Bureau of Energy Efficiency

सत्यमेव जयते
Government of India
Ministry of Power

german cooperation
DEUTSCHE ZUSAMMENARBEIT

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THIS PRESENTATION WAS SHARED BY

Dr. Anir Upadhyay

Architect and Urban Planner, Faculty of the Built Environment, UNSW, Sydney

FOR THE SESSION:

"Climate Resilience in Buildings"

DURING ANGAN 2019

Knowledge Partner

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Creating Innovative Solutions for a Sustainable Future

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ANGAN
Augmenting Nature by Green Affordable New-habitat

Climate Resilient Architecture:

Design for the future climate

-Dr Anir Upadhyay
B. Arch, MSc (Urban Planning), PhD (Sustainable Design)
Lecturer, UNSW Built Environment

UNSW SYDNEY | Australia's Global University

What is resilience?

"Resiliency is a multifaceted lens which balances **proactivity** and **reactivity** to inform solutions to **disruptions**."

(The Resilient Design Institute, 2019)

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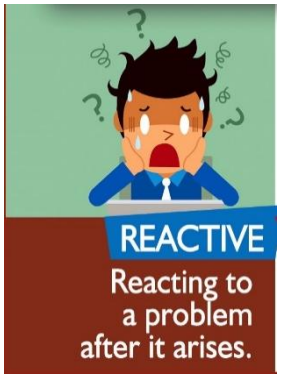
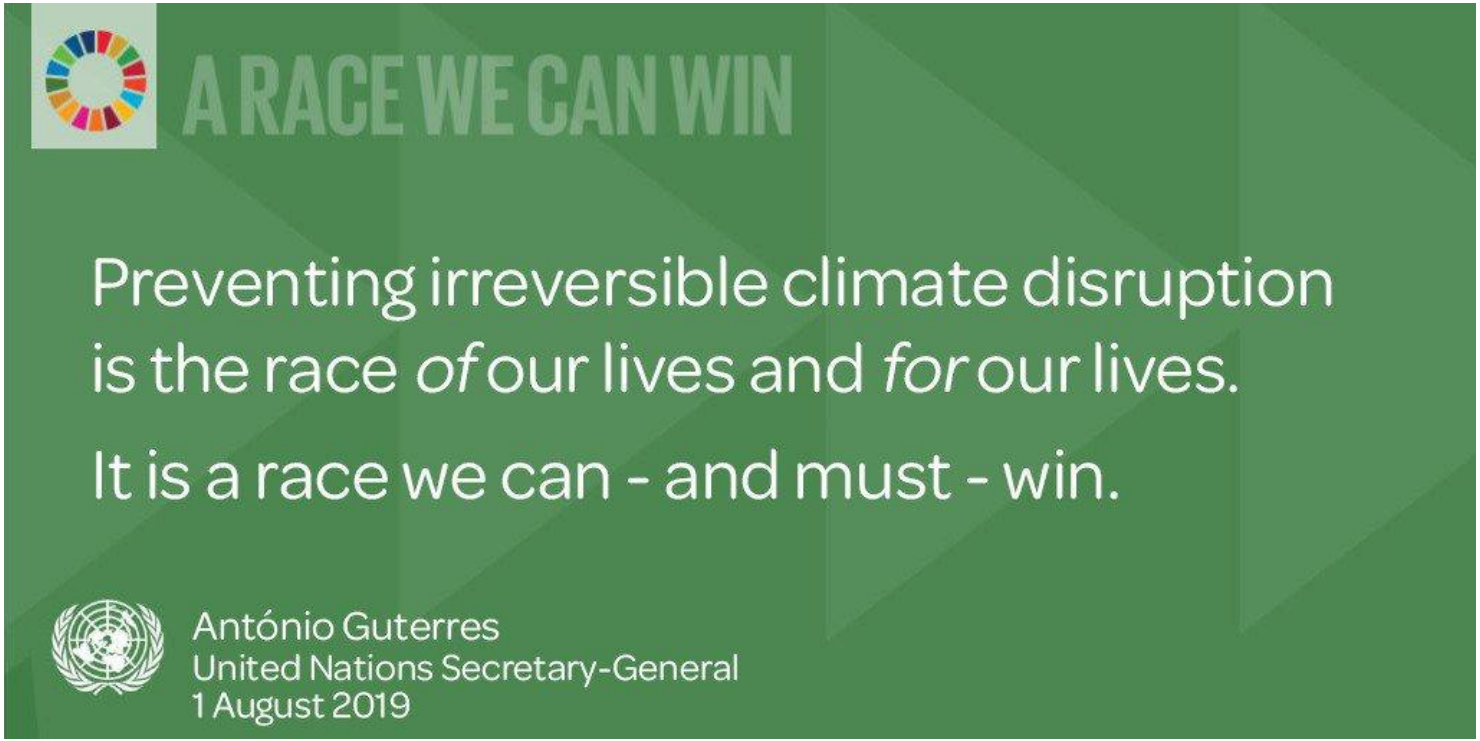


Climate disruptions



Reversing climate disruptions

Shift away from fossil fuels and towards renewable energy

Focus on new commitments on low-emission buildings

https://www.un.org/en/climatechange/un-climate-summit-2019.shtml

Reversing climate disruptions

Shift away from fossil fuels and towards renewable energy

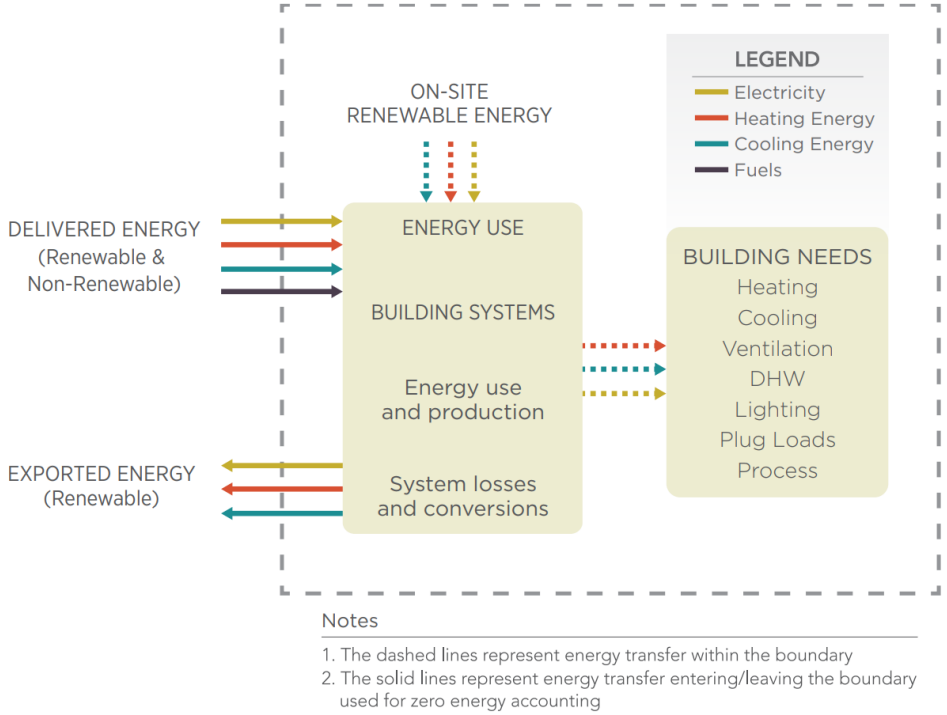
Focus on new commitments on low-emission buildings

Net zero carbon/super low energy/near zero energy buildings

https://www.un.org/en/climatechange/un-climate-summit-2019.shtml

Zero energy buildings

An energy-efficient **building** where, on a **source energy** basis, the actual **annual delivered energy** is less than or equal to the on-site renewable **exported energy.**



https://www.energy.gov/sites/prod/files/2015/09/f26/bto_common_definition_zero_energy_buildings_093015.pdf

Zero energy buildings

MEASURE CATEGORIES	REQUIREMENTS ADDRESSED	STRATEGIES	MEASURES (examples)
PASSIVE	HEATING COOLING LIGHTING	PREVENTION MODULATION REJECTION/COLLECTION CONTROL	ADVANCED ENVELOPE SUNSHADING NATURAL VENTILATION
ENERGY EFFICIENCY	HEATING COOLING DHW LIGHTING PLUG LOADS	LOW EXERGY SYSTEMS ENHANCE NATURAL FLOWS LOAD SIZING ZONING/CONTROL REUSE ENERGY FLOWS	RADIANT HEATING/COOLING MECHANICAL AIR HEAT RECOVERY ADVANCED LIGHTING CONTROL
RENEWABLE ENERGY	ELECTRICITY HEATING COOLING DHW	POWER GENERATION HEAT GENERATION COMBINED HEAT & POWER	BAPV, BIPV SOLAR THERMAL BIPV/T

https://www.energy.gov/sites/prod/files/2015/09/f26/bto_common_definition_zero_energy_buildings_093015.pdf

Designing for the climate

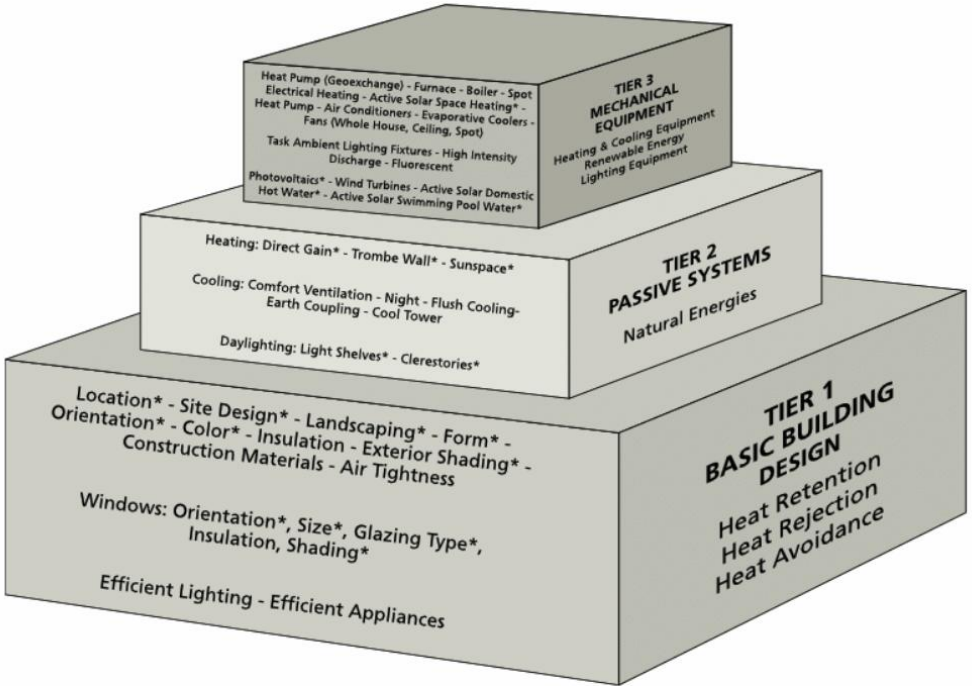


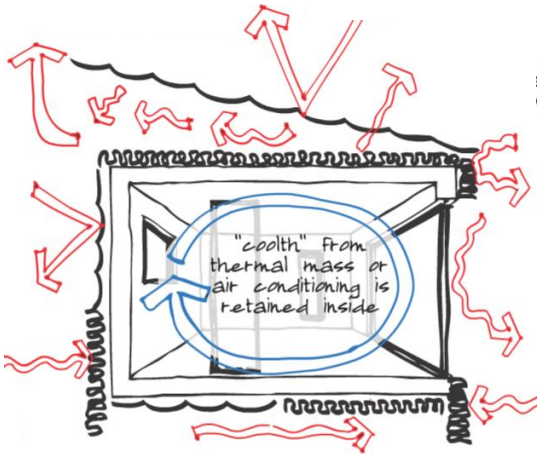
Table 1.4A The Three-Tier Design Approach

