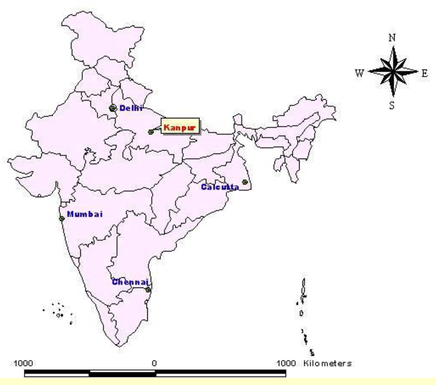

Using Emission Estimates as Exposure Metric: Respiratory Disease and Outdoor Air Pollution in Kanpur, India

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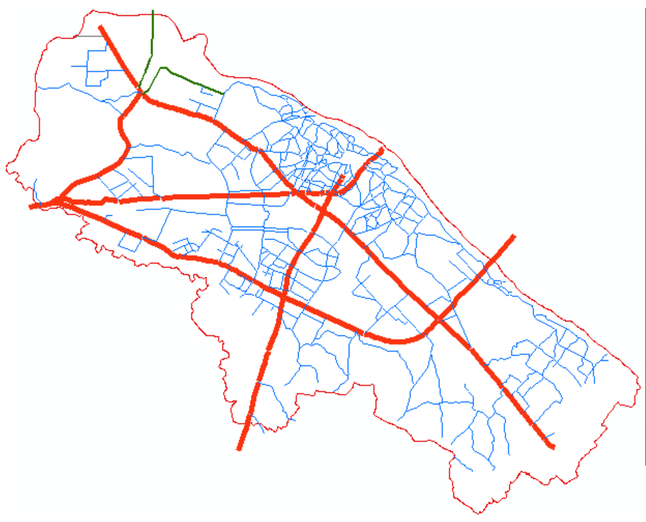
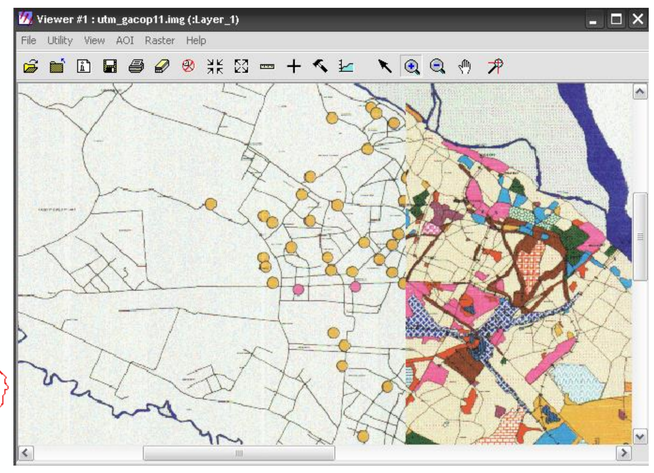
Background: Air quality in Kanpur, Uttar Pradesh, India, was poor during the first half of 2000's, often showing daily PM levels in the range of hundreds of µg/m^3. Air quality monitoring did not cover the whole city and all times, and local information about potential health effects was missing. No health impact assessment was done.

Aim: The study aimed to expand our previous investigations of air quality and respiratory health by analysing one-year hospital records from the main specialist respiratory hospital in Kanpur, in relation to the exposure of the patients. In this way, we wanted to assess the effect of outdoor air pollution on respiratory disease, and provide local evidence of effects.



The road system in Kanpur.

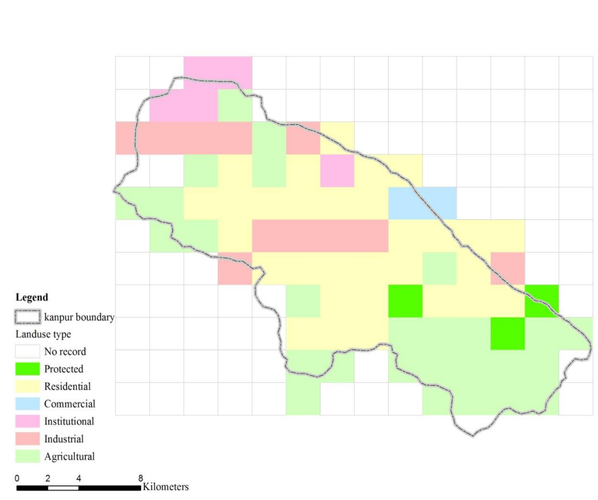


Map overlay with land use categories.

