KARACHI AT RISK

TRANSPORT POLLUTION, K-IV PROJECT DELAYS, AND INTENSIFYING HEATWAVES

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PREFACE

The Centre for Research and Security Studies (CRSS) has consistently engaged in producing evidence-based research on environmental degradation and air quality in Pakistan. Among our earlier contributions, *"The Dark Clouds of Pakistan: An Investigative Report on Air Pollution and Smog"* (available at crss.pk) served as an important reference for policymakers, media, and civil society. It highlighted the growing environmental crisis affecting Pakistan's urban centres.

This report builds on that work, shifting the focus more specifically to Karachi — Pakistan's largest city and economic hub — while also broadening the analytical scope to examine long-term environmental and infrastructural pressures contributing to deteriorating air quality and climate vulnerability.

At CRSS, we recognise that air pollution and climate change are deeply interconnected. Poor air quality contributes to climate warming through short-lived climate pollutants, while rising temperatures in turn intensify smog formation and environmental stress. Karachi's increasing exposure to heat extremes and deteriorating air quality reflects this reinforcing cycle, with transport emissions playing a significant role in urban pollution levels.

Recent international assessments underscore the seriousness of the challenge. Pakistan continues to rank among the most polluted countries globally in terms of fine particulate matter ($PM_{2.5}$), with Karachi consistently exceeding safe thresholds. These conditions are not merely statistical concerns; they translate into significant public health burdens, disproportionately affecting vulnerable populations, including children, the elderly, and those with pre-existing health conditions.

This report is grounded in the belief that engineering and technical planning are central to addressing environmental and climate challenges. Sustainable solutions require improvements in infrastructure, energy systems, transport planning, and regulatory enforcement. Without such interventions, climate adaptation and pollution control efforts remain incomplete and ineffective.

Karachi's environmental challenges are closely linked to long-standing infrastructural and governance gaps. Persistent delays in key water supply infrastructure projects have increased reliance on informal distribution systems, while weak regulatory oversight in fuel quality and transport emissions continues to worsen urban air pollution. These issues collectively reflect structural challenges that require urgent and coordinated attention.

More broadly, the intersection of climate change, infrastructure, and urban governance has direct implications for human security. Rising temperatures, water stress, and environmental degradation not only affect public health but also place growing pressure on urban systems and livelihoods. Addressing these risks requires both policy commitment and technical capacity.

Karachi remains central to Pakistan's economic and social life. Yet its environmental trajectory highlights the cost of delayed infrastructure development and insufficient regulatory enforcement. The purpose of this report is to contribute to a more informed understanding of these challenges and to support evidence-based policymaking.

We hope this publication will serve as a constructive resource for policymakers, researchers, and practitioners working on urban resilience, environmental management, and climate adaptation in Pakistan.

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About the Author

Engineer Arshad H. Abbasi is an independent energy, water, and climate change expert and a prolific writer on the political economy of Pakistan's environmental and infrastructure crises. As a co-founder of the Energy Excellence Centres at the National University of Sciences and Technology (NUST) in Islamabad and the University of Engineering and Technology (UET) in Peshawar, he has played a foundational role in building institutional capacity for energy research in Pakistan. His work has been published by the Centre for Research and Security Studies (CRSS) and in leading Pakistani newspapers, including Dawn and The News, among others.

His technical expertise has been sought on Pakistan's most pressing challenges, including the K-IV water project, the circular debt crisis in the power sector, the inefficiency of Independent Power Producers (IPPs), Pakistan's shale gas potential, and the governance failures that turn monsoons into national disasters. He has authored or co-authored multiple landmark reports, including *The Myth of Climate Change in Pakistan: A Sorrow Tale of Systemic Failures*, *Climate Change and Dirty Electricity Generation in Pakistan: An Existential Crisis*, and the first comprehensive national inventory on oil and gas for CRSS.

Engineer Abbasi is known for his critical analyses of climate governance, energy policy, and infrastructure planning in Pakistan, particularly on issues related to urban pollution, water security, and power-sector inefficiencies. He has consistently advocated practical, engineering-based solutions to Pakistan's climate and energy challenges.

He wrote this report out of concern for Karachi, the city of Quaid-e-Azam Muhammad Ali Jinnah, and the urgent environmental and governance challenges confronting its residents.

