

# Bioclimatic architecture in East-Timor – a path to sustainability

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**ABSTRACT:** The purpose of this study is to provide a contribution to the definition of environmental design strategies applicable to East Timor architecture. In this way, it tries to identify sustainable constructive solutions that can be adapted to the local climate in order to produce buildings with a good environmental performance, and reduced energy consumption.

To do so, a field study was carried out, involving the bioclimatic analysis of several types of architecture existing in the region, from the vernacular architecture and colonial buildings to the contemporary post-independence architecture.

The weather in Timor is mainly hot, with small daily and seasonal temperature amplitudes, and high air humidity. Altogether, these factors determine the quality of human comfort. The thermal issue was therefore the main concern behind the search for architectural solutions, considering passive cooling design strategies aiming to reduce or simply avoid the use of air conditioning. The final result is a summary of passive design solutions that may present a significant contribution to a sustainable development of the territory.

**Keywords:** Architecture, Bioclimatic Design, East Timor, Comfort, Passive Design, Sustainability.

## 1. INTRODUCTION

The application of this study is restricted to the East Timor territory, in a context of sustainable reconstruction and of the project options that can result from that premise.

The choice of the proposed theme had to do mainly with the need of bringing to one's mind a sustainable architecture that can be reconstructed according to:

1. The adaptation to the climatic context and a balanced management of the natural resources;
2. Social and economic needs;
3. The current cultural context and the historic truth that must be kept in the search for East Timor's national identity.

Regarding the sustainability concerns, the emphasis was mainly given to the passive design issue. In this way, we tried to identify passive design strategies that can be easily referred to in practical applications that embrace the environmental component of architecture. That means a kind of architecture that can solve problems such as:

1. Maintaining environmental comfort and user satisfaction;
2. Reducing energy consumption in buildings and its ecological and economic impacts.

The practice of architecture in East Timor brings out the necessity of having a guide of recommendations that can help the professionals with the choice of the best means for achieving safe results, in a swift and accurate way.

The lack of Timorese specialized staff led to the cooperation from foreign countries, namely Portugal, and several Portuguese institutions such as Instituto Camões, Universidade Técnica de Lisboa and Instituto de Emprego e Formação Profissional, in a

solidarity and humanitarian initiative that had the objective of sharing knowledge with a country which had nearly lost the habit of conceiving projects.

Therefore, the main goal of this study is to provide some support to the architects, by recommending passive design solutions for the territory.

The necessity of building quickly and inexpensively, combined with the specific conditions of this country, point out the extreme importance of implementing sustainability strategies, by taking advantage, for instance, of passive design solutions. These systems deal with design strategies that take into consideration the climatic context, selecting the benefits that climate can provide, reducing the need of energy consumption of non-renewable energy sources to provide artificial lighting and acclimatization.

As it is widely recognized by the scientific community, that energy consumption from non-renewable sources, such as oil or coal, is responsible for producing large quantities of GHG's, particularly CO<sub>2</sub>. The CO<sub>2</sub> emissions are also largely responsible for the subsequent climate changes, namely the global heating. In the European Union, for instance, it is estimated that the building sector is, on average, responsible for around 40% of the whole amount of CO<sub>2</sub> emissions.

Therefore, there is an urgent need of reducing the energy consumption through bioclimatic architecture. Firstly due to the social, economic and cultural needs of the country, and secondly to contribute as an emerging example of a sustainability policy for the 21<sup>st</sup> century. "Bioclimatic architecture" is a term that has always been present in this study. It is important to clarify that the prefix "bio" is used precisely to demonstrate that the adaptation to the climate

conditions occurs by natural processes and with minor negative impacts on Nature.

This way of thinking brings skill and art together, in a natural and intuitive way. All architecture professionals should know how to use the different kinds of passive strategies in their projects in the most correct way.

Considering sustainability principles, the use of conventional mechanical systems to obtain comfort - like air conditioning - is now questioned in a newborn fragile economy. In this way, could the passive systems be seen as the correct option from an economic point of view? And what about in a cultural perspective, in a place where the bioclimatic architecture is 100% acceptable, as a result of the skill and creativity developed throughout the centuries in order to provide solutions adapted to the local climate?

The purpose of this study is not to find an architecture style, nor to focus on aesthetical issues. It is, instead, to find project options that take into consideration the climatic context as a fundamental and guiding reason in the process of conceiving architecture.

