Analysis of local strategies in dry and damp warm climate.

Design of a suitable space in Madrid and Valencia.

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DBFCM3

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Abstract

The purpose of this research is the study of the structural connection that exists between the climate of an specific location and its inhabitants, focusing on local strategies developed or how is architecture inhabited.
From this perspective, a thermodynamic approach to architecture needs to explore the interactions between the local climate, the spatial and material particularities of architecture and the lifestyle of its users.
The studio will unfold in two Spanish cities: Madrid, the metropolis of the county, with a damp warm climate, and Valencia, one of the mains coastal cities, with a characteristic wat warm climate. I will study the differences and similarities of their architecture, the strategies develop to combat the drastic weather conditions. Climatic typologies show how architecture can interact between a given climate and the way people live and socialize, bridging the gulf between the thermodynamic processes induced by architecture and the quotidian behaviour of its inhabitants.
This studio explores the potential to conceive architecture from the interior. The objective is to design a space according to the city conditions, trying to integrate local strategies to achieve the most comfortable and sustainable space.

Introduction

Architecture is inevitably linked to its site, and this includes different parameters that conditioned it. Starting from the geographical location to the climate, the strategies to achieve the comfort in an architectural spaces completely change.

A site's climate is the complex combination of different elements, parameters and decisive factors. Solar radiation is the basic factor. On the one hand, the radiation heats up the air being absorbed by the Earth's surface and, on the other hand, it evaporates part of the water surfaces when it reaches them, causing diverse humidity, cloudiness and precipitation grades. Also, due to the unbalanced heating of the Earth's surface, air masses movements are caused, originating winds.

Vernacular town's architecture has always been conditioned by the climatic factors. As Madrid and Valencia have different climates, the strategies and construction requirements are very different. Starting from an exhaustive studio of the particular dry and damp warm weather through local strategies and references, the final point of this research is to design a theorist space compromised with using responsible architecture for the environment.

Geography

The geographic location of a site characterize the climate, and therefore, the resultant architecture. On parameter to consider is the continental factor: cities or towns located in very continental areas have more extreme climates (warmer during the day and the summer, and colder during the night and the winter), whilst in the ones located near the sea the temperatures are softer and don't change that much due to the accumulation of solar energy in the water. Also, these will have higher humidifies than the ones far from the sea. Another one is the altitude over the sea level: the temperature can decrease around half a degree in a saturated air and one degree in dry air every one hundred meters of altitude. Alpine climate is always cold whether its location on the Earth. Finally, the latitude on the site: over low latitudes, sun rays hit on a perpendicular and uniform way during the whole year; medium latitudes have very contrasted seasons; and high latitudes are tangentially reached by sun rays, gaining thus a low amount of energy from them.

-Madrid

Madrid is the capital of Spain. The city has almost 3.2 million inhabitants and a metropolitan area population of approximately 6.5 million. It lies on the River Manzanares in the centre of both the country. It has an elevation over the sea of 667m. Over a quarter of the municipal area is covered by the largely forested protected area of El Pardo.

Madrid is the European city with the highest number of trees and green surface per inhabitant and it has the second highest number of aligned trees in the world, with 248,000 units, only exceeded by Tokyo. Madrid's citizens have access to a green area within a 15-minute walk.

-Valencia

Valencia on the east coast of Spain, is the third-largest city in Spain, with around 800,000 inhabitants in the administrative centre. Its urban area extends beyond the administrative city limits with a population of around 1.5–1.6 million people. Valencia is Spain's third largest metropolitan area, with a population ranging from 1.7 to 2.5 million. The city is situated on the banks of the Turia, on the east coast of the Iberian Peninsula, fronting the Gulf of Valencia on the Mediterranean Sea. In consequence, its elevation over the sea is just 15 metres.

The Albufera, a freshwater lagoon and estuary about 11 km (7 mi) south of the city, is one of the largest lakes in Spain. It forms the main portion of the Albufera Nature Reserve), with a surface area of 21,120 hectares. In 1976, because of its cultural, historical, and ecological value, it was declared a natural park.

Due to their different location and in consequence the different climate we can appreciate notorious variation in culture unfolded by its inhabitants, focusing on social patterns, local lifestyles or how architecture is inhabited.

Madrid is an interior city with no contact with the sea or any enormous quantity of water. In contrast, Valencia is a cost city, in touch with the Mediterranean Sea, and also really close to one of the largest lakes in the country. As consequence, the weather humidity and therefore, que climate is completely different.

Climate analysis

-Madrid

Temperature

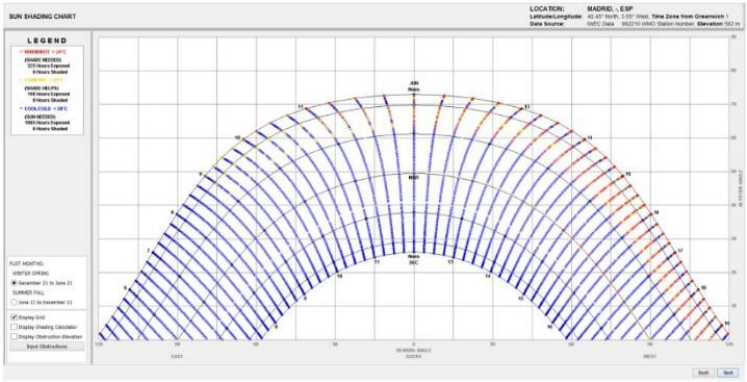
Madrid has a Continental climate. We can consider it as a dry warm climate. That means that it can be quite extreme at times due to the lack of humidity.

