A Sustainable Development and Environmental Quality Management Strategy for Indore

Seeking a sustainable future for a fast-growing city in central India

Rapid urbanization and industrialization often create uncontrolled and indiscriminate growth for cities. This has become the case for the city of Indore in Madhya Pradesh, India.

This article outlines the environmental problems faced by the city, and highlights some of the key steps being taken to move toward a more sustainable pattern of growth.

About This Article

This article begins with some background information on Indore and Madhya Pradesh, including the environmental problems confronting the area. The discussion then describes some environmental planning and information-gathering work that has been done for Indore, including research using geographic information system (GIS) and remote sensing (RS) techniques.

The article goes on to discuss an Urban Management Programme "city consultation" process that has been working to improve governance and environmental protection in Indore. Also discussed are some additional environmental initiatives being carried out in Indore and Madhya Pradesh.

Background: Indore and Madhya Pradesh

Indore, the largest city of Madhya Pradesh state, is located in central India, at 22°43'N latitude and 76°42'E longitude. The city is situated on the Malwa plateau, and there are few physical barriers to the urban area's growth.

The city of Indore currently is estimated to have a population of over 1.8 million. The city serves as the administrative headquarters of the Indore District and the Indore Division.

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Indore has long played an important role in trade and commerce, particularly for central India. The city forms the commercial center of the surrounding agricultural area. In addition, most of the region's imports and exports flow through Indore, which is linked to other cities in the area by road, rail, and air transportation. Indore also is home to the Madhya Pradesh Stock Exchange.

Madhya Pradesh witnessed history's worst chemical disaster in 1984, when a release of methyl isocyanate gas in Bhopal, the state's capital city, led to thousands of deaths and injuries. This incident was instrumental in creating heightened environmental awareness not only in India, but around the world.

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Industrialization in Madhya Pradesh is driven largely by the state's mineral resources. Industrial activities have caused severe environmental problems, including loss of agricultural lands and open space, pollution of air and water, and generation of large quantities of solid waste.

The main industrial sources of water pollution include agriculture-based industries, distilleries, and paper and pulp facilities. There are many under-regulated industrial facilities located in Indore, as well as in other areas of the state.

Indore has seen rapid population growth for the past several decades, with a growth rate from 1991 to 2001 of 48.98 percent. This was significantly higher than the overall national growth rate, and also more than double the rate of rural population growth.

The high rate of growth has led to a population density averaging 470 people per square kilometer, a figure that is more than three times higher than the state's average density of 149 people per square kilometer. The growth of population in the city of Indore is being driven mainly by an influx of people from rural villages seeking employment.

The rapid development of urban areas such as Indore has led to slum-like conditions, with traffic congestion, lack of sanitation, high rates of solid waste generation, and inadequate public services. Industrialization has also accelerated the loss of green space and has contributed to pollution of urban water bodies. It is clear that these problems need to be addressed through well-planned urban infrastructure development projects, along with programs to generate more employment in rural areas (Danida-DEE, 1993).

Madhya Pradesh is one of the largest states in India. Because of its central location, Madhya Pradesh includes six of India's 14 major river systems, as well as many smaller streams and tributaries. Many waterways have been contaminated by domestic and industrial waste.

There also has been a rapid growth of groundwater use and irrigation projects, leading to a decline in water levels in most of the state. In many areas, groundwater levels have declined by up to two meters, with declines of more than four meters occurring in Indore and some other regions.

In addition to being a major producer of agricultural crops, Madhya Pradesh ranks first in cement production in India, accounting for about 25 percent of the country's total capacity. The state is also a leading producer of limestone. Intensive mining of limestone has created many environmental problems, ranging from solid waste–disposal issues to air pollution, harmful hydrogeologic effects, and land degradation.

Forests in the state have experienced serious degradation, including forests in the area around Indore. A major portion of forest land has been lost throughout Madhya Pradesh.

Air pollution also has increased. Although the levels of sulfur dioxide (SO_2) and nitrogen oxides (NOX) generally have remained within allowable limits, suspended particulate matter (SPM) levels

in urban areas are often well above the limits provided in the National Ambient Air Quality Standards. SPM in residential areas of Indore has been measured at critically high levels.

Worsening air pollution in urban areas such as Indore is being caused in large part by an increased use of automobiles. A study from 1997-98 found that there were 43 vehicles per 1,000 persons in Madhya Pradesh, somewhat higher than the national average of 40 vehicles per 1,000. A study the following year found that many of the vehicles in Bhopal and Indore did not comply with emission limits, in part because of poor maintenance. Growing traffic congestion also contributes to air pollution in urban areas.

