IMPLEMENTATION PLAN

Municipal Actions for Air Quality in the Kathmandu Valley

April 2022

Contents

Acronyms

BHC	Building Healthy Cities
CBO	community-based organization
CO	carbon monoxide
DoE	Department of Environment
DoTM	Department of Transport Management
GoN	Government of Nepal
IEC	information, education, and communication
INGO	international non-governmental organization
KVAQMAP	Kathmandu Valley Air Quality Management Action Plan
MoFE	Ministry of Forest and Environment
NGO	non-governmental organization
NO_2	nitrogen dioxide
NRs	Nepali rupees
O_3	ozone
PM	particulate matter
PPP	public-private partnership
NR	Nepali rupee
SO2	sulfur dioxide
USD	United States dollar

Executive Summary

Kathmandu is a multicultural metropolitan city and the political, cultural, and financial center of Nepal. The Kathmandu Valley has experienced rapid urbanization and population growth, an increase in vehicular traffic, and widespread urban infrastructure development including homes, schools, hospitals, and industries. This construction requires brick kilns, boilers, and other sources of pollution. In addition, road construction, unfinished roads, unpaved sidewalks, and the haphazard disposal of construction materials have all contributed to poor air quality. The Kathmandu Valley Air Quality Management Action Plan (KVAQMAP) – 2020 is a five-year plan proposed by the Department of Environment (DoE) within the Ministry of Forest and Environment and approved by the Cabinet of the Government of Nepal. It aims to mitigate air pollution by addressing causes, strengthening institutional capacity, and increasing awareness about and citizen participation in addressing this problem. The KVAQMAP involves different levels, sectors, ministries, and departments of the government and aims to include private sector and citizen groups in its implementation.

The USAID-funded Building Healthy Cities project (BHC) has worked with the DoE and 18 municipalities to roll out the KVAQMAP. The plan has identified strategic areas for local municipalities to implement together with other government, private, and non-government sectors.

To support the KVAQMAP, BHC developed this Implementation Plan for municipalities using a systems thinking approach to identify what systemic issues related to air pollution can be addressed at the municipality level. This approach includes defining the municipal context, identifying best opportunities for municipal intervention, and what inter-relating actions can be implemented at the municipal level.

Introduction

The Kathmandu Valley is the political, cultural, and financial center of Nepal. It is divided into 18 urban municipalities, including two metropolitan cities. The valley has experienced rapid urbanization and population growth as well as an increase in vehicular traffic (Pradhan 2004; Haack 2009). In addition, widespread urban infrastructure development including homes, schools, hospitals, and industries requires brick kilns, boilers, and other supporting industries, many of which are major sources of pollution (CEN 2014; R. M. Shrestha and Raut, n.d.). Finally, road building, unfinished roads, unpaved sidewalks, and the haphazard disposal of construction materials are also important contributors to poor air quality (CEN 2014). The bowl-shaped valley prevents air pollutants from dispersing, while temperature inversions during the winter months increase air pollution (Aryal et al. 2009).

The Department of Environment (DoE) within the Ministry of Forest and Environment (MoFE) has established the National Ambient Air Quality Standard that includes nine particulate, gaseous, and heavy metals to be measured and monitored (see Table 1).

Table 1. National Ambient Air Quality Standard

Pollutant	Period measured to assess allowable level	Maximum allowable level
Benzene Benzene is a chemical that is liquid at room temperature and evaporates quickly into the air. Exposure to benzene can decrease the number of red blood cells, leading to anemia and decreased immune response. Benzene can also cause cancer (Centers for Disease Control and Prevention 2019).	Annual	5 µg/m3
Carbon monoxide Carbon monoxide (CO) is an odorless, colorless gas produced when fossil fuels are burned. It can cause sudden illness and death.	8 hours	10,000 µg/m3
Lead Lead is a naturally occurring element that is toxic to humans. When lead is in the air, people can breathe it in; people can also ingest lead after it settles onto soil, dust, or in the water. Lead can have serious negative effects throughout the body, including the nervous, immune, reproductive, and cardiovascular systems (Environmental Protection Agency 2016).	Annual	0.5 µg/m3

Nitrogen dioxide (NO$_2$) Nitrogen dioxide is a byproduct of burning fossil fuels and most NO$_2$ in cities comes from vehicle exhaust. Excessive exposure to NO$_2$ can inflame the linings of the lungs and reduce immunity to lung infections.	Annual	40 µg/m3
	24 hours	80 µg/m3
Ozone (O$_3$) Ozone is found at both the upper and lower parts of the atmosphere. Occurring naturally at upper levels, it hinders people's ability to breathe. Tropospheric ozone is the main component in smog, which is common in many major cities around the globe.	8 hours	157 µg/m3
Particulate matter$_{2.5}$ (PM$_{2.5}$) This is particulate matter with a diameter of 2.5 micrometers or fewer, including combustion particles, organic compounds, metals, and other inhalable pollutants. Particulate matter of this size has been linked to decreased lung function, aggravated asthma, irregular heartbeat, and premature death in people with respiratory problems.	24 hours	40 µg/m3
Particulate matter$_{10}$ (PM$_{10}$) This is particulate matter with a diameter of 10 micrometers or fewer, including dust, pollen, mold, and other inhalable pollutants.	24 hours	120 µg/m3
Sulphur dioxide (SO$_2$) Sulfur dioxide is a pollutant emitted during fossil fuel combustion at power plants and industrial facilities. People with respiratory issues are particularly susceptible to large concentrations of SO$_2$ in the air.	Annual	50 µg/m3
	24 hours	70 µg/m3
Total suspended particulate Particulate matter comprises liquid droplets and solid particles which can include dust, dirt, soot, smoke, and other inhalable substances harmful to human health.	24 hours	230 µg/m3

Source unless otherwise indicated: Ministry of Forest and Environment 2018

Realizing the need for urgent action to address air pollution, the Government of Nepal (GoN) developed a policy called the Kathmandu Valley Air Quality Management Action Plan (KVAQMAP) – 2020. The KVAQMAP has several objectives and the USAID-funded Building Healthy Cities (BHC) project was asked to identify key elements of the KVAQMAP that could be implemented at the municipality level and then develop guidance for municipalities on how to roll out those activities. This report outlines the findings from that effort.

