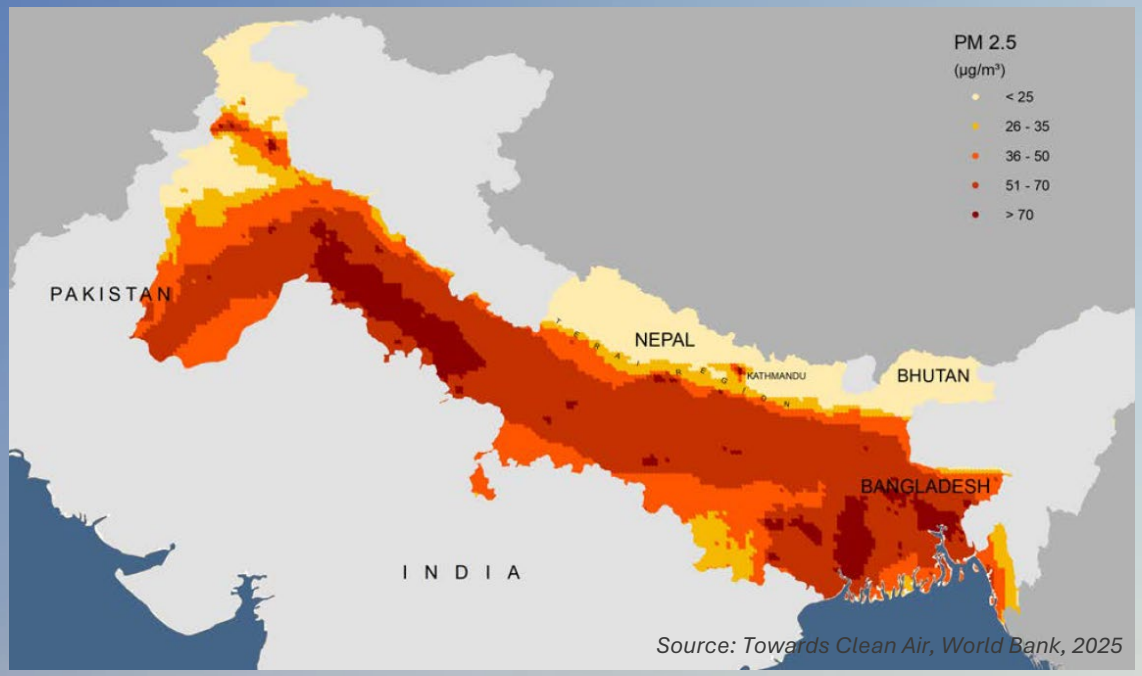
Clean Air Action in in the Indo-Gangetic Gangetic Plain of South Asia



Source: Towards Clean Air, World Bank, 2025

Ashish Tiwari
Action Area Air Lead, ICIMOD

27 April 2026

National Clean Air Action Plan: Framework

Integration of SLCPs in the National Air Action Plans

Develop Emission Inventory

Create a comprehensive database of emissions sources

Conduct Source Apportionment

Identify the contributions of various sources to overall emissions

Perform Policy Gap Analysis

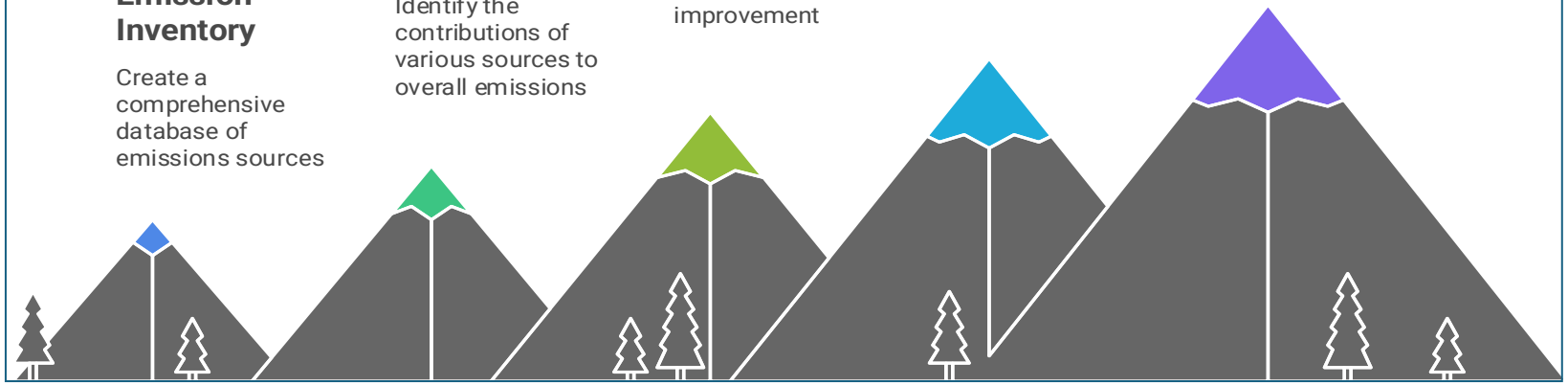
Assess existing policies and identify areas for improvement

