributing to pressing environmental issues.

Indirectly relevant policies with 'medium' relevance, contain none of the 29 key words but may feature synonyms of those words. We also expanded the list of related words for guidance on selecting such policies. Indian policies classified with medium relevance covered about 29 policies (9%) including, for example, 'National Jute Policy 2005', 'National Urban Livelihoods Mission 2011', and 'National Steel Policy 2017'.

Policies with 'low' relevance were identified as the policies having presumed indirect links with N_r due to their association with a certain sector(s) and/or sink(s). A total of 74 policies (24%) were classified with low relevance, including, the 'National Seeds Policy 2002' and 'National Food Security Act 2013'. Although such policies had no direct reference to nitrogen they remained in our collection as they could still have implications on N_r management. For example, seed policies are relevant due to their impacts on yield which may influence agro-management decisions including fertiliser use. Likewise, the 'Food Security Act' influences drives for increasing crop productivity which in turn can affect the agricultural input amount.

Table 7 also illustrates the number and percentage of policies, classified as large, medium and small for impact scope. Impact scope gives an indication of a policy's spatial coverage and its pertinence for N_r management. For example, a total of 150 policies (49%), were found to have a 'large' scope mainly included national level policies that have the potential to influence many people and more directly relevant to N_r management, such as the 'Environment (Protection) Act 1986' and 'National Clean Air Programme 2019'. 73 policies (24%) classified with 'medium' impact scope were mainly the sub-national policies, or the policies with less direct relevance (or reference) to nitrogen, such as the 'Mid-day meal rules, 2015' and 'Agriculture Export Policy, 2018'. The 83 policies (27%) with 'small' impact scope either focused on a very specific location or zone or were nationwide but with distant consequences for N_r management. These include, for example, the 'National Urban Health Mission 2013' and 'Smart Cities Mission 2015'.

3.2.2 Policy Types

Policy type, as a classification category, indicates what type of policy instruments are being suggested or applied within a particular policy. A single policy may have multiple policy type characteristics e.g., framework, data and methods and research and development (R&D). For India there were 531 classifications from the 306 policies and 172 policies (56%) had more than one policy type identified. Policies with multiple instruments are favourable since they indicate a more comprehensive approach.

Figure 13 illustrates the percentage of nitrogen-related policies in India by policy type. The most common classification for policy type is framework (46%) which covers the policies with broad objectives and/or designated governing bodies for example the 'National Biodiversity Action Plan 2008'. The next most common classification is regulatory (21%), followed by data and methods (11%) policy types. The least common policy types featured in the dataset were economic (7%), research & development (7%), commerce (6%) and pro-N (2%). An example of a commerce policy is 'Fertiliser (Control) Order 1985 (*Amended in 2013)'. A pro-N policy includes the 'National Agricultural Policy 2000'.

Regulatory and economic policies are 'core nitrogen policies' as outlined by Kanter et al., (2020b) as they directly address nitrogen production, consumption or loss in a measurable way'. A regulatory policy includes the 'Water Quality Monitoring Order 2005' for example, and an economic policy example includes the' Scheme for Faster Adoption and Manufacturing of (Hybrid &) Electric (FAME) Vehicles in India, 2015'.

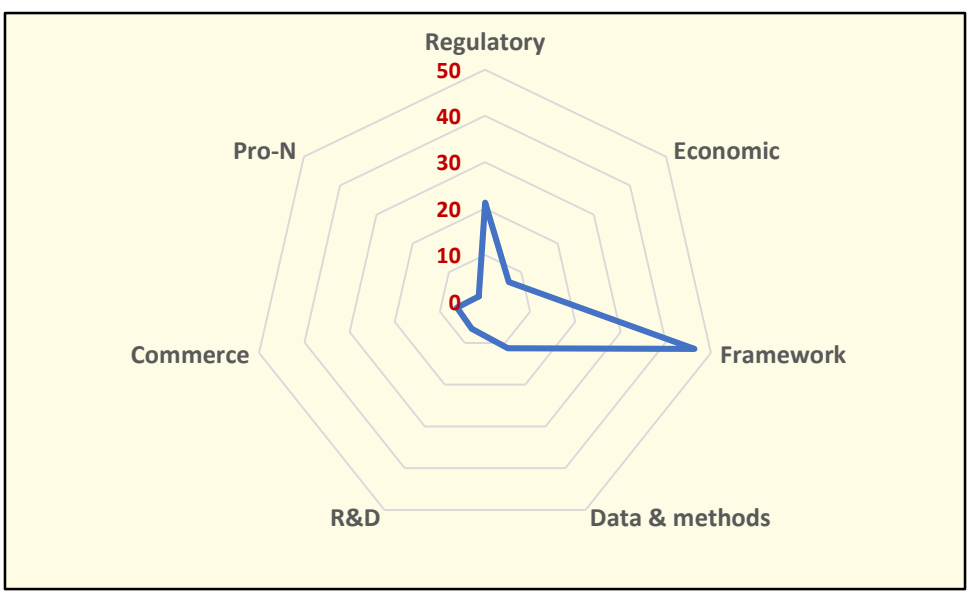


Figure 13: Spider web diagram of the percentage of nitrogen-related policies in India for policy type (Detailed data in Supplementary Table ST 4)

3.2.3 Economic Sector and sub-sectors

Figure 14 provides the percentage of India's nitrogen-relevant policies broken down by sector. The agricultural sector has the maximum number of policies (60) covering about 19% of total policies collected for India. The 'Organic Farming Policy, 2005' and the 'Doubling Farmers Income Policy, 2017' are some of the important policies of this sector. The second most common classification was the multiple sector policies (19%). Policies targeting the multiple sectors are considered favourable as intersectoral and multisectoral policy approaches are crucial for N_r management.

The land use change sector was the third most common sector type featured (13% of policies). The other main sectors featured only as a small percentage of the overall policy collection (ranging from 3% to 10%). Lastly, only 10% of policies did not include a reference to any sector, i.e., these policies are focused only on one or more environmental sinks. These sink-oriented policies are still considered important and positive because they focus on environmental protection and sustainability issues. For instance, non-sector-oriented policy includes the 'National Tribunal Act, 2010' which plays a vital role in framing and implementing measures to combat crop residue burning by the agriculture sector, thereby, controlling N_r emissions released.

The main sectors were further divided into sub-sectors (see Table ST 5) to delineate the policies with a more specified focused sector. Non-applicable was the most commonly observed sub-sector as it is a default category for policies that specify only a main sector, with no sub-sectors listed, or for policies that are generalised and do not refer to any specific area. The next most common sub-sector classification was the 'forestry' (8%) that encompasses the policies specifically focused on land use change such as the 'National Forest Policy 1988 'and the 'National Agroforestry Policy 2014'. The next most common category was the multiple at 7%. The policies covered under rest of the sub-sectors were small in number with ≤5% policies.

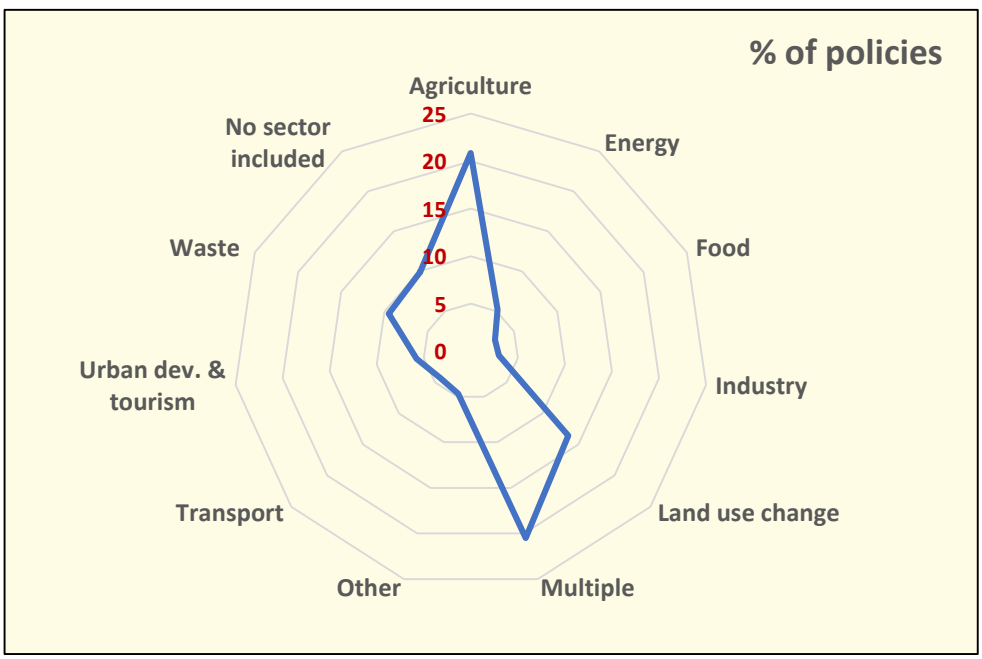


Figure 14: Spider web diagram of the percentage of nitrogen-related policies in India under various sectors and sub sectors (Detailed data in Supplementary Table ST 5)

3.2.4 Environmental Sinks

The classification for environmental sinks indicates if a policy is oriented in its objectives/intent towards either climate, water, air, soil, and/or ecosystems.[11] As a category, sinks can also reflect the environmental aspect at risk (under threat) from N_r. A policy may refer to more than one sink and, if so, would be classified as multiple.

[11]See Table ST 3 for classification definitions.

For India the most common classification was where 'no sink' had been included in the policy text (40%) (Table 6). In other words, almost half of the policies collected were purely sector oriented. This is regarded as an unfavourable characteristic in policies as it indicates that such policies have not considered the potential risks, or options to mitigate negative N_r environmental impacts. This included policies such as the 'National Rehabilitation and Resettlement Policy 2007' and 'National Action Plan on Antimicrobial Resistance 2017'.

Table 6. Number and percentage of nitrogen-related policies in India for environmental sinks

Sink	No. of policies	% of policies
Air	19	6
Climate	8	3
Ecosystem	33	11
Multiple	64	21
Water	58	19
Soil	1	0
No sink Included	123	40
Grand Total	**306**	**100**

However, the next most common classification was for multiple sinks (21%). This is considered a highly favourable characteristic as these policies address two or more sinks. Policy examples include the 'Environment (Protection) Act 1986', a policy which addresses air, water, and ecosystems, and the 'National Policy for Farmers 2007' that deals with all five sinks listed.

Water, as a single sink, was the most commonly featured (19%), including for example the 'Water (Prevention and Control of Pollution) Act 1974' and 'Water Quality Monitoring Order 2005'. The other most common single sink focused policies included ecosystem (11%), then air (6%) and climate (3%). Only 1 policy featured soil as a single sector, this could be considered a surprisingly result considering the importance of soil in N management.

3.2.5 Pollution source type

Pollution source was introduced as a new classification by the SANH team. Policies that are directly relevant to N_r and concerned with environmental protection should aim to target and mitigate against N_r pollution effectively by recognising the difference between pollution type sources. Point source and non-point source (NPS) pollution involve different challenges and different mitigation measures needed to address them. The number and percentage of nitrogen-related policies in India for pollution type source are illustrated in Table 7.

Nitrogen pollution released as a 'point source' refers to whether it is discharged directly into water or into the atmosphere at a 'discrete point', making it easier to control and monitor. 42 (14%) policies in our collection were identified as 'point source' e.g., the "Air (Prevention and Control of Pollution) Act, 1981 and 'National Urban Transport Policy 2006'.

NPS covers N_r pollution that comes from various land, air and/or water sources and can be carried overland, underground, and/or in the atmosphere, making it difficult to measure and control. Table 7 indicates 21 (7%) policies were identified as having targeted and noted NPS, like the 'National Policy for Management of Crop Residue 2014' and 'National Clean Air Programme 2019'. Although an environmental policy should recognise either point source or NPS, it is even more advantageous to consider both. This indicates a more comprehensive understanding of how N_r pollution can enter systems, recognising that different approaches needed to tackle them. Both the pollution type sources were the second common classification (26%) within this category.

However, 61 policies (20%) specified neither point source nor NPS. This could be a disadvantage for a policy's ability to support sustainable N_r management. The 'Biological Diversity Act 2002' and 'National Action Plan on Climate Change 2008' were some of the examples classified as unspecified. Such policies could be amended to consider types of pollution sources, as appropriate. Non-applicable (NA) was the default classification for policies classified with a negative impact direction, and/or as having an indirect relevance to nitrogen these formed 33% of the total policies

Table 7. Number and percentage of nitrogen-related policies in India for pollution source type

Pollution type source	No. of policies	Percentage of policies (%)
Point source	42	14
Non-point source (NPS)	21	7
Both pollution type sources	81	26
Unspecified	61	20
Non-applicable (NA)	101	33
Total	**306**	**100**

3.2.6 Impact direction

'Impact direction' was introduced by the SANH study as a new classification to indicate whether a policy was presumed to have a positive, negative or mixed/neutral impact on N_r pollution. It is worth highlighting that this is based on the assessment of the policy text. Evidence of actual policy impacts on N_r, whilst outside the scope of this study, would be necessary to determine how those policies work in practice. All the policies require further scrutiny to determine their effectiveness linking proposed objectives to actual impacts. The number and percentage of India nitrogen-relevant policies for impact direction are illustrated in Table 8.

For India it was encouraging that 70% of policies had a presumed positive impact and therefore 'might' have promoted a reduction in N_r pollution and/or improved nitrogen management whether directly or indirectly (Table 8). However, actual impact of these policies needs to be verified in real terms. Under this positive impact direction classification included environmentally oriented policies such as the 'Environment (Protection) Act 1986' and 'Organic Farming Policy 2005'.

Only a small number (2%) of policies were found to have a potentially negative impact, i.e., where environmental considerations were absent from the policy text. This is an unfavourable policy indicator as policies may have the potential to increase N_r in the environment by increasing nitrogen waste. A policy classified with a negative impact includes the 'Sagar Mala Programme/Scheme 2015'.

Table 8. Number and percentage nitrogen-relevant policies in India for impact direction

Impact direction	No. of policies	Percentage of policies (%)
Mixed /neutral	85	28
Negative	5	2
Positive	216	70
Grand Total	**306**	**100**

The classification for 'mixed/neutral' identified policies that may have both positive and negative impacts, e.g., a policy that aims to enhance food production and increase fertilizer access but also considers the environmental impacts, or a policy that has potentially neutral impacts (i.e., neither positive nor negative). About 28% of all policies were classified as mixed/neutral, a classification that covers a wide range of policies. Notably those policies include those that may, or may not, lead to sustainable N_r management. Examples of such policies include the 'National Fisheries Policy 2020' and the 'National Action Plan for Tourism 1995'. Further assessments of the mixed/neutral policy group would be needed to identify how far these policies could achieve sustainable outcomes.

4 CROSS COMPARATIVE ANALYSIS OF NITROGEN-RELATED POLICIES

In this section, the policies are cross compared for the combinations including sink and sector, sink and policy type, sector and policy type, to identify their strengths and weaknesses in promoting sustainable N_r management.

4.1 Policy by sink and sector

Figure 15 illustrates the heatmap[12] of the sink and sector policy results. The most common combination was for sector-specific agricultural policies that do not refer to any sinks (13%) (for full data see Table ST 6). Policy examples include the 'Fertiliser (Control) Order 1985' and 'New Urea Policy 2015. Any policies focused on a single sector that overlook sinks would benefit from further review and possible adjustments to mitigate negative environmental impacts. The second most common combination is land use change sector with ecosystem sink at 9%. These policies would also benefit by considering potential impacts on other sinks to avoid negative externalities. This combination includes policies such as the 'National Forest Policy 1988' and 'National Agroforestry Policy 2014'.

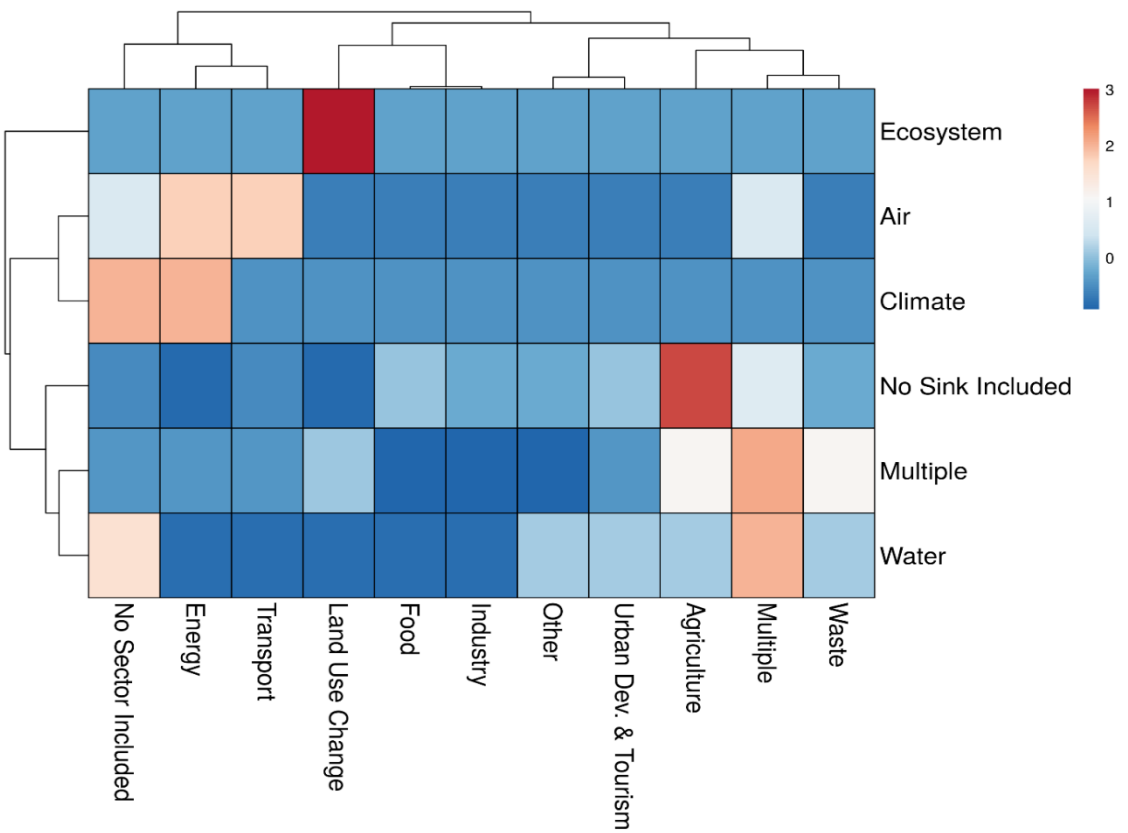


Figure 15: Heatmap diagram of nitrogen-related policies by sink and sector, from India
Detailed data is available in Supplementary Table ST 6.
Note: Red/3 = high values and blue/0 = lowest values

[12]A heat map is a data visualization technique that shows magnitude of a phenomenon as colour in two dimensions. The red coloured cells represent combinations of the two classifications with higher values (the most common classification) relative to blue which represent classification combinations with relatively low numbers (least common).

4.2 Policy by sink and policy type

Environmental sink classified policies are cross compared by Policy type, illustrated in Figure 16 (for full data see Table ST 7). The heatmap indicates that policies classified as 'framework' for policy type are the most common for all sinks, but especially for ecosystems, air and climate, multiple sinks (10%) and where no sinks are included (19%).

Water sink had a higher percentage of combinations with regulatory (7%) and framework (7%) policy types as compared to others. Multiple sinks with regulatory (6%) and ecosystem sink with framework (6%) policy types were also common. Those policies with multiple sinks and having multiple policy types would be considered better suited for N_r management as they are considered to have more integrated objectives and approaches.

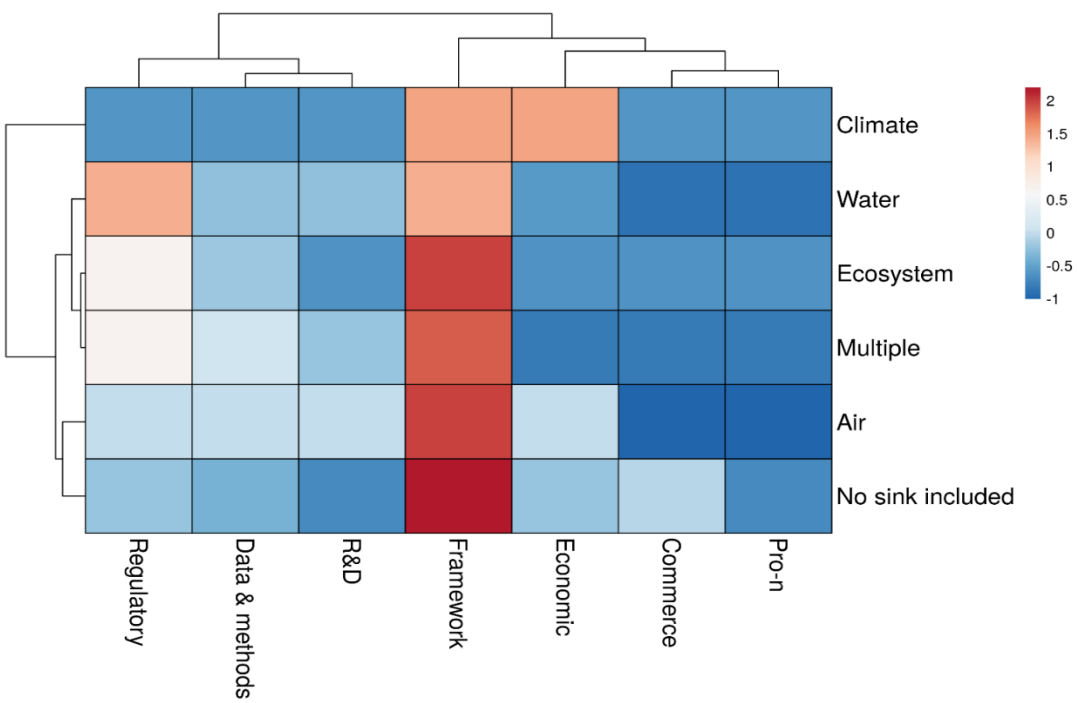


Figure 16. Heatmap diagram of nitrogen-related policies by sink and the policy type from India
Detailed data is available in Supplementary Table ST 7.
Note: Red/3 = high values and blue/0 = lowest values

4.3 Policy by sector and policy type

When sector and policy type classifications are cross compared, we can also see how prominent framework policy characteristics are, prevalent throughout all the sectors, see Figure 17 (for full data see Table ST 7). Agriculture in relation to 'framework' type policy features as the most frequent pair (9%). The category for 'multiple' sectors was also more commonly linked to certain policy types including, framework (8%) and regulatory (4%). As with sinks, the majority of other combinations between policy type and sector indicate a low percentage (≤ 5%).

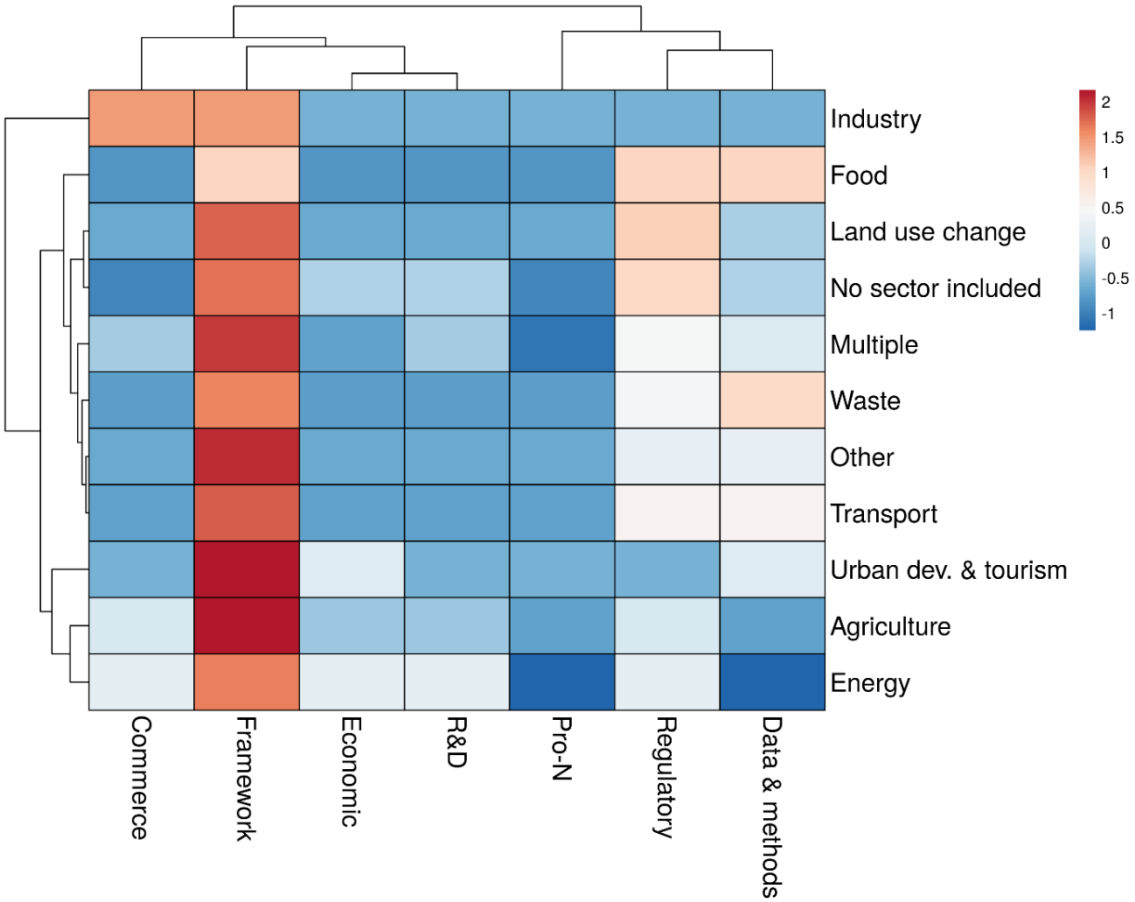


Figure: 17: Heatmap diagram of nitrogen-related policies by policy type and sector, from India
Detailed data is available in Supplementary Table ST 8.
Note: Red/3 = high values and blue/0 = lowest values

4.4 Policy by relevance and impact scope

When policy classifications for relevance and impact scope are crossed compared, policies can be identified as having higher relevance for nitrogen management can be identified. Policies classified as having low relevance and/or small impact scope (omitting 109 policies, 36%) leaves a total of 197 policies, see Table 10. In other words, 64% of the total policies collected for India can be considered of medium to high relevance with large or medium impact scope. These 'selected' policies are assumed to have a greater impact on how N_r enters the environment. Those policies identified to have lower relevance and/or impact scope should, however, not be considered as irrelevant, as such policies still hold potential to have an impact via amendments to consider and mitigate N_r waste and pollution.