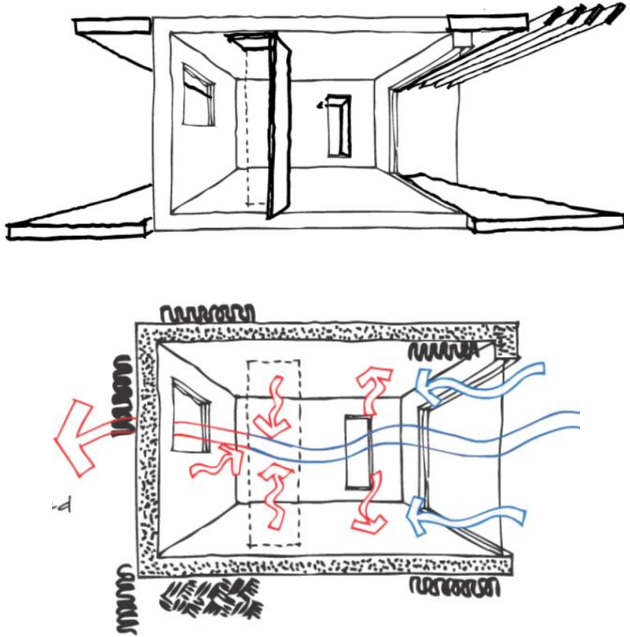
	Heating	Cooling
Tier 1	*Conservation*	*Heat avoidance*
Basic Building Design	1. Surface-to-volume ratio 2. Insulation 3. Infiltration	1. Shading 2. Exterior colors 3. Insulation 4. Mass
Tier 2	*Passive solar*	*Passive cooling*
Natural Energies and Passive Techniques	1. Direct gain 2. Trombe wall 3. Sunspace	1. Evaporative cooling 2. Night-flush cooling 3. Comfort ventilation 4. Cool towers
Tier 3	*Heating equipment*	*Cooling equipment*
Mechanical and Electrical Equipment	1. Furnace 2. Boiler 3. Ducts/Pipes 4. Fuels	1. Refrigeration machine 2. Ducts 3. Geo-exchange

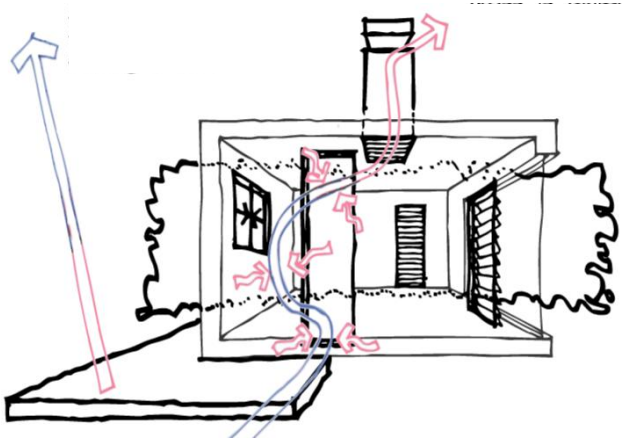
(Lechner, 2014 p.9)

Designing for the climate

Heat protection/ rejection



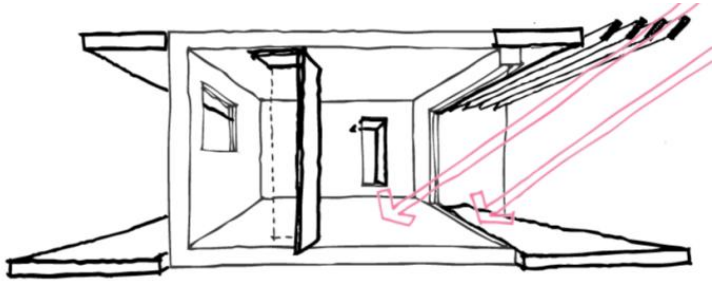


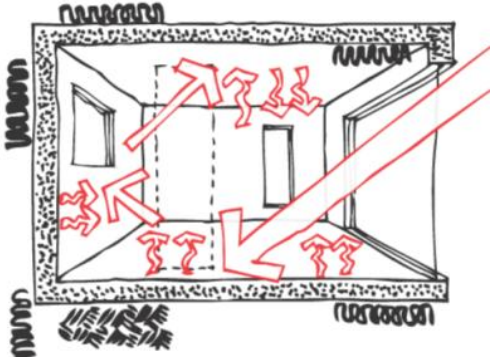


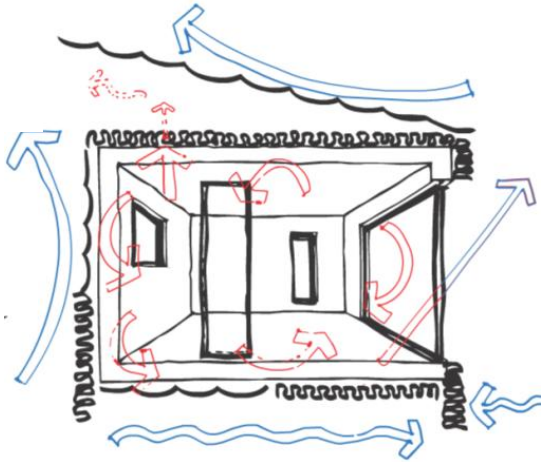
(www.designingforclimate.com.au, 2018)

Designing for the climate

Heat gain/ retention







(www.designingforclimate.com.au, 2018)

Cooling strategies

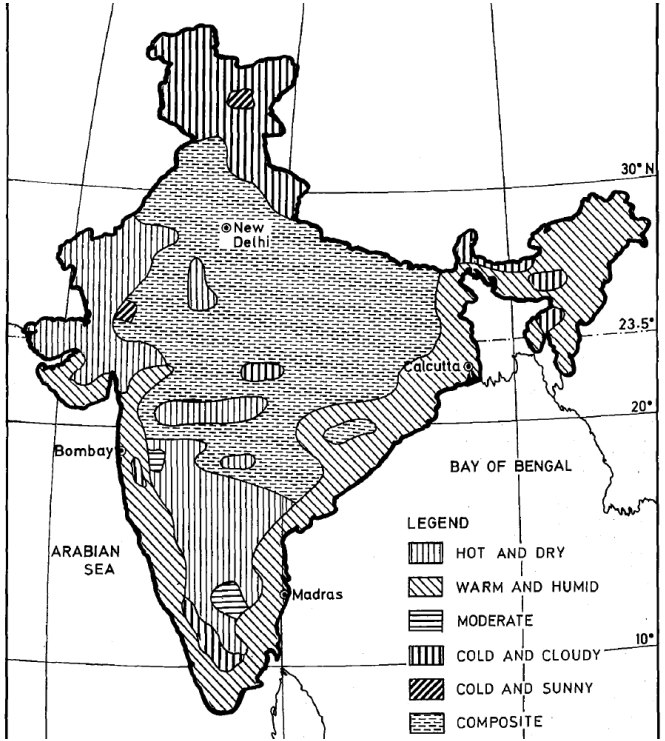
Hot and Dry climate

Gaza, Israel, Middle East
(http://eartharchitecture.org/?tag=domes)

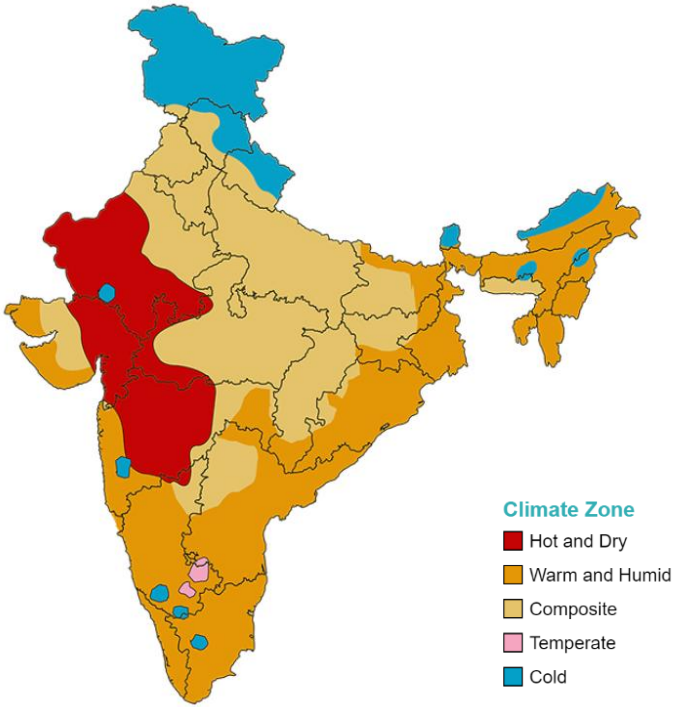
Hot and Humid climate

Malay house, Malaysia
(http://nalenda14.blogspot.com.au/2010/11/malay-vernacular-architecture.html)

Indian climate zones



(Bansal and Minke,1988)



