

# Developing Interface of Information Systems for Preparation of Climate Change Responsive City Plan

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## 1 ABSTRACT

During the last few years climate change has become a growing worldwide environmental concern. The vulnerability of cities to climate change is largely underestimated. There is no established or standardized set of city indicators that measures the effects of climate change on cities and assesses those risks and the role that cities play for, example, in contributing to greenhouse gas (GHG) emissions. Energy consumed in heating and lighting of residential and commercial buildings generates nearly a quarter of GHGs globally and transport contributes 13.5 per cent, of which 10 per cent is attributed to road transport (McCarney 2009). According to the Clinton Foundation, large cities are responsible for about 75 per cent of the GHGs released into our atmosphere. Other way there is no system has been developed yet to collect, collate and disseminate the information. A city has planned without accounting the climate change of city and its consequences. City is a cause of climate change and vice versa its subsequent victims of its affect. Given that half of the world's population started to live in cities by 2007, it is no exaggeration to say that the battle against climate change will be won or lost in our cities.

According to 2011 census of India the total population of India is 1.2 billion the annual growth of population is 1.8%. In India, the urban population is 377 million as per 2011 census, which accounts for 31.6 percent of the total population. Due to rapid industrial growth, the urban population is increasing rapidly. The population is largely concentrated in a few large cities and 35 metropolitan cities, which accounts for 35.4% of the total urban population. The urbanization in India mainly is due rural to urban migration of population. The challenges of urbanization in India are unprecedented in scale and significance. One of the expected impacts of climate change on Indian subcontinent is a general increase in both the mean minimum and mean maximum temperatures by two to four degrees centigrade (Sharma et al. 2006). A 10 to 15 per cent increase in monsoon precipitation in many regions, a simultaneous precipitation decline of 5 to 25 per cent in semi-arid and drought-prone central India, and a sharp decline in winter rainfall in northern India is also projected (Ramesh and Yadava 2005). Carbon emissions, climate change, and their economic and ecological impacts on India's cities are inevitably correlated.

The nation lacks comprehensive, robust, and credible information systems to inform climate choices and evaluate their effectiveness. In this context it is necessary to mention that the content of the master plan of any city contains various aspects that depict the morphology of the city except information on weather, climate, climate change and causes and consequence relationship between climate and city. For a sustainable city plan an integration of information systems where the input will arrive from both urban and environmental sector. In India Ministry of Urban Development has launched National Urban Information System (NUIS) Scheme (March 2006) to develop GIS data bases for towns/ cities in the country. Another initiative by Ministry of Environment, Forest and Climate Change is Environmental Information System (ENVIS) which aims to collect, collate, store, retrieve and disseminate environment related information across the country. ENVIS and NUIS individually act as a self sufficient information system for disseminating information in their respective fields but individually none of them is able to address the climate change issues in urban areas. For preparation of climate change responsive city plan the information input should integrate both ENVIS and NUIS. Developing an interface between ENVIS and NUIS can enable these two systems more affective individually as well as jointly towards climate change responsive City plan.

## 2 BACKGROUND

During last few years climate change has become a growing worldwide environmental concern. One of the most remarkable characteristics of climate change is increase in temperature, so it has been mainly recognized as 'global warming'. This warming has been attributed to enhanced greenhouse effect produced, among others, by increased amounts of carbon dioxide from burning of fossil fuel since Industrial Revolution (Houghton, 2004). Global warming is already having noticeable consequences, and will likely lead to more devastating ones. Some of the impacts of this phenomenon on environment and human beings are, changes in distribution of rainfall and temperature, migration and even extinction of animals and plants,

the spread of diseases to new areas, and melting of glaciers and ice caps (Parry et al., 2007), with consequences of sea level rise and water availability. These impacts on ecosystems are obviously different and more or less severe depending on the region of the world. Effects of climate change, for example, could be more devastating in tropical regions, where more than 50% of the earth’s surface is located (between 300 N and 300S) and 75% of the world population lives (Thompson, 2000).

