



TUVALU (FUNAFUTI) 7TH TO 14TH NOVEMBER 2013

ASSESSMENT OF A SEAWEED BLOOM ISSUE ON FUNAFUTI ATOLL AND ASSOCIATED SOLUTIONS; CONDUCTING AWARENESS SESSIONS FOR THE LOCAL COMMUNITIES¹

By Dr. Antoine De Ramon N'Yeurt (PaCE-SD, USP) and Mr. Viliamu Iese (PaCE-SD, USP)

Background:

Recently, the communities of Funafuti in Tuvalu have been complaining about the over-abundance of a certain kind of seaweed on the atoll, which creates a number of problems:

“In Tuvalu we have a similar bloom of an invasive species that became a nuisance in 2011. We have limited knowledge on what causes the bloom in the Funafuti lagoon. Hope you can pay a visit shortly to Funafuti and investigate these species. We had about 30 truckloads of algae taken from Funafuti beach in 2011 by volunteers because it gave out a uncomfortable smell. Can you look into this and advise us on how it emerge in the Funafuti lagoon.”

Luke Paeniu, Funafuti, posted on the Pacific Solutions Exchange Forum, 2013

Additionally, the Funafuti Conservation area has been experiencing an outbreak of Crown-of-Thorn (COT) starfish, which is destroying the coral reefs of the atoll. Similar outbreaks are taking place on other parts of the Pacific as well; causes may be linked to global warming and overpopulation issues.

Objectives:

1. To make an assessment of the seaweed problem in Funafuti lagoon (identification of the species involved, estimation of the biomass available, distribution and observed impacts).
2. To identify possible causes for the seaweed outbreak, and suggest solutions to remedy or mitigate the issue.
3. To visit the Funafuti Conservation Area and assess the extent of the Crown-of-Thorn (COT) starfish outbreak there. Also assess any algal bloom issues in the conservation area.
4. Assess the potential for the implementation of Algae/COT biogas digesters at three sites on Funafuti (Nauti Primary School and Nanumaga), with a view to produce biofuel and organic fertilizer.
5. Meet with stakeholders (Tuvalu Agriculture Department, Fisheries and Island Council).
6. Conduct awareness sessions for the local population on climate change, the seaweed and COT outbreaks, and uses of this biomass for biofuel and fertilizer production. The sessions will be conducted at the Island Council Community Hall (Kaupule).

Plan of Activities:

Day	Morning	Afternoon
Thursday 7 th November	Fly from Nausori to Funafuti	Meeting with USP Center and Fisheries
Friday 8 th November	Meeting with Govt. stakeholders	Initial survey of lagoon algal blooms
Saturday 9 th November	Visit Funafuti Conservation area	Process data and samples from the survey
Monday 11 th November	Biomass survey of lagoon sites	Process data and samples from the survey
Tuesday 12 th November	Analysis of results for preliminary presentation to stakeholders and Visit to interview home garden farmers	
Wednesday 13 th November	Presentation of initial results and Awareness session for local communities, schools and government officials	
Thursday 14 th November	Fly from Funafuti to Nausori	Arrive in Nausori

¹ Photos in this report are credited to Dr. Antoine D.R. N'Yeurt, unless stated otherwise



Fig. 1. Activities site map for the Tuvalu

Expected Outcomes:

1. Assessment of the extent and type of the seaweed bloom problem in Funafuti.
2. Water quality measurements for Fongafale affected areas, and the Conservation Area.
3. Assessment of current agricultural practices by Funafuti farmers in relation to seaweed fertilizer, and possibilities for expansion of this method to other farmers.
4. Best practice handbook for the mitigation of seaweed and COT outbreaks in Funafuti.
5. Change in community perception, attitudes and practices that will reduce the incidence of seaweed and COT outbreaks.
6. Future implementation of biogas digesters for seaweed and COT to alleviate the symptoms of algae/COT outbreaks and provide a sustainable source of cooking biofuel and organic fertilizer.
7. Presentation of the initial results of the survey to the local Tuvalu Island Council (Kaupule).



ACTIVITIES

1.0. Meeting with Stakeholders Thursday 7th November and Friday 8th November.

The PaCE-SD team met with the following representatives of Government, CROP agencies, NGOs and the general population in Tuvalu about the project:

- **Ms Teulealea Manuella-Morris, PaCE-SD EU GCCA Project In-Country Coordinator for Tuvalu.** She took care of the logistics and coordination of our visit in Tuvalu.
- **Mr. Semese Alefaio, Fisheries Research and Development Officer.** He was instrumental in the logistical aspects of the marine-based activities, namely the survey of the Fongafale coastal area seaweed belt and the Funafuti Conservation area. He also kindly provided us with access to Fisheries Office facilities and equipment. Shortly after our arrival, a meeting was conducted at the USP Tuvalu campus library between us, Ms. Manuella and Mr. Semese Alefaio to take stock of the current situation, organize logistical and financial aspects of the visit, and discuss the planned activities for our stay. The minutes of this meeting are given in the Appendix.



Ms Manuella-Morris, Melali Taape Manager Tuvalu Media Corporation, and Mr. Viliamu Iese at the Airport upon arrival



Preparatory meeting at the USP campus with Mr. Alefaio of Fisheries

- **Mr. David Manuella, Campus Director of the USP Tuvalu Centre.** The Director of the Tuvalu campus gave us his full support and access to USP facilities during our stay. He also agreed to have Mr. Faoliu Teakau, Postgraduate student in climate change, to help out in our field activities in Funafuti.



Mr. Manuella, Dr. N'Yeurt & Mr. Iese at the USP Campus



The USP Campus in Funafuti, Tuvalu

- **Mr. Samasoni Finikaso, Director of Fisheries.** A very difficult person to get to meet, we were fortunate to have his full support for our project, and he also allocated some of his staffs and research facilities to assist us during our surveys. He only requested to pay his staffs who will assist us during after-hours. He is eager to exchange information and also requested a copy of the final report of this research. The Director of Fisheries also shared with us some of his data on past algal blooms in Tuvalu.



