

Landscape Design for Energy Efficiency in Residences of Kerala

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Abstract: Landscaping is considered an integral part of a house, eliminated the distinction between front and backyard, making it possible to place the house in the middle of the landscape. A strategic landscape design is an easy and inexpensive way to improve energy efficiency of a building, enhance the aesthetic value of the property, and provide screening for privacy, and buffer. Landscape design ideally is a part of a wider design process, allowing interactions between the building orientation, building design, and site. The aim of the study is to analyze the influence of site planning aspects of landscaping on the energy efficiency of residence in Kerala (warm and humid climate). To understand the methods for providing natural light and ventilation into the building through proper site planning and determine its ability to reduce the surrounding temperature. The result of the study is a compilation of knowledge base about the different techniques of landscape design strategies and different varieties of indigenous plants and materials that are commonly used in residences, and how they provide a benefit to the overall energy efficiency of the building envelop in Kerala.

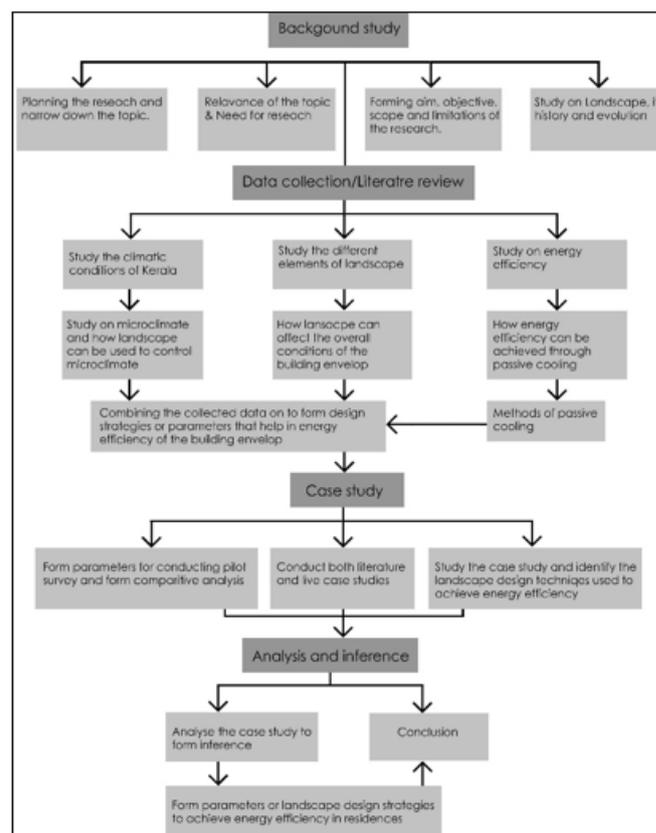
Keywords: Landscape design; warm-humid climate; design process; site planning strategies; passive cooling; evapotranspiration, cross-ventilation; energy-efficient design; natural ventilation

1. Introduction

Climate change is the greatest danger faced by mankind at present. The energy consumption of buildings is dependent directly or indirectly on all phases of its life cycle, in which, the major share is that of the operating energy during the occupancy phase (80%-90%). The cost of heating and cooling represents one of the biggest household expenses which usually take up energy for ventilation and cooling in warm-humid climate conditions (Kerala). Long term energy savings can be fulfilled by improving the building design as well as conserving energy during operating phase, cooling loads. (Tikul, 2017)

The cost of heating and cooling represents one of the biggest household expenses. High energy use for indoor climatic control is not only expensive but also strains the regional and national resources required for energy production and contributes excessive amounts of CO₂ and other pollutants to the atmosphere. The passive cooling strategy is a green design approach which involves reduction in the total effect of heat gain so as to provide a cooler environment which in turn help reduce the cooling load. Landscaping can also offer protection from the most severe conditions and reduce surrounding temperature. (Tikul, 2017) A well planned landscape design is an easy and inexpensive way to improve the energy efficiency of a building, enhance the value and aesthetics of the property, act as a buffer and screening for privacy etc. (Norhanis Diyana Nizarudin, 2011) Landscape design ideally is a part of a wider design process, allowing interactions between the building orientation, building design, site conditions and landscape design.

