URBAN OASIS People Places &Comfort

The project explores how to design comfortable and usable public spaces for neighbourhoods

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With help of Felix Thumm

Great Public spaces are a measure of Livable Cities…
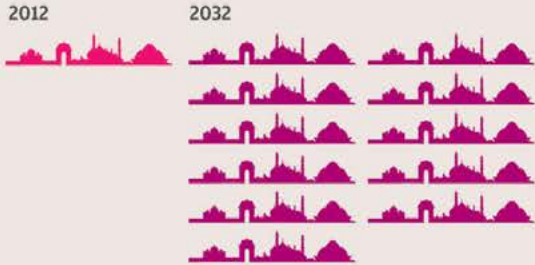
Transsolar**academy**
Mentor : Felix Thumm

URBAN EFFECT

NEW DELHI density $> 5x$ **FRANKFURT** density
11733/km^2 2300/km^2

CITIES

In 20 years, India's cities will have to accommodate 250 million to 300 million more people than they do today. That's the equivalent of 11 New Delhis.

2012   2032

ELECTRICITY

Of the 1.4 billion people of the world who have no access to electricity in the world, India accounts for over 300 million.
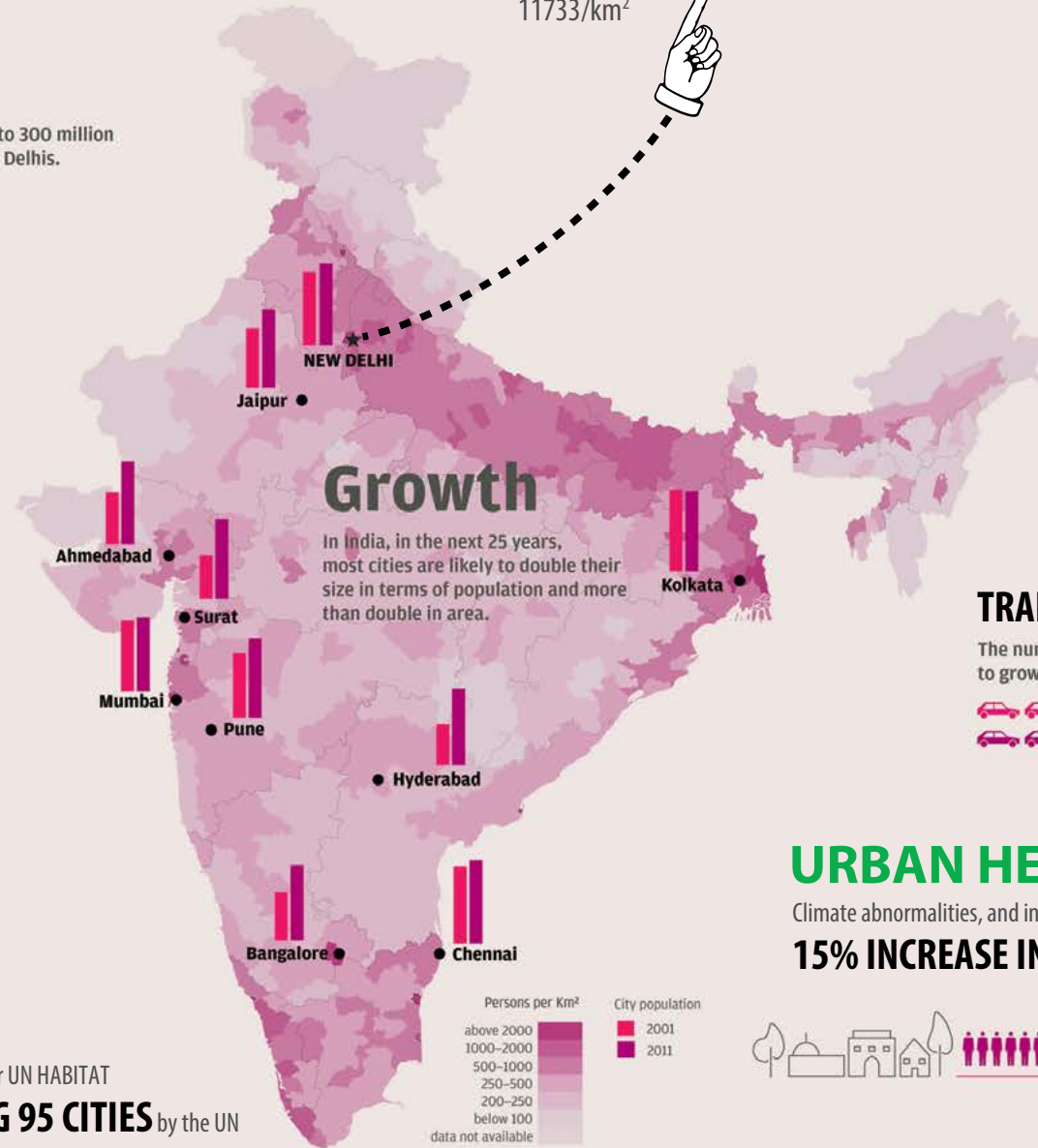
WATER

Only 74% of urban households in India are served by piped water supply. No Indian city has piped water 24 hours a day, seven days a week—4 to 5 hours of supply per day is the average.

OPEN SPACE

Green capita in cities lower than acceptable as per UN HABITAT

NEW DELHI placed **LAST AMONG 95 CITIES** by the UN

Growth

In India, in the next 25 years, most cities are likely to double their size in terms of population and more than double in area.

Jaipur
NEW DELHI
Ahmedabad
Surat
Mumbai
Pune
Bangalore
Hyderabad
Chennai
Kolkata

Persons per Km²   City population
above 2000   2001
1000~2000   2011
500~1000
250~500
200~250
below 100
data not available

1. CHINA
2. USA
3. INDIA

POLLUTION

By 2015, India is expected to become the world's third largest emitter of carbon dioxide—it ranked fifth in 2005.

TRANSPORTATION

The number of private vehicles in India is expected to grow by more than 3 times by 2021.

2012   2021

URBAN HEAT ISLAND EFFECT

Climate abnormalities, and increase in annual mean minimum temperature
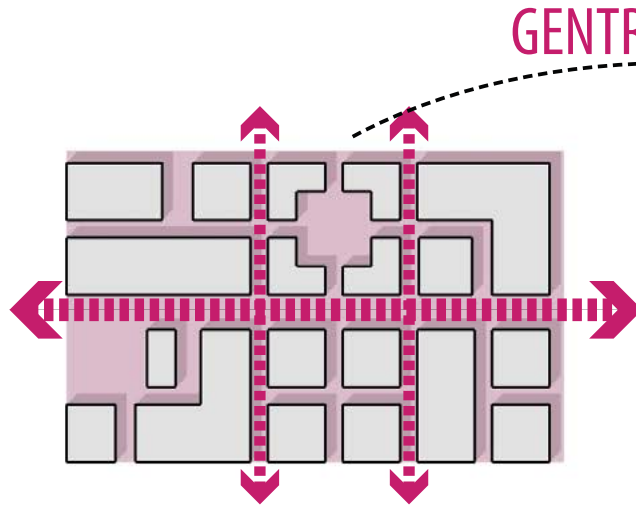
15% INCREASE IN AC DEMAND IN LAST YEAR!

Today cities are experiencing unprecedented densities and on comparing New Delhi is five times greater than the density of Frankfurt. This urban effect puts a lot of pressure on the city including lack of open space , where UN statistics placed New Delhi last among 95 cities evaluated for Green Capita.
This results in rising temperatures in the cities due to urban heat island effect, which in turn increases energy demand.
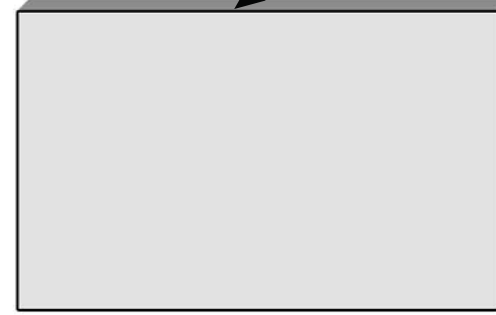
For more information on how IBM is helping to build smarter, more sustainable cities visit: www.ibm.com/smartercities

IBM

SHIFT in TYPOLOGIES

GENTRIFICATION

FINE URBAN GRAIN
TRADITIONAL MARKET

ISOLATED BLOCKS
MALLS TODAY

Social space   Passively designed   Local Economies   Inward Looking   Energy Guzzlers
      Congregation   Community   Social barriers   Adverse local economi

This results in gentrification of our fine grain typologies, embedded with a public realm, into islocated air conditioned blocks. We can take the example of the local market place being replaced with air conditioned malls.

Malls are designed inward away from the public realm. This creates social barriers, adversely affects local economies and consumes more energy and resources. Therefore it is important to demonstrate strategies which can create comfort in outdoor spaces and prolong their use and vitality as urban retreats.

This will promote hybrid typologies for IT parks, recreation parks, educational campuses etc keeping the finer grain.
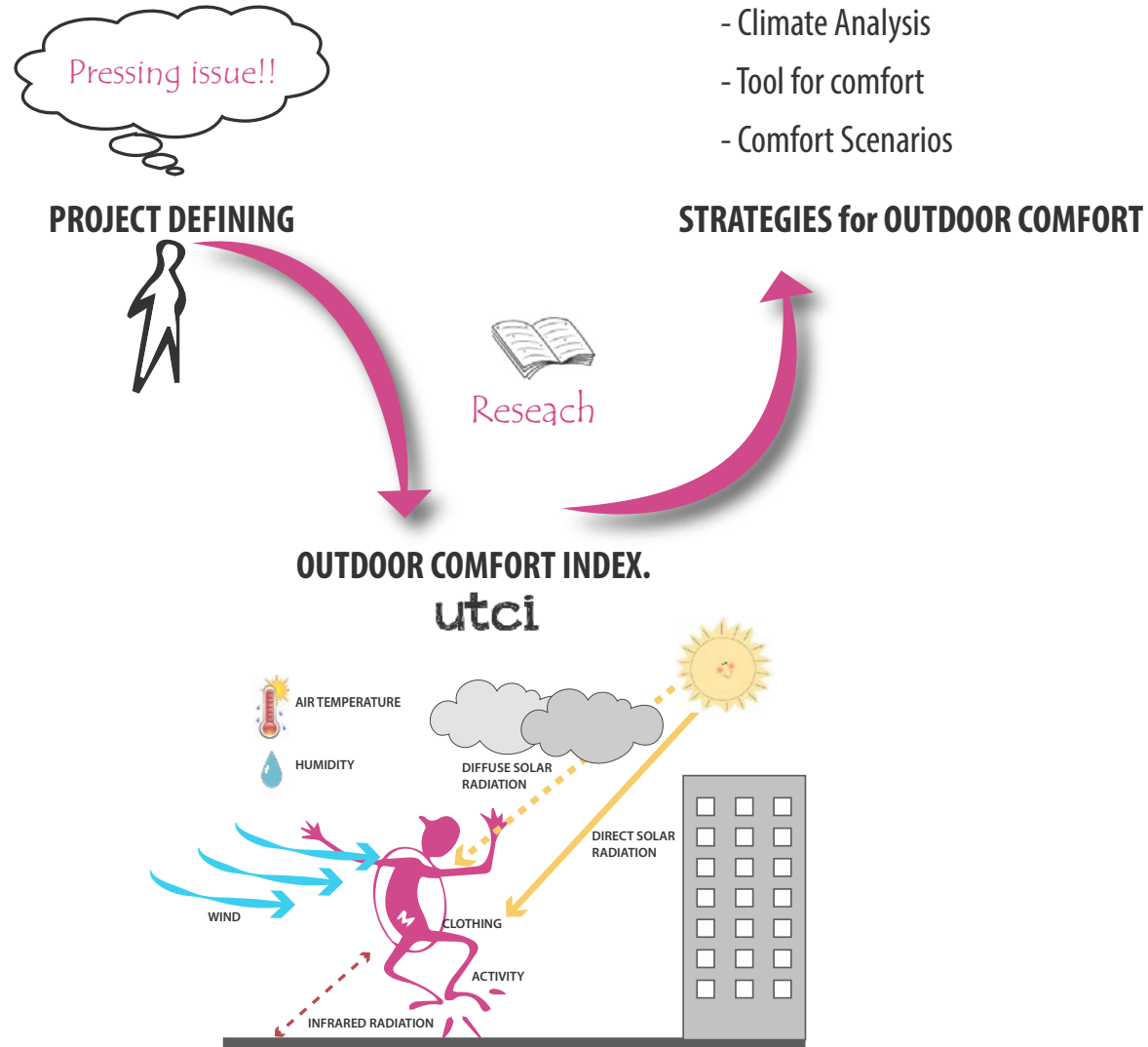
The first part of the project is
RESEARCH which included
1) Studying outdoor thermal comfort
interaction factors. We chose
universal thermal climate index
(UTCI) to evaluate user comfort, and it
takes into account the following :

Pressing issue!!

- Climate Analysis
- Tool for comfort
- Comfort Scenarios

PROJECT DEFINING

STRATEGIES for OUTDOOR COMFORT

Reseach

OUTDOOR COMFORT INDEX.

utci

PARAMETRES

CLIMATIC   HUMAN

Air temperature   Activity

Humidity   Clothing

Air velocity

Solar radiations

Infrared radiations

AIR TEMPERATURE

HUMIDITY

DIFFUSE SOLAR RADIATION

DIRECT SOLAR RADIATION

WIND

CLOTHING

ACTIVITY

INFRARED RADIATION

2) Finding appropriate strategies to
increase pedestrian outdoor comfort
in tropical hot and Humid climate.
Steps followed are:
a) Climate Analysis
b) Comfort Tools
c) Strategies for micro climate

CLIMATE | New Delhi

Dry Bulb Temperature

Max. Outside temperatue	45°C
Min. Outside temperature	4.8°C
Yearly mean Outside temperature	24.9°C

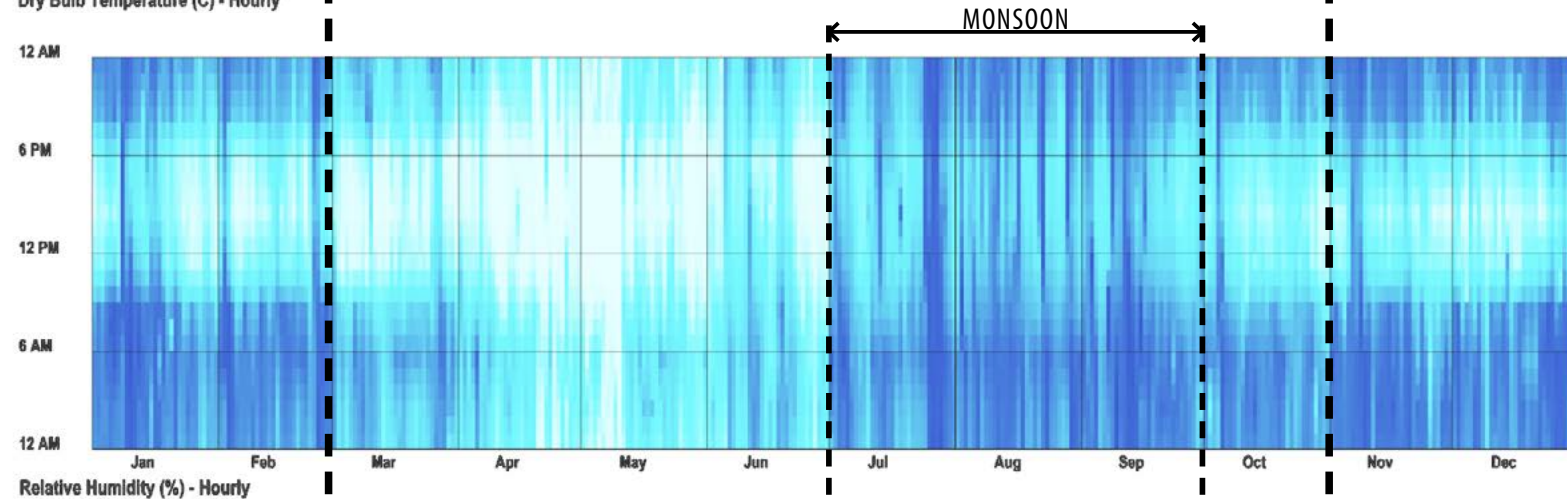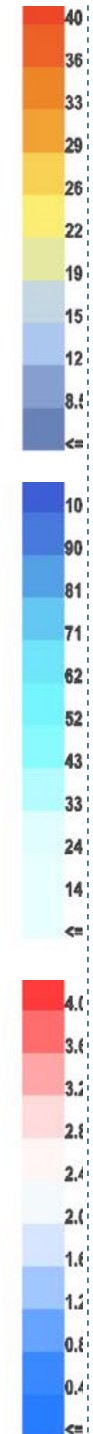**Summer from March to October**
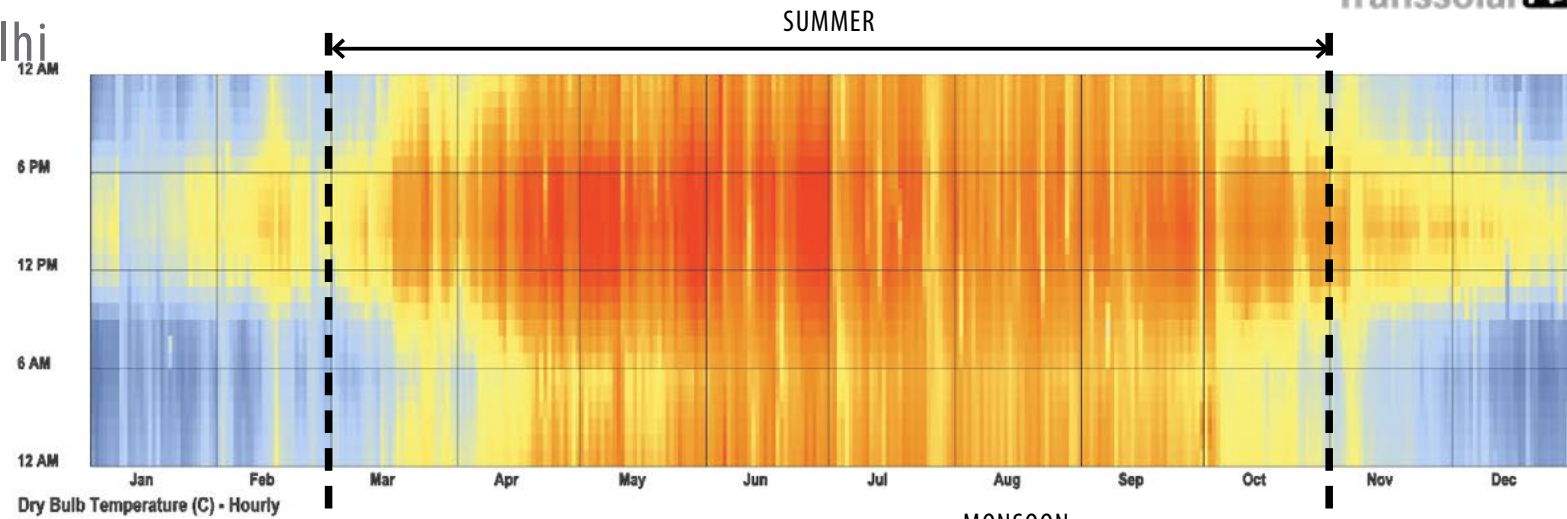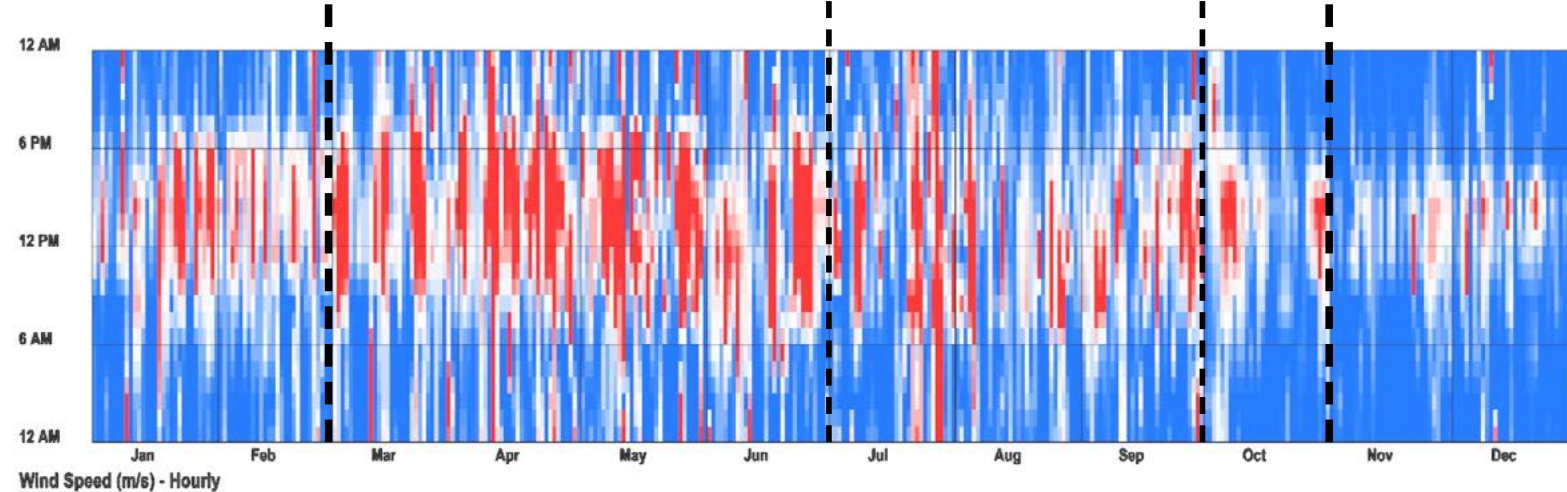
Relative Humidity

35% Humidity > 14g/kg
Annual precipitation average of 700mm

Monsoon from July to September

Wind

Average annual wind velocity   1.5m/s

Wind relatively more during the hot and dry season, during the daytime.

