

Modelling study to support the design of air quality plans and investment strategies for air pollution mitigation in Nepal

1. Background

Air pollution is a global problem that also significantly affects the Hindu Kush Himalaya (HKH) region, both in dense urban areas and rural territories. Nine out of the world's 10 cities with the worst air pollution are in South Asia. Concentrations of fine particulate matter (PM_{2.5}) in some of the region's most densely populated and poor areas are up to 20 times higher than the level considered by the World Health Organization to be healthy breathable levels (5 µg/m³). Poor air pollution causes an estimated 2 million premature deaths in the region each year and incurs significant economic costs. Controlling air pollution is difficult without a better understanding of the activities that emit particulate matter. Air pollution also travels long distances in South Asia and gets trapped in large "airsheds" that are shaped by climatology and geography.

On 24 February 2020, the Council of Ministers of Nepal approved the Air Quality Management Action Plan for Kathmandu Valley. Prepared by the Government of Nepal, the plan was finalized after several rounds of consultation with stakeholders and environmental experts from government and non-government agencies, including ICIMOD. It proposes approaches to improve air quality, help protect public health and the environment, and enhance quality of life whilst considering the mitigation of climate change.

ICIMOD has been providing technical support to the Nepal government's work on its action plan for several years. In 2015, ICIMOD commissioned a policy gap analysis with a focus on short-lived climate pollutants and existing policies and plans related to various sources of air pollution from different sectors in Nepal.

ICIMOD is also continuously supporting the Nepal government to update the air quality monitoring strategies using the most recent and relevant available data. This consultancy will enhance the capacity of ICIMOD and leverage on the results to support the other Regional Member Countries to improve their Air Quality.

2. Objectives

The World Bank in its 2023 report "Striving for Clean Air"¹ identifies six major airsheds in the region, analyses four scenarios to reduce air pollution with varying degrees of policy implementation and cooperation among countries, and offers a roadmap for airshed-wide air quality management.

The main objective of this consultancy is to complement and evaluate the outcomes of the recent World Bank study with a different methodology by analysing the weight of the different sources on air pollution in Nepal. The use of Brute Force (BF) methods consisting in reducing

¹ <https://www.worldbank.org/en/region/sar/publication/striving-for-clean-air>

pollutant emissions for each activity sectors avoids assumptions of linearisation and account for all non-linearities due to the chemistry. By the use of numerical tools, a set of air quality simulations will be performed to:

- *Evaluate the weight of the most influential activity sectors in Nepal on air pollutant concentrations (BC, PM2.5, Ozone, etc.)*
- *Evaluate the benefit of emission reductions at the regional scale (compare to national actions only) on concentrations within Nepal*
- *Prepare the development of an alternative approach to analysing emission reduction scenarios over the HKH*

These BF methodologies provide a realistic and fully integrated picture on how a mitigation strategy can impact the concentrations of pollutants. It accounts for non-linearities due to chemical processes. For example, reducing SO_x emissions results in enhancing the formation of ammonium nitrate concentration in some situations, which represents a non-negligible fraction of particles. Reducing NO_x emissions can also increase Ozone concentrations in urban areas. This type of “brute force” approach is recommended by the European Commission².

Thus, this study will support the Government of Nepal and other stakeholders in prioritising the activity sectors in which necessary action and investment is required in order to improve air quality in the country. Prioritisation of activity sectors will help to target the most efficient investments to be done in Nepal for air quality improvements. A full analysis will be performed on daily, monthly and annual bases for the O₃, NO₂, PM₁₀, PM_{2.5}, SO₂ and Black Carbon (BC) concentrations.

3. Scope of the work

The consultant will use a chemistry transport model (CTM) to run a baseline simulation for an entire year, in order to define the reference simulation including all emission sources. In agreement with ICIMOD, this consultancy will carry out a pre-screening of the emission inventory in order to define a set of 30 scenarios. The consultant will then use these scenarios to evaluate the role and the contribution of each relevant source.

