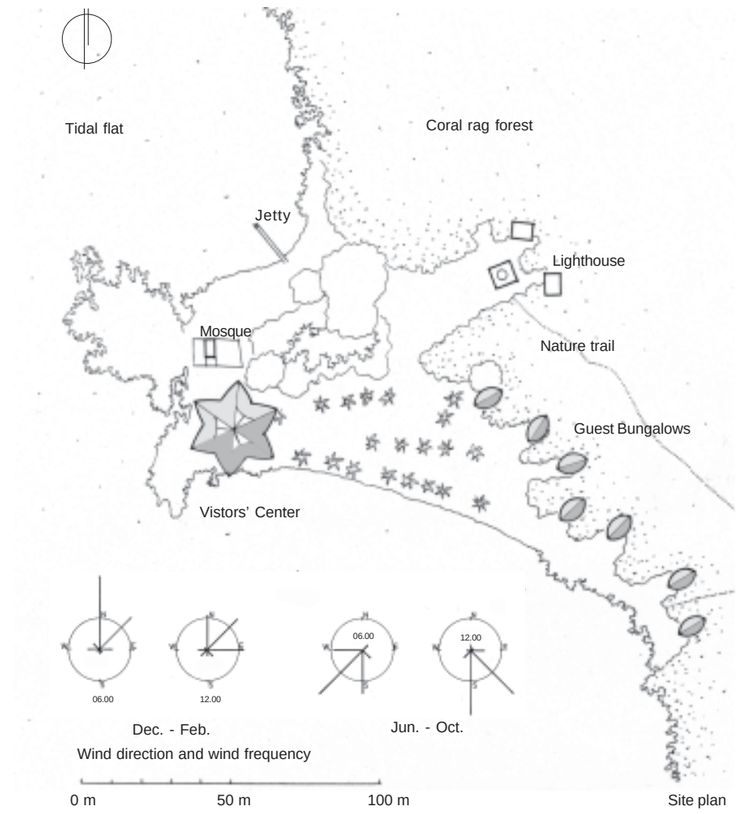
# CHUMBE ISLAND CORAL PARK, ZANZIBAR, TANZANIA

The old lighthouse, built in 1906, and the newly built dome of the Visitors' Centre form a land mark for boats sailing between Zanzibar and Dar Es Salaam.

Chumbe Island, Tanzania's first Marine Park, with its endemic coral rag forest and under water coral garden. The aerial photo and siteplan show the lighthouse, Visitors' Centre and the Guest Bungalows




## THE PROJECT

The Chumbe Island Coral Park project demonstrates sustainable use of a tropical island for the benefit of Zanzibar society. This is achieved by protecting its coral reef, which is of exceptional biodiversity and beauty, and a coral rag forest by means of park management and environmental education. The project is supported by tourism and combines local traditions with modern environmental architecture.

Chumbe Island is situated 12 km south-west of Zanzibar Town and was declared a protected area in 1994. The first Marine Park in Tanzania is managed by the Chumbe Island Coral Park Ltd (CHICOP), a private company.

All infrastructural development has been carried out in a sustainable and environmentally-friendly way, using technologies which have close to zero impact on the environment. The buildings were especially designed and built for this ecologically most sensitive island.

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The dome of the Visitors' Center under construction. The dome is probably the biggest free-spanning dome made from slender poles and coconut ropes.

The Western terrace of the Visitors' Centre facing seawards, showing the footing point of the dome.

Latticed shell under construction

Southern tip of Chumbe Island with Guest Bungalows placed carefully into the forest

View on to the dome of the Visitors' Centre

Part of the 21 m free-spanning roof construction, built from slender local poles

## CONSTRUCTION

Seven bungalows for visitors were carefully placed in the pristine forest. The former lighthouse keeper's house was converted into a Visitors' Centre and was given a new roof dome. The historic mosque and lighthouse remain untouched.

The architecture expresses the African building traditions in a modern and sustainable way and creates an atmosphere of harmony and understanding of the surrounding nature. Its innovative construction and environmental technology is based on traditional building techniques and local materials. It provides valuable experiences in sustainable housing technologies for remote areas and supports small scale industries in the local building sector.

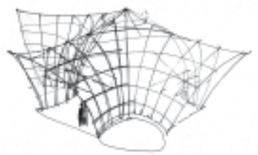
Each building functions as a self-sufficient unit by generating its own energy and water with solar water heating and photovoltaic electricity and rainwater catchment and filtration. Sewage is avoided by using composting systems; plant beds utilise the grey water.

The shape of the roof enables perfect ventilation by sea breezes. The thatched roof structures follow the principle of latticed shell constructions and are made traditionally from local poles and ropes.