2. Methodology



3. Case studies

3.1 The Regimented house, Malappuram

The objective of the study included the identification of parameters for energy-efficient landscape design for

residences which included the study of types and positioning of different landscape elements so as to attain maximum energy efficiency for the overall building envelope thus creating comfortable environments inside and outside at a minimized cost.

The regimented house is located at Malappuram in a 2.45 acre flat land along with an existing house. The house has open planning which consists of 2 blocks separated by an open to sky courtyard in center. (Castro, 2018)



Figure 3: Two blocks with an open to sky courtyard in between connected by a bridge



Figure 1: Site layout with ground floor plan, the regimented house
Source: Lijo Reny Architects

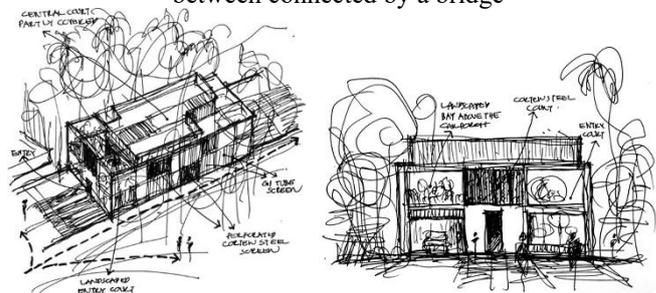


Figure 4: Sketches showing the cross-ventilation and façade elements

The key aspect of site planning is to reduce the heat entering the building envelope by reducing the heat radiated. Trees and shrubs are used to shade the large openings and walls, while the ground cover plants are used on the east and west side that receive maximum suns radiation thus absorbing most of it.



Figure 1: (i) Jali and GI pipe screening. (ii) Vertical garden on western wall

It has incorporated landscape both inside and around the house that seamlessly blends with the open planning of the house. Large full-length openings on either side of both blocks along with vegetation around it aid cross-ventilation by channeling wind inside, as well as act as a screening for privacy and shade.

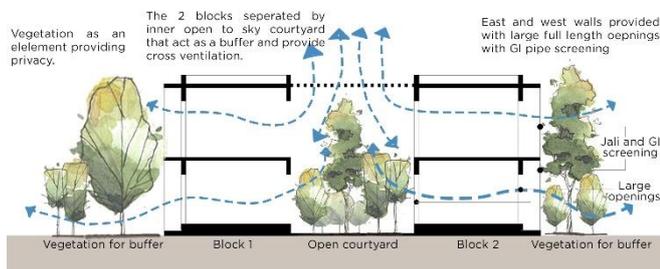


Figure 2: Section showing 2 blocks separated by the open to sky courtyard.

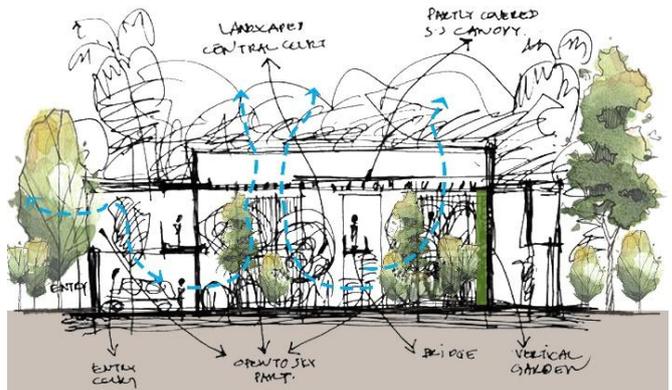


Figure 6: Section showing the inner courtyard and cross ventilation.

Each and every corner of the house is naturally ventilated reducing the cost for cooling and ventilation, thus aiding energy efficiency.

