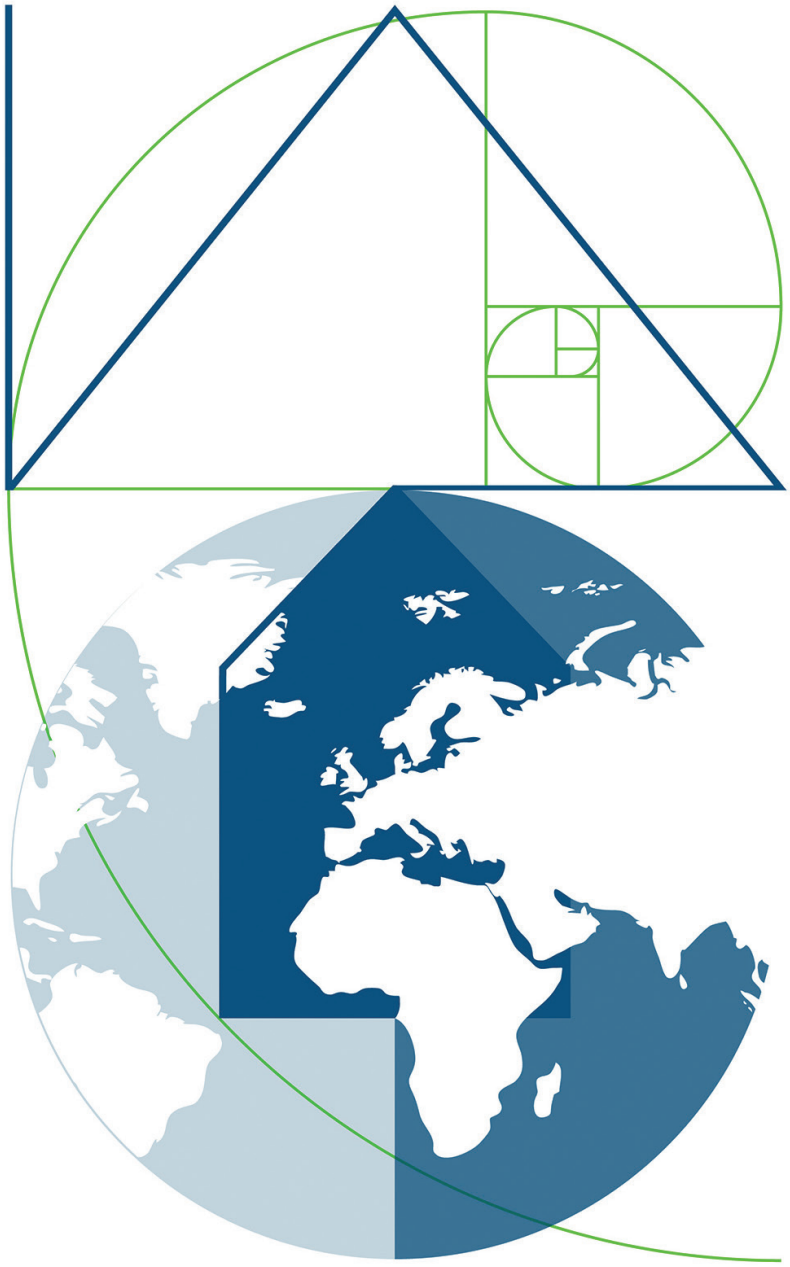
ARCHITECTURE HERITAGE and DESIGN

Carmine Gambardella

XXI INTERNATIONAL FORUM

Le Vie dei Mercanti



World Heritage and Dwelling on Earth

GANGEMI EDITORE SpA
INTERNATIONAL

Carmine Gambardella
WORLD HERITAGE and DWELLING ON EARTH
Le Vie dei Mercanti
XXI International Forum

Editing: Alessandro Ciambrone

Gangemi Editore spa
Via Giulia 142, Roma
www.gangemieditore.it

Le nostre edizioni sono disponibili in Italia e all'estero anche in versione ebook.
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ISBN 978-88-492-4647-6

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WORLD HERITAGE and DWELLING ON EARTH

Le Vie dei Mercanti

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18 • 19 • 20 May 2023 Napoli Capri

A future for Kiribati.
New models for resilient housing settlements

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Abstract
According to the *Special Report on the Ocean and Cryosphere in a Changing Climate* [1], the sea level has grown at a rate of 3.6 mm per year in the period between 2005 and 2015, increasing faster over the last century due to the melting of ice caps and the thermal expansion of the ocean.
This increases the risks for populations living in coastal areas and in particular for those living in arctic regions and in the atolls, like the islands of Kiribati which, by the middle of the century, could become uninhabitable.
The coastal protection systems and the adaptation processes that use ecosystems and solutions derived from nature (ecosystem-based adaptation), foresee rather long realization times and the population of Kiribati runs the risk of being forced to move elsewhere in a short time.
From these premises, the study conducted at the Department of Architecture of the University of Palermo takes its cue, aimed at identifying new housing models capable of facing imminent emergencies and avoiding the abandonment of the lands of origin.
Sustainable housing solutions, designed in accordance with the local settlement tradition and able to satisfy the needs of a community that, although not having no role in the production of greenhouse gases, it must adapt to the new environmental conditions imposed by industrial development policies from which it is totally foreign.