SUMMER

MONSOON

Dry Bulb Temperature (C) - Hourly

Relative Humidity (%) - Hourly

Wind Speed (m/s) - Hourly

a)Climate Analysis
Almost 80% of India experiences hot and humid climate and New Delhi is chosen for investigation as it experiences a more extreme summer and winter, compared to most.

Fig 1) Delhi experiences long summer from March to October and the temp rises upto 45°C.

Fig 2) Monsoon occurs from July to Sep. For 35% of the year humidity outside is above 14g/kg which causes discomfort

Fig3) The average annual wind is 1.5m/s and it is more during the daytime in the hot and dry period .
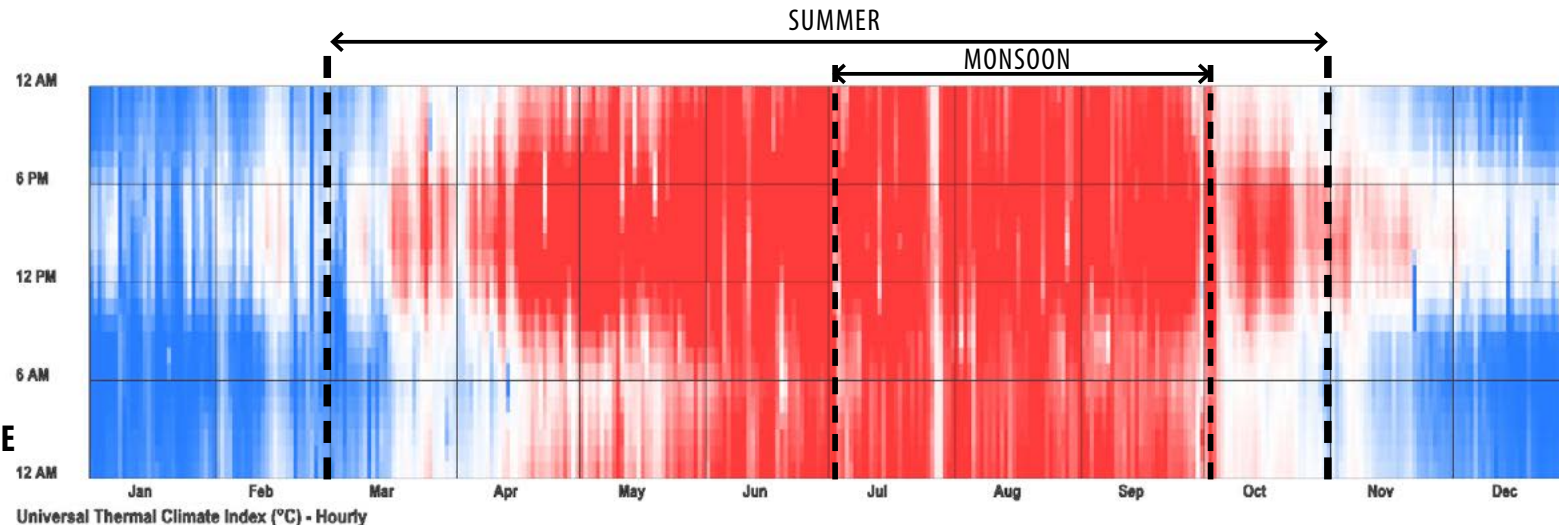
CLIMATE | New Delhi

UTCI ≤ 32⁰C
is considered comfortable in hot and humid climate

UTCI < 9⁰C
experiences cold stress

25% of year UTCI > 32⁰C
72% of Summer UNCOMFORTABLE
(Summer- daytime)

SUMMER

MONSOON

12 AM
6 PM
12 PM
6 AM
12 AM

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Universal Thermal Climate Index (°C) - Hourly

HORIZONTAL SOLAR INSOLATION

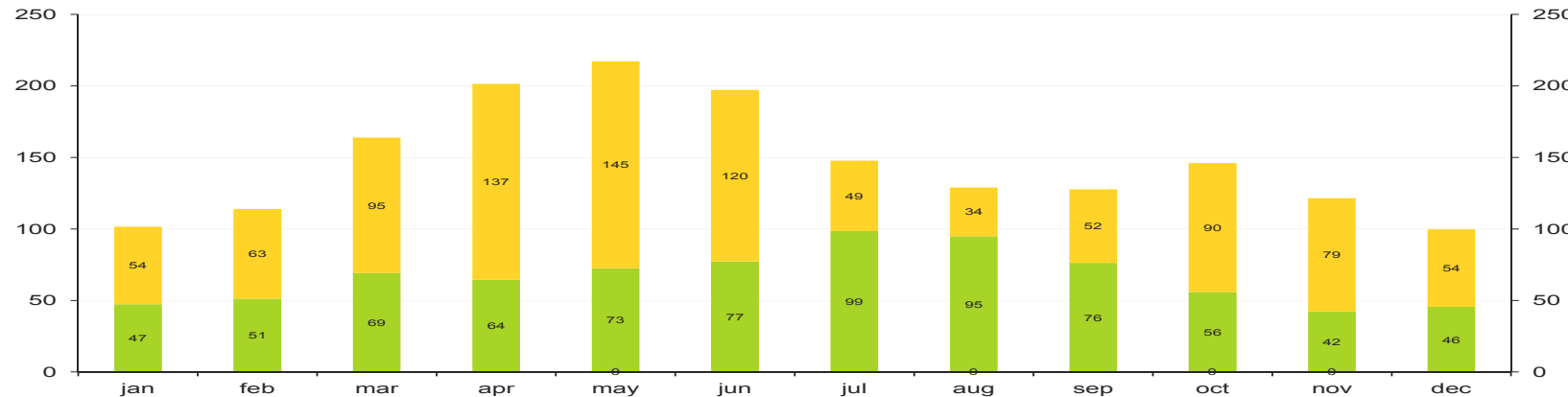| Month	Yellow	Green
jan	54	47
feb	63	51
mar	95	69
apr	137	64
may	145	73
jun	120	77
jul	49	99
aug	34	95
sep	52	76
oct	90	56
nov	79	42
dec	54	46

a) Climate Analysis

We map UTCI over the year; which takes into account the dry bulb temp, relative humidity, wind and considers mean radiant temp of the surrounding same as the ambient temp (open field condition).

In a hot and humid climate UTCI < 32⁰C is considered comfortable. We can see here that the monsoon period with high humidity and less wind is most uncomfortable. Winter is not problematic and with a higher clothing factor, thermal comfort can be easily achieved.

72% of summer daytime is uncomfortable. And during the hot and dry summer, due to less cloud cover there is high direct solar radiation.
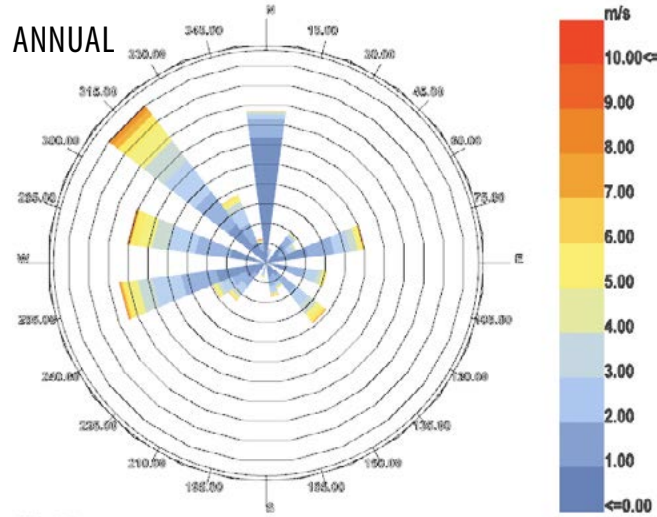
CLIMATE

WIND

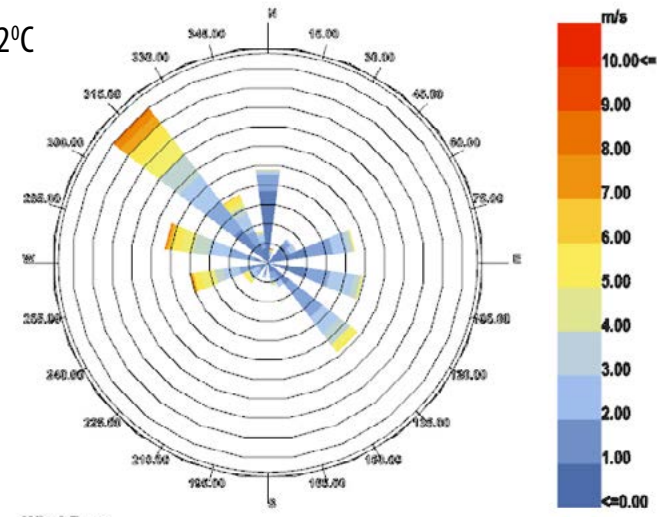Average annual wind speed is 1.49m/s

During the **summer** predominant wind is from
NORTH WEST (when UTCI > 32⁰C)

During the **winter** predominant wind is from
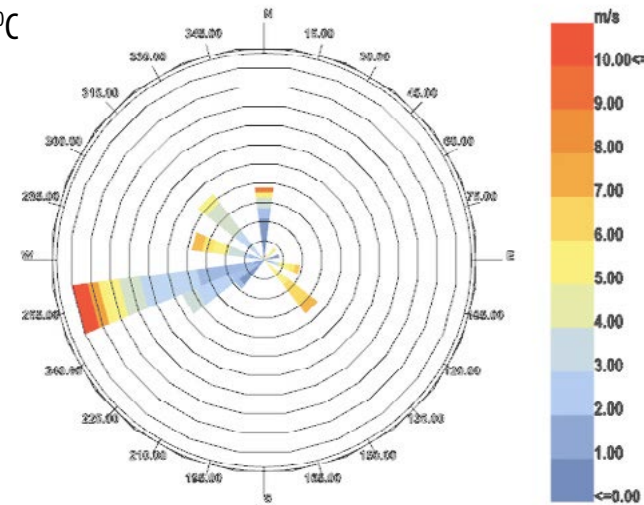the **SOUTH WEST** (when UTCI < 9⁰C)

ANNUAL

Wind-Rose
NEW DELHI_IND
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Wind Speed (m/s)
Calm for 0.00% of the time = 0 hours.
Each closed polyline shows frequency of 1.2%. = 103 hours.

UTCI > 32⁰C

Wind-Rose
NEW DELHI_IND
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Wind Speed (m/s)
Calm for 0.00% of the time = 0 hours.
Each closed polyline shows frequency of 0.4%. = 33 hours.

UTCI < 9⁰C

Wind-Rose
NEW DELHI_IND
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Wind Speed (m/s)
Calm for 0.00% of the time = 0 hours.
Each closed polyline shows frequency of 0.0%. = 3 hours.

a) Climate Analysis
When UTCI > 32⁰C, the predominant wind direction is from the North-West. This presents an opportunity to channel wind from the NW in site planning to improve comfort.

TOOLS FOR COMFORT : SUMMARY

Shading **Increased Wind** **Adiabatic Cooling**

b) Comfort Tools

From the climate analysis we understand the need for

SHADING to protect from solar radiation

INCREASED WIND helps improve comfort
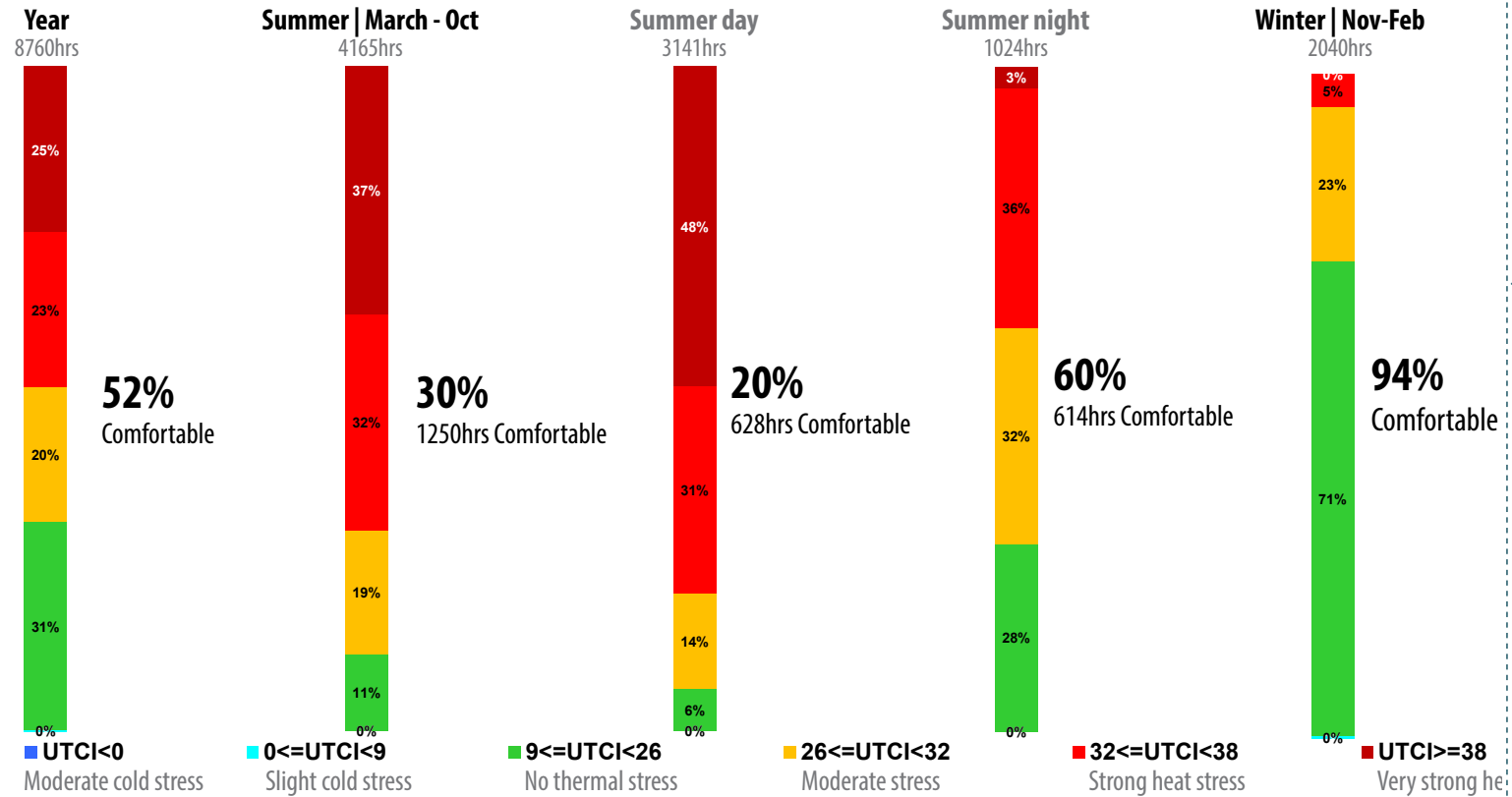
ADIABATIC COOLING reduces air temperature

TOOLS FOR COMFORT

BASE CASE

A person standing the entire year on a black surface receiving full solar radiation and almost no wind.

