Early nomadic shelters, including caves, animal skin tents, and igloos, were used for protection against the wind, rain, snow, sunlight, and other forces of nature. These basic homes also provided defence against predators and were used to store a few important possessions. They were temporary, and proximity to a water source was of prime importance.

Health and comfort were not yet under consideration. As civilization evolved, housing became more permanent, with increasing attention to well-being. The housing and utilities available in rich countries are vastly different from those in poorer settings. Unlike in industrialised countries where piped-in water, indoor toilets, and sewage systems are the norm, in the developing world these facilities are often not available. Waterborne enteric diseases, preventable by the supply of safe water, hand washing, and appropriate sanitation, continue to be a major disease burden in poor countries. Vector-borne diseases that can be controlled by screening and other barrier methods also remain an important health problem. Safe, comfortable, and healthy homes are an essential requisite for healthy living around the world, irrespective of culture or socio-economic status.

Throughout the tropics there is a huge diversity in house design and use of building supplies based on centuries of indigenous experience, customs, and availability of local resources for construction. These differences in building style and materials affect the indoor conditions and comfort of occupants, which in turn influence the occupants’ exposure to certain infectious diseases. In this book the authors describe the architectural designs and materials of rural houses in two countries in Asia (Thailand, Philippines) and two in Africa (The Gambia, Tanzania). They analyse the effect of design on the indoor climate and relate these factors to health, notably the risk of mosquito-borne infectious diseases such as malaria. Based on their findings and a detailed understanding of local building styles, they describe a series of house modifications that could enhance comfort whilst reducing health risks.

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Early nomadic shelters, including caves, animal skin tents, and igloos, were used for protection against the wind, rain, snow, sunlight, and other forces of nature. These basic homes also provided defense against predators and were used to store a few important possessions. They were temporary, and proximity to a water source was of prime importance. For hunters and gatherers, shelter was an important aspect of survival. Health and comfort were not yet under consideration. An civilization evolved, housing became more permanent, with increasing attention to wellbeing. The housing and utilities available in rich countries are vastly different from those in poorer settings. Unlike in industrialized countries where piped-in water, indoor toilets, and sewage systems are the norm, in the developing world these facilities are often not available. Waterborne enteric diseases, preventable by the supply of safe water, hand washing, and appropriate sanitation, continue to be a major disease burden in poor countries. Vector-borne diseases that can be controlled by preventing and other barrier methods also remain an important health problem. Safe, comfortable, and healthy homes are an essential requisite for healthy living around the world, irrespective of culture or socio-economic status.

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Chapter 1: Introduction

Healthy homes: a story of unintended consequences

Early renaissance cities, including canals, animal skin roofs and slums, were used as protection against the elements (wind, rain, snow and sunlight). These structures provided defense against predators and storage facilities for a few important possessions. Early buildings were wigwam- and pyramid-like, referring to a water source way of primal importance. For the hunters and gatherers, shelter was far more important. Health and comfort was not yet under consideration.

As civilizations evolved, housing became more permanent, with increasing attention to being. Unlike its industrialized counterparts where piped water, indoor toilets and sewage systems are the norm, in many developing countries these facilities are often not available. Waterborne endemic diseases, prevalent in the tropics, are endemic. People living in tropical regions where these infections are endemic have adopted their housing structures in different ways to prevent entry of disease vectors.

The term "slum" refers to a portion of society which cannot afford to live there due to its location, infrastructure, or economic status. Slums are often characterized by poor sanitation, inadequate housing, and high levels of overcrowding.

Indoor ventilation is essential for maintaining a comfortable and healthy environment. Poor ventilation in slum areas can lead to increased exposure to infections and respiratory illnesses.

In some areas, the lack of proper ventilation in slum areas can lead to increased exposure to infections and respiratory illnesses. However, the lack of proper ventilation in slum areas can lead to increased exposure to infections and respiratory illnesses.

In conclusion, healthy homes are essential for maintaining a comfortable and healthy environment. Improved ventilation and sanitation in slum areas can significantly reduce the risk of infections and respiratory illnesses.
The issue of mosquito control in Hanoi, Vietnam, led to the design and adoption of an innovative, cost-effective housing solution to prevent mosquito breeding. The house is elevated off the ground, with large windows and screens, allowing for natural ventilation and preventing residents from being exposed to mosquito bites. This approach helps to reduce the number of mosquitoes inside the house, thereby decreasing the risk of mosquito-borne diseases.

