

**Shading Methods and Thermal Comfort in Hermosillo, Sonora, Mexico.**

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## Abstract

Through time we have seen that the environment changes due to human activity. This provides a series of problems that puts the survival of humanity at a disadvantage. In this report, you will find the different shading methods used in the city of Hermosillo, Sonora, Mexico. Where a questionnaire was used to find the most comfortable shading method for the population of Hermosillo. A quiz containing a series of questions about what shading methods they use. Questions related to the basic principles of sustainability in the home are also added. The results that were answered in the Montecarlo residential will be compared. Located in the southwest of the city of Hermosillo, Mexico, and based on these, give importance if the season defines differently the methods that society prefers. Based on the results, it can be seen that the majority would prefer natural methods, like trees that provide shade. However, the results show that not everyone uses this method. This is critical if people cannot maintain a tree or if the environment disadvantages vegetation growth in dry climates. In the end, more complex solutions are sought where people create or use more regular shading methods such as shade sails. However, the shading methods used by the Montecarlo community are not enough to create a pleasant environment during the Spring-Summer season. But they showed that shading does work in seasons where the temperature is not so high, as is the case in Autumn-Winter.

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## Introduction

Hermosillo, Sonora is one of the cities in the world which tends to get high temperatures during the summer. Based on the history of shading, it is known that it can bring about a thermal change. Therefore it is essential to check if shading is a solution for desert areas. Through this investigation, it will be verified if the shading creates a change in people who live in climates that reach at least 100 F degrees.

Faced with high temperatures and the change in weather patterns, adaptation is necessary and urgent, since heat is a major health problem. This is where shading methods and vegetation come into play: they function as refrigerators in our cities.

## Research Question

The following questions can be answered based on the results of this research on shading devices:

1. What is the most used shading method within the Montecarlo Residential?
2. Can shading methods applied in Hermosillo reduce the total cost of electricity at home?
3. What is the cheapest and most sustainable method within the Montecarlo Residential?
4. Will it be possible to provide thermal comfort inside the houses in Montecarlo based on the methods used in the different houses?

Shading methods are defined as the use of any device that creates shadows and blocks the sun. In this investigation, I look particularly for shading methods that lower the temperature of the house/construction during the summer. Based on the shading methods that were applied in the residential area, this research looks at whether these can provide a benefit to people in arid and dry climates.

## Literature Review

Heat can cause problems in human biology, leading to dehydration or heat stroke. "Extreme heat is one of the leading causes of weather-related deaths in the United States, killing an average of more than 600 per year from 1999-2009," comments the Center for Climate and Energy Solutions. This can be an even greater problem in areas left with a shortage of water due to droughts.

For this project, I focus on providing the best solution for shading to communities located in very hot areas. I will specify how to improve the environment for the people of Hermosillo, Sonora, Mexico. This city among others is being affected by heat, facing an increase in temperature every year and even breaking records around the world. Investigating how to improve the homes of the people in this city aims to improve their environment and make this a more comfortable place for the families to live.

This is a problem that is happening around the world, not only in dry and arid areas. Therefore, this problem can cover other areas of the world over time. "Cities will experience the worst impacts of heatwaves due to the urban heat island effect, which keeps them warmer than surrounding rural areas," reports NASA. It is more than clear that problems that will remain in these types of cities, and unfortunately, people do not have what it takes for a change.

This heat problem tends to affect many people and it is important that people feel comfortable in their hometowns. Cities are where there are stories and families, providing the best chance for maintaining the city in addition to contributing to the economy. Therefore, this research encompasses a large community that cannot migrate to other places when there is already a limit of opportunities. A possible solution will make the community feel more comfortable living in the city and will also provide positive things such as reducing its electricity consumption, among others.

## Methodology



Figure. 1 Montecarlo Residential

## Study Site

The area of this study focuses on a residential district called Montecarlo located in the west of the city of Hermosillo, Sonora. This area was selected based on the experience of the researcher living in the location for approximately 10 years. Montecarlo is a residential area that has the mission of creating a strong community. It is made up of 17 private sections, which in total are 1,370 houses and with approximately 3,500 inhabitants. It is a well-known place where a large number of people live and the climate of the city can be critical for the community that lives in this area.



Figure. 2 Montecarlo Residential Classification.

The map shows a classification to distinguish how much vegetation there is in this residential area. This is to analyze if the vegetation works in this city with a dry and arid climate. The vegetation significantly reduces the temperature in the open air and the pedestrian areas. An increase in vegetation in this area could generate more comfort for people.

