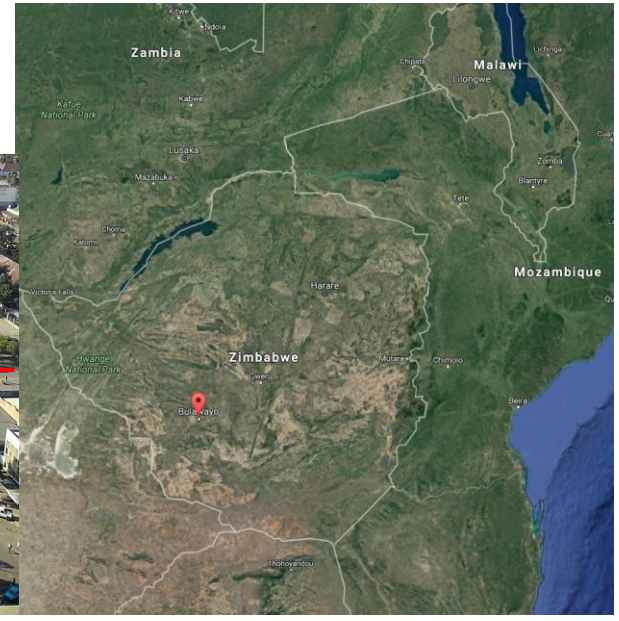
-Central Southern Africa.

-Zimbabwe's second largest city.

-Bulawayo (20.1325° S, 28.6265° E)



Location Maps Source: (Author and Google Maps)

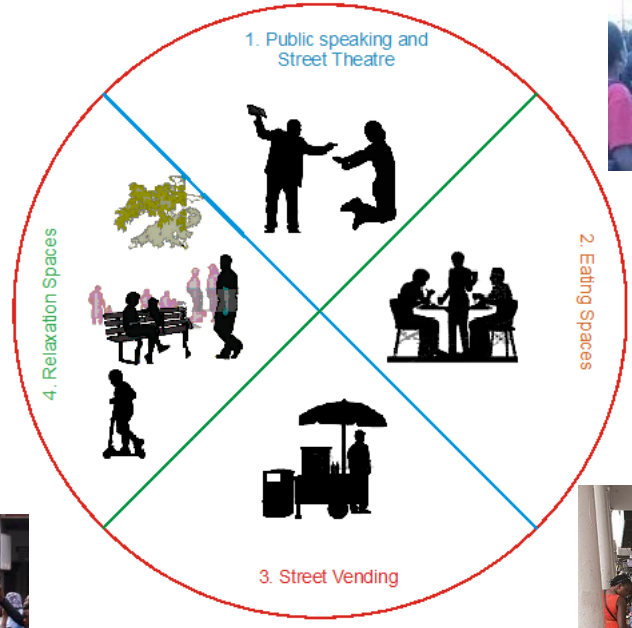
Creating public spaces with thermal comfort in vehicular dominated streets in Bulawayo

prepared by:
Innocent Mhandu

With the help of:
Jochen Lam

Identifying spaces needed by the people

Source: (Author)



Source: (Author)

Source: (Mukwazhi, 2017)

Source: (Mukwazhi, 2017)

Spaces needed include; eating spaces, relaxation spaces, street vending spaces and public speaking and street theatre spaces.

Mukwazhi, P. Zimbabwe To Street Vendors.,http://www.npr.org/sections/goatsandsoda/2015/06/15/414662878/zimbabwe-to-street-vendors-pack-up-clean-up-ship-out/..N.p., 04 Sep. 2017.

Space creation

EXISTING SITUATION

Public transport and cars at 50km/h

INTERVENTION using SUPER ISLANDS

Public transport and cars at 50km/h

Private vehicles at 20km/h

Pedestrian and cycle zone

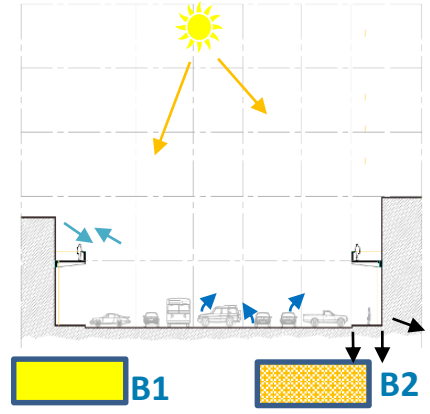
The city roads will be organised into two different networks informed by their traffic volume.
- Primary Network, - high traffic volumes used by public transport and private motorized vehicles;
- Secondary Network, - low traffic volumes and roads are included in the island to be primarily used by local traffic.

