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Caring for the Land and Serving People

Reply To: 1550

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Subject: Observations on Watershed Management in  
the Pacific Islands

To: Roger R. Bay  
Station Director

The Role of the Forest Service in the Pacific Islands was a major issue for the June 8-26, 1987 CPR of PSW. The CPR team (Bay, Krugman, Ross, Whitesell) visited Palau, Yap, and Guam. The CPR trip was preceded by a tour of Pohnpei, Truk, Saipan, Rota, and Guam on April 25-May 8 by West, Fulk, Bell, Harcharik, and Newell (1550 report to Eldon Ross dated June 9, 1987--APPENDIX B of CPR Action Plan).

CPR Action Plan item 5 directs "PSW to complete Tropical Forestry Plan for Western Pacific and develop followup action plan for research". Item 3 of the Findings (page 8) states "Assisting in establishing guidelines for watershed management and protection would be a major contribution to the Islands. This would directly assist the Islands in meeting their water shortages as well as assisting local agriculture and forestry activities by reducing erosion and by producing better soil management and upgrade their general natural resource management activities."

To better identify watershed research objectives in the Pacific Islands, Craig Whitesell and I took a short trip to the Western Pacific November 30-December 10. We visited Palau, Yap, Saipan, Guam, and Pohnpei. Because of the diversity of physical and cultural conditions on each Island, it was possible to obtain only the most sketchy glimpse of watershed condition and technical infrastructure during such a short visit. There is a great danger that such short-term observations are far off mark. In any complex system such as watershed condition and erosion, detailed observation is required over both time and space. Erosion sources, for example, have been found to be generally log-normally distributed both temporally and spatially. That is, most watershed problems come from a small area during an infrequent short-term event. These events are often considered to be "unusual" and are frequently discounted in the planning process as "acts of god". In reality, such events are usually the significant ones from geomorphic, ecological, and economic viewpoints, and, define the effect of cultural practice on the ecosystem.

The bias against considering unusual events is underscored by a paper on agricultural management decisions related to climate presented at the III International Soil Management Workshop: Management and Utilization of Acid Soils in Oceania, held on Palau, February 2-6, 1987. The author used data from 1957 through 1984 and wrote: "Since heavy rainfall from storms and typhoons are regular weather features of the island, no attempts have been made to separate them from the collected data. However, super typhoons such as Karen in 1964, and Pamela in 1976 are considered infrequent events and the rainfall associated with these were excluded from the analysis." Only one paper (by Joan Perry, SCS) presented at this meeting discussed erosion.

However, no papers considered the effect of unusual events on the soil or agriculture.

Each island we visited has a unique set of socioeconomic and political conditions, as well as physical and ecological settings, which make generalizations difficult. In terms of erosion and sedimentation problems, Guam is the most degraded and damaged; Yap and Pohnpei the least; and Palau and Saipan were intermediate. These conditions are not related to forestry activities, however. There is little forestry (or agricultural) activity evident on any of the Islands that we visited. The principal watershed and erosion problems that we observed were related to construction and roads. Such a bias is not unique to these islands, it is world-wide. However, in the island environment, the problem is more acute. Roads and cultural construction are generally near the shoreline and sediment routing to the lagoon and coral system is efficient and can have a serious effect on that ecosystem, both in terms of biological stability and the tourist/snorkeling industry. A 1987 study by Hodgson and Dixon (East-West Center) on the biological and economic effects of siltation pollution of coastal marine areas of Bacuit Bay/El Nido on Palawan Island, report that the economic loss to tourism and fishing by sedimentation far exceed the value of timber and mining which is causing the sedimentation there.

It is dangerous to generalize, but it appears to me that before a watershed research effort is practical, a major education/extension effort is required. None of the people we talked to (except Joan Perry, SCS, Guam) had any training in watershed management. There is a vast amount of information available that would be applicable to a program of identifying and controlling much of the erosion that I observed. Simple things as improved road construction and drainage practices would reduce the sedimentation problems dramatically. Control of the annual burning of the grasslands would reduce the erosion potential in these areas. However, the control of erosion on these islands is as much a social problem as a technical one.

