Course Name: Bioclimatic Architecture: Futureproofing with Simple and Advanced Passive Strategies

Professor: Dr. Iyer Vijayalaxmi Kasinath

Department of Architecture,

School of Planning and Architecture, Vijayawada

Week: 02

Lecture: 04

Climate Zones of India

Hello everybody, welcome to this course Bioclimatic Architecture, Future Proofing with Simple and Advanced Passive Strategies. In the last class, we had seen the climate classification by Koppen, which is accepted worldwide and which is more detailed. We saw how it is classified and subclassified further. We saw Candolle's method, which uses vegetation because the belief is that vegetation is a direct reflection of climate. And we also briefly saw Thornthwaite's. That is more to show that there have been many people who have classified climate.

But we will focus primarily on Koppen's classification when it comes to world climate. When it comes to India, let us see how climate zones of India have been demarcated. So, today we will see climate zones of India. So, climate zones of India are based on two classifications.

One is the criteria as suggested by Bansal and another is the standard SP 7 2005. So, according to Bansal, the hot and dry climate has the mean monthly temperature higher than (greater than) 30 degree Celsius with a relative humidity of less than 55 percent. That is the same for SP72. For warm and humid, the mean monthly temperature is greater than 30 and the relative humidity is also greater than 30, which means it's very hot and humid also. Whereas SP7 gives two bifurcations when the temperature is greater than 30 and the relative humidity is greater than 55% or when the mean monthly maximum temperature is greater than 25 and the relative humidity is greater than 75%.

For moderate climate, also known as temperate climate in SP7, the mean monthly temperature ranges between 25 degrees to 30 degrees, and the relative humidity is less than 75%. This is the same with SP7. Bansal classifies cold and cloudy climate for which the temperature is less than 25 degrees Celsius. The mean monthly temperature should be less than 25 degrees Celsius, and the humidity should be greater than 55 percent. For cold and sunny, the mean monthly temperature should be less than 25 degrees Celsius and the

relative humidity should be less than 55 percent.

Whereas, SP7 gives only one, which is cold, where the mean monthly maximum temperature is less than 25 degrees centigrade for any values of humidity. There is composite climate and this applies when six months or more do not fall within any of the above categories. And it's the same with the SP7. So the NBC has divided India according to these five climate zones. First is the hot and dry climate zone along the west.

Then there is the warm and humid belt. All this is warm and humid. There is temperate climate or moderate climate. There is composite, sorry. Then there is Composite climate, there is a small belt of temperate climate; and then there is cold climate.

So, these are the climate classification as per NBC which is extremely broad for a country like India. So let's look at the characteristics for hot and dry. In a hot and dry climate, this climate is characterized by a mean monthly maximum temperature, which is above 30 degrees Celsius, and the region in this climate is usually flat. The building design criteria should thus provide appropriate shading, reduce exposed area, and increase thermal capacity. The temperature shows that it's very hot weather in summer and cold in winter.

Summer temperatures vary from 40 to 45 degrees centigrade. Winters range from minimum temperatures of 5 to 25 degrees centigrade. High temperature difference between night and day exists. High solar radiation causes glare. The winds are extremely hot drafts.

There is very minimal rainfall. So you can imagine it's very hot, it's very dry, and there is very little precipitation. Humidity: there is very low relative humidity, and ground cover is primarily dry, sandy, or rocky ground with less vegetation. The sky condition is cloudless. Now, a hot and dry climate is seen in the western parts of the country where desert-like conditions exist.

For example, Jaipur, Jaisalmer, Kutch, Gujarat, parts of Maharashtra. Even though the standards say that the temperatures vary between 40 and 45 degrees Celsius. There are places where temperatures this year have even touched 50 degree centigrade. Places like Churu where summer temperature has touched even 50 degrees Celsius. Let us look at warm and humid climate.

