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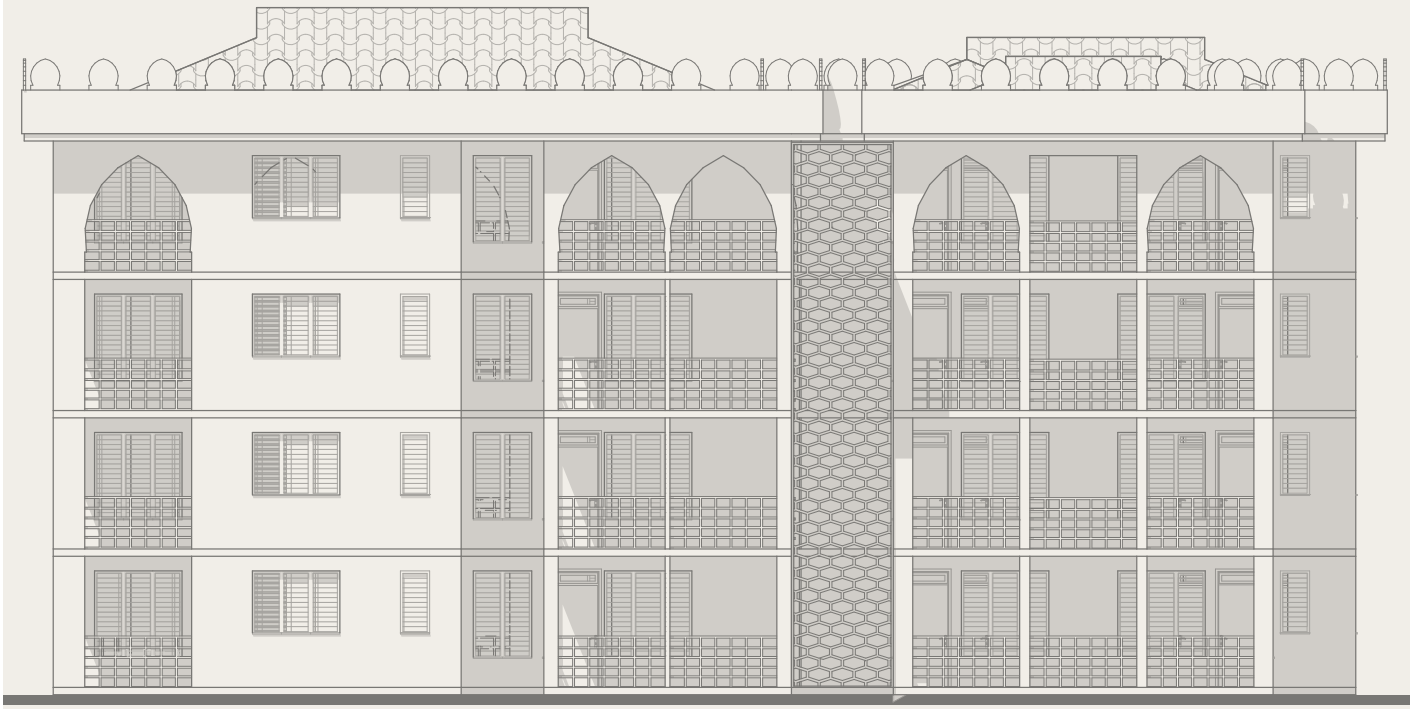
Multi-dwelling housing



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The Journal of Sustainable Building Design

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1 Introduction

Buildings have a strong potential to impact positively or negatively two important elements of everyday life: our environment and energy bills. Their contribution to climate change mitigation on greenhouse gas emission and higher or lower energy bills are directly related to the way buildings are designed in relation to the local climate and site-specific characteristics.

This journal calls for change in the way we build. It promotes creative ways to produce buildings which achieve optimum conditions for their inhabitants whilst making minimum demands on fossil-based energy. The first step in creating comfort and thermal delight in buildings is to understand the relationship between the local climate and our need for shelter. Buildings should vary with climate and thus with location.

Designing an energy efficient built environment involves minimising the wastage of energy resources while maximising the use of passive design options and renewable energy sources.

The design of energy efficient buildings and homes depends on, solar path and solar radiation, rainfall, humidity, prevailing wind, and ambient temperature of a particular place among others. Design parameters of buildings and homes, therefore, vary with different climatic zones. Therefore, to achieve sustainable housing, it is important to build conssidering the prevailing climatic conditions.

Poor climatic design of buildings, all too often seen in 'modern' architecture, causes many buildings to overheat, even in temperate or cold climates where such problems were never faced before the advent of modern architecture. The influence of the sun should be understood and respected by designers of passive solar buildings in which the sun's free energy is used for natural lighting, heating and drying out but will not interfere with the occupants' comfort. Well-designed buildings with environmentally friendly solutions use less energy. They require lower maintenance compared to ordinary buildings and are more comfortable spaces to live in.

Designing an energy efficient built environment involves minimising the wastage of energy resources while maximising the use of passive design options and renewable energy sources. The green building (or sustainable building) is a result of a holistic approach. It is designed, constructed, and operated in an environmentally responsible way; it is resource efficient (land, water, energy, material, waste) throughout the building's life-cycle.