In an attempt to prevent further deterioration in the urban air quality of Madhya Pradesh, government authorities have suggested a number of measures, including:

- improved road design and network planning;
- better regulation of heavy-duty vehicles on the inner-city trunk roads at peak hours, in order to reduce traffic congestion;
- redesign of main junctions, which often slow down the flow of traffic;
- improved maintenance of roads to facilitate smooth traffic movement;
- control of urban growth along highways;
- limits on the growth of commercial complexes that attract automobile traffic on busy roads;
- creation of bike paths, and promotion of bicycle use for short-distance travel; and
- imposition of vehicle parking fees in commercial areas (Environmental Planning & Coordination Organization, 2001).

None of the cities in Madhya Pradesh, including Indore, provide waste disposal and sewage collection and treatment for all their residents. As a result, untreated or partially treated waste ultimately reaches rivers, lakes, and other waterways within the state. Many rivers show evidence of this ongoing pollution. Because of water contamination, diseases such as cholera and jaundice showed an increasing incidence during the 1990s, although the death rate from these diseases decreased.

With continuing increases in urban populations, the solid waste problem has also grown. In 2001, it was estimated that Madhya Pradesh generated about 3.65 million tons of solid waste. Although Indore is using some municipal waste as bio-fertilizer, the solid waste problem is expected to worsen in future years.

A number of hazardous chemicals and substances (including chlorine, ammonia, hexane, and pesticides) are used in large quantities throughout Madhya Pradesh. A fairly high percentage of urban residents use wood for fuel. The rate of liquid petroleum gas and kerosene use is somewhat lower than the national average.

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Sustainability and Environmental Management Planning

Sustainable development requires the conservation of resources, and the protection of environmental quality, in order to protect the interests of future generations. Perhaps the most widely used definition of sustainability is the one agreed on by the World Commission on Environment and Development (the Brundtland Commission) in 1987: "Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Achieving sustainability is especially difficult for a country such as India, which faces a growing number of serious environmental issues. In an attempt to address these concerns, environ-

mental management plan studies have been prepared for many environmentally fragile areas of the country. Growing energy, environmental, and development imbalances make it critical that planners integrate environmental considerations into industrial development (MNCES, 2001).

GIS/RS Research Studies

Government authorities recognize that planning for the city of Indore should encompass peripheral areas so that the city's growth can be well managed, and so that outlying areas can be integrated successfully with the urban core. Effective planning can help growing areas save a significant amount of agricultural land from development, while also channeling growth in more desirable directions.

Much of the planning work in Indore has been based on the joint efforts of the Space Applications Centre of the Indian Space Research Organization (SAC/ISRO), located in Ahmedabad, and the Directorate of Town and Country Planning in Bhopal. These organizations prepared a "Development Plan of Indore City for the Year 2011" with information gathered from geographic information system and remote sensing techniques.

In addition, a "Perspective Plan of the Indore Metropolitan Region for the Year 2025," was initiated jointly by SAC/ISRO, the Directorate of Town and Country Planning, the Indore Municipal Corporation, the Indore Development Authority, and the Madhya Pradesh Remote Sensing Applications Centre.

Given its rapid growth in population, the city of Indore has struggled to provide services and maintain adequate infrastructure. GIS/RS-based information on growth trends can help city officials better understand the problems they face, and can suggest potential solutions.

Preparation of sustainable urban development plans necessitates an understanding of how the many components of the urban environment interrelate. Data collected on various aspects of the environment also must be synthesized into usable information. GIS/RS approaches can provide timely, accurate, and pertinent data that can be readily integrated into sustainability planning and decision making.

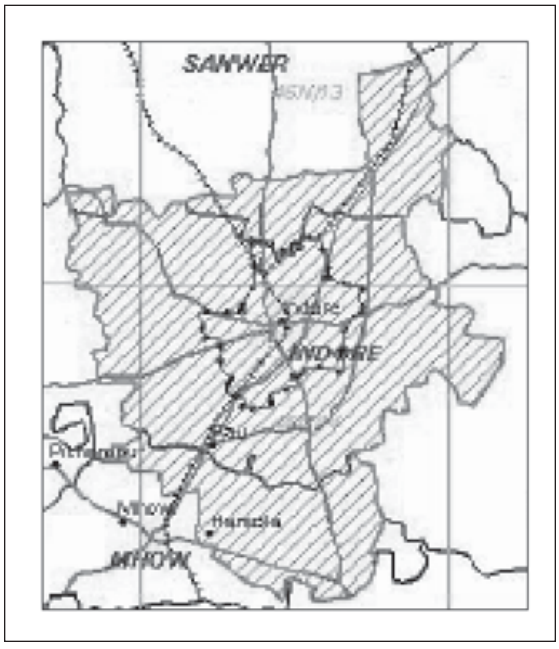
Preparing a development plan for a municipality entails looking not only at the city itself, but also at its surrounding areas. Accordingly, the GIS/RS study included both the city of Indore and its surrounding regional area (see **Exhibit 1**).