BLACK SURFACE
NO SHADING
NO WIND

Year	Summer | March - Oct	Summer day	Summer night	Winter | Nov-Feb
8760hrs	4165hrs	3141hrs	1024hrs	2040hrs

Year 8760hrs
- 25%
- 23%
- 20%
- 31%
- 0%

52% Comfortable

Summer | March - Oct 4165hrs
- 37%
- 32%
- 19%
- 11%
- 0%

30% 1250hrs Comfortable

Summer day 3141hrs
- 48%
- 31%
- 14%
- 6%
- 0%

20% 628hrs Comfortable

Summer night 1024hrs
- 3%
- 36%
- 32%
- 28%
- 0%

60% 614hrs Comfortable

Winter | Nov-Feb 2040hrs
- 0%
- 5%
- 23%
- 71%
- 0%

94% Comfortable

■ UTCI<0 — Moderate cold stress
■ 0<=UTCI<9 — Slight cold stress
■ 9<=UTCI<26 — No thermal stress
■ 26<=UTCI<32 — Moderate stress
■ 32<=UTCI<38 — Strong heat stress
■ UTCI>=38 — Very strong he
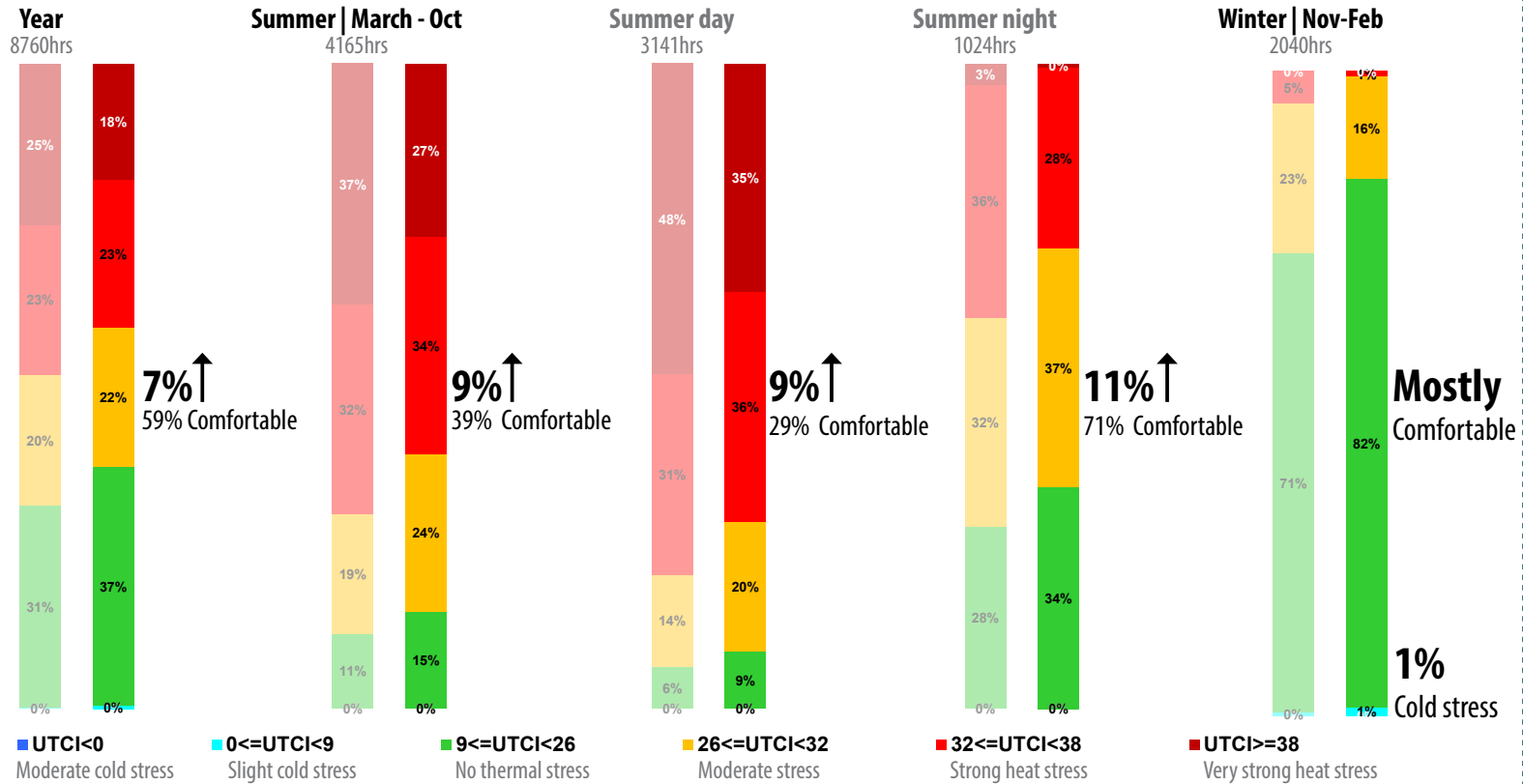
c) Strategies for micro-climate

To evaluate the moderation effects of different strategies towards optimizing outdoor thermal comfort, we consider BASE CASE which shows

During summer daytime only 20% of the time it is comfortable and during summer night time 60% of the time it is comfortable

TOOLS FOR COMFORT

HIGH SOLAR REFLECTIVE SURFACE

WHITE SURFACE
NO SHADING
NO WIND

Year 8760hrs	
Summer | March - Oct 4165hrs	
Summer day 3141hrs	
Summer night 1024hrs	
Winter | Nov-Feb 2040hrs	

Year
8760hrs

25%
23%
20%
31%
0%

18%
23%
22%
37%
0%

7%↑
59% Comfortable

Summer | March - Oct
4165hrs

37%
32%
19%
11%
0%

27%
34%
24%
15%
0%

9%↑
39% Comfortable

Summer day
3141hrs

48%
31%
14%
6%
0%

35%
36%
20%
9%
0%

9%↑
29% Comfortable

Summer night
1024hrs

3%
36%
32%
28%
0%

0%
28%
37%
34%
0%

11%↑
71% Comfortable

Winter | Nov-Feb
2040hrs

0%
5%
23%
71%
0%

0%
16%
82%
1%

Mostly
Comfortable

1%
Cold stress

■ UTCI<0
Moderate cold stress

■ 0<=UTCI<9
Slight cold stress

■ 9<=UTCI<26
No thermal stress

■ 26<=UTCI<32
Moderate stress

■ 32<=UTCI<38
Strong heat stress

■ UTCI>=38
Very strong heat stress

c) Strategies for micro-climate

For the pavement material solar reflectance or albedo , is the primary determinant of the material's maximum surface temperature.

Conventional paving materials such as asphalt and concrete have solar reflectances of 5 to 40 percent, which means they absorb 95 to 60 percent of the energy reaching them. light-colored pavements with solar reflectances greater than 75 percent reduces surface mean radiant temperature. We see 9% improvement in summer with just improving the ground material.

Alternately permeable pavements also helps keep surface temp lower through evaporative cooling.

TOOLS FOR COMFORT

FIXED SHADING

0% Transmittance

BLACK SURFACE
0% TRANSMITTANCE, SHADING
NO WIND

Year
8760hrs

6%	
25%	28%
23%	22%
20%	**13%↑**
31%	65% Comfortable
0%	43%
	0%

Summer | March - Oct
4165hrs

37%	9%
	42%
32%	**19%↑**
19%	49% Comfortable
11%	32%
0%	17%
	0%

Summer day
3141hrs

48%	11%
	43%
31%	**(26%↑)**
14%	46% Comfortable
6%	31%
0%	15%
	0%

Summer night
1024hrs

3%	2%
36%	39%
32%	**(3%↓)**
28%	42% Uncomfortable
0%	34%
	25%
	0%

Winter | Nov-Feb
2040hrs

0%	0%
5%	3%
23%	
71%	97%
0%	**Mostly** Comfortable
	0%

■ UTCI<0
Moderate cold stress

■ 0<=UTCI<9
Slight cold stress

■ 9<=UTCI<26
No thermal stress

■ 26<=UTCI<32
Moderate stress

■ 32<=UTCI<38
Strong heat stress

■ UTCI>=38
Very strong heat stress

Operable shading will allow the ground to reject heat absorbed during the day to the sky

c) Strategies for micro-climate

Opaque fixed shading reduces exposure to solar radiation including infrared-radiation, which keeps the surface temperature lower and thus improves comfort.
However the heat transmitted during the day through the shading is trapped even during night, creating a reverse effect. Hence we see a decrease of 3% in comfort hours during the summer night when compared to base case.
In order to take advantage of night sky cooling potential, operable shading is advisable.

TOOLS FOR COMFORT

OPERABLE SHADING
0% Transmittance

BLACK SURFACE
0% TRANSMITTANCE, OPERABLE SHADING
NO WIND

Year
8760hrs

Summer | March - Oct
4165hrs

Summer day
3141hrs

Summer night
1024hrs

Winter | Nov-Feb
2040hrs
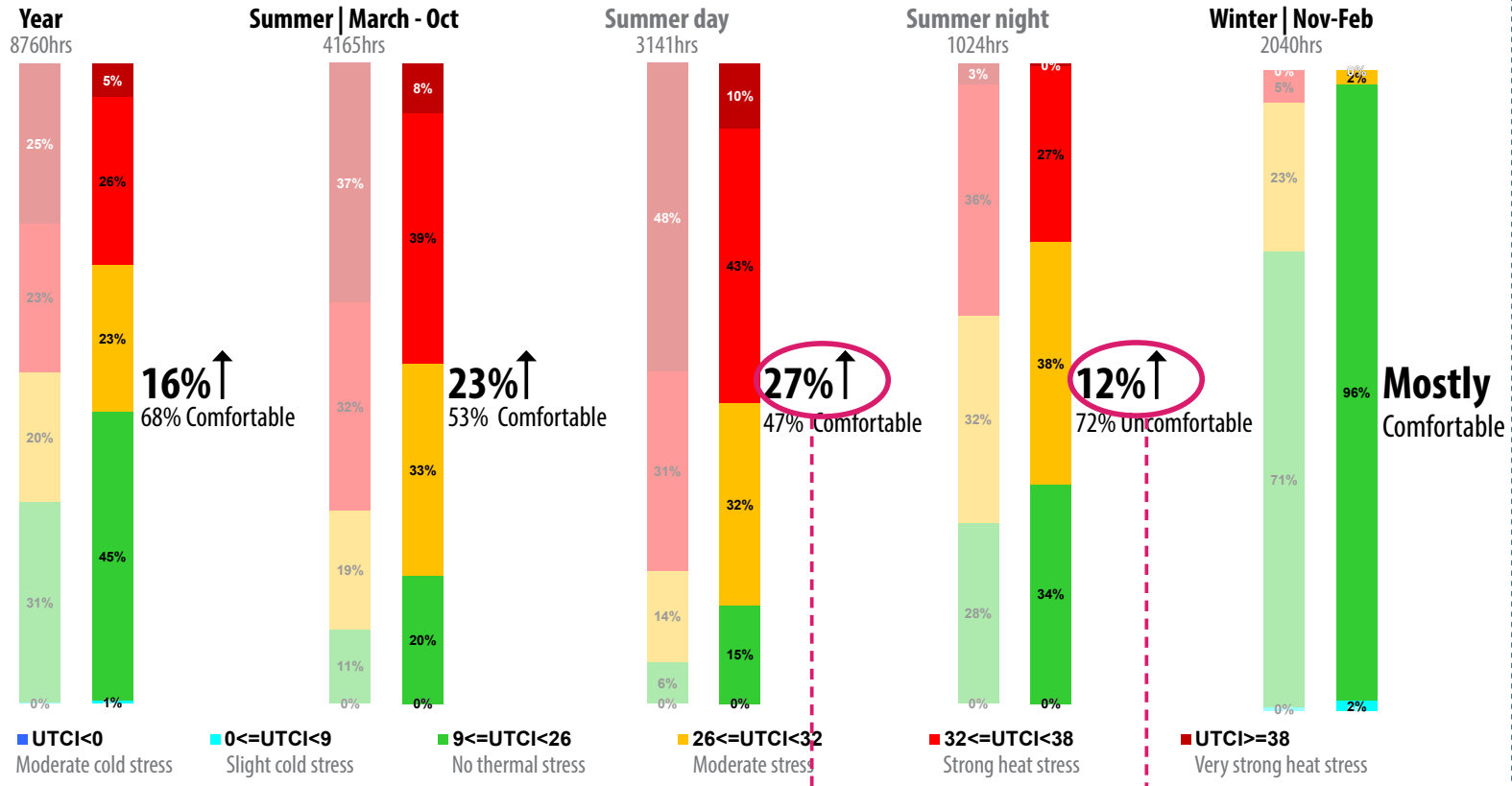
16%↑
68% Comfortable

23%↑
53% Comfortable

27%↑
47% Comfortable

12%↑
72% Uncomfortable

Mostly
Comfortable

Year (left bar)
- 0%
- 31%
- 20%
- 23%
- 25%

Year (right bar)
- 1%
- 45%
- 23%
- 26%
- 5%

Summer (left bar)
- 0%
- 11%
- 19%
- 32%
- 37%

Summer (right bar)
- 0%
- 20%
- 33%
- 39%
- 8%

Summer day (left bar)
- 0%
- 6%
- 14%
- 31%
- 48%

Summer day (right bar)
- 0%
- 15%
- 32%
- 43%
- 10%

Summer night (left bar)
- 0%
- 28%
- 32%
- 36%
- 3%

Summer night (right bar)
- 0%
- 34%
- 38%
- 27%
- 0%

Winter (left bar)
- 0%
- 71%
- 23%
- 5%
- 0%

Winter (right bar)
- 2%
- 96%
- 2%
- 0%

■ UTCI<0
Moderate cold stress

■ 0<=UTCI<9
Slight cold stress

■ 9<=UTCI<26
No thermal stress

■ 26<=UTCI<32
Moderate stress

■ 32<=UTCI<38
Strong heat stress

■ UTCI>=38
Very strong heat stress

Significantly more comfortable days and also improves Nighttime comfort

c) Strategies for micro-climate

Operable shading takes advantage of night sky cooling potential, and allows the ground to reject heat absorbed during the day to the sky. This lowers the surface mean radiant temperature. Therefore we see a 12% increase in comfort hours during summer night when compared to the base case.

TOOLS FOR COMFORT

INCREASED WIND SPEED 2m/s

BLACK SURFACE
NO SHADING
2m/s WIND
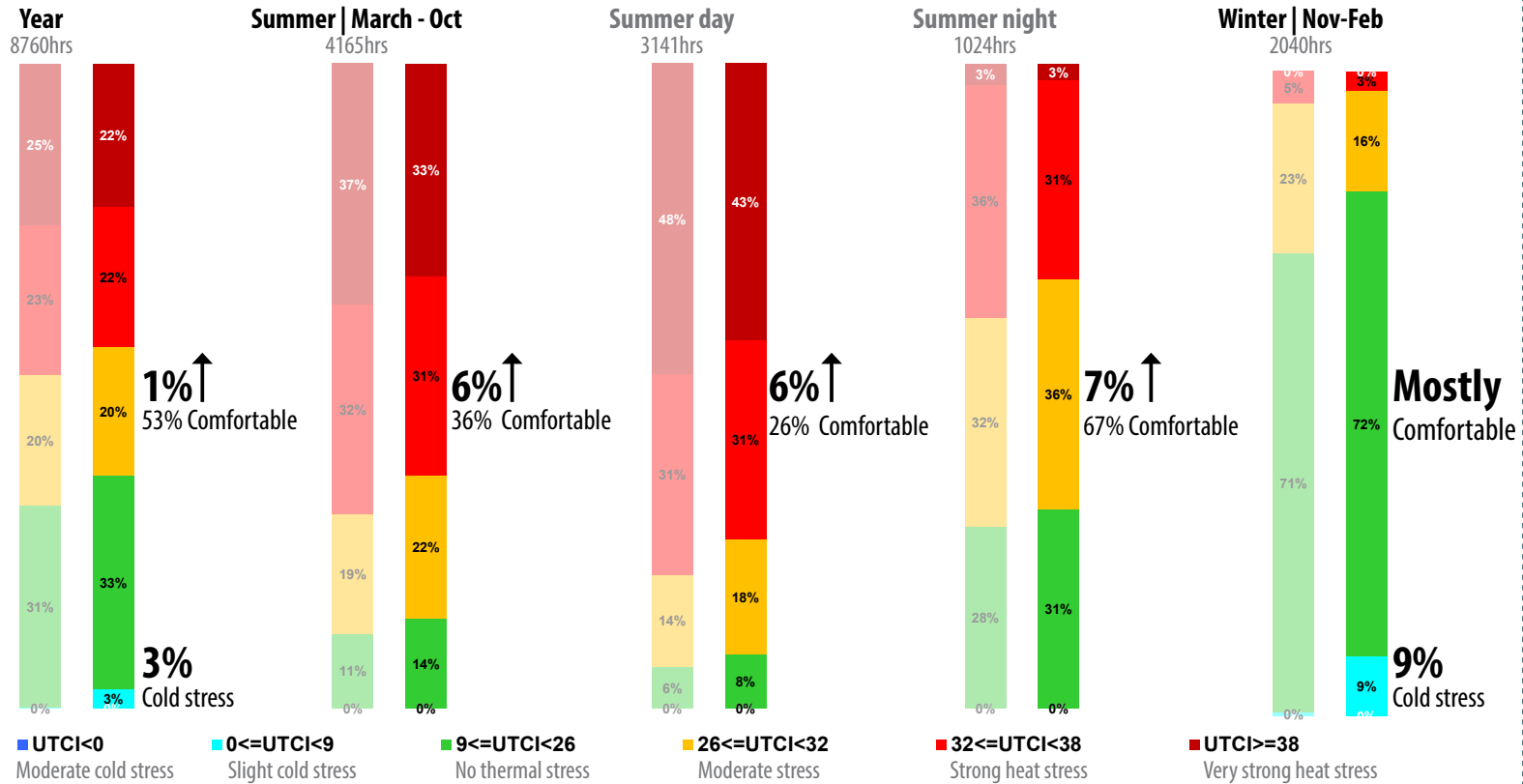
Elevated wind improves comfort, especially during the hot and humid days of the year and we see an overall improvement of 6% in comfort hours during summer, when compared to the base case.

Year
8760hrs

25%	22%
23%	22%
20%	20%
31%	33%
0%	3%

1%↑ 53% Comfortable

3% Cold stress

Summer | March - Oct
4165hrs

37%	33%
32%	31%
19%	22%
11%	14%
0%	0%

6%↑ 36% Comfortable

Summer day
3141hrs

48%	43%
31%	31%
14%	18%
6%	8%
0%	0%

6%↑ 26% Comfortable

Summer night
1024hrs

3%	3%
36%	31%
32%	36%
28%	31%
0%	0%

7%↑ 67% Comfortable

Winter | Nov-Feb
2040hrs

0%	0%
5%	3%
23%	16%
71%	72%
0%	9%

Mostly Comfortable

9% Cold stress

■ UTCI<0
Moderate cold stress

■ 0<=UTCI<9
Slight cold stress

■ 9<=UTCI<26
No thermal stress

■ 26<=UTCI<32
Moderate stress

■ 32<=UTCI<38
Strong heat stress

■ UTCI>=38
Very strong heat stress

TOOLS FOR COMFORT

ADIABATIC COOLING

BLACK SURFACE
NO SHADING
NO WIND
90% HUMIDIFIER EFFICIENCY

Year
8760hrs

9%↑
61% Comfortable

Summer | March - Oct
4165hrs

13%↑
43% Comfortable

Summer day
3141hrs

12%↑
32% Comfortable

Summer night
1024hrs

17%↑
77% Comfortable

Winter | Nov-Feb
2040hrs

Mostly
Comfortable

Year

Stress level	Left bar	Right bar
13%		13%
25%	25%	25%
23%	23%	24%
20%	20%	37%
31%	31%	0%
0%	0%	

Summer | March - Oct

20%	20%
37%	37%
32%	37%
19%	26%
11%	17%
0%	0%

Summer day

48%	26%
31%	41%
14%	23%
6%	9%
0%	0%

Summer night

3%	0%
36%	24%
32%	38%
28%	39%
0%	0%

Winter | Nov-Feb

0%	1%
5%	19%
23%	79%
71%	0%
0%	

■ UTCI<0
Moderate cold stress

■ 0<=UTCI<9
Slight cold stress

■ 9<=UTCI<26
No thermal stress

■ 26<=UTCI<32
Moderate stress

■ 32<=UTCI<38
Strong heat stress

■ UTCI>=38
Very strong heat stress

c) Strategies for micro-climate

Adiabatic cooling using a high humidifier efficiency improves the comfort hours significantly. Here it is critical to use the right equipement to ensure evaporation without leaving a damp feeling on the user.