## 2. BIOCLIMATIC DESIGN, STRATEGIES FOR EAST TIMOR

Bioclimatic architecture does not provide the same kind of environment as air conditioning, and it doesn't intend to. Its intention is to create environments with satisfactory comfort levels, establishing an adaptive balance relationship between inner and outer space.

When there is a large difference between the air conditioning environment and the outdoor environment, the discomfort felt by the building occupants may be very high. This was the situation happening in East Timor, which led us to reject this system also for comfort reasons.

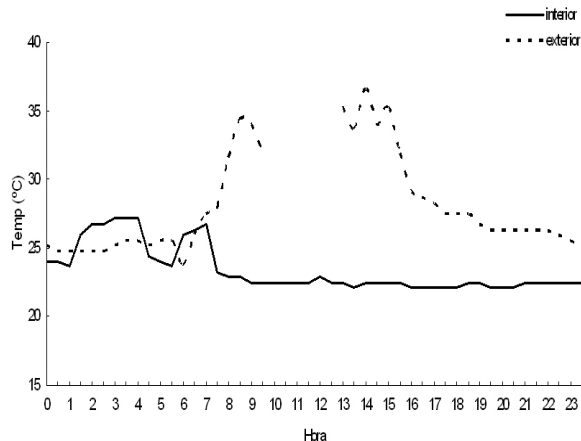


Figure 1: Acclimatize Inside and outside temperature in Dili, April 2005.

Being inquired on this subject, a significant number of Timorese people answered in an unfavourable way towards the use of air conditioning (figure 2). They were in fact unsatisfied with the sudden change of temperature when going outdoors, a situation that caused them discomfort and also

health issues related to colds and even pulmonary diseases.

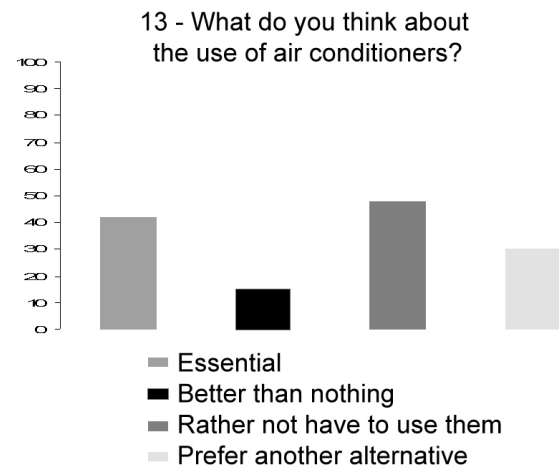


Figure 2: Answers towards the use of air conditioning.

Many Timorese people said that they didn't like to use air-conditioning mainly for health reasons. However, 43% of the inquired revealed that they used air conditioner to improve their comfort level. As we would expect they were mostly foreigners, with superior incomes and higher comfort standards; some of them are also Timorese that answered to this inquiry regarding the buildings where they work in, most of them belonging to foreign companies.

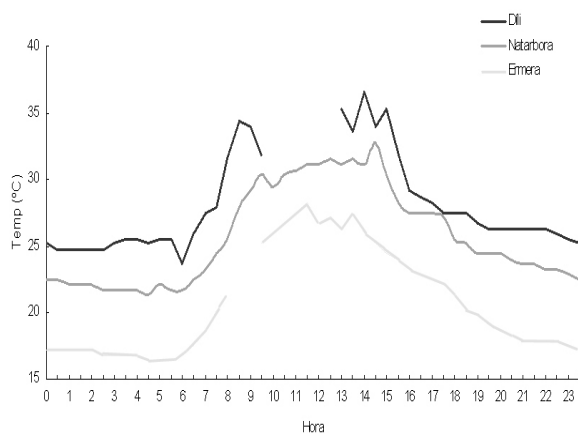
The fact that mechanical ventilators don't work correctly – and we often found case studies in which fans were misplaced – may prove the common idea that air conditioners are essential, along with the social and economical “status” that also comes associated with such devices. It is also important to call the attention of users for the environmental damages caused by air conditioners.

It can therefore be said that the temperature of air conditioners should be adjusted to warmer levels in order to avoid extremely high differences between indoor and outdoor temperatures. But then, speaking from a sustainability point of view and looking for an energy consumption reduction, it is possible to reach those temperatures through a set of bioclimatic strategies.

**Thousands of years living without air conditioning weren't necessarily years of discomfort for all mankind!**

The field study that supported this thesis revealed a set of bioclimatic strategies that can potentially work in an efficient way for East Timor territory.