A warm and humid climate is characterized by high relative humidity, which is around 70 to 90 percent, and high precipitation levels, which is about 1200 millimeters per year. Temperatures usually vary between 25 and 35 degrees Celsius in summer, while in winter, the temperature varies between 20 and 30 degrees Celsius. So, what happens is the temperature is high and the humidity is also high. So, these places are characterized by

typical stickiness, which happens because of extreme sweating. So, there is a lot of fatigue, which is caused primarily because of sweating.

The building design in this climate should aim at reducing heat gain by providing shading and promoting heat loss by maximizing cross ventilation. Dissipation of humidity is also required to reduce discomfort. So the primary way in which one can keep themselves comfortable in this weather is to stand under the shade and be in a breezy environment. What happens is that, the amount of sweat one gets- with cross ventilation, there is a little bit of cooling feeling that one can get Temperatures may not be very high. It is not as high as hot and dry.

It varies between 25 to 35 degrees Celsius in summer and 20 to 30 degrees Celsius in winter. But the humidity is very high. There is very high rainfall. And the cloud cover is 40 to 80 percent, which causes more sultriness. Warm and humid climate is present in regions that are in close proximity to coastal areas.

Areas like Kerala, Tamil Nadu, Goa, parts of Andhra Pradesh, and parts of Orissa. All these fall under warm and humid climate. Even amongst this, there is a debate that some of these areas can be called hot and humid and some of these can be called warm and humid. Hot and humid happens when the annual average temperature is higher than that of a warm and humid climate. So, if a warm and humid climate says 25 to 35 degrees Celsius, the annual average temperature is higher than that.

And the humidity is higher. Then those areas are classified as hot and humid. So in warm and humid conditions, the temperature is not that high. But humidity is high. So these places are prone to continuous rainfall.

Let us now look at a moderate climate. A moderate or temperate climate is characterized by a temperature that is neither too hot nor too cold. The total rainfall usually exceeds 1000 mm per year. Winters are dry in this zone. This climate requires a building design that would reduce heat gain by providing shading and promote heat loss by ventilation.

So, in this climate, the building should be such that heat gain must be reduced through appropriate shading and heat loss must also be promoted through ventilation. The temperatures are in comfort ranges between 30 to 34 degrees Celsius during summer and 27 to 33 degrees Celsius during winter. Humidity is low in winter and summer and extremely high during monsoons. During winter and summer the humidity is about 55% maximum, whereas in the monsoon it can get very sticky. There is low rainfall of about 1000 mm per year, and skies are mainly clear or with dense low clouds in summer.

Temperate or moderate climate regions vary in small parts of India and are considered the most comfortable climate zones in India. Places that have a moderate or temperate climate are Pune and Bengaluru. Let us now look at composite climate. Composite zones are similar to hot and dry climates but with high monsoon humidity, necessitating shading and thermal capacity along with cross ventilation during rainy periods. Most characteristics of the composite zone are similar to those of the hot and dry climate zones, except that the composite regions experience higher humidity levels during the monsoon.

The building design criteria are more or less the same as for a hot and dry climate, such as having appropriate shading, reduced exposed area, and increased thermal capacity. Except that maximizing cross ventilation is desirable in the monsoon period. The temperatures range between 32 and 43 degrees Celsius during summer and 10 and 25 degrees Celsius during winter. Humidity again, it's a variable It's between 20 to 25 percent in dry periods and 50 to 95 percent in wet periods.

Rainfall is again variable. It varies from 500 to 1300 millimeters per year. Sky conditions are variable. The composite climate covers the central part of India, like New Delhi, Kanpur, and Allahabad. But these climate characteristics are highly generic. For example, the temperature in Delhi crosses 45 degrees Celsius during every summer, whereas their winters are very cold.

It goes to 3 degrees or 4 degrees centigrade. Whereas the generic climate classification says that during winter the temperature ranges between 10 and 25 degrees Celsius. So this climate zone has half the year like warm and humid and half the year like hot and dry. So it has both the climate characteristics, and in addition to that, this climate zone has heavy monsoon climate. Regions that lie in the cold climate zone.