Keywords: climate change, environmental emergency, Kiribati, resilient systems, adaptation.

1. Premise
The Republic of Kiribati is an island state of Oceania, located near the equator and made up of the volcanic island of Banaba and 32 atolls, spread over an area of about 3.5 million sq km of ocean. The three main archipelagos that make up the state of Kiribati are: the Gilbert Islands, the Phoenix Islands and the Equatorial Sporades.
The whole territory is spread over 800 sq km of deposits of loose materials consisting of calcareous fragments of biological origin, that is to say shells of clams shredded more or less coarsely by the mechanical action of wave motion, and emerges a few tens of centimeters above the level of the sea. For this reason, it is particularly exposed to rising water levels.
In 1999, two of its uninhabited islands, Abanuea and Tebua Tarawa were swallowed up by the waves.
The United Nations has included the Republic of Kiribati in the category of Small Islands Developing States (SIDS), that is to say a category that identifies the Small Islands of the Pacific as particularly disadvantaged and vulnerable developing countries.
A reason for concern is climate change, as already highlighted in 1989 by the United Nations in a report on the greenhouse effect and the risks associated with it.
Responsible for only 0.6% of global greenhouse gas emissions, Kiribati is, in fact, among the first victims of climate change, with consequences that seriously endanger the future of these territories and its inhabitants.

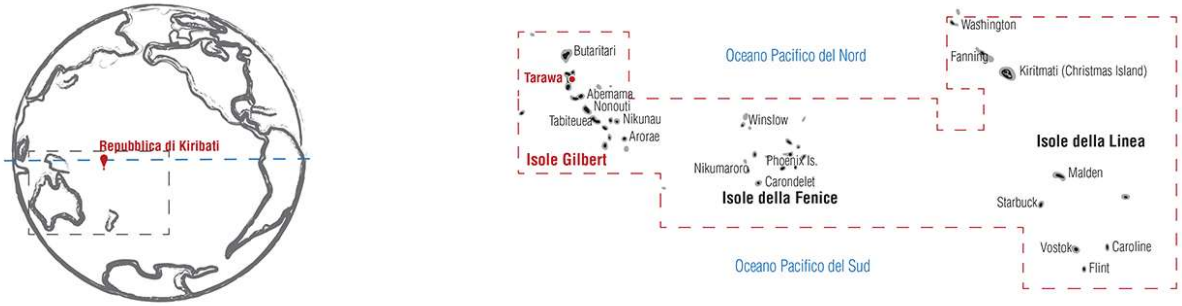

Fig. 1: Location.

2. Consequences of climate change in Kiribati

The consequences are already evident and the predictions are alarming:

1. *Increase in annual and seasonal temperatures, maximum and minimum.*
   Since 1950, data from temperature records have shown a clear upward trend: maximum temperatures have increased by 0.18°C per decade.
2. *Increase in annual rainfall.*
   The data collected since 1951 for Kiribati show an increase in annual rainfall, which is also expected to increase in the future, with a greater number of heavy rainfall and less days of drought.
3. *Sea level rise.*
   Global warming warms the ocean waters and causes the melting of glaciers causing the water level to rise.
   Due to the flow of ocean currents, the seas around the atolls of Kiribati rise by 1.2 centimeters per year, about four times faster than the global average, gradually submerging the territory of the islands.
4. *Increase salinization of groundwater sources and soil.*
   The rising sea level has already begun to contaminate aquifers and fresh water reserves which are undergoing gradual salinization, reducing the already insufficient supplies of drinking water with serious damage also to agriculture.
5. *Increase Ocean acidification.*
   Ocean acidification, caused by global warming, affects the growth of corals and organisms that produce their skeletons from carbonate minerals, jeopardizing the balance of tropical reef ecosystems.
   But not only that, the increase in the acidity of the waters prevents the formation of some organisms that produce plankton, undermining the food chain of fish resources, forcing them to modify their migratory routes, with serious damage to the livelihoods of the population and the fragile economy of the islands, largely dependent on the catch.
6. *Increase demand for food.*
   The damage caused to agriculture and fisheries resources risk no longer satisfying the food needs of the population: it is estimated that by 2030, Kiribati will need 50% more food to support domestic demand.
7. *Increase vulnerability to disease.*
   In October 2022, a team of Doctors Without Borders conducted a study on the health conditions of the population of Kiribati, finding evident consequences caused by the climate emergency on people's health. A high percentage of cases of hypertension, diabetes, leprosy and tuberculosis have been found.
8. *Exodus towards the innermost areas of the archipelago.*
   Due to the rise in water levels, many inhabitants of the coastal areas and outer islands have been forced to abandon their villages and move inland, concentrating in cities whose population increases year after year with the consequences of overcrowding and tensions.
   According to Michigan State University, the urban population in 2020 was about 55.60% of that overall.

