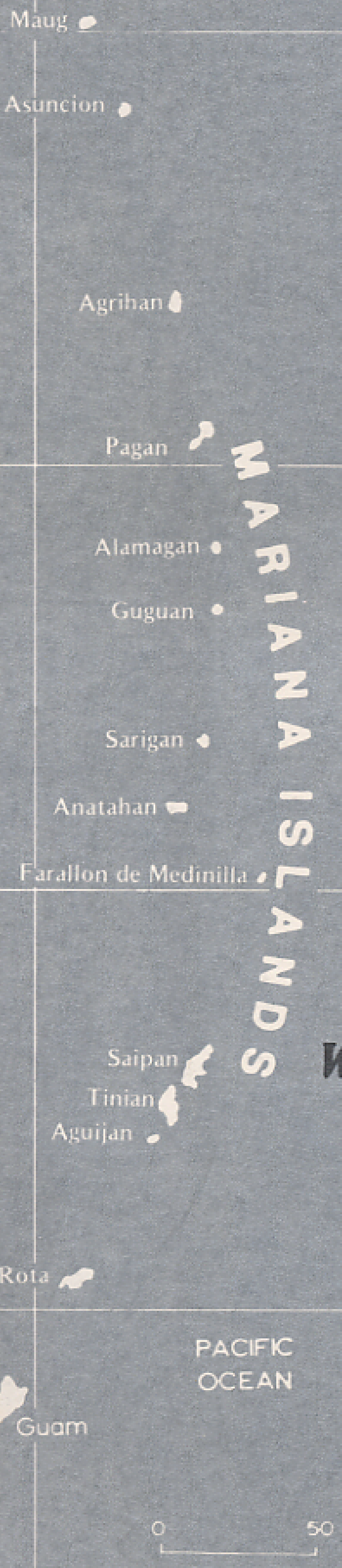

INDIGENOUS FRESH WATER MANAGEMENT TECHNOLOGY OF THE YAP ISLANDS, MICRONESIA

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Project Completion Report

for

Contemporary Irrigation Practices and Traditional Irrigation Facilities in
Yap, Western Caroline Islands

Project No. 02 Grant No. 14-08-0001-G1012
Principal Investigator: Rosalind L. Hunter-Anderson
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ABSTRACT

Recent field investigations in Yap, Federated States of Micronesia, undertaken to document ancient fresh water management practices and their physical manifestations, are reported. Project findings include an indigenous technological tradition of fresh water management designed to provide water for domestic uses and to prevent erosion and minimize soil loss from agricultural plots under variable climatic conditions. The fresh water management system consisted of household catchments, remote seeps, springs and streams, taro patch wells, and a complex series of diversion canals and drainage ditches. Although the fieldwork was focused on Map Island, in northern Yap, the spatial extent of this system is co-extensive with the entire Yap island complex of ca. 30 sq mi, encompassing both upland and lowland topography.

Customary practices involving differential status ranking regulated individual access to fresh water sources. A conservation ethic prevailed with regard to agricultural soils and fresh water. Present use patterns resemble those of the prehistoric past; however, access now is less strictly regulated and the physical system has deteriorated markedly due to an inadequate labor force for maintenance and repair. This lack is due to dramatic population losses after European contact in the early 19th century and subsequent colonial occupations through the second world war. Current and future demands on traditional fresh water sources for domestic consumption appear not to threaten traditional agricultural practices but modernization of water delivery systems is encouraging higher usage rates in households.

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INTRODUCTION

Research focused on water resources in Micronesia has been undertaken by the University of Guam since 1976, through the Water Resources Research Center which in 1981 became the Water and Energy Research Institute (WERI). The Institute's water research has included a number of studies of traditional fresh water uses, customs, and beliefs on islands where fresh water is scarce, either because of seasonal patterns of rainfall and lack of adequate storage and distribution or because a currently acute need has resulted from unusually high population densities. These studies have been conducted on Guam, Belau, Truk, Ulithi, Majuro, and Nama (Upper Mortlocks) (Stephenson, 1979; Winter and Stephenson, 1981; O'Meara, 1982; Stephenson and Kurashina, 1983; and Stephenson, 1984; Dillaha and Zolan, 1983). The present project expands the range of island cases studied by WERI from an anthropological perspective to include Yap Proper, a high island complex in the Western Carolines. Whereas previous projects focused on domestic water use, the Yap research focused on the traditional uses of fresh water for agricultural purposes.