Dr. N'Yeurt, Mr. Finikaso and Mr. Iese at Fisheries Office



Blue-green algae outbreak on Funafuti reefs, 2011

- **Hon. Mr. Elisala Pita, Minister of Natural Resources.** The Honorable Minister gave us also his full support towards this initiative and offered to help in any way possible. We had last met him at the PaCE-SD EU GCCA Stakeholders meeting in Port Vila, Vanuatu in October 2013.



Mr. Iese and Hon. Minister Elisala Pita



Hon. Minister Pita (with the NPAC shirt) and our team

- **Dr. Akihiro Kawada, Coordinator of the JICA-funded Foram Sand Project in Tuvalu.** Dr. Kawada kindly allowed us to use his laboratory at Fisheries for our seaweed survey work. The Japanese-funded Foram Sand Project, Phase I of which ends in March 2014, looks at the viability of culturing foraminifera (calcified microalgae) which contribute a great deal to the composition of beach sand in Tuvalu, with the aim of restocking and increasing the deposited sediments of the atoll nation.



Dr. Kawada near a foram culture tank (courtesy UNDP)



The JICA laboratory used to process our seaweed samples

- **Mr. Yeong-lang Yang, Leader of the Taiwan Technical Mission in Tuvalu (ICDF).** The Taiwanese Technical Mission has a Horticultural Crop Development Project in Funafuti close to the airport, designed to “assist with and demonstrate technologies associated with vegetable and fruit cultivation and production as part of a wider promotion of the consumption of fruits and vegetables”. Collaboration with the Taiwanese project will be invaluable for providing seed stock to farmers participating in our seaweed fertilizer trials.



ICDF Tuvalu Leader Mr. Yeong-Lang Yang meets our team



The ICDF Horticultural Crop Development Project site

- **The Island Council (Kaupule) of Funafuti.** We met with the President, Secretary and Planner of the Kaupule, presenting them the objectives of our visit and our planned activities for the week. They responded with much interest, and had many questions about their perception of the seaweed issue in Funafuti. We agreed to have a presentation of our initial findings to the Kaupule and general public on Wednesday 13th November, at the Funafuti Falekaupule (Funafuti Community Hall).



The Funafuti Kaupule Planner, President and Secretary



The Kaupule Secretary asking a question to the team

- **Mr. Itaia Lausavere, Director of Agriculture.** This meeting was critical in obtaining the support of the Ministry of Agriculture for our planned trials of seaweed-based fertilisers with Tuvaluan farmers. The Director lends his full support for the research and especially using seaweed as an organic fertilizer. He also shared that Butaritari Island in Kiribati are using seaweed to fertilize their crops. He is also interested for his department to be involved in conducting trials for seaweed fertilizer in Tuvalu. However, he emphasized that working with farmers to conduct trials will be essential for the success of the seaweed research especially in collecting data but also establishing demonstration farms. The Director of Agriculture suggested that we meet with **Mr. Otinielu Tausi, master farmer** and Oxford graduate who would be the ideal person to carry out controlled field experiments on crops. We later met Mr. Tausi at his home and visited his farm. He was very keen to assist us in our project. The Director could also facilitate the discussion to use some plots in the Taiwanese Technical Mission in

Tuvalu garden (Faatoaga Fiafia) to conduct the research to compare the growth of crops using seaweed and inorganic fertilizers.



Mr. Itaia Lausavere with the USP team



Mr. Otinielu Tausi, Master Farmer and Oxford graduate

- **Hon. Tofiga Maleko, Deputy Governor-General of Tuvalu.** A brief informal encounter at Princess Margaret Hospital explaining the purpose of our visit and the seaweed bloom issues in Funafuti.



- **Tuvalu Media Corporation (TMC) interview.** At around lunch time on Friday 9th of November, The TMC radio station hosts interviewed both Dr. Antoine N'Yeurt and Mr. Viliamu Iese for about thirty minutes about the purpose of the visit to Tuvalu, and the seaweed bloom issue. Teuleala Manuella started the interview with a general overview of the EUGCCA Project and how it links with the current research trip. Mr. Iese provided the Tuvaluan version of the interview while Dr. NYeurt responded in English. The interviews went on air that evening throughout the country on the Tuvaluan radio channels to raise awareness about our visit (there is no television station in Tuvalu to date). The copies of the interviews will be used by Ms Manuella for more awareness during her EUGCCA community visits.



TMC Diana Semi interviewing the PaCE-SD team



TMC staff Semi Malaki recording the English version of the

2.0. Funafuti – Fongafale initial Seaweed assessment, Friday 8th November:

On the afternoon of the 8th of November, a boat outing was done into Fongafale lagoon with Mr. Semese Alefaio of Fisheries to assess the situation with respect to the seaweed bloom issue. To our surprise, much biomass of the brown seaweed *Sargassum polycystum* was found stretching in a belt around the lagoon coast of the populated areas of Fongafale island in Funafuti, starting at very shallow depths near the shoreline and extending up to 100 metres into the lagoon, literally creating an underwater forest in some areas with plants reaching up to two metres in height. The distribution was irregular, with noticeable ‘hotspots’ in front of populated areas, schools, hospital, Hotels / Government buildings, and also apparently related to water depth.

Preliminary evidence suggests that this is an introduced invasive species, possibly vectored in by international shipping from Wallis and Futuna Islands in 2011, which established itself following a severe period of drought when much of the population resorted to the lagoon for washing, cleaning and defecating. Samples of the seaweeds were collected for DNA genetic studies to pinpoint the origin of the algal population. Inner reef areas were also subject to a blue-green algae outbreak (*Lyngbya* spp.) at the same period in 2011.