Table 9. Number of nitrogen-related policies in India for nitrogen relevance and impact scope

	Impact scope			
Relevance	**Large**	**Medium**	**Small**	**Total**
High	132 (43%)	45 (15%)	28 (9%)	205 (67%)
Medium	7 (2%)	13 (4%)	9 (3%)	29 (9%)
Low	11 (4%)	15 (5%)	46 (16%)	72 (24%)
Total	150 (49%)	73 (24%)	83 (27%)	306 (100%)

Note: the cells coloured blue indicate those identified for having medium to high relevance an impact scope therefore forms the base of the analysis on 'selected' policies.

4.5 Selected policies for pollution source and impact direction

Table 11 illustrates the pollution source type with the impact direction for the 'selected' policies. Policies classified as positive have the largest percentage at 78%.[13] Positive impact direction policies were commonly associated with both (31%), point source (17%), but less so for NPS (7%). All these policies exhibit favourable policy characteristics.

For mixed/neutral impact direction policies (21%) the majority were classified as unspecified (11%) and other pollution type classifications were < 5%. For negative impact direction all categories of pollution source were small (1 -0%). Policies classified for pollution source as 'unspecified' indicate a potential gap. 12% higher than in Table 10, including all the policies in the analysis.

Table 10. Percentage of *selected nitrogen-related policies in India for pollution source and impact direction

Impact direction	Both	Non-Point Source (NPS)	Point Source	Unspecified	Non-applicable	Total
Mixed Neutral	5	1	1	10	4	21
Negative	0	0	0	1	1	2
Positive	31	7	17	16	6	78
Total	36	8	18	27	11	100

*Selected policies are based on high–medium relevance and impact scope, a total of 197 policies

The selected policies were further analysed and classifications cross compared; for results please see supplementary material ST 9.

4.6 Nitrogen-relevant policy changes over time

In this section we outline the nitrogen related policy trends for India at different time periods. The changes in N related policies overall are presented and then broken down by sector and then sink and policy type. For the entire database (total 306) the numbers of nitrogen related policies established over time (before 2000, between 2001-2010 and 2011-2020) were identified, see Figure 18. Most nitrogen-related policies (136) were established in 2011-2020.

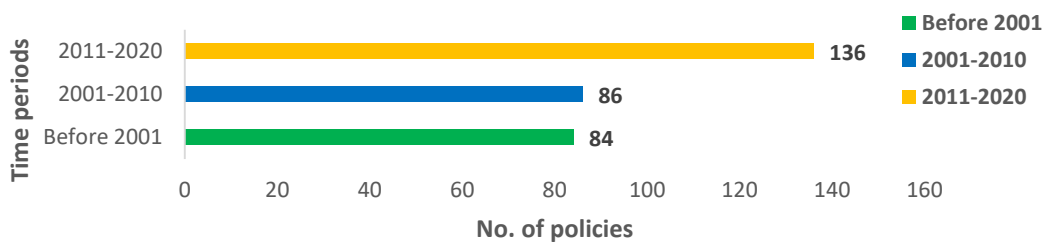


Figure 18: Total number of nitrogen-related policies (from a total of 306), enacted in India, established before 2001, in 2001-2010 and 2011- 2020

[13]12% higher than in Table 10, including all the policies in the analysis.

The number of policies formulated before 2000, between 2001-2010 and 2011-2020, are broken down by sector, as illustrated in Figure 19. The classification for 'multiple' and 'agriculture' where the high, relative to the other classifications, before 2001 and between 2001-2010, but more policies were established in both cases between 2011 and 2020.

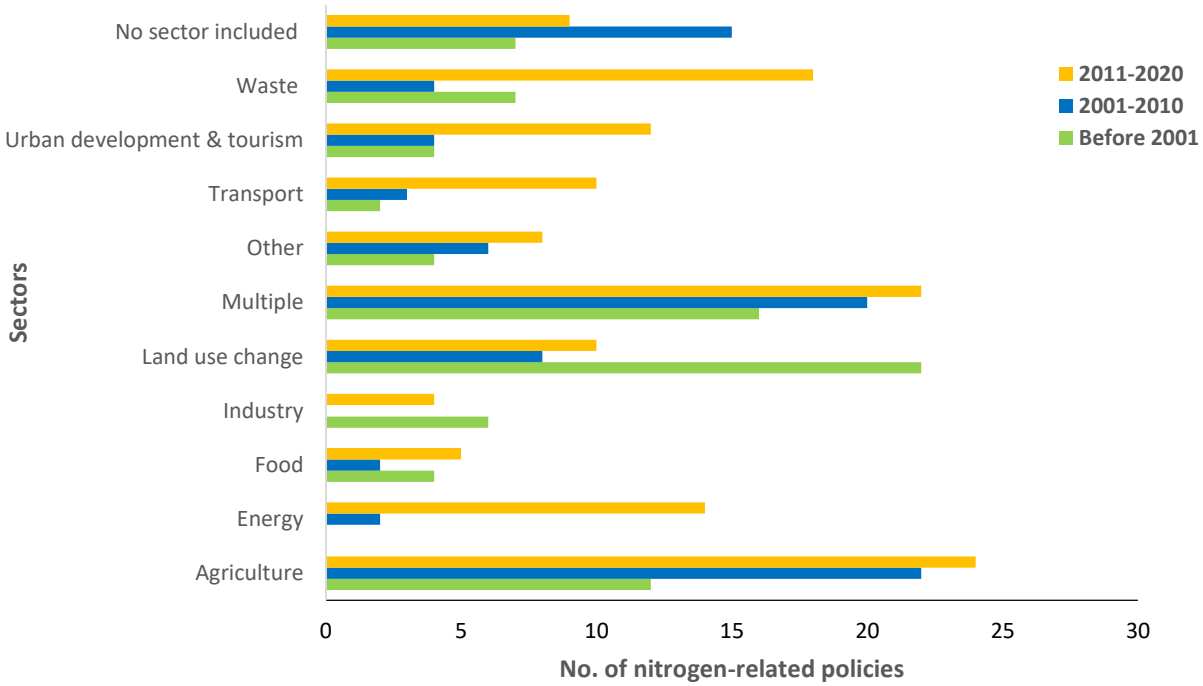


Figure 19: Total number of nitrogen-related policies, enacted in India, broken down by sector, established before 2001, in 2001-2010 and 2011- 2020
Detailed data is available in Supplementary Table ST 10

In Figure 20, the number of policies formulated before 2001, 2001-2010 and 2011-2020, are broken down by sink. As with the other results more policies overall were established in 2011-2020. Here the results illustrate that policies without any reference to sinks (NA) were mostly established in 2011-2020 (total 63). The other classification that was most common for 2011-2020 was for multiple sinks (total 32).

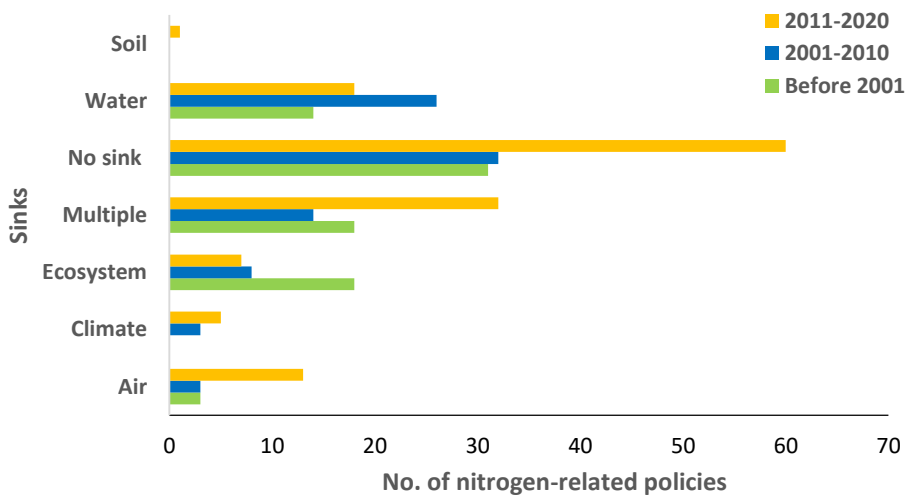


Figure 20: Total number of nitrogen-related policies, enacted in India, broken down by sink, established before 2001, in 2001-2010 and 2011- 2020
Detailed data is available in Supplementary Table ST 11

The number of policies formulated before 2001, 2001-2010 and 2011-2019, are broken down by policy type are illustrated in Figure 21. The classification for 'framework' was by far the highest, relative to the other classifications, for 2011-2020 (110 policies).

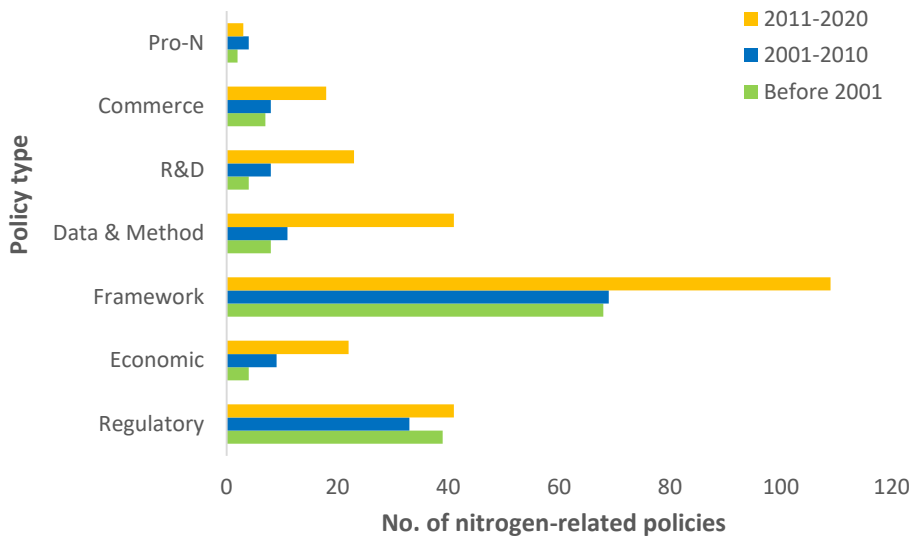


Figure 21: Total number of nitrogen-related policy classifications for policy type, enacted in India, established before 2001, in 2001-2010 and 2011- 2020
Detailed data is available in Supplementary Table ST 12.
Note: The total number of classifications (531) exceeds the total number of policies (306) as a single policy could be classified as multiple policy types.

4.7 Standout policy selection (policy sector, sink & policy type)

Policies that include references to multiple sinks and/or sectors and/or include multiple policy instruments stand out as being those best able to support N management. From India there are 11 (4%) policies that meet these criteria (see Table 12).

Table 11. India's nitrogen-related policies that refer to multiple sectors, sinks and mixed policy types (A total number of 11)

Title of policy	Year established
Notifications of the Ministry of Environment and Forests regarding public hearings	2000
Coastal Regulation Zone Notification S.O.19(E).	2011
Policy Statement for abatement of Pollution	1991
Environment (Protection) Rules 1986	1986
Jammu and Kashmir Water Resources (Regulation and Management) Act, 2010.	2010
Karnataka Lake Conservation and Development Authority Act, 2014 (Karnataka Act No. 10 of 2015).	2015
Karnataka Tank Conservation and Development Authority Act, 2014 (Act No. 32 of 2014).	2014
Kerala State Environment Policy, 2009.	2009
State Action Plan on Climate Change (Bihar SAPCC), 2015.	2015
State Action Plan on Climate Change (Haryana).	2011
The Sikkim Forests, Water Courses and Road Reserve (Preservation and Protection) Act, 1988	1988

When the policies are further filtered by additional encouraging classification indicators, such as having a potentially positive impact direction, and recognising both pollution source types, the total number of policies becomes 4 (1.3%) of the database (Table 13). These stand-out policies refer to multiple sinks, sectors, and include multiple policy types, have high relevance and large impact scope, and recognise pollution source types (i.e., refer to both pollution types: NPS and point source). These four policies have the strongest potential to deal with the complex nature of N management.

Table 12. India nitrogen-related policies that refer to multiple sectors, sinks and mixed policy types and classification for impact direction and pollution source type (Total 4)

Policy name	Impact direction	Pollution Source Type
Notifications of the Ministry of Environment and Forests regarding public hearings, 2000	Positive	Both
Coastal Regulation Zone Notification S.O.19(E)., 2011	Positive	Both
Policy Statement for abatement of Pollution, 1991	Positive	Both
Kerala State Environment Policy, 2009	Positive	Both

It is important to note that whilst this policy collection and analysis provides a new and comprehensive insight into the available nitrogen–related policies, this collection is unlikely to include 'all' policies, for instance some may have not been available online at the time and were inaccessible to the research team. In addition, the selection criteria in the first policy collection round targeted those introduced and active as of 2019, therefore policies introduced post 2019 were not included. Furthermore, the focus was national level policies. In the second policy collection round state level policies were also targeted and an effort was made to identify post-2019 policies. Therefore, the policy database could be treated as a living database that would benefit from continual updates.

5 DRIVERS OF REACTIVE NITROGEN EMISSIONS

5.1 Sectoral analysis of N emissions

Driven by its large population of about 1.40 billion, its pattern of economic growth and its position in the global economy, and associated agricultural and economic activities, India's situation is undoubtedly unique compared to the other South Asian countries. Agriculture is one of the primary sources of nitrogen pollution in India. India uses huge quantities of N-fertilizer to support agricultural production and is globally the second largest user of chemical fertilizer, after China. Around 17 million tonnes of nitrogen fertilizer are consumed annually (FAOSTAT, 2023). In 2020, 20 million tonnes of N synthetic nutrient fertiliser was used. Further, the growing economy of the country produces huge quantity of waste and uses large quantity of fossil fuel to meet its energy and transportation needs, all of which contribute to the total reactive-N budget of the country.

Nitrous oxide (N_2O) is the most important gaseous nitrogen having highest global warming potential with a CO_2 equivalent of 320 (IPCC, 2021) and is directly related to the use of nitrogen fertilizer which provides a major input to the reactive nitrogen footprint of the country. Based on the EDGAR database (ver. 5) analysis of N_2O emission per capita per year (Figure 22) indicate a continued rising trend with the largest amount being contributed by non-combustion sector which also includes agriculture sector dominated by fertilizer-N application. An analysis of the same data on GDP per year (Figure 23) basis however shows a decreasing trend obviously because of the increase in the GDP of the country over the year. Sector wise contribution of N_2O emission to the country N_2O budget, however remains the same with the non-combustion sector contributing the highest amount. Sector wise emission analyses of ammonia (NH_3). Nitrogen oxides (NO_x) and particulate matter ($PM_{2.5}$) (Figure 21), however, indicate a different scenario. While total NH_3 emission was mostly contributed by the agriculture sector, NO_x emission was dominated by power industry and transport. $PM_{2.5}$ emission was led by building sector.

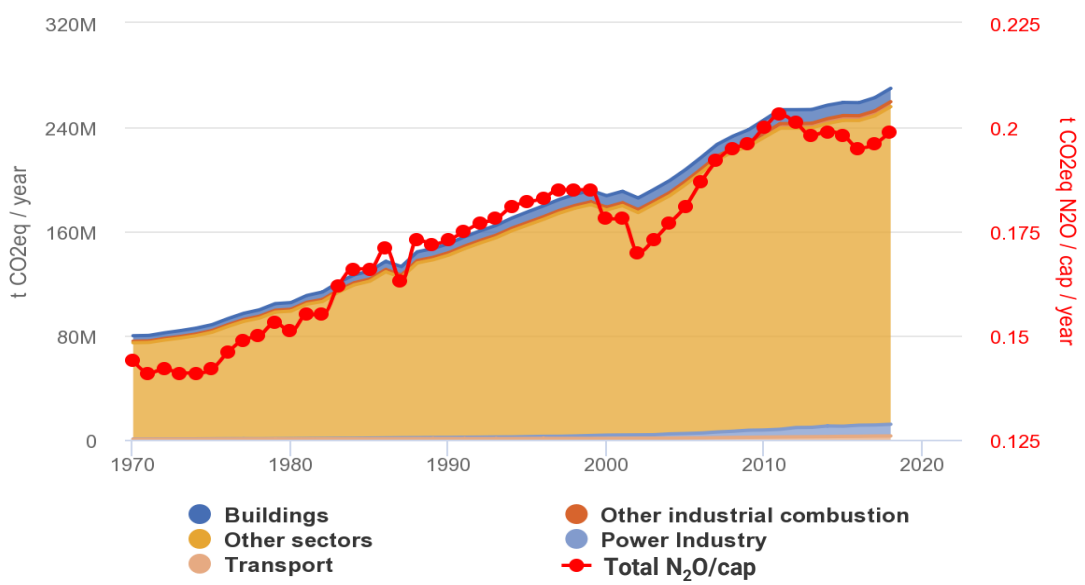


Figure 22: Nitrous oxide (N_2O) emission trends by major sectors, and total N_2O emissions per capita for India 1970 to 2018.
Source: Crippa et al., (2021), derived from EDGAR v7.0
Detailed data is available in Supplementary Table ST 13.

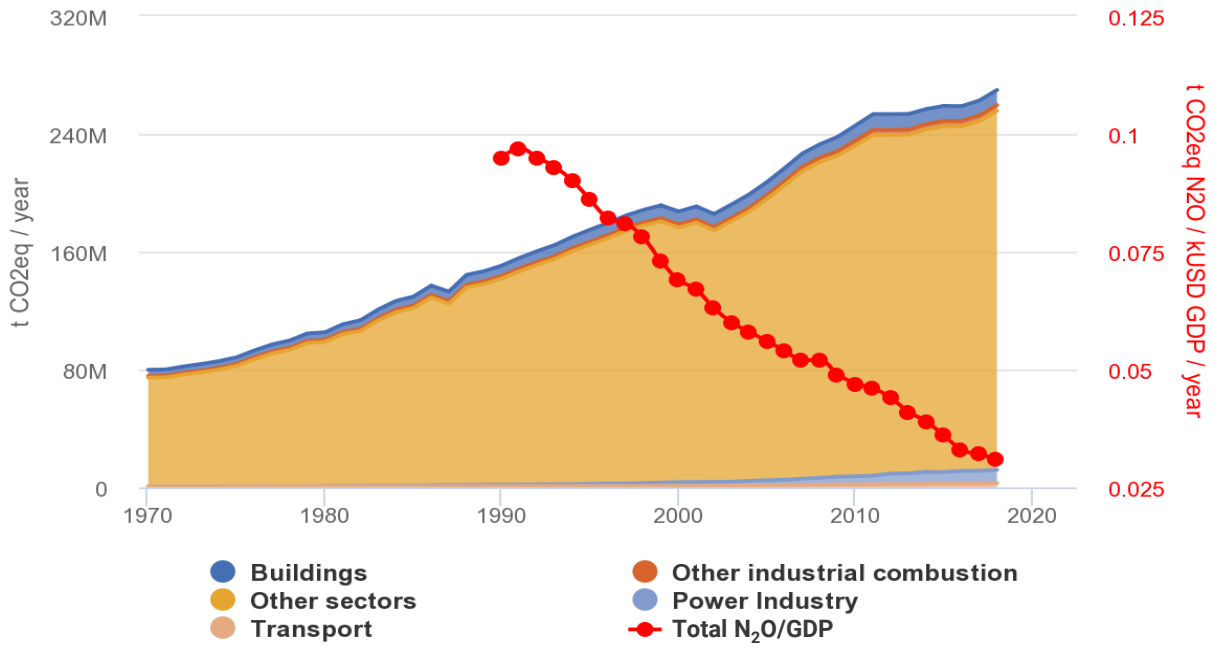


Figure 23: Nitrous oxide (N_2O) emission by major sectors, and total N_2O emissions by GDP for India 1970 to 2018.
Source: Crippa et al., (2021), derived from EDGAR v7.0
Detailed data is available in Supplementary Table ST 13.

Sector wise emission analyses of ammonia (NH_3), Nitrogen oxides (NO_x) and particulate matter ($PM_{2.5}$) (Figure 23), however, indicate different key emissions sector sources. Like N_2O, the agriculture sector contributed most NH_3 emissions, with the waste sector as the next major source, see Figure 24. The power industry and transport dominated NO_x emissions, followed by other industrial combustion. $PM_{2.5}$ emissions were mainly driven by the building sector, followed by other industrial combustion and the power industry.

Detailed segregation of N_2O, NH_3, and NO_x emission data sector-wise (as per IPCC sectoral grouping and sector description) is provided for the year 2015 and percentage change since 2000 (see ST 13). The emission results indicate a skewed picture. N_2O emissions changes were mostly dominated by the transport sector (549%) followed by the power sector (212%) and the agriculture sector (211%). NH_3 emissions followed a similar trend to N_2O, with transport emission increasing by 3,342% since the year 2000. NO_x emission changes were dominated by other industrial combustion.

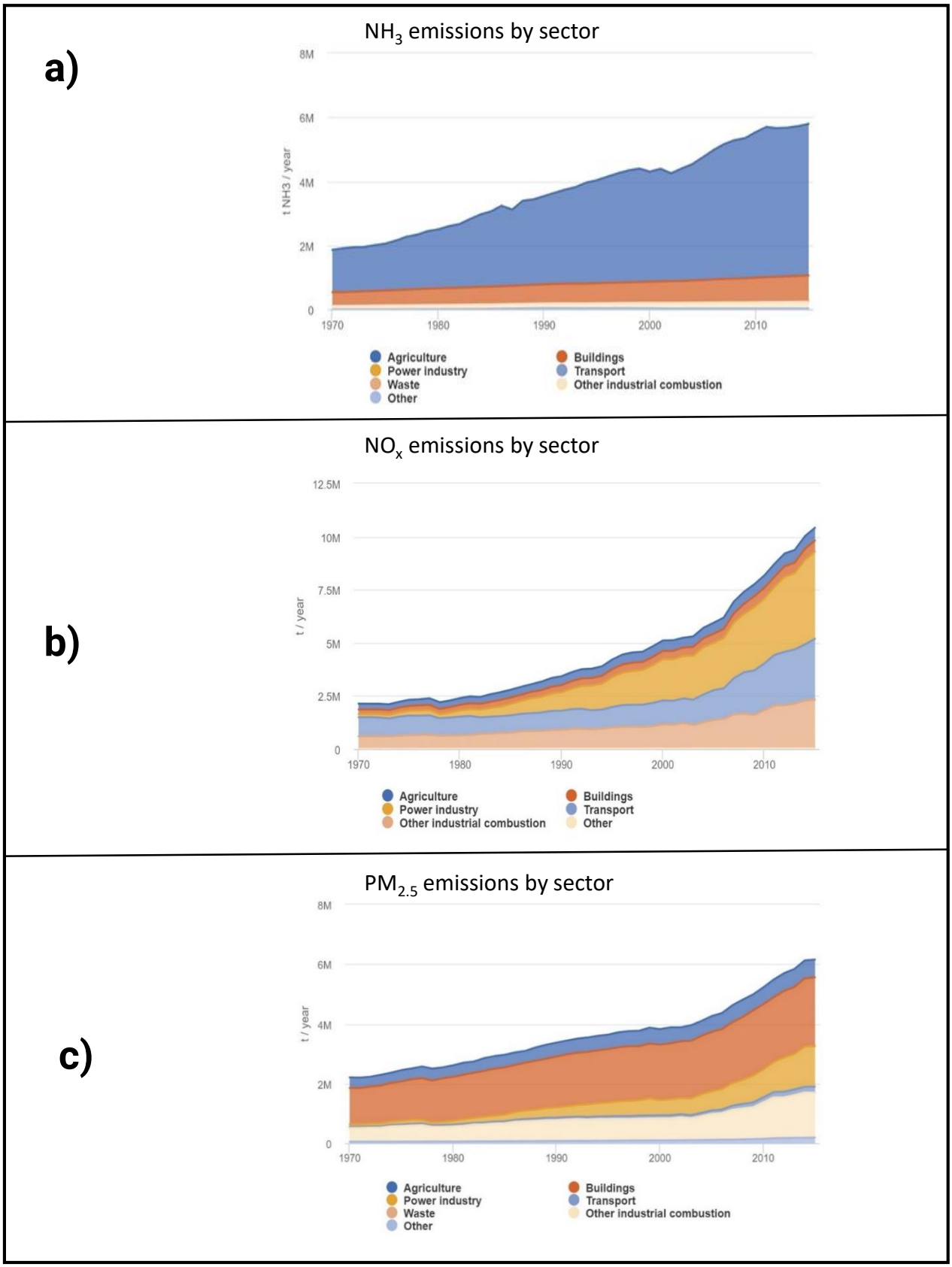


Figure 24: Emissions by major sectors in India from 1970 to 2015 for a) ammonia (NH_3), b) nitrogen oxide (NO_x) and c) particulate matter ($PM_{2.5}$)
Source: EDGAR v6.1 air pollutants, https://edgar.jrc.ec.europa.eu/dataset_ap61
Detailed data is available in Supplementary Table ST 13.

5.2 Sector-wise insights into the major drivers of N emissions

In this section examples from some of the key drivers of nitrogen emissions are discussed in more detail by the key sectors involved.

5.2.1 Agriculture

As the N_r emission results above indicate, agriculture is the major driver of both N_2O and NH_3 emissions for India. Despite the government putting in place several policy measures (see sec. 4) emissions have continued to increase over time (Figure 25). Agricultural soils are indicated to be the biggest agricultural source of NH_3 emission, relative to waste burning and manure management, with increases occurring since the 1970's. In contrast emissions from agricultural waste burning and manure management, have remained, fairly steady.

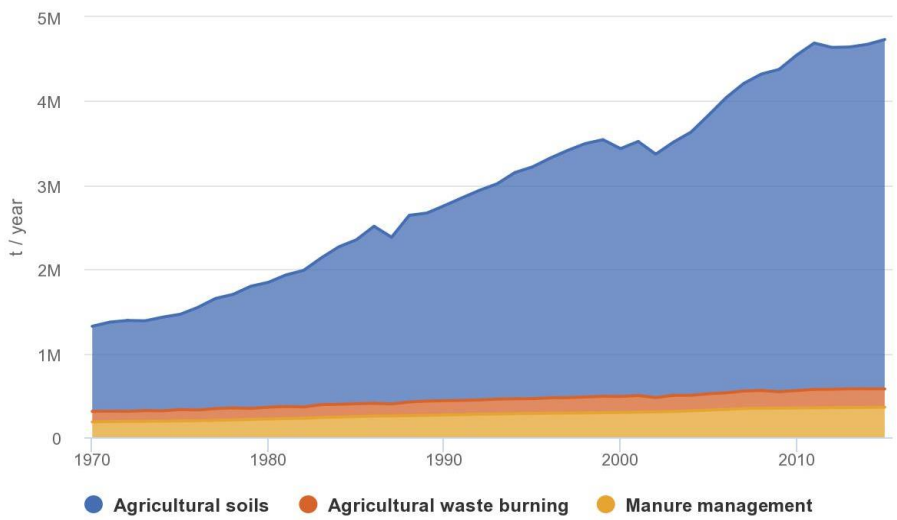


Figure 25: Agricultural sector ammonia (NH_3) emissions in India from 1970 to 2015
Source: EDGAR v6.1 air pollutants, https://edgar.jrc.ec.europa.eu/dataset_ap61

The agriculture sector, currently valued at US$ 370 billion, is one of the major sectors in the Indian economy. According to the Economic Survey 2020-21, GDP contribution by the agriculture sector is likely to be 19.9% in 2020-21, increasing from 17.8% recorded in 2019-20. Gross Value Added (GVA) by agriculture, forestry, and fishing was estimated at Rs. 19.48 lakh crore (US$ 276.37 billion) in FY20. Share of agriculture and allied sectors in GVA of India at current prices stood at 17.8 % in FY20.

