



# Imagine living in a house,

With trees in the open spaces inside and surrounding the house. A gentle breeze touches the skin, filling up the space with air and energy, the sound of birds chirping and the sight of squirrels pacing up the trees while the children playing in the mud getting their clothes dirty. A soft drizzle makes the children scatter for shelter and the sweet fragrance of wet mud percolates the house.

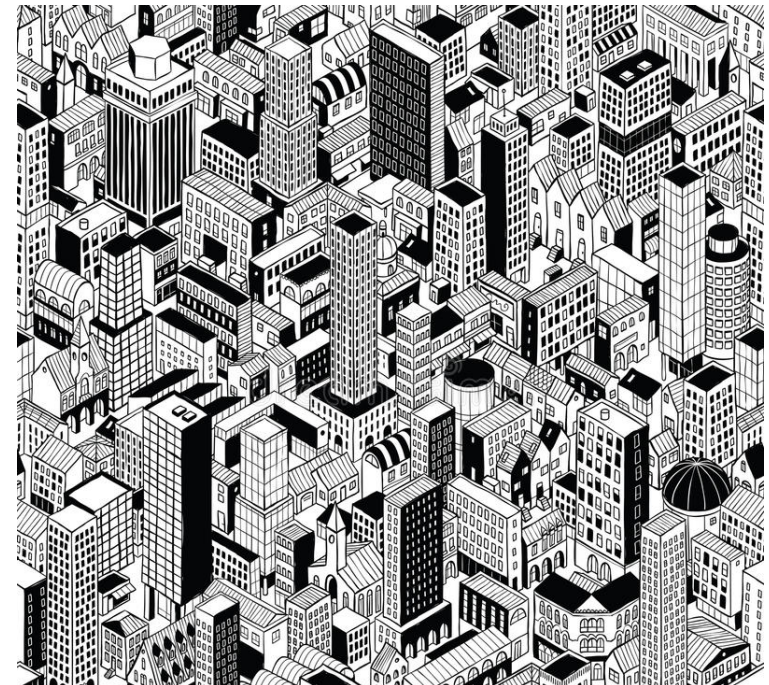
A place where your family can sit and enjoy an evening chai and unwind as all the stresses of the daily bustle fade away, enjoying a typical evening in bliss.

If not this, then how else do we picture our well-being in a space?



Wouldn't that calm your body and soul?

That's the beauty of  
**nature-centric life**,  
quite contrary to the one we dwell in right now.



So let's ask ourselves;

## What is an ideal space?

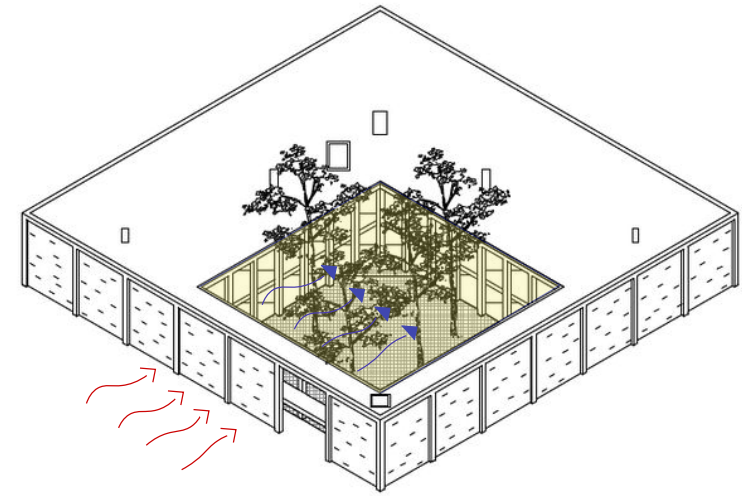
Let's answer it together because we all are familiar with it.

We are familiar with this **nature-centric** lifestyle since a long time now, right from our traditional ways of building houses or any living space. **Verandas, courtyards and aangans** used to be part of our built spaces where the people gathered and spent time. Spaces that would let natural elements in.