3. Measures implemented and in progress

Over the last two decades, thanks to the intense work of Anote Tong, president of the republic of Kiribati from 2003 to 2016, and current climate activist, the problem of the Kiribati archipelago has become a symbol of the fight against environmental disaster.

Tong has publicly called for an increase in policies and initiatives aimed at reducing polluting emissions but, despite the commitments made by about 190 countries to reduce climate-changing emissions, the archipelago risks disappearing by the end of the century and with it the history and the culture of a people.
The critical issues present in the State of Kiribati have generated great global interest by stimulating the proposal of adaptation strategies, compatible with a sustainable life model, to guarantee a future for the indigenous population so that they do not necessarily have to resort to exodus as a last solution but which unfortunately, it has already been taken into consideration. In view of a probable evacuation of the archipelago, in 2015 the government of Kiribati bought 20 square kilometers of land on the Fijian island Vanau Levu for 8.8 million dollars.
Currently the territory is used for agriculture and fish farming but is intended to accommodate the population in case of need. In view of this perspective, the Kiribati government has also asked Australia and New Zealand to accept the people of Kiribati as permanent climate refugees. Initiative supported by the World Bank.
To this end, the government of Kiribati has launched the *Education for Migration* program with the aim of offering the indigenous population of fishermen, sailors and farmers new professional skills useful after migration.
During his mandate, Tong considered, among the possible solutions, the construction of artificial islands, for the realization of which he asked for help from the United Arab Emirates due to their experience in this sector but the cost of the operation was estimated at 100 million dollars and international aid is slow to arrive.
Thought has also been given to the construction of floating platforms similar to those used by oil companies, but even in this case the costs are unsustainable for the local population.
In 2020 the new president, Taneti Mamau signed a memorandum for cooperation with China in the context of the Chinese New Silk Road project, known as One Belt, One Road (OBOR). One of the two main routes included in the plan is the one that will connect China with the Indian Ocean and the South Pacific. The plan provides for the construction of infrastructures that will allow trade between the various states involved. Micronesia could thus face a series of strategic initiatives to address and manage the consequences of climate change.
Meanwhile, the government, assisted by bodies and organizations, studies and implements short and long-term strategies to deal with the impacts of climate change, contain the force of the waters and the erosion of the coasts.
Among these initiatives, the *Kiribati Adaptation Program* (KAP) launched by the national government of Kiribati with the support of the Global Environment Facility, the World Bank, the United Nations Development Program and the Japanese government with the aim of improving Kiribati's resilience to impacts on freshwater supply and coastal infrastructure. The government has built embankments and planted mangrove trees which, with their dense aerial and curved root system, are anchored to the ground, retaining the sand and reducing the effects of the waves.
Another initiative is the preparation of new coral reefs whose growth rate in the Tarawa archipelago is 8 millimeters per year, a value that exceeds the speed of rising tides. However, there is a risk that many corals may not be able to adapt to warmer surface temperatures and increased atmospheric carbon dioxide concentrations, which inhibit coral growth.

Fig. 2: Mangrove cultivations along the coasts.

4. Goals and project proposal

The study conducted at the Department of Architecture of the University of Palermo [2] was inspired by these premises, aimed at identifying new housing models capable of dealing with imminent emergencies

and preventing the abandonment of the lands of origin. The general objective of the program is to guarantee a future for the population of Kiribati, proposing intervention solutions that involve citizens as an active part.
The study is strongly linked to the characteristics of sustainability and the protection of the territory and for this reason it tends to follow fundamental criteria for the protection of the existing natural landscape and the awareness of local communities for the defense of their territory.
The proposal involves the construction of a housing settlement for the native population and a tourist reception facility aimed at boosting the local economy. The elaboration of the project was preceded by a preliminary analysis of the natural and anthropic context, by the identification of the available resources and by an analysis of the climatic data aimed at identifying the characteristics of the place and the design strategies to be applied.