Agriculture, with its allied sectors, is the largest source of livelihoods in India. 58% of the total population, and 70% of its rural households, still depend primarily on agriculture for their livelihood. 82% of farmers own or farm small and marginal holdings (Pathak et al., 2022). In 2017-18, total food grain production was estimated at 275 million tonnes (MT). India is the largest producer (25% of global production), consumer (27% of world consumption) and importer (14%) of pulses in the world. India's annual milk production was 165 MT (2017-18), making India the largest producer of milk, jute and pulses, and with world's second-largest cattle population 190 million in 2012. It is the second-largest producer of rice, wheat, sugarcane, cotton and groundnuts, as well as the second-largest fruit and vegetable producer, accounting for 10.9% and 8.6% of the world fruit and vegetable production, respectively..

Over the years, the government has taken major steps to aid and enhance the agriculture sector with proven farming technologies and supportive policies. The recent evolution of digital technology in farming will further accelerate growth by ensuring higher crop yields and enhance sustainability by reducing water consumption and the use of agrochemicals.

Nitrogenous fertilizer is a major agricultural input. India accounts for 11% of global N production and 19% of global N consumption (FAOSTAT, 2023). In India, fertilizer consumption shows a continuously growing trend, with a yearly increase of 6% since 1970 (Sutton et al., 2017. This can be observed in Figure 25, which shows the annual fertilizer consumption in India in comparison with population (showing a much weaker annual growth rate), and the annual GDP (showing a closer, but much clearer exponential growth over the years). Nutrient-N consumption per unit area also showed a similar increasing trend.

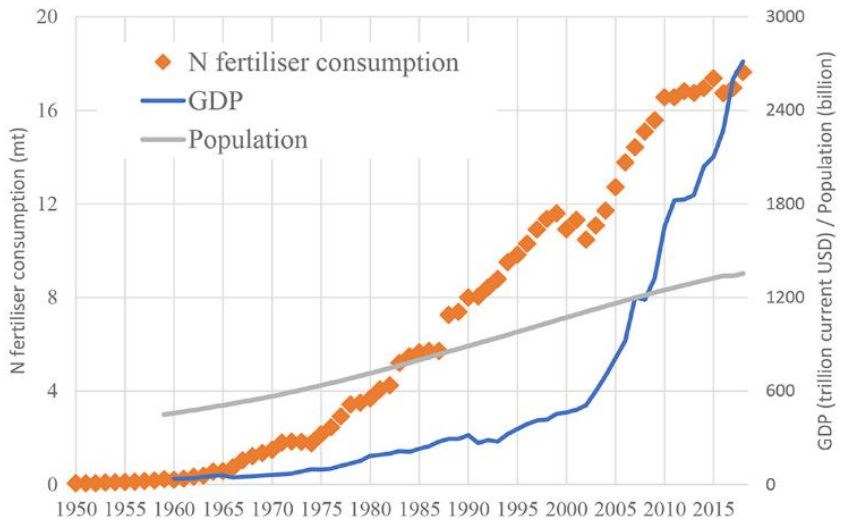


Figure 26. Annual nitrogen fertilizer consumption in million tonnes (mt) in India, annual GDP in 10^9 current USD and population (10^6 people)
Source: Moring et al., (2020).

In order to combat N waste caused by synthetic fertilizer use, saving fertilizer consumption in agriculture is possible if all cropping systems incorporate legumes/pulses that fix atmospheric nitrogen in their crop-rotation system. There is also recent evidence that in rice/wheat cropping systems, half of the urea can be replaced with farmyard manure, bio fertilizer and other organics without any loss of yield (Bhardwaj et al., 2023). But bringing these changes would require a strong national coordination between the Union government and the states involved. Some states like Chhattisgarh have already started promoting manure recycling by government procurement[15].

5.2.2 Energy

The power industry, aka the energy sector, is the biggest driver of rising nitrogen oxide (NO_x) emissions and contributes to nitrous oxide and ammonia emissions (see earlier Figures 22, 24a, and 24b). For example, 44% of India's total NO_x emissions in 2015 were produced by the energy sector.

Power is among the most critical components of infrastructure, crucial for the economic growth and the nation's welfare. India's power sector is one of the most diversified in the world. The sources of power generation in India range from conventional sources such as coal, lignite, natural gas, oil, hydro and nuclear power to viable non-conventional sources such as wind, solar, and waste to energy, as seen in Table 13.

[15] https://www.thehindu.com/news/national/other-states/cow-dung-procurement-scheme-helped-farmers-tide-over-tough-covid-times-chhattisgarh-govt/article37887081.ece

Table 13. Installed electricity generation capacity for India as on 31.12.2022

	Installed generation capacity (Megawatt)	% share in total
Fossil fuel		
Coal	203,755	50%
Lignite	6,620	2%
Gas	24,824	6%
Diesel	589	0.1%
Total fossil fuel	2,35,809	57%
Non-fossil fuel		
Hydro	46,850	11%
Wind, Solar & Other RE	120,900	30%
Wind	47,930	10%
Solar	63,302	15%
BM Power/Cogen	10,210	3%
Waste to Energy	522	0.1%
Small Hydro Power	4,936	1%
Nuclear	6,780	2%
Total Non-Fossil Fuel	174,530	43%
Total Installed Capacity (Fossil Fuel & Non-Fossil Fuel)	410,339	100%

Source: Central Electricity Authority (CEA), Ministry of Power, Government of India
https://powermin.gov.in/en/content/power-sector-glance-all-india

The demand of electricity in India has increased rapidly and is expected to rise further in the coming years. To fulfil the increasing demand for electricity in the country, massive addition to the installed generating capacity is required. India is the third-largest producer and consumer of electricity in the world, with an installed power capacity of 383.37 GW, as of May 2021[14] . Electricity production reached 1,252.61 billion units (BU) in FY20. India was ranked fifth in wind power, fifth in solar power and fourth in renewable power installed capacity, as of 201916

In May 2018, India ranked fourth 17 in power sector[16] out of 25 nations in the Asia Pacific region. India was ranked fourth in wind power and fifth in solar power and fifth in renewable power installed capacity as of 2018. India ranked sixth in the list of countries to make significant investments in clean energy at US$ 90 billion. India is the only country among the G20 nations that is on track to achieve the targets under the Paris Agreement (International Climate Transparency Partnership, 2020). India has already reached its goal ahead of the 2030 target for 40% of installed electricity capacity from non-fossil fuel sources and aims to be net zero emissions by 2070 (IEA, 2021; MNRE 2022).

India aims to reduce emissions intensity of its gross domestic product (GDP) by 45% by 2030 from 2005 levels and increase renewable capacity to 500 GW by 2030 to meet 50% of its energy requirements from renewables (Birol and Kant, 2022; MNRE, 2022). The total power generation through different sources increased from year 2016-17 to 2019-20 (Table 14). The installation capacity of Renewable energy and production has also increased in India from 2015 to 2020 (Table 15).

[14]International Energy agency (IEA): India Energy outlook 2021: https://www.iea.org/reports/india-energy-outlook-2021
[16] https://www.ibef.org/industry/renewable-energy

Table 14. Electricity Generation (Million Units) in India change between 2016-17 and 2019-20.

	Year 2016-17	Year 2019-20	Percentage increase
Total Power Generation	11,78,000	13,30,000	12.9%
Thermal power (Coal, Diesel, High speed Diesel, Naphtha, Lignite, Natural Gas)	9,99,000	11,42,130	11.4%
Nuclear	40,000	44,720	10.2%
Hydro	1,34,000	1,36,932	2.2%
Import from Bhutan	5,000	6,218	24.4%

Source: Annual Reports, Central Electricity Authority, Ministry of Power
* https://cea.nic.in/?lang=en

The power sector of India is undergoing a significant change that has redefined the industry outlook. Sustained economic growth continues to drive electricity demand in India. The Government of India's focus on attaining 'Power for all' has accelerated capacity addition in the country. By 2022, solar energy is estimated to contribute 114 Gigawatt (GW), followed by 67GW from wind power and 15GW from biomass and hydropower. As of February 2021, India had an installed renewable energy capacity of 94.43 GW. In FY21, the total thermal installed capacity in the country stood at 234.72 GW. The Government plans to double the share of installed electricity generation capacity of renewable energy to 40% by 2030. India has also raised the solar power generation capacity addition target by five times to 114 GW by 2022[17]. The Government is preparing a 'rent a roof' policy for supporting its target of generating 40 GW of power through solar rooftop projects by 2022[18].

Table 15. Total energy generation and the percentage share of renewable energy in India.

Year	Total Generation from all sources (in BTU)	Installed RE Capacity (GW)	% Share of RE in total installed capacity	Generation from Renewable Sources (in BTU)	% Share of RE in Generation
2014-15	1110.18	39.55	14.36	61.78	5.56
2015-16	1172.98	46.58	15	65.78	5.6
2016-17	1241.38	57.9	23	81.54	6.56
2017-18	1303.37	69.77	17.68	101.83	7.81
2018-19	1375.96	78.31	20.24	126.76	9.21
2019-20	1390.93	87.07	23.52	138.32	9.95

Source: https://mnre.gov.in/img/documents/uploads/file_f-1618564141288.pdf
Ministry of New and Renewable Energy Annual Report 2020-21; RE = Renewable Energy

The emission of N_2O from Gas–Diesel in India is more as compared to other sources (Figure 26). The emissions of NH_3, NO_x are also found to be more from diesel than from other sector or sources as illustrated in Table 16. The adoption and drive for low-emission combustion and energy-efficient systems for electricity, industry and transport is needed to reduce emissions in addition to disincentivize the sale/use of diesel-cars in major cities suffering air pollution, as diesel engines emit far more GHGs and particulate matter than petrol engines. This was done successfully in Berlin, and other cities in Germany, which applied a 'low-emission zone in order to reduce air pollution (Berlin.de., 2023). Vehicles there with high pollutant emissions are not permitted to drive or park within the low emission zone.

[17] https://mnre.gov.in/img/documents/uploads/file_f-1618564141288.pdf
Ministry of New and Renewable Energy Annual Report 2020-21; RE = Renewable Energy

[18] https://www.google.com/search?q=rent+a+roof+policy&rlz

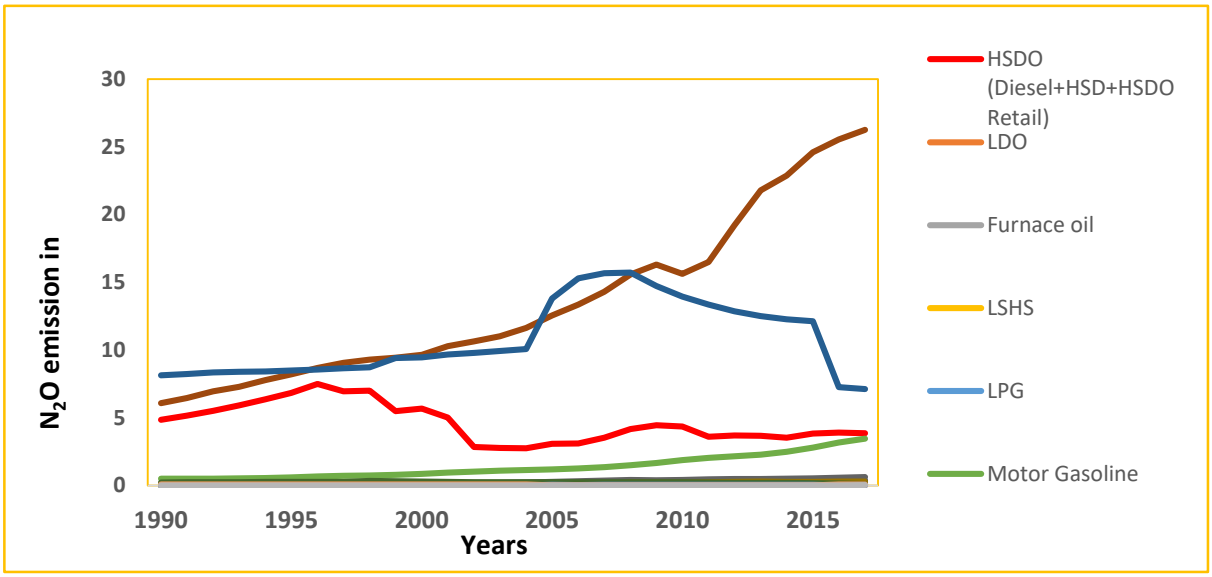


Figure 27. Nitrous oxide (N_2O) emission in Gigagrams (Gg) from different energy sources (HSDO: High Speed Diesel Oil; LDO: Light Diesel Oil; LSHS: Low Sulphur Heavy Stock; LPG: Liquefied Petroleum Gas; CNG: Compressed Natural Gas)
Source: Bansal et al., 2022)

Table 16. Emission of Nitrogen oxides (NO_x) and ammonia (NH_3) from the fuel sector of India in 2016

Fuel	NOx (Gg)	NH_3 (Gg)
Fuelwood	386	0
Crop residue	132	0
Dung cake	28	0
Coal	2844	165
Kerosene	1	0
Diesel	3058	1
Gasoline	285	12
CNG	92	0
LPG	41	0
Total	6867	178

Source: Bansal et al., 2022

5.2.3 Industry and Mining

The manufacturing industries and construction sector is a major contributor to nitrogen oxide (NO_x) emissions for India (see Figure 25). NO_x emissions for this sector rose by 95% from 2000 to 2015. The metal and mining sector also contributes to nitrogen emissions but to a lesser extent. The total industrial sector emissions (Gg) in India, in 2016, are illustrated in Table 17. NO_x emissions are indicated to be more prevalent from the cement industry, and NH_3 emissions from fertilizer production. For particulate matter ($PM_{2.5}$) the 'micro to medium scale industries' were indicated to be one of the biggest sources of emissions.
India holds a fair advantage in production and conversion costs in steel and alumina. Its strategic location enables export opportunities to developed as well as fast-developing Asian markets. Power and cement industries are also aiding growth for the sector. Demand for iron and steel is set to continue given the strong growth expectations for the residential and commercial building industry. The market size for coal production in FY21 was 715.95 million tonnes (MT).

Coal production in FY 2022-23 (April-July, 2022) stood at 210.40 MT. According to Directorate General of Commercial Intelligence & Statistics, in FY22 (until August 2021), iron ore exports reached US$ 2.23 billion, registering an increase of 21.8% Year-on-year basis. In FY21, India's crude steel production was 102.49 million tonnes. According to world steel database, crude steel output in India registered a 46.9% YoY growth to reach 9.2 million tonnes in May 2021, as compared with 5.8 million tonnes of crude steel output registered in May 2020. Production of aluminium stood at 3.65 MT in FY20. In value terms, aluminium export from the country stood at US$ 20.18 million in FY20.

India was the world's second-largest coal producer as of 2021 and second-largest crude steel producer, as of 2020, with an output of 99.6 MT. In February 2021, Coal India Limited (CIL) also announced plans to invest Rs. 1.43 lakh crore (US$ 19.43 billion) in 20 projects, including solar, thermal and aluminium projects (IBEF, 2022).

Table 17. Total industrial sector emissions (Gg) for nitrogen oxides (NO_x) and ammonia (NH_3) and particulate matter ($PM_{2.5}$), in India in 2016

Sector	NOx (Gg/2016)	NH_3 (Gg/2016)	$PM_{2.5}$ (Gg/2016)
Large-scale industry			
Cement	672		304
Iron & Steel	94		16
Aluminium	26		3
Paper	15		6
Glass	37		1
Fertilizers	50	165	5
Sub-Total	894	165	335
Micro-, Small- and Medium-Scale industries	284	0.3	2232
Brick kilns	1		225
Total emissions	1179	164.8	2792

Source: https://www.ibef.org/industry/metals-and-mining-presentation

5.3 Emerging sector: waste

There are several areas of concern for sustainable N management efforts in India across multiple sectors. Yet certain sectors are become increasing contributors to N emissions but also represent some of the solutions, such as the waste sector. A recent study highlighted the recovery of nutrients from wastewater could reduce emissions and avoid 0.38Mt/a in fertiliser imports (103-100 Million USD/Year) (Gowd et al., 2022).

The Indian N assessment has shown that N_r emissions from waste may be growing at higher annual growth rates than fertilizers and fuels, making this sector as growing contributor to N_r emissions. Waste is already a major source for methane emissions, which is another concern from the climate change perspective and our commitment to achieve net zero. Improving waste management for low emissions, nutrient recovery and reuse requires cooperation of state governments and municipalities, which are currently responsible for waste management, sewage treatment plants (STPs) etc. The total installed capacity of STPs in India is less than one-third of the wastewater currently being generated, but their actual utilisation is even lower, as they are shut or are poorly managed. An example worth emulating is of the Delhi government, which has expanded its installed capacity of STPs to over 90% and utilisation capacity of over 80%, and has committed to not releasing any untreated wastewater into the Yamuna River. Apart from improving water quality for various purposes, recovery and reuse of nitrogen, phosphorus and other nutrients could also save fertilizers. Lastly one of the issues is data availability, for example, while the fertilizer use and fossil fuel use data are reasonably well organized and can be updated from time to time, data on Nr emissions from solid and liquid waste are limited and therefore need to be improved.

6 NITROGEN CONTROL POLICIES: SIGNIFICANT CASE STUDIES

Two sets of policies relevant to nitrogen control have been selected as examples for analysis based on their significance and potential contributions to sustainable nitrogen management. Fertilizers are the main source of ammonia pollution, and poor air quality is a major public health hazard in which nitrous oxides and nitrates play major roles.

6.1 Government policies impacting fertilizer use in India

Since independence, the Indian government has been regulating the sale, price and quality of fertilizers, which were recognized as essential commodities under the Essential Commodities Act of 1955. Under the Fertilizer Control Order (FCO) of 1985, the government holds the right to decide the price, distribution and quality of fertilizers[15]. In 2008, the Department of Fertilizer announced the Uniform Freight Policy (UFP), the objective of which was to ensure that every part of the country, especially remote villages, has access to fertilizers at the same price[16]. However, the government's Nutrient Based Subsidy (NBS) policy (effective since April 1, 2010) allowed private corporations to decide the maximum retail price of fertilizers, which resulted in substantial increase in the price of P&K fertilizers and spiked up the use of government-subsidized urea[17]. As of 2016, the consumption ratio of N,P,K fertilizers in India was 6.7:2.4:1 against their recommended dose of 4:2:1. In Punjab and Haryana, the ratio is 31.4:8.0:1 and 27.7:6.1:1, respectively[18]. The policies adopted to regulate fertilizer use in India are outlined in Table 18.

In order to cut excessive consumption of urea and to promote balanced use of fertilizers, the government has decided to sell urea in 45 kg bags instead of 50 kg bags at 242 INR[19]. To reduce detrimental effects on the environment from overuse of urea, and to increase the overall N-use efficiency by crop plants, the Cabinet Committee on Economic Affairs (CCEA), Government of India, approved the Neem Coated Urea policy in 2015[20]. The policy made it mandatory for all indigenous urea producers to produce 100% of their total output of urea as neem coated. With the introduction of neem coated urea in 2015, the actual consumption in 2018-19 was 17.64 MMT, a reduction in use of 0.66 MMT, and the neem coated urea policy may have contributed to this drop, and might have raised nitrogen use efficiency on farms[21]. Thus relevant government policies have enhanced use of fertilizer by farmers as well as attempting to control excessive use of urea for environmental protection.

[15] https://cfqcti.dacnet.nic.in/lst9.1fco.htm

[16] http://fert.nic.in/page/fertilizer-policy

[17] http://fert.nic.in/page/fertilizer-policy

[18] https://www.prsindia.org/policy/discussion-papers/state-agriculture-india

[19] https://economictimes.indiatimes.com/news/economy/agriculture/govt-rules-out-decontrolling-urea-prices/articleshow/69891217.cms?from=mdr

[20] https://www.manifestias.com/2019/12/19/new-urea-policy-2015/

[21] https://www.faidelhi.org/general/con-npk.pdf

Table 18: Policies adopted to regulate fertiliser use in India.

Policy Title	Year	Ministry responsible	Policy type	Spatial scale	SANH database	Scope	N-Relevance
1st generation policies (pre-2009)							
The Fertilizer (Movement Control Order)	1973	MoCF*	Framework / commerce	National	Yes	Large	High
Fertilizer Control Order (FCO)	1985 (amended in 2013)	MoARD**	Economic/ data and methods/ commerce	National	Yes	Large	High
Uniform Freight Policy (UFP)	2008-2017	MoCF*	-	National	No	Large	High
2nd generation policies (2009-2017)							
Freight Subsidy Policy (replaced UFP)	2017	MoCF*	Economic/ Framework/ Commerce	National	Yes	Large	High
Nutrient Based Subsidy (NBS) policy	2010-2019	MoCF*	Economic/ Framework/ Pro-N	National	Yes	Large	High
Neem Coated Urea policy	2015-2019	MoCF*	Regulatory/ economic/ framework/ pro-N	National	Yes	Large	High

Adapted from: Yang et al., (2022)
* Ministry of Chemicals and Fertilizers (MoCF)
** Ministry of Agriculture and Rural Development (MoARD)

6.2 Policy interventions for air pollution in Delhi

This case study deals with multiple policy interventions to address increasing atmospheric concentration of reactive nitrogen compounds such as NO_2 and $PM_{2.5}$ in Delhi. These can adversely affect human health by causing damage to lung tissue, cancer and even premature death (Foster and Kumar, 2011). Multiple sources/sectors including vehicular emissions, heavy industry like power plants, cluster of small-scale industries like brick kilns, dust from construction activities, open waste burning, in-situ power generation via diesel generator sets, combustion of fuels for cooking, lighting and heating contribute to air pollution in Delhi (Chowdhury et al., 2017). Stubble burning in the neighbouring states of Punjab and Haryana worsen Delhi's air quality during winters due to temperature inversions, low mixing height, and low wind speed with no dispersion. The Industrial Policy for Delhi (Delhi Department of Industries 2010) helped to reduce emissions from small-scale industries within the National Capital Territory.

The policies adopted in Delhi relevant to air pollution (see Table 19) are predominantly regulatory in nature and have high N-relevance. They are directly related to the impact of reactive nitrogen on human health and assist to control reactive nitrogen emission in air. Further, small-scale policy interventions applied in Delhi paved a way for development of national level policies, viz metro rail introduction in Delhi in 2002 and the Clean Air for Delhi Campaign launched in early 2018 subsequently led to the Metro Rail Policy, 2015 and National Clean Air Program (NCAP), 2019 (Ganguly et al. 2020).

In conclusion, this is a unique but important case study as it demonstrates the example of a blend of state and national scale policy interventions from multiple sectors targeting the single sink of air by using a sophisticated approach for multi-level actions involving multiple ministerial co-ordination for effective policy implementation on the ground.

Table 19: Policies adopted to combat air pollution in Delhi, 1981-2019.

Policy	Year	Ministry/Organization responsible	Policy type	Spatial scale	Scope	N-relevance
1st generation policies (pre-2009)						
Air (Prevention and Control of Pollution) Act[22]	1981	MoEFCC*	Regulatory	National	Large	High
Environment (Protection) Act[23]	1986	Ministry of Law and Justice	Regulatory	National	Large	High
2nd generation policies (2009-2016)						
National Air Quality Monitoring Program (NAMP)[24]	2009	MoEFCC	Regulatory/ Data & methods	National	High	High
Implementation of BS IV standards[25]	2010	Ministry of Road Transport & Highways	Regulatory	National	Large	High
Industrial policy for Delhi[26]	2010	Department of Industries, Government of NCT, Delhi	Framework	State	Low	High
NAQI** establishment[27]	2014	MoEFCC	Regulatory/ Data& methods	National	High	High
3rd generation policies (2016 and onwards)						
Odd-Even Scheme[28]	2016	Delhi Government	Regulatory	State	Low	High
Graded Response Action Plan (GRAP)[29]	2017	MoEFCC	Framework	State	Large	High
The National Clean Air Program (NCAP)[30]	2019	MoEFCC	Framework	National	Large	High

Source: Yang et al., (2022)
Note: *Ministry of Environment, Forest and Climate Change (MoEFCC)
** National Air Quality Index

[22] https://legislative.gov.in/sites/default/files/A1981-14.pdf
[23] https://www.indiacode.nic.in/bitstream/123456789/4316/1/ep_act_1986.pdf
[24] https://cpcb.nic.in/air-pollution/
[25] https://dieselnet.com/standards/in/
[26] http://industries.delhigovt.nic.in/sites/default/files/374%2B%2B3750001.pdf
[27] https://cpcb.nic.in/displaypdf.php?id=bmF0aW9uYWwtYWlyLXF1YWxpdHktaW5kZXgvRklOQUwtUkVQT1JUX0FRSV8ucGRm
[28] Chowdhury et al (2017)
[29] https://pib.gov.in/PressReleasePage.aspx?PRID=1880819
[30] Ganguly et al. (2020)

7 STAKEHOLDER OVERVIEW

In this report, stakeholders are defined as individuals or groups who have an interest and/or potential influence on N_r management. Such actors and organizations can promote or support N related policies, but they may also oppose policies if these do not meet their interests and/or as stakeholders they feel excluded from policy development stages (Reed et al., 2009). Stakeholders related to N_r management include a wide range of actors due to the multiple sector sources of N_r waste, along with their multiple human and environmental impacts.

Table 20 gives a preliminary overview of some of the main groups who may have a role in improving and addressing N_r management and influencing policy. This list is by no means exhaustive, but it gives initial insights into the wide range of stakeholders related to N_r management. Ministries can be key actors when it comes to N_r management and policy – especially those that are responsible for agriculture, fertilizers, energy, transport and the environment. In addition, stakeholders such as key research organizations and academia, industry, international bodies, NGOs, civil society, the media and farmers have interests in, and influence on, policy generation and implementation. The degree to which all the stakeholders, including politicians, bureaucrats, businessmen, researchers and the public, act in a coordinated and complementary manner will determine policy effectiveness and its ability to prevent reactive N_r compounds from polluting the country's air, water, soil and ecosystems.