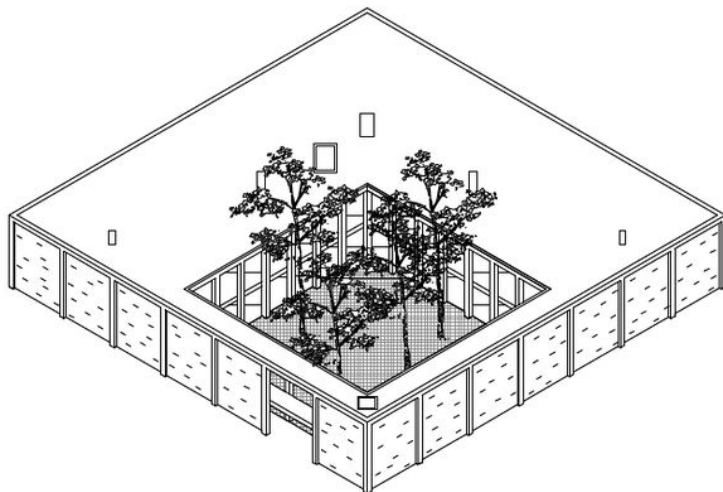
Without restricting it to any particular geographical location throughout the globe we have developed a few methods and techniques to invite nature and its benefits. Imagine all the soulful moments it would bring in!

Buildings in the past were defined by their location, climate and culture. And that is how it should be!

**But is it?**



Well, we adapted to these spaces for different reasons, inviting and living in nature and as a response to the climatic conditions.



As we look at these visuals, we are drawn in nostalgia to the memories spent in such spaces and perhaps wish to experience them at least once. **Spaces like these allow the air entering the house to cool down and the fenestrations allow filtered sunlight to light up the space.**

Along with the visual pleasure, it also connects the inside with the outside and aligns the modern lifestyle with nature. This in turn has collateral benefits such as well-being in the space.

Before discussing the ways of cooling our spaces in buildings, it is important to

## Understand how our body reacts to heat and the natural perspiration that keeps us cool.

One thing we know is that our **bodies react differently to different seasons**. Natural perspiration, **Sweating** is a fantastic process that releases toxins and keeps us healthy and fit.

The irony is that we pay trainers and coach to make us sweat.

Meanwhile the air-conditioned space cut down this metabolism resulting in poor body functioning.



Definitely, the migration of certain birds and animals for suitable ecological conditions for feeding and raising their young ones is a good example.

Life, right from aquatic cells to huge mammals, has been **adapting itself to the changes happening in its environment**.

Similar to all mammals, we are relatively fragile beings, therefore, **avoiding exposure to heat, cold, rain, or wind is one of our primary needs**.

But as we progressed our physiological and psychological tendencies to adapt reduced making us more and more fragile eventually to the state we are in today.

Evolutionarily, as man moved North, he had to develop different types of shelters to remain comfortable throughout the changing seasons.

As a byproduct, the building environment similar to the primordial caves acts as a filter between the inside and the outside and gradually becomes more sophisticated.

It witnessed inviting nature inside of the living spaces to bring it closer to the ideal lifestyle to practice.





# Thoughts?

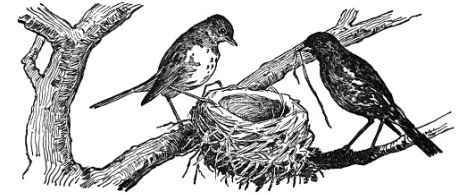
As urbanization took off, gradually **making all built spaces look similar, maintaining a stark distance from nature.** These spaces unknowingly affect the our overall lifestyle.

From disconnection with the people, we share the space with and with the outside to heavy use of mechanical cooling and paying bills to change thermal comfort.



The vision behind making a house or a nest goes beyond making walls and a roof.

There is a good deal of thought put into it as one forms an emotional connection in the process of the building, designing a space for creating stories and memories. What we feel that houses in a typical urban context lack is the connection with nature and beyond.

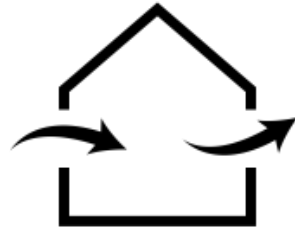


**It is needless to say that modern buildings are designed like matchboxes with mechanical ventilation.**

Our idea behind this book is to look into the holistic practice of making a house and share some of the traditional concepts that everyone knew once, practices that are slowly being lost, putting us and the environment at stake.



Natural ventilation is rather simple!



Spaces should be designed around natural elements like the  
**wind, sun and water**

**Our buildings contribute 40% of energy consumption and emissions.** Over the last four years, we have been researching how improvising traditional concepts of shading, ventilation, orientation and materials can help reduce our carbon footprint and electrical loads. **In this book, we will be focusing on thermal comfort alone and how we can open our spaces to connect with nature.** While we can discuss volumes about traditional buildings and Indian architecture, here we will discuss the four basic concepts of sustainable design

- Shading, Ventilation, Orientation and Materials.

