Keysheet
8

Climate Change Impacts on

Industry in **India**

FOR FURTHER INFORMATION PLEASE CONTACT:

IIM Dr P R Shukla, Indian Institute of Management, Ahmedabad
Email: shukla@iimahd.ernet.in

MoEF Dr Subodh K Sharma, Ministry of Environment and Forests, Government of India
Email: subodh.kumar@nic.in

Defra Email: indiaimpacts@defra.gsi.gov.uk

Designed by Jo Menhinick www.jmd.eu.com

Industry and climate change

Climate change impacts on industry, energy and transportation largely relate to infrastructure, such as transport and distribution systems, machinery, power plants, and water and wastewater systems. India's government has been devoting a large and increasing volume of outlays to the development of this infrastructure through their five-year plans to meet the increasing demands of economic growth.

Physical infrastructure is generally vulnerable to climate change, particularly increased incidence of extreme events, rising sea level, and changes in rainfall patterns, which can increase the financial risks to making capital investment, as well as increase the vulnerability of existing infrastructure. Ultimately, climate change impacts on industry are financial, which may burden the public sector and stifle private investments.

The Indian Institute of Management (IIM) Ahmedabad carried out research aimed to address issues relating to the impact of climate change on industry, energy and transportation, by looking at impacts on infrastructure (see Figure 8.1).

Indian Institute of Management, Ahmedabad

The Indian Institute of Management (IIM), Ahmedabad is one of India's leading business schools. It has conducted numerous research studies and provided consultancy and research services to various Government of India ministries and departments, private and non-government organisations. IIM has done considerable work on energy and environment, including global climate change modelling, energy demand forecasting, and energy and environment modelling and policy analysis. http://www.iimahd.ernet.in

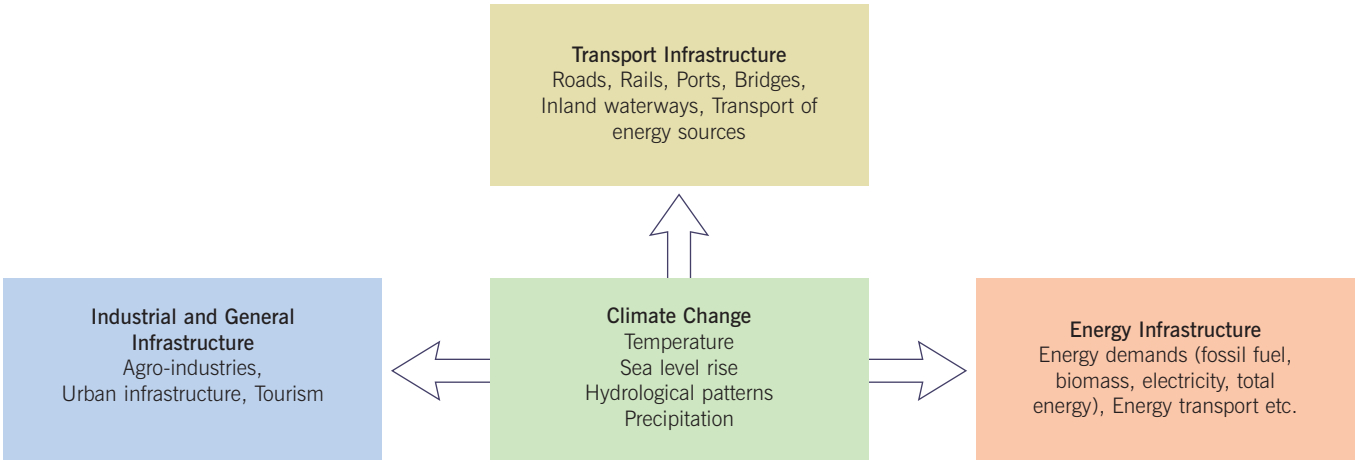
Description of methodology

Two case studies provided a level of focus to the study: transportation infrastructure, and energy demand. The impacts on transportation infrastructure were assessed through a study of the Konkan Railway that runs along India's southwest coast, and energy demand was considered at a national level.

The cases relied on secondary data and expert inputs on the impacts of climate change, as well as limited primary data specific to the case studies.