Table 20. Preliminary overview of nitrogen relevant stakeholders for India

Main groups	Examples of relevant stakeholders
Government	Legislature: Standing and other committees Judiciary: Supreme Court Ministries of Environment Forest and Climate Change (MoEFCC), Chemicals & Fertilizers (MoCF), Petroleum & Natural Gas (MoPNG), Agriculture and Farmers Welfare (MoAFW), Consumer Affairs, Food and Public Distribution (M/O CAFPD), Finance (MoF), New and Renewable Energy (M/O N&RE), etc.
Subnational government	Union/State governments District administration Local administration State Pollution Control Boards State Department of Agriculture, etc.
Government bodies	Central Pollution Control Board (CPCB), Niti Ayog (Previously Planning Commission), Agriculture Development and Rural transformation centre (ADRTC), Council of Scientific and Industrial Research (CSIR) Niti Aayog, Andhra Pradesh Water Resources Information & Management System, etc.
Government committees /commissions	Nitrogen steering committee, Forest Advisory Committee, Commission for Air Quality Management (CAQP), etc.
International organisations	Food and Agricultural Organization, India (FAO), Asian Development Bank (ADB), International Fund for Agricultural Development (IFAD)
Regional partnerships	South Asian Association for Regional Cooperation (SAARC), South Asia Co-operative Environment Programme (SACEP), South Asian Nitrogen Centre (SANC), Regional Seas Programme (UNEP), etc.
Civil society organisations (CSO) / Non-governmental organisations	CHINTAN, World wildlife Fund-India (WWF), Greenpeace India, Help Delhi Breathe, Clean Air Asia, India, The Wildlife Protection Society of India, NAVDANYA, Toxics link, Environics Trust, Hara Jeevan, Clean Air Fund, Society for Conservation of Nature (SCON), etc.
Research and universities	Indian Nitrogen group, National Academy of Agricultural Sciences (NAAS), National Centres of Organic Farming (NCOF), Gujarat Organic Agricultural University; National Agriculture Research System including Indian Council of Agricultural Research (ICAR-IARI), State Agricultural Universities (SAUs), Krishi Vigyan Kendra (KVKs), Kalinga Institute of Industrial Technology, Indian National Science Academy (INSA), South Asia Nitrogen Hub (SANH), etc.
Private sector / industry	Fertiliser Association of India (FAI), Indian Farmers Fertiliser Cooperative (IFFCO), Krishak Bharti Cooperative (KRIBHCO), Rashtriya Chemicals & Fertilizers Ltd. (RCFL), National Fertiliser Ltd. (NFL), Madras Fertilizers Limited- Manali (MFL), Coromandel Group), All India Association of Industries: AIAI India, Federation of Indian Chambers of Commerce & Industry (FICCI), etc.
Civil society/Media	Farmers association/farmers, Warrior mums, Down to Earth, The Hindu, NDTV, Times of India, public, etc.

For the nitrogen-related policy collection the SANH group conducted an initial step to identify ministries directly and indirectly relevant for N management. It was identified that out of the total 57 Ministries in India, 40 Ministries were nitrogen relevant (14 directly and 26 indirectly).

Those assumed to have direct relevance to N management include:

1. Ministry of Agriculture and Farmers Welfare
2. Ministry of Chemicals and Fertilizers
3. Ministry of Civil Aviation
4. Ministry of Coal
5. Ministry of Commerce and Industry
6. Ministry of Environment, Forest and Climate Change
7. Ministry of Law and Justice
8. Ministry of Fisheries, Animal Husbandry and Dairying
9. Ministry of Jal Shakti (Water)
10. Ministry of New and Renewable Energy
11. Ministry of Petroleum and Natural Gas
12. Ministry of Power
13. Ministry of Road Transport and Highways
14. Ministry of Rural Development

Those ministries assumed to have an indirect relevance N management include:

1. Ministry of Development of North-Eastern Region
2. Ministry of Earth Sciences
3. Ministry of Education
4. Ministry of External Affairs
5. Ministry of Finance
6. Ministry of Food Processing Industries
7. Ministry of Health and Family Welfare
8. Ministry of Heavy Industries and Public Enterprises
9. Ministry of Home Affairs
10. Ministry of Housing and Urban Affairs
11. Ministry of Information and Broadcasting
12. Ministry of Micro, Small and Medium Enterprises
13. Ministry of Mines
14. Ministry of Minority Affairs
15. Ministry of Panchayati Raj
16. Ministry of Planning
17. Ministry of Railways
18. Ministry of Science and Technology
19. Ministry of Shipping
20. Ministry of Social Justice and Empowerment
21. Ministry of Statistics and Programme Implementation
22. Ministry of Steel
23. Ministry of Textiles
24. Ministry of Tourism
25. Ministry of Tribal Affairs
26. Ministry of Women and Child Development

7.1 SANH Stakeholder analysis research

SANH is conducting in-depth research into nitrogen related stakeholders for many of the countries in South Asia. Stakeholder analysis research enables the systematic identification of these stakeholders, the assessment and comparison of their particular set of interests, roles and powers, and the consideration and investigation of the relationships between them (Reed et al., 2009). Via this approach is it possible to identify who has an interest, who has the power to influence what happens and how these different groups interact. This information can help to identify barriers and opportunities which influence how these groups could work more effectively together to address the N challenge (Raum, 2018). Stakeholder analysis helps to understand the power dynamic, and current and potential alliances that impact policy decisions or could do so in future. This could help to improve N management in the context of any decision or resource management context to support future policy decisions.

The TERI School of Advanced Studies, as part of SANH, has conducted, as phase 1, a policy and stakeholder analysis of the agricultural sector in India. This policy and stakeholder analysis used a qualitative, multi-stage and multi-method approach. For more details on this approach please see the summary report (Das et al., 2022). A full report is in preparation. In Phase 2 of this approach, a policy and stakeholder analysis is also being conducted for the energy sector in India.

As part of Phase 1 stakeholder analysis on the agriculture sector, policies were firstly assessed to identify key policy changes related to N management within the agriculture sector. Four key policy areas were identified:

- Fertilizers
- Organic & Sustainable Practices
- Crop Residue & Management
- Livestock Feed & Waste Management

After identifying the key policies, stakeholders were identified, via a literature review. These stakeholders were then categorised via inputs from a focus group discussion (FGD) with sector experts, using an Interest-Influence matrix, to categorise stakeholder positions. The Interest-Influence matrix is a visualisation tool that enables mapping the interests and influence of all stakeholders. The mapping exercise also facilitates discussion during the FGD of the position of the stakeholders in relation to interest and influence. The resulting matrix depicts interest on the vertical axis (low, medium, or high) and influence on the horizontal axis (low, medium or high). Such a 3 x 3 matrix provides a nuanced depiction and understanding of stakeholder positions (Yang et. al., 2015).

Figure 27 illustrates the interest-influence matrix results for stakeholders with respect to the fertilizer sector policy reform. The positions of the key stakeholders vary in relation to the policies and agriculture sub-sectors in question. The results are based on the perceptions of the expert group and the literature. However, positions are neither static nor independent of other stakeholder positions. By clarifying relative levels of stakeholder interest and influence, can inform stakeholder engagement strategies to garner policy support and salience in favour of sustainable nitrogen management policies and decisions. Further in-depth discussion of these results will be available in a forthcoming report (Das et al., 2023).

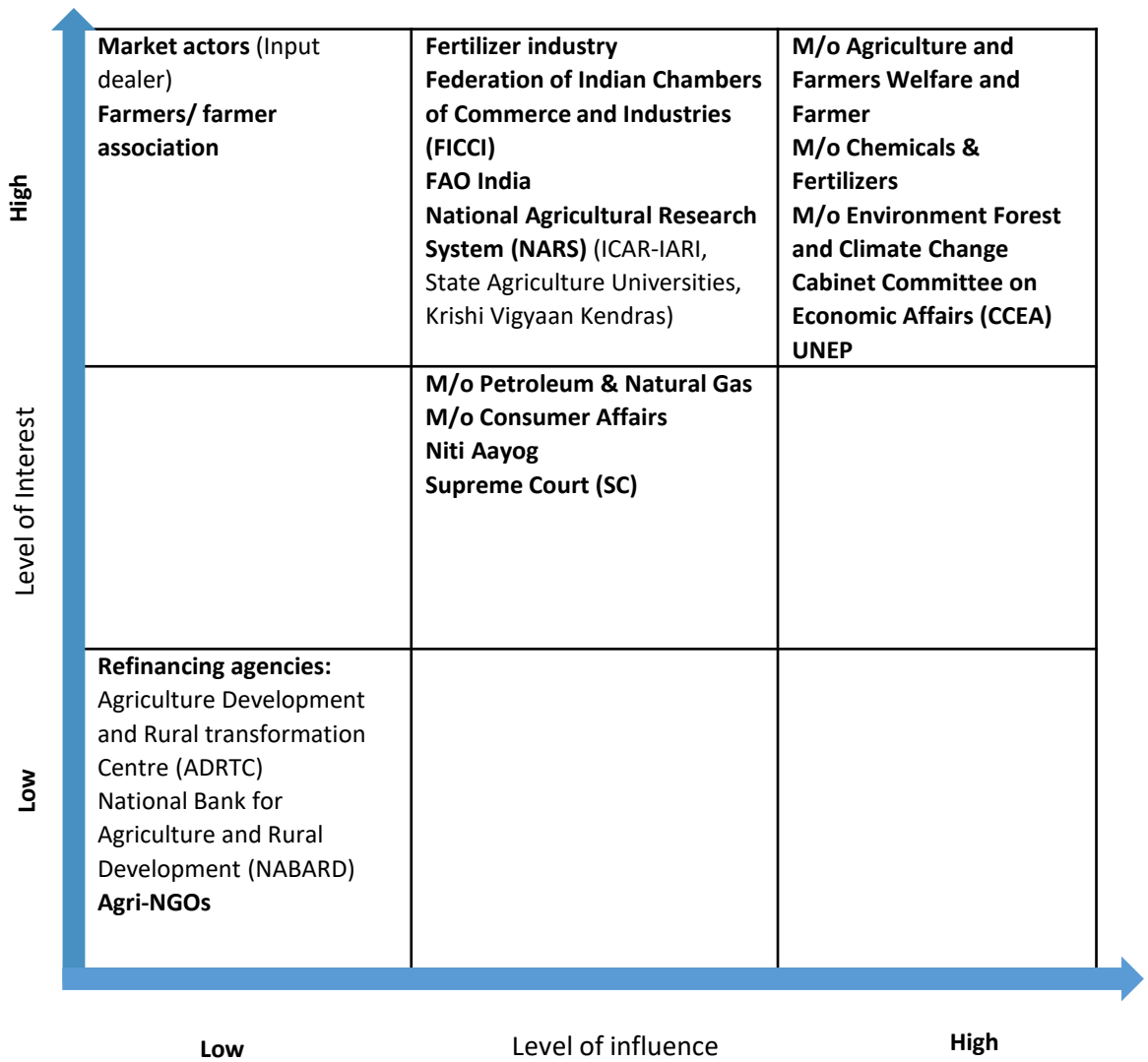


Figure 27: Interest-Influence stakeholder matrix: Fertilizer sector reforms in India.
Source: Das et al., (2022)

8 RECOMMENDATIONS

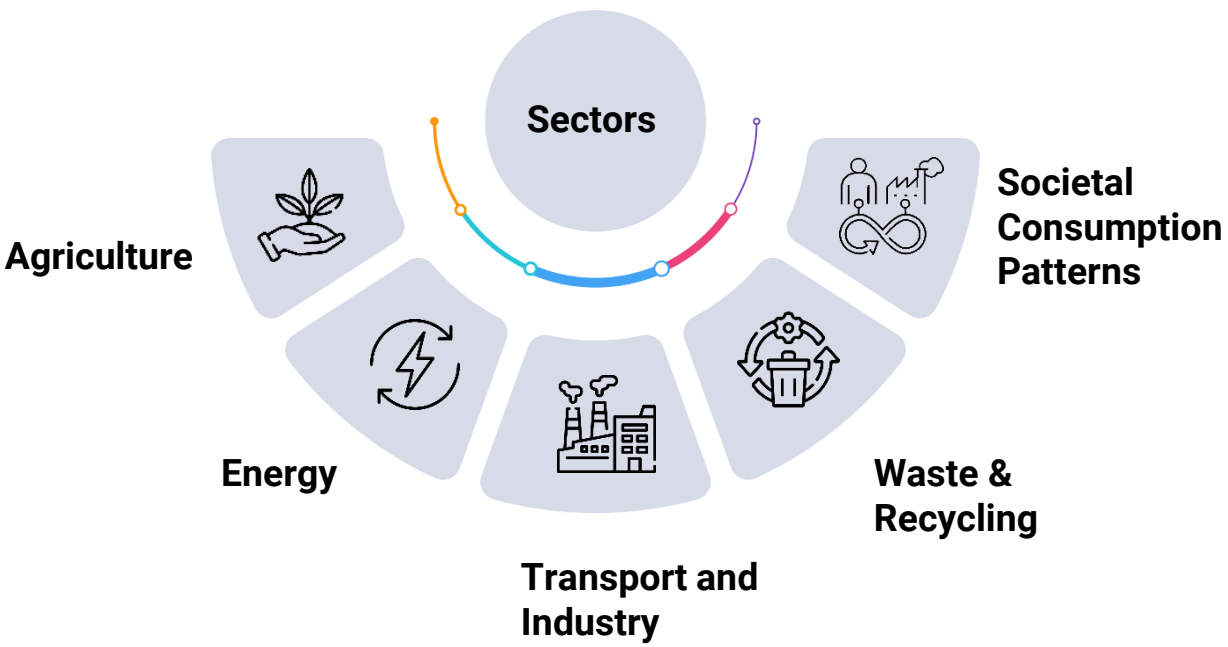
8. Recommendations

From the policy and N emission results outlined in this national report the following key findings and recommendations are highlighted below:

- **The management of nitrogen is a major issue globally and therefore international policy, yet information about nitrogen policies at national levels is scarce**. There is a limited understanding of the policies, the issues addressed, and the types of instruments used, and how existing policies might impact nitrogen pollution.
- **UKRI GCRF South Asia Nitrogen Hub (SANH) has taken action to address this knowledge and evidence gap and for India collected** 306 policies including those at the national and state level, contributing to 28% of the total policy collection for South Asia.
- **The nitrogen-relevant policies were classified by key characterises which enabled a policy assessment** of the text to identify policy opportunities and gaps for sustainable N_r management.
- **64% of the 306 policies collected for India were identified as medium to high relevance and impact scope (*i.e.* higher relevance) for N_r management**. Such policies may refer to environmental issues such as air pollution or climate change, or include those that deal with fertiliser for example. For policies with 'higher' nitrogen management relevance, amendments to specify pollution source type and the risk of nitrogen waste would be advantageous.
- **As well as addressing nitrogen management systematically, such policies with higher N_r relevance should also be accompanied by direct actions, such as 'core' policies, that contain regulatory and economic policy instruments**. Setting quantifiable and enforceable constraints on N production and consumption in nitrogen-related policy is recommended.
- **Policies identified as having lower relevance and/or impact scope should, however, not be considered as irrelevant, as such policies still hold potential to have an impact** and via amendments, they can mitigate any N_r waste and pollution if they do pose a potential risk.
- **In terms of sectors, the most common classification of policies was for 'agriculture' (21%).** Agriculture is one of the main contributors to India GDP and also a core contributor to national N_r emissions. Fertilizers play a vital role but much of the inputs are wasted. Sustainable alternatives are available. Such methods, that would reduce N waste, have the potential to save considerable revenue, maintain soil and human health. 37 of these agricultural policies did not feature any reference to any sink, highlighting a potential policy gap.
- **Overall, 40% of policies do not consider any environmental sink (e.g., air climate, soil etc.) this is an unfavourable characteristic given such policies can impact N pollution**. Such policies present a potential policy gap but via amendments to incorporate the sinks that could be at risk and actions to combat any undesirable N_r impacts. Policies classified with higher relevance and impact scope for N_r management could be prioritised (64% of policies).
- **Another common classification for sectors was for 'multiple sectors' (20%).** Having multiple sectors within a policy is an advantageous characteristic indicating an understanding that multiple sectors have roles to play in N_r management.
- **Only a small number (27%) of policies classified as 'directly' nitrogen-relevant policies determined if pollution sources were 'point source' locations or 'non-point source' or both.** Such policies indicate potentially useful examples for N_r management as there are different challenges involved according to the different pollution source types.
- **India has a large number of policies classified as having a positive impact direction (71%).** Such policies include the 'Odisha Organic Farming Policy, 2018' and the 'Gujrat Waste to Energy Policy, 2016'. It is encouraging to find that India has many environmentally oriented policies in place, but only a few of these recognise N_r waste/emissions as a specific issue, despite its relevance for ecosystem health, soils, climate, air and water pollution.
- **Policies classified as mixed/neutral (28%), indicate to varying degrees dual goals for economic development and the environment. Policies with a potentially negative impact direction (2%) include those that risk promoting N_r waste.** Evidence of actual policy impacts on N_r, whilst outside the scope of this study, would be necessary to determine how those policies really work in practice.

- **Action is needed in emerging sectors, considering relative changes in N_r emissions.** Different sectors contribute to the emission of N_r compounds in various ways and are growing at different rates. Currently, NO_x is one of the fastest rising (+104% between 2000 and 2015) and must abundant N_r compound (10,420 Gg in 2015) in India, sourced mostly by the energy, transport and other forms of industrial combustion sector activities. The overlap in contributing sectors to different compounds, such as NO_x, indicates areas where integrated policies are necessary to avoid pollution swapping and promote coordinated actions.
- **To deal with N_r pollution better, it is necessary to have policies that consider multiple sectors and sinks and policy instruments**. Currently, 11 policies meet this criterion to some degree. Policy examples include the 'Policy Statement for abatement of Pollution, 1991' and the 'State Action Plan on Climate Change (Haryana)'. Although not all policies would need to be integrated in this manner, a policy gap is visible.
- **Despite the number of policies in India 306 that have low to high relevance for N_r management, and the high number of polices with a potentially positive impact direction, all major N_r compound emissions (ammonia, nitrous oxide and nitrogen oxides) are on the rise**. India is a major contributor to all three N_r compounds (NH_3, N_2O and NO_X) and South Asia a global nitrogen emission hotspot (SACEP-SANH, 2022). This alone indicates that more must be done at the international, national and state level to tackle N_r waste.

Sustainable nitrogen management is a complex governance challenge. It requires the coordination of multiple ministries and departments at the central and state level to work together as shown in the diagram below.



In addition, there are a multitude of stakeholders outside of government who have interest, influence and/or impacted by N_r pollution. The Indian government's announcement in 2021 of an Inter-ministerial National Nitrogen Steering Committee for implementation of the UN resolution on Sustainable Nitrogen Management is a major step forward to bring about coordinated action. The Committee may consider, some of the following examples of policy measures/approaches appropriate for the various sectors:

Agriculture

Improving nitrogen use efficiency (NUE) in crop production by legume rotation, recycling all available manure and other organic sources and using fertilizer only to top up as per crop demand (see section 1.5, 5.2.1 and 5.3).
Improving nitrogen use efficiency in animal production by banning untreated release of their excreta and other wastes into the environment and introducing best practices for their collection, storage and recycling for food/feed/fibre and greening purposes. These measures will increase the fertilizer N equivalence value of animal manure and prevent pollution from animal excreta/wastes.

Energy

- Gradual replacement of polluting fuels like coal with cleaner fuels and investment on renewable energy source. India has already announced that it aims to reach net zero emissions by 2070 and to meet 50% of its electricity requirements from renewable energy sources by 2030. Therefore, further effort is needed to reduce polluting energy sources and fuel, especially in reducing nitrogen oxide (NO_x) emissions (see section 5.2.2).

Transport and Industry

- Continue to push for low-emission combustion and energy-efficient systems for electricity, industry and transport. In addition, disincentivize the sale/use of diesel-cars in urban areas suffering air pollution, as diesel engines emit far more GHGs and particulate matter than petrol engines (see section 5.2.2).
- Promote adoption of available NO_x capture and utilization technologies and their improvement towards affordability and efficiency.

Waste & Recycling

- Improving food supply efficiency & reducing food waste at all stages from farm to home/restaurant.
- Recycling nitrogen (and phosphorus) from wastewater systems by expanding sewage treatment capacity to 100% all over India in a phased manner and improving sewer lines connecting them. Currently, an estimated 30% of sewage is treated in India according to the Central Pollution Control Board, New Delhi[31]
- A recent study highlighted the recovery of nutrients from wastewater could reduce emissions and avoid 0.38Mt/a in fertiliser imports (103-100 Million USD/a) (Gowd et al., 2022) (section 5.3).
- https://cpcb.nic.in/status-of-stps/)

Societal Consumption Patterns

- Energy saving: Boost LED light adoption, phase out low energy efficiency gadgets, push roof-top solar electricity generation heavily.
- Transport saving: Return to incentivizing working people to stay close to their workplace and avoid transport, by mandating all major public and private offices/companies to arrange accommodation nearby. This also avoids choking roads and parking slots. Expanding public transport options and encouraging working from home would also be desirable to minimise traffic.
- Dietary changes: Lower the human consumption of animal protein by making pulses and vegetables cheaper for consumers, among other measures. Use government procurement of pulses to incentivize farmers to return to cereal-legume rotations.

[31] https://cpcb.nic.in/status-of-stps/)

9 CONCLUDING REMARKS

9. Concluding Remarks

Of the total of 306 nitrogen-relevant policies framed by the Government of India till date, 70% of N-related policies in India had a presumed positive impact and only 2% with negative impact. However, N_r compound emissions are still increasing. Government of India is well aware of its responsibilities as evidenced by its contributions to nitrogen policy developments at the international level, e.g., its leading role in the first UNEA nitrogen resolution amongst many actions. However, efforts should be made to draft and enact more proactive policies to control N_r and reduce waste in the country. Appropriate policy interventions by the Government can support environment and economy alike. These can be achieved by more efficient use of N-fertilizers and cleaning up the environment by reducing dependence on fossil fuels and supporting green and renewable energy resource and which will save money and also provide a better quality of life to its citizens.

The development of National Action Plans is advised in the United Nations Environment Assembly (UNEA-5) resolution on sustainable nitrogen management. India could strengthen regional/ international commitments by supporting UNEA-5.2 and preparing for UNEA-6 to manage nitrogen sustainably.

Further in-depth research on these N_r relevant policies is necessary, to assess, amongst other aspects, their impact. SANH will continue to analyse N-relevant policy, increase the evidence base, and engage with SACEP member states to broker a better understanding.

Science-based decision-making is crucial to move towards N_r sustainability and SANH is supporting this journey to create the scientific evidence of the sources and causes of emissions, and ways to mitigate their impact. SANH will improve the scientific and technical base and help strengthen India's contributions to address N_r both nationally, regionally and beyond.

10 REFERENCES

10. References

Abrol, Y.P., Adhya, T.K., Aneja, V.P., Raghuram, N., Pathak, H., Kulshrestha, U., Sharma, C. and Singh, B. eds., 2017. The Indian nitrogen assessment: sources of reactive nitrogen, environmental and climate effects, management options, and policies. Elsevier.

Anenberg, S.C., Mohegh, A., Goldberg, D.L., Kerr, G.H., Brauer, M., Burkart, K., Hystad, P., Larkin, A., Wozniak, S. and Lamsal, L., 2022. Long-term trends in urban NO_2 concentrations and associated paediatric asthma incidence: estimates from global datasets. The Lancet Planetary Health, 6: e49-e58.

Bansal, S., Raghuram, N., Adhya, T.K., Rahman, M.M., Tshering, D., Dahal, K.R., Wakeel, A., Aminath, S., Safi, Z., Nissanka, S. and Pathak, H., 2022. Long-term trends of direct nitrous oxide emission from fuel combustion in South Asia. Environmental Research Letters, 17: 045028.

Berlin.de. 2023. Low Emission Zone: Berlin: Senate Department for the Environment, Urban Mobility, Consumer Protection and Climate Action. https://www.berlin.de/sen/uvk/en/environment/air/low-emission-zone/

Bhardwaj, A.K., Malik, K., Chejara, S., Rajwar, D., Narjary, B. and Chandra, P. 2023. Integration of organics in nutrient management for rice-wheat system improves nitrogen use efficiency via favorable soil biological and electrochemical responses. Front. Plant Sci. 13:1075011. doi: 10.3389/fpls.2022.1075011

Bhattacharyya, T., Pal, D.K., Easter, M., Williams, S., Paustian, K., Milne, E., Chandran, P., Ray, S.K., Mandal, C., Coleman, K., Falloon, P., Powlson, D.S. and Gajbhiye, K.S.. 2007. Evaluating the Century C model using long-term fertilizer trials in the Indo-Gangetic Plains, India. Agriculture Ecosystems & Environment 122: 73-83

Bhattacharyya, T., Pal, D.K., Mandal, C., Chandran, P., Ray, S.K., Sarkar, D., Velmourougane, K., Srivastava, A., Sidhu, G.S., Singh, R.S., Sahoo, A.K., Dutta, D., Nair, K.M., Srivastava, R., Tiwary, P., Nagar, A.P. and Nimkhedkar, S.S., 2013. Soils of India: historical perspective, classification and recent advances. Current Science 104: 1308-23.

Bhuvaneshwari, S., Hettiarachchi, H., Meegoda, J.N., 2019. Crop residue burning in India: policy challenges and potential solutions. *International Journal of Environmental Research and Public Health* 16: 832. doi:10.3390/ijerph16050832

Birol, F., Kant, A. 2022. India's clean energy transition is rapidly underway, benefiting the entire world, International Energy Agency https://policycommons.net/artifacts/2210787/indias-clean-energy-transition-is-rapidly-underway-benefiting-the-entire-world/2967163/

Brink C., van Grinsven, H., Jacobsen, B.H., Rabl, A., Gren, I.M., Holland, M., Klimont, Z., Hicks, K., Brouwer, R., Dickens, R., Willems, J., Termansen, M., Velthof, G., Alkemade, R., van Oorschot, M. and Webb, J., 2011. Costs and benefits of nitrogen in the environment (chapter 22) In: European Nitrogen Assessment (ENA): Sources, Effects and Policy Perspectives, edited by Sutton M. et al., Cambridge University Press

Carter, J.G., 2007. Spatial planning, water and the Water Framework Directive: insights from theory and practice. Geographical journal, 173: 330-342.

Chang, J.H., (1967). The Indian summer monsoon. *Geographical review*, 57(3), pp.373-396. doi:10.2307/212640.

Chitale, V.S., Behera, M.D. and Roy, P.S., 2014. Future of Endemic Flora of Biodiversity Hotspots in India. PLoS One. 9: e115264. doi: 10.1371/journal.pone.0115264

Chowdhury, S., Dey, S., Tripathi, S.N., Beig, G., Mishra, A.K., Sharma, S. 2017. "Traffic intervention" policy fails to mitigate air pollution in megacity Delhi. *Environmental science & policy* 74: 8-13.