So far in our work, we realized that natural cooling solutions may not prove to be 100% efficient for our needs.

**The objective is NOT to make our buildings 100% free of mechanical cooling** but to reduce upto 40-50% using the following strategies.

1. Using 100% passive strategies
2. A hybrid system where certain parts of the buildings are air-conditioned and the rest are designed for good passive ventilation
3. Time slots- Using Air conditioners only for certain hours/seasons.

So, what's the idea behind  
**thermal comfort?**

Thermal comfort is a person's perception or how they feel related to the temperature or air quality in a space.

Human bodies, and those of other mammals, are essentially thermal engines that generate and dissipate energy, and we have different ways of regulating our constant heat exchange with the environment.

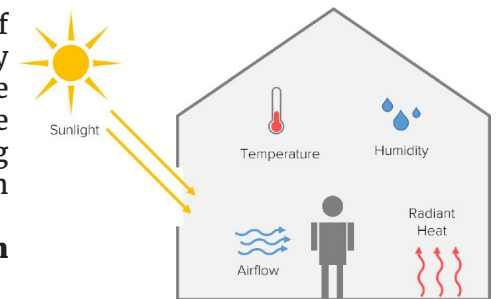
**The objective of our metabolism is to regulate our body temperature with minimal effort.** So, we need to be able to control the physical environment surrounding us.

We all have memories of responding to some spaces with uncomfortable thermal conditions such as a classroom, office, or other spaces, which

- was so hot and stuffy
- hard to concentrate, and
- even induce sleep.

Or maybe it was a station or a terminal space that was too breezy and cold.

These are both examples of bad thermal comfort.



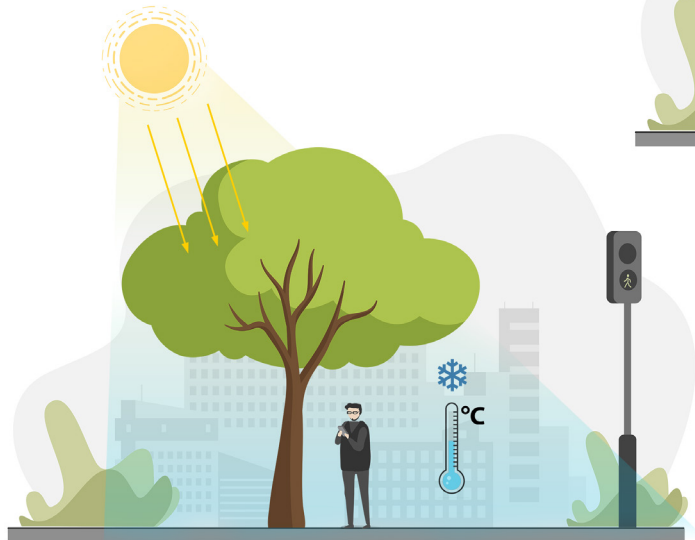
It is a state of physical ease and well-being in a given environment

Therefore, striving to reduce the energy demand of buildings, while providing comfort and well-being, is more important

**The factors affecting 'comfortability' are categorised as follows:**

1. Environmental factors; Air temperature, humidity, air velocity, radiant temperature
2. Personal factors; Metabolic rate, clothing insulation

a quick question,  
**which out of  
these options**



**would you  
stand under?**

Did you choose option 3: under a tree?

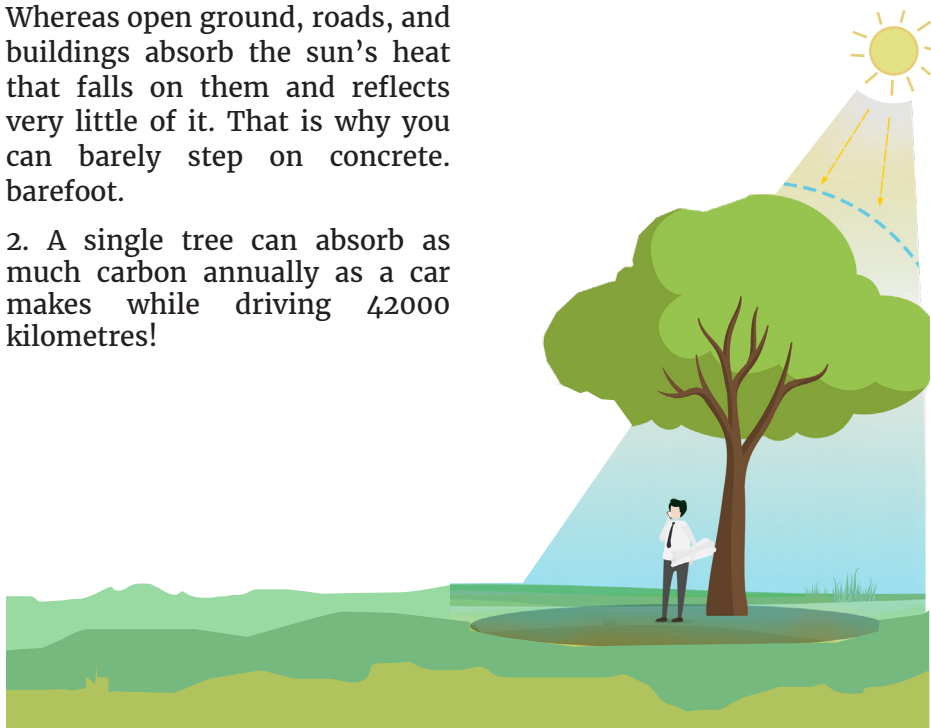
Have you wondered  
Why are trees so cool?  
quite literally