In general, there is an educational link needed to tie erosion to loss of resources. One resource is reduced site productivity, but probably the greatest resource at risk is the lagoon ecology. Research on these relationships is not complete, but there is sufficient information available that resource managers should be concerned. Only recently has the importance of mangrove areas begun to be appreciated--and that appreciation is not yet widespread. Not only does the mangrove provide biological richness, it is an efficient sediment trap/filter between the island land mass and the lagoon. When the mangrove is disrupted, sedimentological problems are exacerbated. It is not clear what effect accelerated erosion and sediment input has on the mangrove, but it is clear that mangrove is an important element in the routing and ecological consequences of sediment.

#### GUAM

There are extensive erosion problems on the volcanic soils of southern Guam.. Repeated fires have led to the soil being eroded to saprolite in an expanding area. These bare areas often appear first on the ridges then expand downward, but there are also gully heads, or head scarps, on mid-slope. Since our visit did not coincide with an erosion event, we did not directly observe the processes of erosion in these areas. We were told that the grasslands were burned during the dry season and new grass invaded quickly after the first rains. The period of vulnerability was said to be short, but sufficient to allow extensive erosion. After many such repeated annual burnings, the soil becomes progressively degraded so as to support only grass and/or fern, and, eventually, the level of fertility is reduced to the point where only bare land remains. The saprolite erodes as the rock rapidly weathers. Joan Perry

(SCS Guam) stated that rain water penetrates to a restricted layer and the entire super-saturated soil/gross mass slumps exposing soil and saprolite to sheet and rill erosion. She felt that woody vegetation would arrest this process. That seems reasonable, if the woody roots could penetrate the restricted layer and/or establish a tensile network within the soil above this layer. We observed some planting trials in southern Guam where trees had been successfully established on the degraded, bare saprolite, and were providing effective erosion control. However, control of the periodic fires is necessary before woody vegetation could become permanently established and maintained. It is believed that with each successive fire, the natural forest margin retreats further and the grasslands expand. This could be verified by an analysis of historic aerial photos.

Given the high clay content of the soil and the depth of weathering, I would not be surprised if creep is not an important geomorphic process on the volcanic soils. Such a process would only become readily apparent when cultural improvements (roads, pipelines, buildings) are deformed. It may require decades before the deformation is identified. In Hawaii, subdivisions constructed in the 1950's have recently been abandoned because of deep-seated instability, and others are currently being considered for expensive drainage and retaining wall treatment--probably a short-term solution at best.

Erosion is not thought to be a serious problem on the limestone soils of northern Guam. A comparison of sediment transport on a unit area basis: between volcanic and limestone watersheds could provide relative rates.

Guam has the best technical infrastructure of any of the islands visited. The SCS is located on the University of Guam campus. SCS has mapped the soils and calculated the erosion hazard using the USLE. The USLE is used throughout the Islands (see Pohnpei), but no effort has been made to validate the erosion rates so calculated. This presents a serious problem, because the USLE rates are being used for land management and planning decisions.

The SCS is just initiating a River Basin Planning program on Guam. The SCS is preparing to use data from the many studies that have been made on the water resources of Guam to gather additional data, and to formulate feasible projects. The initial planning session was held on 12/9--the day after we left Guam. The study will be conducted under the direction of the USDA River Basin Field Advisory Committee, composed of representatives from the FS (Newell??) and SCS (Committee Chairman). A detailed Plan of Work will be prepared, including priorities, manpower assignments by work item, and completion dates. This is the logical avenue to identify researchable questions and develop a research plan on Guam and the other islands, if such a plan is desired by the Station.

There are several USGS hydrologists located on the Campus, but their office was closed while we were on Guam. We were told that they work primarily on the groundwater lens problem. The USGS office would be a logical technical source for any research planning effort.

The University of Guam is a land grant college and has access to McIntyre-Stennis funds. In the past, about \$8,000 per year was available, but the University deemed that to be insufficient and did not utilize the authorization. This year, we were told that \$38,000 was available and a tentative agreement was reached to develop a joint study with PSW and Guam Department of Forestry for species trials. As an aside, Humboldt State has been funding 4 to 6 studies a year with \$22,000. Perhaps the University of Guam might consider a few modest studies that begin to address watershed issues, in cooperation with interested agencies.