3.2 Halaman-the courtyard house, Aluva

Halaman, the courtyard house is located at Aluva in a comparatively smaller area of land of 4356 sq. ft. (Abdel, 2020)

3.3 Good Earth Aangan, Kakknad

Apart from the other two cases, Good Earth Aangan is a villa project with 20 units spread across 2.5 acres of land at different levels. (Earth, Good Earth Aangan, 2019)

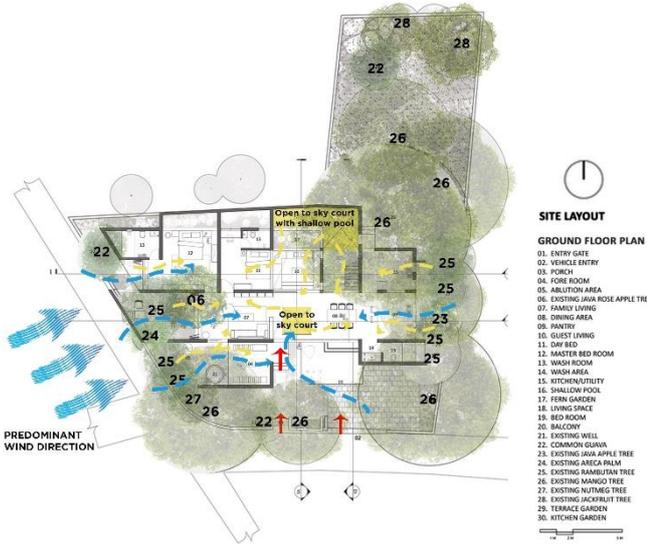


Figure 2: Site layout with ground floor plan, Halaman house
Source: Zero Studio

It has been planned in such a way that the vegetation forms an envelope around the building thus shading the walls and openings throughout the day. Plants are also provided at different levels that have helped to create a microclimate inside. The open to sky courtyard has a water body below that provides evaporative cooling.



Figure 8: Section showing the skylight and shading

The house also has a floating roof with ventilator slits which aid cross ventilation. The overall shading and cross ventilation has reduced the cost for cooling and ventilation thus making it energy efficient.

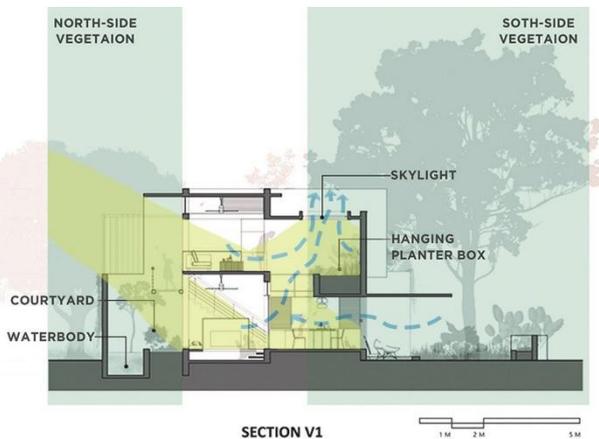


Figure 3: Section showing natural light and ventilation



Figure 4: Site plan, Good Earth Aangan
Source: Good Earth

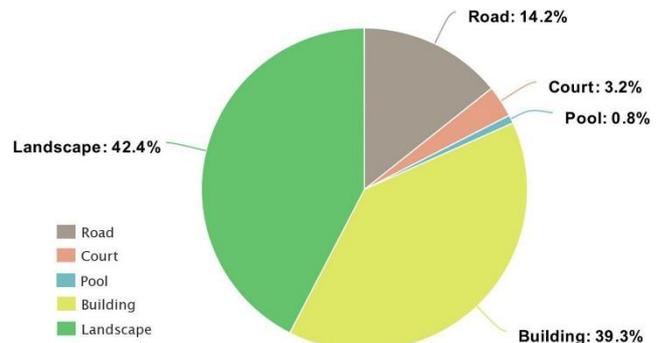


Figure 5: Percentage area comparison of different areas

The landscape planning of the site is designed in such a way that it shades the hardscape elements such as roads and pathways throughout the day making the space to be used comfortably.