The GIS/RS research was undertaken for the purpose of creating a sustainable urban development plan for the city of Indore and its environs. Planners understood that a scientifically based and environmentally sustainable plan would need to consider all existing components of the environment, as well as those that are likely to arise in the future (Goyal, 2003).

Urban Management Programme City Consultation

In May 2000, the Indore Municipal Corporation (IMC) approached the Urban Management

Exhibit 1. Indore Study Area Map



Programme (UMP) with a request for assistance and support.

Background: UMP and Its Activities

UMP is a joint program of UN-HABITAT, the United Nations Development Programme, and the World Bank. It offers technical assistance on urban management in the areas of participatory urban governance, alleviation of urban poverty, and urban environmental management.

India is served by the Urban Management Programme Regional Office for Asia and the Pacific (UMP Asia). UMP Asia describes its mission as follows:

> The development objective of the Urban Management Programme is to strengthen the contribution that cities and towns in developing countries make towards human development, including participatory governance, economic efficiency, social equity, poverty reduction, and environmental improvement. This is to be achieved through more efficient and equitable use and distribution of resources, including the harnessing of skills and initiatives of individuals, communities, private and voluntary organizations and local authorities. (UMP-Asia Web site)

UMP operates through a process of "city consultations" that bring together key participants (including local government authorities, private-sector representatives, community organizations, and other stakeholders) to seek solutions to urban management problems. UN-HABITAT (2001) states:

> The underlying premise of the UMP city consultation process is that . . . poor city administration is often due to bureaucratic and unresponsive modes of administration and a result of weak rapport with the stakeholders, particularly the urban poor. Through the city consultation process, the local governments are encouraged to engage in constructive dialogue with the stakeholders and involve them in . . . decisionmaking concerning [the] city's development. Towards the goal of ensuring [institutionalization of] the consultative process, the local and regional partner institutions are encouraged to build adequate rapport with the city government and the stakeholder groups and ensure that institutional mechanisms are established.

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UMP Asia explains that its consultations are "primarily intended to improve cities' policies, management and administration in the UMP thematic areas of poverty, environment and governance." The consultation process is described as having the following characteristics:

- an embodiment of the tenet of partnership, whereby all stakeholders, both within and without city government, treat with each other on the basis of respect and equality;
- designed as a process, not merely an event and an end in itself, but intended to achieve improvements in the way city governments do business;
- problem-orientated by assessing strategic priorities through dialogue with stakeholders;
- flexible and does not require following specific guidelines and sequences of events;
- supported by anchor institutions that will eventually take over the role of UMP in handling city consultations; and
- replicable to as many cities as possible (UMP Asia Web site).

Local Partner Institutions

UMP relies on local partner institutions to facilitate city consultations and provide an institutional base for its efforts. These local partners typically handle day-to-day facilitation of consultation-related activities.

The primary local partner institution in the case of the Indore city consultation was the Center for Community Economics and Development Consultants Society (CECOEDECON), a nongovernmental organization. CECOEDECON was established in 1981 as a flood relief agency, but since has expanded its efforts to encompass rural development, health- and education-related activities, advocacy, and networking, with an emphasis on soliciting and encouraging community participation. CECOEDECON's mission statement notes:

> The issues that are the focus of [CECOEDECON programs, such as natural resource management] provide the organization with useful entry points that enable it to work with its target groups to develop their institutional capacity. This includes their ability to make wise decisions, mobilize resources, allocate responsibilities, undertake action, and resolve operational problems. They are, thereby, able to effectively participate in and take ownership of the interventions the organization assists them to carry out. However, the aim is also long-term: By assisting the target groups to develop and strengthen their institutional capacity, it is hoped that they will be able to tackle other developmental issues, largely on their own, after the organization's withdrawal from the local area. (CECOEDECON Web site)

Participants in the consultation process recognized that Indore's rapid growth was undermining the city's ability to provide and manage basic services.

CECOEDECON established a field office at Indore in 2001, and began working closely with the city administration. Local activities of CECOEDECON and other organizations involved in the city consultation were supervised by an Officer on Special Duty working in the office of the mayor of Indore.

The City Consultation Process

The consultation process for Indore formally began in February 2001, when UMP representatives signed a Memorandum of Understanding with IMC, CECOEDECON, and a second local partner.

The partners sponsored a launch workshop that attracted about 50 participants from various stakeholder organizations. The workshop was also attended by the mayor of Indore, the city's municipal commissioner, the District Collector, and key IMC personnel.

The local partners prepared a city profile for Indore, and organized formal consultation sessions.