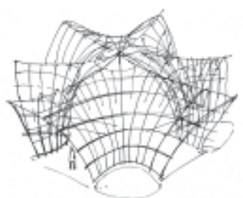
Since 1998 the project has proved its benefit to the Islamic society of Zanzibar by protecting the island, its surrounding reef, and educational activities.

The roof is a free-spanning latticed shell construction out of slender unbarked poles joined with coconut rope

Construction principle of the Guest Bungalow

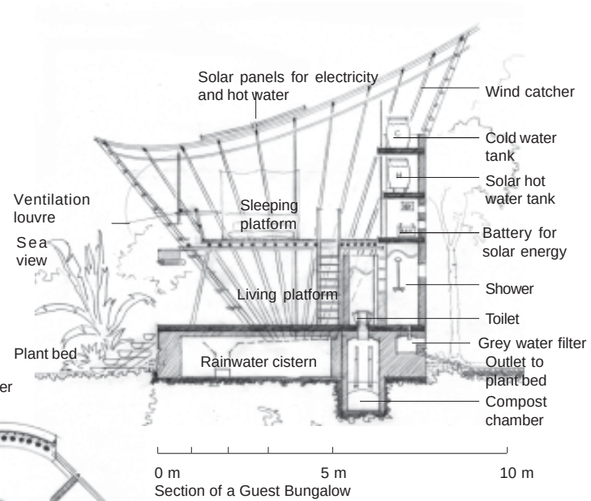


Addition of the construction modules

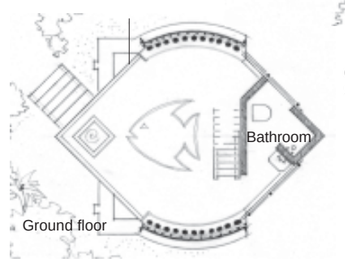


Construction principle of the Visitors' Centre

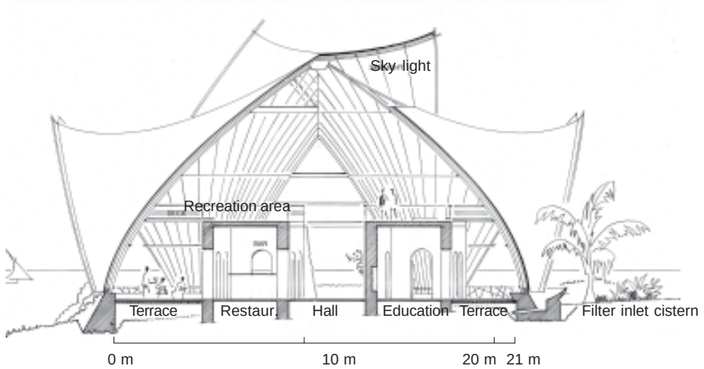
Guest Bungalows placed in the lush vegetation. The roof was designed for perfect ventilation and sea view.




Section of a Guest Bungalow




Each building functions as a self-sufficient unit by generating its own energy and water with solar water heating and photovoltaic electricity, and rainwater catchment and filtration. Sewage is avoided by using composting systems; plant beds utilise the grey water.



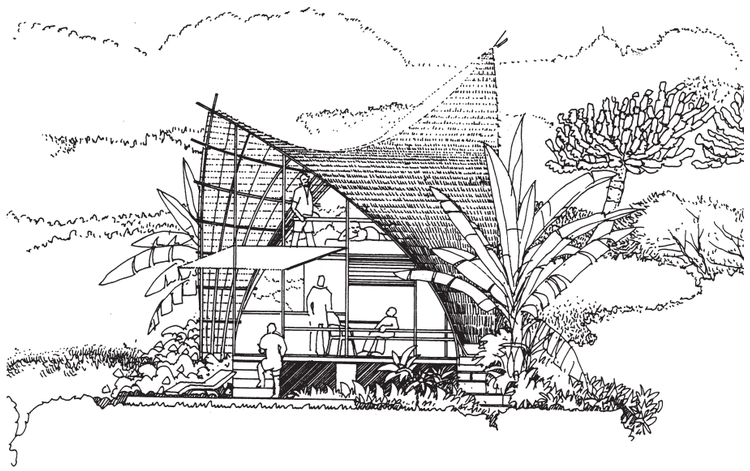

Cross section of the Visitors' Centre showing the impressive inner room of the new dome.The old light-house keeper's house divides the building into different areas on the ground and first floors.

Under the newly built roof dome is the centre for education for local school classes (see picture above), fishermen and tourists. Facilities for visitors, such as a restaurant, recreation areas, reception, office and a kitchen are also integrated in the building.

