Situation Report Palau

Impact assessment of past climate change adaptation actions

Sustainable, transformative, and resilient for a Blue Pacific

SPREP PROE

Impacts Assessment of Past Climate Change Adaptation Actions

Situation Report

Palau

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1 Introduction

This report is structured in relation to the elements of climate change mitigation adaptation actions in Tonga which have element in GIS environment and within a relational database. Parallel to this status report there is a database established. The status report as well as the database documentation will be permanently updated throughout the project.

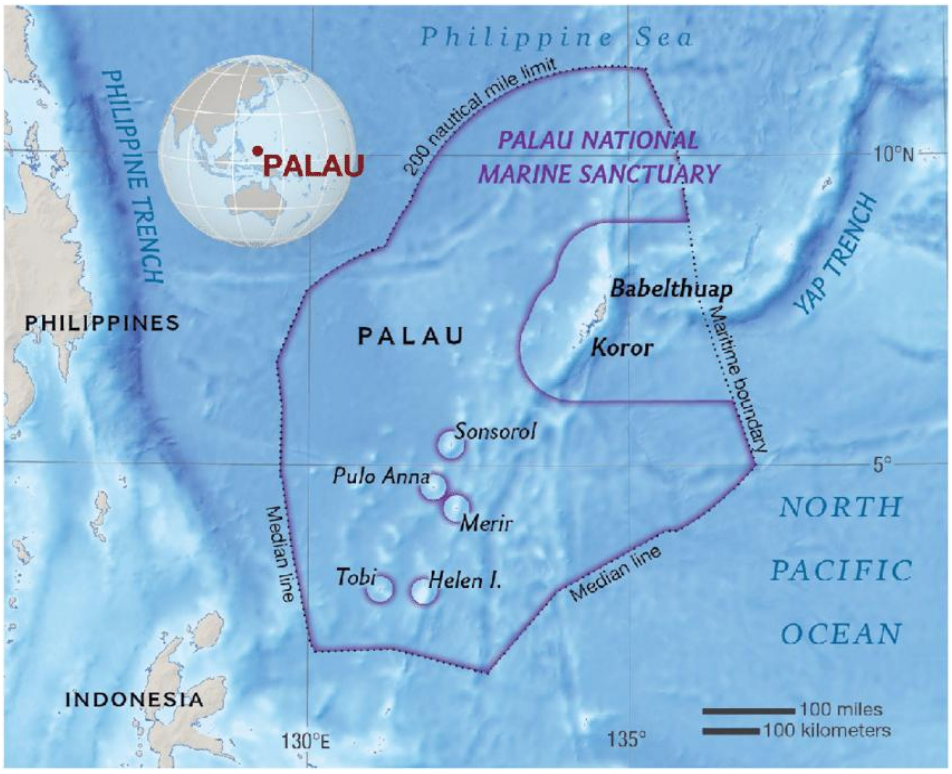

Figure 1-01: *Location and extent of Palau between Yap (FSM) in the north and Indonesia in the south.*

Palau officially the Republic of Palau and historically Belau, Palaos or Pelew, is an island country in the western Pacific. The nation has approximately 340 islands and connects the western chain of the Caroline Islands with parts of the Federated States of Micronesia. It has a total area of 466 square kilometres[1].

2 Mapping System in General

The PALARIS office works in UTM, Zone 53, however, apparently not WGS84 spheroid. There seems to be Clarke 1866 in use. Most probably there will be also a base map in UTM WGS84 which will be verified. The Palau Coordinate System based on Guam Datum 1963 seems to be only applied for historical maps.

For the time being there has been no based map received covering all islands in one unique system. This will be achieved soon and the mapping of houses or roofs will be performed for outer islands such as Tobi where up-to-date satellite image data are available on Google Earth display.

3 Impact Assessment of Climate Change Adaptation Actions

GIS, remote sensing, GPS mapping and database are tools assisting in change detection. Climate change adaption actions should implement a change through better food security and improved water supply.

1 Wikipedia

Before change can be analysed the actions have to be documented: (i) the point in time when the adaption method was conducted has to be known, (ii) the method has to be detailed and (iii) the geographic location has to be recorded. For Palau this data has not been accessed yet.

4 Food Security

Climate change requires the adaptation of the agriculture crops and possible change of traditional food supply. More salt tolerant taro varieties and new techniques for crab farming could provide alternatives to the current food supply.

4.1 Food Security Ngatpang

Ngatpang is one of Palau's sixteen states. It comprises an area of around 47 square kilometres in the west of Palau's largest island, Babeldaob, facing onto Ngeremeduu Bay. The state capital is Ngerdubech. Ngatpang has a population of 282, making it Palau's 9th largest state in population.