Temperature range. Madrid.

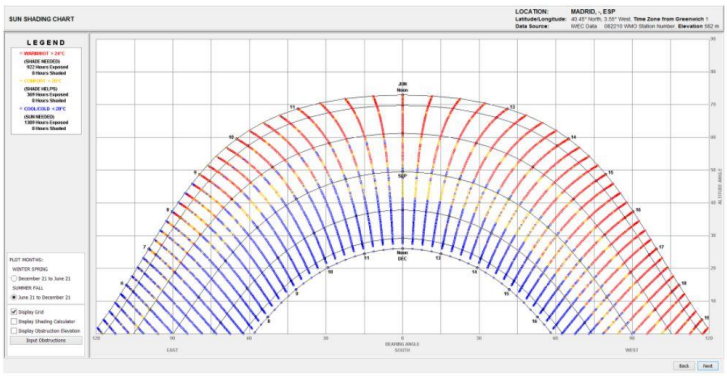
Due to its high altitude of approximately 665 m above sea level, it experience quite different temperatures depending of the season. Winters are cold, including sporadic snowfalls and frequent frosts during the night between December and February. Summers are hot, in the warmest month, July, average temperatures during the day range from 32 to 33 °C, with maxima commonly climbing over 35 °C during frequent heat waves. Due to Madrid's altitude and dry climate, diurnal ranges are often significant during the summer.

Sun shading chart

The following graphics shows the shadows changes during the summer and during winter time. This analysis is precisely helpful, due to the amount of sunshine Madrid receives mostly in summer.



Sun shading: Winter. Madrid.



Sun shading: Summer. Madrid.

As the previous graphics show, in winter there is a lack of sun whereas in summer it is excessive.

Summer:

Summers tent to be dry and very hot, with an average temperature of 25ºC in July and August. Some specific days, the temperature reaches 40 ºC. During these months, days are longer and the city really begins to come alive in the evening, when the temperature decrease a few grades. In August, however, the whole scene looks much quitter, as a large number of Madrileños go away on holiday. In late August and in September, the temperatures drop significantly.

Winter:

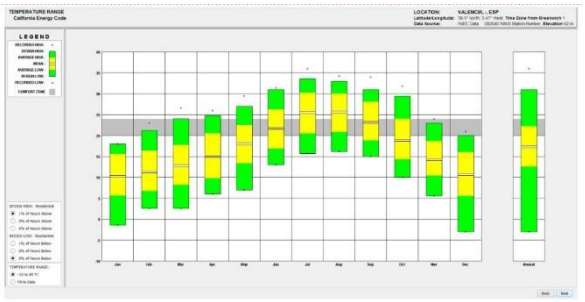
Winters in Madrid are cold and dry, and snow does fall now and then, especially in late December and in January. However, Madrid isn´t known to be a particularly snow city. January is the coldest month of the year, when average temperatures can be as low as 6ºC on average. Nevertheless, cloudless skies are very common in the winter months, so you won´t miss out on the warm and pleasant midday sun.

-Valencia

Valencia is located on the Mediterranean Sea and experiences a Mediterranean climate, characterize for a high humidity and the presence of sea-wind. We can defined it as a wet warm climate.

Temperature

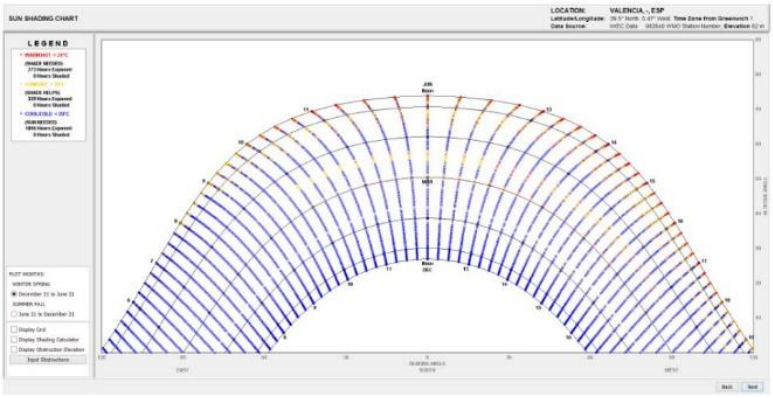
A Mediterranean climate is known for warm summers and mild winters. There is no drastic changes of temperature along the year: during summer the sea-wind causes cooling whereas during winter time it is often warms up. As we can appreciate in the following graphic, the average temperature is close to the comfort temperature along the whole year.