The sheer amount of biomass present at the lagoon sites survey would indicate full suitability for use in a project converting this organic matter into compost for agriculture and biofuel for cooking and lighting purposes. By doing this, it would alleviate the symptoms of the seaweed bloom while at the same time providing an alternative source of sustainable fertilizer and energy for local communities, reducing imports of these two commodities. The scientific findings of the recently approved for funding USP Research Cluster proposal “Pacific community development through fertilizer production and biofuel generation from the red seaweed *Gracilaria edulis* and other marine plants” could hence be successfully extended to *Sargassum* biomass in Tuvalu. More detailed biomass measurements, algal cover estimation and quadrat samplings were planned for Monday 11th of November, along with water quality measurements in the lagoon.

Credit: Viliamu Iese





Mr. Semese Alefaio of Tuvalu Fisheries holding a *Sargassum* plant

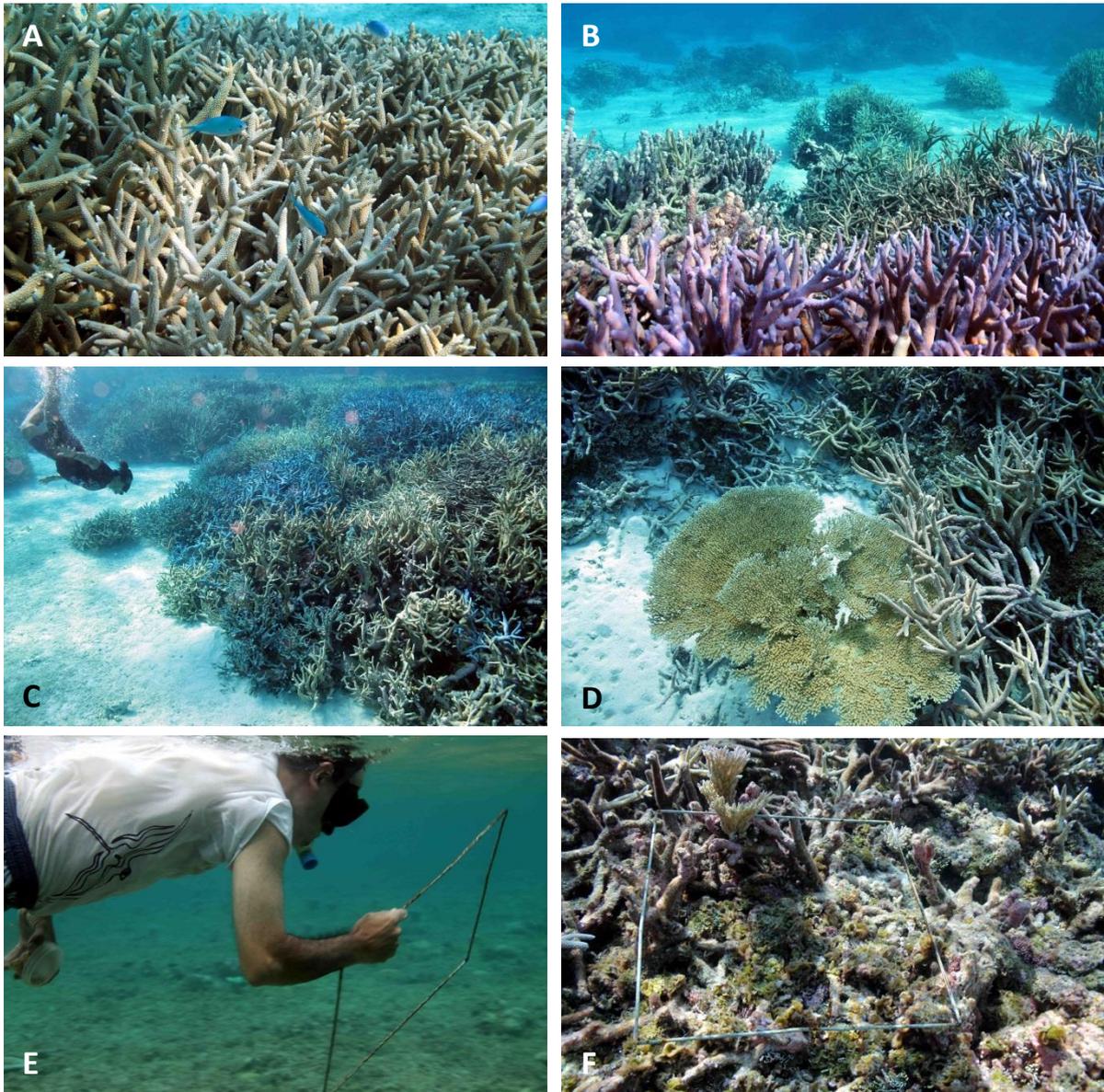
Herbarium specimen of a *Sargassum* plant prepared by Dr. N'Yeurt



3.0. Visit to Funafuti Conservation area, Saturday 9th November

The Funafuti Conservation Area (FCA) covers a total land area of about 33 km², being the first marine protected area declared in Tuvalu in 1996 (Job & Ceccarelli, *Tuvalu Marine Life, Scientific Report*, 2012). It accounts for about 20% of the reef area of the atoll (Figure 1). The purpose of our visit to this area was two-fold: to investigate the algal cover and take water quality measurements as a means of comparison to the heavily populated areas of the lagoon in Fongafale, and to verify the presence of any crown-of-thorn starfish that could be used for biofuel/biofertiliser trials. The team consisted of Dr. Antoine N'Yeurt and Mr. Viliamu Iese of PaCE-SD, Mr. Semese Alefaio of Tuvalu Fisheries, and Mr. Faoliu Teakau, USP Postgraduate student in Climate Change at the Tuvalu Campus. A total of six sites in three representative islands were visited: Fuloapa, Fuafatu and Tefala. At each site, quadrats were laid and seaweed cover noted by the team, along with a GPS position and on-site water quality analysis (pH, Nitrates, Salinity, DO, TDS, Temperature) using the Aquameter™ probe. The coral and algal cover was also documented using an Ikelite™ underwater photographic apparatus. Water quality was found to be very good in the isolated sites, with healthy coral cover, good visibility and no crown-of-thorn starfish. The overall picture was a stark difference with the polluted and algae-infested lagoon areas of Fongafale.