STATEMENT OF RESEARCH PROBLEM

As in the other Micronesian high islands (Belau, Truk, Pohnpei, Kosrae), Yap's indigenous population is growing rapidly, and this trend is likely to continue for the next several years (U.S. Dept of State, 1984). Unlike these other islands, however, the settlement tendency within Yap is for rural villages to increase in size as the local population grows, rather than for the district center, Colonia, to expand by drawing permanent residents away from the rural areas. The settlement trend of dispersed rural population increase throughout Yap is correlated with a high degree of dependence on subsistence farming and lagoon fishing with small but increasing amounts of imported foods being incorporated into the diet of villagers.

Currently the government of Yap is engaged in a number of programs to improve people's access to fresh water resources, by drilling wells, developing perennial seeps and building small-scale distribution systems. Island-wide public bus transportation is available to individuals at nominal cost. Both these measures have encouraged people to continue to reside in the villages even though they may work or attend school in Colonia.

Another government program promoting continued village residence is rural electrification. Extending power lines into the villages from the power plant in Colonia, however, is conditioning a change in settlement within villages. For example, some people are relocating away from the coast, along roads where the power lines are being installed. This in turn creates water delivery problems as the wells and seeps are sometimes at lower elevations (Ed Bretton, Yap Community Action Program, pers. comm.).

Recent anthropological fieldwork on Yap (Hunter-Anderson, 1983, 1984) has revealed that village farmers still utilize the ancient water control facilities (ditches, canals, and modified streams) and gardens (hillside swidden plots and taro patches in the interior and near the coast) which were designed and built during prehistoric times when the population was much larger than at present. It is not known whether or how these farming/water control systems are likely to be used in the future, as the Yapese population continues to grow. The present project was undertaken to help answer this question by documenting the physical properties of Yapese fresh water management technology, learning about how this system was designed to function, and determining its present uses. It was hoped that the field investigations would indicate whether traditional farming methods are likely to affect existing fresh water drinking supplies in future. Information on traditional fresh water customs and beliefs was sought as well.

METHODS

The fieldwork was divided into a wet-season period (June 27--August 1, 1985) and a dry-season period (January 16--February 13, 1986). The principal investigator resided in the village of Waned, on the northeast coast of Map Island, during both field periods. From this position observations conveniently could be made and interviews set up and conducted throughout the island. With the assistance of local guides, visits were made to various ditches, canals, streams, and seeps in Map, and their current physical status and uses were noted. The dry season field period was used for mapping and photo-documentation of water control facilities.

At the request of Mr. Tim Thornburgh, Director of the Yap Community Action Program, water flow measurements were taken at six developed seeps which currently are supplying domestic water to the villages of Bechiyal, Toruw, Waned, Wacholab, Amin, and Talngith (Appendix A).

Formal and informal interviews with knowledgeable older Yapese, regarding traditional fresh water uses and customs, were carried out mainly during the wet season field period. Appendix B lists the questions asked. Appendix C contains two traditional stories about Map's seeps, obtained during interviews.

STUDY LOCATION

The Yap complex consists of four major islands (Yap, Gagil-Tamil, Map, and Rumung) and six minor islands, clustered closely together within a fringing reef averaging less than a mile in width. Yap is located approximately 9 degrees 30 seconds north latitude and 138 degrees 5 minutes east longitude (Figure 1). The nearest inhabited islands are in Ngulu Atoll, about 50 miles to the southwest, and in Ulithi Atoll, about 100 miles to the northeast.