TOOLS FOR COMFORT : SUMMARY

Shading **Increased wind** **Adiabatic Cooling**

PASSIVE STRATEGIES
UTCI < 32°C

30%	39%	38%	49%	53%	36%	43%
BASE CASE	**HIGH SOLAR REFLECTIVE SURFACE**	**FIXED SHADING** 50% Transmittance	**FIXED SHADING** 0% Transmittance	**OPERABLE SHADING** 0% Transmittance	**INCREASED WIND SPEED**	**ADIABATIC COOLING**
BLACK SURFACE NO SHADING NO WIND						
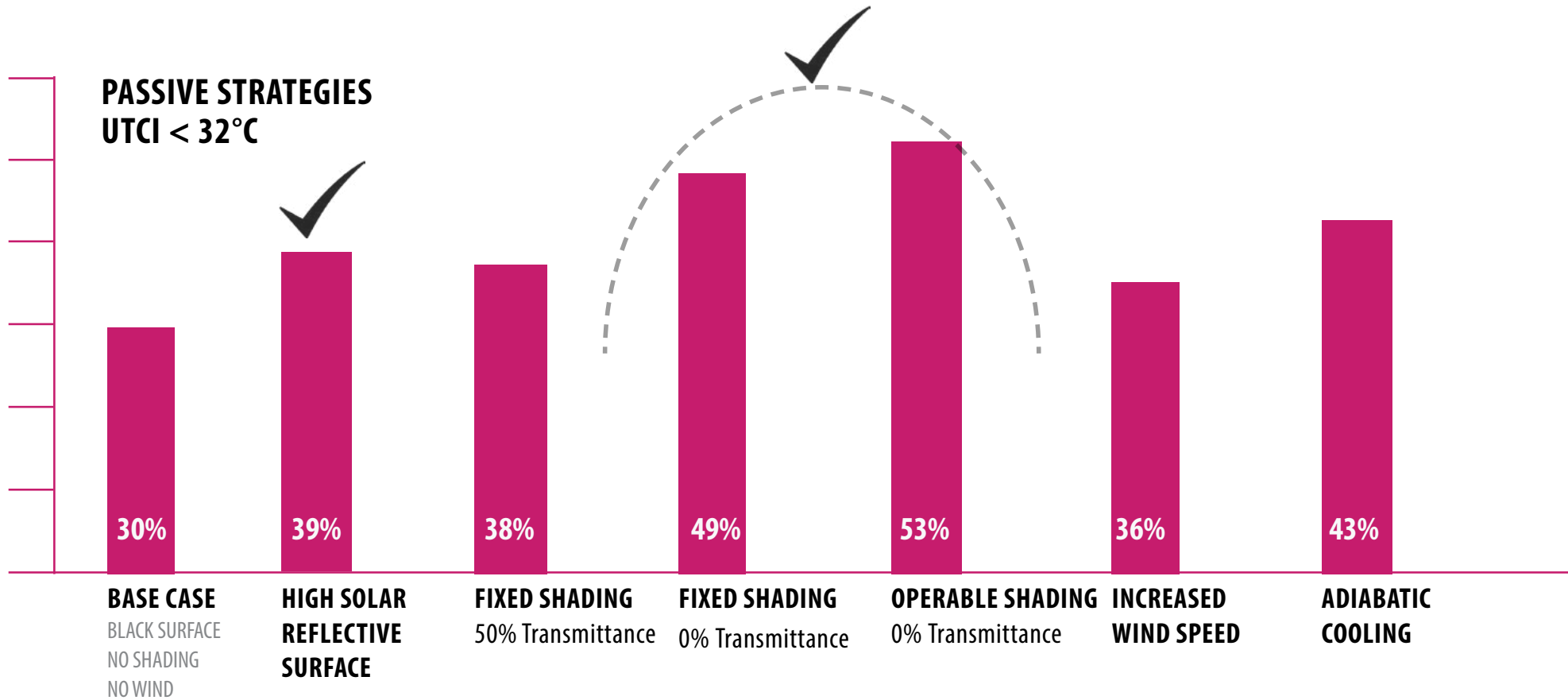
c) Strategies for micro-climate

To conclude from the analysis we find use of high albedo material and shading as the most effective and economical passive strategy to achieve outdoor comfort.

METHODOLOGY | DESIGN

PROJECT DEFINING

Pressing issue!!

Reseach

- Climate Analysis
- Tool for comfort
- Comfort Scenarios
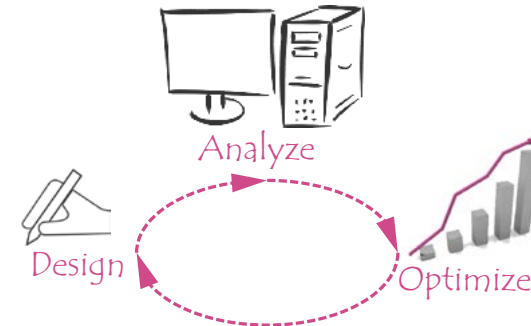
STRATEGIES for OUTDOOR COMFORT

OUTDOOR COMFORT INDEX.

utci

AIR TEMPERATURE

HUMIDITY

DIFFUSE SOLAR RADIATION

DIRECT SOLAR RADIATION

WIND

CLOTHING

ACTIVITY

INFRARED RADIATION

Design

SITE ANALYSIS

Analyze

Design

Optimize
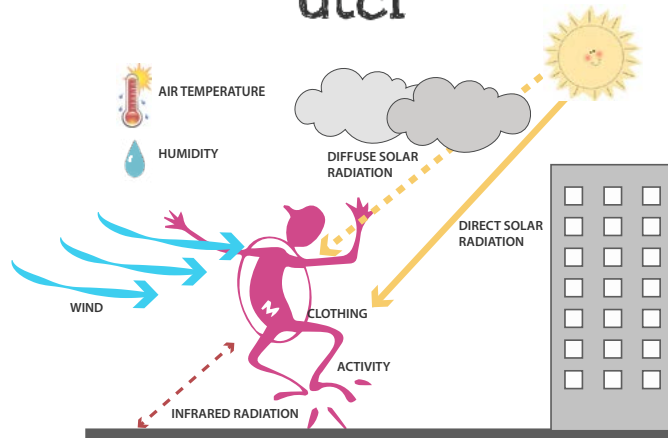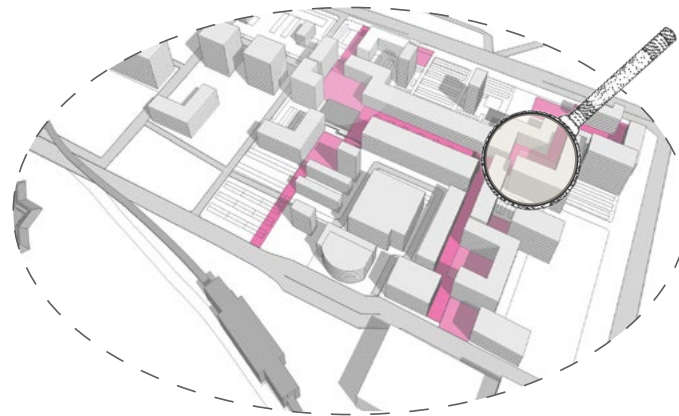
APPLICATION IN TEST-BED

The second part of the project is DESIGN

To demonstrate application of the strategies in a test-bed plaza.

To understand at the fine grain, what layers impact design decisions.

A design process to convert climate strategies into concrete solutions.

DEMONSTRATION PROJECT : New Delhi

LEGEND
- Commercial
- Residential
- Public\ Semi-Public
- Roads
- Recreational
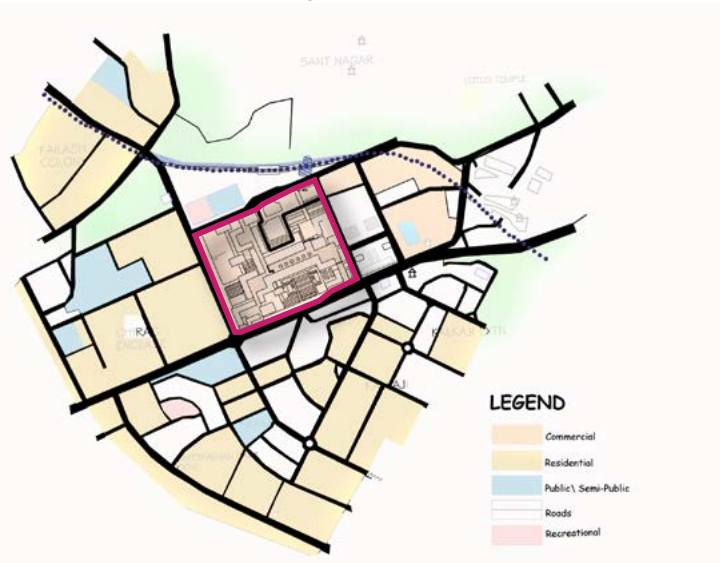
Dying Urban District

Detoriated conditions

Gentrification

NEHRU PLACE

Not Comfortable

Not Programmed

No Green Provision

Water problems

Site selection:

We choose a dying commercial district, in New Delhi, Nehru Place which is ear-marked for gentrification.
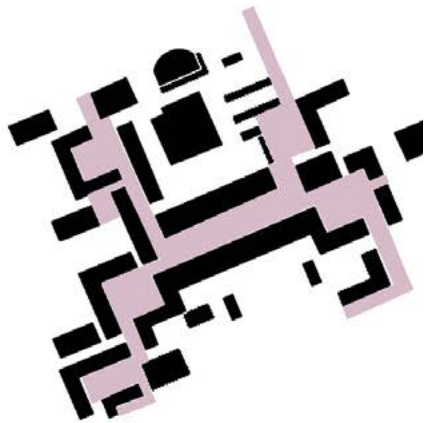
ALL OF THESE ACTIVITIES BRING

1,30,000

PEOPLE TO NEHRU PLACE EVERYDAY

MACRO SITE ANALYSIS

OFFICES   LOCAL ECONOMIES   EATERIES

COMMERCIAL   ENTERTAINMENT   SMALL SHOPS

METRO STATION

BUS STOP

16F · 14F · 4F · 6F · 6F · 6F · 6F · 6F · 14F · 4F · 6F · 6F · 16 · 16 · 6F · 8F · 16 · 6F · 6F

BUS STOP
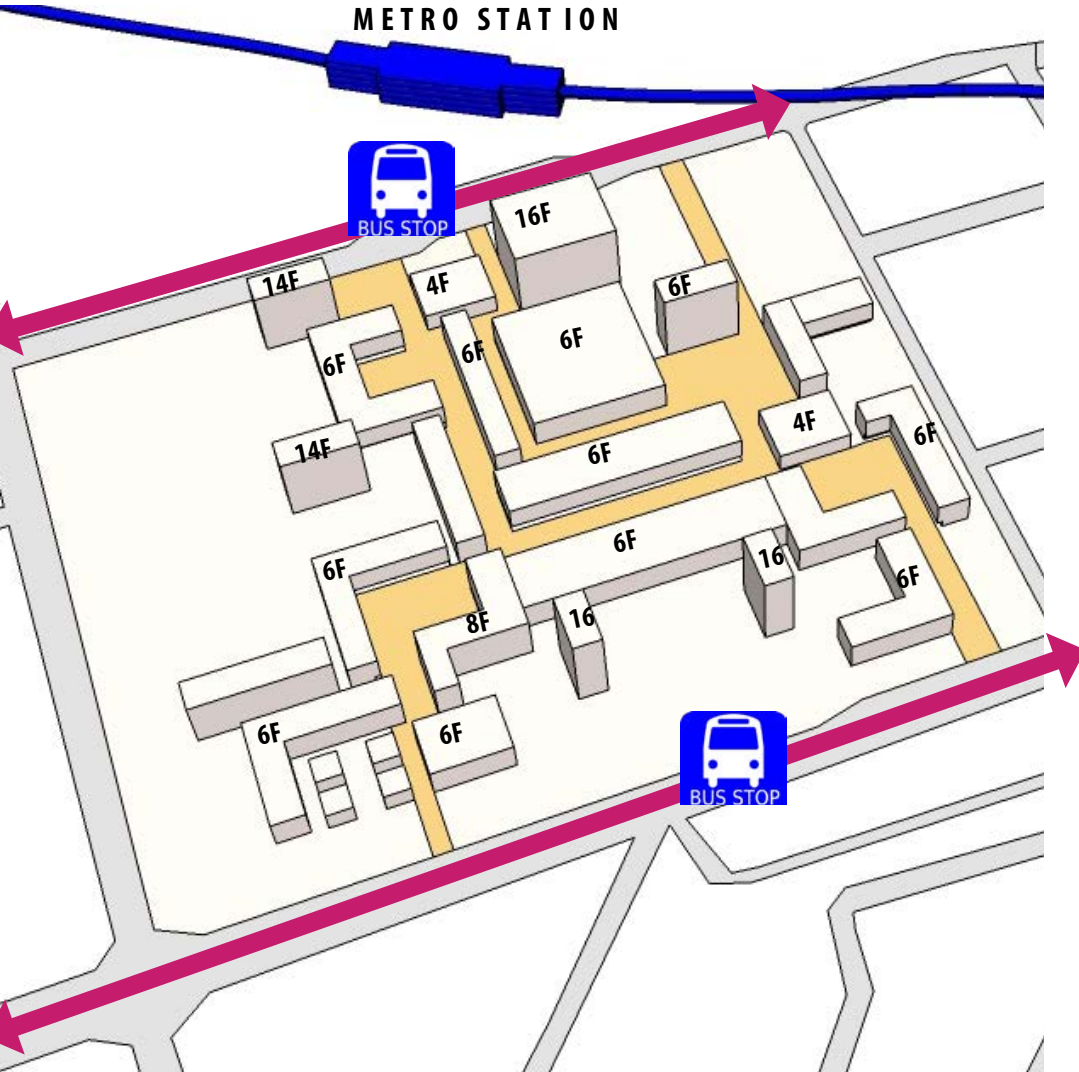
OVER USED

NEED COMFORT FOR MORE RATIONAL USE OF SPACE

BAJAJ CAPITAL

UNDER USED

Site problem

Nehru place already has a fine-grain network of pedestrian streets and plazas. However from the picture we can identify that the self shaded narrow streets are over used whereas the large plazas are uncomfortable and hence under utilized.

If we can program and create comfort in the large plazas, we will decongest the bottle neck areas, and at the same time support more local economies.

MACRO SITE ANALYSIS | SUNHOURS

ANNUAL 4198 hours

Plaza selection

We use sun hours to indicate the worst case plaza, which is selected for redesign.

TEST BED
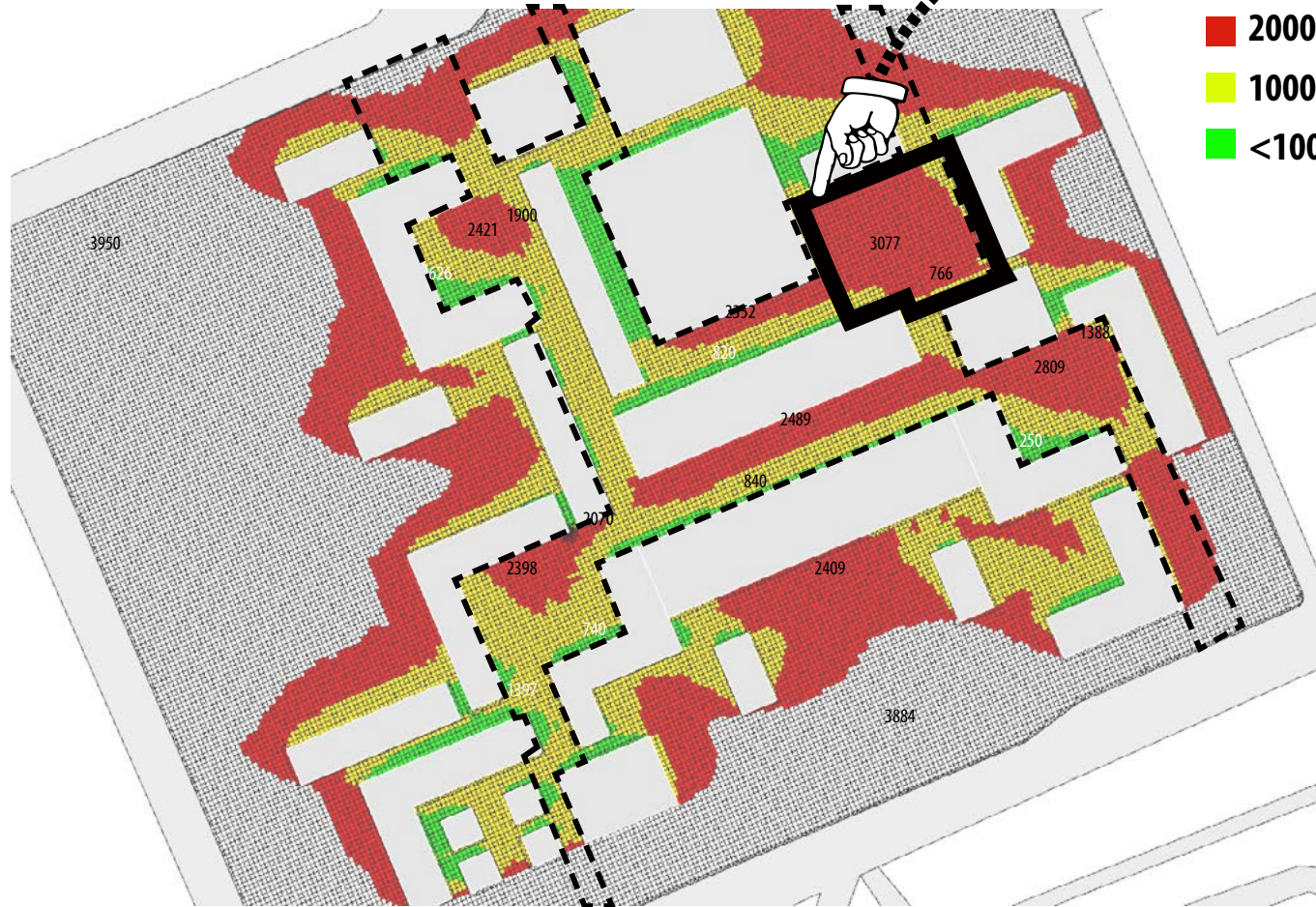
■ 2000-3000
■ 1000 -2000
■ <1000

