We are IntechOpen, the world's leading publisher of Open Access books
Built by scientists, for scientists

6,900
Open access books available

185,000
International authors and editors

200M
Downloads

154
Countries delivered to

Our authors are among the
TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Chapter

Adapting to Climatic Extremes through Climate Resilient Industrial Landscapes: Building Capacities in the Southern Indian States of Telangana and Andhra Pradesh

Narendran Kodandapani

Abstract

There is now greater confidence and understanding of the consequences of anthropogenic caused climate change. One of the many impacts of climate change, has been the occurrence of extreme climatic events, recent studies indicate that the magnitude, frequency, and intensity of hydro-meteorological events such as heat waves, cyclones, droughts, wildfires, and floods are expected to increase several fold in the coming decades. These climatic extremes are likely to have social, economic, and environmental costs to nations across the globe. There is an urgent need to prepare various stakeholders to these disasters through capacity building and training measures. Here, we present an analysis of the capacity needs assessment of various stakeholders to climate change adaptation in industrial parks in two southern states of India. Adaptation to climate change in industrial areas is an understudied yet highly urgent requirement to build resilience among stakeholders in the Indian subcontinent. The capacity needs assessment was conducted in two stages, participatory rural appraisal (PRA) and focus group discussion (FGD) were conducted among various stakeholders to determine the current capacities for climate change adaptation (CCA) for both, stakeholders and functional groups. Our analysis indicates that in the states of Telangana and Andhra Pradesh, all stakeholder groups require low to high levels of retraining in infrastructure and engineering, planning, and financial aspects related to CCA. Our study broadly supports the need for capacity building and retraining of functionaries at local and state levels in various climate change adaptation measures; likewise industry managers need support to alleviate the impacts of climate change. Specific knowledge, skills, and abilities, with regard to land zoning, storm water management, developing building codes, green financing for CCA, early warning systems for climatic extremes, to name a few are required to enhance and build resilience to climate change in the industrial landscapes of the two states.

Keywords: climatic extremes, climate change adaptation, industrial parks, Telangana, Andhra Pradesh, capacity needs assessment

1. Introduction

A recent report indicates that national governments have until 2020 for the carbon emissions to peak in order to contain the global surface temperature below 2°C [1]. After staying flat for about three years, annual global carbon emissions have again begun to rise above 40 Gt and could rise further in the coming years due to the renewed economic growth across the globe. The present global pandemic has resulted in a small decline in global carbon emissions, however, with governments desperate to restore economic activities, this only appears temporary. The Paris Accord in 2017 was ratified and adopted with targets for countries to reduce emissions by 2030 to keep temperatures below 2°C and well below at 1.5° C by the end of the century. Annual carbon emissions will have to decline by greater than 50% compared to present levels by 2050 to keep the global surface temperatures below 2°C [2]. Already, global temperatures are above 1.1° C compared with pre-industrial levels, and there is warming occurring at the rate of 0.2° C/decade [3].

Anthropogenic greenhouse gas emissions has increased substantially since pre-industrial times and directly related to human population and economic growth. The concentrations of greenhouse gas emissions such as CO_2 have increased almost 40% since pre-industrial times [4]. Annual CO_2 emissions have increased from about 30 billion tons in 2000 to about 42 billion tons in 2016 [1]. However, in order to achieve the Paris Agreement, the remaining carbon budget, after accounting for past emissions, is in the range of 150 to 1050 gigatons CO_2.

Major contributors to the increased concentration of CO_2 in the atmosphere chiefly come from cement industries and thermal power plants through the burning of fossil fuels. Two main sinks for CO_2 are the ocean and land sinks. Countries such as China and India are industrializing at a rapid pace, emissions are increasing in these two countries. However, CO_2 emissions from India are much lower compared to China and the United States, CO_2 emissions of India in 2015 were a quarter, and half, of the emissions from China and the United States respectively [5].