Goals of the Consultation Process

Participants in the consultation process recognized that Indore's rapid growth was undermining the city's ability to provide and manage basic services. One key problem identified by the participants was lack of municipal revenue. At the time the consultation process began, the IMC had expenditures of almost 500 million rupees per year, but was collecting revenue of only about 90 million rupees.

One source of the revenue shortfall was the city's water supply system: It was found that 90 percent of water-supply connections were unmetered, and were being assessed only flat charges of 60 rupees per month. Even with these minimal charges, the city's fee collection rate was only 70 percent. Moreover, the demand for potable water in the city was increasing at the rate of nearly 5 percent a year.

It was clear that Indore needed more efficient governance, and especially better revenue mobilization. This in fact became one of the key goals of the consultation process.

In addition, the consultation aimed to create a participatory environmental management system for the city. The ultimate goal was to create a system that could set benchmarks for such key environmental areas as water and sanitation, air quality, and solid waste management. Clearly, delivery of services in all these areas could be substantially enhanced if Indore could collect more revenue.

By encouraging citizen involvement and participation, the consultative process also aimed to make Indore a more "people-friendly" city (UMP Asia, 2001).

Outcome of the Consultation Process

UMP Asia selected Indore for its consultation program in part because the city's governance and environmental problems were representative of those being faced by many other municipalities. In addition, the city's leaders were very committed to the consultation process.

It will probably take several years for the full effects of the city consultation to be seen. However, it is already clear that the city of Indore has benefited from the ideas and recommendations that have been generated by the consultation process.

UMP Asia has noted, "The involvement and commitment of the highest level of city leadership—the Mayor and the Municipal Commissioner—to the consultation process could be a key factor in the acceptability of the process and its outcomes across different stakeholder groups" (UMP Asia, 2002).

Carrying Capacity and the Growth of Indore

It is estimated that Indore will need a significant amount of additional land area for its growing population within a few years. In order to address these increasing demands for land, research has looked at the physical characteristics of the surrounding terrain, and researchers have sought to allocate land to appropriate uses.

As part of the city consultation process, a city profile was prepared for Indore, including information on demographic patterns. Understanding these patterns is crucial to effective planning for sustainable development.

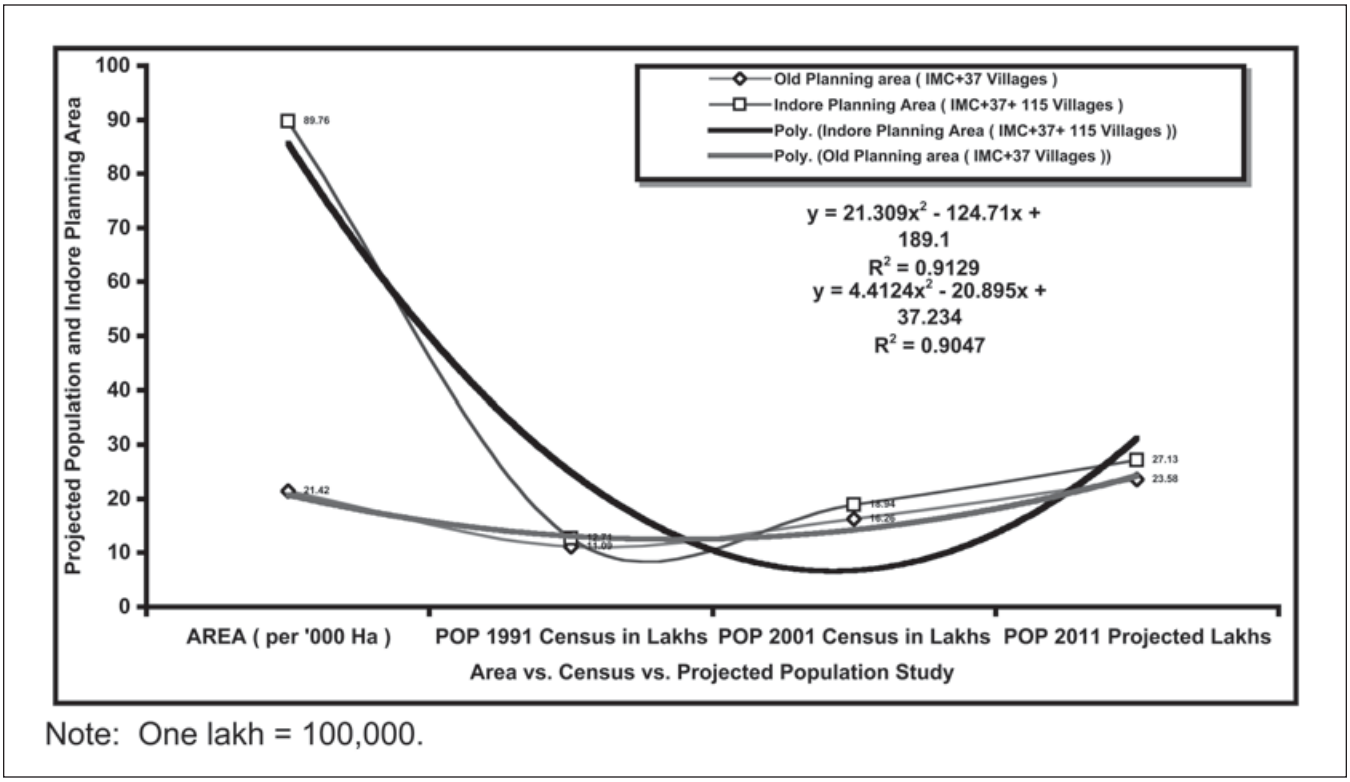
According to the 2001 census, the population density of Indore exceeds 2,000 persons per square kilometer in some areas of the city—a very high density. Population growth in Indore has been rapid. The city planning area grew 46.87 percent from 1971 to 1981, another 33.82 percent from 1981 to 1991, and an additional 48.98 percent from 1991 to 2001 (Goyal, 2003). Future projections indicate that Indore will probably have a population of about 2,713,000 in 2011. See **Exhibit 2.**

