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Acknowledgments

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Abbreviations and Acronyms

AAP	Ambient Air Pollution
AI	Administrative Instruction
AMHIB	Air Monitoring and Health Impact Baseline
AQAP	Air Quality Action Plan
AQM	Air Quality Management
AQS	Air Quality Strategy
BC	Black Carbon
BCA	Benefit-cost Analysis
BCR	Benefit-cost Ratio
CAFE	Clean Air for Europe
CAPRI	Common Agricultural Policy Regionalized Impact
CEA	Country Environmental Analysis
CEM	Continuous Emissions Monitoring
CIA	Central Intelligence Agency
CLRTAP	Convention on Long-range Transboundary Air Pollution
CNG	Compressed Natural Gas
CO	Carbon Monoxide
COPD	Chronic Obstructive Pulmonary Disease
CVC	Center of Vehicle Control
DLI	Disbursement-linked Indicator
EEA	European Environment Agency
EMEP	European Monitoring and Evaluation Program
EPB	Environmental Protection Bureau
ERO	Energy Regulatory Office
EU	European Union
GAINS	Greenhouse gas - Air pollution Interactions and Synergies
GBD	Global Burden of Disease
GDP	Gross Domestic Product
GIZ	German Corporation for International Cooperation GmbH
GoK	Government of Kosovo
HMIK	Hydro-Meteorological Institute of Kosovo
ICMM	Independent Commission on Mines and Minerals
IED	Industrial Emissions Directive
IHD	Ischemic Heart Disease
IHME	Institute for Health Metrics and Evaluation
IHMK	Institute of Public Health Kosovo
IIASA	International Institute for Applied Systems Analysis
JICA	Japan International Cooperation Agency
KEK	Kosovo Energy Corporation (*Korporata Energjetike e Kosovës*)
KEPA	Kosovo Environmental Protection Agency
LAPP	Law on Air Protection from Pollution
LEAP	Local Environmental Action Plan
LEP	Law on Environmental Protection
LRI	Lower Respiratory Illness

MCC	Millennium Challenge Corporation
MED	Ministry of Economic Development
MESP	Ministry of Environment and Spatial Planning
MEST	Ministry of Education, Science, and Technology
MIT	Ministry of Trade and Industry
MoF	Ministry of Finance
MTFR	Maximum Technically Feasible Reduction
NGO	Nongovernmental Organization
NH_3	Ammonia
NMVOC	Non-methane Volatile Organic Compound
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
O_3	Ozone
OECD	Organisation for Economic Co-operation and Development
PAH	Polycyclic Aromatic Hydrocarbon
PAF	Population Attributable Fraction
PforR	Program-for-Results
PM	Particulate Matter
PM_{10}	Particulate Matter with a diameter of 10 micrometers or less
$PM_{2.5}$	Particulate Matter with a diameter of 2.5 micrometers or less
PPP	Purchase Power Parity
PRIMES	Price-Induced Market Equilibrium System
SO_2	Sulfur Dioxide
VOC	Volatile Organic Compound
VSL	Value of Statistical Life
WHO	World Health Organization

Executive Summary

Ambient Air Quality in Kosovo

Many cities in Kosovo suffer from poor air quality, with ambient concentrations of particulate matter with a diameter of 2.5 micrometers or less ($PM_{2.5}$) significantly exceeding the national and European Union (EU) standards and global air quality guidelines for $PM_{2.5}$ established by the World Health Organization (WHO). The air pollution in the capital city of Prishtina rivals that of big cities like Beijing, Mumbai, and New Delhi. Especially in winter, urban areas face severe smog episodes, caused by the increased demand for heat from the residential and commercial sector, which is mainly provided by burning solid fuels. Such levels of air pollution are unsafe for Kosovo's population of 1.9 million and cause significant deleterious health impacts.

This report is one in a series of three reports on air quality management (AQM) in Kosovo, Bosnia and Herzegovina, and North Macedonia. It examines the nature and magnitude of ambient air pollution (AAP) in Kosovo. It provides estimates of the health burden and the economic cost associated with the health impacts of AAP, that is, $PM_{2.5}$, in Kosovo. It also analyzes of the roles of various sources of $PM_{2.5}$ emissions on ambient air quality in Kosovo at a national level. The institutional and policy framework for AQM in the country is examined, including contributions of other development institutions in supporting Kosovo in addressing air pollution. Furthermore, the report presents experiences of selected countries that have applied different policy, investment, and technical interventions for air pollution, prevention, reduction, and abatement. Finally, it provides recommendations for reducing air pollution in Kosovo.

Kosovars and people living in the Balkans and Eastern Europe are typically breathing more toxic particulate air pollution than their neighbors in Western Europe. This is due to fewer air pollution reduction policies and more solid fuel heating and cooking (meaning many more residential wood and coal stoves) in Eastern European and Balkan countries compared to the rest of Europe. Western Europe has mostly moved away from coal-fired power plants (or at least has pledged to reduce coal consumption to meet climate goals), but in the Balkans and in Eastern Europe, they are still widely in use. In fact, the Balkan region is home to many coal- and lignite-fired units and to 7 of the 10 most polluting coal-fired power stations in Europe.

Exposure to fine $PM_{2.5}$ is particularly dangerous to human health because these particles find their way deep into lungs and the bloodstream resulting in disease and death. Consequently, they can cause serious health effects such as lower respiratory infections; trachea, bronchial, and lung cancer; ischemic heart disease (IHD); strokes; and chronic obstructive pulmonary diseases (COPDs). In addition to causing pain and suffering, premature deaths and illnesses caused by air pollution result in increased health expenditures and labor productivity losses. Air pollution also has an impact on agriculture because acidic and nitrogen compounds in the air can be deposited on land and water, degrading their quality and affecting ecosystems with consequences to food quality and commercial use of such areas like tourism. In addition, air pollutants such as black carbon (BC), a constituent of $PM_{2.5}$, are also climate warmers.

Health Burden and Economic Cost of Ambient Air Pollution in Kosovo

This report estimates that about 760 people die prematurely every year in Kosovo because of exposure to AAP. About 11 percent of this health burden is carried by Prishtina. Of the total number of AAP-related deaths, 90 percent are from IHD and stroke combined. About 53 percent of IHD and 63 percent of strokes occur in people of productive age before attaining the age of 70. Population age groups between 50 and 69 years old carry the largest share (about 45 percent) of the total health burden associated with exposure to AAP, followed by people over 70 years of age.

The estimated economic cost associated mortality from exposure to air pollution in Kosovo is in the range of US$160–US$310 million, equivalent to 2.5 percent–4.7 percent of gross domestic product (GDP) in 2016. The economic costs associated with the health damage from AAP in Kosovo is on average US$240 million, equivalent to 3.6 percent of GDP in 2016. This study updates the cost estimates of an earlier World Bank study (World Bank 2013), by taking into account improvements in air quality monitoring and exposure and background mortality data, as well as the latest methodological advances for calculating age-specific and diseases-specific mortality impacts and for health impact valuation since the previous estimates.

To better understand the health impacts of AAP on its population and facilitate prioritization of specific geographical areas, Kosovo needs to improve the completeness and comprehensiveness of vital health statistics, including at the subnational level. Specifically, Kosovo needs to strengthen collection of mortality data by cause. In this context, the government needs to strengthen the health information systems and harmonize the national reporting of health statistics with international systems of disease classification. This will help facilitate ready estimation of health impacts of AAP and strengthen the knowledge and information base for decision making to reduce air pollution. Data to support analysis of morbidity impacts such as bronchitis prevalence for children, COPD in adults, hospital admissions for cardiovascular and respiratory illness, and lost workdays should be collected. Stronger and disaggregated disease- and age-group-specific data on health at the subnational level would help facilitate prioritization of specific geographical areas.

Key Sources of $PM_{2.5}$ Exposure

National-level source apportionment analysis conducted in this report indicates that the residential sector is the largest source of exposure to harmful $PM_{2.5}$ associated with the burning of solid fuels in homes. This study provides a first-time quantitative examination of sources of $PM_{2.5}$ in the country. Additional sources of exposure to $PM_{2.5}$ include energy, industry, agriculture, and others. National-level source apportionment is not a replacement for smaller- or city-level source apportionment studies that would allow more in-depth understanding of the contributions of other sectors such as transport, which may be more important at the local level, or of air pollution hot spots. However, reliable emission inventories and robust monitoring data at the local level are critical for meaningful analysis.

At the national level, the dominant share of $PM_{2.5}$ pollution originates within Kosovo, which underscores the need for the government to take concerted and committed domestic action to tackle air pollution that is complemented with regional efforts to address imported air pollution. The contribution of transboundary sources to AAP in the country, estimated at about 20 percent, is considerably less than domestic sources (about 70 percent). While this situation provides the opportunity for Kosovo's direct control over the selection, implementation, and timelines for the actions that must be taken to achieve a significant impact in improving ambient air quality, effectively tackling imported pollution will call for collaborative or regional approaches with Kosovo's neighbors.

To improve the effectiveness of actions to address air pollution there is a need for a reinforced emissions inventory that is complete and accurate in its coverage of polluting sectors and prioritizes the

residential sector. Ongoing efforts to improve activity and fuel use statistics in the residential sector at the municipal level in Prishtina, Obliq, and Fushe Kosova and its environs should be expanded to other parts of the country. Furthermore, uncertainties related to vehicle age, fuel use, and imported used vehicles need to be addressed to allow more accurate assessment of transport-related emissions.

The lack of long-term air quality monitoring data on $PM_{2.5}$ precludes detailed assessment of air quality status and trends and signals the need to strengthen support for the sustainable and reliable operation of the air quality monitoring network. Long-term air quality monitoring data help identify air quality trends and are essential for informing the identification and selection and assess the effectiveness of interventions and measures to reduce air pollution and its adverse health impacts. The results of limited analysis of selected air quality (particulate matter) monitoring data conducted in this study support the dominance of combustion sources in air quality especially during colder months but also highlight potential opportunities to improve reliability of monitoring data as well as quality control and assurance. Ongoing activities to strengthen the air quality monitoring efforts should be continued and expanded, and resources to safeguard sustained operation and maintenance of air quality monitoring networks and enhance data analysis, reporting, and management should be strengthened.

Given the common practice of burning solid fuels in homes and coal for power generation in Kosovo, monitoring efforts should be expanded to routinely include the measurement of chemical species and constituents of PM that are associated with combustion processes and associated with harmful health effects. Monitoring efforts should include measurement of chemical substances such as elemental carbon, organic carbon, and sulphates). In addition, precursors of $PM_{2.5}$ including sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3), and non-methane volatile organic compounds (NMVOCs) should be monitored, as should BC, a constituent of $PM_{2.5}$ and a climate forcer, and toxic heavy metals such as lead.

$PM_{2.5}$ emissions are not expected to decline markedly under existing policies due to the use of fuelwood burning for heating. The results from application of the Greenhouse gas-Air pollution Interactions and Synergies (GAINS) model to simulate emission scenarios up to 2030 and generate national-level source apportionments indicate that if effectively enforced, the existing environmental and air quality policies are expected to deliver a strong decline in the emissions of SO_2 and NO_x but will not have major impacts on primary $PM_{2.5}$ emissions, as current energy projections do not foresee major shifts away from fuelwood combustion in household stoves and boilers.

Furthermore, while the existing policies should lower concentrations in large parts of the country, concentrations will remain high and in violation of the WHO guideline value in densely populated areas because of persistence of firewood use in households. In hot spots, concentrations will reach up to three to four times the guideline value. As part of efforts to reduce residential emissions, it would be crucial to fill important information and data gaps on fuelwood and technical combustion devices by (a) improving statistical information on the use of fuelwood in the country, including from noncommercial sources; (b) analyzing the typical quality of the fuelwood used in the country; (c) assessing the types of stoves and boilers used in the country and the options to reduce emissions from improved use practices; and (d) strengthening public awareness and education of households on low-emission operation of fuelwood burning devices.

It is technically feasible to bring ambient $PM_{2.5}$ concentrations in most of the country to close to WHO $PM_{2.5}$ guideline value through measures in the residential sector. However, it would require urgent action by the government and households. The relevant measures would require (a) early compliance of all new household stoves and boilers burning fuelwood with the stringent standards of the Ecodesign Directive of the EU, (b) replacement of the oldest existing installations, and (c) assurance of adequate quality of fuelwood which includes burning of only dry fuelwood and proper storage of fuelwood. Such changes would require strong financial and governance mechanisms for their realization.

Policy and Institutional Aspects of Air Quality Management in Kosovo

Recognizing the importance of reducing AAP and its significant health effects, the Government of Kosovo (GoK) has developed a comprehensive legal and regulatory framework for AQM over the last decade. To a large extent, these efforts have been geared toward transposing EU Directives into the domestic legislation. The government has also established environmental institutions with dedicated responsibilities for AQM and assigned responsibilities to authorities from relevant sectors. However, achieving sustained reductions in air pollution will require further government commitment to dedicating increased resources and building capacity at different levels of government to address the problem.

Despite efforts to strengthen the institutional framework for AQM in Kosovo, significant challenges remain in terms of implementing the existing laws and regulations, underlain by significant resource constraints. Some of these challenges include lack of implementation of AQM planning and monitoring instruments at national and municipal levels, failure to implement the approved Air Quality Strategy (AQS) for 2013–2022 due to the lack of an approved Air Quality Action Plan (AQAP), incomplete implementation of requirements related to air quality assessments, and lack of municipal or local environmental action plans (LEAPs). Institutions responsible for AQM face several obstacles, most of which are associated with lack of financial, human, and technical resources, which manifest in various areas, including, among others, failure to adopt AQM planning instruments, inadequate operation of the air quality monitoring network, and limited qualified staff with requisite technical expertise and experience.

As a first step, the government could prioritize the implementation of provisions related to the development and implementation of requisite planning instruments and monitoring of air quality at the national and municipal levels. The government can take some specific steps as follows:

(a) The legal provisions under the Law on Air Protection from Pollution (LAPP) could be revised to simplify the approval process of planning documents, specifically strategies and programs such as the AQS and AQAP. These documents currently require congressional approval, as is the case with new laws, which can introduce delays to their adoption and implementation. There is need for the government to update and implement the AQS, which is now three years from its end date.

(b) There is need for the government to implement the Administrative Instruction (AI) No. 02/2011 on Air Quality Assessment, including requirements to monitor long-term trends in air quality, evaluate the effects of measures implemented to improve air quality, and use that information to guide new strategies, programs, and interventions.

(c) There is need for all municipal governments to develop and approve their LEAPs. Prishtina has developed a LEAP, though not formally approved, and this process needs to be formalized and expanded to other municipalities. Without long-term, strategic actions in place, air pollution will remain a significant challenge and a continuing cause of premature death in Kosovo.

Additional measures that the government could take to strengthen the legal framework for AQM include strengthening legislation on air quality standards and AQM planning. Although not a requirement of the EU Directive on ambient air quality and cleaner air for Europe, the government could introduce a standard for daily average ambient $PM_{2.5}$ concentration in accordance with the WHO Air Quality guideline value (25 µg/m^3) or corresponding interim targets (75 µg/m^3, 50 µg/m^3, 37.5 µg/m^3) as part of a phased approach for bringing ambient concentrations of $PM_{2.5}$ down. In addition, proposed amendments to the LAPP, requiring the government to elaborate AQAPs with shorter time frames, that is, 3 years instead of the current 10-year plans and preparation of stand-alone air quality plans by local governments need to be approved.

The government could expand the menu of instruments for AQM beyond 'command-and-control' instruments. The government could consider using market-based instruments, that have been used to reduce air pollutant emissions efficiently and effectively in other countries. Although Kosovo's legal framework contemplates the creation of air pollution taxes, the only instrument that has been developed to date is the vehicle registration fee, which is not directly linked to emissions. Additional instruments that the government could consider include the following economic instruments: pollution charges to promote a shift from using highly polluting fuels, such as coal and diesel, to cleaner fuels such as natural gas, including targeting fuels according to pollutant type; taxes based on fuel-efficiency standards; tradable permits or pricing policies; and technology- and performance-based standards. In all cases, the design of such instruments should incorporate studies of the distributional impacts associated with their implementation to mitigate any regressive effects.

There is a need to strengthen agencies with responsibilities for AQM at the local and national level and provide them with adequate resources. The organizational structure for AQM requires specialists who can carry out a range of actions, including monitoring, health impact assessment, enforcement, and planning. Recruiting staff with the necessary expertise and background, or outsourcing these functions where efficiencies can be gained, will be paramount to ensure that the Ministry of Environment and Spatial Planning (MESP), Kosovo Environmental Protection Agency (KEPA), Hydro-Meteorological Institute of Kosovo (HMIK), and public health officials can fulfill their responsibilities. In addition, the technical capacity of existing institutions could be strengthened by developing partnerships with academia and research centers to improve development of local and regional air quality models and create centers of excellence in the country on AQM.

Putting in place mechanisms to promote coordination, continuous improvement, and enforcement of regulations related to AQM is key for strengthening the government's institutional capacity to effectively deal with air pollution. Horizontal and vertical coordination on AQM should be strengthened by establishing permanent mechanisms for AQM policy development, implementation, monitoring, and evaluation. Vertical coordination might be initially strengthened by establishing clear protocols and mechanisms for air quality data sharing, gradually broadening the scope to areas such as alignment of national and subnational strategies and plans, and enforcement. In addition, the government could put in place a system of continuous improvement through periodic evaluations of AQM policies and interventions to help assess the efficiency, effectiveness, impact, and sustainability of national and local air quality strategies and plans as vital inputs for improving decision making and strengthening government accountability for AQM results. Furthermore, the government should prioritize expansion of the number of inspectors, equipped with requisite training and resources to conduct field investigations. Tested approaches to reinforcing compliance and enforcement include public disclosure of emitters' environmental compliance, judicial action, and increasing fines and expanding the range of sanctions for noncompliance, potentially including civil, judicial, or administrative, as well as criminal enforcement on legal representatives of a polluting entity.

Current air quality monitoring efforts can be improved through investments in more robust systems for air quality monitoring network, data analysis and management, and capturing of emission sources. Efforts to establish a reliable air quality monitoring network should seek to ensure time series of air quality monitoring data at existing stations and increased geographic coverage of the network. In particular, monitoring efforts should prioritize the pollutant, $PM_{2.5}$, which is not consistently monitored at all stations despite its well documented adverse impacts on health. Additional ways to strengthen the current monitoring program include clear protocols for data analysis, quality assurance and control, and data management; automation of data transmission and storage with newer technologies and software that ensure data integrity and preservation; and provision of adequate budgetary resources to operate and maintain the systems as well as assignment of adequate numbers of personnel with requisite technical expertise and provide ongoing training. Furthermore, registers of polluting facilities should be developed and automated to support enforcement of compliance with emission standards.

The government's recent public information program represents a positive development for promoting stakeholder engagement on AQM and should be further expanded. Different agencies within the government, including the MESP and Ministry of Economic Development (MED), invite stakeholders to participate in the policy formulation process. However, stakeholder engagement and networks should be maintained over the long term to ensure continued learning and dialogue on air quality priorities. In the short term, the government could scale up the public information program started by KEPA in 2018 to reach a broader audience and establish a multi stakeholder air quality advisory board to periodically focus on the development, implementation, and evaluation of actions to improve air quality. In addition, the government should foster the creation of a strong air quality constituency including policy makers, legislators, nongovernmental organizations (NGOs), journalists, and other stakeholders. Public interest advocacy through legal associations, the establishment of environmental law clinics at universities, and providing training and disseminating air quality-related information for targeted audiences, should be supported. Furthermore, the government could consider adopting a public disclosure scheme requiring industries to report their pollutant emissions and rate themselves on compliance with national standards.

Interventions to Reduce Exposure to Ambient Air Pollution

Addressing air pollution effectively in Kosovo will require interventions policy, institutional, and investment interventions to address stationary and mobile sources of air pollution. Some interventions that the government may consider are discussed here:

Residential. The government could develop a large-scale program to substitute traditional stoves with more efficient ones. This could start with implementing a pilot program to substitute traditional stoves with more efficient ones in the short term. Stocktaking and lessons from such a pilot and other similar initiative could be taken into account to inform the development of a possible large-scale stove replacement program. This would help reduce emissions from domestic heating while medium- to long-term options (for example, expanding district heating) can be developed. In many countries, these types of programs have been implemented with positive results. As has been done in some countries, the government could introduce subsidies that are designed and targeted to beneficiaries from poor- or low-income households that cannot afford cleaner stoves. Additional measures could be developed over the medium to long term, such as expanding district heating where operational and other factors allow.

Stationary sources. The government took a decision in 2018 to ban the use of coal for heating public buildings. Stationary sources would include not only lignite-fired power plants but also mines, metallurgical, and cement factories. Interventions should focus on revising sanctions for noncompliance commensurate with the damage caused to ensure that large emitters adopt plans to gradually reduce emissions and comply with environmental standards. Such plans should include the requirement for installation of pollution abatement equipment and emissions control technology in industrial facilities. Revisions could entail strengthening and enforcing sanctions for emitters that exceed approved emissions levels to ensure that they are commensurate with the damage they cause. Additional measures that are available to control emissions from stationary sources include setting consumption caps to gradually reduce coal use, incorporating new technologies for desulfurization, denitrification, and dust elimination, setting more stringent emission control standards for coal-fired plants, and setting resource and energy conservation goals targeting resource-intensive industries. Financial incentives could be provided for smaller industrial installations to strengthen air pollution control.

Mobile sources. Recent revisions to the legal framework reduced the age of imported vehicles and incorporate inspections by Centers for Vehicle Control (CVCs) to verify that imported vehicles meet emissions standards. Kosovo has put in place quality standards for key pollutants in liquid fuel, such as sulfur (10 parts per million for diesel and gasoline), that are consistent with EU Directives. Additional measures that could be taken to reduce pollution from mobile sources include (a) implementing a vehicle scrappage program to replace older, polluting vehicles with newer, natural gas vehicles; (b) promoting the conversion of vehicles to natural gas through technological and financial measures; (c) strengthening the effectiveness of vehicle inspection and maintenance programs; (d) ensuring stricter enforcement of measures to reduce importation of older, polluting vehicles, including the requirement for inspections at the point of entry; (e) strengthening inspection of imported fuels; and (f) ensuring more stringent standards for sulfur content of diesel.

Learning from International Experience in Tackling Air Pollution

Addressing air pollution effectively requires strategic, integrated approaches and solutions that are appropriate to the specific city or geographical context and various actors. A single sector or institution is unable to solely undertake the extensive work that is involved in AQM given its cross-cutting nature. Experiences from other countries that are making progress in tackling air pollution show that an integrated approach is required. By supporting these countries, the World Bank has demonstrated its ability to play an integrative role through bringing together and fostering dialogue between, and engagement of, various national and international stakeholders including different sectors of the economy, think tanks, academia, other development partners and supporting crucial analytical work to inform investments and policy and institutional actions for AQM.

The design and implementation of economically effective interventions to successfully reduce air pollution must be underpinned by a sound foundation of analytical work to inform the identification and selection of priorities and interventions and set realistic and achievable air quality targets. As may be seen from the experiences of other countries discussed in this report, such analytical work also provides a platform for stakeholders to engage and come to informed conclusions about possible interventions and implementation of an appropriate air pollution reduction program. The government could consider setting targets for ambient air quality concentrations of $PM_{2.5}$ and understanding how various pollution contributors can engage in actions to achieve the set target.

Conducting in-depth analytical work is often time intensive, requiring adequate budgetary resources. The severity of air pollution and its health impacts as well as public pressure on government and city officials to act may call for interventions in the immediate to short term to reduce air pollution. In such cases, a city could consider applying reasonable interventions and policy options that would help alleviate air pollution in the short term such as restricting pollution from known stationary sources or traffic restrictions. However, such short-term actions are unlikely to be able to effectively reduce air pollution in the long term, in particular where air pollution sources are many and varied, and should not substitute a strategic and integrated approach informed by rigorous analytical work and engagement of various relevant stakeholders across different sectors (for example, environment, energy, transport, economy, agriculture, and so on); development partners; academia; and others to inform design and implementation of economically effective interventions for sustained or long-term air pollution reduction.

The government, together with neighboring countries, could establish a knowledge platform for collaboration on transboundary air pollution. Although most of the pollution in Kosovo is from domestic sources, the transboundary contribution is not unimportant at 20 percent. To maximize the synergies between similar or shared air quality-related problems, the GoK could consider setting up, together with neighboring countries, a Balkan Knowledge Platform on transboundary air pollution. The knowledge platform could begin with coordination and knowledge sharing on technical aspects related to transboundary air pollution and gradually broaden the scope to collaboration on measures to address transboundary pollution based on experience and knowledge gained through interaction on the platform.

Benefit-cost analysis (BCA) should be used to provide an informed basis for prioritizing and selecting interventions to reduce air pollution from different sectors. The interventions for tackling air pollution in different sectors are generally well-known, for example, promoting cleaner fuels, implementing district heating, and transportation interventions. However, it is important that decision makers in cities and municipalities select economically effective interventions, which have a benefit-to-cost ratio greater than 1. In other words, the health benefits of an intervention, that is, avoided cost of premature mortality and morbidity, should be greater than the cost of implementing the intervention. Such analysis should consider existing policy and operational constraints that foreclose or limit the implementation of certain air pollution reduction interventions.

The experiences of different cities around the globe show that in addition to technical interventions, a menu of instruments, including market-based, economic, and command-and-control instruments, are needed to effectively reduce AAP. Examples from Peru, Mongolia, and China illustrate the types of interventions that have had a strong impact on reducing air pollution over different time frames and may provide useful lessons for Kosovo in its efforts to reduce air pollution. Cities in the aforementioned countries have successfully used a variety of instruments in their efforts to reduce air pollution, including market-based, economic, and command-and-control instruments; investments in technical interventions; and policy and institutional reforms.

Strategies and interventions to reduce air pollution should not disproportionately burden poor and vulnerable groups of people. Poor people are more likely to drive older, polluting vehicles. Poor people are also more likely to burn cheap and highly polluting fuels for domestic purposes. Therefore, policies that prohibit the use of old, polluting vehicles in favor of newer, clean vehicles could incorporate financial or other suitable incentives for poorer people to comply with the policies. Similarly, programs to promote replacement of polluting stoves with clean, efficient stoves should incorporate incentives that will help low-income households' transition to burning cleaner fuels. It would be important to take into account distributional and social impacts of measures to reduce air pollution on affected populations in different income groups. Poverty and social impact analysis could be used to understand distributional impacts of policies to reduce air pollution to ensure that the poor and vulnerable people are not disadvantaged by actions resulting from those policies.

Kosovo's efforts to reduce air pollution are being supported by various donors through technical assistance and capacity-building activities. There is a need to take stock of the outcomes of these activities and identify opportunities where investments and policy and institutional actions can scale up impacts on air quality supported by appropriate financing mechanisms. Technical assistance of development partners such as Japan International Cooperation Agency (JICA), Millennium Challenge Corporation (MCC), the Government of Luxembourg, and others has been instrumental in making advances on the issue of air pollution in Kosovo. While such support has been instrumental, to sustain and build on those efforts, stocktaking of the outcomes of ongoing donor-supported activities and identification of opportunities and financing mechanisms should be coordinated among donors and conducted in collaboration with the government. Government commitment to undergird and build upon the outcomes of ongoing donor support by ensuring sustained and adequate human and budgetary support will be crucial for sustained impact.

Recommendations for Air Quality Management in Kosovo

The key recommendations of this report are summarized in Table ES1.

Table ES.1. Summary of recommendations to strengthen AQM in Kosovo

Recommendation	Time frame
Legal and Policy Framework	
Revise the LAPP provisions to simplify the approval of key planning documents, including AQS and AQAP.	Short term
Implement key legislation: (a) AI No. 02/2011 on Air Quality Assessment and (b) outstanding legislation relating AQAP.	Short term
Strengthen the legal framework, focusing on specific instruments that reduce pollution from household heating, mobile sources, and large stationary sources.	Short to medium term
Strengthen the legal framework by adopting and implementing a menu of air pollution management instruments, including economic and market-based instruments.	Medium term
Introduce standard for daily average ambient $PM_{2.5}$ concentration.	Short to medium term
Introduce standards for solid fuel quality for use in households.	Short term
Air Quality, Emissions, and Health Data and Analysis	
Strengthen the air quality monitoring network to provide robust geographical coverage and time series data on pollutants, notably $PM_{2.5}$.	Short term
Expand air quality monitoring to include chemical constituents and species of PM such as elemental carbon, organic carbon, and sulfates associated with combustion processes; PM precursors including SO_2, NO_x, NH_3, and NMVOCs; BC; and lead and other heavy metals.	Short to medium term
Develop comprehensive and accurate emissions inventory that prioritizes residential sector. (a) *Residential* - improve activity and fuel use statistics and (b) *Transport* - address uncertainties related to vehicle age, fuel use, and imported used vehicles.	Short to medium term

Recommendation	Time frame
Strengthen capacity to conduct air quality modeling and speciation efforts.	Medium to long term
Strengthen health statistics reporting by harmonizing with international bodies such as the WHO.	Short to medium term
Improve collection and reporting of morbidity data for specific diseases and age groups.	
Strengthen capacity to conduct health risk assessment.	
Reducing Pollution from Different Sectors/Sources	
Residential - (a) pilot substitute traditional stoves with more efficient ones and build on lessons learned and experience to date to develop a large-scale program; (b) put in place targeted financial incentives to help poor households adopt clean, efficient stoves; and (c) implement public awareness campaigns to promote stove replacements.	Short term
Expand district heating.	Medium to long term
Stationary sources - (a) strengthen enforcement to ensure that large polluters develop and adopt plans to gradually reduce their emissions and comply with environmental standards should be continued and strengthened, (b) financial incentives for small industrial facilities to undertake air pollution control measures, and (c) use of sanctions that are clear and commensurate with the damage caused for polluters that exceed their approved emission levels.	Short to medium term
Mobile sources - (a) implement a vehicle scrappage program to replace older, polluting vehicles with newer, natural gas vehicles; (b) promote conversion of vehicles to natural gas through technological and financial measures; (c) strengthen effectiveness of vehicle inspection and maintenance programs; (d) ensure stricter enforcement of measures to reduce importation of older, polluting vehicles, including the requirement for inspections at the point of entry; (e) strengthen inspection of imported fuels; and (f) ensure possibly more stringent standards for sulfur content of diesel.	Medium to long term
Transboundary sources - establish, together with neighboring countries, a technical knowledge platform on transboundary pollution.	Short to medium term
Organizational Framework	
Adequately staff organizations with responsibilities for AQM.	Short term
Strengthen horizontal and vertical coordination by establishing permanent mechanisms for AQM policy development, implementation, monitoring, and evaluation.	Medium to long term
Develop an institutional structure to ensure ongoing evaluations of AQM policies and interventions.	Medium term
Public Participation	
Scale up the public information program started by KEPA in 2018 and strengthen it to reach a broader audience.	Short term
Establish a multistakeholder air quality advisory board to periodically discuss the development, implementation, and evaluation of actions to improve air quality.	Short term
Support public interest advocacy through legal associations, establish environmental law clinics at universities, and provide training and disseminate specific materials for targeted audiences.	Medium term
Enforcement	
Expand the number of inspectors and provide them with training and resources to conduct field investigations.	Short term
Strengthen enforcement by clarifying sanctions for noncompliance, increasing fines, and expanding the range of sanctions.	Medium term

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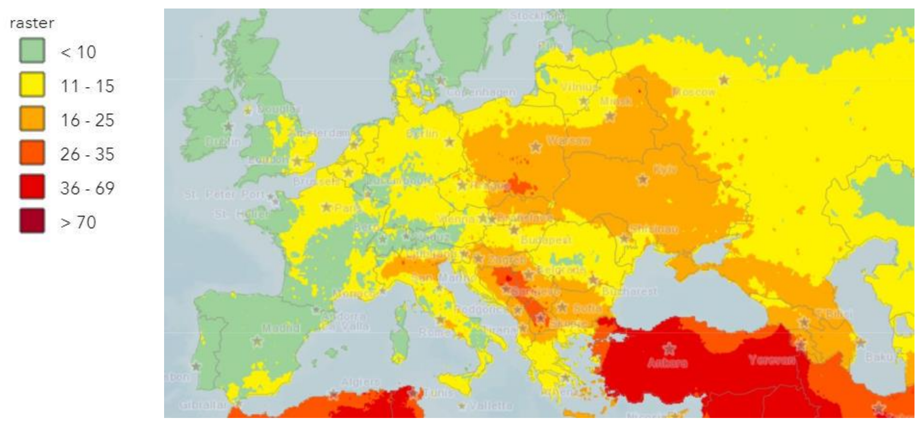
Chapter 1. Ambient Air Quality in Kosovo

1.1. Background

People living in the Balkans and Eastern Europe are typically breathing more harmful air than their neighbors in Western Europe (Figure 1.1). The burning of solid fuels for domestic heating and cooking, wide use of coal-fired power plants, industry, and aging vehicle fleets are contributory factors to elevated concentrations of ambient air pollution (AAP).