This journal acts as a guideline in providing applicable passive design principles for different climatic conditions that should be taken into consideration when designing in the different climates. These include:

- Site analysis
- Building orientation
- Natural ventilation
- Day lighting
- Solar shading
- Building materials
- Window sizes
- Window location
- Location of building services

Whereas sustainable buildings are directly related to local climate and site conditions, this journal is not intended to provide generic templates replicable in any part of the East African region. It aims to discuss examples and guide the user on how best to explore local climatic conditions.

2

Sun Path Analysis

To understand the effects of the sun on the location and design of a building, we need to know its position in the sky at various times throughout the year. The position of the sun at noon will be higher or lower, according to the season (spring/summer/fall/winter). This will help to know the amount of light and heat that a given surface of the building envelope will receive to control the solar radiation that gets into the building.

Sun path diagrams are a convenient way of representing the sun's changing position in the sky throughout the year. The sun's position is represented with a coordinate system (altitude and azimuth). It can be read off directly from the diagram for any time of the day and month. This is useful in providing a summary of the solar position that should be considered when designing.

The most used systems are the polar and the cylindrical sun path diagrams.

Polar sun path diagram: The polar representation gives the image of the celestial sphere by placing itself right above the zenith (the point of the sky directly overhead) of the place under consideration.

In this type of representation, lines of equal solar altitude are spaced widely apart near the zenith of the sky, but are concentrated quite closely together near the horizon.

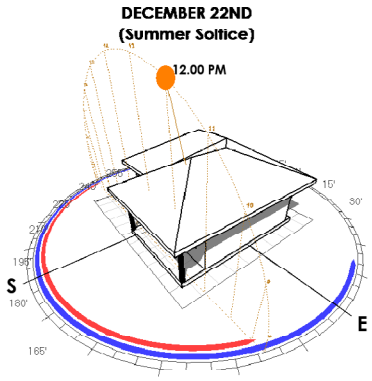
The generation of each sun-path line is done by determining the exact position of the sun as it passes through the sky (hourly) for each date. This is then projected from the sky dome onto the flat image.

Reading the Position of the Sun (altitude and azimuth):

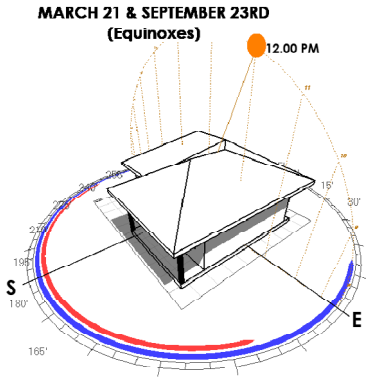
1. Select the chart of the correct latitude (each location has a different chart).
2. Select one date line to be analyzed.
3. Select the hour line and mark its intersection with the date line.
4. Read from the concentric circles the altitude angle (sun height from the ground also known as solar altitude).
5. Lay a straight line from the center of the chart, through the marked time point to the outer circle and read the azimuth angle (sun orientation related to the north).

To access the optimal building orientation, place the building plan in the center of the diagram, aligning it with the orientation under consideration.

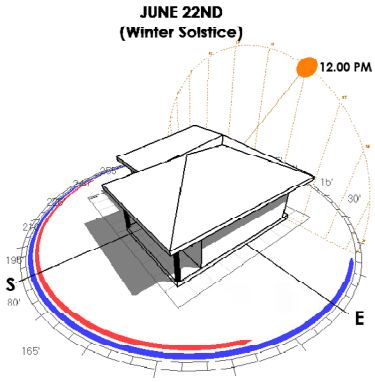
Figure 1: Position of the Sun at different times of the year for Latitude 0°



After September equinox the sun's path gradually drifts southwards. By December 22, it rises south of east and sets at the south of west.