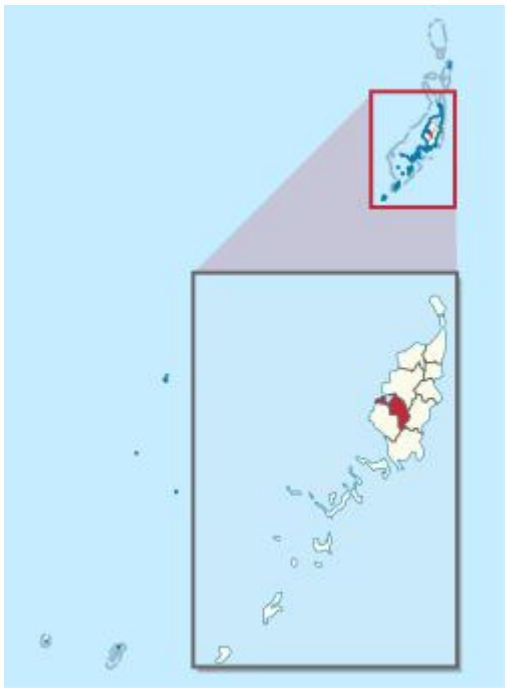

Figure 4.1-01: *Location of Ngatpang within Palau*

Ngatpang, which is located on the central west coast, includes a very large area of the interior to the south-east of Ngeremeduu Bay. Along the west coast, Ngatpang includes the narrow strip of land between Ngeremeduu Bay and the lagoon. This strip of land was ceded to Ngatpang from Aimeliik early in this century. The modern village of Mechebechubel is located on the west coast on the south face of Roisengas. The terrain along this portion of the west coast is very rugged with steep slopes covered with thick forests. On the east side of Ngeremeduu Bay, Ngatpang extends to the Rael Kedam, the central divide on Babeldaob Island. The edges of the bay are lined with a thick fringe of mangrove swamp forest. Inland are rolling hills with short drainages. Many of the hills facing the bay are grass covered, but further inland the hills are covered with an upland forest. To the north lies the drainage of the Ngerbechederngul River, frequently referred to as the Yamato River. The major tributary of the Ngerbechederngul from Ngatpang is the Ngcholetel. In the southern part of the state are the drainages of the Ngatpang and Tabecheding Rivers. The Ngetmiich River, the largest tributary of the Tabecheding, drains the large interior region in the south-east part of the state.

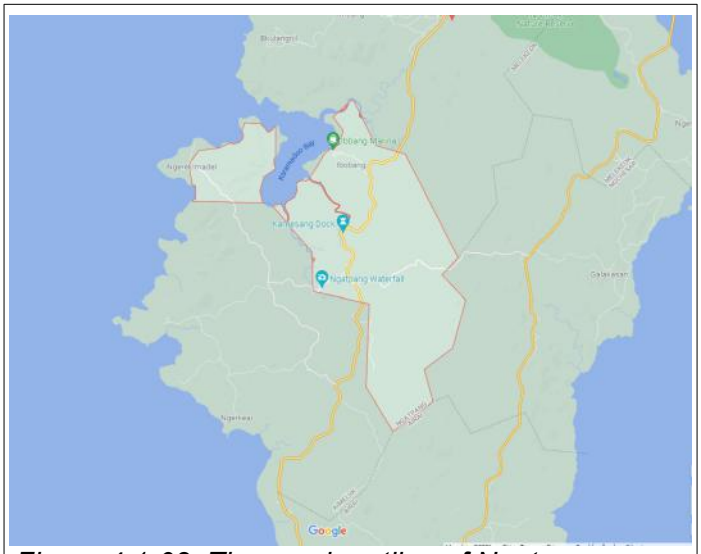

Figure 4.1-02: The rough outline of Ngatpang

Along the edges of the bay, on the lower slopes of the hills, are deep, loamy soils which contain rich deposits of clay. South of the bay on the upland hills, the soils are thin and associated with scrub vegetation. Also associated with thin soils in low lying and poorly drained basins are bogs.

Presently, most of the use of the land in Ngatpang is confined to gardens surrounding the modern villages of Mechebechubel and Ibobang. Interspersed with these kitchen gardens are stands of agroforest which include coconut, and betelnut, breadfruit, almond trees, and banana plants. In and around many of the uninhabited villages are stands of coconut and betelnut palms, and occasionally patches of irregularly attended taro swamp gardens. Except for occasional forays to hunt pigeon or harvest special plants, there is little active use of most of the interior of Ngatpang[2].

4.1.1 Salt tolerant Taro Production in Ngatpang State

Salt tolerant taro varieties can assist food security. To potentially visualise the area with improved survival after salt water intrusion the area has to be mapped, which is possible through image data capture downloadable from GoogleEarth.

Figure 4.1.1-01: *Very high resolution image data captured from Ngatpang 14.08.2020. The figures on the next page show the potential of sub-metre image data when zooming in.*

Satellite image data with sub-metre resolution allow to see the agriculture plantations as shown when zooming into more details. However, it requires a GPS survey to indicate which farm field has planted salt water tolerant taro. The planting areas have to been delineated.

Image available on Google Earth from Palau are not frequently captured enough to conduct an optical change detection of agricultural crops at the current stage.

2 https://en.wikipedia.org/wiki/Ngatpang

Figure 4.1.1-02: *Zooming into the Google Earth image data*

Figure 4.1.1-03: *A further zooming in allows to recognise agricultural crops*

4.1.2 Required Details of Taro Farm Assistance

Recent image data is available with a spatial resolution allowing to see agricultural crops as shown in figure 4.1.1-03. Currently the information is missing:

- Which fields have new more salt water tolerant taro?
- When the taro was planted?
- Which type of planting was performed e.g. the taro was mixed with other varieties or areas of pure new variety?
- The project donor.

Optimal would be a DGPS[3] survey to map the exact location, which has to be performed directly after the planting. If the farms are known it would be also possible to print VHR image data and send laminated images to and the farmers mark the areas where salt water tolerant taro has been planted.

4.1.3 Crab and Clam Farming in Ngatpang State

The idea is to enhance aquaculture techniques and introduce new innovative techniques into crab and clam farming to boost alternative choices of food security[4]. It is difficult to see crab and clam farms with remote sensing techniques, but the crab and clam production areas could be mapped with GNSS equipment.