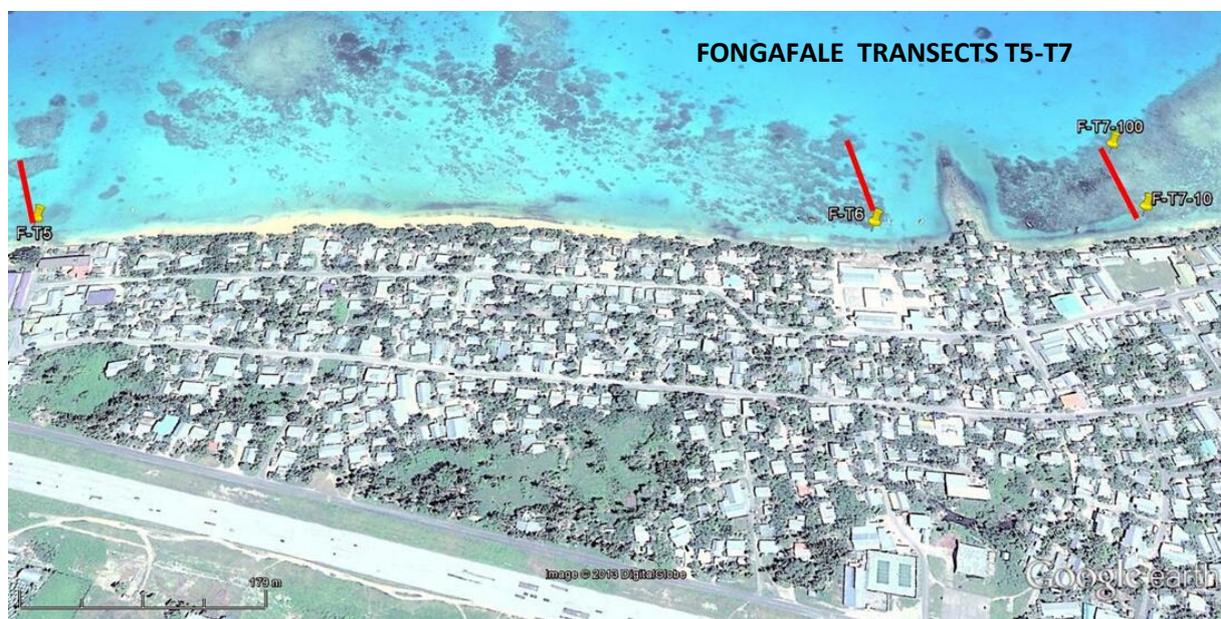
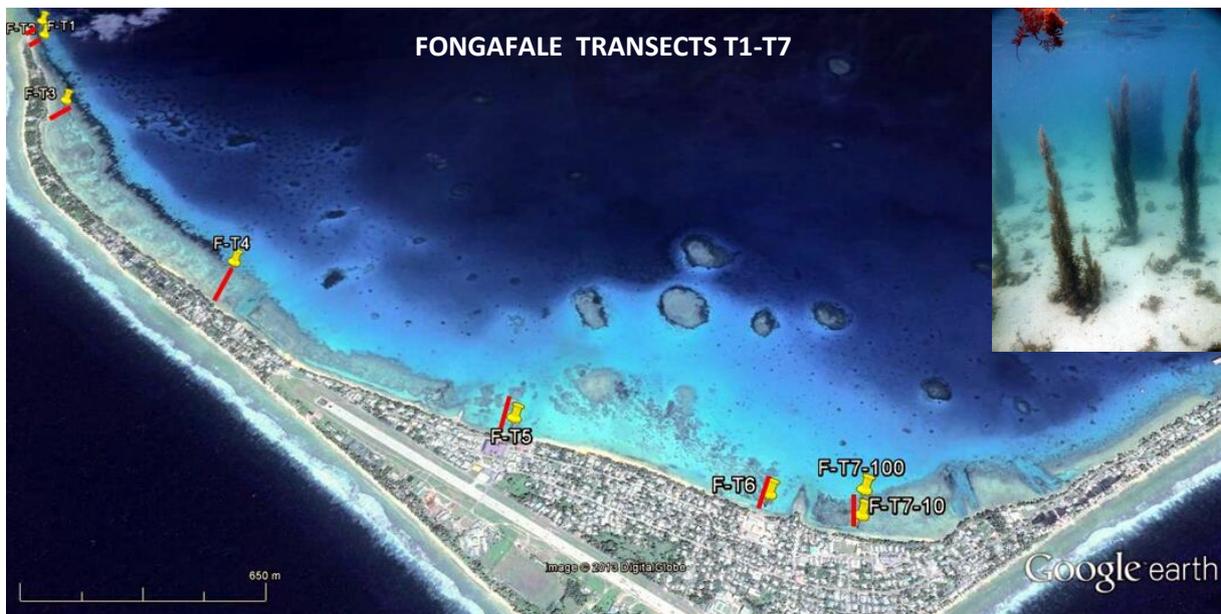


Funafuti Conservation Area survey. **A:** *Acropora* corals with blue damselfishes in the foreground. **B:** Branched coral assemblages on sandy bottom. **C:** Diving to collect an algal sample. **D:** A large table coral amidst branched *Acropora*. **E:** Preparing to lay a quadrat. **F:** Quadrat to quantify the cover of macroalgae.