The vulnerability of cities to climate change is largely underestimated. There is no established or standardized set of city indicators that measures the effects of climate change on cities and assesses those risks and the role that cities play, for example, in contributing to greenhouse gas (GHG) emissions. To the extent that cities promote use of cars, urban sprawl is also often associated with climate change. Energy consumed in heating and lighting of residential and commercial buildings generates nearly a quarter of GHGs globally and transport contributes 13.5 per cent, of which 10 per cent is attributed to road transport (McCarney, 2009). It can safely assume that a sizeable portion of this volume of emissions is generated in cities. According to the Clinton Foundation, large cities are responsible for about 75 per cent of the GHGs released into our atmosphere. Other way there is no system which has been developed to collect, collate and disseminate the information related to cause and effect relation between City and climate change. A city has been planned without accounting the climate change of city and its consequences. City is a cause of climate change and vice versa its subsequent victims of its affect (Figure: 1).

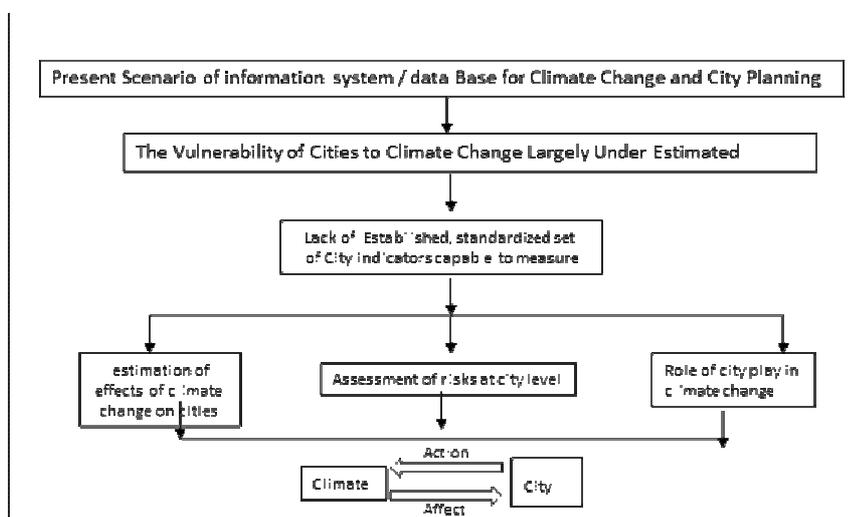


Figure: 1 City is a cause of climate change and vice versa

### 3 URBANISATION IN INDIA

According to 2011 census of India total population of India is 1.2 billion, annual growth rate of population is 1.8%. In India, the urban population is 377 million, which accounts for 31.6 percent of total population. The population is largely concentrated in a few large cities and 35 metropolitan cities, which accounts for 35.4% of total urban population. As per 2011 census total no of town is 7935. The urbanization in India mainly is due rural to urban migration of population. However, the higher productivity seen in urban areas is contingent upon the availability of quality infrastructure services. Urban economic activities are dependent on infrastructure, such as power, telecom, roads, water supply, and mass transportation, coupled with civic infrastructure, such as sanitation and solid waste management. Challenges of Urbanization in India are unprecedented in scale and significance. The fast growing metropolitan cities in India has contributed negatively in the development process through different issues. Lopsided pattern of urbanization and inadequate investments has led to serious deficiencies in urban infrastructure and services like housing, transport, water supply, sanitation and social infrastructure especially in small and medium size cities.

#### 3.1 Consideration Climate change in Master Plan preparation

The master plan of any city of India contains various aspects that depict the morphology of the city like Regional and Sub-Regional Frame, Population and Employment, Urban limit/ Municipal Areas, Shelter, Trade and Commerce, Wholesale Trade, Industry, Government Offices, Environment, Conservation of Built Heritage, Urban Design, Transportation, Social Infrastructure, Physical Infrastructure, Mixed Use

Regulations, Landuse Plan, Development Code etc, but there is no section on weather, climate and climate change.

