Toward Cleaner Air and Healthier Lives:
Exploring Air Quality Effects and Patterns in Siddharthanagar

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Nepal's rapid urbanization has led to a country-wide struggle with health outcomes and pollution; as of 2018, Nepal is one of the ten most polluted countries in the world [1]. The Kathmandu valley faces a unique problem with air quality; due to the high surrounding mountains in the region, winds cannot easily carry air into and out of the valley. Thus, pollution generated in urban areas can affect the entire valley. The negative ecological and health effects of heavy air pollution are well-understood by scholars and professionals, but the effects on daily life for Nepalese citizens are not yet understood.

Our study is motivated by the goal to understand how air pollution affects the daily lives of individuals within the survey area and to understand air pollution patterns therein. These two pieces of information combined give both individuals and policymakers the information necessary to understand the air pollution issue and take action steps towards mitigating the health and safety risks associated with air pollution.

Our research goals presented us with two research questions to answer:

- How does air pollution affect the daily lives of people within the survey area?

- How do air pollution levels vary over long periods of time? Is there a trend of any sort to the levels of air pollution within the survey area?

In order to answer these questions, we approached our analysis and modeling from two angles. We modeled the impact of air pollution as a suite of chi-squared tests of independence which compared a survey variable to the respondent's reported effects of air pollution on their lives. To search for air quality patterns, we used a dataset generated by a Kaiterra Laser Egg 2 indoor air quality sensor placed in the survey area by a previous research project to generate a list of average $PM_{2.5}$ levels over the course of 321 days. This data was then graphed and analyzed to find a pattern of best fit.

In summary, our research project consisted of three methodological phases:

1. Analyze the effects experienced by individuals using the NSC survey data.

2. Use the Laser Egg monitoring data to attempt to find a trend in air quality levels.

3. Combine the findings of phases 1 and 2 to form an action plan for further research and mitigation strategy.

Breathing problem, shortness of breath	Effects of air pollution in residency? Low	High	Total
0	338	366	704
[1] Got Sick	15	28	43
Total	353	394	747

Pearson chi2(1) = 2.8020 Pr = 0.094

Respiratory infection	Effects of air pollution in residency? Low	High	Total
0	349	381	730
[1] Got Sick	4	13	17
Total	353	394	747

Pearson chi2(1) = 3.9289 Pr = 0.047

How satisfied are you with your life, all things considered ?	Effects of air pollution in residency? Low	High	Total
0	1	1	2
1	0	2	2
2	0	7	7
3	1	18	19
4	8	42	50
5	35	96	131
6	53	82	135
7	76	58	134
8	84	42	126
9	43	17	60
10	53	29	82
Total	354	394	748

Pearson chi2(10) = 114.8631 Pr = 0.000

Fig. 1: Chi-squared tests comparing perceived air pollution levels and breathing problem rates (top-left), respiratory infections (bottom-left), and overall life quality (right).

The chi-squared tests in the first phase of analysis only showed significant association ($p < 0.05$) with respiratory infections and the respondents' self-reported life satisfaction. While these results were puzzling at first, they make sense in the context of how air pollution affects health; high $PM_{2.5}$ counts cause very few direct deaths but instead reduce lung function and development in children, making a population in highly polluted areas more susceptible to disease and infection [2].