When we look at the cold climate zone, regions that lie in the cold climate zone in India are situated at high altitudes. The temperatures range between 20 and 30 degrees Celsius in summers, while in winters they can range from minus 3 to 8 degrees Celsius, making it extremely cold and chilly. Jammu, Kashmir, Shimla, Manali—all these places fall under a cold climate. Cold climate requires buildings to have appropriate insulation and infiltration to resist heat loss and promote heat gain by directly admitting and trapping solar radiation within the living space. Temperatures, typically low temperatures of 17 to 20 degrees Celsius, occur during the summer and minus 7 to minus 8 degrees Celsius during the winter.

Humidity is low in sunny regions and high in cloudy regions. Rainfall is low. It is about 200 mm per year, and sometimes it can be moderate of 1000 mm per year. Sky condition is clean with less than 50% cloud cover. So, cold climates exist in the northern parts of the

country near the Himalayas, like Shimla, Shillong, Leh, Jammu, Kashmir, and so on.

Here, let us see the classifications of different climate zones in India. Hot and dry: When the climate zone is hot and dry, it is marked by high temperatures, low humidity and rainfall, intense solar radiation, and a generally clear sky. Hot winds during the day and cool winds at night. Sandy or rocky ground with little vegetation.

Water is a huge issue. So they have a low underground water table and very few sources of surface water. The mean temperature during summer midday is between 40 and 45 degrees centigrade. The summer night temperature is between 20 and 30 degrees Celsius. So, you can see there is a diurnal variation of 20 to 15 degrees centigrade. During summer, winter midday temperatures range between 5 and 25 degrees Celsius, and the low ranges between 0 and 10 degrees Celsius.

So, diurnal variations are between 5 and 15 degrees centigrade in the winter. So, on average, the diurnal variation is between 15 and 20 degrees centigrade. If we look at the mean relative humidity, the mean relative humidity is very low. It is between 25 and 40 percent. Annual precipitation is less than 500 mm, making this place extremely hit by water scarcity.

Sky condition is cloudless sky with high intensity solar radiation, which can cause glare. Places which have these climate characteristics are Rajasthan, Gujarat, Western Madhya Pradesh, Central Maharashtra, etc. Then we have the warm and humid climate. In warm and humid climate zones, temperature is moderately high during day and night.

Very high humidity and rainfall. There is diffused solar radiation if cloud cover is high and intense if sky is clear. There are calm to very high winds from prevailing wind directions. Vegetation is in abundance because it's very hot, precipitation is very good, and there is a lot of sunshine hours. So abundant vegetation is there. This provision for drainage of water must be given essentially.

Summer midday high temperature ranges between 30 and 35 degrees Celsius as far as Bansal and Minke and Krishnan et al. says, Arvind Krishnan. But actually warm and humid, the temperature soars much beyond this and reaches even 40 degrees centigrade. Summer night, yes, between 25 degrees and 30 degrees Celsius.

Winter midday is high. So, what happens is that in summer the diurnal variations are about 5 degrees. That is it. Winter midday ranges between 25 and 30 degrees Celsius, and winter nights the temperature is between 20 and 25 degrees Celsius. This again makes the diurnal variation only 5 degrees centigrade. So, the diurnal variation is between 5 and 8 degrees

Celsius, unlike hot and dry, where the diurnal variation is about 15 to 20 degrees Celsius.

The mean relative humidity is very high, between 70 and 90 percent. Annual precipitation is more than 1200 millimeters per year. There is overcast sky. So, cloud cover ranges between 40 to 80 percent, causing very unpleasant glare. Places include Kerala, Tamil Nadu, coastal parts of Odisha, and Andhra Pradesh.

Let us now see temperate climate zones. A temperate climate zone has moderate temperature, moderate humidity, and rainfall. The solar radiation is the same throughout the year, and the sky is generally clear. There are high winds during the summer, depending on topography. The terrain could be a hilly or high plateau region with abundant vegetation. Summer midday temperatures range between 30 degrees and 34 degrees, and summer nights are between 17 and 24 degrees Celsius.