Recent reports from the IPCC, such as the *fifth assessment report* has provided unequivocal evidence of the impacts on various earth system processes due to anthropogenic caused warming [4]. There is now greater confidence and understanding of the consequences of anthropogenic caused climate change [4]. The globally averaged land and sea surface temperature shows an increase of about 0.8° C over the period 1880–2012 and an increase of about 1° C over pre-industrial temperatures [6]. There has been an increase in decadal annual global mean surface temperature at an average rate of 0.07° C per decade during the 1880s, increasing to 0.17° C per decade during the 1970s, increasing to 0.3° C per decade during the 2000s. There has been a decline in the extent of ice-sheets, loss of glacial mass, and also northern hemisphere spring snow cover in several regions across the world. Likewise, the mean sea level rise between 1901 and 2010 has risen by about 20 cm [4].

1.1 Global impacts of extreme climatic events

Other impacts of climate change are the occurrence of extreme climatic events, recent studies indicate that the magnitude, frequency, and intensity of hydro-meteorological events such as heat waves, cyclones, droughts, wildfires, and floods are expected to increase several fold in the coming decades [7]. Globally, between 1980 and 2018, on average 400 disasters occurred annually, resulting in about 23000 fatalities, and leading to direct economic damage of about USD 100 billion each year [8]. Globally, the number of extreme events has increased from 200 during the 1980s to about 700 during 2016, therefore almost a three-fold increase in the number of extreme events in a thirty-five year period [9]. Globally, the number of extreme hydrological, climatological, and meteorological events has doubled in a 30 year period [5]. Worldwide, about 100 million people were affected by disasters in 2015, with climate being a factor in 92% of the events [10], about one-fifth of those affected were from India.

Not only are extreme events becoming more frequent, they are also becoming costlier, for example, Hurricane Harvey is the costliest disaster to strike the United States, estimated cost of damages is about $190 billion [11]. In 2016, insurance companies reported losses of about $175 billion around the world, three-fourth of these losses were caused by meteorological, hydrological or climatological events [12]. During the year 2015, the total economic loss from disasters globally was about $66.5 billion; the economic damage for India was about $ 3.3 billion [9]. The economic loss from the Chennai floods has been estimated to be about $ 0.3 billion of insured losses, and the total loss was about $ 2 billion. Similarly, the floods of Mumbai in 2005 resulted in economic losses of $1.7 billion. Likewise, the flooding in the southwestern state of Kerala in 2018 resulted in the death of 470 people.

The costs and risks of climate change are substantially high and all options to manage the impacts of climate change require urgent interventions. The *World Economic Forum Global Risks Perceptions Survey 2017–2018* [13] has ranked extreme events and natural disasters as top two risks in terms of likelihood. Similarly, extreme events, natural disasters, and failure on climate change mitigation and adaptation, are ranked second, third, and fourth in terms of impacts. These risks and impacts have been reported during successive years and there has been an increasing trend in environmental risks gaining prominence overtime over a ten-year horizon, commencing from 2008. Similarly, the recent, *Global Risks Perception Survey 2021* [14], indicates that extreme climate events are the most important risks to livelihoods. Infact, extreme climate events have emerged as the primary risk to humans since 2017.

2. Extreme climatic events in India

Recent studies in India, indicate increasing trends in the occurrence of hydro-meteorological extreme climatic events across the country. A systematic analysis of these events pan-India over the last five decades provides insights into the spatial and temporal patterns of these extreme events [15]. This same study indicates, that about 100 million people were affected by floods each year, similarly, 140 million people were affected by droughts each year, about 40 million people were affected by tropical storms and cyclones. Thereby a substantial number of people across the country were affected by these hydro-meteorological events each, almost a quarter of the population in India each year. An analysis of floods, droughts, and cyclones over the last five decades, at the district scale, reveals an increasing trend, especially during the last two decades. For example, the number of annual extreme flood events across India has increased from 2 to 16 during the last five decades (1970–2020). Likewise, the number of districts affected by floods has also increased from 10 to 150 districts. The number of districts affected by tropical storms and cyclones has increased from 5 to 90. Overall, there is an acceleration in the frequency of floods, increasing at the rate of 25%/decade, likewise, tropical cyclones are increasing at the rate of 6.5%/decade.

While the decadal number of droughts has not revealed any substantial changes, the number of districts affected by droughts has increased from 10 to 250. Prolonged droughts have occurred in different regions of India, for example in the early 2000s, the Western Ghats entered a period of drought, possibly as a result of global climatic change [16]. Also, the Indian sub-continent and the Western Ghats receive a significant proportion of their annual rainfall from the south-west monsoon. Rainfall data from long-term (1951–2003) observations suggest decreasing trends in both early-monsoon and late-monsoon rainfall and the number of rainy days [17]. Frequent droughts has been a recurrent feature of climate variability in India, between 1901 and 2015, India has experienced 23 drought events [18].