The University of Guam apparently has no watershed program, although on December 16 (after our return to Honolulu) we learned that Dr. H. Manner had made an inquiry about funds to conduct some catchment studies on Guam. While we were at the University, Dr. Manner was not mentioned, although we were explicitly discussing watershed concerns. In 1981, Dr. Manner (then at the University of South Pacific) made a proposal for a joint study with the Fiji Pine Commission and Public Works Department to study the impacts of pine on the "talasiga" grasslands. The methodology proposed was similar to that used by Bormann and Likens--long-term monitoring and analysis of nutrients in a watershed system, prior to and after conversion. The study was modified and ecological data have been collected since 1982. Earlier studies by Kammer and Raj (1979) had concluded that conversion from grass to *Pinus caribaea* in the dry zones of Fiji reduced low streamflows by 50% or more in areas having 6-year-old pine. They forecast that these flows would be further decreased as the trees approach maturity (15-25 years). The East-West Center has close ties to the watershed studies in Fiji, and more recent studies in Papua New Guinea. The Center also has a publication that reviews the hydrology of tropical grasslands.

#### POHNPEI

In 1979, Pohnpei enacted the Forest Management Act of 1979. Section 6 of this Act provides the authority to set aside Watershed Reserves "so as to insure the public the continuous and uninterrupted availability of uncontaminated domestic water supplies". In this context, "lands within a Watershed [may] be zoned so as to protect the Watershed".

In 1987, the Pohnpei Watershed Forest Reserve and Mangrove Protection Act of 1987 was passed. In this Act, "Watershed Forest Reserves" are contiguous areas of highly or very highly erodible soils. These soils are defined by the SCS in the Soil Survey of Pohnpei. Severe land-use restrictions are proposed for these soils in this Act and in the draft Forestry Resources Program Plan. According to the table provided in the Plan, 54% of the total forest area is located on the highly and very highly erodible soils. Given the large proportion of land on these classes of soils, and given that the erodibility was determined by the USLE, which the SCS states has never been verified for these soils and climate, I wonder whether the proposed regulation is couched in a context of proper and available data. In detailed discussions and a field trip with Herson Anson, Chief of the Division of Forestry, he was unable to describe or to show to us any forest areas where erosion was a problem. When queried about the restrictions described in the Forestry Plan, he replied that the Plan was being revised by Len Newell, but he was not aware of the details of this revision.

There is a danger in enacting severe land use restrictions on such a large area when the consequences of alternative land uses has not been verified. That danger is related to credibility in both a political and social context. It seems to me that land use restrictions should be based on demonstrable risk. The first step has been completed by the SCS Soil Survey, and areas of POTENTIAL concern have been identified. The next step, which I believe has not yet been taken, is to develop a series of experimental treatments to determine the magnitude of the consequences of anticipated land management activities. If these activities are already taking place, the data may be obtained by simple case studies. However, during our short visit, our hosts were unable to show us any areas of forest management where erosion was a problem. If such examples are lacking, manipulative studies might be in order. In any event, without such data, restrictive regulation is perhaps premature, if for no other reason than Public acceptance. We did see a number of roads and construction projects having accelerated and uncontrolled erosion, and some regulation of these activities seem to be needed on all

Islands that we visited. If it is politically not feasible to regulate these major and on-going sources of erosion, it seems pointless to attempt to regulate potential and undocumented sources of erosion which may result from some future activity.

We did see some grassland areas on Pohnpei, but their extent and degradation was not nearly as great as on Yap, Saipon, Palau, and Guam.

At this time, there appears to be a political opportunity for research cooperation at a high level. Marcelino Actouka is the new Secretary of the FSM Department of Resources and Development. Actouka impressed us as a very bright, young graduate from University of Hawaii, who was also at the East-West Center for some time. He took the time to talk with us for about 2 hours. He has several pet projects that he personally wants to see occur.. One is alternative energy sources, including wood biomass for fuel. He is interested in experimental plantings, and eventual expansion to plantations on a relatively large scale. We briefly discussed erosion concerns related to these projects, but that was not high on his agenda or perhaps awareness. There is an opportunity and need for companion erosion studies to be attached to the biomass feasibility study. For any large-scale forestry or agriforestry program in this region, awareness of potential erosion problems is critical.