In Kosovo, large numbers of people are exposed to ambient concentrations of fine particulate matter (PM) with a diameter of 2.5 micrometers or less ($PM_{2.5}$) which exceed the World Health Organization (WHO) air quality guideline value of 10 $\mu g/m^3$ and the less stringent European Union (EU) limit value of 25 $\mu g/m^3$ (Figure 1.1). The detrimental health effects of $PM_{2.5}$ are well documented, and it is one of the world's leading causes of illness and death, associated with lung cancer, ischemic heart disease (IHD), stroke, chronic obstructive pulmonary disease (COPD) and respiratory disease. In addition, PM comprises black carbon (BC), which is formed from incomplete combustion of fossil fuels, wood, and other fuels, and has climate warming properties.

Figure 0.1. Locations where annual mean $PM_{2.5}$ (ug/m^3) meet or exceed WHO guidelines



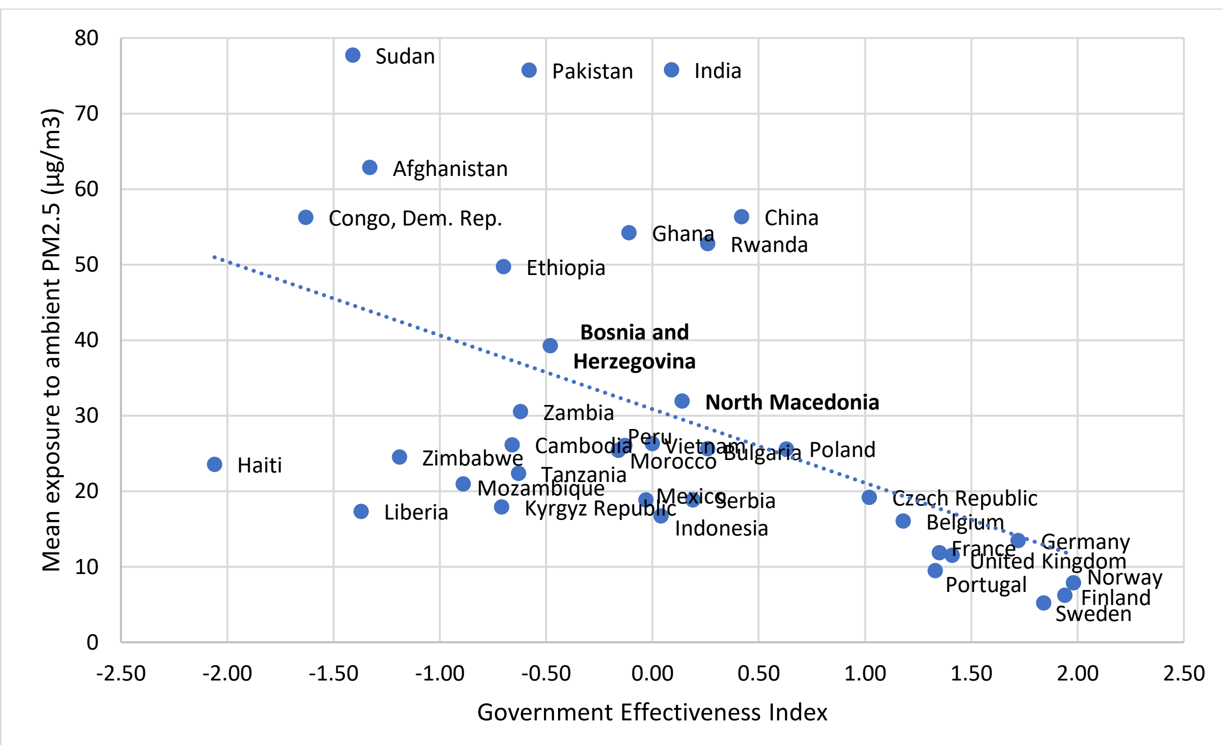
Source: WHO 2016. http://maps.who.int/airpollution.

Ambient concentrations of PM are significantly higher during winter months due to adverse meteorological conditions limiting atmospheric dispersion, coupled with increased emissions particularly from burning of solid fuels for heating in homes and other buildings. Kosovo's air is sufficiently poor that it has spawned public protests, apps, and even its own hashtag. A 2017 Public Pulse survey showed that approximately one in four Kosovars consider their local environment to be very polluted. In particular, the survey results showed that residents of big cities, including Prishtina, Prizren, Mitrovica, and Ferizaj, tend to perceive their areas as being very polluted as well as residents in the municipality of Obiliq where two power plants, Kosovo A and Kosovo B, are located (United Nations Development Programme 2018). Poor air quality has prompted announcements of emergency measures by the government, including banning vehicles from entering Prishtina in January 2018, but clearly sustained efforts are needed to effectively tackle air pollution.

The EU accession process provides an incentive to adapt legislation and learn from the experience of other EU countries on how air quality can be improved through emissions reductions from key sources of polluting air emissions. The EU-Kosovo Stabilization and Association Agreement has been in force since 2016 and the country launched the European Reform Agenda in November 2016. The new government committed itself to the implementation of EU-related reforms. However, progress to date—including the preparation of environmental management programs—has been slow. Furthermore, political fragmentation and polarization have adversely affected political processes and have had negative consequences on the effectiveness of the government (European Commission 2018). For potential accession to the EU, the countries in the region must, under the EU Industrial Emissions Directive (IED), reduce emissions by 94 percent for airborne particulates, 90 percent for sulfur dioxide (SO_2), and 67 percent for nitrogen oxides (NO_x) by 2028.

Environmental quality indicators correlate with governance indicators such as government effectiveness, voice and accountability, political stability, regulatory quality, rule of law, and control of corruption (Figure 1.2). The World Governance Indicators, published annually by the World Bank, reflect institutional problems that are relevant to environmental quality management (World Bank 2018). The Government Effectiveness Index captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Some of these governance issues are relevant to air quality management (AQM) and could be relevant to the institutional framework for AQM in Kosovo. As can be seen, a positive correlation exists between government effectiveness and air quality. Western Balkan countries such as North Macedonia and Bosnia and Herzegovina have higher levels of AAP than some other countries with lower government effectiveness indexes.

Figure 0.2. Government effectiveness and air pollution ($PM_{2.5}$)



Source: Data from World Bank, World Development Indicators, 2018.

1.2. Objectives of this Report

This report is one in a series of three reports on AQM in Kosovo, Bosnia and Herzegovina, and North Macedonia. It examines the nature and magnitude of AAP in Kosovo. It provides estimates of the health burden and the economic cost associated with the health impacts of AAP, that is, $PM_{2.5}$, in Kosovo. It also provides an analysis of the roles of various sources of $PM_{2.5}$ emissions on ambient air quality in Kosovo at a national level. The institutional and policy framework for AQM in the country is examined, including contributions of other development institutions in supporting Kosovo in addressing air pollution. Furthermore, the report presents experiences of selected countries that have applied different policy, investment, and technical interventions for air pollution, prevention, reduction, and abatement. Finally, it provides recommendations for reducing air pollution in Kosovo.

1.3. Methodology

Air quality assessment. This report provides an assessment of the ambient air quality status in Kosovo based on a desk review of available data and information from Kosovo Environmental Protection Agency (KEPA), as well as reports and other information received from local consultants and relevant government counterparts.

Economic analysis of health effects of AAP. The environmental health and economic analysis rely on primary data obtained from statistical yearbooks in Kosovo (Kosovo Agency of Statistics 2015, 2017), including mortality, as well as information from Kosovo Ministry of Environment and Spatial Planning (MESP) and various reports that summarize this information. The analysis also uses peer-reviewed publications from Western Balkans, as well as from global and European organizations. Quantification of health effects from air pollution is grounded in commonly used methodologies that link mortality of the population and exposure to pollution. The economic costs of these health effects are assessed using standard valuation techniques that present the economic value of the attributable mortality in monetary terms, based on economic indicators from Kosovo.

Institutional and policy review. This report includes a desk review of the institutional and policy framework for AQM in Kosovo, including progress in transposing EU legislation, and key aspects of AQM such as monitoring, data management, and dissemination of air quality information that can inform strategies and interventions to reduce air pollution. It also summarizes the roles of organizations that are responsible for developing, implementing, monitoring, evaluating, and enforcing air quality legal and policy instruments. Based on information obtained from development partners active in Kosovo, it also discusses how they are contributing to AQM efforts in the country.

Analysis of key sources of $PM_{2.5}$ exposure. Following a qualitative overview of sources of exposure to $PM_{2.5}$ in the country, this report provides a quantitative analysis of the source structure of $PM_{2.5}$ emissions for the first time in this region (covering Kosovo, North Macedonia, and Bosnia and Herzegovina) in a harmonized way, comparing model-calculated $PM_{2.5}$ concentrations with recent observations from local measurement networks as available, and developing source apportionments for ambient $PM_{2.5}$ for Kosovo and the two other countries mentioned. The quantitative analyses were performed with the Greenhouse gas - Air pollution Interactions and Synergies (GAINS) model developed at the International Institute for Applied Systems Analysis (Amann et al. 2011). The model allows simulation of the impacts of policy actions that influence future driving forces (for example, energy consumption, transport demand, agricultural activities) and of dedicated measures to reduce the release of emissions to the atmosphere, on total emissions, resulting air quality, and a basket of air quality and climate impact indicators.

1.4. Analytical Value Added

This report provides analysis that adds to knowledge in the following areas:

1. Updated national-level assessment of health and economic damages from air pollution in Kosovo, primarily from $PM_{2.5}$the most detrimental air pollutant to health—and based on the most up-to-date methodologies

2. Development, for the first time, of a preliminary national-level source-apportionment analysis for $PM_{2.5}$

3. Analysis of scenarios of $PM_{2.5}$ emissions, and ambient concentrations, from a baseline of 2015 up to 2030

4. Sharing of global experiences and lessons learned from interventions by other World Bank client countries to address AAP in key sectors

5. A basis to inform possible long-term engagement by the World Bank in supporting Kosovo in tackling air pollution, taking into account efforts of other development partners

1.5. Ambient Air Quality in Kosovo

Ambient air quality is assessed not only by the concentration of a pollutant but also by the number of times that the limit value for that pollutant is exceeded. Ambient air quality standards in Kosovo are provided in Table 1.1 along with EU limit values and WHO guideline values. Kosovo's air quality standards are aligned with EU air quality standards. Limit Values for annual average ambient concentrations of $PM_{2.5}$ and particulate matter with a diameter of 10 micrometers or less (PM_{10}) are exceeded at most of Kosovo's air quality monitoring stations (Figures 1.3 and 1.4). According to Kosovo's air quality standards, the 24-hour or daily mean concentration of PM_{10} should not be exceeded more than 35 times in a calendar year. In 2015, the following number of days of exceedances of the daily mean concentration were observed at monitoring stations, including Obiliq (90 days), Gjilan (75 days), Prishtina-IHMK (74 days), Pirishtina-Rilindja (66 days), Drenas (61 days), and Hani i Elezit (45 days) (KEPA 2017). No exceedances were reported for SO_2, carbon monoxide (CO), nitrogen dioxide (NO_2), and ozone (O_3) during the same period.

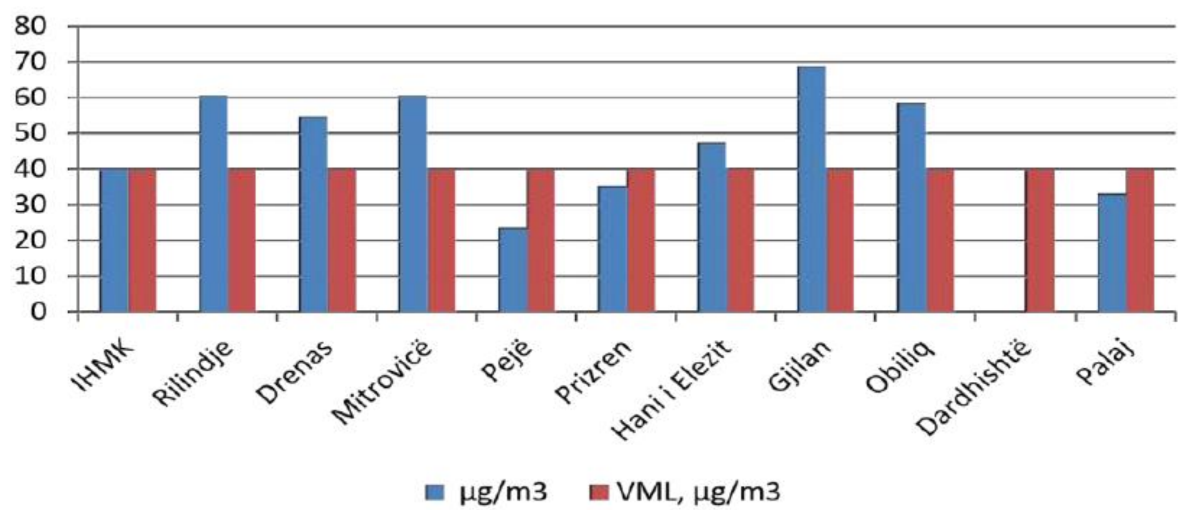
Table 0.1. Ambient air quality standards in Kosovo compared to the WHO guidelines and EU standards

Pollutants	Averaging Period	Kosovo ambient air quality standard[1]	EU ambient air quality standard[2]	WHO air quality guideline value
PM_{10}	Annual average 24 hours 24 hours (information threshold) 24 hours (alert threshold)	40 μg/m^3 50 μg/m^3 100 μg/m^3 100 μg/m^3	40 μg/m^3 50 μg/m^3 n.a. n.a.	20 μg/m^3 50 μg/m^3 n.a. n.a.
$PM_{2.5}$	Annual average 24 hours	25 μg/m^3 n.a.	25 μg/m^3 n.a.	10 μg/m^3 25 μg/m^3
O_3	Maximum daily 8 hours average	120 μg/m^3 (long-term objective)	120 μg/m^3	100 μg/m^3

Pollutants	Averaging Period	Kosovo ambient air quality standard[1]	EU ambient air quality standard[2]	WHO air quality guideline value
	1 hour (information threshold) 1 hour (alert threshold)	180 μg/m^3 240 μg/m^3	n.a. n.a.	n.a. n.a.
NO_2	Annual average 1 hour Alert threshold	40 μg/m^3 200 μg/m^3 400 μg/m^3	40 μg/m^3 200 μg/m^3 n.a.	40 μg/m^3 200 μg/m^3 n.a.
SO_2	24 hours 1 hour Alert threshold 10 minutes	125 μg/m^3 350 μg/m^3 500 μg/m^3 n.a.	125 μg/m^3 350 μg/m^3 n.a. n.a.	20 μg/m^3 500 μg/m^3 n.a. 500 μg/m^3
CO	Maximum daily 8 hours average Maximum daily 1 hour average	10 mg/m^3 n.a.	10 mg/m^3 n.a.	10 mg/m^3 30 mg/m^3
Lead	Annual average	0.5 μg/m^3	0.5 μg/m^3	0.5 μg/m^3
Benzene	Annual average	5 μg/m^3	5 μg/m^3	n.a.

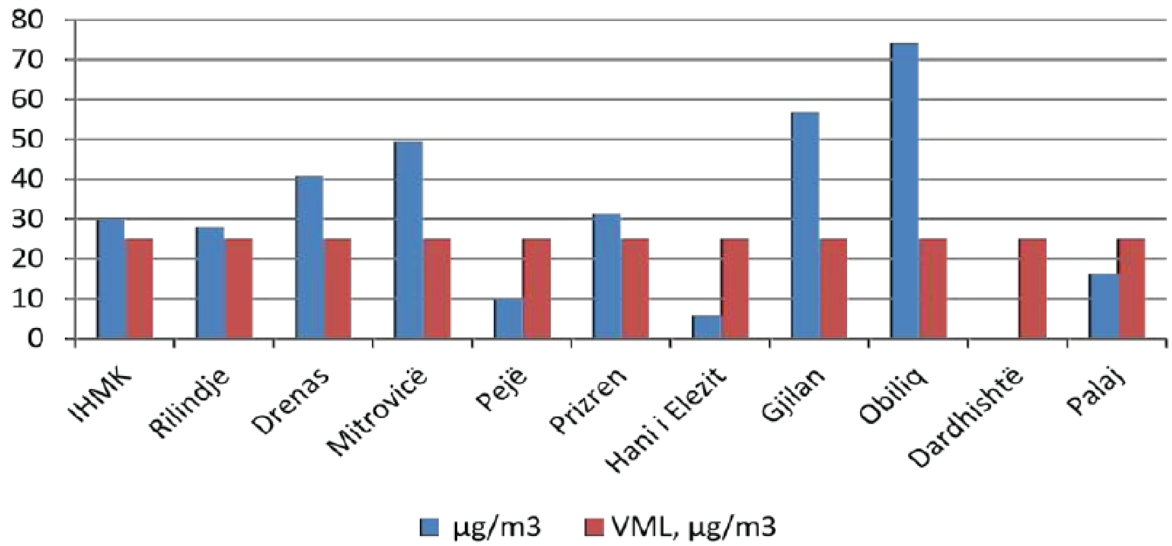
Source: Republic of Kosovo 2011; WHO 2006; EU 2008.

Figure 0.3. Annual average PM_{10} concentrations in 2015



Source: KEPA 2017.
Note: (VML stands for limit value)

Figure 0.4. Annual average $PM_{2.5}$ concentrations in 2015 (VML stands for limit value)



Source: KEPA 2017.
Note: (VML stands for limit value)

Measurements in Prishtina during 2015–2017 indicate that the number of exceedances is above the allowed number (35 days) according to Kosovo's air quality standards (Table 1.2). Furthermore, majority of exceedances occur during winter months. This might be due to adverse meteorological conditions limiting dispersion of pollutants in the atmosphere coupled with residential heating emissions increased during winter season.

Table 0.2. Number of PM_{10} exceedances recorded in Prishtina by HMIK (2015, 2016, 2017)

Daily PM_{10} limit value (µg/m^3)	50		
Allowed number of exceedances per year (days)	35		
Year	2015	2016	2017
Total number of exceedances during the year (days)	73	53	58
November (days)	20	10	15
December (days)	23	21	13
January (days)	18	19	17
Number of exceedances during winter (days)	61	50	45
Number of exceedances during summer (days)	12	3	5
Annual average $PM_{2.5}$ concentration (µg/m^3)	30.18	27.81	26.2
Annual average PM_{10} concentration (µg/m^3)	40.38	30	33.25

Source: KEPA 2018.

Long-term Air Quality Assessments and Trends

Long-term assessments of air quality are not available in published reports. At the time of this study, monitoring data available and provided by KEPA comprised data recorded on an hourly basis for only 3 monitoring stations (that is, Obiliq, Palaj, and Dardhishtë) out of 12 stations, for six months in 2017. The data received do not have sufficient spatial and temporal resolution to conduct detailed assessments and derive precise conclusions. For this reason, this study provides a limited assessment. Further discussion on technical capacity issues related to data quality is provided in Chapter 4 of this report.

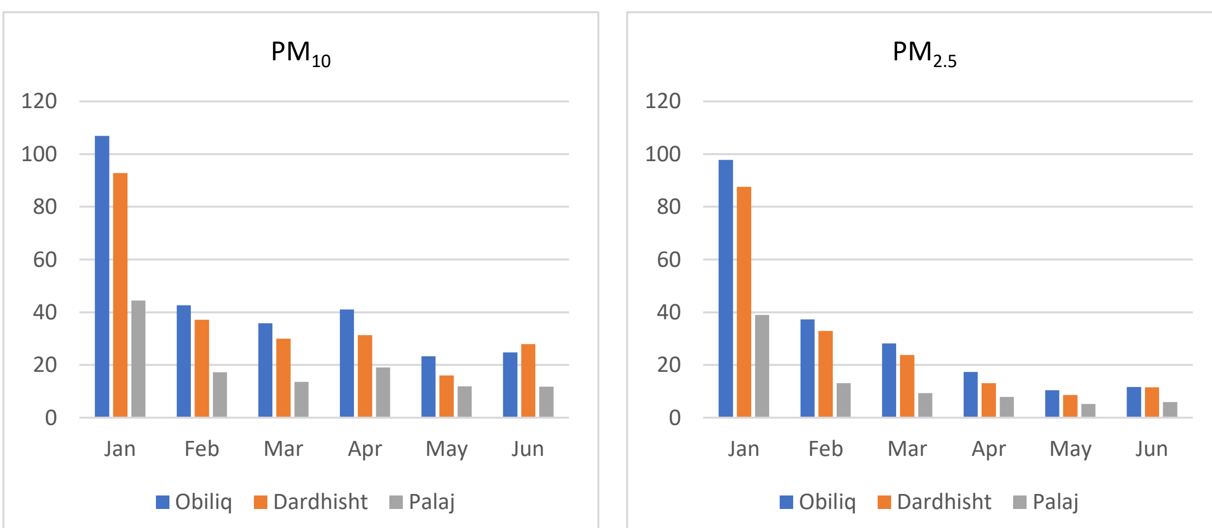
Although data exist only for six months, they are compared with annual standards to have a broad understanding of the air pollution problem (Table 1.3). Six-month average concentrations of PM_{10} and $PM_{2.5}$ recorded at Obiliq air quality monitoring station are above the annual average limit value of 40 μg/m^3 and 25 μg/m^3, respectively, for PM_{10} and $PM_{2.5}$. The number of exceedances observed at Obiliq station for PM_{10} are above the maximum allowable number of exceedances (that is, 35 days) within the first six months of the year. The number of exceedances observed at Dardhishtë are close to the maximum allowable number of exceedances in the first six months.

Monthly average concentrations of PM_{10} and $PM_{2.5}$ measured at Palaj, Obiliq, and Dardhishtë stations in 2017 are presented in Figure 1.5. The highest PM_{10} and $PM_{2.5}$ concentrations are observed during January at all stations. Obiliq and Dardhishtë stations record much higher PM concentrations than Palaj station.

Table 0.3. Data summary recorded at Palaj, Obiliq, and Dardhishtë air quality monitoring stations (January–June 2017)

	Palaj		Obiliq		Dardhishtë	
	PM_{10}	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
% Data capture (hourly data)	95.49	96.97	99.95	99.98	84.37	80.56
6-month average concentration (μg/m^3)	20.54	14.11	47.06	35.09	38.02	30.21
Max. hourly concentration (μg/m^3)	317.59	246.03	877.35	628.90	861.35	616.50
Daily average concentration (μg/m^3)	20.90	14.47	48.11	35.98	38.42	30.30
Number of exceedances (days)	12.00	10.00	42.00	31.00	29.00	22.00

Figure 0.5. Monthly average PM_{10} and $PM_{2.5}$ concentrations at Obiliq, Palaj, and Dardhishtë stations (January–June 2017)



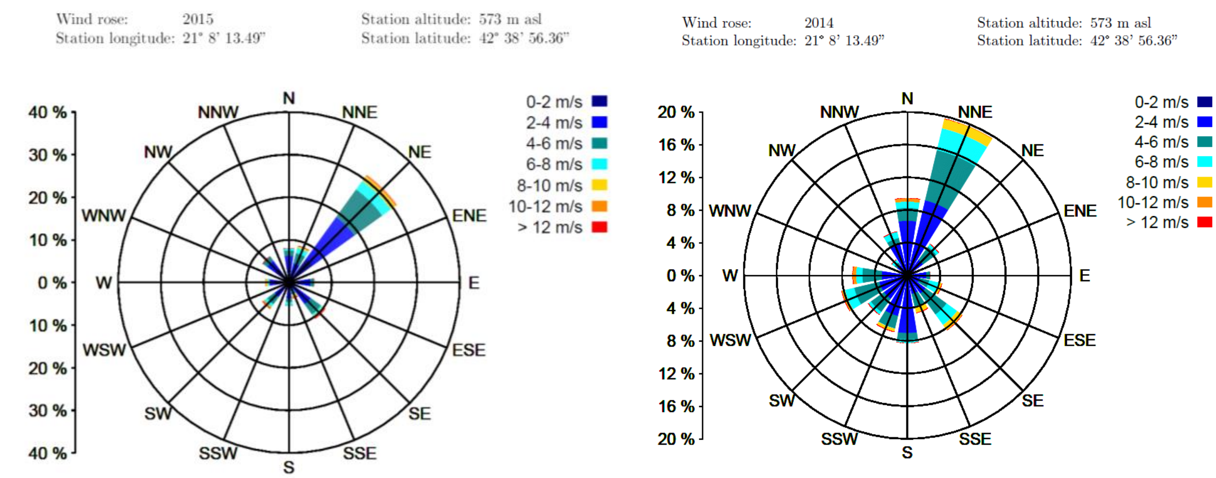
All three stations are classified as industrial background monitoring stations (KEPA 2017) and located as shown in Figure 1.6. They are in the vicinity of Kosovo A and Kosovo B thermal power plants, which are operated by Kosovo Energy Corporation (*Korporata Energjetike e Kosovës*, KEK) (World Bank 2013). Obiliq station is in a residential area between Kosovo A and Kosovo B power plants. Dardhishtë station is in a suburban area south of Kosovo A, and Palaj station is in a rural area in the vicinity of an industrial workshop.

Figure 1.7 shows wind roses, for 2014 and 2015, for Prishtina, which is located less than 10 km southeast of the KEK power plants (see Figure 1.8). It is preferable to use long-term wind roses (such as the past 10–20 years) for air quality assessments. However, this study did not find such long-term data. The wind roses show that winds blowing from the northeast and north-northeast are dominant in Prishtina although winds from other directions are also observed. Furthermore, the wind roses show that all three monitoring stations might be influenced by emissions from the KEK power plants while Dardhishtë is located downwind of Kosovo A power plant, which may explain high pollutant concentrations measured at this station. In addition to emissions from KEK, Obiliq station is also influenced by urban emissions such as residential heating and traffic, which may explain the highest pollution concentrations observed at this station compared to other two stations.

Figure 0.6. Location of Obiliq, Palaj, and Dardhishtë monitoring stations (indicated by yellow pins)

Source: KEPA 2017.

Figure 0.7. Wind roses for Prishtina (left: 2015, right: 2014)



Sources: KEPA 2018 and 2016.

Due to the lack of time series of monitoring data, it was not possible to analyze air quality trends and examine correlations between pollutants. Used together, these types of analyses are useful in understanding trends in concentrations of air pollutants and providing information on their sources.

Based on limited data, analysis of the $PM_{2.5}/PM_{10}$ ratio was conducted instead of trend analysis of pollutants. Analysis of the $PM_{2.5}/PM_{10}$ ratio is useful in understanding how the fine proportion of ambient PM varies with time and can be indicative of pollutant sources. The $PM_{2.5}/PM_{10}$ ratio analysis can also serve a data quality control function.

While the $PM_{2.5}/PM_{10}$ ratio shows temporal variation, a value of about 0.5 is typical in urban areas and is indicative of contributions of both coarse and fine particles (Xu et al. 2017). Higher ratios of $PM_{2.5}/PM_{10}$ indicate abundance of particles from combustion sources. Figure 1.8 shows the $PM_{2.5}/PM_{10}$ time series for Palaj, Obiliq, and Dardhishtë stations during January–June 2017. Close inspection of the monitoring data reveals several outliers in the data, that is, values of $PM_{2.5}/PM_{10}$ greater than 1. Given that fine $PM_{2.5}$ is a component of coarse PM_{10}, the $PM_{2.5}/PM_{10}$ ratio should typically not exceed unity. The occurrence of a ratio greater than 1 may be indicative of problems associated with data quality assurance and control, and the need for closer examination of the data, data management, quality control and assurance procedures to understand the potential causes of outliers. When the most prominent data outliers are removed, an average $PM_{2.5}/PM_{10}$ ratio of about 0.6, indicative of abundance of combustion sources, was obtained for the three stations based on the data series for January–June 2017 (Figure 1.9). Furthermore, the $PM_{2.5}/PM_{10}$ ratios are generally higher in the colder (first few months) months than the latter warmer months, again associated with increased combustion of solid fuels.

Figure 0.8. Hourly $PM_{2.5}/PM_{10}$ ratio for Palaj, Obiliq, and Dardhishtë stations (January–June 2017)

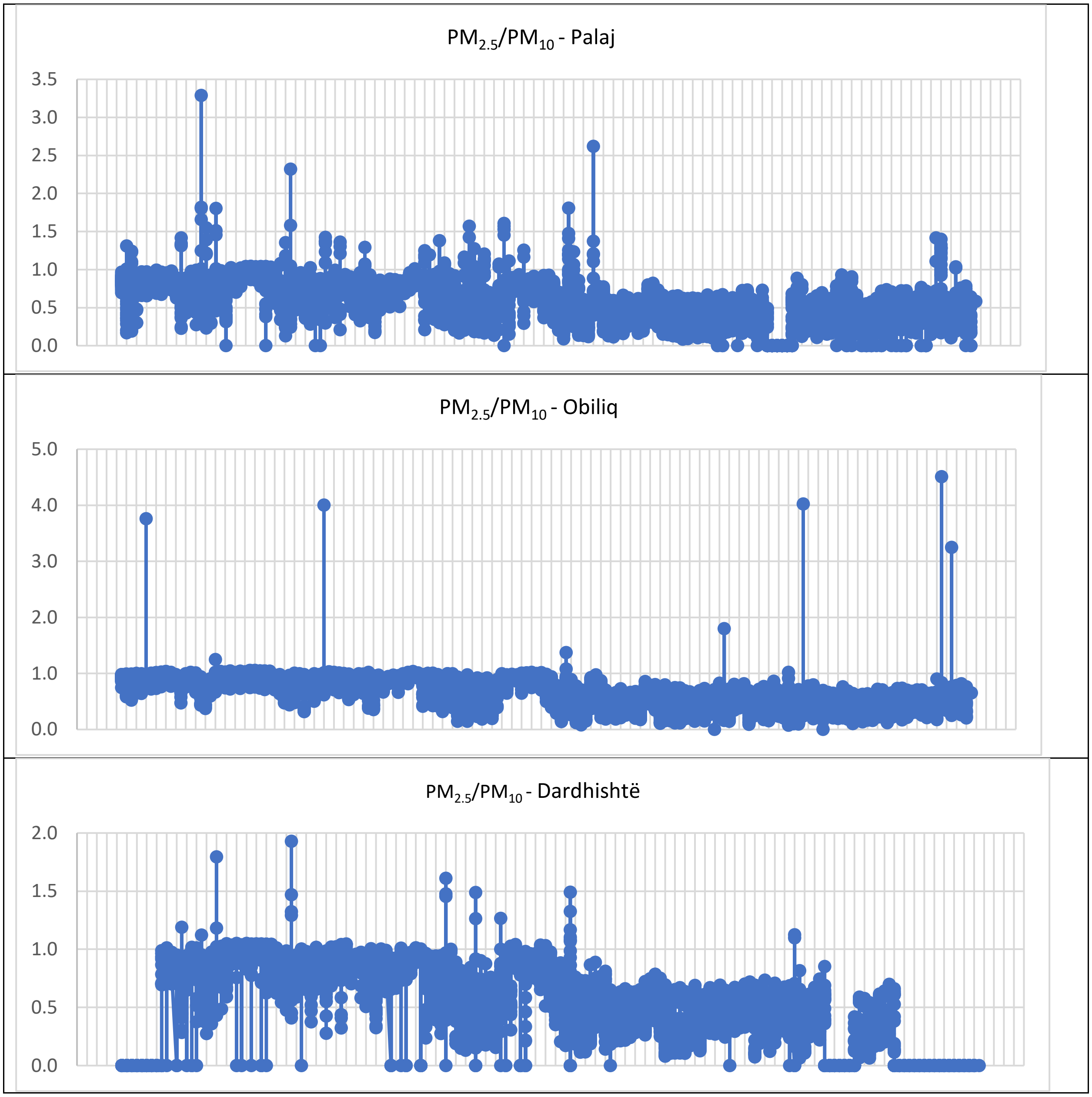
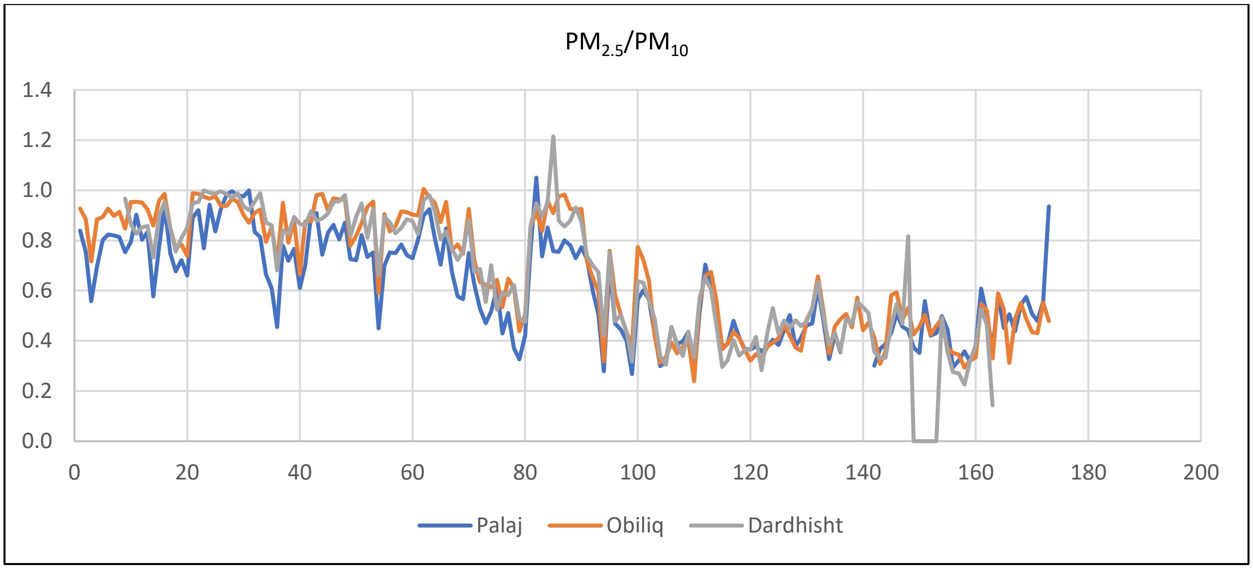


Figure 0.9. $PM_{2.5}/PM_{10}$ ratios for Palaj, Obiliq, and Dardhishtë stations (January–June 2017) - Outliers removed



1.6. Summary

AAP, notably $PM_{2.5}$ is a problem in cities and urban centers in Kosovo. Results from Prishtina show that most exceedances of ambient air quality standards occur during the winter season.