The impact of successful farming will be difficult to map with GIS and RS techniques as it is only visible in the socio economic area more healthy population and more family income. The increase of crab and clam farming areas is an indicator and this can be mapped GPS (GNSS) equipment. However, it requires a periodically survey. Such farm mapping was already performed in the Pacific 20 years ago[5].

3 DGPS = GPS system with differential correction to archive an accuracy of sub-five metre required for 1:10,000 scale mapping.

4 See Palau-FoodSecurity_IA_Adaptation profile

5 See "GIS & RS for Pearl Farm Management in Manihiki, Cook Islands" Pacific Islands GIS&RS newsletter 2002 Issue 01 page 8 http://www.picgisrs.org/wp-content/uploads/2019/09/0201.pdf

4.2 Food Security Hatohobei (Tobi) Island Community

Tobi, or Hatohobei (Tobian), is the southernmost of Palau's sixteen states, consisting of Tobi Island and Helen Reef. The total land area is about 0.88 km². The population was 25 in 2015[6]

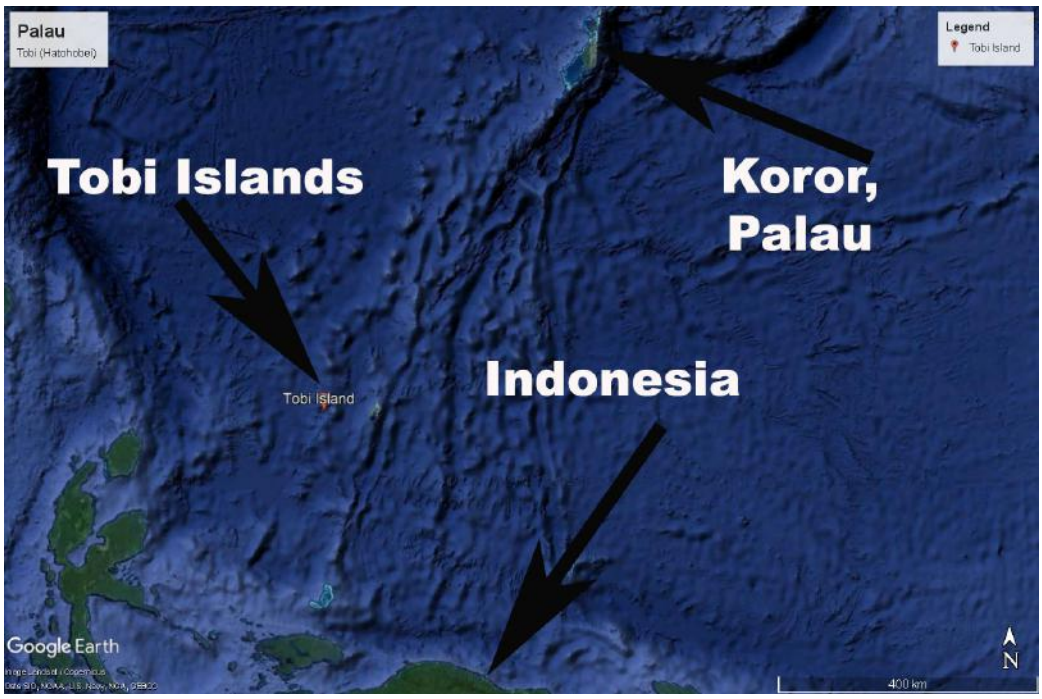

Figure 4.2-01: *Location of Hatohobei (Tobi Islands).*

Its highest point is less than 20 feet above sea level and most of the island's elevation is less than half that. Surrounded by a fringing reef, the island consists of a beach, a band of high ground planted with coconuts, a path circling the island, another band of coconuts and bush, and taro gardens at the centre. Tobi is home to relatively few native species of plants or animals.[7]Salt tolerant Taro Production on Tobi Island

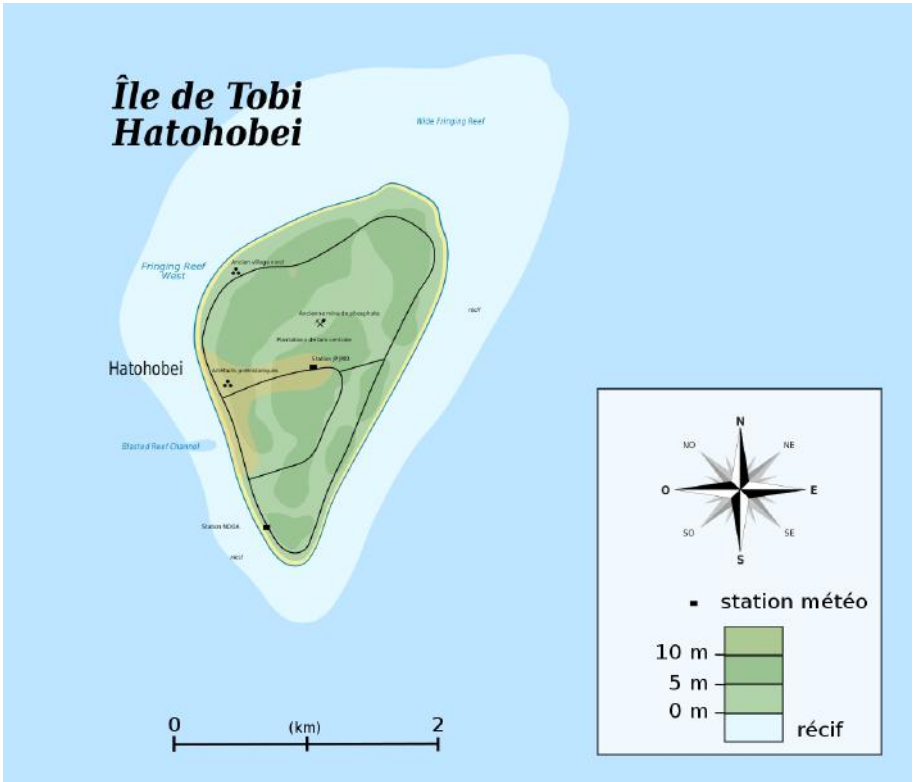

Figure 4.2-01: *Elevation and shape of Hatohobei (Tobi Islands)*

The taro plantation area is indicated on the map,

6 https://en.wikipedia.org/wiki/Hatohobei
7 http://www.friendsoftobi.org/misc/tobiislandoverview.htm

the centre of the map below the phosphate mine. However, the image data do not show a significant difference.

