Project Proposal

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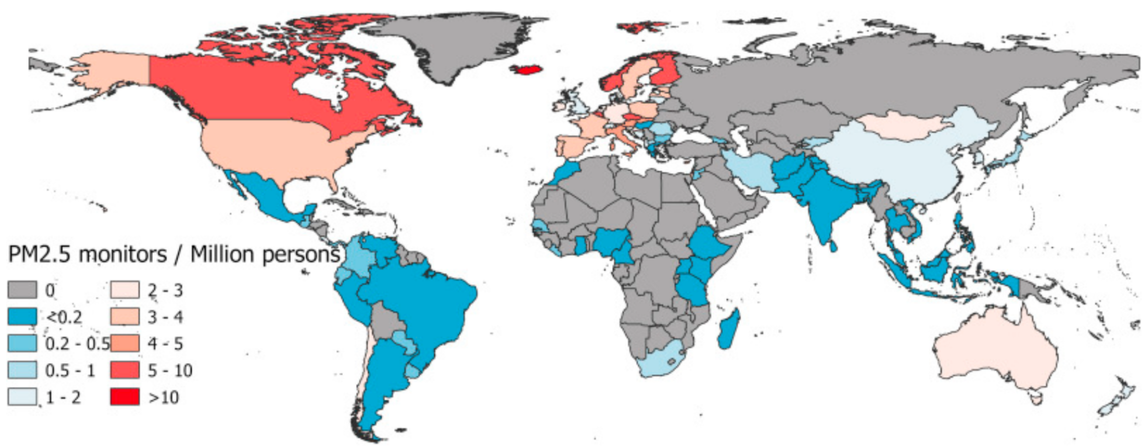
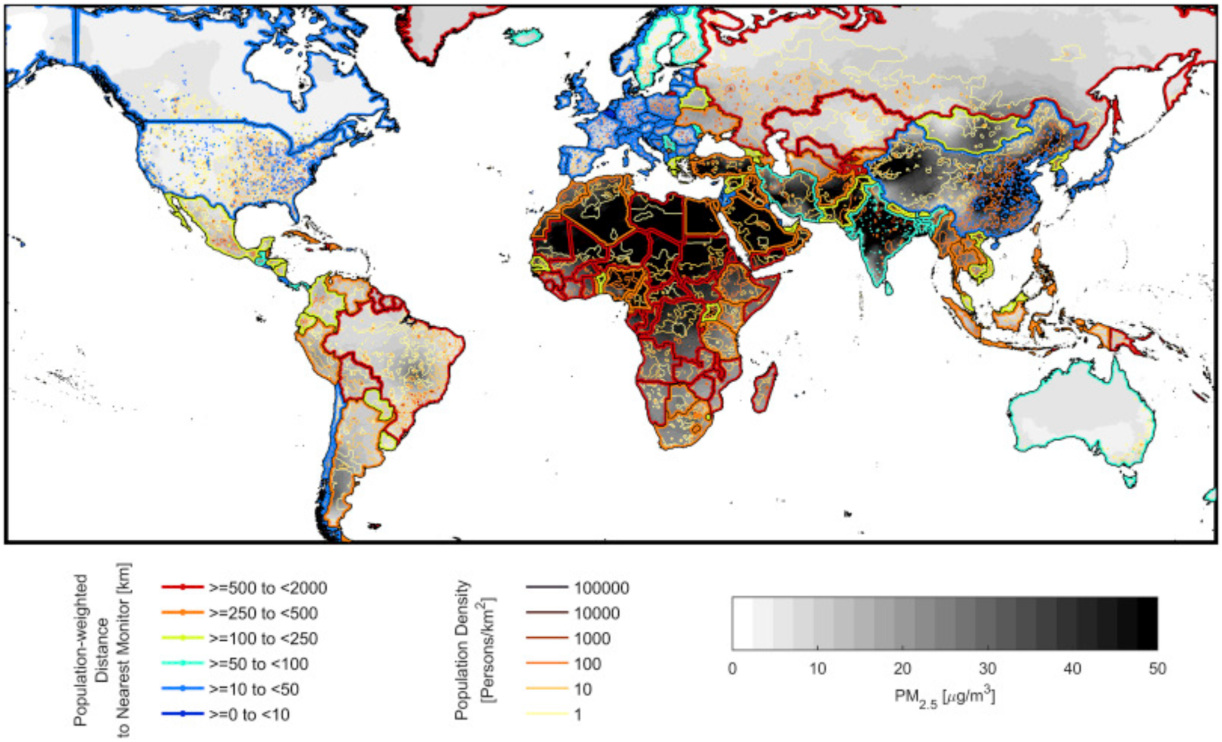
The leading global environmental risk factor for mortality and disease burden is exposure to ambient fine particulate matter (PM2.5) and is associated with global welfare costs in the trillions of dollars. (Martin, Brauer, et. al 2019) PM2.5 are fine, inhalable particles with diameters 2.5 micrometers or smaller. Despite the need for understanding the spatial pattern of PM2.5 at a global scale, insufficient monitoring data exists to answer this question. (Martin, Brauer, et. al 2019)