GEOGRAPHIC AND CULTURAL SUMMARY

Yap's climate is marine tropical, with average temperatures in the low 80s. Annual rainfall averages 121 in, most of it falling during the northern summer months. Yap's standard deviation in annual rainfall (18 in) is similar to that of Belau and Truk, although those islands receive

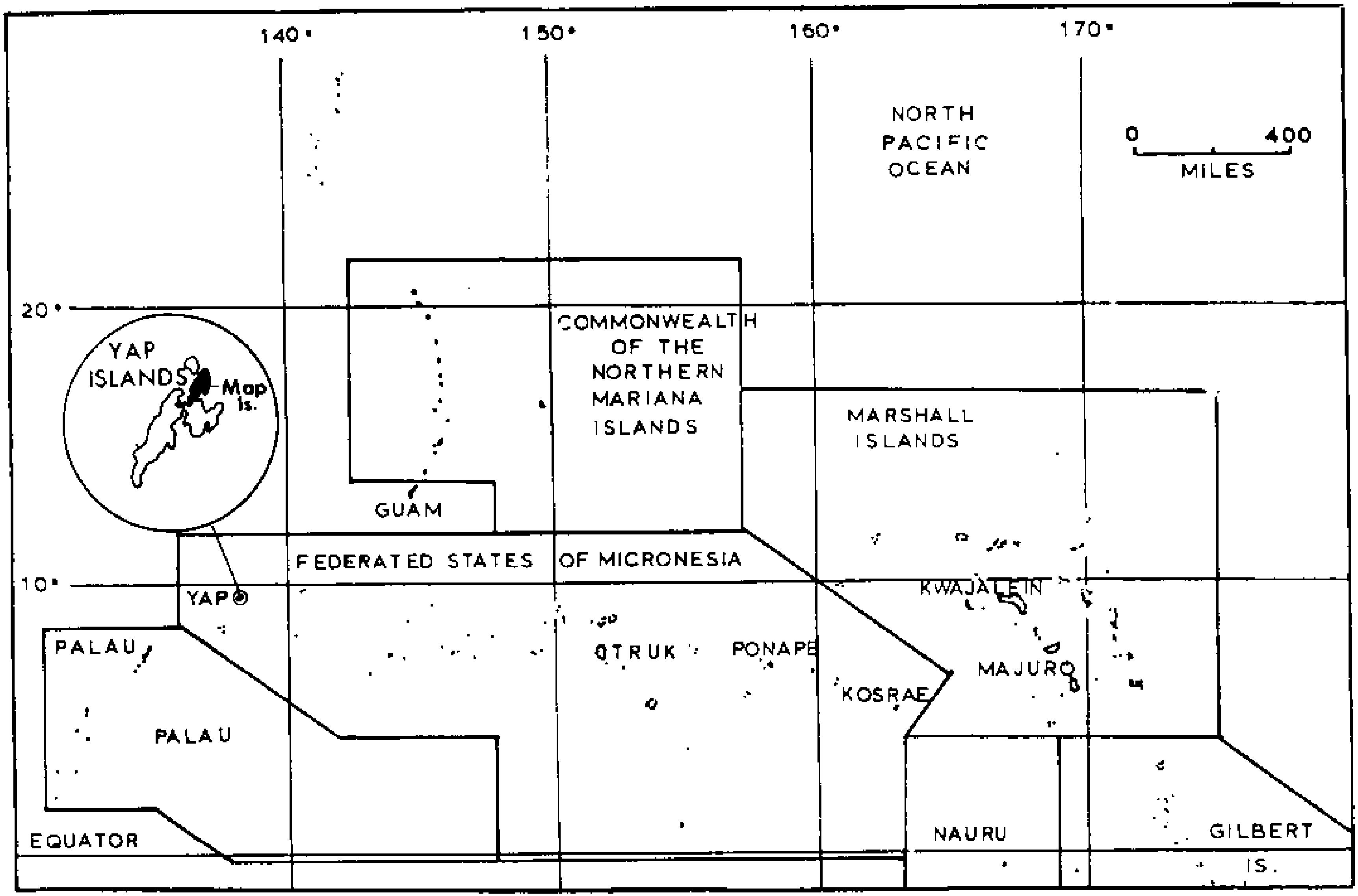

Figure 1. Location of the islands of Yap, Federated States of Micronesia.

more total precipitation. Typhoons are relatively rare in Yap; most tropical storm centers pass to the north, three times in two years on average. The last severe tropical storm to hit Yap directly occurred in 1966 (NOAA, 1983).