## 1) BLOCKING SUNLIGHT (shading)

### FUN FACT:

**1. Tree canopies can intercept up to 90% of the sun's heat.** Whereas open ground, roads, and buildings absorb the sun's heat that falls on them and reflects very little of it. That is why you can barely step on concrete. barefoot.

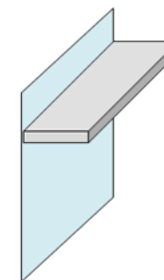
**2. A single tree can absorb as much carbon annually as a car makes while driving 42000 kilometres!**



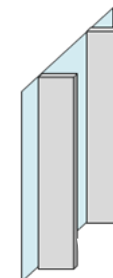
Now to answer that, trees cool  
the surrounding air by  
4 methods:

**The performance of shading devices is specified by two angles: the horizontal and the vertical shadow angle.** These are both measured from a line perpendicular to the elevation and indicate the limit, beyond which the sun would be excluded, but within which the sun would reach the point considered.

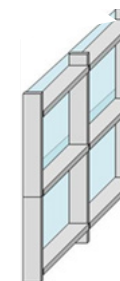
Shading devices shield windows and other glazed areas from direct sunlight to reduce glare and excessive solar heat gain in warm weather.



*Horizontal shading device*



*Vertical shading device*



*Egg-crate shading device  
Jaali*



## 2) VENTILATION

*(Trees facilitate the movement of air from cooler to hotter areas or wind which ventilates the surroundings )*

Let's take an example of a non-air-conditioned bus. Have you noticed that during hot summer days, when we have just gotten into the bus, **we feel as if we are trapped inside a heated oven?**

But, as it starts to move, we breathe a sigh of relief. As the bus stops at any point during the journey one starts to feel sweaty and uncomfortable due to the summer heat.

**Ever wondered why it happens?**

This happens due to the **evaporation of sweat** from the surface of the skin as it comes in **contact with air of higher velocity, leaving behind a cool sensation for the skin.** Thus, making us feel comfortable for a while even on a hot sunny day.



As the sun beats down on the metallic roof, heating up the interiors of the bus just because there is no insulation inside. Also since Indian buses are traditionally congested, it means it gets suffocating after a certain point of time. But when the bus finally starts moving and picks up speed, the heat slowly dissipates.

with the windows opened up, a cross-breeze builds up, and we don't feel hot and sweaty anymore.

## that's the magic of ventilation!

There are types of ventilation and they are categorized as;

