Since the beginning of time, man has been affected by climate and its influence over the earth. The first humans built shelters and lived in caves to protect themselves from the weather elements. However, the first documentation of architectural design with climate interests in mind dates back to fourth century B.C. in Greece. The philosopher Vitruvius is quoted as saying, “We must at the outset take note of the countries and climates in which buildings are built (Oktay).” In Rome, architects made note of the reduction of temperature created by the huge stonewalls and their shadows. The walls were made of stuccoed brick and were typically twelve to twenty feet wide which allowed for an extended area to be captured in the shadows of the walls keeping the city cool during the midday hours (Oktay). The stuccoed walls are an example of climate-responsive architecture, or architecture that is constructed and built with designs that make use of the surrounding climate and its natural effects. With the help of new climate technology, many developing countries, such as Algeria, are making use of climate-responsive architecture and its benefits in helping to keep humans comfortable (Bensalem). The impact in Algeria is strong because with the country’s struggling economy and varying climate zones, it is a huge step to be able to use the country’s natural environment as a building tool instead of expensive technology. Climate-responsive architecture takes advantage of free energy in the form of heat and light. Each region of the world employs its own techniques and designs in its buildings that are best suited to that particular region and that encompass the region’s cultural patterns. This is known more commonly as vernacular architecture, or “forms which grow out of the practical needs of the inhabitants of a place and the constraints of the site and climate (Oktay).” Vernacular architecture varies for regions of hot climate and regions of cold climate. Many of the same techniques are employed, but it is the way they are used in each respective climate that makes them unique.

Before getting into the specifics of each climate, general guidelines are used by all architects in any building situation. A man by the name of Olgyay is credited with creating a bioclimatic chart that helps in the design of buildings so that they are conducive to the human requirements of comfort using the surrounding climatic conditions. Olgyay’s chart is a “zone of human comfort in relation to ambient air temperature and humidity, mean radiant temperature, wind speed, solar radiation, and evaporative cooling” (Givoni 280). The axis of the chart include the dry bulb temperature and relative humidity which create the “zone” in which other important characteristics can be calculated. A comfort zone is created in the center of the chart, which emphasizes the correct temperature and humidity for maximum comfort. If the temperature and relative humidity fall below the lower limit, shading is required to maintain comfort and if they rise above the upper limit, then the cooling effects of the
wind is usually the only element that can balance the comfort zone (Givoni 280). To create the chart, local data are collected and recorded regularly and then charted based on annual percentages. The bioclimatic chart is important because it allows builders and architects to figure out the right specifications for design factors such as orientation, location, size, shading, and form.

A hot-humid climate is defined as a “region that receives more than 20 inches of annual precipitation” and either has 3,000 or more hours of 67 deg F temperature or 1,500 or more hours of 73 deg F temperature during the warmest six months of the year (Building Science Corporation). In this type of climate, the main function of the buildings is to simply moderate the daytime heating effects of the external air (Givoni 290). In other words, it is important to design buildings whose structure and interior are best able to keep warm air out. Living in a hot climate can quickly become uncomfortable for its inhabitants with the extreme heat that is built up by midday. That is why it is important for the buildings structures to have effective ventilation and an internal temperature below the outdoor level (Givoni 285). The ventilation keeps air moving through the environment and, therefore, keeps the inhabitants cooler.

In many arid, desert regions, buildings are designed with flat roofs, small openings, and heavy weight materials. These materials include dried mud in rural areas and reinforced concrete in urban areas (Givoni 316). The thick exterior roof and walls help to absorb temperature fluctuations and, therefore, keep internal temperatures from rising above the outside surface temperature. An important function of the roof is its color. A white or light colored roof will stay approximately the same temperature as the outdoor air during the day, and six to ten deg C cooler than the outside air at night (Givoni 319). This is an important feature because the cooler nighttime air will be channeled down by the sloop of the roof and into the rooms in the building. One function of the small openings is to prevent dust, a huge problem in Africa, West Asia, and West Australia, from entering buildings. Windows are arranged so that equal areas are open on the windward and leeward sides of the building. The reason for this is very simple, the air stream can be directed into rooms that need constant ventilation such as the bedroom (Givoni). When one window is positioned higher than another, thermal force will direct the airflow from the high window to the lower window creating good ventilation.