4.1 Natural and anthropic environment and local resources

Kiribati is one of five countries in the world made up almost exclusively of atolls. Atolls represent the most complex type of coral reef both in terms of morphology and origins. It is the ecosystem with the greatest biodiversity on Earth but, at the same time, the most complex and delicate of the entire marine environment.
The soil is poor, without waterways and with more or less luxuriant spontaneous vegetation that alternates with white coral beaches. According to the Global Forest Resources Assessment 2010, Country Report, Kiribati [3], an assessment prepared by FAO relating to Kiribati, 80% of the surface of the state is occupied by coconut palm forests; 15% is occupied by other trees and shrubs, such as pandanus and mangroves, while the remaining 5% is occupied by ponds, fields and buildings.
Local resources, as is often the case for isolated and distant places or for small emerged lands, are very limited. The inhabitants are used to making the most of everything that the area offers. Coconut palms, pandanus, bamboo, taro, banana trees and mangroves also provide the raw material for housing construction. Coral reefs also offer an excellent building material: the corals deposited by the tides along the coasts are used to build retaining walls to protect the waters and to make bricks.
Kiribati is particularly sensitive to the tidal phenomenon which occurs every six hours, reaching a height of about two meters, governing and profoundly influencing the life, habits and daily activities of the inhabitants. For this reason, traditional houses are raised above the ground but also without walls, to allow for good cross ventilation in an environment where humidity is very high.
The most important and sophisticated architectural component is the robust projecting and waterproof roof, able to resist the violent downpours typical of certain periods of the year and also provide excellent shelter from the sun.
The typical house is made up of an aggregate of pandanus wood huts, characterized by a particular constructive simplicity and spaces reduced to the minimum necessary, each of which is intended for a specific function: the Bwuia for resting and spending free time, the Umwa for cooking, the Bata for storing the canoe, the Kia-kia for sleeping. Much of life takes place outside shelters and toilet facilities are quite rare. Few homes have access to public water and the water supply generally comes from cisterns designed to collect rainwater and from private or neighborhood wells. The center of the community's social life is represented by the Maneaba, the largest and most identifying building in the village, used for meetings, celebrations, parties and also as a resting place for the community.
During the last two centuries, traditional building materials have been progressively replaced by imported materials, such as galvanized iron and prefabricated concrete blocks with which traditional buildings are built, keeping their original shape almost completely unchanged.

Fig. 3: Left: the roof of a traditional house made with pandanus leaves. Right: example of a galvanized sheet roofing.

4.2 Climate analysis

Kiribati has a tropical, rainforest climate, also known as an equatorial climate, with no significant seasonal differences. The average annual rainfall is 60 mm.
According to the Köppen-Geiger classification, the climate is of type Af which identifies a rainy tropical climate with an average temperature of the coldest month above 18 °C, without a cold season and with rainfall in all months.
The maximum daytime temperature in the hottest period (August-November) exceeds 31 °C. The predominant winds blow from eastern quadrants with a peak from the east in January, with an average speed of 24.4 kilometers per hour. Day length in South Tarawa does not vary substantially over the course of the year.

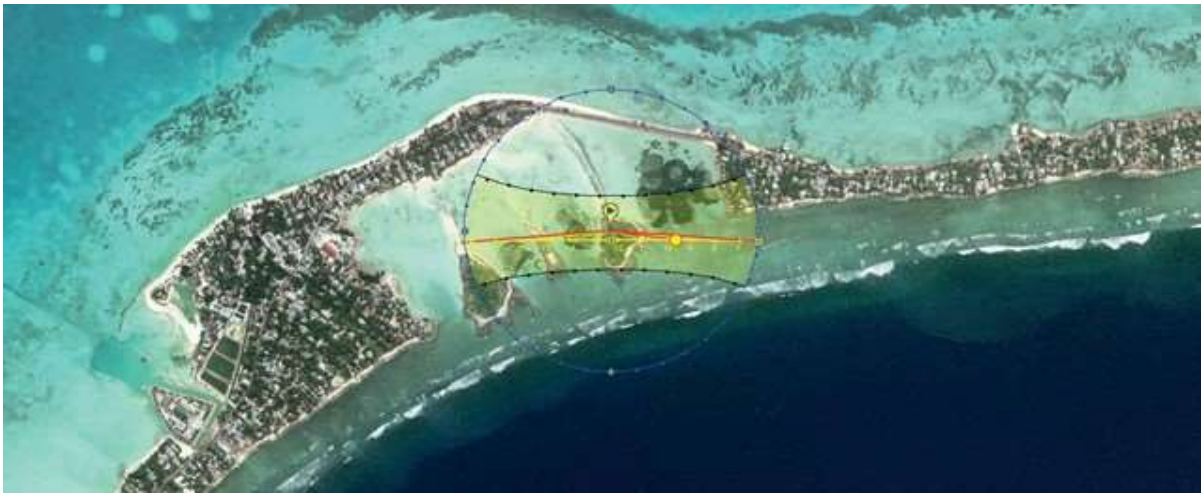

Fig. 4: Satellite photograph of the site with solar path. https: www.sunearthtools.com.

4.3 Design criteria

The fundamental criteria followed in the design phases can be summarized as follows:
• attention to the forms of existing architecture and landscape;
• use of materials and techniques of the local tradition;
• reversibility of the construction systems and ease of maintenance of all the elements that make up the housing settlement;
• recovery and purification of meteoric and marine waters;
• satisfaction of energy needs through the use of renewable energy sources;
• use of passive ventilation and cooling systems;
• preparation of careful waste management;
• use of low environmental impact systems for the treatment of waste water;
• coastal erosion protection.

