

Multivariate Analysis of Air Quality and Urbanization Characteristics:

A Comparative Study of Cities in China and India

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Outline

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 - Data and Variables
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Introduction - Context

- ◆ Three largest cities in China and India will be among the twenty most populous in the world by 2020
- ◆ Increasingly congested traffic conditions
- ◆ UNESCAP/ADB (2002) named Delhi as the most polluted city in the world (with respect to PM)
- ◆ WHO in 1998 notes: seven of the ten most polluted cities in the world in China

Introduction: Other Studies

- ◆ Countries very similar in terms of GDP and per capita income in 1956 (agricultural economy 80% rural population)
- ◆ Both implemented economic reforms during the 1990s
- ◆ Since then China has recorded a much higher GDP and per capita income
- ◆ Aggregated national characteristics can mask similarities in the urban characteristics

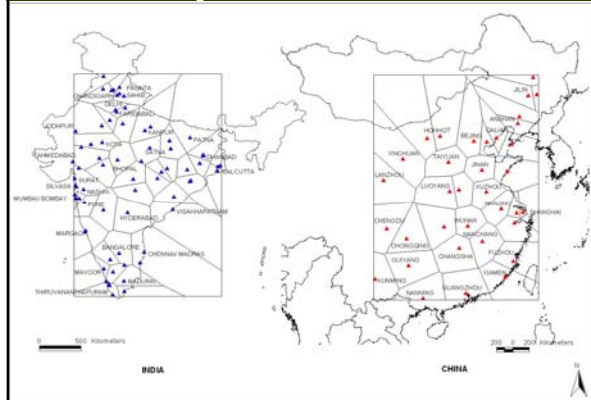
Comparative Studies

- ◆ India has transformed from rail-dominated transport to road-dominated (National highways constituted only 2% of the total road network but carried 40% of the total road traffic)
- ◆ China experienced a similar trend in mode shares though at a different scale as China is far ahead of India in terms of passenger and ton km transported by road

Introduction – Data

- ◆ India (87 locations):
 - Central Pollution Control Board,
 - RITES, India,
 - World Bank
 - National Institute for Urban Affairs and
 - State Transportation Authorities
- ◆ China (70 locations):
 - China urban transportation center (CUTC) affiliated with the Ministry of Construction (MOC)
 - Provincial and transportation yearbooks

Study Area Locations



Introduction – Variables

Population, Worker density
 Transport infrastructure (road length)
 Land use related (Forests and agricultural land, agricultural risk, urban risk)
 Climate (Temperature and Precipitation)
 Ambient concentrations (1998 annual average) (three major pollutants: total suspended particles – TSP, sulfur dioxide – SO₂, and nitrogen oxides – NO_x)

Methodology

Principal Components Analysis (PCA)
 ANOVA by location and size of the city (Population)
 Regression of PM on several independent variables from the PCA

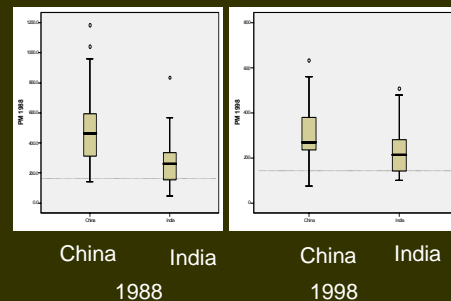
Results PCA: India

- ◆ Factors in 1988:
 - “pollution factor”
 - “urbanization factor” and
 - “urban risk factor”
- ◆ Factors in 1998:
 - “urbanization factor”
 - “at-risk agricultural land factor”
 - “PM” and
 - “pollution factor”

Results ANOVA: India

- ◆ In 1998 many cities appear to be at risk of urbanization, regardless of size or geographic situation.
- ◆ This was not true in 1988 with larger cities on the coast or in the south urbanizing faster.
- ◆ In 1998, as in 1988, larger cities are significantly more polluted.

Ambient PM: China vs. India



Results PCA: China and India

- ◆ 1988 factors:
 - “urbanization factor” that includes pollution related variables other than PM
 - “urban risk factor” and
 - “high PM factor”
- ◆ 1998 factors:
 - “urban risk factor”
 - “pollution factor” that includes all pollution related variables and urbanization variables and
 - “industrialization factor” changes in worker density

Results ANOVA: China and India

- ◆ Cities in two countries differ with respect to pollution as well as urbanization in 1988 and 1998
- ◆ In 1998 it appeared that in both countries:
 - larger cities were significantly more polluted
 - differences in the geographic location of industrialization

Regression Results : China and India

- ◆ In both countries northern locations have on average higher PM and coastal locations would on average have lower PM
- ◆ Urbanized (and polluted) locations (as measured by PCA component) have higher PM levels (all other variables being equal) on average
- ◆ In 1998 (as opposed to 1988) ambient PM in both Chinese and Indian cities could be best differentiated by how urbanized they were rather than which country they were in

Conclusions

- ◆ This study suggests a strong relationship between ambient PM and urban growth in both countries
- ◆ Poor air quality and health issues are some of the consequences.
- ◆ Other issues that arise from urbanization and motorization include roadway congestion, and traffic injuries and fatalities and transportation equity for low-income residents of these cities



Policy implications

1. Balancing economic/urban growth across regions
2. Addressing differences in regional financing of transport infrastructure
3. Need for transportation compliance framework with air quality standards
4. Better data collection and coordination of data