2.1 Climatic extremes in AP and Telangana

Climatic extremes such as cyclone/storms, droughts, floods, and heatwaves are prevalent in the two Indian states of Andhra Pradesh and Telangana. An analysis of cyclones on the western and eastern coasts of India, over a 100 year period, indicated that close to 92 of the 262 cyclones occurred in a 50 km stretch on the east coast of India [19]. Andhra Pradesh is particularly vulnerable to cyclones formed in the Bay of Bengal. About four cyclones have occurred per decade in Andhra Pradesh since the 1980s, with one out of the four classified as severe.

Precipitation in AP and Telangana are largely due to the Indian monsoon system. The south-west monsoon is the main source of rainfall for the two states [20]. The monsoon advances from the southern tip of peninsular India at the end of May and spreads across the entire country within 10 to 15 days [21]. The monsoon gradually withdraws at the end of September commencing from northern India and reaching the tip of southern peninsular India by early December. Thus the advancing phase (South-West Monsoon) and, the withdrawal phase (North-East Monsoon) contributes to the rainfall pattern in the two states. Apart from the seasonality of rainfall, the distribution is variable, for example, the coastal areas of AP receive higher annual rainfall (750–1500 mm), whereas in the interior areas of AP and Telangana rainfall is much lower (300–500 mm), thus rainfall variability is high, 20 to 30%, particularly high in coastal areas. Thus, heavy rainfall occurs in cyclone prone areas along the coast in AP, besides, the two major river systems in AP and Telangana, the Krishna and Godavari rivers, which originate in the Western Ghats, can cause flooding due to the accumulated discharges of water from upstream areas. The flooding in delta flood plains is exacerbated by the combination of cyclonic rainfall and storm surges.

Droughts are a recurrent feature of the two states, 12.5 million ha in the two states are drought prone [22], defined here as areas that receive annual rainfall less than 75% of the normal (30 year average) in 20% of the years examined and where less than 30% of the cultivated area is irrigated.

Heat waves are another climatic extreme prevalent in the two states, during the months of April and May, maximum temperatures of about 49°C can be recorded. Not only are maximum temperatures high, the duration of maximum temperatures has increased from 7 days during the 1980s to 19 days during the 2000s.

3. Climate Change adaptation (CCA)

Adaptation has been defined by the IPCC as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Increasingly, there has been an emphasis on mechanisms that can anticipate and prepare communities to effectively deal with both gradual climate change and also extreme climatic events, commonly referred to as climate change adaptation strategies. The annual average adaptation costs for India in 2100 under various C-C scenarios can range from 0.36% of GDP to 1.32% of GDP [23]. CCA can result in win-win outcomes, by moderating the impacts of climate change, enable sustainable development, and also useful for disaster risk reduction [23]. Hence it will be important to understand how management actions can be developed, refined, and employed in the context of well-developed and flexible management systems in order to enhance our ability to cope with climate change [24].

3.1 CCA and Industries in India

India has embarked on an ambitious industrial program, wherein it plans to increase industrial growth rate from 10 to 14%, increasing the contribution of the industrial sector to 25% of GDP, adding 100 million jobs, by 2022. However, these milestones could be impacted, if industries are not resilient to emergent climate change threats, such as extreme weather. Industries are vulnerable to losses, stemming from extreme climate, due to flooding, tropical storms, and heatwaves. Adaptation, to these emerging threats need to be incorporated into master planning while setting up industrial parks, industrial estates, and special economic zones. There is an urgent need to enhance climate resilient industrial parks throughout the country, resilience could be incorporated at the planning stage for extreme climatic events, it could be made mandatory to include CCA in the EIA. For example adaptation measures such as, managing drainage for run-off of excess water; mitigation of heat islands; increase provision of intermediate water storage facilities; provision for water recycling; creation of green spaces/blue spaces; storm reduction measures; separate storm water/sewage; maintenance of drainage networks. It is important to locate critical infrastructure at higher elevations to prevent flooding. Industries could shift to renewable energy, and also have provision for sustainable backup of power. With increase in the frequency of heat waves, there is need for cooling for ICT facilities; develop shade and cool storage facilities; design green buildings and enhance thermal regulation within elevated buildings; design roofs of industry to cope with tropical storms/hurricanes. There is also need to improve circularity and resource efficiency, through increased water efficiency in production, reuse of water, including recycled materials into the production process, and also reduce dependency on climate impacted raw materials [25].