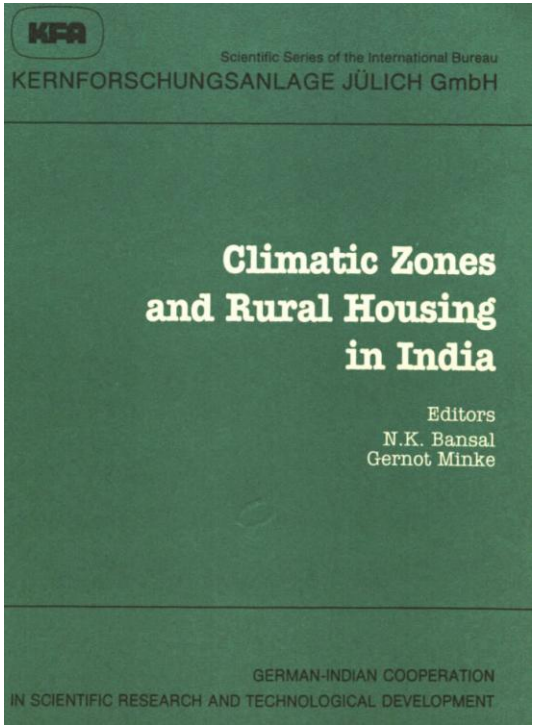
http://www.econiwas.com/tool/

Indian climate zones

Criteria of Bansal et al. [1]			Criteria of SP 7: 2005 [9]		
Climate	**Mean monthly temperature (°C)**	**Relative humidity (%)**	**Climate**	**Mean monthly maximum temperature(°C)**	**Relative humidity (%)**
Hot and dry	>30	<55	Hot and dry	>30	<55
Warm and humid	>30	>55	Warm and humid	>30 >25	>55 >75
Moderate	25-30	<75	Temperate	25-30	<75
Cold and cloudy	<25	>55	Cold	<25	All values
Cold and sunny	<25	<55			
Composite	This applies, when six months or more do not fall within any of the above categories		Composite	This applies, when six months or more do not fall within any of the above categories	

(www.mnre.gov.in/solar-energy/ch2.pdf)

Indian climate zones



(Bansal and Minke, 1988)

Title of project

Passive Space Conditioning
Part I: Climatic Zones and Rural Housing in India
Part II: Design Guidelines for Passive Space Conditioning in Different Climatic Zones

Projekttitel

Passive Klimatisierung von Gebäuden - Erkenntnisse aus traditionellen Bauweisen in Indien und Möglichkeiten ihrer Übertragbarkeit
Projekt-Nr. 03E-8665-A

Research Team

India

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Indian Institute of Technology, Delhi
New Delhi 110 016

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(Project Leader)
Mr. R. Muthu Kumar, Architect
Mr. Anil Misra, Building Physicist
Mr. Satendra Pal Singh, Physicist
in cooperation with
Central Building Research Institute, Roorkee
Dr. M.R. Sharma, Climatologist
Mr. Sharaft Ali, Climatologist

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Dipl.-Ing. Peter Reutter, Architect
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Ingenieurbüro für Bauphysik, Baunatal
(Consultants for Building Science)
Prof. Dr.-Ing. Gerd Hauser

Sponsors

Department of Non-conventional Energy Sources,
New Delhi, India

Bundesministerium für Forschung und Technologie,
Bonn, Federal Republic of Germany

Indian climate zones

UDC: 551.58(540) Keywords: Building design; Climate; Climatic zones; Comfort.

Architectural Science Review
Volume 36, pp 31—36

Published in 1993

Climatic Classification for Building Design in India

Sharafat Ali, M.R. Sharma, and V.K. Maiteya

Central Building Research Centre
Roorkee, U.P., 247 667, India

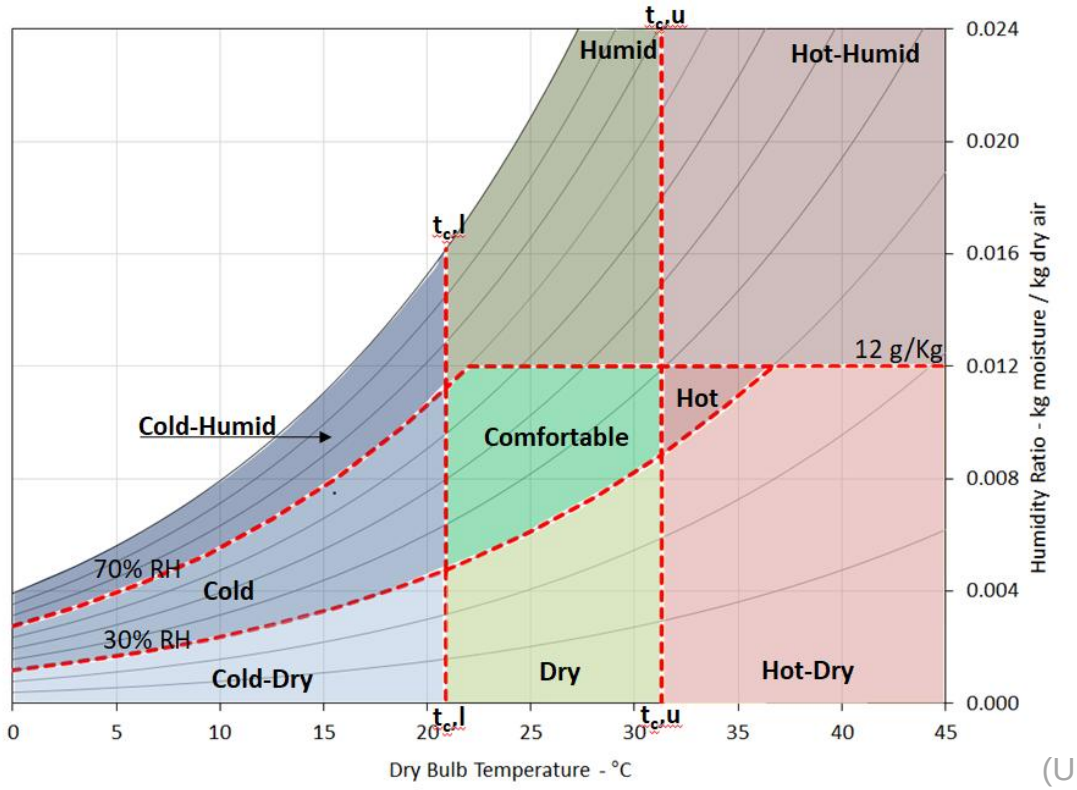
A study on climatic data for nearly 225 stations spread over the whole country has been carried out to determine climatic zones which may meet common basic design features in buildings and requirements of heat flow computations. The country is categorised in four major types of climates viz, hot-dry, warm-humid, temperate and cold and a sub-group "Composite". The greater part of the country falls under composite followed by warm - humid zone.

Table 1

Basis for Climatic Classification

S.No.	Climatic Zone	Mean Monthly Max. Air Temperature	Mean Monthly Relative Humidity
1.	Hot-dry	above 30°C	below 55%
2.	Warm-humid	a) above 30°C b) above 25°C	above 55% above 75%
3.	Temperate	between 25°-30°C	below 75%
4.	Cold	below 25°C	all values

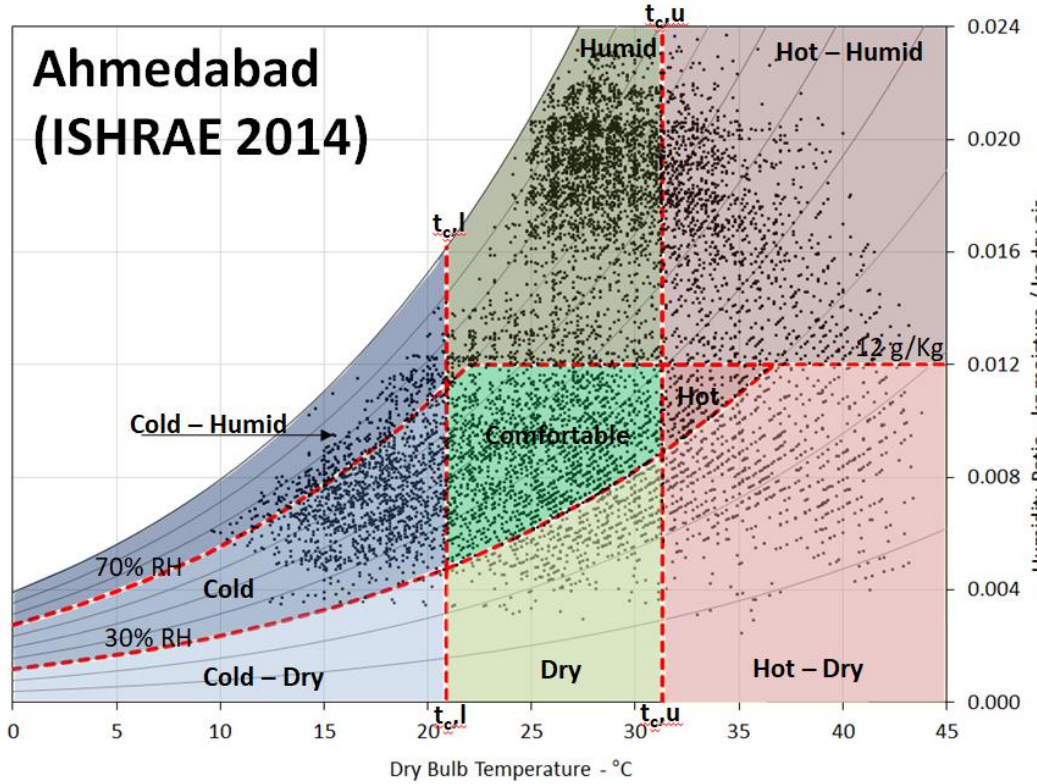
Thermal environmental conditions

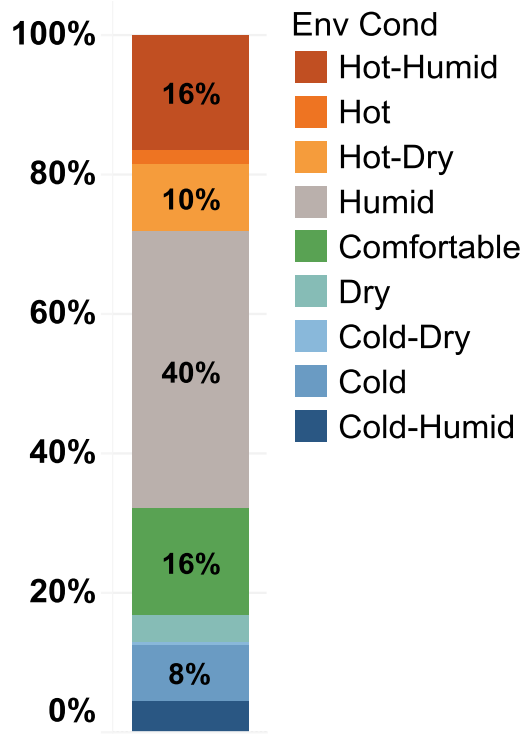


(Upadhyay, 2018)