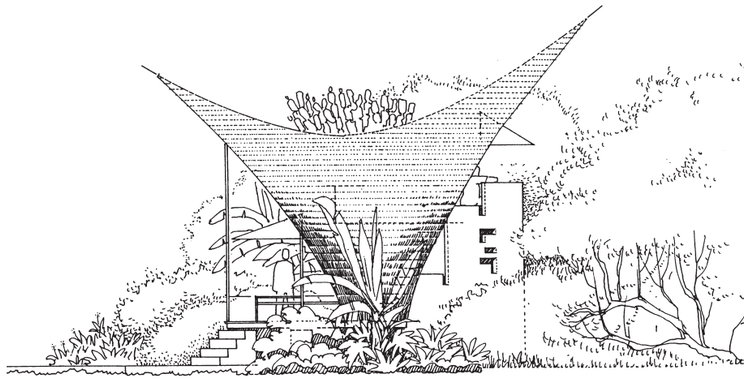
Locally made furniture in a bungalow

Sea view from the bungalow sleeping platform showing the roof construction

# GUEST BUNGALOWS



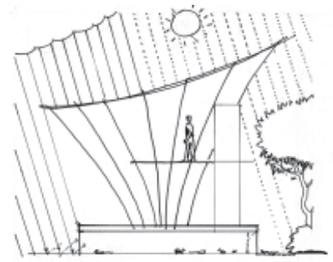
Sketch view of the Guest Bungalow from the sea



Sketch view of the Guest Bungalow from the side

The Guest Bungalows are small units carefully placed into natural clearings in the coral rag forest. Without disturbing the surrounding nature they offer protection from sun, rain and insects, and use the wind for ventilation. The bungalows provide the guests with water and electricity. The construction, the orientation and the interior of the bungalows give the visitors the sense of being alone on an island in harmony with nature.

**Design concept:**



The roof protects the guests from sun and rain. Only the evening sun can enter the building. The solid base of the bungalow protects from insects and water.

The roof acts as a wind catcher. During the south-west monsoon it is open to the sea with a closing ventilation louvre in the case of storms. During the north-east monsoon the roof is high enough to catch the breeze which blows above the tree line.

The house is a composition of the solid base and tower for the technical components (here the grey part), and the light-weight roof. The position of the bungalow was determined by the seaview and the natural surrounding features.

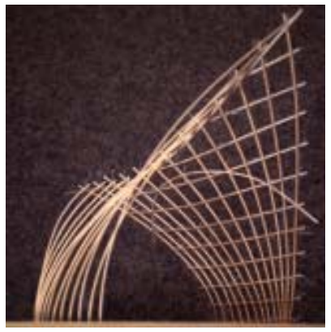
# CHUMBE ISLAND CORAL PARK, ZANZIBAR, TANZANIA

Latticed shell roof on top of the solid base which forms the cistern and rainwater filter

The bungalows are embedded into the forest; every guest is by himself with nature.