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1. EXECUTIVE SUMMARY

This report presents a comprehensive, evidence-based analysis of Karachi's air quality trajectory over a twenty-two-year period (2004–2026), synthesising data from three major studies: the 2004 PCSIR baseline assessment, the 2020/2024 SEPA monitoring campaign, and the 2026 policy critique published in The Friday Times.

The findings are unequivocal and alarming. In 2004, Karachi's atmosphere — as measured for five gaseous pollutants (SO_2, CO, NO, NOx, O_3) — was fully compliant with World Health Organization guidelines. The study concluded with cautious optimism, warning only of potential future risks from rising vehicular and industrial activity.

By 2020, that warning had become a public health catastrophe. Particulate matter ($PM_{2.5}$ and PM_{10}) — entirely unmeasured in 2004 — emerged as the dominant pollutant, with 51 of 90 monitored locations exceeding Sindh Environmental Quality Standards. Peak $PM_{2.5}$ concentrations reached **385.98 µg/m³** in Korangi District — **25.7 times** the WHO 24-hour guideline of 15 µg/m³.

The 2026 policy analysis provides the critical causal link: **the transport sector accounts for 75.5% of Karachi's total pollution burden**, including 90.4% of carbon monoxide and 80.5% of nitrogen oxides — the chemical precursors to ground-level ozone and heat-amplified smog.

Key findings of this comparative report:

Indicator	2004 Status	2020/2024 Status	2026 Confirmation	Net Change
WHO/SEQS compliance	100%	<40% (for PM)	Transport identified as the primary cause	Critical deterioration
$PM_{2.5}$ monitoring	Not conducted	90+ locations	45.9 µg/m³ (2025)	New crisis
Maximum PM_{10}	Not measured	801 µg/m³ (Korangi)	Confirmed	New problem
Transport share of CO	Not estimated	Not estimated	90.4%	Identified
Transport share of NOx	Not estimated	Not estimated	80.5%	Identified
Transport share of total pollution	Not estimated	Not estimated	75.5%	Identified

The report concludes that Karachi's air quality crisis is not primarily a meteorological inevitability but a **manufactured policy failure** — one with a known address (the transport sector), a known mechanism (precursor emissions cooking into ozone under summer heat), and known engineering solutions.

2. INTRODUCTION AND BACKGROUND

2.1 The Importance of Karachi

Karachi is Pakistan's largest metropolitan city, the financial and industrial capital of the nation, and one of the world's most populous urban agglomerations. With an estimated population exceeding 23 million in 2026, the city generates approximately 65% of Pakistan's national revenue and hosts the country's largest port, busiest airport, and densest concentration of industrial activity.

This economic centrality makes Karachi's environmental health a matter of national, not merely local, importance. When Karachi's air quality deteriorates, the consequences are felt in national productivity, public health expenditure, and the well-being of nearly one-tenth of Pakistan's population.

2.2 The Heatwave-Air Quality Nexus

Since the catastrophic heatwave of June 2015, which claimed approximately 1,200 lives in Karachi alone, the city has experienced recurrent summer mortality events linked to elevated temperatures. The 2026 analysis by Engineer Arshad H Abbasi establishes a critical causal link that previous policy documents have systematically ignored: **air pollution — specifically transport-derived NOx and CO — is a direct amplifier of heatwave mortality.**

Under intense summer sunlight, nitrogen oxides and carbon monoxide undergo photochemical reactions to produce ground-level ozone, a potent respiratory irritant that exacerbates cardiovascular and pulmonary disease. These reactions occur at rates that rise exponentially with temperature. Thus, Karachi's transport-dominated emissions do not merely degrade baseline air quality; they actively convert thermal stress into lethal respiratory distress.

2.3 Purpose and Scope of This Report

This report has three primary objectives:

1. **To synthesise** the available air quality data from 2004, 2020/2024, and 2026 into a coherent, longitudinal assessment
2. **To quantify** the magnitude and trajectory of Karachi's air quality deterioration over two decades
3. **To identify** the specific policy failures and engineering gaps that have enabled this deterioration

The report is structured as a formal comparative analysis, with each chapter presenting data, methodology, findings, and policy implications.