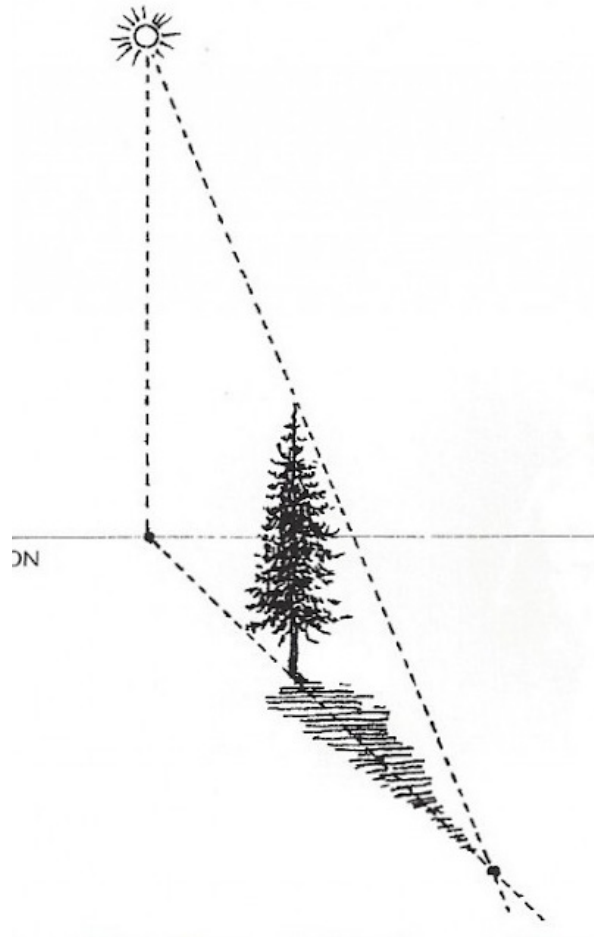
- Supply of fresh air
- Convective cooling
- Stack effect (provision for ventilation)
- Physiological cooling
- Cross ventilation
- Evaporative cooling

**Evaporative cooling is a passive cooling technique in which outdoor air is cooled by evaporating water before it is introduced into the building.**

Its physical principle lies in the fact that the heat of air is used to evaporate water, thus cooling the air, which in turn cools the living space in the building.

**However passive evaporative cooling can also be indirect. The roof can be cooled with a pond, wetted pads or spray, and the ceiling transformed into a cooling element that cools the space below by convection and radiation without raising the indoor humidity.**

### 3) ORIENTATION



*The way a tree is oriented with respect to the direction of the sun is directly related to the efficiency of shading as the canopy absorbs the sunlight.*

As we all know just how important it is to get a good seat while travelling in a hot climate, it is also important for us to understand the significance of the orientation of any component.

The orientation itself can add a lot of difference in the aspect of thermal comfort. As one travels by bus, **they should intend to find themselves a suitable seat where the sun can be dodged on a hot sunny day in order to be more relaxed and comfortable.**

**The key to selecting the perfect bus seat is to understand orientation.**

One should aim for the seat opposite to the direction of sun movement with respect to the direction in which the bus is travelling for the purpose of comfort.

## 4) MATERIAL; TRANSPIRATION COOLING

*The skin of the leaves and the soil around the tree witness loss of water through transpiration and evaporation, making us feel cooler around the tree this is called 'Evapotranspiration'.*

Now in trees, a similar process takes place in order for them to grow. The leaves lose water absorbed by their roots during the day. **As a result, the space under a tree's canopy is much cooler than in the surrounding areas; called,**

**EVAPOTRANSPIRATION**

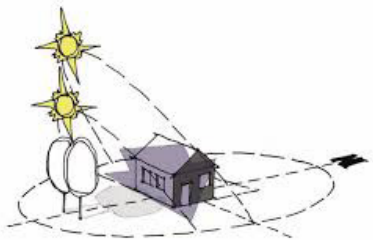
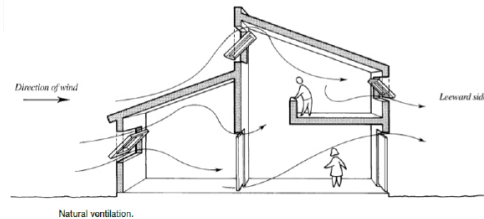
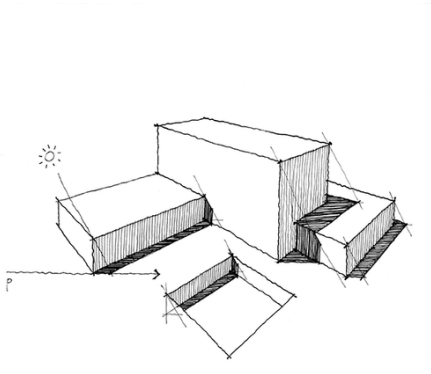


When you sweat on a hot day and sit in a moving vehicle after that you feel cooler even if it is hot outside.

**That is because of a process called evaporation.**

There lie 4 major factors that govern the cooling techniques in a designed manner;

- Shading
- Ventilation
- Orientation
- Materials



## YE PED NAI KATEGA!

Did you know that trees have always been an important part of Indian traditions? In fact, it is believed that trees are living beings with feelings and each tree has an individual personality. Trees not only cool this world but also provide us with food and medicines.

So why ever would one even think of cutting down trees? Huh?