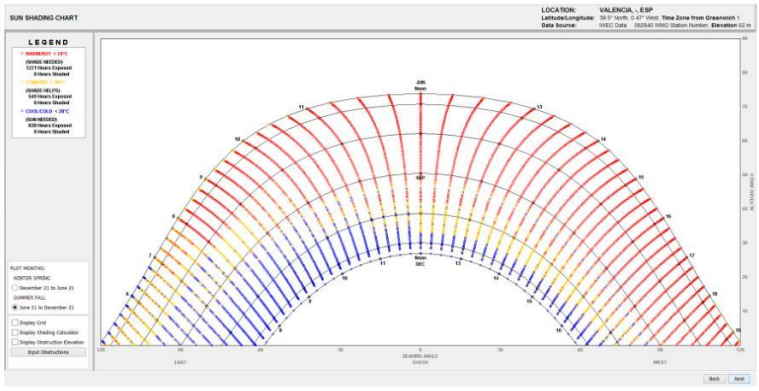
Temperature range. Valencia.

Sun shading chart

The following graphics shows the shadows changes during the summer and during winter time. This analysis is precisely helpful, due to the amount of sunshine Valencia receives along the year.



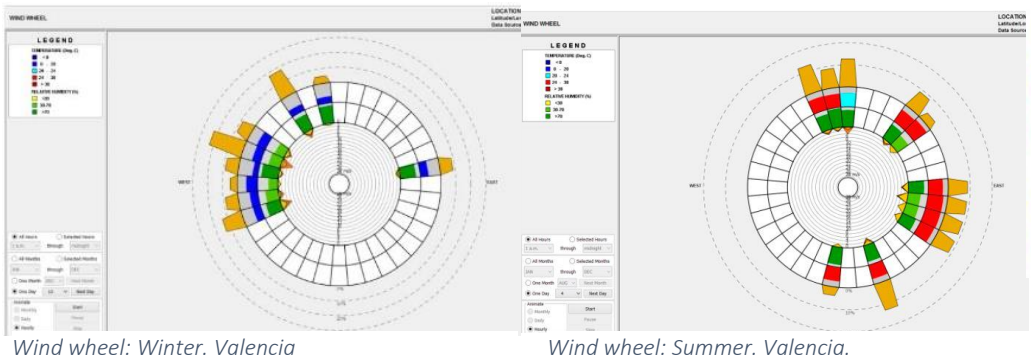
Sun shading: Winter. Valencia.



Sun shading: Summer. Valencia.

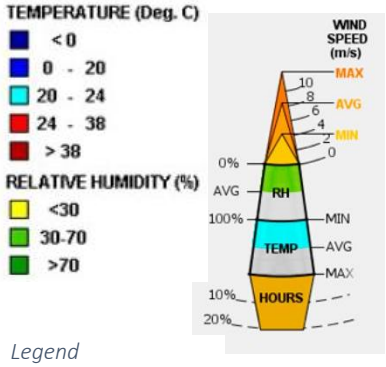
Wind

From an architectural point of view, a part from the temperature analysis and the sun shadow rate, the wind speed and temperature, during summer and winter (extreme changes between both) the wind wheel varies. Wind is especially important when talking about Valencia since it is located next to the sea and wind hits in a different way and other temperatures.



Wind wheel: Winter. Valencia

Wind wheel: Summer. Valencia.



Legend

Winter

Winters in Valencia are very mild. December, January and February are the coldest months, with average temperatures around 17ºC during the day, and 8ºC at night. From a few dozen days in the winter, the temperatures exceeds 20ºC. Because of the very mild temperatures in winter, most of the vegetation remains green thoughout the year.

Summer

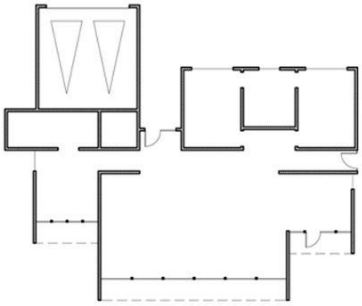
Summers in Valencia area are long and warm to hot (in the middle of summer). Generally the summer season lasts about eight months, from April to November. Regular temperaturs above 20ºC begin as early as Arpil, although in this month the sea temperature is still cool: about 15/16ºC. The summer season ends in November, in this month sometimes occurring days with temperatures below 20ºC. The sea temperature in November remains mild: about 18ºC. This allows for enjoying the beach mostly the whole year.

July and August are the warmest months, with average temperatures around 29ºC during the day and 22ºC at night. In June and September the average temperature is around 26-28ºC during the day and 18-20ºC at night. In May and October the average temperature is around 24ºC during the day and 15-16ºC at night and in April and November the average temperature is around 20-21ºC during the day and 12ºC at night. These warms temperatures make liveble the nigths and permit enjoy openair spaces.

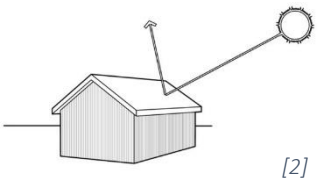
Local strategies

-Madrid

The low temperatures during the winter cause a deficit of warm in this season. To alleviate this situation, the buildings in Madrid are design in a south orientation[installing glass facade, in order to maximize winter sun exposure and *[1]* using passive solar heating. The floorplans are organized so in winter sun penetrates into daytime. On the contrary, during the summer, the excessive sun shading and elevated temperatures are a negative point. It is solved by the design that overhangs to get fully shade in that season.



