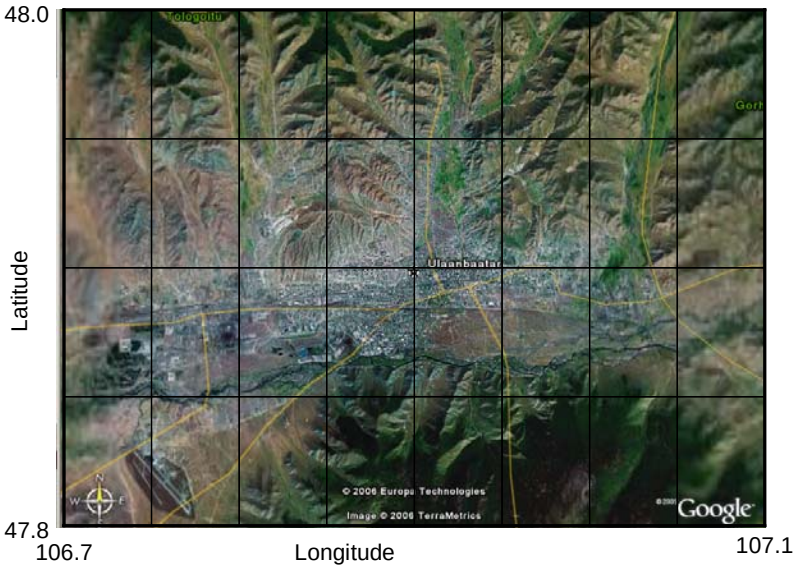

Urban Air Pollution Analysis for Ulaanbaatar

The World Bank Consultant Report

Washington DC USA

Prepared by

Dr. Sarath Guttikunda

Contact Information:
Email: sguttikunda@gmail.com
+91 9891315946, New Delhi, India

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Abstract

Mapping the changes

The objective of this report is to provide an analytical basis to underpin discussions on air quality in Ulaanbaatar and to discuss possible long-term strategies for reducing air pollution; given the changing demographics, in terms of increasing population and a growing urbanization and industrialization. These trends have spurred an increase in the demand for energy in several sectors including transport, construction, heating, industrial production and have resulted in challenges related to the secondary effects of growth and industrialization such as pollution from transport, waste disposal, natural resource mining among others.

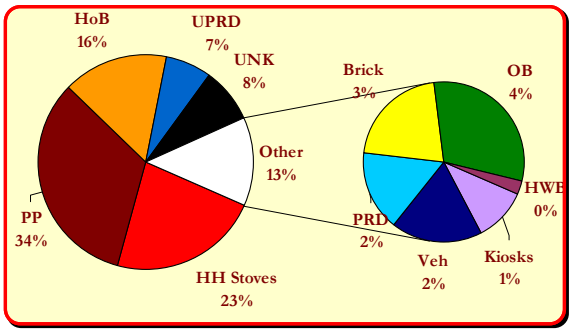
Thus the increase in air pollution as a result of growing population and urbanization poses a significant challenge for rapidly growing city like Ulaanbaatar. A scenario analysis of air pollution emissions in Ulaanbaatar for the years 2010 and 2020 indicate that unless the government makes a concerted effort to address the issue at multiple levels, air pollution and its corresponding health impacts in Mongolia will be significant. While there is no single solution to reduce emissions, a combination of measures ranging from public education and awareness to strengthening of monitoring and enforcement, to improving technology is necessary in order to successfully address the increasing levels of air pollution.

Long term measures such as large scale district heating, building public transportation infrastructure (paving roads) require action at the institutional level, large capital investments and have a long gestation period. On the other hand short term actions such as installing solar panels, introducing efficient stoves, education and awareness on proper ventilation of

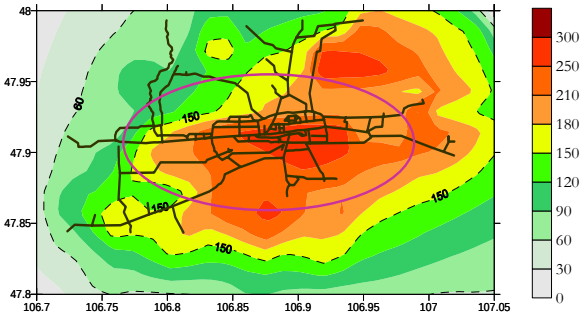
kitchens are less capital intensive and while they require mobilization at the level of the user, are relatively easier to implement. Hence a successful strategy to address air pollution should include a combination of short term and long term solutions.