A total of **31 annual scenario simulations** and **2 additional simulations** to assess the impact of emissions external to Nepal and forest fires, will be required to complete this work.

4. Work plan

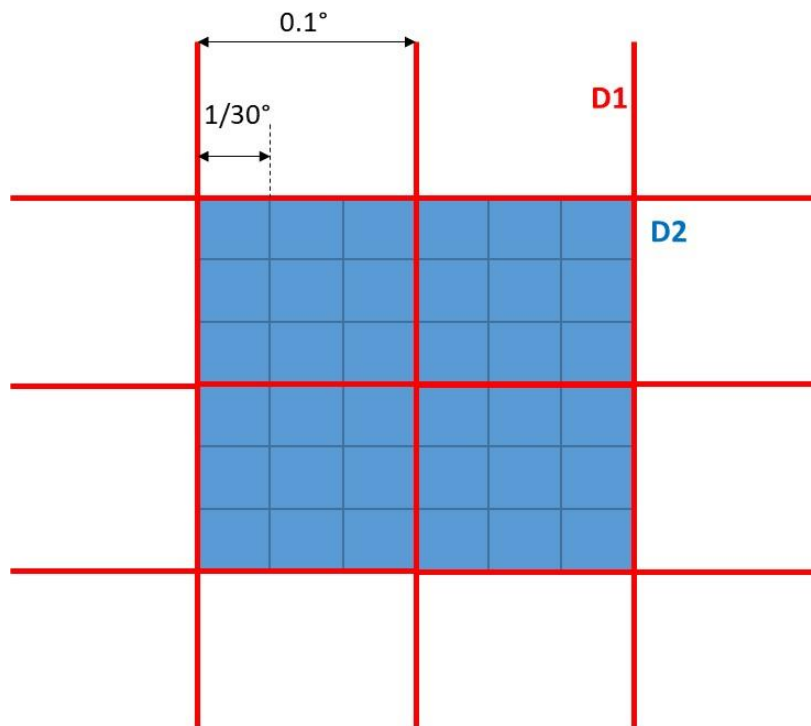
The Consultant must describe in their proposal a framework with milestones and comprehensive deliverables **rigorously respecting** the following requirements:

Model set-up

- The selected CTM will be one of the following: **WRF-Chem** or **WRF-CHIMERE** (in their latest version)
- The simulated meteorological year will be 2022 or 2023 (recent and post-COVID year)

² <https://publications.jrc.ec.europa.eu/repository/handle/JRC130562>

- In the model settings, the model will be run off-line, meaning that the chemistry will not affect the calculation of the meteorology
- The CTM will run over the whole HKH region at a resolution of $0.1^\circ \times 0.1^\circ$ (Domain **D1**) over a window covering **at least 60°E to 100°E in longitude and 5°N to 40°N in latitude** as a subset of the EDGAR emission grid (see below). A regular (in longitude and latitude) nested domain at $1/30^\circ \times 1/30^\circ$ resolution encompassing Nepal will be defined (domain **D2**). The meshes D2 will exactly match D1 as shown in the following figure:



Emissions

- The reference emission inventory will be **EDGAR v8** (released in May 2024) available at https://edgar.jrc.ec.europa.eu/dataset_ap81#p2
- In the pre-treatment of emissions, the following nomenclature of EDGAR emissions will be respected in the model since the scenario will target some of the EDGAR activity sectors:

AGS	Agricultural soils
AWB	Agricultural waste burning
CHE	Production of chemicals
ENE	Energy
ENF	Enteric fermentation
FFF	Fossil fuel fires
FOO	Food Production
IND	Combustion in manufacturing industry
IRO	Iron and Steel production
MNM	Manure Management
NFE	Non-Ferrous metals production
NMM	Production of non metallic minerals