It was noted that much of the coral community was composed of branched and table corals, a sign of good health of the coral reef. Water clarity was also optimal with minimal turbidity, and sediments were mostly white sand and rubble. Fish species encountered were representative of the habitat, with a dominance of damselfishes as reported by Job & Ceccarelli (2012) in their detailed survey of the FCA, although no top predators such as sharks or barracudas were seen. Only one holothurian was spotted, and surprisingly, not a single *Sargassum* plant. This observation reinforces the notion that the *Sargassum* outbreak seen in Fongafale lagoon near the port of entry is an alien invasive introduction to Tuvalu, most likely from Wallis Island. The dominant algae in the quadrats of the FCA were *Microdictyon* sp., followed by *Halimeda* spp., *Dictyota* spp., coralline algae and *Padina* spp.

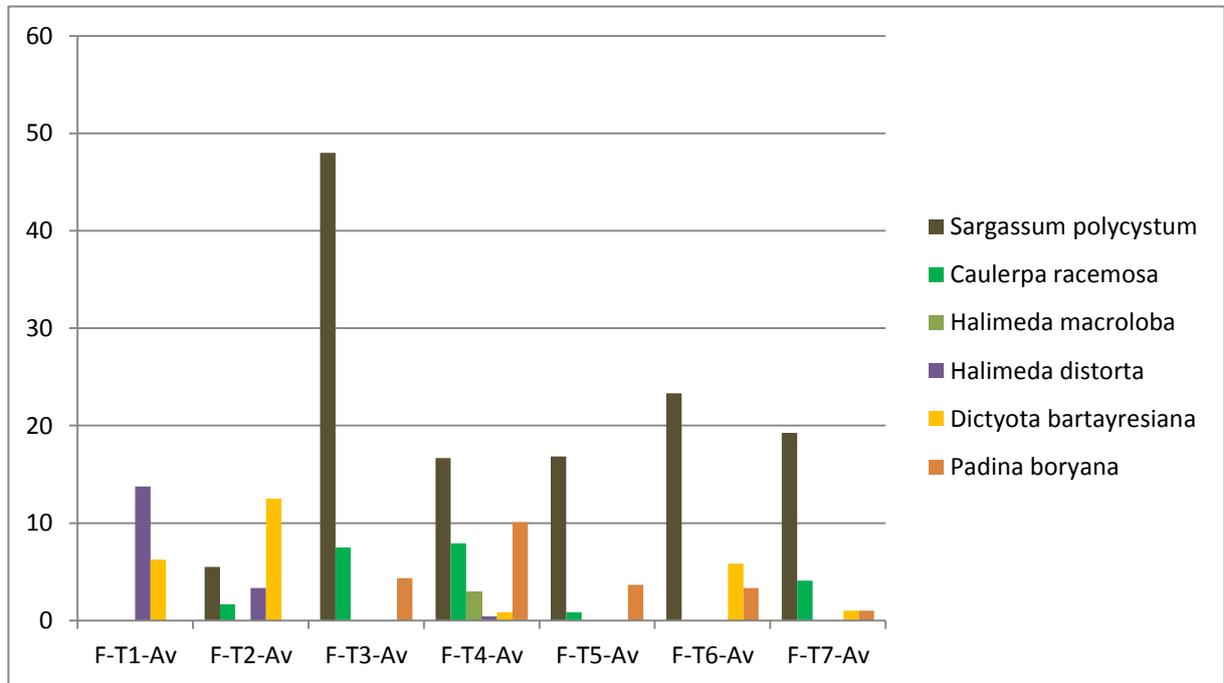
4.0. Fongafale Lagoon Transects and Biomass Assessments, Monday 11 November 2013

A total of seven transects were laid, starting from the sparsely populated southern end of Fongafale islet up to the front of the Government Building and Hotel. Each transect was between 30 and 110 meters long, starting from the shoreline and going seaward. At every ten meter interval, a 0.5m² quadrat was laid on the transect line, and all algal cover recorded. For the last two transects, all *Sargassum* plants were collected from each transect, in order to obtain the wet weight and assess the average biomass per square meter. The plants were then sun-dried to obtain the dry weight, and were brought back to Fiji for eventual analysis of nutrient content in the laboratory. Preliminary results indicate that the dominant algal cover is of the brown alga *Sargassum polycystum*, followed by the green alga *Caulerpa racemosa* and the brown alga *Dictyota bartayresiana*. A total of 17 species of algae were found. While the *Caulerpa* and *Dictyota* are normal components of Pacific tropical atoll floras, *Sargassum polycystum* appears to be an invasive introduced species. The distribution pattern of *Sargassum* along the transects has clear links with the amounts of nutrients in the water (pollution levels) correlated with densely populated areas, schools and the hospital, (T3, T6, T7) creating ideal conditions for its growth. The area in front of the school, T7, was particularly badly affected.