The College of Micronesia (COM) is headquartered in Kolonia and has branch campuses on other islands. Ishmael Lebehn is Director of the College of Tropical Agriculture and Science. COM has land grant status and access to McIntyre-Stennis funds, although it has not utilized the program to date. It is possible that cooperative studies could be conducted through COM, utilizing students from the University of Hawaii and/or the East-West Center.

Goats have recently been introduced on Pohnpei in an effort to increase domestic meat production using local resources, and reduce reliance on imported meat. There is a recent article in the September 1987 issue of Agricultural Information Development Bulletin 9(3):11-12, concerning this program. It is not clear if this program will be successful on Pohnpei. The people we talked to did not use the meat. It had not yet gained acceptance as a part of the diet. The does were not milked. We observed several mixed herds of Saanen and Alpine goats running loose. These goats are well-adapted to this environment, can breed at all times of the year, and can produce three kiddings in two years. Twins are common, but triplets are not unusual. Without some form of control, there is a high probability that a feral population will become established, causing problems to agriforestry and other vegetation management programs.

#### SAIPAN

We were on Saipan for only a short time. Most of the island is limestone.. There is a small area of volcanic soils mid-island that looked similar to those on Guam, with bare areas and what appeared to be either gully head-scarps or slumps. These were in grass lands. We saw no areas of forestry activity. Saipan appeared to be an analog of Guam. Hotel construction for tourists was accelerating. Water supply was a problem. Domestic water quality was poor, being very salty. Most watershed problems that we saw were related to land use planning and encroaching urbanization.

We were told by Lebehn (COM) that the College of Northern Marianas has recently been given land grant status and is eligible for McIntyre-Stennis funds. We obtained this information while in Pohnpei, after leaving Saipan, and were unable to obtain further details.

## PALAU

Mangrove ecology is becoming an issue and there is an emerging understanding of its importance to fish and the health of the lagoon system. There is no baseline information for the mangrove, or for the degree of lagoon degradation. There is a concern that seaweed, small fish, and coral is disappearing, based on elder's recollections of what the area used to look like. There is no data base to document changes, but there is concern that such changes, if real, might be linked to the bare areas and accelerated erosion.

As on other islands, the land is routinely burned. Grass and fern lands occupy large areas. Many ridges are now bare and soil fertility is probably being continually reduced by erosion following burning. There are no data on erosion rate and sediment transport from these areas relative to unburned grasslands and forests, nor are there data on the disposition of sediment once it gets to the mangrove. Agriculture and forestry are minor land uses. Burning is a cultural endeavor with little objective other than recreation and habit. Its importance to the sediment regime is unknown.

There is a stated desire to begin to collect information on ecological changes taking place and its relation to land use practices. However, there is a great lack of technical expertise in watershed matters. Perhaps an IPA by someone with watershed skills would be a first step to identify research and management objectives. We were told that regulations are easy to obtain, once the need for such regulation is articulated. Presently, there is no basis for requesting regulation of land use practices from an erosion perspective. To date there has been no inventory of watershed condition or erosion hazard, and no linkage made to effects on beneficial uses or ecological stability.

As with many societies, short-term economic gain can override normal regulatory processes. We learned that a new airport is to be constructed on Babelthaup, requiring 22 miles of new road. Completion is scheduled within 30 months. The environmental effects of this construction are unknown. Although there is an EIS process in place, the appropriate agencies are not required to be notified or to concur in proposed projects, and they are routinely by-passed. As elsewhere in the world, sister agencies, especially regulatory agencies, are viewed as impediments to project completion and their advice is not actively sought.

The first step in improved watershed management on Palau, according to Marcello Brel (Chief of Agriculture) and David Idip (Director of Agriculture), is in training their staff in watershed issues. For example, a watershed IPA to Palau would be a dramatic improvement. The use of on-site training sessions, such as those conducted by US ASEAN, and literature and bibliographic services would initiate the educational process.