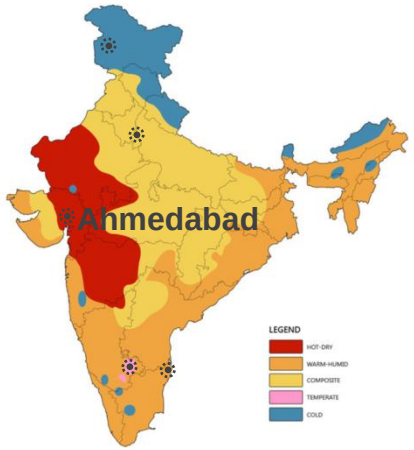
Thermal environmental conditions

Month	Year
Jan	1995
Feb	1994
Mar	1998
Apr	1990
May	1996
Jun	1998
Jul	1996
Aug	1997
Sep	1991
Oct	2001
Nov	2003
Dec	1993



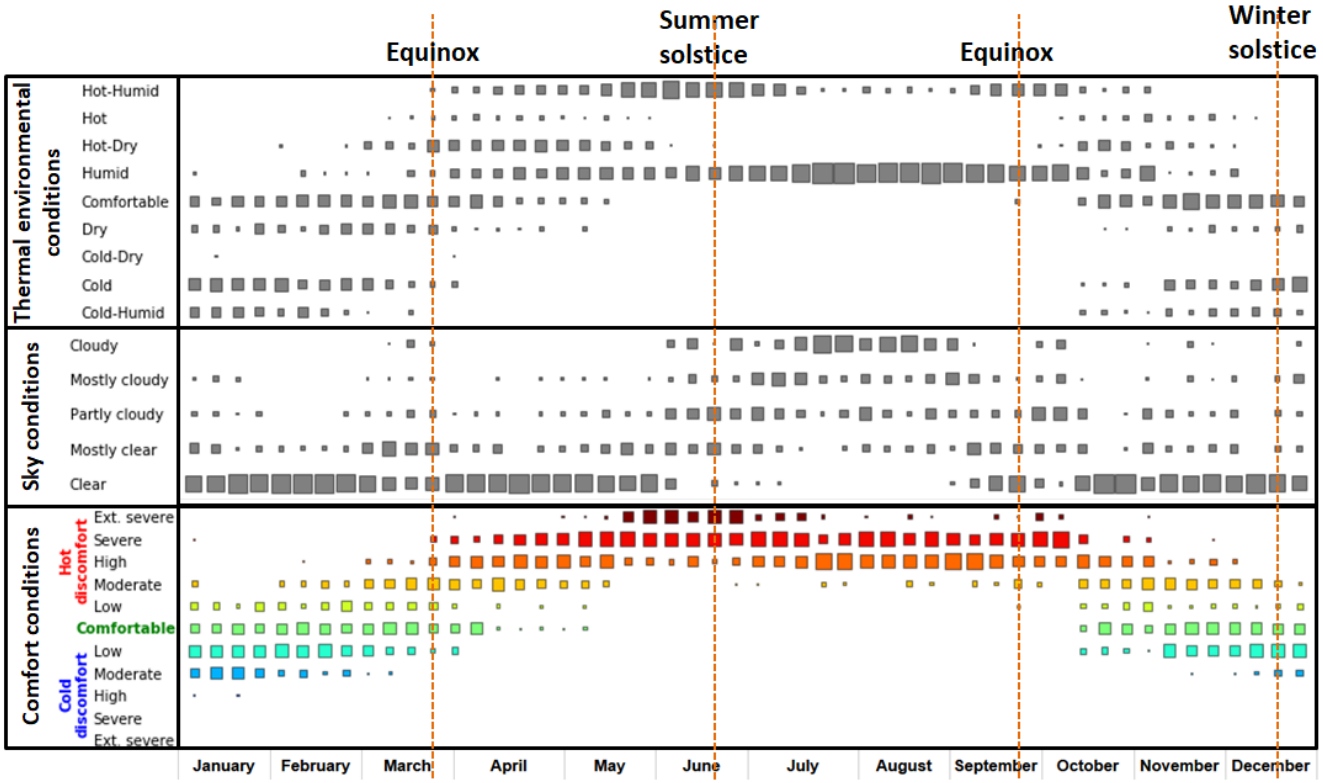


Ahmedabad climate outlook

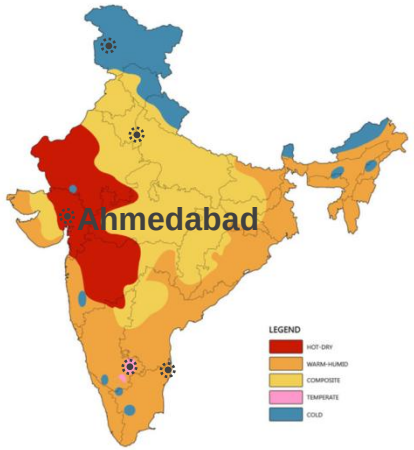


Classified as

hot-dry

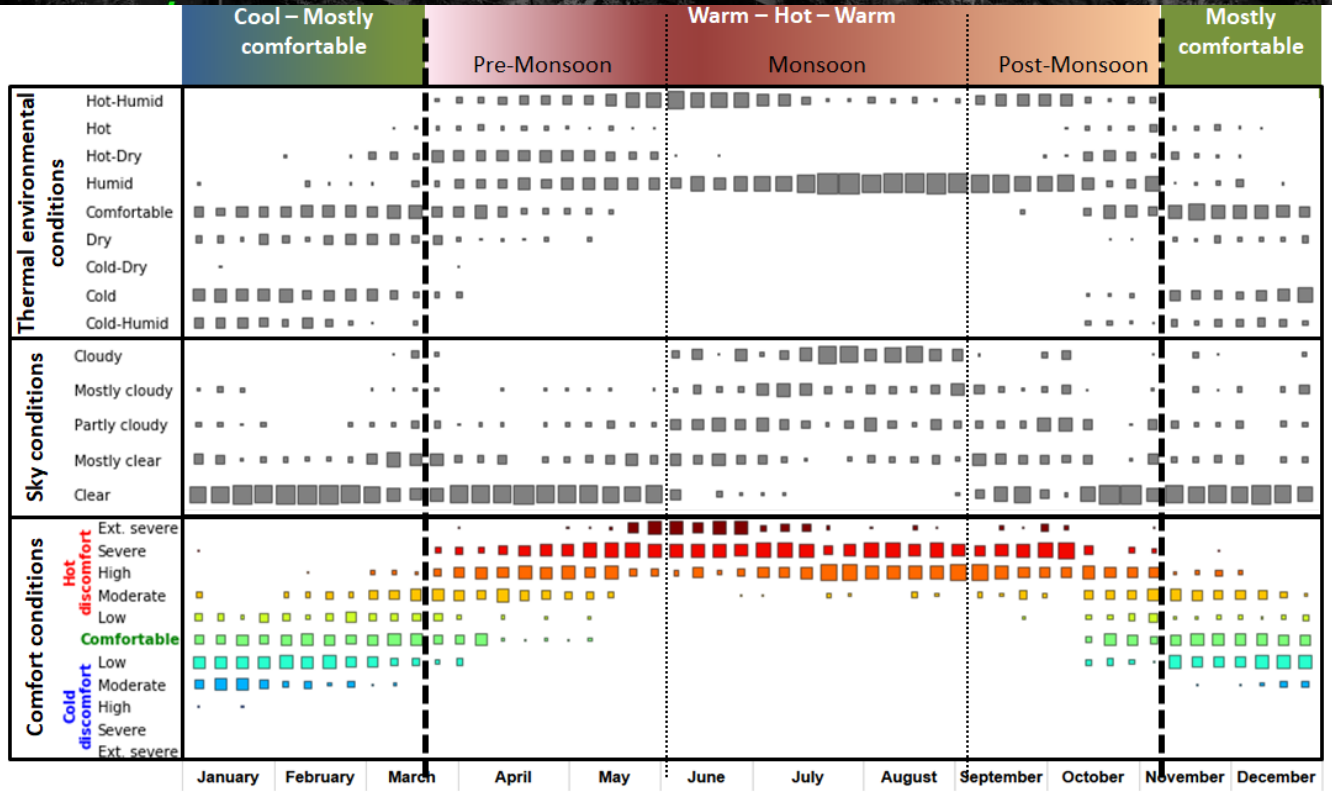


Ahmedabad climate outlook

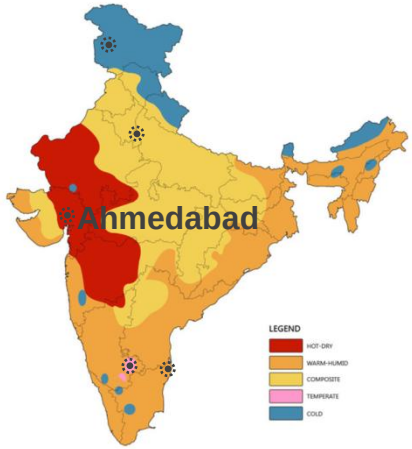