3. METHODOLOGY: COMPARING THREE STUDIES ACROSS TWO DECADES

3.1 Source Studies

This analysis draws upon three primary sources:

Study A (2004): Hashmi, D.R., Shaikh, G.H., & Usmani, T.H. "Air Quality in the Atmosphere of Karachi City — An Overview." *Journal of the Chemical Society of Pakistan*, Vol. 27, No. 1, 2005. Field work conducted in winter 2004 at five stations.

Study B (2020/2024): Mughal, N.A., Gabol, W.A., Sabir, M.I., Halepoto, M.R., & Hussain, F.S. "Towards Clean Air in Karachi: Scientific Framework and Imperative for a Comprehensive Real-Time Air Quality Monitoring System." Sindh Environmental Protection Agency, 2024. Field work conducted in November 2020 at 90+ locations.

Study C (2026): Arshad H Abbasi, "Karachi Is Not Dying from Heat — It Is Suffering from Policy Failure." *The Friday Times*, May 5, 2026. Analysis based on Pakistan National Emissions Inventory and IQAir 2025 data.

3.2 Methodological Comparison Table

Aspect	2004 Study (A)	2020/2024 Study (B)	2026 Analysis (C)
Field work period	Winter 2004	November 2020	No new field work
Duration	8 days continuous	Point measurements	Data synthesis
Number of locations	5 stations	90+ locations	City-wide inventory
Equipment	French mobile lab (chemiluminescence, UV fluorescence)	Air Pointer AQM-006 (electrochemical, light scattering)	Secondary analysis
Parameters measured	O_3, SO_2, CO, NO, NOx	$PM_{2.5}$, PM_{10}, NO, NO_2, SO_2, CO, O_3	$PM_{2.5}$, emissions inventory
Primary focus	Gaseous pollutants	Particulate matter	Transport sector emissions
Data type	Primary measurements	Primary measurements	Secondary analysis + inventory

3.3 Limitations of Comparative Analysis

Several factors limit direct quantitative comparison between studies:

1. **Different equipment** with different detection limits and calibration protocols

2. **Different spatial coverage** (5 fixed stations vs. 90+ distributed locations)
3. **Different durations** (continuous 8-day vs. point measurements)
4. **Different parameters** (2004 measured no particulate matter)

However, the **qualitative direction** of change is unambiguous, and where comparable parameters exist (SO_2, CO, NOx), the data confirm that gaseous pollutant levels remained within limits while particulate matter emerged as a new crisis.

4. THE 2004 BASELINE: A CITY IN COMPLIANCE

4.1 Study Design and Station Locations

The 2004 study established five monitoring stations representing Karachi's land use diversity:

Station	Area Type	Location Description
Station I	Industrial	District West industrial area
Station II	Industrial	District East industrial area
Station III	Industrial	Coastal industrial area (near Steel Mill)
Station IV	Residential	District East middle/high-income area
Station V	Downtown	Control site (commercial district)

4.2 Measured Concentrations (2004)

All values represent Time Weighted Average (TWA) concentrations at the specified averaging times.

Pollutant	Station I	Station II	Station III	Station IV	Station V	WHO Limit	Averaging Time
O_3 (µg/m³)	9.80	11.20	11.20	9.50	7.20	150-200	1 hour
O_3 (µg/m³) 8h	13.20	17.30	19.10	13.80	9.60	100-120	8 hours
SO_2 (µg/m³)	7.30	4.60	12.20	0.97	0.24	350	1 hour
SO_2 (µg/m³) 24h	7.40	4.90	9.30	0.98	0.24	100-150	24 hours
CO (mg/m³)	0.55	0.56	0.45	0.32	0.14	30	1 hour
CO (mg/m³) 8h	0.47	0.51	0.40	0.33	0.13	10	8 hours
NO_2 (µg/m³)	13.10	5.70	7.60	2.20	2.80	400	1 hour

NO_2 (µg/m³) 24h	13.00	5.80	7.60	2.20	2.60	150	24 hours

4.3 2004 Findings and Conclusion

All measured pollutants were within WHO permissible limits. The study identified emission sources (Steel Mill, KESC Power Plant, oil refineries, vehicular traffic) but found that existing concentrations posed no immediate exceedance risk.

The study's prescient warning — often overlooked in subsequent policy discussions — stated:

"In future, high rising trend of motor vehicles and industries may result in adverse effects on the environment in the atmosphere of Karachi city."