The bound roofing construction is visually attractive

The elevated base forms the living platform and offers a splendid seaview



The latticed shell framework as a model

... and in reality

The floor is made from coloured cement decorated with marine motives

'Technic Tower' with hot and cold water tanks, solar power system

Rainwater filter and overflow

Sleeping platform

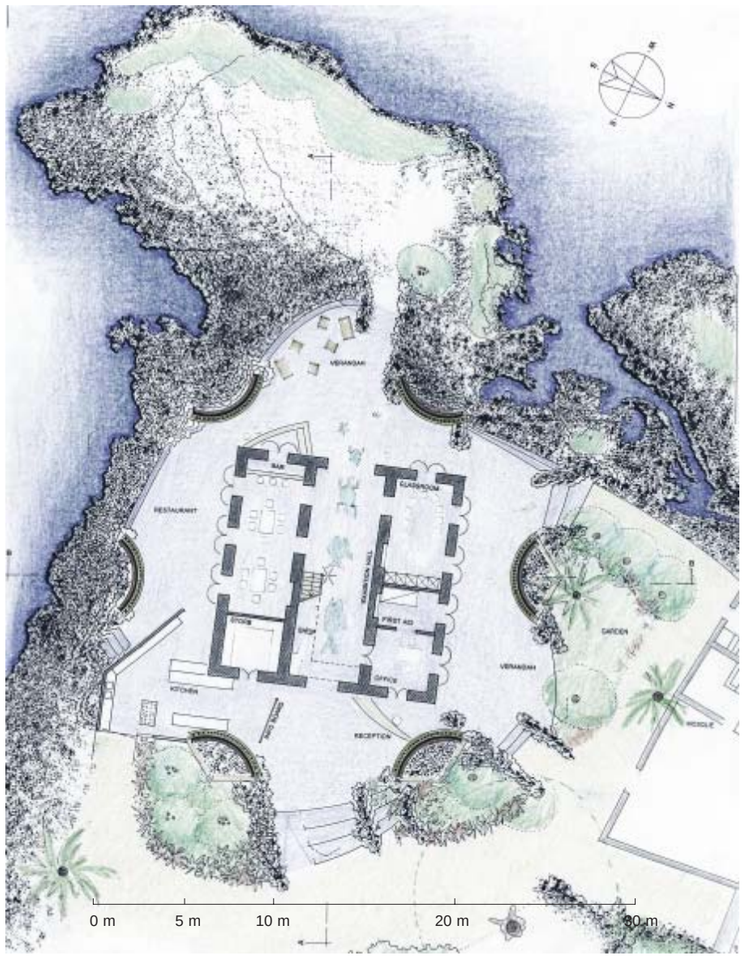
## VISITORS' CENTRE

## CHUMBE ISLAND CORAL PARK, ZANZIBAR, TANZANIA

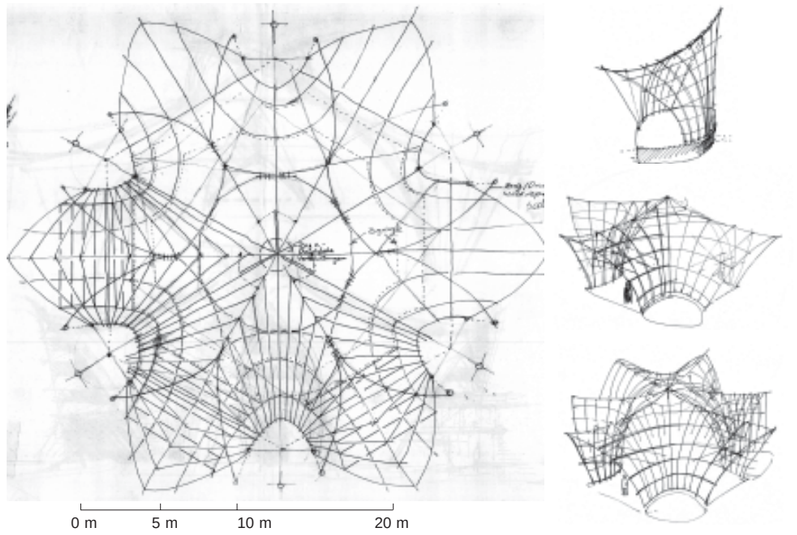
The new roof dome of the Visitors' Centre vaults over the former lighthouse keeper's house.The centre, with its reception area, restaurant and kitchen, and a classroom for environmental education, offers shaded and well-ventilated verandahs and decks with a splendid view of the surrounding nature.

The roof forms a large free-spanning latticed shell construction from slender poles and coconut rope which are bound together with a traditional technique.

View of the vertex and a skylight of the roof dome.

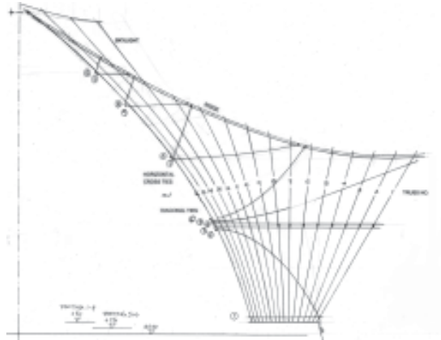



Ground floor of the Visitors' Centre with surrounding landscape, showing the feature position of the Centre at the edge of the elevated coral rag platform. This converted lighthouse keeper's house now offers areas which can be closed off for different functions. Several verandahs are grouped around the core building, and harmonise it with the landscape.




Sketches of the construction principle: the latticed shell dome is the result of an addition of six single modules. These bear their origin in the construction of the guest bungalows.

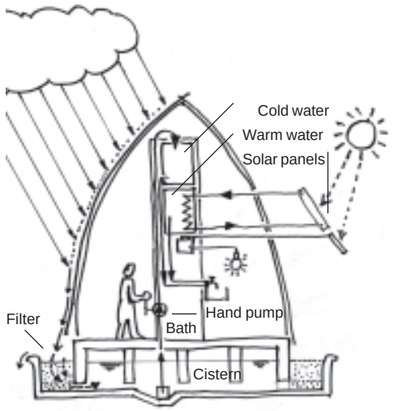
The lattice shell under construction



Section of one module showing the heights of the frames.

Partial view of the inner dome showing the areas on top of the lighthouse keeper's house.

Exhibition area with stairs to the top floor.




Scheme of the freshwater system:
The bungalow and the technical components form an integrated system

'Technic Tower' at the rear of the bungalow with hot and cold water tanks and space for solar batteries.