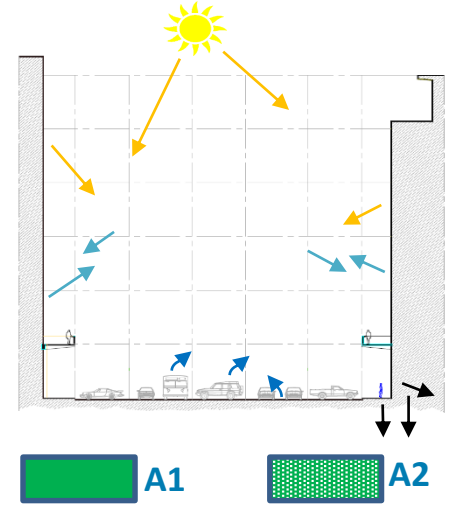
Inside an island, access is only granted to residents' cars, emergency vehicles and freight distribution vehicles.

-Zoning the City centre into islands.

- Islands organize the city roads into two different networks which are the primary and secondary networks.

Selected Space

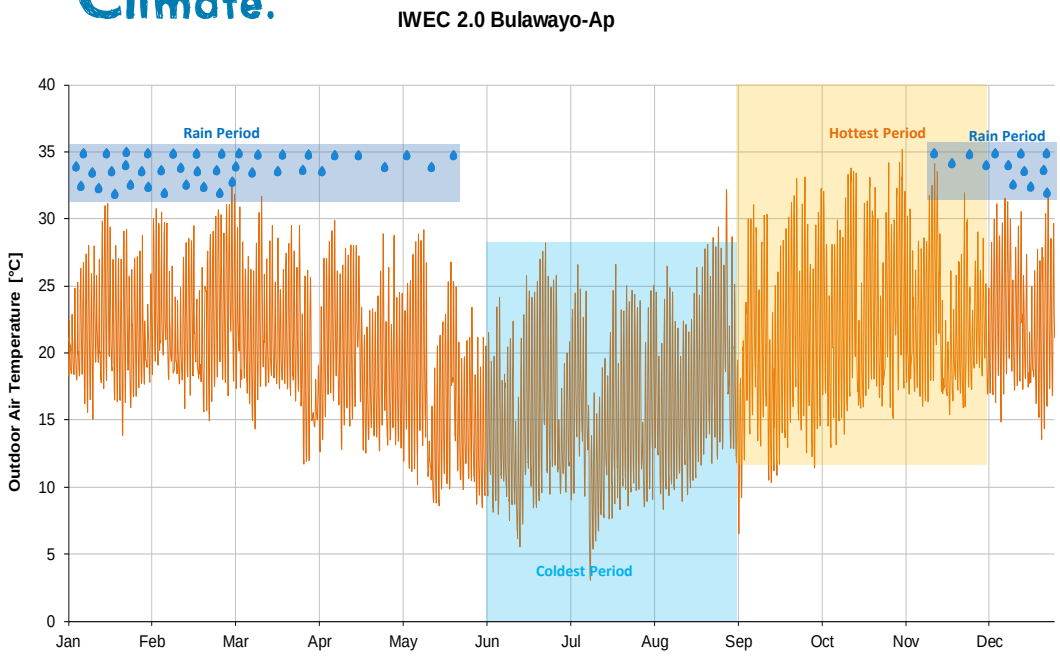




-All the streets in the focus area are analysed but the results for the street B1 with the extreme conditions are presented in this project.

-Aim is to provide people with high quality outdoor spaces.

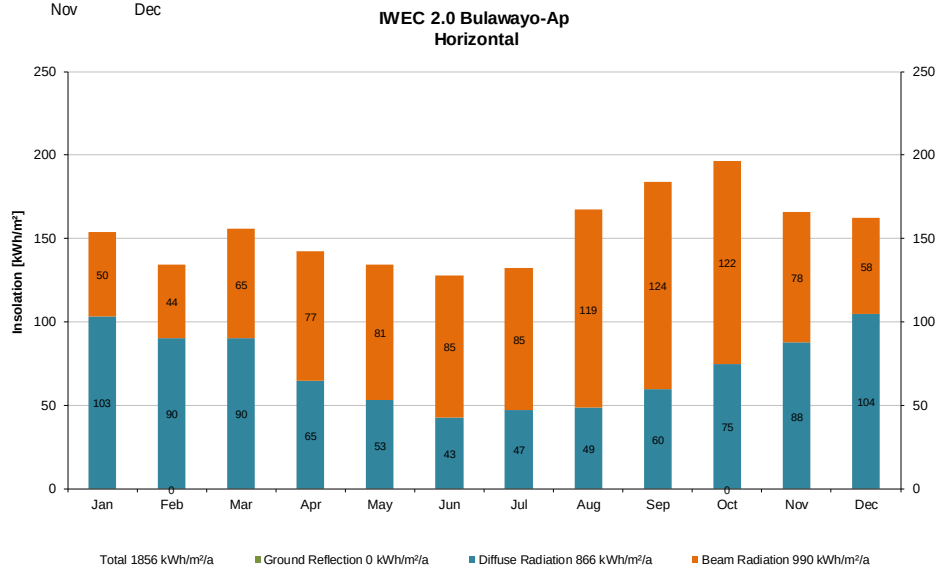
Climate.



