Keeping it cool

Passive strategies to design good indoor climate in the hot-humid region

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1 Introduction

Having a decent indoor climate is a privilege and essential for several reasons. It affects how you sleep and the level of energy you have, how you work and what activities you are able to do in your home. To make this efficient in low-income housing the designing of a good indoor climate must be taken into account.

Many of the countries in the hot-humid climate-zone are developing countries. To minimize or reduce the use of climatizers is to design a good and healthy indoor climate for everybody and is a question of human rights and equality (United Nations [UN], art. 25, 1948). While designing low-income and social housing the local climate conditions are something we must take into account. By learning about thermal comfort and natural ventilation the need for active climatizers could be reduced – and with it the impacts on the personal economy.

The use of natural ventilation is rarely seen in the modern architecture in Manila. It used to be an important feature in the traditional architecture but western influences on the building design have made an electronic fan or acclimatizer a requirement in order to have a comfortable temperature indoors in this hot-humid climate. The use of so called active cooling (air-conditioner, fan and other electronic climatizers) is a privilege not all can afford or should prioritize. The use of active cooling also affects the outdoor climate in a negative

way. By outsourcing heat from indoors the hot air is brought directly to the outdoors. This heats up the outdoor which is not desirable in the hot-humid region, the outdoor air usually does not need to get any warmer to be comfortable.

In this essay I will investigate in what ways the natural indoor temperature can be lowered if local climate conditions are taken into account and strategies for cooling are part of the early stage in the housing-design process. With a focus on the hot-humid climate situation in Manila I will look for strategies and methods that can reduce or eliminate the use of climatizers in hot-humid regions and give a good indoor climate and thermal comfort - also while designing low-income housing.

2 Literature Review

The climate is an inevitable and difficult aspect of the daily life in countries on tropical latitudes. The hot-humid climate reaches very high outdoor temperatures thoughout the year, in Manila the avarage temperature often reaches above 30-35°C, and the humidity in the air increases the experience of uncomfortable heat. The experience of thermal comfort depends on the climate the people are used to, in the hot-humid region the upper comfort level is defined to 25-26°C. Using airconditioner in a hot-humid climate makes the difference between indoor and outdoor temperature large, and it can make the temperature where thermal comfort is experienced lower than then actual outdoor climate.

Many countries in the hot-humid areas are developing countries, and the resources to adjust the living conditions after the climate are often reduced. The hot-humid equatorial climate is defined as 15° north and 15° south of the equator (Adamsson & Åberg, 1993). A majority of people in this zone cannot, or have difficulty to, afford air conditioning, writes Givoni. Less research has been done on climatically appropriate urban and building design for this climate in comparison with research on other climates. (Givoni, 1998)

There are especially two aspects that should be taken into account during the design process to take advantage of natural possibilities and make the indoor-condition approach comfort conditions in the given climatic setting, according to Olgyay (1973), the reducing of heat production and radiation gain.

2.1 Reducing heat production and radiation gain

The heat production is simply the fact that exposure to the sun will heat up the building. Therefore, if the aim is to keep the indoor climate cool, exposure to the sun should be reduced or completely avoided. As the roof is the most exposed part of the building it is a crucial part to avoid the heat production in the building. One strategy to avoid the heat production and radiation gain is to use two layers of roof. With a free air-path between the two roofing layers, one layer is exposed to the sun, and the other layer is shadowed by the first.

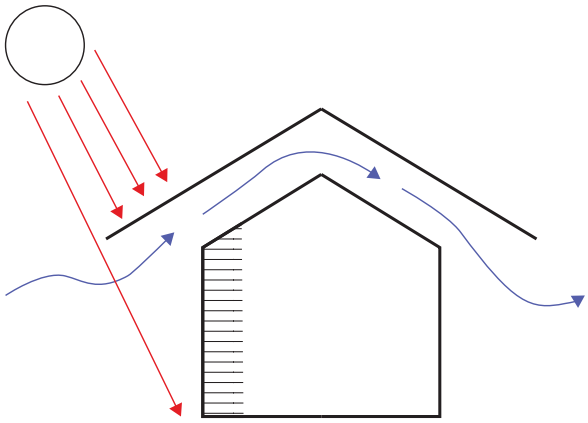


Image 1. Two layered roof with an overhang that shades the wall

The roof can also reduce the heat production on the walls if it has a large overhang. The roof can give shadow to the walls and the windows for most of the day if designed with large enough dimensions (Image 1). Where the roof does not shade different types of shading devices are effective. Screenings and louvres are especially effective since they give shade but also lets the air flow in to the building (Olgyay, 1973)