It is estimated that Indore will need a significant amount of additional land area for its growing population within a few years.

The GIS/RS research discussed above looked at the physical growth of Indore from 1975 to 2000, and then created an "urban sprawl" map using topographical depictions and remote sensing data. **Exhibit 3** shows detail on the physical growth of the city, indicating sprawl periods and areas.

It has been calculated that the city of Indore will need as much as 5,910 additional hectares of land by 2011, based on a population density averaging 150 persons per hectare. However, only 4,996 surrounding hectares are considered to be "highly suitable" for urban development. Additional areas totaling approximately 25,020 hectares are considered "moderately suitable" for such development (Goyal, 2003). **Exhibit 4** shows the additional land that Indore will need by 2011, based on projected population increases.

Exhibit 2. Population Projection—Indore Planning Area



Note: One lakh = 100,000.

Exhibit 5 shows the percentage distribution of present land uses, and the target percentages for residential, commercial, industrial, recreational, public and semipublic, and transportation activities, based on the norms provided in the Ministry of Urban Affairs and Employment's guidelines for urban development plan formulation and implementation (UDPFI).

Exhibit 3. Indore Urban Sprawl

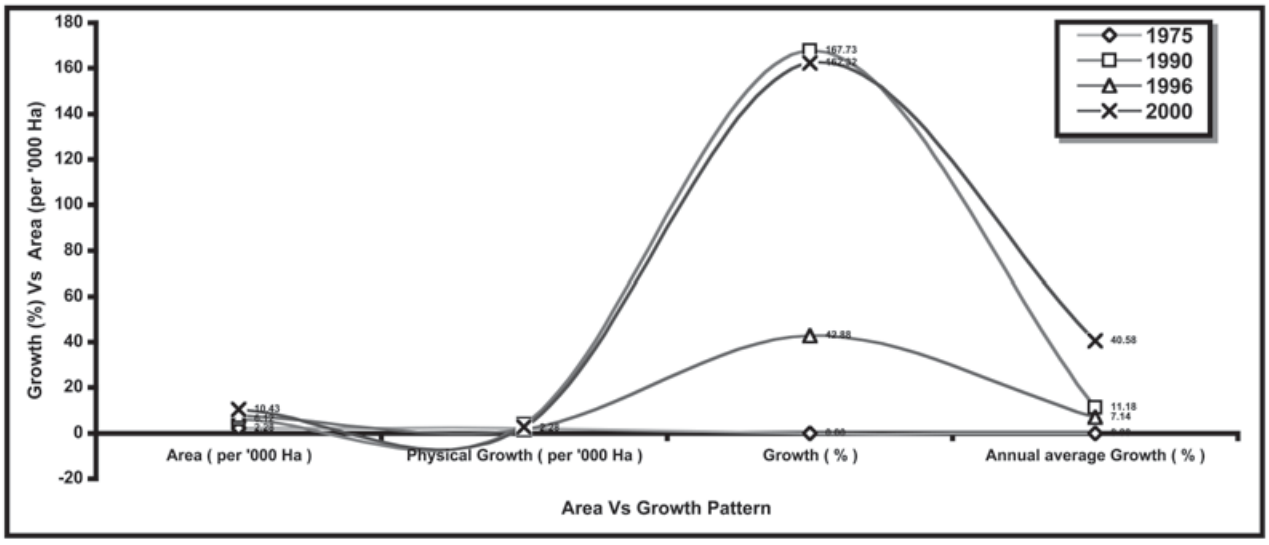
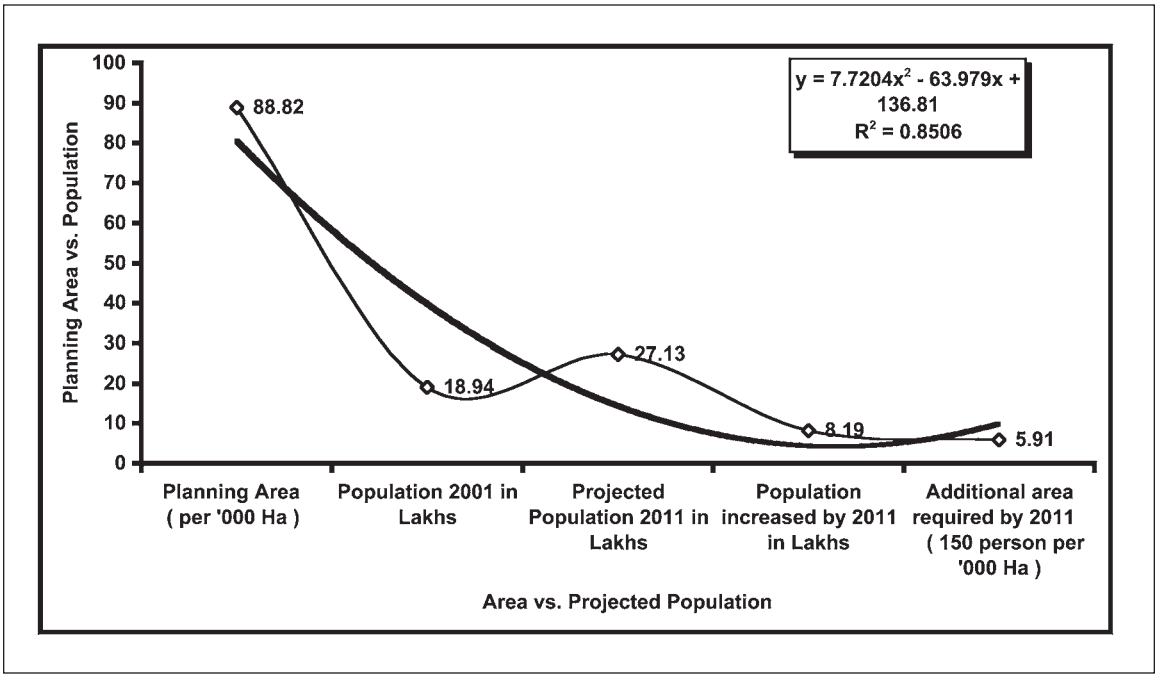