In addition, the PACC project had a time period from 2009 to 2014[8] and the image data was captured 2012. It I possible that a cropland extension was made after 2012.

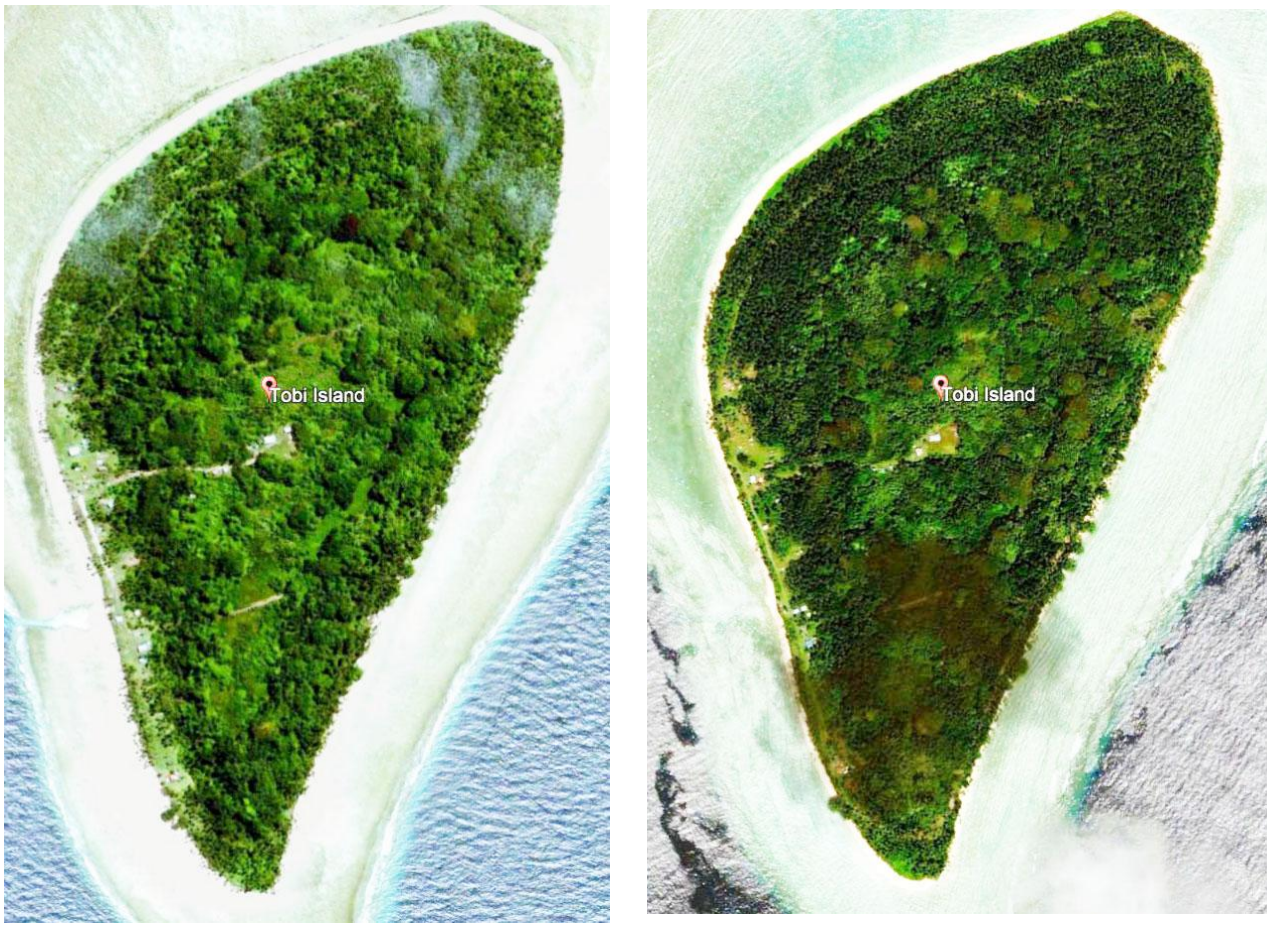

Figure 4.2-03: *Tobi Islands 07 June 2006 (left) and 07 December 2012 (right)*

To monitor the taro farm development the farm areas have to be mapped with GPS (GNSS), drone survey or new satellite image data of very high resolution. The report “Farms Coordinates corners_List” does not cover Tobi Island.

4.2.1 Crab and Clam Farming in Tobi Island

For crab and clam farming applies what was stated for Ngatpang State. Survey has to be conducted periodically with GPS equipment to see if farms extent, keep stable size or shrink over time. Current satellite remote sensing data will not allow to map submerged crab and clam farm support infrastructure. In capter “Crab and Clam Farming in Ngatpang State” is was stated that such mapping was conducted by SOPAC 20 years ago.

