CHAPTER I

Introduction

Air pollution has always been part of life. Early humans contended with air pollution from forest fires, volcanic eruption and decay of organic matter. People have been aware, for centuries, of the effects of airborne pollutants on human health. Historical records reveal early concerns with the undesirable effects of air pollution and society's attempts to reduce those effects. One of the early attempts to control air pollution occurred in the England in 1300s, when silver and armor smithing was banned (Moeller, 1992). A number of air pollution related episodes occurred in nineteenth and twentieth centuries as a result of industrial growth. In December 1930, a heavily industrialized section of the Meuse Valley in Belgium experienced a severe 3- day long episode of fog during which hundreds of people became ill and 60 died (Moeller, 1992). In 1948, in Donora, Pennsylvania, a small mill town dominated by steel and chemical plants, 20 people died as a result air pollution (Lipfert, 1994). In London in 1952, 4,000 people died in the " Great Fog Episodes" caused by domestic coal burning and the meteorological condition of a thermal atmospheric inversion. Only after these acute episodes, did policy makers and the public realize that air pollution could have significant effects on health (Lipfert,1994).

Air pollution has been defined as the presence in the air of substances in concentration sufficient to interfere with health, comfort, safety, or the full use and

enjoyment of property (Moeller, 1992). In the United States, for regulatory purposes, air pollutants can be categorized in two groups: criteria pollutants and hazardous air pollutants. Criteria pollutants are considered to be those substances which pose a general risk to public health and for which ambient air quality guidelines / standards have been issued (Lipfert,1994). Hazardous air pollutants are those substances, which are associated cancer, birth defects, and neurotoxicity, and for which ambient standards /guidelines are not practical. Thus, criteria pollutants are generally associated with urban atmospheres, whereas most hazardous pollutants are identified with industrial settings (Lipfert, 1994). The main criteria pollutants include particulate matter, lead, sulfur dioxide, carbon monoxide, nitrogen dioxide and ozone, each of which are described briefly as follows:

1) Particulate air pollution:

Particulate air pollution refers to an air suspended mixture of solid and liquid particles that vary in size, composition, origin and effects (Dockery and Pope III. 1994). Particulate matter are classified on the basis of their size. Hence, PM_{10} refers to particles with an aerodynamic diameter of equal or less than 10 micron (um) (Scannell and Balmes, 1997). Similarly the term, Total Suspended Particles (TSP) is applied to particles with aerodynamic diameter of less than 50 micron (um) (Lipfert, 1994). Elevated particulate concentrations in the atmosphere have been linked to increases in the number of hospital visits, respiratory infections, cardiac disorders, bronchitis and asthma.

2) Lead:

Lead is the most ubiquitous toxic metal and it has no function in the human body. Based on the extent of the exposure, individuals may develop symptoms of acute or chronic lead poisoning. The principal target organs or organ systems include blood, the brain and the nervous system, the kidney and the reproductive system. Symptoms from acute exposures may include severe anemia, acute nervousness, kidney and irreversible brain damage.

3) Sulfur Dioxide:

Sulfur dioxide (SO_2) is a colorless and highly water soluble gas. Sulfur dioxide is a respiratory irritant that can also cause bronchoconstriction. Being highly soluble, sulfur dioxide is removed in the mouth and pharynx and primarily affects the upper respiratory tract. When sulfur is entrained in an particles, however, the aerodynamic of the particles, themselves, affect the area of deposition in the lungs. The combination of particulate matter and sulfur dioxide then acts synergistically, with the effects of both together being much more detrimental than either of them acting alone.

4) Carbon monoxide:

Carbon monoxide (CO) is a colorless, odorless, tasteless gas. It is produced when carbonaceous fuels are burned in the conditions of incomplete combustion emitting carbon monoxide instead of carbon dioxide. Carbon monoxide readily binds hemoglobin of blood and, thereby, it interferes with the blood's ability to carry oxygen to the cells of the body. Carbon monoxide at ambient levels of exposure may

exacerbate ischemic heart disease, increase cardio-respiratory morbidity and cardiac mortality (Scannell and Balmes, 1997).

5) Nitrogen Dioxide:

Nitrogen dioxide ($N0_2$) is an oxidation product of nitric oxide (NO) and is also a pollutant that is an ubiquitous component of urban smog. Studies to date have shown conflicting evidence of NO_2- induced health effects at ambient levels of exposure. Epidemiological studies have shown inconsistent associations between respiratory symptoms and illnesses and outdoor NO_2 levels(Scannell and Balmes,1997).

6) Ozone:

Ozone (O_3) is a colorless, pungent gas which occurs when oxides of nitrogen and various hydrocarbons in the presence of sunlight react with each other to produce a number of secondary pollutants including ozone. Ozone is irritating to the upper respiratory tract and can cause breathing impairment and reduced athletic performance and in high concentrations can cause edema (Lipfert, 1994). But ozone is rarely the sole pollutant of concern in urban smog.