The efforts to decarbonise and adopt climate resilient development would require substantial knowledge up grading, skill development, and awareness among various stakeholders of the industrial areas in these two states. Capacity development for all stakeholders connected with industrial development in the two states will be critical to meet the needs of a climate resilient industrial development future. Decision makers in departments such as the environment, industries, planning, will have to integrate climate resilience into planning processes. Capacity of technicians and engineers to develop and design novel and innovative technologies, for example the ability to install technologies in renewal energy, will be important. Currently, organizational structures and management skills are lacking to make decisions under climate uncertainty.

Capacity development is central to the improvement of societies, organizations, and individuals and is essential to strengthen and maintain the abilities of these structures at all levels of management. In fact development can encompass a wide variety of measures ranging from, the creation of enabling policies that accelerate the capacity development of organizations/individuals, to changes in individual behaviors through knowledge and skills.

4. Objectives

The main objective of our chapter was to systematically examine learning and skill development needs for the stakeholders in industrial parks of two southern states of India, Telangana and Andhra Pradesh (AP) in the wake of climate change and extreme climatic events. APIIC (Andhra Pradesh Industrial and Infrastructure Corporation) and TSIIC (Telangana State Industrial and Infrastructure Corporation) are two umbrella organizations responsible for catalyzing industrial development in the two states, in a planned manner. There are about 257 industrial parks in AP spread over 13 districts, similarly in Telangana there are about 118 industrial parks (IPs) (**Figure 1**). A stakeholder analysis was conducted to assess the current capacity and gaps in existing knowledge, skills, and abilities to meet the needs for CCA.