In case Delhi of where estimated CO<sub>2</sub> emission from the metropolis itself is around 15.42 million metric Tons, in Delhi Master Plan 2021 in the section of environment the increase in temperature, emission of GHG are not mentioned. Issues related to GHG emission from various sectors, projected GHG emission from existing city life as well as from proposed development/ change in landuse are totally neglected. Variation in daily minimum and maximum temperature, temperature dissimilarity in the core and periphery of the city, variation in spatio-temporal distribution of rainfall are not considered during Master Plan preparation. The proposals are delivered in isolated matter. The features of urban sectors are not integrated with its counter part of environmental factors. The gaps in consideration of aspects related Climate Change in City Planning practice are mainly due to the following reasons:

- (1) Limited Knowledge of Climate Change Adaptation: The critical gap is lack of knowledge about both the processes of climate change and also its impacts. Also, the measures identified by the stakeholders deal mostly with mitigation (afforestation, sustainable transport), and not with adaptation. Knowledge about possible adaptation mechanisms specific to the local context is missing. This gap can be potentially addressed through conducting workshops with various stakeholders at local state and national level.
- (2) Lack of information and lack of formal mechanism of information exchange: One of the emergent gaps is the lack of reliable, accessible data sets. While some data is available with the government, and with a couple of NGOs, it is highly problematic that data is not available in the public domain. Most of the information with the government can be accessed through the Right to Information Act. But it remains a project in itself to access and collate the data in different places especially spatial data required for planning at a city level. By using spatial data sets available in public domain, some of the constraints can be overcome.
- (3) Limited Planning Capacities and Restrictive Planning Processes and Institutions: Most of the cities have limited internal capacity to plan beyond the immediate project at hand. Moreover the planning process itself is protracted, and still driven primarily by land-use planning, that often fails to incorporate the current risks and resource constraints. The institutions dealing with planning are fragmented- the municipal corporations, the development authorities, and the town planning institutions all have a role to play. This is a gap that has to be addressed if public systems oriented adaptation has to take place.

#### **4 INDICATORS TO ADDRESS CLIMATE CHANGE AND CITY PLANNING URBAN AREAS**

While assessment on climate change and risks to cities is quite diverse and varied. Four broad categories are identified for considering urban vulnerabilities associated with climate change by IPCC, 2007 as under:

- (1) Alterations in temperature include warmer and more frequent hot days and nights in cities termed as heat island effects. Cities at their core tend to be 1 to 10°F (0.56 to 5.6°C) warmer than their surrounding suburbs and rural areas (Science Daily, 2003). This is caused by extensive paving, high densities of buildings and minimal green space and fauna in city cores resulting in an increased number of heat related deaths.
- (2) Alterations in precipitation mainly frequency and intensity in cities can cause pressure on, and deterioration of, water and sanitation infrastructure, particularly for weak and/or aging municipal infrastructure facilities. In addition, these alterations create adverse effects on the quality of surface and groundwater, contaminate water supply, create waterborne diseases, increase risk of deaths, infectious respiratory and skin diseases, disrupt settlements, commerce and transport due to flooding.
- (3) Alterations in storm intensity affect power outages and disruption to the public water supply; disruptions to settlements associated with flood and high winds; migration of population under stress; loss of property; increased risks of deaths, injuries, and water and food-borne diseases and post-traumatic stress disorders.
- (4) Sea level change include permanent erosion and submersion of urban land and settlements; loss of property and livelihood; costs of coastal protection; costs of land-use relocation; decreased freshwater availability due to saltwater intrusion and salinity in estuaries and coastal aquifers; increased risks of deaths and injuries by drowning in floods; rising water tables and impeded drainage; destruction of urban infrastructure; and long-term effects on economic growth.

To analyze the climate change cause and consequences in city level the following hypothetical aspects has been worked out with the help of literature study, personal experience and discussion with the experts (Figure : 2).