Implement Sector-Specific Action Planning

Address the unique challenges faced by different sectors

Establish MNE Framework & Dashboard

Facilitate the monitoring and evaluation of emissions and policy effectiveness



Safeguard health outcomes while ensuring equity and inclusion

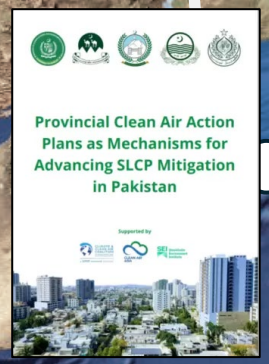
Synergy with Climate & Economy

Harmonize with regional AQM efforts

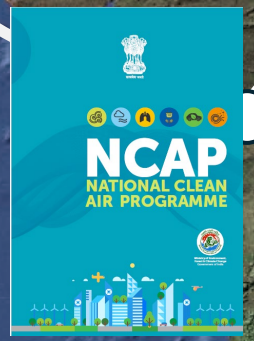
Impacting the region

Nepal National Air Quality Management Action Plan (NAQMAP)

Bhutan Clean Air Action Plan (BCAAP)



EI, Sectoral Policies, DSS, IDD



EI, Sectoral Policies, DSS,IDD

Regional Cooperation

Sectoral Policies, DSS, IDD

Approach:

- RMC's Ownership: RMCs reached out to ICIMOD
- Building upon the existing work
- Consultative Approach
- Focus on Evidence Based Policies & Delivery Framework with Financial Plan
- Uniform DSS across the region
- Integrated AQ Data Dashboard for the Region

3

Robust National Plans Supporting Regional Co-operation

Regional Co-operation for AQM in IGP-HF: Science-Policy-Finance Dialogue

Oct 2020

1ST HKH MINISTERIAL MOUNTAIN SUMMIT

Nov 2022

1st SPD

KATHMANDU ROADMAP ON AQM IN IGP-HF

June 2023

2nd SPD

THIMPHU OUTCOME TOWARDS CLEAN AIR IN IGP-HF

Mar 2025

TECHNICAL COMMITTEE ON AQM IN IGP-HF KATHMANDU

Dec 2025

3rd SPFD

ACTION PLAN FOR AQM IN IGP-HF

The 3rd SPFD was held on 15-16 December 2025.

Black Carbon monitoring on glaciers

High-Altitude Air Quality Observatories

Currently, there are **2 high-altitude Black Carbon stations** in the HKH region.

- Yala glacier, Nepal (~5000 m)
- Chele La, Bhutan (~4100 m)

Publications by ICIMOD's Air Team only on Black Carbon

Atmos. Chem. Phys., 22, 8725–8737, 2022
https://doi.org/10.5194/acp-22-8725-2022
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Atmospheric Chemistry and Physics

Measurement of light-absorbing particles in surface snow of central and western Himalayan glaciers: spatial variability, radiative impacts, and potential source regions

Chaman Gul[1,2,3,4], Shichang Kang[1,4], Siva Praveen Puppala[2], Xiaokang Wu[5], Cenlin He[6], Yangyang Xu[5], Inka Koch[2,7], Sher Muhammad[2], Rajesh Kumar[6], and Getachew Dubache[3]

Atmospheric Environment 125 (2016) 404–417

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

Black carbon and the Himalayan cryosphere: A review

Charles G. Gertler[a,b,*], Siva Praveen Puppala[a], Arnico Panday[a], Dorothea Stumm[a], Joseph Shea[a]

Science of The Total Environment
Volume 858, Part 3, 1 February 2023, 160137

Variability of ambient black carbon concentration in the Central Himalaya and its assessment over the Hindu Kush Himalayan region

Praveen Kumar Singh[a,b], Bhupesh Adhikary[a], Xintong Chen[c,d], Shichang Kang[c,d], Shankar Prasad Poudel[e], Tshering Tashi[f], Ajanta Goswami[b,g], Siva Praveen Puppala[a]

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https://doi.org/10.1016/j.scitotenv.2022.160137