PAP	Pulp and Paper production
PRO	Production of fuels
PRU	Production and Use of other products
RCO	Small scale combustion
REF	Refineries
SOL	Solvents
SWD	Solid Waste Disposal
TNR	Non-road transport
TRF	Transformation industry
TRO	Road Transport
WWT	Waste Water Treatment

- BC, OC, PM10, PM2.5, SOx, NOx, NH3, NMVOC, CO primary emissions will be considered. The carbonaceous fraction (BC, OC) will be well identified in the output of the CTM.
- **The emission pre-processing must ensure an adequate downscaling procedure to refine the emissions with fine scale emission proxy so that the D2 emissions will be not based on a simple interpolation of the EDGAR emission inventory. The downscaling will be briefly described in the methodology.**

Simulations

- A reference simulation called the ‘**basecase**’ will be performed over the two domains defined above (D1 and D2)
- Forest fires and biogenic emissions must be taken into account in all simulations
- Boundary conditions must come from a global model at 6-hourly time resolution (as a minimum)
- A total of **30 scenarios** will be performed over the domains by reducing the emissions by pollutant and sectors
 - 15 simulations will be performed to evaluate the emission reductions over the D1 and D2 domains with reductions applied over Nepal only. The emission reductions will be coherent between D1 and D2
 - 15 simulations will be performed to evaluate the emission reductions over the D1 domain only to evaluate the model responses to emission reductions over the whole HKH and analysing the impact on Nepal
- Additionally, **2 simulations** over the D1 domain will be performed to analyse the influence of forest fires and the influence of sources external to Nepal
- The level of emission reductions, the pollutants and the activity sectors will be defined by ICIMOD after the emission dataset screening.

5. Detailed tasks and deliverables

This project will be divided into four main tasks to be conducted successively. A meeting will be set up by ICIMOD before starting each task. If required, two experts from ICIMOD will visit the consultant at the beginning and at the end of the contract. A minimum of 5 meetings (mainly online) will be therefore organised.

Task I: Consolidation of the emission pre-treatment for the CTM

Task I aims to:

- Collect and format the EDGAR v8 database in a suitable format for the CTM to respect the work plan
- Ensure the EDGAR activity nomenclature is respected in the pre-treatment of emissions
- Evaluate and screen Nepal emissions to target the likely most influential sources in Nepal

Task II: Base case simulation

Task II aims to:

- Define the configuration files for the base case
- Ensure an appropriate downscaling of emissions for domain D2
- Run the model on D1 and D2 domain with all emissions to simulate the basecase
- Evaluate the model with available observation dataset (at least PM10, PM2.5, NO₂ and Ozone) on a daily basis

Task III: Identification of external drivers (Forest fires and long-range transport of air pollution)

Task III aims to perform:

- A simulation over the largest domain D1 only, without anthropogenic emissions from Nepal, to evaluate the role of the transboundary pollution on Air Quality in Nepal
- A simulation over the largest D1 and the nested D2 domains, without fire emissions from Nepal, to evaluate the role of Nepal forest fires on Air Quality in Nepal
- An analysis of these external contributions. The analyses will be performed on a daily, monthly and annual basis for the O₃, NO₂, PM10, PM2.5, SO₂ and BC concentrations

Task IV: Simulation of scenarios

Task IV aims to:

- Define the 30 scenarios: level of reductions, pollutants, activity sectors in agreement with ICIMOD
- Perform the scenario simulations over D1 and D2 domain according to the specifications previously mentioned in the **work plan** section
- Analyse the results in terms of impact on Air Quality. The analyses will be performed on a daily, monthly and annual basis for the O₃, NO₂, PM10, PM2.5, SO₂ and BC concentrations. The population-weighted concentration can be used to focus on the most densely populated areas.