Classified as

hot-dry

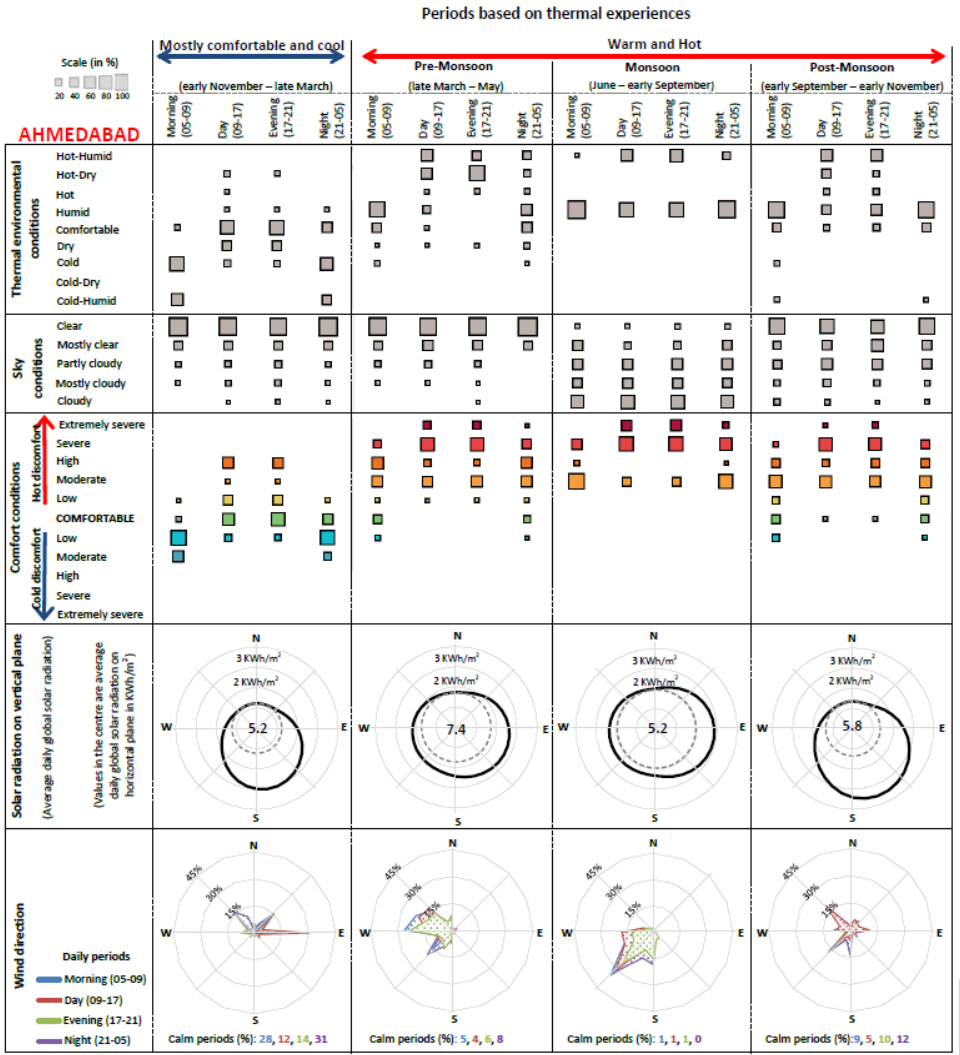


Ahmedabad climate outlook



Classified as

hot-dry

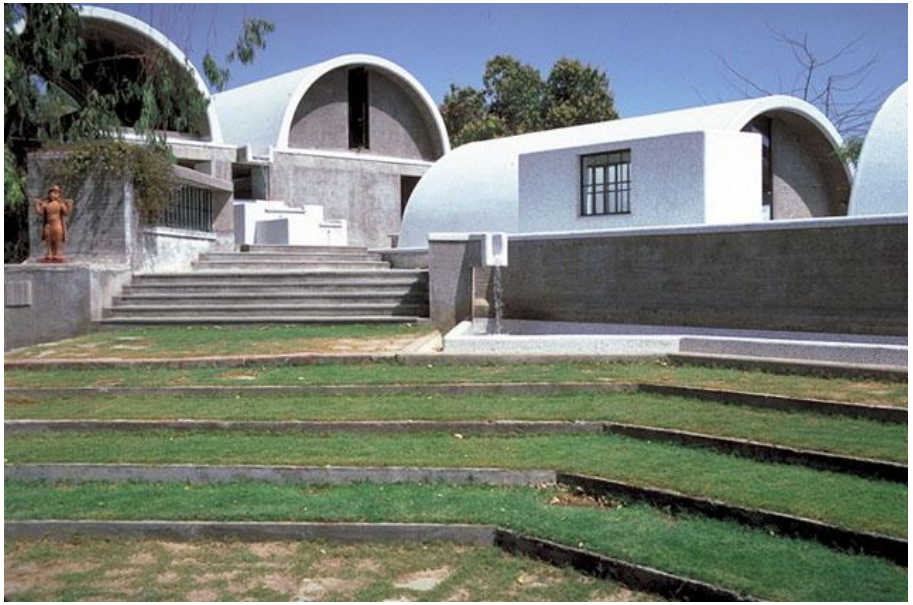


Torrent Research Centre, Ahmedabad

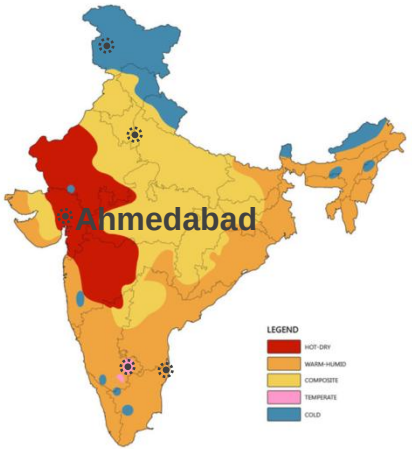
https://archnet.org/sites/4454/media_contents/17672

https://archnet.org/sites/4454/media_contents/17675

Sangath, Ahmedabad



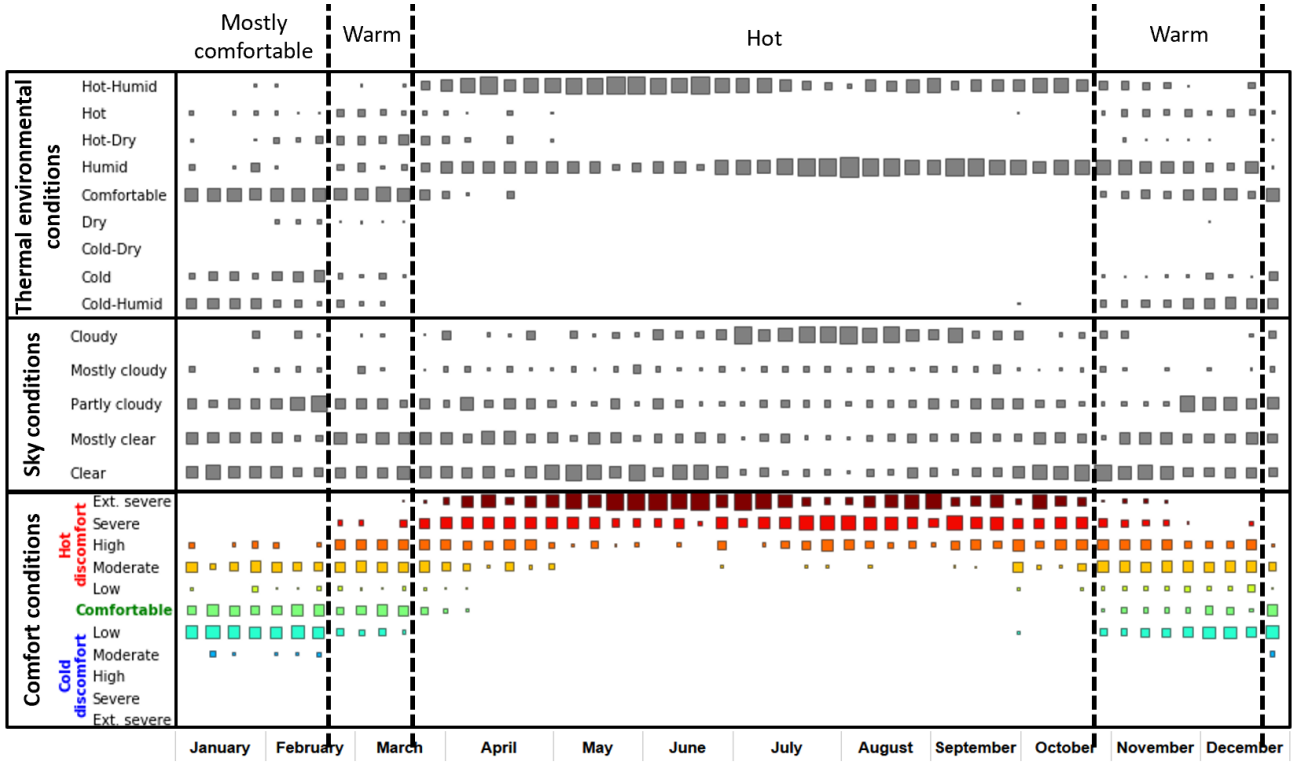
Ahmedabad climate outlook (2050)