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Aerosol Radiative Forcing Estimation over a Remote High-altitude Location (~4900 masl) near Yala Glacier, Nepal

2019 - Volume 19 | Volume 19, Issue 8, August 2019 | 31 July 2019 | Reach: 8561

Optical/Radiative Properties and Remote Sensing | South Asia

Mukesh Rai[1,2], Parth Sarathi Mahapatra[2], Chaman Gul[2,3,4], Rijan Bhakta Kayastha[3], Arnico K. Panday[4], Siva Praveen Puppala[2]

+ Show author affiliations

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https://doi.org/10.4209/aaqr.2018.09.0342

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https://doi.org/10.5194/acp-18-4981-2018
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Atmospheric Chemistry and Physics

Concentrations and source regions of light-absorbing particles in snow/ice in northern Pakistan and their impact on snow albedo

Chaman Gul[1,2,3], Siva Praveen Puppala[2], Shichang Kang[1,3,4], Bhupesh Adhikary[2], Yulan Zhang[1], Shaukat Ali[2], Yang Li[1], and Xiaofei Li[1]

Atmospheric Pollution Research
Volume 15, Issue 9, September 2024, 102203

Measured black carbon deposition over the central Himalayan glaciers: Concentrations in surface snow and impact on snow albedo reduction

Chaman Gul[a,b,c,d], Cenlin He[e], Shichang Kang[b], Yangyang Xu[f], Xiaokang Wu[f], Inka Koch[c,g], Joel Barker[h], Rajesh Kumar[e], Rahat Ullah[i], Shah Faisal[i], Siva Praveen Puppala[c]

Environmental Pollution
Volume 275, 15 April 2021, 116544

Black carbon concentration in the central Himalayas: Impact on glacier melt and potential source contribution ☆

Chaman Gul[a,b,c,d], Parth Sarathi Mahapatra[a], Shichang Kang[b,d,e], Praveen Kumar Singh[a,f], Xiaokang Wu[g], Cenlin He[h,i], Rajesh Kumar[i], Mukesh Rai[a,b,d], Yangyang Xu[g], Siva Praveen Puppala[a]

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https://doi.org/10.1016/j.envpol.2021.116544

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Remarkable Achievements: Air Quality Observatories in the HKH

- What began as just 5 Ambient Air Quality Monitoring Stations (AAQMS) has grown into a nationally owned network of 30 stations in Nepal.
- Since mid-2025, the Government of Nepal has shown clear institutional ownership by committing to independently finance the operation of 30 monitoring stations.
- New BC monitoring stations planned for Manang (Nepal) and Shodug (Bhutan)
- There is gradual shift towards decentralized ownership, with institutions like NTNC (Nepal) and NCHM (Bhutan) committing to support routine operations.

National Air Quality Programmes in Bangladesh

Clean Air And Sustainable Environment (CASE) project

(2009-2019)

- **16 Continuous Air Monitoring Stations (CAMS)** installed across 13 major cities in Bangladesh
- Additional **15 mobile monitoring units** deployed
- Vehicular **emission inspection** equipment was purchased.
- Programs focused on replacing **traditional fixed chimney kilns with zigzag kilns**
- Published a draft **Clean Air Act in 2019**

Bangladesh Clean Air Project

(2023-ongoing)

- **$290 million** programme to scale national air quality management, marking a transition from pilot intervention to **large-scale investment-driven implementation**.
- Enhancing monitoring, strengthening regulations, reducing emissions from vehicles and industries.
- These efforts will help cut down harmful **$PM_{2.5}$ emissions by 2,734 metric tons** each year.

Major Milestones in Bhutan

National Clean Air Action Plan (NCAAP)

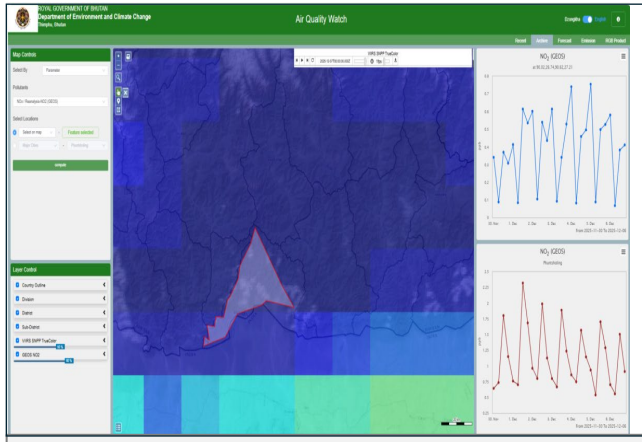
(2025-ongoing)