Exhibit 4. Additional Land Area Requirement by 2011 as per Indore Planning Area

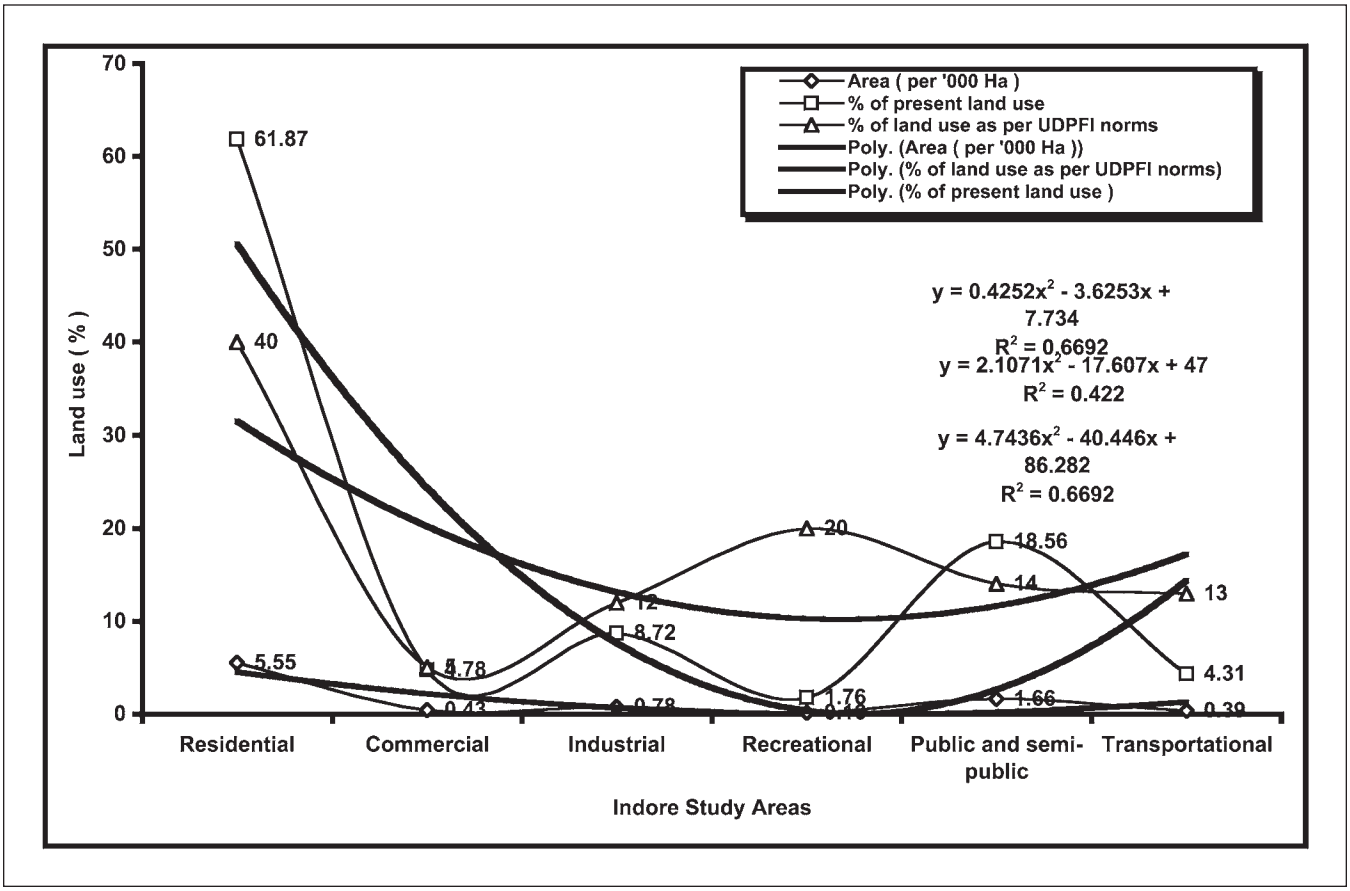


Environmental Initiatives in Indore and Madhya Pradesh

In addition to the activities described above, several other initiatives, both public and private, currently are seeking to address environmental issues in Indore and Madhya Pradesh:

- The government of India has approved a proposal to create a combined treatment system for hazardous industrial wastes generated in Indore and other surrounding areas (MoEF, 1992). Helping with this project are the International Development Agency of Canada and India's Ministry of Environment and Forests.
- With assistance from the State Pollution Control Board, 12 industrial facilities situated in Madhya Pradesh have gained ISO 14001 certification, and another 13 facilities are in the process of obtaining certification.
- Emergency Response Centers (ERCs) have been established at several locations in India, with the goal of preventing chemical accidents that could adversely affect humans and the environment. ERCs also provide technical assistance during chemical disasters. In 1999, when a cyclone struck Orissa and created a hazard to ammonia tanks, the ERC provided valuable technical information, as well as first-aid assistance.
- A green productivity workshop was organized for industrial facilities in Indore and Bhopal, with the help of the Asian Productivity Organization, based in Japan. This organization also agreed to establish a pilot project for green productivity at the Rama Phosphates Limited facility located in Indore. The project identified several problem areas that were producing excessive wastes and emissions, and helped develop options for addressing them; many of these measures already have been adopted.
- An environmental management plan (EMP) for the Indore urban area was completed in 2003. EMPs are intended to help provide planning and environmental management solutions for cities that are faced with increased environmental risks.

Exhibit 5. Distribution of Existing Land Uses and UDPFI Norms



- A number of towns and cities in India have volunteered to prepare local reports on their socioeconomic, development, and environmental status. This Urban Environmental Information System initiative has been implemented in Indore, as well as in other cities of Madhya Pradesh.
- Regular air-quality monitoring continues to be carried out through the Central Pollution Control Board, pursuant to the National Ambient Air Quality Standards. As noted previously, the most prevalent form of air pollution involves high levels of SPM. Indore is one of the cities that is seriously affected by this pollutant (see **Exhibit 6**), due in large part to widespread domestic use of coal, wood, and biomass fuel.