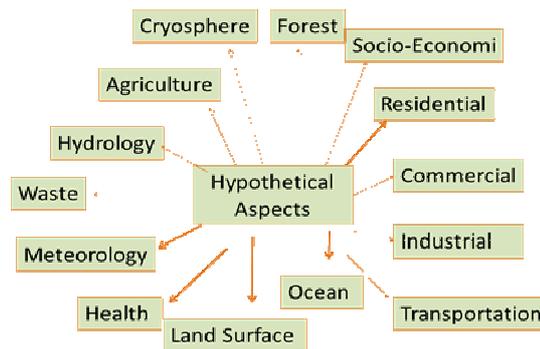


Figure :2 Hypothetical Components of Climate Change and City Planning

## 5 OVERVIEW OF NGIS AND MAJOR INFORMATION SYSTEM FOR INTEGRATION

### 5.1 National GIS (NGIS)

During 12th Five year Plan of India the centre of attention is on the development of agriculture; manufacturing, infrastructure, rural connectivity, health and education services and with special challenges to address vulnerable/deprived areas. Planning Commission of India felt the need for a new paradigm and Governance regimes with considerable change – moving from the traditional allocation systems to determining equitable systems. This would require a scientific mapping of the needs/aspirations/desires and limitations of the beneficiaries and society, especially the most disadvantaged; transparent systems of inclusivity of citizen participation and entitlements; guaranteed development/service delivery with high-level of accountability of governance systems and a very effective (feed-back) and responsive redressal system.

To handle this national development demand there was a requirement of multi-sectoral information regime “powered by very efficient national information system that would have to be the foundation for the governing and the governed - bringing the assessment of development needs, bridging disparity and gaps, bringing equity. The modules like, City-GIS service, Water –GIS, GIS for Disaster Management Support GIS for Infrastructure sector, Env-GIS for Environment and Climate Change, Weather-GIS and ES-GIS - weather and climate coastal zone management of NGIS can be utilised for interface.

### 5.2 Environmental Information System (ENVIS)

The Environmental Information System acronymed as ENVIS was implemented by the Ministry of Environment, Forest and Climate Change for environmental information collection, collation, storage, retrieval and dissemination to policy planners, decision makers, scientists and environmentalists, researchers, academicians and other stakeholders. ENVIS is a decentralized computerized network database system consisting of the focal point located in the Ministry and a chain of network partners, known as ENVIS Centres located in the potential organizations/institutions throughout the country.

In order to develop ENVIS network as a comprehensive distributed environmental information network system, the ambit of ENVIS was extended to cover all the States/UTs of the country. Presently, the ENVIS network consist of 76 ENVIS centres link to apart from the focal point located in the Ministry, out of which, 30 Centres are on State Government Departments dealing with the Status of Environment and related issues of the concerned State Government and the remaining 46 have been set up on various environmental disciplines covering from air pollution, water pollution, noise pollution, biodiversity, solid waste management, ecology and ecosystems, environmental education, NGOs, media and even environmental parliament, coastal ecosystem, clean technology, etc. Functionally, it is a decentralized system of ENVIS Centres mandated to develop a distributed network of subject-specific databases

Both the Focal Point and ENVIS Centres in their assigned subject-areas are developing the requisite databases on identified parameters in order to disseminate information concerning their subject-areas to the user concerned. In order to disseminate information online almost all the ENVIS Centres have developed their interactive databases in their assigned subject-areas for requisite dissemination. The ENVIS Focal Point

has also developed a comprehensive interactive website for online coordination with all its network partners as well as dissemination of information to the users whenever required.

The focal point of ENVIS has developed a comprehensive database with GIS interface known as Indian State Level Basic Environmental Information Database (ISBEID) on 17 modules in various subject areas of environment and its associated fields which are quite relevant to the State ENVIS Centres. This will assist the State ENVIS Centres to produce the State of Environment report for the concerned states/UTs,

#### 5.2.1 Indian State Level Basic Environmental Information Database (ISBEID)

In order to develop the databases on environment and its related parameters and to make it online to the Ministry for to and fro information flow, a web enabled software, namely, Indian State Level Basic Environmental Information Database (ISBEID) was developed by ENVIS in collaboration with National Informatics Centre (NIC). The objective for development of this software is to cover the gap in environmental data dissemination with regard to vast parameters such as air pollution, water pollution, forestry, land resources, flora and fauna, etc. In total there are 17 modules. Initially, the database consisting of 23 modules in various environmental fields was tested on pilot basis by Eight States with 12 modules in two phases. There are two components of ISBEID application, namely, Management Information System (MIS) and Geographic Information System (GIS).