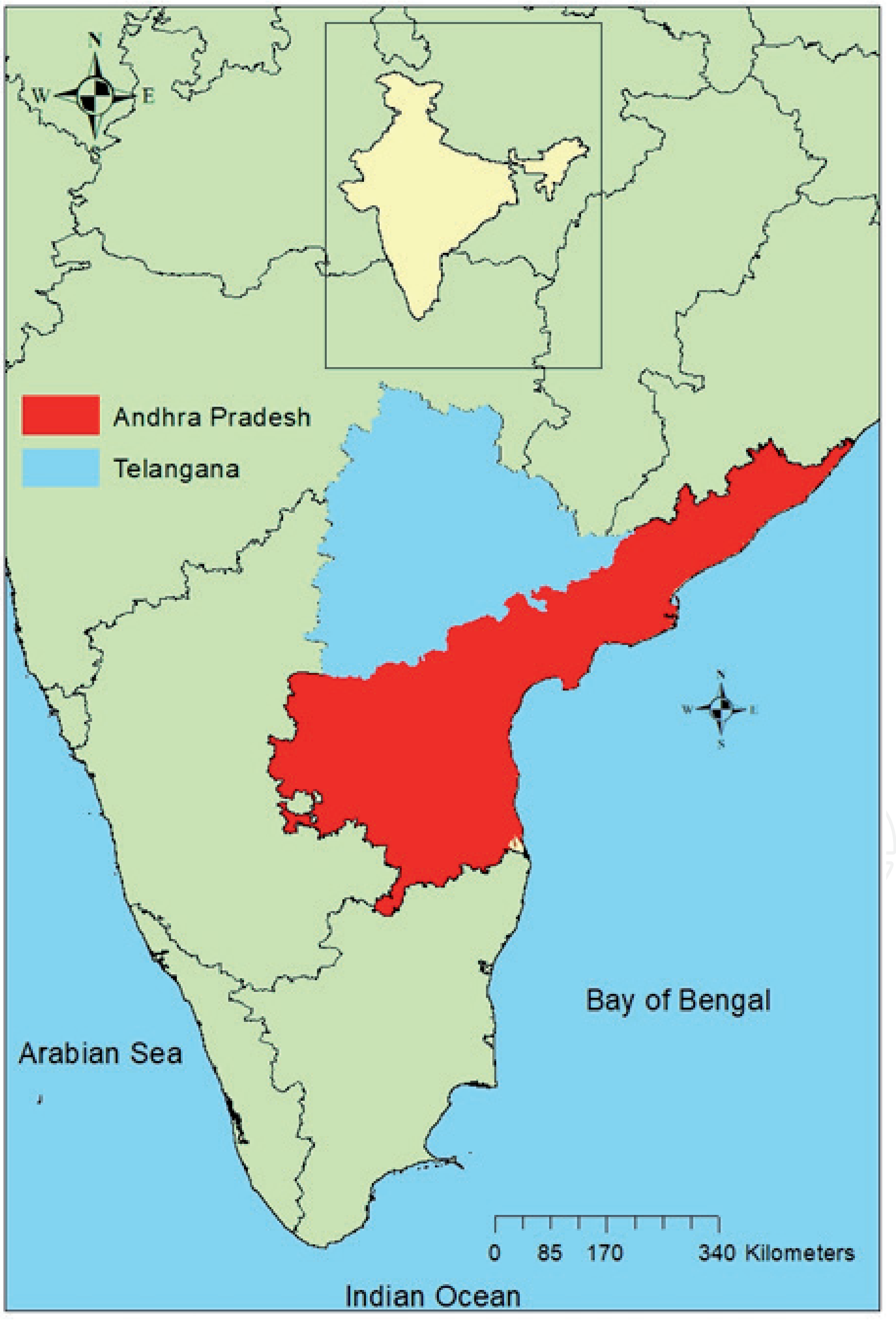

Figure 1.
Location of the two study states in India.

5. Methods

Stakeholder consultations were conducted in three IPs in Telangana State, including Cherlapally (I to IV), Hitech City, Madhapur, and Jeedimetla. Similarly, stakeholder consultations were conducted in four IPs in the state of Andhra Pradesh, including, Kakinada, Gajulamandhyam, Gajuwaka, and Ongole. Details regarding the type of industries in these IPs, the number of plots in each, and the extent of these IPs can be found elsewhere [25]. The criteria used for selecting the IPs, was based on the exposure of existing IPs to climatic changes, especially extreme climatic conditions in recent times such as severe cyclones, droughts, heat waves, and floods. Likewise, we included a variety of industries ranging from information technology to pharmaceuticals.

The capacity needs assessment was conducted in two stages, during the first stage, a brief presentation was made on climate change, and distinctions between gradual and extreme climatic events and its impacts. During the second stage, a focus group discussion (FGD) was conducted among the various stakeholders by dividing them into smaller groups to elicit the current level of capacity with regard to various functions and tasks with regard to CCA for both stakeholders and functional groups [25].

Information on current capacities and future needs for CCA were assessed, based on a numerical scale, scores were computed for current capacities for stakeholder groups (industry, local, and state functionaries), and simultaneously for functional groups (financial tasks and functions, planning tasks and functions, and engineering and infrastructure tasks and functions), and likewise scores were computed for target capacities.

$$\mathrm{AS} = \sum_{i=1}^{n} \text{Current tasks} \tag{1}$$

$$\mathrm{TS} = \sum_{i=1}^{n} \text{Expected tasks under CCA} \tag{2}$$

Where AS = Actual score; TS = Total score

$$\text{Current Capacity} = \sum_{i=1}^{n} \text{Current tasks} \Big/ \sum_{i=1}^{n} \text{Expected tasks under CCA} \tag{3}$$

$$\text{Capacity Gap} = \left(1 - \sum_{i=1}^{n} \text{Current tasks} \Big/ \sum_{i=1}^{n} \text{Expected tasks under CCA} \right) \tag{4}$$

Eq. (4) provides the capacity gap, high value indicates greater training needs.

6. Results

6.1 Analysis of capacity needs for CCA in Telangana

Our analysis indicates that in the state of Telangana, all stakeholder groups and functional groups require significant training on various issues related to CCA.

The stakeholder consultations and analysis revealed that for the stakeholder group industry, capacity building needs are moderate, likewise, for the stakeholder group, local functionaries; capacity building needs varies from low to moderate (**Table 1**). Similarly, for the stakeholder group state level functionaries, capacity building needs varies from moderate to high (**Table 1**). Currently, about one-third to half of the task and functions with respect to CCA is performed by various stakeholders, for about half of the remaining tasks and functions required under CCA, it is required to be developed through training and other mechanisms.

