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Contribution of Positive Feedback Loop to Increase Vehicular Emission and Its Transformation to Negative Feedback Loop for Controlling Localized Climate Change

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Abstract
Localized climate change is a confined phenomenon usually restricted to small areas where infrastructural development is dense. One of the major causes for localized climate change in urban areas is vehicular emission. In this paper, presence of a positive feedback loop in transportation sector which is contributing to increase the vehicular emission, along with its mitigation measure is suggested.

Keywords
Localized climate change – feedback loop – transportation sector – vehicular emission

1. Introduction

Climate change is not only a global but also a local phenomenon. Areas with immense development and/or urbanization can undergo a change in weather pattern (dominantly temperature) primarily due to anthropogenic activities conducted locally – this change in whether pattern is known as localized climate change. Localized climate change, like global climate change can be vigorously accelerated due to positive feedback loops: Identifying such feedback loops and transforming them into negative feedback loops can check the process of localized climate change considerably. Localized climate change – to which vehicular emission makes a major contribution – is caused mainly due to infrastructural development. Increased density of infrastructures in certain locale increases the intensity of anthropogenic load on the environment of that very area which consequently disrupts the local weather pattern. This may also, in many cases, contribute to global climate change.

2. Literature Review

Feedback Mechanisms are the factors which increase or amplify (positive feedback) or decrease (negative feedback) the rate of a process. An example of positive climatic feedback is the ice-albedo feedback [1].

There are many feedback mechanisms in the climate system that can either amplify ('positive feedback') or diminish ('negative feedback') the effects of a change in climate forcing. For example, as rising concentrations of greenhouse gases warm Earth's climate, snow and ice begin to melt. This melting reveals darker land and water surfaces that were beneath the snow and ice, and these darker surfaces absorb more of the Sun's heat, causing more warming, which causes more melting, and so on, in a self-reinforcing cycle. This feedback loop, known as the 'ice-albedo feedback', amplifies the initial warming caused by the rising levels of greenhouse gases[2].

Converting wind's kinetic energy into electricity, wind turbines modify surface-atmosphere ex-changes and transfer of energy, momentum, mass and moisture within the atmosphere. These changes, if spatially large enough, might have noticeable impacts on local to regional weather and climate [3].

Vehicle emissions contribute to air pollution generated from the combustion of fossil fuels from many other sources, including the burning of coal and oil in power plants, incinerators, home heating oil, and construction equipment. The combustion of gas and diesel fuels produces greenhouse gases that are contributing to local, regional and global climatic changes [4].

Shorter commutes distance correlated with higher propen-

sity to bike more for all groups of bicycle users. In addition, building adequate and available biking infrastructures are conductive to greater interests in future bike use, despite such correlation was less significant for those who had never used bikes. Awareness of environmental issues and biking as healthier way to travel were found to be strongly correlated with a interest in future bike use [5].

3. Observation

As a matter of fact, vehicular emission is one of the major causes of localized climate change and also plays a significant role in altering global climatic scenario. Reduction of vehicular emission in urban areas is one of the major challenges for policy makers, Environmentalists and other concerned community and agencies. There are usually two approaches to control vehicular emission: I) Reducing emission of vehicles using highly efficient engines or electrically-powered engines and II) Reducing number of vehicles by encouraging public transportation system and/or non-motorized vehicles. Particularly in Urban areas of Nepal, where air pollution and consequent climate change is an alarming issue, the latter approach is most widely adopted, as the former approach is far beyond the technological and financial capacity of the nation and its nationals, as of now. The control of vehicular emission largely contributes to control of air pollution and localized climate change. Therefore it is important to assess and increase the effectiveness of ongoing approaches to control/reduce vehicular emission.

Traffic flow in wide bicycle lanes of Kathmandu Valley is almost nil and people seem to prefer private vehicles even for short walkable intra-city trips. Following the primary observation an elaborated discussions with vehicle users with the purpose of understand the causes for preference to motorized vehicles, was done. It indicated that one of the main causes for preferences of motorized private vehicles for shortening the exposure to pollution and hot weather. It was found that cycling and/or walking in the busy roads of Kathmandu even for a walkable distance is a tough job mainly due to pollution and temperature.

Subjective analysis of this scenario indicated the presence of a positive feedback loop which is discussed in the upcoming sections of this paper.