There are no perennial streams in Yap; however, as the annual rainfall is highly variable, there are some years when runoff is sufficient for stream flow to continue through the dry season, when the northeast trades prevail. By the same token, drought conditions occur fairly frequently. The last severe drought was in 1983 (van der Brug, 1984); the municipal water supply failed and village sources were used exclusively. This drought was Micronesia-wide and is thought to have been related to the El Nino phenomenon. The implications for fresh water uses and customs of a pronounced dry season and lack of perennial streams will become apparent below. Table 1 shows basic climatic data by month for Yap (after NOAA, 1983).

Table 1.

(a) Yap average temperature: record mean, maximum, and minimum (degrees F).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Mean	80.3	80.5	81.0	81.7	81.8	81.4	81.0	80.9	81.0	81.2	81.4	80.9	81.1
Max	85.6	85.9	86.6	87.6	87.7	87.4	87.1	87.0	87.2	87.4	87.3	86.3	86.9
Min	75.0	75.1	75.3	75.8	75.8	75.4	74.9	74.7	74.8	74.9	75.4	75.4	75.2

(b) Yap average precipitation: record mean and standard deviation (inches).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Mean	7.83	5.49	6.06	6.03	9.44	11.87	13.97	14.34	13.58	12.46	9.87	9.83	120.77
s.d.	5.00	3.65	4.00	4.08	3.87	5.35	5.74	5.52	3.30	4.03	4.17	3.35	18.35

According to Johnson et al (1960) and USDA (1983), the soils of Yap are relatively poor; only about half the total land area is suitable for intensive cultivation. Most of this has been devoted to hillside swidden crop-growing and a small fraction to lowland wet taro growing (mainly Cyrtosperma chamissonis (Schott) Merr. which, however, is the staple crop). Colocasia esculenta (L.) Schott is also grown but is not such a critical resource as Cyrtosperma. Swidden gardens are planted to over thirty varieties of yams (Dioscorea esculenta (Lour.) Burk., D. alata L., D. nummularia Lam.). Dryland taro (Alocasia macrorrhiza (L.) Scott, bananas (Musa spp.), papaya (Carica papaya L.), various cucurbits, eggplant (Solanum melongena), tapioca (Maniot esculenta Crantz), sweet potatoes (Ipomoea batatas), turmeric (Curcuma domestica Valet), sugar cane (Saccharum officinarum L.), and red pepper (Capsicum sp.) are some of the more common species. Some of these swidden garden plants and other useful trees and decorative plants such as coconut (Cocos nucifera L.), betel nut (Areca catechu L.), Codioeum variegatum L., Cordyline terminalis (L.)

Kunth, Polyscias scutellaria, Artocarpus altilis (Park.) Fosb., Inocarpus fagiferus (Park) Fosb., crotons, Hibiscus rosa-sinensis L., Piper betle L., passion fruit, and various citrus are planted near dwelling houses.

"Agroforests" (Falanruw, in press) of mixed tropical hardwoods which produce lumber for houses and canoes, medicines, fruits, and nuts (e.g., Cocos nucifera, Areca catechu L., Crataeva speciosa, Calophyllum inophyllum L., Inocarpus fagifer, Artocarpus spp., Pangium edule Reinw, Mangifera indica L.) cover the highest ridges and upper valleys. In portions of these forests there are some faster-growing herbaceous species such as Hibiscus tiliaceus and Bamboo. These patches of herbaceous cover represent various stages in the succession from swidden gardens to mature secondary forest, as the Yapese gardeners shift their cultivation sites over time.

The low hills and ridges in the interior tend to support mainly grass and Pandanus associations which present a parkland appearance. Dominant grasses in these settings are Ischaemum muticum L. and Andropogon glaber. Dense areas of Gleichenia linearis (Burmann), a fern, occur on especially nutrient poor soils with heavy concentrations of bauxite. Mangrove forests fringe most of the shoreline and penetrate into the interior in several places where valleys have sunken. Typical species found in mangrove and swamp forests are Bruguiera conjugata, Sonneratia caseolaris, Rhizophora mucronata, and Nipa fruticans. A large expanse of lateritic, uncultivable badlands can be seen in the interior plateau of Gagil-Tamil Island.

