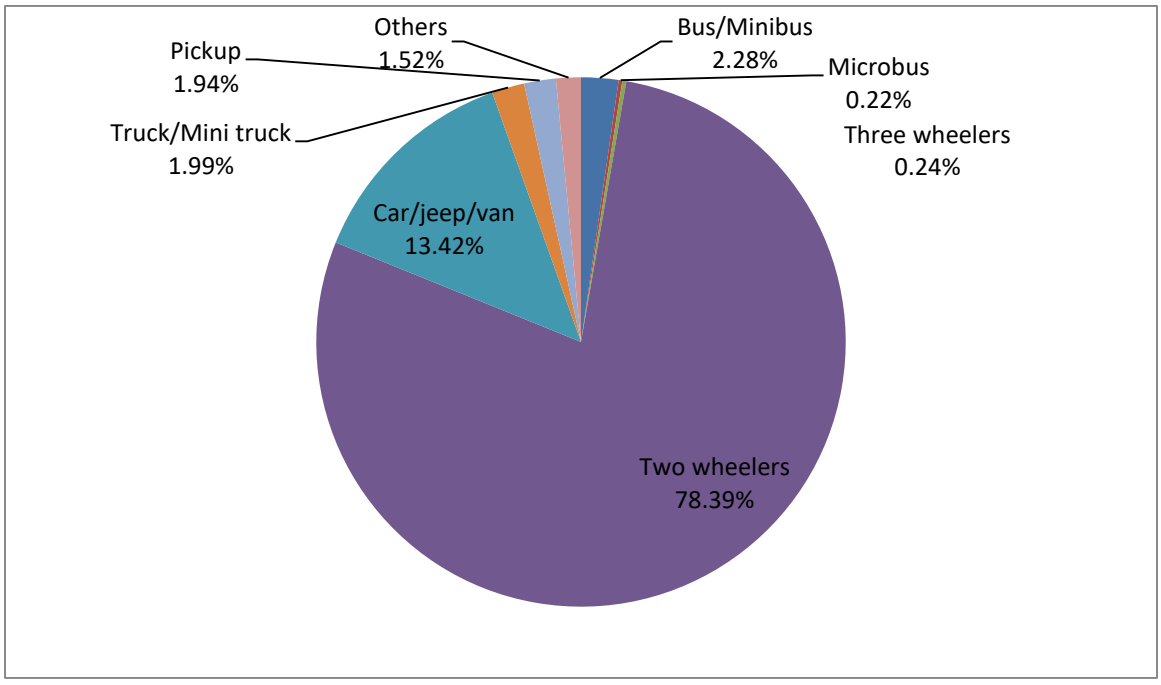
Introduction

Air pollution is a major public health risk in Kathmandu Valley where the annual average concentration of $PM_{2.5}$ is about five times higher than World Health Organization (WHO) guidelines (WHO, 2018). Realizing this, the Ministry of Health and Population together with the WHO is implementing the Urban Health Initiative (UHI) in Kathmandu Valley to build evidence on the health impacts of air pollution, enhance the capacity of the health sector and raise awareness on this issue. This policy brief on air pollution from transport in Kathmandu Valley is part of a series on different sources of air pollution in Kathmandu Valley and its linkage to health.

Various studies have shown that transport – both vehicle emissions and resuspension of road dust – is a major contributor to air pollution in Kathmandu. Furthermore, with the number of vehicles continuing to increase rapidly, emission from this sector is bound to increase.

The urban transport system in Kathmandu Valley is dominated by large number private vehicles, mainly two-wheelers, and a highly unorganized public transport system. The number of vehicles registered in Bagmati zone, most of which are in Kathmandu Valley, is increasing at a rate of over 12% per annum. Among these vehicles, more than 78 percent are two wheelers and only about 3% are public transport vehicles (DoTM, 2018).