Air Pollution in the Kathmandu Valley

Worldwide, air pollution was the 4th leading risk factor for early death in 2019 (Health Effects Institute 2020). It both leads to and exacerbates several non-communicable diseases including ischemic heart disease, chronic obstructive pulmonary disease, stroke, lower respiratory infections, and asthma, among others (Quest Forum 2017; Saud and Paudel 2018). Air pollution is a major challenge for Nepal. There are an estimated 42,100 deaths per year due to air pollution and in 2019, Nepal ranked 2nd in South Asia in particulate matter $PM_{2.5}$ exposure (Health Effects Institute 2020) with nearly 75 percent of the population exposed to unsafe levels of these particulates (Hsu et al. 2016).

Certain population groups are at higher risk for health impacts from air pollution. A study among traffic police, who only receive masks and often do not use them, showed long-term impacts on pulmonary, cardiovascular, and ocular health due to air pollution (A. Shrestha and Manandhar 2019). Children are also disproportionately impacted by air pollution. Table 2 below details health complications that are impacted by poor air quality.

Table 2. Air Quality-Related Health Statistics, Kathmandu Valley

Health concern	Percentage or incidence	Year
Acute respiratory infection, children under 5	1.7%[1]	2019
Congenital heart disease in school children	1.3 per 1,000[2]	2016
Babies born with low birth weight	12-32%[3]	2011
Preterm births	93 per 1,000 live births[4]	2018
Neonatal mortality (deaths <28 days)	16.9 per 1,000 live births[5]	2020
Pre-eclampsia / eclampsia	2.2%[6]	2014
Stillbirths	18 per 1,000 pregnancies[7]	2015

Sources: 1. "Nepal - Prevalence Of Acute Respiratory Infection (ARI) (% Of Children Under 5): Q4 - 2022 Data 2023 Forecast 2001-2019 Historical" n.d.; 2. Chapagain et al. 2017; 3. Sharma et al. 2015; 4. Gurung et al. 2020; 5. "Nepal Neonatal Mortality Rate, 1960-2021 - Knoema.Com" n.d.; 6. Bilano et al. 2014; 7. UNICEF 2017.

Air pollution also impacts the economy, agriculture, tourism, and other sectors by stunting plant growth, reducing the number of visitors because of their unwillingness to stay in a polluted city, and increasing the burden of cleaning for residents (Quest Forum 2017).

Mitigating air pollution to safe levels could result in savings of approximately NRs 315 million ($4.4 million USD) in health costs per year in Kathmandu and Lalitpur. The health benefits (e.g. savings from avoiding treatment from illness) alone would be approximately NRs 3,043 million ($42.8 million USD) (Adhikari 2012).

There are five major sources of pollution in the valley: vehicles and roads, construction, industries, waste burning, and indoor air pollution. Vehicular emissions account for 38 percent of pollutants and the number of vehicles is increasing every year. The annual vehicle growth rate for two wheelers and four wheelers between 1990 to 2018 was 14 and 17 percent respectively (CEN 2014). In Kathmandu and Lalitpur, most highways and large roads are paved but only 60 percent of feeder roads are (Quest Forum 2017). Dust kicked up from unpaved or badly paved roads accounts for 25 percent of pollutants (CEN 2014).

Road construction activities, primarily road expansion and digging up roads for the installation of electricity, telephone, and internet cables as well as water and sewage pipes, contribute heavily to air pollution (Republica 2020). The dumping of construction materials near roads has also led to suspension and resuspension of dust, contributing to air pollution (Quest Forum 2017).

Brick kilns are responsible for approximately 28 percent of the total PM_{10} concentrations and 40 percent of black carbon in winter (Eil et al. 2020). Concentrations of PM_{10} in the air are three times higher when kilns are operating than during the off-season (Raut 2003).

An estimated 5 to 10 percent of household-generated solid waste is burned in the open and the burning of plastic, which releases dioxins and furans, is particularly concerning (Quest Forum 2017). Other contributors include the use of fossil fuels and wood for cooking and other domestic purposes, as well as hospital waste burning, agro-waste burning, and the use of diesel generators (Quest Forum 2017; Saud and Paudel 2018).

There are currently six official air quality monitoring stations in the valley. Four of them are managed by the DoE, and two by the United States Embassy. There is one additional low-cost sensor that reports data, but the owner of the sensor is not listed (Department of Environment 2022; The World Air Quality Index project 2022; IQAir 2022).

Kathmandu Valley Air Quality Management Action Plan

Introducing the KVAQMAP

The KVAQMAP is a five-year plan proposed by the DoE and approved by the Cabinet of the GoN in 2020. It aims to mitigate air pollution by addressing sources, strengthening institutional capacity, and increasing awareness and citizen participation. The KVAQMAP requires participation of many sectors, ministries, and departments at different levels of the government and aims to include private sector and citizen groups in its implementation.