Credit: Joël Orepuller - UPF

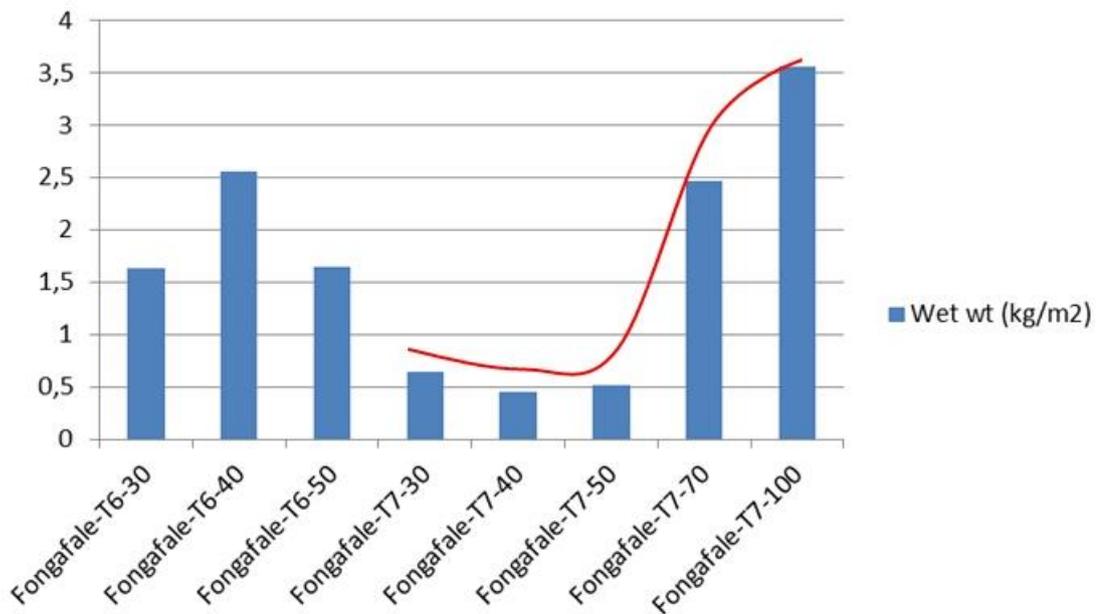


MAIN ALGAL PERCENTAGE COVERS FOR FONGAFALE TRANSECTS T1-T7

Credit: Viliamu Iese



Wet wt (kg/m²)



SARGASSUM BIOMASS RESULTS FOR TRANSECTS T5-T7

Fongafale Transect Survey. **A:** Area in front of the Government Building, showing *Sargassum* growing in distinct rows (arrows). **B:** Sun-drying a whole *Sargassum* plant for nutrient analysis. **C:** Wet weight per quadrat determination in the laboratory. **D:** Recording the total wet biomass per quadrat.