Map Island

The present study was conducted in Map (pronounced like "mop") Island, a municipality in the northern part of Yap (Figure 2). In settlement patterns and socio-political organization, Map is a microcosm of the Yap Island complex. Roughly oval in plan, Map's land area (ca. 10 km^2) presently is partitioned into 17 contiguous villages, most of them distributed along the island's perimeter, as is the case in the other main islands of the complex. Most villages in Map, like those elsewhere in Yap, contain more abandoned house sites than inhabited ones. Typically people live close to the shore, although exceptions exist and, as noted above, some villagers are moving inland to be closer to electric lines. Most settlements have a coconut grove or a mangrove forest shoreline; the latter is the more common (U.S. Dept. of Interior, 1983).

In the beach area are ceremonial "public" lands (actually privately held) on which young men's houses and community meeting houses and dance areas once stood. Few of these traditional structures exist today (Photos 1 and 2). Some villages possess large coastal taro swamp complexes. In Map (Figure 3) they occur in the northern and eastern side of the island, on soils overlying the Map geological formation (Shiraki, 1971). One of these large complexes, in Waned Village, was mapped during the present project (Figure 4) and is discussed in a later section of this report.

Behind the coastal zone are numerous residential land plots interspersed with small taro patches and forest-garden plots. Gardens increase in frequency as the topography gently rises toward the interior. In Map the highest point is 78 meters. As one proceeds inland, the density of abandoned dwelling sites decreases until finally on the interior