These strategies where implemented with good result according to passive-house-builder Kotaro Nishiki, who built his own home in Leyte, Phillippines. The house is completely climatized by using passive cooling strategies, and does not use any airconditioner or electrical cooling to regulate the indoor climate. The house is using the two-layered roof, with overhangs that shade the south and the north walls most of the day. Nishiki also used the two-layered strategy on the eastern and western walls to keep the cool, which according to him were two very effective techniques (Nishiki, 2013).

One very important aspect in the natural cooling of the house that both Olgyay and Nishiki mentiones is the importance of the air movements. Olgyay divides the cooling air movements into two forces: the air movements that are produced by a difference in pressure and the air movements caused by difference in temperature, writes Olgyay. These forces may act alone, together or in opposition to the other, how they act depends on the building design and the surrounding conditions.

2.2 The pressure difference

A house placed in the middle of an air stream makes the air slow down and "build-up" a pressure difference on the side that the wind comes from – this side has then a high pressure. On the sides there is now a lower pressure and the backside of the house has a wind shadow. The difference in pressure on the different sides contribute to air flow inside the building if there are strategically placed openings to the house. Openings should face the high pressure area, the outlet should face the low-pressure area (or wind shadow). (Olgyay, 1973) In a hot-humid climate the aim is to maximize the air-flow and natural cooling, the ideal effect of the cooling is achieved when two large openings are placed opposite of each other, preferably in each room to enable cross-ventilation in all spaces (Givoni, 1998). The highest wind speed is found when a small inlet is combined with a large outlet (Image 2).

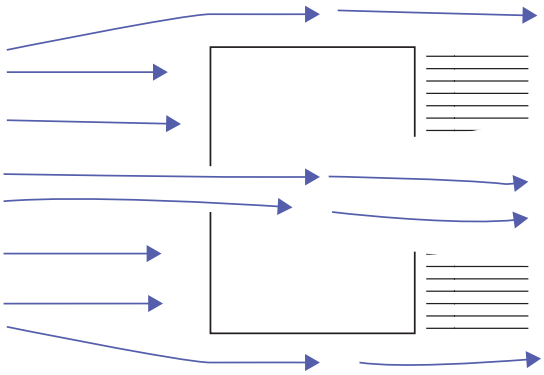
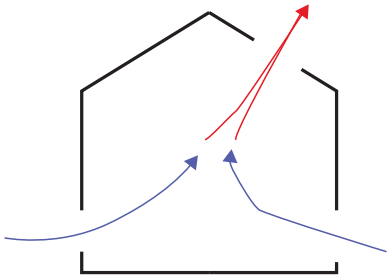


Image 2. The pressure difference through a building with a smaller inlet and larger outlet.

2.3 Air change

The force of air change is created by a difference in temperature. The difference in temperature on the inside and the outside creates a movement in air,

the stack effect (Image 3). The warm air rises up and moves out through the openings in the ceiling while fresh air is drawn in and replaces the warm air (Correa, 1999). The bigger the difference is in temperature between the two, the greater the effect of the movement. This can be implemented in the use of high ceilings in hot-humid countries. It will simply give more space to the hot air in top of the room. (Olgyay, 1973). The stack effect is of course particularly useful in regions where the temperatures vary greatly between night and day, in the hot-dry areas for example.



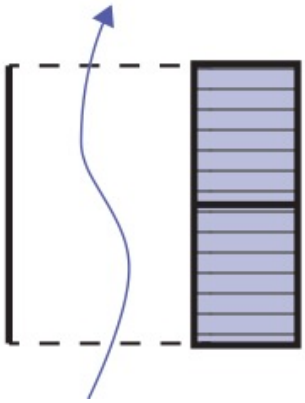


Image 3. The stack effect. Image 4. Zoning in plan, passive and active strategies.