## Introduction

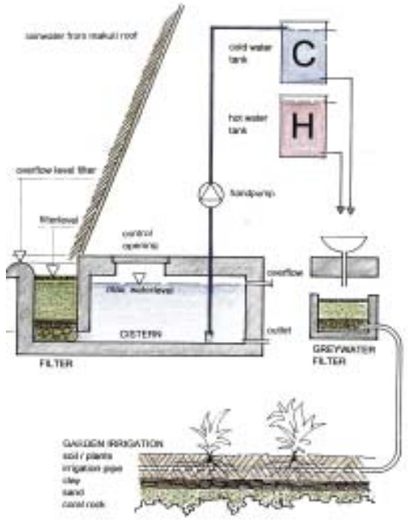
Each building functions as a self-sufficient unit by generating its own water and energy with rainwater catchment and filtration, solar water heating and photovoltaic electricity. Sewage is avoided by using composting systems, and plant beds utilise the grey water.

## Solar energy

Small decentralised solar power systems provide electricity for lighting in the bungalows. The Visitors' Centre has its own solar generator lighting. A DC/AC converter enables TV sets and Video players to be used for educational purposes.

## Fresh water

Chumbe Island has no source of fresh water other than rain. Therefore rainwater catchment provides the most feasible water supply for drinking and washing. From the roof of each building the rain water is funnelled via a sandstone filter into a cistern which forms the base of each Guest Bungalow and parts of the Visitors' Centre. The large size of the cistern enables water storage during an average rainy season sufficient to provide the bungalow with water even during the following dry season. For showering, the water is heated by a solar water heater attached to the rear of the technique tower.

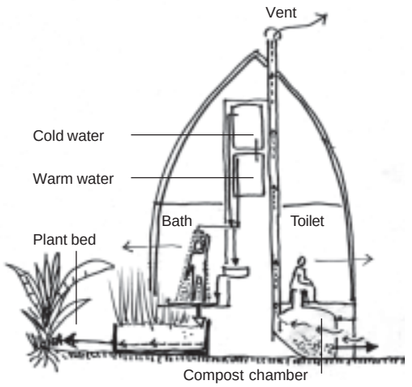



Scheme of the fresh and grey water system

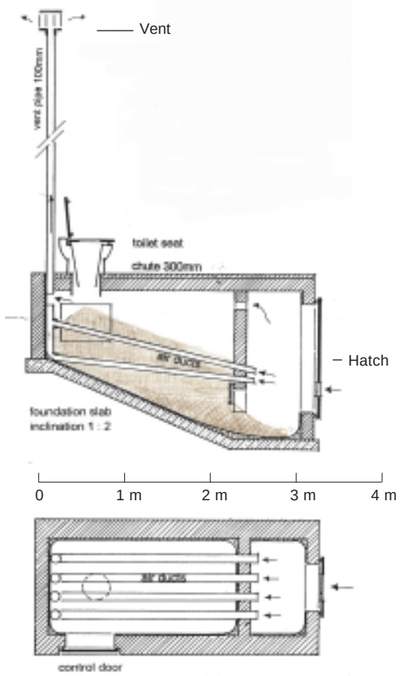
Plant bed and filter inlet in front of the bungalow

## Grey water

The slightly-soiled water from the bathrooms is directed through a filter bag for large particles into a coral-stone-filled ventilated water tank. Here the first stage of microbial decomposition takes place by the process of oxygen enrichment of the water. The water is then collected in a small reservoir which empties within twelve hours via a drip-irrigation system. The whole system, including the pipes and the reservoirs, are screened from insects. The irrigation hoses are placed in a vegetated soil bed with a sealed base. Soil bacteria in the humus soil purify the nutrient-rich water completely. Specially-adapted plants absorb the water continually, keeping the ground porous and supporting microbial decomposition.




Scheme of the grey water and toilet system:
The bungalow and the technical components form an integrated system




Cross section and ground section of the compost chamber integrated into the solid base of the bungalow

## Compost toilet

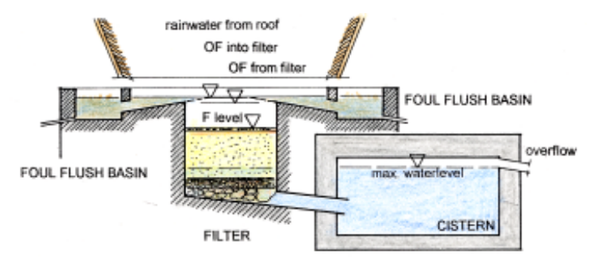
Human wastes are not flushed away with water, but fall directly into a hermetically-closed container. A sophisticated ventilation system enables aerobic decomposition to take place inside the container instead of anaerobic putrefaction. During the composting process the organic wastes are completely transformed into fertilising soil and a complete decomposition of all germs takes place. During the process the waste is reduced to one sixth of its original volume. The ventilation exit is located above the roof level and the suction in the ventilation pipe ensures an odour-free environment.

At approximately six month intervals, a small amount of soil can be removed and used as fertiliser. The completely-closed compost chamber is screened from insects. The toilet seats are tightly sealed, hygienic and easily cleaned.

