Memo

From: Dr. Jim Hendee, NOAA/AOML, Miami, FL
To: Coral Reef Advisory Group, American Samoa
Subject: Monitoring Station Site Survey
Date: 9 August 2000

From August 1 through August 7 Dr. Al Strong (NOAA/NESDIS) and I visited American Samoa for the purpose of surveying candidate sites for the installation of a near real-time meteorological and oceanographic monitoring station at a marine coastal site. This effort constitutes the Coral Reef Early Warning (CREWS) or "in situ instrumentation" portion of NOAA's Coral Reef Watch program, for which I have the lead, while Al Strong has the lead for the satellite calibration/validation portion.

This initial of two proposed monitoring stations is intended to provide long-term environmental data near important coral reef area—possibly an area that has already been routinely monitored; to provide surface-truthing for satellite sea temperature and surface wind sensing instruments; and to provide data for environmental modeling, monitoring and alerting of conditions conducive to important environmental events, especially coral bleaching. (CREWS may be configured to monitor, predict and model other environmental events, but that is not our emphasis at this time.) The CREWS data are sent to a GOES satellite every hour, and will be available on the Web shortly thereafter. Specially configured reports will also be available via automated email immediately after the hourly daily acquisition.

There are three broad considerations in the surveying of candidate sites for the station installation—logistical, scientific, and political.

Logistical Considerations

Although it would be conceivable to have a station tower installed on land near the coast, with cables for oceanographic sensors running down to the sea, that case would be present some tough logistical problems such as signal drop, a platform for the positioning of the various sensors, and a greater chance for ensnarement by boat anchors. However, this is something I admittedly need to look into more if this becomes the desire for the American Samoa site. The new station more likely would be in an area from 3 m to 10 m deep on a fixed platform, preferably on a tower extending above the surface of the water approximately 6 m to 8 m so that it will be high enough to avoid being swept away by large seas during storms. To facilitate the approval process by the US Coast Guard for the installation of the station, it would be helpful if the station also served as a navigational aid, if possible. In fact, the US Coast Guard may want a navigational aid at a spot we would all consider. The station should be at a site easy to reach by boat during moderately rough weather without compromising the safety of the recommended routine maintenance crew of two. The station will need to be maintained ideally every ten days to two weeks. Maintenance will usually entail taking surface truth (i.e., against the in situ sensors) sea temperature and salinity measurements with a SeaBird Conductivity/Temperature sensor, and include scrubbing of the in situ sea temperature and salinity sensors of biofouling. However, maintenance may also include swapping-out of a drifting or inoperative sensor, replacement of a meteorological sensor, battery replacement, or even the removal of bird feces from the solar panels. Although scrubbing the sensors will generally only require snorkeling, the swapping out of sensors will require scuba diving. Because of the period of maintenance, the expense of operating a boat, and personnel costs of two people, it would be best to locate the station at a site fairly easily accessible by boat that can be reached within a relatively short amount of time. If at all possible, it would also be desirable to locate the station at an area where vandals would not be tempted to visit. You

can see that these last two considerations may be mutually exclusive, thus a trade-off is usually the solution. Finally, one thing I'm not sure of is how good a connection with the GOES satellite can be achieved at different times of the day, from these latitudes, when next to areas with steep cliffs.

Scientific Considerations

Ideally, we would like to install the station in ~~at~~ an area where extensive biological and/or physical monitoring has taken place in the past. This not only helps us to understand what has caused changes in coral populations in the past, but also helps us to formulate a better modeling and monitoring plan for the new station. The meteorological parameters to be measured include wind speed, wind gusts, wind direction, air temperature, and barometric pressure, while the oceanographic parameters minimally include sea temperature and salinity, with more sensors added as funding permits. We are aware that NOAA monitors these same meteorological parameters at various other locations; however, the CREWS monitoring and modeling approach uses very local conditions to help understand the processes of coral bleaching and other biological events. A report of this approach can be read on the Web at http://www.coral.noaa.gov/ncri/ncri-sk5.pdf. Basically, CREWS attempts to monitor and model the effect of sea temperature, winds, tide, light and other factors—singly and in combination—on coral bleaching. Initial attempts have looked at how low winds and low tides, which allow a greater penetration of light, together with high sea temperature, affect bleaching. Future attempts will hopefully include the measurement of ultraviolet light, water clarity, nutrients and carbon dioxide. Thus, an understanding of what conditions were present previously, and how the corals reacted to these conditions, helps us to better model, predict and understand future events.

Political Considerations

The station should be at a location that offers benefit to the local population and/or government, if at all possible. Special interest groups such as fishermen and diving clubs would ideally gain benefit from the positioning of the station. Also, it would be of great benefit if the data being gathered were helpful to other scientific or public concerns. For instance, water clarity readings may be of benefit to local diving clubs, wind speed and direction, together with tidal state, would be of potential benefit to boaters and fishermen. Finally, the site would hopefully not present an eyesore in an area traditionally considered an uncluttered, cherished, etc., viewpoint.