#### 5.2.2 NUIS – National Urban Information System

Ministry of Urban Development has launched National Urban Information System (NUIS) Scheme in March, 2006 to develop GIS databases for 137 towns / cities in the country in two scales i.e., 1:10,000 and 1:2000. As on date the total number of towns in NUIS Scheme is 152. In addition utility mapping in 1:1000 scale will also be undertaken for 24 towns. Apart from spatial data, the Scheme has another component i.e. National Urban Data Bank and Indicators (NUDBI).

#### Components of NUIS Schemes

The NUIS scheme comprises two major components. They are:

- Urban Spatial Information System (USIS) – Includes development of GIS based multi –hierarchical database, with application tools to support Master/Zonal plan preparation; Urban Local Bodies(ULB) administration and utilities management.
- National Urban Databank and Indicators (NUDB&I) – Includes designing and establishing a comprehensive data bank and integration of these parameters to support planning and derive indicators for National Urban Observatory (NUO) for monitoring the health of urban settlements.

#### Content of NUIS Scheme

Under NUIS Scheme the development of information system is in three levels. They are:

- I. Development/Master plan Level (1:10,000 scale)
- II. Zonal Plan (1:2000 scale)
- III. Utility Mapping (1:1000 scale)

Indicators for NUO Database: This data base has Six modules namely:

- I. Background :
- II. Socio-Economic Development
- III. Infrastructure
- IV. Transportation
- V. Environmental Management
- VI. Local Authorities
- VII. Housing
- VIII. Ministry of Urban Development

## 6 NEED FOR DEVELOPMENT OF INTERFACE BETWEEN ENVIS AND NUIS TO ADDRESS CLIMATE CHANGE IN URBAN AREAS

### 6.1 ENVIS in light of Climate change and city Planning:

ENVIS was implemented by the Ministry of Environment & Forest for environmental information collection, collation, storage, retrieval and dissemination to policy planners, decision makers, scientists and environmentalists, researchers, academicians and other stakeholders. 76 ENVIS centres are dealing with the state-wise status of Environment, air pollution, water pollution, noise pollution, biodiversity, solid waste management, ecology and ecosystems, environmental education, NGOs, media, coastal ecosystem and clean technology. ENVIS has both Management Information System (MIS) and Geographic Information System (GIS). The interactive database of ENVIS on Climate, Industrial, Residential, Vehicular Pollution, Disaster, Electricity Consumption, Energy Consumption, Non Renewable Energy, Renewable Energy, Actual Forest Cover by Density Class, Distribution of Forest Cover, Forest Produce, Joint Forest Management Committee, Mining in Forests, Recorded Forests, Category of Industry, Mining & Quarrying, Housing, Transport, Clean Technology, Effluent Treatment plant, Type of Waste aspects is efficiently capable to handle the environment related issues of urban areas. ENVIS is capable to handle efficiently database on environmental status at city level and build a baseline data source for city’s environment study. But ENVIS not able to provide information related to urban sectors e.g landuse. Moreover, transportation network, trip generation, Housing, infrastructure etc., Spatial data of ISBEID is in 1:250,000 scale not fit for city planning, it can only provide point source data on environmental aspects (Figure :3) .