The lack of long-term air quality monitoring data precludes detailed assessment of air quality status and trends, which are essential for informing the identification and selection and assessing the effectiveness, of interventions and measures to reduce air pollution. In addition, the existence of several outliers in PM monitoring data may suggest problems related to data quality control and assurance. Nonetheless, the average $PM_{2.5}/PM_{10}$ ratio, greater than 0.5 at three stations in the vicinity of Prishtina, suggests that PM air pollution from combustion sources is dominant. Furthermore, the results suggest that combustion of solid fuels is a more dominant source of PM during the colder months.

Although there are shortcomings related to completeness of monitoring data and long-term data are not available for detailed assessment, the existing data and the analyses in this chapter show that PM pollution is a significant problem in Kosovo and needs to be addressed urgently.

Chapter 2. Health Burden and Economic Cost of Ambient Air Pollution in Kosovo

2.1. Introduction

It is well documented that the strongest and most rigorously proven causal associations between health and poor air quality are between cardiovascular and pulmonary disease and $PM_{2.5}$ pollution.[1] Particles of smaller size reach deeper into the lower respiratory tract and thus have greater potential for causing lung and heart diseases. As a Lancet review (Landrigan et al. 2017) reports, $PM_{2.5}$ air pollution is associated with several risk factors for cardiovascular disease, including hypertension, increased serum lipid concentrations, accelerated progression of atherosclerosis, increased prevalence of cardiac arrhythmias, increased numbers of visits to emergency departments for cardiac conditions, increased risk of acute myocardial infarction, and increased mortality from cardiovascular disease and stroke. Recent work by Burnett et al. (2018) suggests that health impacts of $PM_{2.5}$ are more significant than previously understood and that exposure to $PM_{2.5}$ contributes to mortality from causes other than typically examined in global burden of disease (GPD) studies (that is, lung cancer, IHD, COPD, lower respiratory illness [LRI], and stroke). These findings underscore the need to prioritize actions to tackle AAP.

This chapter focuses on estimation of the health burden (that is, mortality) and cost of AAP ($PM_{2.5}$), based upon available information on population exposure, background health statistics, and economic data for Kosovo. In winter months, in addition to long-term mortality, air pollution is responsible for acute health effects, such as increases in cardiovascular and respiratory hospital stays, and lost workdays. However, these acute health effects are not estimated because of the lack of background morbidity information at the time of this study.

2.2. Analytical Approach to Health Damage Estimation

In line with the EU strategies 'Clean Air for Europe (CAFE)' (CEC 2001) and 'Environment and Health for the Urban Environment', the problems of toxic emissions and their impacts on human health need to be addressed with an integrated approach, which includes estimation of the health burden of air pollution, valuation of attributable health burden, identification of responsible polluters, and prioritization of cost-efficient mitigating interventions. This report focuses on estimation of the cost of AAP, based on the GBD 2016 methodology, using available information on population exposure, background health statistics, and economic data. Annexes B and C of this report provide additional details on the methodology used in this chapter.

Step 1. Estimate population exposure to the pollutant of interest ($PM_{2.5}$) in terms of number of people exposed and level(s) of concentration.

Step 2. Calculate the health burden, premature death (mortality) due to a disease, that may be attributed to the pollutant in question ('population attributable fraction' [PAF]) based on

[1] As recommended by the WHO, health risk factors are divided into three groups: metabolic, behavioral, and environmental (see http://ghdx.healthdata.org/gbd-results-tool). Other risk factors for cardiovascular and pulmonary disease include tobacco smoking, alcohol and drug use, dietary risks, high blood pressure, and so on.

population exposure and relative risk that the pollutant presents for the occurrence of the disease, per epidemiological studies.[2]

Step 3. Estimate the economic value of the health burden in monetary terms. This study uses the welfare-based approach for valuation.

The strongest causal associations are seen between $PM_{2.5}$ pollution and cardiovascular and pulmonary diseases. Particles of smaller size reach the lower respiratory tract and thus have greater potential for causing lung and heart disease. This report estimates the risk of long-term mortality by the age group associated with air pollution as PAFs of

1. IHD (population above 30 years of age)
2. Stroke (population above 30 years of age)
3. Lung cancer (population above 30 years of age)
4. COPD (population above 30 years of age)
5. LRI (all ages)

An earlier World Bank study estimated the cost of AAP in Kosovo at €97.6 million, equivalent to 2.33 percent of gross domestic product (GDP) in 2010 (World Bank 2013). The current study incorporates a number of updates related to improvements in air quality, exposure, and background mortality data, as well as methodological updates for health impact valuation. Specifically, in 2011, only 2 monitoring stations operated in Kosovo, both in Prishtina, compared to 12 today. Furthermore, background mortality information has improved with the publication of a report on causes of death in Kosovo in 2012 and 2013, by the Kosovo Agency of Statistics. In addition, internationally applied methodology for estimation of air pollution health burden and valuation has also been updated. World Bank (2013) applied the methodologies of Pope et al. (2002) study for estimating mortality and Ostro (1994) and Abbey et al. (1995) for estimating morbidity. GBD (2016) incorporates the latest advances in epidemiology for calculating the age-specific and disease-specific impacts of pollution on mortality. GBD 2016 developed an approach to define mortality causes in each country that are consistent with WHO methodologies, with comprehensive presentation of causes of death across all age groups. The GBD approach allows comparison of AAP-related health outcomes across different countries. Finally, this report uses an updated methodology for valuation of health impacts of air pollution as summarized in Narain and Sall (2016). The welfare-based approach used in this study is recommended for valuation of the cost of air pollution on a national level.

[2] Relative risk is defined as the ratio of the probability of a health outcome, namely premature death (mortality) or disability from a disease, occurring in an exposed group to the probability of it occurring in a non-exposed group; PAF is defined as the reduction in population health outcome that would occur if exposure to the pollutant were reduced to an alternative ideal exposure scenario, such as pollutant concentrations below WHO limits. (Adapted from WHO definition at www.who.int/healthinfo/global_burden_disease/metrics_paf/en/ [accessed on 2/13/2018]).

2.3. Ambient Air Quality and Exposed Population in Kosovo

In Kosovo, the average annual ambient $PM_{2.5}$ concentration is estimated to be 26-31 μg/m^3 (Table 2.1), based on the data obtained from the 2017 State of the Environment report (MESP 2017). This value is consistent with $PM_{2.5}$ monitoring data from the US Embassy in Prishtina but lower than the value (30–40 ug/m^3 for the urban population only) used in the World Bank (2013) study. The current study assumes that the entire population of Kosovo is exposed to the estimated ambient $PM_{2.5}$ concentration, since most of the population in rural areas are affected by pollution generated by residential heating boilers that use solid fuel for heating. $PM_{2.5}$ pollution is more severe in winter, reaching average monthly ambient $PM_{2.5}$ levels of 60–70 μg/m^3 in January 2017 in Prishtina (MESP 2017).

Table 0.1. Available average annual PM pollution information in Kosovo

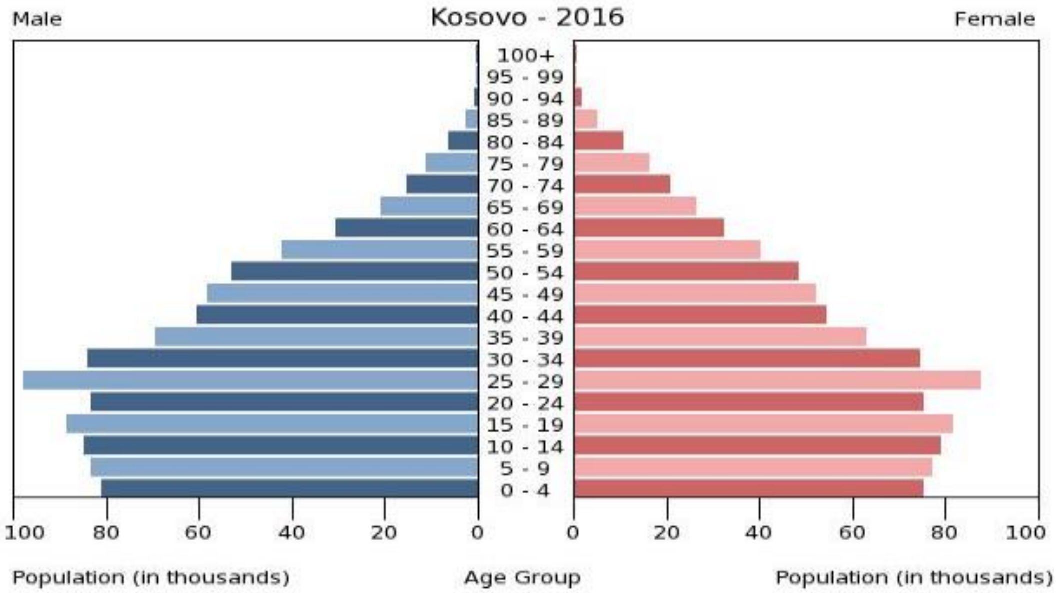
Monitoring stations	Average annual PM_{10} concentration, μg/m^3	Average annual $PM_{2.5}$ concentration, μg/m^3
IHMK-Prishtina	33	26
Rilindja-Prishtina	33	27
Drenas	43	28
Mitrovice	37	28
Peje		
Prizren		
Brezovice		
Gjilan		
Obiliq	61	44
Dardhishtë	63	35
Palaj		
Average	45	31

Source: MESP 2017.

Note: Only monitoring stations that recorded data for more than 70 percent of the months in a year are used for the analysis in this report.

Kosovo has an unusual demographic age structure as illustrated in Figure 2.1. Most European countries are aging rapidly. Many of the lower-income economies also face issues related to emigration of the youth seeking better employment opportunities. Kosovo's population, however, comprises relatively few old people and its age structure is markedly skewed toward youths by contrast to most of Europe. This demographic characteristic affects the health statistics for the country. For any given level of air pollution, related mortality would be expected to be less in Kosovo, as older people are more likely, than younger people, to die from exposure to air pollution.

Figure 0.1. Demographic age structure of Kosovo



Source: Central Intelligence Agency (CIA) 2016.

2.4. Health Burden of Exposure to Ambient Air Pollution in Kosovo

In Kosovo, vital statistics data are mostly missing. Only total and violent deaths are available for 2016, which amount to 8,495 and 188, respectively (Kosovo Agency of Statistics 2017). The total non-accidental deaths are estimated at about 8,300. The 2015 publication of the Kosovo Agency of Statistics reports all deaths with diagnoses in 2012 and 2013, accounting for 75 percent and 79 percent of total registered deaths in the respective years (Kosovo Agency of Statistics 2015). To estimate annual deaths in 2016, this study took a two-step approach as follows: (a) the 2013 percentage (that is, 79 percent) for registered deaths with diagnoses was used to redistribute all deaths (including those without any diagnosis) in 2013 and approximate total deaths due to cardiovascular diseases, neoplasms, respiratory, and external causes (mostly injuries) and (b) the estimated percentages for deaths due to cardiovascular diseases, neoplasms, respiratory, and external causes in 2013 were subsequently applied to calculate the total deaths by the aggregated cause (cardiovascular diseases, neoplasms, respiratory, and external causes) in 2016. The resulting estimates are presented in Table 2.2. Annex B provides additional information on the methodology for calculation of health burden from AAP.

Table 0.2. Annual deaths in Kosovo in 2016

Cause of death	Annual cases	Share of the total (%)
Total deaths	8495	100
External deaths	293	3
Neoplasms	1,337	16
Cardiovascular	4,958	58
Respiratory	225	3

Source: Estimated by authors.

Due to the lack of mortality information for Kosovo in the GBD database, this study applies mortality by cause (from GBD 2016) for neighboring North Macedonia for estimating the share of IHD and stroke in cardiovascular mortality, lung cancer in neoplasms, and COPD and LRI in respiratory mortality. It is assumed that North Macedonia has a similar average rate of health burden as Kosovo. The resulting approximation of deaths by diagnosis or cause is presented in Table 2.3.

Table 0.3. Annual estimated background mortality in Kosovo in 2016

Cause of Death	IHD	Stroke	COPD	Lung cancer	LRI
Number of cases	1,637	1,755	94	291	26

Source: Estimated by authors.

The updated information is used to make more accurate estimations of the share of cardiovascular deaths in the total annual mortality (58 percent instead of 66 percent) and lung cancer deaths (3.4 percent instead of 3.7 percent) compared to World Bank (2013). The latter shares were based on the Government of Kosovo (GoK) 2009 information, updated to 2011. In addition, estimates of premature mortality from air pollution for Kosovo differ from other similar European countries because of the country's age structure, as previously noted.

Using the annual average exposure to $PM_{2.5}$ pollution and background mortality for 2016, the total annual mortality attributed to AAP ($PM_{2.5}$) by age group in 2016 is estimated (Table 2.4).

Table 0.4. Annual mortality by age group attributed to AAP in Kosovo

Age group	0–4	5–14	15-49	50–69	70+	Total
IHD	0	0	56	102	139	296
Stroke	0	0	30	213	145	388
COPD	0	0	1	6	16	22
Lung cancer	0	0	8	21	18	47
LRI	1	1	0	3	2	7
Total	1	1	95	344	319	760

Source: Estimated by authors.

In total, about 760 people die from causes associated with AAP in Kosovo annually. About 90 percent of the deaths are from cardiovascular diseases, specifically IHD and stroke. A total of 47 percent of deaths from IHD and 37 percent of deaths from strokes occur in people over 70 years of age. Cardiovascular diseases mostly affect the population over 65 years of age. Thus, this population subgroup should be a focus of specific mitigation measures to reduce the health impacts of air pollution in Kosovo.

Based on the estimated exposure, about 11 percent of the total health burden attributed to AAP originates in Prishtina.

2.5. Economic Cost of Exposure to Ambient Air Pollution in Kosovo

In monetary terms, the economic burden associated with AAP is quantified using a welfare-based approach and presented in Table 2.5. The welfare-based cost of mortality is calculated by multiplying the estimated number of deaths by the Value of Statistical Life (VSL). The methodology used for mortality valuation is provided in Annex C.

The annual cost of mortality caused by AAP in Kosovo is estimated at US$165–US$314 million (equivalent to 2.5–4.7 percent of GDP in 2016).

Table 0.5. Annual cost of AAP in Kosovo (US$, billions)

	Value	High	Low
Total cost	0.24	0.31	0.16
% GDP in 2016	3.6	4.7	2.5

Source: Estimated by authors.

2.6. Conclusions and Recommendations

The health and economic burdens of poor ambient air quality in Kosovo are significant. AAP caused 760 deaths in 2016 of which 90 percent were from IHD and stroke combined. Population age groups over the age of 65 years carry a significant share of the health burden. About 53 percent of IHD and 63 percent of strokes occur in people of productive age before attaining the age of 70. The economic cost associated with the health damage from AAP in Kosovo is on average US$240 million, equivalent to 3.6 percent of GDP in 2016.

Data shortcomings precluded disaggregation of the health and economic burden at the subnational level, which could help prioritize specific geographical areas to be prioritized. Nonetheless, 11 percent of the health burden attributed to AAP originates in Prishtina. The significant health and cost consequences of AAP in Kosovo underscore the need for a concerted effort to reduce air pollution in the country.

There is need for a reliable health information system that provides timely access to health data to facilitate health impact assessments and better understanding of the impacts of AAP on health of Kosovars, based on local data, notably in the most polluted areas.

Ultimately, air pollution is most significantly felt at the local level. Interventions to tackle air pollution should be based on understanding air quality and its deleterious health impacts at the local level. Specific recommendations by which Kosovo could strengthen the analytical basis for informing decision making on AQM include the following:

Strengthen health statistics reporting by harmonizing reporting with international bodies such as the WHO.

- The government should strengthen the completeness and comprehensiveness of data on mortality by cause. To this end, the government could harmonize reporting with the International Statistical Classification of Diseases and Related Health Problems, which is the international standard diagnostic tool for epidemiology, health management, and clinical purposes. Applying such reporting would facilitate understanding and estimation of the health burden associated with air pollution and allow for international comparisons to be made.

Improve collection and reporting of morbidity data for specific diseases and age groups.

- The government could improve the accuracy and comprehensiveness of vital statics collected in the country and strengthen morbidity reporting related to specific diseases and age groups. The government could incorporate the collection of the following data for morbidity analysis: (a) bronchitis prevalence for children 6–12 years old; (b) chronic bronchitis, including COPD incidence for adults over the age of18; (c) cardiovascular hospital admissions; (d) respiratory hospital admissions; and (e) lost workdays. Such data should be area specific for urban or rural areas in particular where ambient air quality monitoring is in place.

Strengthen capacity to conduct health risk assessment.

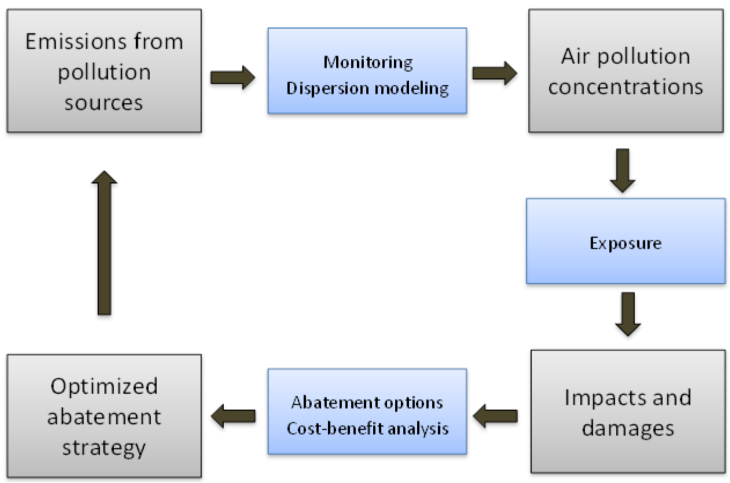
- The government should strengthen capacity to carry out routine environmental health risk assessment, to better understand health impacts of air pollution, and analyze health effects from individual industrial facilities. Such assessments should be used to prioritize pollution control activities.

Chapter 3. Key Sources of $PM_{2.5}$ Exposure

3.1. Introduction

To effectively address air pollution, a comprehensive and integrated approach to AQM is needed. This approach embodies the concept of a continuous cycle of planning, implementing, evaluating, and adjusting abatement strategies and measures for continual improvements (Figure 3.1). The key elements of this approach include (a) understanding air pollution sources such as energy, traffic, households, industry, agriculture, and others; (b) understanding air quality; (c) understanding health impacts; and (d) optimizing abatement strategy on the most economically effective interventions. This approach should also take into account existing policy and operational constraints that could foreclose or limit the implementation of certain air pollution reduction interventions.

Figure 0.1. Framework for integrated AQM



Source: Awe et al. 2015.

This chapter addresses the following foundational pillars of this framework, specifically

(a) Understanding of air pollution sources which involves the identification of emission sources, including their geographic location, by conducting a detailed inventory and analysis of emission sources, including stationary and non-stationary (fixed and area) sources. Emission inventories are needed both at a national level as well as at the local level where people are most exposed to air pollution and where AQM actions are taken. Emission inventories also provide a vital input for understanding the contributions of different polluting sources to ambient pollutant concentrations; and

(b) Understanding of ambient air quality, based on a combination of monitoring observations and atmospheric dispersion modeling to determine ambient concentrations of air pollutants and their concentrations.

Kosovo has prepared an emissions inventory of air pollutants according to the guidelines of the European Monitoring and Evaluation Program (EMEP) under the Convention on Long-range Transboundary Air Pollution (CLRTAP). However, this inventory is incomplete and missing many sectors.

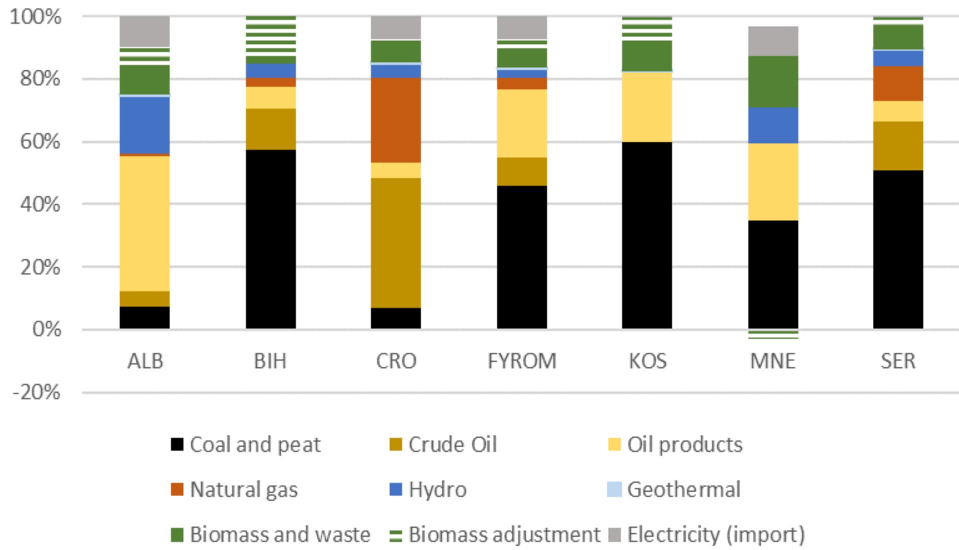
The following sections of this chapter first provide a qualitative description of AAP sources in Kosovo. This is followed by a more quantitative analysis, using the GAINS model to better understand the emission source structure and key contributors to air pollution in Kosovo, by generating modeled $PM_{2.5}$ concentrations and developing future emission scenarios and a source apportionment for populations' exposure to ambient $PM_{2.5}$. The analysis and discussion in this chapter focuses primarily on $PM_{2.5}$, the most documented pollutant, for its detrimental effects on human health. Some precursors of $PM_{2.5}$ are also discussed.

Air Pollution Emission Sources in Kosovo

According to Kosovo Environment Strategy 2013–2022, major contributors to air pollution are power plants, industrial plants (metallurgy, mines, and cement factories); households; transport sector; small combustion plants; agricultural activities; and waste burning. Some of these key sources are discussed in the following paragraphs.

Energy and mining. The primary energy supply profile for Kosovo (Figure 3.2) indicates that coal and peat accounted for about 60 percent of primary energy supply in 2012, followed by biomass and waste, and oil products accounting for 20 percent each, respectively (World Bank 2017). Lignite is the dominant coal in use, accounting for 97.4 percent of total coal used nationally. Renewable energy sources represent only about 9 percent of primary energy consumption. There are two coal-fired power plants of the KEK—Kosovo A and B thermal power plants in the municipality of Obiliq, a few kilometers from Prishtina. These power stations burn lignite extracted from nearby mines, also known as brown coal, as their main fuel. Lignite has lower energy density and higher moisture content than other types of coal. In the absence of adequate pollution control technologies, burning of lignite can result in higher emissions of air pollutants, including PM, sulfur oxides, and NO_x than burning of black coal. Use of lignite also results in higher greenhouse gas emissions per unit of electricity generated (EPA 1995). Lignite surface mining, for example, in Obliq, is also reported to be a source of polluting air emissions. An analysis conducted in 2015 found that the two thermal power plants operating in Kosovo did not have any technologies for environmental control of emissions of NO_x or sulfur oxides. Although the plants did have dust control technologies, they did not comply with EU emission limit values (JICA 2018).

Figure 0.2. Primary energy supply of Western Balkans countries, adjusted for unregistered biomass consumption

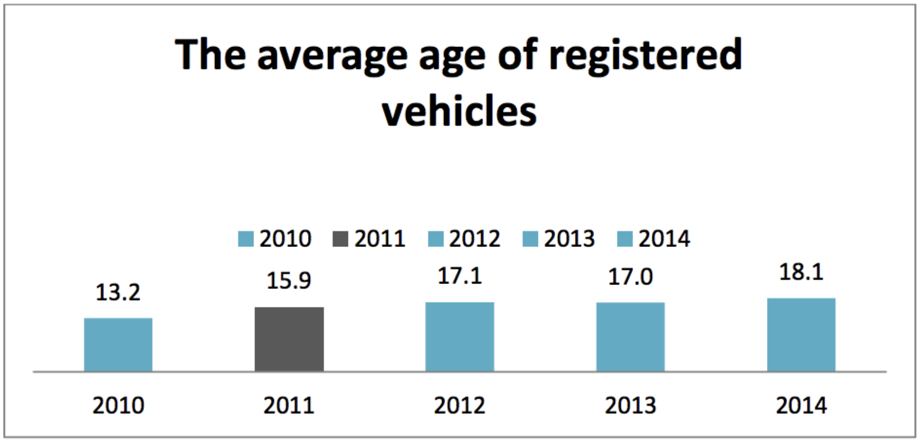


Source: World Bank 2017.
Note: ALB = Albania; BiH = Bosnia and Herzegovina; CRO = Croatia; FYROM= North Macedonia; KOS = Kosovo; MNE = Montenegro; SER = Serbia.

Residential and service sectors. The main energy sources for heating homes in Kosovo are biomass, primarily fuelwood, in addition to natural gas, electricity, biofuels, and solar energy (Kabashi et al. 2016). In the service sector, diesel, heavy oil, and coal are also used. The cheaper prices of solid fuels make them a commonly used fuel source and significant contributor to AAP, particularly during winter months. Residential heating emissions have significant influence on air quality because they are released close to the ground during winter, when dispersion characteristics are less favorable due to more frequent stable atmospheric conditions. Biomass and waste, thought to be used mainly for residential cooking and heating, jointly account for 20 percent of primary energy supply (Figure 3.2). Public district heating facilities are relatively new in the country and are available in Prishtina with a capacity of 140 MW, Gjakova with a capacity of 38.6 MW, and Mitrovicë with a capacity of 8.3 MW (Kabashi et al. 2016).

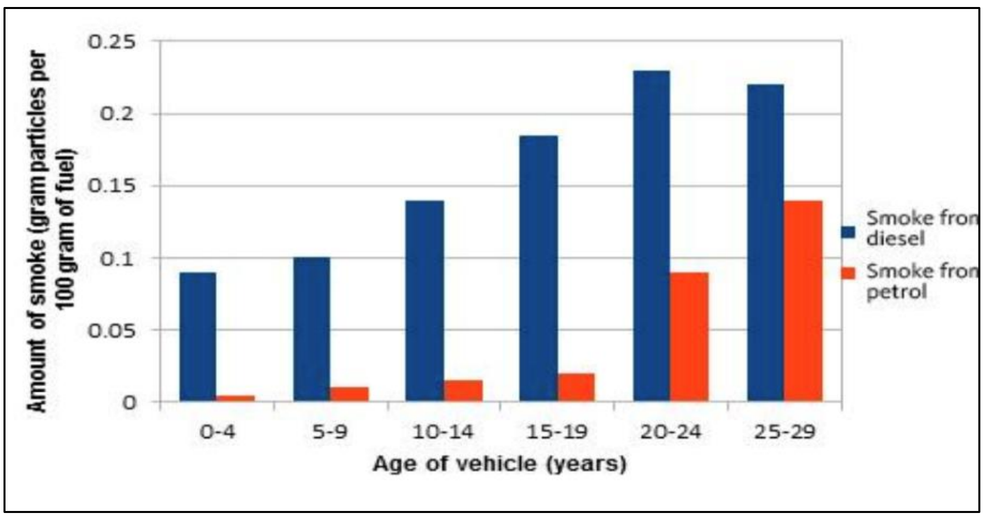
Transport. Pollution emissions from vehicles have increased with time because of a growing fleet, mainly comprising old cars, and increases in kilometers traveled per vehicle. The number of registered vehicles increased from approximately 125,000 in 1999 to 215,000 in 2003, a 172 percent increase (Kabashi et al. 2011). By 2017, 334,440 motor vehicles and non-motor vehicles were registered in Kosovo, including more than 273,000 cars (Kosovo Agency of Statistics 2017). In 2014, vehicles circulating in Kosovo were 18 years old, on average, which is 10 years more than the average age of vehicles in the EU (Figure 3.3). Older vehicles typically emit more pollution than newer models because they have outdated or worn-out pollution control devices and are less fuel efficient (Figure 3.4). The average age of vehicles in Kosovo likely increased because of various decisions made by the GoK. In 2011, the government modified the existing restrictions for the import of used vehicles, allowing vehicles that were up to 13 years old into the country, compared to the previous age limit of 8 years. In March of 2015, the government removed all age restrictions on the import of used vehicles. Centers for Vehicle Control (CVCs) are required to inspect vehicles before their importation to verify that their emissions conform to applicable standards and provide a stamp for vehicles that meet the set criteria. By 2015, these centers did not perform any of these functions (GAP Institute 2015). Age restrictions were recently reintroduced, requiring that imported vehicles must be 10 years old or newer.

Figure 0.3. Average age of vehicles in Kosovo



Source: GAP Institute 2015.

Figure 0.4. Smoke emissions per unit of fuel by age of vehicle



Source: GAP Institute 2015.

Industry. Industrial plants are also a major source of particulate and other polluting air emissions due to outdated technologies and the use of fuels with high sulfur content. According to KEPA, major sources of air pollution include, among others, industrial complex in Mitrovica; nickel, lead, and zinc mining and smelting in Drenas; cement production in Hani I Elezit; construction; and quarries. Manufacturing, construction, and lead mines and their tailings remain key sources of lead emission in Kosovo (World Bank 2013). Vehicles used to be a main source of lead emissions until its content in gasoline was regulated in 2012. Maxhuni et al. (2015) found that elevated concentrations of toxic heavy metals, including chromium, nickel, lead, and zinc, particularly in the western part of Kosovo, and ambient lead concentrations in the country were on average six times higher than the average for European countries. Industrial sources, including mining, industrial landfills, and traffic, were identified as the main emission sources of these heavy metal pollutants.

Analysis of Sources of $PM_{2.5}$ Exposure and Ambient Concentrations of $PM_{2.5}$

GAINS methodology. The development of any AQM plan, including economically effective interventions to address air pollution, requires a firm understanding of the contributions of various economic activities to ambient air quality. This study produced a national-level source apportionment that estimates the current contributions of key sectors (for example, power plants and industry, transport, residential combustion, and agriculture) to ambient $PM_{2.5}$ concentrations. It is important to note that this analysis provides a national-level source apportionment and that additional analysis would be required to better understand source apportionment at the local level, including in hot spots.

The quantitative analyses in this chapter were performed with the GAINS model developed by the International Institute for Applied Systems Analysis (Box 3.1) (Amann et al. 2011). The GAINS model is used as part of the standard modeling framework for negotiations under the CLRTAP and the EU.[3]

The GAINS model uses linear source-receptor coefficients to calculate ambient $PM_{2.5}$ concentrations from emissions of $PM_{2.5}$ and precursor gases (SO_2, NO_x, NH_3, and NMVOC). These source-receptor coefficients are derived from full-year perturbation simulations of the EMEP Chemical Transport Model (Simpson et al. 2012), in which emissions from one source country and one pollutant are reduced by a given percentage. The response in simulated ambient concentrations is then used to define source-receptor coefficients from countries to grid concentrations at approximately 28 km resolution ($0.5^o \times 0.25^o$). For primary PM emissions from low-level sources (residential combustion, traffic), a downscaling is applied to 7 km resolution ($0.125^o \times 0.0625^o$) to reflect small-scale concentration gradients. For details, see Kiesewetter et al. (2015a; 2015b).

To estimate contributions from individual source sectors to ambient $PM_{2.5}$, bottom-up calculated emissions from individual sectors are multiplied with the appropriate pollutant-specific transfer coefficients and then summed across pollutants. Population exposure is calculated from the overlay with gridded population (Gallego 2010) at the same resolution.