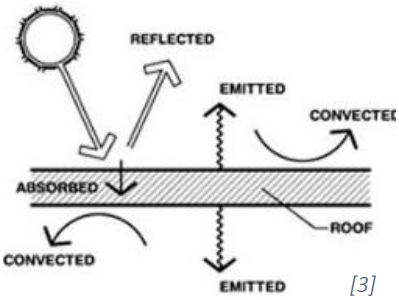
[1]



[2]

Another used strategy used to combat this, is using materials with high SRI (solar reflective index) for maximum emissivity to minimize amount of heat absorbed by the roof. *[2], [3].*

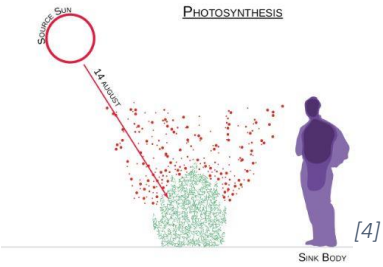
Moreover, using coloured building materials to minimize conducted heat gain is also useful. Painting roofs white is a low-cost improvement that reduces energy consumption of building during hotter months. White roofs reflect up to 90% of sunlight which reduces the energy use of building and minimise urban heat.



[3]

Another strategy is to combine green roofs and solar technology. Roof vegetation increases efficiency of PV panels, reducing ambient temperatures. Sustainable roofs improve insulation and air quality, provide cooling and create habitat for biodiversity.

As Madrid faces increasing population density and shortage of space at ground level, vertical green landscapes *[5]*, installed on "unused" facades are likely to become more prominent. Green walls improve air quality and acoustics while protecting buildings from thermal fluctuations and extreme weathers. Low-cost solutions also include using existing structures for climbing plants. As already was mentioned, Madrid is the European city with the highest number of trees and green surface per inhabitant and it has the second highest number of aligned trees in the world, with 248,000 units. This vegetation also use to generate shadows over the street and generate evaporating cooling through the photosynthesis. *[4]*



[4]

On the other hand, the humidity needed in Madrid due to its dry climate, as seen in the previous climate analysis, can be released in the environment through the integration of water features into public spaces *[6]*. Water can provide multiple benefits: it can reduce local temperature and mitigate the carbon heat effect. Fountains, mist, waterfalls can be used to create playgrounds and recreational spaces for urban residents.

[5]

Finally, the open spaces can be used in both seasons applying some strategies. In cool weather, sunny wind-protected outdoor spaces can extend living areas. Enclosed patios, courtyard, and terraces can reach comfort state both in winter and summer thanks to materials used. Most of the bar terraces in Madrid are enclosure by glass [*7].* The glass reflects heat radiation when it is necessary but allows the place to heat up. Helped with the retractile textile awning that acts as a roof, letting sun radiation in summer or heating up in winter. Inside

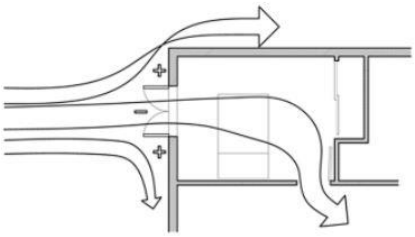
[6]

[7]

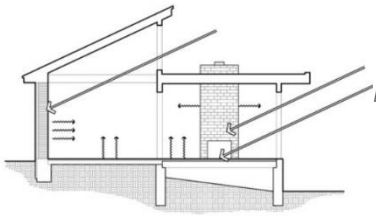
courtyard shaded by the building and with plenty of vegetation and water elements that help the evaporative cooling.

-Valencia

The characteristic damp and warm climate of Valencia is countered by local design strategies.



Good natural ventilation is really useful to eliminate the excessive humidity. In addition, during the summer, ventilation can reduce or even eliminate air conditioning, if windows are well shaded and oriented to prevailing breezes. *[1]*

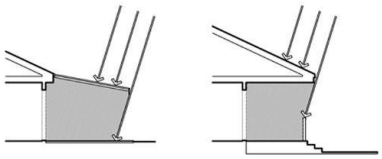


[1]

Along the same lines of passive methods, use high mass interior surfaces like slab floors, high mass walls and stone fireplace to store winter passive heat and summer night cold. Thick and heavy walls for achieving an indoor temperature similar to the daily average. *[2]*

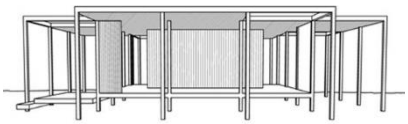
[2]

For mitigate the excessive solar radiation that Valencia receives along the year, and specially harmful during the summer, the most common strategy regarding building is window overhangs specially designed for this latitude, or operable sunshades with awnings that extend in summer, can result really useful *[4]*.Furthermore, the use of air conditioning can be reduced or eliminate with this practise. In the same way, on public spaces the use of textile temporary shading structures or structures that act as support for climbing plans, seasonal shading can help to mitigate heat in the summer and ensure that public spaces are more comfortable during the hottest hours of the day. *[3]*



[3]