The large spaces that can be seen on the map are parks and these are also necessary for this type of neighborhood. However, you can also see other spaces where it is only bare ground. This land can be used to add more vegetation and create a greater thermal change inside the houses that surround these green spaces.

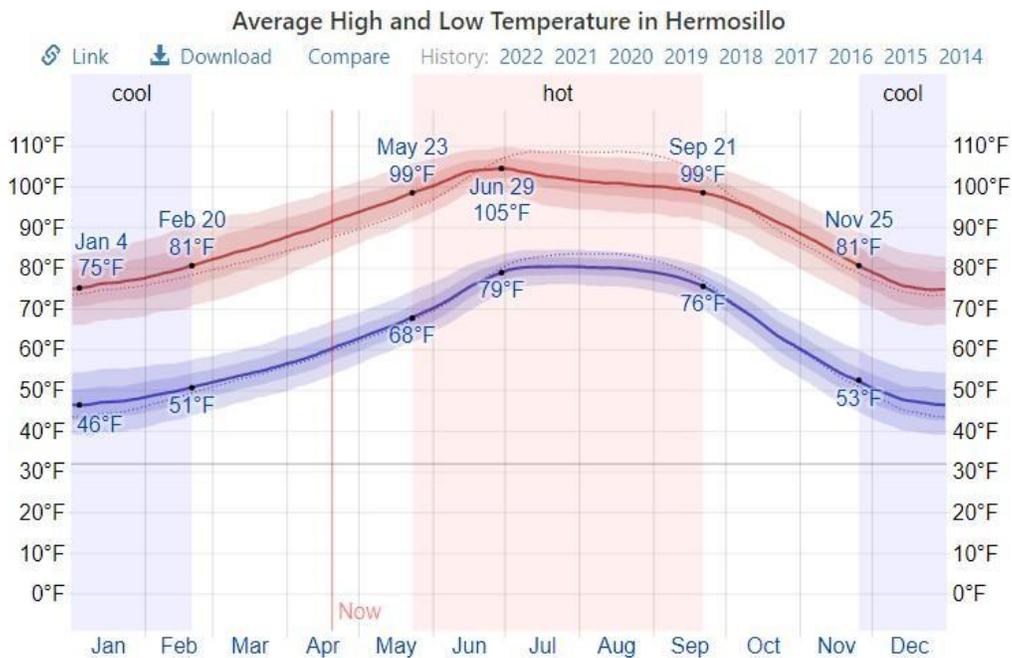


Figure. 3 Hermosillo average temperature during 2020.

This is a table that shows the average temperature of the city during the year 2020. The temperature in the summer is an average of 104 F, thus classifying it as a hot city. Typically 85F temperatures are considered hot for humans. Studies mention that the most comfortable temperature is 72 F, however for the city of Hermosillo these numbers do not happen until the fall. Over time the city's temperature has been shown to rise and it has been known to break records for maximum temperature from time to time.

## Method

This paper is focused on finding the different shading methods used within the Montecarlo community and seeing which of these provides the greatest benefit for the inhabitants. A special Spanish-language online questionnaire was created to identify the shading methods used in each home in order to identify the most common method. Additionally, the survey tries to identify which of these provides more satisfaction to each person and/or family. Within this questionnaire, different points are mentioned that are used to find out if the method of shading causes any positive effect in each house.

The online questionnaire was created on the Qualtrics page, which facilitates those who need to create questionnaires for business or personal use. Within this questionnaire, a total of fourteen questions were created. Most related to the shading method that is included in each house.

Questions were also asked related to ventilation, thermal compliance, and electricity costs, among others. The questions will be shown below.

1-City and neighborhood in which you live

2- How many square meters is the property you

live in? 3-What material is your house made of?

4-How many windows do your house have?

5-What type of artificial climate does your house have?

6- On average during the summer, what is the amount of your electricity

bill? \$ 7-How many trees do the property have?

8-Do you have any shading methods inside outside the home?

9- What type of shading device do you own? (Select multiple answers if you have the devices listed..)

10- Based on the question above, what is the cost of the device for your shading

system? 11-From 0 to 5, how effective is the shading method?

12-Any shading device you are interested in adding to your home?

13- Are you currently comfortable at home without the use of air conditioning/ventilation during summer?

14- What's your occupation?

Each of the questions was tested and put through a process in which it was decided whether it would be kept in the questionnaire, eliminated, or changed. It began with a series of open-ended questions and as most of these were edited, multiple options were added so that the participant felt comfortable answering in different ways. An introduction was added at the beginning of this document where the operation of this questionnaire is explained, so the participant could understand that this is only to verify if he knows and applies sustainable principles inside and outside the home. They were informed that the information would be anonymous for the safety of the participant.