Sites Considered

Tutuila Island

Fagatele Bay (S 14° 21.981', W 170° 45.811')

We did not dive at this spot, as the swells made approach by boat difficult. Apparently, though, this area is not as rich in coral growth as nearby Larsen Bay, and is generally difficult to dive in because of the nature of the swells. However, since this is the sanctuary, if maintenance arrangements could be made, this would be a good spot since it has a long history of monitoring, and would *theoretically* be more protected from vandalism.

Taema Bank (S 14° 19.466', W 170° 40.472')

We did not dive at this area, but did visit the buoy. The main advantage offered by this spot is that it could be quickly reached from Pago Pago harbor for maintenance. Another advantage would be that a rugged tower installed here could also serve as a valuable navigational aid. The main disadvantages would include the water depth (about 10 m at the shallowest), ocean swells and currents. This site might also be

largely influenced by runoff from Pago Pago harbor; however, this might be an advantage if such monitoring would be desired.

Auasi Harbor (S 14° 16.377', W 170° 34.332')

As with many other sites around Tutuila, there is a concern that this site might be vandalized. It would be difficult to install a station outside the harbor here, too, as the bottom drops off quickly from just outside the harbor and the currents appear to be problematic. However, there was moderate coral coverage at the area visited.

Nuutele Rocks, near the Observatory (S 14° 14.696', W 170° 34.003')

I only took a very quick look at the bottom here, but from what I saw, there were no corals in the immediate area. A station here would be advantageous as it could serve as a navigational aid to warn of the Rocks, and according to Eric Sandberg of the Observatory, the local villagers would probably not vandalize it, since they would think it was part of the Observatory, which they apparently never bother. Also, it would be conceivable to use a microwave transmitter for the data and transmit the data package directly to a microwave receiver at the station, where it could then be directly sent via their high-speed Internet connection to NOAA/AOML. The transmitter and receiver would be expensive (about $5K each), however.

Oa Bay (S 14° 15.101', W 170° 38.524')

This site offered what appeared to be excellent coral diversity and coverage, both shallow and deep, and would appear to offer good protection from swells most of the year. Although this site had no village at the shore, there is a perception that this might actually be a disadvantage rather than an advantage, since the leaders of a village might not be able to keep their eyes on it. Of course, if they could keep their eyes on it, they might not like looking at it! If a station were installed here, it could be installed at one of several places where there is nothing but rubble on the bottom (but corals nearby). The principal disadvantage of this site, as with many of the other sites on the northern side of the island, is one of quick access by boat. Safe passage to the station would probably be via the eastern side of the bay, as there is one area near the western side where a coral mound reaches from about 15 m at bottom to within about 3 m of the surface. It was also noted that the possibility appears to exist at this site for transmitting data to the Observatory via a microwave transmitter using a reflector on Tapisi Point, but this requires further verification.

Massacre Bay (S 14° 17.409', W 170° 45.406')

This site, and nearby Fagafue Bay, had good coral coverage and areas on the bottom where a station could be installed at desirable depths. Here again, the problem would be one of ready access, rough swells at certain times of the year, and protection against vandalism.

Aoloau Bay (S 14° 17.524', W 170° 46.827')

The same considerations as pertain to Massacre Bay, apply here. This area had some great coral coverage, but dropped off rather quickly, with not very many clear bottom areas for the installation of a station.

Leone "Cliffs", near Logologo Point (S 14° 21.671', W 170° 47.152')

At about 20 m deep, this area has some spectacular coral growth and would be a good pristine site to monitor. However, positioning and installing a tower here (in shallower water) would be difficult without damaging some of the corals; hence, installation could be considered nearby where the bottom would contain areas of no coral growth.

Ofu Island

Harbor (S 14° 09.821', W 169° 40.928')

At the harbor southwest of Tauga Point (formed between Ofu and Utele Island), there are lights both at the end of an artificial jetty, and in the middle of the channel, marking a narrow passage into the harbor. Of the two islands we visited (Tutuila and Ofu), I believe this second light is the only tower actually located in the water, which is the ideal situation for a CREWS implementation. Although there was some pretty fair coral coverage near that site, perhaps 15 to 30 m west, there was a gorge that dropped from 1 m to about 10 m, and in that gorge was some very good coral coverage and diversity. We purposely made our exploratory dive at the top of the tide so as to miss the rapid current flow in this area during mid-tides, and this we believe would be something a maintenance crew should be attuned to. The fact that this area might be dangerous at these other times might work in our favor if there is concern vandals might visit the site. However, it was pointed out to us that arrangements ("gratuity"?) might be made with the local people (Alaufau and/or Ofu) to help watch out over the site. Interestingly, there is a NOAA meteorological monitoring station near here, at the base of the jetty, at S 14° 09.777', W 169° 40.907'.