-Drier version of the humid subtropical climate, and lies on an altitude of 1 358m

-The daily outdoor temperatures range from 3°C - 37°C annually. The coldest period is from June to end of August and the hottest period occurs from September till the end of November

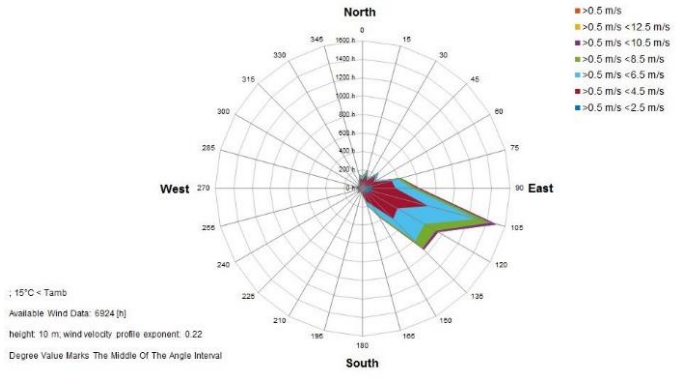
Horizontal Insolation: 1856kWh/m²/a



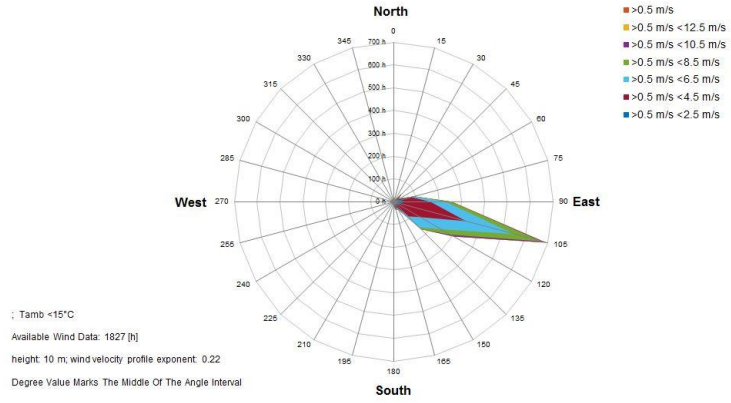
-Horizontal insolation of 1856kWh/m²/a.

-More diffuse radiation than beam radiation from November — March because of the summer cloud cover.

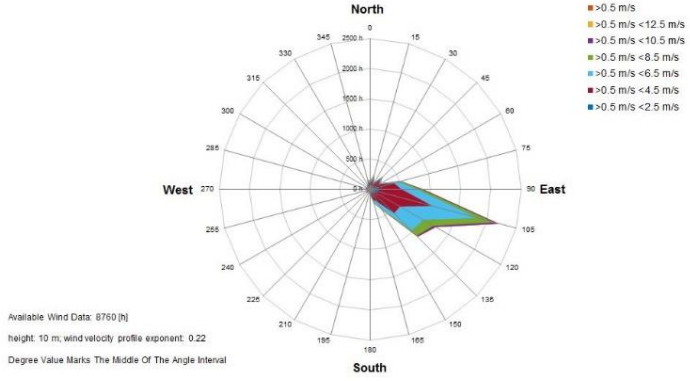
Wind analysis.



Wind rose — Summer (Tamb > 15 C.



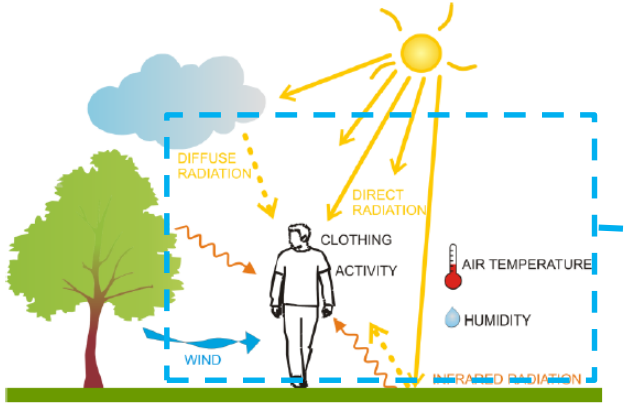
Wind rose — Winter (Tamb<15 C)