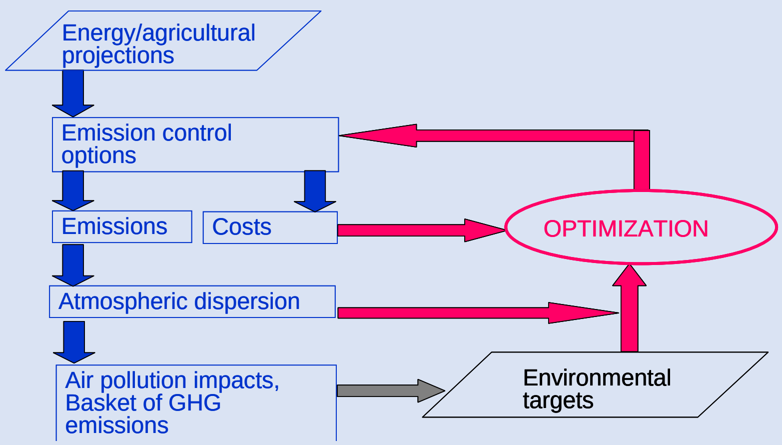
In this report, the GAINS model is used to (a) estimate baseline and future emission scenarios of $PM_{2.5}$, $PM_{2.5}$ precursor emissions (SO_2, NO_x, NMVOC, and NH_3), and BC up to 2030; (b) estimate ambient $PM_{2.5}$ concentrations at the spatial resolution of 7 × 7 km, with the sectoral emission estimates of the GAINS model, computations of the EMEP atmospheric chemistry transport model of the long-range dispersion of pollutants, and local information on the distribution of low-level emission sources, meteorology, and topography (Kiesewetter et al. 2015b); and (c) extract the contributions made by each emission source to ambient $PM_{2.5}$ concentrations at a given receptor site based on the model calculations.

[3] Available at: http://www.iiasa.ac.at/web/home/research/researchPrograms/air/GAINS.html.

Box 0.1. The GAINS Model

The GAINS (Greenhouse gas - Air Pollution Interactions and Synergies) model explores cost-effective multi-pollutant emission control strategies that meet environmental objectives on air quality impacts (on human health and ecosystems) and greenhouse gases. The GAINS model brings together data on economic development (including energy and agricultural projections that typically originate from external supply-demand models), the structure, control potential and costs of emission sources, the formation and dispersion of pollutants in the atmosphere, and an assessment of environmental impacts of pollution. The model allows simulation of the impacts of policy actions that influence future driving forces (for example, energy consumption, transport demand, agricultural activities) and of dedicated measures to reduce the release of emissions to the atmosphere, on total emissions, resulting air quality, and a basket of air quality and climate impact indicators. GAINS addresses air pollution impacts on human health from fine PM and ground-level O_3, vegetation damage caused by ground-level O_3, the acidification of terrestrial and aquatic ecosystems and excess nitrogen deposition to soils, in addition to the mitigation of greenhouse gas emissions.

GAINS assesses, for each of the source regions considered in the model, more than 1,000 measures to control emissions to the atmosphere. It computes the atmospheric dispersion of pollutants and analyzes the costs and environmental impacts of pollution control strategies. In its optimization mode, GAINS identifies the least-cost balance of emission control measures across pollutants, economic sectors, and countries that meet user-specified air quality and climate targets. The flow of information in the cost-effectiveness analysis of the GAINS model is illustrated below:



An essential element of the GAINS calculation is reliable information about activity statistics on fuel use, industrial production, fleet composition and distance travelled, and livestock numbers. The GAINS model draws on international and national statistical data on energy use, which provide this information for fossil fuel use and key economic sectors. However, in many countries as is the case in Kosovo, data for the residential sector, and especially for household heating devices, are often of poor quality or suffer large uncertainties. This includes information about the use of noncommercial biomass (wood logs), low quality coal, and municipal waste, for which the real amounts are often unknown and/or not well reflected in national statistics. In addition, official statistical data often do not include information about the structure of fuel use in the residential sector, for example, allocated to heating stoves, manual boilers, automatic boilers, and pellet stoves.

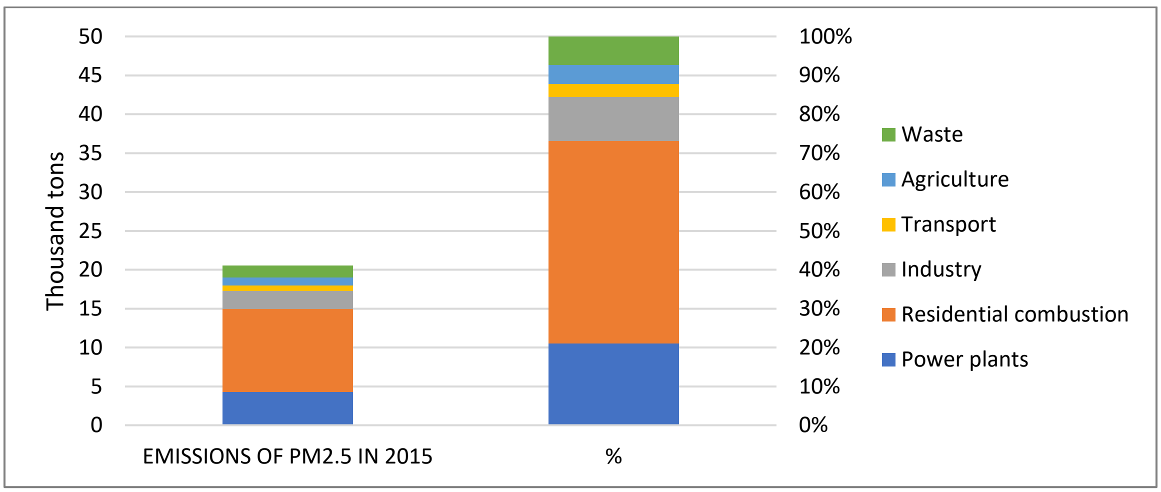
Updated fuel use data by combustion technology were then used in the GAINS model to calculate emissions of primary $PM_{2.5}$, particulate BC, and PM precursor emissions. In the absence of a complete national emissions inventory for Kosovo, this presentation of the importance of different emission source categories is based on data extracted from the GAINS model (Box 3.1).

3.2. Air Pollution Emissions in Kosovo

Annual Emissions Estimates in Kosovo in 2015

Fuelwood, used primarily in the residential sector, accounts for about 20 percent of overall energy consumption in Kosovo (UNECE 2018; World Bank 2017). Figure 3.5 shows modeled sources of $PM_{2.5}$ emissions in Kosovo. Based on the GAINS estimates, the residential sector was responsible for nearly half of $PM_{2.5}$ emissions and almost 80 percent of BC emissions in 2015. For SO_2, the overwhelming share of emissions is caused by coal combustion, mainly in the power sector. For NO_x, the largest share of emissions originates from the use of liquid fuels, mainly in the transport sector. Agricultural activities are the dominant contributors to ammonia (NH_3) emissions. Residential combustion and industry are the two leading sources of non-methane volatile organic compounds (NMVOCs) emissions.

Figure 0.5. Annual emissions of $PM_{2.5}$ in Kosovo in 2015



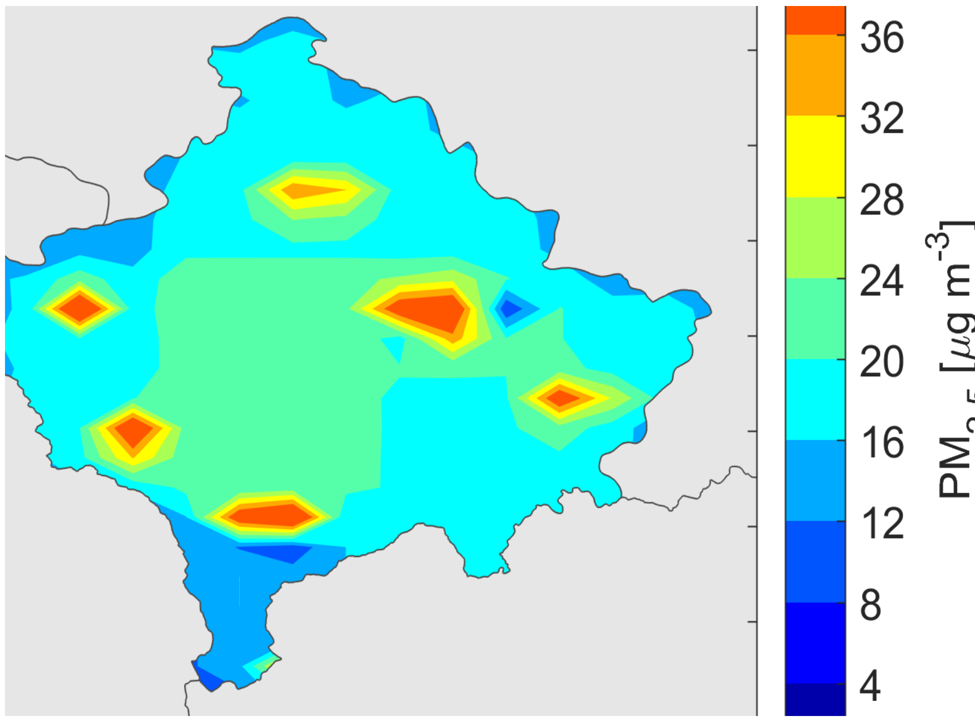
Source: GAINS Model 2015.

Comparing the emission estimates developed using the GAINS model with the official national inventory submission to the CLRTAP and other official sources could be a useful exercise, where available. However, Kosovo's national inventory reports emissions mainly for the power sector, while data for several other sectors including transport, agriculture, and some industries are missing. For residential combustion, only a limited part of activities is considered, resulting in very low emissions reported for this sector. Thus, while for the power sector the national inventory appears complete and consistent with the GAINS model estimates, a comparison of total national emissions is not meaningful.

3.3. Ambient Concentrations of $PM_{2.5}$

As indicated previously, for this study, the GAINS model performs a national-level source apportionment. Understanding concentrations and sources at a local level will require further analysis not conducted within the scope of this study. As a starting point for the source apportionment, the spatial patterns of ambient concentrations of $PM_{2.5}$ in Kosovo are computed for the baseline year 2015 (Figure 3.6) with the highest concentrations noted around Mitrovica, Prishtina, Gjilan, Prizren, Gjakova, and Peja.

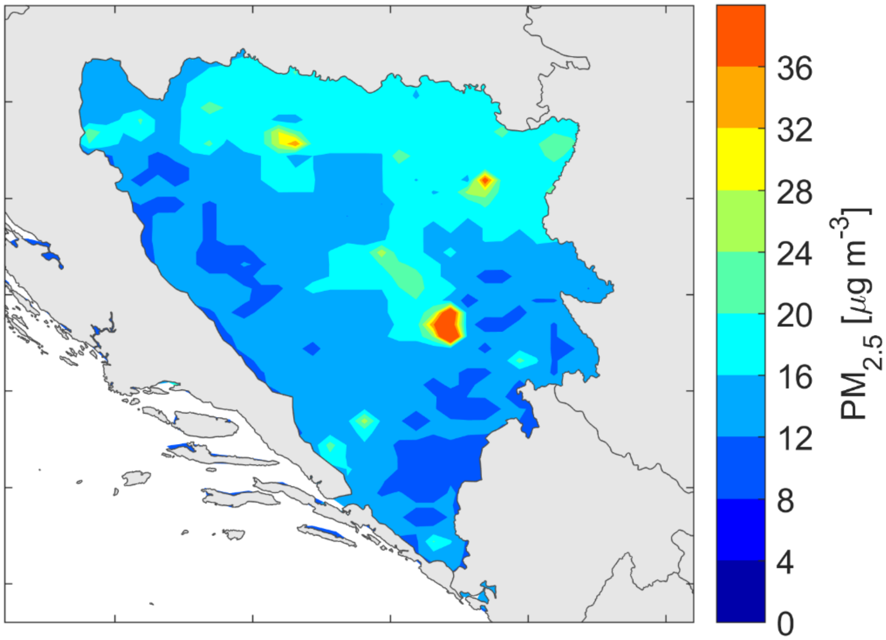
Figure 0.6. Annual average $PM_{2.5}$ concentration estimated for 2015 in Kosovo



Source: GAINS Model 2015.

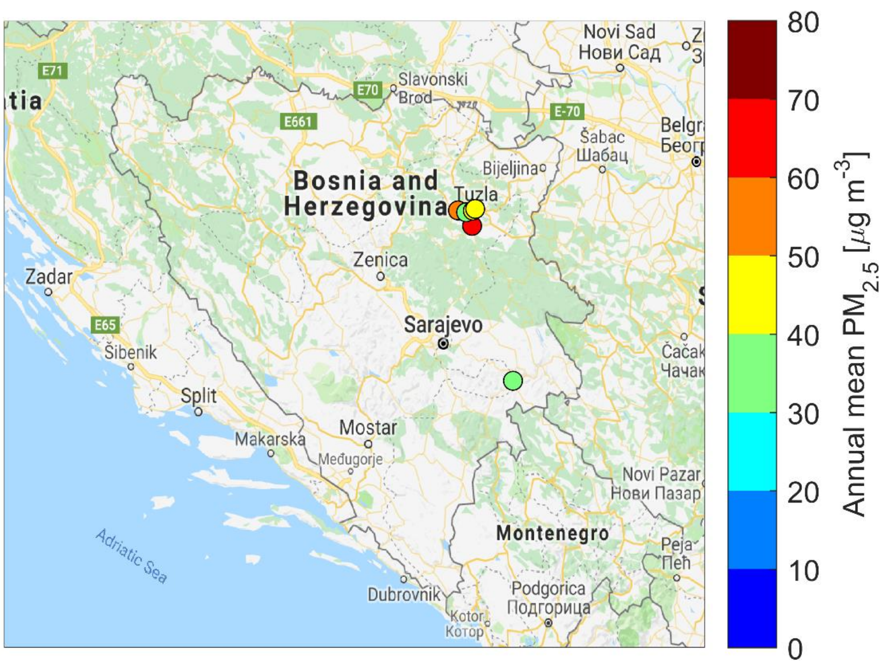
While the model calculation produces complete spatial coverage for the region, there is only a limited set of monitoring stations with sufficient temporal data coverage available against which the model results of annual mean $PM_{2.5}$ concentrations can be meaningfully compared. While observational and model data could not be meaningfully compared for Kosovo, suitable information was available for another Western Balkan country, Bosnia and Herzegovina. The observational data from Bosnia and Herzegovina, from stations with a temporal coverage of at least 75 percent for 2017 (Figure 3.7), were found to be in reasonable agreement with the GAINS estimate (Figure 3.8), especially keeping in mind the large variability within urban areas, and thus provide reasonable basis for the subsequent source apportionment and scenario analyses.

Figure 0.7. Annual average $PM_{2.5}$ concentrations estimated for 2015 in Bosnia and Herzegovina



Source: GAINS Model 2015.

Figure 0.8. Annual average $PM_{2.5}$ concentrations in 2017 for available stations in Bosnia and Herzegovina



Source: Bosnia and Herzegovina National Measurement Network 2017.

3.4. Source Apportionment for Population Exposure to $PM_{2.5}$

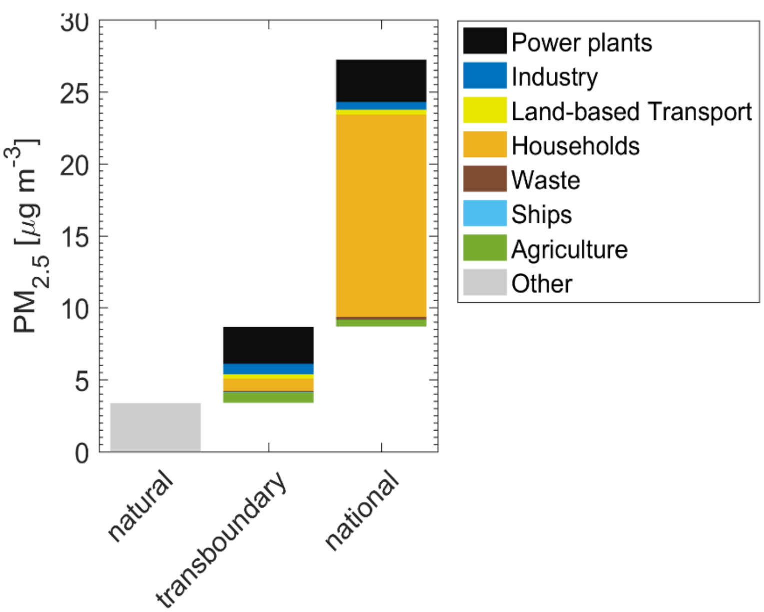
The model calculations deliver estimates of concentrations of $PM_{2.5}$ in ambient air across the full model domain. By contrast, monitoring data are restricted to a few places of interest, often to locations of high population densities (urban areas) or with high pollution levels (for example, industrial areas). Although there may be overlaps between the full model domain and monitoring locations, the spatial distribution of population is not always identical to the distribution of pollution. Model results, combined with population data, can be used to compute the overall population exposure, which then provides important input for the development of economically effective policy interventions to reduce the harmful impacts of pollution. It is important to note, however, that strategies targeted at improvements in total population exposure could be different from priority actions to alleviate concentrations in the most polluted locations.

This national-level study provides model-based source apportionment analyses for population exposure, which integrate over the total population, both within cities and in rural areas. Further analysis, with more detailed information, would be required to conduct reliable source apportionments for specific cities and locations.

The results of the source apportionment from the GAINS model, show three notable features (Figure 3.9). The 'natural' contribution refers to natural sources like soil dust, forest fires, and sea salt.

- While pollution hot spots exist, the population-weighted mean exposure to $PM_{2.5}$ exceeds the WHO guideline value of 10 µg/m^3 for $PM_{2.5}$ by a factor of almost 3.
- The dominant share (about 69 percent) of $PM_{2.5}$ pollution originates from within the country, and about 20 percent is imported from neighboring countries. This is different from many other countries in Europe, where the transboundary component contributes the largest share (Kiesewetter et al. 2014). Nonetheless, the transboundary contribution is significant.
- The residential sector is by far the largest source for population-weighted $PM_{2.5}$ exposure.

Figure 0.9. National-level source apportionment for population-weighted annual mean concentrations of $PM_{2.5}$ in Kosovo for 2015



Source: GAINS Model 2015.

3.5. Future Trends

Emission Scenarios

To explore the possible future evolution of emissions, air quality, and population exposure to $PM_{2.5}$ in the region, as well as the scope for improvements through dedicated policy interventions, two emission scenarios were developed. Both scenarios use the same assumptions about the future economic development and the evolution of pollution-generating activities up to 2030. Future levels of energy use, industrial production, transport, and agricultural activities are based on the macroeconomic and energy projections of the World Energy Outlook 2017, developed by the International Energy Agency, and on the projections developed for the European Commission with the Price-Induced Market Equilibrium System (PRIMES)[4] energy model and the Common Agricultural Policy Regionalized Impact (CAPRI)[5] agricultural model.

- **The baseline case** illustrates the likely development of emissions and air quality from the base year of 2015 up to 2030 assuming compliance with current environmental laws, considering both national and international legislation that are applicable to Kosovo. The key laws significantly affecting the trajectory of future emissions include the provisions of the Energy Community Treaty (Energy Community 2005), which requires compliance with the EU Large Combustion Plant Directive (European Commission 2001) by 2018, and EU legislation for the transport sector, which are assumed to be introduced with a 10-year delay in comparison with EU Member States.
- The **maximum technically feasible reduction (MTFR) or maximum mitigation case** outlines the scope for emission reductions that could be achieved through immediate and full application of the best available technologies for all new installations (to the technically feasible extent),[6] as characterized in the GAINS model. However, this case does not consider the potential emission reductions that could result from changes in energy, agricultural, and transport policies, which would affect future levels of polluting activities.

Emissions in Baseline Case Scenario

The emission trajectories for air pollutants, in the baseline scenario, are presented in Figures 3.10 and 3.11. Existing environmental and air quality policies, if effectively enforced, are expected to deliver a strong decline in the emissions of SO_2 and NO_x (Figures 3.10 and Figure D.1), mainly due to EU legislation for large combustion plants and the emission standards for new vehicles. SO_2 emissions in the power sector will be cut by about 80 percent and NO_x emissions by about 40 percent. At the same time, emissions of primary $PM_{2.5}$ are not likely to change significantly in the near term (Figure 3.11), as the underlying energy projections do not foresee major shifts away from fuelwood combustion in household stoves and boilers. Emissions of NO_x, NMVOC, NH_3, and BC are expected to remain at about the same level or could even increase (presented in Annex D).

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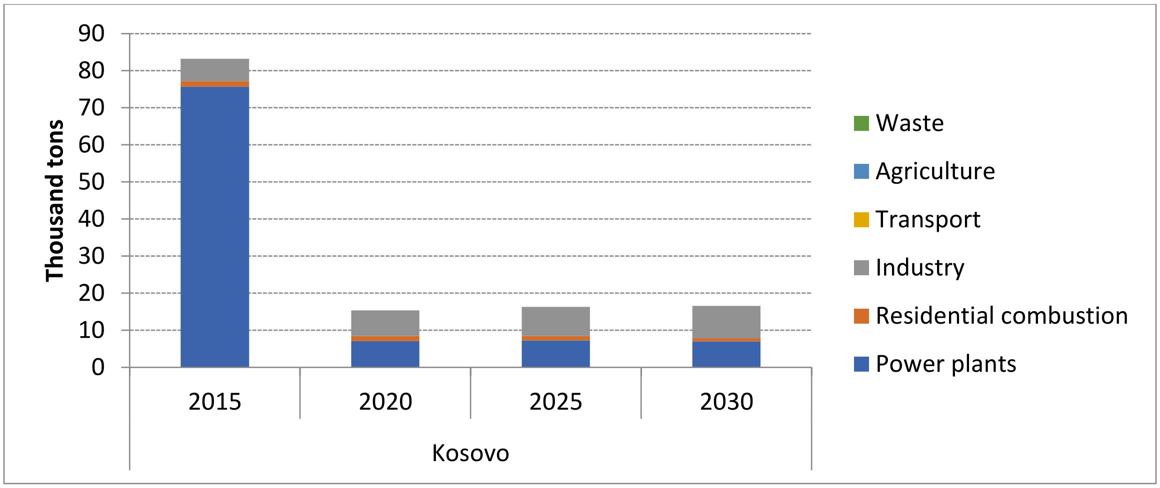
[4] The PRIMES model is an EU energy system model, which simulates energy consumption and the energy supply system.

[5] The CAPRI model is a tool for ex ante impacts assessment of agricultural and international trade policies with a focus on the EU.

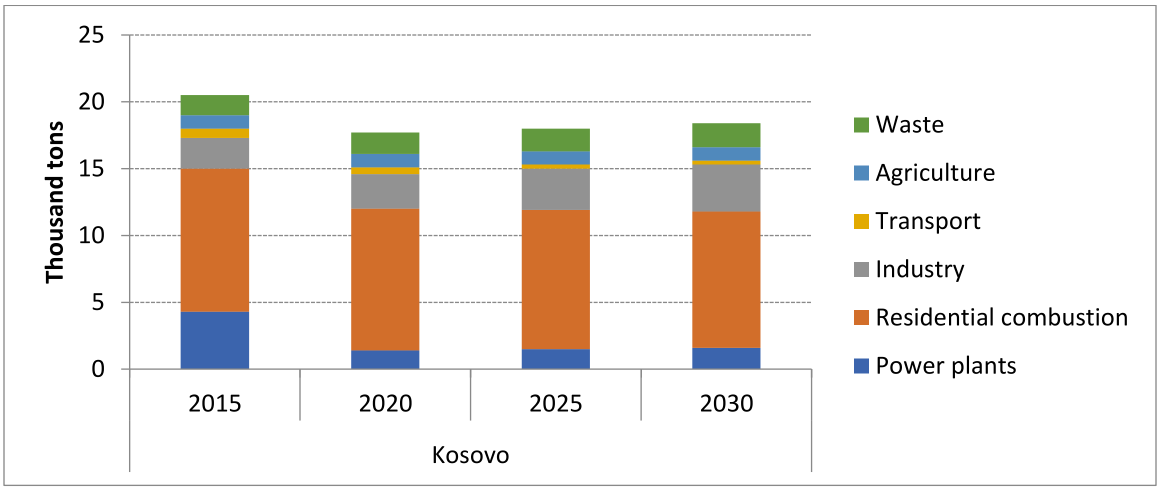
[6] Excluding premature scrapping of existing capital stock.

Figure 0.10. Emissions of SO_2 in the baseline scenario



Source: GAINS Model 2018.

Figure 0.11. Emissions of $PM_{2.5}$ in the baseline scenario



Source: GAINS Model 2018.

Emissions in Maximum Mitigation Case Scenario

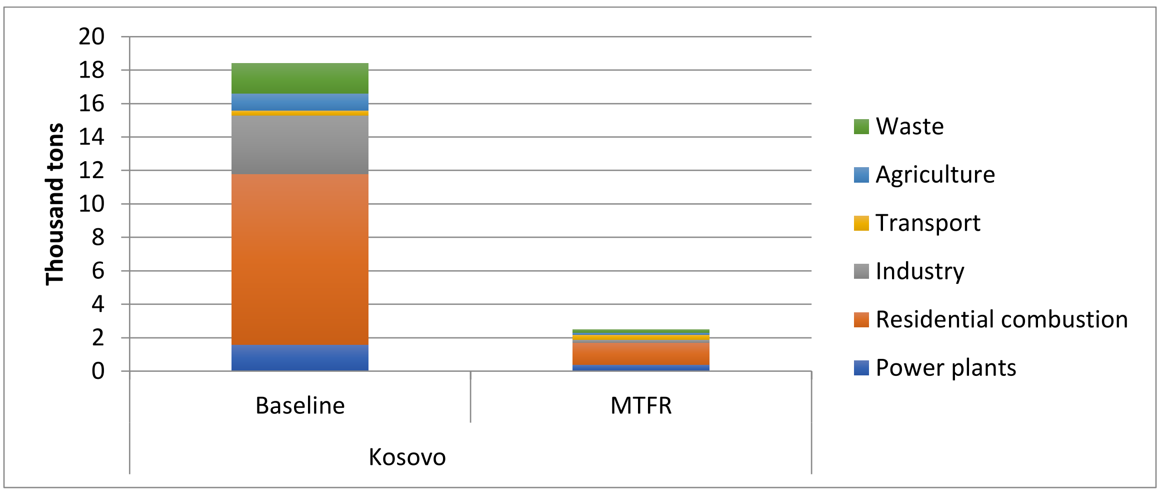
For $PM_{2.5}$, the largest mitigation potential emerges in the residential combustion sector and in industry (Figure 3.12). Since these sectors contribute the largest emissions currently, the overall emission reduction potential for $PM_{2.5}$ is about 90 percent and similar for BC (Annex D). The measures that could lead to such emission reductions include, among others, (a) immediate compliance of all new household stoves and boilers burning fuelwood with the stringent standards of the Ecodesign Directive of the EU; (b) replacement of the oldest existing stoves and boilers, (c) assurance of adequate quality of fuelwood, that is, fuelwood shall be dry when burned, which implies proper storage of the wood; and (d) compliance of all new industrial plants with the EU IED. In the absence of strong financial and governance mechanisms, such in-depth changes are unlikely to occur in the near future under the assumed projections of socioeconomic development, that is, population and economic growth.

For SO_2, power plants and industry contribute the largest shares to national emissions. Owing to the commitments that are part of the Energy Community Treaty to which Kosovo is a member, emissions from the power sector are expected to decline sharply by 2030 in the baseline scenario, which leaves the largest potential for further mitigation to the industrial sector (Figure 3.13).

For BC and NMVOC, the largest reduction potential beyond current legislation emerge in the residential sector. In addition, solvent use (under industry) offers important opportunities for NMVOC reductions (for example, low solvent products or end-of pipe measures like incineration or recovery, which are widely applied within the EU) (Annex D).

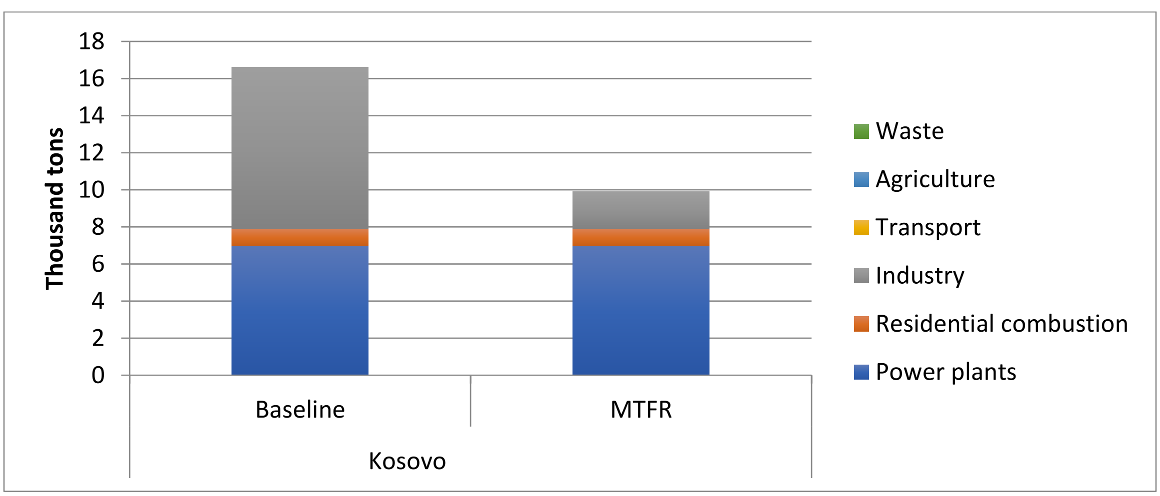
NO_x emissions can be reduced by more than 60 percent compared to the baseline in 2030 through best available technology standards involving, for example, selective catalytic or non-catalytic reduction in the power and industrial sectors, and EURO 6 equivalent standards for vehicles (Annex D). For NH_3, mitigation opportunities are typically smaller because there is no technology to remove NH_3 efficiently at a large scale. Instead, reducing input of nitrogen into the system and optimizing the use of nitrogen-rich manures can avoid losses to the atmosphere and typically reduce emissions by 20–40 percent depending on the structure of emission sources (for example, the importance of urea-based fertilizer application, share of cattle in total livestock, and so on).

Figure 0.12. Emissions of $PM_{2.5}$ in 2030 for the baseline and MTFR scenarios



Source: GAINS Model 2018.

Figure 0.13. Emissions of SO_2 in 2030 for the baseline and MTFR scenarios

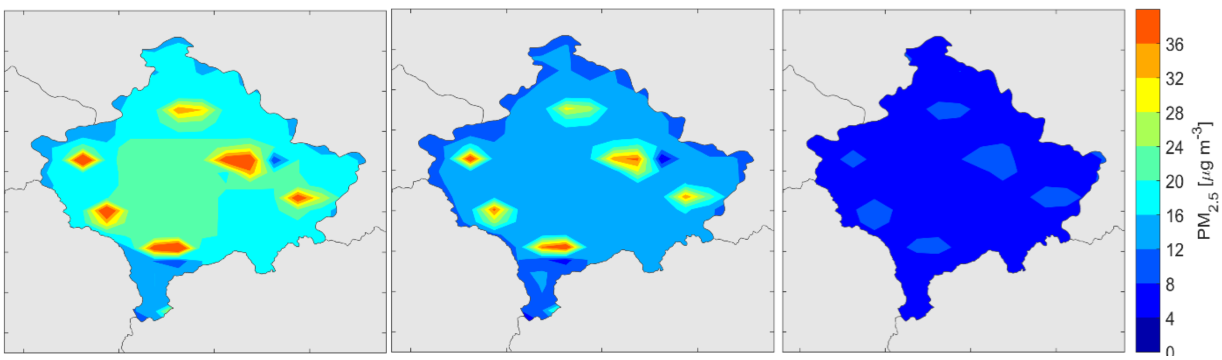


Source: GAINS Model 2018.

3.6. Future Ambient Particulate Matter Concentrations

The envisaged future emissions discussed in the above section will have significant impact on future air quality in the country. Currently, for most areas in Kosovo, the estimated levels of $PM_{2.5}$ concentrations are significantly above the WHO guideline value of 10 µg/m^3, with urban areas exceeding this value typically by a factor of four (Figure 3.14). In the baseline scenario in 2030, despite overall emission reductions, concentrations will remain high in the more densely populated areas, because of the persistence of firewood use in households. By contrast, it would be technically feasible, through measures for the residential sector, to bring most of the country, including many cities, below the WHO $PM_{2.5}$ guideline value, although full implementation of all measures will be challenging.