Thanks to its mild weather, open air spaces can be lived the whole year in Valencia. Porches and patios can provide passive comfort, cooling by ventilation open to breezes in warm weather and can prevent insect problems. They can be also use to shade to prevent overheating during summer, and use passive solar gain in winter. *[5]*



[4]

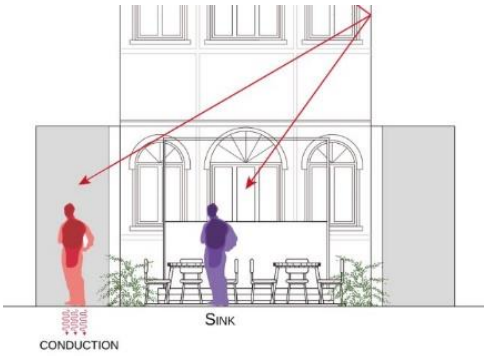
[5]

Analysis of reference

In the following, we can see some of the previous strategies explained, applied in real examples.

- Madrid. Corona house courtyard.

The popular Mexican beer Corona opened its biggest local in Madrid located in a courtyard. Thanks to this, it can be liveable in warm and cold season.

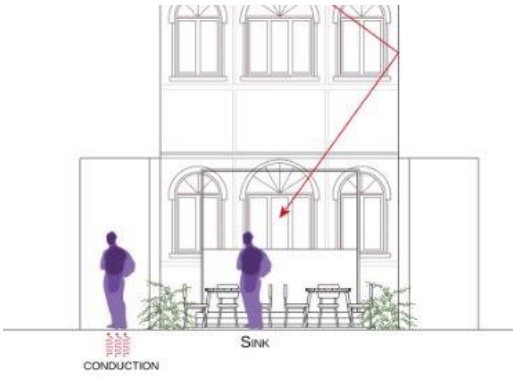


In summer, the surrounding buildings shaded the court, protecting the consumers from que high solar radiation (90%). Furthermore, floor tiles, while in the shadow, through conduction cool down the body, absorbing heat from it.

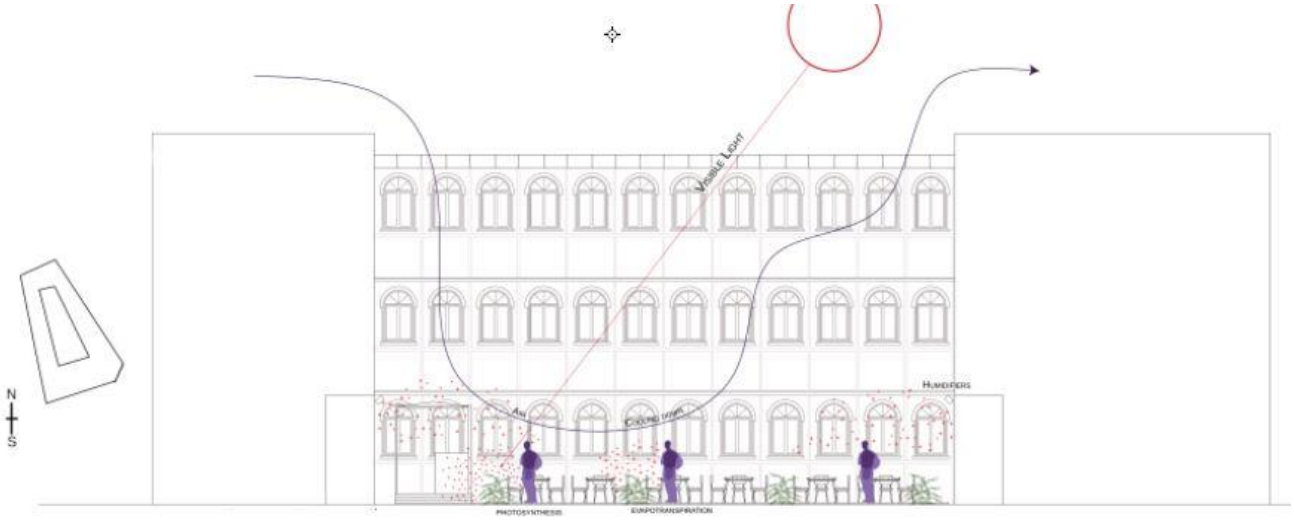
In this project, thanks to new technology in glass windows used in the roof, visible light is allows to get in but heat radiation reflects, keeling lower temperatures inside.

This roof has some openings permits air entrance in warm season. The patio has enough length to ventilate from one point to another, cooling down.

Due to the low humidity, about 40%, the use of strategies focused in increasing this rate is necessary. Adding humidifiers, is a easy way of creating a cool climate atmosphere. But also vegetation is very useful. Humidity increases thanks to the evapotranspiration in plants, from watering. Due photosynthesis, plants are able to do their vital functions, increasing their biomass and therefor, release certain amount of heat in the environment.