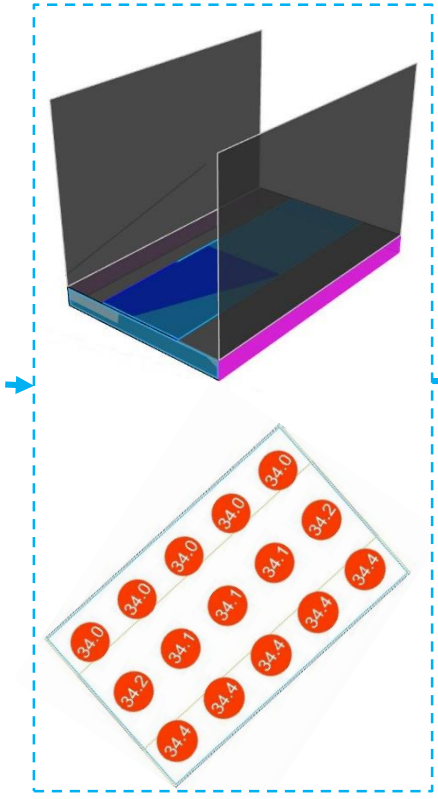


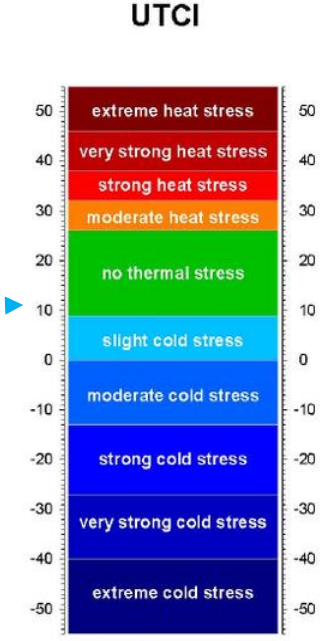
Wind rose — Yearly

-Prevailing winds predominantly from the South Easterly throughout the year

TRNLizard Model.







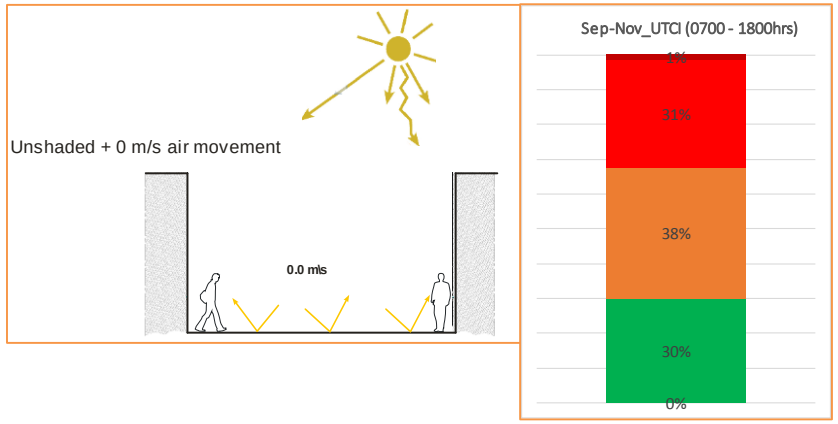
Comfort points are created to show the thermal perceptions at 15 different points in the street.

-Street design scenario simulated by software TRNLIZARD.

-Comfort quantified using the Universal Thermal Climate Index (UTCI).

OUTDOOR THERMAL COMFORT

Hottest Period

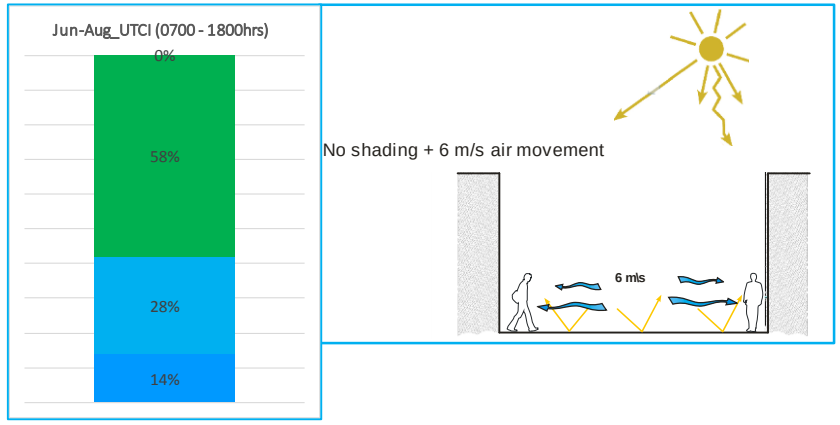


Low Buildings
E-W

-Hottest period simulation uses the extreme conditions which include; exposure to solar radiation, and no still wind movement. The results show a 30% (no thermal stress) perception