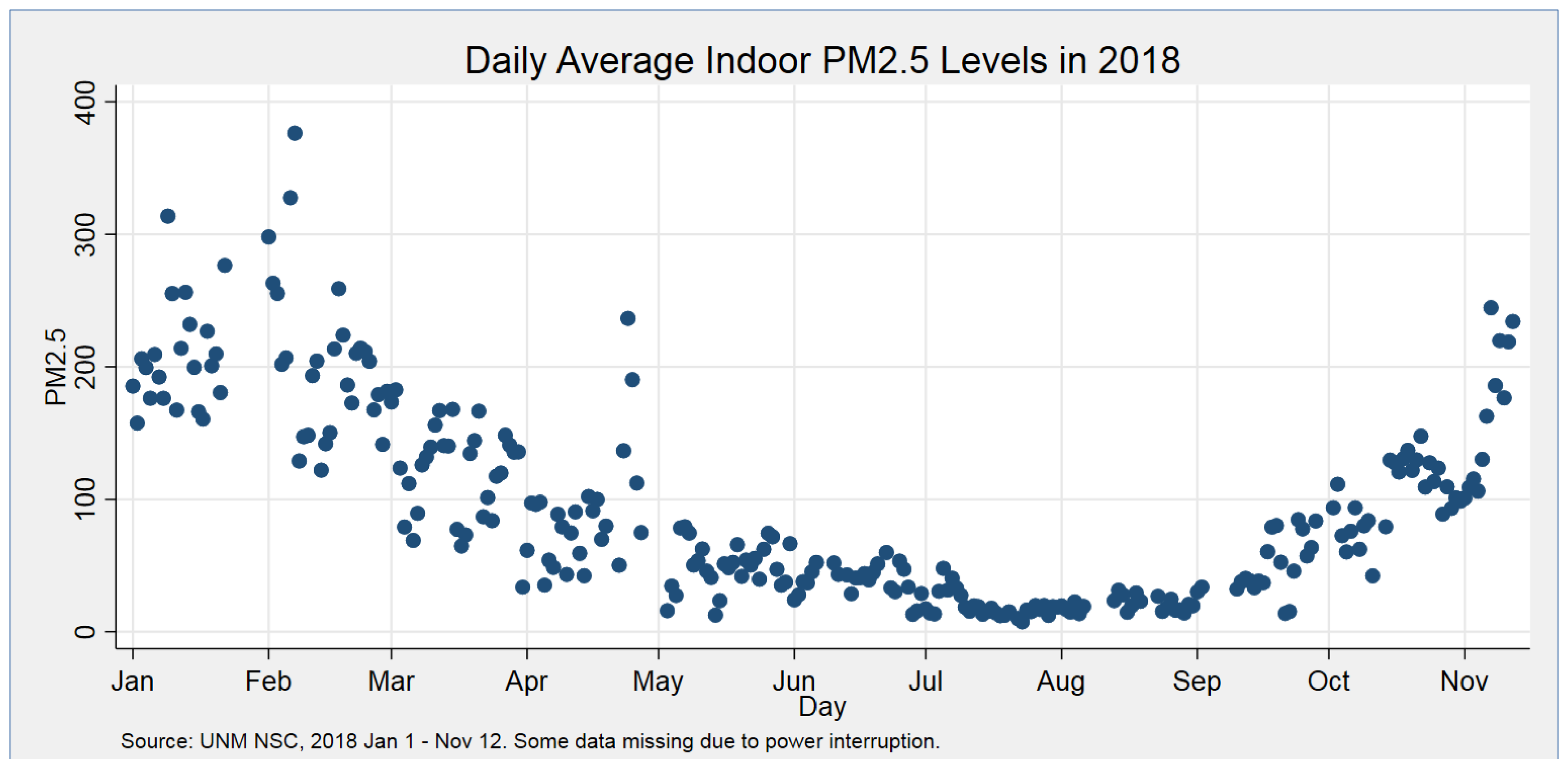

Fig. 2: Scatter-plot graph showing the average $PM_{2.5}$ count for each day over the course of 2018.

The daily averages of $PM_{2.5}$ demonstrate a convex curvilinear relationship over the course of the year, with the highest counts occurring during winter and spring (November – March) and the lowest counts appearing during summer and autumn (April – October). This pattern suggests that ambient air pollution is related to temperature and/or weather patterns. As a result, we expect this pattern to repeat in subsequent years and be related to a combination of weather effects and additional pollution during cold months.

While reductions in $PM_{2.5}$ over the long term are achievable through infrastructure improvements, this study has already provided useful information for improving health outcomes in the short-term:

- Days with dangerous $PM_{2.5}$ levels are generally predictable and thus sensitive individuals can prepare for them (through face masks, etc.)

- The survey area has a strong association between quality of life and air pollution levels, but this could be due to confounding factors (inner city vs. outer city, etc.)

- Air quality varies on a yearly time scale, providing avenues for future research into the cause(s) of this fluctuation.

In order to improve outcomes for health and safety in the short-term, awareness of *solutions* is more necessary than awareness of the *problem*. As such, our short-term action plan is to expand our data-gathering capabilities in the survey area for both air pollution and weather data, then to make our findings accessible to the public alongside safety information and resources.

Fig. 3. A Kaiterra Laser Egg 2, used in the study to monitor $PM_{2.5}$ levels over time.

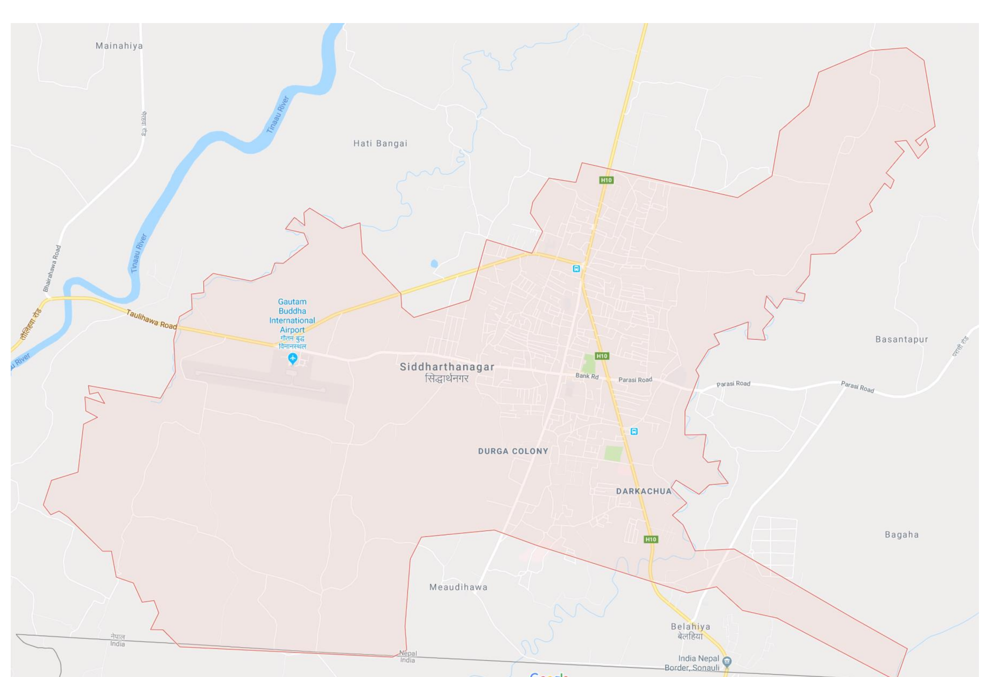

Fig. 4. Proposed locations for additional installations of air quality monitors to improve future data collection.

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