

***Training on Energy Efficiency in Buildings  
of stakeholders in urban planning,  
construction and building***

***Organised by ECREEE***

**PRAIA, CABO VERDE, 9th-10th June 2014**

**SERA Sustainable Energy & Resources Availability**

**SUSANNE GEISSLER \_ CÉSAR FREITAS**

# *Bioclimatic and tropical architecture*

# ■ ■ Bioclimatic and tropical architecture

## ■ ■ Principles

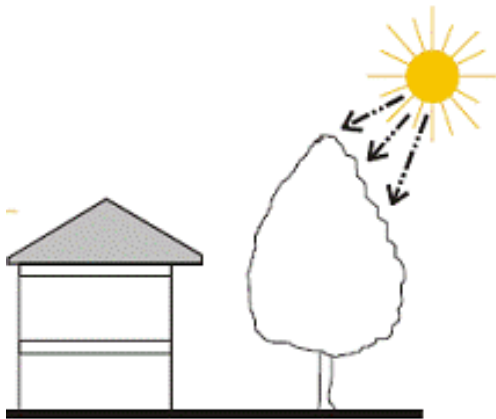
### > Principles

- > The consideration of the weather, hydrography and ecosystems of the environment in which buildings are built for maximum performance with the least impact.
- > The efficacy and moderation in the use of construction materials, giving priority to low energy content compared to high energy.
- > The reduction of energy consumption for heating, cooling, lighting and equipment, covering the remainder of the claim with renewable energy sources.
- > The minimization of the building overall energy balance, covering the design, construction, use and end of its life.
- > The fulfillment of requirements of hygrothermal comfort, safety, lighting and occupancy of buildings.

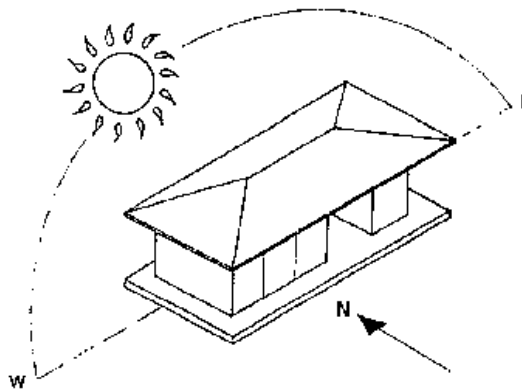
# Bioclimatic and tropical architecture

## Aspects to consider

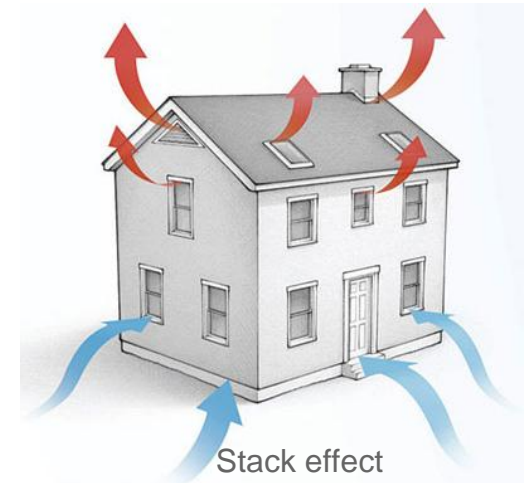
- > Aspects to consider and to make use of the natural environment
- > Sun orientation
- > Solar radiation (incidence of the sun)
- > Wind orientation
- > Difference of pressure
- > Stack effect
- > Local materials
- > Vegetation



Vegetation



Sun orientation



Stack effect

# ■ ■ Bioclimatic and tropical architecture

## ■ ■ Climate features | main design objectives

### > Hot and dry climate

> **Macro feature:** clear sky, dry atmosphere, extends periods of overheating and high diurnal range. Among the principle parameters of overheating is the formation of the dust particles in the air that absorb solar radiation and radiates heat through atmosphere

> protect from the intense radiation from the sun, ground and surrounding buildings, from dust, sandstorms and insects (flies and mosquitoes)

> maximize filtered air movement in summer

### > Hot and humid climate

> **Macro feature:** humid atmosphere, light winds and still air, extends periods of even overheating and low diurnal temperature range. The high amount of water vapor in this climate absorbs more of solar radiation that causes the uncomfortable feeling.