KVAQMAP Participation

Table 3 below lists KVAQMAP stakeholders involved in planning and implementation.

Table 3. KVAQMAP Implementation Committee

Ministry of Forest and Environment (Secretariat/Chair)	National
Ministry of Forest and Environment Biodiversity and Environment Division	National
Ministry of Financial Affairs	National
National Planning Commission	National
Ministry of Industry, Tourism, Forest, and Environment, Bagmati Province	Provincial
Department of Environment (Member Secretary)	Federal
Department of Roads	Federal
Department of Transport Management	Federal
Department of Industry	Federal
Department of Water Supply and Sewage Management	Federal
Department of Environment Management, Kathmandu	Municipal
Department of Environment Management, Lalitpur	Municipal
Kathmandu Metropolitan City Traffic Division	Municipal
Environment and Social Studies Department, Nepal Electricity Authority	National
Three independent content experts selected by the Ministry of Forest and Environment	Non-governmental
Invited members of civil society, NGOs, INGOs, and organizations engaged in air pollution control activities	Non-governmental

There are several key stakeholders currently missing from the implementation committee, including the Ministry of Health and Population, the National Health Research Council, the Department of Health Services, and several departments within the Ministry of Urban Development. While these sectors are not represented, they are listed as responsible for some key strategies and activities, which could represent an issue when it comes to implementation.

Strategic Areas, Sub-Headings, and Activities

The KVAQMAP lists eight objectives and twelve strategic areas for engagement. These areas are further divided into sub-headings focusing on mitigating sources of air pollution and adapting to reduce its negative impacts. Under these, the KVAQMAP lists 136 specific activities to be implemented. The list below outlines strategic areas and sub-headings; details on all activities are available in the KVAQMAP.

1. Reduce Air Pollution by Preventing Vehicular Emissions
   a. Control of vehicle emissions
   b. Promotion of electric and clean energy vehicles
   c. Increase availability of quality fuel
   d. Development and use of effective monitoring and evaluation system for vehicle-borne pollution

2. Develop Environmentally Sustainable Transport Management System
   a. Effective public transportation system
   b. Effective traffic management
   c. Effective infrastructure development
   d. Creation of pedestrian- and cycle-friendly cities

3. Develop Environmentally Friendly Construction Activities
   a. Promotion of environmentally friendly construction activities
   b. Promotion of greenery and green spaces

4. Reduce Emissions from Industries
   a. Implementation of prescribed emissions standards
   b. Promotion of clean technology

5. Develop Environmentally Friendly Management of Factory, Hospital, Household, and Agricultural Wastes
   a. Management of industrial and hospital-borne waste
   b. Management of household and agro-based waste

6. Mitigate Air Pollution from Household Activities
   a. Promotion of clean energy and technology to reduce household air pollution

7. Develop and Implement Public Awareness Activities

      a. Production, publication, and dissemination of public awareness materials through public communication channels

      b. Mobilization of artists and sportspersons to help raise public awareness

      c. Delivery of public awareness activities at schools

      d. Observation of commemoration days and promotion of workshops and seminars

8. Develop Air Quality Management Decision Support Systems
   a. Strengthening and expansion of air quality monitoring system
   b. Development of status monitors for sources of pollutants
   c. Completion of field mapping, source apportionment, and modeling of emissions
   d. Completion of impact assessment of air quality on health, environment, and the economy

9. Improve Management of Air Quality Emergencies
   a. Define air quality-related disasters
   b. Engagement in air quality disaster mitigation activities

10. Strengthen Policy and Legal Structures for Air Pollution Mitigation
    a. Enactment or review of existing laws
    b. Development of land use plans

11. Develop Institutional Arrangements for Effective Implementation
    a. Development of coordination mechanisms
    b. Development of institutional capacity

12. Manage Resources for Effective Implementation of KVAQMAP.
    a. Pollution taxes and user fees
    b. Maximum utilization of Environment Conservation Fund and Green Climate Fund

The KVAQMAP provides a timeline for completion, illustrative process indicators, and primary and secondary institutions involved in implementation. No further information has been included on how specific responsibilities for implementing the KVAQMAP have been communicated to primary and secondary institutions listed as responsible for completing the activity.

Building Healthy Cities and KVAQMAP

The BHC project was engaged for one year to support the effective rollout of the KVAQMAP at the municipality level, with a focus on actions which also have the potential to improve maternal and child health. This engagement led to longer-term USAID support through the five-year Mission-funded project called the Kathmandu Valley Clean Air

Program, which focuses on defining financial, human, and material needs and policies, rules, and regulations at the municipality level, as well as on implementing the KVAQMAP.

The BHC approach to supporting KVAQMAP implementation relied on multisector engagement, data driven decision-making, and citizen empowerment.

Contextual Considerations

Despite the fact that a new Nepali Congress coalition government is in place, the current political status of Nepal is in flux. Parliament was dissolved and reinstated twice between 2020–2021, which made it difficult to engage in major policy initiatives. The current coalition government is slated to govern through the end of 2022 but elections may be held earlier if the coalition does not hold. The term for locally elected representatives is also ending soon and mayors and ward chairs are already involved in their re-election campaigns.

A second consideration is that the KVAQMAP does not identify financial resources to fund activities. It may be assumed that the primary institution responsible for implementation of each activity will have to find funds from within their budget or through external sources.

Finally, while there have been no mass media campaigns, several newspapers and media sources regularly report on air pollution issues and have raised some level of public awareness.

