Dear Members,

I am Antoine De Ramon N'Yeurt, Research Fellow with the European Union Global Climate Change Adaptation (EU GCCA) Project (www.uspeugcca.net) under the PACE-SD (Pacific Centre for Environment and Sustainable Development; www.usp.ac.fj/pace), based at the University of the South Pacific in Fiji (USP). My background over the last 20 years has been in tropical Pacific marine botany, ecology and taxonomy, and more recently in climate change and the marine environment.

Lately I have been involved in surveying and analyzing sudden seaweed blooms that have occurred on the main island of Viti Levu in Fiji. This problem has only just started occurring in the last few years, and we suspect the sudden bloom of this normally discrete seaweed is caused by recent changes in the environment (rise in seawater temperature due to climate change, poor water circulation in the lagoons, increase in anthropogenic (ie man-made) nutrients, pollution, etc).

The blooms almost exclusively consist of a fast-growing, local and pan-tropical species of red seaweed (Gracilaria edulis) which can become very abundant, with up to 100% cover on the shallow inner reef flats. When dislodged by rough weather, the seaweed washes up in great quantities onto beaches and the shoreline. This is causing environmental issues as it smothers traditional fishing grounds and reduces the productivity of the reef flats by taking nutrients and oxygen out of the water, and also displaces the normal seaweed assemblages that grow there. For locals, it is also unsightly and causes a severe odour problem as it rots and releases noxious gases such as Hydrogen Sulfide (rotten-egg smell).
Several local communities have approached us at PACE-SD about this problem affecting their villages and urban areas, and **we are seeking solutions to contain or eliminate the expansion of this locally invasive species.**

Are other members of this PSE network aware of similar algal blooms? I would be very interested to hear from you and exchange information about:

- Where else is such a problem occurring, with locally invasive and/or introduced species of seaweed?
- What are the possible scientific causes and/or solutions to this problem?
- How can we sustainably use these seaweeds, such as fertilizer, ocean afforestation or perhaps biomass for fuel or energy sources (as is done with other types of organic wastes)?

Thanking you in advance for your time and responses.

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**Responses were received, with thanks, from**

1. **Kelvin Passfield**, IUCN (International Union for Conservation of Nature) Commission on Ecosystem Management, Rarotonga, Cook Islands
2. **Peter Muller**, United Nations Office for the Coordination of Humanitarian Affairs (OCHA), Suva, Fiji
3. **Peter Sinclair**, Applied Geoscience and Technology Division (SOPAC), Secretariat of the Pacific Community (SPC), Suva, Fiji Islands
4. **Dr Stefan Kraan**, Ocean Harvest Technology Ltd, Milltown, Galway, Ireland
5. **Beatriz Vera**, Universidad Central de Venezuela (UCV), Caracas, Venezuela
6. **Clifford Goudey**, C.A. Goudey & Associates, Newburyport, USA
7. **Neil Sims**, Kampachi Farms, Hawaii
8. **Kamal Khatri**, SOPAC (Pacific Islands Applied Geoscience Commission, Applied Geoscience and Technology Division of Secretariat of the Pacific Community), Suva, Fiji
10. **Jyotishma Naicker**, Piloting Climate Change Adaptation to Protect Human Health (PCCAPHH) in Fiji Project, Ministry of Health-WHO-UNDP-GEF, Suva, Fiji
11. **Litiana N. Tuilaselase Kuridrani**, Umanand Prasad School of Medicine, Lautoka, Fiji
12. **Zaidy Khan**, Regional Programme Coordinator and Grants Manager, Communities and Coasts Programme, The Foundation of the Peoples of the South Pacific International, Suva, Fiji
13. **Mark Skinner**, Independent Contributor, Concord, Australia
14. **John Foster**, Forster Consulting Inc, United States of America
15. **Teuleala Manuella Morris**, Funafuti, Tuvalu, In Country Coordinator (ICC) PACE-SD USP EU GCCA Project
16. **Herb Vandermeulen**, Saint Andrews Biological Station, New Brunswick, Canada
17. **Vaasiliifiti Moelagi Jackson**, Faasao Savaii Society (conservation and environmental organisation), Savaii, Samoa (Response 1; Response 2)
18. **Dr. Thierry Chopin**, Scientific Director of the Canadian Integrated Multi-Trophic Aquaculture Network (CIMTAN) and Professor of Marine Biology at the University of New Brunswick, Saint John, Canada
20. **Bridgette Clarkston**, Carl Wieman Science Education Initiative University of British Columbia, Vancouver, Canada
21. **Rangi Johnson**, Manihiki, Cook Islands, Ministry of Marine Resources
The recurrence of overly abundant seaweed blooms is becoming a concern for many Pacific countries, with recent and problematic experiences cited in Fiji, Cook Islands, Solomon Islands, Kiribati and Tuvalu. These concerns were discussed by an unprecedented 40 respondents from across 17 countries in Pacific Solution Exchange’s recent e-conversation about seaweed proliferation, as posed by Dr Antoine De Ramon NYeurt who is a research fellow with the European Union Global Climate Change Alliance Project (EU GCCA) with the Pacific Centre for Environment & Sustainable Development (PACE-SD), based at the University of the South Pacific. The discussion revolved around confirmation of this issue then about whether prevention, removal or utilisation is the best solution to the problem. The fact this Pacific-based discussion went global seems indicative of shared international concerns about the increasing prevalence of
excessive seaweed and its detrimental impacts on marine and coastal ecosystems, not to mention the foul stench!

There is an increase in seaweed prevalence, based on the anecdotal and research-based evidence shared in this e-conversation. Respondents related their various stories on the seaweed blooms, and how it is no longer a simple cycle of algae blooms that naturally appear then disappear into the coastal ecosystem. This sudden abundant growth of seaweed is becoming a regular occurrence, not only in the Pacific but also in other countries such as USA (Nahant Bay, Boston), Venezuela (Paraguana, Falcon State), Canada (Prince Edward Island) and also in the Caribbean Islands (Bahamas & Grenada). Based on Members’ shared experiences, it was noted that apart from the local species of red seaweed (Gracilaria edulis), other local species are fast becoming invasive due to their excessive growth in the past years, like ‘boodlea’ in the Cook Islands, ‘ulva’ in Venezuela, ‘pilayella littoralis’ in Boston, and Canada’s ‘cladophora, ulva, pilayella, ectocarpus, and heterosiphonia japonica’.

Case studies of problem seaweed in the Pacific include red seaweed (Gracilaria edulis) in Suva, Fiji; the severe seaweed outbreak at Morovo Lagoon in Solomon Islands suspected as being the cause of a massive fish kill in the area; the recent increase in fish poisoning in Tuvalu that some are linking to the vast growth of seaweed; and at Bonriki in Kiribati where a sampling project of elevated nutrients in the ocean waters may indicate a connection to local algae bloom outbreaks.

Perhaps the central issue that was continuously highlighted throughout the email-based exchange is the unexplained cause of this unwarranted growth of seaweed, with explanations ranging from rise in seawater temperature due to climate change, poor water circulation in the lagoons, increase in anthropogenic (ie man-made) nutrients, pollution and other causes. Respondents could not agree on a singular cause, with most divided between climate change versus development. Many of the respondents, while trying to describe the seaweed situations in their countries, blamed climate change as the main cause. However, other explanations pointed to development being the cause, particularly human contamination of the sea due to poor waste management. This includes dumping of rubbish into the sea, the discharge of ballast water from ships, having pig stys beside lagoons resulting in pig excrement and other untreated waste washing directly into the local waterways. Members from Cook Islands and Tuvalu shared stories how seaweed outbreaks were typically near highly populated areas, often in drought times, inferring waste to be the cause.

In most situations shared by respondents, major impacts are currently not felt or seen apart from the usual foul odour and appalling appearance of overly abundant seaweed. However, with examples such as Morovo Lagoon starting to surface, coupled with environmental variations the seaweed phenomena introduces into the marine and coastal ecosystem, the issue is sounding ‘alarm bells’ that are resonating amongst practitioners and scientists across the globe. As a result, a subsequent discussion ensued among Members about whether the best solution to the problem is either prevention, removal, or utilisation such as recycling and manufacturing.

In terms of removal methods, some pertinent recommendations were provided by the Members, however, practicality and associated costs might be the stumbling blocks for most Pacific Islands. Removal of the decomposed seaweed from beaches is only a short-term ‘band-aid’ solution that can either be incredibly labor intensive (though effective when a community works together such as in Tuvalu), or extremely costly such as in Hawaii where hi-tech removal equipment is being used. However, as one member explained “haul-out treats the symptom, but not the cause.”

For prevention, members mentioned the need for better waste management. Alternatively, one of the suggested long-term solutions to this dilemma is having some form of fisheries protection such as MPAs (Marine Protected Areas) to avoid damaging shifts in the marine ecosystem. An
ongoing research study in Fiji shows how an increase in algae is impacting on populations of certain herbivorous fish such as Naso and Siganus, while in Hawaii algae-eating sea urchins are being bred in nurseries and released into oceans. The challenge with fisheries protection is sharing the message of regulating protected areas, across to economically challenged communities that are ever in need of more fish or sea urchins to sell.

Utilisation and recycling of seaweed seems to be the most viable option to overcome this problem, based on responses received. Commercial uses of seaweed were discussed in detail, along with the options to farm seaweed including red seaweed to ensure supply can meet ongoing demand. Excellent ideas and suggestions were discussed, including using seaweed for:
1. Food: as an ingredient in processed food for human consumption such as seaweed noodles
2. Fertilizer or Compost: in the Pacific ‘Traditional Knowledge’ reveals past use of seaweed as fertilizer for taro and other crops but modern day use would first require testing for compounds and salt content that may be harmful to the plants
3. Pig and animal feed: using seaweed as a raw material in patented feed formulation, thus replacing or eliminating synthetic additives from animal feed
4. Seaweed soap: introduced in Fiji under the GEF Small Grants Programme program
5. Source of raw material/export: many other potential sources of use for seaweed were discussed and can be investigated.

Furthermore, based on responses received during this conversation, prospective buyers are readily available from the developed countries for such products. The main challenge though, which most Pacific countries are facing, is the inability of producing and selling in large volumes due to lack of resources.

In conclusion, respondents shared their thoughts and ideas on prevention, removal and also utilization of seaweed. Based on the responses, there seems to be irrefutable evidence that seaweed outbreaks are becoming more prevalent in the Pacific but, while this is an environmental concern, this problem could be converted to an income-generating opportunity via the managed production and processing of seaweed. Removal is only a short-term solution to long-term problem. Regardless of uses, whether via removal or re-use, better understanding the problem and how to prevent it remains the central issue. There is a growing need to pinpoint and rectify the cause of overly abundant seaweed especially given the consistently cited link between outbreaks and poor waste management, which will have multiple impacts on communities beyond smelly seaweed! Perhaps seaweed is Mother Nature’s alarm bell for a bigger crisis ahead.

