HIGH RESOLUTION SATELLITE IMAGING OF NITROGEN DIOXIDE FROM LOW EARTH ORBIT

IMPROVING ENVIRONMENTAL POLICY EFFICACY THROUGH PERSONAL AND PUBLIC ACCOUNTABILITY

An Undergraduate Thesis Portfolio
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SOCIOTECHNICAL SYNTHESIS

Harmful pollutants such as nitrogen oxides can cause severe lung damage, decrease visibility, and lead to global climate change, among other effects. As many countries try to implement and enforce emission regulations, they require ways to monitor progress and evaluate the best course of action moving forward. The technical solution designed by the capstone team is a small satellite equipped with a high-resolution spectrograph designed to pinpoint the exact locations of increased nitrogen oxide emissions in select cities around the world. The focus of the STS research examines the ways in which governments, industries, and citizens can and should impact emissions in the areas they affect. Specifically, the STS research focuses on improving emission regulation efficacy through personal and public accountability garnered through education and widely available data. This data will come from both currently available satellites and the CubeSat developed by the technical project team to provide deeper insight into urban pollutants and their sources.

The most significant contributor to urban air pollution is vehicle exhaust. This information is determined mainly through estimates and modeling combined with detailed accounting of other sources such as directly measured industrial power plant emissions. Ground stations for measuring air quality are too discrete in their measurements, so total regional measurements are often taken by satellite observatories, which can cover more ground. The spatial resolution of these satellites is especially important for nitrogen dioxide measurements used in the tracking of vehicular emissions. Chemical changes in nitrogen oxides occur on timescales of minutes during the day, resulting in relatively insignificant lateral movement of the gas, constraining the observed high concentrations to within roughly a kilometer of the roadway.

Thus, a new scientific instrument is necessary to monitor the NO_2 levels indicative of vehicular emission along roadways and separate their contribution from the environment around them.

The technical capstone team, under the guidance of Professor Chris Goyne of the Mechanical and Aerospace Engineering Department, have progressed in the design of a CubeSat to measure nitrogen dioxide in the atmospheres of major cities around the world. Having completed a Preliminary Design Review in February and presented the final design summary in April, the team is well positioned for a Critical Design Review early next semester. Nearly all of the component selections are complete, and the information given in the final report will allow next year's team to swiftly begin ordering components and beginning assembly.

The STS research paper focuses on improving how effective environmental policy is in terms of reducing air pollutants. While some regions have managed to decrease their emissions through regulations and other measures, rapidly developing regions such as India struggle to do the same. How can developing countries increase the efficiency of their environmental action policies in regards to nitrogen oxide emissions? They must adopt similar plans to those in the Netherlands and Sweden with changes based on cultural shifts to incentivize personal accountability in preserving the environment.

One of the major problems with current policy attempts is that the governments do not consider all the actors and how they would be affected by the policy. Thus, an Actor-Network model should be considered so all industries, local governments, and citizens have input on the policy so that it can be most effective for them. The actors need some sort of pressure to take part in this process, so education, moral appeals, and public accountability through the media may be necessary to appeal to their better judgement. This personal and public accountability aspect will take some strain off the governments, who may not have the power necessary for strict oversight.

The detailed study of nitrogen oxide mapping within cities will provide insight into the exact causes of increased or excess pollution. In turn, this research can be used to further the development of procedures to limit or eliminate emissions in the areas studied. Scientists may then work with local governments and industry officials in the area to develop a mitigation plan that is specifically targeted to the needs and concerns of that particular area in order to have the greatest impact.

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