The compost toilet system on Chumbe Island is based on the Swedish "Clivus Multrum Compost Toilet System", which proves 60 years of successful operation.

Formwork for the vaulting of the cistern ceiling with bricks in order to avoid the use of easily-corroding reinforcement bars

Foul-flush filter of a bungalow




Principle section of the rainwater filter for the Visitors' Centre

Rainwater gutter and filter and 'foul-flush' basin of the Visitors' Centre

'Technic Tower' of the bungalow with solar panels for hot water and cold water and electricity

## IMPRESSIONS ON CHUMBE ISLAND

## CHUMBE ISLAND CORAL PARK, ZANZIBAR, TANZANIA


Preliminary site plan of the project area during the design process.

Aproaching Chumbe Island and the Visitor's Centre by boat at low tide.

Three huge baobab trees are an impressive landmark close to the Visitors' Centre.

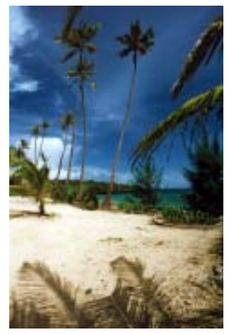
The top platform of the lighthouse offers a superb view over Chumbe Island and its reef. To the east, Zanzibar and to the west, the African mainland can be seen.

Northern tip of Chumbe Island showing the dense coral rag forest. A distance of approx. 12 km away is Zanzibar Town.

The lighthouse built in 1904 by the British, is still in operation.

The mosque was built for the lighthouse keeper in 1904.

The overhanging coral rag is densely vegetated with primary forest.



Coconut palms grow in a clearing made in 1904.

View of Chumbe Island from a ferry boat travelling between Zanzibar and Dar Es Salaam, mainland Tanzania.

## NATURE TRAILS ON CHUMBE

## CHUMBE ISLAND CORAL PARK, ZANZIBAR, TANZANIA

**Underwater nature trail:** the Chumbe coral reef sanctuary is home for more than 370 species of fish and most of the hard coral species in East Africa. Guided snorkelling tours are led by rangers.

Ranger explaining the fish identification card to a tourist, which is attached to the floating information device, moored on the reef.

**Intertidal nature trail:** this area is defined by the tidal changes and has many species of flora and fauna specially adapted to this harsh environment. This trail leads the visitors around the entire island.

Park rangers on the the intertidal nature trail at low tide underneath a coral rag overhang. In the background the Visitors' Centre can be seen.

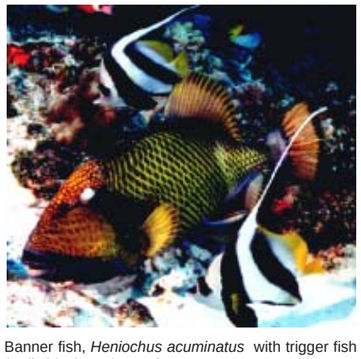
**Coral rag forest trail:** a clearly marked path with information boards and accompanying booklets guides the visitors through parts of the dense forest to the other side of the island .

A group of Zanzibari villagers on the forest nature trail looking at the dense vegetation, which roots itself and is nourished within holes in the rugged coral rag.

Lionfish (Scorpion fish), *Pterois miles,* hovering over fire coral, *Millepora sp.*

Digitate and branching species of *Acropora* corals dominate the reef crest.

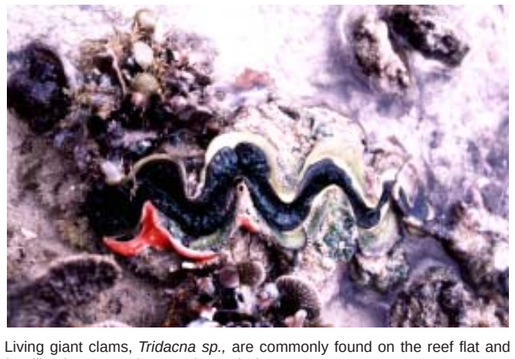
The palm climbing coconut crab, *Birgus latro,* is common on Chumbe Island but is red listed as an endangered species.



Banner fish, *Heniochus acuminatus* with trigger fish (Balistidae) on the reef.

Brain coral, *Leptoria phrygia,* showing worm tube hole.

Sea star, *Protoeaster lincki*



Living giant clams, *Tridacna sp.,* are commonly found on the reef flat and fossilised ones on the coral rag platform.

Fire ball lily

Mangrove kingfisher, *Halcyon senegaloides,* is one of more than 70 bird species found on Chumbe Island.

## BUILDING TECHNIQUES AND SUPPORT OF LOCAL SMALL SCALE BUSINESSES

## CHUMBE ISLAND CORAL PARK, ZANZIBAR, TANZANIA

During the designing and building process many local tradesmen and small scale building enterprises were consulted and incorporated. They contributed with their knowledge of traditional buil-

Weaving of 'makuti' from coconut palm leaves, traditionally used as roofing material

It was the aim of the architects to design structures which combine local building traditions and materials with modern architecture and its technical components. The result are solid and plastic

Due to Chumbe's national park status all building materials needed to be brought over from Zanibar by boat.