Figure ES.1: Estimated baseline emissions and concentrations in 2006

Percent Emissions



Total PM_{10} Concentrations ($\mu g/m^3$)



Annual Total PM_{10} = 98.5 ktons

Annual Total $PM_{2.5}$ = 43.5 ktons

Annual Total SO_2 = 23.3 ktons

Annual Total NO_x = 53.2 ktons

Daily Standard = 150 $\mu g/m^3$

Annual average = 200 $\mu g/m^3$

Winter average = 265 $\mu g/m^3$

Summer average = 125 $\mu g/m^3$

Local authorities need to develop a well defined process for action planning, preferably based on existing processes and activities, and built on the existing institutional frameworks. It is important to associate the process of Action Planning with other activities and functions such as – establishing a baseline, analyzing the source categories, developing set of options, considering the necessary indicators (air quality improvements, perceptions and practicability) then prioritizing the options with the highest marginal benefits in the short and long term, and draft the Action Plan, involving an array of stakeholders from public, private, political, and academic backgrounds. Figure ES.1 presents the baseline contributions of identified sources to the PM emissions in the city along with the modeled concentrations. Although this report focuses more on the outdoor air pollution issues, it is important to note that the same pollution sources also contribute to indoor air pollution within the Gers.

Opportunities for pollution reduction

Initiatives aimed at reducing emissions from local sources should be based on assessments of their relative contributions to the pollution load. The problem of air pollution is complex for where there are no *cookie cutter* solutions. Interventions that are tailor made for Ulaanbaatar should build on existing practices and institutional setup and should include a large awareness campaign that is implemented at all levels; among citizens and the public, non-governmental organizations, industry, the municipality, government, and donor agencies. Some of the ways in which air pollution can be addressed are detailed in Table ES.1 (note that there is an overlap between types of interventions) and level of impact of some of these interventions is presented in Table ES.2.

Table ES.1: Examples of technical, institutional, and policy interventions

Technical (T)

- Eliminate gas leaks – VOC recovery – primary at least (P)
- Inspection & maintenance for commercial vehicles (P, E)
- Coal briquettes, wood pellet, better solid fuel stove design (P)
- Promote more efficient agricultural burning methods (P, E)
- Less polluting – better ventilated kitchens (A)
- Reduce sulphur content of diesel and gasoline to 500 ppm or lower (P)
- Require new gasoline cars to have three way catalytic converters (P)

Institutional (I)

- Identify, encourage and promote best practices (A)
- Create Clean Air Group which includes industry, fuel provides and NGOs (A)

Road, Transport, Traffic Management (R)

- One way traffic with synchronized signals (T, E)
- Paving roads (T, E)
- Pavements for pedestrians (A, E)
- Affordable public transportation (A, E, T)

- Train bus drivers about pollution and fuel use (A)
- Discourage SUVs and encourage fuel efficiency goals (T, A)

Policy (P)

- Lead -free gasoline (T)
- Promote only four stroke vehicles (T)
- No burning of garbage, leaves (E)
- Discontinue fuel subsidies
- Lower tax on clean fuels and energy efficient technologies (T)
- Wet sweeping of the roads (R)

Awareness, Media, Educational and social (A)

- Publish and broadcast AQI (T)
- Regular media outlet for AQ stories to keep up interest (T)
- Draw the connections between air quality and health.
- Environment education at primary level, agricultural extension (T)

Enforcement (E)

- Identify gross polluters (T)
- Squealer or complaint phone or text message number to report polluters (P)

Examples of Failures

- Too advanced technology – beyond capacity to maintain – parts supply
- I & M for personal vehicles without proper Q & A
- Capital investment without operation and maintenance funds
- Emissions Inventory is wrong which leads to wrong solutions
- Oxygenated fuel – introduction of heavy aldehyde, subsidies, etc.
- Arguing for leaded gasoline against the impacts benzene and other VOCs from unleaded gasoline