OUTDOOR THERMAL COMFORT

Coldest Period

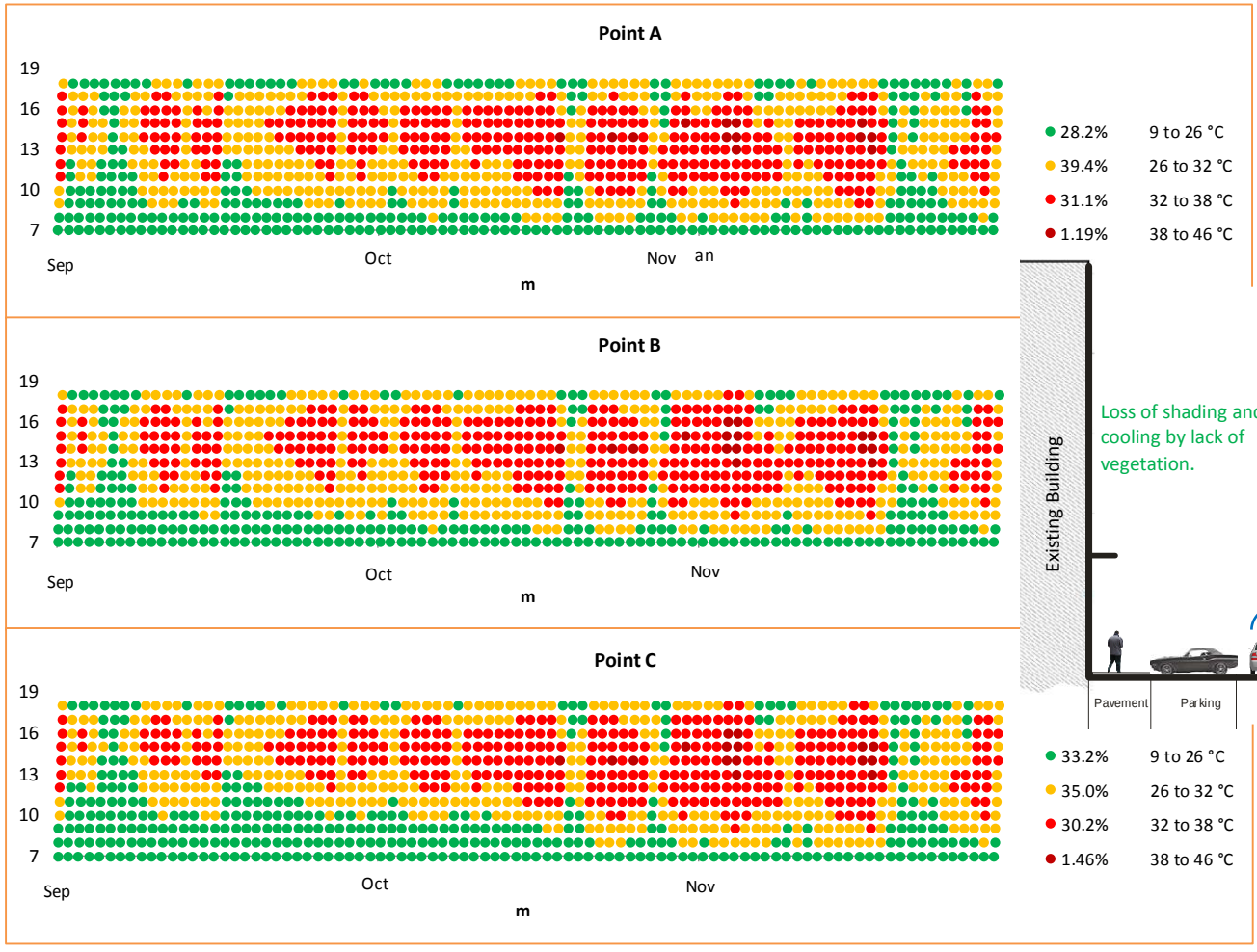


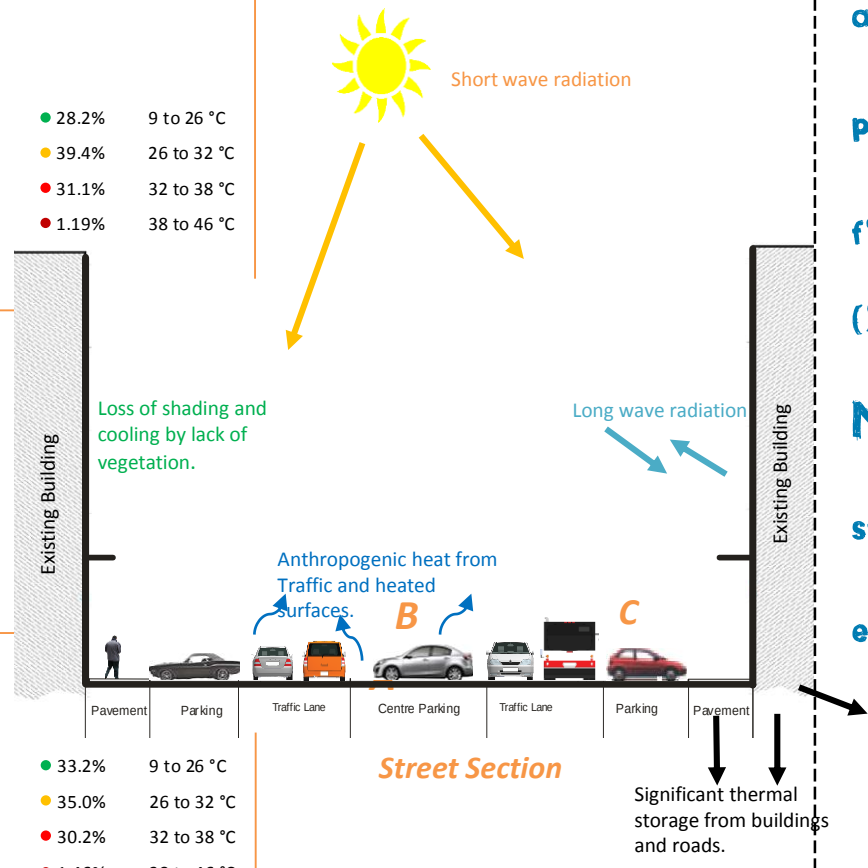
High-Rise Buildings
N-S

-Coldest period simulation uses the extreme conditions of high wind