The first task is to define the building site, which will probably be located near the seashore or in a high altitude area. In this last case, it's not necessary to pay that much attention to thermal comfort aspects, except to the ones that have to do with solar intensity and with providing the buildings with mechanisms that can control effectively ventilation and insulation.



**Figure 3:** Outside temperature in Dili (seashore), Natarbora (medium altitude area) and in Ermera (high altitude area), April 2005.

The design strategies to follow must consider a group of actions that can be taken to reach thermal comfort, regarding an adaptive comfort criterion [1].

Designing buildings located in low altitude areas demands the architect's extreme attention when developing constructive solutions, because even a small mistake may contribute to overheating and, consequently, to the failure of the final result. The designer must always bear in mind the very specific climate of East Timor. When it's necessary to develop a project while being out of the territory, he must be capable of distracting himself from his surrounding environment.

The following strategies are a result of the field study and the previous experience in developing projects for this region. Therefore, we tried to choose the most efficient strategies among the different types of architecture that have been identified.

From a heat protection point of view, we must:

1. Prefer long shapes and avoid excessive building depth, in order to promote crossed ventilation. Using high ceilings allows hot air to flow in the upper space and keeps it away from the occupant.



**Figure 4:** Dr. Ramos Horta House, Dili.

2. Shading of windows, door and facades must be carefully designed, in order to obtain a positive balance between the need of shading and the control of natural lighting; the roof must protect the remaining building elements: take advantage of shading, for instance locating buildings in arborous places so that the trees and plants can work as natural shade providers.



**Figure 5:** Building locate in an arborous place, Dili.

3. The building insulation must work efficiently, especially in the roof. Local, and traditionally used materials like gomuti can be used in it.



**Figure 6:** Gomuti over zinc, Portuguese School, dili.

4. When choosing a less inclined roof, we must use light-coloured covering materials as often as we can to reflect the sunlight;
5. The reduction of indoor heat gain must be obtained by selecting areas like terraces where several activities can take place; other rooms like sanitary facilities or kitchens may also reveal an interesting compromise between semi-closed and fully closed areas.



**Figure 7:** Building with terrace, Venilale.

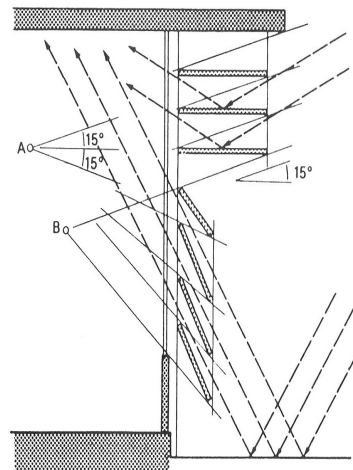
From a heat dissipation point of view:

1. The ventilation is essential; it must be efficient. We must always keep in mind that protecting away from mosquitoes with mosquito nets can affect the ventilation. We must design the ventilation path inside the buildings accurately, and they must have preferably long-shape plans that allow cross ventilation in all rooms. One of the first references for this study, namely the Baruch Givoni [2] psychrometric chart, indicates that comfort can be obtained through ventilation processes in tropic regions like it is East Timor.
2. We can use fans as an auxiliary system for natural ventilation in order to increase the convection and evaporation of skin [3]. According to the majority of users, these devices have shown good results and their use must be encouraged. They are in fact a low energy consumption alternative, when compared to air conditioners.



**Figure 8:** Fan.

3. The windows must have systems that allow ventilation adjustment, like for instance window blinds. The results of the questionnaire demonstrate that the adjustable elements were preferred over the fixed ones.



**Figure 9:** Window blinds, from Koenigsberger [4]

4. Considering Timor's tropical climate, with high humidity, heat and low daily temperature (below 8°C), the use of thermal inertia is not desirable; a high thermal inertia may contribute to overheating and condensations.
5. Ceilings should be high, because low room heights and small volumes are not efficient enough, as they concentrate hot air closer to the occupants; we should also include air exits on the roofs that allow the hotter air to go outdoors.

The construction of a building in such a climate should meet some minimum requirements: it should promote efficient ventilation in a continuous way; it should prevent heat entering during daytime by having the adequate systems to do so, protect people from rain and from mosquitoes. In this way we conclude that the houses must have wide shading areas, low thermal inertia and generous ventilation [5].