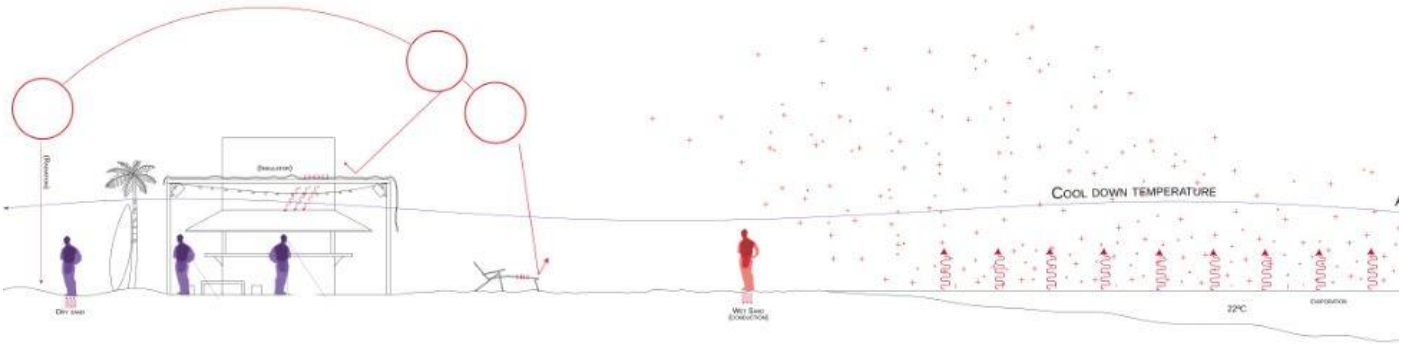


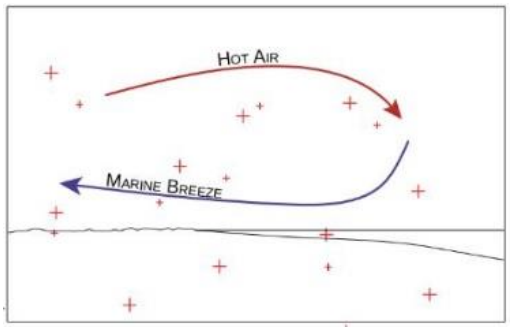
During the winter the low temperatures (minimum 2ºC) are mitigate applying some different strategies. The glass skylights are closed in order to store the heat as long as possible, letting solar radiation and visible light though. Now, the floor tiles which receive the solar radiation, warms up the body through conduction. In addition, the floor with maximum exposure to sun is made out of wood, whose thermal capacity depends on its type and when there is humidity. The more humidity there is (in this kind of wood used), the greater thermal capacity there is. Heating the body thanks to conduction. So, in order to increase humidity, vegetation is so useful also in this season. Even more, the increase in biomass thanks to photosynthesis, generates heat around each plant, increasing the thermal sensation.



- Valencia. Beach club.

Due to the mild weather in Valencia, and its perfect summer temperature, most activities are outside. That is way a lot of bars and clubs are in the beach, next to the sea in this season.



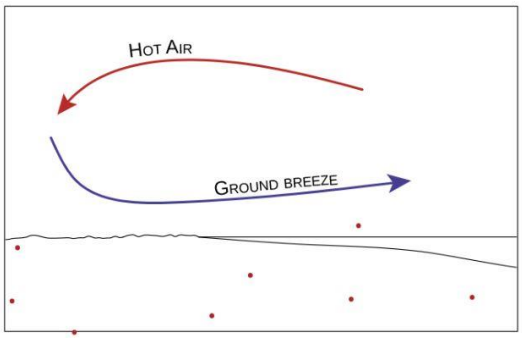


During the day, the sea breeze cools down the body against the summer temperatures. Heading west, it has a cooling down effect: hot air from the nearby land is changed by this marine breeze that is send back to the land.

In addition, Mediterranean Sea, as any other fluid is capable of evaporating at certain temperatures, and by doing so it adds humidity and lowers down the temperatures next to it. A perfect sport to set a beach club.

On the other hand, sand is a material composed of finely divided rock and mineral particles. When exposed to solar radiation, it heats up and by conduction, it gives heat to the fare boot. Although sand next to sea, is wet and damp, so when step on it, conduction allows our feet and so our body to cool down.

It is also needed a protection for the high sun shading. A textile covering the terrace acts as an insulator, filtering sun radiation, reflecting, absorbing and letting some go though.



I contrast, at nights, the situation changes. In this case due to daytime sea currents, sand is completely damp and wet, allowing body temperature to be cool, against the high temperatures during nigh time. In this case, the ground breeze spreads into the sea, and is changed to hot air that blows to the nearby land heating the environment up.

At the same time, heat that has been stored in the sea during day time is released, making night temperature hotter. This heat is then spread through air flow and convection occurs with the human body standing nearby.

Thermodynamical space

Through the information previously compiled, the aim of this research is to achieve a comfort space using the local strategies.