Figure 0.14. Ambient $PM_{2.5}$ concentrations in Kosovo in 2015 (left panel) for the baseline scenario in 2030 (center panel) and the MTFR scenario in 2030 (right panel)



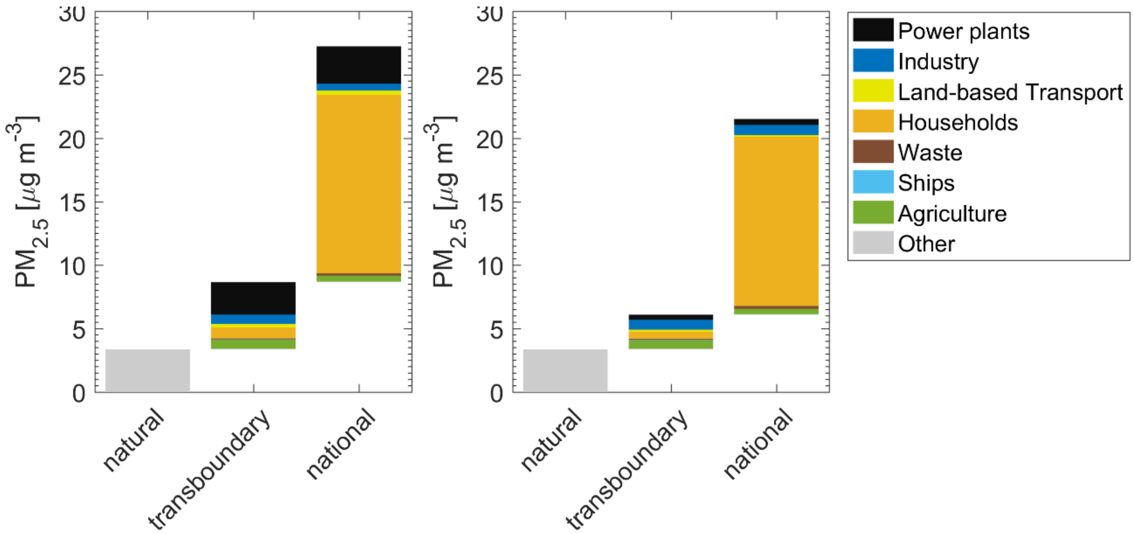
Source: GAINS Model 2018.

3.7. Future Source Apportionment

The expected declines in the emissions of the various sectors would not only have an important impact on ambient $PM_{2.5}$ levels, they would also profoundly change the relevance of the remaining emission sources to ambient population-weighted $PM_{2.5}$ concentrations. In the baseline scenario, the emissions contributions from the power sector are strongly declining. By contrast, there will be only little changes in the emissions contributions of the residential sector, leaving considerable potential for further emission reductions by 2030.

Currently, the domestic sector makes a large contribution to population exposure to $PM_{2.5}$ in Kosovo, but the impact of other sectors, in particular power generation, is also considerable (Figure 3.15). About 70 percent of the total population exposure to $PM_{2.5}$ originates from sources within the country. By 2030, current measures for large sources, if effectively implemented, will sharply reduce their impact on population exposure, both from within the country and from the inflow from neighboring countries. In the absence of dedicated policies, the contributions from the domestic sector will persist and overall population exposure is expected to decline by about 25 percent. At the same time, the potential for elimination of emissions from residential combustion sources will be still untapped in 2030. From a technical perspective, measures for this sector could reduce exposure by some 70 percent compared to the current levels.

Figure 0.15. National-level source apportionment of population-weighted mean $PM_{2.5}$ concentrations in Kosovo in 2015 (left panel) and for the baseline scenario in 2030 (right panel)



Source: GAINS Model 2018.

3.8. Conclusions and Recommendations

Summary of Conclusions

Several areas in Kosovo suffer from poor air quality, with concentrations significantly exceeding the global air quality guideline for $PM_{2.5}$ established by the WHO and the air quality limit values for $PM_{2.5}$ and PM_{10} of the EU. Especially in winter, urban areas face severe smog episodes, caused by the increased demand for heat from the residential and commercial sector, which is mainly provided by burning fuelwood.

As the first study analysing the emission source structure of $PM_{2.5}$ and $PM_{2.5}$ precursor emissions in this region in a harmonized way, the study compares modeled $PM_{2.5}$ concentrations with recent observations from local measurement networks and develops source apportionments for ambient $PM_{2.5}$ for all considered countries. It explores the future trends in emissions and air quality and identifies opportunities for emission reductions.

Official information on emission inventories is scarce and incomplete. Kosovo has provided a national inventory (in the CLRTAP format) to the European Environment Agency (EEA), which, however, does not include important source sectors, notably the residential sector.

Source apportionments have been developed that quantify the contributions of key sectors to ambient $PM_{2.5}$ concentrations. The results show that (a) the population-weighted mean exposures to $PM_{2.5}$ exceed the WHO guideline value by a factor of almost 4, particularly in hot spots; (b) most of $PM_{2.5}$ pollution is from within the country and not from other countries; and (c) the residential sector is markedly the largest source of population-weighted $PM_{2.5}$ exposure in the country.

If effectively enforced, the existing environmental and air quality policies are expected to deliver a strong decline in the emissions of SO_2 and NO_x but will not have major impacts on primary $PM_{2.5}$ emissions, as the current energy projections do not foresee major shifts away from fuelwood combustion in household stoves and boilers. While these policies should lower concentrations in large parts of the region to levels around the WHO guideline value, concentrations in urban areas will remain high and violate the guideline value by a factor of 1.6–2.0 in most of the country, reaching almost 4 in hot spots, mainly due to the persistence of fuelwood burning for heating purposes.

The expected declines in baseline emissions of the various sectors will not only have an important impact on ambient $PM_{2.5}$ levels in the country but will also change the relevance of the remaining emission sources to population-weighted exposure to $PM_{2.5}$. Notably, because the contributions from the power sector will decline markedly, the residential sector will remain as the dominant $PM_{2.5}$ emission source.

While it would be technically feasible, through measures in the residential sector, to bring ambient $PM_{2.5}$ concentrations in most of the country, including key cities, below or slightly above the WHO $PM_{2.5}$ guideline value, full implementation of required measures would be challenging. Relevant measures would require (a) immediate compliance of all new household stoves and boilers burning fuelwood with the stringent standards of the Ecodesign Directive of the EU, (b) replacement of the oldest existing installations, and (c) assurance of adequate quality of fuelwood which includes burning of dry fuelwood and proper storage of fuelwood. Such changes would require strong financial and governance mechanisms for their realization.

Key Recommendations

Based on the analysis of the emission inventories, current and potential future ambient $PM_{2.5}$ concentrations, and source apportionments, the following recommendations emerge for improving AQM in Kosovo.

Develop comprehensive emissions inventory covering all sources and types of air pollution, prioritizing the residential sector. There is an urgent need to further develop the official emission inventory. Ongoing work supported by other development partners to develop residential inventories in and around the city of Prishtina, for example, should be continued and expanded to other big cities in the country.

In addition to addressing large stationary sources, such as industry, and mobile sources in such an inventory, it will be essential to address small stationary sources in the household sector, in particular to achieve full coverage of all emission source sectors, with special emphasis on the residential sector which makes the dominant contribution to population exposure in the country.

Application of advanced emission inventory techniques. It is also recommended that advanced emission inventory techniques (at least Tier 2) be employed for small stationary combustion sources in the household sector to capture the local peculiarities and technical features of the most important emission sources in Kosovo and to reveal the potential for emission reductions.

Strengthen temporal coverage of air quality monitoring. Due to the serious impacts of air pollution, particularly during the winter, attention should be given to improving air quality monitoring to improve temporal coverage and quality control of air quality monitoring, with special emphasis on the winter period and areas of high population.

Fill information and data gaps on fuelwood use and technology of combustion devices. Given the impact of fuelwood combustion on air quality in the country, there is an urgent need to (a) improve statistical information on the use of fuelwood in the country, including from noncommercial sources; (b) analyze the typical quality of the fuelwood used in the country; (c) assess the types of stoves and boilers used in the country and the options to reduce emissions from improved use practices; and (d) strengthen public awareness and education of households on low-emission operation of fuelwood burning devices.

Strengthen incentives and legislation to address emissions from household sector. It is essential that Kosovo enforces full compliance with its current emission control legislation for stationary and mobile sources. To harness the potential for further emission reductions in the residential sector, the country could (a) put in place incentives and mechanisms to accelerate the replacement of old stoves and boilers and (b) undertake early adoption ecodesign standards of the EU for small combustion devices in the household sector.

Develop regional approach to address transboundary air pollution. Notwithstanding that imported pollution contributes a lower amount to population-weighted concentrations of $PM_{2.5}$, than domestic sources, it is important that collaborative approaches with neighboring countries are developed to support regional actions to address transboundary air pollution as part of a comprehensive AQM approach. To maximize the synergies between similar or shared problems, the GoK could consider setting up, together with neighboring Balkan countries, a Balkan Knowledge Platform on transboundary air pollution. The knowledge platform could begin with coordination and knowledge sharing on technical aspects related to transboundary air pollution and gradually broaden the scope to collaboration on measures to address transboundary pollution based on experience and knowledge gained through interaction on the platform.

Chapter 4. Air Quality Management Institutions

4.1. Introduction

Kosovo's institutional and policy framework for AQM has evolved rapidly over the last decade, driven in part by efforts to gradually transpose EU Directives into domestic legislation. During these years, the GoK has developed some of the basic pillars of AQM, which are required to tackle the harmful levels of AAP observed in the country.

The 2009 Law on Environmental Protection (LEP) provides the policy foundation for environmental protection in Kosovo and its passage was an important step in approximating EU environmental standards. The Law on Air Protection from Pollution (LAPP), which was approved in 2010, contains detailed provisions to regulate air pollutants, contemplates instruments for air quality planning, and mandates the government to determine the limit values of emissions to achieve ambient air quality objectives. Various Administrative Instructions (AIs) related to air quality have been adopted by the government under the LAPP's provisions.

Over the last decade, the government has also established environmental organizations with responsibilities for AQM and assigned relevant responsibilities to authorities of other sectors. The Assembly of the Republic of Kosovo (national legislative body) approves the national budget and plays an important role in allocating resources for AQM. The MESP is responsible for policy formulation and development of environmental protection standards with a mandate for air quality monitoring.

Despite important efforts to create and strengthen the institutional and policy framework for AQM in Kosovo, significant challenges remain in terms of bringing down AAP levels. AAP is a severe developmental challenge for Kosovo. People living in Kosovo are typically breathing more toxic particulate air pollution than their neighbors in Western Europe. According to data monitored by the United States Environmental Protection Agency, during the winters of 2016 and 2017, the population in Prishtina was exposed to hazardous levels of air pollution similar to those of Beijing, Mumbai, and other large cities with severe air pollution problems (Plesch 2018). Institutional weaknesses associated with a lack of organizational, human, and financial resources to conduct key actions help explain such high pollution levels, particularly in urban areas.

In the absence of targeted interventions, AAP, specifically $PM_{2.5}$, could become even more severe because of trends in residential combustion of biomass, industrialization, and motorization. Actions are needed on multiple levels and as part of a wider strategic plan that should be based on sound data, technical inputs, and financial backing so that meaningful progress on air quality improvements can be achieved and sustained.

This chapter provides an overview of Kosovo's AQM institutions and policies at a national level. It does not provide an exhaustive assessment of the effectiveness and efficiency of the institutional and policy frameworks for AQM. While the merits of such assessment are recognized, it would entail the additional use of surveys, focus groups, stakeholder analyses, interviews, and other tools, at various levels of government and stakeholder groups, beyond the scope of this study. The first section briefly introduces the development of the country's legal framework on AQM starting with the 2009 LEP and including the LAPP and relevant air quality standards. It also provides a comparison of Kosovo's air quality standards with those of the EU and the WHO. The following sections describe the roles of various environmental agencies in AQM and the existing coordination of responsibilities. Subsequent sections focus on Kosovo's capacity to monitor AAP and stationary sources and public disclosure of air quality-related information. In addition, the chapter identifies areas for strengthening enforcement of air quality policies. Some recent and ongoing activities of international development partners in supporting Kosovo's efforts to improve AQM are presented. Finally, the chapter presents recommendations for strengthening the institutional and policy framework for AQM in Kosovo.

4.2. Kosovo's Air Quality Regulatory Framework

The GoK has developed a comprehensive legal and regulatory framework on AQM over the last decade (Table 4.1). To a large extent, these efforts have been geared toward transposing EU Directives into the domestic legislation. Specifically, the 2009 LEP promotes the establishment of a healthy environment for Kosovo's population. Its provisions mandate the government to establish norms to limit emissions and monitor environmental quality in the air, soil, and water. The LEP delineates the responsibilities of the MESP for environmental monitoring and the systematic measurement, analysis, and evaluation of environmental quality indicators, including for air quality. The 2010 LAPP includes more detailed provisions to regulate and guarantee Kosovo's citizens' rights to live in a healthy and clean environment. It covers several major air pollutants: (a) particulate matter with a diameter of 1.0 micrometers or less (PM_1), $PM_{2.5}$, and PM_{10}; (b) CO; (c) O_3; heavy metals (lead, mercury, arsenic, cadmium, nickel, and their compounds); (d) NO_x; (e) haloid; (f) hydrocarbons (benzene); and (g) SO_2. The LAPP also mandates the government to determine the limit values of emissions to the air to achieve air quality standards (see Table 4.2 for a comparison of Kosovo's air quality standards, with EU standards and WHO Air Quality guidelines).

Table 0.1. Development of Kosovo's Air Quality Regulatory Framework, since 2007

Law, strategy, plan, or standard	Year	Requirement
LEP	2009	Provides the backbone of the legal framework for environmental protection with the purpose to approximate EU environmental standards. Mandates the government to establish norms to limit emissions and monitor environmental quality of air, water and soil. Assigns the MESP responsibilities for environmental monitoring, including for air quality.
LAPP	2010	Introduced more detailed provisions to regulate air pollutants (including PM, CO, O_3, heavy metals, NO_x, haloid, hydrocarbons, and SO_2). Mandates the government to determine limit values of emissions into the air to achieve air quality standards. Identifies two main sources of air quality information in Kosovo: (a) air quality data generated by monitoring stations throughout Kosovo and (b) emissions data reported monthly by Economic Operators.[7] Contemplates four complementary instruments for air quality planning.
LAPP Complementary Instruments		
Air Quality Strategy (AQS)	2013–2022	The MESP elaborated an AQS for 2013–2022, which was approved by the National Assembly.

[7] The person or organization that owns a pollution source.

Law, strategy, plan, or standard	Year	Requirement
Air Quality Action Plan (AQAP)	2018–2020	The MESP developed a three-year action plan to improve air quality. The MESP has yet to develop a long-term AQAP to help achieve the AQS.
Local Air Protection Action Plans	n.a.	Municipal governments are responsible for developing local plans, which must be aligned with the AQS and Local Environmental Action Plans (LEAPs).
Reports on AQAP Implementation	n.a.	The LAPP requires the government to present reports on air quality data and trends, including emissions at the national level, to the Kosovo Assembly.
Administrative Instruments		
AI No. 06/2007 on the Rules and Standards of the Discharges on Air by the Stationary Sources of Pollution	2007	Introduces rules and standards for control and monitoring of emissions from stationary sources and sets maximum air emission levels. Exempts older combustion equipment from EU norms.
AI No. 04/2009 on Control of Volatile Organic Compounds Emissions During the Storage, Filling, Discharging, Packaging, and Transfer of Fuels	2009	Controls volatile organic compound (VOC) emissions during storage, filling, discharge, packaging, and transfer of fuels
AI No. 15/2010 Criteria for Defining of Air Quality Monitoring Points, Number and Frequency of Measurement, Classification of Pollutants which are Monitored, the Methodology of Work, Form, and Timing of Data Reporting	2010	Establishes criteria for defining AQM points, number and frequency of measurements, classification of pollutants to be monitored, and methodology of work/form/timing of data reporting, in line with relevant legal requirements of EU Directive 022/50/EC
AI No. 02/2011 on Air Quality Assessment	2011	Defines and establishes objectives for ambient air quality designed to avoid, prevent, or reduce harmful effects on human health and the environment in line with EU Directive 2008/50/EC and EU Directive 2004/107/EC
AI No. 21/2013 for Arsenic, Cadmium, Mercury, Nickel, and Polycyclic Aromatic Hydrocarbons in Air	2013	Updates some provisions of AI No. 02/2011, regulating pollutants of arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons (PAHs) in the air
AI No. 08/2016 for the Allowed Norms of Discharges in Air from Mobile Sources	2016	Defines allowable air pollutant emissions from vehicles that use gasoline, diesel, natural liquefied gas, and biodiesel and establishes CVCs. Partially harmonized with EC Regulation No. 715/2007.
AI No. 01/2017 on Fuel Quality	2017	Determines permissible values on the quality of petroleum-derived liquid fuels in line with applicable European standards

While there has been important progress in updating its legal framework for AQM, available evidence points to significant implementation gaps. An audit conducted by Kosovo's National Audit Office[8] found limitations in the LAPP implementation in terms of developing and adopting planning instruments, conducting air quality monitoring, and enforcing existing regulations.

[8] Based on data from 2016 and 2017; published in May 2018.

Table 0.2. Comparison of Kosovo's national air quality standards with EU standards and WHO guideline values

Pollutants	Averaging Period	Kosovo ambient air quality standard[a]	EU ambient air quality standard[b]	WHO air quality guideline value
PM_{10}	Annual average 24 hours 24 hours (information threshold) 24 hours (alert threshold)	40 µg/m^3 50 µg/m^3 100 µg/m^3 100 µg/m^3	40 µg/m^3 50 µg/m^3 n.a. n.a.	20 µg/m^3 50 µg/m^3 n.a. n.a.
$PM_{2.5}$	Annual average 24 hours	25 µg/m^3 n.a.	25 µg/m^3 n.a.	10 µg/m^3 25 µg/m^3
O_3	Maximum daily 8 hours average 1 hour (information threshold) 1 hour (alert threshold)	120 µg/m^3 (long term objective) 180 µg/m^3 240 µg/m^3	120 µg/m^3 n.a. n.a.	100 µg/m^3 n.a. n.a.
Nitrogen Dioxide (NO_2)	Annual average 1 hour Alert threshold	40 µg/m^3 200 µg/m^3 400 µg/m^3	40 µg/m^3 200 µg/m^3 n.a.	40 µg/m^3 200 µg/m^3 n.a.
SO_2	24 hours 1 hour Alert threshold 10 minutes	125 µg/m^3 350 µg/m^3 500 µg/m^3 n.a.	125 µg/m^3 350 µg/m^3 n.a. n.a.	20 µg/m^3 500 µg/m^3 n.a. 500 µg/m^3
CO	Maximum daily 8 hours average Maximum daily 1 hour average	10 mg/m^3 n.a.	10 mg/m^3 n.a.	10 mg/m^3 30 mg/m^3
Lead	Annual average	0.5 µg/m^3	0.5 µg/m^3	0.5 µg/m^3
Benzene	Annual average	5 µg/m^3	5 µg/m^3	n.a.

Source: EU 2008; Republic of Kosovo 2011; WHO 2006.
Notes: n.a. = not applicable. Information threshold is a level beyond which there is a risk to human health from brief exposure for particularly sensitive sections of the population and for which immediate and appropriate information in necessary. Alert threshold is a level beyond which there is a risk to human health from brief exposure for the population as a whole and at which immediate steps are to be taken by the government.
a. Limit value to be achieved by January 2017.
b. EU concentration limits based on Air Quality Directive.

Although the government adopted an AQS for 2013–2022, it was not implemented due to the lack of a long-term AQAP to achieve the strategy's objectives. Instead, a short-term emergency plan was adopted by the MESP as a result of severe air pollution episodes in the winter of 2016–2017, which was unable to address the multiple causes of AAP. A similar emergency plan was again adopted a year later—including 9 out of 12 unimplemented measures proposed in the first plan—due to alarming air pollution levels during the winter. A three-year action plan for 2018 to 2020 was developed by the MESP at the end of 2017, which proposes sectoral measures and activities to improve air quality (Table 4.3 presents selected measures from the action plan). However, the government has lacked the budgetary resources to implement all the AQAP measures, leading to recurring air pollution events.

In addition, the government has yet to fully implement AI No. 02/2011 on Air Quality Assessment, including requirements to monitor long-term trends in air quality; evaluate the effects of measures implemented to improve air quality; and use that information to guide new strategies, programs, and interventions. Under the AI, the MESP has the obligation to inform the public about AQM, including information on air quality and air quality plans, and annual reports on air quality. Similarly, at the municipal level, governments generally lack a valid LEAP, and many fail to comply with their obligations under the LAPP, including reporting on air quality to the national government. The existing LEAPs are not sufficiently aligned with national strategies, and there are gaps in reporting on LEAP implementation progress.

Table 0.3. Selected measures from the proposed Air Quality Action Plan 2018–2020

Proposed Action	Responsible Agency	Cost (€)	Deadline
Reducing emissions from small combustion plants			
Draft regulations for the determination of emission limit values from small combustion plants (sources)	MESP, Ministry of Economic Development (MED)	7,000	2019
Inventory of thermal resources with power less than 1 MW	MED, MESP, municipalities	12,000	2019–2020
Review of implementation of energy efficiency regulations in new construction	MED, MESP, municipalities	10,000	2017
Energy efficiency building program in existing buildings	MESP, municipalities	30,000	2017–2018
Promote the use of energy from renewable sources for domestic water heating systems and public services	MED, MESP	12,000	2017–2019
Prepare a public awareness campaign on the importance of using high-efficiency electrical equipment (including sellers)	MED; MESP; Ministry of Trade and Industry (MIT); Ministry of Education, Science, and Technology (MEST); and private trade sector	10,000	2017
Reducing emissions from the energy sector			
Purchase and install an automatic emission monitoring system for SO_2, NO_x, and dust for Kosovo A thermal power plant	MED KEK	1,000,000	2017–2018
Feasibility study for Kosovo A thermal power plant	MED, KEK	1,500,000	2017–2018
Control of ash dispersion by ash dumps (Kosovo A and Kosovo B thermal power plants)	MED, KEK, MESP	8,000,000	2017–2020
Expand the network of heating systems and improving the existing heating capacities	MED, KEK, Termokos (Prishtina public heating company), municipalities	150,000,000	2020
Study of financial, environmental, and social justification for the use of natural gas combustion, especially in the district heating and transport sector, to replace fuels such coal, wood, and diesel	MED, MIT, Ministry of Finance (MoF), Energy Regulatory Office (ERO)	30,000	2017–2018
Implement energy efficiency measures	MED, MIT, MESP, KEK, ERO, central heating companies	1,500,000	n.a.

Proposed Action	Responsible Agency	Cost (€)	Deadline
Reducing emissions from transportation			
Restrict access in polluted urban areas for vehicles with high emissions	Ministry of Infrastructure, Ministry of Internal Affairs, municipalities	100,000	2018–2020
Determine or expand areas in the city center, where parking fees are higher	Municipalities	15,000	2017–2018
Improve quality of public transportation services	MI, MoF, municipality	350,000	2017–2019
Develop municipal strategies for construction of bicycle trails	MI, municipality	300,000	2017–2018
Improve railway infrastructure for passenger and goods transport	MI, MoF, municipality	25,000,000	2017–2022
Develop road concept for heavy goods vehicles in urban areas, combined with one-stop ring building in sensitive areas	MI, municipalities	50,000	2017–2018
Reduce soil/dust deposition by road traffic	MoF, municipality	80,000	2017–2018
Public information and awareness raising campaigns	MESP, MEST, municipalities	70,000	2017–2018
Total cost		*188,076,000*	

Source: MESP 2016.

4.3. Organizational Structure for Air Quality Management

Several organizations have responsibilities for AQM in Kosovo at the national and local levels. The Assembly of the Republic of Kosovo is the national legislative body, consisting of representatives who are directly elected by the people. Within the Assembly, two committees have direct responsibility over environmental issues: (a) Environment and Spatial Planning and (b) Agriculture, Forestry, and Rural Development. The Assembly is responsible for approving the AQS and AQAP and oversees progress on the implementation of the AQAP based on annual reporting by the government, as required under the LAPP's provisions. The Assembly also approves the national budget, and has an important role in allocating sufficient resources for AQM.

The government has the authority to propose changes in the legislation, including in the legal framework for AQM, make decisions, and issue legal acts or regulations necessary for implementation of existing laws. It also proposes the required budget for implementation of laws or regulations, guides and oversees the work of administration bodies, and exercises other executive functions that are not assigned to other central- or local-level bodies.

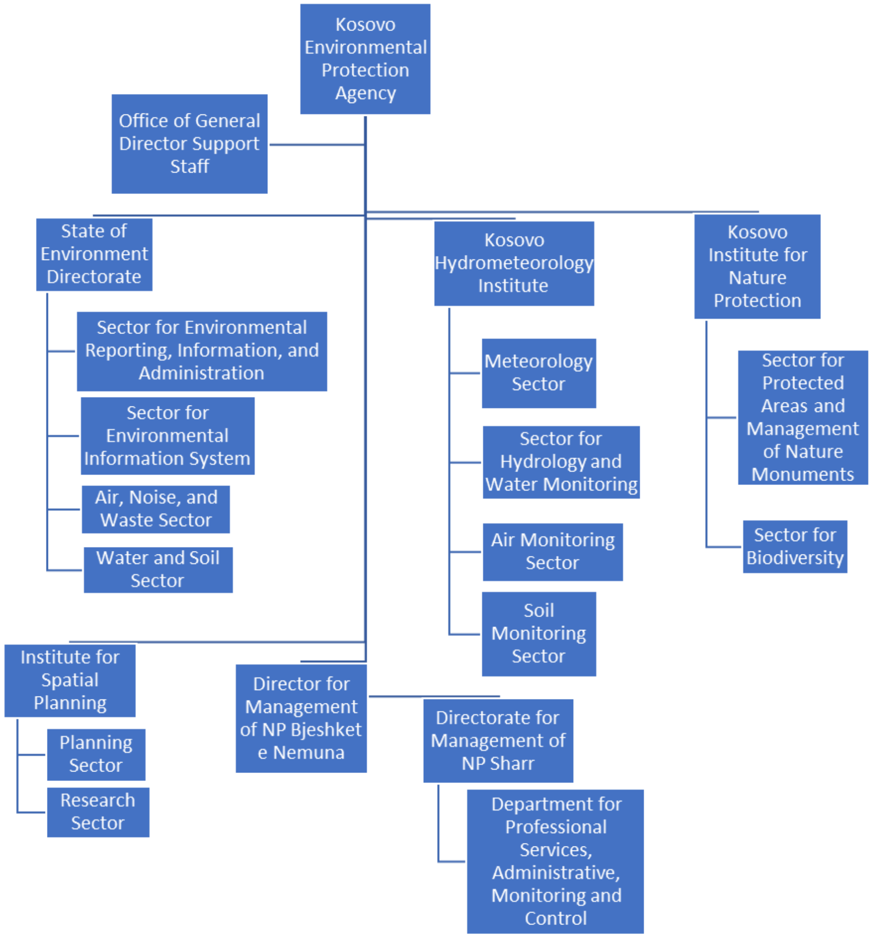
The MESP,[9] with a staff of about 321 people, has responsibility for the development and implementation of legislation in the field of environment, water, housing spatial planning, and construction. Its mandate includes (a) developing and implementing policies and programs to tackle pollution; (b) setting and overseeing compliance with norms, standards, and guidelines for environmental protection; (c) promoting community participation; (d) conducting public information campaigns and other promotional activities to increase public awareness and compliance with environmental protection standards; and (e) assessing environmental quality. With respect to AQM, the MESP's responsibilities include (a) conducting permanent air quality monitoring and publicizing reports on measured pollutant concentrations; (b)

[9] Defined by United Nations Interim Administration Mission (UNMIK) regulation No. 2002/5 and No. 2005/15.

disseminating information about air quality among the general public by publishing monthly reports in electronic and print media; (c) issuing warnings to the general public, local governments, and other national government agencies if monitoring data indicate that pollution thresholds have been exceeded; (d) determining measures to control, restrict, and limit air pollution emissions; (e) preparing a cadaster of polluters documenting air emissions at a national, municipal, and pollution source level; and (f) enforcing compliance with emission standards and the implementation of measures to reduce air pollution. The environmental protection inspectorate within the MESP is responsible for all inspections of projects and for implementation of the provisions of the law. Polluters, municipalities, and professional institutions are required to report air pollution emissions data to the MESP but often fail to comply, as noted earlier.

Within the MESP, KEPA provides information to the administration, government, and Assembly on the implementation of environmental protection policies. KEPA is responsible for developing and coordinating environmental information collected through monitoring stations and reported by stakeholders. It has a staff of about 70 people, including 23 within the Hydro-Meteorological Institute of Kosovo (HMIK), a unit of KEPA. The HMIK is responsible for establishing and maintaining the basic network of hydrological and meteorological stations to measure and collect multiple types of data (including, among others, hydrological, meteorological, and pollution of air and water). It is responsible for the systematic assessment of air quality. As part of this responsibility, the HMIK is in charge of managing laboratories, developing air emissions inventories, and developing air quality models to inform decision making. Figure 4.1 presents the organizational structure of KEPA.

Figure 0.1. Organizational chart of KEPA



4.4. Coordination of AQM: Roles and Responsibilities

Air pollution does not respect political or administrative boundaries and is typically felt locally, where municipalities and local authorities are often in a better position to address environmental problems. In decentralized systems such as Kosovo's, coordination of efforts on AQM is of key importance and may fail without a reasonable level of supervision and monitoring by the central government. To complement central responsibilities, the national government should provide technical assistance and training at the local level and enhance the institutional capacity of local governments, but it should also impose sanctions (such as limiting access to grants and federal funding) for cities that fail to meet air quality standards. Vertical coordination might be initially strengthened by establishing clear procedures and mechanisms for air quality data sharing and gradually including a broader range of topics, including alignment of national and subnational strategies and plans, as well as enforcement.

Overall, limited coordination and data sharing between the central government and municipalities impairs efforts to implement actions to improve air quality. Intersectoral coordination on AQM, to date, has been promoted through ad hoc working groups tasked with solving specific issues. For example, the poor air quality experienced during the winters of 2016 and 2017 prompted the GoK to establish a task force (including the ministers of the MESP, MED, Ministry of Local Government Administration, MEST, MIT, Ministry of Health, and Ministry of International Affairs) to coordinate and align activities at the national level. While this was an important first step, improved intersectoral coordination should include priority setting, design and implementation of interventions, accountability mechanisms, and monitoring and evaluation of effectiveness to ensure that the adopted emergency measures are implemented. A number of ways are available to promote interagency collaboration, specifically (a) routine meetings of professional-level, permanent staff (to build trust and expand understanding of the perspectives and responsibilities of different organizations) or establishing technical working groups; (b) creation of interministerial commissions or signing of formal collaboration agreements; and (c) interagency coordination by legislative power to develop new laws.

Several sectoral agencies are important players in the design and implementation of AQM policies (Table 4.4).

Table 0.4. Responsibilities for AQM aspects across sectors

Agency	Responsibility
MED	MED manages all public companies in Kosovo. The most important from an air quality standpoint are those in the energy sector. MED has drafted relevant laws, including the Law on Energy, Law on Energy Efficiency, and Law on Mines and Minerals. It also developed the Kosovo Energy Strategy (2009–2018). Working groups composed of different institutions, nongovernmental organizations (NGOs), industry, university, and others participated in during the drafting of these documents. MED also fulfills other international obligations (for example, the Energy Community Treaty) on limitation of emission by large combustion plants.
MoF	The MoF has a role in assessing the budgetary implications of project and program proposals, such as the AQAP. Customs (under the MoF) is responsible for the implementation of the Decision of Government in relation to the import for used vehicles, which since January 1, 2018, banned the import of vehicles more than 10 years old.
Ministry of Infrastructure	The Ministry of Infrastructure is responsible for the application of legal rules for gas emissions from the vehicles, which ought to be monitored by the CVCs according to the requirements of AI No. 08/2016. Even though the first version of this AI was approved in 2011 and then updated in 2016, the CVCs have yet to implement this requirement.
MIT	The MIT implements AI No. 01/2017 on the quality of petroleum-derived liquid fuels and is responsible for monitoring the quality of imported fuels.
National Institute of Public Health	The National Institute of Public Health conducts continuous research on the impact of environmental factors on population health and develops recommendations to competent institutions on measures that could be adopted to reduce environmental health risks. It also has a mandate to inform the population about environmental health risks.
Independent Commission on Mines and Minerals (ICMM)	ICMM regulates mining activities in Kosovo and ensures that companies are in compliance with the environmental aspects.

4.5. Monitoring and Reporting of Ambient Air Pollution

The LAPP and its regulations identify two main sources or air quality information in Kosovo: (a) air quality data generated by monitoring stations located throughout Kosovo and (b) emissions data reported on a monthly basis by economic operators (for example, the person or organization that owns a pollution source).

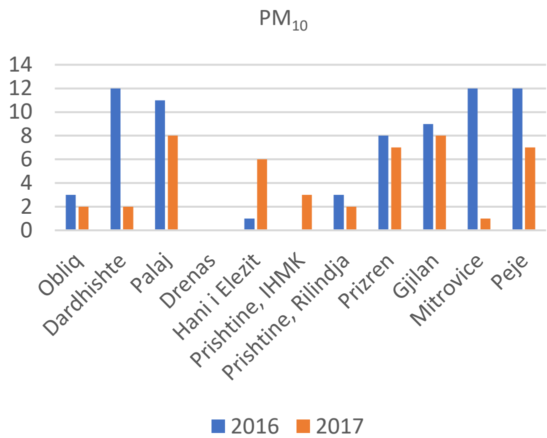
Kosovo's ambient air quality monitoring network is operated by the HMIK. In 2010, the MESP started installing a network of air quality monitoring stations and by the end of 2017, Kosovo had a total of 12 air quality monitoring stations throughout the country (Table 4.5). The number of stations was based upon a preliminary study complying with EU Directive 2008/50/EC. The monitoring stations are supposed to measure concentrations of SO_2, O_3, CO, PM_{10}, $PM_{2.5}$, and NO_2, but not a single monitoring station reported data for all relevant parameters during 2016 and 2017. Although the stations operated more regularly during 2017 than in the previous year, most of them experienced problems and only one station (Drenas) was able to provide data continuously through the entire year, with the exception of O_3, which was not reported at all. The air pollution index and air quality data for the last 24 hours are available in tabular and map format on the HMIK's website.