8 Palau-FoodSecurity_IA_Adaptation profile.docx

5 Water Infrastructure

The water infrastructure related to rainwater harvest has three main parts: (i) the roof areas able to catch the water, (ii) the tanks to store the water and (ii) the gutter to allow the water reaching the tanks.

5.1 Concrete Tanks and Rainwater Catchment on Island Tobi

The project document mentions concrete tanks and rainwater harvest assistance for Tobi island.

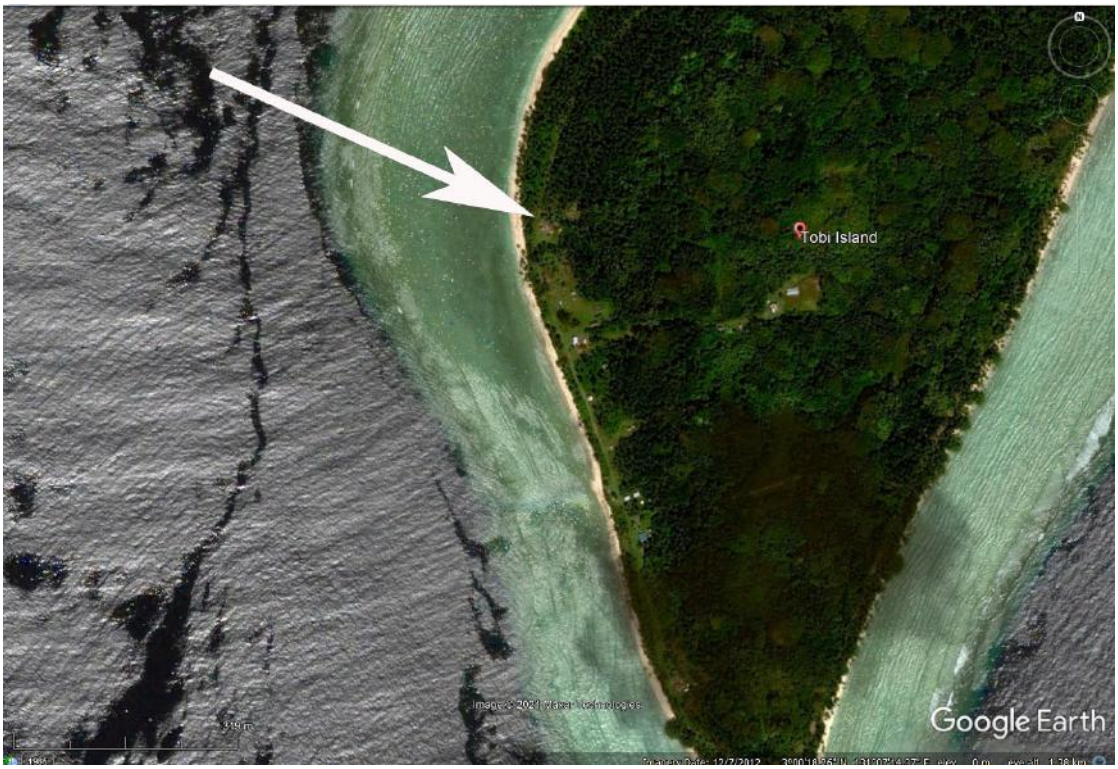

Figure 5.1.01: *Location of a housing area which potentially is equipped with rainwater tanks. The image data was captured on 07 December 2012.*

5.1.1 Requirement for Monitoring Rainwater Harvest Assistance for Tobi Island

So far data are not available for:

- The locations of the houses assisted,
- The project and project donor,
- The date installation,
- The details of installation.

Additional reports will be found to access the missing data.

5.1.2 Assessment Possibility of Rainwater Harvest Actions

Figure 5.1.2-01: *Zooming in allows to recognise infrastructure which could be concrete rain water tanks.*

The required action would be:

- Digitising of roof area of all houses,
- Establishing database with tables:
  - houses,
  - households
  - water tanks
  - gutter
  - roof
- Field visit to check:
  - the link between houses (roofs) and households
  - roof: (i) percentage of captured by gutter and tank, (ii) type of roof
  - gutter condition
  - tank condition: (i) capacity, (ii) physical condition, (iii) connected Y/N

Tobi island has less than 20 houses visible in VHR satellite image data and data is available recorded 2020. Th roof area will be mapped as soon as base maps are received from the PALARIS office.

5.2 Concrete Tanks and Rainwater Catchment Island Sonsorol

The project document mentioned that concrete tanks and rainwater harvest facilities are supposed to provide impact in Sonsorol.

5.2.1 Location and Description Sonsorol

Figure 5.2.1-01: *Location of Sonsorol Islands south west of Koror*

Sonsorol Island, also called Dongosaro or Dongosaru, is encircled by a coral reef extending 160 to 480 m offshore. It is 2 km long north south, and up to 890 m wide in the north. It is located 1.6 km south of Fanna Island. The village of Dongosaro, which is the capital of the state, is located on the west coast. The island is thickly wooded with coconut palms and other trees. Together with Fanna, it forms the Sonsorol Islands[9].

Figure 5.2.1-02: *Satellite image of Sonsorol Island captured on 27 January 2006*

The village of Dongosaro is visible in the west of the islands on the satellite image to the right (figure 5.2.1-02).

When zooming in on the same satellite image the houses are clearly visible and the roof area could be mapped with GIS tools. This would be the potential catchment area. The real area is the area where the water is captured with gutters draining into tanks. The gutter condition cannot be estimated from space. However, the image data was captured in 2006 before starting the rain water catchment assistance. Even the estimation of the “potential catchment area” image data captured shortly after the project termination data is required not space borne image data 1 ½ decades old.