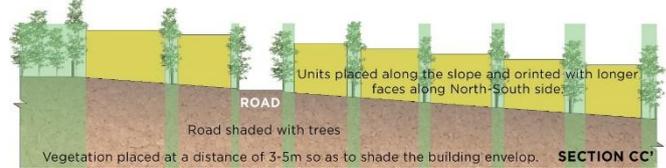


Figure 6: Section showing shaded road and units placed along the slope.



Figure 7: Shaded roads



Figure 8: Softscape and hardscape features

The landscape around each unit is planned in such a way that the bedroom walls are shaded with trees that are planted at a distance of 2-3m. Also, the car porch is shaded using creepers spread across the pergola.



Figure 9: Images showing the Shaded areas

The units also have been placed along the existing site terrain which has created a natural shade for units placed on the lower areas. The pool as well as the central garden also uses the same technique along with large vegetation to create shaded comfortable spaces for users.

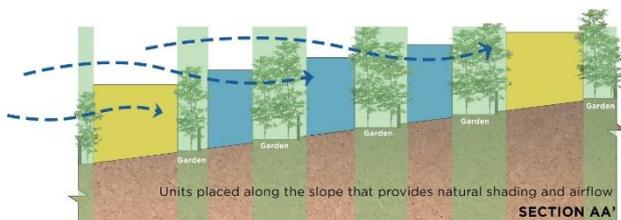


Figure 10: Section showing positioning of units without blocking wind

All the above cases have used maximum softscape elements and minimum hardscape elements of porous material for landscape planning. Native and indigenous plants along with a maximum of the existing vegetation are used for softscape thus making sure that the vegetation requires very less maintenance and remains healthy for a longer period of time. Buffalo grass is used for ground cover rather than high maintenance lawns thus reducing the cost for maintenance. All this in turn has helped the cases to achieve an overall energy efficiency by lowering the cooling and ventilation load of the building and maintenance cost of vegetation.

4. Results and Discussion

It can be inferred from the careful study and analysis of the above cases based on the set of parameters, that, a strategically planned landscape design can extensively produce a cooling effect which in turn can lead to energy efficiency. The parameters identified for analyzing the case studies for energy efficiency in residences were:

- 1) Orientation of site
- 2) Orientation of building on site
- 3) Orientation of plants on each side
- 4) Type and level of shading on South and West sides
- 5) Type and position of ground cover plants
- 6) Type of plants used: Indigenous / Exotic

- 7) Type and position of trees and shrubs: Evergreen /deciduous
- 8) Materials for hardscape
- 9) Wind direction and cross ventilation

We can observe that each of these parameters are not dependent on each other, rather they are linked to each other and combine together to give passive cooling which in turn provide energy efficiency.

- The orientation of the building with longer faces along the north-south direction ensures the reduction of heat from the direct solar radiation.
- Providing evergreen trees on south, west and east sides is important as the spreading crown part provide shade for both the roof and walls and the airy trunk ensures that the wind flow is not blocked.
- The distance of the evergreen trees from the building envelop should be 3m to 5m so as to ensure that the shade falls on the walls and roof. Larger distances of the trees from the building shades the ground surface which can reduce the amount of heat radiated from the ground surface.

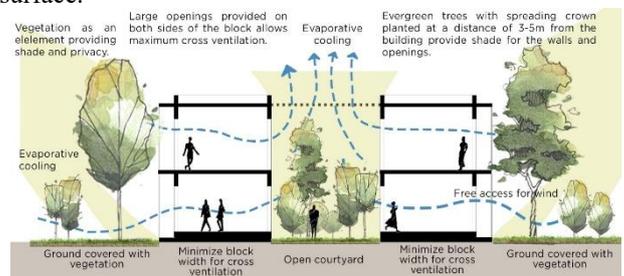


Figure 17: Section showing placement of different landscape parameters

- The ground cover plants can be provided on the east and west sides which receive the maximum direct solar radiation and ensures that most of the heat is absorbed.
- Selecting native or indigenous plants is very important as it reduces the long term maintenance cost.
- The area covered by hardscape should be reduced and use porous materials for pavement and driveway help in water penetration and reduce drainage issues, which indirectly helps in energy efficiency.