Weaving of 'madema' from reeds for partitions

ding techniques and skills to define a new architectural language and construction, mainly based on the nature of the local material.

modern architectural forms topped with a light-weight filigree latticed shell and interlace.

The slender poles from local casuarina-trees are bound together with coconut rope.

Interiors are made from local poles and coconut timber



Cubic elements form the stairs to a Guest Bungalow

Locally-produced cement earth bricks were used for the solid base which holds the cistern

Cutting of coconut boards

The roof is covered with 'makuti'

The coloured cement floors of the bungalows are decorated with African marine motives.

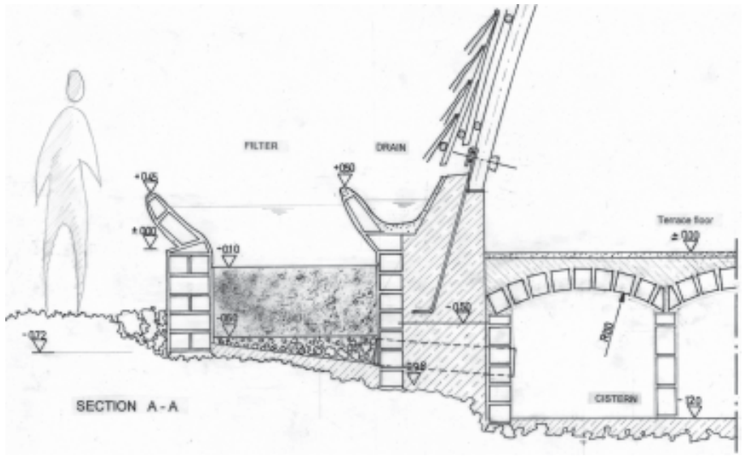
Weaving of floor mats

A blacksmith bending iron anchors for the Visitors' Centre

## BUILDING THE VISITORS' CENTRE

## CHUMBE ISLAND CORAL PARK, ZANZIBAR, TANZANIA

Aerial photo of the former lighthouse keepers' showing the footing points of the roof dome, yet to be constructed.




The rain water inlets of the cistern function as a combined filter and 'foul flush' unit. These separate the first, rather 'dirty' rain water flush, from the 'cleaner' second flush which then enters the cistern through the sand-stone filter.

Most of the doors and windows of the lighthouse keepers' house are widened and enlarged.

Some of the damaged walls of the existing building are rehabilitated.

A 'filter and foul flush unit' in use. According to the prevailing water level, the water flows into the next partition.

At the base of the former lighthouse keepers' house cisterns are excavated to store rain water.

A 'filter and foul flush' unit, which also forms a footing point of the roof dome,

at two different stages of its construction.

A revision hatch for the cistern is placed close to the filter unit.

## BUILDING THE VISITORS' CENTRE

## CHUMBE ISLAND CORAL PARK, ZANZIBAR, TANZANIA

Aerial photo of Chumbe Island, approaching the island from the south. The roof dome of the Visitors' Centre is not yet under construction. The Guest Bungalows are arranged along the bay.

The bare pole construction of the roof dome spans over the former lighthouse keeper's house.

One of the sea-facing modules.

For the construction of the free spanning roof dome of the Visitors' Centre, six latticed shell modules are built simultaneously to meet in the centre of the construction, forming its vertex.

The roof dome is partly covered with 'makuti'. Solar panels are installed to provide energy for lighting and radio communication to Zanzibar.

Two workers attaching poles with coconut ropes within the dome construction.

One latticed shell module under construction.

Finally the six modules join up in the centre, forming the vertex.

The 'makuti' is placed in horizontal layers, starting from the bottom to the top of the construction.

## BUILDING THE GUEST BUNGALOWS

## CHUMBE ISLAND CORAL PARK, ZANZIBAR, TANZANIA

The three building sites, carefully placed into existing openings of the forest, show different building stages: the bottom one shows the cistern's foundation, the middle one the concreted partitions of the cistern and the top one the as yet not covered expressive roofing construction.

Two workers concrete the platform inside the 'technique tower' which will eventually carry the hot water tank.

In contrast to the solid 'technique tower' and the partition wall to the bathroom, which are made from blocks, the light roof is made from local poles.

The rain water gutter below the footing points of the roof frames is wide enough to collect tropical rains. The groove running around the base of the bungalow is a measure to prevent termites from entering the house.

The compost chamber has been excavated from the coral rag. The first blocks of the chamber are layed by Abdi, the foreman.