Solomon Islands

Marovo Lagoon, Honiara (from Peter Sinclair, Applied Geoscience and Technology Division (SOPAC), Secretariat of the Pacific Community (SPC), Suva, Fiji Islands)
The severe seaweed outbreak (algal blooms red and yellow in color) experienced at Morovo Lagoon, Honiara, was assumed to be the main cause of a massive fish kill in the area. Most of these fish were identified as deep sea fish but other marine organisms like bechdemer, clamshells and other bottom dwelling barrowing organisms such as worms also died and floated up to the water surface. The source or reason for the blooms is still being traced. Read more

Tuvalu

Community Hand Removes Seaweed, Fongafale, Funafuti (from Teuleala Manuella Morris, Funafuti, Tuvalu, In Country Coordinator (ICC) PACE-SD USP EU GCCA Project)
In Fongafale seaweed “sprung up” and especially in the lagoon area where people lived, causing a terrible smell and attracting jelly fish. Funafuti local government council coordinated a 2-week,
300-person community clean-up to remove the seaweed by hand, supported by Red Cross and Tuvalu Association of Non Governmental Organisations (TANGO). It has not reoccurred since that drought, when waste from humans and pig stys likely contaminated the water. Read more

**Kiribati**

**Elevated Nutrient Levels at Bonriki, Kiribati** *(from Peter Sinclair, Applied Geoscience and Technology Division (SOPAC), Secretariat of the Pacific Community (SPC), Suva, Fiji Islands)*
The cause of excessive algae blooms in the Bonriki area were unknown. A sampling project of the ocean waters some 100s of metres offshore from Bonriki, discovered elevated nutrients and an assumption was made that this was connected to the unusual growth of algal blooms. As a result a draft report is being prepared and may be available on request from the project team at the Department of Environment (MELAD) in Kiribati. Read more

**Cook Islands**

**Pearl Farmers Concerned About Extended Seaweed Outbreak, Manihiki, Cook Islands** *(from Rangi Johnson, Manihiki, Cook Islands, Ministry of Marine Resources)*
Often for 3-4 days the local lagoon becomes murky and seaweed gathers but in 2011 the problem persisted for 6 months, concerning local pearl farmers and fishermen. Marine biologists (visiting for another purpose) assessed the waters as safe for the pearl oysters but fishermen had to go ocean fishing instead on fishing in the lagoon. Locals believe human contamination caused the outbreak that just died away after 6-months for reasons unknown. Read more

**Hawaii, United States of America**

**‘Super Sucker’ machine and Sea Urchins Remove Seaweed, Kaneohe Bay, O’ahu Hawai’i** *(from Jacqui Berrell, Pacific Solution Exchange (PSE) Facilitation Team, United Nations Development Programme, Suva, Fiji)*
There is currently an excessive amount of invasive (non-native) seaweed algae in Kaneohe Bay. This is being removed by a barge-mounted, massive vacuum cleaner “Super Sucker”, along with cultured native Sea Urchins that are being grown at a hatchery on Sand Island. The goal is to clear the bay’s north end of the worst algae by 2015 - 5,000 pounds of algae a day for three more years - at a cost of about $2.6 million. Read more

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**Related Resources**

**Recommended Documentation**

**Marovo Lagoon Event- Solomon Islands newspaper article** *(from Peter Sinclair, Applied Geoscience and Technology Division (SOPAC), Secretariat of the Pacific Community (SPC), Suva, Fiji Islands)*
Available at;  
[http://www.solutionexchange-un.net/repository/pc/ccd/pse_ccd_seaweed-Peter.pdf](http://www.solutionexchange-un.net/repository/pc/ccd/pse_ccd_seaweed-Peter.pdf)  
(PDF, Size: 186KB)  
Story on the harmful algal blooms being the potential cause of thousands of fish in the Marovo Lagoon in the Solomon Islands

From **Dr. Antoine De Ramon N’Yeurt**, European Union Global Climate Change Alliance Project (EU GCCA), Pacific Centre for Environment & Sustainable Development (PACE-SD), University of the South Pacific, Suva, Fiji

**Experimental Cultivation of Gracilaria Edulis (Gmelin), Silva in Gulf of Mannar at Tuticorin**
Discusses culture techniques of Gracilaria edulis in Gulf of Mannar, Hare Island, Tuticorin, during 1996-97 favourable period for culture and influence of environmental parameters.

Raft Culture of Gracilaria edulis in open sea along the South-Eastern Coast of India

Studies of the culture of Gracilaria edulis was undertaken using a floating raft method to improve biomass production.

Agars from Three Fijian Gracilaria Species

A handbook on Eucheuma seaweed cultivation in Fiji and in particular an analysis of the Gracilaria species.

Short communication: Cultivation of marine red alga Gracilaria edulis (Gigartineales, Rhodophyta) from spores

Discusses the successful cultivation of the 'Gracilaria edulis', a major Indian agarophyte, in an experimental scale from spores at sea off Narakkal, Kochi.

Studies on the Agarophyte, Gracilaria Edulis - Experimental Field Cultivation and Methods of Improving Yield and Quality of Agar

Preliminary investigations on the extraction of phycocolloids from five common red algae of Shri Lanka.

From Zaidy Khan, Regional Programme Coordinator and Grants Manager, Communities and Coasts Programme, The Foundation of the Peoples of the South Pacific International, Suva, Fiji.

Eastern Caribbean Seeks Funds for Green Growth

School children planted mangrove seedlings to fortify coastal areas from the effects of climate change, as supported by the Caribbean Coastal Area Management Foundation.

Training the Leaders of "Generation Climate"

Climate change is impacting Trinidad in a variety of ways, as in the Pacific, and education is being used to combat the future effects.

Barbados Looks to Beaches as First Line of Defence

Impacts of climate change and other environment issues are resulting in changes to the seafront in Barbados with local communities and practitioners taking adaptive measures.
The Sargasso Sea, located entirely within the Atlantic Ocean, is the only sea without a land boundary
Article By: National Ocean Service, National Oceanic and Atmospheric Administration (NOAA)
Available at: http://oceanservice.noaa.gov/facts/sargassosea.html

Article on the Sargasso Sea, a vast patch of ocean named for a genus of free-floating seaweed called Sargassum

Caribbean Hit Hard by Sargassum Seaweed Invasion
Article by: Desmond Brown, Inter Press Service (IPS), ST. JOHN'S, Antigua, 29 Feb. 2012
Copyright permission sought. [Copyright © 2013 IPS-Inter Press Service, all rights reserved.]
Available at: http://www.ipsnews.net/2012/02/caribbean-hit-hard-by-sargassum-seaweed-invasion-2/

Discusses how changes in currents coupled with weather and temperature patterns is causing Sargassum Seaweed to wash ashore en masse onto Caribbean beaches

Understanding the recurrent large-scale green tide in the Yellow Sea: Temporal and spatial correlations between multiple geographical, aquacultural and biological factors (from Dr. Thierry Chopin, Scientific Director of the Canadian Integrated Multi-Trophic Aquaculture Network (CIMTAN) and Professor of Marine Biology at the University of New Brunswick, Saint John, Canada)
Article by: Feng Liu, Saojun Pang, Thierry Chopin, Suqin Gao, Tifeng Shan, Xiaobo Zhao and Jing Li. Published in Marine Environmental Research 83 (2013): 38-47.
Available at: http://www.sciencedirect.com/science/article/pii/S0141113612002036

Study on the green tide in the coast of Jiangsu Province in China and the correlation factors such as the ‘Ulva prolifera’

From Tim Carruthers, Secretariat of the Pacific Regional Environment Programme (SPREP), Land Ocean Interactions of The Coastal Zone, Samoa

A New Approach for Detecting and Mapping Sewage Impacts
Article by; S.D. Costanzo, M.J. O’Donohue, W.C. Dennison, N.R. Loneragan and M. Thomas Marine Pollution Bulletin Vol 42, No. 2, pp. 149-156, 2001 © Elsevier Science Ltd. All rights reserved
Available at: http://dx.doi.org/10.1016/S0025-326X(00)00125-9

Discusses a technique that identifies the source, extent and fate of biologically available sewage nitrogen in coastal marine ecosystems

Using nitrogen stable isotope ratios of macroalgae to determine the effectiveness of sewage upgrades: changes in the extent of sewage plumes over four years in Moreton Bay, Australia
Paper by; Simon D Costanzo, James Udy, Ben Longstaff, Adrian Jones. Marine Pollution Bulletin Vol 51, pp. 212-217, 2005 © Elsevier Science Ltd. All rights reserved.
Available at: www.sciencedirect.com

Discusses the "sewage plume mapping" technique that demonstrated a large reduction in the magnitude and spatial extent of sewage nitrogen within Moreton Bay over 5 years

Macroalgal bioindicators detect nutrient enrichment from shrimp farm effluent Entering Opunohu Bay, French Polynesia
Article by; David T Lin, Peggy Fong. Marine Pollution Bulletin Vol 56, pp. 245-249, 2008 © Elsevier Science Ltd. All rights reserved
Available at: www.sciencedirect.com

Reports on the effectiveness of macroalgal bioindicators and stable isotopes in assessing nutrient enrichment from shrimp farm waste effluents
Lagoon Scale Processes in a Coastally Influenced Caribbean System: Implications for The Seagrass Thalassia Testudinum
Journal Article by; T. J. B. Carruthers, P. A. G. Barnes, G. E. Jacome and J. W. Fourqurean
Caribbean Journal of Science, Vol. 41, No. 3, pp 441-455, 2005 © 2005 College of Arts and Sciences, University of Puerto Rico, Mayaguez
Available at: http://academic.research.microsoft.com/Publication/4819260/lagoon-scale-processes-in-a-coastally-influenced-caribbean-system-implications-for-the-seagrass
Summarizes patterns in water column and sediment characteristics within seagrass meadows in the three main water bodies in the Bocas del Toro archipelago

Gracilaria Edulis (Rhodophyta) as a Biological Indicator of Pulsed Nutrients in Oligotrophic Waters
Journal Article by; Simon D. Costanzo, Mark J. Donohue, and William C. Denison
Responses of the algal bioindicator to variable nutrient pulses – maybe a useful tool for investigating source and geography of nutrients entering oligotrophic coastal waters

Influence of Submarine Springs and Wastewater on Nutrient Dynamics of Caribbean Seagrass Meadows
Research Article by; T.J.B Carruthers, B.I.van Tussenbroek, W.C. Dennison
Estuarine, Coastal and Shelf ScienceVol 64, pp. 191-199, 2005 © Elsevier Science Ltd. All rights reserved.
Available at: www.sciencedirect.com
Studies the potential for Submarine Springs to influence nutrient processes within seagrass meadows, by assessing nutrient status of Thalassia testudinum meadows
From Miguel Esteban, Waseda University, Department of Civil and Environmental Engineering, Tokyo, Japan

Coral Reefs (Chapter 7)
Studies are showing that coral reefs act much like submerged breakwaters, bars, or depth-limited coastlines

Phase shifts in coral reef communities and their ecological significance
Paper by; Done, T. J. (1992)
Available at; Hydrobiologia, 247, 121-132
Develops a better understanding of how population, community and ecosystem structure and function differ in degraded from un-degraded reefs

Corals fail to recover at a Caribbean marine reserve despite ten years of reserve designation
Available at; Coral Reefs 30:1077-1085, 1
Tests whether 10 years of reserves to replenish fish stocks have translated into positive effects on coral communities in Glover's Reef, Belize
Navy Drives Algal Biofuel Production (from Frits Rincker, Renewable Energy Technology Expert and Climate Change Blogger, Netherlands)
http://www.climatebabes.com/index.php?/categories/2-OneCellOil

Explains how the US Navy expects to get 336 Million gallons of algae generated biofuels by 2020, given its interest in capabilities to produce JP-8 grade jet fuel

Gracilaria culture in China - PowerPoint Presentation (from Professor Jiaxin Chen, Yellow Sea Fisheries Research Institute, Qingdao, China)
http://www.solutionexchange-un.net/repository/pc/ccd/pse_ccd_SeaweedQuery_China.pdf (PDF; Size: 317KB) and also http://www.solutionexchange-un.net/repository/pc/ccd/pse_ccd_SeaweedQuery_Noodle.pdf (PDF; Size: 350KB)