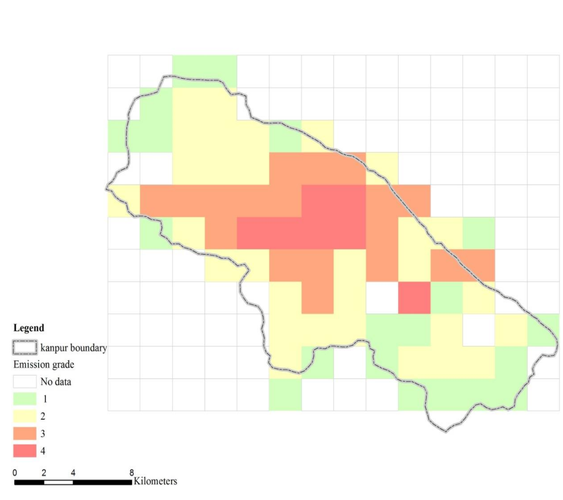
Methods: Available health data consisted of journal information on respiratory symptoms and hospital visit dates of over 7000 patients who visited the hospital for respiratory symptoms in 2006. For all patients, the symptoms recorded in the journal were coded by the medical personnel, and later classified into 12 symptom categories. It was not possible to reliably code the diagnosis.

While some air quality monitoring data were available, they did not cover the whole city and all days, and we decided instead to express exposure using emissions. We performed an emission inventory using a combination of techniques. The city was divided into 154 grids of equal size of 2 *km* x 2 *km.* Population distribution in the grid was obtained by converting ward data. The main land use types were identified using official statistics combined with satellite data. Road network data and information about point sources was obtained from the authorities. A house-to-house survey was conducted in seven key grid squares with varied land use types, noting types of activity on the premises. This procedure led to an emission inventory for SO_2, NO_x and PM_{10}.

Relationships between individual health information (symptoms at consultation, hospital admission) and exposure characterized by the emission category of the grid of the home address were analyzed using logistic regression models, controlling for month.

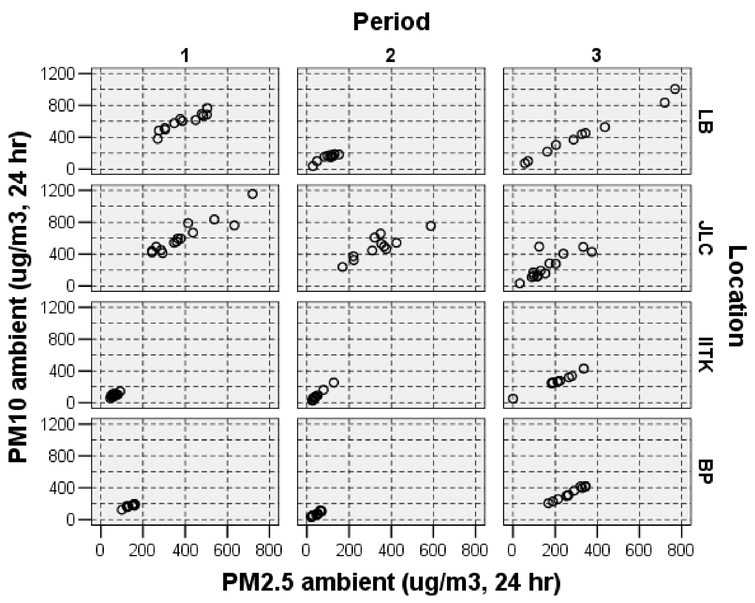


Land use types in grid.

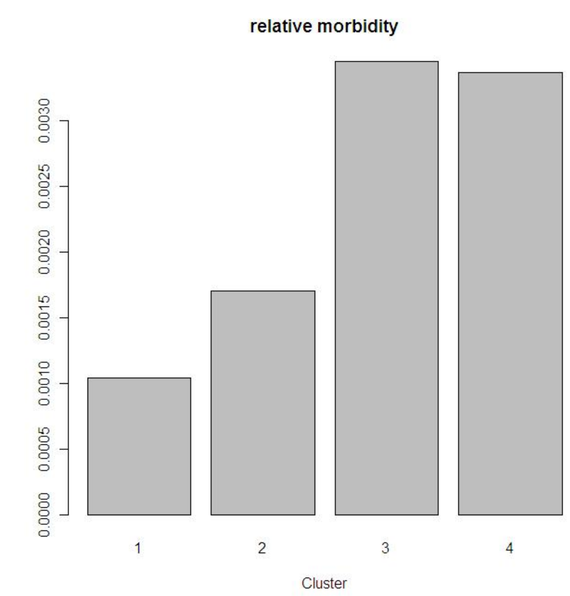


Grid characterization by emission strength.