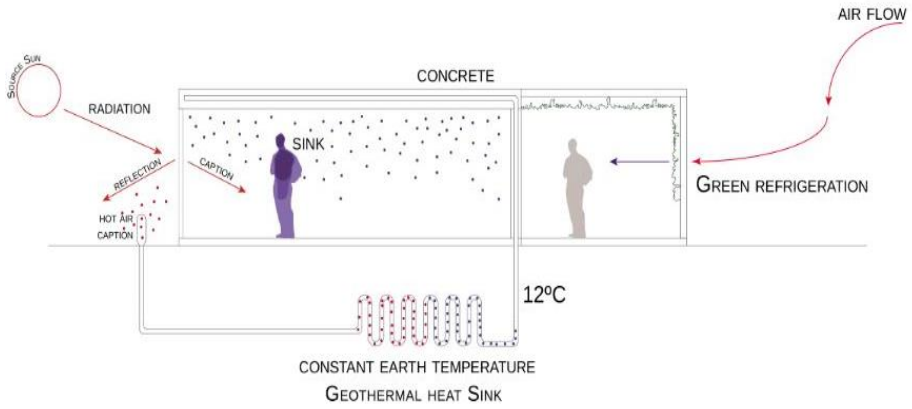
-Madrid. Summer.

The weather conditions are:

-Humidity: 40%

-Sunshine: 90%

-Temperature: 38ªC Max.



During day-time:

1. Noth- South orientation.

2. Geothermal heat sink. The temperature of the ground some meters below the surface of the earth is constant all year round. Geothermal sinks exploit this source of cool temperatures by passing air through long tubes in the earth. As air passes it loses its heat by conduction and radiation in the cool tube. The cooler air can be pumped back to the surface where people can enjoy this passive conditioning.

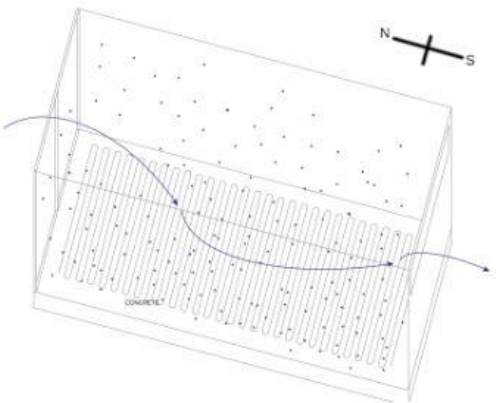
3. Southern Winds have to be stopped due to their high temperatures, with a closed façade that allows only visible light through.

4. White green grass or pale green vegetation is more suitable in this case, since ir reflects much light reducing the heating effect.

5. Porous façade lets northern wind into the space, cooling it down.

During night time:

1. Cool radiant surface work cooling both the air and skin of people who are near them. The surface itself is cooled through a network of tubing through which flows a cooling fluid (hydronic cooling). Instead of actively cooling the system, the constant temperature of the earth at two meters can be utilized to passively and continuously cool the fluid. In this case, since the human body is resting, the cooling down of the concrete happens at ground level, so there is not such a heavy and direct cold impact in the body.
2. Ventilation is essential during night time, to refresh the air trapped in the space. Therefore crossed ventilation is the easiest way to do so.
3. Closing the south façade to avoid any more heat inside the space.
4. Open and porous façade to take advantage of the fresh northern winds.



-Madrid. Winter.

The weather conditions are:

-Humidity: 80%

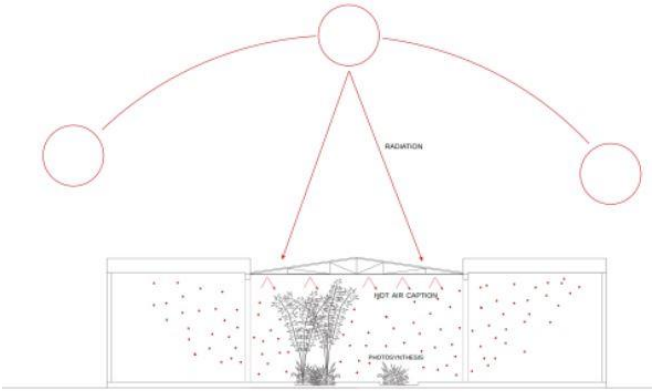
-Sunshine: 40%

-Temperature: 2ªC min.

During day-time:

1. Usage of glass: allows the sun radiation to be stored as heat to later on during the night, be released warming up the space light allows the vegetation to grow inside, acting as a greenhouse.

2. Vegetation: The increase in biomass due to photosynthesis, provided by the greenhouse effect, generates a certain amount of heat.



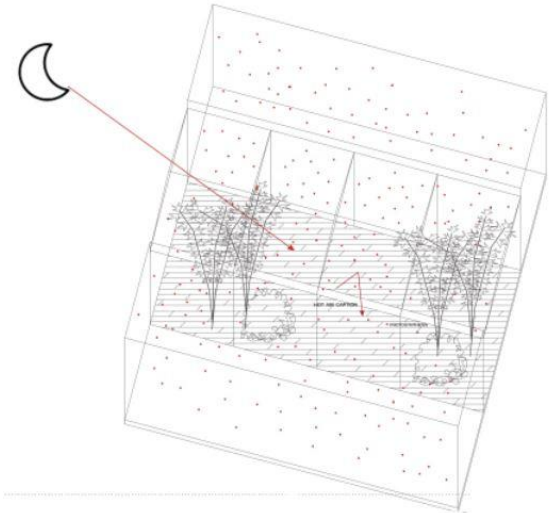
3. Wood floors: the chosen wood for the floor is due to its changing thermal capacity, since temperatures need to be high enough to reach a comfort zone, therefore the humidity vegetation is spreading, makes this kind of wood increase its thermal properties. This way it sores more heat that through conduction will warm up the human body.