## YAP

There are extensive grass and fern lands on Yap, which as on other islands, are maintained by burning. In addition, within one of the grass-fern areas, there is a large bare and gullied badlands, locally called "the grand canyon of Yap". This appears to be an ancient and perhaps natural feature. The soil is a dramatic pink-red color. The badlands are presently being prospected for gold. While we were there, I observed a line of boreholes, probably for subsurface mineralogic or seismic evaluation. Erosion products from this area probably do not reach the lagoon because of a long, flat, vegetated area downslope.

Traditional agricultural land use is in small (< 1 ha) patches where

individual trees are killed by burning piles of fuel around the base, then interplanting with crops of banana, yams, etc. There is probably some short-term erosion from this system of agriculture, but the amount must be small and the soil would travel only a short distance to the forest immediately downhill. These areas are thus farmed for 3 to 5 years, then the area is abandoned to return to jungle. Land use on Yap is much less severe than it was in pre-European times, when the population was much larger--perhaps 50,000 people.

On the lower slopes, there is an elaborate system of irrigation waterways connecting taro fields. Thus, most sediment that entered the fields was deposited before reaching the mangrove. In addition, very little sediment was capable of passing through the mangrove to the lagoon, unless the mangrove was disrupted. Today, this system is changing. Most people have jobs in town and have little time for traditional agriculture. The waterway system is deteriorating. Roads have been constructed at the mangrove margin, with upslope drainage constricted to widely spaced culverts. The water flow is thereby disrupted and the mangrove, where it has not already been cleared, is suffering on the upslope side of the road.

From an erosion viewpoint, roads and urbanization are the major problem on Yap. Most roads conform to the local topography. But, there is a program to construct more roads and to "improve" the existing roads by widening and straightening. Road drainage is generally by in-board ditch, routed long distances to be discharged in a small channel. That channel must then adjust to the added runoff by enlarging.

As on all of the islands that we visited, there is talk of major land use changes. For example, we learned of a plan to clear 90,000 acres on Yap to plant *Acacia mangium*. Where and how this would be accomplished was unknown, but should such a program become a reality, ecological and watershed stability would become major concerns--particularly with regard to site preparation.

Perhaps because of Yap's conservative nature, the tension between traditional values and modern westernized society seems to be more intense than on the other islands that we visited. Change has been slower on Yap, but the area around Colonia is urbanized and the adjacent lagoon is turbid.

The presence of Marjorie Falanruw on Yap presents a base for research that is not evident on the other islands that we visited, with the exception of Guam. Although Falanruw professes no watershed training, she has an ecological research orientation and could potentially provide supervision and support for watershed studies. Unfortunately, there are fewer apparent watershed problems on Yap than on the other Islands visited, with the possible exception of Pohnpei.

It is important to reiterate that these notes are simply impressions from a short visit to a limited portion of a diverse region by a person marginally acquainted with tropical watershed management. My observations are undoubtedly incomplete and may be incorrect. I have reviewed the available literature on tropical island watershed management. That literature is extremely deficient, generally transferring the results of temperate studies to the tropical setting without verification of applicability. Based on my limited observations, the primary concern of island erosion is (1) the effect of sediment on the lagoon ecosystem, followed by (2) loss of soil fertility. I expect the first priority is to inventory the "health" of the island by watersheds, including the mangrove/lagoon ecosystem. This would require some information on the rate of change of these areas, which should be possible using past and present aerial photo coverage. A part of this inventory is an evaluation of sediment sources and routing. This process will undoubtedly

identify unknown linkages in this system, requiring more detailed investigation.

Finally, research in the western Pacific will continue to be extremely difficult and expensive. There is a limited technical infrastructure, the climate is arduous and hard on equipment, and travel is time consuming. Any work should have an on-site research-oriented staff. I observed only three locations where such a staff is presently available: Hawaii, Guam, and Yap. Should the Station desire to develop a watershed research program in the western Pacific, the East-West Center has many contacts and is a good source of information on the state of tropical watershed and agriforestry research in this region.

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