4. Discussion

There is a presence of positive feedback loop that is contributing to accelerate the vehicular emission in roads of urban area of Nepal. As it is clear from the picture that due to pollution and higher temperature, people are inclined towards use of private motorized vehicles, to shorten and/or avoid direct exposure to the urban atmosphere. Use of private vehicles further worsens the urban environment and in-turn preference to private vehicle increases and the cycle continues.

4.1 Positive Feedback loop

Figure 1 shows the positive feedback loop that is contributing to accelerate the vehicular emission in roads of urban area of Nepal. As it is clear from the picture that due to pollution and higher temperature, people are inclined towards use of private motorized vehicles, to shorten and/or avoid direct exposure to the urban atmosphere. Use of private vehicles further worsens the urban environment and in-turn preference to private vehicle increases and the cycle continues.

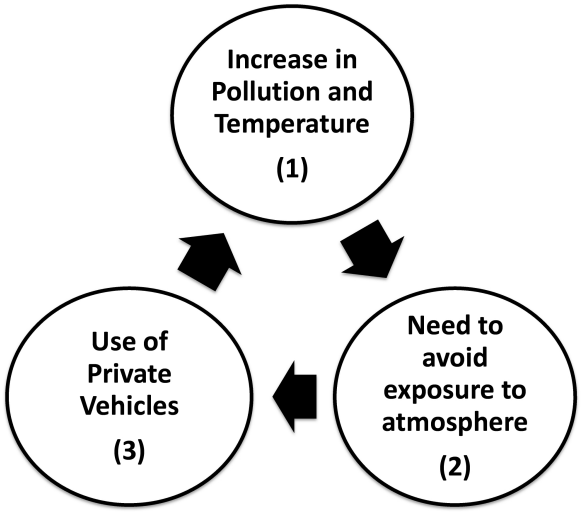

Figure 1: Positive Feedback Loop Present In Urban Road Network

4.2 Transformation to Negative Feedback Loop

In the positive feedback loop described in the section above, the pivot point is factor number 3 as per the numbering within the brackets. Private vehicles are popularly being used as screen between unfavorable environment

of urban roads and road users. If somehow an alternative, environmental friendly screen is provided to the road users, private motorized-vehicles could considerably be replaced by bicucles and the positive feedback loop would be transformed into negative feedback loop. Options that can increase use of bicycle may be an alternative route with restriction to motorized vehicles or bicycle lane with canopy.

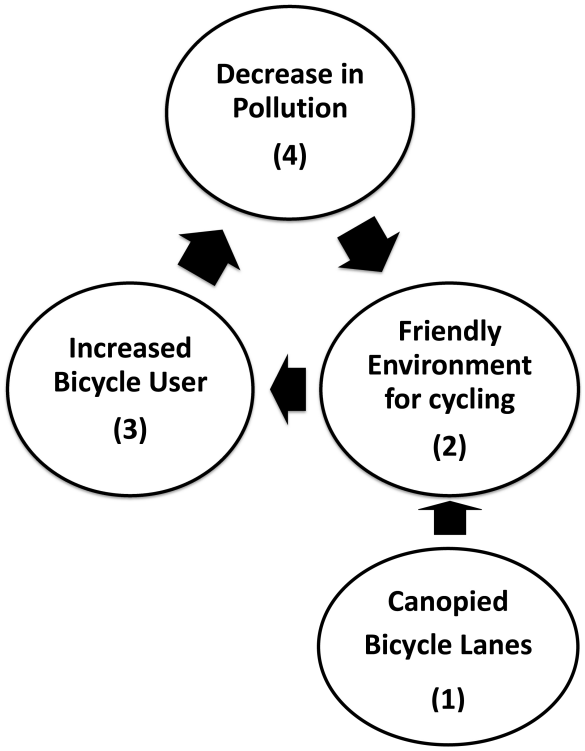

Figure 2: Transformed Negative Feedback Loop

It has already been established by previous studies that there exists a positive correlation between availability of adequate bicycling infrastructures and interest in future bike use. Planting trees in bicycle lanes can provides canopy to riders, it also helps in settlement of dust particles and protects the riders from light rainfall. Canopied lanes are also aesthetically pleasant to walk or ride on. Beside pivoting the loop to negative direction canopied lanes also have additional benefits: The vegetation used for canopy also contribute in carbon sequestration. Transformation of the loop can also be enhanced by the means of external catalyzing agents. For instance, propagating health benefits of walking and riding bicycles can furthermore encourage road users to refrain from using motorized vehicles. A transformed negative feedback loop is illustrated above.

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