Clean Air Fund (2021) *Air Pollution and its Impact on Business: The Silent pandemic*, Clean Air Fund (CAF). https://www.cleanairfund.org/wp-content/uploads/01042021_Business-Cost-of-Air-Pollution_Long-Form-Report.pdf

Connor, D.J., Loomis, R.S. and Cassman, K.G., 2011. Crop ecology: productivity and management in agricultural systems. Cambridge University Press.

Crippa, M., Guizzardi, D., Muntean, M., Schaaf, E., and Oreggioni, G., 2019a. EDGAR v5.0 Global Air Pollutant Emissions. European Commission, Joint Research Centre (JRC) [Dataset] PID: http://data.europa.eu/89h/377801af-b094-4943-8fdc-f79a7c0c2d19

Crippa, M., Guizzardi, D., Muntean, M., Schaaf, E., Lo Vullo, E., Solazzo, E., Monforti-Ferrario, F., Olivier, J.G.J. and Vignati, E.E., 2019b. EDGAR v5.0 Greenhouse Gas Emissions. European Commission, Joint Research Centre (JRC) [Dataset] PID: http://data.europa.eu/89h/488dc3de-f072-4810-ab83-47185158ce2a

Crippa, M., Guizzardi, D., Solazzo, E., Muntean, M., Schaaf, E., Monforti-Ferrario, F., Banja, M., Olivier, J., Grassi, G., Rossi, S. and Vignati, E., 2021. GHG emissions of all world countries. Publications Office of the European Union. https://publications. jrc. ec. europa. eu/repository/handle/JRC126363.

Dahiya, S., Myllyvirta, L., Sivalingam, N. 2017. Airpocalypse: Assessment of air pollution in Indian cities. Bengaluru: Greenpeace India. https://secured-static.greenpeace.org/india/Global/india/Airpoclypse–Not-just-Delhi–Air-in-most-Indiancities-hazardous–Greenpeace-report.pdf.

Dalgaard, T., Hansen, B., Hasler, B., Hertel, O., Hutchings, N.J., Jacobsen, B.H., Jensen, L.S., Kronvang, B., Olesen, J.E., Schjørring, J.K. and Kristensen, I.S., 2014. Policies for agricultural nitrogen management—trends, challenges and prospects for improved efficiency in Denmark. Environmental Research Letters, 9: 115002.

Das, S., Tyagi, N., Choubey, S. 2022. *Barriers and Challenges to effective Nitrogen Management: Stakeholder Analysis of Agriculture Policies in India; A Summary Document*. New Delhi, India: TERI School of Advanced Studies.

Delhi Department for Industries. 2010. Industrial Policy for Delhi, Department for Industries, Delhi, New Delhi. http://www.indiaenvironmentportal.org.in/files/DelhiIndustrialPolicy2010-2021.pdf

Dunne, D. 2020. Nitrogen fertiliser use could 'threaten global climate goals'. Carbon Brief. https://www.carbonbrief.org/nitrogen-fertiliser-use-could-threaten-global-climate-goals/#:~:text=N2O%20is%20a%20long%2Dlived,microbes%20in%20soils%20and%20oceans

Eliazer Nelson, A.R.L., Ravichandran, K., Antony, U. 2019. The impact of the Green Revolution on indigenous crops of India. *Journal of Ethnic Foods* 6: 1-10.

Erisman, J. W., Galloway, J. N., Seitzinger, S., Bleeker, A., Dise, N. B., Petrescu, A. M., Leach, A. M. and de Vries, W., 2013. Consequences of human modification of the global nitrogen cycle. Philosophical transactions of the Royal Society of London. Series B, Biological sciences, 368(1621), 20130116. https://doi.org/10.1098/rstb.2013.0116.

Erisman, J.W., Bleeker, A., Galloway, J. and Sutton, M.S., 2007. Reduced nitrogen in ecology and the environment. Environmental Pollution. 150: 140-149.

Erisman, J.W., Leach, A., Adams, M., Agboola, J.I., Ahmetaj, L., Alard, D., Austin, A., Awodun, M.A., Bareham, S., Bird, T.L. and Bleeker, A., 2014. Nitrogen deposition effects on ecosystem services and interactions with other pollutants and climate change. In Sutton, M.A., Mason, K.E., Sheppard, L.J., Sverdrup, H., Haeuber, R., Hicks, W.K. eds. Nitrogen deposition, critical loads and biodiversity (pp. 493-505). Springer, Dordrecht.

European Environment Agency (EEA), 2020. Indicator assessment; Emissions of air pollutants from transport, https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-air-pollutants-8/transport-emissions-of-air-pollutants-8 European Environment Agency. Copenhagen.

European Space Agency. 2019. Copernicus Open Access Hub. European Space Agency, France. Available online: https://scihub.copernicus.eu/ accessed July 24, 2022

FAO [Food and Agriculture Organization of the United Nations], 2021. The State of the World's Land and Water Resources for Food and Agriculture: Systems at Breaking Point. Synthesis Report 2021. Rome, doi.org/10.4060/cb7654en.

FAO [Food and Agriculture Organization of the United Nations], 2016. FAOSTAT3. ed. United Nations Food and Agriculture Organization. Romehttp://www.fao.org/faostat/: http://www.fao.org/faostat/

FAO [Food and Agriculture Organization of the United Nations], 2017. The future of food and agriculture: Trends and challenges. FAO, Rome, pp. 1-180.

FAOSTAT, 2023. Food and agriculture data; Food and Agriculture Organisation (FAO); https://www.fao.org/faostat/en/#home

Forster, P., Ramaswamy, V., Artaxo, P., Berntsen, T., Betts, R., et al. 2007. Changes in atmospheric constituents and in radiative forcing. In *Climate change 2007. The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. Solomon, S., Qin, D., Manning, M., Avery, K., Marquis, M., et al. Cambridge: Cambridge University Press

Foster, A., Kumar, N., 2011. Health effects of air quality regulations in Delhi, India. *Atmospheric Environment* 45: 1675-83.

Galloway, J.N., Townsend, A.R., Erisman, J.W., Bekunda, M., Cai, Z., Freney, J.R., Martinelli, L.A., Seitzinger, S.P. and Sutton, M.A., 2008. Transformation of the nitrogen cycle: recent trends, questions, and potential solutions. Science, 320: 889-892.

Ganguly, T., Selvaraj, K.L., Guttikunda, S.K. 2020. National Clean Air Programme (NCAP) for Indian cities: Review and outlook of clean air action plans. *Atmospheric Environment: X* 8100096. https://doi.org/10.1016/j.aeaoa.2020.100096

Giannakis, E., Kushta, J., Bruggeman, A., Lelieveld, J. 2019. Costs and benefits of agricultural ammonia emission abatement options for compliance with European air quality regulations. *Environmental Sciences Europe* 31: 1-13. https://doi.org/10.1186/s12302-019-0275-0

Goodkind, A.L., Tessum, C.W., Coggins, J.S. and Marshall, J.D., 2019. Fine-scale damage estimates of particulate matter air pollution reveal opportunities for location-specific mitigation of emissions. PNAS 116 (18) 8775-8780 https://doi.org/10.1073/pnas.1816102116

Gowd, S.C., Ramakrishna, S., Rajendran, K., 2022. Wastewater in India: An untapped and under-tapped resource for nutrient recovery towards attaining a sustainable circular economy. *Chemosphere* 291: 1-20. https://doi.org/10.1016/j.chemosphere.2021.132753

Gu, B., Zhang, L., Van Dingenen, R., Vieno, M., Van Grinsven, H.J., Zhang, X., Zhang, S., Chen, Y., Wang, S., Ren, C., Rao, S. 2021. Abating ammonia is more cost-effective than nitrogen oxides for mitigating PM2. 5 air pollution. *Science*, 374: 758-62.

Gunningham, N., Grabosky, P. and Sinclair, D., 1998. *Smart regulation: Designing environmental policy*, Vol. 514 WorldSciNet.com.

Hicks, K., 2011. Nitrogen deposition and Natura 2000: Science and practice in determining environmental impacts.

Hicks, W.K., Whitfield, C.P., Bealey, W.J. and Sutton, M.A., (2011). *Nitrogen deposition and Natura 2000: Science and practice in determining environmental impacts.* COST office-European Cooperation in Science and Technology.

IBEF. 2022 Metals and Metal Industry Report. New Delhi: India Brand Equity Foundation. https://www.ibef.org/industry/metals-and-mining

IEA [International Energy agency], 2021. India Energy outlook 2021: https://www.iea.org/reports/india-energy-outlook-2021

Indian Network for Climate Change Assessment. 2010. India: Greenhouse Gas Emissions 2007, Ministry of Environment and Forests, Government of India. https://www.iitr.ac.in/wfw/web_ua_water_for_welfare/water/WRDM/MOEF_India_GHG_Emis_2010.pdf

International Climate Transparency Partnership. 2020. *The Climate Transparency Report 2020*. Berlin: Berlin Governance Platform.

IPCC/TEAP, 2005. *IPCC/TEAP Special Report on Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons*. Prepared by Working Group I and III of the Intergovernmental Panel on Climate Change and the Technology and Economic Assessment Panel (Metz, B., Kuijpers, S., Solomon, S., Andersen, S.O., Davidson, O., Pons, J., de Jager, D., Kestin, T., Manning, M. and Meyer, L.A. (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 448.

Jadeja, N.B., Banerji, T., Kapley, A. and Kumar, R., 2022. Water pollution in India–Current scenario. Water Security, 16: 100119.

Jarvis, S., Hutchings, N., Brentrup, F., Olesen, J.E. and van de Hoek, K.W. (2011) Nitrogen flows in farming systems across Europe. In: Sutton, M.A., Howard, C.M., Erisman, J.W., Billen, G., Bleeker, A., Grennfelt, P., van Grinsven, H. and Grizzetti, B., eds. (2011) *The European Nitrogen Assessment*. pp. 211-228. Cambridge: Cambridge University Press.

Ji, X., Yao, Y. and Long, X., 2018. What causes PM2. 5 pollution? Cross-economy empirical analysis from socioeconomic perspective. Energy Policy, 119: 458-472.

Kanter, D.R., Bartolini, F., Kugelberg, S., Leip, A., Oenema, O. and Uwizeye, A., 2020a. Nitrogen pollution policy beyond the farm. Nature Food, 1: 27-32.

Kanter, D.R., Chodos, O., Nordland, O., Rutigliano, M. and Winiwarter, W., 2020b. Gaps and opportunities in nitrogen pollution policies around the world. Nature Sustainability, 3: 956-963.

Kaur, S., Singh, I., 2012. Quality evaluation of Yamuna water at Wazirabad and Okhla in Delhi region in summer, winter and monsoon season. *Global J. of Mod. Biol. & Tech* 2: 20-22.

Kegl, B., 2007. NOx and particulate matter (PM) emissions reduction potential by biodiesel usage. Energy & fuels, 21: 3310-3316.

Klimczyk, M., Siczek, A. and Schimmelpfennig, L., 2021. Improving the efficiency of urea-based fertilization leading to reduction in ammonia emission. Science of The Total Environment. 771, 145483. https://doi.org/10.1016/j.scitotenv.2021.145483

Kundu, S., Coumar, M.V., Rajendiran, S., Rao, A., Rao, A.S. 2015. Phosphates from detergents and eutrophication of surface water ecosystem in India. *Current science* 108: 1320-25.

Lan, R., Eastham, S.D., Liu, T., Norford, L.K. and Barrett, S.R., 2022. Air quality impacts of crop residue burning in India and mitigation alternatives. *Nature Communications*, 13: 6537.

Lassey, K. and Harvey, M., 2007. Nitrous oxide: the serious side of laughing gas. *Water Atmosphere* 15: 10-11.

Lelieveld, J., Evans, J.S., Fnais, M., Giannadaki, D. and Pozzer, A., 2015. The contribution of outdoor air pollution sources to premature mortality on a global scale. Nature, 525: 367-371.

Ma, R., Zou, J., Han, Z., Yu, K., Wu, S., Li, Z., Liu, S., Niu, S., Horwath, W.R. and Zhu-Barker, X., 2021. Global soil-derived ammonia emissions from agricultural nitrogen fertilizer application: A refinement based on regional and crop-specific emission factors. Global Change Biology, 27: 855-867.

Martin, G.D., Nisha, P.A., Balachandran, K.K., Madhu, N.V., Nair, M., Shaiju, P., Joseph, T., Srinivas, K. and Gupta, G.V.M., 2011. Eutrophication induced changes in benthic community structure of a flow-restricted tropical estuary (Cochin backwaters), India. Environmental monitoring and assessment, 176: 427-438.

Ministry of Earth Sciences. 2020. Annual Report, Ministry of Earth Sciences, Government of India, New Delhi.

Ministry of Urban Development (2017) National Policy on Faecal Sludge and Septage Management (FSSM): Ministry of Urban Development, Government of India, http://amrut.gov.in/upload/newsrelease/5a5dc55188eb0FSSM_Policy_Report_23Feb.pdf

MNRE [Ministry of New and Renewable Energy], 2022. Renewable Energy in India, Press Information Bureau: Government of India, https://pib.gov.in/FeaturesDeatils.aspx?NoteId=151141&ModuleId%20=%202

Móring, A., Hooda, S., Raghuram, N., Adhya, T.K., Ahmad, A., Bandyopadhyay, S.K., Barsby, T., Beig, G., Bentley, A.R., Bhatia, A. and Dragosits, U., 2021. Nitrogen challenges and opportunities for agricultural and environmental science in India. Frontiers in Sustainable Food Systems, 5, p.505347.

National Institute for Transforming India. 2018. Composite water management index. New Delhi: NITI-AAYOG. Available at: http://niti.gov.in/content/composite-water-management-index-june-2018-0.

Pathak, H., Mishra, J.P. and Mohapatra, T. (eds.), 2022. Indian Agriculture after Independence. Indian Council of Agricultural Research, New Delhi 110 001, pp 426

Pauleta, S.R., Carepo, M.S., Moura, I. 2019. Source and reduction of nitrous oxide. *Coordination Chemistry Reviews* 387: 436-449.

Prasad, R. and Prasad, S., 2019. Algal blooms and phosphate eutrophication of inland water ecosystems with special reference to India. International Journal of Plant and Environment, 5: 1-8.

Prather, M.J. 1998. Time scales in atmospheric chemistry: coupled perturbations to N2O, NO y, and O3. *Science* 279: 1339-41.

Raghuram, N., Abrol, Y.P., Pathak, H., Adhya, T.K. and Tiwari, M.K., 2020. The INI South Asian regional nitrogen centre: Capacity building for regional nitrogen assessment and management. In Just Enough Nitrogen: Perspectives on how to get there for regions with too much and too little nitrogen, pp. 467-479. Cham: Springer International Publishing.

Raghuram, N., Aziz, T., Kant, S., Zhou, J. and Schmidt, S., 2022. Editorial: Nitrogen Use Efficiency and Sustainable Nitrogen Management in Crop Plants. Front. Plant Sci. 13:862091. doi: 10.3389/fpls.2022.862091

Raghuram, N., Sutton, M.A., Jeffery, R., Ramachandran, R. and Adhya, T.K., 2021. From South Asia to the world: embracing the challenge of global sustainable nitrogen management. One Earth, 4: 22-27.

Raum, S. 2018. A framework for integrating systematic stakeholder analysis in ecosystem services research: Stakeholder mapping for forest ecosystem services in the UK. *Ecosystem Services* 291: 70-84.

Reed, M.S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., et al. 2009. Who's in and why? A typology of stakeholder analysis methods for natural resource management. *Journal of environmental management* 90: 1933-49.

SACEP-SANH. 2022. *South Asian Regional Cooperation on Sustainable Nitrogen: Management, Nitrogen Pollution in South Asia: Scientific Evidence, Current Initiatives and Policy Landscape*. Colombo & Edinburgh: South Asia Co-operative Environment Programme; South Asian Nitrogen Hub pp.

Sengupta, M., Anandurai, R., Nanda, S., Datti, A.A. 2017. Geospatial identification of algal blooms in inland waters: A post cyclone case study of Chilka Lake, Odisha, India. *RASAYAN Journal of Chemistry* 10: 234-39. http://dx.doi.org/10.7324/RJC.2017.1011585

Singh, A.K., Upadhyaya, A., Kumari, S., Sundaram, P.K., Jeet, P., 2020. Role of Agriculture in making India $5 trillion Economy under Corona Pandemic Circumstance. *Journal of AgriSearch* 7: 54-58.

Singh, A.P. and Chaudhary, B.R., 2011. Phenological diversity of chlorophycean algae from river Ganges at Varanasi, Uttar Pradesh. J. Algal Biomass Utln, 2: 21-29.

Srinivasarao, Ch., Rakesh, S., Ranjith Kumar, G., Manasa, R., Somashekar, G., Subha Lakshmi, C. and Kundu, S., 2021. Soil degradation challenges for sustainable agriculture in tropical India. *Current Science* 120: 492.

Srivastava, A.L. (2020) Chemical fertilizers and pesticides: role in groundwater contamination. In Agrochemicals Detection, Treatment and Remediation Pesticides and Chemical Fertilizers. Chapter 6, pp. 143-159 Srivastav, A.L. Ed., 2020. Butterworth-Heinemann.

Sutton, M., Raghuram, N., Adhya, T.K., Baron, J., Cox, C., de Vries, W., Hicks, K., Howard, C., Ju, X., Kanter, D. and Masso, C., 2019. The nitrogen fix: from nitrogen cycle pollution to nitrogen circular economy. In Frontiers 2018/2019 (pp. 52-64). United Nations Environment Programme.

Sutton, M.A. and Billen, G., 2010. European Nitrogen Assessment: Technical Summary. In: Sutton, M.A., Howard, C.M., Erisman, J.W., Billen, G., Bleeker, A., Grennfelt, P. and Hansen, J., eds. (2011) *The European Nitrogen Assessment*. Cambridge: Cambridge University Press

Sutton, M.A., Drewer, J., Moring, A., Adhya, T.K., Ahmed, A., et al. 2017. The Indian nitrogen challenge in a global perspective. In *The Indian Nitrogen Assessment*, ed. Abrol, Y.P., Adhya, T.K., Aneja, V.P., Raghuram, N., Pathak, H., et al, pp. 9-28. Duxford, Cambridge UK: Woodhead Publishing

Sutton, M.A., Howard, C.M., Kanter, D.R., Lassaletta, L., Móring, A., Raghuram, N. and Read, N., 2021. The nitrogen decade: mobilizing global action on nitrogen to 2030 and beyond. One Earth, 4: 10-14.

Sutton, M.A., Howard, C.M., Erisman, J.W., Billen, G., Bleeker, A., Grennfelt, P., van Grinsven, H. and Grizzetti, B., 2011. Assessing our nitrogen inheritance. *In*: Sutton, M.A., Howard, C.M., Erisman, J.W., Billen, G., Bleeker, A., Grennfelt, P., van Grinsven, H., Grizzetti, B. (eds.) *The European Nitrogen Assessment: Sources, Effects and Policy Perspectives.* Cambridge, Cambridge University Press, Cambridge & New York, pp. 1-6.

Sutton, M.A., Oenema, O., Erisman, J.W., Grennfelt, P., Beier, C., Billen, G., Bleeker, A., Britton, C., Butterbach-Bahl, K., Cellier, P., van Grinsven, H., Grizzetti, B., Nemitz, E., Reis, S., Skiba, U., Voss, M., de Vries, W. and Zechmeister-Boltenstern, S., 2009. *Managing the European Nitrogen Problem. A proposed strategy for integration of European Research on the multiple effects of reactive nitrogen.* NERC Centre for Ecology & Hydrology (CEH) and the Partnership for European Environmental Research (PEER), 24pp. (CEH Project No: C04910).

Tian, H., Xu, R., Canadell, J. G., Thompson, R. L., Winiwarter, W., Suntharalingam, P., et al. (2020). A comprehensive quantification of global nitrous oxide sources and sinks. Nature, 586: 248-256. doi:10.1038/s41586-020-2780-0

Udvardi, M., Below, F.E., Castellano, M.J., Eagle, A.J., Giller, K.E., Ladha, J.K., Liu, X., Maaz, T.M., Nova-Franco, B., Raghuram, N., Robertson, G.P., Roy, S., Saha, M., Schmidt, S., Tegeder, M., York, L.M. and Peters, J.W., 2021. A Research Road Map for Responsible Use of Agricultural Nitrogen. Front. Sustain. Food Syst. 5: 660155. doi: 10.3389/fsufs.2021.660155

Ul Solim, S. and Wanganeo, A. 2008. Excessive phosphorus loading to Dal Lake, India: Implications for managing shallow eutrophic lakes in urbanized watersheds. International Review of Hydrobiology, 93: 148-166.

UNEP (2018). Air Pollution in Asia and the Pacific: Science-based Solutions, United Nations Environment Programme (UNEP), https://ccacoalition.org/en/resources/air-pollution-asia-and-pacific-science-based-solutions-summary-full-report

UNEP, 2019. *Frontiers 2018/19 Emerging Issues of Environmental Concern*. Nairobi: United Nations Environment Programme.

UNEP. 2022. Resolution adopted by the United Nations Environment Assembly on 2 March 2022: Sustainable nitrogen management, United Nations Environment Assembly (UNEA) of the United Nations Environment Programme (UNEP).

UNFCCC, 2015. *Report of the Conference of the Parties to the United Nations Framework Convention on Climate Change (21st Session, Paris)*. New York: UN. 2017 pp. 27.

Van Grinsven, H.J.M., Holland, M., Jacobsen, B.H., Klimont, Z., Sutton, M.A. and Jaap Willems, W., 2013. Costs and Benefits of Nitrogen for Europe and Implications for Mitigation Environ. Sci. Technol. 47: 3571–3579

Venkataraman, K., Sivaperuman, C., 2018. Biodiversity Hotspots in India. In: Sivaperuman, C., Venkataraman, K. (eds) Indian Hotspots: Vertebrate Faunal Diversity, Conservation and Management Volume 1, pp.1-27. Springer Nature Singapore Pte Ltd. Singapore. https://doi.org/10.1007/978-981-10-6605-4_1

Verma, P. and Sagar, R., 2020. Effect of nitrogen (N) deposition on soil-N processes: a holistic approach. Scientific Reports 10:10470 https://doi.org/10.1038/s41598-020-67368-w

Vijayvergia, R.P., 2007. Eutrophication: a case study of highly eutrophicated Lake Udaisagar, Udaipur (Raj.), India with regards to its nutrient enrichment and emerging consequences. Proceedings of TAAL.

Vishwanath, B. and Ukil, A.C. (1943) Soil Map of India, Indian Agricultural Resarch Institute, New Delhi.

Water Aid. 2019. India Water Fact Sheet. https://www.wateraid.org/in/sites/g/files/jkxoof336/files/2021-10/india-water-fact-sheet-2019.pdf.

Wuebbles, D.J. 2009. Nitrous oxide: no laughing matter. *Science* 326: 56-57.

Xu, R., Tian, H., Pan, S., Prior, S.A., Feng, Y., Batchelor, W.D., Chen, J. and Yang, J., (2019). Global ammonia emissions from synthetic nitrogen fertilizer applications in agricultural systems: Empirical and process-based estimates and uncertainty. *Global change biology*, 25(1), pp.314-326.

Yang, A.L., Nandula Raghuram, N., Adhya, T.K., Porter, S.D., Panda, A.N., Kaushik, H., Jayaweera, A., Nissanka, S.P., Anik, A.R., Shifa, S., Sharna, S.C., Joshi, R., Watto, M.A., Pokharel, A. , Shazly, A., Hassan, R., Bansal, S., Kanter, D., Das, S. and Jeffery, R., 2022. Policies to combat nitrogen pollution in South Asia: gaps and opportunities. Environ. Res. Lett. 17: 025007

APPENDIX

Appendix I : Supplementary Tables

ST 1: Land cover as total land area and % of land under each class for India as per the data of Indian Space Research Organization for 2018-19

Land cover class	Total Area (Lha)	% of total land cover
Built-up	99.04	3.0
Arable Land (Rabi crop, Double/Triple crop, Kharif crop, Zaid Crop)	1393.64	42.5
Forest Area (Deciduous Forest, Evergreen Forest, Degraded Forest, Plantation)	844.72	25.7
Wetlands (Water bodies min, max, Littoral Swamp)	144.11	4.4
Shifting Cultivation	1.07	0.0
Rann	16.51	0.5
Current Fallow	295.12	9.0
Grassland	23.49	0.7
Wasteland	376.53	11.5
Snow Cover	87.32	2.7
Total	**3281.55**	**100**

Source: https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php

ST 2: List of Basin Name and Area (As per NASA-SRTM)

Sl. No	Basin Code	Basin Name	Area(sq.km)
1	1	Indus (Up to border) Basin	4,53,932
2	2a	Ganga Basin	8,08,334
3	2b	Brahmaputra Basin	1,86,422
4	2c	Barak and others Basin	45,622
5	3	Godavari Basin	30,206
6	4	Krishna Basin	2,54,743
7	5	Cauvery Basin	85,624
8	6	Subarnarekha Basin	25,792
9	7	Brahmani and Baitarni Basin	51,894
10	8	Mahanadi Basin	1,39,659
11	9	Pennar Basin	54,243
12	10	Mahi Basin	38,337
13	11	Sabarmati Basin	30,679
14	12	Narmada Basin	92,671
15	13	Tapi Basin	63,923
16	14	West flowing rivers South of Tapi Basin	1,11,644
17	15	East flowing rivers between Mahanadi and Godavari Basin	46,243
18	16	East flowing rivers between Godavari and Krishna Basin	10,345
19	17	East flowing rivers between Krishna and Pennar Basin	23,336
20	18	East flowing rivers between Pennar and Cauvery Basin	63,646
21	19	East flowing rivers South of Cauvery Basin	38,646
22	20	West flowing rivers of Kutch and Saurashtra including Luni Basin	1,84,441
23	21	Minor rivers draining into Bangladesh Basin	5,453
24	22	Minor rivers draining into Myanmar Basin	24,731
25	23	Area of North Ladakh not draining into Indus Basin	29,239
26	24	Drainage Area of Andaman and Nicobar Islands Basin	69,19
27	25	Drainage Area of Lakshadweep Islands Basin	463
28		Island Basin	372

ST 3: Classifications used in the SANH policy analysis approach.