Presentations demonstrating actual examples of seaweed uses for food production such as seaweed noodles

Seaweed Soap Production (from Devika Raj, NaDraki Weather, Suva, Fiji)
Newspaper articles; by Fiji Times and Fiji Sun
Available at; ‘Women Exchange Knowledge’ and http://www.fijitimes.com/story.aspx?id=176270 and ‘A creamy gumbo from Ono-i-Lau’

Women from two isolated Fiji islands came together for a one-day sustainable livelihoods training workshop learning about handicraft skills and seaweed soap production

Recommended Organizations and Programmes

ECOWOMAN (from Litiana N. Tuilasela Kuridrani, Umanand Prasad School of Medicine, Lautoka, Fiji)
http://uoft.asiapacificreader.org/index.php?option=com_content&task=view&id=317&Itemid=97

Ecowomen is a South Pacific NGO promoting the use of women’s traditional knowledge and practices and advocating for women’s participation in science and technology fields

South Pacific Action Committee for Human Ecology and Environment (SPACHEE)
(from Litiana N. Tuilasela Kuridrani, Umanand Prasad School of Medicine, Lautoka, Fiji);
http://www.uia.be/s/or/en/1100049937

Aims to improve cooperation and communication between people and agencies in the South Pacific

Fisheries Oceans Canada (http://www.dfo-mpo.gc.ca/libraries-bibliotheques tech-eng.htm)
(from Herb Vandermeulen, Saint Andrews Biological Station, New Brunswick, Canada)
http://www.dfo-mpo.gc.ca/index-eng.htm

Details tides, currents and water levels; nautical charts; Canadian Coast Guard; fishery openings and closures; shellfish harvesting area closures; commercial fishing

Kiribati, Sustainable Towns Project (from Peter Sinclair, Applied Geoscience and Technology Division (SOPAC), Secretariat of the Pacific Community (SPC), Suva, Fiji Islands)
http://www.citiesalliance.org/ca_projects/detail/14682

has undertaken some sampling of ocean waters in the Bonriki area and that they found some elevated nutrients some 100s of metres offshore and that this possibly is connected to the algae blooms. A draft report maybe available for that and the project team would need to be contacted at the environment department MELAD in Kiribati.

Ocean Harvest Technology (from Dr Stefan Kraan, Ocean Harvest Technology Ltd, Milltown, Galway, Ireland)
www.oceanharvest.ie
Seeks opportunities to utilise seaweed and other marine resources to provide patented feed ingredients for salmon, shrimp and pigs

**Recommended Portals and Information Bases**

**Advice from Algae-L Members for Seaweed Biodiversity Talk** (from Bridgette Clarkston, Carl Wieman Science Education Initiative University of British Columbia, Vancouver, Canada)
http://www.solutionexchange-un.net/repository/rcd/pse_ccd_SeaweedQuery_Bridgette.doc
(Size: 52KB)

Details responses from a recent conversation about Seaweed Biodiversity facilitated by the global, email-based exchange of Algae-L

**Recommended Tools and Technologies**

**Super Sucker** (from Jacqui Berrell, Pacific Solution Exchange (PSE) Facilitation Team, United Nations Development Programme, Suva, Fiji)
(Permission requested to link article; full attribution is given to The Midweek publication, online at www.midweek.com, only reproduce with permission, ©2013 MidWeek Printing, Inc. An Oahu Publications company. All rights reserved)

Seaweed is being removed by a barge-mounted, massive vacuum cleaner “Super Sucker”, along with cultured native Sea Urchins that are being grown at a hatchery

**Responses in Full**

Kelvin Passfield, IUCN (International Union for Conservation of Nature) Commission on Ecosystem Management, Rarotonga, Cook Islands

Hi Antoine,

Thanks for the query, and glad to see you are managing to maintain your involvement with marine algae in your new position. Just goes to show how cross-cutting climate change is.

I can't help you with a Gracilaria invasion, but here in Rarotonga we are currently experiencing a large bloom of Boodlea (local seaweed) again, similar to several we have had in recent years. You may recall I sent you the original sample a few years ago for identification. It seems to be associated with summer water temperatures, and possibly even cyclonic weather conditions.

I am not sure if it is having any major impacts here, apart from looking unsightly for the tourists. Of course without a proper study we may not know what impacts there may be on the reef and marine life of a Boodlea bloom. But I agree it would be good to find a worthwhile use for the stuff. At least Gracilaria is an edible species with a market. Is there any possibility of harvest for export? Or is the shelf life too short?

Fertiliser also is a possibility, as you mentioned. A mulch for taro (dalo) patches perhaps? But it may need to be tested first, in case there are some compounds, or salt content, that is harmful to the plants we would be trying to grow.

**I also look forward to any more ideas people may have on uses for these occasional blooms**, and also causes/solutions.

Regards.
Dear Solution Exchange,

I remember in recent years an algae bloom caused similar conditions and worries in Solomon Islands (Marovo Lagoon, August 2011) and in Tarawa lagoon (could also be Funafuti now that I think of it, can't seem to find the emails on that). The algae bloom in Solomons reportedly killed many fish, the one in Tarawa (or Funafuti) was apparently harmless but just looked (and smelled?) bad.

People who know more about that would staff at SOPAC, WHO and UNICEF.

Best.

Hi All,

Just following from Peter's thread. I have limited experience in this area and so am only able to direct you to some of the information that has passed across my desk, or I have witnessed in the field.

Certainly as Peter indicates there has been some algae outbreaks in Marovo Lagoon Solomon Islands; Funafuti lagoon, Tuvalu; and on the ocean side of Bonriki airport, Tarawa Kiribati in recent years.

I have limited information on the latter two at the moment and have attached some of the information on the Marovo Lagoon event: [http://www.solutionexchange-un.net/repository/pc/ccd/pse_ccd_seaweed-Peter.pdf](http://www.solutionexchange-un.net/repository/pc/ccd/pse_ccd_seaweed-Peter.pdf) (PDF, Size: 186KB)

Some of my colleagues may be able to offer more.

For Kiribati I believe that one of the projects currently operating in Kiribati, Sustainable Towns Project, has undertaken some sampling of ocean waters in the Bonriki area and that they found some elevated nutrients some 100s of metres offshore and that this possibly is connected to the algae blooms. A draft report maybe available for that and the project team would need to be contacted at the environment department MELAD in Kiribati.

In Funafuti, the outbreak in the lagoon was a very filamentous brown weed, which was covering much of the reef material and floated in large clumps. A colleague Dave Hebblethwaite took images and if I can locate images I am sure we can forward across. The outbreak was present in Oct 2011 and had been persistent for some months at least, I am not aware of its current status.

Trust this is of some use.

Regards.
Dear Dr N’Yeurt,

As Scientific Director and co-founder of Ocean Harvest Technology (www.oceanharvest.ie) we take interest in opportunities to utilise seaweed and other marine resources to provide our patented feed ingredients for salmon, shrimp and pigs - these products are all derived from 100% natural, marine resources that are fully sustainable and are supported by full scientific trials and analysis that replace synthetic ingredients found in a wide range of aquaculture and animal feed. In addition, using these natural marine resources means we can replace or eliminate synthetic additives from animal feed allowing food producers to achieve significantly improved yields as well as taste, flavor and texture, whilst complying with organic standards and ever stricter regulatory restrictions.

Seaweed is a great resource for us to use.

Over the last few years at Ocean Harvest Technology we have been making specific tailor made feed ingredients from seaweed and one of the species we use is Gracilaria from Vietnam. As we use 100’s of tonnes we would be interested if the species is harvested to control the invasiveness. Potentially we would be able to purchase these quantities which would help paying people to remove it.

Given the species is Gracilaria edulis, then we are very interested and would like to explore mutual opportunities to help the environment by removing the species, help to develop and stimulate the social rural maritime economy by creating another industry in Fiji and helping ourselves with a new source of raw material.

Kind regards.

Dr. Antoine De Ramon N’Yeurt, European Union Global Climate Change Alliance Project (EU GCCA), Pacific Centre for Environment & Sustainable Development (PACE-SD), University of the South Pacific, Suva, Fiji

Dear Stefan,

Thank you for this very interesting proposition Stefan. We will have to see how much biomass there is available (naturally, or in culture later) and if it is economically viable to export. The species is Gracilaria edulis, and there are some papers around on its nutrient content such as the following (mostly these are protected by Copyright):

1) **Experimental cultivation of Gracilaria edulis (Gmelin), Silva in Gulf of Mannar at Tuticorin**
   Pon Sirameetan and M. Selvaraj
   Research Centre of Central Marine Fisheries Research Institute, Tuticorin - 628 001, India
   Seaweed Res. Uliln., 21 (1&2): 121-124, 1999

2) **Raft culture of Gracilaria edulis in open sea along the south-eastern coast of India**
   M. Ganesan, Nivedita Sahu, K. Eswaran
Marine Algal Research Station, Central Salt and Marine Chemicals Research Institute, Council of Scientific and Industrial Research (CSIR), Mandapam camp-623 519, Tamilnadu, India

3) Agars from Three Fijian Gracilaria Species
R. Falshaw, R. H. Furneaux, T. D. Pickering and D. E. Stevenson

4) Short communication: Cultivation of marine red alga Gracilaria edulis (Gigartineales, Rhodophyta) from spores
Reeta Jayasankar & Sally Varghese
Central Marine Fisheries Research Institute, Kochi-682014, Kerala India
January 2001; revised October 2001
Indian Journal of Marine Sciences, Vol. 31(1), March 2002, pp. 75-77

5) Studies on the Agarophyte, Gracilaria Edulis - Experimental Field Cultivation and Methods of Improving Yield and Quality of Agar
A. Sivapalan and K. Theivendirarajah
Department of Botany, University of Jaffna, Jaffna, Sri Lanka

We will definitely keep in touch and as our pilot project on the distribution/biomass of this algae starts this year, I can have more figures for you on how much there is available for your use. Again, thank you and with kind regards.

Beatriz Vera, Universidad Central de Venezuela (UCV), Caracas, Venezuela

Appreciate your question Dr. Nyeurt with respect to Gracilaria,

I’m a Professor at the Universidad Central de Venezuela (UCV) and recently I have a project for using algal blooms for fertilizer and possibly Micro-elements in compost (micro-elements are known as trace elements and sometimes people even call them the “multi vitamins” for plants).

With respect to Gracilaria, it grows in natural banks in Paraguaná, Falcon state but we do not have Gracilaria blooms, only moderate Ulva blooms.

Gracilaria is sensitive to nutrient enrichment by residual waters, this is a problem on the coastal area that is necessary to control. It is possible to use these blooms in fertilizer, agar production and other uses, but it is necessary cut out the waste. In the Venezuelan coast, Ulva was the group of seaweed abundantly growing. Gracilaria growth is abundant in some regions in the west, at Paraguaná, Falcón state.

The climate change is overlapping with contamination problems and it’s difficult to separate the causes. The water temperature is increasing. I’m interested in this because some other algae disappeared in the Margarita island upwelling area, and I want to know if it is possible for incremental temperature (change) by climatic change to increase contamination? That is a question I would like answered.

I hope you resolve this situation.

Clifford Goudey, C.A. Goudey & Associates, Newburyport, USA
Antoine,

The situation you describe in Fiji sounds similar to a problem I confronted while at MIT (Massachusetts Institute of Technology). A beach north on Boston on Nahant Bay had become increasingly plagued by the brown algae Pilayella littoralis that, while naturally occurring, was collecting in the bay and washing up on the beaches under summertime wind conditions. The resulting wrack and smell from its decomposition was awful. Attempts to scrape it off the beach at low tide removed more sand than algae.