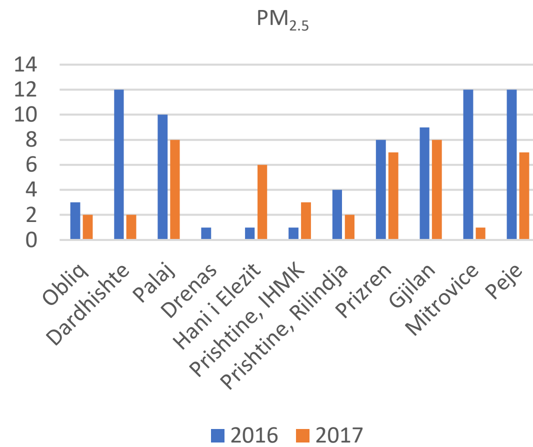
Table 0.5. Air quality monitoring stations in Kosovo

Number	Name of monitoring station	Location	Measured parameters	Type of area
1	IHMK	IHMK, Prishtina	PM_{10}, $PM_{2.5}$, SO_2, NO_x, O_3, CO	Urban
2	Rilindja	Backyard of Rilindja, Prishtina	PM_{10}, $PM_{2.5}$, O_3	Urban
3	Pejë	Primary School "Lidhja e Prizrenit"	PM_{10}, $PM_{2.5}$, SO_2, NO_x, O_3, CO	Urban
4	Prizren	Municipal building	PM_{10}, $PM_{2.5}$, SO_2	Urban
5	Brezovicë	Skiing area	PM_{10}, $PM_{2.5}$	Urban
6	Hani I Elezit	Primary School "Ilaz Hallaqi"	PM_{10}, $PM_{2.5}$, SO_2, NO_x, O_3, CO	Urban
7	Gjilan	Municipal building	PM_{10}, $PM_{2.5}$, SO_2, NO_x, O_3, CO	Urban
8	Drenas	Municipal building	PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO	Urban
9	Obiliq	Family health center	PM_{10}, $PM_{2.5}$, SO_2, NO_x, O_3, CO	Urban
10	Dardhishtë	Primary school	PM_{10}, $PM_{2.5}$, SO_2, NO_x, O_3, CO	Industrial
11	Palaj	Kosova Mont	PM_{10}, $PM_{2.5}$, SO_2, NO_x, O_3, CO	Industrial
12	Mitrovicë	Meteorology station	PM_{10}, $PM_{2.5}$, O_3, CO	Urban

Particularly of concern, from a health perspective, is that data reporting from several stations was interrupted for $PM_{2.5}$ and PM_{10} during the winter months of January through March of 2017 when pollution concentrations tend to be the highest (NAO 2018) (Figure 4.2). This is a cause of concern because $PM_{2.5}$ is the pollutant that causes the most significant adverse health effects and dearth of air quality data during those critical months hampers the government's capacity to made evidence-based decisions and adequately inform the population about potential health risks.

Figure 0.2. Number of months during which air quality monitoring stations did not report data, 2016–2017





Problems leading to the intermittent operation of the stations range from failure to set air pollution parameters to lack of communications between the station's software and data logging equipment, problems with air conditioning, power supply, or Internet connection. Underlying these failures is a lack of funding, which results in inadequate maintenance, incomplete relocation of misallocated monitoring stations, and lack of measures to protect the stations from potential damages and theft (NAO 2018). Additional challenges arise from technical constraints and insufficiently qualified staff for collecting and analyzing monitoring data that can support AQM planning. In all but one monitoring station, collected data are physically retrieved by the HMIK officials using flash drives twice per month. Processing of the approximately 1,400 values for air quality parameters (per month) is done manually by spreadsheets, a time-consuming method susceptible to human error, which hampers the dissemination of reliable air quality information for decision makers and the general public.

Municipal authorities, in general, do not have real-time access to monitoring data and must wait until it is disseminated through the HMIK's website, at which point the information is no longer timely or accurate, impairing the ability of municipalities to inform their AQM actions based on data. To circumvent this problem, the municipality of Prishtina established its own air quality monitoring network consisting of six stations that are maintained by a private company contracted to collect, interpret, and report data, as well as maintain the monitoring locations. However, the air quality data observed at Prishtina's network has been reported to often differ from those stations maintained by the HMIK in Prishtina, leading to confusion among concerned citizens (NAO 2018). This lack of accurate information and coordination impairs actions to improve air quality and underscores the imperative for monitoring air quality parameters, especially $PM_{2.5}$.

4.6. Public Disclosure of Air Quality Information

In Kosovo, the MESP and KEPA are responsible for making updated information on air quality available to the public and interested organizations. These organizations conduct public outreach at least once a month through electronic and print media, and daily in specific cases. In addition, they exchange information on air quality and emissions with international organizations (including the EEA) and other countries in accordance with international agreements. In 2018, KEPA started a test phase to disseminate the monitoring data from eight air monitoring stations online.[10] While this is undoubtedly an important and positive step, all information on air quality ultimately depends on the data collected by the air quality monitors. Therefore, the weaknesses of the existing air quality monitoring network remain a key obstacle for the dissemination of timely air quality information.

Based on the LAPP, the government should present annual reports on the implementation of the AQAP, including data and trends on air quality and pollution emission, to promote the accountability of the national entities responsible for AQM. Given that the AQAP was not adopted by the National Assembly, reports by the MESP have been limited to episodes of severe pollution and air quality reports for specific years. Currently, the reports do not provide information about the contributions of different sources to deteriorating air quality, actions that have been implemented to improve air quality and their results, and longer-term strategy on AQM.

The MESP has yet to develop a reliable cadaster of air polluters, as required by the LAPP. This is essential to gather and process historic and existing pollution data, which can then be used to inform policies and strategies, as well as discussions among different stakeholders on potential actions to reduce pollution.

4.7. Enforcement of Regulations

An audit conducted by NAO (2018)[11] found that municipal governments failed to comply with their obligations under the LAPP. By the end of 2017, none of the selected municipalities had a valid LEAP due primarily to lack of budget. Although Prishtina did not have a formally approved LEAP, it was the only one of these municipalities that reported on the implementation of the action plan to the MESP, based on a plan it was developing with the support of the German Corporation for International Cooperation GmbH (GIZ). This lack of reporting from municipalities to the national government was attributed to a lack of accountability and commitment from municipalities, as well as the dearth of reporting requirements from the MESP (NAO 2018).

Recognizing the need to update the legal and policy framework, the MESP prepared a series of amendments for the LAPP. These amendments would mandate the government to elaborate plans covering 3 years instead of 10-year periods. In addition, the amendments would require local governments to establish stand-alone air quality plans that would not be integrated into LEAPs.

Strengthening institutional capacity to enforce the existing air pollution limits is a pressing priority. Based on the LAPP's provisions, polluters, municipalities, and professional institutions are required to regularly report their air pollution emissions data to the MESP. Monthly reporting of polluting emissions by economic operators to the MESP is inadequate and often noncompliant with the LAPP provisions (NAO 2018). Furthermore, data collected for monthly emissions monitoring is unlikely to be representative of the operators' actual emissions. While the inspectorate within the MESP is responsible for verifying reported data, its capacity to do so is severely constrained by limited equipment and resources. As of 2014, a total of 14 inspectors were responsible for enforcing all environmental laws at the national level, whose capacity is severely constrained by lack of equipment, training, and resources to conduct actual measurements of emissions in the field.

[10] See: http://kosovo-airquality.com/secure/index2.html.

[11] The audit selected the five municipalities that were most significantly exposed to air pollution as case studies: (a) Gijlan, (b) Hani I Elezit, (c) Mitrovica, (d) Obliq, and (e) Prishtina.

Failure to enforce compliance of key polluters with environmental standards sends a strong signal that polluters can continue to damage the general population's health without serious consequences. When regulatory avenues for environmental enforcement fail, the judicial system is often the only other recourse for resolving environmental conflicts. An independent judiciary and judicial process enhances implementation, development, and enforcement of air pollution control regulations. However, these processes also require strengthening the capacity of courts and judges, as well as the technical capacity of inspectors to provide sound evidence of infractions. While legal actions have been rarely used in Kosovo, they have proven effective as policy instruments in other developing countries. In India, for example, two NGOs (the Indian Council for Enviro-Legal Action and the Centre for Science and Environment) brought public interest lawsuits and generated a fact-based, high-profile publicity campaign that compelled the government to enforce legal regulations on air pollution.

4.8. Recent and Ongoing Efforts of Development Partners to Support AQM in Kosovo

This section discusses some recent and ongoing efforts of international development partners to support improvement of AQM in Kosovo. Taking this type of discussion into account could help inform efforts of development partners by making sure that they are complementary, mutually reinforcing, and not duplicative.

This study found the following development partners working directly and tangentially on AQM-related issues in Kosovo.

Japan International Cooperation Agency (JICA). As part of a €4 million technical cooperation project titled Capacity Development for Air Pollution Control in Republic of Kosovo, JICA is providing technical assistance to the MESP to strengthen AQM, during October 2017–September 2020, in the following areas: (a) capacity development for preparation of emission inventories; (b) evaluation of the existing monitoring network; (c) rehabilitation of monitoring stations; (d) capacity building for laboratory analysis; (e) modeling of air quality simulation; (f) elaboration of emission inventories of the municipalities of Prishtina, Obiliq, and Fushë Kosova; and (g) emission measurements from industrial and manufacturing facilities.

The Millennium Challenge Corporation (MCC). The US$49 million grant-funded Millennium Challenge Kosovo Threshold Program, launched in November 2017, focuses on two main challenges in Kosovo: unreliable electricity supply and weaknesses in governance, through (a) the Reliable Energy Landscape Project (US$34 million), which seeks to reduce the gap between energy demand and supply, by lowering energy use through piloting household investments in energy efficiency, switching to cost-effective non-electricity sources of heating, and reducing barriers to independent power producer entrants to the market and (b) the Transparent and Accountable Governance Project (US$8.3 million), which aims to improve public availability and analytical use of judicial, environmental, and labor force data by civil society, business, and government. Under the Transparent and Accountability Governance Project, the MCC is supporting the government in building capacity through improved environmental information systems; strengthening systems for collection, processing, and visualization of air quality data, including automated transfer of air quality monitoring data to the HMIK; and increasing the number of monitoring stations (MCC 2018). As of the end of September of 2018, program expenditures and commitments totaled about US$1 million or 2 percent of the grant budget.[12]

[12] https://www.mcc.gov/where-we-work/program/kosovo-threshold-program.

The Government of Luxembourg is providing technical assistance and capacity building through the €950,076 'Healthier Kosovo' Project, implemented by the WHO in collaboration with the Ministry of Health, MESP, the United Nations Development Programme, and the United Nations Volunteers Program. This two-year project aims to achieve two outcomes: (a) help Kosovo institutions achieve more effective governance in environment and health through inclusive, evidence-based planning, implementation, and monitoring of air pollution impacts on health and (b) more people adopt behaviors that are healthy and that increase resilience to potential threats from environmental pollution. To achieve its outcomes, project activities include (a) upgrading the air quality monitoring system to provide usable data for health impact assessment, (b) facilitating public access to data from the air quality monitoring system and environmental monitoring system in general, (c) providing technical assistance to the Kosovo Institute of Public Health (KIPH) and KEPA to upgrade environmental health methods and health impact assessment focusing on the quantification of the health risks of air pollution, and (d) supporting civil society organizations to provide watchdog and other functions to support the implementation of environmental pollution reduction strategies.

These projects, described earlier, are expected to make valuable contributions to addressing air quality in Kosovo. Compared to the need, however, the sum of the budgets of the abovementioned programs is well below the budget estimate of €188 million for implementation of the selected measures from the proposed AQAP 2018–2020, as presented in Section 4.2. Furthermore, the abovementioned donor-supported activities are funded by grants, provide technical assistance to strengthen specific areas of AQM, and demonstrate opportunities for additional support including lending and knowledge development and advisory services.

4.9. Conclusions and Recommendations

Recognizing the importance of reducing AAP and its significant health effects, the GoK has developed a comprehensive legal and regulatory framework for AQM over the last decade. To a large extent, these efforts have been geared toward transposing EU Directives into the domestic legislation. The government has also established environmental institutions with dedicated responsibilities for AQM and assigned responsibilities to authorities from relevant sectors. However, achieving sustained reductions in air pollution will require further government commitment to dedicating increased resources and building capacity at different levels of government to address the problem.

Despite efforts to strengthen the institutional framework for AQM in Kosovo, significant challenges remain in terms of implementing the existing laws and regulations including the lack of implementation of AQM planning and monitoring instruments at the national and municipal levels, failure to adopt the AQS for 2013–2022 and the resulting lack of an AQAP, incomplete implementation of requirements related to air quality assessments, and lack of municipal LEAPs. The institutions responsible for AQM face several obstacles, most of which are associated with lack of financial, human, and technical resources, which manifest in various areas, including, among others, failure to adopt AQM planning instruments, inadequate operation of the air quality monitoring network, and limited qualified staff with requisite technical expertise and experience. Following is a brief description of key actions that the government should adopt over the short, medium, and long term to improve air quality, particularly in urban areas. In the absence of targeted interventions, urban air pollution could become even more severe with growing development.

The following paragraphs provide recommendations on how the GoK could improve air quality.

Strengthen the Legal Framework for AQM

Introduce a standard for daily average ambient $PM_{2.5}$ concentration. One evident gap in the legal framework is the lack of a daily air quality standard for ambient $PM_{2.5}$ concentration. Although this gap is also present in the EU Directive on ambient air quality and cleaner air for Europe (Directive 2008/50/EC), the WHO includes a $PM_{2.5}$ daily standard 25 µg/m^3 24-hour mean) and interim targets (75 µg/m^3, 50 µg/m^3, and 37.5 µg/m^3 24-hour mean) that could be adopted in Kosovo.

Simplified legal processes. The legal provisions under the LAPP should be reviewed and revised to simplify the approval process of key planning documents, including those of the AQS and AQAP. In most countries, the National Assembly has the role of approving new laws and amending existing ones, but the development of specific strategies and programs falls under the purview of agencies within the executive branch. In Kosovo, congressional approval is required for adoption of the AQS and AQAP separately, which seems to have created more challenges than opportunities, based on experience to date.

Specific measures that should be adopted in the short term include revising the legal framework to reduce pollution from the following:

- **Domestic heating.** Interventions should consider establishing standards for solid fuel quality for use in households. In addition, a large-scale program to substitute traditional stoves with more efficient ones could be developed. The government could start with implementing a pilot program in the short term. Lessons from such a pilot and other existing initiatives could be taken into account to inform the development of a possible large-scale stove replacement program. In many countries, similar programs have been implemented with targeted subsidies for project beneficiaries who cannot afford to pay the full costs of substituting their stoves with cleaner alternatives. A public awareness program would help educate the public on the purpose of stove replacement, low-emission stove use, and available resources for households, and promote adoption of clean stoves in households. Additional measures could be developed over the medium to long term, such as expanding district heating.
- **Stationary sources (including not only lignite-fired power plants but also mines, metallurgical, and cement factories).** This should focus on revising sanctions for noncompliance commensurate with the damage caused to ensure that large emitters adopt plans to gradually reduce their emissions and comply with environmental standards. Such revisions could entail strengthening and enforcing sanctions for emitters that exceed their approved emissions levels to ensure they are commensurate with the damage they cause. In addition, the government could provide financial incentives for smaller industrial undertakings to strengthen AQM. Additional measures that are available to control emissions from stationary sources include setting consumption caps to gradually reduce coal use; incorporating new technologies for desulfurization, denitrification, and dust elimination; setting more stringent emission control standards for coal-fired plants; and setting resource and energy conservation goals targeted at resource-intensive industries. However, it would be important to assess whether the benefits of these interventions would outweigh their costs.

- **Mobile sources.** Recent revisions to the legal framework reduced the age of imported vehicles and incorporate inspections by CVCs to verify that imported vehicles meet emissions standards. In addition, Kosovo has established liquid fuel quality standards that are consistent with EU Directives, including for pollutants such as sulfur. Additional measures that could be taken include (a) implementing a vehicle scrappage program to replace older, polluting vehicles with newer, natural gas vehicles; (b) promoting the conversion of vehicles to natural gas through technological and financial measures; (c) strengthening the effectiveness of vehicle inspection and maintenance programs; (d) ensuring stricter enforcement of measures to reduce importation of older, polluting vehicles, including the requirement for inspections at the point of entry; (e) strengthening the inspection of imported fuels; and (f) ensuring possibly more stringent standards for sulfur content of diesel.

Expand menu of instruments for AQM. The government recently approved a decision to ban coal heating in public buildings. To complement this decision, the government could develop 'command-and-control' instruments, that is, standards for fuel quality for use in households. In addition, the government might consider using market-based instruments, in the medium term, that have been used to reduce air pollutant emissions efficiently and effectively in other countries. The existing legal framework, including the LAPP, AI No. 08/2016, and AI No. 06/2007, contemplates the creation of air pollution taxes. However, the only instrument that has been developed to date is the vehicle registration fee collected by the Ministry of International Affairs, which is not directly linked to air emissions. Additional instruments that the government could consider include the following economic instruments: pollution charges to promote a shift from using highly polluting fuels such as coal and diesel to cleaner fuels such as natural gas, including targeting fuels according to pollutant type; taxes based on fuel-efficiency standards; tradable permits or pricing policies; and technology- and performance-based standards. In all cases, the design of such instruments should incorporate studies of the distributional impacts associated with their implementation to mitigate any regressive effects.

Build Capacity to Design, Implement, and Enforce AQM Policies

The main challenge confronting the government is to implement existing laws and regulations, starting with all the provisions regarding the development and implementation of planning instruments and monitoring of air quality at the national and municipal levels. Although the GoK adopted its AQS for 2013–2022, it was not implemented due to the lack of an AQAP. In addition, the GoK has yet to fully implement AI No. 02/2011 on Air Quality Assessment, including requirements to monitor long-term trends in air quality; evaluate the effects of measures implemented to improve air quality; and use that information to guide new strategies, programs, and interventions. Similarly, municipal governments generally lack a valid LEAP. Without long-term, strategic actions in place, air pollution will remain a significant challenge resulting in hundreds of premature deaths and other negative social and economic effects.

Achieving reductions in air pollution will require political will and resources as well as building capacity of key institutions focused on AQM. A key priority is therefore to strengthen agencies with responsibilities for AQM at the local and national level and provide them with adequate resources. The organizational structure requires specialists who can carry out a range of actions, including monitoring, enforcement, health impact assessment, and planning. Recruiting staff with the necessary expertise and background will be paramount to ensure that the MESP, KEPA, HMIK, and public health professionals can fulfill their responsibilities. However, in some instances, outsourcing of these functions to specialized firms may be more efficient. The technical capacity of existing institutions should be strengthened by developing partnerships with research centers to conduct applied research, improve local and regional air quality models, and create centers of excellence in the country on AQM.

Over the medium to long term, horizontal and vertical coordination should be strengthened by establishing permanent mechanisms for AQM policy development, implementation, monitoring and evaluation. In Kosovo, vertical coordination might be initially strengthened by establishing clear protocols and mechanisms for air quality data sharing and gradually including a broader range of topics, such as alignment of national and subnational strategies and plans, as well as enforcement.

In addition, the GoK should develop an institutional structure to ensure ongoing evaluations of AQM policies and interventions. Ideally, systematic and objective evaluations would be conducted periodically in Kosovo to assess the efficiency, effectiveness, impact, and sustainability of national and local air quality strategies and plans. Information provided by evaluations is key for incorporating lessons learned into decision making, as well as to hold governments accountable for results.

To strengthen institutional capacity to enforce existing air quality laws, regulations, and pollution limits, the government should prioritize expanding the number of inspectors and providing them with training and resources to conduct field investigations. Tested approaches to reinforce compliance and enforcement, include publicly disclosing emitters' compliance with environmental standards to generate social pressure against violators. When regulatory avenues for environmental enforcement fail, the judicial system is often the only other recourse for enhancing implementation, development, and enforcement of air pollution control regulations. These processes, however, also require strengthening the capacity of courts and judges, as well as the technical capacity of inspectors to provide sound evidence of infractions. Over the medium term, there is a need to increase fines and clarify and expand the range of sanctions for noncompliance, potentially including civil, judicial, or administrative, and criminal enforcement that can result in jail sentences for the legal representative of the polluting entity.

Invest in a Robust Air Quality Monitoring Network, Data Analysis and Management, Emission Inventories

Investing in a reliable air quality monitoring network is indispensable to understanding the risks of air pollution and achieving improved ambient air quality in Kosovo. Efforts to establish a reliable air quality monitoring network should prioritize increased geographic and time series coverage of $PM_{2.5}$. Furthermore, given the heavy dependence on combustion of solid fuels in Kosovo, for power generation and in households, routine monitoring efforts could be expanded to include chemical species of constituents of $PM_{2.5}$ such as elemental carbon, organic carbon, sulfates, and BC, which has the dual property of being a component of $PM_{2.5}$ and a climate warmer. In addition, monitoring should be expanded to precursors of PM, that is, SO_2, NO_x; NH_3; and lead and other toxic substances. The current monitoring program should be strengthened, for example, by incorporating newer technologies that automatically transmit data to a centralized depository and use modern data analysis software. In addition, adequate resources are essential to develop and implement quality control and quality assurance protocols that ensure the validity of data. Responsible agencies should be provided with ongoing training and sufficient budget to operate and maintain the equipment.

Also important, over the medium to long term, is the development of a registry of air pollution sources. Limited resources and capacity constrain inspectors from verifying emissions data submitted by regulated operators, weakening the reliability of reported emissions. As a result, there is little to no information that can help the MESP or local environmental agencies map the locations of different sources of air pollution, assess the types and quantities of pollutants that are being discharged into the environment, identify non-compliant units, and develop the necessary corrective actions. For non-household fixed sources, the focus could initially be on large polluters but evolving gradually to include small and medium enterprises, which may cumulatively emit large quantities of air pollutants.

Strengthen Stakeholder Engagement

Experiences from across the globe show that stakeholder engagement is crucial to reform and bolster environmental actions, particularly when well-articulated constituencies can demand improved governmental responses to a clearly identified priority issue (World Bank 2011). While different agencies within the government (including the MESP and MED) invite stakeholders to participate in the policy formulation process, there is a need to maintain stakeholder engagement and networks over the long term to ensure continued learning and dialogue. In the short term, the government could strengthen the public information program started by KEPA in 2018 to reach a broader audience and establish a multistakeholder air quality advisory board to periodically discuss the development, implementation, and evaluation of actions to improve air quality. In addition, the government should foster the creation of a strong air quality constituency by providing training and disseminating specific materials among policy makers, legislators, NGOs, journalists, and other stakeholders. Public interest advocacy through legal associations, the establishment of environmental law clinics at universities, and provision of training and dissemination of specific materials for targeted audiences should be supported.

Growing evidence from industrialized and non-industrialized countries suggests that public disclosure can spur emissions reductions. Public disclosure mechanisms disseminate information in a manner that is easy to understand and that enables communities to function as informal regulators. Such mechanisms also promote accountability on the part of those being regulated. The GoK should consider adopting a public disclosure scheme requiring industries to report their pollutant emissions and rate themselves on compliance with national standards.

Chapter 5. Learning from International Experience in Tackling Air Pollution

5.1 Introduction

Air pollution by nature cuts across activities of various sectors of the economy and geographic boundaries and respects no age group of persons. Addressing such a cross-cutting problem effectively requires concerted and sustained, multidisciplinary, and cross-sectoral efforts that engage a broad range of stakeholders including the government, civil society, academia, private sector, and international development partners.

The complexity of air pollution calls for a strategic and integrated approach that is based on a comprehensive understanding of the air pollution problem and solutions appropriate to the specific context of the affected city or country. The complexity of air pollution is borne out in the varying levels of progress that cities in developed and developing countries have made in improving air quality and the time frames within which such progress has been achieved. For illustrative purposes, it took about 50 years for cities in the United States to achieve the WHO Air Quality guideline value for PM_{10}—they went from an average value of 60µg/m^3 in the 1960s to around 20µg/m^3 in the 2010s (World Bank 2012). Cities in developing countries are also recording progress in their efforts to reduce AAP and the results show that with government commitment and sustained and focused efforts, it is possible to achieve improved air quality outcomes and in shorter time frames (Table 5.1). These country experiences and results lend support to optimism for similar positive progress in Kosovo.

Table 0.1. $PM_{2.5}$ and PM_{10} reduction in selected cities

City, Country	Highest concentration	Reduction (%)	Time frame
Mexico City, Mexico[13]	PM_{10} = 180µg/m^3	>70	25 years (1990–2015)
Lima – Callao, Peru[14]	PM_{10} = 85µg/m^3	>50	8 years (2006–2014)
Beijing, China[15]	$PM_{2.5}$ >89µg/m^3	> 30	4 years (2013–2017)
Ulaanbaatar, Mongolia[16]	$PM_{2.5}$ =250µg/m^3	> 60	8 years (2009–2015)

This chapter presents cases illustrating how different countries have addressed, with World Bank support, air pollution from various sources using a variety of interventions including policy reforms, investments, knowledge development, and technical assistance and various policy instruments such as command-and-control, economic, and market-based instruments. The chapter draws lessons learned from the experiences of, and approaches used in, these countries, which underscore the need for integrated, strategic, and context-specific approaches to tackle AAP. The examples also demonstrate how the World Bank has played an integrative role in supporting countries in addressing a complex issue such as air

[13] Air Quality Mexico City, Experience 1990–2018. Presentation by Rodolfo Lacy, Government of Mexico. Presentation in Delhi, March 2018

[14] Based on Macizo and Sanchez (forthcoming)

[15] ICCS (Innovation Center for Clean-air Solutions). 2018..

[16] Based on communication between World Bank staff member and Prof. S. Lodoysamba (retired) of the National University of Mongolia and air quality monitoring results provided by the Ministry of Environment and Tourism in Mongolia for 2008 to 2015.

pollution. It is envisaged that the discussion in this chapter could provide a background to inform potential and ongoing efforts of the World Bank and other development partners in supporting Kosovo's actions to reduce air pollution in a manner that ensures that those efforts are strategic, integrated, and complementary.

5.1 Global Experiences in Tackling Air Pollution

Tackling Air Pollution from Domestic Heating in Mongolia

Background. Ulaanbaatar, Mongolia, is among the cities with the worst air quality in the world. PM might be responsible for up to one in five deaths in the city. Air pollution is particularly poor in Ger[17] areas surrounding Ulaanbaatar where about two-thirds of the city's 1.4 million inhabitants live. Annual average ambient concentrations of PM pollution can range from 200 to 350 µg/m^3. Air pollution is particularly severe during the cold winter months, when households burn coal and wood for heating and cooking, releasing polluting emissions at breathing height (2–3 m above ground). During this season, $PM_{2.5}$ concentrations can exceed the WHO guideline for daily average concentrations (25 µg/m^3) by 120 times.

Plans to establish a stove replacement program in the Ger areas were initially met with resistance from city government officials who were not convinced that a stove replacement/removal program, which could be conducted in the short term, should be prioritized and felt that alternative long-term options would be more economically effective. The government, with World Bank support, decided to undertake full-scale AQM planning to obtain a complete understanding of sources, concentration levels, and health impacts and identify the most economically effective abatement options for reducing air pollution in the short, medium, and long term. The World Bank mobilized grant funding, totaling about US$1 million, from several sources to provide technical assistance to the Government of Mongolia, which was underpinned by the Ulaanbaatar Air Monitoring and Health Impact Baseline (AMHIB) study conducted between 2008 and 2011.

The three-year technical assistance entailed (a) redistribution of air quality monitors across Ulaanbaatar to cover the central area, as well as the Ger areas, which were previously not monitored; (b) one full year of air quality monitoring at all locations to allow for capture of seasonal variations; (c) establishment of an inventory of emissions from all major sources in the city, air pollution modeling, and estimation of population exposure to PM pollution; (d) a health impact assessment in Ulaanbaatar to establish a baseline for health impacts as well as local (Ulaanbaatar) dose-response relations between PM concentrations and various health end points; and (e) identification of economically effective interventions.

Process. The development of AMHIB entailed an extensive process of bringing together and engaging various stakeholders who were already working on air quality in Mongolia as well as integrating new stakeholders to fill knowledge and technical gaps in the process. At the time of the study, several development institutions were engaged on different elements of AQM planning (see Figure 0.1) in the country. The comprehensive scope of a study of this type of AMHIB, and the World Bank's role in leading it in collaboration with the government, resulted in a process where the World Bank played a central role not only in technical coordination of the AQM planning process but also in administrative coordination of the engagement of diverse stakeholders including national (various ministries including Health, Energy,

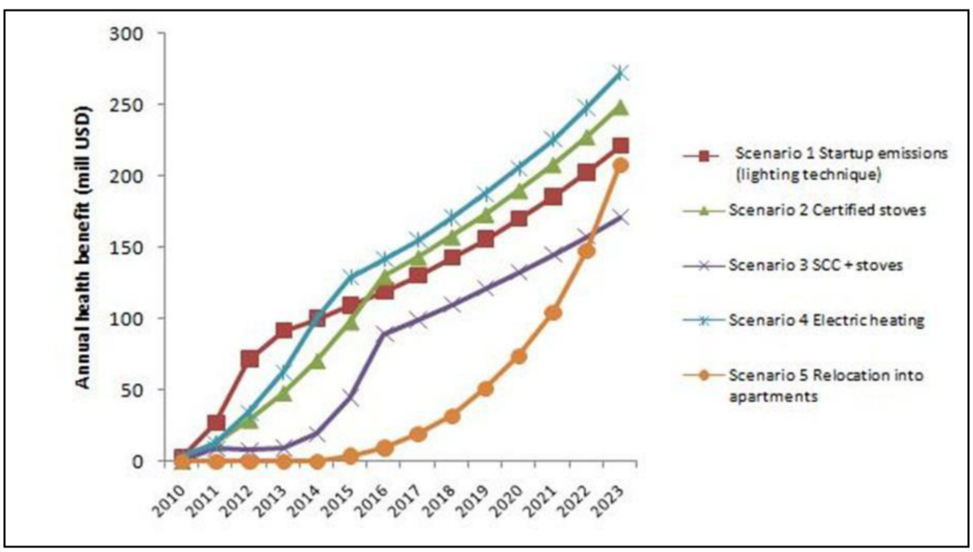
[17] Portable wooden homes traditionally used by Mongolian and other Central Asian nomads.

Transport, Housing, Urban Development; the Ulaanbaatar city departments; and academia) and international (agencies of Japan, Germany, France, and Republic of Korea) institutions and in engaging international expertise (on epidemiology, health research, and economists) in the AQM planning process.

Actions. The AMHIB study established that small stoves in about 150,000 Gers, at the time of the study, were the main source of PM in Ulaanbaatar and examined nine options for reducing air pollution including (a) reducing start-up emissions by backlighting the fire, (b) reducing start-up emissions through stove modifications, (c) replacing the existing stoves with cleaner stoves and no fuel change, (d) replacing existing stoves and fuel with cleaner stoves and semicoked coal, (e) installing electric heating in Ger homes, (f) relocating Ger households to apartment buildings; (g) improving heat-only boilers, (h) cleaning streets to reduce road dust suspension, and (i) greening urban areas to prevent dust suspension.

Of the initial nine options, five were found to provide the highest health benefits (Figure 5.1). The abatement options that provided the highest net benefit—that is, monetary value of reduced health impact minus the cost of the abatement—were also examined. The immediate term option with the stove start-up modification gave the highest net benefit, while improved stoves and fuels and the medium-term option with electric heating in the Gers gave significant benefits. The long-term option of moving Ger households into apartments was very costly, while street cleaning and city greening had only limited health benefits. Realizing the health benefits lost (that is, the cost of not applying immediate abatement options, in favor of longer-term options like relocation of Ger households to apartment buildings), the government decided to go ahead with a program to replace existing stoves with clean, certified stoves.