The cooling strategies broadly depend on the climatic conditions one lives in. So let's briefly discuss the Indian Climatic zones and our natural modes of adaptation.

Being a large country with a large population, **India presents endless varieties of physical features and cultural patterns.**

the topography of india can be subdivided  
into 6 climatic regions;  
hot and dry, warm-humid, composite,  
temperate, and cold.

#### Cold and cloudy (hilly areas)

Usually experiences snowfall, high levels of humidity and rainfall throughout the year. Temperature: 0–15° C

Building Materials: Rocks, stones, mud mortar, wood.

**Thick walls and large window openings.** Compact Houses with thicker walls are preferred to retain heat. Have two stories, with the livestock living on the ground floor. Often a verandah runs along the side. The roof is pitched to deal with the monsoons and the house may sit on a raised platform, plinths or bamboo poles to cope with floods.

#### Warm and Humid Regions (Coastal Areas)

It is hot all year round, a rainy season with stuffy weather, cloud cover and almost daily rains. Temperature: 28–32° C

Building Materials: Wood, Basalt stone, brick, mud, laterite, granite, lime mortar, bamboo, clay roofing, coconut palm leaves **Sloped roofs with overhangs cater to prolonged months of monsoon.** Some commonly identified features of local architecture here are verandahs, wooden frame structures, high basalt stone plinths, and thick brick infill walls. Baffle walls were used to acquire the desired flow of wind.

#### Hot and Dry Regions (Deserts)

Experience extreme temperatures over the year.

Temperature: 4–33° C

Building Materials: Clay, mud, stones, grasses leaves, bamboo and wood.

**Thick walls and Smaller wall openings.** Sandstone and marble are also popularly used to create chhajjas, jalis and Jharokhas. Most forts have ingenious water structures designed for harvesting and storage, including stepwells, elaborate reservoirs and channels. Courtyards are a prevailing feature in these traditional houses.



*Cold and cloudy (hilly areas)*



*Warm and Humid Regions (Coastal Areas)*



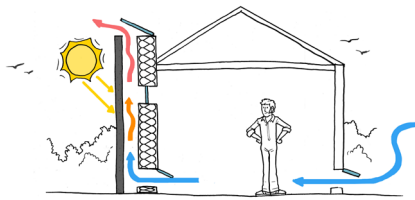
*Hot and Dry Regions (Deserts)*

Let's understand how they work together as a design cooling technique in a liveable space resulting in what we term **'passive cooling'**

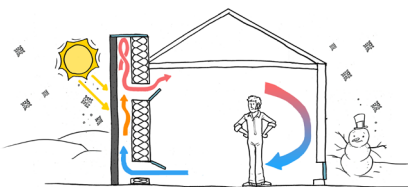
We understood the distinction between these 4 elements that make us feel cool under a tree and the climatic zones in India.

The basic idea is to optimize the amount of heat and wind moving through the building to achieve the desired indoor climate.

COOLING



HEATING



Passive cooling solutions are available for all climate types as the solutions differ for each climate.

The way you design a building affects thermal comfort. Using design elements we can reduce the heat gain and increase the heat loss by natural means, this is the passive way of doing it. As we have already discussed them.

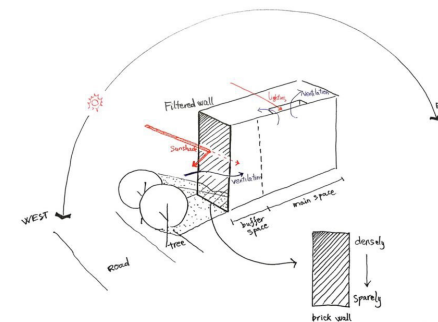
**Passive cooling can be achieved through many design solutions like shading, cross ventilation, courtyards, design and placement of windows, etc.**

- A hot and dry region has small openings with jaalis to avoid the entrance of direct sunlight. They also have courtyards and ventilators to allow hot air to move out of houses.
- Quite contrary to it, houses in Leh have thick walls for insulation. The houses there have bigger openings to allow

**As we see in traditional houses throughout india, so how do we implement these techniques at home/ office space?**

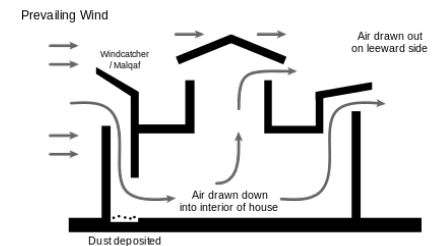
As we apply sunscreen or sun-coats to avoid heat gain in our body, it works on the same idea to avoid heat gain in a space/ building.