Once the movements of this unattached mass was tracked, we tried to remove it from the bottom of the bay using a towed suction dredge operated from a local lobster boat. However, the algae proved too dispersed to do this economically. Ultimately we developed a means of removing it during episodes when deposited on the beach by pumping it when just suspended at the water’s edge. We used portable centrifugal trash pumps, special suction nozzles that avoided the sand, and screened dumpsters to allow the wet algae to drain. The resulting dumpster full of biomass was hauled to a composting facility and successfully mixed with yard waste. Efforts to find higher uses for it were unsuccessful.

The removal method was ultimately judged successful, albeit labor intensive. Even at that state of development it could have economically solved that local problem had it have been implemented by the local town authorities.

The key to making such an approach work is confronting the algae when nature has already concentrated it. In our case that required coordination with the tides and the moon phase, as the enduring wracks were most easily dealt with and those seemed to regularly occur after peak tides in the summer months. Having people and equipment staged became important.

I would be happy to provide details if you are interested, though the documentation may be less than ideal given that the work occurred over 15 years ago.

Neil Sims, Kampachi Farms, Hawaii

Dear Antoine, et al.,

Haul-out treats the symptom, but not the cause. If you don’t want to be doing this haul-away for the rest of your life, then perhaps try to figure out ‘why the bloom’?

Perhaps nutrient enrichment, as you suggest, but … perhaps also look at what has happened to herbivorous reef fish stocks in the area over the last few decades. I would suspect that local stocks of Naso, Siganus, Kyphosus, Acanthurus, etc – which might normally have kept macroalgae in check – have been decimated. A long-term solution might then be some form of fisheries protection – closed areas, or such.

Good luck with that!

Aloha kakou.

Dr. Antoine De Ramon N’Yeurt, European Union Global Climate Change Alliance Project (EU GCCA), Pacific Centre for Environment & Sustainable Development (PACE-SD), University of the South Pacific, Suva, Fiji
Dear Neil,

Thank you for these insights. Ongoing research by a group led by Dr. Mark Hay of Georgia Tech in Fiji has shown that the populations of certain herbivorous fish such as Naso and Siganus is indeed dropping dramatically in areas where reefs are becoming algae-dominated. This shift in the ecosystem could be reduced by having MPAs (marine protected areas) and regulating the fishing of these species. The problem is getting the message across to economically challenged communities that are ever in need of more fish to sell, and regulating protected areas.

Kamal Khatri, SOPAC (Pacific Islands Applied GeoScience Commission, Applied Geoscience and Technology Division of Secretariat of the Pacific Community), Suva, Fiji

Dear all,

Further to Peter’s comment (about Marovo), while I was not involved directly in carrying out any assessment, this did have kind of a disaster response planned over 6 months in 2011.

I found the Marovo fish kill reports which I am sharing, for your information:

• Marovo Lagoon Fish Kill - Preliminary Field Report 14-19 June 2011, The University of Queensland, Dr. Simon Albert and Mr. Brad Moore. This report for the Solomon Government outlines preliminary observations and limited data from a 5 day investigation of a large fish kill in Marovo Lagoon, Solomon Islands. [http://www.solutionexchange-un.net/repository/pc/ccd/cr17_Marovo_Fish_Kill_Preliminary_Report.pdf](http://www.solutionexchange-un.net/repository/pc/ccd/cr17_Marovo_Fish_Kill_Preliminary_Report.pdf) (PDF; Size: 1.08MB)


Best regards.

Takena Redfern, Ministry of Environment, Lands, and Agricultural Development, Tarawa, Kiribati

Dear Antoine and members of CCD solution exchange,

The sudden bloom of seaweed as already mentioned by other members is also happening in Kiribati. As far as I know after living on Tarawa or in Kiribati for many years, this bloom of seaweed is something new and I always wonder about the cause of it and think that it is possibly linked to this change of climate. As I picked up from your mail, this bloom has negative impacts on the marine and coastal ecosystem and this was something new to learn. What I always only concern about the bloom of seaweed on beaches is the bad odor to the people who lived along the coast. It’s also kind of a nuisance to everyone when seaweeds spread along the beaches closed to public roads.
Because of this problem of bad odor from seaweeds, we initiated a small trial in 2005 on investigating the beneficial use of this seaweed in farming. Based on the help from one of the Fisheries officials, we only got into genus (Gracilaria sp.) the name of this seaweed that we used in our trial. We carried out a trial on comparing growth of taro (Colocasia esculenta) with and without seaweed. From our results, it showed that inclusion of seaweed in composting improves growth of taro. We didn't make it to see its effect on the yield due to high infestation of taro beetle in our research station.

Basically, our aim of testing the effects of seaweed in farming is based on the idea that we want to establish a way that can help removing this seaweed from beaches and thus reduce bad odor problems by utilizing this seaweed in farming. Also, we learn from older traditional growers that they have been using marine resources in their farming to improve growth and yield of their local crops. However, there is very few local growers that we knew adopt this composting method and this associate with many factors that some are beyond our reach.

This year, we plan to carry out another small trial on feed formulation where we are going to use this seaweed as one of the raw materials in our feed formulation. We are hoping for a success in this research since one of the important needs that always raised by people is the limited supply and high costs of imported feed for pig production. So we are hoping that this research will help pig producers to get cheap and reliable supply of feeds and same time help reduce problems associated with seaweed bloom.

Hope this answers some of the questions you outlined in your mail.

Best Regards.

Jyotishma Naicker, Piloting Climate Change Adaptation to Protect Human Health (PCCAPHH) in Fiji Project, Ministry of Health-WHO-UNDP-GEF, Suva, Fiji

Dear Community,

Hi, my name is Jyotishma Naicker and I am posting this comment as an individual. I do not have any expertise on uses of seaweed, but I feel I must raise some important questions.

I recently watched a documentary on water hyacinths in a lake and the problem had ascended to a level where it was practically impossible to navigate the lake on boats, fisheries had seriously declined and local authorities had almost given up on the problem. On the other hand, women of the area were making good of this 'problem' by using dried hyacinth stems as weaving materials, and making really beautiful handicraft items, that sold at premium prices in the market. At first I thought- good, why waste a potential resource?

Then I saw that the hyacinths were still there in the lake, and still problematic and thought, is there a danger of this weed/pest now becoming a valuable resource? Therefore is there a danger that locals will want the hyacinths to remain, and not eliminate them?

The questions I would like answered are:

a) What are the economics of making commercial use of such blooms/outbreaks in the short-term compared to the ecological/social/ economic costs in the long-term?
b) Why isn't the immediate solution for the community to get together and remove the rogue seaweed? This seems like more of a 'common sense' solution to me, acknowledging this may not be possible for particular blooms.

Best wishes.

Litiana N. Tuilaselase Kuridrani, Umanand Prasad School of Medicine, Lautoka, Fiji

Dear Members,

I wish to respond to Jyotishma’s question regarding water hyacinth known as “bekabekairaga” in Fijian.

Modern Science has taught some of us that water hyacinth is a weed as per grass classification. However with indigenous knowledge it is believed to have valuable qualities similar to the “kuta” (a special Fijian mat) in Fiji. There is a particular preparation done to the water hyacinth and it produces mat like texture that could be weaved into baskets, belts, hats, and so forth, as earlier mentioned by Jyotishma. Having come from Nausori, Central Fiji, I wish to raise that this is also a problem to the Rewa river and other surrounding river outlets - Waimanu, Waidamu rivers. I know from childhood experiences that water hyacinth provide harboring environment for freshwater eels, scrimp and tilapias.

ECOWOMAN
(http://uoft.asiapacificreader.org/index.php?option=com_content&task=view&id=317&Itemid=97) a woman NGO was doing some work in this area aligned to enterprise development. SPACHEE (South Pacific Action Committee for Human Ecology and Environment; http://www.uia.be/s/or/en/1100049937), If I recall correctly was also working around water hyacinth development as one of its project.

The greatest challenge in relation to climate change and indigenous knowledge would be resource planning, biodiversity conservation management, and enterprise development. After all this freshwater weed is not infectious.

In terms of TK about seaweed - the availability of large volumes of seaweed confirms warming of the sea beds. Seaweeds are equivalent to algae and fungi family which dwell well in warm and moist environments. It might look infectious at face value but is providing more feeding grounds for foreshore fishes, mangrove crabs and etc.

By this, I mean the different species of seaweed: “nama” (dark green and small sized grape shaped) , “lumi” (yellowish weed), “denisenikavere” (greenish noodle type). I do not know their scientific names. “Lumi” seaweed can be used to produce traditional skin lotions just by rubbing. Modern science have actually tested and provided facial cream, shampoo, soap and etc. Both “nama” and” lumi” seaweed with coconut cream is a delicacy in traditional Fijian societies.

Seaweed is also the principle totem plants for some traditional Fijian tribes in Fiji like Gau island. I know for these tribes, the large volume of seaweed around our shores would symbolize “mana”, blessing to the land and its people.

Also TK - Raw seaweed, “lumi” is a STOMACH cleanser (believed to remove toxicity of the intestines- cholesterol and so forth). It is believed by some traditional societies in Fiji that when prepared and drank it can cause diarrhea effects and cleanses the stomach or intestines. Given to
those that feel bloated, constipated, present with long term illnesses, bedridden, stroke cases. Mix with deep sea water. Needs to be scientifically proven

Thanks.

Zaidy Khan, Regional Programme Coordinator and Grants Manager, Communities and Coasts Programme, The Foundation of the Peoples of the South Pacific International, Suva, Fiji

Hi,

This has been a major observation in the Caribbean. The problem has been notified in 2010, 2011 in the Bahamas and this year it was major problem in other Caribbean islands. I am in Grenada and we had been experiencing this on the Atlantic side of the island in all coastal communities. It has become a major problem for fishermen especially with boating and shorelines.

My email intention is to share other scientific explanation of what may be causing this and about the Sargasso Sea, and trade winds. Hope this helps for developing further scientific understanding and explanation of the local observations.

Article: “The Sargasso Sea, located entirely within the Atlantic Ocean, is the only sea without a land boundary”
By: National Ocean Service, National Oceanic and Atmospheric Administration (NOAA)
http://oceanservice.noaa.gov/facts/sargassosea.html

Article: “Caribbean Hit Hard by Sargassum Seaweed Invasion”
By: Desmond Brown, Inter Press Service (IPS), ST. JOHN’S, Antigua, 29 Feb. 2012
Copyright permission sought. [Copyright © 2013 IPS-Inter Press Service, all rights reserved.]

“When scientists speak of the Sargasso Sea, which occupies part of the Atlantic Ocean, there is usually little mention of things drifting out because of the immobile currents. That is until now. Over the past few weeks, seaweed from the Sargasso Sea has been making its way towards the Caribbean, washing up en masse on beaches as surrounding currents change with weather and temperature patterns. Read more

Related IPS Articles:

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CLIMATE CHANGE: Barbados Looks to Beaches as First Line of Defence:
http://www.ipsnews.net/2012/02/barbados-looks-to-beaches-as-first-line-of-defence-3/
**Article: “Too much seaweed”**
Media Release: provided by Pacific Solution Exchange
Published and Edited in Fiji Times by: Ioane Burese, Saturday 19 January 2013

“There is growing concern about the recurrence of abundant seaweed blooms on Viti Levu which are defacing beaches and impacting the environment, probably as a result of climate change. According to a statement, the knowledge-sharing forum Pacific Solution Exchange (PSE) is making this its number one climate change discussion across all Pacific islands this month. Read more

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**Mark Skinner, Independent Contributor, Concord, Australia**

Yes, we “weed “ on land why not in the sea? But you will find it a never ending task unless you take out the nutrient sources (sewerage, agricultural fertilisers) from your lagoons at the same time!