Figure 0.1. Health benefit projections under various abatement scenarios in Ulaanbaatar

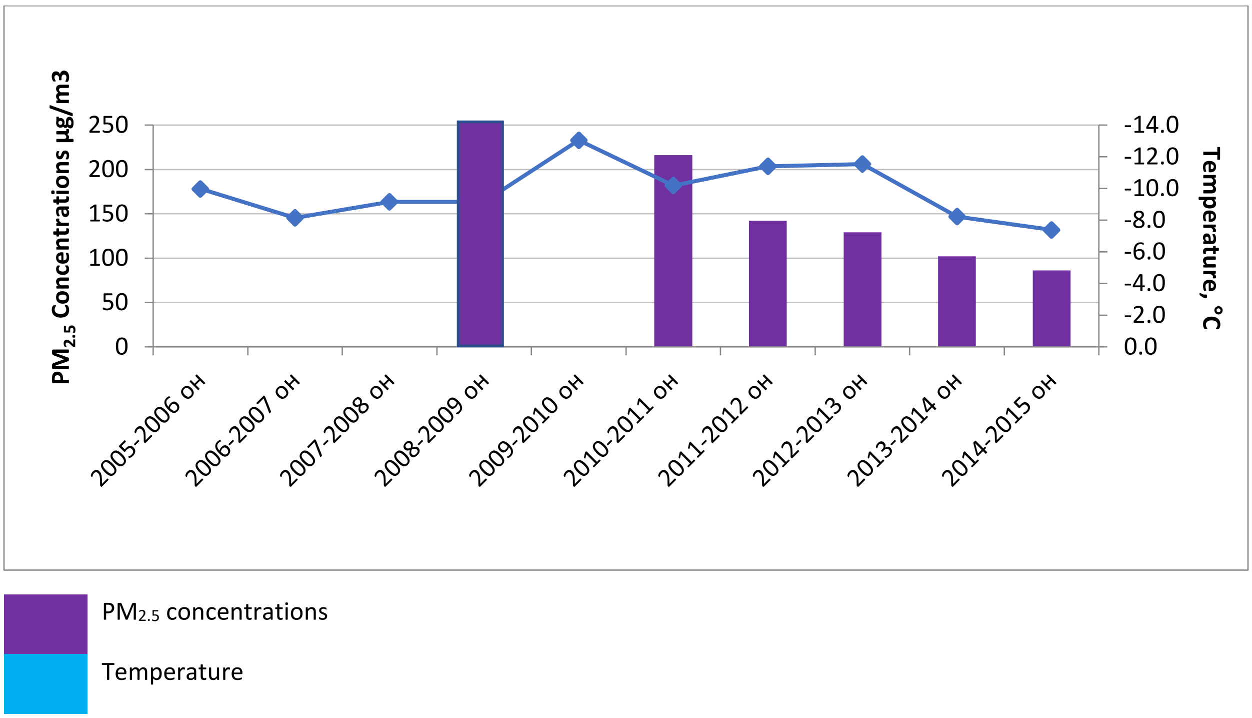


Source: World Bank 2011.

Results. Following completion of the full-scale AQM plan, the Ulaanbaatar Clean Air Project, supported by a loan from the World Bank, implemented the immediate intervention of replacing stoves in Ger households with cleaner, more efficient models. Between 2011 and 2015, the MCC, the World Bank, and the Government of Mongolia distributed more than 168,000 stoves representing 91 percent of the households that used coal-fueled stoves for cooking. Importantly, households received a subsidy that reduced the costs of replacing the stoves. During 2011–2013, the average subsidy was equivalent to 91 percent of the cost and was eventually reduced to 66 percent during 2014–2015. Subsequently, all 180,000 households were covered by the stove replacement program.

The implementation of the different measures to improve air quality—among which replacing stoves with cleaner, more efficient models was the most important immediate intervention—has resulted in clear improvements in air quality in Ulaanbaatar (Figure 5.2). Air pollution remains high, which underscores the need to broaden implementation of additional, multisectoral interventions to reduce pollution emissions in the medium to long term.

Figure 0.2. $PM_{2.5}$ concentrations in Ulaanbaatar 2005–2015



Source: Lodoysamba 2016.[18]

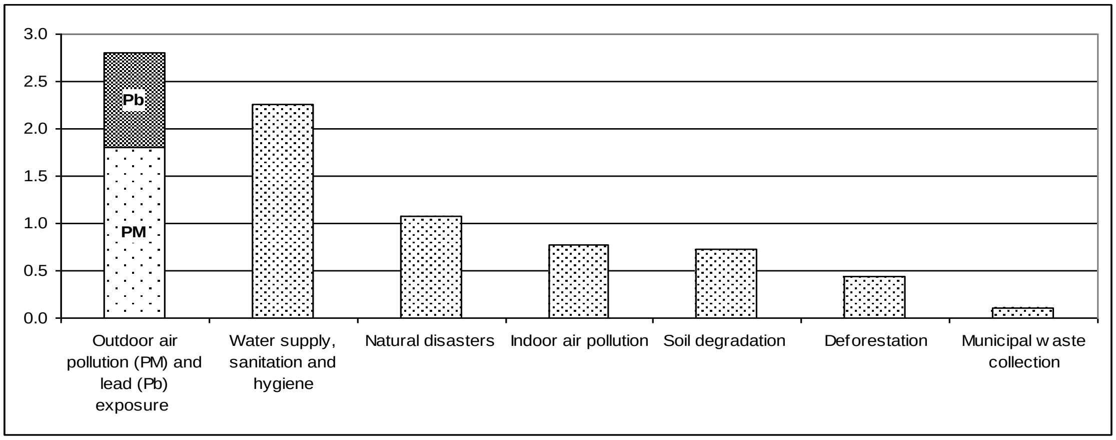
Reducing Air Pollution from Mobile Sources in Peru

Background. By the early 2000s, the Government of Peru had identified environmental degradation as a significant challenge for sustained economic growth. Upstream analytical work, specifically a Country Environmental Analysis (CEA) for Peru, was conducted with the World Bank's support. According to the CEA, the main categories of environmental degradation had an estimated cost of PEN 8.2 billion, an amount equivalent to 3.9 percent of Peru's GDP in 2003. Poor air quality in urban areas—from PM and ambient lead—accounted for the largest share of the health damage, which jointly amounted to about PEN 2.8 billion or 1.3 percent of GDP (Figure 5.3). AAP caused about 3,900 premature deaths annually and about 2,200 children suffered enough IQ loss to cause mild mental retardation associated with lead exposure. Air pollution was particularly severe in urban areas and industrial corridors such as Lima-Callao and Arequipa, the two largest cities in Peru. The CEA showed that poor people disproportionately carried

[18] Based on presentation to the World Bank in December 2016 by Prof. S. Lodoysamba (retired), National University of Mongolia, Ulaanbaatar

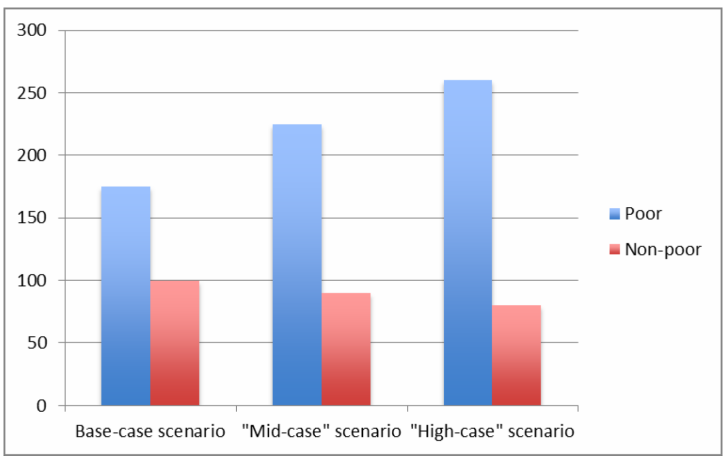
the health burden of air pollution, with impacts on the poor more than three times higher than on non-poor people, relative to income (Figure 5.4).

Figure 0.3. Annual cost of environmental degradation (billion soles)



Source: World Bank 2007.

Figure 0.4. Health impacts of APP on poor and non-poor people in Lima-Callao

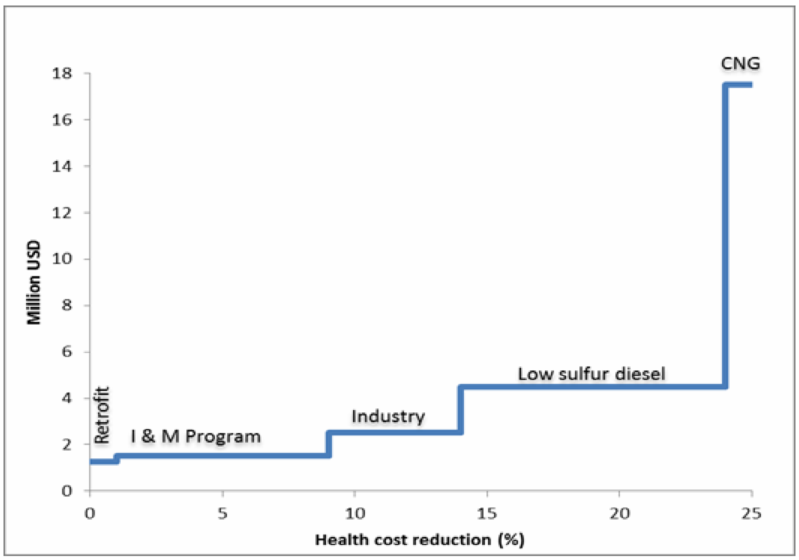


Source: Larsen and Strukova 2005.

Process. The CEA came from a process of dialog between the Government of Peru and the World Bank and sharing with country stakeholders, to build consensus around the analysis, and provided the basis for priority setting and decision making to inform the development of the government's program of policy actions to address air pollution. Within this context, 12 options for reducing AAP were examined: (a) introduction of low-sulfur diesel; (b) promotion of use of gasoline-fueled cars instead of diesel through various tax incentives; (c) conversion of gasoline/diesel cars to natural gas; (d) conversion of some vehicles to ethanol or biofuel; (e) development of a new public transport system in Lima, the capital city; (f) provision of tax incentives to scrap older high-use cars (for example, taxis); (g) strengthening of inspection and maintenance programs; (h) retrofit of catalytic converters on cars and particle control technology on diesel vehicles; (i) bans on importation of used cars for taxi use; (j) ban on use of diesel cars and/or two stroke engines as taxis; (k) implementation of various city planning interventions such as 'green traffic light waves' and bike lanes; and (l) introduction of measures to reduce industrial emissions. Some of the options were not considered in further detail beyond the initial examination due to various reasons. For example, the development of a new public transport system in Lima was not considered due to environmental reasons. Other policies had implications for welfare of transport users and/or affected other sectors, for example, increase in price of cars. Of the initial 12 options, the following 5 were ranked by comparing the health damage costs associated with a ton of emissions of PM, with the cost of a specific abatement option (Figure 5.5).

- Introduction of low-sulfur diesel
- Inspection and maintenance programs
- Retrofit of particle control technology
- Shift from low-sulfur diesel to compressed natural gas (CNG)
- Reduction of industrial emissions

Figure 0.5. Marginal costs and benefits of interventions to reduce PM emissions in Peru



Source: ECON 2005.

Actions. Building on this analytical foundation, the government undertook a comprehensive and programmatic series of policy and institutional actions to address the severe costs of outdoor air pollution supported by a series of three World Bank loans totaling US$475 million over a two-year period. The government's program entailed tailored interventions to reduce emissions from mobile and industrial sources as well as interventions to strengthen the overall institutional framework for air quality and environmental management. Specific actions included strengthening the framework for air quality standards, emission levels, air quality monitoring, and incorporating environmental sustainability principles in urban transport and industry, the main sectors responsible for driving air pollution in Peru.

A first set of actions taken by the government to reduce air pollution included, among others, (a) reducing sulfur content in diesel; (b) implementing a vehicle scrappage program to replace older, polluting vehicles with newer, natural gas vehicles; (c) enacting a law requiring reduction of sulfur content in diesel; (d) issuing a decree establishing requirements for diesel vehicles to access economic incentives; and (e) putting in place standards for the scrapping process. Subsequent actions by the government included the following:

(a) Actions to publish and disseminate air quality monitoring data in the highly polluted cities of Lima and La Oroya, a key center of metal smelting and refining.

(b) Issuance of a decree prohibiting supply of high-sulfur diesel (more than 50 parts per million sulfur content) in the metropolitan areas of Lima and Callao.

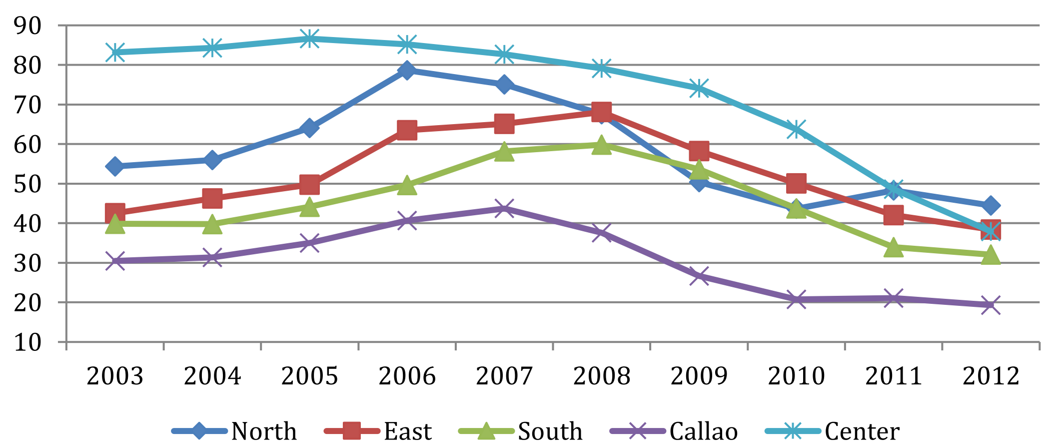
(c) Institutional measures to ensure continued funding of the vehicle conversion programs.

(d) Issuance of regulations to implement a vehicle inspection and maintenance program designed to remove highly polluting vehicles from the streets of Lima-Callao. Vehicles operating on public roads in this region were required to submit to a mandatory technical inspection for certifying the proper functioning and maintenance of motor vehicles and compliance with emission standards. As a result of these measures, approximately 1,000,000 vehicles are inspected yearly in Lima, and some 80,000 vehicles are inspected in the rest of the cities.

(e) Adoption of an investment plan for the modernization of Petróleos del Perú S.A.'s (PETROPERU) refinery that reduces the sulfur content in diesel.

Results. As a result of the comprehensive package of policy reforms and interventions adopted by the Government of Peru between 2009 and 2011, air quality improved markedly in the Lima-Callao region (Figure 5.6). Additional results included (a) inspection of 585,000 vehicles conducted compared to the baseline of 60,000 vehicles; (b) conversion of 83,000 vehicles to CNG; (c) all stations in Lima-Callao supplied with clean low-sulfur diesel by 2010, and 100 percent coverage was achieved in four additional major cities by 2012; and (d) number of service stations supplying natural gas in Lima rising from 0 to over 90.

Figure 0.6. Annual concentration of $PM_{2.5}$ in Lima-Callao, 2003–2012 ($\mu g/m^3$; 3-year average)



Source: Macizo and Sanchez, forthcoming.

Reducing Polluting Emissions through Multisectoral Interventions in China

Background. The Beijing-Tianjin-Hebei region (also known as Jing-Jin-Ji) has some of the most severe air pollution problems in China. Hebei Province is responsible for about 70 percent of emissions in the region.

In 2012, the annual average concentration of ambient $PM_{2.5}$ was 112.9 μg/m^3, compared with 88.3 μg/m^3 in Beijing. Air pollution is caused by the high concentration of polluting industries, vehicles, and a large agricultural sector. Hebei is the largest iron and steel producer in China, accounting for about one-quarter of the national output. The power sector is almost entirely fueled by coal and nearly one-third of total installed capacity (15 GW out of 49 GW) was added since 2010. Hebei is also an important cement producer, having 21 plants with a total production capacity of 58.3 Mt per year, which is nearly 10 times the combined production capacity of Beijing and Tianjin of 6.3 Mt per year. In addition, the province accounts for 17 percent of national flat glass production. The agriculture sector is an important source of secondary PM pollution associated with NH_3 emissions from use of nitrogen-based fertilizers and livestock waste management.

As part of national efforts to improve air quality, the State Council of China issued the National Air Pollution Control Action Plan (the 'Ten Measures') in September 2013. According to the Action Plan, the Jing-Jin-Ji region was required to reduce concentrations of ambient $PM_{2.5}$ by 25 percent by 2017, compared to 2012. To achieve this goal, municipal, provincial, regional, and national governments implemented a comprehensive set of air quality improvement measures between 2013 and 2017 that targeted polluting emissions from coal, industrial sources, and mobile sources, as well as interventions to improve environmental management.

Process. In support of the government's program, the World Bank built on its long-term engagement on environmental, energy efficiency, and renewable energy topics in China, including analytical work and technical assistance, as well as established dialogue with different sectors across the government. To this end, the World Bank provided support to the Government of China to implement multisectoral interventions to address air pollution through two lending projects providing Program-for-Results (PforR) financing: the Hebei Air Pollution Prevention and Control Project (US$500 million) and the Innovative Financing for Air Pollution Control for Jing-Jin-Ji Project (US$500 million) (World Bank 2016a, 2016b).The PfoR financing supports the government 's program and links disbursements to the achievement of results on the ground. Through the process of preparing these projects, the World Bank systematically reviewed the measures contained in the government's programs and plans; mobilized grant funding; and deployed international expertise and best practice across various relevant disciplines to provide technical assistance to the government for the identification, selection, and design of substantive actions that could be used as disbursement-linked indicators (DLIs) for the two projects. In addition, the process involved collaboration with think tanks, academia, and other development partners working on air quality issues in China.

Actions. The Hebei PforR Project aimed to reduce emission of specific air pollutants from industry, rural areas, and vehicles and improve air quality monitoring in Hebei. The Jing-Jin-Ji PforR Project aims to reduce air pollutants and carbon emissions through increasing energy efficiency and clean energy in Jing-Jin-Ji and neighboring regions.

Under the Hebei PforR, among the key actions taken to reduce polluting emissions are the following:

- **Continuous air emissions monitoring in industry and other point sources.** The Province of Hebei is strengthening the system of continuous emissions monitoring (CEM) for air emissions and, to date, has broadening its implementation by Environmental Protection Bureaus (EPBs) at the provincial and prefecture level for enforcing emission standards. To date, 12 EPBs are implementing the CEM. In addition, the government strengthened implementation and expanded the coverage of the CEM system for industrial and other point sources of pollution. Currently, all state- and municipal-controlled enterprises have been integrated into the CEM system.

- **Installation of clean stoves in households.** The government strengthened technical standards for clean and efficient stoves and provided incentives for adoption of clean stoves that use processed biomass or coal briquettes, by rural households. More than 1,200,000 clean stoves have been installed.

- **Adoption of environment-friendly fertilizers.** The actions aimed to support the adoption by farmers of environment-friendly, slow-release fertilizers that increase efficiency of nitrogen use based on soil testing and nutrient needs of crops. Nitrogen utilization efficiency has been increased in over 2 million ha of land planted with wheat.

- **Replacement of diesel buses with clean energy buses.** To reduce vehicular emissions, the government targeted urban public transport to accelerate the elimination of diesel buses, their replacement with battery and plug-in electric vehicles, and their proper disposal in accordance with national regulations. More than 2,400 diesel buses have been decommissioned and replaced with clean energy buses.

- **Establishment of air quality monitoring and warning systems and planning tools**. The government program supported (a) strengthening of the data collection system to have a comprehensive and complete source and composition inventory of the source structure of both primary and secondary PM and (b) the development of a five-year plan for air pollution prevention and control, using modern ambient AQM planning tools to ensure cost-effectiveness and prioritization.

Under the Jing-Jin-Ji PforR, among the key actions taken to reduce polluting emissions are the following:

- **Reduction of coal consumption.** The national government set coal consumption cutting goals, which for Jing-Jin-Ji meant reducing 13 million tons, 10 million tons, and 40 million tons for Beijing, Tianjin, and Hebei, respectively. Measures to achieve these goals included the replacement of coal-fired power generation, upgrading of industrial boilers, switching of thermal power sources, and control of raw coal burning.

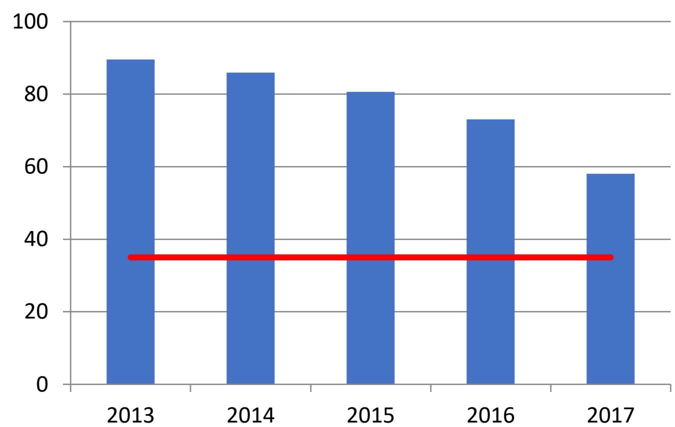
- **Desulfurization, denitrification, and dust elimination.** According to the Action Plan, by the end of 2015, Jing-Jin-Ji and its surrounding areas were expected to build or retrofit 59.7 GW of desulfurization capacity for coal-fired units, add or retrofit 16,000 m^2 of sinter machines for iron and steel manufacturers, add 110 GW of denitrification capacity for coal-fired power plants, and add or retrofit production capacity of 110 million tons of denitrification of cement clinker.

- **Ultra-low emission control.** Beginning in 2015, China started the ultra-low emission conversion of coal-fired power stations, which required that the pollutant emissions of these plants have the same emissions levels as those from combustion gas turbines. Nationwide, a total of 444 GW of coal power-generating units are being converted to ultra-low emission units.

- **Optimize industrial structure and eliminate disqualified enterprises.** The national government has revised regulations and requirements for high-energy consumption, high pollution, and resource-intensive industries. It also set new targets for resource and energy conservation and pollutant emissions. Regions with severe pollution problems, such as Jing-Jin-Ji, can adopt even more stringent requirements. As a result, by the end of 2017, more than 60 million tons of steel production capacity was eliminated from the Jing-Jin-Ji region. In addition, coal-fired non-heat and power cogeneration units of less than 100 MW were completely phased out, while the elimination of units of less than 200 MW started.

Results. As a result of the adoption of comprehensive measures to improve air quality, $PM_{2.5}$ concentration in the Jing-Jin-Ji region declined by an average of 39 percent between 2013 and 2017. Air quality improvements have been especially significant in Beijing, where the annual average concentration of $PM_{2.5}$ fell from 89.5 $\mu g/m^3$ in 2013 to 58 $\mu g/m^3$ in 2017 (Figure 5.7). However, $PM_{2.5}$ concentration in the city still substantively exceeds China's national standard. In addition, the share of renewable energy in Beijing increased from about 3 percent in 2010 to 7.6 percent in 2017. The reductions in coal consumption (72.3 million tons) for the region were also accompanied by significant reductions in CO_2 emissions (105.31 million tons).

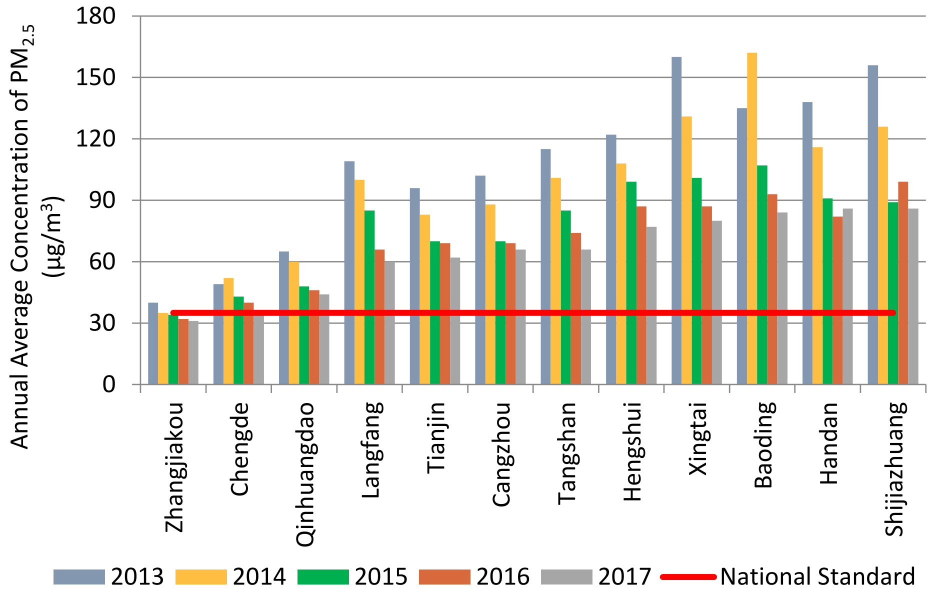
Figure 0.7. Annual average concentration of $PM_{2.5}$ in Beijing from 2013 to 2017



Source: ICCS 2018.

In most cities surrounding Beijing, $PM_{2.5}$ concentrations have been falling constantly, but only two cities (Zhangjiakou and Chengde) met the national standard in 2017. Only in one city (Handan City in Hebei Province) did pollution increase in 2017 compared to the previous year (Figure 5.8). Improving air quality requires sustained commitment to implement comprehensive interventions that result in emissions reductions in the short, medium, and long term, as underscored by the fact that cities continue to exceed China's air quality standards.

Figure 0.8. Annual average concentration of $PM_{2.5}$ for 12 surrounding cities of Beijing in Jing-Jin-Ji Region, 2013–2017



Source: ICCS 2018.

5.2 Conclusions and Lessons Learned

The examples presented in this chapter illustrate the complexity of air pollution and the need for integrated approaches and solutions that are appropriate to the specific city (or urban area) context. A single sector or institution is unable to solely undertake the extensive work that is involved in effectively addressing air pollution. The examples discussed show how the World Bank has been able to play an integrative role through bringing together and fostering dialogue between, and engagement of, various national and international stakeholders including different sectors of the economy, think tanks, academia, other development partners and supporting crucial analytical work to inform investments and policy and institutional actions for AQM.

The following paragraphs provide some additional salient conclusions from the Mongolia, Peru, and China examples and lessons learned from their experiences, which may find application in Kosovo as the government advances in its efforts to tackle air pollution.

The design and implementation of economically effective interventions to successfully reduce air pollution must be underpinned by a solid and rigorous foundation of analytical work to inform the identification and selection of priorities and interventions. As may be seen from the Peru and Mongolia examples, such analytical work also provides a platform around which various relevant stakeholders, including, among others, the government (across different sectors and different levels of government), think tanks, academia, private sector, and donor agencies, can engage and come to informed conclusions about possible interventions and implementation of an appropriate air pollution reduction program.

Interventions for abating air pollution from different sectors are broadly well known. The selection of specific interventions in a given context should, however, be informed based on analysis of the benefits and costs of implementing the respective intervention. Benefit-cost analysis (BCA) compares the health benefits of an intervention, that is, avoided cost of premature mortality and morbidity due to air pollution, to the cost of implementing the intervention. BCA allows decision makers to rank and prioritize alternative interventions and select interventions that have a benefit-cost ratio (BCR) greater than unity (BCR > 1). This exercise should also take into account the existing policy and operational constraints related to performance of existing infrastructure and institutional capacity that could foreclose or limit the implementation of certain air pollution reduction interventions.

Conducting in-depth analytical work is often time intensive and could span several years, as in the case of Mongolia, requiring adequate budgetary resources. It is recognized that in many contexts, the severity of air pollution and its health impacts as well as public pressure on government and city officials to act may call for interventions in the immediate to short term to reduce air pollution. In such cases, a city could consider applying reasonable interventions that would help alleviate air pollution in the short term such as restricting pollution from known stationary sources or traffic restrictions. However, such short-term actions are unlikely to be able to effectively reduce air pollution in the long term, in particular where air pollution sources are many and varied, and should not replace a strategic and integrated approach informed by rigorous analytical work and engagement of various relevant stakeholders across different sectors (for example, environment, energy, transport, economy, agriculture and so on); development partners; academia; and others to inform design and implementation of economically effective interventions for sustained or long-term air pollution reduction.

In addition to technical interventions, for example, implementation of a clean stove program or installation of emission reduction technologies in industrial facilities such as in the China example, efforts to reduce air pollution should incorporate the use of a menu of instruments, including command-and-control, market-based, and economic instruments such as in the example of Peru where a law was enacted to reduce sulfur content of diesel and a regulation was issued to implement a vehicle inspection and maintenance program (command-and-control) and use of economic incentives for replacement of diesel vehicles with cleaner vehicles. Setting air quality targets, as shown in the China example, is also an important aspect of improving air quality, and government commitment to achieving targets is required, including through supporting requisite analytical work for developing realistic and achievable targets.

Air pollution disproportionately affects people of lower economic status compared to non-poor people. It is important that policies to reduce air pollution take into account distributional and social impacts on affected populations in different income groups. Poverty and social impact analysis could be used to understand distributional impacts of policies to reduce air pollution to ensure that poor and vulnerable groups of people do not disproportionately carry the burden associated with implementation of such policies. For example, poorer people are more likely to drive older, polluting vehicles. Poor people are also more likely to burn cheap and highly polluting fuels for domestic purposes. Therefore, policies that prohibit the use of old, polluting vehicle in favor of newer, clean vehicles could incorporate financial or other suitable incentives for poorer people to comply with the policies. Similarly, programs to promote replacement of polluting stoves with clean, efficient stoves should incorporate incentives that will help low-income households' transition to burning cleaner fuels.

Some ongoing efforts by various development partners to support Kosovo's efforts to reduce air pollution were highlighted in the previous chapter. Moving forward, stocktaking of the outcomes of these efforts and identification of opportunities, where investments and policy and institutional actions can augment impacts on air quality supported by appropriate financing mechanisms, could be useful in informing the government's next steps. Stocktaking and identification of opportunities and financing mechanisms should be coordinated among donors and conducted in collaboration with the government. Government commitment to undergird and build upon the outcomes of ongoing donor support by ensuring sustained and adequate human and budgetary support will be crucial for sustained impact in reducing air pollution.

Chapter 6. Recommendations for Air Quality Management in Kosovo

The recommendations of this report are summarized in the Table 6.1.