A variety of conceptual models provided a framework to assess the possible impacts of climate change on transport and energy demand. These drew from diverse areas including climate science, ecology, impacts assessment, probability, decision analysis, macro and microeconomics, and technology. The study required mapping of the socio-economic development scenarios (Keysheet 3) to the climate change impacts assessment (Keysheet 2), decision analysis and a meta-framework for integrating the analysis across diverse disciplines. Tools and models used for the study included GIS (Geographical Information System), energy system models and macroeconomic models.

Figure 8.1
Impacts of Climate Change on Infrastructure



Predicted climate change impacts on infrastructure

Transportation: Konkan Railway Case Study

India has the largest railway network in the world, and a large percentage of the population depends on it for travel as well as for employment opportunities. Disruption of services due to climate change impacts could have significant financial and social consequences. To provide evidence of some of the potential impacts of climate change, the researchers developed a case study on the Konkan Railway Corporation Limited (KRCL), a coastal railway system in southwest India. The Konkan Railway runs 760 Km along the Western coastal Ghats of India (Figure 8.2).

Presently, the KRCL reports that 20% of repair and maintenance expenses are due to climatic factors, such as heavy rainfall and extreme weather events.

Based on the studies conducted by IIM, the potential impacts of climate change on KRCL relate to temperature, precipitation, sea level change, and incidence of extreme events. These impacts can be both direct and indirect:

- **Temperature increase** can directly affect the stability and strength of building materials, and indirectly increase the need for air-conditioning on trains;
- **Rainfall increase** can cause water logging, a direct effect, as well as erosion, which indirectly leads to increased maintenance costs;
- **Sea level change** can also cause land erosion, flooding and water logging, which have both direct (maintenance costs) and indirect (service disruption, location of railroad systems) effects; and
- **Extreme events** can cause direct damage to the rail network.

Table 8.1 describes in greater detail how each of these factors associated with climate change can impact both the structure as well as the operations of the railway.