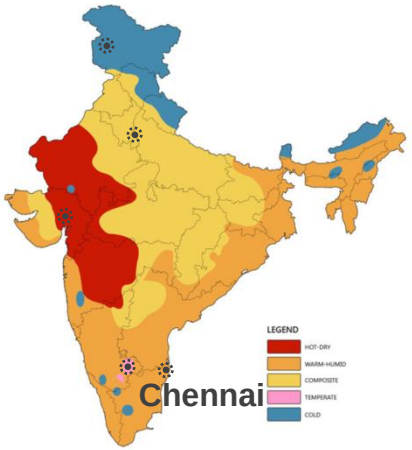
should be Classified as

~~hot-dry~~

hot-humid/ humid

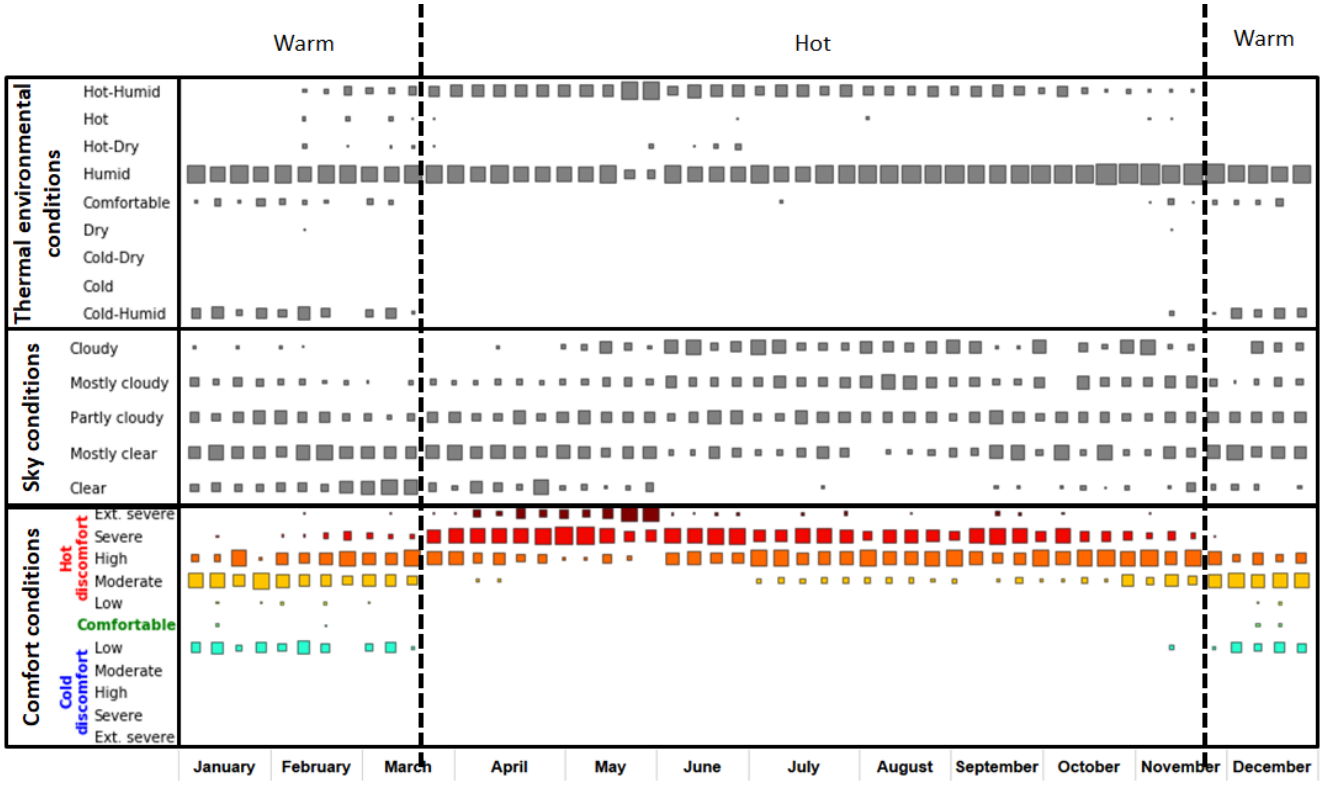


Chennai climate outlook

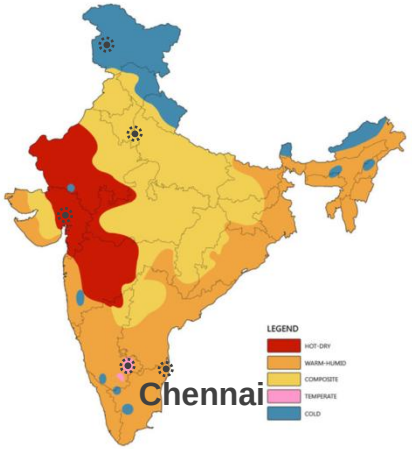


Classified as

warm-humid



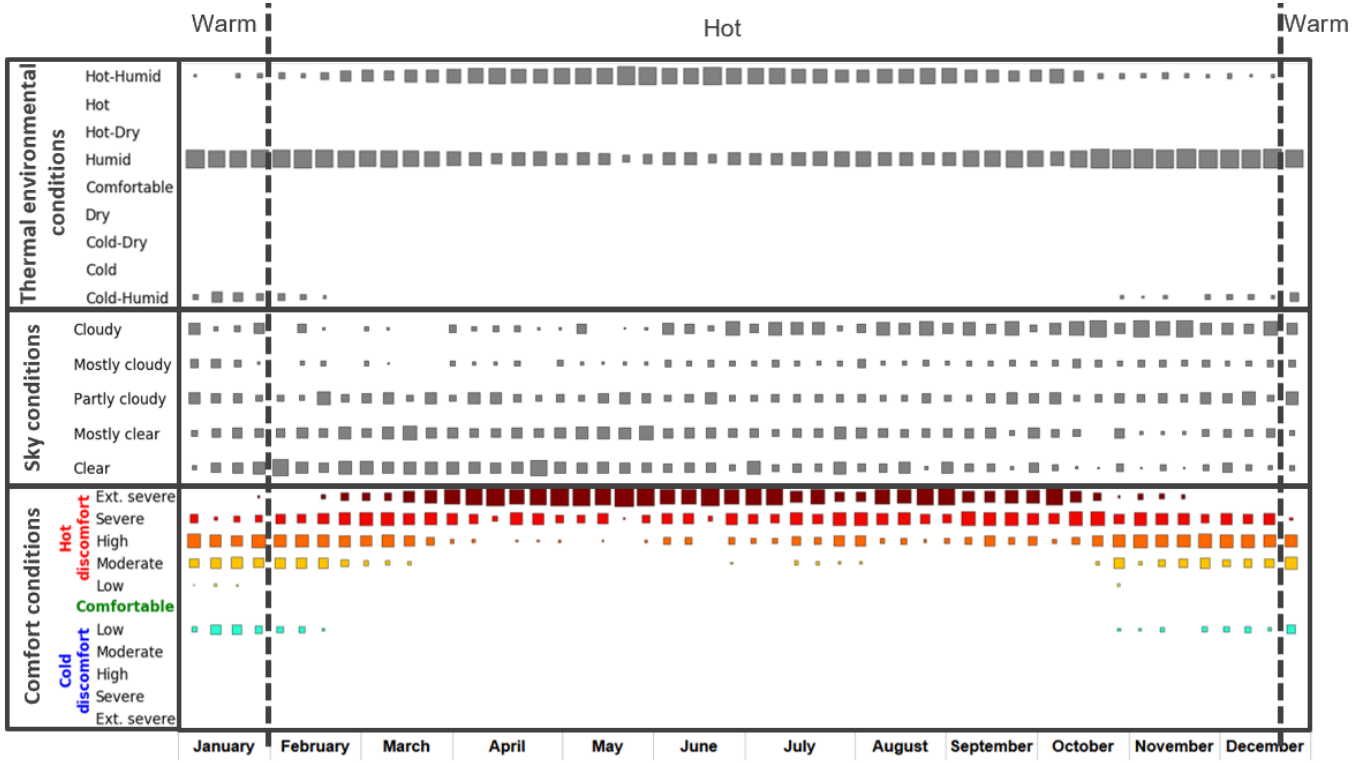
Chennai climate outlook (2050)