There was not more up-to-date image data available of the web.

9 Wikipedia

5.2.2 Details of the Climate Change Adaptation Activity

For the time being it is unclear:

- The the exact locations of the rainwater harvest assistance,
- The project and project donor,
- The date of the installation,
- The details of the installation elements.

Additional reports will be found to access the missing data.

Figure 5.2.2-01: *The northern part of the village Dongosaro a zoom in using the same space born image data captured on 27 January 2006. Most probably recorded from satellite QuickBird with 60 cm spatial resolution.*

Figure 5.2.2-02: *The southern part of the village Dongosaro a zoom in using the same space born image data as figures above.*

At 2006 water tanks are not visible as the project started later.

5.2.3 Impact Assessment of Water Harvest in Sonsorol

The required action would be:

- Digitising of roof area,
- Establishing database with tables:
  - houses,
  - households
  - water tanks
  - gutter
  - roof
- Field visit to check:
  - the link between houses (roofs) and households
  - roof: (i) percentage of captured by gutter and tank, (ii) type of roof
  - gutter condition
  - tank condition: (i) capacity, (ii) physical condition, (iii) connected Y/N

However, this requires up-to-date image data. This can be ordered by satellite data companies which now sells for small minimum capture area. The alternative would be image capture by

drones which requires to bring a drone to Sonsorol, which is most probably the much more expensive solution.

When printing maps and sending them to Dongosaro the required field work could be carried out by somebody from the village as complicated measurements are not needed.

This would allow to compare water harvest and storage capacity with predicted weather situations. The impact can be estimated by comparing the situation with rainwater harvest and the situation without harvest.

Other impacts of bridging water shortage are in the social area and health situation. This would be difficult to estimate with remote sensing technique.

5.2.4 Example of Roof Area Estimation with VHR Image Data

The Google Earth image display was captured as screen dump together with a polygon drawn on top of the image. The polygons were exported as KML files and imported to GIS environment. As a next step the screen dumps were registered using the KML polygon corner points as reference points.

The resulting GIS layer was used to digitise the roof area.

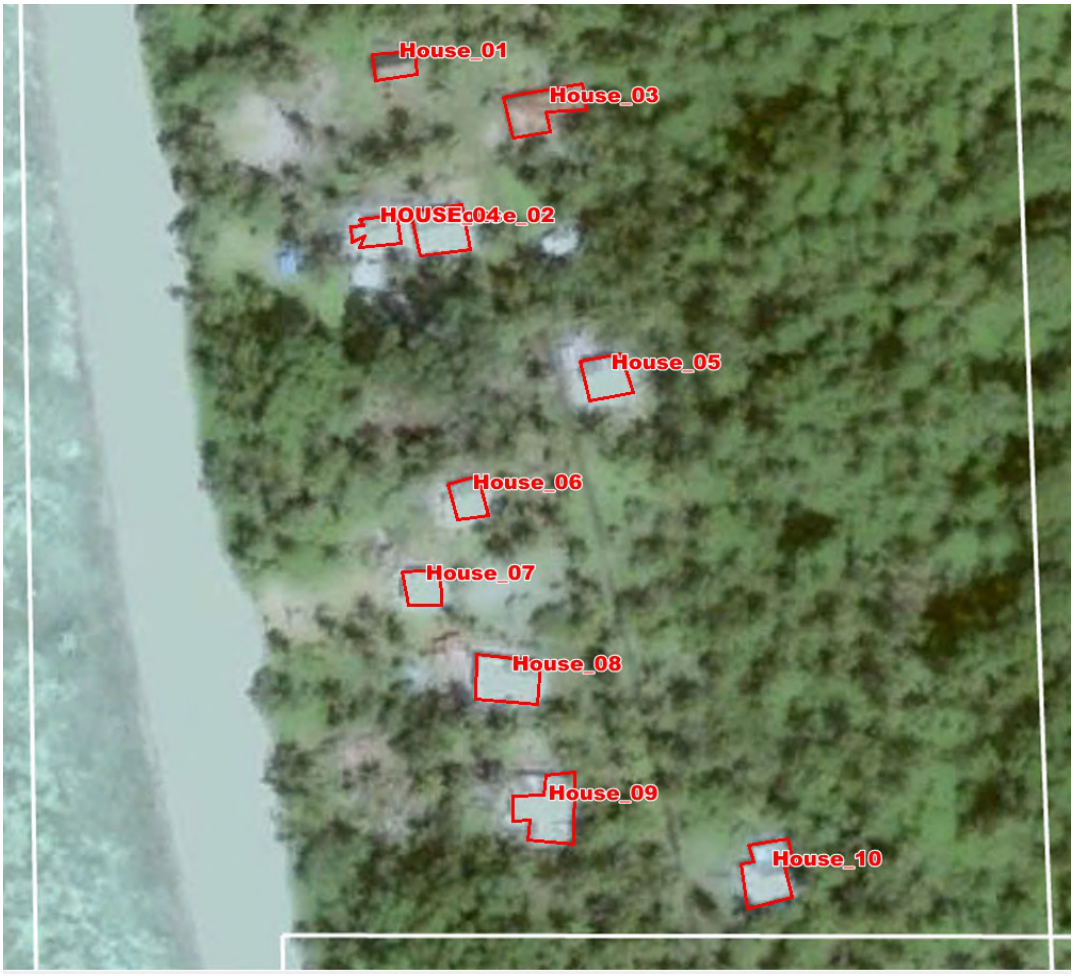

Figure 5.2.4-01: *Digitised roofs in the northern part of village Dongosaro*

Figure 5.2.4-02: *Digitised roofs in the southern part of village Dongosaro*

HOUSE-NUMBER	Roof Area m^2
House_01	49
House_02	107
House_03	121
House_04	55
House_05	80
House_06	56
House_07	57
House_08	129
House_09	146
House_10	124
House_11	144
House_12	142
House_13	190
House_14	111
House_15	163
House_16	110
House_17	51
House_18	204

Table 01: *Calculated roof area in m^2 through GIS tools.*

As explained before the rainwater harvest area is only the roof area which has a gutter and downpipe connection to a water tank and the water tank is in good condition and has appropriate capacity.