Anyone located within the Montecarlo residential area was considered a potential participant in the questionnaire and the investigation. The focus in this particular neighborhood was because the researcher has close knowledge of the residential area and previously used to live on the site. This relationship with the site was an easy way to get responses from the participants, so much so that around sixty-two responses to the questionnaire were collected.

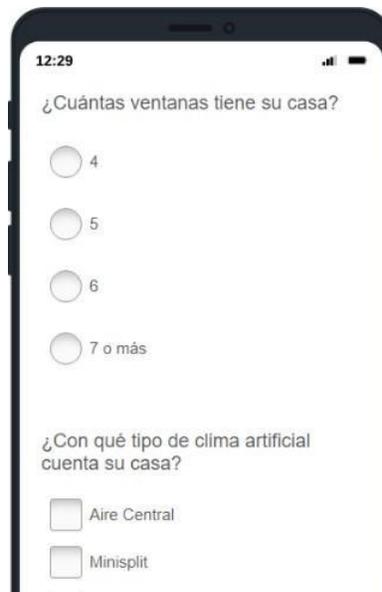


Figure. 4 Online questionnaire as seen through a mobile phone.

## Results

First, the terrain in which each of the participants lives was discussed. This is to take into account the sufficient space they have for the shading methods that each one applied inside their house and also those that they could add in the future. Among all those who participated in the survey, 60% live in an area smaller than 150 square meters. This means that most people have limited space. Based on the entire section in the image (Figure 1), it is notable that the same design and space were used for each of the houses at the beginning of their construction. Only a limited number of houses are different from most houses. Property owners can make changes to their homes.

It was found that 94% of the participants used concrete blocks as the main building material for their houses. These concrete blocks are used in large numbers mainly because of their size and because it also reduces construction time. In addition, the use of these blocks requires a smaller amount of mixture to join them. This material is commonly used for its resistance and great durability. They have substantial thermal mass and take time to heat up or cool down based on the fact that they are thick, however, they can also concentrate the temperature too much and create a large thermal change inside the house.

For survey respondents, 52% have a minimum of 7 or more windows inside at home. This makes them excellent in terms of access to good natural air circulation within the home. It works perfectly in seasons like fall or spring, where temperatures are usually within an average range for the city. However, if a large number of people apply shading methods around their homes, this could provide the same cooling effects as natural ventilation indoors during the summer.

**50%** of the participants have a shading devices

It is common in Hermosillo that an AC mini-split is used at home, and the survey results show that 61.9% use it at home. These are located mainly inside each room or open area since it is easier to cool individual area without the need to wait for a certain amount of time to distribute cooling. Its installation is more flexible than central air, but it is not cheap. Another climate control system that is used in large quantities is central air with a percentage of 28.6% within the survey, followed by fans with 27% of respondents. Central air was the main ventilation method at the construction of the subdivision and each of these houses is designed with ventilation ducts that lead to each of the rooms.

## Trees per House

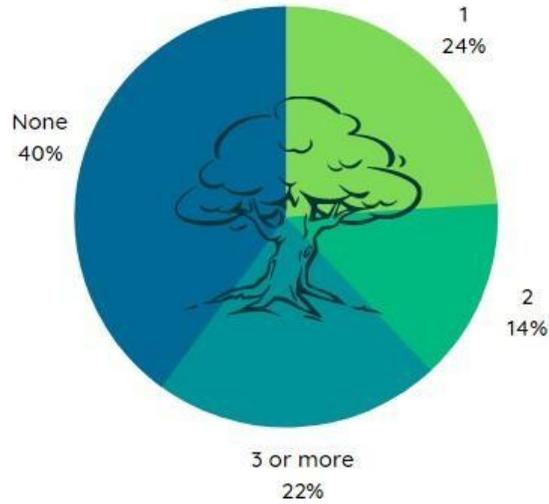


Figure. 5 Trees per house.

Based on the data, most of the people within the subdivision do not have trees on their property. Trees are probably one of the best shading methods because it is so natural. In addition to the fact that this is the cheapest and most sustainable method because it is created in a natural way, it also does not provide any contamination as other shading methods can.