Classification	Codes	Description
Sink	Water; Air; Climate; Soil; Ecosystem; Multiple (if more than one sink was referred to); & Not Applicable (NA) (if no sink was referred to).	If the policy objective or content mentioned one or more sinks. Classifications were not based on assumed links or impacts. A sink refers to a reservoir that takes up a nitrogen or, where nitrogen loads can accumulate and can have an 'impact'.
Sector	**Main sectors:** Agriculture; Energy; Food; Industry; Land Use Change; Transport; Urban Development & Tourism; Waste; Other; Multiple; Not Applicable (NA).	Policies were coded to a main sector, where possible, they were also coded to a sub-sector, indicating the specificity of a policy. If the policy covered multiple sub-sectors, categorising as a main sector was sufficient.
Policy type (Policies could include multiple policy instruments, therefore policies could be coded under one or more of these codes as appropriate.)	Regulatory	Policies that set quantifiable limits or restrictions on N production, consumption and loss. This could also include broader strategies if they include quantifiable targets that could have impacts on N management.
	Economic	Policies that use financial incentives and signals to spur quantifiable improvements in N management and N mitigation'. Following Kanter et al. (2020b) *regulatory* and *economic* policies were classified as 'core' policies, i.e., those most likely to have an impact on N production, consumption of management.
	Framework	Broad objectives relevant to N pollution with no quantifiable constraints and/or delegation of authority for N policymaking to another governing body'. A number of indirectly relevant policies fell under this definition. For example, it could be a regulatory policy, but in the absence of direct quantifiable constraints on nitrogen it would be classified as a 'framework' as in the case of the Regulations on Safe Food (Healthy Environment Protection), from Bangladesh.
	Data and methods	Those that 'establish data collection and reporting protocols for various aspects of N pollution but do not set environmental standards or enforce them'. This would also include standards (which could in addition be classified as regulatory). Policies that refer to an objective and/or actions for Monitoring and evaluation (M&E) were also classified under this

	Research & Development (R&D)	Policies that allocate funding for R&D both into the effects of N pollution on the environment and human health and into new technologies that could improve N management'. A policy could be classified under this code if it referred to promoting research in the text and that research relates to N related practices
	Commerce	Policies that regulate an aspect of the business environment surrounding N production and consumption'.
	Pro-N	Policies that lower the price of N production and consumption via government aid or other means, usually incentivizing higher farmer-level N use'
Pollution type	Point source	*Point source pollution* is where nitrogen pollution is discharged directly into water or into the atmosphere at a 'discrete point', making it easier to control and monitor. A policy would be classified as this if it states actions to target/control/measure point source pollution.
	Non-point source	*Non-point source* covers pollution that comes from many land, air or water sources and can be carried overland, underground, or in the atmosphere, making them difficult to measure and control (Islam et al., 2018; Liu et al.,2020). A policy would be classified as this if it states actions to target/control/measure non-point source pollution.
	Both	Policies refer targeting both point and non-point source pollution
	Unspecified	For policies that do not reference or recognise the different types of N pollution sources, and do not specify any intention/ measure/control pollution from either of those source types.
	Not applicable (NA)	The default classification for Policies classified with a *negative* impact direction, and/or as having an *indirect relevance* received.
Impact direction	Positive	A policy was coded with 'positive' impact if it promoted a reduction in N pollution and/or improved nitrogen management whether directly or indirectly. This would likely include policies that were environmentally oriented such as environmental standards, and water quality control policies.

Impact direction	Mixed/ neutral	Policies coded 'mixed neutral' if it could do both, e.g., aiming to enhance food production but also considering environmental impacts, or if the policy is potentially neutral in its impacts
	Negative	A policy that could potentially cause excess nitrogen, such as those that promote synthetic fertiliser use or fossil fuels, would be coded as 'negative' e.g., promotion of fossil fuels
Impact scope	Large	This classification was for distinguishing the scale of 'possible' impact a policy could have on N use. A *'large'* scope would include nation-wide policies such as an agricultural policy with wide implications for N management.
	Medium	*Medium* scope would include those that may encompass a large area (national) but have fewer implications for N management, or sub-national level but large implications for N management. For example, national food and security policies, or a provincial Forest Act
	Small	Policies with a *small* scope include smaller spatial areas than provincial, and may be area/zone specific, and/or with minor implications for N management, e.g., plant quarantine rules
Relevance	High (direct)	For high and direct relevance to N, 29 key words were used to identify policies, i.e., if the policy contained one or more of these listed key words.[32]
	Medium (indirect)	Those classified with 'medium' relevance included 'indirect policies' that still had clear relevance to nitrogen but did not contain the key words.
	Low (indirect)	Policies classified with 'low' relevance include those policies more distantly related to N management such as 'seed' policies or road expansion policies. These policies did not contain any key words or related synonyms but could have indirect knock-on implications for N pollution. For example, road expansion policies encourage more cars, thus leading to increases in NOx emissions, unless mitigated by other policy initiatives and measures.

[32]**Key words:** fertilizer, manure, N, N pollution, nutrient pollution, nitrate, nitrates, ammonia, N oxides, nitrous oxide, N2O, NH3, NO3, NOx, eutrophication, hypoxia, air quality, air pollution, emissions, groundwater quality, groundwater pollution, freshwater quality, freshwater pollution, water quality, ozone depletion, climate change, greenhouse gas, agro-chemical and effluent

ST 4: Number and percentage of nitrogen-related policies in India for policy type

Policy Type	Total No. of policy classifications	% of classifications
Regulatory	113	21
Economic	35	7
Framework	246	46
Data & methods	60	11
Research & Development (R&D)	35	7
Commerce	33	6
Pro-N	9	2
Total	531	100

Note: The total number of classifications (531) exceeds the total number of policies (306) as a single policy could be classified as multiple policy types

ST 5. Number and percentage of nitrogen-related policies in India for sectors and sub-sectors

Main Sector	No. of policies	% of policies	Sub-sector	No. of policies	% of policies
Agriculture	**58**	**19**	Agricultural biotechnology	**1**	0
			Agriculture other	**16**	5
			aquaculture	**7**	2
			Synthetic Fertilizer	**9**	3
			Crop residues	**1**	0
			Livestock	**5**	2
			organic farming	**3**	1
			Multiple	**4**	2
			Food safety	**1**	0
			Non-applicable*	**11**	4
Energy	**16**	**5**	Biofuel and bio energy	**3**	1
			Low Carbon and Renewables	**7**	2
			Multiple	**0**	0
			NA	**1**	0
			Non-Renewable Energy	**5**	2
Food	**11**	**4**	Agriculture other	**1**	0
			Food safety	**6**	2
			Food Security	**4**	1
Land Use Change	**40**	**13**	Forestry	**24**	8
			Multiple	**3**	1
			NA	**1**	0
			Other Land Use and Land Use Change	**12**	4
Industry	**10**	**3**	Industrial/ Commercial Waste	**3**	1
			NA	**6**	2
			Non-Renewable Energy	**1**	0
Other	**18**	**6**	Multiple	**1**	0
			NA	**17**	6
Urban Development & Tourism	**20**	**6**	Livestock	**1**	0
			Multiple	**5**	2
			NA	**13**	4
			Other Land Use and Land Use Change	**1**	0
Waste	**29**	**9**	Medical Waste	**2**	1
			Industrial/Commercial Waste	**1**	0
			Multiple	**8**	3
			Municipal Waste	**16**	5
			Non-applicable*	**2**	1
Multiple	**58**	**19**	Multiple	**26**	9
			Non-applicable*	**32**	10
			Forestry	**0**	0
No Sector Included	**31**	**10**	NA	**31**	10
Transport	15	5	Aviation	**2**	1
			Multiple	**1**	0
			Rail	**1**	0
			Road transport	**5**	2
			Transport other	**6**	2
Total	**306**	**100**	-	**306**	100

Note: * Non-applicable (NA) represents a general sector policy that does not specify a

ST 6: Percentage of nitrogen-related policies by sink & sector, from India

Sink		Air	Climate	Ecosystem	Multiple	Water	No Sink Included	Soil	Grand Total
Sector	Agriculture	0	0	0	4	2	13	0	**19**
	Energy	2	1	0	1	0	1	0	**5**
	Food	0	0	0	0	0	4	0	**4**
	Industry	0	0	0	0	0	3	0	**3**
	Land Use Change	0	0	9	2	0	1	0	**13**
	Multiple	1	0	0	6	6	6	0	**19**
	Other	0	0	0	0	2	3	0	**6**
	Urban Development. & Tourism	0	0	0	1	2	4	0	**7**
	Waste	0	0	0	4	2	3	0	**9**
	Transport	2	0	0	1	0	2	0	**5**
	No Sector Included	1	1	0	1	5	2	0	**10**
Grand Total		6	3	11	21	19	41	0	**100**

ST 7: Percentage of classifications by sink and policy type classification for India's nitrogen-related policies

Sink	Regulatory	Economic	Framework	Data & methods	R&D	Commerce	ProN	Total
Air	1	1	3	1	1	0	0	7
Climate	0	1	1	0	0	0	0	3
Ecosystem	3	0	6	1	0	0	0	11
Multiple	6	1	10	4	3	1	1	24
No sink included	4	3	19	3	1	5	1	35
Soil	0	0	0	0	0	0	0	1
Water	7	1	7	2	2	0	0	19
Grand Total	21	7	46	11	7	6	2	100

Note: The percentage is calculated from the total number of classifications (i.e., 531) and not the total number of policies. This is because one policy could have multiple policy types.

ST 8: Percentage of classifications by policy type and sector for India's nitrogen-related policies

	Policy Type							
Sectors	**Regulatory**	**Economic**	**Framework**	**Data & methods**	**R&D**	**Commerce**	**Pro-N**	**Total**
Agriculture	3	2	9	1	2	2	1	20
Energy	1	1	2	0	1	1	0	5
Food	1	0	1	1	0	0	0	3
Industry	0	0	1	0	0	1	0	3
Land use change	5	0	7	1	0	0	0	14
Multiple	5	1	8	3	2	2	0	21
Other	1	0	3	1	0	0	0	5
Transport	1	0	2	1	0	0	0	4
Urban dev. & tourism	0	1	4	1	0	0	0	6
Waste	2	0	4	3	0	0	0	9
No sector included	3	1	4	1	1	0	0	10
Grand total	21	7	46	11	7	6	2	100

Table ST9.1: percentage of *selected India nitrogen-relevant policies for sink and sector

Sink	Sector											
	Agriculture	Energy	Food	Land use change	Multiple	No sector included	Other	Industry	Transport	Urban Dev. & Tourism	Waste	Total
Air	0	3	0	0	2	1	0	1	3	0		9
Climate	0	2	0	0	0	2	0	0	1	0	0	3
Ecosystem	1	0	0	3	1	1	1	0	0	0	0	5
Multiple	7	1	0	1	9	2	1	0	1	1	3	23
Not Applicable (NA)	13	2	1	1	4	1	2	3	1	2	4	32
Soil	1	0	0	0	0	0	0	0	0	0	0	0
Water	2	0	0	0	9	6	3	0	1	3	3	25
Grand Total	23	7	1	5	24	12	6	4	5	5	9	100

Note: *Selected policies are based on high–medium relevance and impact scope, a total of 197 policies

Table ST 9.2: Percentage of *selected India nitrogen-relevant policies for sector, sub-sectors and policy type

Sector and sub sectors	Regulatory	Economic	Framework	Data & methods	R&D	Commerce	Pro-N	Total
Agriculture*	3	3	9	2	3	3	2	24
Agriculture biotechnology	0	0	0	0	0	0	0	0
Agriculture other	1	1	2	0	0	0	1	5
Aquaculture	0	0	1	0	0	0	0	1
Crop residues	0	0	0	0	0	0	0	0
Food safety	0	0	0	0	0	0	0	0
Livestock	0	1	1	0	0	0	0	2
Multiple	0	1	1	0	0	1	1	3
NA	1	0	2	1	2	1	0	7
Organic farming	0	0	1	0	0	0	0	2
Synthetic Fertilizer	0	1	1	0	0	1	0	3
Energy*	1	1	3	0	1	1	0	7
Biofuel And Bioenergy	0	0	1	0	0	0	0	1
Low carbon and renew	1	1	1	0	1	1	0	4
Multiple	0	0	0	0	0	0	0	0
NA	0	0	0	0	0	0	0	0
Non Renewable energy	0	1	1	0	0	0	0	2
Food*	0	0	0	0	0	0	0	1
Food Safety	0	0	0	0	0	0	0	0
Food Security	0	0	0	0	0	0	0	0
Industry*	0	1	1	0	0	1	0	3
Industrial/Commercial Waste	0	0	1	0	0	0	0	1
NA	0	0	1	0	0	0	0	1
Non Renewal energy	0	0	0	0	0	0	0	1
Land use change*	1	0	2	1	0	0	0	5
Forestry	0	0	0	0	0	0	0	1
Multiple	0	0	1	0	0	0	0	1
Other land use and land use change	1	0	1	1	0	0	0	4
Multiple*	6	1	10	4	3	1	0	25
Agriculture _other	0	0	0	0	0	0	0	0
Flood water	0	0	0	0	0	0	0	1
Multiple	4	0	4	2	2	0	0	14
Municipal Waste	0	0	0	0	0	0	0	0
NA	1	1	6	1	1	1	0	10
NA*	4	1	4	1	1	0	0	12
Forestry	0	0	0	0	0	0	0	0
NA	4	1	4	1	1	0	0	12
Non-renewable energy	0	0	0	0	0	0	0	0

Other*	2	0	2	1	0	0	0	5
Multiple	0	0	0	0	0	0	0	1
NA	2	0	2	1	0	0	0	4
Transport*	1	1	2	1	0	0	0	6
Aviation	0	0	0	0	0	0	0	0
Multiple	0	0	0	0	0	0	0	1
Rail	0	0	0	0	0	0	0	1
Road transport	0	0	0	1	0	0	0	1
Transport other	1	0	1	1	0	0	0	3
Urban development & tourism*	1	1	3	0	0	0	0	4
Multiple	0	0	1	0	0	0	0	1
Non-applicable	0	1	2	0	0	0	0	3
Waste*	3	0	4	3	0	0	0	9
Industrial/Commercial Waste	0	0	0	0	0	0	0	1
Multiple	1	0	2	1	0	0	0	3
Municipal waste	1	0	2	2	0	0	0	4
NA	1	0	0	0	0	0	0	1
Grand Total	21	8	41	13	9	6	2	100

Note: *Main sectors. Note: Selected policies include those with high–medium relevance and impact scope, a total of 197 policies. The percentages are based on the total number of classifications, and a total of 306 for the selected policies. Rows coloured in light blue indicate the main sectors and the subtotal for sub-sectors.

ST 10. Number and percentage of Indian nitrogen-relevant policies broken down by sector before 2000, 2001-2011 and 2011-2020

Sector	No. of policies			% of policies		
	Before 2000	2001-2010	2011-2020	Before 2000	2001-2010	2011-2020
Agriculture	12	22	24	4	7	8
Energy	0	2	14	0	1	5
Food	4	2	5	1	1	2
Industry	6	0	4	2	0	1
Land use change	22	8	10	7	3	3
Multiple	16	20	22	5	7	7
Other	4	6	8	1	2	3
Transport	2	3	10	1	1	3
Urban development & tourism	4	4	12	1	1	4
Waste	7	4	18	2	1	6
No sector included	7	15	9	2	5	3
Grand Total	84	86	136	27	28	45

ST 11: Number of nitrogen-related policies broken down by sink before 2000, 2001-2010 and 2011-2020

Sink	No. of policies			% of policies		
	Before 2000	2001-2010	2011-2020	Before 2000	2001-2010	2011-2020
Air	3	3	13	1	1	6
Climate	0	3	5	0	1	2
Ecosystem	18	8	7	6	3	3
Multiple	18	14	32	6	5	14
No sink	31	32	60	10	10	28
Water	14	26	18	5	8	8
Soil	0	0	1	0	0	0
Grand Total	84	86	136	27	28	45

ST 12: Number and percentage of nitrogen-related policy classifications for policy type before 2000, 2001-2010 and 2011-2019

	No. of policies			% of policy classifications		
Policy Type	**Before 2000**	**2001-2010**	**2011-2020**	**Before 2000**	**2001-2010**	**2011-2020**
Regulatory	39	33	41	7	6	8
Economic	4	9	22	1	2	4
Framework	68	69	109	13	13	21
Data & Method	8	11	41	2	2	8
R&D	4	8	23	1	2	4
Commerce	7	8	18	1	2	3
Pro-N	2	4	3	0	1	1
Grand Total	132	142	257	25	27	48

Note: The total number of classifications (531) exceeds the total number of policies (306) as a single policy could be classified as multiple policy types.

ST 13: Emissions of nitrous oxide (N2O), nitrogen oxides (NOx) ammonia (NH3), for different sectors for the year 2015 and percentage change since 2000 in India

	N_2O	NO_x			NH_3				
Sectors	**Gg/ 2000**	**Gg/ 2015**	**% change**	**Gg/ 2000**	**Gg/ 2015**	**% change**	**Gg/ 2000**	**Gg/ 2015**	**% change**
Chemical Industry	6	1	-85	12	14	11	32	26	-18
Civil Aviation	0	0	328	7	31	328	0	0	328
Direct N_2O emissions from managed soils	391	527	35	324	458	41	3721	5389	45
Emissions from biomass burning	6	7	14	229	261	14	191	218	14
Fossil fuel fires	0	0	0	13	13	0	-	-	-
Indirect N_2O emissions from managed soils	76	109	45	-	-	-	-	-	-
Indirect N_2O emissions from manure management	3	3	15	-	-	-	-	-	-
Indirect N_2O emissions from the atmospheric depos-ition of nitrogen in NO_x and NH_3	30	52	71	-	-	-	-	-	-
Incineration and Open Burning of Waste	-	-	-	-	-	-	2	2	8
Main Activity Electricity and Heat Production	8	25	204	1947	4075	109	2	13	519
Manufacturing Industries and Construction	7	15	117	1110	2166	95	116	144	24
Manure Management	8	8	7	18	21	17	295	358	21
Non-Energy Pro-ducts from Fuels and Solvent Use	-	-	-	-	-	-	0	0	146
Metal Industry	-	-	-	1	3	287	-	-	-
Non-Specified	0	0	128	20	39	92	0	0	81
Oil and Natural Gas	0	0	2040	0	2	0	1	2	60
Other	-	-	-	1	3	161		-	-
Other Product Manufacture and Use	0	0	24	-	-	-	-	-	-
Other Transportation	0	0	26	3	2	-18	0	0	2343
Petroleum Refining - Manufacture of Solid Fuels and Other Energy Industries	0	0	2	29	26	-10	0	0	27
Railways	2	3	88	76	142	88	0	0	88
Residential and other sectors	25	29	15	351	423	20	641	698	9
Road Transportation no resuspension	8	20	137	858	1602	87	7	20	201
Solid Fuels	0	0	9	1	1	9	52	57	9
Wastewater Treatment and Discharge	37	50	36				5	6	27
Water-borne Navigation	0	0	43	40	57	43	0	0	43
Grand Total	**608**	**851**	**40**	**5040**	**9339**	**85**	**5065**	**6934**	**37**

Data sourced by: Crippa et al., (2021) EDGARv7.0, EDGARv6.1 air pollutants, https://edgar.jrc.ec.europa.eu/dataset_ap61

Appendix II

List of nitrogen-related policy documents used in this study for policy analysis with ID URL and the Related URL

Sl no	Record ID URL	Related File URL (weblink)	File Language	Territory subdiv.	Type of text	Title	Year Est	Main Ministry - if applicable
1	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC002085.	http://extwprlegs1.fao.org/docs/pdf/ind2085.pdf	English	National	Legislation	Water (Prevention and Control of Pollution) Act 1974 (*Amended in 1988)	1974	Ministry of law and justice
2	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC021695	http://extwprlegs1.fao.org/docs/pdf/ind21695.pdf	English	National	Legislation	Environment (Protection) Act, 1986	1986	Ministry of Law and Justice
3	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC021723		English	National	Miscellaneous	Notifications of the Ministry of Environment and Forests regarding public hearings	2000	Ministry of Environment, Forests and Climate Change
4	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC040559	http://legislative.gov.in/sites/default/files/A1981-14.pdf	English	National	Legislation	Air (Prevention and Control of Pollution) Act, 1981	1981	Ministry of Environment, Forests and Climate Change
5	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC040634	https://www.jspcb.nic.in/upload/uploadfiles/files/MSWrules2000.pdf	English	National	Regulation	Municipal Solid Wastes (Management and Handling) Rules	2000	Ministry of Environment, Forests and Climate Change
6	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC072610	http://extwprlegs1.fao.org/docs/pdf/ind72610.pdf	English	National	Regulation	Water Quality Monitoring Order 2005	2005	Ministry of Environment, Forests and Climate Change
7	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC102344	http://extwprlegs1.fao.org/docs/pdf/ind102344.pdf	English/Hindi	National	Miscellaneous	Notification of the Ministry of Environment and Forests declaring the Sultanpur National Park to be an Eco-sensitive Zone	2010	Ministry of Environment, Forests and Climate Change
8	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC129935		English	National	Regulation	Fertiliser (Control) Order 1985 (*Amended in 2013)	1985	Ministry of AGRICULTURE and Farmers Welfare
9	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC143981	http://extwprlegs1.fao.org/docs/pdf/ind143981.pdf	English	National	Regulation	Coastal Regulation Zone Notification S.O.19(E).	2011	Ministry of Environment, Forests and Climate Change

10	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC163087	http://extwprlegs1.fao.org/docs/pdf/ind163087.pdf	English	National	Miscellaneous	National Biodiversity Action Plan 2008	2008	Ministry of Environment, Forests & Climate Change
11	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC169057	http://extwprlegs1.fao.org/docs/pdf/ind169057.pdf	English	National	Policy	National Policy for Farmers 2007	2007	Ministry of AGRICULTURE and Farmers Welfare
12	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC168165/	http://extwprlegs1.fao.org/docs/pdf/ind168165.pdf	English/ Hindi	National	Regulation	Food Safety and Standards (FOOD Recall Procedure) Regulations 2017	2017	Ministry of Health and Family Welfare
13	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC169636/	http://extwprlegs1.fao.org/docs/pdf/ind169636.pdf	English	National	Miscellaneous	National Action Plan on Antimicrobial Resistance	2017	Ministry of Health and Family Welfare/2017-2021
14	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC170494/	http://extwprlegs1.fao.org/docs/pdf/IND170494.pdf	English	National	Miscellaneous	National Wildlife Action Plan	2017	Ministry of Environment, Forests and Climate Change
15	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC177473/	http://extwprlegs1.fao.org/docs/pdf/ind177473.pdf	English/ Hindi	National	Policy	National Policy on Marine Fisheries	2017	Ministry of AGRICULTURE and Farmers Welfare
16	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC179416/	http://extwprlegs1.fao.org/docs/pdf/ind179416.pdf	English/ Hindi	National	Regulation	Wetlands (Conservation and Management) Rules	2017	Ministry of Environment, Forests and Climate Change
17	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC180266/	http://extwprlegs1.fao.org/docs/pdf/ind180266.pdf	English	National	Regulation	Food Safety and Standards (Organic FOODs) Regulations	2017	Ministry of Health and Family Welfare
18		http://environmentclearance.nic.in/writereaddata/FormB/EC/EIA_EMP/151220150QWYHGYJCPWDEMPRA.pdf	English	National	Miscellaneous	Environmental Management Plan GENERAL POOL RESIDENTIAL ACCOMMODATION (GPRA)	1997	Ministry of Environment, Forests and Climate Change
19	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC052267	https://mmrda.maharashtra.gov.in/documents/10180/760410/Notification+MoEF+Matheran+Eco-Sensitive+Zone.pdf/ff47de8c-59dd-498e-81f8-a82133578839?version=1.0	English	State	Miscellaneous	Matheran And Surrounding Region In The State Of Maharashtra As The Matheran Eco Sensitive Zone	2003	Ministry of Environment, Forests and Climate Change
20	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC082386	http://extwprlegs1.fao.org/docs/pdf/ind82386.pdf	English	State	Legislation	The Mizoram ORGANIC FARMING Act, 2004	2004	Ministry of Commerce and Industry
21	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC089823	http://extwprlegs1.fao.org/docs/pdf/nze89823.pdf	English	State	Miscellaneous	Dahanu Taluka, District Thane Ecologically Fragile and Impose Restrictions on the setting up of Industries1991	1991	Ministry of Environment, Forests and Climate Change
22	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC132586	http://extwprlegs1.fao.org/docs/pdf/ind132586.pdf	English	Natioal	Regulation	National FOOD SECURITY Act, 2013	2013	Ministry of Law and Justice
23		http://extwprlegs1.fao.org/docs/pdf/IND170482.pdf	English	State	Miscellaneous	Gujrat Water Supply and Sewerage Board, Gandhinagar	2010	Government of Gujarat

24	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC177596	http://extwprlegs1.fao.org/docs/pdf/ind177596.pdf	English	National	Regulation	Mid-Day Meal Rule	2015	Ministry of Education
25		http://www.fao.org/3/a0257e/A0257E07.htm	English	National	Miscellaneous	Central Fertilizer Pool	1944	Ministry of AGRICULTURE and Farmers Welfare
26		http://krishi.maharashtra.gov.in/1063/Fertilizer-Control-Order,-1973	English	National	Legislation	The Fertilizer (Movement Control Order)	1973	Ministry of Chemicals and Fertilizers
27	https://fert.nic.in/fertilizer-policy/urea-policypricing-and-administration	http://fert.nic.in/page/urea-policypricing-and-administration	English	National	Policy	New Urea Policy 2015 -2019	2015	Ministry of Chemicals and Fertilizers/ 31.05.2015. Remained in force till 31st March 2019.
28		http://agricoop.nic.in/sites/default/files/Guideline2013.pdf	English	National	Miscellaneous	Guidelines for Production and Use of Customised Fertilizers	2008	Ministry of AGRICULTURE and Farmers Welfare
29		http://fert.nic.in/sites/default/files/What-is-new/Policy%20for%20encouraging%20production_0.pdf	English	National	Policy	Policy for encouraging production and availability of fortified and coated urea	2015	Ministry of Chemicals and Fertilizers
30		http://fert.nic.in/fertilizer-policy/phosphatic-and-potassic-pk-policy	English	National	Policy	Nutrient based subsidy regime (NBS Policy) 2010 - 2019	2010	Minitsry of Chemicals and Fertilizers/ April 2010-August 2019
31	http://www.rkvy.nic.in/	http://agricoop.nic.in/divisiontype/rashtriya-krishi-vikas-yojana	English	National	Miscellaneous	The Rashtriya Krishi Vikas Yogna or The National AGRICULTURE Development Programme	2007	Ministry of AGRICULTURE and Farmers Welfare
32		http://agricoop.nic.in/sites/default/files/NPMCR_1.pdf	English	National	Policy	National Policy for Management of Crop Residue	2014	Ministry of AGRICULTURE and Farmers Welfare
33	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC098219	http://extwprlegs1.fao.org/docs/pdf/ind98219.pdf	English	National	Legislation	The National Tribunal Act, 2010	2010	Ministry of Law and Justice
34		https://www.mdpi.com/1660-4601/16/5/832/pdf	English	National	Miscellaneous	The Waste to Energy Mission	2010	Ministry of New and Renewable Energy
35		http://urbantransport.kar.gov.in/National%20Urban%20TransportPolicy.pdf	English	National	Policy	National Urban Transport Policy	2006	Ministry of Housing and Urban Affairs/ 2006-2018