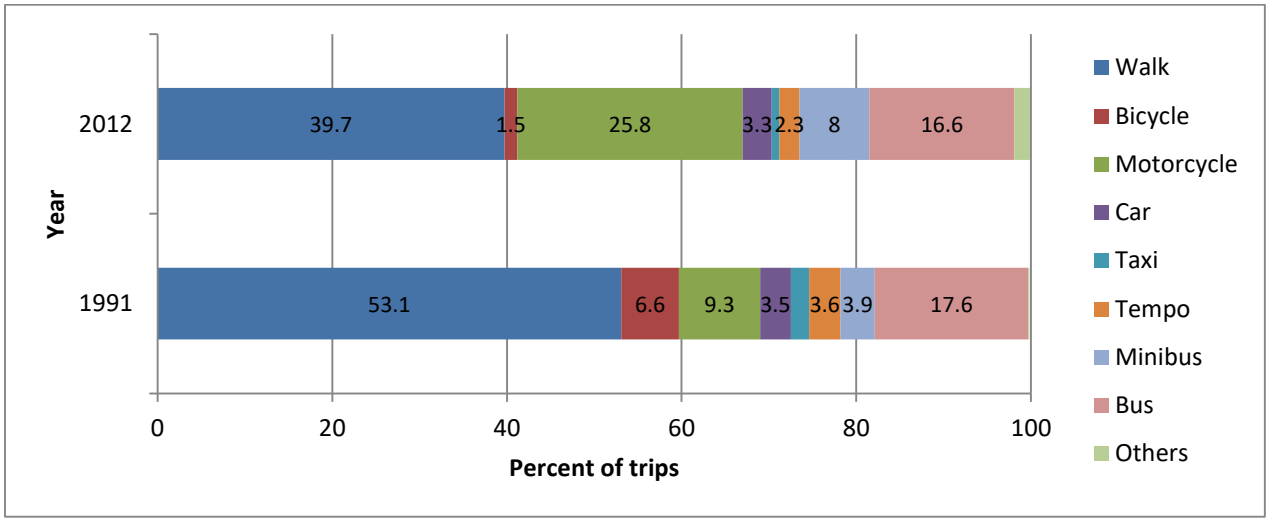
Figure 1: Types of Vehicles Registered in Bagmati Zone



Source: DoTM, 2018

Although walking and cycling are very important modes of transport in Kathmandu Valley, their use is decreasing due to a vehicle-centric transport planning system that does not prioritize these modes. Between 1991 and 2011, the percentage of trips made on foot decreased from 53.1% to 39.7% and the percentage of trips made on bicycles shrunk from 6.6% to 1.5% while trips made on motorcycles almost tripled from 9.3% to 25.8% (DoR/JICA, 2012). However, as the average travel distances are still low at less than 5km and many people cannot afford vehicles, there is an opportunity to increase these modes of clean transport in Kathmandu Valley.

Figure 2: Changes in mode share in Kathmandu Valley between 1991 and 2012



Source: DoR/JICA, 2012

Air Pollution due to Transport Sector in Kathmandu Valley

Air pollution from the transport sector includes tailpipe emissions, evaporative emissions, resuspension of road dust, and particles from brake and tire wear. Among these, tail pipe emissions and road dust are the major ones. Transportation emissions are driven by many factors, including (i) city panning as compact cities with mixed land use tend to reduce travel demand, (ii) economic growth, which often increases personal vehicle ownership and freight transport, (iii) type and quality of fuel used, (iv) vehicle technology, (v) vehicle operation and maintenance, (vi) traffic congestion, and (vii) prioritization of sustainable modes of transport such as walking, cycling and public transport in policy and practice.

The traditional towns in Kathmandu Valley were developed as compact settlements and mobility requirement were met mostly by foot and later by bicycles. In recent years, however, with the rapid growth of settlements within the Valley, people are increasingly using motorized transport to meet their travel needs. This has increased emissions from this sector.

30% of PM_{10} emissions in Kathmandu Valley was from transport sector, which is second only to construction activities, which contributed 53% (DoE, 2017). As much of the construction activities also happen on or near streets, this also contributes to road dust.

Within the transport sector globally, on-road diesel vehicles are the main contributors to air pollution and associated disease burdens (Anenberg et al., 2019). One study estimates that trucks are the major contributors to air pollution in Kathmandu due to their substantially higher emission factor. Although trucks account for only 2.3 % of total numbers of vehicles, the study estimates that they are responsible for 80% of vehicle emissions in the Valley for both $PM_{2.5}$ and NO_X, and 50% or more for the other pollutants (Zhong et al., 2019).

Health Impacts of Air Pollution due to Transport

As transport is a major contributor to air pollution, particularly $PM_{2.5}$ and ozone, transport sector emissions are a major causes of morbidity and mortality globally. Emissions from transport were responsible for 11.7% of global $PM_{2.5}$ and ozone mortality in 2010 and 11.4% in 2015 and vehicle tailpipe emissions were responsible for an estimated 5.43 deaths per 100,000 people globally in 2010 and 5.38 deaths per 100,000 people in 2015. Together, $PM_{2.5}$ and ozone concentrations from transportation emissions resulted in 7.8 million years of life lost and approximately $1 trillion (2015 US$) in health damages globally in 2015 (Anenberg et al., 2019). Besides air pollution, other important health impacts of transport include health impacts due to noise, physical inactivity, and road injuries.