The foundation of the cistern is ready to be filled with concrete. The compost chamber is shaded with coconut palm leaves to ensure curing of the plaster.

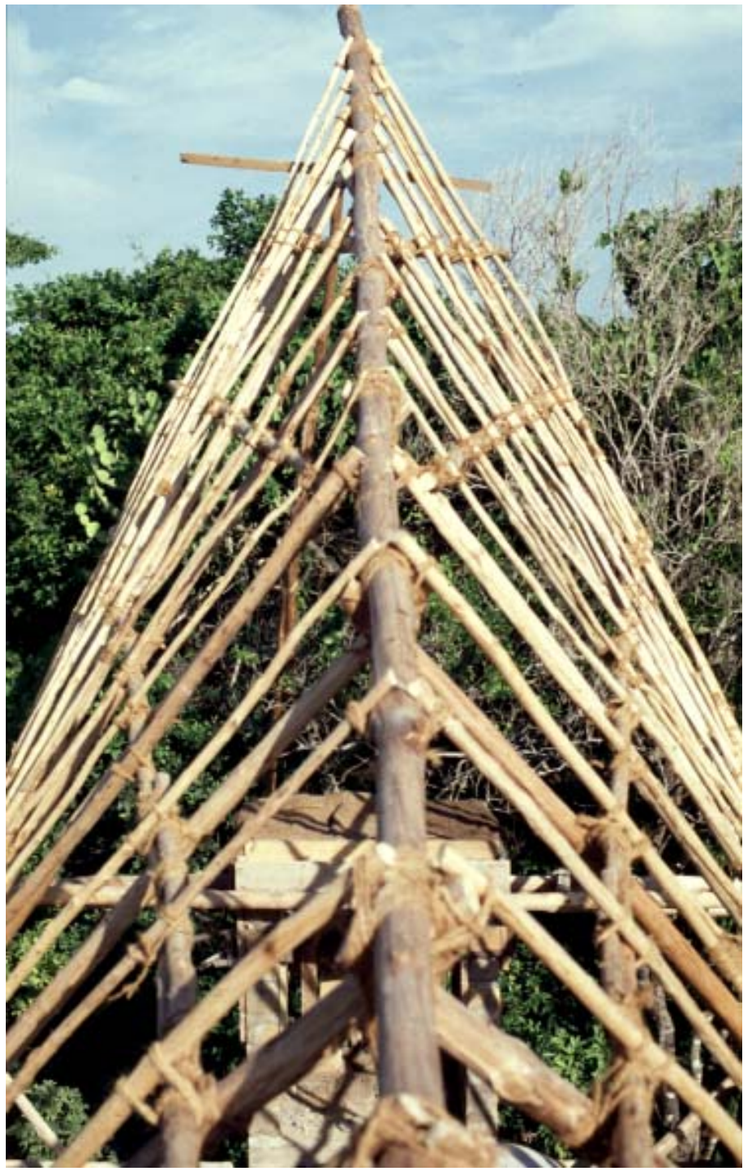
The joints between the sand-cement-blocks, placed on the formwork, will be filled with cement. Once the cement is hardened, the formwork will be removed from the cistern chamber through the revision hatch.

Standard plastic tubes and buckets are used to make openings for water pipes and the compost toilet refuse opening in the vaults.

## BUILDING THE GUEST BUNGALOWS

## CHUMBE ISLAND CORAL PARK, ZANZIBAR, TANZANIA

Workers attaching the ridge to the upright frames.



The ridge of the bungalow reaches over the treeline to catch the sea breeze for natural ventilation.

The roof is nearly coverd on both sides with ‘makuti’, the local roofing material made from coconut palm trees.

The upright frames are propped up by temporary supporting poles, until ...

horizontal beams are attached to completely stabilise the roof structure.

The latticed shell construction forms a pliable, but very stable structure.

Only the rooves of the bungalows are visible through the dense vegetation.

The project's transport- 'dhau' loaded with building materials from Zanzibar Island is approaching Chumbe Island at high tide.

At low tide the transport -'dhau' is unloaded block by block, bag by bag. At the second next high tide, 18 hours later, it will set off for Zanzibar again using the constant winds during daytime.

Due to Chumbe Island's national park status, no building material could be taken from the island to protect the delicate ecosystem.

With a local 'dhau' all building materials were sailed to Chumbe according to the wind and the tides. It was even neccessary to take sand, aggregates and some-times fresh water, to Chumbe Island before cisterns were available to store rain water.

Sand and aggregates packed in bags, and blocks from Zanzibar are deposited above the high tide water mark before being taken to the building sites.

The repetition of the 'dhau' falling dry on the rocky tidal flat on Chumbe Island made boat repairs neccessary. These were carried out by local ship builders.

The project's transport- 'dhau' at the sandy loading ground at Chukwani, Zanzibar, at low tide.