3950

2421 1900

026

3077

766

2552

1388

820

2809

2489

250

840

2070

2398

2409

240

1397

3884

SITE ANALYSIS | PROGRAM

Metro station

🚶 **Movement**

BUS STOP

Bus stop
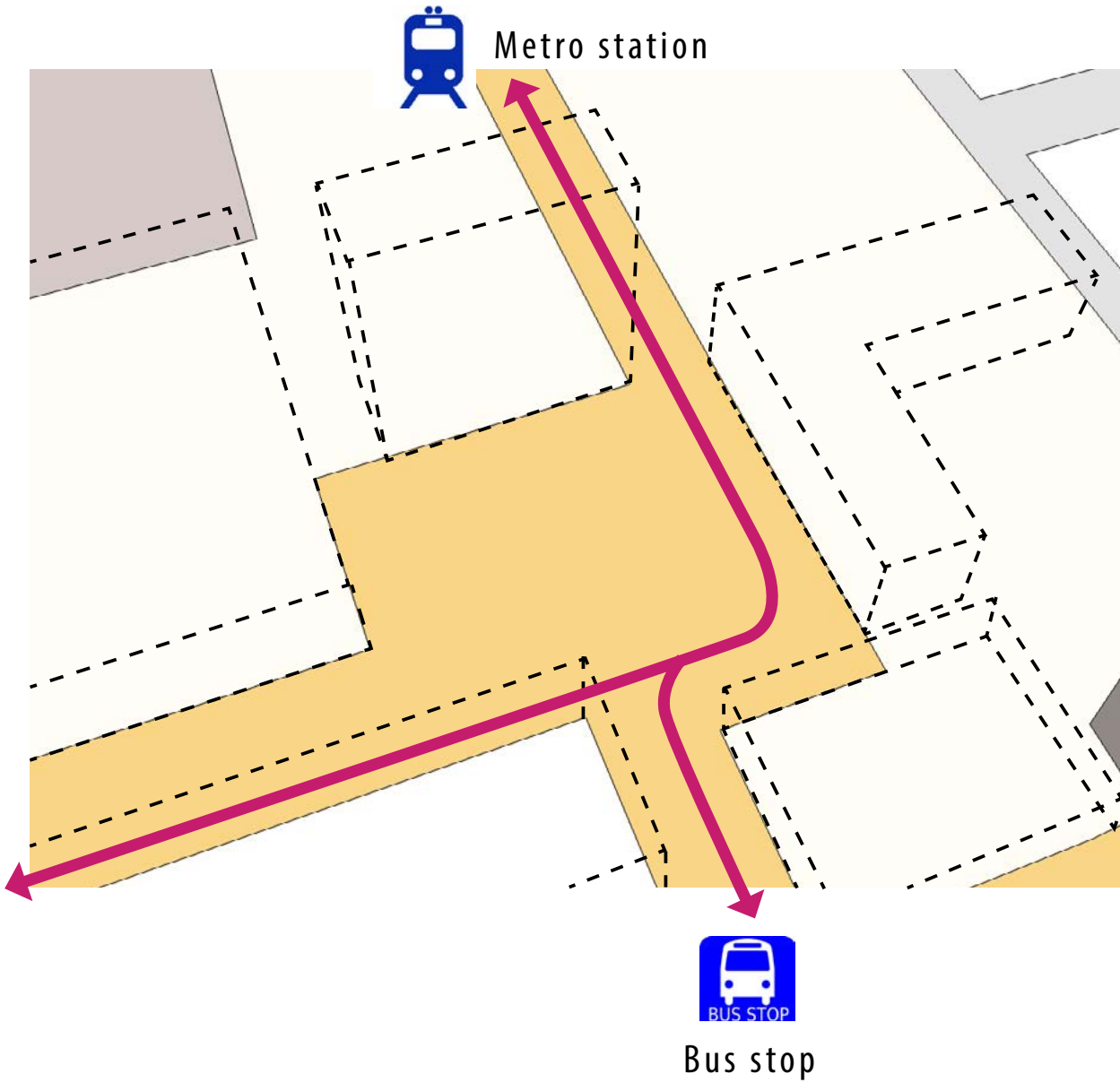
Site program analysis

This plaza is in the pedestrian path connecting the two transit stations (Metro and Bus) on either end of the precinct. Hence a lot of people move via this area during the day.

SITE ANALYSIS | PROGRAM
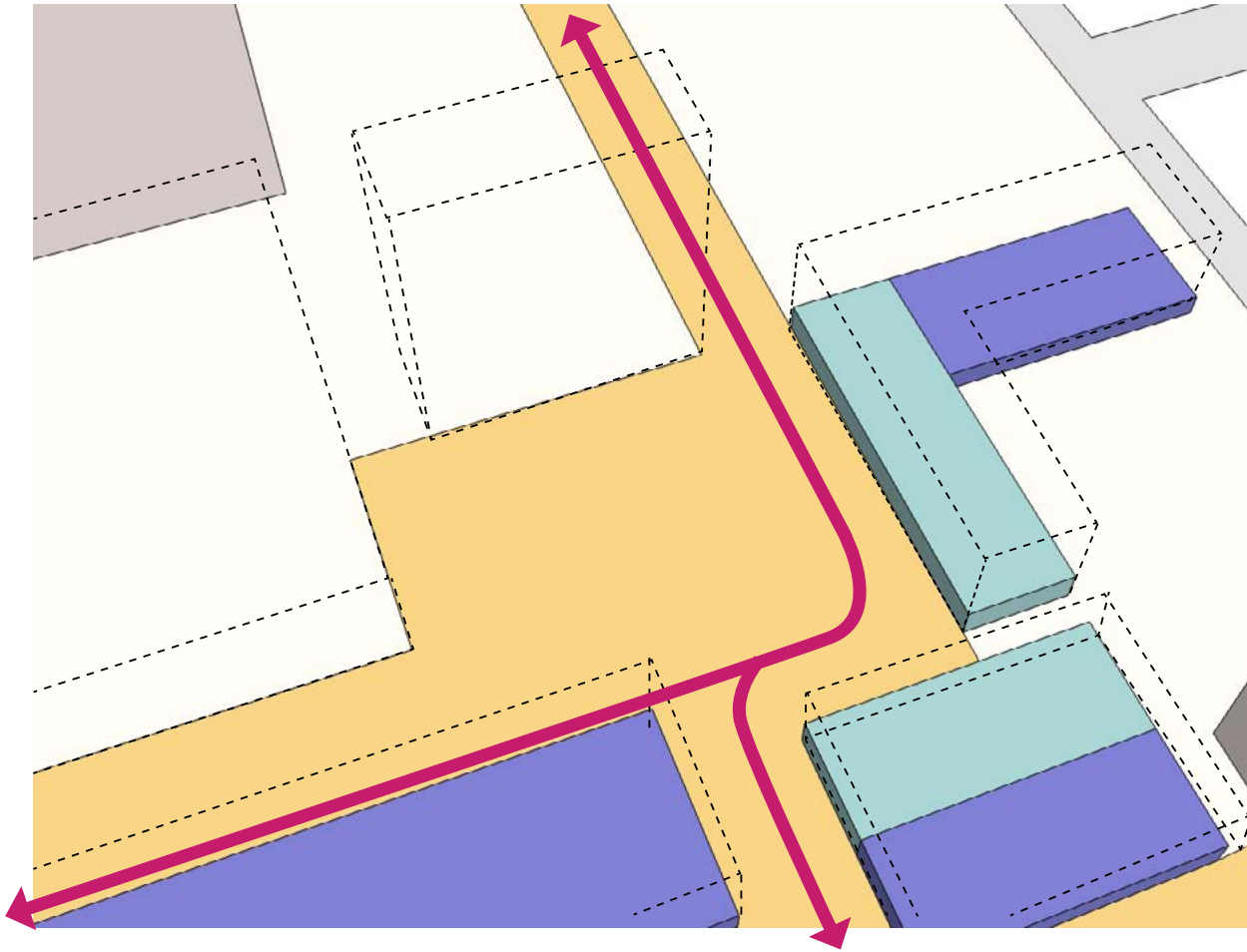
🚶 **Movement**

🍽 **Restaurant**

🛒 **Commercial**

Site program analysis

The ground floor is mostly commercial and restaurants, which can spill on to the plaza and activate the ground floor

SITE ANALYSIS | PROGRAM
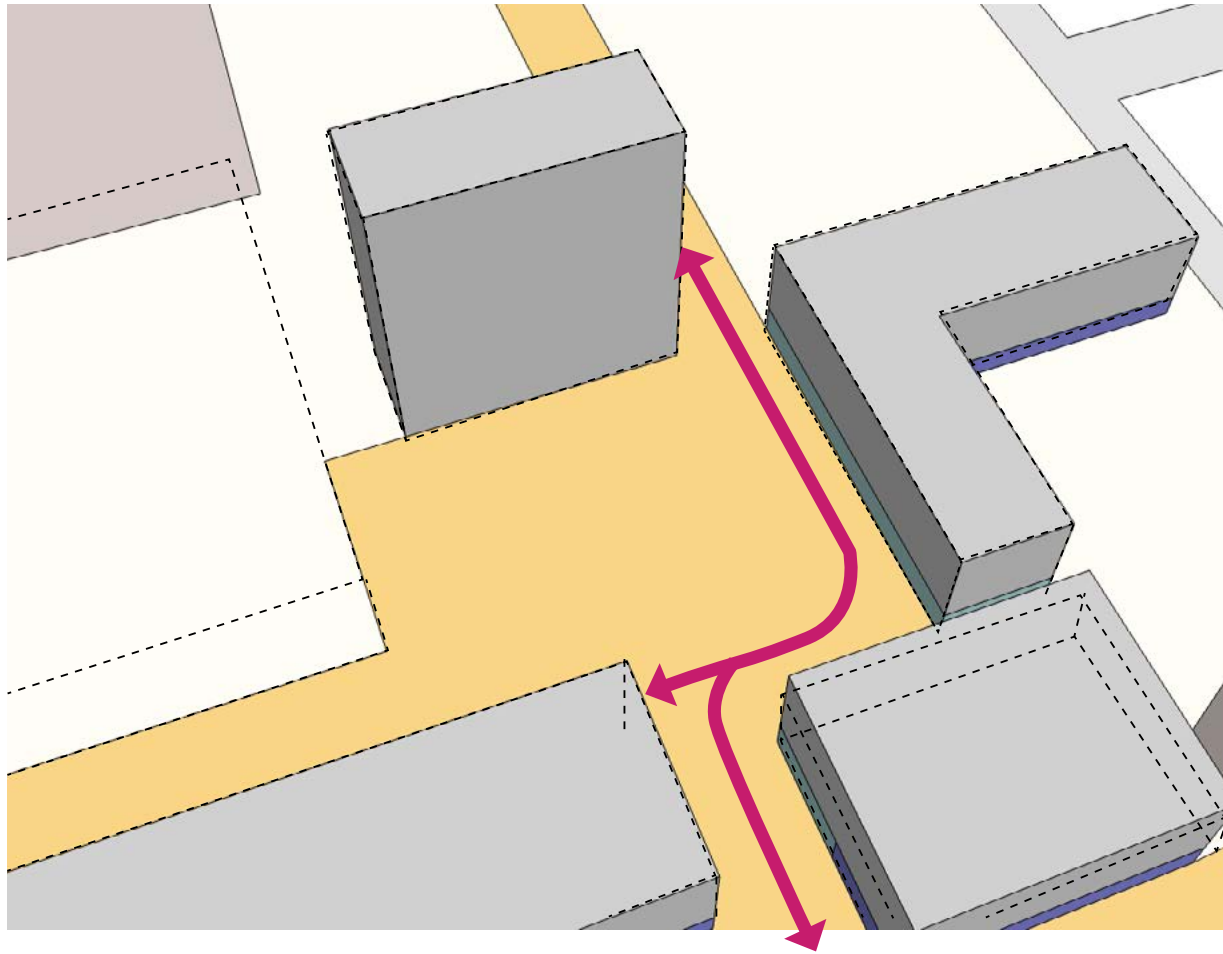
🚶 **Movement**

🍽 **Restaurant**

🛒 **Commercial**

👷 **Offices**

Site program analysis

The offices surrounding the plaza will bring large footfall to the plaza during the lunch hour and after office hours. This makes it a viable location for local economies to be set up.

SHADING STUDY | 21 March sunrise 06:28, sunset 18:27
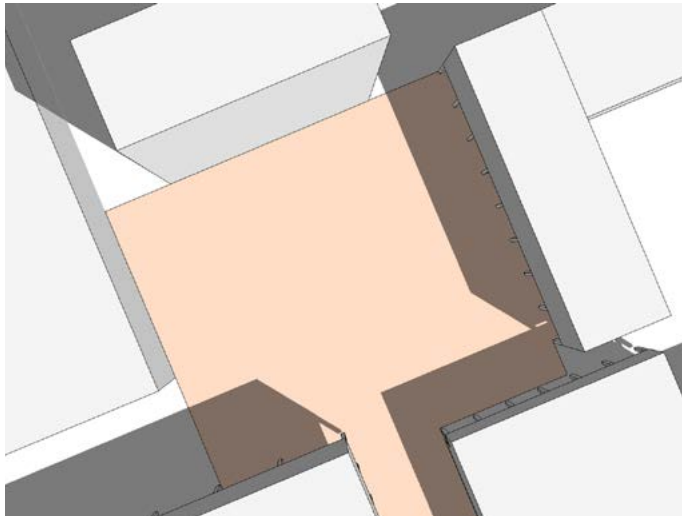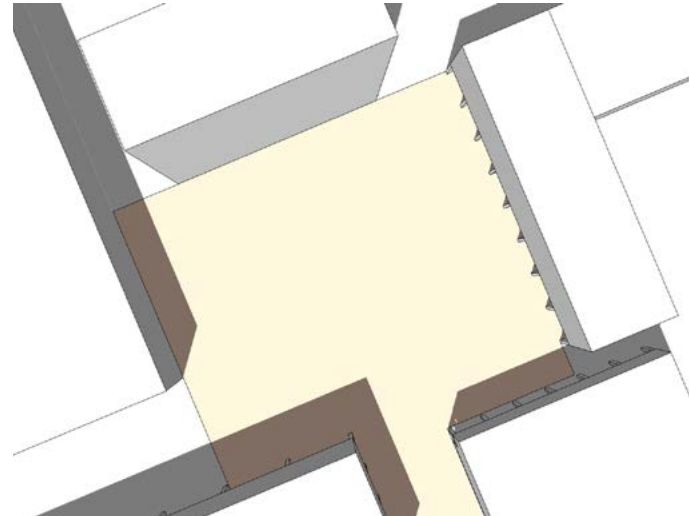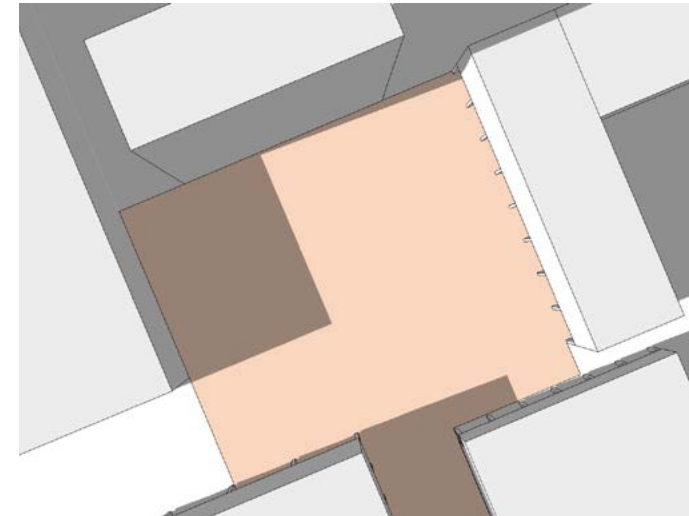
25% shade in plaza

10:00

13:00

16:00

SHADING STUDY | 21 March sunrise 06:28, sunset 18:27

25% shade in plaza
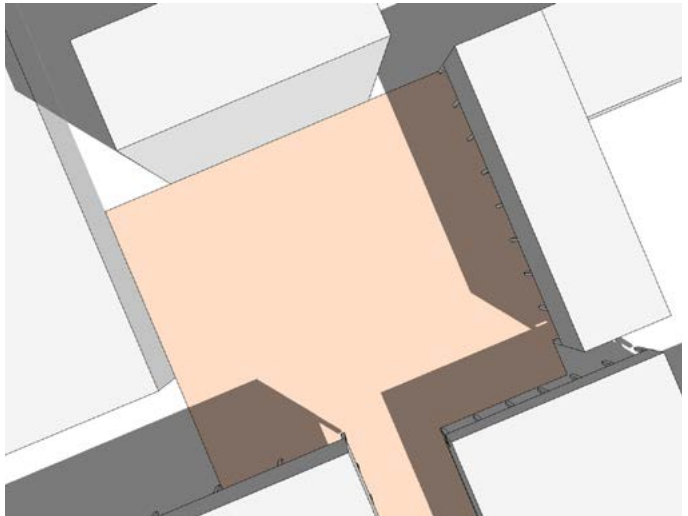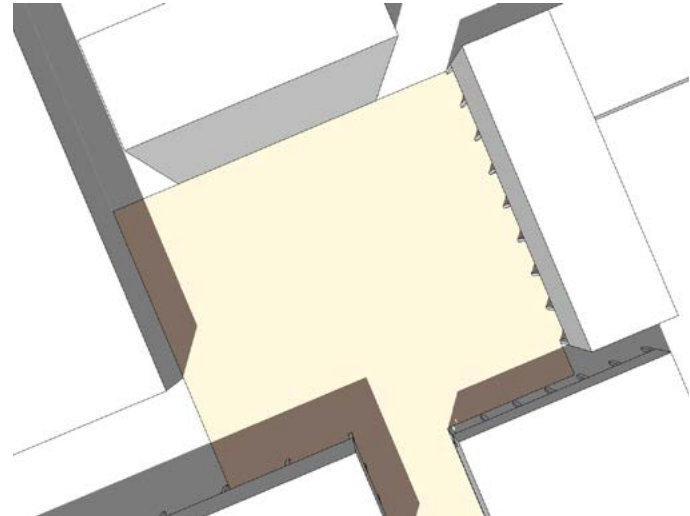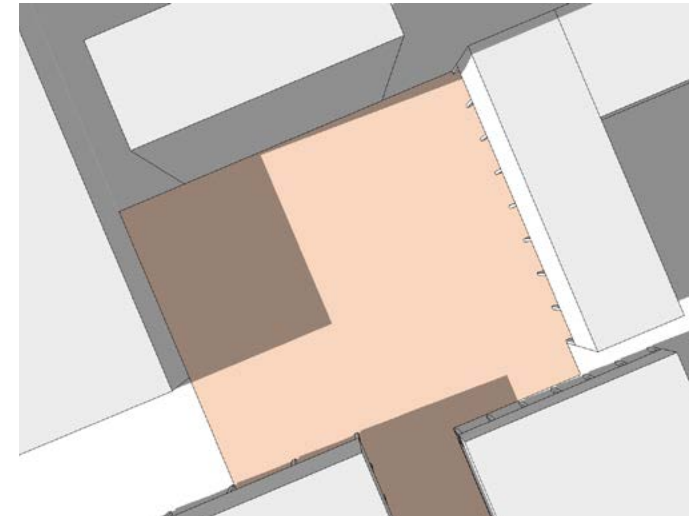
10:00