- avoid as much heat gains as possible,
  - to slow the heating process
  - to remove the uncontrollably gained heat, or
  - to store cold air or elements, the following four passive cooling actions can be taken:
1. **Storing cold mass or air within a building envelope** is defined as cooling down the air before entering the interior spaces through courtyards, basements, and



buffer spaces.

2. **Avoidance of direct external solar radiation** heat gain. Avoidance could be applied by using shading windows and glazed areas, using landscape, and designing self-shading forms.
3. **Removal of gained heat from the interior** or exterior sources. This action is required to remove portions of undesirable heat performed by using wind towers, earth tunnels, and windows to support ventilation requirements.
4. **Slowing heat transfer from the external climate** through the building envelope. This action is conducted by using techniques like efficient insulation and double-glazing window units.

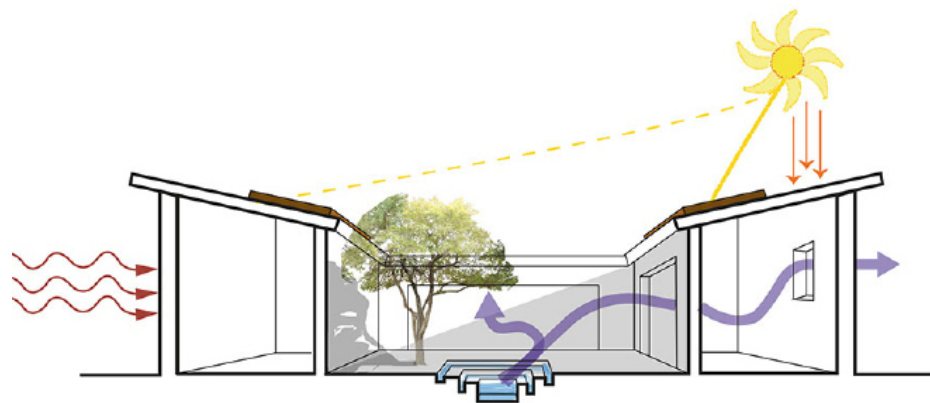


we have had a sense of passive cooling for a long time now. so much that it is a good part of the structure even after so many ages.

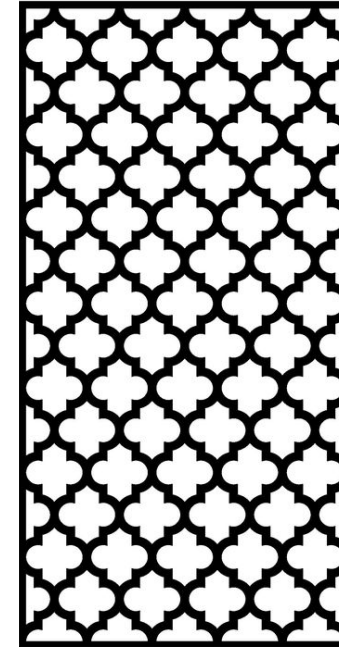
The small holes increase the velocity of air as it passes through them, similar to the function of a funnel, enhancing even the mild breeze outside and allowing for deeper penetration.

The air also cools down while moving through the small apertures which function as an air conditioner compressor.

Thus comfort of the occupants is increased  
Controlled light enters the interior space as light enters in and the sun's glare is cut out



## Jaali



Jaali are ornamental perforated screens for permitting light and ventilation in buildings have been used extensively in India. 'Jaali' word means a net or a fine web. Usually found in Indian, Indo-Islamic, and Islamic architecture.



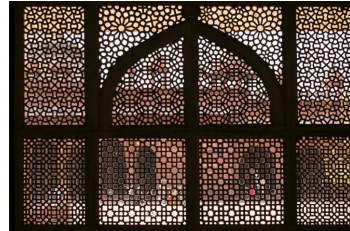
Passive cooling solutions are a part of traditional knowledge systems for buildings.

They bring a permanent solution to maintain indoor temperature without any day-to-day consumption or cost.

Jaalis and courtyards are used in different combinations all across India in various climatic zones to maintain thermal comfort. As we know jaalis are also a good shading device and the courtyard is used to store cold mass in the building envelope.

## 1 Jaalis in composite climate zone

- The intricate geometric jaalis are the trademark of Mughal architecture, which produced magnificent shadows inside the space.