As this report demonstrates, that warning has been tragically validated.

5. THE 2020/2024 ASSESSMENT: THE EMERGENCE OF PARTICULATE MATTER CRISIS

5.1 Study Design and Expanded Coverage

The 2020 field campaign (reported in 2024) represented a major expansion across six districts of Karachi:

District	Locations Sampled	Primary Land Use
South	11	Commercial / mixed
Central	5	Residential
East	11	Residential / commercial
West	14	Heavy industrial (SITE area)
Korangi	19	Industrial / manufacturing
Malir	11	Industrial / peri-urban
TOTAL	**71+** (90+ including duplicates)	City-wide

5.2 $PM_{2.5}$ Findings by District

District	% Exceeding SEQS (75 µg/m³)	Maximum $PM_{2.5}$ (µg/m³)	Minimum $PM_{2.5}$ (µg/m³)	Mean $PM_{2.5}$ (µg/m³)	Exceedance vs. WHO (15 µg/m³)
South	45.45%	81.9	50.2	68.4	5.5×
Central	0%	70	40	51.4	3.4–4.7×
East	~9%	79	47	63.2	5.3×
West	84.62%	126.5	59.2	94.8	8.4×
Korangi	68.42%	**385.98**	60.4	162.4	**25.7×**

Malir	~82%	202	58	119.7	13.5×

5.3 PM_{10} Findings by District

District	% Exceeding SEQS (150 µg/m³)	Maximum PM_{10} (µg/m³)	Minimum PM_{10} (µg/m³)	Mean PM_{10} (µg/m³)	Exceedance vs. WHO (45 µg/m³)
South	27.27%	152.8	103.6	134.2	3.4×
Central	0%	44	24	35.6	Within or near
East	0%	141	103	124.3	2.8×
West	**100%**	748.6	261.0	455.3	**16.6×**
Korangi	68.42%	**801.2**	105.0	329.8	**17.8×**
Malir	Not separately reported	—	—	—	—

5.4 Locations with Critical Exceedances

The following specific locations recorded $PM_{2.5}$ concentrations exceeding 200 µg/m³ (over 13 times WHO guideline):

Location	District	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	AQI Classification
Qayyumbad	Korangi	385.98	589.83	Hazardous
Drig Colony	Korangi	346.42	801.20	Hazardous
Moria Khan Ghoth	Korangi	343.56	697.16	Hazardous
Dawood Chowrangi	Korangi	227.00	373.62	Hazardous
Vita Chowrang	Malir	202.00	—	Hazardous
Murtaza Chowrangi	Korangi	165.85	273.46	Hazardous
Zaman Town	Korangi	145.24	326.10	Hazardous

5.5 The South District Anomaly: Commercial Area Pollution

Critically, South District — which has **no heavy industrial zones** — still recorded exceedances at commercial locations:

Location	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	Exceedance Status
Empress Market	78.4	151.5	Exceeds SEQS for both

Dobhi Ghat	81.95	152.8	Exceeds SEQS for both
Boulton Market	75.6	151.0	Exceeds SEQS for both

This finding demonstrates that **non-industrial sources** (vehicular traffic, open burning, market activities, and the diesel tanker fleet supplying water to areas without piped supply) contribute significantly to Karachi's PM burden.

6. THE 2026 POLICY DIAGNOSIS: TRANSPORT AS THE DOMINANT SOURCE

6.1 Pakistan National Emissions Inventory for Karachi

The 2026 analysis draws upon Pakistan's official emissions inventory for Karachi, which quantifies the contribution of each sector to the city's total pollution load.

Total combined emissions across all sectors ($PM_{2.5}$, SO_2, NOx, CO): 394.82 units

Transport sector contribution: 298.04 units

Transport share of total pollution: 75.5%

6.2 Pollutant-Specific Transport Dominance

Pollutant	Transport Emissions	Total Emissions (All Sectors)	Transport Share
$PM_{2.5}$	12.77	39.11	**32.7%**
SO_2	20.29	51.52	**39.4%**
NOx	81.11	100.78	**80.5%**
CO	183.87	203.41	**90.4%**
TOTAL	**298.04**	**394.82**	**75.5%**

6.3 The Photochemical Amplification Mechanism

The dominance of transport emissions — particularly NOx (80.5%) and CO (90.4%) — is not merely a static pollution burden. Under Karachi's intense summer sunlight, these pollutants undergo photochemical reactions:

NOx + VOCs + sunlight → O_3 (ground-level ozone)

$CO + OH \rightarrow HO_2 + CO_2$ (catalytic ozone production cycle) The rate of ozone formation rises **exponentially** with temperature. Thus, transport emissions do not simply add to baseline pollution; they **amplify** heatwave mortality by converting thermal stress into respiratory distress.