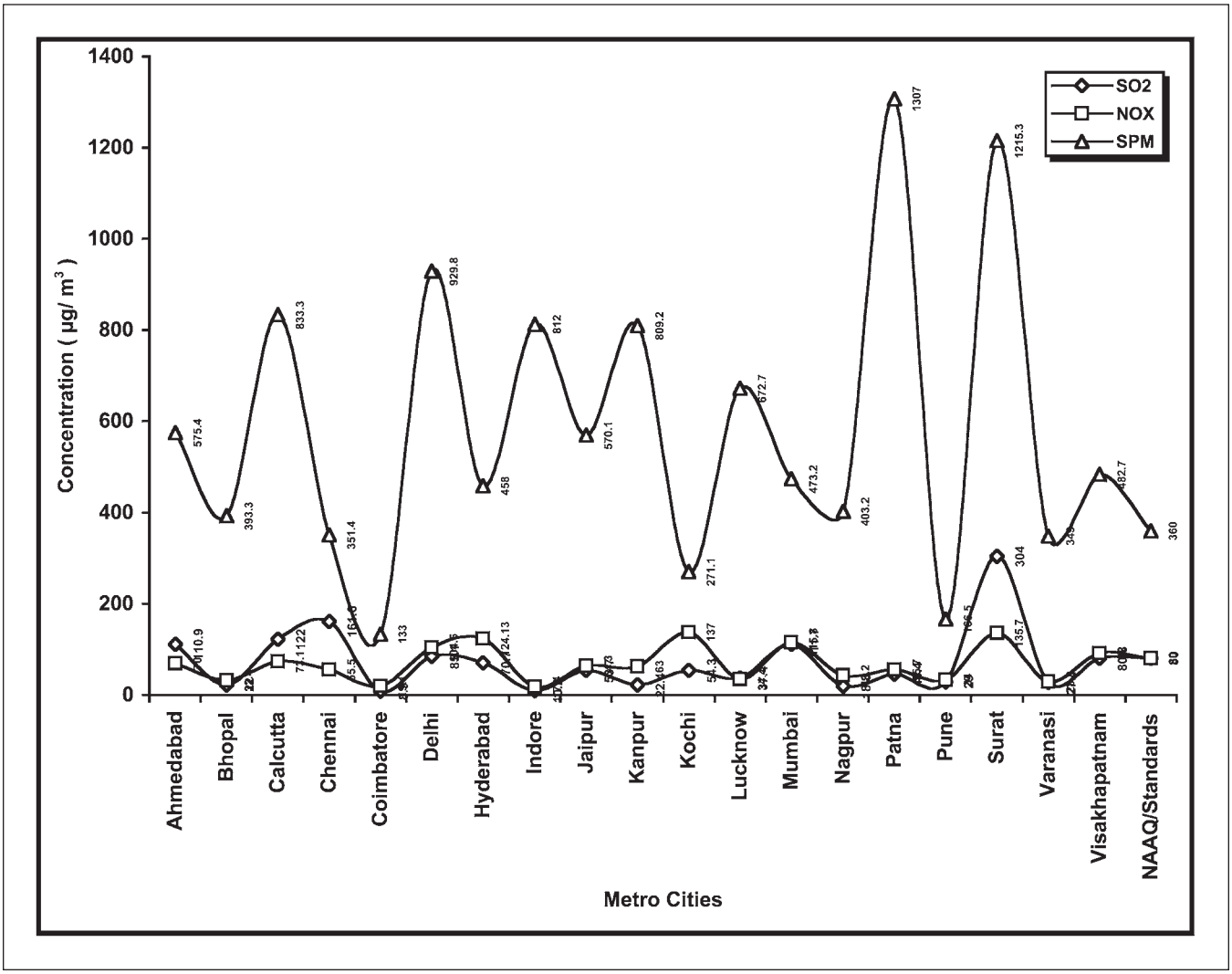
Conclusion

Indore is the largest city in the central Indian state of Madhya Pradesh. It serves as a commercial capital, and is one of the fastest-growing urban centers in the country. The population of the city is projected to increase to over 2,700,000 by 2011.

Urban growth has already resulted in the loss of substantial amounts of agricultural land around the city of Indore, an effect that can clearly be detected with GIS/RS techniques.

This rapid growth has been driven by industrialization, and has involved a significant migration of population from more rural areas of the surrounding region into the city. Industrialization is economically important to Indore and to Madhya Pradesh state, but it also plays a major role in creating environmental problems that

Exhibit 6. Maximum Level of Air Pollution in Metro Cities, India



range from destruction of forests and loss of cropland to pollution of the air and water.

Municipal officials in Indore are aware of the need for better planning to ensure a sustainable future for the city and its surrounding areas. Several efforts have been initiated in recent years to gather information and promote more environmentally friendly development.

GIS/RS studies clearly show the explosive growth that Indore has undergone, and reflect rapidly expanding demographic patterns.

The Indore Municipal Corporation's work with UMP Asia has created a basis for more efficient governance, enhanced revenue mobilization, and a participatory environmental framework that can set effective goals in areas such as water and sanitation, air quality, and solid waste management.

It is hoped that these efforts can contribute to creation of a sustainable future environmental strategy for the city of Indore and its surrounding areas.

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