Creating the Implementation Plan

Systems thinking, a planning process resulting in the creation of maps that define context, opportunities, and action, drove the development of this Implementation Plan. This participatory methodology is useful to bring stakeholders together to develop a common vision related to a specific policy, program, or urban development plan (Sedlacko et al. 2014). Systems thinking also sheds light on how stakeholders see a particular system from various perspectives and empowers them to produce feasible and viable solutions (Wilkinson et al. 2021). The systems thinking and mapping approach used to develop this Implementation Plan was designed by Engaging Inquiry, LLC and adapted for use by BHC in Kathmandu.

Before creating the Implementation Plan, BHC project staff completed a literature review focused on air quality in the valley and collected primary qualitative data through interviews with government, private, and civil society actors. This information helped identify causes and consequences of pollution and develop a common vision and set of goals. It also led to the development of a Context Map (available in English and Nepali; also see Figure 1), which identified causes and effects of pollution on the health and well-being of community members. Themes identified during development of the Context Map can be seen as virtuous, vicious, stagnating, or stabilizing forces. The Context Map also identifies how each theme relates to others, providing a more nuanced view of current dynamics.

After completing the Context Map, the BHC team shared it with a wide range of national and municipal government officials, donor groups, and civil society members (see Annex A). These interactions provided rich feedback and suggestions to strengthen the Context Map. The next stage was developing a Leverage Map to identify potential areas of change. The BHC team identified patterns and areas in the Context Map where change was unlikely and where positive changes were already taking place, as well as issues that had the potential to change and create a chain reaction of positive impacts. Potential changes were categorized into five groups of opportunities.

Based on these two maps, BHC organized a day-long Implementation Plan workshop with stakeholders from Chandragiri and Kirtipur Municipalities. Staff and representatives from the Kathmandu and Lalitpur Metropolitan Cities also attended, as did members of civil society organizations that BHC engaged during mapping discussions. Participants developed the Implementation Plan based on what the Leverage Map identified as actions that were achievable within one to two years. They also examined major activities within the KVAQMAP that were directly or indirectly the responsibility of the municipalities. Participants identified 16 major activities that could be implemented by the 2 municipalities.
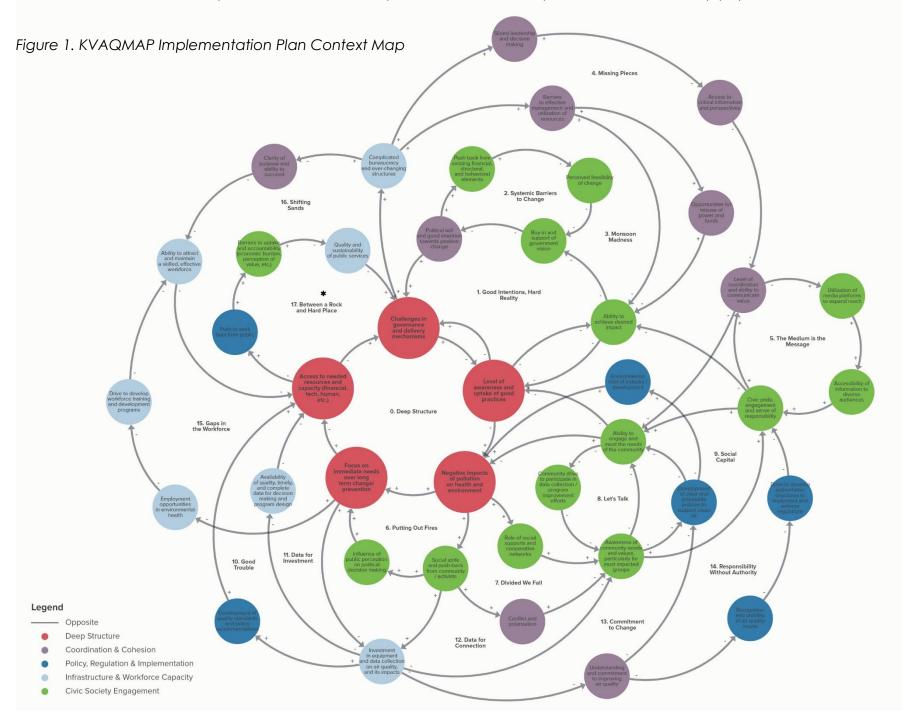
Findings

Defining the Municipal Air Quality Context

The Implementation Plan workshop identified several obstacles and opportunities to address air pollution in the valley (see Table 4). In order to achieve the shared vision named in the KVAQMAP of "Kathmandu Valley with Clean and Fresh Air," municipalities will need to overcome obstacles and capitalize on opportunities.

Table 4. Opportunities and Obstacles to Address Air Pollution

Opportunities	Obstacles
Strong political will	Rigid and complicated bureaucracy
Media interest	Limited financial and human capital
Private sector engagement	Limited data and data sharing
Circular approaches to waste (profitable re-purposing, recycling, composting)	Limited support from existing financial and institutional structures
Decentralization of power and decision-making to local government	Siloed leadership and institutional structures
Strong community engagement through women's and other community groups	Awareness does not translate into action
	Negative environmental externalities
	Focus on immediate problems

Reviewing the relationships between these opportunities and obstacles helped to define the context for air quality action at the municipality level. Figure 1 shows the fully executed Context Map. Within the map, the legend defines larger themes that surfaced from the analysis and are discussed in further detail below.

Figure 1. KVAQMAP Implementation Plan Context Map

Deep Structure

Since becoming a Federal Democratic Republic in 2008, Nepal has experienced unprecedented change, growth, and reinvention. While leadership vision and capacity across levels of government is strong, rapid change has created challenges to governance and to developing necessary mechanisms for implementing policies and allocating funds. Deep structure issues form the center of the Context Map and show that without effective pathways for delivery, the awareness and uptake of good practices remains low across governmental systems and in communities. These gaps have resulted in an increase in air pollution and negative impacts on human health and the environment.