velocity at 6m/s and the results show a 58% (no thermal stress) perception

-Worst-case scenarios for the hottest and coldest period were simulated.

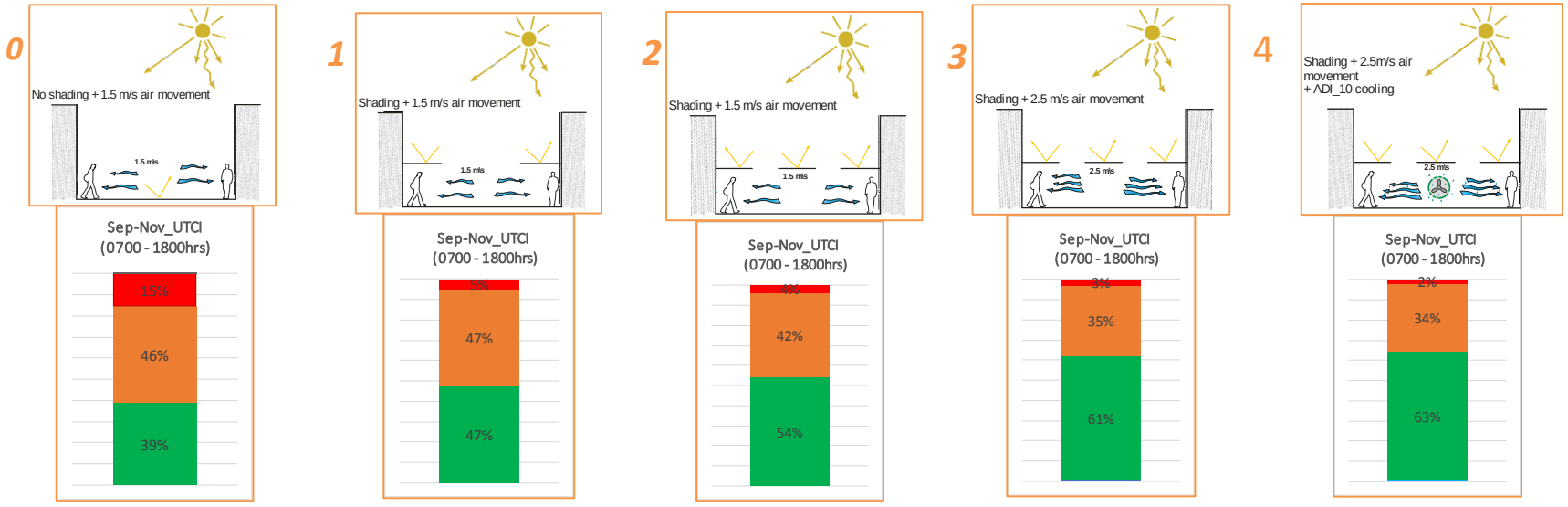
Existing thermal perceptions.