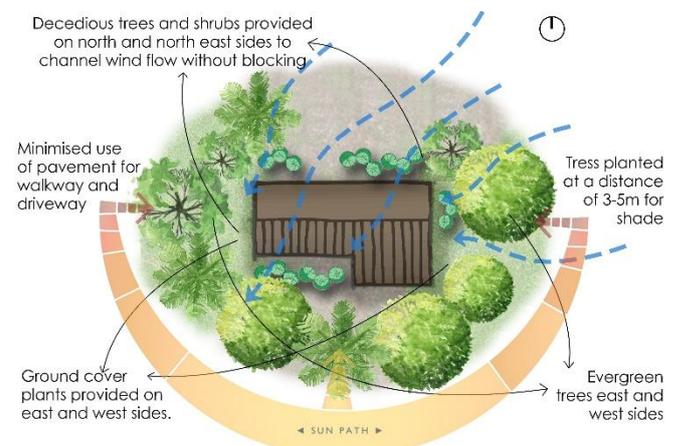


Figure 18: Landscape planning parameters for energy efficiency in residences

5. Conclusion

Designing energy-efficient residences have gained more importance. Residential buildings are considered as a system that has constant interaction between the external surrounding environmental conditions and indoor comfort. The energy consumption of buildings in both construction and operation phase account for 49% of total energy use, of which 40% - 60% is estimated for cooling and ventilation needs of indoors. We can see that modern architecture fails to consider the environmental aspects, creating uncomfortable conditions indoor that require artificial, or mechanical systems, thus, causing large energy consumption. (A, 2013)

The present situations of energy consumptions of building, demands the need for the considerations of energy conservation strategies throughout the building life from construction to the living phase. A carefully planned landscape and other external features considering the microclimate and topography can reduce up to 50% - 80% of the energy consumed for cooling and ventilation. (Ramesh, Energy efficient landscape for thermal comfort in buildings and builtup areas, 2016)

Priority must be given to the design of external or surrounding spaces so as to create a comfortable indoor environment that is energy efficient. Careful positioning of trees, shrubs, ground cover, pavements, and materials can greatly reduce the temperature around the building and create a comfortable environment. Vegetation can vary the microclimate both directly by shading and channeling the wind flow and indirectly by the process of evapotranspiration and can control the storage and exchange of heat between surfaces. Thus, the selection of trees and plants and the positioning around the building, building form and the orientation of different spaces, type, position and size of openings, type and position of hardscape elements, etc., link to each other and create a system that controls both indoor and outdoor environmental condition, thus aiding the overall energy efficiency by reducing the cooling loads of the building and the maintenance cost of the landscape. It also includes the topography, existing vegetation, soil conditions, water body, and the aesthetical needs for the building. (Misni, 2018)

Residential landscape can provide people the opportunity to experience nature, positive impact on the climate and ecology, provide comfortable temperature, and aid the economic value of the property. (Fitrynadia Mohd Shahli, 2014) The study helped to create a set of parameters that can be looked upon while designing a residential building in Kerala. Landscape design can help modify the outdoor and indoor environment in addition to the visual and aesthetic values of the built-up area, thus, improving the overall energy efficiency.

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Author Profile



Anamika Joggy received her Bachelor of Architecture (B.Arch.) degree from TKM College of Engineering in 2021. She is currently pursuing a Master of Design (M.Des.) in Furniture and Interior Design at National Institute of Design. Her academic and professional interests focus on sustainable built environments, passive design approaches, and human-centered design. She has professional experience working on residential, interior, and resort projects, contributing to design development, visualization, working drawings, and site coordination.



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