Table ES.2: Level of impact of interventions on air quality in Ulaanbaatar

Intervention	Status	Impact on Air Quality in the short term	Comments
Monitoring	Current capacity to monitor PM pollution in the city is low.	Low	AQ monitors are very **essential** to evaluate the impact of air pollution reduction measures.
Client Capacity	Air Quality Management Bureau (AQMB) formed in August 2006	Low	Capacity building on integrated air quality management is **necessary** to prepare a sound and effective action plan.
Public awareness	Media, public, and political demands.	Low	An **essential** part of the campaign to promote energy efficiency at the household level.
Improved Stoves	Pilot program in implementation	High	Household stoves are a low lying source and contributes significantly in the winter months. This intervention is expected to have an immediate impact on ground level concentrations.
Fuel substitution - briquettes	Private and small scale projects in implementation	High	Along with the improved stove program, fuel substitution with briquettes from sawdust and coal is expected to further reduce the outdoor air pollution burden. This intervention expands to all coal users.
Pollution control at power plants	Only CHP-4 is using ESP at 95 % PM capture efficiency and no sulfur or NOx controls in place.	High	One of the largest elevated sources in the city. Technology such as ESPs and FGDs is mature and available internationally.
Garbage collection	Limited program in place with substantial amount being burnt in-situ	Medium	This requires institutional set-up for garbage collection and landfill management.
LPG	Limited supply to taxis	Low	This intervention needs pricing and supply reforms, to make it more widely available.
Paved road dust	Manual sweeping in place	Medium	This intervention is expected to reduce spring and summer time on-road fugitive source. Heavy-duty vehicles for this purpose are available internationally.
Energy efficiency at heat only boilers	A number of small and medium scale boilers in use	High	Nearly 800 small boilers are operated in the city for heating purposes. This intervention can reduce dispersed pollution by abolishing small scale boilers and upgrading them to district heating system.
Solar water heating for housing systems	No activity	High	This is an expensive and possible short term intervention. With the new 40,000 housing system in plan, the solar water heating can reduce the load on district heating system and power plants. Technology is available internationally.
Gasification of urban and solid waste	No activity	Medium	In combination with garbage and solid waste management, can supply for small scale energy needs and heating. Technology is well documented and available internationally.
Ash ponds from power plants	No activity	Medium	This intervention is expected to reduce spring and summer time fugitive source out of power plants ash ponds. Technology for using ash to make bricks and construction material is well studies and available internationally.
Bus Rapid Transport	No activity	Low	Fleet is small and their effect may be counteracted by growth in the passenger vehicles and barriers such as lack of policy frameworks for inspection and maintenance.

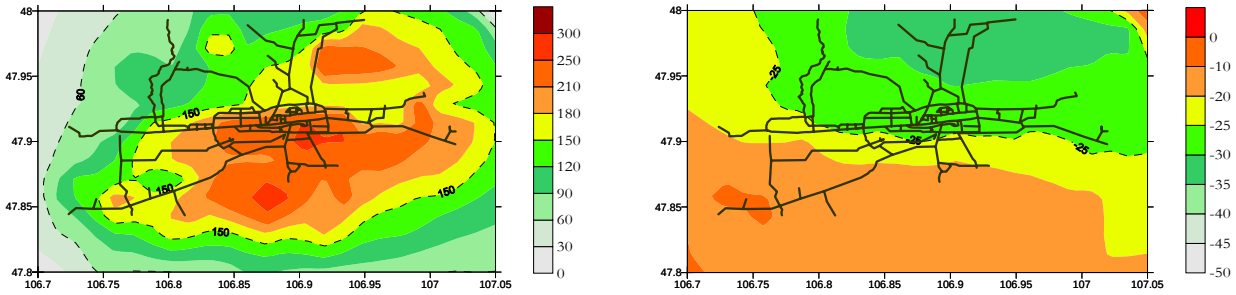
Note: High indicates immediate and large reductions; Medium indicates moderate and sporadic reductions; Low indicates less or non-direct reductions in air quality

Figure ES.2: Modeled future (2010 & 2020) PM_{10} concentrations (µg/m³) with controls

2010

Assumed improvements from business as usual (BAU): 50 percent shift to improved stoves in the households; 50 percent shift from coal to briquettes in the household stoves; 50 percent abolishment of small heat only boilers operating in the city; 50 percent improvement in the garbage collection and reduction of in-situ burning; Use of fly ash from power plant ash ponds, reducing the unknown