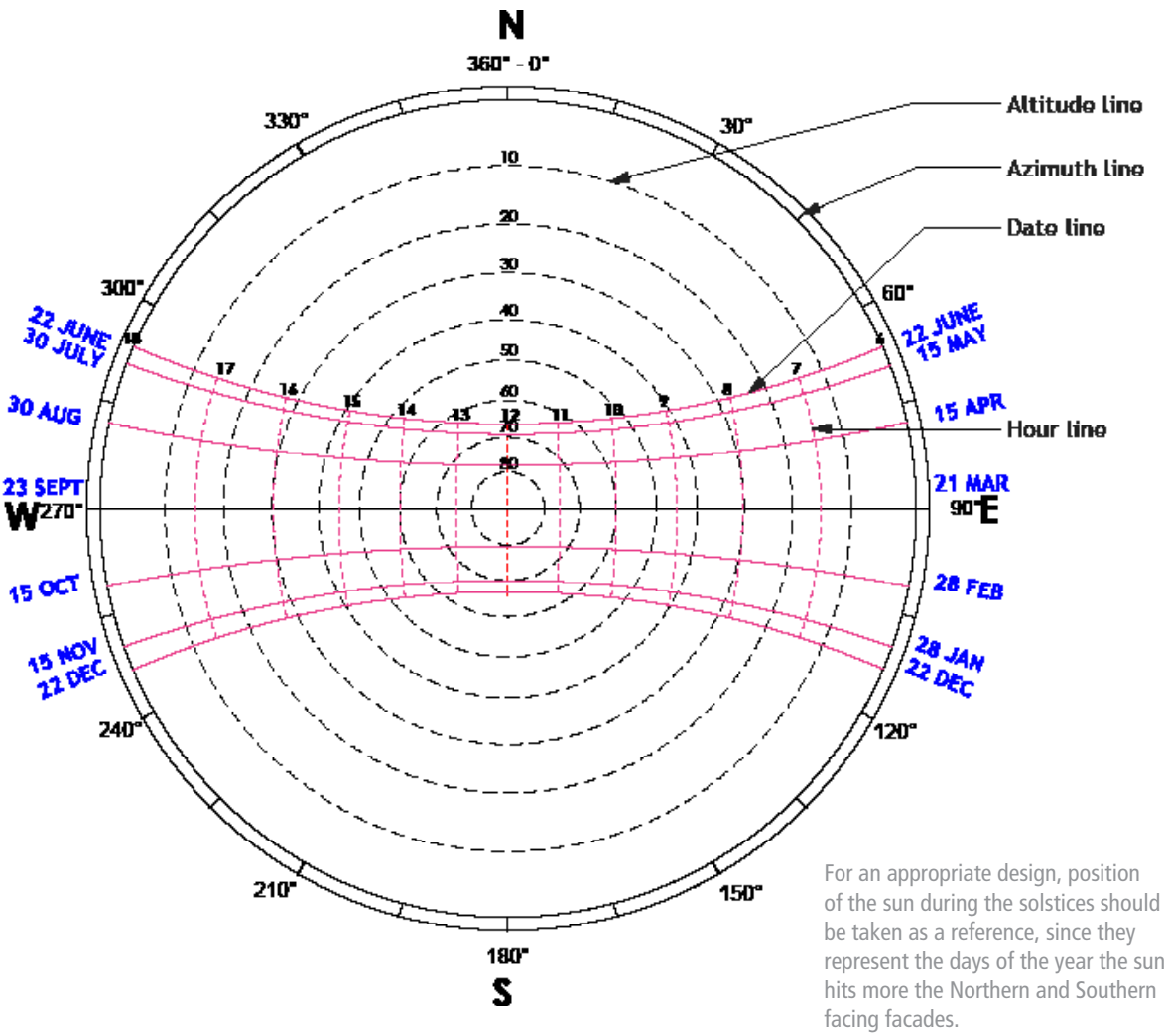


During these dates, the sun's path follows the celestial equator and rises directly east and sets directly west.



After March equinox, the sun's path gradually drifts northward. By June 21 it rises due north of the east and sets due north of west.

Figure 2: Polar sun path diagram for Latitude 0° (E.g. Eldoret town 0°31'N 35°17'E)



For an appropriate design, position of the sun during the solstices should be taken as a reference, since they represent the days of the year the sun hits more the Northern and Southern facing facades.

3

Sun Shading

The most significant factor affecting the built environment in the East Africa region is solar radiation which impacts on it throughout the year. Buildings and space shapes have a significant impact on indoor temperatures. When designing a new building, it is very important to pay attention to the needs of its users and consider the environment they are most likely to spend most of their time in. The building should be user friendly and comfortable. Factors to be considered for adequate indoor comfort are daylight, room temperature and indoor air quality.

The implementation of sun shading devices is one of the passive strategies needed to improve indoor thermal conditions during sunny conditions. Appropriate and well-designed sun shading devices can dramatically affect indoor conditions by controlling indoor illumination from daylight, solar heat gains and glare while at the same time maintaining view out through windows, thus saving thermal energy, lighting and maintaining visual comfort.

To size the sun shading device a Sun Path Diagram (figure.2) should be used to find the solar altitude and azimuth angles for any given time. To do this, choose the sun path diagram with the latitude closest to the site. Find the intersection of the two curves corresponding to the month and hour of interest. From this point, read the solar altitude and azimuth angles. This is the sun's position at that month and hour.

External sun shading devices are the most effective way of controlling solar heat gain through glazed areas in buildings. These can either be devices attached to the building envelope or extensions of the envelope itself. An external sun shading system has the advantage of blocking the solar radiation before it penetrates buildings, but has the disadvantage of exposure to the climatic elements for maintenance. The size and position of these external shading elements can be calculated so as to cover all glazed areas or windows on the most problematic hours i.e. 9.00 am to 4.00 pm. This reduces energy consumption for cooling of buildings.

It is important to make sure that sun shading devices do not cause glare.

Types of external sun shading devices.

There are 3 types of sun shading devices namely:

1. Horizontal
2. Vertical
3. Eggcrate

Figure 3: Horizontal overhangs along north and south facing elevations cut out unwanted solar radiation