## 2 Jaalis in a hot and dry climate

- In the hot dry desert of Rajasthan, the fenestrations are taller and narrower, which allows for deeper penetration of light and air inside the building.
- Floral motifs



## 3 Hot and humid climate zone

- The Padmanabhapuram palace, Thukale, exhibits wooden latticework, a consequence of the availability of timber and allow for the escape of hot air transferred down from the tiled roof. This provides good insulation, as its second roof remains cooler than the sloping roof above
- Apertures are larger, but cover smaller proportions of the wall compared to the jaalis seen in Rajasthan and other parts of the country.



## 4 Mashrabiya of the middle east

- Mashrabiya is a variation of jaalis in Egypt and Oman, which means 'a place for drinking'.
- In the earlier phases it was used to cool drinking water placed in clay pots.
- Winds would pass over the porous surface after passing through the shaded lattice screen and bring down the temperature of water inside by evaporative cooling.
- Later, these were fitted with beds inside, where the occupant could relax and it suited their privacy notions.





# Courtyard



A courtyard is an open space surrounded by rooms with openings on the conjoint wall between the rooms and the courtyard space, to allow air, exchange daylight and view.

The working mechanism of the courtyard depends on the cycle of day and night, which results in a continuous change of air temperature and the difference in air temperature between the inside and outside of the courtyard.

In Shahjahanabad, the lower floors are used to spend the hot days while the nights are spent on the terrace taking advantage of the radiative cooling.

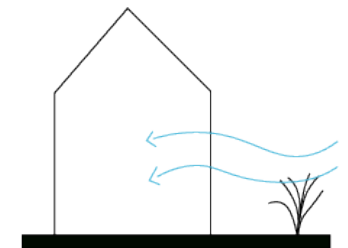
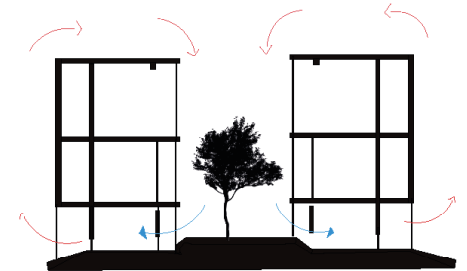
The rooftops are sprinkled with water for an evaporative cooling effect. Whereas during the winters, the days are spent on the sunny rooftops and the nights in the enclosed rooms.

The buildings in Shahjahanabad, India were designed to allow the heavy cool air to enter the building. Large openings are provided in the courtyard to take advantage of radiative cooling so that the cool air is passed through the interiors.

## Evaporative cooling in courtyards

This evaporative cooling technique can reduce upto 9.6 degrees celsius of micro climate temperature. The use of fountains or any other water bodies will help regulate the indoor temperature within a comfortable zone of not more than 20 degrees Celsius.

Fountains are an architectural feature occupying a privileged place in the house plan. It is placed in the middle of the courtyard with the living spaces open onto it.



It is not bad that we adapted to modern active cooling solutions. The use and mechanism differ and so is their impact on the environment.

Though passive cooling systems are effective in keeping the areas cooler, most of the systems are to be pre-planned and executed for any house.

Mechanical cooling or heating systems are accordingly used for specific needs of the space.

Mechanical cooling refers to any method that uses energy to actively cool down an area. Fans, coolers, and AC units can be considered a part of mechanical cooling.

### Fans

Fans are one of the oldest and most commonly used mechanical cooling solutions. The fan starts moving stagnant air in the room, forcing ventilation.

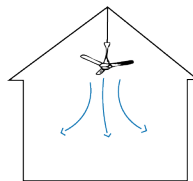
### Desert coolers

Desert cooler take in air from the surrounding and allows it to merge with water content inside.

There is a complete circulation of water inside the cooler, which makes the incoming air more humid and cooler due to the evaporation of water.

### Air-conditioners

An air conditioner provides cool air at home or an enclosed space by actually removing heat and humidity from the indoor air. It returns the cooled air to the indoor space and transfers the unwanted heat and humidity outside.



## Wrapping up ...

Though air conditioners are effective in dry as well as humid conditions, they consume high levels of energy for cooling.

Apart from it, ACs are harmful to our nearby areas as it raises the general temperature of our surroundings by releasing hot gases. Usage of ACs to cool down rooms and houses results in a hotter environment.

Sustainable cooling methods as discussed in the book can be implemented in varying degrees to achieve a desired outcome. In the process cutting down on emissions, expenses and increasing efficiency.

**It is the need of the hour to shift to a more sustainable and efficient system.**

**sustainably cooler homes = cooler planet**  
**cooler planet = cooler homes**

It's called the butterfly effect!