In general it is possible to estimate the potential village rainwater harvest capacity with VHR space borne image data.

If the images shown in figures 5.2.4-01 and 5.2.4-01 are printed and send the village the survey just concentrates on:

- Water tank condition (described above)
- Gutter plus downpipe condition
- Estimated percentage of roof from which water can be captured.

Such survey might have to be performed one time with project staff, but the follow up surveys could be delegated to the village.

Assessing rainwater harvest potential was successfully conducted by SOPAC for Tuvalu and Nauru. There must be corresponding reports in the SPC virtual library.

5.3 Refurbishment Cistern Angaur

The terms of reference mention that a cistern was refurbished in Angaur and that the impact is unknown.

5.3.1 Location and Description of Angaur

Angaur is a coralline island located some 10 km south-west of Beliliou at the southern tip of the main group of islands in the archipelago, and is situated outside of the lagoon and enclosing reef for this main group. Angaur is surrounded by a thin reef which encloses a narrow lagoon, though for the most part the reef is so small and low that it offers little impediment to the waves which break directly on the steep cliffs which ring the island. Distinct from the rock islands which lie between Beliliou and Koror, Angaur is a raised platform island. The profile of the island is a low table with very little relief. The highest point on the island, a small hill north-west of Rois, is only 40 m above sea level, and most of the island is less than 10 m above sea level. On the ground, however, the terrain is very rugged with steep, jagged outcrops of ancient reef rising unpredictably in a tangled maze. To the north-west the ground is slightly higher, and to the south-east the ground is slightly lower with marshy swamps across the karstic landscape[10].