**Unintended consequences**

Interventions that aim to solve complex problems sometimes lead to unintended consequences, ranging from beneficial to detrimental. The well-intentioned quest for healthy homes has led to several negative unintended consequences. For example, the使用 of screens in the housing design might require a considerable effort in terms of high maintenance costs. If screens are not properly maintained, they might become breeding grounds for mosquitoes.

These unintended consequences highlight the importance of considering all potential outcomes when implementing interventions. In this case, the focus on preventing mosquito breeding has led to a reduction in the number of mosquitoes inside the house, but it has also led to increased maintenance costs, which might have unintended negative impacts on the residents.

**Lessons learned**

The case of Hanoi illustrates the importance of balancing intervention goals with unintended consequences. By focusing on the core issue of mosquito control, the intervention successfully reduced the risk of mosquito-borne diseases. However, the increased maintenance costs associated with the use of screens might have unintended negative impacts on the residents, such as increased costs and decreased access to natural ventilation.

Each intervention has its unique set of structural consequences, which may be overlooked or thought to be insignificant. During the intervention design phase, it is crucial to consider all potential outcomes, including those that might have negative impacts on the residents. This approach ensures that interventions are not only effective in addressing the core issue but also consider the broader implications of their implementation.
As shown in chapter 15, air entry through trachea is critical for airflow and air temperature. Once airflow in a wind tunnel is reduced, the indoor climate can become uncomfortable due to the heat stresses that resist the evaporative cooling. However, for a number of reasons, including the presence of more frequent and more severe storms, the risk of respiratory infections and the transmission of respiratory infections like influenza, is a concern. 

Thus, a better understanding of how the entry of moisture into the environment can influence the indoor environment is needed. We consider these factors in Chapter 15. Here we note that the indoor environment of local houses in Southeast Asia is characterized by a humid, hot climate. The high temperature and humidity in these areas can cause discomfort and lead to respiratory infections. In this chapter, we describe the architectural designs of local houses in two countries in Asia (Thailand and Philippines) and in two in Africa (The Gambia, Togo). We analyze the indoor climate of local houses in these settings and examine climate-driven design and comfort-related variables. The results of these studies are presented in the final chapter. We then describe several potential design solutions that could enhance comfort and reduce the risk of severe health risks.


References
Chapter 2. Climate

Temperature, humidity, and airflow are the three principal conditions that determine whether humans will feel comfortable in a given climate. Most people feel comfortable when the indoor temperature is between 22°C and 24°C and the relative humidity is between 40% and 60%. Airflow becomes critical at the upper limits of the thermal comfort zone. On a hot summer day we feel much more comfortable when there is a little breeze. This is witnessed by the number of people crowding on beaches during hot summer days in the hope to get a little bit of relief from the heat.

One approach to creating a thermal comfort in air-conditioning is to introduce the financial capital of Singapore and Hong Kong: they only emerged after universal air-conditioning. At the workplace became affordable. Prior to air-conditioning, high-efficiency offices were primarily located in the Northern Hemisphere. As mentioned in the previous chapter, there are several disadvantages to universal air-conditioning. Besides the cost for buying the appliance, air-conditioning requires a permanent power supply, which is neither available nor affordable for large populations.

There is currently great interest in designing structures adapted to human needs without the use of air-conditioning. It is widely accepted that there is no single approach that works best in all climate zones. Some 200 years ago, the Roman architect Vitruvius wrote in the ninth of his Ten Books on Architecture: “One style of house suits

Figure 2.1. The predominant climate zones.