4.4 Project area

Project site is the Tarawa atoll, in the Gilbert Islands; the most populated of the archipelago and the second by size. It lies approximately halfway between Hawaii and Australia and features a vast lagoon bordered by a 'V' shaped reef, approximately 35 km long, made up of over 30 islets.
As with most atolls, the phenomenon of the tides characterizes the life and habits of the inhabitants of Tarawa. The tidal excursion occurs every 6 hours and generates a change in the water level of about two meters.

Fig. 5: Left: Tarawa Atoll. satellite view and map. Right: the different phases of the tide.

Such a condition profoundly affects the lives of the inhabitants and their settlements which, in some places on the island, are subject to continuous flooding, the intensity and frequency of which are aggravated by climate change, which influences sea currents and causes tropical cyclones and rising seas.

Fig. 6: Effects of the floods in Tarawa.

A study conducted in 1999 by SOPAC (South Pacific Applied Geosciences' Commission), on the vulnerability of the southern coast of the atoll and on the possible consequences on the coral reef and on the inhabitants, predicted the increase in water salinization, coastal erosion, contamination of groundwater and coral bleaching, with major effects on coral reefs and ecosystems.

5. The project

The Tarawa atoll has already lost many square kilometers, now submerged by water, as well as the only driveway, subject to continuous renovations.
For those reasons and with the intention of offering a solution that contributes to implementing initiatives to adapt to the environmental emergency, the location of the settlement was chosen in South Tarawa, a thin strip of islets that house over half of the 100 thousand inhabitants of the archipelago and where the administrative capital of the republic of Kiribati is also based, in a coastal inlet characterized by a relatively shallow seabed, close to some islets.

5.1 Settlement principle

The complex develops on a floating platform according to a double cross system which houses the houses for the local population to the north-west and is characterized by the presence of the Maneaba. The tourist facility develops to the south-east, at the center of which is the meeting point containing a refreshment area and complementary services. The two plants, although independent from each other, find a meeting point in the large covered square which hosts an open-air market with small stalls for the sale of typical products.

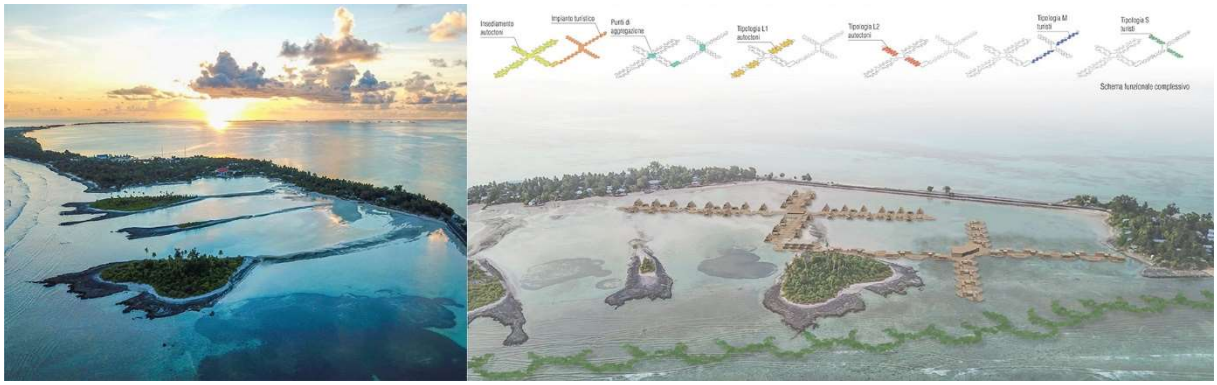

Fig. 7: Left: project site. Right: settlement principle and functional scheme. Graphic elaboration by S. Puglisi and A. Siligato.

The total area of the complex is 16,390 m2. The settlement principle is closely related to the wind direction, a resource used for cooling and passive ventilation of the settlement.
In order to safeguard the entire coastal inlet, the construction of a mangrove breakwater barrier is envisaged, which will favor sedimentary processes, opposing the phenomenon of erosion. The

hexagonal shape of the units that make up the barrier takes as a reference the modular system, known as the CALTROPE Project, conceived by a team of Hungarian architects, designers, biologists and engineers. The mangrove plants are placed inside pots of natural fibers which decompose naturally during the growth of the plant.

5.2 Floating platform

The floating platform is made up of the aggregation of irregular octagonal modules and is more versatile than fixed stilt systems. Indeed, the platform is connected to large vessels anchored to the ground which act as a guide for vertical lifting and the consequent adaptation of the system to the different phases of the tide; all this thanks to a floating system made up of recycled aluminum barrels which, placed under the platform, allow it to be lifted.