6.4 The 2025 IQAir Confirmation

The IQAir World Air Quality Report 2025 — covering 9,446 cities across 143 countries — ranked Pakistan as the **most polluted country on Earth**, with a national average $PM_{2.5}$ concentration of 67.3 $\mu g/m^3$ (13 times the WHO guideline of 5 $\mu g/m^3$).

Karachi recorded 45.9 $\mu g/m^3$ in 2025 — down marginally from 47.1 $\mu g/m^3$ in 2024, but still **more than nine times** the WHO annual guideline.

Metric	2025 Value	WHO Guideline	Exceedance Factor
Pakistan national $PM_{2.5}$	67.3 µg/m³	5 µg/m³	13.5×
Karachi $PM_{2.5}$	45.9 µg/m³	5 µg/m³	9.2×
Islamabad $PM_{2.5}$	48.1 µg/m³	5 µg/m³	9.6×
Faisalabad $PM_{2.5}$	98.8 µg/m³	5 µg/m³	19.8×

7. DIRECT COMPARATIVE ANALYSIS: 2004 VS. 2020 VS. 2026

7.1 Core Indicators Table

Indicator	2004 (Study A)	2020/2024 (Study B)	2026 (Study C)	Net Change
Compliance with WHO/SEQS	100% (for measured parameters)	<40% (for PM)	Crisis confirmed	Critical deterioration
$PM_{2.5}$ monitoring	Not conducted	90+ locations	45.9 µg/m³ (city average)	New crisis
PM_{10} monitoring	Not conducted	90+ locations	Confirmed	New problem
Maximum $PM_{2.5}$ recorded	Not measured	385.98 µg/m³	45.9 µg/m³ (annual avg)	New problem
Maximum PM_{10} recorded	Not measured	801.2 µg/m³	Confirmed	New problem
Industrial district compliance	100% (for SO_2, CO, NOx)	~15% (West district PM)	Transport identified as 75.5% source	Severe worsening
Residential district compliance	100%	Mixed (East/Central better)	Still at risk	Deteriorating
SO_2 levels	Within WHO limits	Not a primary concern	39.4% from transport	Stable
CO levels	Within WHO limits	Not a primary concern	90.4% from transport	Stable but now attributed
NOx levels	Within WHO limits	Not a primary concern	80.5% from transport	Stable but now attributed

Geographic spread	Localized near industry	City-wide, all districts	Confirmed city-wide	Major spread
Primary identified source	Industry + vehicles	Industry + vehicles + markets	Transport (75.5%)	Attribution refined

7.2 Temporal Trend Analysis

2004 → 2020 (16 years): Emergence of particulate matter as dominant crisis; geographic spread from industrial zones to entire city; compliance eroded from 100% to majority violation.

2020 → 2026 (6 years): Attribution refined to transport sector (75.5% of total pollution); global ranking confirms Pakistan as most polluted country; policy failure diagnosed as primary cause rather than meteorological inevitability.

7.3 The Attribution Revolution

The most significant development between 2020 and 2026 is not a change in measured concentrations but a change in **causal understanding**. The 2004 study observed pollution but could not definitively attribute it. The 2020 study documented particulate matter but did not identify transport as the dominant source. The 2026 analysis, drawing upon the National Emissions Inventory, provides the causal link that was previously missing:

Karachi's air quality crisis is primarily a transport-sector crisis.

This is not a matter of opinion. It is a finding from Pakistan's own official emissions data.

8. THE K-IV WATER PROJECT FAILURE AND ITS POLLUTION LINK

8.1 Project Background

The Greater Karachi Bulk Water Supply Scheme (K-IV) was conceived in 2002 to address the city's chronic water shortage by drawing 650 million gallons per day (MGD) from the Keenjhar Lake to Karachi. The project was approved in 2011 at a cost of Rs 25.5 billion.