36		https://autotechreview.com/media/attachments/18_20_ATR_Oct15.pdf	English	National	Miscellaneous	Automotive Mission Plan of India	2016	Ministry of Heavy Industries and Public Enterprises/ 2016-26
37		http://petroleum.nic.in/national-policy-biofuel-2018-0	English	National	Policy	National Policy on Biofuels 2018	2018	Ministry of Petroleum and Natural Gas
38		http://cpheeo.gov.in/cms/national-mission-on-sustainable-habitat.php	English	National	Miscellaneous	National Mission on Sustainable Habitat	2010	Ministry of Housing and Urban Affairs
39	http://amrut.gov.in/upload/uploadfiles/files/AMRUT%20Guidelines%20(1).pdf	http://amrut.gov.in/content/innerpage/the-mission.php	English	National	Miscellaneous	Atal Mission for Rejevenuation and Urban Transport (AMRUT)	2015	Ministry of Housing and Urban Affairs
40		https://www.metrorailnews.in/wp-content/uploads/2017/09/New_Metro_Rail_Policy_India_2017.pdf	English	National	Policy	Metro Rail Policy	2015	Ministry of Housing and Urban Affairs
41		https://theicct.org/sites/default/files/publications/India%20BS%20VI%20Policy%20Update%20vF.pdf	English	National	Miscellaneous	Bharat Stage (BS) VI Emission Standards	2016	Ministry of Road Transport and HIGHways
42		https://www.iasparliament.com/current-affairs/corporate-average-fuel-efficiency-norms-vehicular-pollution#:~:text=The%20CAFE%20regulations%20are%20in,113%20gm%20per%20km%20thereafter.	English	National	Regulation	Corporate Average Fuel efficiency Standards - CAFÉ system (Regulations)	2015/ 2017	Ministry of Power/2015 for passenger cars and 2017 for buses and trucks.
43		https://dhi.nic.in/writereaddata/UploadFile/DHI-NAB-Auto%20Policy%20Draft%20Document_vDRAFT.pdf	English	National	Policy	National Auto Policy	2018	Ministry of Heavy Industries and Public Enterprises
44		http://sagarmala.gov.in/about-sagarmala/vision	English	National	Miscellaneous	Sagar Mala Programme/Scheme	2015	Ministry of Shipping/2015-2035
45		http://smartcities.gov.in/upload/uploadfiles/files/SmartCityGuidelines(1).pdf	English	National	Miscellaneous	The Smart Cities Mission	2015	Ministry of Housing and Urban Affairs/2015-2020
46		file:///C:/Users/himad/Downloads/sustainable_urban_transport_programme_factsheet.pdf	English	National	Miscellaneous	Sustainable Urban Transport Programme	2009	Ministry of Housing and Urban Affairs/2009-2018
47		https://commerce.gov.in/writereaddata/uploadedfile/MOC_636802088572767848_AGRI_EXPORT_POLICY.pdf	English	National	Policy	AGRICULTURE Export Policy	2018	Ministry of Commerce and Industry
48		http://petroleum.nic.in/sites/default/files/autopol.pdf	English	National	Policy	Auto fuel vision and policy	2014	Ministry of Petroleum and Natural Gas
49		https://rkvy.nic.in/static/download/pdf/BGREIGuidlines.pdf	English	National	Miscellaneous	Bringing Green Revolution in Eastern India	2010	Ministry of AGRICULTURE and Farmers Welfare
50		https://mpcb.gov.in/sites/default/files/common-effluent-treatment-plant/guidelines/FAP-MoEF.pdf	English	National	Miscellaneous	Centrally Sponsered Scheme of Common Effluent Treatment Plants	1991	Ministry of Environment, Forests and Climate Change/1991-2018

51		http://fert.nic.in/phosphatic-and-potassic-pk	English	National	Miscellaneous	Concession Scheme for SSP (Single super phosphate)	1993	Ministry of Chemicals and Fertilizers
52	http://www.fao.org/faolex/results/details/es/c/LEX-FAOC183730/	http://extwprlegs1.fao.org/docs/pdf/ind183730.pdf	English	National	Regulation	Construction and Demolition Waste Management Rules	2016	Ministry of Environment, Forests and Climate Change
53	https://agricoop.nic.in/sites/default/files/NITI%20Aayog%20Policy%20Paper.pdf	http://niti.gov.in/writereaddata/files/document_publication/DOUBLING%20FARMERS%20INCOME.pdf	English	National	Policy	Doubling Farmers Income Policy	2017	Ministry of AGRICULTURE and Farmers Welfare
54		https://nmcg.nic.in/gangaactionplan1.aspx	English	National	Miscellaneous	Ganga Action Plan, 1985	1985	Ministry of Jal Shakti
55	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC183717/	http://extwprlegs1.fao.org/docs/pdf/ind183717.pdf	English	National	Regulation	Hazardous and other waste (Management and Transboundary Movement) Rules	2016	Ministry of Housing and Urban Affairs
56		http://164.100.47.193/Refinput/New_Reference_Notes/English/15112019_160206_102120367.pdf	English	National	Legislation	Jal Shakti Abhiyan/Urban Water Conservation Act, 2019	2019	Ministry of Jal Shakti
57		https://en.wikipedia.org/wiki/Jawaharlal_Nehru_National_Urban_Renewal_Mission#:~:text=Jawaharlal%20Nehru%20National%20Urban%20Renewal%20Mission%20(JNNURM)%20was%20a%20massive,under%20Ministry%20of%20Urban%20Development.&text=JNNURM%20was%20a%20huge%20mission,focusing%20to%20the%20Indian%20cities.	English	National	Miscellaneous	Jawaharlal Nehru National Urban Renewal Mission (JnNURM)	2015	Ministry of Housing and Urban Affairs/2005- 2015
58	https://cprindia.org/sites/default/files/Proposed%20MCRZ%202017%20.pdf	https://cprindia.org/sites/default/files/Proposed%20MCRZ%202017%20.pdf	English	National	Miscellaneous	Marine Coastal Regulation Zone Notification	2017	Ministry of Enviornment, Forests and Climate Change
59		http://tourism.gov.in/sites/default/files/policy/Draft_National_Tourism_Policy_2015.pdf	English	National	Policy	National Action Plan For Tourism 1995	1995	Ministry of Tourism
60		http://agropedia.iitk.ac.in/content/national-agricultural-policy	English	National	Policy	National Agricultural Policy 2000	2000	Ministry of AGRICULTURE and Farmers Welfare
61		http://agricoop.gov.in/sites/default/files/National_agroforestry_policy_2014.pdf	English	National	Policy	National Agroforestry Policy	2014	Ministry of AGRICULTURE and Farmers Welfare
62		http://164.100.47.193/lsscommittee/Petroleum%20&%20Natural%20Gas/16_Petroleum_And_Natural_Gas_5.pdf	English	National	Policy	National Auto Fuel Policy	2003	Ministry of Petroleum and Natural Gas
63		http://moef.gov.in/wp-content/uploads/2019/05/NCAP_Report.pdf	English	National	Miscellaneous	National Clean Air Programme	2019	Ministry of Environment, Forests and Climate Change

64		https://niti.gov.in/writereaddata/files/new_initiatives/NEP-ID_27.06.2017.pdf	English	National	Policy	National Energy Policy (Draft)	2017	Ministry of Petroleum and Natural Gas
65		http://moef.gov.in/wp-content/uploads/2018/03/THE_NATIONAL_ENVIRONMENT_TRIBUNAL_ACT.pdf	English	National	Legislation	National Environment Tribunal	1995	Ministry of Environment, Forests and Climate Change
66	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194100	http://extwprlegs1.fao.org/docs/pdf/ind194100.pdf	English	National	Policy	National Environment Policy	2006	Ministry of Environment, Forests and Climate Change
67		https://darpg.gov.in/sites/default/files/National%20FOOD%20Security%20Mission.pdf	English	National	Miscellaneous	National FOOD SECURITY Mission	2007	Ministry of Agriculture and Farmers Welfare
68	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC170492	http://extwprlegs1.fao.org/docs/pdf/IND170492.pdf	English	National	Policy	National Forest Policy 1988 (*Revised in 2018)	1988	Ministry of Environment, Forests and Climate Change
69		http://mohua.gov.in/cms/hariday.php	English	National	Miscellaneous	The National Heritage City Development and Augmentation Yojna (HRIDAY)	2019	Ministry of Housing and Urban Affairs
70		http://www.agricoop.gov.in/sites/default/files/National%20Mission%20For%20Sustainable%20AGRICULTURE-DRAFT-Sept-2010.pdf	English	National	Miscellaneous	National Mission for Sustainable AGRICULTURE	2010	Ministry of AGRICULTURE and Farmers Welfare
71		http://indianwindpower.com/pdf/Policies/National-Offshore-Wind-Energy-Policy.pdf	English	National	Policy	National Offshore Wind Energy Policy	2015	Ministry of New and Renewable Energy
72		http://moef.gov.in/wp-content/uploads/2019/09/NPCA-MOEFCC-guidelines-April-2019-LOW-resolution.pdf	English	National	Miscellaneous	National Plan for Conservation of Aquatic Ecosystems	2019	Ministry of Enviornment, Forests and Climate Change
73		http://www.centralcoalfields.in/indsk/pdf/employ_land/land_rules/natnl_rehab_restltmnt_plcy_2007.pdf	English	National	Policy	National Rehabilitation and Resettlement Policy	2007	Ministry of Enviornment, Forests and Climate Change
74		https://pib.gov.in/newsite/erelcontent.aspx?relid=18777; https://nrcd.nic.in/nrcp.pdf	English	National	Regulation	National River Conservation Plan	1995	Ministry of Enviornment, Forests and Climate Change
75		http://164.100.47.193/Refinput/New_Reference_Notes/English/National%20Steel%20Policy%202017.pdf	English	National	Policy	National Steel Policy	2017	Ministry of Steel
76		http://mohua.gov.in/upload/uploadfiles/files/NUSP_0.pdf	English	National	Policy	National Urban Sanitation Policy	2008	Ministry of Housing and Urban Affairs
77		http://nwm.gov.in/sites/default/files/nwm28756944786.pdf	English	National	Miscellaneous	The National Water Mission under the National Action Plan on Climate Change	2008	Ministry of Jal Shakti

78		http://jalshakti-dowr.gov.in/sites/default/files/National%20Water%20Policy%201987%20English.pdf	English	National	Policy	National Water Policy 1987 (*Amended in 2002, 2008, 2012)	1987	Ministry of Jal Shakti
79	https://fert.nic.in/fertilizer-policy/urea-policypricing-and-administration	http://fert.nic.in/page/urea-pricing-policy-section	English	National	Policy	New Investment Policy 2012 (*Amended in 2014)	2012	Ministry of Chemicals and Fertilizers
80		https://ncof.dacnet.nic.in/Policy_and_EFC/Organic_Farming_Policy_2005.pdf	English	National	Policy	ORGANIC FARMING Policy	2005	Ministry of AGRICULTURE and Farmers Welfare
81		https://darpg.gov.in/sites/default/files/Paramparagat%20Krishi%20Vikas%20Yojana.pdf	English	National	Miscellaneous	Paramparagat Krishi Vikas Yojana	2015	Ministry of AGRICULTURE and Farmers Welfare
82	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC183721	http://extwprlegs1.fao.org/docs/pdf/ind183721.pdf	English/ Hindi	National	Regulation	Plastic Waste Management Rules (*Amended in 2018)	2016	Ministry of Environment, Forests and Climate Change
83	https://vikaspedia.in/energy/policy-support/pradhan-mantri-ujjwala-yojana	https://pmuy.gov.in/about.html	English	National	Miscellaneous	Pradhan Mantri Ujjwala Yojana	2016	Ministry of Petroleum and Natural gas
84		http://164.100.94.214/sites/default/files/schemes/RevisedGuidelines.pdf	English	National	Miscellaneous	Programme on Energy from Urban, Industrial,Agricultural Wastes/Residues and Municipal Solid Waste	2018	Ministry of New and Renewable Energy/July 2018-March 2021
85		http://www.fert.nic.in/sites/default/files/2020-08/City%20Composed.pdf	English	National	Policy	Promotion of City Compost Policy	2016	Ministry of Chemicals and Fertilizerrs
86		https://www.soilhealth.dac.gov.in/Content/FAQ/FAQ_Final_English.pdf	English	National	Miscellaneous	Soil Health Card Scheme	2015	Ministry of AGRICULTURE and Farmers Welfare
87		http://swachhbharaturban.gov.in/writereaddata/SBM_Guideline.pdf?id=vy2hym3f27zbs67q	English	National	Miscellaneous	Swachh Bharat Mission-Urban (SBM-U)	2014	Ministry of Housing and Urban Affairs
88	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC040698	http://extwprlegs1.fao.org/docs/pdf/ind40698.pdf	English	National	Legislation	The Biological Diversity Act, 2002	2002	Ministry of Law and Justice
89	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC003172	http://nbaindia.org/uploaded/Biodiversityindia/Legal/22.%20Forest%20(Conservation)%20Act,%201980.pdf	English	National	Legislation	The Forest (Conservation) Act, 1980	1980	Ministry of Law and Justice
90		http://164.100.47.193/lsscommittee/Chemicals%20&%20Fertilizers/16_Chemicals_And_Fertilizers_41.pdf	English	National	Policy	Freight Subsidy Policy	2017	Ministry of Health and Family Welfare
91		https://www.nhp.gov.in/sites/default/files/pdf/nhp_1983.pdf	English	National	Policy	National Health Policy 1983 (*Amended 2002, 2017)	1983	Ministry of Health and Family Welfare
92		http://nhm.gov.in/images/pdf/NUHM/Implementation_Framework_NUHM.pdf	English	National	Miscellaneous	National Urban Health Mission	2013	Ministry of Housing & Urban Affairs

93		https://nhm.gov.in/images/pdf/NHM/NHM_more_information.pdf	English	National	Miscellaneous	National Health Mission	2013	Ministry of Health and Family Welfare
94		https://industriescom.assam.gov.in/sites/default/files/swf_utility_folder/departments/industries_com_oid_4/portlet/level_2/assam_bamboo_and_cane_policy_2019.pdf	English	State	Policy	The Assam Bamboo and Cane Policy	2019	Department of Industries and Commerce, Government of Assam
95		https://dipp.gov.in/sites/default/files/IndustriesAct_1951_11June2018.pdf	English	National	Legislation	Industries (Development and Regulation) Act, 1951 (*Amended in 1953, 2016)	1951	Ministry of Law and Justice
96		http://www.indiawaterportal.org/sites/indiawaterportal.org/files/Guidelines_of_the_Central_Rural_Sanitation_Programme_and_Total_Sanitation_Campaign_by_the_Department_of_Drinking_Water_and_Sanitation_2011.pdf	English	National	Miscellaneous	Central Rural Sanitation Programme 2011	2011	Ministry of Rural Development
97		https://smartnet.niua.org/sites/default/files/resources/policy_reuse_of_wastewatera.pdf	English	National	Policy	Policy for Reuse of Treated Wastewater	2018	Ministry of Housing and Urban Affairs
98		http://cpheeo.gov.in/upload/uploadfiles/files/Advisory%20on%20Improving%20Municipal%20Solid%20Waste%20Management%20Services.pdf	English	National	Miscellaneous	Advisory on Improving Municipal Solid Waste Management Services	2013	Ministry of Housing and Urban Affairs
99		https://smartnet.niua.org/sites/default/files/resources/surveykshan_survey_book_english_final.pdf	English	National	Miscellaneous	Swachh Sarvekshan	2018	Ministry of Rural Development
100		https://smartnet.niua.org/sites/default/files/resources/draft_national_land_utilisation_policy_july_2013.pdf	English	National	Policy	National Land Utilisation Policy (Draft)	2013	Ministry of Rural Development
101		https://smartnet.niua.org/sites/default/files/resources/nmtguidancefinal.pdf	English	National	Miscellaneous	Non-Motorised Transport Guidance Document	2016	Ministry of Housing and Urban Affairs
102		https://smartnet.niua.org/sites/default/files/resources/advisory_note_on_septage_management_in_urban_india.pdf	English	National	Miscellaneous	Advisory Note on Septage Management in Urban India	2013	Ministry of Housing and Urban Affairs
103		https://smartnet.niua.org/sites/default/files/resources/annexure_i1.pdf	English	National	Miscellaneous	IREDA's Financing Norms & Schemes	2017	Ministry of heavy indusry and public enterprises
104		https://smartnet.niua.org/sites/default/files/resources/gazette_notification_fame_india.pdf	English/Hindi	National	Miscellaneous	Scheme for Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India - FAME India - Reg. (Gazette Notification)	2015	Ministry of Enviornment, Forests and Climate Change
105		https://smartnet.niua.org/sites/default/files/resources/final_guidelines_on_buffer_zone_29052017.pdf	English	National	Miscellaneous	Guidelines on the provision of buffer zone around waste processing and disposal facilities	2017	Ministry of Enviornment, Forests and Climate Change
106		https://smartnet.niua.org/sites/default/files/resources/odour_guidelines_30.03.2017.pdf	English	National	Miscellaneous	Guidelines on Odour Monitoring & Management in Urban Municipal Solid Waste (MSW) Landfill Site	2017	Ministry of Housing and Urban Affairs

107		http://smartcities.gov.in/upload/uploadfiles/files/SmartCityGuidelines(1).pdf	English	National	Miscellaneous	Smart Cities Mission Guidelines	2015	Ministry of Housing and Urban Affairs
108		https://smartnet.niua.org/sites/default/files/resources/58a3de0868e9dAdvisory6_0.pdf	English	National	Miscellaneous	Strategy for Smart Health in Smart Cities Mission	2017	Ministry of Housing and Urban Affairs
109		https://smartnet.niua.org/sites/default/files/resources/FSSM%20Policy%20Report_23%20Feb_Artwork.pdf	English	National	Policy	National Policy on Faecal Sludge and Septage Management	2017	Ministry of Housing and Urban Affairs
110		https://smartnet.niua.org/sites/default/files/resources/MoUD%20Advisory%20on%20Urban%20Water%20Bodies_0.pdf	English	National	Miscellaneous	Conservation and Restoration of Water Bodies in Urban Areas (Advisory)	2013	Ministry of Housing and Urban Affairs
111		https://smartnet.niua.org/sites/default/files/resources/MoUD%20Guidance%20Note%20on%20MSW%20Management%20on%20a%20Regional%20Basis_0.pdf	English	National	Miscellaneous	Municipal Solid Waste Management on a Regional Basis	2011	Ministry of Housing & Urban Affairs
112		https://smartnet.niua.org/sites/default/files/resources/MoUD%20Guidance%20Notes%20for%20Continuous%20Water%20Supply%20%2824-7%20supply%29_0.pdf	English	National	Miscellaneous	Guidance Notes for Continuous Water Supply (24-7 Supply)	2011	Ministry of Housing and Urban Affairs
113		https://smartnet.niua.org/sites/default/files/resources/NLCP_guideline_0.pdf	English	National	Miscellaneous	National Lake Conservation Plan	2008	Ministry of Enviornment, Forests and Climate Change
114		https://smartnet.niua.org/sites/default/files/resources/NULM_mission_document_0_0.pdf	English	National	Miscellaneous	National Urban Livelihoods Mission	2011	Ministry of Housing and Urban Affairs
115		https://smartnet.niua.org/sites/default/files/resources/action%20plan%20for%20MSW%20management.pdf	English	National	Miscellaneous	Action Plan for management of Municipal Solid Waste (Draft) 2015	2015	Ministry of Enviornment, Forests and Climate Change
116	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC169749	http://extwprlegs1.fao.org/docs/pdf/IND169749.pdf	English	State	Policy	Gujarat Waste to Energy Policy	2016	Department of Energy and Petrochemicals, Government of Gujarat
117	http://www.fao.org/faolex/results/details/fr/c/LEX-FAOC183723/	http://extwprlegs1.fao.org/docs/pdf/ind183723.pdf	English/ Hindi	National	Regulation	Solid Waste Management Rules	2016	Ministry of Enviornment, Forests and Climate Change
118		https://smartnet.niua.org/sites/default/files/resources/Smart%20Sewerage.pdf	English	National	Miscellaneous	Smart Sewerage: Guideline No. 2.4 (iii)	2016	Ministry of Housing and Urban Affairs
119		https://smartnet.niua.org/sites/default/files/resources/MoUD%20Advisory%20Note%20-%20Urban%20Water%20Supply%20%26%20Sanitation%20Services.pdf	English	National	Miscellaneous	Improving Urban Water Supply & Sanitation Services Advisory note	2012	Ministry of Housing and Urban Affairs
120		https://smartnet.niua.org/sites/default/files/resources/Integrated%20LOW%20Cost%20Sanitation%20Scheme%20%28ILCS%29%20Revised%20Guidelines.pdf	English	National	Miscellaneous	Integrated Low Cost Sanitation Scheme (ILCS)	2008	Ministry of New and Renewable Energy
121		https://smartnet.niua.org/sites/default/files/resources/Scheme-Grid-Connected-Rooftop-%26-SMALL-solar-power-plants.pdf	English	National	Miscellaneous	Off-Grid and Decentralized Solar Application Scheme	2014	Ministry of New and Renewable Energy

122		https://smartnet.niua.org/sites/default/files/resources/strategic_plan_mnre_2011_17.pdf	English	National	Miscellaneous	Strategic Plan for New and Renewable Energy Sector for the period 2011 - 2017	2011	Ministry of New and Renewable Energy
123		https://www.civilAVIATION.gov.in/sites/default/files/Final_NCAP_2016_15-06-2016-2_1.pdf	English	National	Policy	National Civil Aviation Policy 2016	2016	Ministry of Civil AVIATION
124		https://www.civilAVIATION.gov.in/sites/default/files/Whitepaper%20on%20National%20Green%20AVIATION%20Policy.pdf	English	National	Policy	National Green Aviation Policy 2019	2019	Ministry of Civil AVIATION
125		http://jalshakti-dowr.gov.in/sites/default/files/Water_Framework_18July_2016%281%29.pdf	English	National	Miscellaneous	DRAFT NATIONAL WATER FRAMEWORK BILL, 2016	2016	Ministry of Jal Shakti
126		http://nwm.gov.in/sites/default/files/nwm16606419934.pdf	English	National	Miscellaneous	National Water Mission	2011	Ministry of Jal Shakti
127		http://tourism.gov.in/sites/default/files/2019-10/Tourism%20Policy%201982.pdf	English	National	Policy	National Tourism Policy (*Amended in 1997, 2002)	1982	Ministry of Tourism
128		https://dhi.nic.in/writereaddata/fame/famedepository/3-operational%20guidelines.pdf	English	National	Miscellaneous	Fame Scheme II-2019	2019	Ministry of Heavy Industries and Public Enterprises
129		http://texmin.nic.in/sites/default/files/jutepolicy2005.pdf	English	National	Policy	National Jute Policy	2005	Ministry of Textiles
130		https://www.iitr.ac.in/wfw/web_ua_water_for_welfare/environment/Pollution_Policy_Statement_1992.pdf	English	National	Policy	Policy Statement for abatement of Pollution	1991	Ministry of Environment, Forests and Climate Change
131		http://moef.gov.in/wp-content/uploads/2017/07/introduction-csps.pdf	English	National	Policy	National Conservation Strategy and Policy Statement on Environment and Development	1992	Ministry of Environment, Forests and Climate Change
132		https://mines.gov.in/writereaddata/UploadFile/Policy_Legislation_more.pdf	English	National	Policy	National Mineral Policy 1993 (*Amended in 2008, 2019)	1993	Ministry of Mines
133	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC147206	http://extwprlegs1.fao.org/docs/pdf/ind147206.pdf	English	National	Policy	National Livestock Policy	2013	Ministry of AGRICULTURE and Farmers Welfare
134		http://dahd.nic.in/sites/default/filess/REVISED%20GUIDELINES%20OF%20NLM%2027.04.16.pdf	English	National	Miscellaneous	National Livestock Mission	2016	Ministry of AGRICULTURE and Farmers Welfare
135		https://odishaahvs.nic.in/upload/files/Odisha%20State%20Livestock%20Sector%20Policy.pdf	English	State	Policy	Orissa State Livestock Sector Policy	2002	Department of Fisheries and Animal Resorces Development, Government of Odisha
136		https://aajeevika.gov.in/sites/default/files/resources/NRLM-Mission-Document.pdf	English	National	Miscellaneous	National Rural Livelihood Mission	2011	Ministry of Rural Development
137	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC119046	https://fssai.gov.in/upload/uploadfiles/files/FSS_Gazete_Rules_2011.pdf	English/ Hindi	National	Regulation	Food Safety and Standards Rules 2011	2011	Ministry of Health and Family Welafre
138	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC080255	http://faolex.fao.org/docs/texts/ind80255.doc	English	National	Legislation	The FOOD Corporations Act, 1964	1964	Ministry of Consumer Affairs, FOOD and Public Distribution

139		https://dfpd.gov.in/fgAvAHcAcgBpAHQAZQByAGUAYQBkAGQAYQB0AGEALwBQAG8AcgB0AGEAbAAvAE0AYQBnAGEAegBpAG4AZQAvAEQAbwBjAHUAbQBlAG4AdAAvAA==/1_365_1_cwcact.pdf	English	National	Legislation	The Warehousing Corporation Act, 1962 (*Amended in 2015)	1962	Ministry of Law and Justice
140		https://dfpd.gov.in/fgAvAHcAcgBpAHQAZQByAGUAYQBkAGQAYQB0AGEALwBQAG8AcgB0AGEAbAAvAE0AYQBnAGEAegBpAG4AZQAvAEQAbwBjAHUAbQBlAG4AdAAvAA==/1_367_1_Warehousing_Development_and_Regulation_Act_2007.pdf	English	National	Legislation	The Warehousing (Development and Regulation) Act, 2007	2007	Ministry of Law and Justice
141		https://dfpd.gov.in/fgAvAHcAcgBpAHQAZQByAGUAYQBkAGQAYQB0AGEALwBQAG8AcgB0AGEAbAAvAE0AYQBnAGEAegBpAG4AZQAvAEQAbwBjAHUAbQBlAG4AdAAvAA==/1_258_1_1A.pdf	English	National	Legislation	The Sugar Development Fund Act, 1982	1982	Ministry of Law and Justice
142		https://nmcg.nic.in/pdf/13_Guide%20Lines%20IAndD%20and%20STP%20-%20Final.pdf	English	National	Miscellaneous	National Mission for Clean Ganga	2018	Ministry of Jal Shakti
143		https://www.up-rera.in/pdf/reraact.pdf	English	National	Legislation	Real Estate (Regulation and Development) Act, 2016	2016	Ministry of Law and Justice
144		https://dipp.gov.in/sites/default/files/po-ann3.pdf	English	National	Policy	National Manufacturing Policy	2011	Ministry of Commerce and Industry
145		https://www.kntlawoffices.com/wp-content/uploads/2017/10/NELP-v-HELP-Comparative-Analysis-as-on-23-3-2016-1.pdf	English	National	Policy	Hydrocarbon Exploration and Licensing Policy	2016	Ministry of Petroleum and Natural Gas
146		https://www.indiacode.nic.in/bitstream/123456789/1651/1/a1956-48.pdf	English	National	Legislation	The National HIGHway Act, 1956	1956	Ministry of Law and Justice
147		https://www.indiacode.nic.in/bitstream/123456789/2028/3/A2003-13.pdf	English	National	Legislation	The Control of National HIGHways (Land and Traffic) Act, 2002	2002	Ministry of Law and Justice
148		https://www.indiacode.nic.in/bitstream/123456789/1798/1/1988____59.pdf	English	National	Legislation	The Motor Vehicles Act, 1988	1988	Ministry of Law and Justice
149		https://www.nhb.org.in/Urban_Housing/HousingPolicy2007.pdf	English	National	Policy	National Urban Housing and Habitat Policy	2007	Ministry of Housing and Urban Affairs
150		https://darpg.gov.in/sites/default/files/Pradhan%20Mantri%20Krishi%20Sichai%20Yojana.pdf	English	National	Miscellaneous	Pradhan Mantri Krishi Sinchai Yojana (PMKSY)	2015	Ministry of AGRICULTURE & Farmers Welfare
151		http://www.digitalrtimission.com/uploads/GRAMIN_BHANDARAN_YOJANA.pdf	English	National	Miscellaneous	Gramin Bhandaran Yojana/Rural Godown Scheme	2007	Ministry of AGRICULTURE & Farmers Welfare
152		https://pmaymis.gov.in/pdf/UserMannual/PMAY_UserMannual.pdf	English	National	Miscellaneous	Pradhan Mantri Awas Yojana	2015	Ministry of Rural Development
153		https://pmjay.gov.in/sites/default/files/2018-09/PMJAY%20Brand%20Guidelines%2031st%20Aug%202018.pdf	English	National	Miscellaneous	Ayushman Bharat Pradhan Mantri Jan Arogya Yojana	2018	Ministry of Health & Family Welafre