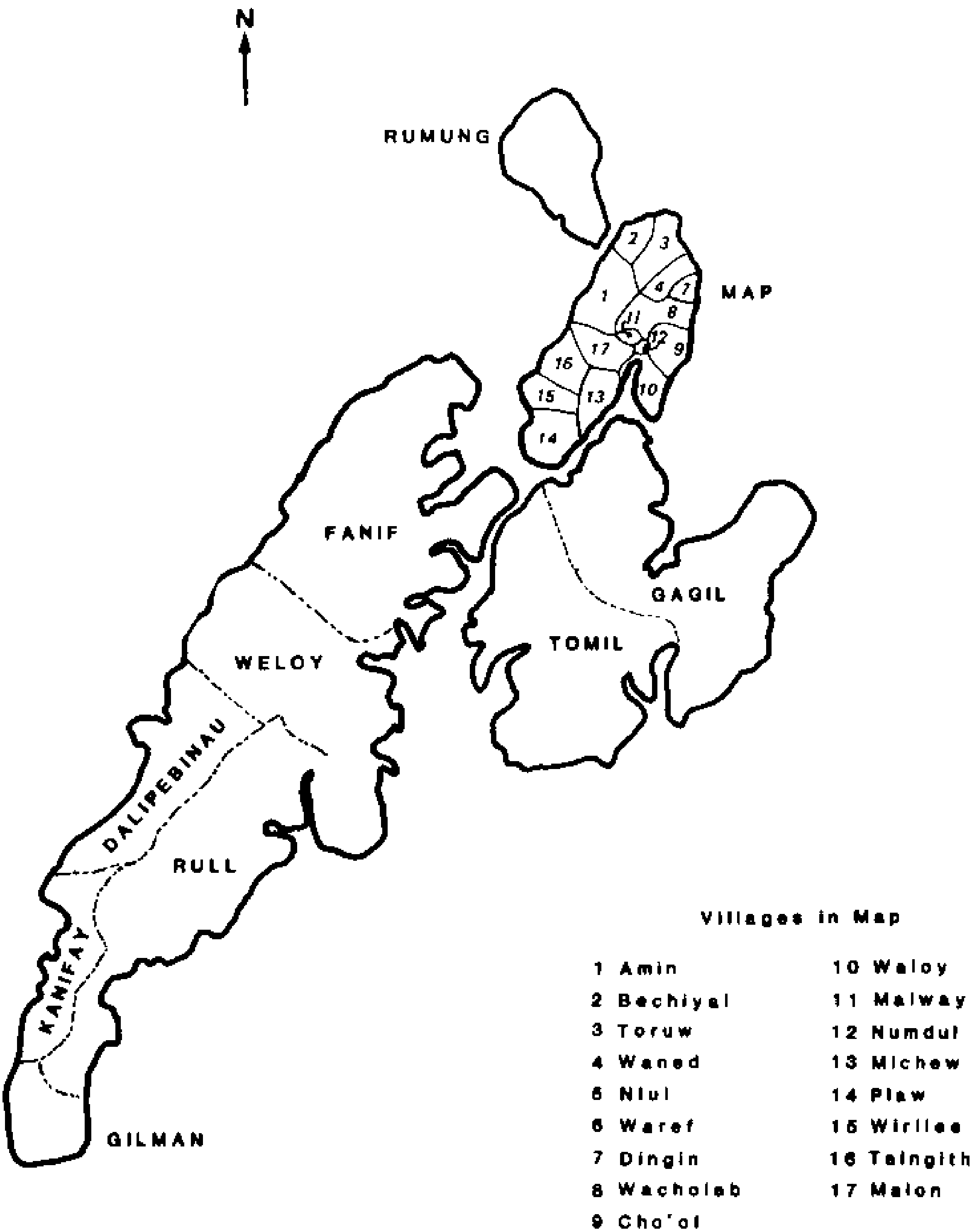

Figure 2. Location of Map Island, Yap Islands· villages of Map Island.