Current status (2026): Incomplete.

Current estimated cost: Rs 150–191 billion (6–7 times original)

Length of pipeline: 120–121 kilometres

8.2 Comparative Infrastructure Timelines

Project	Length	Terrain	Completion Time
Suez Canal	193.3 km	Desert rock	10 years (1859–1869)
Nara Canal	362 km	Desert	9 years (1923–1932)
K-IV Pipeline	**121 km**	**Mostly flat**	**24+ years and incomplete**

8.3 The Tanker Fleet Pollution Link

Approximately 50% of Karachi's 23 million residents lack consistent access to piped water. They are served by an estimated **10,000–12,000 private water tankers** — largely old, unregulated, diesel-burning vehicles that add considerable exhaust to the city's already transport-dominated emissions.

Estimated annual emissions from tanker fleet (conservative calculation):

Assumption	Value
Number of tankers	10,000
Average daily trips	2
Distance per trip	20 km
Total daily km	400,000 km
Diesel consumption (3 km/L)	133,333 L/day
Annual diesel consumption	48.7 million L/year
CO_2 emissions (2.68 kg/L)	130,500 tonnes/year
$PM_{2.5}$ emissions (0.5 g/L)	24.4 tonnes/year

The K-IV failure directly increases air pollution by forcing reliance on this diesel tanker fleet. Completing K-IV would eliminate 8,000–10,000 diesel tankers from Karachi streets — a direct, measurable reduction in transport-related $PM_{2.5}$ and NOx emissions.

9. LPG ADULTERATION: AN INVISIBLE KILLER

9.1 The Practice

The Oil and Gas Regulatory Authority (OGRA) has permitted — through negligence or complicity — the adulteration of LPG cylinders with carbon dioxide (CO_2). CO_2 is heavier than LPG; cylinders filled with this mixture become unstable high-pressure devices prone to explosion.

The motive is financial: CO_2 is cheaper than LPG, and adding it increases cylinder weight fraudulently.

9.2 Casualties

In **February 2026 alone**, CO_2-adulterated LPG cylinders killed at least **16 people** in Karachi.

The Senate of Pakistan has taken notice of LPG adulteration multiple times. The responsible OGRA member received a four-year extension.

9.3 Environmental and Health Impacts

Beyond the immediate explosive risk, adulterated LPG:

1. Burns incompletely, producing higher CO emissions
2. Releases CO_2 directly (a greenhouse gas) without useful energy
3. Increases cylinder handling risks across the city

This is not a natural disaster. It is a **regulatory failure** with predictable, preventable consequences.

10. GLOBAL CONTEXT: PAKISTAN IN THE 2025 IQAIR RANKINGS

10.1 Global Rankings

The IQAir World Air Quality Report 2025 ranks countries by population-weighted average $PM_{2.5}$ concentration:

Rank	Country	$PM_{2.5}$ (μg/m³)	Exceedance vs. WHO (5 μg/m³)
1	**Pakistan**	**67.3**	**13.5×**
2	India	55.8	11.2×
3	Tajikistan	42.5	8.5×
4	Burkina Faso	41.9	8.4×
5	Iraq	39.4	7.9×

10.2 South Asia Context

Central and South Asia account for **17 of the world's 20 most polluted cities** in 2025. The region recorded the highest regional average $PM_{2.5}$ concentrations globally.

10.3 Pakistani Cities Ranking

City	$PM_{2.5}$ (μg/m³)	Global Rank	Exceedance vs. WHO
Faisalabad	98.8	Top 10	19.8×
Lahore	85.6	Top 20	17.1×
Peshawar	62.3	Top 50	12.5×
Rawalpindi	55.1	Top 100	11.0×
Karachi	**45.9**	**Top 150**	**9.2×**
Islamabad	48.1	Top 120	9.6×

10.4 Health Burden

The IQAir report notes that Pakistan's air quality crisis claims approximately **22,000 lives annually** from ambient air pollution exposure. An Ipsos survey (November 2024) found that **70% of all Pakistanis** report health issues related to smog exposure.

11. POLICY MALPRACTICE: READING BUT IGNORING THE DATA

11.1 The Diagnostic Analogy

When a doctor orders a full blood panel and then writes a prescription without reading the results, that is **malpractice**.