In addition, when critical needs arise, they demand immediate attention and take focus and resources away from efforts to promote long-term change, including policy and workforce development, and data collection and analysis. Without needed resources and capacity, challenges to strong governance and the delivery of programs to protect air quality persist.

Building out from deep structure issues, BHC and stakeholders identified 42 key factors, each of which is represented by one bubble on the Context Map. Those factors were organized into 17 themes and color coded into four broad categories described below.

Coordination and Cohesion

There is strong political will to address air pollution and pressure from non-governmental actors like the media and civil society to do so. Despite this, several institutional and structural barriers have created a siloed environment whereby governmental agencies do not work together in a coordinated and cohesive way. This siloed leadership has led to agency unwillingness to share data with other governmental and non-governmental entities.

Policy, Regulation, and Implementation

While the GoN has set standards for air quality, there are no acts or policies that specifically focus on air quality and priorities to address air pollution. Instead, air pollution is simply identified in other documents as a problem. Furthermore, industries have not been held responsible for the pollution they create.

The KVAQMAP is the first comprehensive plan designed to address air pollution, but implementation of these regulations has generated pushback, especially related to financial requirements. For example, the valley has several brick kilns that the federal and local government have tried to shut down but these efforts have been opposed by local interest groups concerned about the local economy and jobs. Local politicians are

impacted by the votes that people working in these industries provide, which creates further conflicts of interest.

The introduction of user fees also generates pushback. For example, waste collection fees, which range between NRs 150-600 depending on the area and waste disposal method, are perceived as too high and as a result, many choose to burn their waste or throw it into rivers or other open spaces.

Data Infrastructure and Workforce Capacity

Greater investment in infrastructure and workforce capacity both within and outside the government to address air pollution is critical. There is also insufficient access to air pollution data and while the DoE is currently investing more than NRs 20 million per year on air quality data monitoring stations and data analysis, greater efforts are needed to ensure that data are safely stored and easily accessible to multiple parties. Furthermore, it is critical that decision-making be data driven rather than based only on budget allocations.

Developing and maintaining a skilled workforce is also a challenge. While the government is investing in training and capacity building, the current policy of transferring staff every two years impacts progress and reduces institutional memory. Furthermore, it is not uncommon for government staff to lack the necessary skills for their work, as job placement is not always based on expertise. The importance of personal relationships between government officials in decision-making, which can foster or hinder progress, must also be addressed.

Civil Society Engagement

Civil society engagement, especially on the part of the media, local women's groups, youth groups, and health volunteer programs, has raised awareness about air pollution and its impacts. When civil society engagement leads to government action, such as the case of a bicycle lane being installed in Lalitpur, there is a positive feedback loop that leads to greater community buy-in and engagement. Despite this, many individuals still avoid basic responsibilities to address air pollution.

Framework for Addressing Challenges at the Municipal Level

As part of the Leverage Map phase of the systems thinking process, stakeholders were asked to identify what issues were unlikely to change, what issues might be ripe for change, and what changes might make the most substantial impacts if implemented. This process identified five opportunity areas for action and informed the framework for choosing actions to prioritize at the municipal level.

Participatory Leadership and Decision-Making

When leaders listen to their constituents, understand their concerns and values, and spend time building buy-in for policies or programs, community members become more trusting and willing to engage and adopt new practices. By making leadership structures more transparent and consistent, stronger partnerships will emerge across sectors and within the community, which will in turn create pathways to access important perspectives and data to make informed decisions.

To improve participatory leadership and decision-making, stakeholders must address complicated and shifting bureaucratic structures as well as challenges to accessing resources in a timely fashion.

An example of a good practice is how the Mayor of Madhyapur Thimi Municipality supported construction of a new composting facility and helped gather community support for it by listening to community member concerns and providing information and examples of the benefits of this new facility. Many municipalities across Nepal have since sent staff to this composting facility to learn about it and Chandragiri Municipality is currently taking action to build a similar facility.

Partnerships to Reduce Waste and Create Opportunities

Developing sustainable industries will not only reduce the impact of waste but also create opportunities for new jobs, building materials, and compost for crops. Increasing coordination between the government, private sector, and greater community will improve communication and the ability to develop shared goals and priorities. Greater alignment among these groups will reduce negative impacts of industry on health and the environment and will encourage greater focus on long-term prevention efforts.

An example of good practice is a composting effort in Madhyapur Thimi Municipality in partnership with the Rikisi Compost Company that has brought quality compost to farmers. This has improved crop yields while reducing air pollution caused by burning waste.

Clear Policies that Support Strong Implementation

Strong policies that include clear processes for implementation, accountability, and improvement are critical to enact change. Investing in efforts to improve data for decision-making will increase commitment to improving air quality and in turn increase the accuracy and impact of policies to mitigate pollution. Ensuring that policies define what successful implementation entails will hold people accountable to produce tangible outcomes, which will in turn increase awareness and uptake of better behaviors and actions. In order to seize this opportunity, challenges around collecting quality, timely data as well as implementing accountability structures must be prioritized.

An example of good practice is the DoE investing significant funds in air quality monitoring as well as in the KVAQMAP.