Capacity gaps with regard to functional aspects, such as finance, engineering and infrastructure, and planning revealed moderate to high needs. While, capacity needs with respect to engineering and infrastructure and planning are moderate especially among the officials from the head office, such as TSIIC. Capacity needs were high with regard to tasks and functions related to finance knowledge, skills, and abilities (**Table 2**).

6.2 Analysis of capacity needs for CCA in AP

Our analysis indicates that in the state of Andhra Pradesh, all stakeholder groups and functional groups require significant training on various issues related to CCA. For the stakeholder group industry, capacity building needs varies from low to moderate. For the stakeholder group local functionaries, capacity building needs varies from low to high, probably indicating higher training needs. Similarly, for the stakeholder group state functionaries, capacity building needs varies from moderate to high (**Table 1**). Thus in Andhra Pradesh from the perceptions of the various stakeholders in the consultations it appears that approximately 25 to 50% of the tasks and functions with respect to climate change adaptation is performed by various stakeholders. There is a substantial need for capacity building required under CCA to be developed through training and other mechanism.

When it comes to specific tasks and functions related to CCA with reference to finance, engineering and infrastructure, and planning, the stakeholder consultations indicated moderate needs among the officials from the head office, such as APIIC (**Table 2**).

Sl. No.	Stakeholder	Telangana	AP
1	Industry	Moderate	Low to Moderate
2	Local functionaries	Low to Moderate	Low to High
3	State functionaries	Moderate to High	Moderate to High

Low: <50%; Moderate: > 50 < 75%; High >75%.

Table 1.
Capacity needs gap for stakeholder group industry in Telangana state and Andhra Pradesh.

Sl. No.	Functional group	Telangana	AP
1	Finance	High	Moderate
2	Engineering & Infrastructure	Moderate	Moderate
3	Planning	Moderate	Moderate

Low: <50%; Moderate: > 50 < 75%; High >75%.

Table 2.
Capacity needs gap for specific tasks and functions required for CCA in Telangana state and Andhra Pradesh.

7. Discussion

Our analysis from the stakeholder consultations provides support that various stakeholder groups require capacity building for CCA and climate resilient development outcomes. Individual industries in both states appear to have higher capacity with regard to CCA, nevertheless, for the overall success of CCA, there is a need to simultaneously develop the capacities of decision makers at the scale of individual IPs as well as state level organizations. In particular, officials working in various agencies such the environment agency, the district planning agencies, the local municipalities require assistance to improve resilience of industries for managing climate change impacts. There is an urgent need to develop capacity of decision makers to identify solutions based on the impending climate impacts, with emphasis on local conditions, for example, capacity of officials could be developed in such a manner that they identify and implement local interventions, such as land zoning, storm water management, and developing building codes.

The ability of local institutions and functionaries to intervene is a critical component in moderating the harmful effects of climatic extremes [4, 26]. At the local scale, in IPs, local municipalities need capacity building to identify key climate related hazards, the spatial and temporal pattern of these hazards, the susceptibility, and the resilience of IPs, climate change adaptation measures, and locally viable climate resilient strategies need to be developed. Likewise, the industry stakeholder group requires substantial training for developing climate resilient measures and climate proofing industries to extreme climatic events. For example, industries could identify alternate sources of supplies and markets for products. Innovations in identifying new markets could lead to numerous new opportunities and spinoffs provided by CCA. Similarly, factoring the long-term risks of C-C and the early adoption of C-C adaptation measures could result in resilient and profitable industrial landscape. An interesting finding from the stakeholder analysis was the higher capacity with regard to CCA among certain industries, such as the ICT (Information and Communication Technologies). This could be explained by the global nature of this industry, hence it is better prepared to deal with extreme climatic events, both in terms of financing as well as the knowledge base.