Conceivably, since the present tower does not appear to be tall enough, and may not easily be re-engineered to hold a platform for our instrumentation, the present tower could be replaced with one that would have the desired characteristics. At the bottom of the present tower, it looks as though it has been bolted to a concrete platform resting, or somehow affixed, to the bottom. It might be possible to remove the existing tower and put in our own tower (which would also have a light) as a replacement. This is something that we would have to confer with the US Coast Guard about. Unfortunately, none of the three US Coast Guard people I spoke with in Pago Pago were aware of how that station was installed, so it appears we would have to pursue this though bureaucratic channels. Here again, we have been advised that it would be possible to transmit data via a microwave transmitter directly to the Observatory.

Bridge Connection Between Ofu and Olosega (S 14° 10.127', W 169° 37.930')

There is a considerable exchange of water with the tide through the bridge connecting the two islands. It might be possible to construct a tower and platform extending out from the side of the bridge, or to use one of the telephone poles at the end of the bridge (S 14° 10.134', W 169° 37.910') to hold the meteorological platform, with cabled sensors in the water below. One problem here is that the station sensors would not be immediately adjacent to an area of coral growth that would be easy to monitor. Another problem would be the construction and placement of the platform and cabling to another, extremely robust platform, to hold the ocean sensors in the rapidly moving water.

Toaga Beach (S 14° 10.669', W 169° 39.256')

The shallow area from the beach to the outer side of the fringing reef (especially south and west) here contains a spectacular assemblage of corals, but presents some problems. It would probably be difficult to install a platform here without adversely affecting a large area of the bottom. It would be difficult to service the area with a boat, however, it would be conceivable to get a shallow draft boat such as a Zodiac in there if you had to swap out large instruments or equipment (e.g., batteries, anemometer, CTs, etc.). Finally, it would probably not be in the long-term best interest of the island to clutter the view at this beach with a large station. However, if a station were positioned right at the fringing reef edge, or just oceanward of the reef, it might serve as an important navigational aid.

Vaoto Lodge (S 14° 11.040', W 169° 39.991' [inshore lat/long])

This general area might be advantageous from the standpoint that it might be monitored by the Lodge managers, and for serving as a navigational aid (for both ships and planes), if placed near Papaloloa Point or Fatuana Point. The Lodge owners, however, would probably object to their view being compromised, unless it was far enough up or down shore to be unobservable by the Lodge visitors. The same logistical problems here as for Toaga Beach apply.

Summary

At this time, based on our August survey, our preference for installing a station on Tutuila would be Oa Bay, while on Ofu, it would be at the harbor. As far as costs and the logistics of actually installing a tower, Ofu would seem to have the edge. However, we doubtless have not addressed all the considerations the Coral Reef Advisory Group (CRAG) might have, and the problem of routine maintenance at any of the sites to be considered still remains. The CRAG will of course have the final say as to the optimal installation site.

One thing not addressed above is the possible collaboration with the National Geographic Society (NGS) to install a real-time underwater camera ("coral cam") at the proposed station. If this comes to be a driving factor in a decision, then of the Tutuila sites, it would be desirable to install a microwave transmitter for the large data stream the camera would require, at a site within line-of-sight distance of the Observatory (i.e., probably the north side of the island). It would apparently be possible to have a station in a bay or cove, then transmit the camera data via microwave transmitter to a reflector at a point that is within the line-of-sight of the Observatory; there would also have to be a receiver at the Observatory. These costs would almost certainly have to be met by the NGS. Apparently the harbor at Ofu is within line-of-sight of the Observatory, hence an additional reflector would not be required in between. Dr. Marguerite Toscano of NOAA/NESDIS will be involved in any future negotiations between the NGS and NOAA concerning the installation of the "coral cam."

The problem of cost and logistics, including permission from the US Coast Guard, for the installation of a tower is our biggest obstacle, and is something that will at some point probably have to be addressed locally, as it will be difficult for us to address all the issues from the US. Thus, we will be highly dependent upon the CRAG or a specific person or agency to work with us on this before we can actually begin to acquire and send the station instrumentation to American Samoa. There are also funding concerns on our end; however, we feel confident that we can begin to have a station installed within the next six months to a year. We need to have your feedback and desires as quickly as possible.

In closing, Al and I would like to express our deepfelt thanks to the members of the CRAG for their help during our stay, especially Peter Craig, Jennifer Aicher and Paul O'Connor, who spent quite a bit of their valuable time and resources in showing us candidate sites and discussing the complex issues involved in this venture. Thank you all so very much for your help and cooperation.

Cheers,
Jim Hendee