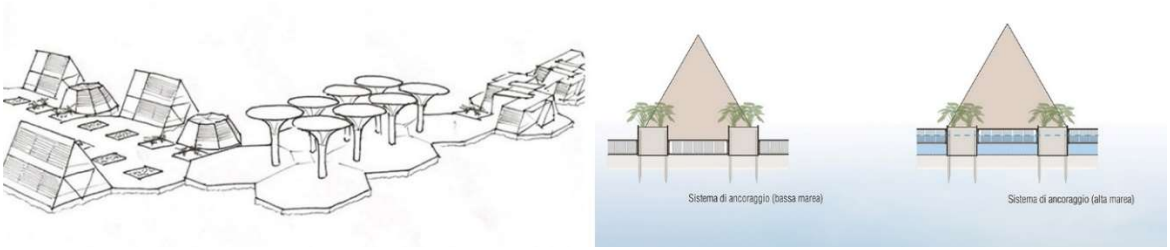

Fig. 8: Left: sketch of the node connecting the two settlements. Right: scheme of anchoring and floating of the platform in the different phases of the tide. Graphic elaboration by S. Puglisi and A. Siligato.

The pots contain the typical bawbwai plants, commonly known as taro, which can also be planted in swampy areas and are particularly resistant to brackish water. The dried leaves are also used to cover houses. The aggregation of the octagonal modules, replicated in series, allows the elimination of the traditional connecting walkways between the housing units, typical of this type of system. The modules have three dimensional types, based on the intended use of the housing units that responds to different needs.

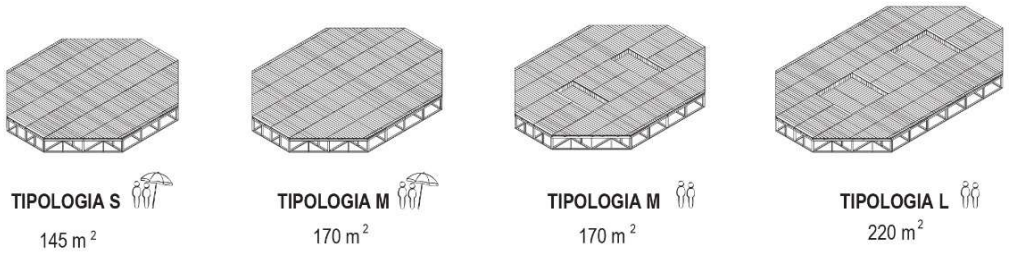

Fig. 9: Abacus of the octagonal modules making up the platform. Graphic elaboration by S.Puglisi and A. Siligato.

5.3 Housing typologies

Four types of housing are envisaged (two for the settlement intended for the local population and two for tourists), with a triangular matrix structural scheme that draws inspiration from the geometry of the existing structures in the place. Particular attention is paid to passive ventilation, an aspect that has influenced the layout of the houses in a windbreak position and the reason why there are two modules for each housing type.

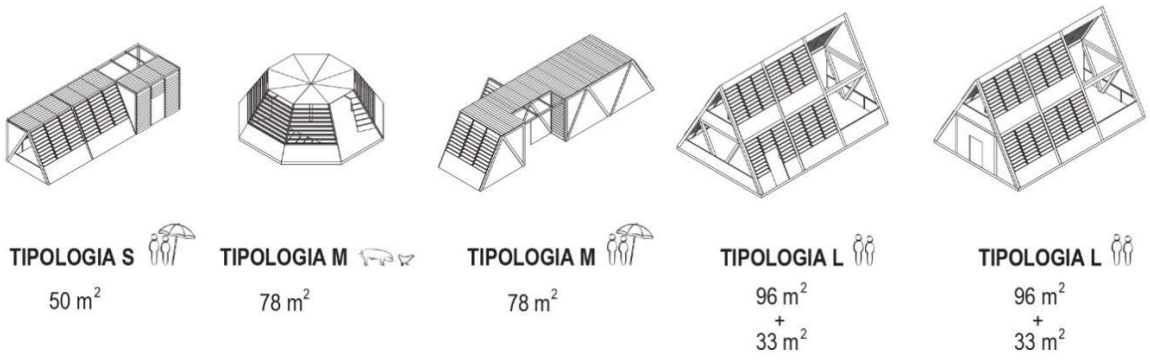

Fig. 10: Abacus of housing typologies. Graphic elaboration by S. Puglisi and A. Siligato.