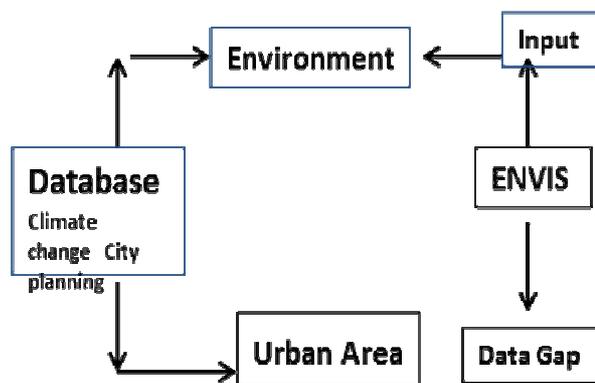


Figure: 3 ENVIS to address Climate change and city Planning

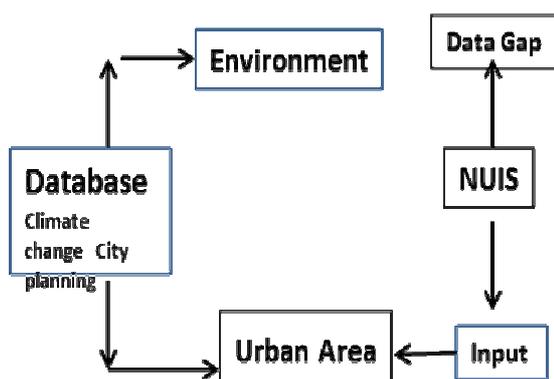


Figure 4: NUIS to light of Climate change and city Planning

### 6.2 NUIS in light of Climate change and city Planning:

Ministry of Urban Development has launched NUIS comprising of GIS databases for towns / cities in the country in 1:10,000 and 1:2000 scales. This information system also contains utility mapping in 1:1000 scale. The modules of NUIS covers the entire database required for the preparation of Master/Developmental Plan. It covers every aspects Master/ City Plan. As on date the total number of towns in NUIS Scheme is 152. NUIS Includes development of GIS based multi –hierarchical database, with application tools to support Master/Zonal plan preparation; Urban Local Bodies(ULB) administration and utilities management. It Includes designing and establishing a comprehensive data bank and integration of these parameters to

support planning and derive indicators for National Urban Observatory (NUO) for monitoring the health of urban settlements. NUIS has developed a system to Integrate conventional data sources with modern data sources to develop GIS database. The information system has the capacity to develop automated integration/application techniques in GIS to provide inputs for Master/Zonal Planning and utilities management – to be utilized by the urban planners/administrators/decision makers. It is a decentralized data generation, storage and manipulation system at various levels of planning. In the present practice of master plan/ city plan/development plan preparation the environmental aspects specifically deviation in normal distribution of temperature and rainfall, occurrence of super store, flood, accumulation of GHG etc data bases are meagerly considered. But for sustainable city planning environmental data base is equally important akin to urban information. During the course of master/developmental plan preparation both these aspects should be united.

### 7 ENVIROURBAN INTERFACE

In order to address the climate change in urban area combination of ENVIS and NUIS provide input data base that can handle the data requirement more efficiently. An interface namely ENVIROURBAN between these two information systems i.e. ENVIS and NUIS developed by two different Ministries; Ministry of Environment and Forests and Ministry of Urban Development respectively can complement the data gap of each other. The ENVIROURBAN interface can act as key data contributor to address the climate change and city planning in isolation as well as in combination The Comparative analysis of these two systems can represent the compatibility of these two information systems towards developing the interface for Climate change and City Planning (Table -1 Compatibility Analysis of Systems) Figure : 5 establish the need for development of Interface.

ENVIS	NUIS
Provide information related to environment across the country	Provide information related urban areas of India
The level of information is State Level and District Level	The level of information is at City level
It had 76 centres across the country	Information is available for 137 towns in 10,000 & 1:2000 scale 24 towns in 1:1000 scale 153 towns under NUO
ENVIS has 10 types centres dealing with various aspects of Environment	Uniform data set
ENVIS Centre provides information in form of report format	Provides information Spatial Data and Attribute data
ISBIED provides information in MIS and GIS	All the data are GIS based
The Spatial Data are available in 1:2,50,000 scale	The Spatial Data are available in 1:10,000, 1:2000 and 1:1000 scale