Ciguatera fish poisoning, detailed in a free online article on Ciguatera in the Pacific, is caused by benthic toxic microalgae that live on macroalgae the host, will be less if you remove their hosts ([http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0001416](http://www.plosntds.org/article/info%3Adoi%2F10.1371%2Fjournal.pntd.0001416): article published on PLOS (nonprofit publisher and advocacy organization with a mission to accelerate progress in science and medicine by leading a transformation in research communication).

So weeding macroalgae blooms (including sargussum) can only be a good thing!

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**John Foster, Forster Consulting Inc, United States of America**

Dear Antoine,

Is there any chance that this seaweed could be fresh and clean enough and available for a long enough period that it could be collected and made into food for people?

My experience teaches me that the key thing is first to find a commercial use for the raw material and cleaning it up will then be something people will want to do. I understand that this species may have resisted previous attempts to make it palatable, but I have to think that with all the culinary skills and creativity we have today and with a billion under-nourished people in the world and two billion more to come that looking for ways to turn raw material such as this into nutritious food should be a first priority.

I note that some species of Gracilaria are eaten in some countries and there seems to be opportunity for culinary invention in the field generally. If it could be used in this way, then it might be collected by hand, which would be gentler on the rest of the habitat and might create some jobs in process. For example, what might be possible if the raw seaweed was collected and sold to a processor at $0.05/kg?

**Gracilaria Spaghetti and Tomato Sauce**

1 tablespoon oil (olive)
½ pound ground beef
1 medium onion, chopped
1 clove minced garlic
1/8 cayenne
1 can tomato sauce (8 ounce)
1 cup carrot, 2 cups Gracilaria
2 quarts boiling water
½ cup cheese, grated (optional).

Brown meat in oil with onion and garlic. Add tomato sauce, cayenne, carrot and herbs and simmer 15 minutes. Drop Gracilaria into the boiling water for just 15 seconds. Drain, serve with sauce and top with grated cheese. (From Sea Vegetables by Evelyn McConnaughey.)


In addition, I attach a short article on seaweed farming that I was asked to write recently for the program materials for a recent symposium in India on solutions to human malnutrition – see [http://www.afsib.in/pdf/Global_Symposium_AFSIB_2012.pdf](http://www.afsib.in/pdf/Global_Symposium_AFSIB_2012.pdf) (PDF; Size: 1.23MB)

And closer to home, working for myself at Forster Consulting Inc., serving in an independent advisory capacity as an aging fish farmer, some of my recent writings may be of interest to members and can be seen at: [http://aquacomgroup.com/wordpress/2012/02/04/aquaculture-and-low-hanging-fruit/](http://aquacomgroup.com/wordpress/2012/02/04/aquaculture-and-low-hanging-fruit/) - here’s an extract:

“Covering 70% of the Earth, the oceans offer almost unlimited potential for a future marine agronomy that would farm plants (seaweeds) as its primary crop to be used for food, feed and fuel, as we use terrestrial crops today. Such an industry could more than double our global output of farmed biomass while using only a small proportion of the oceans’ surface... With nine billion people to nourish by 2050, production of more food, feed and fuel seems like a pretty good bet for economic growth.”

Also, in thinking about this further, if the food idea doesn’t work then would it be possible to invest a little time (and money) in looking for other values in the material? This seaweed could be harvested fresh on a daily basis over a prolonged period - even year round. If this is possible then other processing possibilities become more feasible. For example what about cosmetic or medical applications - see [https://www.asianproducts.com/hotproduct/manufacturer_seaweed-gracilaria_1.htm](https://www.asianproducts.com/hotproduct/manufacturer_seaweed-gracilaria_1.htm)? Some seaweed polysaccharides have antiviral and other medically valuable properties. Dealing with this problem will be so much easier if it can be turned into an opportunity and it seems to me that some effort should be made to do this before thinking about dredges and compost!

With best wishes.

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**Teuleala Manuella Morris, Funafuti, Tuvalu, In Country Coordinator (ICC) PACE-SD USP EU GCCA Project**

I think it was 2010 when there’s a lot of seaweed at Funafuti mostly where the people lived in Fongafale. The seaweed just sprung up and grew where the people lived especially in the lagoon area. Then there’s a few reports that the children were bitten by jelly fish amongst the seaweed – we don’t usually have jelly fish.

The seaweed comes together with the drought for most of 2010-11, and the people were having problems because they have to go swim in the sea (to bathe) because of the drought and the water shortages. But they had to get through the seaweed to swim.
Then at low tide some of the seaweed died and it gave a lot of bad smell. It got so bad that in 2011 the indigenous community of Funafuti made a campaign to remove the seaweed. So they hand picked it - the community is 300 people and other volunteers like Red Cross also joined and Tuvalu Association of Non Governmental Organisations (TANGO) also helped out in that campaign. It took them about 2 weeks to clear the seaweed. That really helped and reduced the problem. The removal was initiated by the Funafuti local government council.

This is the first time for us to have this problem and the species is new as well. It grows from underneath and just grows up like trees in the water - like a forest in the water.

Some of the explanations from the fisheries department was contamination of the sea because a lot of people use the sea for the toilet and then if there is a lot of rain there is contamination - dumps on the northern and southern side of the island (mean) there is a lot of rubbish, batteries and everything and if it rains it all goes into the sea. There is also the pig stys in peoples houses near the lagoon side, and they use the water to clean the pig stys and then the water washes back into the lagoon.

All along the other islands its okay - Funafuti island consists of several islands and a lagoon – its only the area where people live that was effected by the seaweed, so it seems it is the human contamination that caused it.

Herb Vandermeulen, Saint Andrews Biological Station, New Brunswick, Canada

Hello,

I am a research scientist working for Canada’s federal department of Fisheries and Oceans specializing in nearshore marine habitat issues and seaweeds in particular.

Canada’s Pacific coast does not presently have reported cases of excessive algal growth on bay-wide scales. However, we do have this problem on the Atlantic coast. Typically this will include complaints about local blooms of Cladophora, Ulva, Pilayella or Ectocarpus. Almost all of these can be traced back to sources of eutrophication or higher than normal water temperatures or some combination of both. In some instances, these blooms are suspected factors leading to local declines of seagrass beds (Zostera marina).

No complaints presently accrue due to red algae, although Heterosiphonia japonica is on its way north.

Although Canada has a long history in correcting eutrophication in fresh waters (source controls, non-point source land use regulations and guidelines, storm water management, etc.) or applying ‘Band-Aid’ solutions like macrophyte harvesting - we are only just becoming aware of the growing marine eutrophication problem on the east coast. For now, it’s mainly a technical exercise to define the marine problem.

Our smallest province, Prince Edward Island, has a eutrophication issue affecting a significant number of its estuaries. Agriculture based nitrogen loading enters these estuaries via groundwater source base flows in streams during the months when Ulva is actively growing (May through October). Massive blooms of Ulva result, particularly in the upper portions of the estuaries, and the resulting ‘crash’ of Ulva biomass causes total water column anoxia on a regular basis. Loading reductions of over 50% may be required in some of these estuaries to prevent the anoxic events.
There will be a technical report published on this issue - the Prince Edward Island report should be posted by mid-2013. The report will be part of the series “Canadian Technical Reports of Fisheries and Aquatic Sciences”. Search under that heading and you will be directed to the Fisheries Oceans Canada department’s website (http://www.dfo-mpo.gc.ca/libraries-bibliotheques/tech-eng.htm), the documents are available there. I was part of a small technical team for the report and will not be the lead author. Neither the title nor the authorship list is firm at this point, although a draft is under review.

Hope this helps.

Vaasiliifiti Moelagi Jackson, Faasao Savaii Society (conservation and environmental organisation), Savaii, Samoa

Hello,

I have a Traditional Knowledge Solution (in response to Teuleala’s comment about ‘human contamination’).

Go back to the traditional toilets (dry toilets) where, after one does the business, leaves were used to clean and were thrown into the hole. Usually the hole was often covered. Later on improvement was made with a proper seat made of wood and a cover - inside a closed square room with a roof made of natural materials (wood and coconut leaves). When the hole is full it was covered with leaves and mud and the room which was built on a wooden structure is shifted on to another hole dug away from the first one.

Advantages:
1. Great fertility as whatever trees are planted by they bear well.
2. With all the villages having this system 5 years ago there was no algae on the coastline, neither at the pools. The water and beaches were pristine and clean.

Very difficult now with all the soap chemicals running and with all the toilet run off, it is providing good sustenance for healthy algae.

Good bye and Wishful thinking.

Dr. Thierry Chopin, Scientific Director of the Canadian Integrated Multi-Trophic Aquaculture Network (CIMTAN) and Professor of Marine Biology at the University of New Brunswick, Saint John, Canada

Hi all,

Different blooms have often different origins and the “s” in “origins” is certainly important. The search for the source(s) is indeed key for management of “nuisance” species [until use(s) are found for them].

There is a paper “hot off the press” on the recurrent and massive green tide phenomenon in the Yellow Sea in China. It is called ‘Understanding the recurrent large-scale green tide in the Yellow Sea: Temporal and spatial correlations between multiple geographical, aquacultural and biological factors’ by Feng Liu, Saojun Pang, Thierry Chopin, Suqin Gao, Tifeng Shan, Xiaobo Zhao and Jing
The abstract is posted below. Because of copyright laws, the full article cannot be posted on your website or mine. Interested people can, however, make an individual request to me for sending them the paper for educational purpose:

“The coast of Jiangsu Province in China - where Ulva prolifera has always been firstly spotted before developing into green tides - is uniquely characterized by a huge intertidal radial mudflat. Results showed that: (1) propagules of U. prolifera have been consistently present in seawater and sediments of this mudflat and varied with locations and seasons; (2) over 50,000 tons of fermented chicken manure have been applied annually from March to May in coastal animal aquaculture ponds and thereafter the waste water has been discharged into the radial mudflat intensifying eutrophication; and (3) free-floating U. prolifera could be stranded in any floating infrastructures in coastal waters including large scale Porphyra farming rafts. For a truly integrated management of the coastal zone, reduction in nutrient inputs, and control of the effluents of the coastal pond systems, are needed to control eutrophication and prevent green tides in the future.”

Happy reading and all the best to all.

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**Temente Melitiana, Ministry of Finance and Economic Development Government of Tuvalu, Funafuti Tuvalu**

Further to Teuleala's account of the unusual abundant growth of seaweed in Tuvalu, there were two types of seaweeds which sprung up at an alarming rate and amount especially in 2010 in the foreshores of the Funafuti lagoon. One was a tree type covering a relatively large surface area, and grew more spaciously but in huge numbers. The other which was more alarming, was of green fine hair type, and grew closely in huge numbers, covering sands, rocks, corals etc. endangering marine lives where they concentrated. In 2010, it was a major concern because of the foul smell they emitted especially when washed up on shore in large quantity, so the island community removed these seaweeds.

However they kept coming back, and in some of the foreshore areas, they still are abundant but not as worse as in 2010.

Some have linked the recent increase in fish poisoning in Tuvalu to these seaweeds. Last year as well as the beginning of this year, we have a lot of cases in Funafuti where people got poisoned from consuming reef fish from the lagoon. Surprising some of the fish they got poisoned with were not known to be poisonous.