Figure 8.2
Konkan Railway

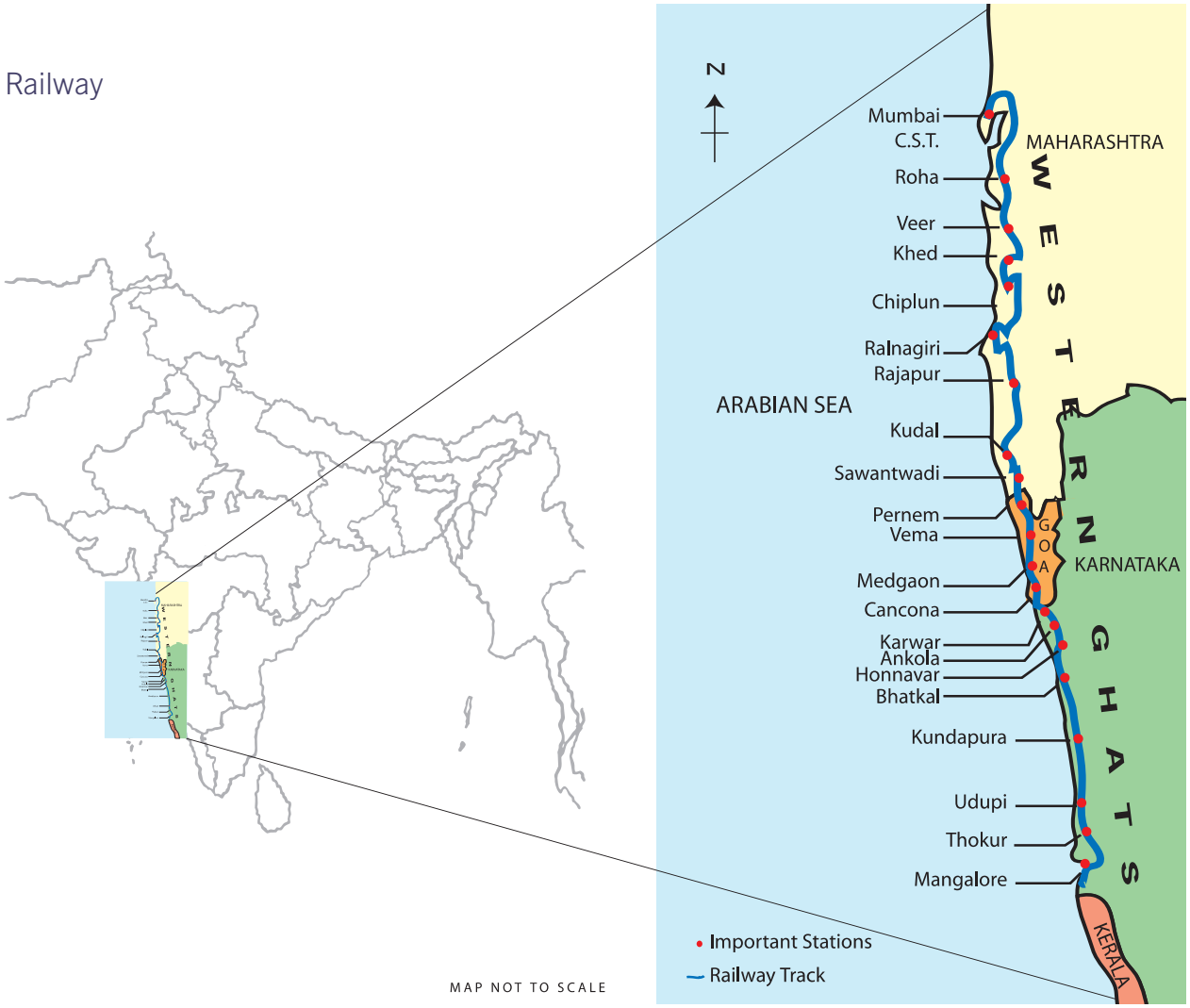


Table 8.1

Climatic Parameter	Impact Parameter	Intervening Parameter	Impact on KRC
Temperature Increase	High evaporation rate	Stability and strength of the building materials	Weakened buildings require more and frequent repair and maintenance
	Surface and ground water loss	Crop productivity in the region may be affected	Agricultural freight traffic
	Need for air-conditioning	Passenger traffic may shift to air conditioned class	Affects efficiency, carrying capacity and composition
Rainfall Increase	Ground and surface water level change	Flooding, water logging, erosion reduces quality of land cover	Greater structural damage, increased maintenance and other related costs
	Improved water availability in the region	Agricultural production	Changes in agricultural freight traffic
	Humidity increase	Uncomfortable climatic conditions, vegetation growth along the track	Passenger traffic affected, increased maintenance cost
Sea Level Change	Land erosion	Tracks, tunnels and bridges affected	Increased maintenance
	Flooding	Land stability and land slides	Damage to infrastructure, reconstruction and relocation
	Water logging	Amount and spread of water	Delays, risk increase
Extreme Events	Cyclone and high velocity winds and storms	Damage to buildings, communication lines etc	Disruption of services, repair and reconstruction costs
	Cloud bursts	Land erosion, floods, and land slides	Extensive damage to infrastructure, high cost of repair and reconstruction

Energy demand

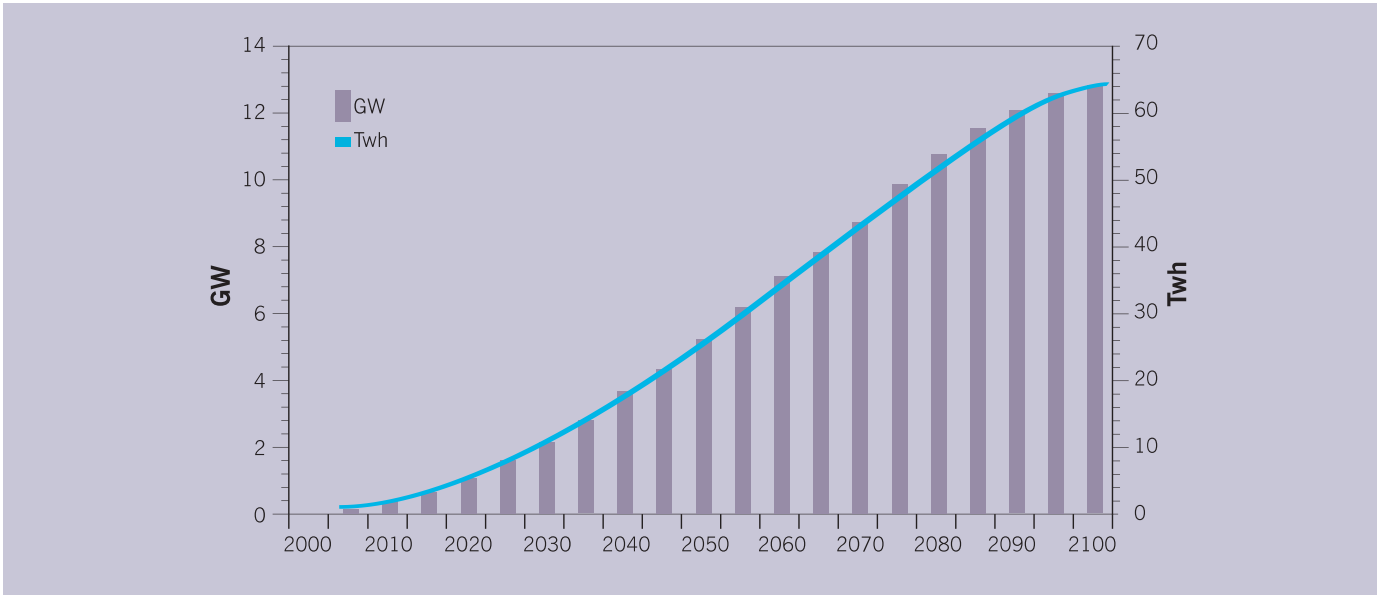
Existing economic growth scenarios project total power generation capacity in India to increase nine times from 96 GW to 912 GW between 1995-2100. As a result of climate change, it is estimated that approximately 1.5% more power generation capacity will be required (Figure 8.3). Increased energy demand may arise from a number of sources. For example, increases in average temperature can result in the need for space cooling for buildings, and variability in precipitation can impact irrigation needs and consequent demand for energy from groundwater pumping.

