---

1. INTRODUCTION

Early victims of climate change are the Kiribati Islands, a group of low-lying islands in the Pacific Ocean, which will probably be unable to be settled by the end of the century because of the increase of the sea level. The Kiribati government already bought land somewhere else, and it seems that there is no other solution than to relocate people from the islands. If we choose to fight climate change on every possible battlefield, we can't let this happen so easily, knowing that there is more of the same to come. We should do whatever is possible to preserve those islands and keep people living there.

Tarawa from above

This paper presents some ideas for saving at least some of the Kiribati Islands, using technological solutions. The solutions are partially based on concepts used for creating underground structures. The main concept is described in a paper that can be viewed at: https://deeepunderground.com/underground.html.

2. KIRIBATI ISLANDS AND ITS PROBLEMS

There are 32 Kiribati islands in three groups. The biggest is Christmas (Kiribati), and the most settled is Tarawa. The surface of each island is generally not more than 2–3 m above sea level. Most of the islands are not settled. They have relatively good weather and have avoided being hit by major hurricanes.

Climate change is not the only problem Kiribati has. There are many other challenges that are caused by location and the distribution of islands. Some of the challenges are:

- Most of the food must be imported.
- There are problems with the fresh water lenses above saltwater level.
- Some islands are overcrowded.
- Unemployment is high.
- Living conditions are poor.

3. HOW TO SOLVE KIRIBATI ISLANDS' PROBLEMS

3.1. Protect the islands from the sea

Sea level is already rising and will rise more in the future. Some predictions project a meter or more before this century ends. A low-lying island's only defense against that is a barrier between sea and land, built high enough to prevent sea water inflow. Barriers are usually constructed as embankments from rocks or soil, able to handle high static and dynamic forces caused by the sea. But we could take advantage of the favorable weather on the Kiribati islands and create something that is an embankment and a structure at the same time. Figure 1 shows 6 phases of construction of something like that.