Civil Society Actions for Air Quality Awareness

There are many local community collaboratives and advocacy groups in the valley that have fostered engagement and identified community needs. Leveraging these groups to collaborate with city and local government representatives will increase locally-informed policy and civic engagement as well as grassroots awareness, understanding, and action, particularly for the needs of vulnerable populations. While this will produce greater learning and impact, it will also support local pride and engagement as people see their communities driving change and influencing decision-making.

Examples of good practices include local community groups including mother's groups, women's groups, youth clubs, and others that have effectively communicated with community members about air pollution. The women's health volunteer program facilitated by the GoN is also a successful model to follow.

Workforce Training and Capacity Building

With increased focus on developing jobs and industries that contribute to cleaner air comes the opportunity to build new workforce capacity. Targeted training will help community members secure stable, meaningful, and long-term employment and improve the likelihood of successful implementation of initiatives.

Examples of good practice include how the GoN funds environment officers in all municipalities and how government officials often engage in training and capacity-building programs which help them work more effectively.

Municipal Actions for Air Quality

Through engagement with key stakeholders and analysis of the KVAQMAP, BHC identified certain activities within the 136 activities listed in the KVAQMAP that are specific to municipalities and which municipalities can implement immediately with few resources. We have categorized the activities into eight thematic areas that local municipalities can lead collaboratively with other government, private, and non-governmental actors.

In the final stage of the systems thinking approach, key officials from Kirtipur and Chandragiri Municipalities, Lalitpur and Kathmandu Metropolitan Cities, and members of academia and civil society worked together to connect Leverage Map findings with the KVAQMAP agenda and identify steps that could be taken by municipalities immediately. These are described in detail below.

Vehicle Emissions and Traffic Management

Emissions and traffic management are major challenges and while there is political will to create change, pushback from existing systems of traffic management and people who prefer private vehicles remains. As a result, the country has not developed a mass transit system to reduce the need for individual transport and private vehicle use continues to increase.

The KVAQMAP lists 43 major activities to be implemented, 8 of which come under the jurisdiction of municipalities. These include demarcating vehicle-free zones, analyzing the feasibility of mass transit systems, constructing and managing roads, and managing integrated transport and traffic light systems.

During the Implementation Plan workshop, participants identified the following activities to implement immediately:

1. Manage bus stations and appropriate pickup and drop off points to reduce emissions from unmanaged traffic jams.
2. Develop widely supported smart parking and multistory parking through public-private partnerships (PPP).
3. Pave petrol pumps to reduce dust from vehicles.

Infrastructure Development

The Context Map identified a problem faced during infrastructure development in Nepal, often referred to as "Monsoon Madness." This dynamic is illustrated by federal, provincial, and municipal governments' cash flow systems that are meant to evenly distribute the development budget throughout the fiscal year that runs from July through June. Due to rigid fiscal regulations and limited autonomy at the local government level, development projects routinely suffer from ineffective implementation. This results in late disbursement and a race at the city level to spend those late funds against obligations, which coincides with the last months of the monsoon season. This timing of budget release is the least opportune time to undertake field work and implementation, such as roads, electricity, water supply, sewage, and other infrastructure projects.

The KVAQMAP includes 38 activities related to infrastructure development, 20 of which come under complete or partial jurisdiction of municipalities. Municipalities have complete jurisdiction over the construction of roads, parking spaces, and basic infrastructure like sewage, drainage, and telephone and electricity lines and partial authority over ensuring that infrastructure and construction activities are safe and environmentally friendly.

During the Implementation Plan workshop, Kirtipur and Chandragiri officials identified two activities to implement immediately:

1. Use high-quality materials to construct roads. Municipalities have the authority to set standards for construction material procurement, which would lead to smoother roads and less dust.
2. Maintain existing roads, as better maintenance will reduce dust.

Greenery Promotion

Greenery promotion is a major goal for many mayors in the Kathmandu Valley. Political will is particularly high for creating green spaces and many mayors are rushing to make small public parks or "vatikas," sometimes using their own discretionary funds. As an example, the mayor of Lalitpur is building several parks in the city to improve the city's aesthetics. There is buy in and support for greenery promotion among the public as well, who are starved for green spaces in the urban jungle of Kathmandu.

The KVAQMAP identified four major activities to be implemented, all of which come under the total or partial jurisdiction of municipalities. Municipality officials identified three activities that their municipalities can implement immediately:

1. Promote household greenery. Currently, Chandragiri Municipality is implementing a rule requiring any new home construction to include the planting of at least two trees. Municipalities are also encouraging household greenery for food production, aesthetics, and environmental value.
2. Develop roadside and divider mini parks and plant trees on footpaths along roads.
3. Turn public land into park space. The municipalities are in the process of expanding the number of parks by turning unused public land into park space with a goal of creating at least two parks in each municipality.

Brick Kilns

Brick kilns are a considerable source of pollution and a major polarizing factor between the government, industry, and communities. Efforts to remove brick kilns have been met with widespread pushback due to the economic value, jobs, and votes that people working in this industry provide to local elected officials. The government has been unable to enforce industrial waste standards, which has impacted human health and led to conflict between industry and the government.

The KVAQMAP includes three major activities to reduce brick kiln emissions that come under total or partial jurisdiction of municipalities. Workshop participants identified two activities to implement immediately:

1. Promote alternative materials where possible. After the devastating earthquake in 2015, many non-governmental stakeholders took the opportunity to help private companies rebuild brick kilns with better technology to reduce emissions. The

government could provide incentives to industries to promote the production and use of alternative construction materials to reduce emissions.

2. Shift to greener technology. In its long-term planning, municipalities can move towards greener technology that causes less pollution.