Better planning for mainstreaming of climate change adaptation into plans of the government would be important. National and state level plans for climate change adaptation in Andhra Pradesh and Telangana could provide overall policy and goals to develop climate resilient pathways. Some of these measures include providing policy framework to guide decisions at the state level; providing legal framework; directing actions in key sectors. Similarly, multi-sectoral and multi-spatial planning across sectors such as environment, agriculture, industries, urban, irrigation, and other sectors are crucial for CCA. The stakeholder analysis identified specific needs with regard to development of master plans, including climate resilient measures at inception stage of project, mock drills, risk analysis for C-C, development of early warning systems for floods, cyclones, heat waves, and droughts in both states. A key aspect lies in the dissemination of the CCA planning strategies, it is critical that ICT (Information and Communication Technologies) are leveraged by officials in both states to ensure effective outcomes. A reassuring finding of the stakeholder analysis was the existing capacity among various officials, especially among engineers, with regard to engineering and infrastructure. However, specific capacity development with regard to mainstreaming climate change adaptation into their existing capacities would enhance CCA outcomes [27]. In line with Nationally Determined Contributions (NDC) of the Paris Agreement, development of green infrastructure, climate resilient infrastructure and nature based solutions to address climate change would lead to win-win outcomes.

During the stakeholder consultations a frequently occurring need was regarding capacity to leverage financial resources to meet the demands of CCA. Specific gaps in skills included, sustainable financing, green financing, and green budgeting. In this regard, specific training to attract funding from the Green Climate Fund (GCF) would be important [28]. Specific training programs garnered towards financial incentives, including taxes and subsidies; insurance, including weather based insurance schemes; creation of catastrophe bonds; payments for ecosystem service; differential water tariffs; microfinance; and disaster contingency funds were identified during the analysis. Financing that includes diversity of portfolios, such as public and private funding mechanisms; debt and equity for climate financing; export credits and foreign direct invests for climate change adaptation could be important information to be included in capacity development for CCA [29].

8. Conclusions

Climate change and the occurrence of extreme climatic events could have deleterious effects on industrial activities. The occurrence of disastrous events such as floods, droughts, storms, and heatwaves could have implications for human lives and economic losses for organizations. Climate change adaptation to these impending threats to industrial activities could moderate the impacts of these extreme climatic events, thereby reducing loses to industries. The study indicates that, there is an urgent need to build capacity among various stakeholders involved in the industrial development landscape. Functionaries at local and state levels need critical training in various climate change adaptation measures, similarly, industry owners, need support to alleviate the impacts of climate change. Specific knowledge, skills, and abilities, with regard to infrastructure and engineering capacities, planning capacities, and financial aspects, especially green financing of CCA activities are required. The chapter provides important information on assessing capacity gaps with regard to CCA in the industrial sector. Further, the chapter also identifies critical gaps in capacity among various stakeholders.

Acknowledgements

I would like to thank the funding agency GIZ for a grant to successfully carry out the research in the two states. I would also like to thank the various officials and industry representatives in the two states for their active participation and feedback in preparing the capacity needs assessment. I would especially like to thank Dr. Dieter Brulez, Dr. Hrishikesh Mahadev, and Dr. Rajani Ganta for their useful comments.

Author details

Narendran Kodandapani
Center for Advanced Spatial and Environmental Research (CASER),
Bangalore, India

*Address all correspondence to: svknaren@gmail.com

IntechOpen

© 2021 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/3.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

References

[1] Figueres C, Schellnhuber HJ, Whiteman G, Rockstrom J, Hobley A, Rahmstorf S. Three years to safeguard our climate. Nature. 2017:546:593-595.

[2] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)].

[3] Jolly, W. M., Cochrane, M. A., Freeborn, P. H., Holden, Z. A., Brown, T. J., Williamson, G. J., & Bowman, D. M. J. S.. Climate induced variations in global wildfire danger from 1979 -2013. Nature Communication. 2015:|6:7537|DOI: 10.1038/ncomms8537.

[4] IPCC, 2014. Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Work- ing Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 2014:1327-1370.

[5] GEO-6. Healthy planet healthy people. Cambridge University Press, Cambridge, UK. 2019.

[6] Hughes TP, Barnes ML, Bellwood DR, Cinner JE, Cumming GS, Jackson JBC, Kleypas J, van de Leemput IA, Lough JM, Morrison TH, Palumbi SR, van Nes EH, Scheffer M. Coral reefs in the Anthropocene. Nature. 2017:546, 82-90.

[7] IPCC, 2012. Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of working groups I and II of the Intergovernmental Panel on Climate Change. IPCC, Cambridge University Press, Cambridge.