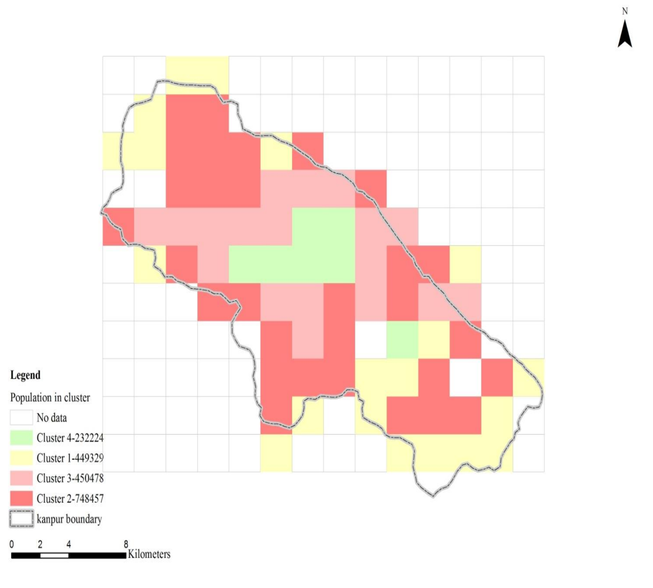
Results: The main sources of air pollution were industries (SO_2 and NO_x), domestic fuel burning (SO_2, PM, NO_x) and vehicles (NO_x and PM). The emissions of PM per grid are strongly correlated to the emissions of SO_2 and NO_x. We found a strong correlation between visits to the hospital due to respiratory problems, and emission strength in the grid of residence.



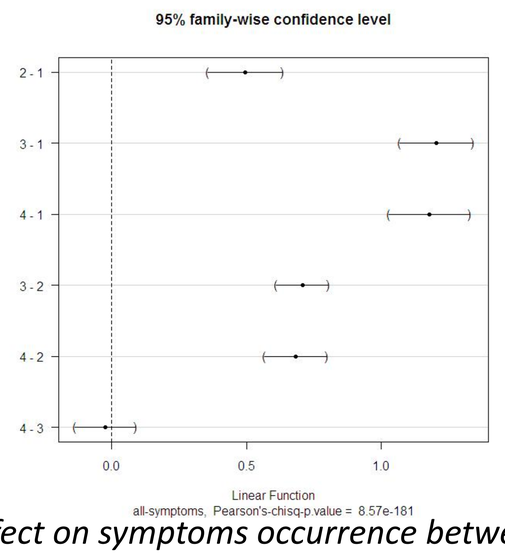
Average daily ambient levels of particulate matter at four locations in Kanpur, (BP and IITK – background, JLC- urban residential, LB –central urban poor area) three seasons, monitoring done in three weeks period using an Indian made air sampler; 2005.



Ratio of hospital inpatients to total cluster population; clusters 3&4 are the most polluted.



Spatial distribution of emission strenght clusters and total population.



The difference of effect on symptoms occurrence between the pairs of emission clusters (Y-axis, cluster pairs); more symptoms are experienced in the more polluted localities.

Conclusion: There is a difference in hospital visits between the areas with less pollution (cluster 1) and pollution (clusters 2, 3 and 4). E.g., comparing cluster 1 and 3, in the grids where the average pollution of SO_2 increases from 36 to 62, *PM* from 45 to 135 and NO_X from 39 to 194 kg per day, the relative risk of hospital visits is higher 3.33x (with 95% CI of (2.91, 3.81)).

Within the 12 pulmonary disease symptoms, only common cold, cough, fever and hemoptysis were significantly associated with emissions. For fever and hemoptysis, the relative risk increases in the highly polluted areas, e.g. in the highest polluted areas (cluster 4), the relative risk of having fever increases by approximately 25%. Common cold and cough are less frequent in the higher polluted areas.

The study demonstrates that in a high pollution area, that other exposure metric than air concentration can be used for health risk assessment.

References: Liu et al, ARCHIVES OF ENVIRONMENTAL & OCCUPATIONAL HEALTH Volume: 68 Issue: 4 Pages: 204-217 DOI: 10.1080/19338244.2012.701246 in print, 2013

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