Figure 2.5. Contemporary building materials in Thailand: cement tiles, thatch and bamboo panels for roof and walls respectively.
appropriate in Egypt, another in Spain, a different kind in Peru, one still different in Rome and on
with the lands and countries of other characteris-
tics.” Climate zones around the world have been
classified by temperature and humidity (figure 2).
The focus of the Healthy Homes project is the
adaptation of houses to tropical climate found in
the populated areas of sub-Saharan Africa and
Asia. Tropical climate is characterized by stable high
humidity and high temperature, which vary only
slightly between day and night, as well as
cross the seasons throughout the year. In these
areas there is continuous precipitation amounting
very high humidity. Nightfall is not accompanied
by a heavy downpour as in a considerable glass.
The Asian response to tropical climate is open
leakage structures with wide walls to desert rain
and light. Building materials such as bamboo are
lightweight and allow easy ventilation. The floor
and terraces tend to be elevated on stilts, which
increases airflow and where needed provides some
protection against flooding.
In contrast to the hot, humid climates of the tropics, hot desert climates are characterized
by large differences in temperature between day
and night, mild winters and extreme summers.
White skin and lighter clothing are present
generally throughout the year. Though not usually
a large problem than floods. People residing
permanently in desert climates tend to use
massive structures constructed out of heavy materials
such as stone, which can hold a large thermal
load to moderate indoor climate between
the outdoor extremes. Such massive buildings
lead to severe-heat during the day, radiate heat
during the night with slowly cooling down and
restrain the outdoor heat during the day. Desert
climate tends to be dry, high humidity not to
be a major issue and ventilation has a relatively low
priority. Adaptation to a desert climate is in many
ways the opposite of the requirements in a hot,
humid, tropical zone.

The inappropriate use of styleKishinev
troph building in a tropical climate is exemplified by Kishinev
in Zanzibar, United Republic of Tanzania.
The area growing architecture of Zanzibar was part of the
Omani culture whose rulers brought their
architects and builders to Zanzibar to construct a
city following the Omani style. Storrmers
consists of massive stone structures with few or
no windows and narrow roofs that prevent reason-
able airflow from inside and into buildings. The
appropriation of heat between day and night, most
dwellers in desert climates, does not take place in
Zanzibar as it is hot and humid around the
clock for most of the year. As such, when it is
hottest, the narrow alleys between the edifices
radiate trapped heat, and during the monsoon
season water collects and runs through these
passages. In humid heat without air-conditioning,
it is dark and uncomfortable within Storrmers
massive walls day and night. Although
c onsidered a UNesco heritage site because of its unique
feature of Arab and African culture, Storrmers
is a climatological calumet for Zanzibans who
have to live and work there. Today relics are a
major source of income for the island and are
conditioning units have been installed in a large
number of the old stone buildings. This results in
overheating of the available supply of electricity
costing Europe regular power outages.

Figure 12: Storrmers, Zanzibar, possible one of the
most inappropriate architecture in technology
form ever. Massive stone buildings, poorly suitable
for a desert climate, have been installed in the
tropical desert of East Africa.
The human comfort zone: It started in Copenhagen...

The relationship of the thermal variables that determine thermal comfort is illustrated in Figure 3. Most people feel comfortable in an indoor temperature between 21°C and 25°C. This range decreases with increasing relative humidity above 50%. If the relative humidity makes you wet, then people feel comfortable at an indoor temperature of about 23°C. Above this temperature, feel discomfort increases rapidly. Below 20°C, comfort decreases with increasing temperature. The relationship of comfort to the temperature indoors is illustrated in Figure 3.

Air flow can extend the comfort zone to a wider range, which allows someone to sense comfort at temperatures outside the range. Figure 4 shows that the comfort zone is extended at lower temperatures and extended at higher temperatures. comfort is extended at lower temperatures and extended at higher temperatures. Figure 4 shows that the comfort zone is extended at lower temperatures and extended at higher temperatures.

...and what does all this mean for humans in rural sub-Saharan Africa? In contrast to the open air structures described above, rural sub-Saharan African houses have not evolved to optimize the thermal comfort zone. There is little or no emphasis on insulation in rural sub-Saharan Africa. Consequently, houses are usually not designed and usually not planned. Many homes have no ceiling insulation, and the roof is not extended over the windows to provide some insulation. With rain, the rain is open on top and windows and doors are not equipped with curtains or some other type of insulation. As a result, the comfort zone is extended at lower temperatures and extended at higher temperatures.

Figure 2.4: The human thermal comfort zone (after Kjaer), 21°C - 25°C is the optimal range, and 23°C is the lower temperature.

Figure 3.3: The optimal comfort range for different indoor temperatures and humidity levels.

Figure 4.4: The comfort zone is extended at lower temperatures and extended at higher temperatures.