-Thermal perception assessment done at points A; B and C for the hottest period (September - November) in the street to assess the existing conditions

Strategies for the hottest period

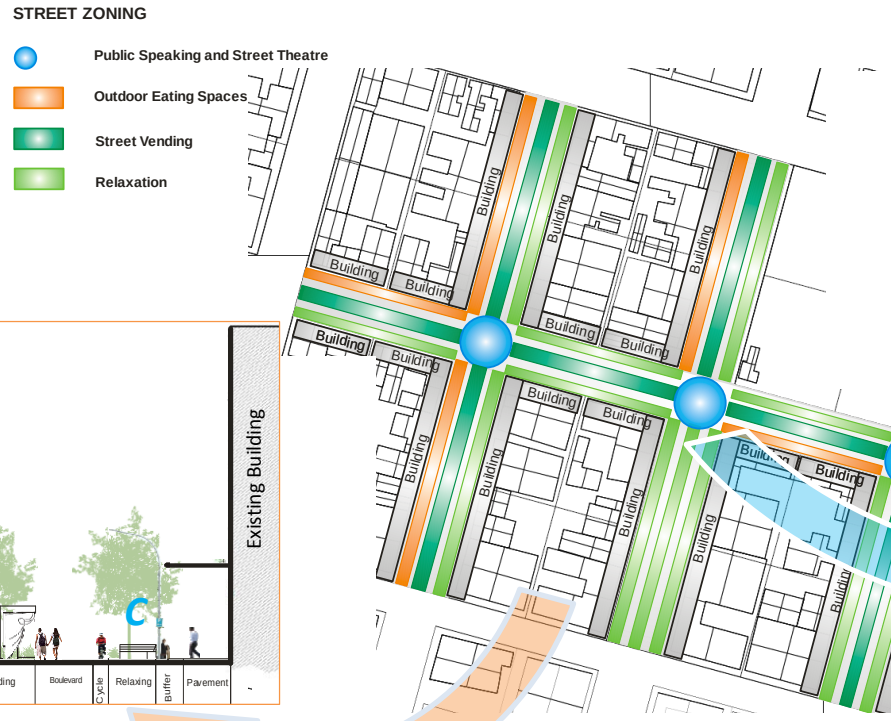


1. Initial shading (in the form of a 4m overhang to the side walls)
2. Increase in shading to 75% (using umbrellas, retractable awnings and planting trees in the centre of the streets).
3. Increase of air movement to 2.5m/s using fan.
4. Adiabatic cooling.

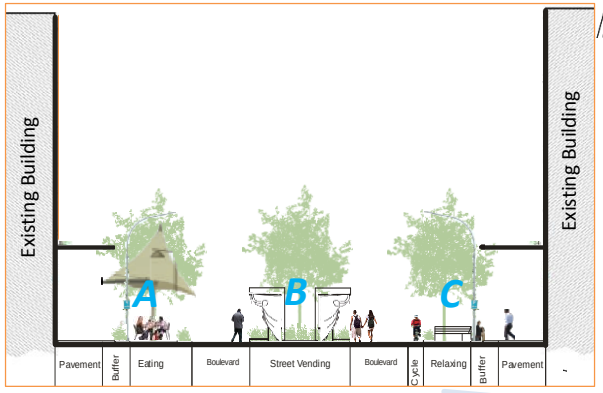
-Strategies for cooling include:

1. Protection from solar radiation by shading
2. Increase air speed: by providing fans
3. Adiabatic cooling
4. Cooling by plants through evapotranspiration