During night time:

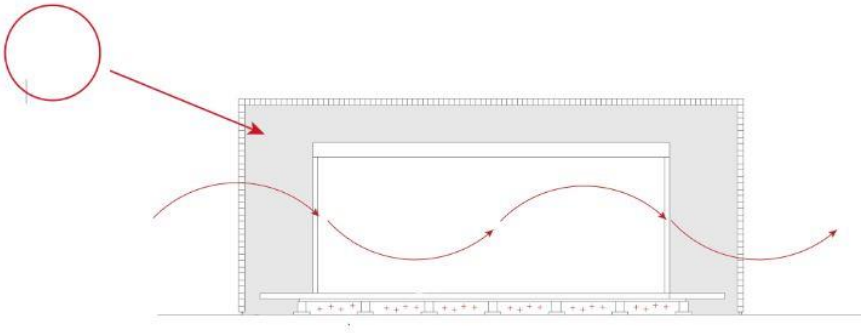
It is precisely during that time when all the above strategies are extremely useful.

1. Stored energy in the wooden floors is released, spreading to all the space.

2. Heat from the biomass in plants is used to warm up during nigh time.



-Valencia. Summer.



The weather conditions are:

-Humidity: 80%

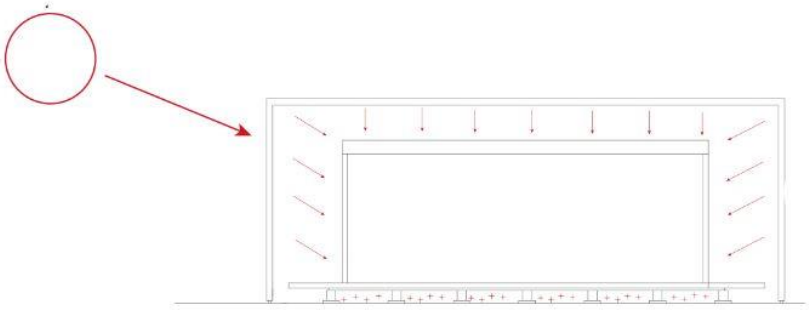
-Sunshine: 70%

-Temperature: 28ºC Max.

During day-time:

1. Double skin facade: made out of wood. Act as an insulator letting little radiation go through and generates shadows.
2. The orientation of the building allows perfect ventilation, using the cold sea breeze to cool down the heated environment.
3. Shadow cools the floor temperature and therefore, by conduction cools the human body.
4. Air flow by convection, can also reduce the body temperature, since it is the marine breeze.

-Valencia. Winter.



The weather conditions are:

-Humidity: 60%

-Sunshine: 50%

-Temperature: 9ºC Min.

During day-time:

1. Double skin building. Humidity is extremely high in Valencia, It is the main problem when building, that we need to solve. This is a strategy provides shadows during summer time and heat is stored to then be applied in winter.

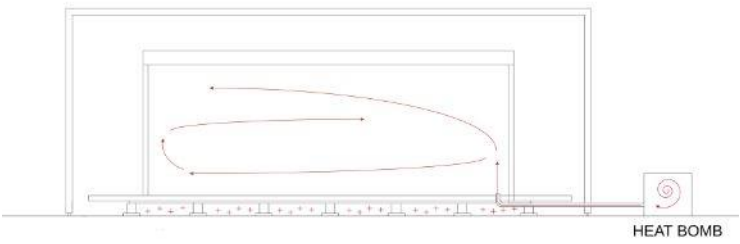
2. Solar radiation heats up the interior of the building. The concrete absorbs this sun heat and spreads to fight against cold.

3. Elevating the building allows it to avoid the humidity the wet floor will spread. A sealer along the floor will also ensure that no humidity will get inside.

During night-time:

1. The usage of heat bomb is good to heat up the interior of a house, in a climate where the temperatures are not extreme.

2. The cold air is transformed into hot air to create a comfortable environment inside.



Conclusion

Thanks to the studio of climate parameters, the compression of local strategies and references, it has been possible to design a space comfortable and functional. It is only a sketch, but contains all the tips learned from the analysis.

The designer has to keep in mind, more urgent each day, the need of saving energy and minimize the environmental impact produced by the constructions. It doesn't make sense to turn the back to the bioclimatic strategies in other to just achieve aesthetical purpose. From this kind of sketch, it is possible to design a complete project, always respecting the initial constructive tips. The functionality of the architectural sources makes the project more intelligent and gives interest to it, further than just attractive shapes and materials.

The good architecture in the future, should be that one where the designer try to minimize the energetic need of the building through passive strategies, using the technology near us in order to achieve: to produce enough energy to supply the energetic needs of the buildings; to use sustainable materials (keeping in mind its absorbed energy, its recycling and origin); to reach a proper relationship with the environment. Ergo, to deal with the remains in a way that cause the less impact possible to the earth.

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