ESRC Strategic Network:
Data and Cities as Complex
Adaptive Systems
(DACAS)

CASE STUDY REPORT

CASE STUDY 02.B
AIR POLLUTION AS AN EMERGENT PROCESS (INDIA)
DELHI STRUGGLES TO MANAGE

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JOINT DACAS
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Report on the case study 2: Modelling Delhi struggles to manage increasing air pollution.

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The aim of our collaboration was to identify suitable concepts and techniques for modelling the health crisis of Delhi caused by ever increasing air pollution.

Our first approach was directed to the introduction of new ideas for the improvement of the quantitative characterisation of air pollution. This resulted to be a tremendous difficult task. In fact, it is hard to define general pollution indexes as the type and effect of chemical pollutants are very different. Moreover, pollution is strongly dependent on environmental conditions and effects, a fact that generates strong heterogeneity in the possible comparison and evaluation of general aggregate indexes. These behaviours are generally described by means of mechanical models which represent very involved chemical-physics dynamics. This suggests that such phenomena are more characterised by complicated processes than complex dynamics. Moreover, it would be essential to introduce, as a fundamental ingredient for a general modelling of pollution, the collective behaviour generated by the users of the transportation networks of the city under investigation.

Considering that a direct contribution on a microscopic modelling of these phenomena is out of the scope of our study, we thought that a more successful approach could be implemented looking for the presence of scaling laws related to pollution. In fact, scaling laws can be useful in the characterisation of general and universal properties which scale looking at the city as a whole, even if produced by different and specific microscopic interactions and details, which can be ascribed to variation inside the city.

An investigation along these lines should be able to select a specific pollution index which can be measured among different cities with a quite homogeneous scenario in the causes responsible for the pollution. Unfortunately,

at present, we do not know if it could be possible to access these type of data, with a sufficient quality and frequency of measurements, in India. Perhaps, this could be possible using the PM10 evaluation in different european cities. In fact, in Europe, the pool of circulating cars is quite uniform and the indexes are extensively measured. These pollution indexes should be represented as a function of the total time spent on a car by the total population. The idea is to look for a clear relation between a specific pollution index and cars usage, with a quantity that can encompass the number of cars and their effective use. Unfortunately, we think that this quantity can not be easily accessed or inferred.

Next, we turned our attention to the sociological aspect of this problem. As clearly stated by Christopher Doll's presentation, the case of Delhi contrasts with the story of the city of Surat. This city registered an outbreaks of pneumonic plague in 1994. Following this tragic event, a series of changes were introduced to the structural organisation of the city which resulted in improvements in sanitation. In fact, the city went from one of the filthiest cities in India to be recognised as one of the cleanest. By contrast, Delhi struggles to manage increasing air pollution, despite a raft of measures that have been introduced and constant legislative pressure. The natural question is why, in the case of Delhi, the introduced measures did not promote the expected transformations.

One evident difference between Delhi and Surat can be ascribed to the fact that, at individual level, a pneumonic plague and general pollution effects on healths are not perceived in the same way. Dissimilarly to pollution, the Surat case is felt as an intimidating and direct threat. In contrast, it is difficult to recognise a direct cause-effect between pollution and health problems. These differences are responsible in breaking the feedback mechanisms

generated by common people which produce the pressure on the governance which triggers the political will and practice for determining effective policy.

For these reasons, the problem results in a paradigmatic public goods problem. Reducing the use of personal car is a typical situation where it is privately optimal not to contribute, but socially optimal to contribute fully. The determination of the condition which can enhance cooperation and altruism are the key targets in the analysis of these systems. In general, these ideas can be explored by means of a game theory approach. An implementation for the particular situation of Delhi air pollution will probably need a more specific and detailed modelling approach, capable of introducing specific elements of the actual scenario. Perhaps, an agent based implementation could be the more promising strategy for obtaining some interesting results to describe and model the conflict between individual propensity to free-ride and social disposition to contribute toward the provision of a public good.

On one hand, we are confident that the implementation of these techniques will be able to produce some interesting answers. On the other hand, the definition of model parameters which could be directly interpretable in terms of real data and potentially measurable will be a significant difficult to overcome. This is the first necessary step for realising a consistency check between model outputs and field measurements. In this situation, we could be able to discriminate whether or not our answers are really correct and if they can generate innovative solutions to the real problem.