Ministry of Health and the Department of Fisheries had warned the public especially on Funafuti through radio announcement to refrain from eating reef fish as they contain poison chemicals. Unfortunately, because of the dependence of people on fish as their main source of fresh protein, people continue to take the risk by eating reef fish and count on their luck that they do not get poisoned, some were not that lucky and that is why we continue to have reported cases of fish poisoning on Funafuti. Luckily, there were no fatal cases.

Thank you, hope I have made some valuable contribution to the discussion.

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**Bridgette Clarkston, Carl Wieman Science Education Initiative University of British Columbia, Vancouver, Canada**
Hello,

A few months ago I asked the algae-L community (ALGAE-L@LISTSERV.HEANET.IE) to help me prepare for a public presentation on seaweed biodiversity for the Beaty Biodiversity Museum (Vancouver, B.C., Canada). I received helpful and enthusiastic responses from many people. In the interest of sharing (and because I had many requests to share this info), I've compiled the responses as well as the literature I cited in the talk and attached it as a word document here: http://www.solutionexchange-un.net/repository/pc/ccd/pse_ccd_SeaweedQuery_Bridgette.doc. You'll find links to various photos, videos, and articles as well as some great ideas for hands-on activities and analogies to help your audience connect with seaweeds.

If anyone is interested in seeing my talk, the video is posted here: http://beatymuseum.ubc.ca/blog/video-seaweeds-way-cool

To be as interactive as possible, I brought a selection of books, presses, food items containing seaweed and art for people to play with before and after the talk. During the talk, I polled the audience several times using 'clickers' (a type of audience response system using hand-held remote voting devices). The clickers were greatly enjoyed by the kids. I spent quite a bit of time on slides, trying to use as many images (almost all from www.algaebase.org) and as little text as possible.

I'm happy to share for other educational talks.

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Rangi Johnson, Manihiki, Cook Islands, Ministry of Marine Resources

Hello members,

On our island alone there has been a lot of murkiness in the water. It started from the year before, 2011, between November and April and it has happened before, but only for short periods of time like 3-4 days, but this is concerning as this algae was around for 6 months.

We’re pearl farmers and so what happens in the lagoon impacts our livelihoods. We use the lagoon for income derived from our pearls and we also sell our pearl shells. We are also in the process of selling pearl meat as a gourmet product. It’s also where we catch fish to eat.

We are a farming community so the murkiness was of great concern to our people because the farm programmes were restricted. For a lot of farmers there was a bit of concern about the mortality of the pearl stocks. We were concerned about oysters that had been seeded and their vulnerability to sustain their life span, so we looked at options to harvest the pearls to save them before their due date to harvest, but because we sell our products as a quality product we guarantee an 18-month product endorsement, which produces a total grow out period. So harvesting before that period would cause economic problems. So we did not harvest, and luckily for us marine resources biologists had flown up at the right time - not for that reason but for another reason - and were able to make some assessments of what was happening in the lagoon. They said it was safe and it would not cause mortality to the oysters and so farmers were able to leave their stocks inside the lagoon. The changes in currents and the wind direction had intensified for longer periods of time and so it stirred up the crap from the ocean floor.

On the shoreline seaweed had started to grow an extensive, expansive amount – it has happened before but again not for long periods like this – usually it lasted for 3 days maximum and then dies away but this time it is 6 months. The impact of that for fishermen was that you
couldn't go out and get fish, you couldn't do your net fishing and spear fishing, so a lot of fishermen had to change the way they fished and go ocean fishing instead on fishing in the lagoon.

After 6 months the seaweed just died away and everything came into balance again. The marine biologist said the seaweed was nothing dangerous but was just the same as before, but it was around for a longer time.

The farmers hope it doesn't happen again. They know it won't damage their oysters but they would still like marine biologists to be on hand to advise next time this happens just in case it is not the same as the last event.

This is something that is spontaneous. We know that wind changes and heavy rain do affect the condition of the lagoon on a daily, weekly and monthly basis. We did have a period in 2000 or 2001 when it didn't rain for 7 months. We were fortunate enough by that stage after Cyclone Martin that 95% of the homes did still have water tanks, but if they didn't it would have been a big problem. How did we handle that? We were fortunate enough to have community water tanks so when personal tanks ran low then individuals and families could turn to the community tanks.

Just for me personally, my husband and I have decided to live sustainably. We live sustainably by producing our own bacon, ham and sausages so our dependency on imported foods is minimised. I'm a chef so I can do the foodie thing. We also have a poultry farm for the eggs so we don't need to rely on imported eggs. We fish as a family and so we nurture and educate our children by incorporating traditional and cultural practices and tastes. We also like to sell our fish commercially when we have an abundance. We export to the main island so we teach our children how to prepare on board, on land; catching and killing fish, safety practices, filleting, and the whole fish processing thing right down to packaging fish for sale. We also incorporate the traditional bi-laws and marine protected areas that are enforced on us and we teach our children the importance of it and what it means to us. We have our own desalinating unit to prepare us for drought periods.

Frits Rincker, Renewable Energy Technology Expert and Climate Change Blogger, Netherlands

Hi,

I'm Frits Rincker, I'm a renewable energy technology expert and climate change blogger. Maybe my perspective can be helpful.

My reference for the processes occurring in our oceans at the moment is the End Permian Extinction, which was characterized by global warming over a longer period than we see now. Then the oceans degassed, turned acid and released massive amounts of hydrogen sulfide. In the sediment it shows large blooms occurred supposedly due to nutrient runoff due to intensive rains. This caused anoxic rotting to occur on the bottom, producing Hydrogen Sulfide. This gas, the 'bad odour' mentioned in other mails, has killed a horse recently in France who waded into seaweed washed up on the shore. The horse sniffed the seaweed and died a minute later. It is corrosive and highly toxic (although reversibly).

Because I believe we have a larger trend, and this trend is the problem, not the individual effects of it, I wonder if there is agreement that an effective solution to algae/seaweed blooms means dealing with carbon dioxide. This is actually a major opportunity I have advocated for many
years. Now it seems to become a necessity as well. This is not to say I believe there will be an immediate impact to the local ecosystem but eventually there can be.

Algae have been used as fertilizer and feedstock, as well as for many other purposes, the oil (if it’s oily) is omega-3 fatty acid rich. But in my perspective there should be more algae and seaweed, especially if it grows spontaneously, not for utility to man, but to sequester CO2. This can be done by pyrolyzing it (decomposition of organic compounds by heating to high temperatures in the absence of oxygen), which produces gas, oil and carbon. Part of these fuels can be used to farm, gather and sell, part has to be sunk to the bottom of the ocean, dumped, to get the carbon out of the system. This could and should happen on a large scale. The only scientific objection to it is that the earth would warm a little bit more if we were to stop growing algae suddenly, but this is irrelevant because we are already facing catastrophic warming 4+ and why stop if it feeds people and drives an industry?

Here are some of the references I gathered

http://www.climatebabes.com/index.php/?categories/2-OneCellOil

I believe an industry can be build upon causing and exploiting algae/seaweed growth, across large areas of ocean. The nutrients are found in the deep waters (200m) in case they don't occur on the surface. As long as this is done in sufficiently oxygenated water this will be a benefit. The toxic type occurs when oxygen becomes depleted. I think there can be opportunity in developing the expertise necessary to grow more algae and use them to both generate useful fuel, fertilizer and other commodities, and dump carbon to the bottom of the ocean.

If anyone is thinking in this direction I would like to know more about it.

Best regards.

_____

**Birtha Togahai, USP-EU GCCA Project, Niue**

Thank you Rangi for a very enlightening piece. I hope that some scientists come to Manihiki and do further research as the problem seems to recur over and over again.

I admire your family for the sustainable living, you showed us that it can be done and heavy reliance on imported foods only exacerbate the increase of NCDs. May you continue to harvest your pearls sustainably and never leave your Manihiki paradise.

Regards.

_____

**Victor Bonito, Reef Explorer Fiji Ltd, Nadroga, Fiji**

Hi Zaidy,

Algal overgrowth / phase shifts on coral reefs is my next topic for fortnightly FT (Fiji Times) article ... great minds think alike!

We have it on our beaches, but it is not coming from the Sargassum sea ... it is from nutrient enrichment and loss of key herbivores.

While it a mess on the beach at time, it sure is good fertilizer in the garden!
Luke Paeniu, GCCA Research Assistant, PACE-SD, USP, Tuvalu

Dear Dr Antoine,

(As we discussed) 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 truck loads 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.

Laiakini Waqanisau, United Nations Development Programme (UNDP), Environment Unit, Suva, Fiji

Dear Dr. N'Yeurt,

Reading your article, it states that alga e blooms are posing problems and it is affecting fishing grounds of several communities with no immediate solution at hand. Hence if this type of problem persists is there any way for commercial harvesting of these variety of seaweed or has it become a menace?

Second, which varieties of seaweed are edible and which ones are harmful to humans and marine life? This alga blooms can be overcome somehow with harvesting or changing the conditions such as treating the sewage outfall that sometimes are the cause of it all.

We look forward to your recommendations.

Thanks.

Dr. Antoine De Ramon N'Yeurt, European Union Global Climate Change Alliance Project (EU GCCA), Pacific Centre for Environment & Sustainable Development (PACE-SD), University of the South Pacific, Suva, Fiji

Dear Laiakini,

Thank you for your questions about the algal bloom issue. This particular species (Gracilaria edulis) is edible but not a favoured variety compared to others sold in the market. Other algae such as Sargassum, Boodlea and Turbinaria that can become invasive are not readily edible. One of our objectives (and purpose of this query) is to find ways to use this algal biomass, both sustainably and if possible commercially to benefit local communities affected by it.

All algal blooms are harmful as they deplete nutrients, invade the habitat of other marine species and cause problems to humans (unsightliness, loss of fishing grounds, smell, toxicity in case of microalgal blooms causing for instance fish poisonings and fish kills). From our experience sewage outfalls are definitely a part of the cause for these blooms in Fiji, especially near resorts.

Regards.

Litiana N. Tuilaselase Kuridrani, Umanand Prasad School of Medicine, Lautoka, Fiji

Friends and colleagues; while we are still discussing the overly abundant seaweed around the Pacific islands, I wish to share with us some enlightening experience about traditional knowledge.
Yesterday, Fiji received the "tsunami" warning and most of us were running around calling our family members to move to higher grounds.

Interesting when I called my village in Namatakula, along the Coral Coast of Fiji... our people were happily embraced around a big kava bowl. I was yelling at my son.... please move to higher grounds, this is urgent.

And the response was:

"Why do you worry mum? The dogs are still sleeping, the chickens are peacefully wandering around the village, the herons have not crossed the village to go to higher ground. This is nature that we are dealing with, the animal instinct will show that something like the tsunami is on its way, so relax mum."

My uncles and elders are telling me this.

I believe that this part of indigenous knowledge about the climate is important to be shared widely to all our Pacific families.

Vinaka.

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Vaasiliifiti Moelagi Jackson, Faasao Savaii Society (conservation and environmental organisation), Savaii, Samoa

Dear Charles Carlson,

Thank you so much for sharing the Cook Island practice which should help all of us believers in the Traditional Knowledge to be part of the Climate Change Resilience and Adaptation Plans. I am finding it very difficult to convince the Academia with questions like: "How can we go back?"

My reply is there is no need to go back, with all your professional ideas we must cuddle and include our Traditional Knowledge that we find are more appropriate and better than the modern one. eg. If we have learned and keep passing knowledge of: predicting strong winds and rough seas by the behaviour of birds; the feeling of uncomfort due to sudden rise of temperature; and the sudden flowering, then perhaps a lot of our fishermens lost at sea would have been still here now.