## Shading Devices

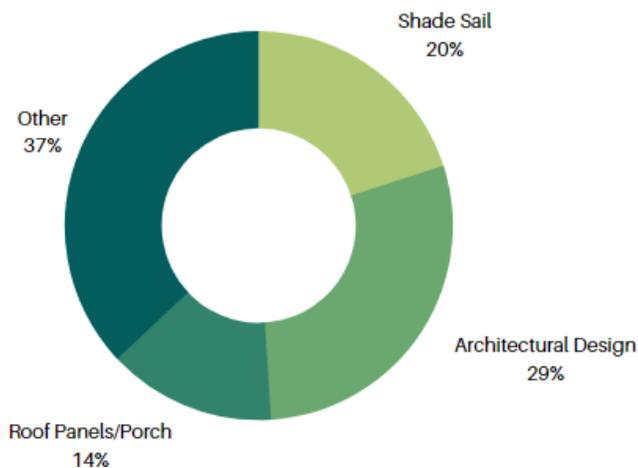


Figure. 6 Shading Devices used by the participants.

Within the results of "Other", the option of trees was mentioned. However, a large percentage mentioned that they had no shading method outside the home. Therefore, it is very likely that a large number of people are not informed of the benefits that shading provides for thermal comfort. Or just people don't believe that shading makes a change inside their houses due to the type of weather. The average of the people rated their shading method as having an average compliance result.



Therefore, based on the survey results, it might be concluded that shading methods do not provide effective results within arid and dry areas. The climate makes life difficult for people without the use of a fan. The methods that are applied can lower the temperature, however, these do not provide such a satisfactory result to avoid using air conditioning.

### Significance of Research

The results show a great variety of answers to each one of the questions added to the questionnaire. These data may be relevant for other types of investigations. Through the answers, the type of shading that each society maintains can be compared with other locations. Based on the shading strategies that apply in Mexico, these may vary in other areas either in Mexico or elsewhere in the world.

The results show the type of environmentally sustainable principles that exist within the Montecarlo residential complex. Based on the methods applied in Monte Carlo, it is apparent that a change is needed in this area. Since you do not take advantage of the space you have to place a good shading system around your houses. However, this only applies to the shading method approach. However, the answers to the questions related to natural ventilation and thermal comfort compliance show that this area knows the importance of the sustainability of a house.

Another fact to mention is that being a very hot area, shading does not usually provide noticeable results, Hermosillo. Based on the responses of the participants, it appears that the shading methods do not work at all in very hot weather. Applying this same study to areas with more neutral climates could show more efficient results.

The online questionnaire provided a way for obtaining quick results. However, it should be mentioned that this type of method does not work for everyone. At the moment, many potential elderly participants do not know about technology. In addition, even though the internet is easy to access it may not be available at home, so this may limit the results of the investigation.

### Future Steps

It is necessary to present this questionnaire in a personal way for the improvement of this research and that of the studied area. Being in front of the participant encourages them to answer safely and ask any questions that arise about the investigation. In addition, participants can mention curiosities related to the investigation. This requires a great deal of time. In the future, you may have to spend more of your time looking for the greatest number of survey responses.

Based on the results obtained, it is necessary to compare them with another area. Therefore, this same research should be applied in an area close to the current one under investigation. This would show if the results are concrete and whether results obtained from this area will apply throughout the city or only in this area.

In the future, it is possible to separate the results from those who have more knowledge of sustainable principles and compare them with those who do not apply these principles. This would find if those who apply them have any advantage in terms of energy savings and thermal comfort. Classifying sites can provide an option to calculate the space that is composed of only vegetation. This would be important in the improvement of the research, since this way it would demonstrate with data the clear difference that there is in terms of the little vegetation within the residential area. Finally, based on the ideas of the participants within the questionnaire, it is important to promote education on the principles of environmental sustainability. So that residents in the area can apply these principles at home, Creating a more natural environment in Montecarlo Residencial and others.

## Conclusion

Through the study in the areas where the questionnaire was applied, a variety of responses is seen that could provide a solution to the entire dry and warm area. Based on the answers, most people use the default shading method that comes in houses already designed by specialized architects for areas considered to be the suburbs. These designs can be above the windows of the houses or the entrance to the house. Many times these designs are only done for aesthetics and not to benefit the buyer or owner. The community of Hermosillo ends up consuming a lot of energy in air conditioners. Based on the questionnaire it can be identified that shading methods often cannot create a thermal change for certain people. This calls into question whether shading methods can be a benefit for hot areas. This may depend on the temperature of the area, since simply at a certain point, this solution can no longer be used for these areas effectively. The results show that people are interested in using more trees/vegetation as a solution to this dry and hot environment.

However, not everyone uses this method simply because it is time-consuming or difficult to maintain in a warm environment. Those with a higher economic class usually have more vegetation while in others it is usually scarce due to the occupation of each person. People who have shading devices were asked if they feel a change during certain seasons of the year. In the summer the heat becomes so strong that the function of the shade does not perform well in creating thermal comfort. Summer and spring are times when the people of Hermosillo tend to resort to other methods to be comfortable inside their homes.

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