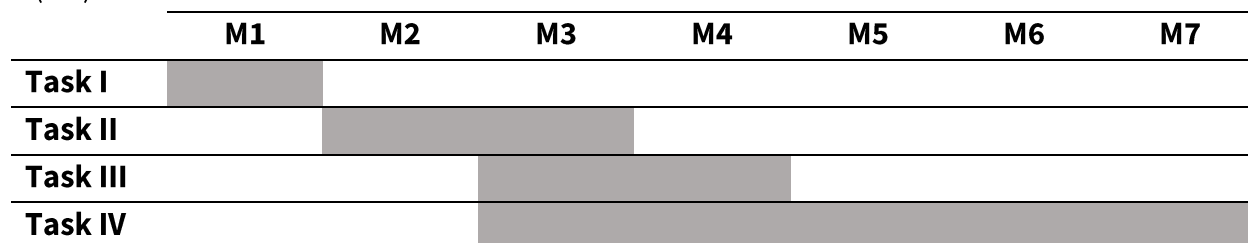
Data Management and Transfer

The consultant will provide to ICIMOD all CTM output files in a *netcdf* format on request. All intermediary and meteorological files for the base case and the scenarios must be kept during at least 1 year after the end of the contract.

- To limit the volume of data, ICIMOD will provide a list of variables (emissions, concentrations and meteorological variable) to store on an **hourly basis** and transfer by the consultant to ICIMOD
- Only the **ground level** for concentrations and meteorological variables will be stored. The sum of all levels will be provided for emissions.
- For emissions, gridded hourly emissions of NO_x, PM_{2.5}, PM₁₀, NMVOC, Sox, NH₃, BC, OC, per EDGAR activity sectors must be stored and sent to ICIMOD for all simulations.
- All outputs will be delivered over the D1 and D2 domain meshes.

The source code and all configuration files will be provided as a *tar* archive to ICIMOD.

The tasks will be scheduled according to this simplified Gantt chart from Month 1 (M1) to Month 7 (M7).



6. Team

The proposed resources must be part of the project team for the time period specified. Additional resources must be included in the technical proposal with roles, responsibilities, and expertise.

Responsibilities	Role and expertise in the project
Project Director	Team leader Provide overall guidance on project implementation and complete the research.
Senior Expert in air pollution management and air quality plans	Project coordinator

	Follow the technical activities, ensure quality and adhere to timelines
Modelling expert	Modelling expertise
Emission expert	Emission expertise

7. Timelines and deliverables (outputs)

The end of the contract period is **31 March 2025**. The following timeline must be followed:

Deliverable	Deadline	Payments
Work plan	01 September 2024	20%
Mid-term report: presentation of the base case and evaluation	30 November 2024	50%
-Final report: scenario analysis and analysis of forest fires and transboundary contribution -Output files requested by ICIMOD with required variables -All source code and configuration files	31 March 2025	30%

8. Proposal

Technical proposal

The bidder must submit the technical proposal, including but not strictly limited to the following items:

1. **Technical approach and methodology:** The bidder should explain their understanding of the objectives of the assignment, approach to the services, and detailed methodology to obtain the output.
2. **Work plan:** The bidder should include the main activities of the proposal, content and duration, milestones, detailed log frame, detailed consultative measures, adoptive measures, baseline indicators, measures for impact indicators, targets, and delivery date to achieve the project output. The proposed work plan should be consistent with the technical approach and methodology. The bidder must propose a management and operation plan. The bidder must also include the project management approach including quality management and dedicated team.
3. **Organisation and experts:** The bidder should propose the structure and composition of their team, mentioning their qualifications, roles, responsibilities, skills, and expertise as requested in Section 6. The bidder should list the main discipline of the assignment, key expert responsible, and the proposed technical and support staff. Submitted staff CVs should not exceed three pages each.

4. **Relevant past experience:** The bidder must include the details of similar projects and similar past experience of their organisation and experts in the last five years relevant to this RFP.
5. A Consortium is allowed for this RFP. The bidder should be either a company (single legal entity) or a consortium of companies. In the case of a consortium, the bidder consortium shall submit a valid agreement among the members.