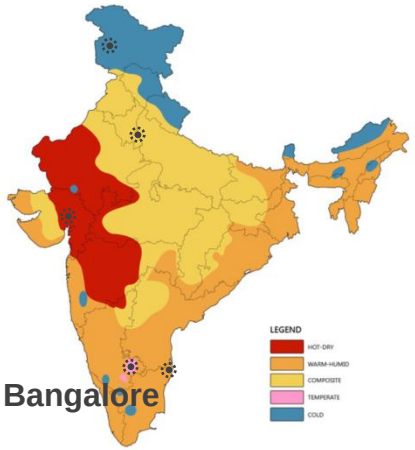
should be Classified as

~~warm-humid~~

hot-humid

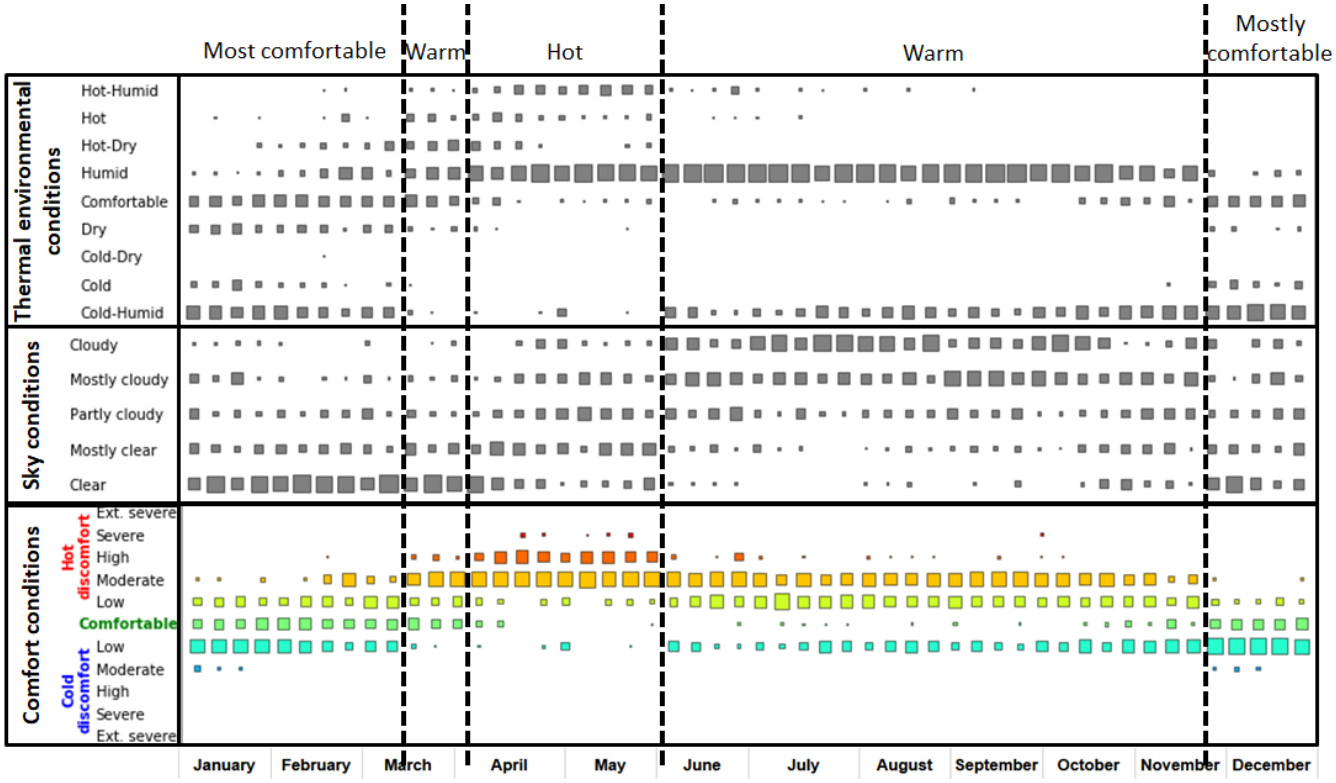


Bangalore climate outlook

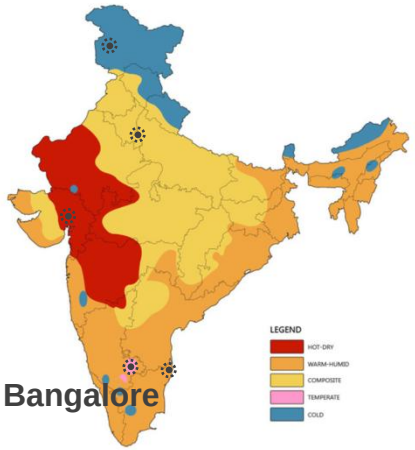


Classified as

temperate



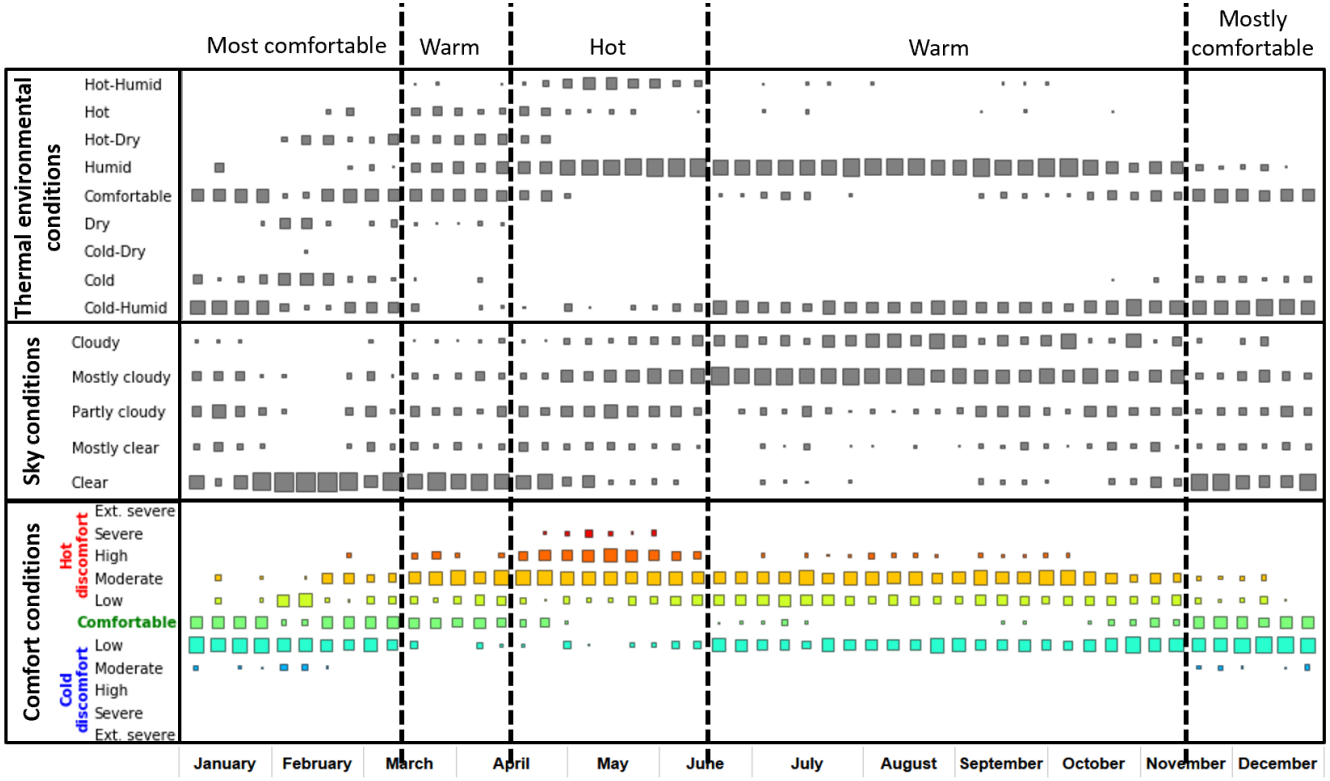
Bangalore climate outlook (2050)



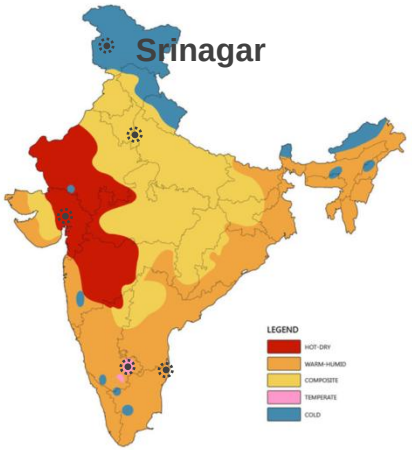
should be Classified as

~~tempearte~~

warm-humid

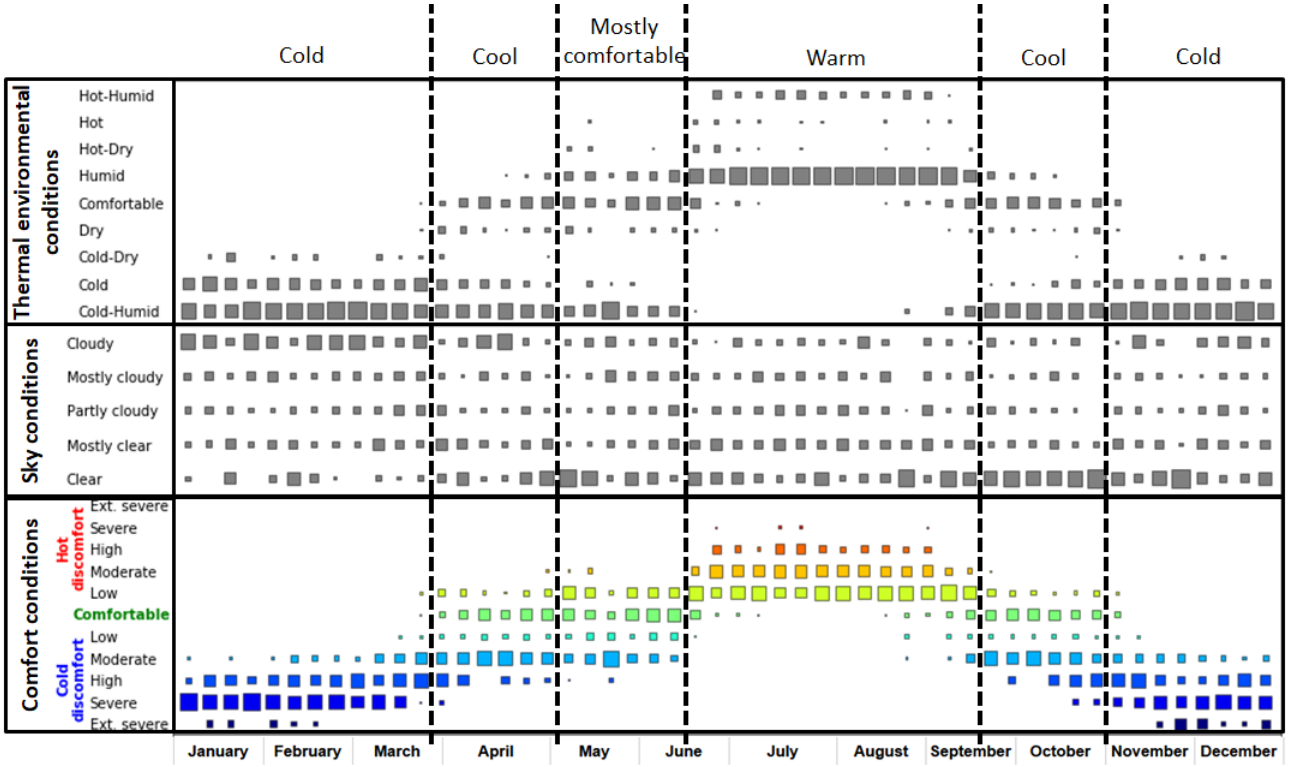


Srinagar climate outlook

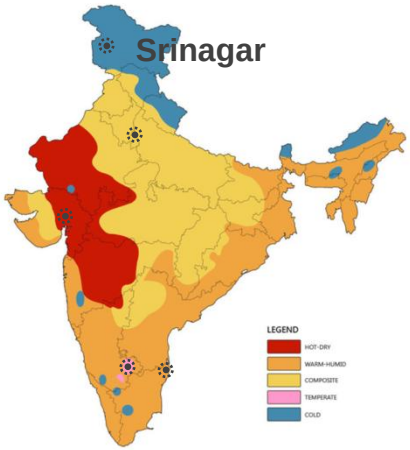


Classified as

cold

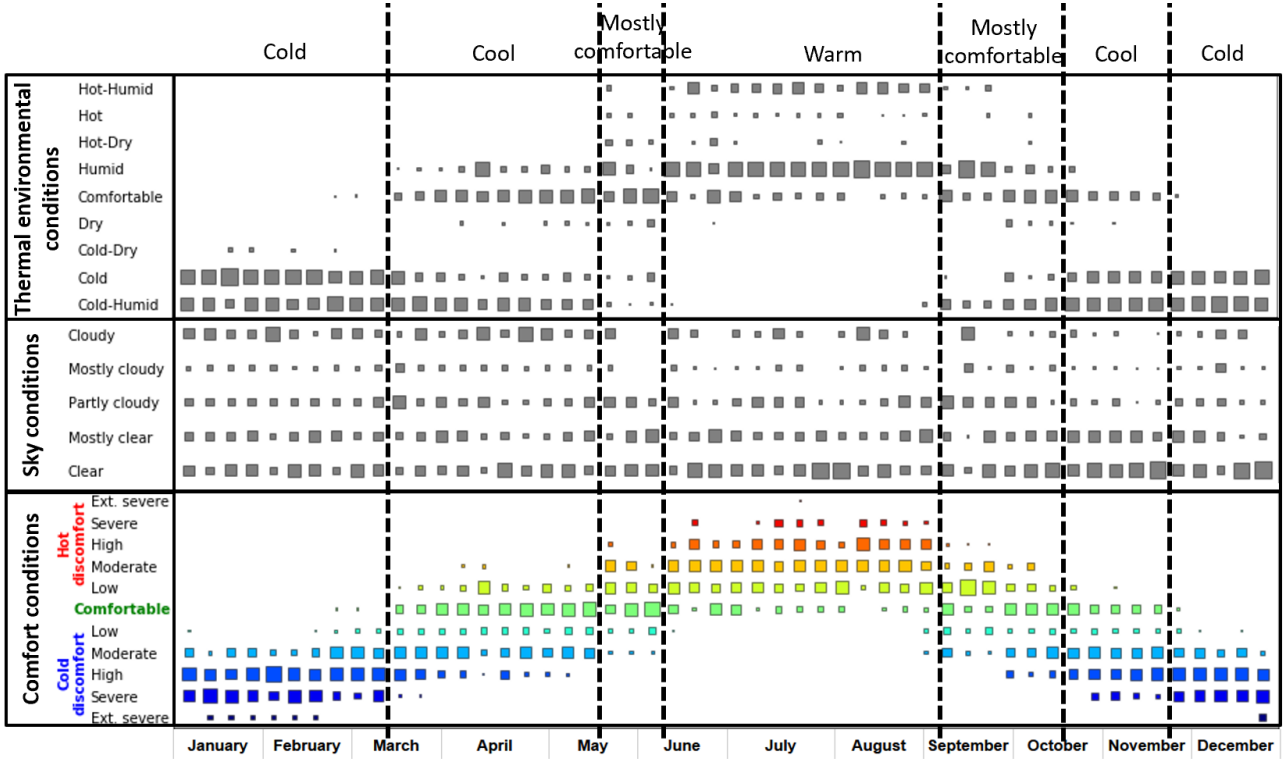


Srinagar climate outlook (2050)