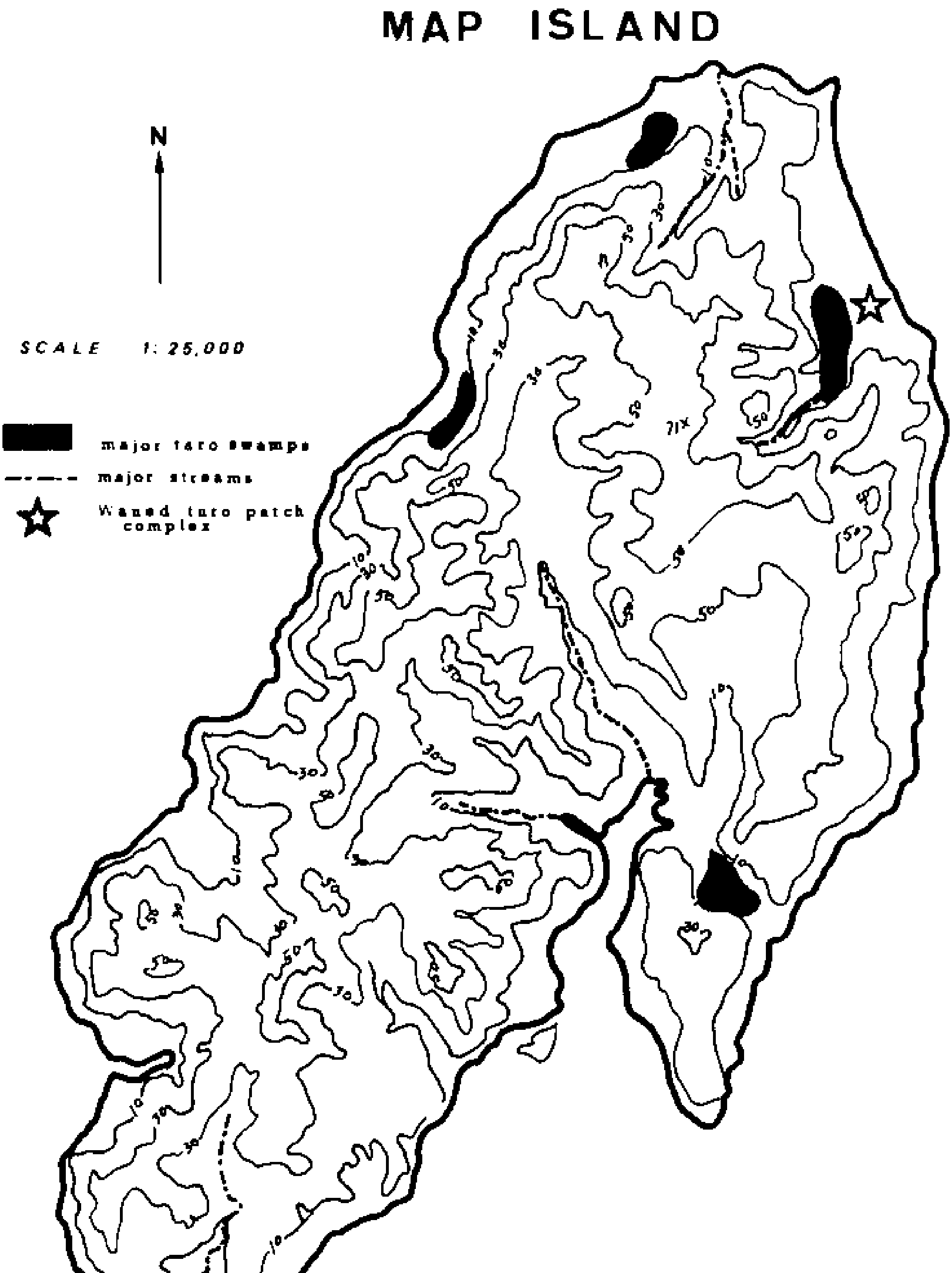

Figure 3. Major taro swamps and streams of Map Islands.

Photo 1. Village meeting house in Bechiyal Village, Map Island.

Photo 2. Young men's house in Bechiyal Village, Map Island.

hilltops one sees only gridded series of raised garden mounds with ditches between them, channeling run-off downslope (Photo 3). This is the open "savanna" (tayid in Yapese) (Photo 4). These ancient mounds are mostly unused but seasonally a few may be planted to sweet potatoes (Photo 5). Also in the interior part of the island are tiered graves and abandoned menstrual seclusion sites.

While the majority of Map's villages give onto the sea directly, a few are landlocked. Traditionally these were the lowest ranking settlements, appearing as little enclaves within the interior lands of adjacent larger villages whose lands stretch from the coast to the center of the island (Figure 2). Most interior villages are now abandoned for residential purposes, although people continue to plant gardens and harvest tree crops in some of them.

The residential and political divisions recognized in Map today are basically the same as those documented by Mueller (1917) at the beginning of this century. As just noted, the lowest ranking villages tend to be located in the interior and to be very small but exceptions exist (such as Michiew on Map, which is relatively large for such a low ranking village and which possesses a coastal portion). The low ranking interior villages are composed of finely subdivided land parcels belonging to high ranking estates in adjacent villages.

The relationship between a high ranking estate and its lands in a small interior village is called suwon ("overlord") in Yapese. This term connotes parent-child kinds of obligations between the people living in the interior village on such lands and their suwon from high ranking estates in the large coastal settlements.

Within the Yap Island complex, Map is a low ranking component of the Gagil paramountcy. Within this political grouping, Map ranks higher only than Rumung, the small island to the northwest (Figure 2). Gagil's traditional hegemony extended to the eastern atolls of the Carolines; see Lessa (1950) and Alkire (1965). It should be noted that the Yapese no longer engage in the various forms of reassigning village and district rank; endemic warfare and frequent competitive displays ceased during the German period (1899-1914).

The issue of ranking of lands (and derivatively of individuals) in Yapese culture is highly involved and cannot be treated in detail here; the reader is referred to Lingenfelter (1975) and the references therein. For our purpose it is sufficient to realize that many traditional freshwater management practices were directly governed by concepts of differential ranking and status. To some extent this is still true today; however, drastic depopulation since European contact in the 19th century has prevented the continued practice of many customs related to high population density. As will be shown below, lack of sufficient labor caused by depopulation has contributed to the deterioration of the ancient farming/water control facilities in partial use today.

Photo 3. Aerial view of hill top garden mounds in northern Map Island.

Photo 4. Toruw Village hillside, interior Map Island, looking north.

FINDINGS

It was found through direct observations and interviews that the existing fresh water control facilities -- open canals, ditches, and streams -- and fresh water resources -- rainfall, wells, natural springs, and seeps -- are parts of an ancient and highly developed land use system with a complex set of rules and practices that promoted stability. This land use system includes non-agricultural land and sea plots as well (Hunter-Anderson, 1981, 1983, 1985).

The larger villages of Map incorporate hundreds of small swidden plots on forested and unforested hillsides, small taro patches along stream bottoms and cut into hillsides (Photo 6), and larger taro patches in lowlying "hydromorphic" soils (Barrau, 1961) behind the shoreline (Photo 7). Some of the coastal taro patches are in former swamp forest land and in reclaimed mangrove swamps; others are in natural estuaries which have been modified for taro growing. In the smaller villages, particularly the inland ones, there are no large taro patches, and fresh water control facilities are found on fewer types of garden land. The following discussion includes information about both small and large village settings and attempts to convey some of the variability, as well as the marked redundancy, evident in Map's land use system as it relates to fresh water management.