Settlement for the indigenous population
The settlement complex intended for the native population is spread over an area of 11,740 square meters. The difference between the two types of homes for the local population is determined by the entrance which can take place from the short side or from the long side.
Both structures develop on two elevations and enjoy a particular constructive simplicity, typical of traditional houses and, in respect of local tradition and habits, they have no walls, replaced by brise-soleil that can be adjusted according to needs and weather conditions.
The spaces are reduced to the minimum necessary as much of life takes place outside the homes: the ground floor houses the living area with outdoor kitchen and bathroom; the rest area develops on the upper floor.
The choice of the outdoor kitchen respects the local custom.
The presence of the bathroom inside the house is, on the other hand, a choice dictated by health needs as part of the pollution of the few fresh water reserves is due to still archaic practices, due to the lack of a sewage system and the custom of discharging sewage into the sea, a habit that constitutes a serious problem of hygiene and a danger for the spread of diseases.
Each housing unit is equipped with a vegetable garden and an animal shelter in which it is also possible to grow small food plants vertically which, once grown, will be moved to the garden in front of the house.

Fig. 11: Housing typologies. Graphic elaboration by S. Puglisi and A. Siligato.

Fig. 12: Glimpse. Graphic elaboration by S. Puglisi and A. Siligato.

Tourist reception facility
The settlement complex intended to host tourists is spread over an area of 5,140 square meters that can be walked on, partly public and partly private.
The houses are divided into two types, one double and one quadruple which, placed at the center of the corresponding platforms, separate the public area from the private one. They are articulated on a single level and have a covered area reduced to the essential minimum, as happens in traditional homes. A large part of the space is dedicated to the private exterior, from which you have the possibility of directly accessing the sea, when the tide allows it.

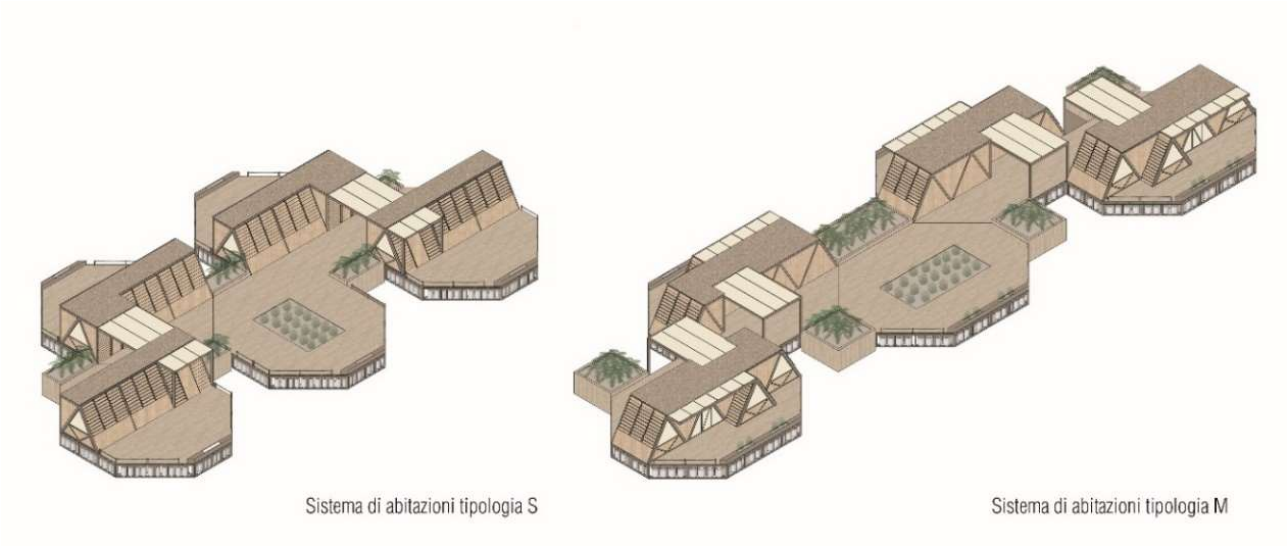

Fig. 13: Housing typologies. Graphic elaboration by S. Puglisi and A. Siligato.

Fig. 14: Glimpse. Graphic elaboration by S. Puglisi and A. Siligato.