13:00

16:00

70 - 75% shade in plaza by covering 45% of the area

10:00
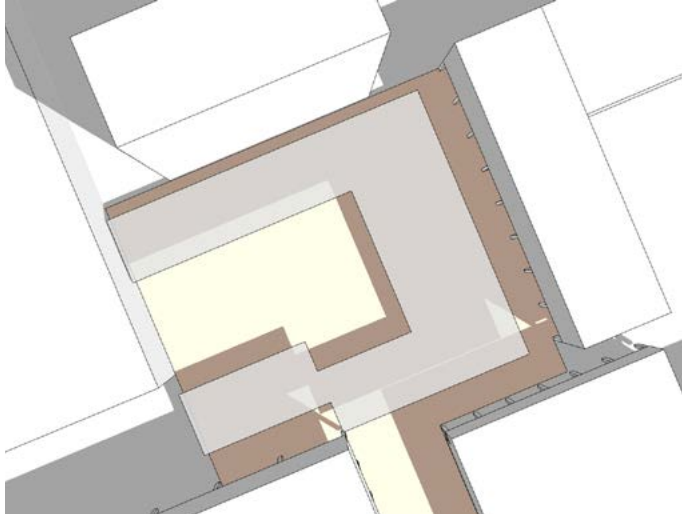
13:00
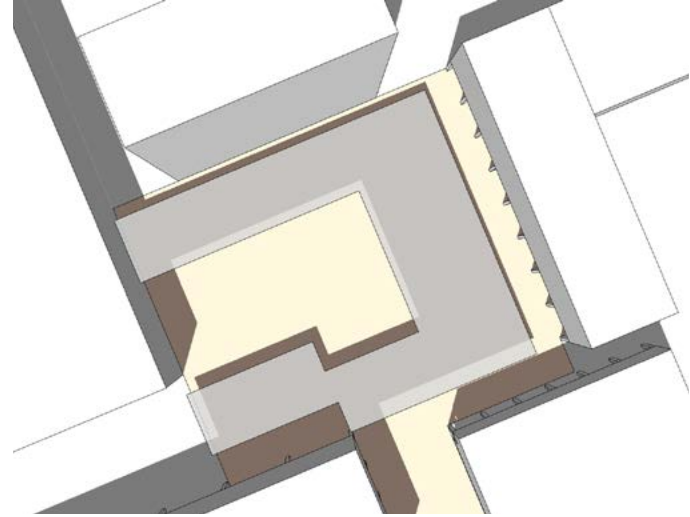
16:00
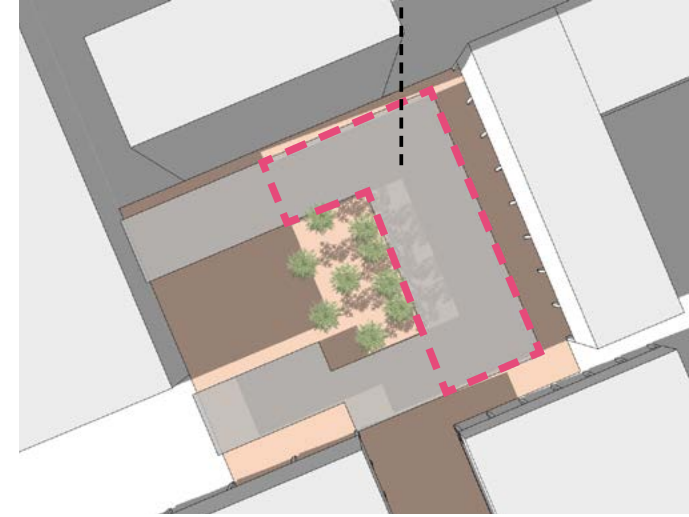
MOST CRITICAL TO SHADE
Most exposed sun

SITE DESIGN | **PROGRAM** COMFORT

13:00
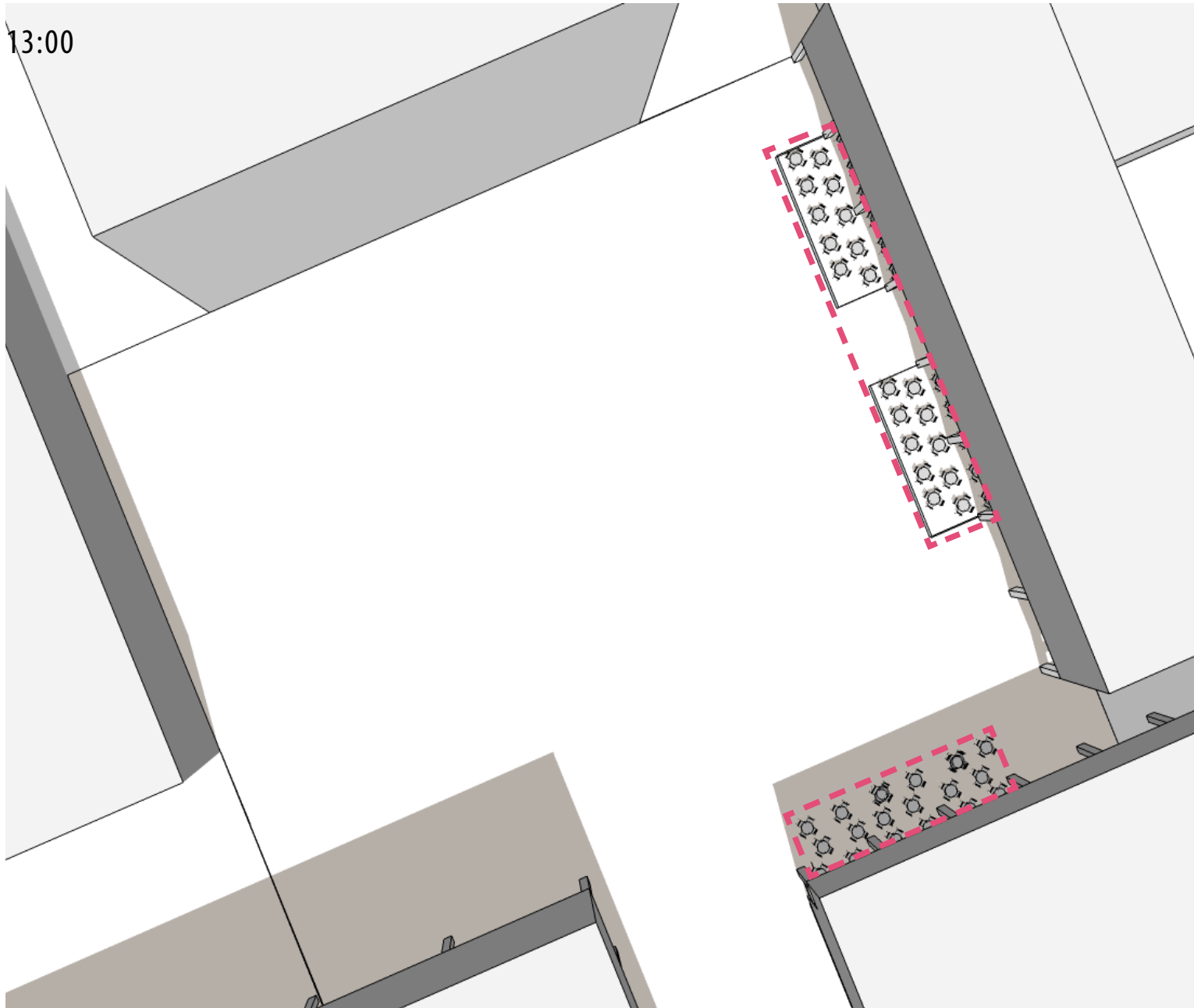
SPILL OVER CAFES

12:00 - 15:00 | 19:00 - -23:00
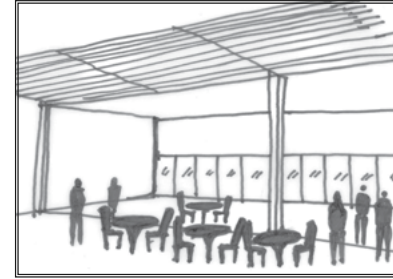
Programming the plaza

The cafes are programmed to spill onto the plaza. They cater to the people working in the surrounding offices. The will operate during lunch hour and after office hours until late night.

13:00
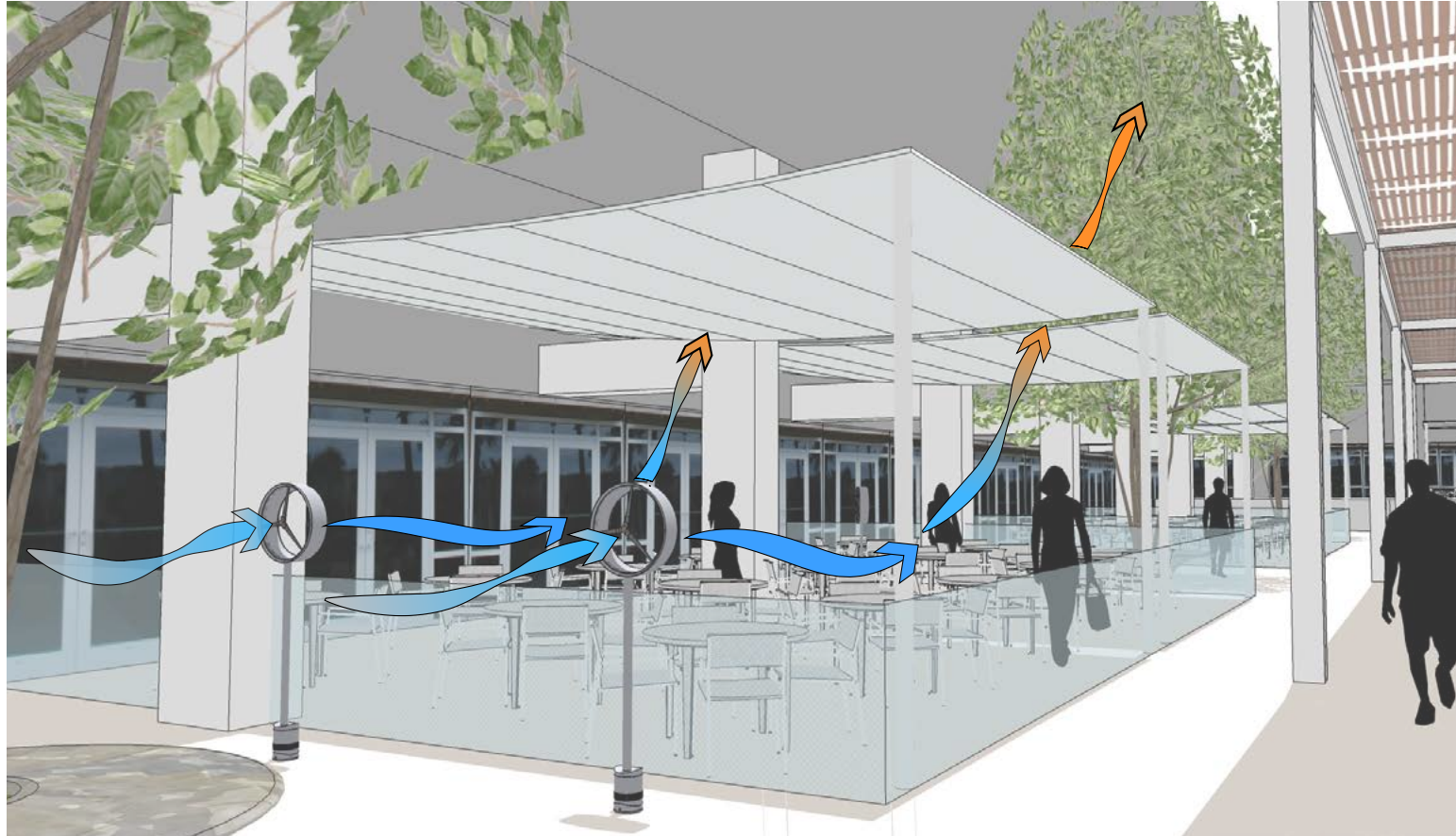
SPILL OVER CAFES

12:00 - 15:00 | 19:00 - -23:00

Summer | Mar - Oct | UTCI < 32°C

Base	Shade Fan (2m/s)	Radiant floor Fan (1m/s)
24%	54%	74%
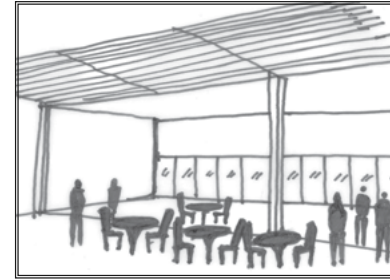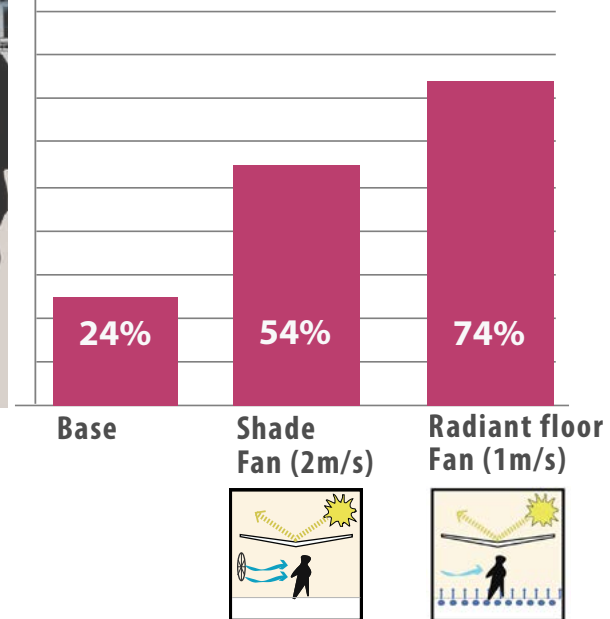
Programming + Comfort

Providing shade and elevated air speed improves comfort hours by 30%, however in a dining scenario draft may not be preferred.

For fine dining restaurants, cooled floor with activated slab and low wind speed can provide much more comfort. We must bear in mind that this would mean more investment in construction and maintainance.

15:30
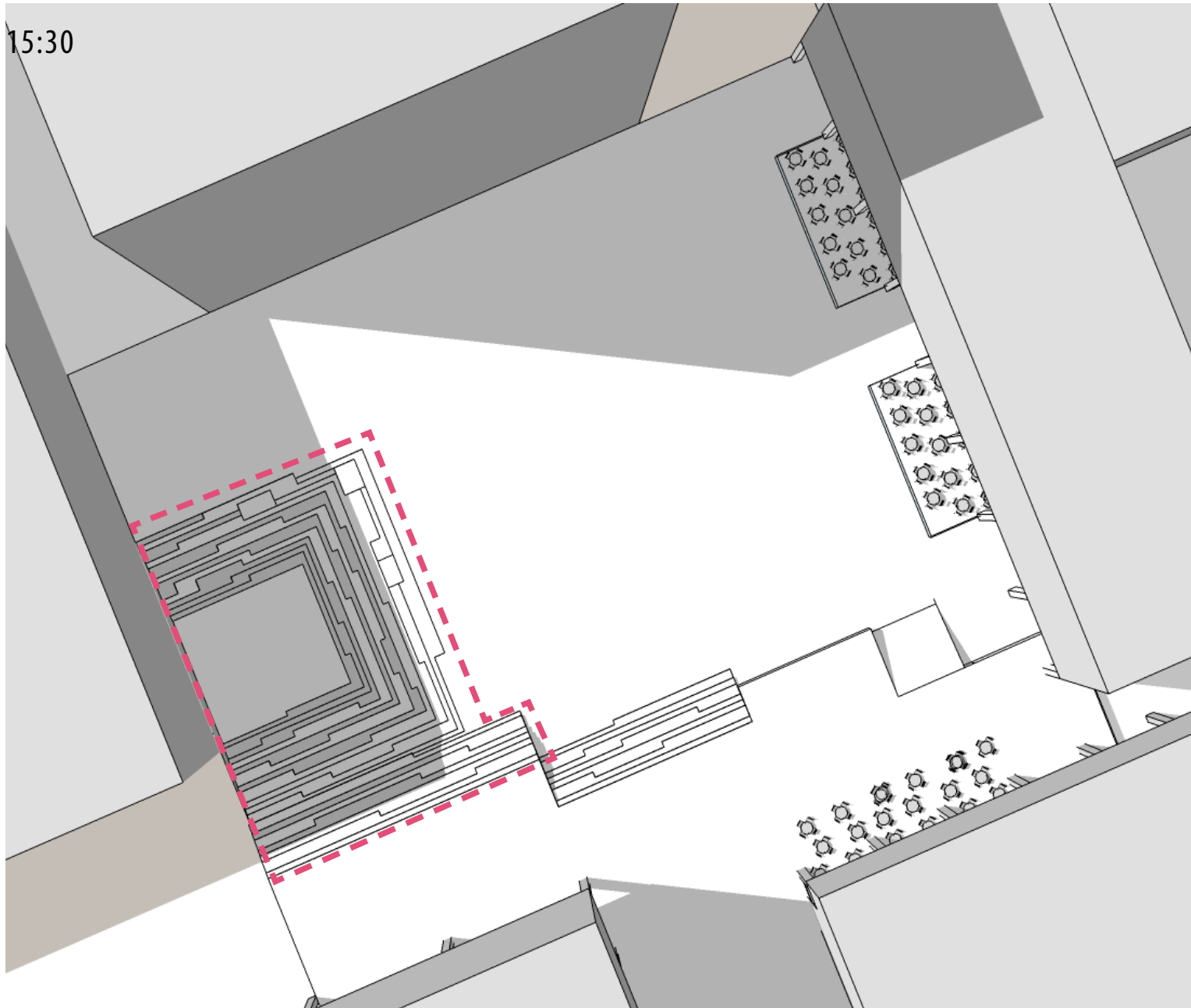
CONGREGATION | AMPHI

18:00 - 23:00

Programming the plaza

After office hours the plaza will be used for congregrational.

We program the congregational zone in an area which is in shade after 3:00pm, so by evening when it is used by people, the surface temperature is much lower.

SITE DESIGN | PROGRAM COMFORT

CONGREGATION | AMPHI

18:00 - 23:00

Summer | Mar - Oct | UTCI < 32°C

Base	Self Shade	Shade Mist Jetfan
53%	61%	89%

Programming + Comfort

Just with the right programming we improve the comfort hours to 61%, when compared to programming it in an area always exposed to sun.