If we kept on passing the whistle call that was used by our Head Men to call if there is trouble or that guests are arriving - then there could be no reason for all these horns and telephones.

God Bless you I totally agree with you and will surely ask one of my friends in the Cooks to buy me a copy.

---

Scott Walton, Treasure Island & Bounty Resorts, Lautoka, Fiji

Hi,

Extremely interesting threads.

Our immediate solution is to collect the seaweed and then dispose of it as we do rubbish to the mainland refuse dumps. We have an Environment Officer who I have asked to continue the research on our seaweed. In the past year we have concentrated on keeping our beaches clean by employing seaweed clean up teams, this has assisted us in reducing the volume that washes up on our beaches and, with a 12 month concentrated effort, we have noticed levels declining. Time will tell as we start to cycle through another 12 months, it is labour intensive and an ongoing issue.
Possible harvesting for other uses has been advised to us in the past but with little follow up. Once we have the island returned to normal we’ll reengage (our Environment Officer) to explore uses of Gracilaria edulis.

Vinaka.

Professor Jiaxin Chen, Yellow Sea Fisheries Research Institute, Qingdao, China

Hi,

I am a Chinese (professor) dealing with seaweed culture for 50 years. I want to know where is the deadzone and their conditions of hydrology, geological and others that are indispensable conditions for seaweed culture or enhancement.

As you know that seaweeds and phytoplankton consists of the primary productivity of the oceans besides a little of autotrophic bacteria. These algae contribute all of fishery productivity that involves fishes, crustacean, shellfish and others. Phytoplankton in the ocean is difficult to be controlled by us, but macro-seaweeds, including red, brown, and green, can be produced in selected sites. For example, Saccharina (Laminaria) japonica was occasionally brought to Chinese coast water from Japan in 1927, now, we can produce 4 million metric tonnes (wet weight) or more if we like in China seas. That means the sea has huge potential to produce seaweeds under our control. No doubt, seaweed culture or enhancement is a systematic programme, that needs seedling breeding system, culture engineering, harvesting system and post harvest processing and so on. Notwithstanding, huge commercial vale and social effects from seaweeds is a meaningful project. I think it is worthy to pay more attention on it.

Gracilaria is a large genus, normally the biomass of Gracilaria has been used for the feedstock of agar, and then, the final product, agar, is prepared for jelly, ice-cream and other food additives as well as agarose. If you want directly to use it as marine vegetable, you can boil it for minutes, and then mix sauce, salad jam with it that depends on your habit. In China, Gracilaria has been cultured in large commercial scale. Its main utilization is feeding abalone and processing agar. I can assist you to sell your harvested Gracilaria to Chinese buyers if you like. But, the quality and quantity depends on its prices. Samples are required for quality evaluation.

Here’s a ppt about Gracilaria culture in China: [http://www.solutionexchange-un.net/repository/pc/ccd/pse_ccd_SeaweedQuery_China.pdf](http://www.solutionexchange-un.net/repository/pc/ccd/pse_ccd_SeaweedQuery_China.pdf) (PDF; Size: 317KB)

Also please find the ppt file attached here, which is marine vegetable and seaweed's noodle. They are popular marine vegetable and food in China: [http://www.solutionexchange-un.net/repository/pc/ccd/pse_ccd_SeaweedQuery_Noodle.pdf](http://www.solutionexchange-un.net/repository/pc/ccd/pse_ccd_SeaweedQuery_Noodle.pdf) (PDF; Size: 350KB)

My dream is to get one or two ex-service aircraft carriers, which will be anchored in the deadzone/marine sanctuaries. The carriers will be as logistical supplier as well as the base of integrated hatcheries. We can farm seaweeds and then harvested seaweeds can directly feed abalone and finfish (rabbit fish), and other herbivorous animals with higher commercial value. The FCR (feed conversion ratio) of it is about 20-25. The harvested animals are perfect food with considerable protein. while most of biomass from harvested seaweeds will be processed into biogas in sea-base, the residuals will be processed into fertilizers and feed additives.

The problems to realise the dream are that who will support the project.
Best regards.

Miguel Esteban, Waseda University, Department of Civil and Environmental Engineering, Tokyo, Japan

Dear colleagues,

It is difficult to really say much without knowing more details, but have you thought of the possibility of a change of state in the coral reefs? If you check the work of Paul Kench you can find some more information of this idea of a change in state. For example some of his research includes:


Essentially it is possible that somehow some organism that keeps such seaweed under control could be dying out due to high coral mortality.

However, it is difficult really to say more without having more information. Just something that you might want to consider (I am happy to forward you some papers if you contact me directly: esteban.fagan@gmail.com)

Regards.

Tim Carruthers, Secretariat of the Pacific Regional Environment Programme (SPREP), Land Ocean Interactions of The Coastal Zone, Samoa

Dear Antoine,

Thanks for the post and raising this issue.

I would suggest that this expansion provides an opportunity to use the Gracilaria as a bio-indicator, measuring tissue N and P as well as stable isotopes of nitrogen. This could provide information on the cause (if it is a direct result of nutrient input, possibly the location or nature of the source) or by looking at macronutrient tissue %age values and ratios, identification of which is the limiting macronutrient (N or P) also providing information about causes (for example if the algae are nitrogen limited, then it may be an expanded or pulse of sediment input providing terrestrially derived P to the inshore). Especially if the area has (or had) high coral cover and is highly carbonate, the increase in macroalgae may be driven by phosphorus input.

The other main hypothesis is that there has been a reduction in grazing pressure - due to change in urchin or grazing fish population.
Are you also aware of the macroalgal bloom in Tuvalu, around September 2011? That affected a large area of the lagoon, SPC inshore fisheries team in Noumea collected some field data on that event.

I am providing some references for papers that detail use of Gracilaria as a bio-indicator of nutrient status and then some other macroalgal species that were used in short term deployments to measure nutrient status and source, as well as a couple of papers (on seagrass) sampling intact beds to infer nutrient inputs and status. Some relate to detecting nutrient inputs and some are relevant more in a methodological sense (particularly use of tissue nutrients and stable isotope analysis in marine macrophytes to determine system scale nutrient processes, and therefore potential drivers of algal blooms).

**A New Approach for Detecting and Mapping Sewage Impacts**

By: S.D. Costanzo, M.J. O’Donohue, W.C. Dennison, N.R. Loneragan and M. Thomas

Marine Pollution Bulletin Vol 42, No. 2, pp. 149-156, 2001 © Elsevier Science Ltd. All rights reserved.

Abstract: “Increased nitrogen loading has been implicated in eutrophication occurrences worldwide. Much of this loading is attributable to the growing human population along the world’s coastlines. A significant component of this nitrogen input is from sewage effluent...”

**Using nitrogen stable isotope ratios of macroalgae to determine the effectiveness of sewage upgrades: changes in the extent of sewage plumes over four years in Moreton Bay, Australia**

By: Simon D. Costanzo, James Udy, Ben Longstaff, Adrian Jones

Marine Pollution Bulletin Vol 51, pp. 212-217, 2005 © Elsevier Science Ltd. All rights reserved.

Available on line at: [www.sciedirect.com](http://www.sciedirect.com)

Abstract: “Nitrogen loading to aquatic ecosystems from sewerage is recognized worldwide as a growing problem. The use of nitrogen stable isotopes as a means of discerning sewage nitrogen in the environment has been used annual by the Ecosystem Health Monitoring Program in Moreton Bay (Australia) since 1997 when the technique was first developed.”

**Macroalgal bioindicators detect nutrient enrichment from shrimp farm effluent entering Opunohu Bay, Moorea, French Polynesia**

By: David T. Lin, Peggy Fong

Marine Pollution Bulletin Vol 56, pp. 245-249, 2008 © Elsevier Science Ltd. All rights reserved.

Abstract: “Nutrient enrichment from shrimp aquaculture poses an increasing environmental threat due to the industry’s projected rapid growth and unsustainable management practices. Traditional methods to monitor impacts emphasize water quality sampling; however, there are many advantages to bio-indicators, especially in developing countries.”

**Lagoon Scale Processes in a Coastally Influenced Caribbean System: Implications for the Seagrass Thalassia testudinum**


Carribean Journal of Science, Vol. 41, No. 3, pp 441-455, 2005 © 2005 College of Arts and Sciences, University of Puerto Rico, Mayaguez


Abstract: “The Bocas del Toro archipelago in the Caribbean sea on the northwest coast of Panama has high annual rainfall (>3000 mm) and a mountainous watershed, resulting in high inflow of fresh water. The two main lagoons have different geologic structure and different inputs... The purpose of this research was to use the seagrass Thalassia testudinum as a bio-indicator of nutrient status of these lagoons, particularly to assess the extent and influence of mainland inputs of freshwater, nutrients and sediments.”
Gracilaria Edulis (Rhodophyta) as a Biological Indicator of Pulsed Nutrients in Oligotrophic Waters
By: Simon D. Costanzo, Mark J. Donohue, and William C. Denison
Abstract: “The response of the marine macroalga Gracilaria Edulis (Gmelin) Silva to nutrient pulses of varying magnitude was investigated to test its applicability as a marine bio-indicator at two oligotrophic locations.”

Influence of submarine springs and wastewater on nutrient dynamics of Caribbean seagrass meadows
By: T.J.B. Carruthers, B.I. van Tussenbroek, W.C. Dennison
Estuarine, Coastal and Shelf Science Vol 64, pp. 191-199, 2005 © Elsevier Science Ltd. All rights reserved. Available online at: www.sciencedirect.com
Abstract: “The east coast of the Yucatan Peninsula, Mexico, consists of highly permeable limestone, such that surface flow and rivers are absent in this region. Extensive underground cave systems connect sink holes (cenotes) to submarine springs (ojos de agua), which vent into the seagrass meadows of the adjacent oligotrophic coastal lagoons. This study investigated the potential for these submarine springs to influence nutrient processes within seagrass meadows, by assessing nutrient status of Thalassia testudinum meadows in two contrasting coastal lagoons along the north eastern Yucatan peninsula.”

Hope this helps and it would be great to discuss this further.

Kind regards.

Dr. Antoine De Ramon N’Yeurt, European Union Global Climate Change Alliance Project (EU GCCA), Pacific Centre for Environment & Sustainable Development (PACE-SD), University of the South Pacific, Suva, Fiji
Dear Tim,
Many thanks indeed for the reply and document references.
The Gracilaria edulis one is particularly relevant to our issue, which we believe is partly a result of uncontrolled sewage input into the area concerned. We have tested the water samples from the area for Nitrogen, NH4 and Phosphate, but levels have been below detection. So either the algae act as very rapid nutrient sinks, or we sampled at the wrong time. Tissue level analysis would be the next logical step, and we hope to do that this year.
I would be very glad to learn more about the Tuvalu bloom.
Thanks again and best regards.

Ross Craven, Urban Development Coordinator, New Zealand Development Program, Kiribati
Mauri,

My name is Ross, Urban Development Coordinator, for the New Zealand Development Program, in Kiribati.

We are engaged in Water and Sanitation (supply/water tanks/equipment), Solid Waste Management (recycling/landfills), Land Development (town planning) and education and capacity support across all of these. It’s no longer known as the ‘Sustainable Town Programme’ however, we currently refer to it as the Urban Development Programme, but the content is fundamentally the same.
...Regrettably (no), I do not have data in any form, published or otherwise, linked specifically to algal blooms to contribute to this interesting topic.

I do know that the Environment Conservation Division (ECD), MELAD, have recent water testing results. This data has some measures of the nutrients in the lagoon water adjacent to three landfills on South Tarawa. This can be obtained from the ECD on request and I agree with Peter (Sinclair) that staff from Ministry of Environment, Lands and Agricultural Development would be the best contact for further information.