Table 1: Compatibility Analysis of ENVIS & NUIS

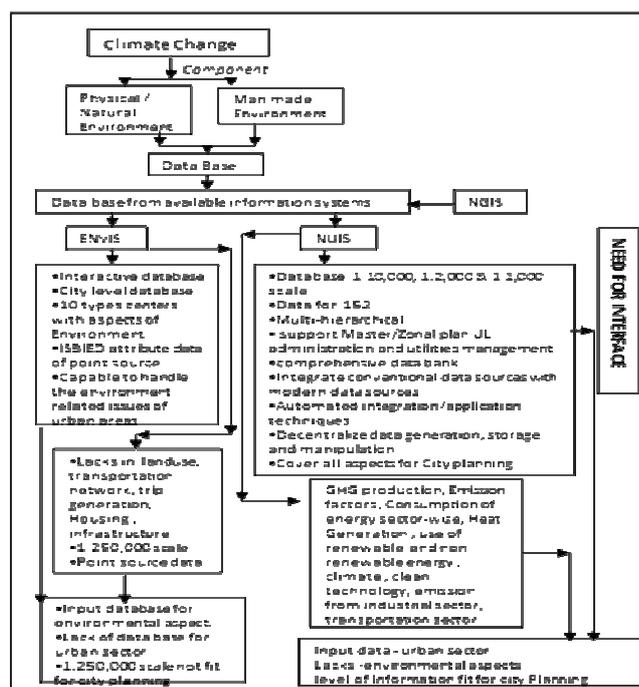
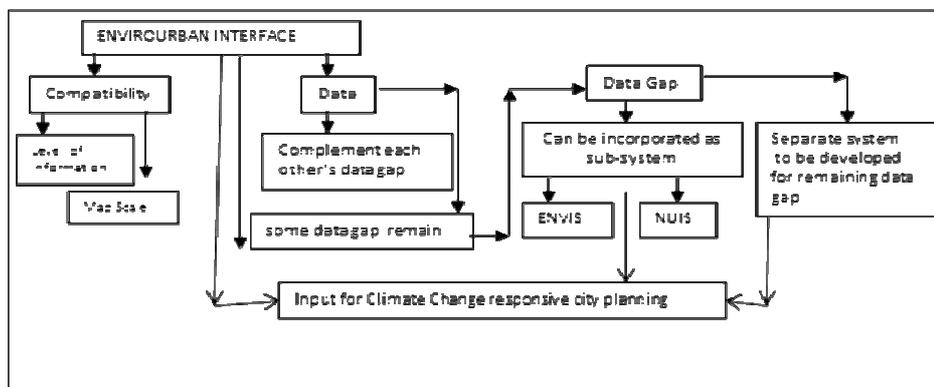


Figure 5 : Need for Development of ENVIROURBAN Interface

## 7.1 Data Status - Post ENVIROURBAN Interface

The Interface developed between ENVIS and NUIS is largely complementary and integration by nature. It integrates information in the form of map, attribute data and annotation. Figure 6 show the post interface status of availability of information in respect of the indentified indicators, data base for Climate change and City Planning (Figure :6).



There are some data and information gap which still persists after establishment of interface. The data gap related to Environment field may be added, append with ENVIS as a sub-system. Similarly information related to urban sphere can be added with NUIS as sub-system of NUIS. The information, which is very unique by nature for example Health related information is not directly related with NUIS and ENVIS, it can be added with other information system (Present/Future) or can be developed as a stand-alone system.

## 8 CONCLUSION:

India's first National Action Plan on Climate Change (NAPCC) has been fixed outlining existing and future policies and programs addressing climate mitigation and adaptation. The plan identifies eight core "national missions" viz. National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a "Green India", National Mission for Sustainable Agriculture, National Mission on Strategic Knowledge for Climate Change. Under Indian Network for Climate Change Assessment (INCCA) Steps have also been taken to increase capacity at the institutional level for conducting research into Climate Change science and making necessary assessments. The Ministry has already set up a network, namely the Indian Network for Climate Change Assessment (INCCA) comprising of 127 research institutions tasked with undertaking research on the science of Climate Change and its impacts on different sectors of economy across various regions of India. INCCA has helped the Ministry put together its Green House Gas (GHG) Emissions Inventories and in carrying out other scientific assessments at more frequent intervals. The interface of existing information system will act as a tool for Planning reference, hotspot detection and tracing for implementation.

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