The prevalence of high relative humidity levels brings out the necessity of air speed adequate enough to promote an efficient perspiration, as also to avoid, as much as possible, the discomfort caused by the humidity in clothes and in skin. Continuous ventilation is therefore the most important requirement regarding comfort, and it affects all building design aspects such as orientation, size, window location or surrounding outer shape. We should encourage the use of fans instead of air conditioners.

This is the right path; we must conceive valuable bioclimatic architecture in order to raise the users' expectations about environmentally friendly systems. Timorese people must learn that they can be an example of an emerging country supported by sustainability principles.

We analyzed some examples from the three major climate zones: the northern region, the mountain region and Timor's Southern region.

Besides these climate zones, the different types of construction selected were also analyzed as examples, in a context of the Timorese architecture typologies, like vernacular buildings, Portuguese colonial buildings, Indonesian buildings and also contemporary architecture.

After having studied several recently restored buildings in East Timor, we noticed that they are getting more and more insulated from the outdoor environment. It is crucial that the integration of bioclimatic design in the process of conceiving architecture doesn't confine itself to the design of new buildings only, but will also be applied in reconstruction projects. Restoration is in fact very important from a sustainability point of view, as it involves less embodied energy.

For this study, we analyzed examples of passive systems that are used in the territory since its human occupation, like the use of local vegetal materials and its construction system, that reflect mainly the knowledge developed over thousands of years. Through the recent analysis of the architectural heritage we could also identify several examples of how constructions adapt themselves to the climate that should be followed also for cultural reasons.

Passive systems, besides trying to reach satisfactory comfort levels for the occupants, have a clear goal of reducing energy consumptions. In this way, we are in the right path towards sustainability, in both economical and ecological terms.

The conventional air conditioning system is often preferred even in temperate climates, like the Portuguese. Too many people want to use air conditioners, but few of them know the risks they represent towards a path to sustainability.

Residences with air conditioners are not good examples. The ones to follow are those who show a climatic adaptation, using local resources such as construction materials and taking advantage of knowledge acquired across generations.

A deep understanding of the heat transmission physical phenomena, combining the experience of the buildings relationships with the thermal comfort phenomena, can lead to better and more satisfying results.

Passive design can significantly reduce, or even eliminate the need for conventional acclimatization systems. Adopting solutions that can lead to the prevention or the diminishing of heat gains, as well as strategies that result in heat dissipation processes, will certainly mean a reduction on cooling needs and an improvement in thermal comfort conditions.

It is also important to notice that bioclimatic architecture makes sense in several types of buildings, configurations and different architectural styles. In this way, it cannot have a single or unique style, nor be associated with any kind of formalism. The prevention or the protection from heat gains can be included in all kinds of buildings through different architecture options. The good architecture is the one that considers all the existing variables within a given context.

We analyzed projects that have shown highly appropriate strategies to the territory. Among them, the narrow means available, encouraging a modular and updated logic in construction, and the architectural language, whose plastic values reveal shapes and spaces that work together with collective pre-existing memories already adopted by people as their cultural roots, alongside with materials, elements and traditional Mauberian shapes.

Bioclimatic architecture can be seen as traditional architecture and this national identity can become a true inspiration for architects.

We should never forget that mankind has lived for ages without air conditioning, and on behalf of a sustainable development, we must come up with good examples of climate-adapted architecture. There are some good examples of contemporary passive design with good comfort levels, like for instance Dr. Ramos Horta residence. Air conditioning raises comfort expectations, and that doesn't contribute to a sustainable development.

The constructive logic must respect the values, the methods and the traditional imagery. Using these passive design strategies, as well as other concerns emerging at a construction economy level, is a very important step towards the territory's sustainable development – especially when talking about reference buildings – important role models to be followed by present and future generations.

The analysis of the architectural whole, even being general, confirms the urgent need of a programmed action in the construction industry. The precariousness and the shortage of residences, the lack of economic means for the population to conserve them and the poor levels of habitableness generated by those factors make this industry one of the most seriously affected.

In a strategy of intervention established on the maximization of existing resources, we should conduct a national construction policy supported by sustainability logic, one of extreme importance for the development and the well being of Timorese people.

### 3. CONCLUSION

This paper shows that there is still a lot to be done in this field and we have no time to wait for political decisions. We can start off by drawing the attention of everyone who has anything to do with the construction industry, especially architects, engineers and other project designers. This must be seen as the very first step and it demands the development of the research on this subject.

Promoting bioclimatic architecture is therefore essential, so that a sustainability strategy regarding the development and well-being of timorese people can be achieved.

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