[8] Munich RE (2020). NatCatSERVICE analysis tool. Retrieved from https://natcatservice.munichre.com

[9] The Economist. A rising tide: Natural disaster loss events by cause. September 2017.

[10] Economic Times, 2016. Disaster Count.

[11] Tubiana L. The people's pledge to fight climate change. THE HINDU|The New York Times (30th December, 2017 issue).

[12] Hov O, Terblanche D, Carmichael G, Jones S, Ruti PM, Tarasova O. Five priorities for weather and climate research. Nature. 2017:552:168-170.

[13] WEF 2018. The global risks report 2018.

[14] WEF 2021. The global risks report 2021.

[15] Mohanty, A. 2020. Preparing India for Extreme Climate Events: Mapping Hotspots and Response Mechanisms. New Delhi: Council on Energy, Environment and Water.

[16] Kale MP, Ramachandran RM, Pardeshi SN, Chavan M, Joshi PK, Pai DS, Bhavani P, Ashok K, Roy PS. Are climate extremities changing fire regimes in India? An Analysis using MODIS fire locations during 2003-2013 and gridded climate data of Indian Meteorological Department. Proc. Natl. Acad. Sci., India, Sect. A Phys. Sci. 2017: 87(4), 827-843.

[17] Ramesh KV, Goswami P.. Reduction in temporal and spatial extent of the Indian summer monsoon. Geophysical Letters. 2007: 34: L23704, doi: 10.1029/2007GL031613.

[18] Borah PJ, Venugopal V, Sukhatme J, Muddebihal P, Goswami BN. Indian monsoon derailed a North Atlantic wavetrain. Science. 2020:370:1335-1338.

[19] EPTRI 2012. State Action Plan on Climate Change for Andhra Pradesh. Submitted to Ministry of Environment and Forests, Government of India, New Delhi. Available online at www.moef.nic.in/sites/default/files/sapcc/Andhra-pradesh.pdf

[20] Pai DS, Sridhar L, Rajeevan M, Sreejith OP, Sathbai NS, Mukhopadhyay B (2014) Development of a new high spatial resolution (0.25° × 0.25°) Long Period (1901-2010) daily gridded rainfall data set over India and its comparison with existing data sets over the region. Mausam, 65, 1-18.

[21] Pascal J-P (1986) Explanatory booklet on the Forest map of South India. (French Institute, Pondicherry).

[22] World Bank 2005. Drought in Andhra Pradesh: Long term impacts and adaptation strategies. South East Asia Environment and Social Development Department.

[23] Kabisch S, Bollwein T, Bank P, Brulez D, Varaprasad SS, Mahadev HR, Ganta, R. Climate change adaptation for sustainable industrial development: A strategy outline for the implementation of the "Climate Change Adaptation Project (CCA)" in industrial areas of AP and Telangana, India. 2015.

[24] Julius SH, West JM, Nover D, Hauser R, Schimel DS, Janetos AC, Walsh MK, Backlund P. Climate Change and US Natural Resources: Advancing the Nation's capability to adapt. Issues in Ecology. 2013.

[25] Kodandapani N, Bala Subramanyam G. Understanding capacity needs requirements for different stakeholders of climate change adaptation for industrial areas of Andhra Pradesh & Telangana. Funding agency, Integration and GIZ. 2016.

[26] Denton, F., T.J. Wilbanks, A.C. Abeysinghe, I. Burton, Q. Gao, M.C. Lemos, T. Masui, K.L. O'Brien, and K. Warner, 2014: Climate-resilient pathways: adaptation, mitigation, and sustainable development. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1101-1131.

[27] Klein, R.J.T., G.F. Midgley, B.L. Preston, M. Alam, F.G.H. Berkhout, K. Dow, and M.R. Shaw, 2014: Adaptation opportunities, constraints, and limits. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 899-943.

[28] UNFCCC, 2007: Investment and Financial Flows to Address Climate Change. The United Nations Framework

Convention on Climate Change (UNFCCC), UNFCCC Secretariat, Bonn, Germany, 272pp.

[29] Chambwera, M., G. Heal, C. Dubeux, S. Hallegatte, L. Leclerc, A. Markandya, B.A. McCarl, R. Mechler, and J.E. Neumann, 2014: Economics of adaptation. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 945-977.

IntechOpen

IntechOpen