> maximize filtered air movement, speed up winds

> minimize humidity and avoid mould growth

> provide maximum shade, especially in late morning and all afternoon

# Bioclimatic and tropical architecture

## Climate features | main design objectives

### > Hot and dry climate

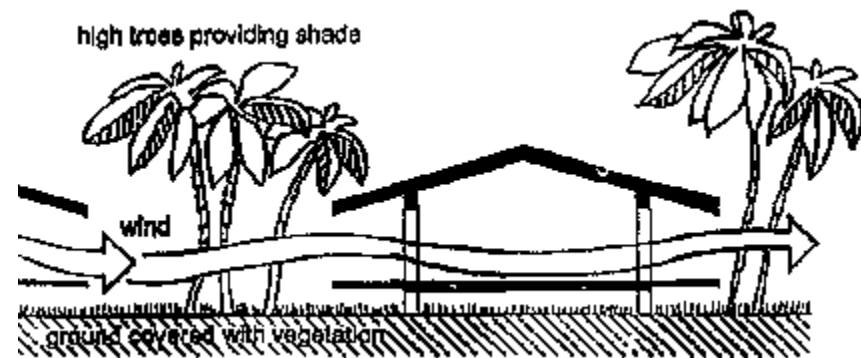
- > maximize humidity
- > provide maximum shade, especially in late morning and all afternoon
- > create cool and dark micro-climate
- > vegetation is desirable as a radiation absorbent surface and for its evaporative and shade properties



Vegetation in Mindelo, Cape Verde

### > Hot and humid climate

- > create cool and dark micro-climate
- > vegetation is desirable as a radiation absorbent surface and for its evaporative and shade properties. However, it has to be arranged in a way that does not impede air circulation
- > low building density for better air movement



# ■ ■ Bioclimatic and tropical architecture

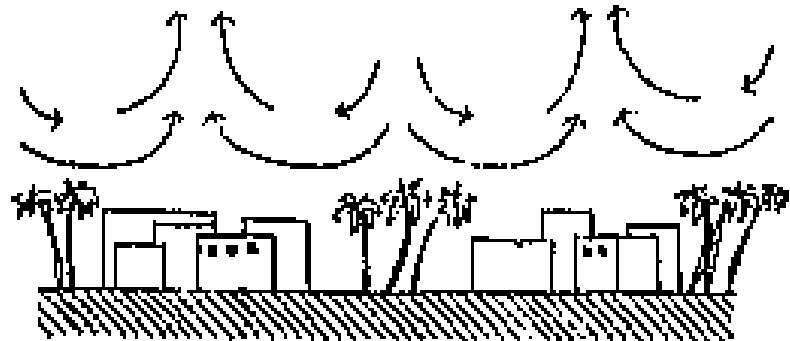
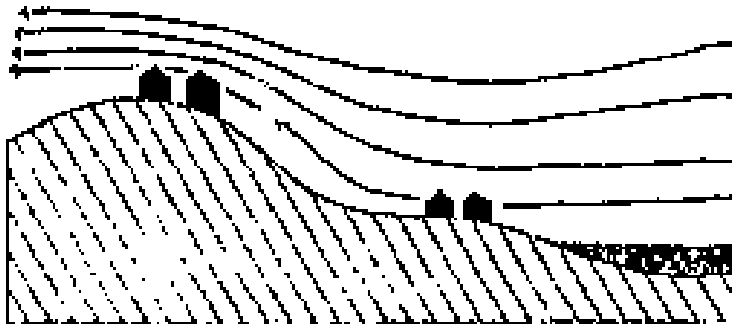
## ■ ■ Some recommendations for building design

### > Hot and dry climate | hot and humid climate

> building should be sited in high altitudes for maximum cool airflow and locations with evaporative possibilities are advantageous

> settlements have to be properly oriented regarding prevailing winds

> settlements in flat areas (less natural features: hill sides, slopes) should include vegetation because the air is cooled while crossing green shaded areas





# Bioclimatic and tropical architecture

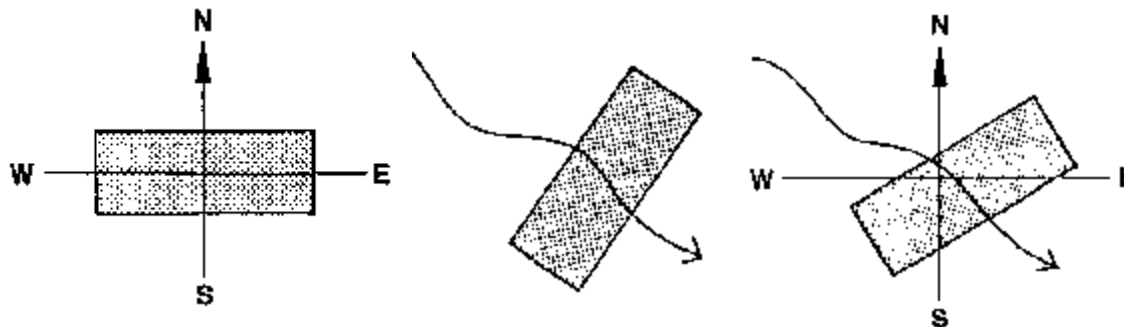
## Some recommendations for building design