During performances or cinema, use of mist jet fans provide comfort for 89% of the scheduled time.
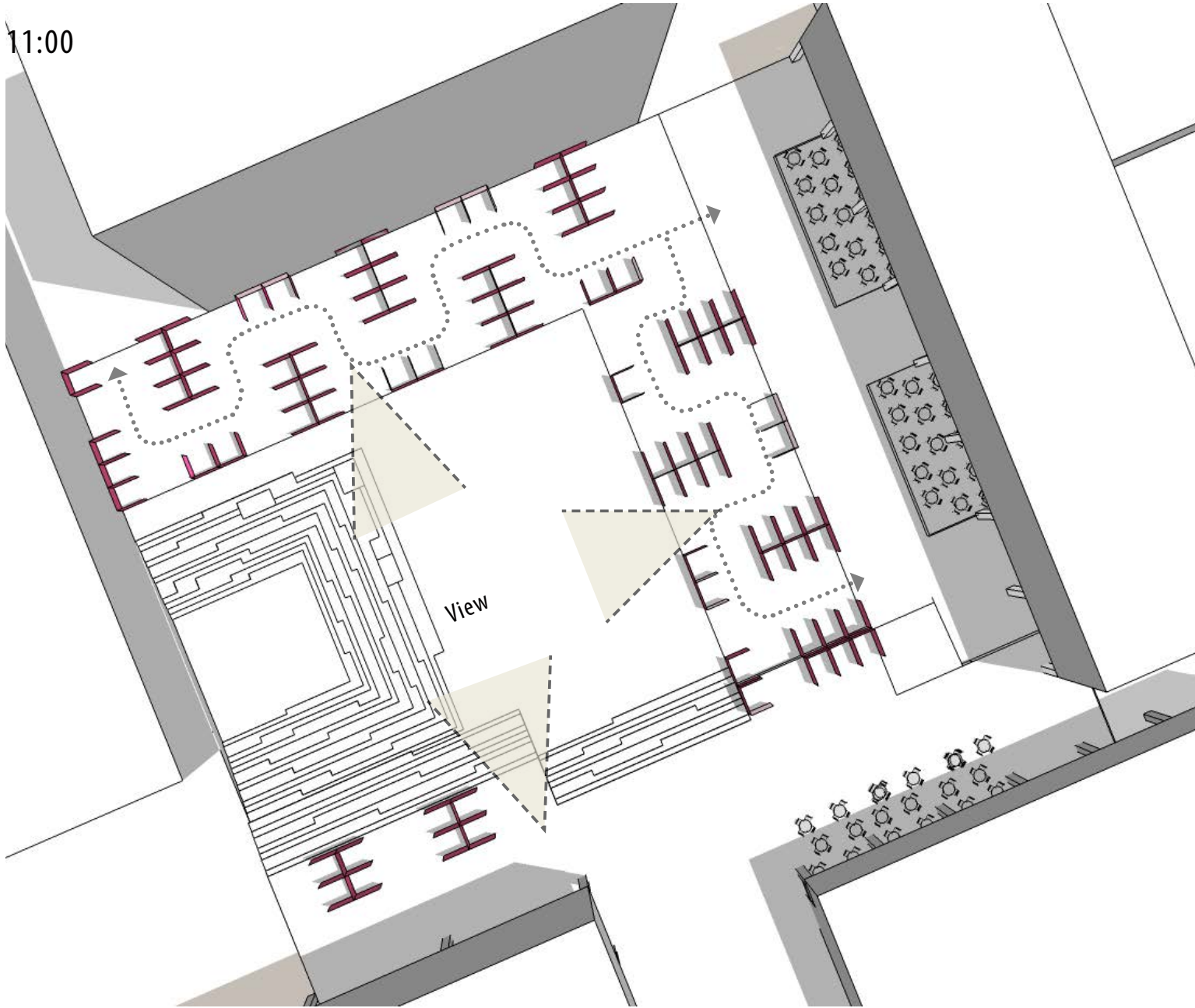
11:00

KIOSK | Local economy

11:00 - 23:00
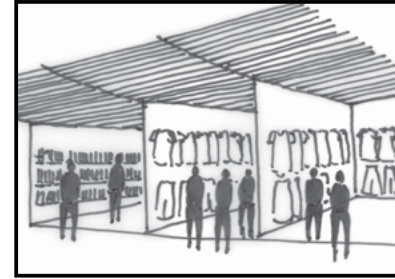
Programming the plaza

Local kiosk zone programmed along pedestrian movement, allows users to always stroll under shade. This maintains wind movement and visual connection from one side to the other.

View

SITE DESIGN | PROGRAM COMFORT

13:00
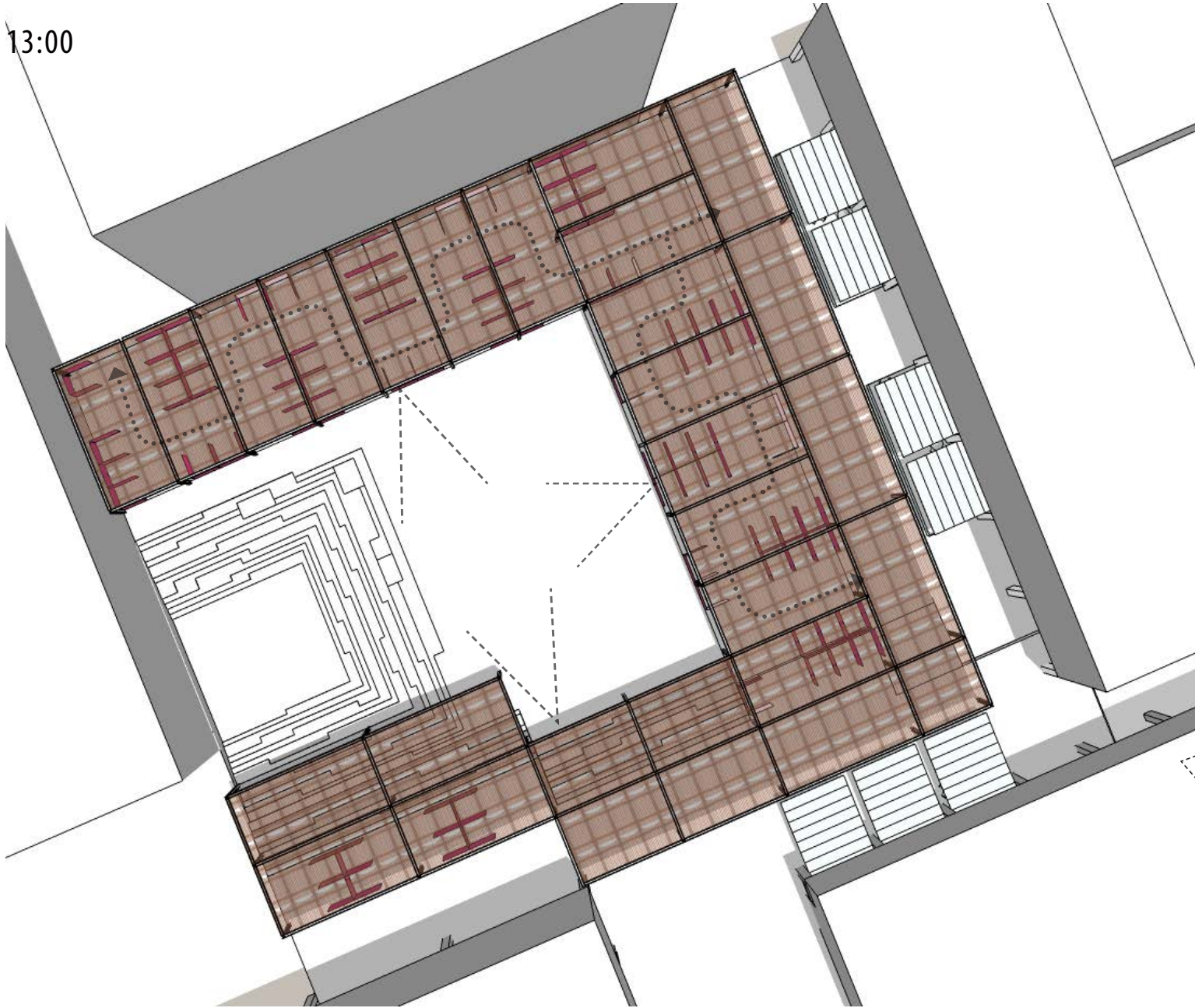
KIOSK | SHADE
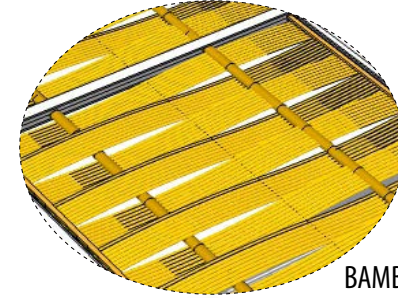
BAMBOO WEAVE

BAMBOO MOVABLE
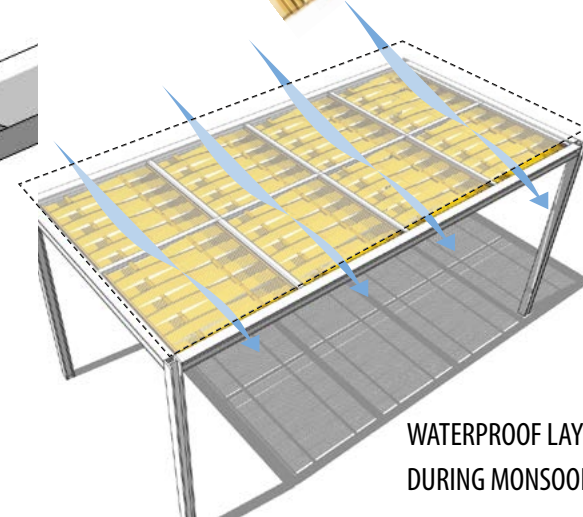
WATERPROOF LAYER
DURING MONSOON

Programming + Comfort

Using local material like bamboo will be a cost effective solution which will engage local craftsman.

Bamboo mats can be made operable, to use night sky cooling potential and allow the ground to reject heat absorbed during the day to the sky

During monsoons a rain protection layer is added leaving an air gap allowing ventilation, ensuring no heat is trapped inbetween the two layers.

SITE DESIGN | PROGRAM COMFORT

KIOSK | Local economy

11:00 - 23:00

Summer | Mar - Oct | UTCI < 32°C

| 8% |
| 29% | 45% | 86% |
| **Base** | **Bamboo Shade** | **Shade Mist fan** |
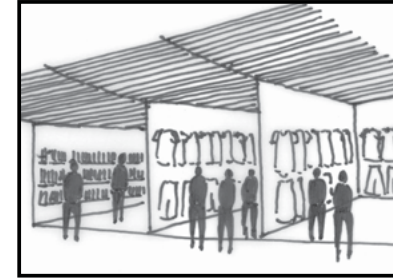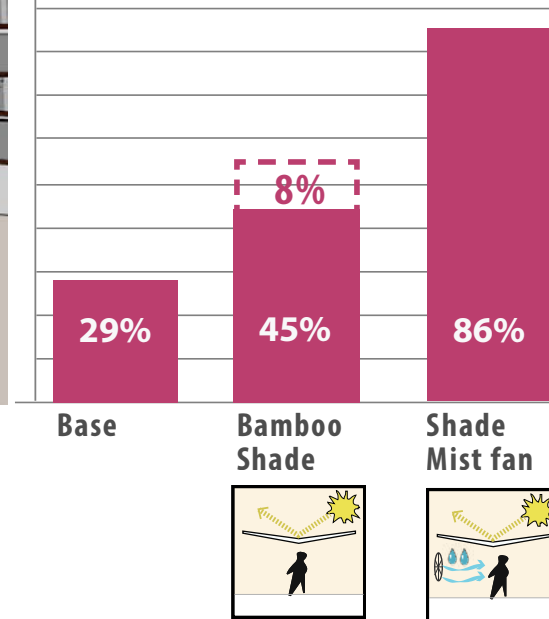
Fan only 5% improvement

Programming + Comfort

Using an operable shade will increase comfort hours by 8%, compared to a fixed shade.

Elevated wind and adiabatic cooling using mist fan creates localized comfort pause points , where people can stop and relx.
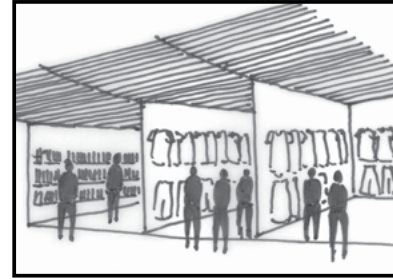These pause points are comfortable for 86% of the scheduled time.
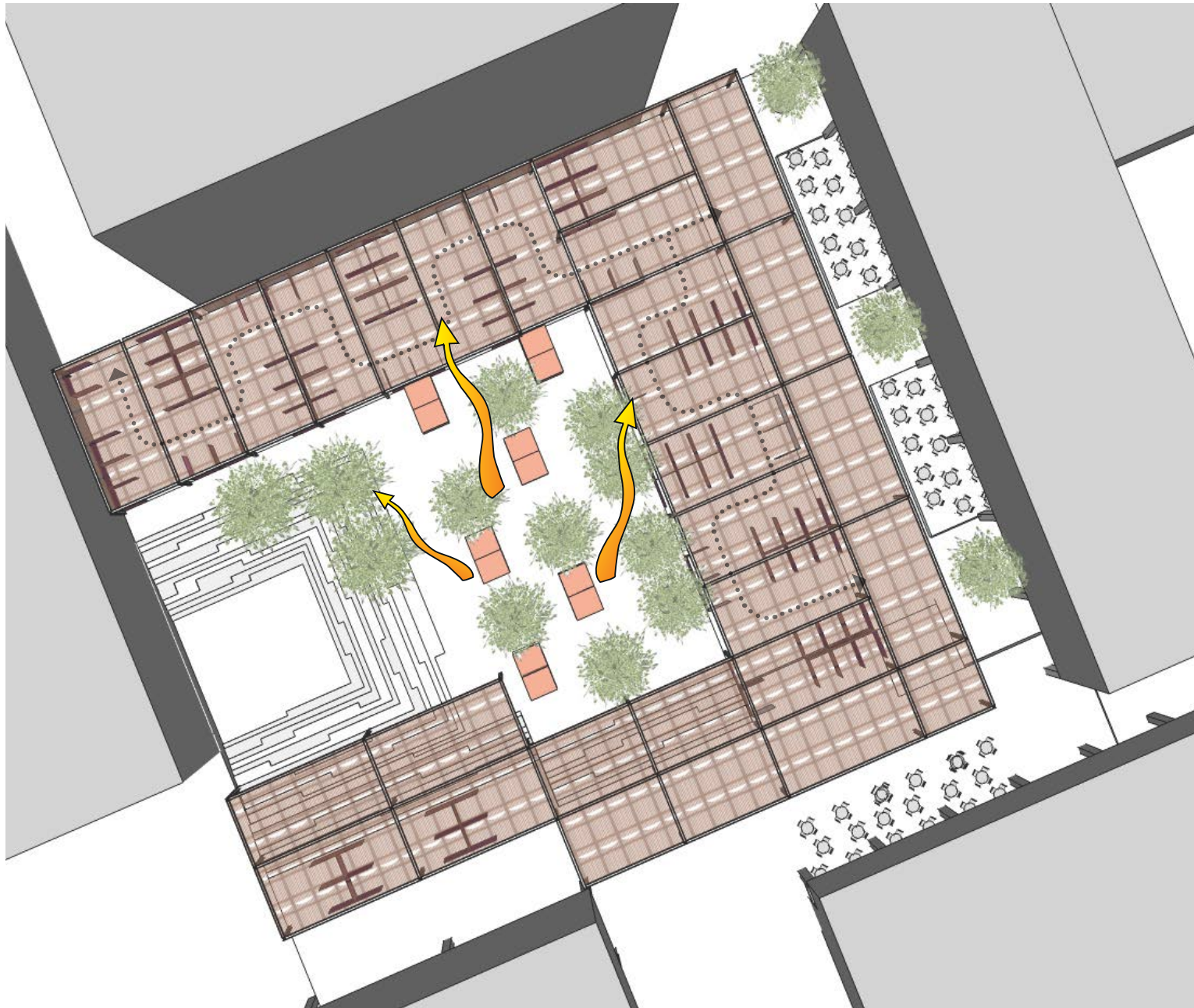
KIOSK | Food Bazar

18:00 - 23:00

Summer | Mar - Oct | UTCI < 32℃
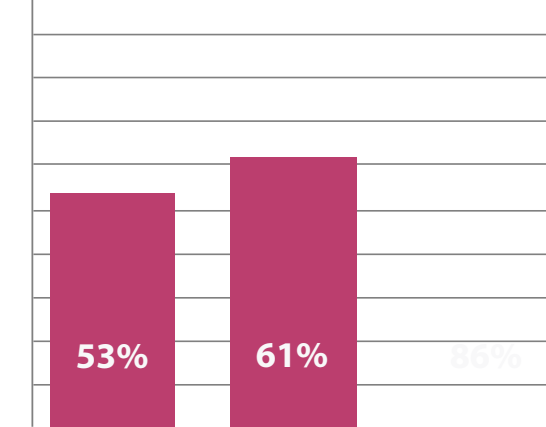
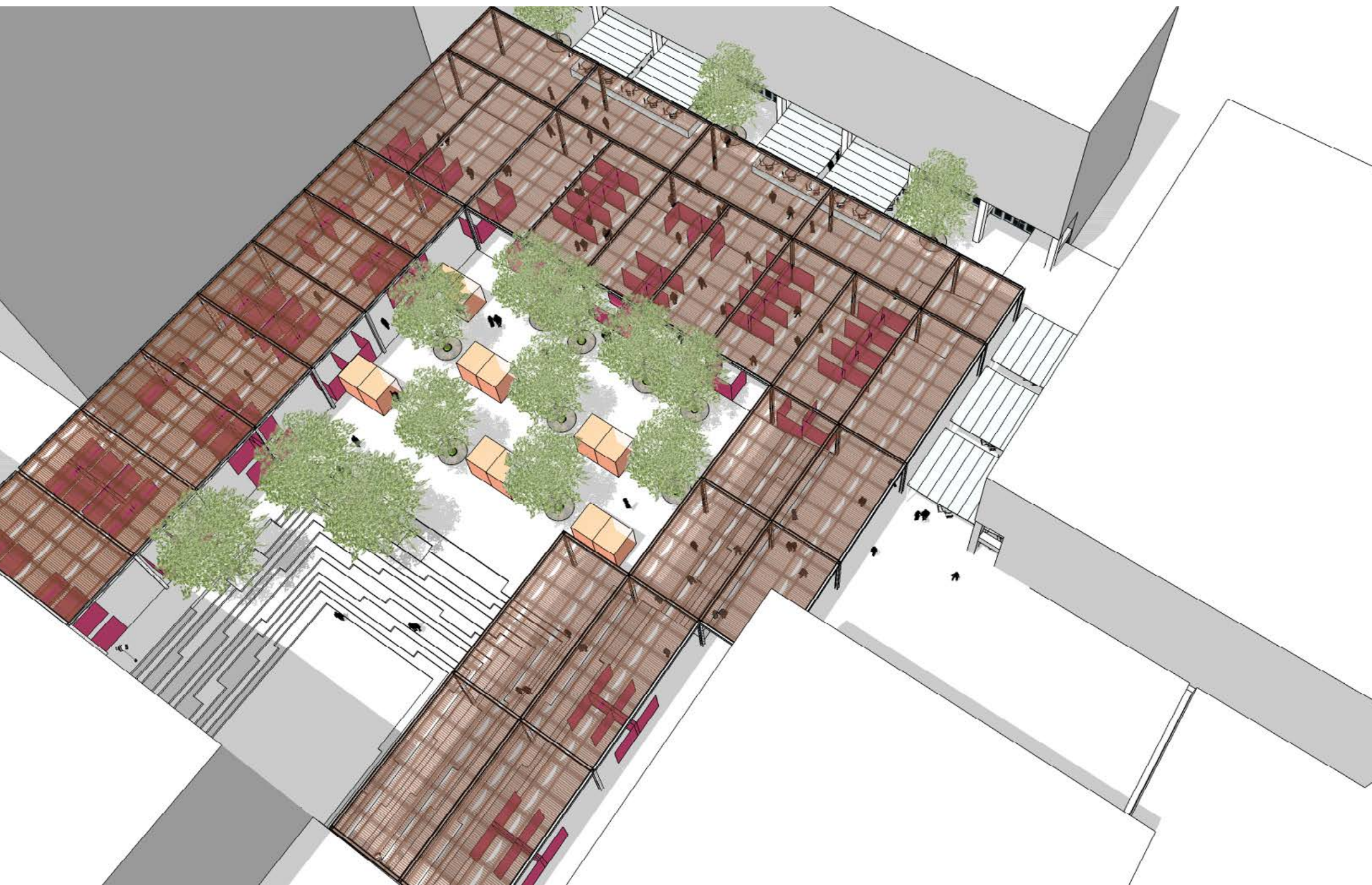| 53% | 61% | 86% |
| Base | Tree shade | |