PM_{10} **% Change from BAU**

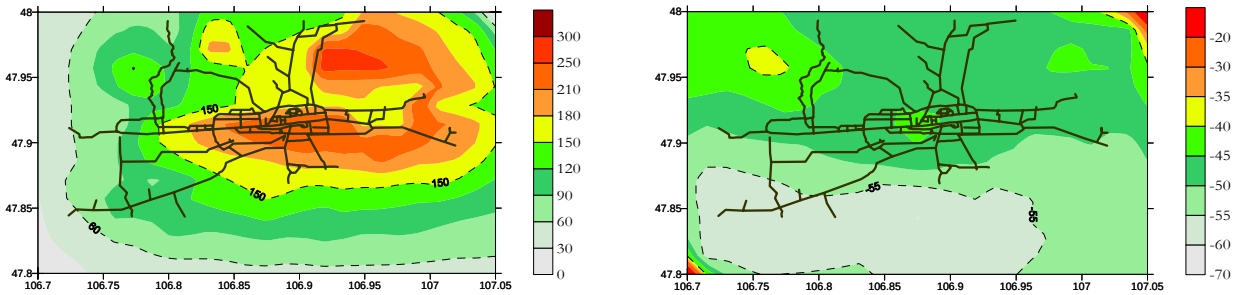


City central annual average = 195 µg/m³; Avoided health costs = US$ 148 million

2020

Assumed improvements from BAU: 100 percent shift to improved stoves in the households; 100 percent shift from coal to briquettes in the household stoves; 50 percent abolishment of small heat only boilers operating in the city; Halving the growth of small and big heat only boilers and promotion of district heating and solar water heating; 50 percent improvement in the garbage collection and reduction of in-situ burning; Introduction of ESPs for all the power plants without (2 & 3) and improving the efficiency of ESPs with (4 & 5); Introduction of FGD systems reducing SO_2 and NO_x emissions by 75 percent; Use of fly ash from power plant ash ponds, reducing the unknown; Mechanical sweeping of the paved roads and reducing the silt loading on roads for the spring and summer and conversion of a fraction of unpaved to paved roads in the Ger area.

PM_{10} **% Change from BAU**



City central annual average = 163 µg/m³; Avoided health costs = US$ 690 million

Road ahead

The scenarios and control options for year 2010 and 2020 are based on several assumptions; however they provide a direction to policy makers and experts and allow them to evaluate the relative benefits and impacts of different policy strategies, which are discussed in greater detail in this report. Figure ES.2 presents pollution levels estimated for year 2010 and 2020 with some control measures, expected reduction in concentrations from business as usual scenarios for 2010 and 2020 and avoided health costs compared to business as usual.

The framework for the Air Quality Analysis for Ulaanbaatar, as detailed in this report, has been established after consultation and interaction with multiple stakeholders in Ulaanbaatar, and taking into account the current institutional setup. It is important that stakeholders at all levels are taken into consideration when establishing a long term air quality strategy.

Report Structure

Chapter 1 presents background information on the city of Ulaanbaatar and the current air quality management program. Chapter 2 provides an overview of air quality problem including general statistics, air quality, and climate for the city of Ulaanbaatar, followed by Chapter 3 which describes an inventory for sources of air pollution. Chapter 4 presents methods used to calculate, results from the emissions inventory exercise, compilation of the final emission maps and data products. Chapter 5 presents results from air pollution dispersion modeling for baseline scenarios, contributions from various sectors to ambient levels. Chapter 6 provides an overview of possible interventions for various sectors, followed by respective modeling results for two scenarios in Chapter 7.

The main objectives of this study are to review and assess the sources of PM, using a combination of data collection, surveys, and application of analytical tools. These methods have the potential to provide an indication of the relative contributions of different sources to ambient air pollution and potential to reduce emissions and ambient pollution levels. The analysis covered in this project involves four general tasks:

1. Review of currents trends in air pollution in Ulaanbaatar
2. Review of sources of air pollution, with focus on particulate matter
3. Development of a baseline emissions inventory for primary pollutants
4. Analyze potential for reduction emission sources