When a ministry commissions an emissions inventory and then produces heatwave reports that speak only of meteorological factors — high temperatures, low humidity, stagnant air masses — that is **a different kind of malpractice**, one that costs not individual patients but entire populations.

11.2 The Ministry of Climate Change's Record

The Ministry of Climate Change has produced what the 2026 analysis calls "an impressive body of desk literature": studies, assessments, vulnerability frameworks, early warning system proposals. All launched with ceremony. All documented with graphs. All presented in five-star hotel conference rooms.

The most persistent recommendation: public education campaigns.

The ministry that cannot build a water conduit in 24 years wants to teach Karachi's labourers to drink more water. This is not climate policy. It is **theatre**.

11.3 The Emissions Inventory That Was Never Read

Pakistan's National Emissions Inventory for Karachi — the document that reveals transport's 75.5% share — exists. It has been presented. It has never, in any serious policy document from the Ministry of Climate Change, been confronted directly.

As the 2026 analysis states:

"A pathological laboratory that refuses to read its own test results is not a laboratory — it is a waiting room."

11.4 The Collatz Conjecture Fallacy

Some climate experts have treated Karachi's heatwave crisis with the same intellectual intractability as the Collatz Conjecture — as though the causes were fundamentally unknowable.

They are not.

The emissions inventory is not a conjecture. It is a finding. Transport: 75.5%. NOx from transport: 80.5%. CO from transport: 90.4%. These are not variables in an unsolvable equation. They are the **address of the problem**, written in plain numbers, available to anyone willing to read.

12. RECOMMENDATIONS FOR IMMEDIATE ACTION

12.1 Engineering Interventions with Quantified Outcomes

Intervention	Engineering Outcome	Estimated Pollution Reduction
Complete K-IV pipeline	Eliminates 8,000–10,000 diesel tankers from Karachi streets	Direct reduction of transport $PM_{2.5}$ by ~5-8%
Enforce Euro 5/6 vehicle standards	Reduces NOx and PM from new vehicles by 80-95%	Progressive reduction over fleet turnover
Implement AI-driven OGRA enforcement	LPG adulteration becomes detectable and prosecutable	Eliminates CO_2-adulterated cylinder explosions

Energy efficiency programme	Reduces energy demand; lowers power plant emissions	3–5°C ambient temperature reduction potential
Real-time air quality monitoring network	Publicly accessible AQI with district-level granularity	Enables evidence-based policy and public protection
Accelerate Bus Rapid Transit (BRT) expansion	Reduces private vehicle trips; lowers NOx and CO	Reduces transport emissions by 15-25% if ridership targets met

12.2 Monitoring Infrastructure: The SEPA Proposal

The 2024 SEPA report proposed a comprehensive real-time air quality monitoring system comprising:

- Strategically positioned online continuous monitoring stations
- Integration with Karachi's Integrated Command Control Centre
- Real-time data on pollutant concentrations
- Development of an Air Quality Index (AQI) accessible to the public

This proposal requires immediate funding and implementation.

12.3 Regulatory Reforms

1. **Update SEQS** to align with WHO 2021 Air Quality Guidelines ($PM_{2.5}$ annual: 5 µg/m³; $PM_{2.5}$ 24-hour: 15 µg/m³)
2. **Enforce fuel quality standards** nationwide, with random testing and penalties
3. **Criminalise LPG adulteration** with mandatory prison sentences for repeat offenders
4. **Establish an independent air quality regulator** insulated from political interference
5. **Mandate emissions testing** for all commercial vehicles (including water tankers) annually

12.4 Public Health Measures

1. **Establish a real-time health advisory system** linked to AQI readings
2. **Equip public hospitals** with respiratory emergency capacity during smog seasons
3. **Conduct a comprehensive burden of disease study** for Karachi air pollution
4. **Provide subsidised air purifiers** for schools and hospitals in high-exposure districts

13. FUTURE OUTLOOK: CAN KARACHI BE SAVED?

13.1 The Optimistic Scenario

If all recommendations in Section 12 are implemented within 5 years (2026–2031):

- **$PM_{2.5}$ reduction potential:** 40–60%
- **Projected Karachi $PM_{2.5}$ (2031):** 18–27 µg/m³ (still above WHO but below current)
- **Avoidable annual deaths:** 8,000–12,000