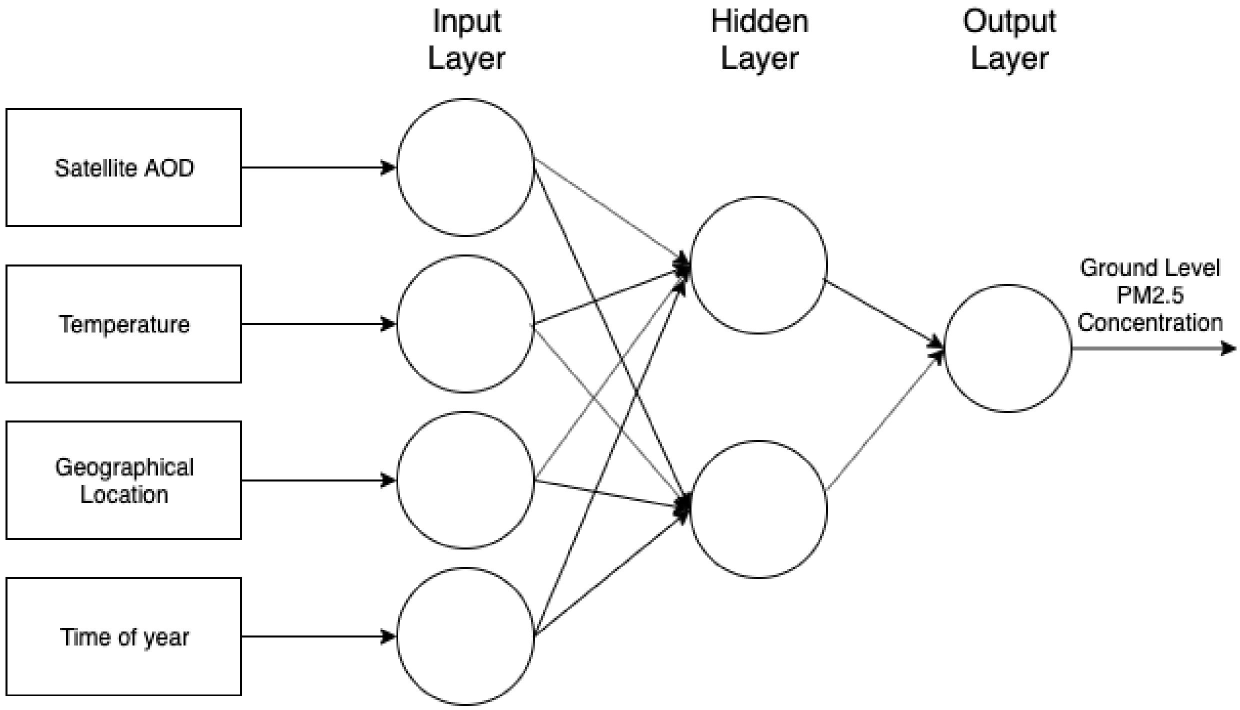
Figure 1 illustrates the number of PM2.5 monitors per million people by country. According to the map, only 24 of 234 countries have more than 3 monitors per million. This is less than 9% of the world's population.



We can also see that monitoring density is particularly low in Africa. The average distance to the nearest monitor exceeds 1000km in central Africa, compared to the global population-weighted mean distance to the nearest monitor of 220km. (Martin, Brauer, et. al 2019) This is certainly too low and hinders the implementation of any adequate air quality management programs. Figure 2, which maps the population-weighted distance to the nearest PM2.5 monitor, starkly illustrates this disparity.



Combining satellite observations with ground station measurements is a promising method for monitoring air pollution by particulate matter (in particular PM2.5). Incorporating geographical data with attributes such as temperature and wind speed into an environmental simulation framework, ground level estimates for PM2.5 can be obtained. A common problem in geophysical research, however, is the lack of sufficient ground station data for remote regions of the world. In such situations, simulation without adequate initial parameters results in air quality predictions that contradict both local ground level observations and visual inspection of atmospheric satellite imagery. As a solution to this, we suggest incorporating simple ground level data such as temperature, geographical parameters such as latitude and longitude, temporal information, and satellite observations (commonly available as satellite aerosol optical depth/thickness via NASA Deep Earth Observatory) into a deep learning architecture that will predict ground level PM2.5 concentrations. The diagram below depicts a schematic of a simple perceptron neural network that can be used to accomplish our objective.



Vast amounts of ground station data exist in the NOAA database that contain detailed meteorological information pertaining to regions within the United States. This data also contains atmospheric PM2.5 concentrations, thus in tandem with other available data points and the aforementioned NASA DEO data, we will have a significant volume of information to form an adequate training set for our model.

Citations

"Aerosol Optical Depth." NASA, NASA, earthobservatory.nasa.gov/global-maps/MODAL2_M_AER_OD.

Martin, Randall V., et al. "No One Knows Which City Has the Highest Concentration of Fine Particulate Matter." Atmospheric Environment: X, vol. 3, 2019, p. 100040., doi:10.1016/j.aeaoa.2019.100040.

"National Centers for Environmental Information." National Climatic Data Center, www.ncdc.noaa.gov/.