Winter midday ranges between 27 and 33 degrees Celsius, and winter nights are between 16 and 18 degrees Celsius. Diurnal variations are moderate between 18 and 13 degrees Celsius. The mean relative humidity is between 60 and 85, so it can be considered high. Annual precipitation is high, with 1000 mm per year. The sky conditions are mainly clear, occasionally overcast with low, dense clouds in the summer.

Places include Bengaluru, Goa, and parts of the Deccan. Pune can also be included. Let us now look at cold, sunny, and cloudy. These have moderate summer temperatures, and they are very low in winter. Low humidity in cold, sunny climates and high humidity in cold and cloudy climates. Low precipitation in cold, sunny climates, and high precipitation in cold and cloudy climate.

High solar radiation in cold, sunny days and low in cold and cloudy days. Cold winds in winter. Very little vegetation in cold, sunny, and abundant vegetation in cold and cloudy. Summer midday temperature ranges between 17 and 24 in cold and cloudy. cold and sunny: Summer midday temperature in cold and sunny ranges between 17 and 24 and in cold and cloudy between 20 and 30.

Mean night temperature in cold and sunny is between 4 and 11 degrees Celsius and 17 to 21 degrees Celsius in cold and cloudy. In cold and sunny, winter midday ranges between minus 7 and 8 degrees Celsius and between 4 and 8 degree Celsius in cold and cloudy. In cold and sunny, winter night ranges between minus 14 and 0 degrees Celsius and between minus 3 and 4 degrees Celsius in cold and cloudy. Diurnal variations are very high, about 25 degrees centigrade. Relative mean relative humidity is low between 10 to 50 percent and high when it is high; it can be 70 to 80 in cold and cloudy weather.

In cold and sunny weather, it is very little. Annual precipitation is low; it is less than 200 mm in cold and sunny and moderate up to 1000 mm in cold and cloudy. Sky conditions are clear with cloud cover in cold and sunny, and they are overcast for most parts of the year in cold and cloudy. Areas include Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttaranchal, Sikkim, and Arunachal Pradesh. Let us now look at composite climate. This applies when six months or more do not fall within any of the above categories.

These are governed by high temperatures in summer and cold in winter, low humidity in summer, and high humidity in the monsoons. High direct solar radiation in all seasons except monsoon, high diffused radiation. Occasional hazy sky, hot winds in summer, cold winds in winter, and strong wind in monsoons with variable landscape and seasonal vegetation. During summer, the midday high is about 32 to 43 degrees centigrade.

And summer night lows range from between 27 and 32 degrees centigrade. Winter midday is between 10 and 25 degrees Celsius. And winter nights are between 4 and 10 degrees Celsius. Diurnal variation is extremely large, to the order of 35 degrees Celsius to 22 degrees Celsius. Mean relative humidity is variable during dry periods; it is 20 to 50 percent; during wet periods, it can even reach 95 percent. Annual precipitation again between 500 and 1300 millimeters per year during the monsoon, reaching 250 mm in the wettest month.

Sky condition is variable. It is overcast and dull in the monsoon. Places include Uttar Pradesh, Haryana, Punjab, Bihar, Jharkhand, Chhattisgarh, Madhya Pradesh, etc. So we can see how these climate characteristics are associated with climate type. But if you actually see, you should also interpret what impact this has on building materials. In places that have extremely high or high diurnal variation, like composite climate or hot and dry climate, one has to be very careful in the choice of building materials because the building material is subjected to extreme temperature ranges within a year, year on year. So, all materials will not be able to withstand it while keeping its ingrained strength.

So, there are many repercussions of this on the choice of building materials and, of course, on design by an architect and designer, which is what we will be seeing in the forthcoming classes. So, with this, we will stop today's class where we have seen the climate classification in India. From the next class, we will have a look at another topic. Until then, thank you.