Transport is also a major contributor to the health impacts of Kathmandu's air pollution. As part of UHI, Kathmandu University (2020) estimated the health impacts of air pollution caused by transport for four different scenarios (Table1). The Integrated Sustainable Transport Carbon-Health-Economic Assessment Tool (ISThAT) was used to calculate emission from the existing vehicles and the health impacts derived from these emissions over time in four different scenarios. In the first scenario, the existing public transport routes were restructured and small vehicles in primary routes were replaced by big buses as proposed by the Kathmandu Sustainable Urban Transport Project. The second scenario envisioned the introduction of EURO VI standards for new vehicles. In scenario 3, there is a significant increase in electric mass transit and in Scenario 4 there is an increase in cycling and walking, along with an increase in electric mass transit.

The analysis clearly indicates that the health benefits in terms of averted deaths due to air pollution are very significant when cleaner transport options are introduced. While just reorganizing the public transport system also results in health benefits, the benefits increase by over three folds when cleaner EURO VI vehicles are introduced and increases further to about four folds when electric buses are introduced and walking and cycling is also promoted. Scenario 4, which assumes electric public transit Zhong, M., Saikawa, E., Avramov, A., Chen, C., Sun, B., Ye, W., Keene, W. C., Yokelson, R. J., Jayarathne, T., Stone, E. A., Rupakheti, M., & Panday, A. K. (2019). Nepal Ambient Monitoring and Source Testing Experiment (NAMaSTE): Emissions of particulate matter and sulfur dioxide from vehicles and brick kilns and their impacts on air quality in the Kathmandu Valley, Nepal. *Atmospheric Chemistry and Physics*, *19*(12), 8209–8228. https://doi.org/10.5194/acp-19-8209-2019

together with increase in walking and cycling is ambitious but it is not unrealistic. The analysis also showed that the health benefits of investing in cleaner transport are higher than introduction of progressive policies in other sectors such as waste management, industries and cleaner cooking.

Table 1: Health Benefits from Transport System Improvement under Different Scenarios

Scenarios	Description	Health Benefits (Number of Averted deaths)	
		All causes mortality	Cause specific mortality
1	Optimized bus routes and microbuses in primary routes replaced by a big buses	13,680	3,091
2	Scenario 1 + Introduction of Euro VI emissions standards only from 2020	42,796	11,557
3	Scenario 2 + 300 electric buses each year from 2020 replacing diesel buses	50,213	14,511
4	Scenario 3 + increase walking travel mode to 20% & increase the of cycling to 8% in 2030 (of total passenger-km)	52,964	15,722

Source: KU/WHO (2020)

Institutional and Policy Framework for Transport

The main agency responsible for transport management is the Ministry of Physical Infrastructure and Transport and the Department of Transport Management (DoTM) within the Ministry. With the promulgation of the new constitution, much of the responsibilities of DoTM are now handled by the provincial governments. Municipalities are also involved in constructing transport infrastructure at the local level and some have also invested in public transport. Kathmandu and Lalitpur Metropolitan cities have invested shares in Sajha Yatayat, a public transport cooperative and Lalitpur Metropolitan City has also started building bicycle lanes. The public transportation system in the Valley is primarily operated by private entrepreneurs. While some of these operators have only one or two vehicles, some have fairly large fleets. Private entrepreneurs also operate the 700 electric three-wheelers that run in various fixed routes within the Valley.

Nepal has several policies that address the issue of air pollution from transport. These include the following:

- National Transport Policy, 2001 states 'making the transport sector environment friendly' as one of its objectives.
- Environment Friendly Vehicle and Transport Policy, 2014 aims to reduce air pollution from the transport sector by increasing the share of electric vehicle up to 20% by 2020, promoting the transformation of other regular vehicle to electric vehicles, and providing subsidy for the promotion of electric and non-motorized vehicles.
- National Action Plan for Electric Mobility, 2018 proposes three priority actions: (i) establish unit for electric mobility (ii) national program for electric mobility, and (iii) financing mechanism for electric mobility to promote electric mobility.
- Nepal's Second Nationally Determined Contributions (NDC) to the Paris Agreement includes several targets for electric mobility such as increasing the market share of private electric vehicles to reach 25% by 2025 and 90% by 2030, and sales of public electric vehicles to reach 20% by 2025 and 60% by 2030.
- The first periodic plan of Bagmati Province, which includes Kathmandu Valley, states the target of removing all petroleum-powered vehicles from its urban centres by 2028.