Courtyards, patios, and verandas are other common features of buildings in hot climates. With high walls, these outside areas provide shade and a relaxing environment to their inhabitants for social gatherings, evening entertainment, food preparation, and domestic work such as laundry (Okty). Concrete is the most common material used in the walls because it has low cost and high thermal capacity which in turn reduces internal temperatures (Givoni 316). This keeps the patios cooler and more enjoyable. Another way to provide shade in a more aesthetically pleasing way is through greenery. For example, trees, shrubs, and bushes provide natural shade from the sun while giving the courtyard area a pleasing look. Why are these outside areas so important? They are important because essential functions happen outside like cooking and entertaining. The outside environment in hot regions is just as important as the inside because it is a daytime relief from the intense climate. The following chart was created to show the
optimal comfort temperature for an outside area in a hot region. As one can see, depending on the orientation of the building, there is a different corresponding optimal temperature (Bensalem). Generally between the afternoon hours of the day (1:00pm to 4:00pm), the most comfortable temperature is around 30-35 degrees C.

In summary, a typical hot climate building possesses three main sections, a main building, a service building, and an inner courtyard (Oktay). The main building will contain the living room so as to make use of the cross ventilation from the windows and has a north-south orientation is preferable to deal with ventilation issues. The outside areas provide relief from heat with thick, concrete walls.

A cold climate is defined as a region with approximately 5,400 to 9,000 heating degree-days (Building Science Corporation). A heating degree-day is calculated by subtracting the mean temperature for the day from 65 deg F. It is general belief that when the temperature drops below 65 deg F, people begin to turn on their furnaces, so therefore when the mean temperature drops below 65 deg F the day is assigned a heating degree number. A building constructed in cold climates should ideally have healthy and comfortable indoor thermal conditions and a reasonable fuel economy with the heating methods locally employed (Givoni 291). The key to reaching that goal is good insulation and sunshine exposure, which helps to keep the warm air inside the building. The ancient Greeks employed this technique by realizing that the winter sun had a low arc in the southern sky, due to the tilt in the Earth at the season, allowing windows in the walls to capture much needed heat from the sun (Oktay). A traditional building is usually built just below the brow of a hill on the southward slope. This way the building is protected by the hill and by surrounding shelterbelts of trees (Oktay). The north face of the building typically has few openings while the south contains the main openings to maximize sun exposure. Orientation is important because it affects which sides of the buildings receive the most sunlight and how long the sun stays with those sides. The long axis of the building should ideally stretch east to west. The north end receives the least amount of sunlight and, consequently, has lower temperatures (Oktay). This is why storage rooms, toilets, and kitchens typically are located at the north end of many buildings. The south end is much warmer and generally will house the living room, bedrooms, and study areas. To minimize and reduce heat loss many rooms contain low ceilings, thick stonewalls, small windows, and centrally located heating. The difference between thick walls in cold and hot climates is that in hot climates the walls outside are meant to shade the interior from the intense heat, whereas, in cold climates the walls inside are meant to insulate and keep heat in. The chart below was created to show the
optimal comfort temperature for a cold region at different times of the day (Bensalem). As discussed early, the chart shows that the south end of the building in a cold region is in fact warmer than the other ends of the building, especially in the mid afternoon hours of the day (1:00pm to 4:00pm).

Many settlements, like The Dechra settlements in Italy, cluster their houses close together facing the south in order to minimize heat loss (Bensalem). It is an inexpensive way to solve a heating problem because, unfortunately for many countries, detailed climatic data and analysis is not available. In Austria, for example, thermal insulation must be calculated based on the average annual minimum outdoor temperature (Givoni 280). Where in other countries, houses are constructed based on a detailed scale that helps decide how much insulation is really required. In a cold climate, using the right type and amount of insulation is key to conserving heat loss and energy and it is the ultimate goal of cold climate architecture.

Both hot and cold climate-responsive architecture use special techniques and designs to help get the most benefit out of the natural environment. Architects who use climate-responsive architecture build their creations with the intent on taking advantage of the surrounding environment and the average climate conditions of the region. Around the world there are famous examples of buildings and settlements that employ such designs. For example, in Cypriot, an Italian settlement, houses in towns and villages are grouped close together in order to help shade each other from the intense sun (Oktay). In Delhi and Lahore, mosques consist of large areas of open space surrounded by just enough built form to make one feel “inside” a piece of architecture (Correa). Around the world architects are continuously expanding and inventing new ideas that make use of the natural environment and its extraordinary effects on the way humans live comfortably in their homes and workplaces.
References


*Houses That Work II: Cold Climate*. Building Science Corporation. 26 October 2003

*Houses That Work II: Hot-Humid Climate*. Building Science Corporation. 26 October 2003