Kind regards.

Farran Redfern, Environment and Conservation Division, Ministry of Environment, Lands and Agriculture Development, Tarawa, Kiribati

Mauri,

Unfortunately, I don't have info on what you are after with me now. I will look up (into my external) and check and get back to you and may also share briefly some personal experiences with excessive algal bloom and the environment division initiatives in the past that attempted to solve this common problem on the island.

I’m also copying my work colleagues (and persons who may be of some assistance to you) if they can contribute to this discussion.

I trust the above is of some help.

... Good luck with your research and feel to contact us should you need more information on environmental project in Kiribati and we will try to assist where we can.

Ricardo Radulovich, University of Costa Rica, Republic of Costa Rica, Central America

Seaweed blooms should be turned into a positive phenomenon, if we should fail to stop them and continue to exist. In order to stop them or to learn how to take advantage of them we must learn to cultivate and use seaweeds on a permanent basis. Once we have many hectares of cultivated seaweeds in areas rich in nutrients, all-year-round, then besides bio-remediating these waters so that hardly any bloom should occur (and if it does then it will be peaks of production—a very good thing) there will be products all-year-round to sell or use. It is indeed a second agriculture, at least that’s how I - an agricultural water scientist turned sea farming researcher and advocate - see it.

But since we don't know what is first, the chicken or the egg, it is necessary to develop cultivation together with uses and learn to use seaweeds as we cultivate them. This is a tricky part that requires some seed or soft money to get it moving.

Uses of seaweeds already are many, and experimentation and experience should produce many more and valuable uses. A little analysis and ‘hands-on’ can take most experimenters and practitioners into large and rewarding fields. To begin with, the right attitude should be fostered and some if not many ‘seaWEEDS’ should be thought of as crops. Macroalgae is a name we should start using. Then, instead of thinking what to do with so much seaweed (‘such a nuisance’) we should start creating opportunities so that we don't get enough of them.
To use them as fertilizers is a remedial and marginal use (though perhaps a good one at hand if you are confronted with yet another bloom). Most seaweeds are good for human eating (they are nutritious and some are if not tasty acceptable; we have tried in Costa Rica so many of them in so many recipes, and we keep getting better at using them that way), as animal feed (not only as component of industrialized aquafeeds, but used directly to feed herbivore fish and other animals like sea urchins and abalones that can be produced concurrently with seaweed cultivation), hydrocolloids, and many other growing uses in pharmacology and even in the bioenergy sector. My experience also shows that cultivated seaweed plots act as attractants of biodiversity (something that is not always positive since sharing plots with sharks is not the best experience), and thus can promote fisheries (not unlike fish attracting devices adding the benefit of trophic chains that sprout out of a tolerable depredation by herbivores). In this sense, small-scale seaweed cultivation is perhaps a marine activity that can bring together farmers and conservationists alike. Thus, seaweed and low-trophic fish production by local coastal dwellers, who often lack other income-generating opportunities, is an avenue for the generation of equitable wealth. In fact, seaweed cultivation is usually not a heavy chore and it does not require much investment or resources, thus it is an activity that can include both men and women as well as the youth and the elderly.

Granted, the solution is not immediate. It takes some effort and time to build up this new paradigmatic approach to coastal-sea management.

But the time is now and just as agriculture grew out of growingly insufficient hunting/gathering, so should sea farming based on primary productivity (of seaweeds directly and of microalgae indirectly through filter feeders) grow out of dwindling fisheries, freshwater shortages and nutrient-polluted coastal waters. As it shall turn out, we should aim at rejoicing from seeing seaweeds grow so much instead of worrying and suffering from uncontrolled blooms.

And this is the state of the art. I imagine what the future may bring once seaweeds are subjected to selection and genetic improvement and advanced cultivation and use techniques are developed. So I say let’s take the plunge and start concerted efforts at using these valuable resources.

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**Dr Temakei Tebano, Tm’akei Services, Tarawa, Kiribati**

I have my own story re: excessive algal bloom.

After doing a little research back in 2008 in Tarawa and the two neighboring islands I realized that Tarawa reef is polluted with sewage refuse as a result of broken pipes, hence every now and then Acanthopora, Hypnes, Gracilaria spp. and others will wash up the beaches of Betio and South Tarawa. Therefore, South Tarawa refs and even the lagoon, is/are polluted. By extension, South Pacific waters are also polluted with human waster, animal waste, vegetation, etc., etc., One encouraging word, these wastes can be turned into useful matter such as animal feed, fertilizers, fuel.

These are God's gifts we must harvest and make use of. Let us do something (more) practical than talking and thinking, time to act.

Sincerely.

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**Jacqui Berrell, Pacific Solution Exchange (PSE) Facilitation Team, United Nations Development Programme, Suva, Fiji**
Hello,

I thought you may like to know about a “Super Sucker” being used in the used in the US, along with cultured sea urchins, to deal with invasive/non native seaweeds algae from parts of Kaneohe Bay. Here is a link to a recent article about the barge-mounted vacuum cleaner “Super Sucker” that is more than doubling the amount of invasive algae that can be removed from the bay, and is being used along with cultured sea urchins on O’ahu Hawai’i to deal with invasive/non native seaweeds:  


(Permission requested to link article; full attribution is given to The Midweek publication, online at www.midweek.com, only reproduce with permission, ©2013 MidWeek Printing, Inc. An Oahu Publications company. All rights reserved)

According to the article the project is a partnership between the University of Hawaii, The Nature Conservancy (TNC) and the state Division of Aquatic Resources (DAR). The article explains that:

“The Nature Conservancy and the state Division of Aquatic Resources (DAR) are partners in the latest effort to break up the chokehold the algae has on parts of the bay. The goal is to clear the bay's north end of the worst algae by 2015 - a doable task, according to the group’s executive director Suzanne Case, if they can raise $650,000 more to reach the $2.6 million needed to pay for it. That’s the price tag for keeping up the pace of removing 5,000 pounds of algae a day for three more years… The process employs Super Sucker 1 (now operated by DAR), the Conservancy’s Super Sucker 2, two barges and two divers for each machine. They feed algae into hoses that connect to pumps that bring it onto barges. The Hawaii Institute of Marine Biology on Coconut Island helped launch Sucker 1 and now provides a base for both barges… Each Super Sucker also is supported by a Mini Sucker, which enables it to reach shallow patch and fringing reefs throughout the bay… The state, meanwhile, is growing native sea urchins at its hatchery on Sand Island and placing them on the reefs, where they keep the algae in check. Divers and fishermen should be aware of their presence and leave the hungry urchins to their mission.”

Here are some other links about the “Super Sucker”:
- https://www.facebook.com/noalienseaweed

Please note the PSE Facilitation Team made contact with the University of Hawaii but due to timing and other commitments a response was not possible before today’s close of this conversation.

Cheers.

Fredrik Norén, Marine Botanist and Marine Ecology Consultant, Sweden

Dear colleague

I read your mail about seaweeds on the shores of Fiji and the following problems - it is indeed very sad.

In Sweden we have the same problem on our southern shores and are very interested in any solutions that you find and to inform you about you on our ideas.
Where else is such a problem occurring, with locally invasive and/or introduced species of seaweed?
- Along many shores in the Baltic Sea (south east Sweden, Poland, Baltic countries). I suspect most of the species is native to our waters but the problem arose this century as I understand.

What are the possible scientific causes and/or solutions to this problem?
- Causes: Eutrophication
- Solutions: No working solution available yet

How can we sustainably use these seaweeds, such as fertilizer, ocean afforestation or perhaps biomass for fuel or energy sources (as is done with other types of organic wastes)?
- Since the algae are rich in cadmium, it is not possible to use them as fertilizers directly. Biogas production has a low yield and is expensive. But research and development are under progress.

I can send you more info later on if you are interested.

Can you tell us what’s happening in your areas?

I have tried to register to the discussion forum and the web-page (www.uspeugcca.net) but has not succeeded.

Antoine de Ramon N'Yeurt, European Union Global Climate Change Alliance Project (EUGCCA), Pacific Centre for Environment & Sustainable Development (PACE-SD), University of the South Pacific, Suva, Fiji

Dear Fredrik,

Thank you very much indeed for your mail, and interest in our seaweed bloom problem in the Pacific. I am sorry that you could not join the Forum, and have put Jacqui Berrell of the Solutions Exchange Community in copy of this mail, in the hope that she can include you in the discussions.

I was very interested in your comments about the high levels of Cadmium in seaweeds from Sweden. Do you know if Gracilaria from the tropics has high levels of this element? We are considering using the alga as fertilizer/foliar spray, and we already had good preliminary results from people who have used this resource on their crops, so perhaps we should test this element before using it.

In our case, we believe that rising seawater temperatures in conjunction with increased nutrient/phosphate input into the waters are responsible; also overfishing of herbivorous fishes is a factor. Which kinds of algae are a problem in your area? Green, red or brown?

Looking forward to hear from you.

Devika Raj, NaDraki Weather, Suva, Fiji

Hi,

My name is Devika Raj and I work for NaDraki Weather - a private company based in Suva, Fiji, providing expert weather and climate consultative services.
Potential Use for Seaweed: While attending the Pacific Solution Exchange ‘Annual Forum’ last year, which was held at the University of the South Pacific, I came across “Seaweed Soap” funded by UNDP’s GEF (Global Environment Facility) Small Grants Program.

Here are some interesting articles I found online:

I am sure the people who are more involved in this programme can explain this in more detail. I just thought this is something worth sharing with others.

Regards.

Vasiti Navuku, Global Environment Facility (GEF) Small Grants Programme, Suva, Fiji

Bula and thanks Devika,

The Community Natural Resource Management and Enhancement in Ono-i-Lau for Biodiversity Conservation and Sustainable Livelihoods is the project you are referring to. It was funded by the GEF Small Grants Programme in 2007 and came to an end in 2010. WWF (World Wildlife Fund) were the facilitators and implementers of project activities on the ground, in the district of Ono in Lau. The seaweed soap was a result from one of the eight activities implemented by the community.

The ‘Community Development Plan and Strengthening Alternative Livelihoods’ activity outlined that the conservation and protection of biodiversity could not be achieved in isolation of community aspiration for development and income generation. It was important to integrate community conservation activities and community development needs, into an overarching community long term development plan. This was to ensure neither of the two components come into direct conflict or be contradictions of each other. The development plan is also important in gauging existing and potential community income generating opportunities and strengths.

As seaweed is seen as a high value commodity in Lau this opportunity allowed the Ono-i-Lau women to value add to this commodity to ensure high return at an equitable manner.

I hope this information is of assistance.

Isikeli Mataitoga, Fiji Embassy of Japan, Suva, Fiji

Bula vinaka Devika Raj & Vasiti Navuku,

Thank you for your contribution.

One of the issues constantly raised with the Fiji Embassy, Japan is to identify buyers for produce from small, rural/island based communities. In particular for seaweed; beechdemer & other sea slugs, sandalwood etc. We are hampered in our efforts to convince potential buyers in Japan/Korea/Taiwan/HK etc due to lack of researched based data on volume that could be produced by these communities and current price being paid for these products in Fiji.
Are you aware of any detail information the issues I have raised above? Thank you for your consideration.

Many thanks to all who contributed to this query!

If you have further information to share on this topic, please send it to Solution Exchange for the Climate Change and Development Community in the Pacific at ccd-pc@solutionexchange-un.net with the subject heading “Re: [ccd-pc-se] QUERY: Solutions for Overly-Abundant Seaweed. Additional Reply.”

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