- All vehicles imported into Nepal must meet Nepal Mass Vehicle Emission Standards, which is equivalent to Euro III standards. Government has also introduced emission standards for in-use vehicles operating in Kathmandu Valley.

The Kathmandu Valley Air Quality Management Action Plan, 2076 (KVAQMAP) has mentioned 'reduce pollution from transport sector and construction activities' as one of its objectives. The plan has listed 11 strategic areas of intervention, of which the following three are related to the objective mentioned above: (i) vehicular emission control (ii) environmentally sustainable transport, and (iii) construction activities. Proposed activities to control vehicle emission include controlling emission of new and in-use vehicles, promoting electric and clean vehicles, providing access to high quality fuel and establishing an effective vehicle emission testing system. Similarly, activities listed under environmentally sustainable transport system include having an effective public transport system, proper traffic management, transport infrastructure development, and promoting walking and cycling.

Overall, Nepal has many good polices related to control air pollution from transport sector. However, implementation of these policies is often lacking.

Way Ahead

Air pollution from the transport sector can be reduced by promoting sustainable urban mobility solutions. Some measures that can be taken are as follows:

1. Promote walking and cycling: This can be done by investing in infrastructure for pedestrians and cyclists and prioritizing their safety. Core areas of the traditional towns in the Valley, which are very dense, can be pedestrianized to further promote walking and cycling.
2. Establish effective public transport system: The public transport system needs major restructuring and proper management to make it more effective and efficient.
3. Promote electric vehicles: As the supply of electricity has improved in recent years as well as EV technology, the government needs to promote EVs, particularly for public transport, by implementing the National Action Plan for Electric Mobility.
4. Enforce in-use vehicle standards: Regular and on-the spot emission testing should be made more effective to identify gross polluters and encourage proper maintenance of vehicles.
5. Effectively manage traffic: An effective management system for traffic, including parking, should be enforced to reduce congestion on the streets.

As the KVAQMAP has clearly identified numerous activities that need to be conducted to minimize air pollution from transport, this plan should be implemented immediately. Furthermore, as many of the activities can be implemented immediately with minimum resources, this should be seen as a low hanging fruit on the road to clean air in Kathmandu.

References

Anenberg, S., Miller J., Henze D, Minjares R. (2019). A Global Snapshot of the Air Pollution Related Health Impacts of Transportation Sector Emissions in 2010 and 2015. The International Council for Clean

Transport (ICCT) and Climate and Clean Air Coalition to Reduce Short Lived Climate Pollutants (CCAC). Washington DC.

DoE (2017). *Air Quality Management Action Plan for Kathmandu Valley* [Unpublished], Department of Environment. Kathmandu.

DoTM (2018). Registered Vehicles till Fiscal Year 2075/76, Department of Transport Management, Kathmandu. https://www.dotm.gov.np/Files/NoticePDF/Vehicledatatill20762020-01-17_04-54-21-965.pdf

GoN, 2020: Second Nationally Determined Contributions (NDC), Government of Nepal, Kathmandu

DoR/JICA (2012). *Final Report: Data Collection Survey on Traffic Improvement in Katmandu Valley* [Unpublished]. Department of Roads, Ministry of Physical Infrastructure and Transport. Kathmandu.

KU/WHO (2020). *Technical Report on Health Impacts and Economic Analysis of Air Pollution in Kathmandu Valley* [Unpublished]. World Health Organization & Kathmandu University, Kathmandu.

Kim, B.M., Park, J., Kim, S., Kim, H., Jeon, H., Cho, C., Kim, J., Hong S., Rupakheti, M., Pandey A., Park, R., Hong J., Yoon, S. (2015). Source apportionment of PM10 mass and particulate carbon in the Kathmandu Valley, Nepal. *Atmospheric Environment* 123 (2015), 190-199

WHO (2018). WHO Global Ambient Air Quality Database (update 2018). Geneva. https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/ambient-air-pollution

Zhong, M., Saikawa, E., Avramov, A., Chen, C., Sun, B., Ye, W., Keene, W. C., Yokelson, R. J., Jayarathne, T., Stone, E. A., Rupakheti, M., and Panday, A. K.(2019). Nepal Ambient Monitoring and Source Testing Experiment (NAMaSTE): emissions of particulate matter and sulfur dioxide from vehicles and brick kilns and their impacts on air quality in the Kathmandu Valley, Nepal, Atmos. Chem. Phys., 19, 8209–8228, https://doi.org/10.5194/ acp-19-8209-2019.