Table 0.1. Summary of recommendations for AQM in Kosovo

Recommendation	Time frame
Legal and Policy Framework	
Revise the LAPP provisions to simplify the approval of key planning documents, including AQS and AQAP.	Short term
Implement key legislation: (a) AI No. 02/2011 on Air Quality Assessment; (b) outstanding legislation relating AQAP.	Short term
Strengthen the legal framework, focusing on specific instruments that reduce pollution from household heating, mobile sources, and large stationary sources.	Short to medium term
Strengthen the legal framework by adopting and implementing a menu of air pollution management instruments, including economic- and market-based instruments.	Medium term
Introduce standard for daily average ambient $PM_{2.5}$ concentration.	Short to medium term
Introduce standards for solid fuel quality for use in households.	Short term
Air Quality, Emissions, and Health Data and Analysis	
Strengthen the air quality monitoring network to provide robust geographical coverage and time series data on pollutants, notably $PM_{2.5}$.	Short term
Expand air quality monitoring to include chemical constituents and species of PM such as elemental carbon, organic carbon, and sulfates associated with combustion processes; PM precursors including SO_2, NO_x, NH_3, and NMVOCs; BC; and lead and other heavy metals.	Short to medium term
Develop comprehensive and accurate emissions inventory that prioritizes residential sector. (a) *Residential* - improve activity and fuel use statistics and (b) *Transport* - address uncertainties related to vehicle age, fuel use, imported used vehicles.	Short to medium term
Strengthen capacity to conduct air quality modeling and speciation efforts.	Medium to long term
Strengthen health statistics reporting by harmonizing with international bodies such as the WHO.	Short to medium term
Improve collection and reporting of morbidity data for specific diseases and age groups.	
Strengthen capacity to conduct health risk assessment.	
Reducing Pollution from Different Sectors/Sources	
Residential - (a) pilot substitute traditional stoves with more efficient ones and build on lessons learned and experience to date to develop a large-scale program; (b) put in place targeted financial incentives to help poor households adopt clean, efficient stoves; and (c) implement public awareness campaigns to promote stove replacements.	Short term
Expand district heating.	Medium to long term
Stationary sources - (a) strengthen enforcement to ensure that large polluters develop and adopt plans to gradually reduce their emissions and comply with environmental standards, (b) financial incentives for small industrial facilities to undertake air pollution control measures, and (c) use of sanctions that are clear and commensurate with the damage caused for polluters that exceed their approved emission levels.	Short to medium term
Mobile sources - (a) implement a vehicle scrappage program to replace older, polluting vehicles with newer, natural gas vehicles; (b) promote conversion of vehicles to natural gas through technological and financial measures; (c) strengthen	Medium to long term

Recommendation	Time frame
effectiveness of vehicle inspection and maintenance programs; (d) ensure stricter enforcement of measures to reduce importation of older, polluting vehicles, including the requirement for inspections at the point of entry; (e) strengthen inspection of imported fuels; and (f) ensure possibly more stringent standards for sulfur content of diesel.	
Transboundary sources - establish, together with neighboring countries, a technical knowledge platform on transboundary pollution.	Short to medium term
Organizational Framework	
Adequately staff organizations with responsibilities for AQM.	Short term
Strengthen horizontal and vertical coordination by establishing permanent mechanisms for AQM policy development, implementation, monitoring. and evaluation.	Medium to long term
Develop an institutional structure to ensure ongoing evaluations of AQM policies and interventions.	Medium term
Public Participation	
Scale up the public information program started by KEPA in 2018 and strengthen it to reach a broader audience.	Short term
Establish a multistakeholder air quality advisory board to periodically discuss the development, implementation, and evaluation of actions to improve air quality.	Short term
Support public interest advocacy through legal associations, establish environmental law clinics at universities, and provide training and disseminate specific materials for targeted audiences.	Medium term
Enforcement	
Expand the number of inspectors and provide them with training and resources to conduct field investigations.	Short term
Strengthen enforcement by clarifying sanctions for noncompliance, increasing fines, and expanding the range of sanctions.	Medium term

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Annex A. Overview of Major Air Pollutants

Table A.1. Major air pollutants

Pollutant	Full name	Description
PM	Particulate matter	Airborne PM includes a wide range of particle sizes and different chemical constituents. When inhaled, PM can cause inflammation and worsen heart and lung diseases, which can lead to premature death. Fine and ultrafine PM are particularly harmful, as they tend to penetrate deepest into the lungs due to their smaller size. $PM_{2.5}$, a known carcinogen, is most documented for its adverse health impacts. Primary particles are emitted directly from a source, such as combustion of fossil fuels, especially coal and diesel, in vehicles and industry, domestic heating and cooking, construction, and burning of waste crop residues. Secondary particles, on the other hand, are formed in complicated atmospheric reactions among gases that are emitted from power plants, industries, agricultural practices, and automobiles. Key precursors of secondary PM are SO_2, NO_x, and NH_3.
SO_2	Sulfur dioxide	SO_2 is a colorless gas with a sharp odor, produced by combustion of fossil fuels and the industrial refining of ores that contain sulfur. Its oxidized form, also known as sulfate, is a particulate. SO_2 can affect the respiratory system and irritate the eyes.
NO_x	Nitrogen oxides	Major emission sources of NO_x include automobiles and combustion in power plant boilers and industrial activities. NO_2 is a gas which, at higher concentrations, can irritate the airways of the lungs, increasing the symptoms of those suffering from lung diseases. It also contributes to the formation of ground-level O_3 and fine particle pollution. It is chemically related to nitric oxide (NO) and together NO_2 and NO are known as NO_x.
O_3	Ozone	O_3 is a gas which can adversely affect the respiratory system even at relatively low levels. O_3 is the most complex of the legislated pollutants, and therefore the hardest to reduce, as it is not emitted directly from any source. Instead it is formed in the atmosphere by photochemical reactions in the presence of sunlight and precursor pollutants, such as NO_X and VOCs. It is also destroyed by reactions with NO_2. Tropospheric (ground level) O_3 is a contributor to global climate change.
Toxic air pollutants	Toxic air pollutants	The air toxics are a cluster of pollutants that are implicated in higher cancer rates and higher rates of immune or neurological damage, genetic defects, and/or heart and respiratory issues. Members of this group include benzene, PAHs; polychlorinated biphenyls; and VOCs, dioxins, and furans, which are products of incomplete combustion of carbon-based fuels. Air toxics can come from mobile sources, stationary sources, or some indoor sources, such as certain solvents or building materials. Their damage is directly correlated to overall levels in the body. They can accumulate in the body's fatty tissues and can be passed to infants through breast feeding. One member of this group is the carcinogenic benzo[a]pyrene (B[a]P), which is a polycyclic aromatic hydrocarbon. Major sources of PAHs in ambient air include residential and commercial heating with wood, coal, or other biomasses; motor vehicle exhaust (especially from diesel engines); industrial emissions; and forest fires.
Heavy metals	Heavy metals	Human populations can suffer morbidity and mortality from certain heavy metals that are sometimes found in the air. Lead is the most important heavy metal for health globally, given its widespread distribution at concentrations that may damage health. Prolonged exposure to lead is linked to neurological and developmental damage in children. In addition to lead, this group includes arsenic, cadmium, manganese, mercury, and nickel. Arsenic, a carcinogen, is emitted from both natural and anthropogenic sources. Anthropogenic sources are primarily associated with the mining and smelting of base metals, fuel combustion (of waste and low-grade coal), and the use of arsenic-based pesticides.

Annex B. Calculation of the Health Burden Attributed to Ambient Air Pollution

Risk of Mortality Attributed to $PM_{2.5}$

The strongest causal associations are seen between $PM_{2.5}$ pollution and cardiovascular and pulmonary disease. Particles of smaller size reach the lower respiratory tract and thus have greater potential for causing the lungs and heart diseases. As the Lancet review (Landrigan et al. 2017) reports, $PM_{2.5}$ air pollution is associated with several risk factors for cardiovascular disease, including hypertension, increased serum lipid concentrations, accelerated progression of atherosclerosis, increased prevalence of cardiac arrhythmias, increased numbers of visits to emergency departments for cardiac conditions, increased risk of acute myocardial infarction, and increased mortality from cardiovascular disease and stroke.

Hence, epidemiological studies (Landrigan et al. 2017) established that long-term exposure to current ambient PM concentrations lead to a marked reduction in life expectancy. The increase of cardiopulmonary (IHD, stroke, COPD), lung cancer mortality in population over 30 years of age, and LRI mortality in all population are the main reasons for the reduction in life expectancy.

As the WHO project 'Health risks of air pollution in Europe' advised for the use in Europe and based on the established methodology in the World Bank (Heroux et al. 2015; World Bank and IHME 2016), this report estimates risk of long-term mortality associated with air pollution as PAFs of the following diseases (disease codes from GBD 2016 are provided in square brackets):

1. IHD (population above 30 years of age) - [B.2.2]
2. Stroke (population above 30 years of age) - [B.2.3]
3. Lung cancer (population above 30 years of age) - [B.1.11]
4. COPD (population above 30 years of age) - [B.3.1]
5. LRI (all ages) - [A2.2]

This approach allows estimating age-specific mortality attributed to AAP for the most affected population groups. Risks associated with exposure to $PM_{2.5}$ are estimated using methods described in Burnett et al. (2014) that assume supralinear and age-specific (for IHD and stroke) function of relative risk attributed to air pollution. Relative risk estimates for all five diseases in question are consistent with the GBD 2016 study (GBD 2016 Disease and Injury Incidence and Prevalence Collaborators 2017).

PAF translates the annual mortality for LRI, COPD, lung cancer, stroke, and IHD into the health burden attributed to $PM_{2.5}$ exposure. Using the established relative risk functions, the PAF by disease (LRI, COPD, lung cancer, stroke, and IHD) from $PM_{2.5}$ exposure is calculated using the following formula, for each age group l and for each disease outcome k:

$$PAF_{kl} = \frac{\sum_{i=1}^{n} P_i(RR-1)}{\sum_{i=1}^{n} P_i\,(RR-1)+1},$$

where, i is the level of $PM_{2.5}$ in µg/m^3, P_i is the percentage of the population exposed to that level of air pollution, and RR is the relative risk of mortality due to $PM_{2.5}$ exposure.

Then the disease burden (B) in terms of annual cases of disease outcomes due to $PM_{2.5}$ exposure is estimated by

$$B = \sum_{k=1}^{t}\sum_{l=1}^{s} D_{kl} PAF_{kl},$$

where D_{kl} is the total annual number of cases of disease, k, in age group, l, and PAF_{kl} is the attributable fraction of these cases of disease, k, in age group, l, due to $PM_{2.5}$ exposure. Additional information on the applicable functions can be found in the following sources: GBD 2016 Disease and Injury Incidence and Prevalence Collaborators (2017); Ostro et al. (2018); and World Bank-IHME (2016).

Annex C. Valuation of Mortality and Morbidity Attributed to Ambient Air Pollution

Welfare Approach for Valuation of Mortality Cases

The VSL is estimated for Kosovo to monetize risk of a mortality cases associated with air pollution. The range in cost is due to the range of baseline VSL in Organisation for Economic Co-operation and Development (OECD), as first suggested in the OECD study (Lindhjem et al. 2011) and updated in (Narain and Sall 2016), and different elasticity of willingness to pay to avoid health risk. The baseline VSL is selected as the mean for high and median for low of VSL estimated in the OECD studies (Narain and Sall 2016)

For transfers between countries, VSL should be adjusted with the difference in GDP per capita in purchase power parity (PPP) coefficient to the power of an income elasticity of VSL of 1-1.4 (Narain and Sall 2016), for low- and middle-income countries. Application of PPP for VSL estimation requires adjustment of the estimated VSL back to market prices.

VSL estimates can be transferred from OECD countries to Kosovo using benefits transfer method, which posits that

$$VSL_{K\ in\ PPP} = VSL_{OECD\ in\ PPP}\left(\frac{Y_{K\ in\ PPP}}{Y_{OECD\ in\ PPP}}\right)^{\varepsilon},$$

$$VSL_K = \frac{VSL_{K\ in\ PPP}}{PPP},$$

where

$VSL_{K\ in\ PPP}$	=	VSL in Kosovo in PPP terms (2016)
$VSL_{OECD\ in\ PPP}$	=	VSL in OECD countries in PPP terms (2011)
$Y_{K\ in\ PPP}$	=	Per capita GDP in Kosovo in PPP terms (2016)
$Y_{OECD\ in\ PPP}$	=	Per capita GDP in OECD in PPP terms (2011)
PPP	=	Purchasing power parity for Kosovo (2016)
ε	=	Income elasticity of VSL

Table C1 presents the derivation of a range of VSL for Kosovo from low-end (US$0.22 million) and high-end (US$0.41 million) VSL estimates in OECD countries (Narain and Sall 2016), using the abovementioned formula. This range of adjusted VSL is used in welfare-based Cost of Environmental Degradation (CoED) estimates in this report.

Table 0.1. Benefit transfer of VSL for Kosovo

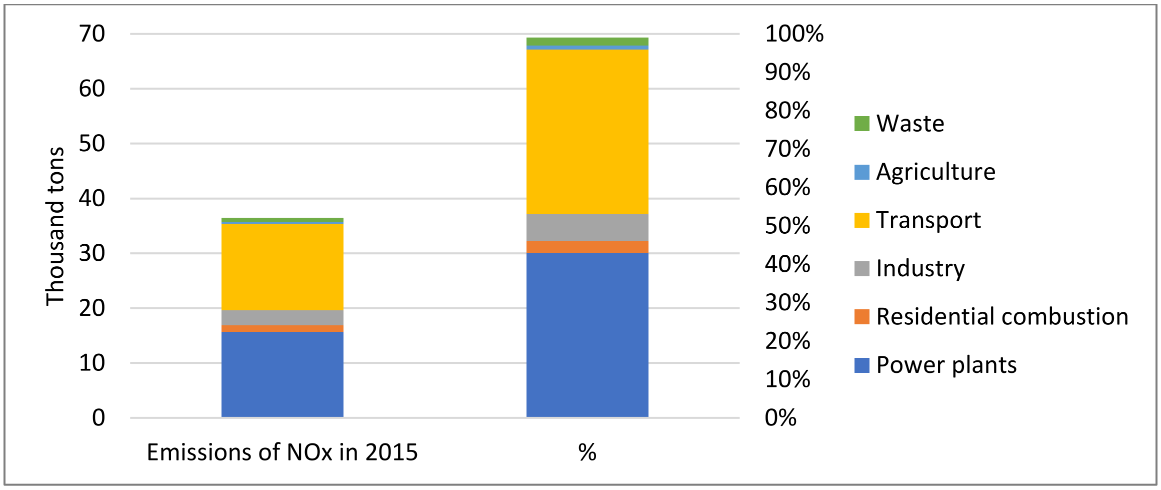
	Low	High
Average VSL estimates from OECD (US$, millions)	3.6	4.1
Country's GDP (US$, billions) in 2016	6.7	6.7
Country's GDP PPP (US$, billions) in 2016	18.3	18.3
Population (millions) in 2016	1.8	1.8

	Low	High
GDP per capita (PPP US$) in 2016	10,245	10,245
Average GDP/capita differential	0.28	0.28
Income elasticity of VSL	1.4	1.0
PPP	2.75	2.75
VSL transferred to Kosovo (US$, millions)	0.22	0.41

Source: Estimated by authors.

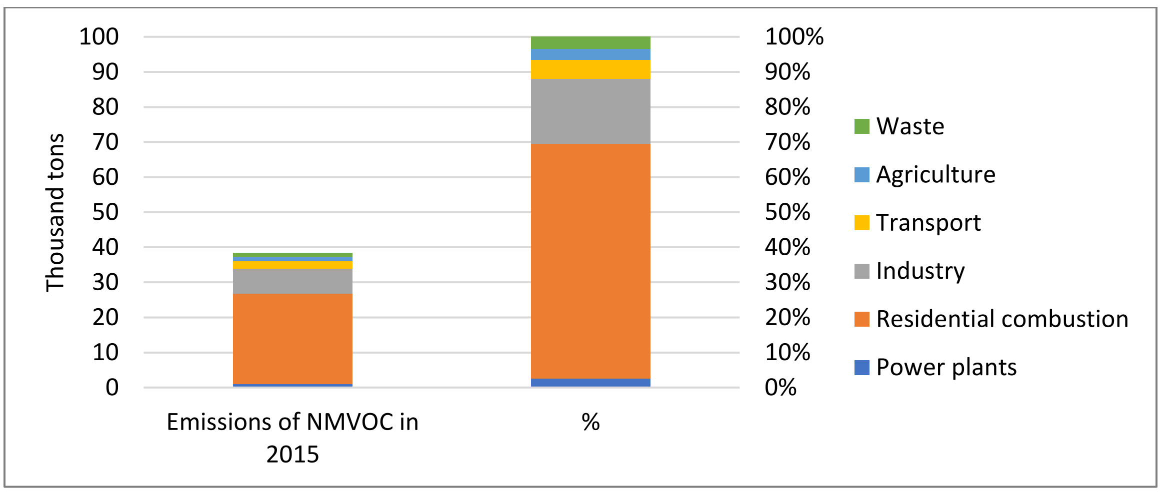
Annex D. Additional Estimates from GAINS Model for Kosovo

Figure 0.1. Emissions of NO_x in 2015



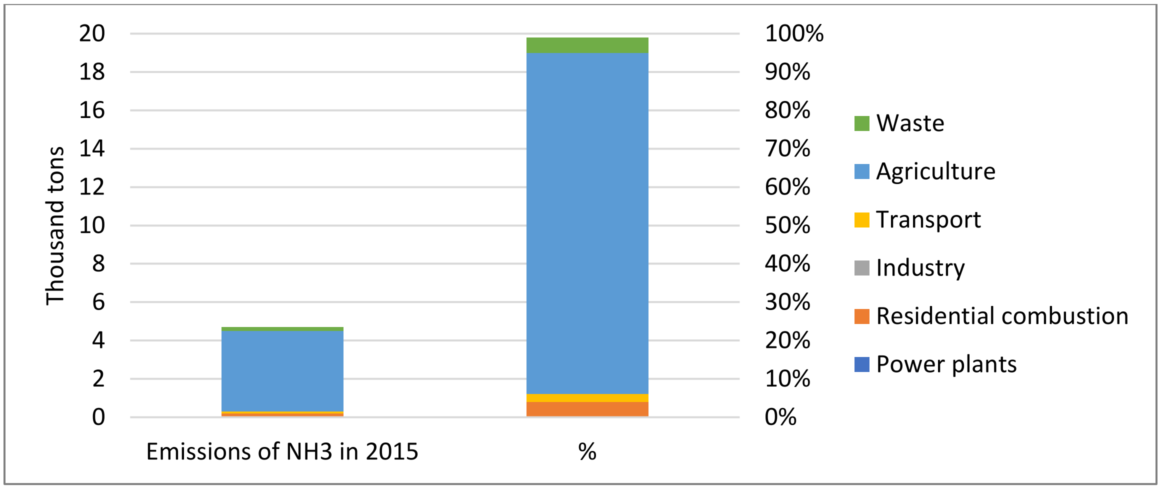
Source: GAINS Model 2015.

Figure 0.2. Emissions of NMVOC in 2015



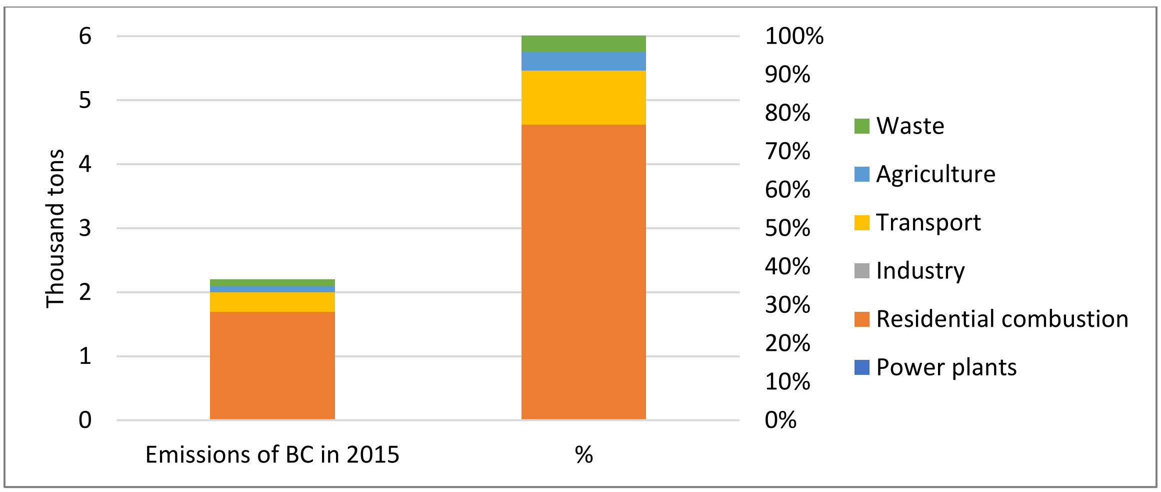
Source: GAINS Model 2015.

Figure 0.3. Emissions of NH_3 in 2015



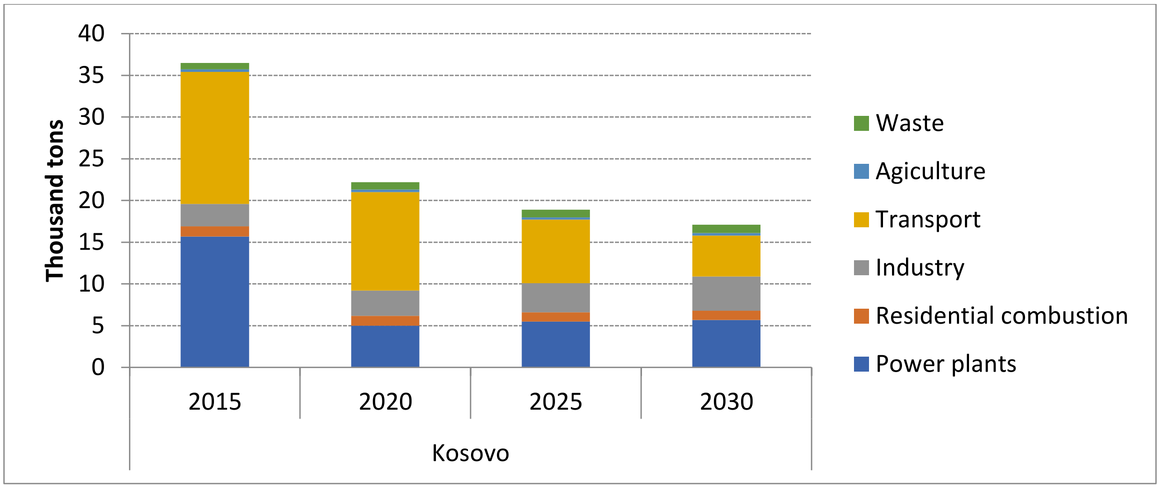
Source: GAINS Model 2015.

Figure 0.4. Emissions of BC in 2015



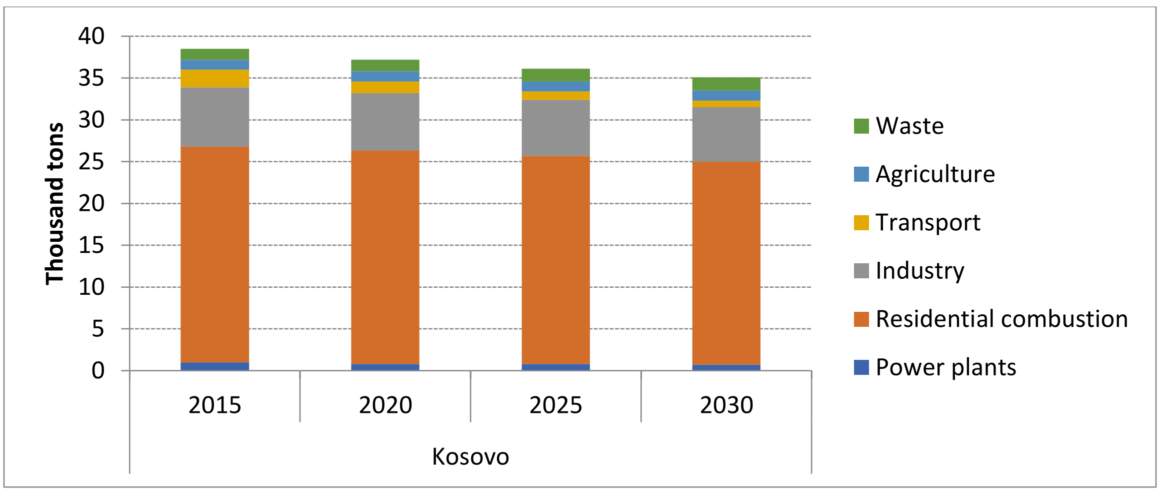
Source: GAINS Model 2015.

Figure 0.5. Emissions of NO_x in the baseline scenario



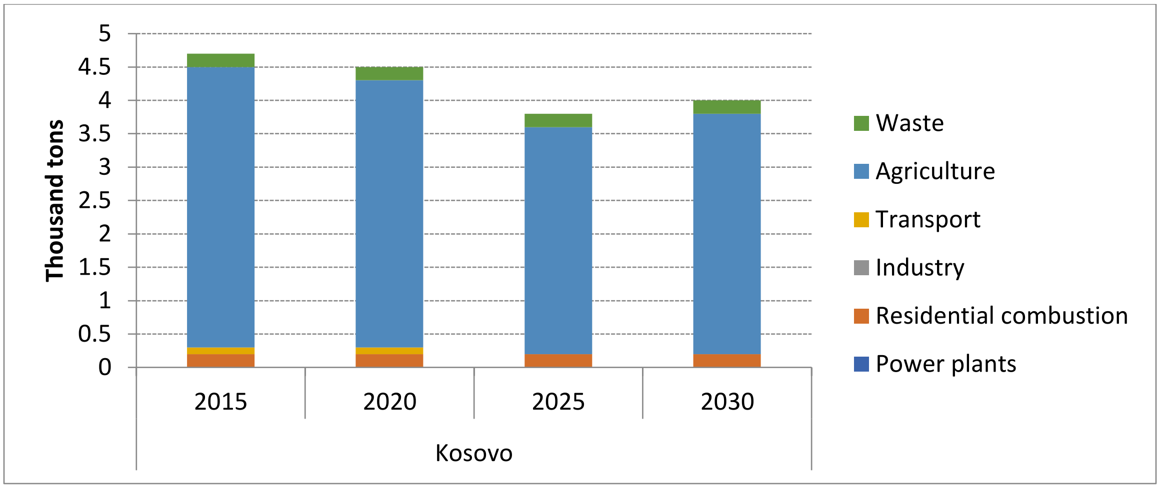
Source: GAINS Model 2015.

Figure 0.6. Emissions of NMVOC in the baseline scenario



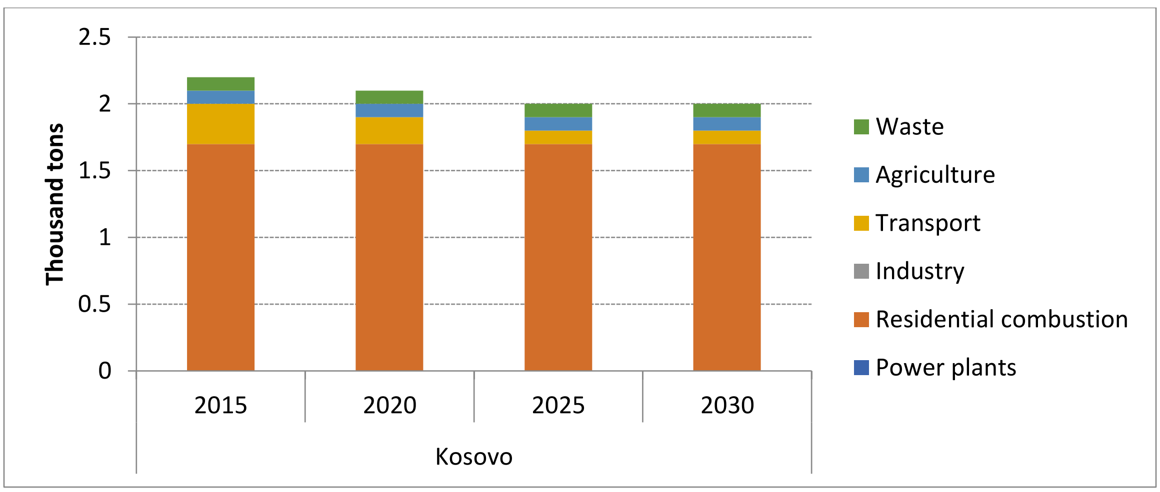
Source: GAINS Model 2015.

Figure 0.7. Emissions of NH_3 in the baseline scenario



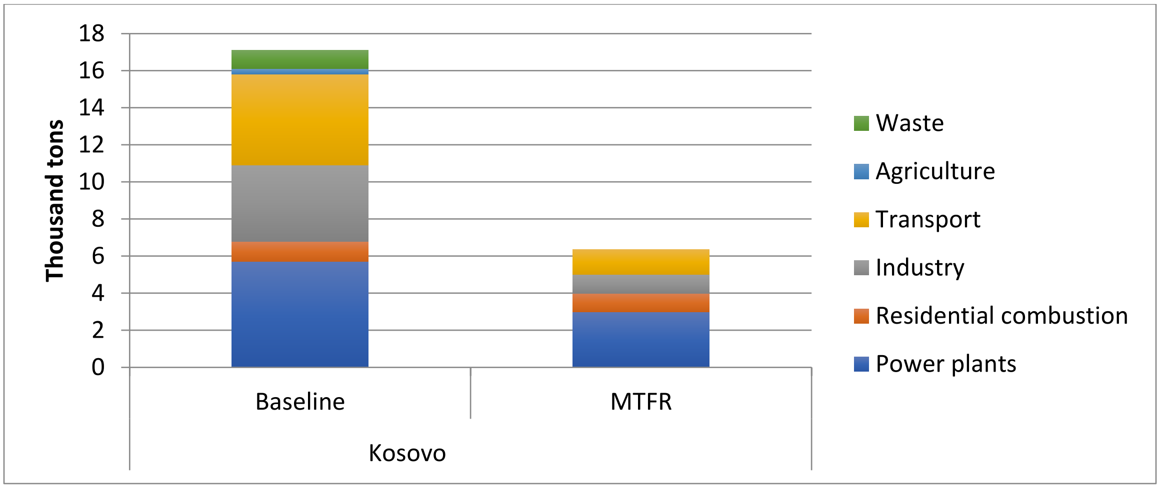
Source: GAINS Model 2015.

Figure 0.8. Emissions of BC in the baseline scenario



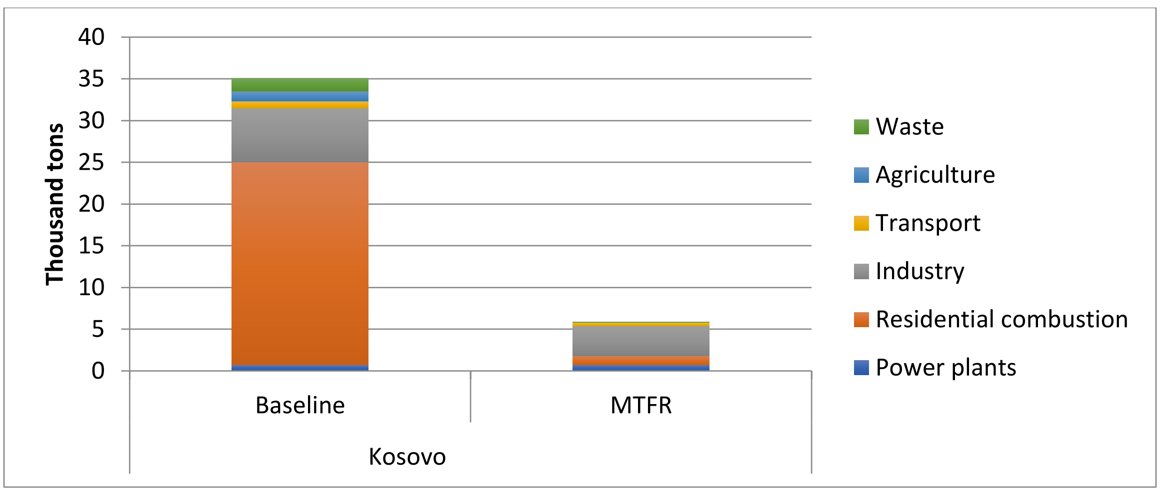
Source: GAINS Model 2015.

Figure 0.9. Emissions of NO_x in 2030 for the baseline and the MTFR scenarios



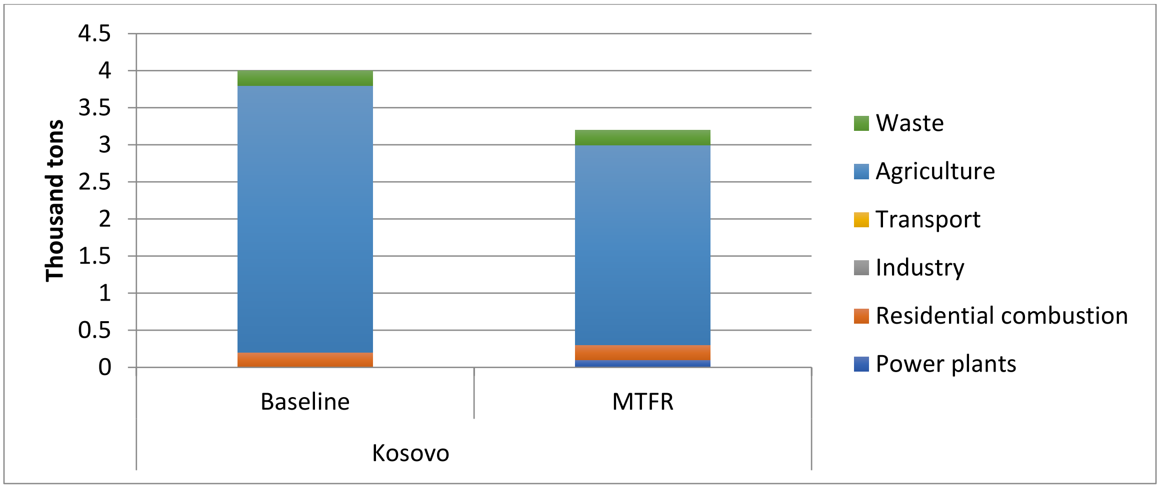
Source: GAINS Model 2015.

Figure 0.10. Emissions of NMVOC in 2030 for the baseline and the MTFR scenarios



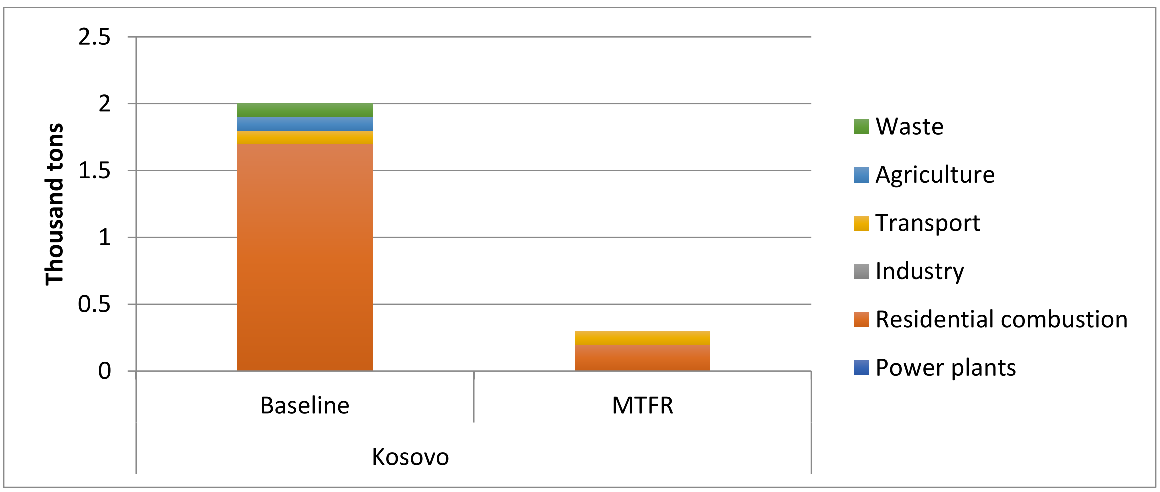
Source: GAINS Model 2015.

Figure 0.11. Emissions of NH_3 in 2030 for the baseline and the MTFR scenarios



Source: GAINS Model 2015.

Figure 0.12. Emissions of BC in 2030 for the baseline and the MTFR scenarios



Source: GAINS Model 2015.