Of these six main criteria pollutants, particulate matter evidently appears to be the most important as comparative risk assessment and health studies, carried out in a number of cities (e.g., Bangkok, Cairo, Mexico City, Quito, Santiago, cities of Central and Eastern Europe), have indicated that typically fine suspended particulate (PM_{10} and smaller) and exposure to lead (Pb) cause the greatest damage to human health

(www. Worldbank.org./ undated). The two largest health impacts of air pollution: a) premature mortality and b) excess respiratory infections are also associated with particulate matter. A worldwide review of 126 cities, in which the levels of particulates exceed the World Health Organization (WHO) guidelines, estimates that air pollution is responsible for 130,000 premature deaths and 50- 70 million incidents of respiratory illness each year (Brandon., www.worldbank.org/ undated). Anthropogenic particulate air pollution originates from two classes of sources: stationary and mobile. Stationary sources can be further grouped in two main categories: (i) large stationary sources, for example, cement industries; (ii) small stationary sources, such as, households. Whereas, mobile sources consist of traffic. Traffic is a large contributor to particulate pollution in cities with frequent traffic congestion of large and poorly maintained vehicle fleets using high-sulfur diesel fuel (e.g. in Nepal). In cities where leaded gasoline is still used, traffic is also a major contributor of ambient lead concentrations.

Kathmandu is facing a serious PM_{10} pollution. The situation in Kathmandu valley is not promising as approximately 50 percent of more than one million people in the valley is exposed to a Total Suspended Particle (TSP) concentration above the annual average of The World Health Organization Air Quality Guideline (WHO AQG) (Larssen et al., 1996). Three to four percent of the population is exposed to TSP greater than twice the annual average of WHO AQG (Larssen et al., 1996). As a result, particulate pollution is causing excess deaths, excess morbidity and huge health care costs in Nepal.

The main cause of PM10 pollution in Kathmandu Valley is traffic. Reducing vehicular emissions is the main focus of this thesis. The thesis is organized in the following manner. In the second chapter the situation of ambient air quality in Kathmandu Valley is discussed and this is followed by a discussion on problem identification: Why air lead pollution and air particulate matter pollution are the most damaging problems in Kathmandu Valley.

The problem identification is done on the basis of the causes and consequences of both lead and particulate matter pollution. Various causes and consequences of air lead and PM_{10} pollution are elaborated. Then, there is an analysis for priority setting, which discusses why PM_{10} pollution should be mitigated. Priority setting is followed by justification on choosing traffic emissions to reduce PM_{10} pollution among all sources of pollution. The justification is done on the basis of cost effective analysis.

Chapter two also discusses the possible alternative approaches of pollution control and why information approaches are the most suitable among all alternatives. Lastly, as the project tries to change the behavior of taxi drivers for vehicle maintenance by a radio program, chapter two also discusses the use of radio as a medium for behavior change in different countries including Nepal.

Chapter three is the project proposal with the general objective to reduce adverse health affect by reducing vehicular emissions. It starts with the introduction of the problem area i.e. Kathmandu Valley. This is followed by a situation analysis

which includes discussion on the following issues: the present situation of PM_{10} pollution in Kathmandu valley, to what extent traffic emissions are responsible for PM_{10} pollution, and the present measures to control the air pollution. As this project attempts to reduce air pollution by maintenance of vehicles, the rationale of chapter three explores the benefits and feasibility of different options that can reduce traffic emissions and gives reasons why it is effective to choose car maintenance among all other options. Chapter three further answers why it is effective to choose taxis as the target to control pollution, in spite of a number of other choices. As the project adopts the information approach to control the air pollution by giving information to taxi drivers, the rationale also justifies the need of information. This is followed by a discussion on reasons behind choosing mass media rather than face-to-face communication, and the discussion further continues to explore reasons behind choosing radio among other choices of mass media. Lastly, justification is given to why this project is a worthwhile an effort on the basis of reduction of PM_{10} and its monetary and public and individual health benefit. Further, chapter three also explores the costs and benefits involved in vehicle maintenance behavior. All the activities for program is outlined. The project budget and possible threats to the projects follow this.

The fourth chapter of this thesis is the data exercise. This deals with the data collection from Indian/ Nepali community of Phahurat, Bangkok. The main objective of data exercise is to develop practical knowledge and to refine instruments that will be used when the proposed project is implemented in Nepal.

The chapter five contains the presentation of my thesis examination. This chapter deals with some transparencies that will be used during the thesis presentation. Chapter six is the annotated bibliography. This chapter provides a brief overview of top six books / chapters that were consulted frequently during the writing of the thesis. This is a general overview of this thesis, which addresses the strategy to reduce vehicular emission of PM_{10} though behavioral change and this will lead to a reduction of adverse health affects from PM_{10} pollution.

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