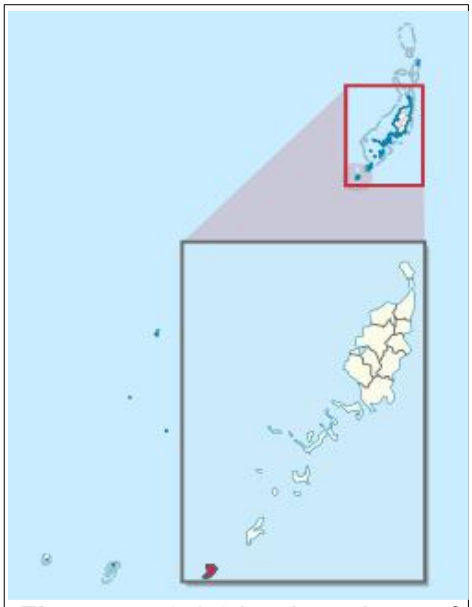

Figure 5.3.1-01: *Location of Angaur in Palau*

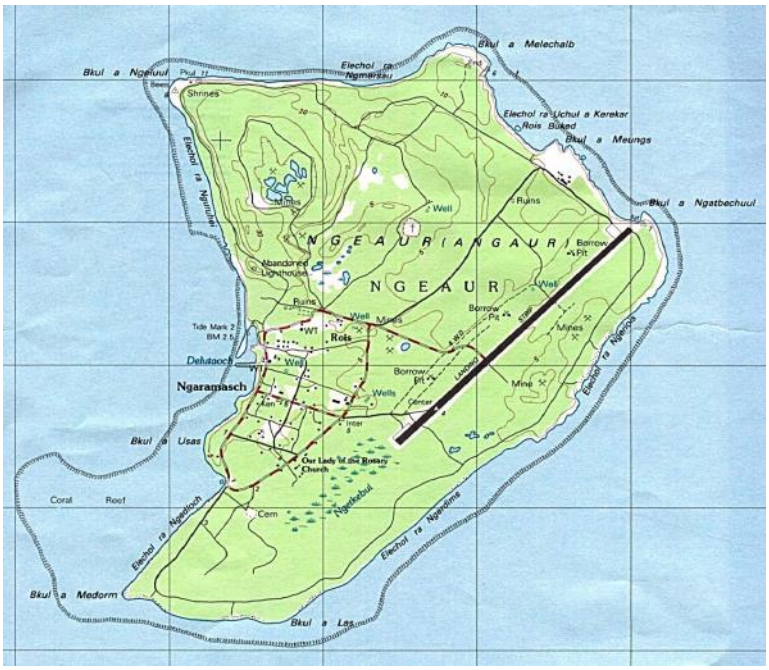

Figure 5.3.1-02: *Map of Angaur*

10 Wikipedia

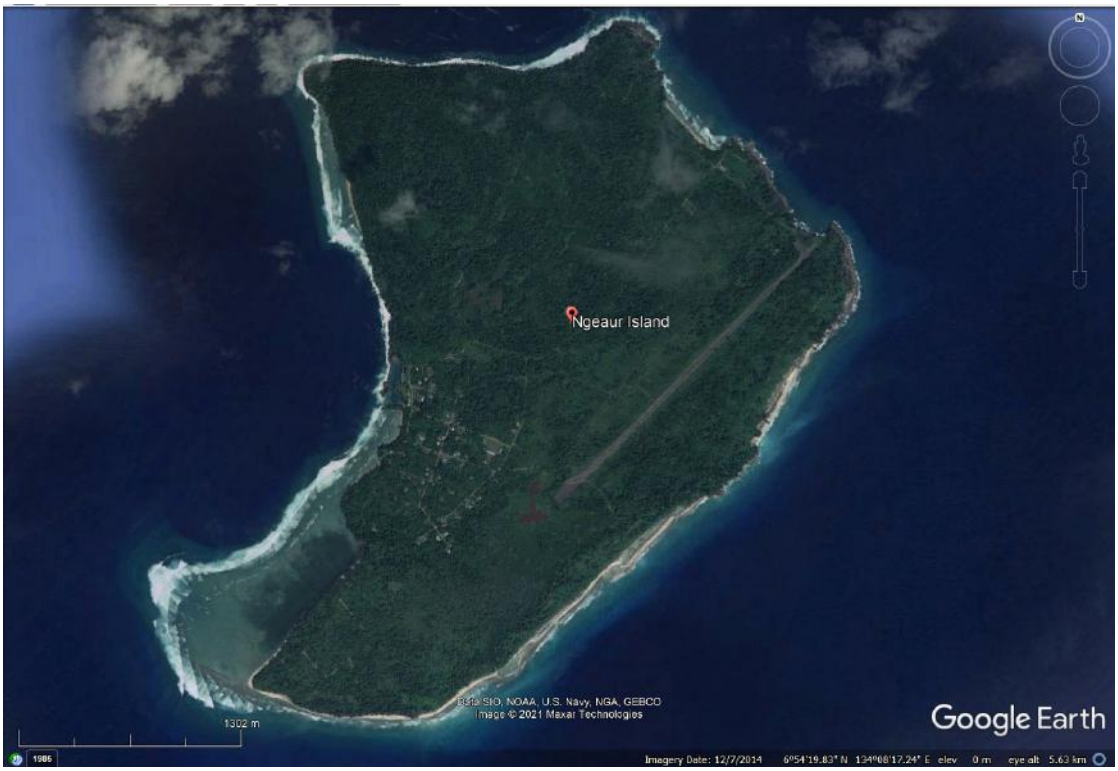

Figure 5.3.1-03: *Satellite image of Angaur captured 07 December 2014*

Figure 5.3.1-03: *The satellite image of Angaur (most probably WorldView-2 data) have a very good spatial resolution.*

5.3.2 Details of the Climate Change Adaptation Action

Climate change mitigation actions details have to be found out such as:

- The locations of the cistern,
- The project and project donor,
- The date of the refurbishment,
- The details of the refurbishment.

Additional reports will be found to access the missing data.

5.3.3 Impact of Refurbished Cistern

A better functioning cistern will enable better water supply. The improved livelihood of households normally is invisible with remote sensing data. There is a slight possibility that households have gardens connected to the houses and that these gardens are in better shape during dry periods than gardens of households not connected to the cistern or a visible brown gardens when the water supply from cistern fails.

Figure 5.3.3-01: *Backyard of a house with apparently agricultural products. These could be an indicator for a functioning water supply during try periods.*

The visibility of drought effected vegetation would increase if VHR satellite image data would be ordered for the agriculture area and the near infrared red edge band can be analysed. This would be more cost efficient than capturing drone images.

5.4 Installation of Solar Pumps in Angaur

The terms of reference mention that water pumps were installed in Angaur.

5.4.1 Solar Pumps

There are several companies on the market producing solar pumps. There are two type to distinguish (i) bigger systems pumping water from the ground to a reservoir from where gravity feeding supplies the consumers, (ii) small units producing pressure in yachts or single households to get e.g. a shower working with water supply from a tank close by. These individual systems can also be used to pump water out of an own well.

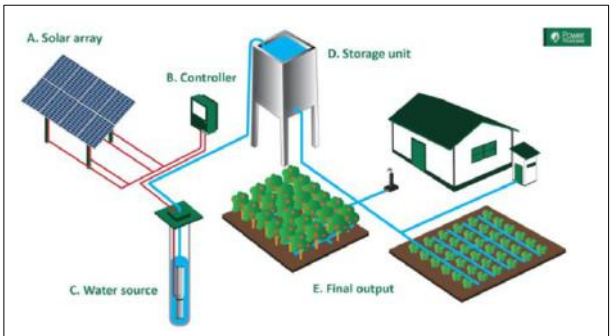

Figure 5.4.1-01: *Parts of a bigger solar pump driven water supply system*

Figure 5.4.1-02: *Parts of a small water pump driven water supply system*

Reports for Palau also mentioning ground water harvest[11].

5.4.2 Visibility of Solar Pumps Impact

All solar pumps have a solar panel and solar panels are normally installed on the roof and should be visible with VHR satellite image data. This dos not tell if the panels are functioning and it does also not tell if the solar pumps are connected and also functioning. In addition they are only one part of the water supply system. However, if monitored in regular intervals missing solar panels can be noticed. Up-to-date VHR satellite image data has to be available. Here the public accessible coverage through Google Earth is increasing.

5.4.3 Action Details

Climate change mitigation actions details have to be found out such as:

- The locations of the solar pumps,
- The project and project donor,
- The date of installation,
- The type of solar water pumps.

Additional reports will be found to access the missing data.

11 Global Climate Change Alliance: Pacific Small Island States, Volume 2: Country Reports, page 86