Financial proposal

The bidder should provide the financial quote with the breakdown of all the costs and include the tax in the budget (refer to the table provided below):

- Breakdown of the experts needed, number of days required, quantity, rate
- Breakdown of other costs, unit, quantity, rate

Project Activity/ breakdown	Cost Category	Unit (A)	Number of Days	Unit rate ©	Amount (A*B*C*D)
Human Resource Cost					-
	Staff Cost				
	Staff Cost				
	Staff Cost				
	Staff Cost				

9. Reporting

Monthly reporting to ICIMOD for progress updates is required, with the report format subject to ICIMOD’s approval.

10. Proposal submission

The completed proposal should be submitted by email to consultancy.int@icimod.org by **5 PM (Nepal Standard Time), 05 July 2024**. Two separate files – technical and financial proposals – should be submitted.

11. Evaluation

The service provider will be selected on the basis of the highest-ranked technical proposal (60% weightage) and the lowest-cost financial proposal (40% weightage).

The service provider will be selected on the basis of the highest cumulative scores obtained in the technical and financial proposals using the following formula:

- Technical score = Score obtained based on technical proposal (total 100)
- Financial score = Score obtained based on financial proposal (total 100)
- Total score = 60% of technical proposal + 40% of financial proposal

The service provider scoring the maximum score based on the criteria will be awarded the consultancy. However, the service provider should score at least 70 points in the technical proposal.

12. Ethical consideration

The Consultant will be required to take all the necessary actions to handle the collected data responsibly (see [ICIMOD Responsible Data Policy](#)) to ensure data privacy, anonymity, and confidentiality.

13. Our commitment to the prevention of sexual harassment

ICIMOD is committed to the prevention and redressal of sexual harassment at the workplace and promoting the welfare of children, young people and adults and expects all staff, consultants, and volunteers to share this commitment. We will do everything possible to ensure that only those who are suitable to work within our values are selected to work for us.

14. Confidentiality/non-disclosure

All material issued in connection with this ToR shall remain the property of ICIMOD and shall be used only for the purpose of this procurement exercise. All information provided shall be either returned to ICIMOD or securely destroyed by unsuccessful applicants at the conclusion of the procurement exercise.

During the performance of the assignment or at any time after expiry or termination of the Agreement, the consultant shall not disclose to any person or otherwise make use of any confidential information which s/he has obtained or may obtain during this agreement relating to the partner organisation/ICIMOD, the respondents or otherwise.

The consultant will be required to sign a non-disclosure / confidentiality agreement as part of their undertaking of this work.

15. Intellectual property, copyright, and ownership of all prepared information

The consultant shall retain all rights to pre-existing (background) intellectual property or materials used by the consultant in the delivery of this study. All arising intellectual property, ideas, materials, or processes formed in contemplation, the course of, or as a result of this study shall be passed to ICIMOD without restriction.

The consultant shall warrant that all arising intellectual property, materials and/or products produced in pursuit of this study shall be original and shall not infringe on any third party's claim. All technical or business information, in whatever medium or format, originated, collated, or prepared by or for the consultant in contemplation, course of, or as result of this assignment shall be transferred to ICIMOD without restriction on completion and shall not be used by the consultant for any other purpose without express written permission of ICIMOD.

Copyright of all arising documents, data, information, or reports produced by the consultant under this agreement shall belong to ICIMOD and will be passed to ICIMOD without restriction. Such documents, data, information, and reports shall not be used by the

consultant for any other purpose other than in conjunction with this assignment, without the express written permission of ICIMOD.

16. Organisation profile

Bidders/Consortium must provide supporting documents to demonstrate eligibility: a legally registered institution requires an incorporation document; a minimum average annual turnover of USD 500,000 necessitates audited financial statements for the past three years and a tax clearance certificate. Also, proof of successful completion of similar projects mandates documentation for bilateral/international donors.