Household, Hospital, Factory, and Agricultural Pollution

Household, hospital, factory, and agricultural waste burning are major sources of air pollution and efforts to address this issue have been largely unsuccessful. People often resort to burning waste to avoid paying fees for waste disposal, while different rate quotes for waste collection services have created conflict between community members and ward officials. Moreover, in the absence of an effective government inspection system, over 100 hospitals in the valley are not monitored in terms of hazardous waste disposal.

The KVAQMAP includes 26 major activities to address waste burning, 5 of which come under total or partial jurisdiction of the municipalities. Through discussions during the workshop, officials identified 4 activities that the municipalities can implement immediately:

1. Develop mechanisms to register complaints through the use of technology. Compliance with existing rules is a major issue and it is critical to create mechanisms to register complaints easily.
2. Develop mechanisms to investigate complaints.
3. Create a plan for local governments to enforce rules and take action against those who violate them.
4. Develop household level waste management mechanisms such as plastic banks and composting facilities and create public awareness of these mechanisms. Community-driven programs for composting and recycling will reduce waste and raise awareness at the same time.

Policy and Legal Structures

Developing standards and policy recommendations will increase access to needed resources and capacity to address challenges. Evolving PPP models focusing on air quality management are generating corporate social responsibility projects and other resource mobilization.

The KVAQMAP identified 14 major activities for immediate implementation, 3 of which come under total or partial jurisdiction of municipalities:

1. Implement this Implementation Plan. Officials agreed that creating, approving, and implementing this plan on a municipal level is a critical first step to building a strong policy and legal structure to combat air pollution.

2. Develop a Coordination Committee. Once this Implementation Plan is approved, the municipality can form a Coordination Committee between different governmental structures to facilitate intra-governmental collaboration.
3. Build capacity of government staff to ensure that these structures and collaborations are upheld.

Public Awareness

While there is some awareness of air quality issues among the general public, the systems thinking approach has shown that this awareness is surface level and often does not translate into action and positive impacts. Efforts that do not engage key stakeholders will not succeed in increasing awareness and changing practices. The government has been successful in raising critical awareness on topics related to COVID-19 through telephone communication, including ringtone alerts and messages during the pandemic. A similar strategy could be useful to create awareness about air pollution and its effects. A nuanced understanding is required not just among the general public but also among governmental bureaucrats, as they are not always knowledgeable about air quality issues. It is critical to develop a strong connection between policy makers and the needs of communities to create effective plans and policies.

The KVAQMAP includes seven major activities related to awareness raising, five of which come under total or partial jurisdiction of municipalities. Participants identified two activities for immediate action:

1. Produce and disseminate Information, Education and Communication (IEC) materials to raise awareness among the general public.
2. Develop and prioritize awareness activities geared to transport workers and traffic police focusing on vehicular emissions and fuel.

Data and Research

Existence and use of data are major gaps. Limited investment in air sensing equipment and data collection has limited the quantity and quality of timely and complete data to inform decision-making and program design related to air quality. There are also no institutional agreements or existing mechanisms to create shared databases or store data for future use. Without these data, it is hard for the government to justify allocating needed human and financial resources and hinders municipalities' ability to accurately gauge community needs and values, especially for vulnerable groups.

The KVAQMAP listed 30 major activities to be implemented related to data and research, 15 of which come under total or partial jurisdiction of municipalities. Workshop participants identified three activities for immediate implementation:

1. Share and display air pollution data. The municipalities are attempting to address the lack of access to air pollution data through the use of a public data sharing platform. They have records of all industries in their areas and can create a comprehensive database of sources of pollution within their boundaries.
2. Collect data on polluting industries and sources (source apportionment).
3. Create emergency declarations and mobilize volunteers. Municipalities can declare emergencies and mobilize volunteers in the event of extreme air pollution events such as forest fires.

Recommendations for Implementing the KVAQMAP

To implement the municipal level KVAQMAP activities described above, officials will need to build consensus with governing bodies and civil society stakeholders, demonstrate strong leadership, and find the financial and human resources needed to act.

Building Healthy Cities identified several gaps in the KVAQMAP that may need to be addressed to support further implementation:

Confirm Multi-Sector and Municipality Engagement

- Most municipalities are not currently members of the KVAQMAP implementation committee. It is important to include and engage all 18 municipalities within the Kathmandu Valley in the KVAQMAP decision-making process to better define their implementation roles and responsibilities.

- Ensure all relevant implementation ministries are included in the KVAQMAP implementation committee. The Ministry of Health and Population, the National Health Research Council, the Department of Health Services, and several departments within the Ministry of Urban Development are listed as responsible for some key strategies and activities but are not on the committee.

Specify Indicators and Monitoring Framework for KVAQMAP

- The KVAQMAP implementation committee must further develop roles and responsibilities, timelines and costs in order to best facilitate implementation of the major activities in the plan.

- Further disaggregation of major interventions is needed in order to realistically monitor implementation.

- More detailed discussion of assumptions and risks for these activities should be included.

- A monitoring and evaluation plan with SMART key performance indicators, yearly targets, and a final goal must be developed to track progress for this plan.

- Further information on time, costs, quality, expertise, human resource development, and other practical information should be included to assist implementation.

- It would be useful to complete a deeper analysis of mitigation and adaptation measures.

Create Regular Public Participation in the KVAQMAP

- The KVAQMAP implementation process should include more opportunities for public participation and ownership of solutions to air quality issues.

- Public health and health equity should be more explicitly included in the expected results and long-term vision of the KVAQMAP.

- Consider using public competitions or communications campaigns to both disseminate information about air quality and receive information about citizens' changing needs and suggested solutions.