Street design proposal



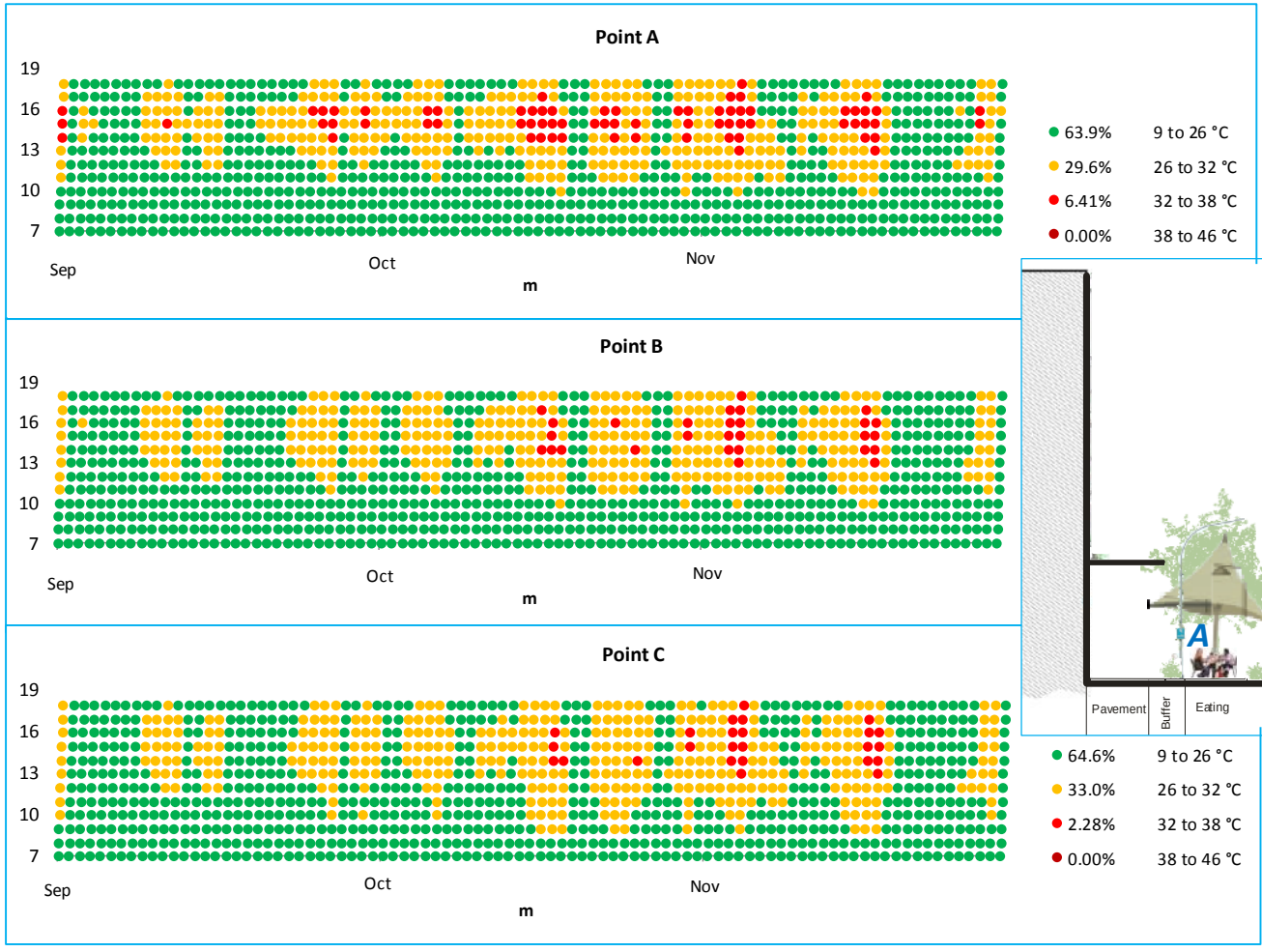
Proposed Street Theatre space

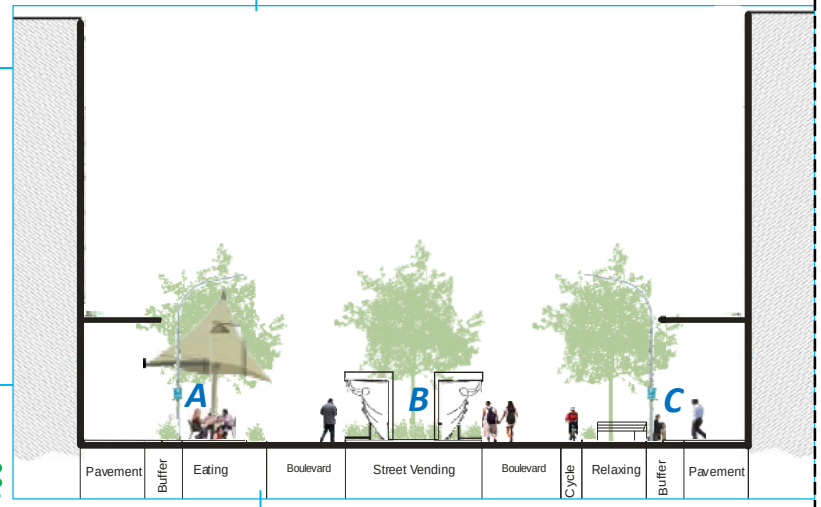


Proposed Street Section

-Outdoor eating spaces close to the buildings and relaxation spaces. Street vending spaces along the streets to provide circulation space on either side of the centrally positioned vending stalls.

Thermal perceptions after interventions.





Street Section

-Shading is applied to points A, B and C. This is made possible using deciduous trees and movable shading elements. This allow the solar radiation in the coldest period for thermal comfort.

1. Protection from solar radiation by shading
2. Increase air speed: by providing fans
3. Adiabatic cooling
4. Cooling by plants through evapotranspiration

Conclusions.

-The findings show that each strategy makes a clear contribution to improved comfort, with the greatest reduction in thermal stress provided by a combination of shading and increased air velocity.

-The use of improved climate based design strategies aids in a result of a more balanced urban environment where everyone feels happy and safe including empowering the social and economic capacity of the local community.

Acknowledgements:

This project was possible with the support and supervision of Transsolar Academy and Transsolar Energietechnik GmbH