Long-term strategy that focus on:

- Source apportionment
- Emission inventories
- Sector-specific interventions
- Monitoring systems

Development of **Clean Air Zone**

- Pasakha Industrial Estate
- Thimphu Thromde
- Gelephu Mindfulness City



First Air Quality Dashboard- AQ Watch

(2025)

- Bhutan's first dedicated air quality dashboard was launched, enabling **real-time visualization and analysis** of pollution.
- Combines into a single platform. ground monitoring stations, satellite data, reanalysis datasets, and forecasts into a single platform, **overcoming data gaps to support proactive policy action.**

Policy & Technology-driven actions in India

National Clean Air Programme (NCAP)

(2019-ongoing)

NCAP is multi-sectoral initiative with an aim to **improve air quality in 131 cities**.

Compared to FY 2017-18, in FY 2023-24, following improvements were observed:

- **97 cities** showed improvement in air quality
- **55 cities** achieved reduction of 20% and above in PM_{10} levels
- **18 cities** met National Ambient Air Quality Standards (NAAQS) for PM_{10} (60 µg/m3)

Tighter emission norms & EV adoption

BS IV to BS VI

- By 2019, all refineries in India were producing **ultra-low sulphur fuels**, aligning with BS VI standards.
- In 2020, The Supreme Court ruled **ban on sale of BS IV vehicles**.
- A total of **1,130 E-buses** have been deployed across 13 cities, and **163 E-charging stations** have been set up in 16 cities, under Smart City Mission.

Clean Cooking and EV Transition in Nepal

Improved Cookstoves (ICS)

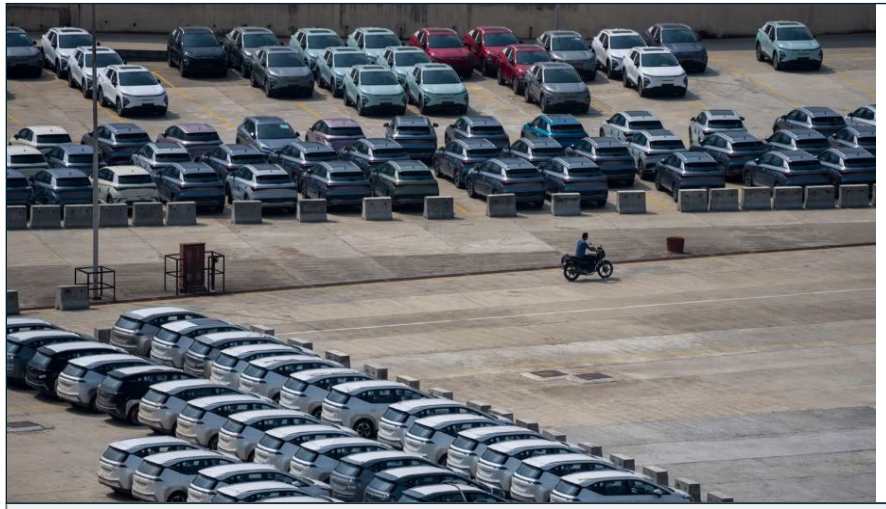
700,000+ ICS installed across 63 districts of Nepal

$PM_{2.5}$ and CO were reduced by 63% and 60%, respectively.

Biogas plants

~450,000+ biogas plants installed across 66 districts of Nepal

Biogas systems can reduce firewood use by up to 90%, improving health outcomes and economic conditions.



Electric Vehicle (EV) Adoption in Nepal

- Nepal is **ranked second globally in EV adoption.**
- EV share of new car sales increased from **8% in 2019 to 73% in 2025,** one of the fastest EV adoption rates globally.
- **11,701 EVs imported in 2023/24**
- Over **10,000 EVs imported in just 9 months of 2024/25**

Brick Kiln Transformation in Pakistan

ICIMOD

18 JUL 2022 | ENGAGING POLICY MAKERS

Cleaner bricks

Pakistan's brick sector transformation has led to significant reduction in fuel consumption and pollutant emissions

~7,000 out of ~20,000 kilns in Pakistan have transitioned to zig-zag technology

Environmental benefits:

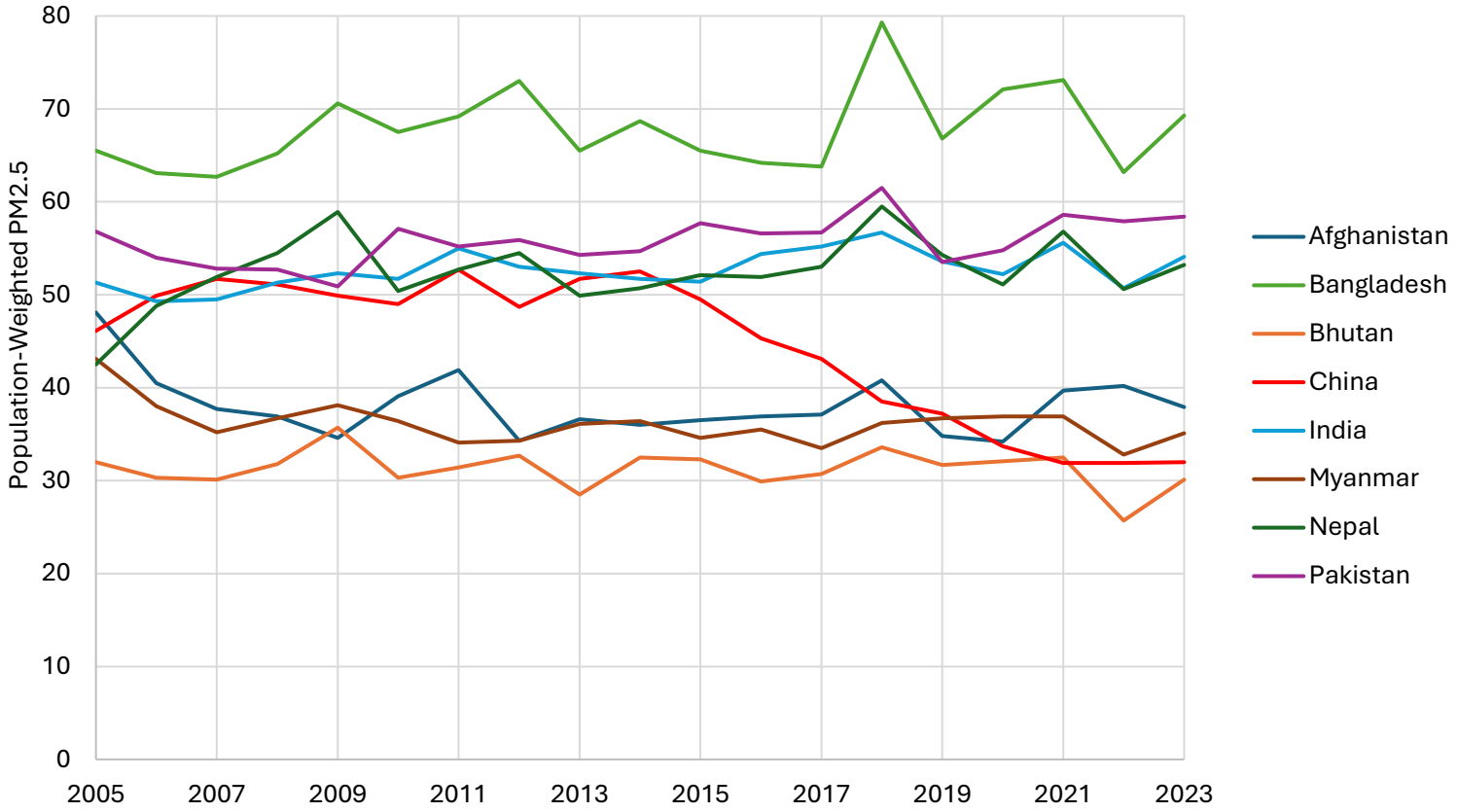
Annual reduction of ~1.7 million tonnes of CO_2, ~10.7 thousand tonnes of PM, and 2.2 thousand tonnes of black carbon.

Economic benefits:

Where traditional kilns consume ~100 tons of coal per month and produce 70 per cent first-grade bricks, zig-zag kilns consume 70 tons but produce 90–95 percent first-grade bricks.

Air Quality Trends in the IGP-HF

Annual population-weighted $PM_{2.5}$ in the IGP-HF region



Source: Global Burden of Disease Study 2023

- Even with rapid economic growth, $PM_{2.5}$ levels across the IGP-HF region have remained **broadly stable**, signalling the potential of targeted interventions to decouple development from emissions.
- Over the last decade (2015-2023), countries such as Bhutan, China, India, and Nepal show **a negative trend in $PM_{2.5}$**, reflecting the impact of sustained policy and technological measures.
- China shows the most **pronounced declining trend,** highlighting the effectiveness of large-scale emission reduction measures.

Thank you

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