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ANNEX A: List of Stakeholders

	Name	Organization
1	Prakash Lamsal	Ministry of Forests and Environment
2	Gyanendra Mishra	Ministry of Forests and Environment
3	Mukunda Niraula	Department of Environment
4	Indu Bikram Joshi	Department of Environment
5	Shankar Poudel	Department of Environment
6	Deepak Gyawali	Department of Environment
7	Bishnu Pandey	Department of Environment
8	Nabina Maharjan	Department of Environment
9	Govinda Lamichhane	Department of Environment
10	Ramesh Maharjan	Kirtipur Municipality
11	Saraswoti Khadka	Kirtipur Municipality
12	Krishna Prasad Sapkota	Kirtipur Municipality
13	Gyan Bazra Maharjan	Kirtipur Municipality
14	Anuj Pradhan	Kirtipur Municipality
15	Santaman Manandhar	Kirtipur Municipality
16	Aman Maharjan	Kirtipur Municipality Ward 10
17	Ghanashyam Giri	Chandragiri Municipality
18	Lisa Nakarmi	Chandragiri Municipality
19	Niraj Paudel	Chandragiri Municipality
20	Bhadra Aryal	Chandragiri Municipality
21	Ram Mani Ghimire	Chandragiri Municipality
22	Damodar Rijal	Chandragiri Municipality
23	Gopal Krishna Maharjan	Chandragiri Municipality Ward 10
24	Sabina Raut	Chandragiri Municipality Ward 8
25	Saroj Basnet	Kathmandu Metropolitan City Planning Commission
26	Mana Raja Ranjit	Kathmandu Metropolitan City Planning Commission

27	Kirti Kusum Joshi	Kathmandu Metropolitan City Planning Commission
28	Jayshree Rajbhandari	Kathmandu Metropolitan City Planning Commission
29	Nilima Shrestha	Kathmandu Metropolitan City Planning Commission
30	Sandhya Bajracharya	Kathmandu Metropolitan City Planning Commission
31	Pradeep Amatya	Lalitpur Metropolitan City
32	Binod Tamrakar	Lalitpur Metropolitan City Ward 19
33	Bulal Maharjan	Lalitpur Metropolitan City Ward 19
34	Nhuchhe Khadgi	Lalitpur Metropolitan City Ward 19
35	Anjana Madhikarmi	Madhyapur Thimi Municipality
36	Rajani Joshi	Bhaktapur Municipality
37	Bidhya Banmali Pradhan	ICIMOD
38	Swoyambhu Man Amatya	Government of Nepal
39	Sarita Lama	Independent Expert
40	Raja Ram Pote	WHO
41	Arnico Pandey	National Planning Commission
42	Rejina Maskey	CDES, Tribhuvan University
43	Ramesh Sapkota	CDES, Tribhuvan University
44	Enna Mool	CDES, Tribhuvan University
45	Narayan Babu Dhital	CDES; Tribhuvan University Patan Multiple Campus
46	Kosmos Bishwokarma	Nepal Forum of Environmental Journalist; Clean Air Network Nepal)
47	Malin Alhback	UNICEF
48	Hemu Kafle	Kathmandu Institute of Applied Sciences; Clean Air Network Nepal
49	Sushil Baral	Health Research and Social Development Forum
50	Shophika Regmi	Health Research and Social Development Forum
51	Abriti Aryal	Health Research and Social Development Forum

52	Deepak Joshi	Health Research and Social Development Forum
53	Sampurna Kakchapati	Health Research and Social Development Forum
54	Indira Shrestha	Stri Shakti; National Planning Commission
55	Ramesh Karki	Stri Shakti
56	Mahika Shrestha	Stri Shakti; Times College
57	Prashansha Sharma	Times College
58	Lalmani Wagle	Clean Energy Nepal; Clean Air Network Nepal
59	Kriti Shrestha	Clean Energy Nepal
60	Anju Koirala	Clean Energy Nepal
61	Nabina Tiwari	Clean Energy Nepal
62	Usha Giri	Rikisi Compost
63	Bhoj Raj Shrestha	Independent Living Center
64	Krishna Gautam	Independent Living Center
65	Gita Tumbahamphe	Independent Living Center
66	Sadan Pandit	Independent Living Center
67	Anupam Bhattarai	Independent Living Center
68	Rajendra Maharjan	Young Farmers Group
69	Jeetendra Shrestha	Young Farmers Group
70	Mahalaxmi Maharjan	Young Farmers Group
71	Radhika Maharjan	Nahuda Health Group
72	Ramila Shrestha	Nahuda Health Group
73	Narayan Devi Shrestha	Nahuda Health Group
74	Rita Maharjan	Nahuda Health Group
75	Sarita Shrestha	Nahuda Health Group
76	Sarita Nakarmi	Nahuda Health Group
77	Anmol Rai	Blue Diamond Society
78	Manisha Dhakal	Blue Diamond Society
79	Pinky Gurung	Blue Diamond Society
80	Simran Sherchan	Blue Diamond Society
81	Artisha Magar	Blue Diamond Society

82	Anuj Petter Rai	Blue Diamond Society
83	Nita Giri	Laliguras Women's Group
84	Sumitra KC	Pragatisheel Women's Group
85	Gayatri Sangroula	Laliguras Women's Group
86	Uma Pudasaini	Laliguras Women's Group
87	Shanta Chettri	Laliguras Women's Group
88	Tara Gurung	Pragatisheel Women's Group
89	Rama Maya Tamang	Laliguras Women's Group

BUILDING HEALTHY CITIES