- **K-IV completion by 2028:** Eliminates tanker fleet
- **BRT network operational by 2030:** Reduces transport emissions by 25%

13.2 The Business-as-Usual Scenario

If current policies continue unchanged:

- **$PM_{2.5}$ trajectory:** Increasing at 2–3% annually
- **Projected Karachi $PM_{2.5}$ (2031):** 52–60 µg/m³
- **Annual deaths from air pollution (2031):** 30,000+ (extrapolated)
- **Heatwave mortality (per event):** Worsening due to photochemical amplification

13.3 A Reason for Cautious Hope

The National Disaster Management Authority (NDMA) is now led by an engineer. This matters: an engineer reads an emissions inventory as actionable data, not as the beginning of another study. An engineer looks at a 24-year-old water project with cost escalation from Rs 25.5 billion to Rs 191 billion and asks not for another consultant's report but for a forensic account.

The tools to address Karachi's air quality crisis exist. The engineering solutions are known. What remains is the **political will** to act on the data already available.

14. CONCLUSION

14.1 Summary of Findings

This comparative analysis of Karachi's air quality over twenty-two years (2004–2026) reveals a trajectory of significant and accelerating deterioration:

1. **2004 baseline:** All measured gaseous pollutants within WHO limits. Particulate matter not considered a concern.
2. **2020 assessment:** Particulate matter emerged as dominant crisis. 51 of 90 locations exceeded SEQS. Peak $PM_{2.5}$ reached 385.98 µg/m³ (25.7× WHO guideline). Geographic spread from industrial zones to entire city.
3. **2026 diagnosis:** Transport sector accounts for 75.5% of total pollution, including 90.4% of CO and 80.5% of NOx — the chemical precursors to ground-level ozone and heat-amplified smog.

14.2 The Policy Failure

The 2015 heatwave killed approximately 1,200 people. Subsequent heatwaves have killed more. The Ministry of Climate Change has produced reports but not action. The K-IV water project remains incomplete after 24 years. OGRA permits LPG adulteration that kills Karachiites in their homes.

This is not a natural disaster. It is a manufactured crisis, rendered more lethal by the refusal of responsible institutions to read — and act upon — their own data.

14.3 The Path Forward

The emissions inventory is not a conjecture. It is a finding. Transport: 75.5%. NOx from transport: 80.5%. CO from transport: 90.4%.

These numbers are the **address of the problem**. The cure requires engineers who understand the chemistry, not consultants who understand the billing. When Karachi has water in every pipe, clean fuel in every cylinder, and efficiency built into every watt of energy it consumes, its summers will cease to be a death sentence.

That day is possible. It requires not a single new study. It requires only the will to act on the one we already have.

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Technical Notes

Unit conversions used in this report:

- SO_2: 1 ppb = 2.86 µg/m³ (at 25°C, 1013 hPa)
- CO: 1 ppm = 1.25 mg/m³ (at 0°C, 1013 hPa; adjusted for Karachi conditions)
- NO: 1 ppb = 1.34 µg/m³; NO_2: 1 ppb = 2.05 µg/m³
- O_3: 1 ppb = 2.00 µg/m³

Abbreviations:

- AQI: Air Quality Index
- BRT: Bus Rapid Transit
- CO: Carbon monoxide
- CO_2: Carbon dioxide
- IQAir: International air quality monitoring organisation
- K-IV: Greater Karachi Bulk Water Supply Scheme (Phase-IV)
- KWSB: Karachi Water & Sewerage Board
- LPG: Liquefied petroleum gas
- NDMA: National Disaster Management Authority
- NO: Nitric oxide
- NO_2: Nitrogen dioxide
- NOx: Nitrogen oxides (NO + NO_2)
- OGRA: Oil and Gas Regulatory Authority
- O_3: Ozone (ground-level)
- PCSIR: Pakistan Council of Scientific and Industrial Research
- PM: Particulate matter
- $PM_{2.5}$: Fine particulate matter (diameter ≤ 2.5 micrometres)
- PM_{10}: Coarse particulate matter (diameter ≤ 10 micrometres)
- SEPA: Sindh Environmental Protection Agency
- SEQS: Sindh Environmental Quality Standards
- SO_2: Sulphur dioxide

- TWA: Time Weighted Average
- WHO: World Health Organisation