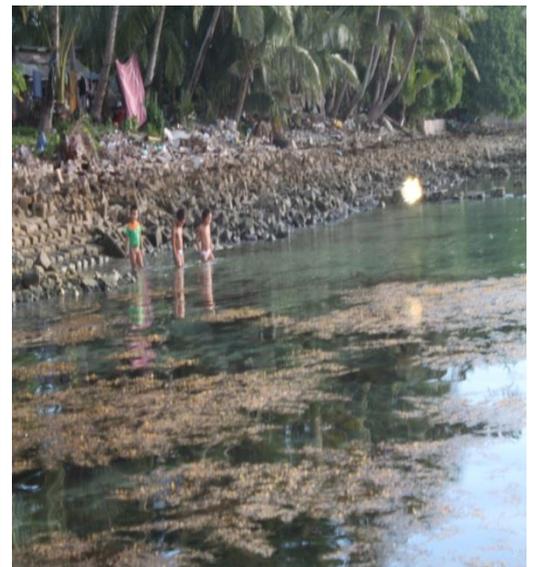
TRANSECTS STRUCTURE



Credit: Viliamu Iese



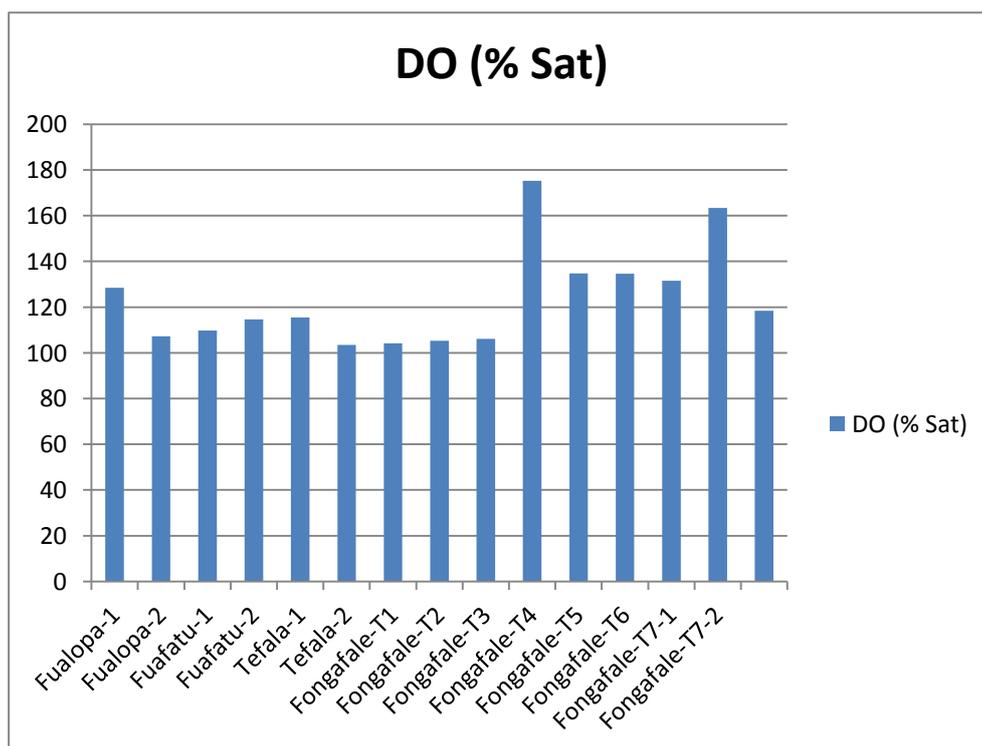
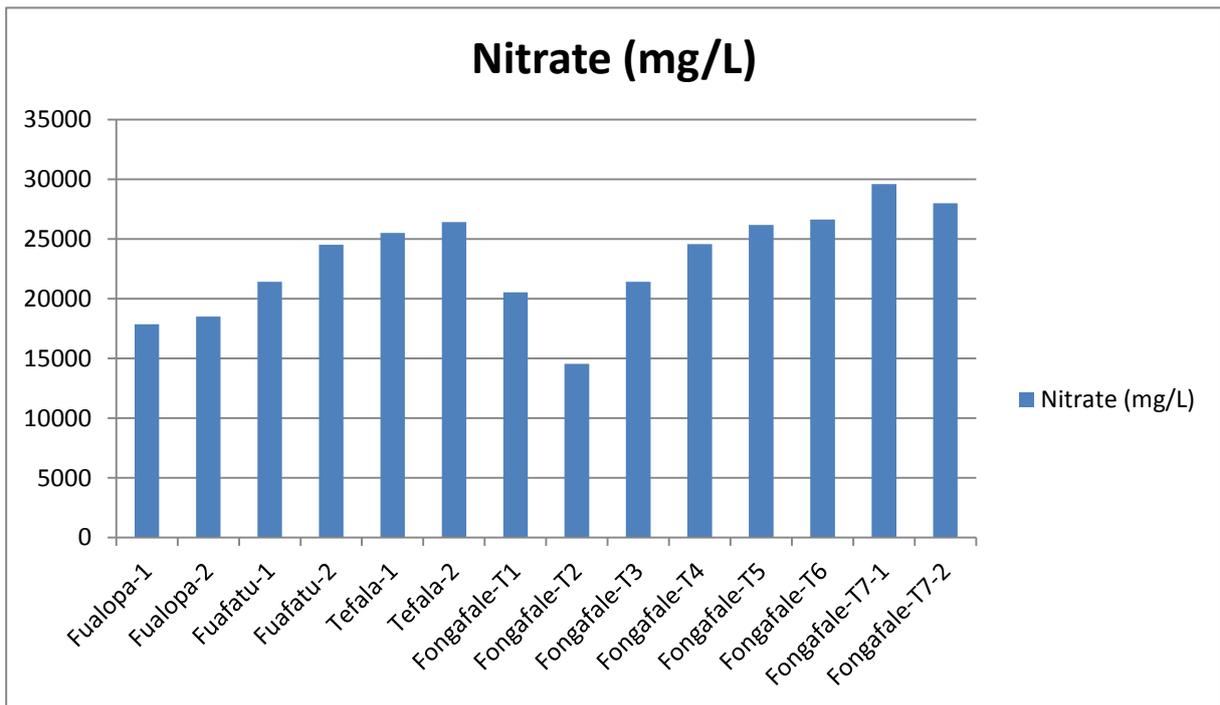
Credit: Viliamu Iese



Fongafale Transect Survey. L: Distribution of *Sargassum* in the lagoon showing how the plants prefer shallower waters. R: Children going to swim in *Sargassum*-infested waters in front of the Kaupule Hall. This poses a serious skin irritation risk.

5.0. Water quality data for Conservation area and Fongafale lagoon sites

At each site, water quality was measured with a precision instrument (Aquaread Aquameter™) which automatically recorded the GPS position, pH, temperature, salinity, dissolved oxygen (DO), total dissolved solids (TDS) and Nitrates. The results were directly exportable into GoogleMaps with transect points. Of particular interest were Nitrate levels, which were almost twice as high in the heavily populated areas of Fongafale (e.g. T7, up to 30,000 mg/L, near the upper detection limit) compared to the conservation area (Fualopa 1, 17,855 mg/L). Nitrates are derived from sewage and other effluents, and are excellent nutrients for algal growth, as shown by the high daytime DO levels in these areas because of the higher photosynthetic activity by the abundant seaweed forests.



6.0. Agricultural practices using seaweed fertiliser:

Ten home garden farms were visited at Funafuti on Tuesday (12/11/2013). The main purposes of the visits were to observe the type of crops cultivated by the farmers, how they plant their crops and also to conduct interviews on whether they would adopt seaweed fertilizer as an organic compost. Five farmers were interviewed. It was very encouraging to see that home garden farmers in Tuvalu are planting various crops including but not limited to pawpaw, bananas, cucumber, egg plant, water melon, spring onions, chili, Chinese cabbage, pineapple, sweet corn, long beans, tomatoes, guava, lime, avocado, taro and new varieties of giant swamp taro. Most of the farmers obtained their seeds, or planting materials from the Taiwan Technical Mission. Some farmers are now starting to produce their own seedlings. All farmers started home gardening to provide healthy fresh foods for their households, source of income, alternative exercise, and also to participate in regular competitions held by the Agriculture Department and Taiwan Technical Mission (TTM).

Most of the farmers visited used inorganic fertilizers provided by the TTM but after they heard of the negative impacts of inorganic fertilizers on coastal water especially in atolls, they are shifting back to organic farming using compost (they bought from waste management or they collected themselves) and animal manures.

Two farmers interviewed mentioned that they used or using seaweed as an organic fertilizer. Mr. Otinielu Tausi used to apply seaweed before. He soaked his seaweeds for three days (three times in three days) before mixing with composts. Mr. Tausi tried mixing compost with seaweed before but he did not notice any difference in growth compared to other non-seaweed fertilized crops. He mentioned though that he did not spend more time observing his crop growth so therefore may be his conclusions were wrong. He is very eager to use seaweed again after our discussions.



Mr. Otinielu Tausi and his organic farm in the heart of Funafuti

Another farmer Mr. Amasia Amitai, is using *Sargassum* plants washed up on the beaches which he collected for his various crops including tomatoes, cabbage, watermelons and long bean. He soaked his seaweed in water before application. He also reuses the same water for his plants. He has been using this method for the last six months and reports good growth so far. The washed, dried seaweed is manually applied to the base of the plants at regular intervals. This farmer observed a fast growth of cucumber and water melons that are fertilized with seaweed compared to other farmers who are not using seaweed. They planted their crops at the same time. He is sharing this knowledge with his close friends and neighbors and they are all eager to use seaweed as fertilizers.