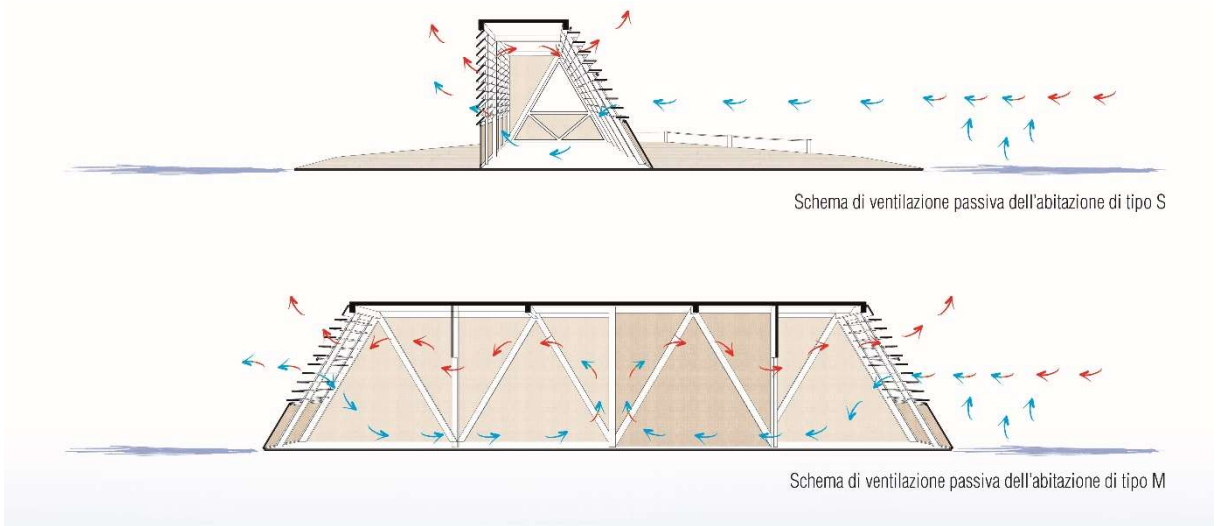

Fig. 15: Passive ventilation scheme. Graphic elaboration by S. Puglisi and A. Siligato.

6. Project materials and insights

Particular attention has been paid to the choice of materials and to the reversibility of the construction system in order to ensure easy assembly of the parts in the construction phase and equally easy disassembly.
In addition to the use of coconut palm wood for the structural part of the housing units, pandanus wood will be used for the construction of secondary structures and mangrove wood for the platform, as it is more resistant to humidity.
We also propose a reinterpretation of the weaving of pandanus leaves which is used to make the slats mounted on the palm wood frame of the brise-soleil.
A particular system for the recovery of sea water for domestic use is installed inside the houses and exploits the evaporation and subsequent condensation of the water which, during the hours of high tide, is conveyed inside a specially positioned barrel.
An electric motor pump leads the water to the tap by means of forced suction. The recovery of rainwater for irrigation is instead guaranteed both by a system of gutters installed in the roof pitches of the houses and by the elements that make up the roof of the large square.
The system consists of drainage chains, arranged inside each element, whose cone shape facilitates the conveyance of rainwater inside the structure itself, at the base of which the collection tanks are located.
The biological treatment of the wastewater makes use of a submerged flow constructed wetlands system, also set up on the floating platforms, each of which serves five homes.
As for the energy supply system, the use of wave and tidal energy conversion devices is envisaged, located near the coastline but hidden by mangrove barriers.

Bibliographical References

[1] IPCC_ The ocean and cryosphere in a changing climate, 2019. Fifth Assessment Report of the United Nations Intergovernmental Panel on Climate Change (IPCC, 2018).

[2] The study was conducted with the collaboration of the students Stefano Puglisi e Andrea Siligato of the Environmental Design Degree Laboratory of the LM4 Degree Course in Architecture of the University of Palermo.

[3] Forestry Economics and Policy Division. Global Forest Resources Assessment 2010 - Main report. FAO Forestry Paper. ISBN 9251066546.

[4] ANGELI, A., PICCIOCCHI, A. Kiribati, cronache illustrate di una terra (s)perduta. Milano: 24 ORE Cultura, 2016.

[5] CHAPMAN, P. Sea levels force Kiribati to ask Fijians for new home. The Sidney Morning Herald, 09/03/2012.

[6] KENCH, P. S., THOMPSON D., FORD M. R., OGAWA H., MCLEAN R. F. *Coral islands defy sea-level rise over the past century: Records for a central Pacific atoll.* Geology, 2015, Vol.43, n.6, p. 515–518.

[7] OAKES, R., MILAN, A., CAMPBELL, J. Kiribati: *Climate change and migration–Relationships between household vulnerability, human mobility and climate change*. Report No. 20. Bonn: United Nations University Institute for Environment and Human Security (UNU-EHS), 2016.

[8] PALA, C. *Kiribati and China to develop former climate-refuge land in Fiji*. The Guardian, 24/02/2021.

[9] SMITH, R., McNamara, K. *Future migrations from Tuvalu and Kiribati: exploring government, civil society and donor perceptions. Climate and Development*, vol. 7, 2014, p. 47-59.

[10] STOREY, D., SHAWN, H. *Kiribati: an environmental "perfect storm"*, Australian geographer, 2010, p. 167-181.

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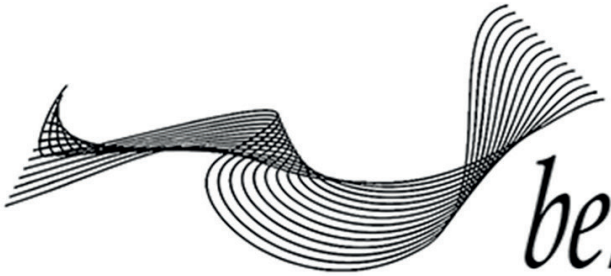

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