### > Hot and dry climate | hot and humid climate

> sun orientation: preference for north-south orientations of the main facades of the building

> wind orientation: main walls and windows should face the prevailing (cool) wind direction in order to allow maximum cross-ventilation of the rooms

> often the above two parameters are contradictory. In this case, a reasonable compromise should be made based on a detailed analysis of the specific situation, considering the possibilities for diverting the wind direction by means of vegetation and structural arrangements

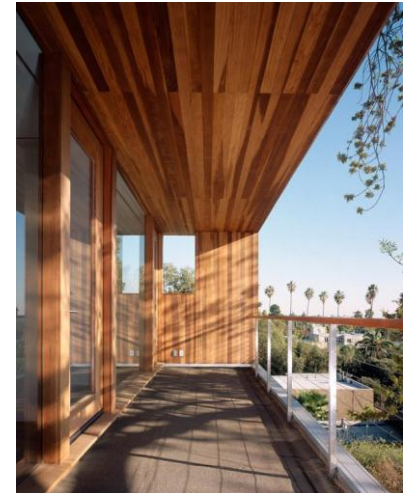
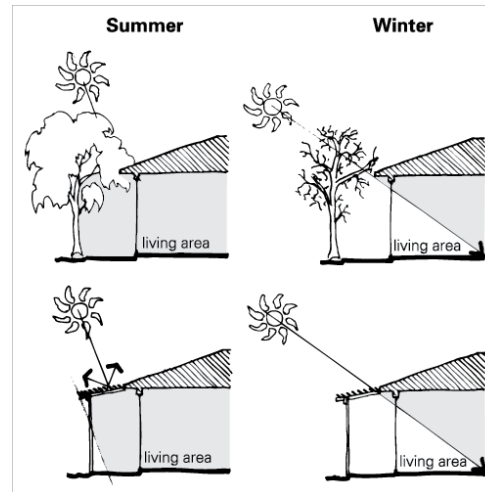




# Bioclimatic and tropical architecture

## Some recommendations for building design

- > Hot and dry climate | hot and humid climate
- > use decks, as they are less reflective, less hot and allow air circulation underneath
- > orient active living areas to the southeast to collect early morning sun
- > glass areas should face south with properly designed overhangs
- > use deciduous trees in south
- > east and west windows should be avoided to minimize radiation with low sun angles



# ■ ■ Bioclimatic and tropical architecture

## ■ ■ Some recommendations for building design

> Hot and dry climate | hot and humid climate

> outlets at higher levels serve to vent hot air

> semi open spaces such as balconies and porches can be used advantageously for daytime activities as well give protection from rainfall. In multistoreyed buildings a central courtyard can be provided with vents at higher levels to draw away the rising hot air

> the form of the roof should be planned to promote air flow. Vents at the rooftop induce ventilation and draw hot air out. A double roof with ventilated space in between can be used to promote air flow. The space between can also act as a heat buffer.



# ■ ■ Bioclimatic and tropical architecture

## ■ ■ Some recommendations for building design

### > Hot and dry climate | hot and humid climate

> use exterior shading devices: venetian blinds, trellises, overhangs, balconies, decks, trees ...

> air should enter the building through shaded outdoor areas, avoiding passing through heated surfaces

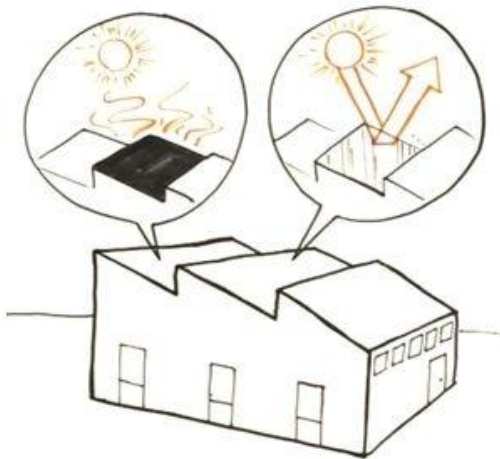
> seal windows and door openings with mesh screens made of stainless steel or plastic and position them in front of the fenestrations - for protection against mosquitoes and flies