Programming the plaza

The central area is programmed as a night food market. It is shaded with trees which reduces the amount of solar radition during the day and it will be comfortable for use during the evening and night. The no-shade zone allows for the fumes to exhaust easily.
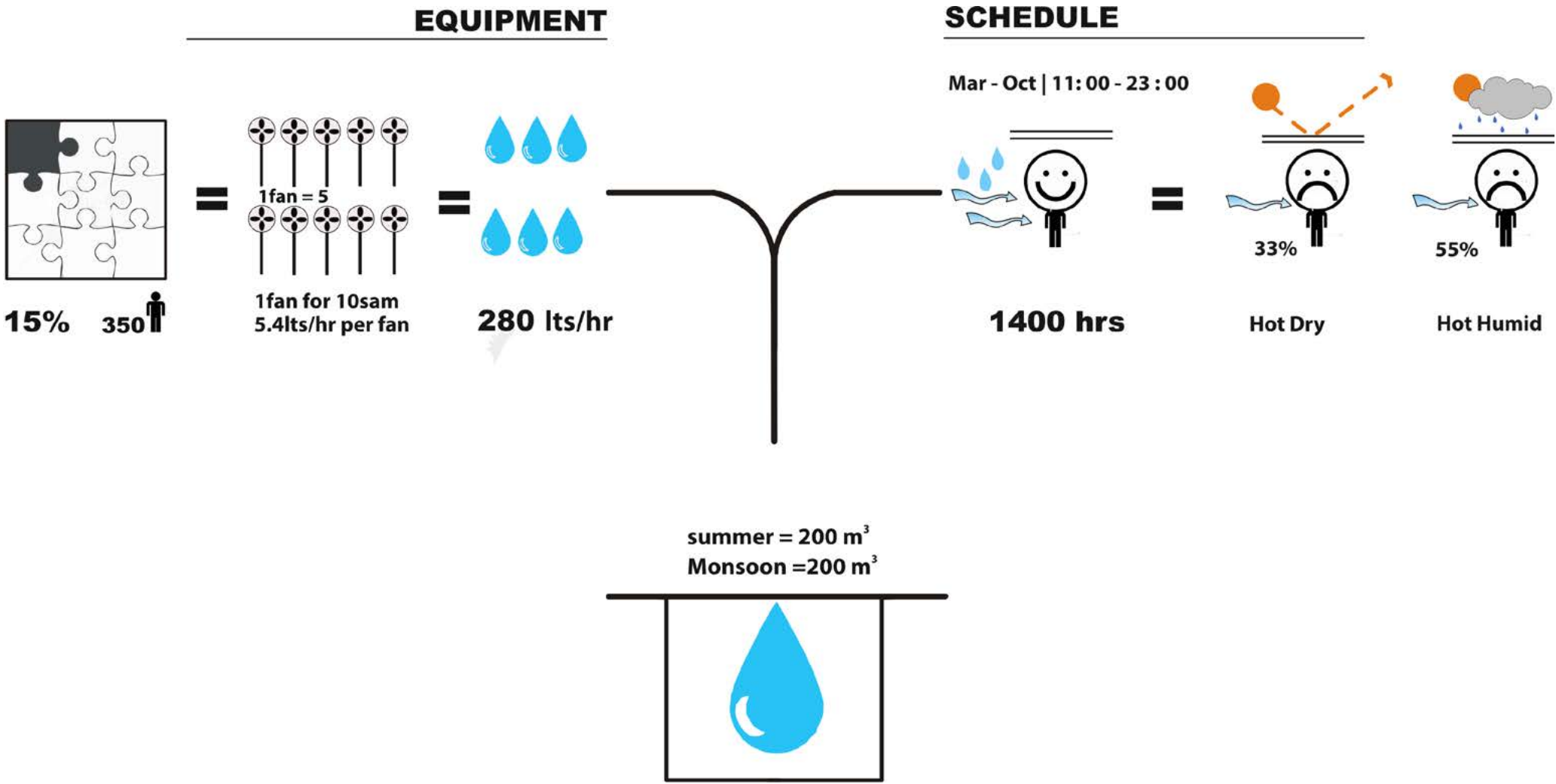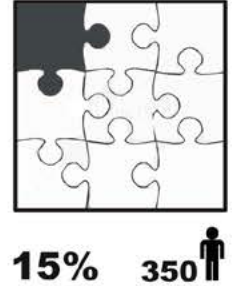
Overall program of the plaza

Shading for comfort

WATER

EQUIPMENT

15%   350

1 fan = 5

1 fan for 10sqm
5.4lts/hr per fan

= 280 lts/hr

summer = 200 m³
Monsoon = 200 m³

SCHEDULE

Mar - Oct | 11:00 - 23:00

1400 hrs

33% — Hot Dry

55% — Hot Humid

WATER

EQUIPMENT

1 fan = 5

1 fan for 10 sam
5.4 lts/hr per fan

280 lts/hr

15%   350

SCHEDULE

Mar - Oct | 11:00 - 23:00

1400 hrs

33%
Hot Dry

55%
Hot Humid

AVAILABILITY

1/4 of RWH

Rainwater harvested Potential in Ltrs

250000
200000
150000
100000
50000
0

Jan Feb Mar Apr May June July August Sep Oct Nov Dec

USE

summer = 200 m³
Monsoon = 200 m³

250m³
Underground Storage
10X5X5

SEDIMENTATION

PARTICLE FILTER
5 µm   1 µm

UV DISINFECTION

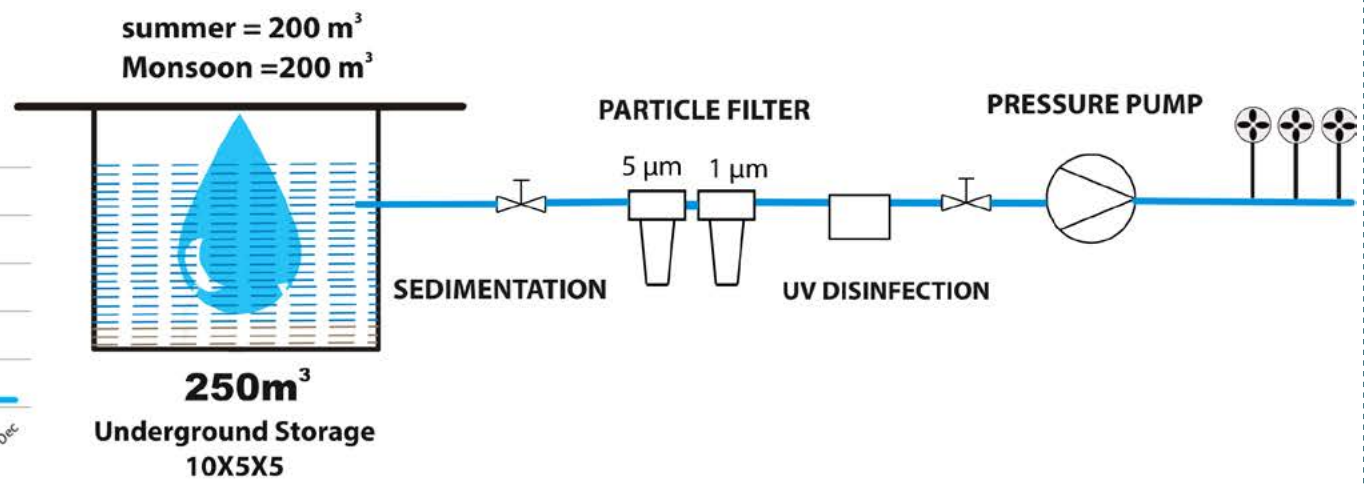**PRESSURE PUMP**
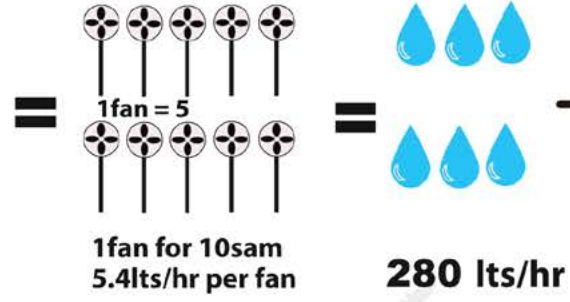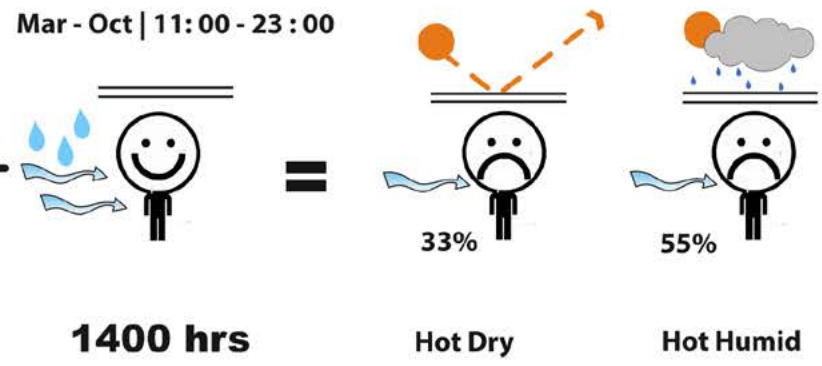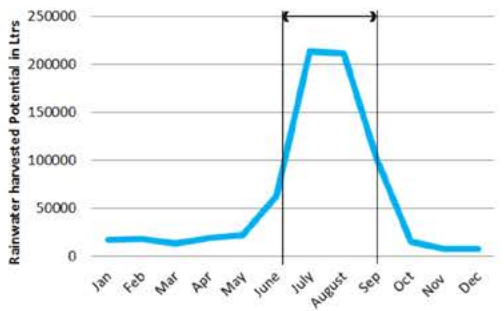
Availability of water on site & water quality

1/4th of the rainwater harvested from the adjacent car-park roof is sufficient to meet the total need for all the mist fans.

We should bear in mind the importance of maintaining water quality when using misters. Legionella bacteria can breed in water stored between 20°C – 60°C, and prove fatal when sprayed. It is important to ensure proper disinfection and filtration before the water is used in mist fans.

LEARNINGS

Major factors contributing to thermal comfort in Hot & Humid
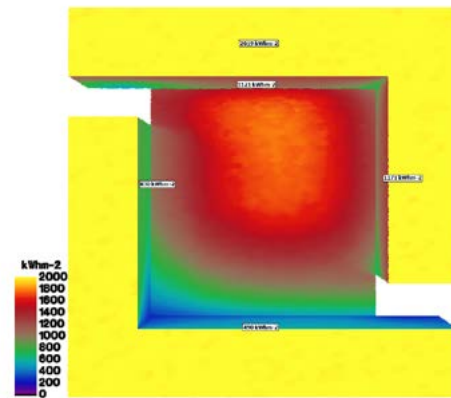
LANDSCAPE & BUILDING MATERIALS

Surface Temperature

High Solar reflectance (Albedo) - Limit heat gain*
Pearmeable surfaces permit evaporative cooling when moist
Vegetated Surface temperature lower than ambient air temp
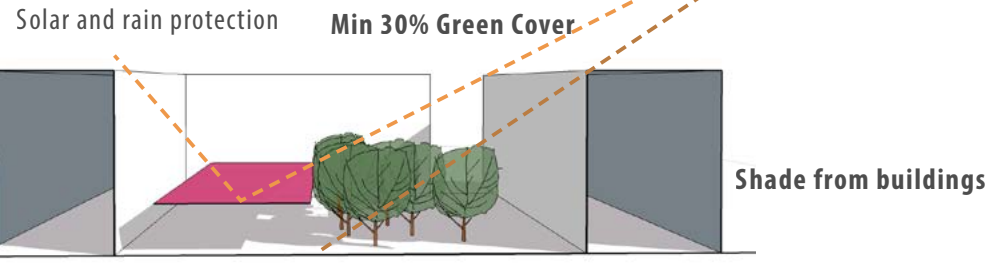
COOL PAVEMENTS reduce MRT

*Wearing of material can reduce perfermance over time

SHADING CONDITIONS

Shading
Low Solar transmittance (Opaque)
Low Sol. absorption (White high reflectance)
Emissivity
Operable : **Sky cooling potential**

Solar and rain protection   **Min 30% Green Cover**

Shade from buildings

EVAPORATIVE COOLING + INCREASED WIND

To conclude:

Outdoor thermal comfort is regulated by atmospheric environment and urban density.

The surface materials and vegetation cover significantly help improve comfort. High albedo paving materials or permeable surfaces can help reduce the surface temperature. Vegetated surfaces lower the ambient air temperature due to evapotranspiration.
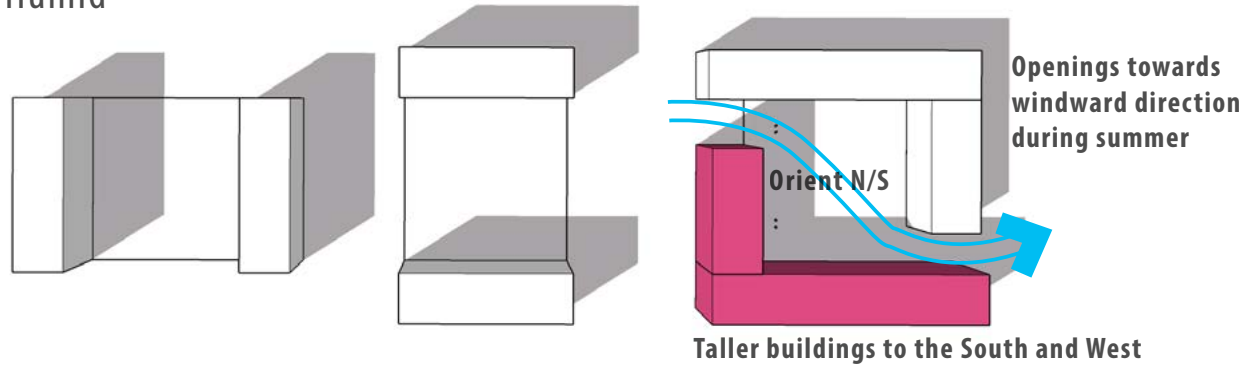
Shading is a cost effective passive measure to create comfort. Low solar transmittance (i.e opaque) and low solar absorption (i.e white) material is recommended. Using operable shading allows to benifit from night sky cooling potential.

Increased air speed and adiabatic cooling is effective to improve comfort in hot and humid climate like Delhi.
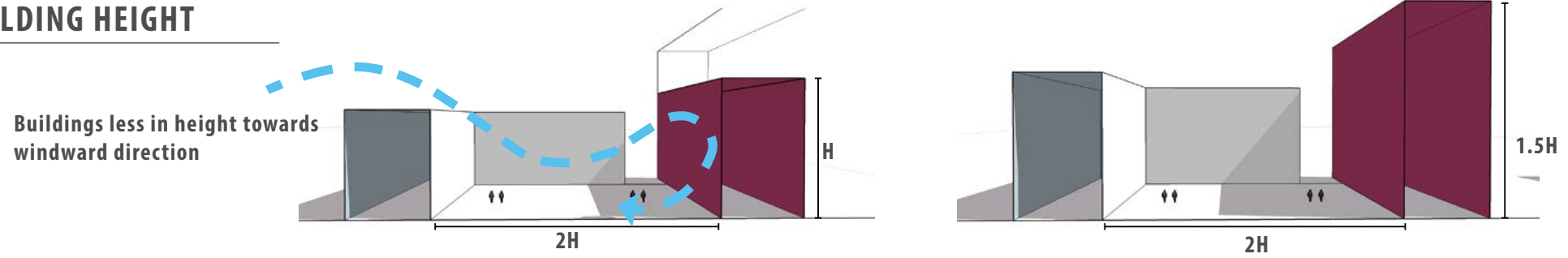
LEARNINGS

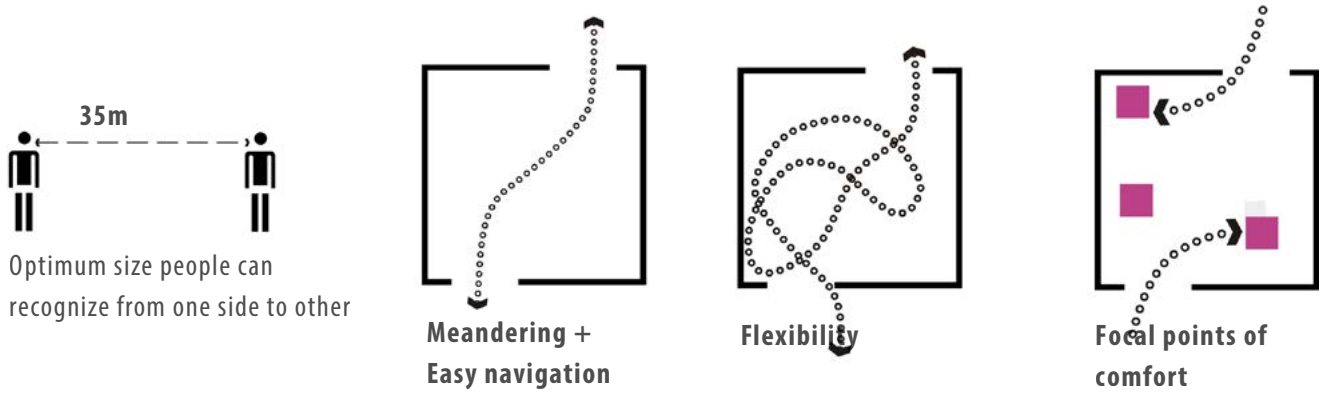## Designing plaza India | Hot & Humid

SHADE WITH BUILDINGS

Orient N/S

Openings towards windward direction during summer

Taller buildings to the South and West

BUILDING HEIGHT

Buildings less in height towards windward direction

H

2H

1.5H

2H

PROGRAMMING

Flexibility
Variety

35m

Optimum size people can recognize from one side to other

**Meandering +
Easy navigation**

Flexibility

Focal points of comfort

OPTIMIZE COMFORT requires site specific study

To translate into design guidelines

First optimize the surounding massing to create shade in the plaza and at the same time allow it to be cross ventilated.

Building height to plaza width is important to consider to create self shaded areas with appropriate scale. Height to width ratio of 1:2 to 1.5:2 is reasonable. Building heights should be planned to redirect the wind downward.

At the fine grain the surrounding context and program need to be analyzed to design for optimized comfort.

Jan Ghel recommends a plaza width of 35m , and if more the plaza should be divided into smaller programs. Rather than creating comfort in the entire plaza, create comfortable pause points which people will navigate towards

DANKE SCHÖN for a great year! Cheers!

Mentor : Felix Thumm
Alejandra Cassis, Christian Degenhardt, Christian Fenzel, Joshua
Vanwyck, Mathias Ramming, Matthias Schuler, Martin Engelhardt, Moni
Lauster, Raphael Lafargue,Tommaso Bitossi, Thomas Auer, Wolfgang
Kessling + All Transsolar

Academy family . . .