2.4 Zoning

A third aspect to take into account while designing for hot-humid climate is where the rooms and functions are placed within the indoor space. The floorplan zoning is to place functions in the indoor-space strategically after the different temperatures the indoor space has during a day. For example, the place that has the lowest temperature during the evening and night is best suited as sleeping area. To zone is to place the different functions during the day in the most suitable temperature zone for the time and the activity (Nishiki, 2013).

3 Argument, Critique, Discussion & Urban Shelter Design

To build completely naturally ventilated housing in hot-humid climate is a challenge. The climate in the hot-humid zone of the Manila-region is with very humid air and very high temperatures uncomfortable during many days of the

year. Constructing a completely naturally ventilated house seems to be possible according to the works of Nishiki, but learning to design with passive cooling strategies can be profitable even if you do not eliminiate the use of electricity completely. By optimizing the benefits of the natural surroundings the use of electricity could be drastically minimized.

Although natural ventilation had an important part in traditional architecture in Manila, these have not been adapted to the metropolitan situation of today. The big city design has significant traits of the western colonization, with the flat roofs and buildings put up directly on the ground. The western-influences creates one demand, the nature creates another. Traditional techniques have not developed with the city, but traditional or not, the old houses are a reminder to the importance of adapting the architecture to its environment. How does the wind move? Where is the sun (and as important, the shadows) on the site and how does the surroundings affect the site?

In the design of low-income housing in Manila there is often a lack of adaptation to the local climatic conditions. This has of course economical reasons and cheap housing is often based on standardized solutions. If passive cooling strategies were considered in an early part of the design process it would be possible, with more or less, the same budget to create preconditions more sutiable to the climate. To not adapt a building after local condition gets consequences. One should also question what the “lifetime” costs of the adaptation would be in comparison to how much money the inhabitants will spend on electricity for air-conditoning and cooling. This regard would perhaps be more important if the electricity bill was to be payed by the developer throughout the years.

The strategies mentioned in the literature review could make a significant difference for the indoor climate and minimize the using of electricity for climatizers. While designing a building it is important to understand the difference between designing an active or a passive building. The requirements are often in total opposite to one another. The airconditoned room requires an enclosed space, as small as possible to reduce the energy used and the costs for cooling, whereas the naturally ventilated room requires openings and free air-flow. The fan is the middle course, which has good effect in both situations.

Based on the literature, I believe that the use of room-zoning is an important key to design economically and ecologically feasible housing. Different functions and rooms can have different temperatures depending on what time of the day

they are used, for how long time and how frequent. One historical example of zoning was seen in older housing design in Sweden, where if was common to have a non-insulated storage room in the kitchen and only a few “core”-places heated up in the winter. In tropical conditions the natural ventilation can be maximized in passages, places used shortly in the evenings or more public spaces of the home that allow a lot of openness for the air to flow. The use of fans could be a complement to the passive cooling strategies, that can help the natural ventilation-design to function on very warm or less windy days. Zoning the use of airconditioning could be to the smallest space necessary, for example a study or a bedroom. In this way both economical and ecological resources could be saved.

4 The Role of Architects

Many countries in the hot-humid region are, as mentioned earlier, developing countries. This deeply affects how architects should work in the area. This is a situation where climatic conditions and economical conditions are very important and intertwined in the design process.

We need to find inspiration from traditional architecture but also try to look forward towards new materials and new techniques. Perhaps the old together with the new can create new solutions, and

Architects have a great responsibility in making the most out of the available resources. When we design with small resources the responsibility to make the most out of them is bigger, we need to know what to prioritize. Architects need knowledge, both local and general on how to solve design in these regions to maximize the social and economical benefits.

To create good indoor housing for everybody is a question of equality and the right to a decent house. I am certain that architects with the right knowledge can make a great difference and improvement to create better preconditons for the people in the hot-humid region and the low-income housing.

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