# ■ ■ Bioclimatic and tropical architecture

## ■ ■ Some recommendations for building design

- > Hot and dry climate | hot and humid climate
- > use north and east areas for outdoor activities
- > use low conductive, high reflective materials of light color in sun-exposed surfaces and dark color in shaded surfaces
- > use local, sustainable and durable materials and local constructive technics
- > heat and moisture producing areas like toilets and kitchens must be ventilated and separated from the rest of the structure



# Bioclimatic and tropical architecture

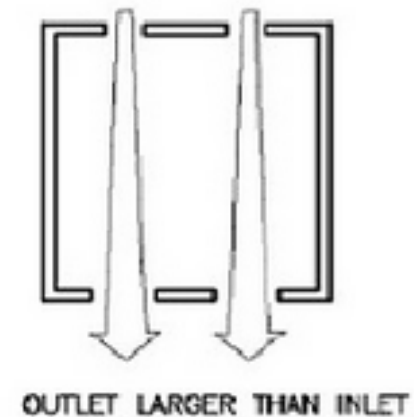
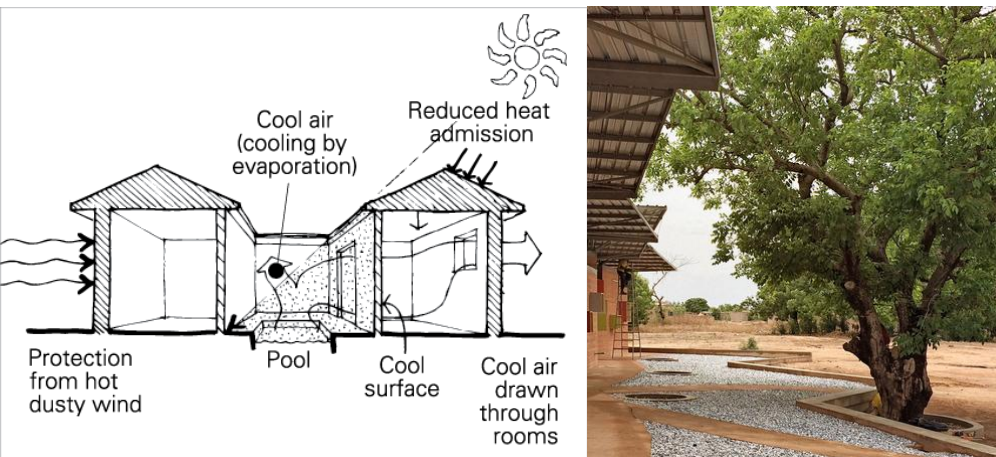
## Some recommendations for building design

### > Hot and dry climate

- > use balconies, overhead canopies, courtyards and canopy trees to slow evaporation
- > cluster buildings and utilize solar panels for shade

### > Hot and humid climate

- > the surface finish should be protected from / resistant to the effects of moisture
- > openings of a comparatively smaller size can be placed on the windward side, while the corresponding openings on the leeward side should be bigger for facilitating a plume effect for natural ventilation



# Bioclimatic and tropical architecture

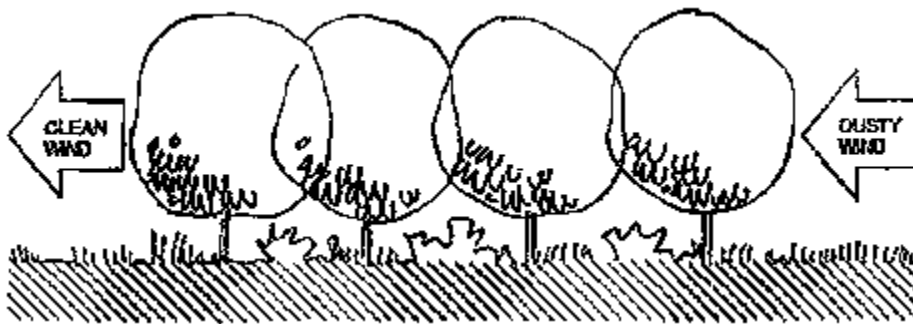
## Some recommendations for building design

### > Hot and dry climate

- > use dust and draught resistance vegetation
- > use of vegetation: garden covers / roofs and green facades
- > tight closing joints and window profiles are important to prevent the penetration of hot air, sand and dust

### > Hot and humid climate

- > separate buildings and utilize solar panels for shade
- > walls: the walls must be designed to promote air flow so as counter the prevalent humidity. Baffle walls can help to divert the flow of wind inside.



***Thank you for your attention!***

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