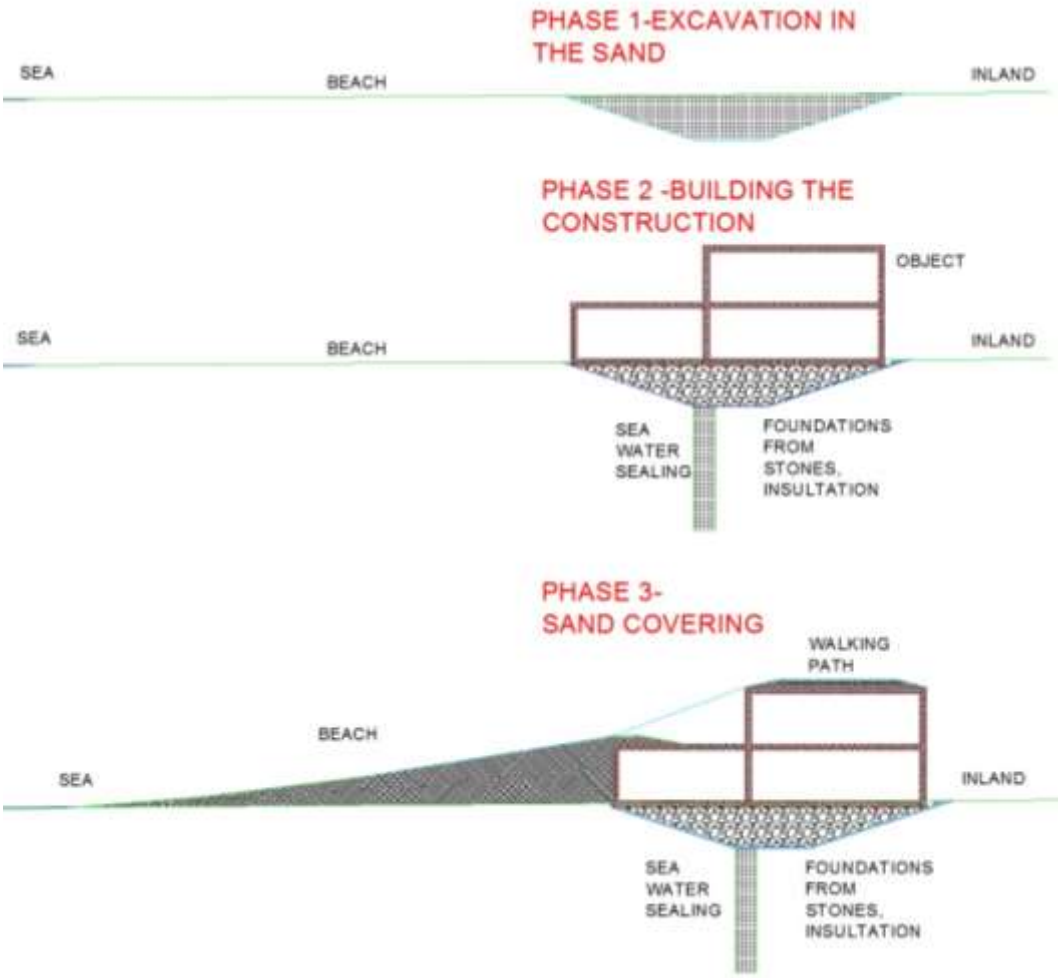

Figure 1: Construction phases

The first phase requires an excavation of the hole in the sand, maybe 2–3 m deep and 20–30 m from the sea. Slopes shouldn't be too steep. In the second phase the bottom is sealed by drilling and injecting water-sealed material (jet grouting, clay barrier, or other technique). After that we should then put a hydro-insulation on the hole boundaries and then fill the hole with rock material.

Now that there is a proper, dry foundation, we can create a simple box construction on it that consists of two floors, with two rooms on the lower floor, and a single room on the higher floor. The construction is mostly made from reinforced concrete, as shown in phase 2. The left wall should be isolated against water. In phase 3 we cover the first floor with sand. We can use the roof of the secondfloor as a walking path. As shown in figure 2, the left room needs windows which can be installed on the roof, and there is a door to the right room, which also needs another door to the inland, and windows at the right side wall. The second floor may have windows and doors from both sides and only needs stairways to the ground on the right side.

What we are getting by performing such works?

We are getting an embankment that is able to defend the inland by the sea level rise at least 2.5 m, and up to 4-5 m if necessary. Then, we have a construction that can be used for living. And there is a walking path.

1.1. Where to get construction material

Beaches on the Kiribati islands are sandy, and the upper part of the surface consists of coral debris. Both materials are not really useful for construction. But according to some geological investigations, limestone can be found below (some sources say 11 m below the surface on Tarawa and on the surface on Christmas island). And limestone can be used as construction material, as rock for the construction foundation, or as an input material for concrete mixtures. I suggest using underground queries on the Kiribati islands.

Lines of protection-Tarawa

1.2. What is underground

Underground constructions are expensive, so there should be a good reason to go underground. Construction material can be brought from elsewhere if necessary, so it wouldn't be worthwhile if that was the only reason. On the Kiribati islands, there are actually several reasons to go underground.

- To get construction material.
- To create underground objects that are able to be productively used.
- To reach water sources, possibly hidden in the limestone base rock.
- To produce energy and heat.
- To establish transport routes between islands.

These objectives can be achieved by using solutions provided by the **Deep Underground Concept** (you can read the details here: https://deeepunderground.com/underground.html) and can be applied on the Kiribati islands, too.