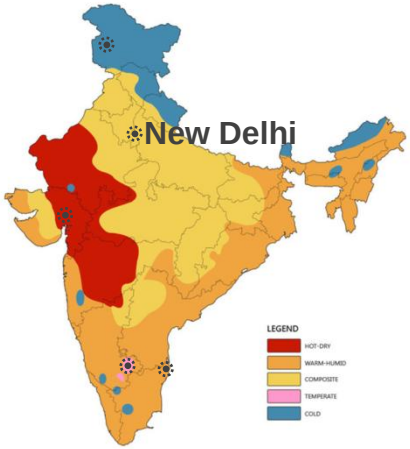


Classified as

cold

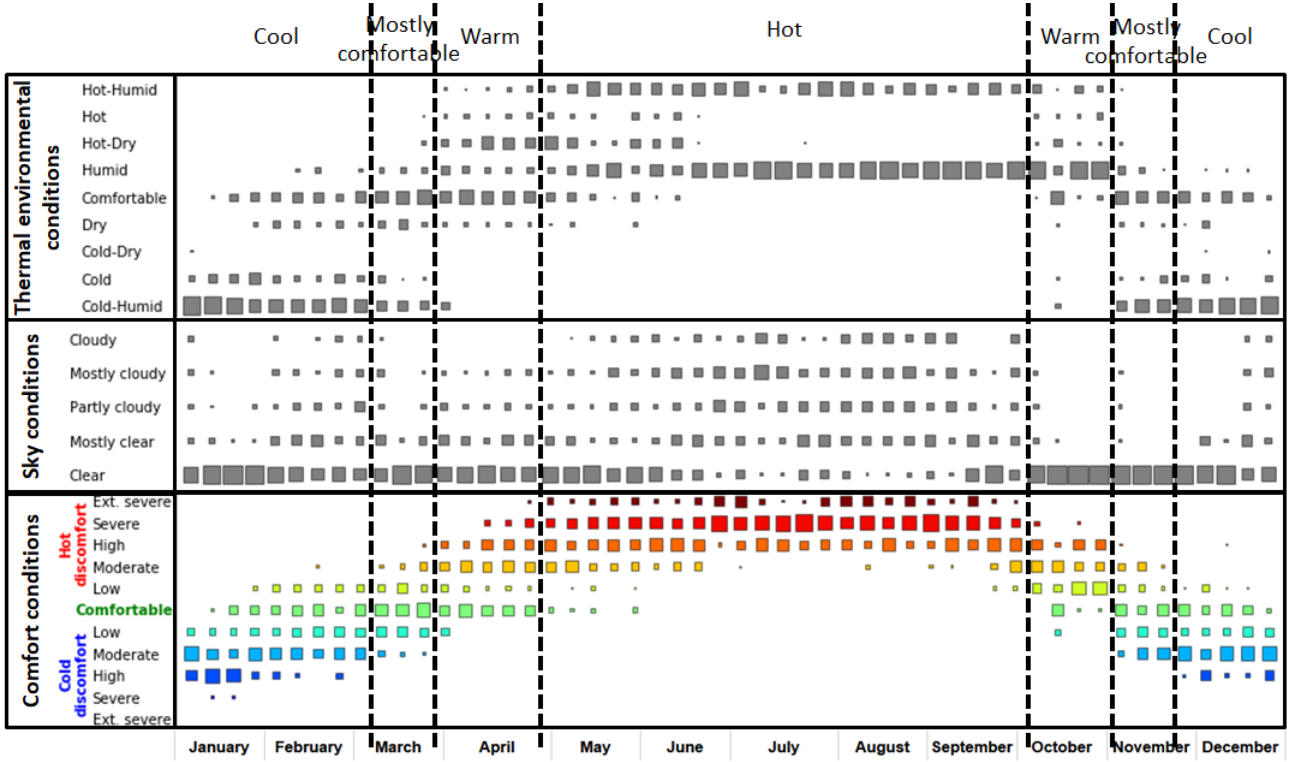


New Delhi climate outlook

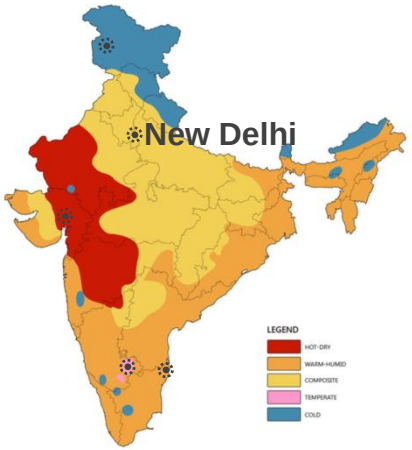


Classified as

composite



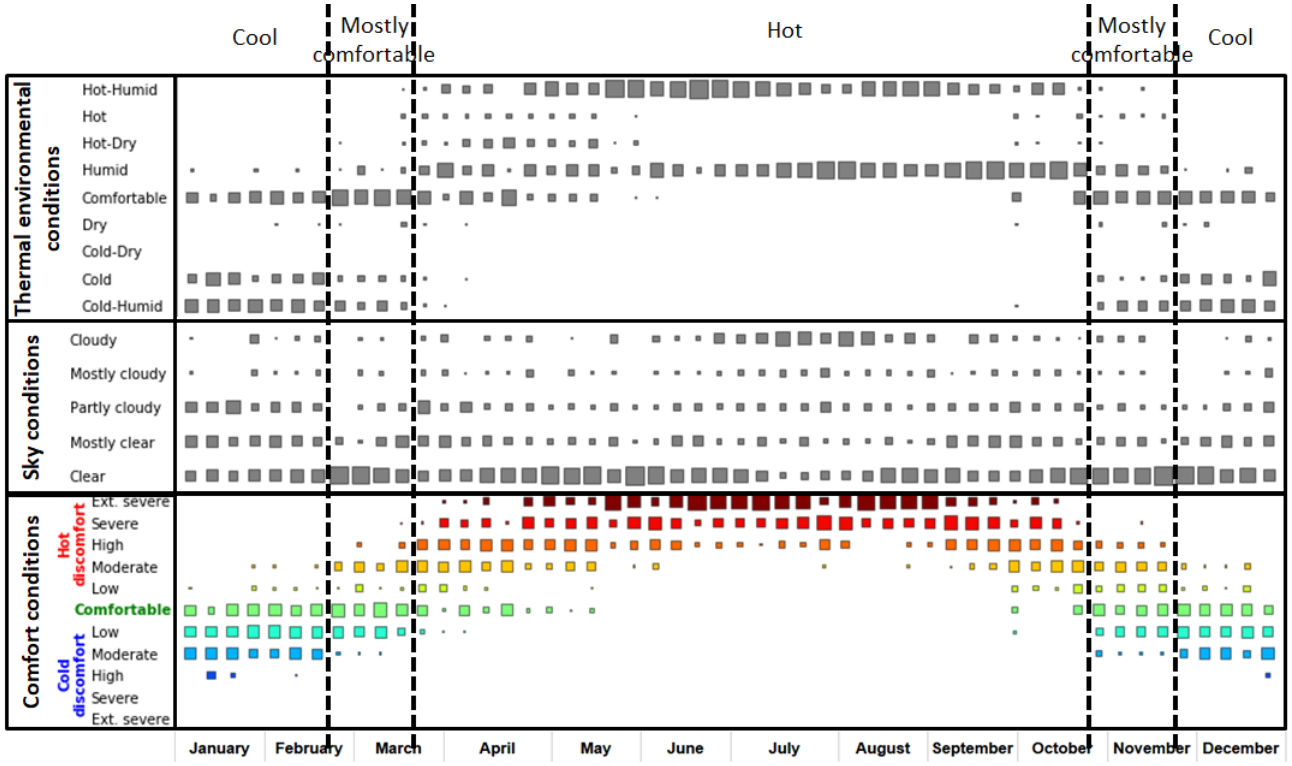
New Delhi climate outlook (2050)



should be Classified as

~~composite~~

predominantly hot-humid + a brief cool period

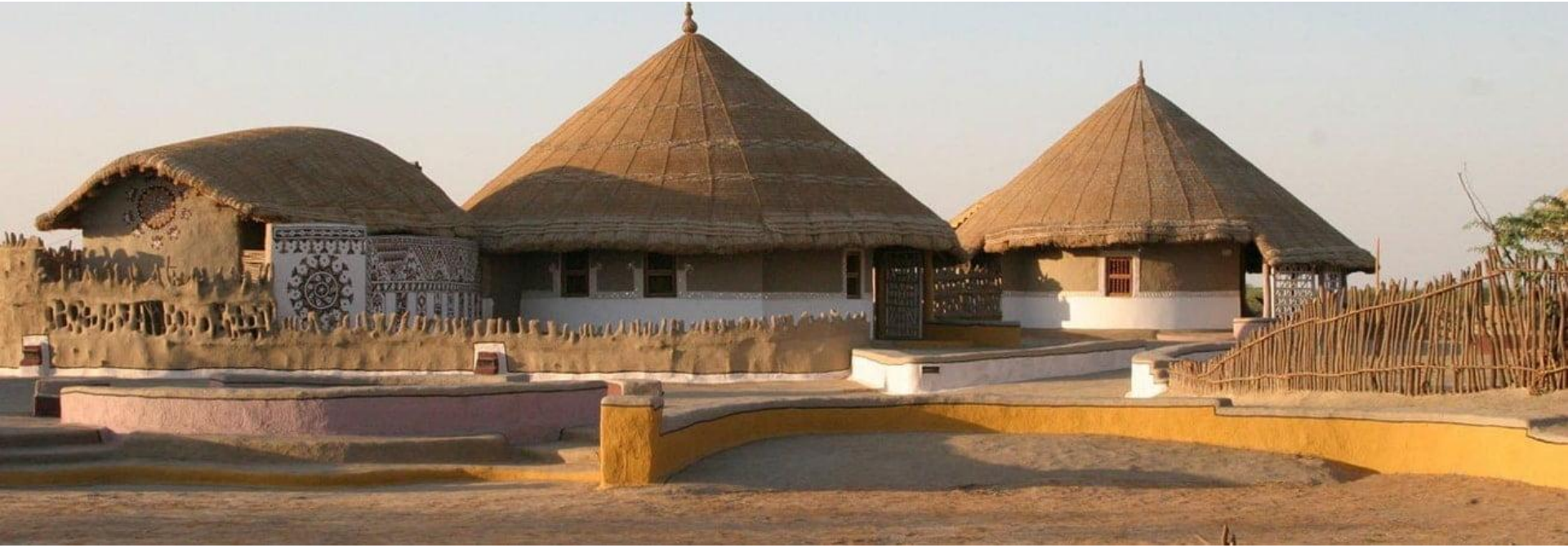


Resilient Design Strategies

- Design and construct (or renovate) buildings to handle severe climate related impacts that are expected to result from a **warming climate**.
- Model design solutions based on **future climatic conditions** as much as possible, rather than relying on past data.
- Rely on *vernacular design* practices that were prevalent **before the advent of air conditioning** and central heating. Combine these design strategies with modern materials to optimize resilient design.

(The Resilient Design Institute, 2019)

Let’s collaborate



(https://gharpedia.com/wp-content/uploads/2019/02/Bhunga-Kutch-06-0101040001-1024x354.jpg)

Thanks!

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