Mr. Amasia Amitai applying seaweed fertilizer to his farm

7.0. Presentation of initial Results to the Community and DRM workshop, 13th November

At the end of our visit to Funafuti, we organized through the assistance of Ms Teulealea Manuella-Morris for a presentation of our initial findings to the Kaupule and general public on Wednesday 13th November, at the Funafuti *Falekaupule* (Funafuti Community Hall). The meeting started at 9 AM and ran until about 3:30 PM, with morning tea, lunch and afternoon sea served. It was attended by about 120 members of the community, including about 70 high school students, 20 women and 30 men. Also in attendance were the acting Director of Environment Mrs. Pepetua Lakasi, and the Director of Energy. The Tuvalu Media Corporation was there to record the event for the local news media, and a complete video footage of the sessions was captured by Mr. Fikau Teponga, a prominent Tuvaluan climate change awareness advocate now living in Melbourne, Australia. The morning sessions were concerned about introducing PaCE-SD and the EU GCCA project, the purpose and findings of our work in Tuvalu about the seaweed proliferation issue, and presentations about alternative energy sources using biogas and seaweed fertilizer use in Tuvalu. The afternoon sessions were concerned with a public forum and a Disaster Risk Management workshop for the community. The presentation

was very well received by the community, and many questions were asked. Those in attendance reported finding it very educational and informative. The brief schedule of the event is as follows:

Time	Activity	Person(s) in charge
0900-0930	Opening and introductory remarks	Ms. Teulealea Manuella-Morris; PaCE-SD
0930-1000	Presentation of survey methods	Mr. Semese Alefaio, Fisheries
1000-1030	Results of marine surveys	Dr. Antoine N'Yeurt / Viliamu Iese
1030-1015	Morning Tea	
1015-1045	Results of agricultural surveys	Mr. Viliamu Iese
1045-1100	Nanumea biogas project	Ms. Teulealea Manuella-Morris
1100-1130	Biogas and fertilizer from algae	Dr. Antoine N'Yeurt / Viliamu Iese
1130-1200	Discussion forum	All participants
1200-1300	Lunch	
1300-1500	Disaster Risk Management workshop	Ms Teulealea Manuella-Morris / V. Iese
1500-1545	Talk on climate change in Tuvaluan	
1545-1600	Closing remarks	Ms Teulealea Manuella-Morris / V. Iese



Presentations at the Kaupule Hall. A: Teulealea Manuella-Morris. **B:** Viliamu Iese. **C:** Semese Alefaio. **D :** Audience including high school students. **E:** Dr. Antoine N'Yeurt. **F:** Community members listen in.



Disaster Risk Management Workshop. **A:** Teulealea Manuella-Morris and Viliamu Iese. **B:** Semese Alefai, Teulealea Manuella-Morris and Viliamu Iese. **C:** Presentation by women. **D:** Activities session. **E:** Presentation by men. **F:** Community members listen in. **G:** Presentation by women. **H:** View of the community members assiduously listening-in to a presentation by Dr. N'Yeurt and Mr. Iese.

8.0. General Conclusions and Recommendations:

- From initial results, the seaweed problem in Funafuti consists of the opportunistic brown seaweed *Sargassum polycystum*, which is not native to Tuvalu.
- The most likely vector for the introduction of *Sargassum* into Tuvalu could be commercial shipping (through ballast waters, hulls, anchors), and the origin of the population from Wallis Island (DNA studies could confirm this). The outbreak of this bloom appears to follow a period of drought in 2011, also an El Niña year when current patterns in the lagoon were disrupted, and very favourable nutrient conditions existed in the lagoon (shortage of water, people using the lagoon as a latrine, for washing etc.).
- Blooms have a positive correlation with high nitrate levels in the lagoon, opposite the borrow pits settlements, schools, the hospital and hotels. These areas might have improper latrines, combined with leaking sewer systems, leaching nutrients into the lagoon and promoting luxurious algal growth. Plants also prefer shallow areas less than 1 m deep, with hard substratum to attach to (not sandy ones).



- Problems caused by the blooms include:
 - Social – ugly, difficult to access swimming areas
 - Economic – Reducing fisheries productivity, Damages to fishermen’s gears
 - Health – fish poisoning, itchiness, discomfort
 - Environmental – encourage the settling of other invasive species, reduce flow of nutrients, decrease Dissolve Oxygen, damages to corals
- Continue addressing and reducing pollution of lagoon – fix the latrine and waste problem.
- The Environment and Fisheries Department to continue the research to cover all other areas of Funafuti and continue monitoring the seaweed growth and distribution using the same reference points and method.

- Proper inspections and enforcements of shipping laws – no ballasting of water.
- Establish a small committee to spearhead efforts to address the seaweed problems.
- Put in place pilot projects in Funafuti for converting seaweed biomass into fertilizer for local farmers.



POSSIBLE CULPRIT #1: poor waste management in densely populated areas such as these borrow-pit communities?



POSSIBLE CULPRIT #2: International Shipping; through ballast waters, hulls, anchors and discarded fishing nets?

ACKNOWLEDGEMENTS

Falekaupule Funafuti

President and Members of the Funafuti Island Council (Kaupule Funafuti)

Director and Fisheries Department

Director and Agriculture Department

Director, USP Campus Tuvalu Mr. David Manuella

Mr. Faoliu Teakau, USP Postgraduate student

Fishermen and Farmers

Our families, Friends

Mr. Semese Alefaio, Tuvalu Fisheries Department

Ms. Teuleala Manuela-Morris

EU GCCA, PaCE-SD, USP