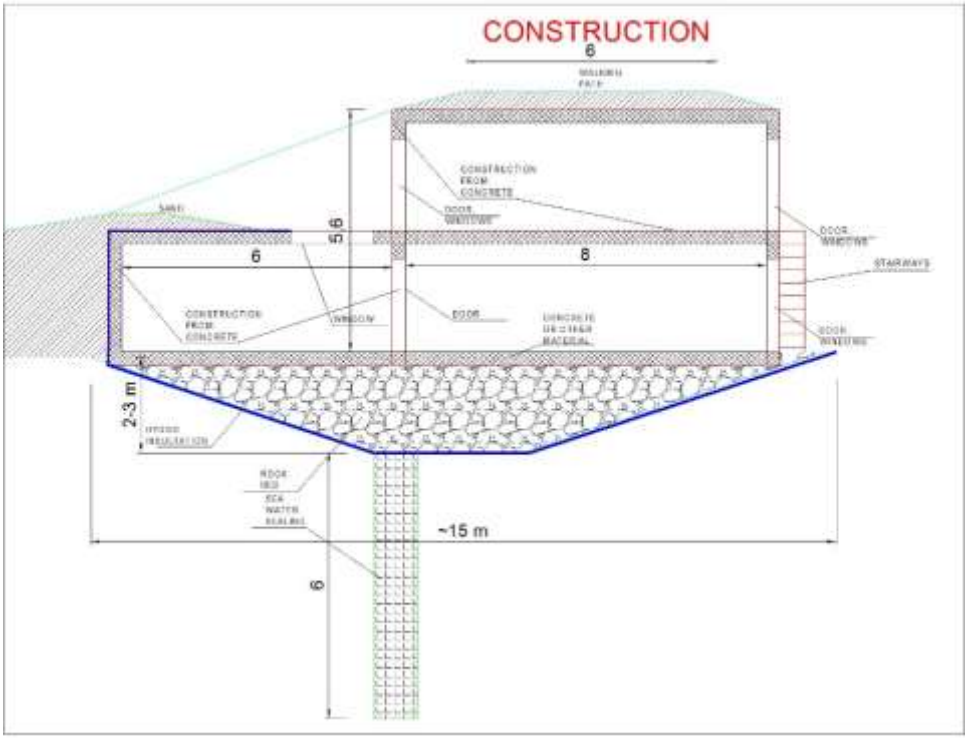

Figure 2: Construction

1.3. Quantities and prices

How much construction material do we need for embankment? And what works should be carried out? How much should this cost? The following table shows the data for each m of length of the embankment.

#	Item	quantity	unit
1	Excavation in the sand	25	m3/m
2	Water sealing	6	m/m
3	Hydroinsulation	30	m2/m
4	Rock fill	22	m3/m
5	Concrete	15	m3/m
6	Sand filling	50	m3/m
7	Walking path	3	m3/m

It's hard to determine the price for such construction, but I believe every m of length would cost between 3000-7000 EUR/m length. That's a lot, but we have to keep in mind that with embankment we get also 22 (6+8+8) m^2/m of surface for living, which is between 136 and 318 EUR/m^2, which is actually pretty cheap for a house by the sea.

Let's say that we would like to provide the protection of 100 km beaches on Tarawa. The embankment would cost between 300 and 700 million EUR and will require about 4 million of m^3 of rock material. Cost for excavating such material is hard to determine, but it's not cheaper than embankment, so the whole investment for such works can be anywhere between 1-2 billion EUR.

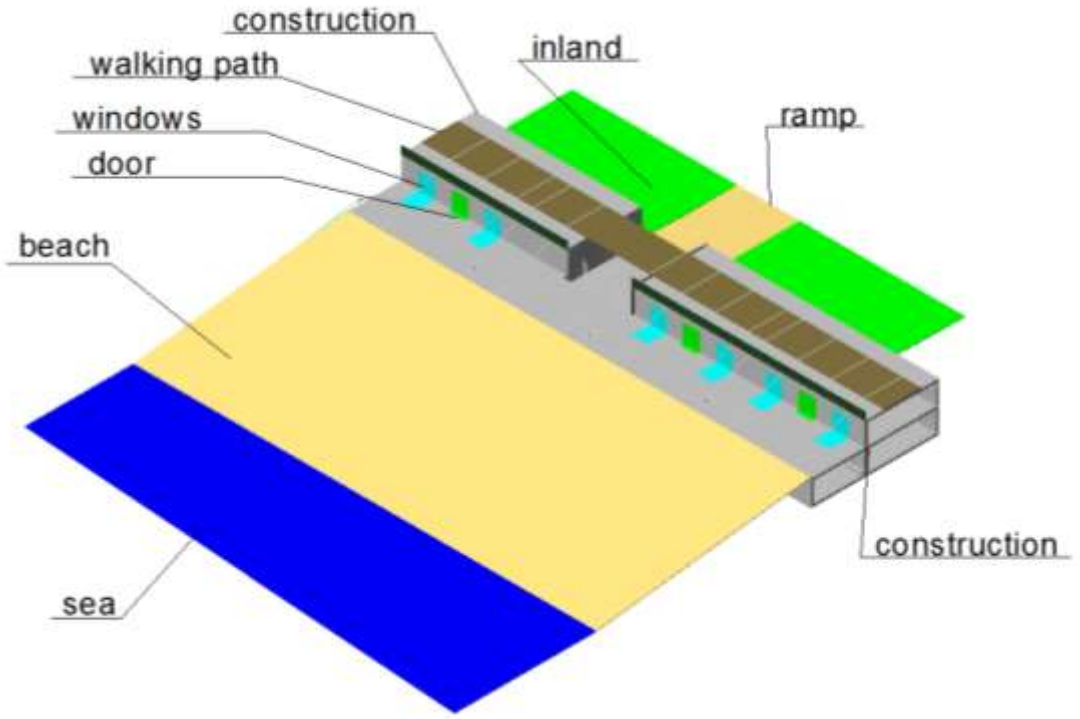

Figure 3. 3D view with passage to inland

---

2. WHERE TO GET MONEY

Needless to say, Kiribati doesn't have the money for something like that. But if you think of a sunny island in the Pacific Ocean, and a house on a sandy beach, you think about tourism. A 100 km-long embankment with the construction can serve as many as 100.000 tourists at the same time, which may be enough to generate interest from businesses to invest.