Increased demand for energy can increase greenhouse gas emissions that contribute to climate change, creating a feedback effect. For example, higher demand for space cooling raises demand for oil, resulting in higher emissions.

Importantly, the fuel mix for the power sector in India is largely driven by coal, although the share of natural gas and oil continues to grow at a steady rate and is predicted to reach around 25%. The extent to which increased energy demand alters climate change scenarios will be influenced by the types of fuels used.

Figure 8.3

Additional power capacity and power generation requirement due to climate change



What are the policy implications of these predictions?

Given the potential impacts of climate change on industry, as seen through the impacts on transportation and energy demand, policy makers may wish to consider the following implications:

- Inclusion of risk assessment and vulnerability studies in national infrastructure planning;
- Integration of climate change scenarios into decision making at local, regional, and national levels;
- Development of adaptation options such as ensuring high design standards for new infrastructure to protect against extreme events;
- Integration of emissions reduction and climate change adaptation strategies into policies that seek to promote industrial growth and urban development (eg industrial siting policies);
- Promotion of insurance products for a range of customers, to protect individuals, communities, and industry from extreme weather events.

Needs for further research

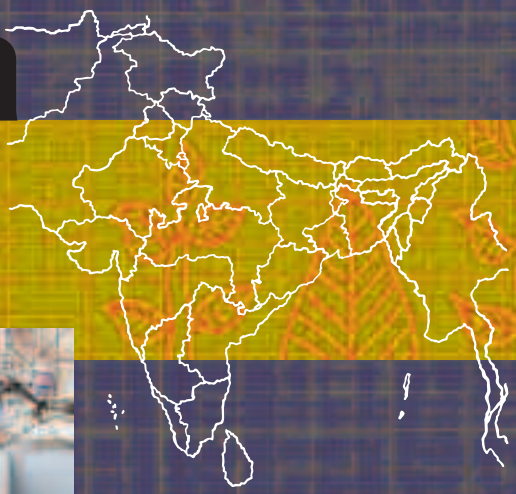
Further studies are required to develop a better understanding of climate and human system interactions and the adaptation strategies for addressing adverse impacts. These include:

- Preparation of a catalogue of historic extreme events, assessing the damages and providing loss estimates from infrastructure in coastal and inland areas, as well as showing the spatial distribution of these events.
- Detailed GIS analysis with topographic and geological details showing the major infrastructure systems and components, to identify specific infrastructure projects that are at greatest risk to climate change.
- Sensitivity assessment of infrastructure with respect to various forcing climate parameters, such as changes in rain fall, temperature, and extreme events.

Keysheet
8

Climate Change Impacts on

Industry, Energy and Transport in India



Climate change impacts on industry largely relate to infrastructure. Infrastructure development requires significant financial investment and is an important key to India's development to meet the increasing demands of a growing economy. Climate change can increase risk to investment in and sustainability of large infrastructure, through damage and disruption caused by increases in rainfall, temperatures and extreme events, and therefore policy makers will need to incorporate climate change risk assessment into their infrastructure planning.