154		http://www.swaniti.com/wp-content/uploads/2014/05/UIDSSMT_edited_formatted.pdf	English	National	Miscellaneous	Urban Infrastructure Development Scheme for SMALL and MEDIUM Towns	2005	Ministry of Housing and Urban Affairs
155		http://mohua.gov.in/upload/uploadfiles/files/introduction03.pdf	English	National	Miscellaneous	North Eastern Region Urban Development Programme	2009	Ministry of Housing and Urban Affairs
156	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC040561	http://extwprlegs1.fao.org/docs/pdf/ind40561.pdf	English	National	Regulation	The Air (Prevention and Control of Pollution) Rules	1982	Ministry of Environment, Forests and Climate Change
157		https://dipp.gov.in/sites/default/files/AmmoniumNitrate_Rules_2012_24June2020.pdf	English/Hindi	National	Regulation	Ammonium Nitrate Rules 2012 (*Amended in 2013)	2012	Ministry of Commerce and Industry
158		https://npcb.nagaland.gov.in/wp-content/uploads/2016/03/HWM-2008.pdf	English	National	Regulation	Hazardous Material (Management, Handling and Transboundary Movement) Rules	2007	Ministry of Environment, Forests and Climate Change
159		https://parivesh.nic.in/writereaddata/ENV/HSM/note26.pdf	English/Hindi	National	Regulation	Bio-Medical Waste (Management and Handling) Rules 1998 (*Amended in 2003, 2016)	1998	Ministry of Environment, Forests and Climate Change
160		http://agricoop.nic.in/sites/default/files/NWDPRA8410.pdf	English	National	Miscellaneous	National Watershed Development Project for Rainfed Areas	1990	Ministry of AGRICULTURE and Farmers Welfare
161	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC188478	http://faolex.fao.org/docs/pdf/ind188478.pdf	English	National	Policy	India's Intended Nationally Determined Contribution (INDC): Working Towards Climate Justice	2015	Ministry of Environment, Forests and Climate Change
162	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195378	http://faolex.fao.org/docs/pdf/ind195378.pdf	English	National	Miscellaneous	National Rural Drinking Water Programme	2013	Ministry of Jal Shakti
163	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC169542	http://faolex.fao.org/docs/pdf/ind169542.pdf	English	National	Policy	National Policy for Containment of Antimicrobial Resistance	2011	Ministry of Agriculture and Farmers Welfare
164	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC168181	http://faolex.fao.org/docs/pdf/ind168181.pdf	English	National	Policy	National Policy on Disaster Management	2009	Miinistry of Home Affairs
165	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC163860	http://faolex.fao.org/docs/pdf/ind163860.pdf	English	National	Policy	Comprehensive Marine Fishing Policy	2004	Ministry of AGRICULTURE and Farmers Welfare
166	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC170576	http://faolex.fao.org/docs/pdf/IND170576.pdf	English	National	Policy	National Seeds Policy	2002	Ministry of AGRICULTURE and Farmers Welfare
167	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC170574	http://faolex.fao.org/docs/pdf/IND170574.pdf	English	National	Policy	New Policy on Seed Development	1988	Ministry of AGRICULTURE and Farmers Welfare

168	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC170509	http://faolex.fao.org/docs/pdf/IND170509.pdf	English	National	Policy	National Action Plan on Climate Change	2008	Ministry of Environment, Forests and Climate Change
169	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC170578	http://faolex.fao.org/docs/pdf/IND170578.pdf	English	National	Miscellaneous	National Seed Plan	2007	Ministry of AGRICULTURE and Farmers Welfare
170	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC171097	http://faolex.fao.org/docs/pdf/IND171097.pdf	English	National	Legistlation	Agricultural and Processed food Products Export Cess Act, 1985	1985	Ministry of Law and Justice
171	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC018593	http://faolex.fao.org/docs/pdf/ind18593.pdf	English	National	Legistlation	Seeds Act, 1966	1966	Ministry of Law and Justice
172	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC077871	http://faolex.fao.org/docs/texts/ind77871.doc	English	National	Legistlation	Insecticides Act, 1968 (*Amended in 2000)	1968	Ministry of Law and Justice
173	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC068512	http://faolex.fao.org/docs/pdf/ind68512.pdf	English	National	Regulation	Protection of Plant Varieties and Farmer's Rights Regulations 2006 (*amended 2009, 2011)	2006	Ministry of Agriculture and Farmers Welfare
174	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC165097	http://faolex.fao.org/docs/pdf/ind165097.pdf	English	National	Regulation	Insecticides Rules 1971 (*Amended in 2015)	1971	Ministry of AGRICULTURE and Farmers Welfare
175	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC077864	http://faolex.fao.org/docs/pdf/ind77864.pdf	English	National	Legistlation	Disaster Management Act, 2005	2005	Ministry of Law and Justice
176	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC132404	http://faolex.fao.org/docs/pdf/ind132404.pdf	English/ Hindi	National	Regulation	Disaster Management (National Institute of Disaster Management) Rules	2006	Miinistry of Home Affairs
177	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC008236	http://faolex.fao.org/docs/pdf/ind8236.pdf	English	National	Regulation	Environment (Protection) Rules 1986	1986	Ministry of Environment, Forests and Climate Change (Ammended in 2003, 2004, 2005, 2006, 2008, 2009)
178	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC040725	http://faolex.fao.org/docs/pdf/ind40725.pdf	English	National	Regulation	Manufacture, Storage and import of Hazardous Chemical Rules	1989	Ministry of Environment, Forests and Climate Change (Ammended in 2000)
179	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC040573	https://npcb.nagaland.gov.in/wp-content/uploads/2016/03/Ozone-Rules-2000.pdf	English	National	Regulation	Ozone Depleting Substances (Regulation) Rules	2000	Ministry of Environment, Forests & Climate Change
180	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC040635	http://extwprlegs1.fao.org/docs/pdf/ind40635.pdf	English	National	Regulation	Recycled Plastics Manufacture and Usage Rules	1999	Ministry of Environment, Forests and Climate Change

181	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC040630		English	National	Regulation	2-T Oil (Regulation of Supply and Distribution) Order	1998	Ministry of Environment, Forests and Climate Change
182	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC040726	https://www.ap.gov.in/Acts%20Policies/THE%20CHEMICAL%20ACCIDENTS%20RULES-1996.pdf	English	National	Regulation	Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules	1996	Ministry of Environment, Forests and Climate Change
183	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195365	http://extwprlegs1.fao.org/docs/pdf/ind195365.pdf	English	National	Miscellaneous	Guidelines for Clean India "Swachh Bharat" Mission (Gramin)	2018	Ministry of Jal Shakti
184	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC010941	http://extwprlegs1.fao.org/docs/pdf/ind10941.pdf	English	National	Miscellaneous	Resolution of the Ministry of Environment and Forests approving the Scheme on Labelling of Environmental Friendly Products (ECO-Mark) - (G.S.R. 85(E)).	1991	Ministry of Environment, Forests and Climate Change
185	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC066493	http://extwprlegs1.fao.org/docs/pdf/ind66493.pdf	English	National	Legislation	The Coastal AQUACULTURE Authority Act, 2005	2005	Ministry of Law and Justice
186	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC077848	http://extwprlegs1.fao.org/docs/pdf/ind77848.pdf	English	National	Legislation	Food Safety and Standards Act, 2006 (*Amended in 2008)	2006	Ministry of Law and Justice
187	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC132405	http://extwprlegs1.fao.org/docs/pdf/ind132405.pdf	English	National	Regulation	Organic Agricultural Produce Grading and Marking Rules 2009 (*Amended in 2011)	2009	Ministry of AGRICULTURE and Farmers Welfare
188	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC170508	http://extwprlegs1.fao.org/docs/pdf/IND170508.pdf	English	National	Regulation	Agricultural and Processed food Products Export Development Authority Regulations (*Amended in 2013)	1986	Ministry of Commerce and Industry
189	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC079977		English	National	Legislation	Central Silk Board Act, 1948	1948	Ministry of Law and Justice
190	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC007958	http://extwprlegs1.fao.org/docs/pdf/ind7958.pdf	English	National	Legislation	River Boards Act, 1956	1956	Ministry of Law and Justice
191	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC184935	http://extwprlegs1.fao.org/docs/pdf/ind184935.pdf	English	National	Legislation	Brahmaputa Board Act, 1980	1980	Ministry of Law and Justice
192	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC169630			State	Legislation	Andhra Pradesh (Agricultural Produce and Livestock) Markets (Amendments) Act, 2015	2015	
193	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC027212			State	Legislation	Andhra Pradesh Farmers' Management of Irrigation Systems Act (Act No. 11 of 1997)	1997	
194	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC193913			State	Legislation	Andhra Pradesh Water Resources Regulatory Commission Act, 2009 (Act No. 15 of 2009).	2009	
195	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC041989			State	Legislation	Andhra Pradesh Water, Land and Trees Act, 2002.	2002	

196	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC193505			State	Legislation	Arunachal Pradesh land and Ecological (Protection and Management) Act, 2018 (Act No. 13 of 2018).	2018	
197	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195431			State	Legislation	Assam Ground Water Control and Regulation Act, 2012 (Assam Act No. XVI of 2012).	2012	
198	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC193894			State	Legislation	Assam Irrigation Water Users Act, 2004 (Act No. 5 of 2005).	2005	
199	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195435			State	Legislation	Assam Urban Water Supply and Sewerage Board Act, 1985 (Assam Act No. II of 1986).	1986	
200	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC184936			State	Legislation	Bansagar Control Board Act, 1976 (No. 8/17/74-DW-III).	1976	
201	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC197019			State	Legislation	Bihar Ground Water (Regulation and Control of Development and Management) Act (2006).	2006	
202	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC169649			State	Legislation	Bihar Irrigation Act, 1997	1997	
203	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC198266			State	Legislation	Bihar State Water and Sewage Board (Repeal) Act, 2017 (No. 3 of 2018).	2018	
204	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195456			State	Legislation	Calcutta Metropolitan Water and Sanitation Authority Act, 1966 (Act No. XIII of 1966).	1966	
205	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195379			National	Regulation	CGWA Guidelines Criteria on Saline Ground Water Abstraction in Areas Notified for Ground Water Regulation.	2013	
206	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194131			State	Legislation	Delhi Agricultural Produce Marketing (Regulation) Act, 1998 (Act No. 7 of 1999).	1999	
207	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194118			State	Legislation	Delhi Water Board Act, 1998 (Act No. 4 of 1998).	1998	
208	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194198			State	Legislation	Goa Agricultural Produce Marketing (Development and Regulation) Act, 2007 (Goa Act No. 11 of 2007).	2007	
209	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194201			State	Legislation	Goa Ground Water Regulation Act, 2002 (Goa Act No. 1 of 2002).	2002	
210	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195149			State	Legislation	Goa Rural Improvement and Welfare Cess Act, 2000 (Goa Act No. 29 of 2000).	2000	
211	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195004			State	Regulation	Goa Sewerage System and Sanitation Services Management Rules, 2010.	2010	

212	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC170481			State	Legislation	Gujarat Agricultural Lands Ceiling Act, 1960	1960	
213	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC170468			State	Regulation	Gujarat Agricultural Produce Markets (Amendment) Rules, 2013.	2013	
214	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC198263			State	Legislation	Gujarat Domestic Water Supply (Protection) Act, 2019 (No. 22 of 2019).	2019	
215	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC170478			State	Legislation	Gujarat Essential Commodities and Cattle (Control) Act, 2005 (No. 15 of 2005).	2005	
216	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC200764			State	Regulation	Gujarat Irrigation and Drainage Rules, 2014.	2014	
217	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC169747			State	Policy	Gujarat Solar Power Policy, 2015	2015	
218	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC169749/			State	Policy	Gujrat Waste to Energy Policy, 2016	2016	
219	http://www.fao.org/faolex/results/details/ru/c/LEX-FAOC169748/			State	Policy	Gujrat Wind Power Policy, 2016	2016	
220	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195433			State	Legislation	Guwahati Metropolitan Drinking Water and Sewerage Board Act, 2009 (Assam Act No. X of 2009).	2009	
221	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194963			State	Legislation	Guwahati Waterbodies (Preservation and Conservation) Act, 2008 (Assam Act No. XX of 2008)	2008	
222	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC118346			State	Regulation	Himachal Pradesh Ground Water (Regulation & Control of Development and Management) Rules, 2007.	2007	
223	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195427			State	Legislation	Hyderabad Metropolitan Water Supply and Sewerage Act, 1989 (Act No. 15 of 1989).	1989	
224	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC201318			State	Legislation	Jammu and Kashmir Water Resources (Regulation and Management) Act, 2010.	2010	
225	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195037			State	Policy	Karnataka Agribusiness and Food Processing Policy 2015.	2015	
226	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC193475			State	Legislation	Karnataka Lake Conservation and Development Authority Act, 2014 (Karnataka Act No. 10 of 2015).	2015	
227	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194967			State	Legislation	Karnataka Tank Conservation and Development Authority Act, 2014 (Act No. 32 of 2014).	2014	
228	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC079294			State	Legislation	Kerala Ground Water (Control & Regulation) Act, 2002 (Act No. 19 of 2002).	2002	

229	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC079291			State	Legislation	Kerala Protection of River Banks and Regulation of Removal of Sand Act, 2001 (Act No. 18 of 2001).	2001	
230	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC193545			State	Policy	Kerala State Environment Policy, 2009.	2009	
231	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC202177			State	Legislation	Madhya Pradesh Municipal Corporation (Recycled and Reuse of Grey Water in Buildings) Model Byelaws, 2010.	2010	
232	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC132530			State	Legislation	Maharashtra Agricultural Produce Marketing (Regulation) (Amendment) Act, 2005.	2005	
233	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC054873			State	Legislation	Maharashtra Management of Irrigation Systems by Farmers Act, No. 23 of 2005.	2005	
234	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194970			State	Legislation	Manipur Conservation of Paddy Land and Wetland Act, 2014 (Act No. 10 of 2014).	2014	
235	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC106822			State	Legislation	Manipur Loktak Lake (Protection) Amendment Act, 2007 (Act No. 5 of 2007).	2007	
236	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC174042			State	Legislation	Meghalaya Commercial Crops Development Board (Amendment) Act, 2001 (Meghalaya Act No. 3 of 2001).	2001	
237	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC098307			State	Legislation	Mizoram Water Supplies (Control) Act, 2004 (Act No. 11 of 2004).	2004	
238	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC171078			State	Legislation	Nagaland Agricultural Produce Marketing (Development and Regulation) Act, 2005 (No. 5 of 2005).	2005	
239	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC201321			National	Policy	National Fisheries Policy 2020.	2020	
240	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC201039			National	Policy	National Mineral Exploration Policy (Non-Fuel And Non-Coal Minerals) 2016.	2016	
241	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC193473			National	Legislation	National Waterways Act, 2016.	2016	
242	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC098216			National	Miscellaneous	Notification of the Ministry of Environment and Forests establishing the Uttarakhand State Ganga River Conservation Authority.	2010	
243	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC184934			State	Miscellaneous	Notification of the Ministry of Irrigation and Power constituting the Tungabhadra Board.	1976	
244	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC193294			State	Policy	Odisha Bovine Breeding Policy, 2015.	2015	
245	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC193293			State	Policy	Odisha Poultry Policy, 2015.	2015	

246	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC072609			National	Regulation	Order of the Ministry of Environment and Forests establishing the Water Quality Assessment Authority.	2001	
247	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC090732			State	Miscellaneous	Orissa Agricultural Produce Markets (Amendment) Rules, 2007.	2007	
248	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC102032			State	Legislation	Pamba River Basin Authority Act, 2009 (Act No. 33 of 2009).	2009	
249	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC200786/			State	Policy	Policy for Reuse of Treated Waste Water.	2018	
250	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC082249			State	Legislation	Pondicherry Ground Water (Control and Regulation) Act, 2002.	2002	
251	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC082379			State	Legislation	Punjab Agricultural Produce Markets (Haryana Amendment) Act, 2005 (Haryana Act No. 22 of 2006).	2006	
252	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC202088			State	Legislation	Punjab Preservation of Subsoil Water Act, 2009.	2009	
253	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC198262			State	Legislation	Punjab Water Resources (Management and Regulation) Act, 2020 (No. 2 of 2020).	2020	
254	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC171183			State	Legislation	Rajasthan Agricultural Produce Markets (Amendment) Act, 2013.	2013	
255	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC171180	http://faolex.fao.org/docs/pdf/IND171180.pdf		State	Legislation	Rajasthan River Basin and Water Resources Planning Act, 2015	2015	
256	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194002			State	Policy	State Action Plan on Climate Change (Bihar SAPCC), 2015.	2015	
257	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194032			State	Policy	State Action Plan on Climate Change (Haryana).	2011	
258	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194030			State	Policy	State Action Plan on Climate Change (Jammu & Kashmir).	2010	
259	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195369			National	Miscellaneous	Swachh Bharat Mission (Grameen).	2020	
260	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194101			State	Policy	Tamil Nadu Biotechnology Policy 2014.	2014	
261	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC171120			State	Legislation	Tamil Nadu Farmer's Management of Irrigation Systems Act, 2000 (No. 7 of 2001).	2001	
262	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194044/			State	Policy	Tamil Nadu State Environment Policy 2017.	1017	
263	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC169631			State	Legislation	Telangana (Agricultural Produce and Livestock) Markets (Amendments) Act, 2016	2016	
264	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC194920			State	Legislation	Telangana Water Resources Regulatory Commission Act, 2009 (Act No. 15 of 2009).	2009	

265	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC132461			State	Regulation	Tripura Biological Diversity Rules, 2006.	2006	
266	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC195364			State	Miscellaneous	Uniform Drinking Water Quality Monitoring Protocol.	2013	
267	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC193900	http://faolex.fao.org/docs/pdf/ind193900.pdf		State	Regulation	Uttar Pradesh Participatory Irrigation Management Rules 2010	2010	
268	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC171101			State	Legislation	Uttar Pradesh Water Management and Regulatory Commission Act, 2008.	2008	
269	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC193599			State	Legislation	Uttarakhand Plastic and Other Non Biodegradable Garbage (Regulation of Use and Disposal) Act, 2013 (Uttarakhand Act No. 17 of 2013).	2013	
270	http://www.fao.org/faolex/results/details/en/c/LEX-FAOC170539			State	Policy	West Bengal Fisheries Policy, 2015	2015	
271	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC195136/			State	Legislation	Maharashtra Fisheries Act, 1960	1960	
272	https://www.fao.org/faolex/results/details/es/c/LEX-FAOC193274/	https://indiacode.nic.in		State	Legislation	Jammu and Kashmir State Fisheries Act, 2018	2018	
273	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC102345/	www.lawsofindia.org		State	Legislation	Arunachal Pradesh Fisheries Act, 2006	2006	
274	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC194133/	http://www.lawsofindia.org		State	Legislation	Delhi Degradable Plastic Bag (Manufacture, Sale and Usage) and Garbage (Control) Act, 2000 (Act No. 6 of 2001).	2000	
275	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC195026/	http://faolex.fao.org/docs/pdf/ind195026.pdf		State	Legislation	Jammu and Kashmir Food Control Act, 1986	1986	
276	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC079303/	http://faolex.fao.org/docs/pdf/ind79303.pdf		State	Legislation	Kerala Promotion of Tree Growth in Non-Forest Areas Act, 2005	2005	
277	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC079330/	http://faolex.fao.org/docs/pdf/ind79330.pdf		State	Legislation	Delhi Preservation of Trees Act, 1994	1994	
278	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC171077/	http://faolex.fao.org/docs/pdf/IND171077.pdf		State	Legislation	Meghalaya Forest Authority Act, 1991	1991	
279	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC195022/	http://faolex.fao.org/docs/pdf/ind195022.pdf		State	Legislation	The Sikkim Forests, Water Courses and Road Reserve (Preservation and Protection) Act, 1988	1988	
280	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC119093/	http://faolex.fao.org/docs/pdf/ind119093.pdf		State	Legislation	Assam Forest Protection Force Act, 1986	1986	
281	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC118360/	http://faolex.fao.org/docs/pdf/ind118360.pdf		State	Legislation	Jammu and Kashmir Forest Act, 1987	1987	
282	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC080119	http://faolex.fao.org/docs/pdf/ind80119.pdf		State	Legislation	Goa, Daman and Diu Preservation of Trees Act, 1984	1984	

283	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC080121/	http://faolex.fao.org/docs/pdf/ind80121.pdf		State	Legislation	Kerala Preservation of Trees Act, 1986	1986	
284	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC118383/	http://faolex.fao.org/docs/pdf/ind118383.pdf		State	Legislation	Jammu and Kashmir State Forest Corporation Act, 1978	1978	
285	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC170605/	http://faolex.fao.org/docs/pdf/IND170605.pdf		State	Legislation	Karnataka Preservation of Trees Act, 1976	1976	
286	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC169740/	extwprlegs1.fao.org/docs/pdf/IND169740.pdf		State	Legislation	Maharashtra Private Forest (Acquisition) Act 1975	1975	
287	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC171163/	http://faolex.fao.org/docs/pdf/ind171163.pdf		State	Legislation	Uttar Pradesh Forest Corporation Act, 1974	1974	
288	https://www.fao.org/faolex/results/details/fr/c/LEX-FAOC195018/	http://faolex.fao.org/docs/pdf/ind195018.pdf		State	Legislation	Gujarat Private forests (Acquisition) Act, 1972	1972	
289	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC132154/	http://faolex.fao.org/docs/pdf/ind132154.pdf		State	Legislation	Meghalaya Forest Regulation (Application And Amendment) Act, 1973	1973	
290	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC171103/	http://faolex.fao.org/docs/pdf/IND171103.pdf		State	Legislation	Indian Forest (The Uttar Pradesh Amendment) Act, 1973	1973	
291	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC090566/	http://faolex.fao.org/docs/pdf/ind90566.pdf		State	Legislation	Orissa Forest Act, 1972	1972	
292	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC171084/	http://faolex.fao.org/docs/pdf/IND171084.pdf		State	Legislation	Nagaland Forests Act, 1968	1968	
293	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC170548/	http://faolex.fao.org/docs/pdf/IND170548.pdf		State	Legislation	Karnataka Forest Act, 1963	1963	
294	http://faolex.fao.org/docs/pdf/IND171185.pdf	http://faolex.fao.org/docs/pdf/IND171185.pdf		State	Legislation	Rajasthan Forest Act, 1953	1953	Government of Rajasthan
295	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC091040/	http://faolex.fao.org/docs/pdf/ind91040.pdf		State	Regulation	Himachal Pradesh Participatory Forest Management Rules	2000	
296	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC193472/	http://faolex.fao.org/docs/pdf/ind193472.pdf		State	Legislation	Andhra Pradesh Forest (Amendment) Act, 2016	2016	Department of Environment, Forests, Science & Technology, Government of Andhra Pradesh
297	https://www.fao.org/faolex/results/details/en/c/LEX-FAOC119274/	http://faolex.fao.org/docs/pdf/ind119274.pdf		State	Legislation	Kerala Forest (Amendment) Act, 2010	2010	Government of Kerala
298		https://cpcb.nic.in/OddEvenScheme-Jan.pdf		State	Policy	The Odd-Even Scheme (short-term policy), 2016	2016	
299		https://cpcb.nic.in/uploads/GRAP_Notification.pdf		State	Miscellaneous	Graded Response Action Plan (GRAP), 2017	2017	
300		https://www.dpcc.delhigovt.nic.in/acts_rules		State	Legislation	The Delhi Degradable Plastic Bag (Manufacture, Sale and Usage) and Garbage (Control) (Amendment) Act, 2008	2008	

301		http://www.cbip.org/Policies2019/PD_07_Dec_2018_Policies/Delhi/2%20Order%202016_08_03_6_Delhi_Solar_Policy.pdf		State	Policy	Delhi Solar Policy, 2016	2016	
302		http://ihbas.delhigovt.nic.in/wps/wcm/connect/e47f4e004eb29c2d88b09f1a0acd5676/Industries+%5B28-37%5D.pdf?MOD=AJPERES&lmod=-336767137&CACHEID=e47f4e004eb29c2d88b09f1a0acd5676		State	Policy	Scheme of "Relocation of Industries" in Delhi	1996	
303		http://scstsenvis.nic.in/WriteReadData/links/Sikkim%20Organic%20Policy%202015-401740061.pdf		State	Policy	State Policy on Organic Farming Government of Sikkim	2015	
304		https://www.indiacode.nic.in/bitstream/123456789/16804/1/organic_searchable_act_2019.pdf		State	Legislation	The Uttarakhand Organic Agriculture Act, 2019	2019	
305		http://www.indiaenvironmentportal.org.in/files/file/Organic-Policy.pdf		State	Policy	Karnataka Organic Farming Policy-2017	2017	
306		http://www.agriodisha.nic.in/content/pdf/Notification%20on%20Odisha%20Organic%20Farming%20Policy%202018.pdf		State	Policy	Odisha Organic Farming Policy, 2018	2018	

UKRI GCRF South Asian Nitrogen Hub

KIIT 25 Years Silver Jubilee 1997–2022 SOIL TO SILVER

GCRF Global Challenges Research Fund