3. CONCLUSIONS

There is no way to put 100.000 more people on those islands, so we need another space. Underground constructions are therefore important, as we can get a lot of useful space underground, for traffic, services, and many other possibilities. With 4 million excavated material, we can establish a lot space underground, as schematically can be seen in figure 3.

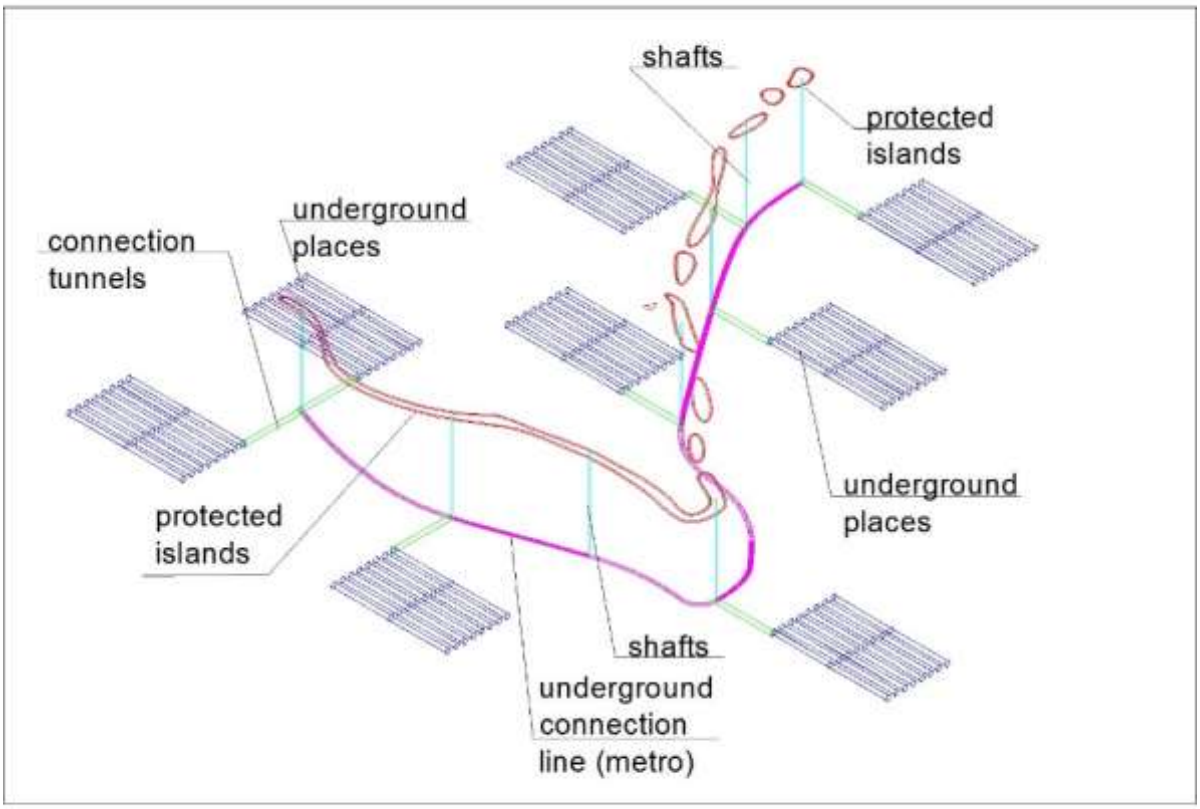

Figure 3: Schematic view-Tarawa with underground places

My suggestion is to use business to save the islands. Kiribati can, according to this proposal, offer unique holidays in the house by the sea, complete with sun, fishing, yachting, coral reefs, underground shops, gardens, and maybe even the world's biggest and best underground roller coaster as an ultimate attraction. It could potentially even offer metro as its sole transportation, resulting in islands without a single car.

What would Kiribatians get this way? Well, a huge change in life, for sure. Some of the positive changes would include:

- Saving at least some part of the islands.
- Jobs.
- Better quality of life.
- Connection to the world.
- New water sources.
- New energy sources.

As I said before, we should fight climate change everywhere, starting where it occurs first. Unfortunately, we cannot expect that the world (which is responsible for climate change) would invest to protect those islands in a way that would solve the major issues they face. Therefore, Kiribatians should lean on business to protect their homeland.

Deep underground project
January 2021

https://deeepunderground.com/
https://join.deeepunderground.com/

Related content:
Deep underground concept

Literature:

- Geology and Hydrogeology of Tarawa and Christmas island, KIRIBATI (A.C. Falkland, C.D. Woodroffe, 1997)