Rainfall, Wells, Natural Springs, and Seeps

Rainwater Catchment

As can be seen in Table 1, rainfall (*'nuw* in Yapese) is relatively abundant in Yap, mostly falling during the months of June, July, August, September, and October. There is great year-to-year variation in annual totals, however, and in month-to-month totals as well. The driest month is February but even during the dry season, roughly January-April, a few inches of rain per month are usual. The three months of highest average rainfall (June-August) tend also to be those with the highest rainfall variance, reflecting the fact that droughts occur with some frequency in this area (van der Brug, 1984).

Abundant rainfall fills natural streams flowing through the villages, providing water for bathing at stream side and at pools and small water falls. Some rain water can be caught in natural depressions. These sources are unreliable, however, and during a "normal" dry season are unavailable. In the past most Yapese bathed in the sea, using a small amount of fresh water to rinse off. Babies were bathed at stream side or with fresh water carried in or caught at home in coconut shells. Coconut oil was routinely applied to the body after bathing.

The Yapese traditionally practiced individual household rainwater catchment, both in the wet season and during the dry season, when most streams had dried up or were very low. Rainwater running down selected tree trunks (tall coconut and betel nut palms or other trees with few branches) was guided into large coconut shells from which the meat and husk had been removed. The spherical shell was suspended from the tree trunk with sennit twine, and the rainwater flowed down the sides of the tree and

Photc 5. Sweet potatoes planted on raised garden mounds, interior Toruw Village.

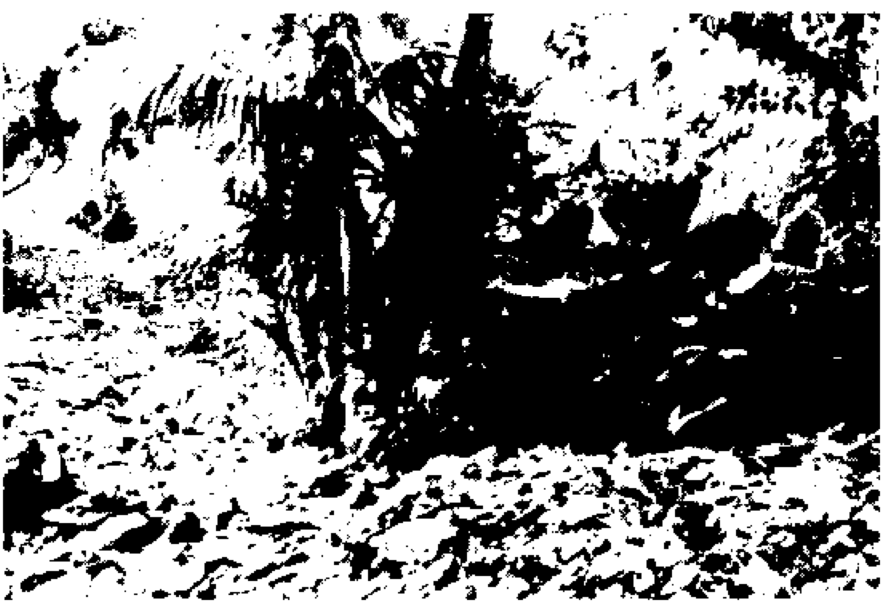

Photo 6. Small taro patch cut into hillside, Toruw Village, Map Island.

was guided into the shell through the downward-trending leaves of a coconut frond tied against the trunk above the shell. This catchment device is called a dag (Photo 8).

I found that a 1 liter-capacity coconut shell suspended from a mature coconut tree was filled to overflowing after three minutes during a moderate rainshower. Ordinarily several dag would be present in a household. The water caught in this way would be used mainly in food and medicinal preparations. Drinking coconuts supplied most directly consumed liquid in the traditional Yapese diet, and sea water was used for handwashing and bathing.

The Yapese claim never to have used their traditional pottery for water catchment or storage. It was too precious and too fragile, and furthermore was not the right shape, being shallow and wide-mouthed. One occasionally sees large ceramic jars left from the Japanese period (1914-1944) used for water catchment and storage around village houses in Map. However, steel drum cans, first available after World War II, soon became the preferred catchment containers, in combination with corrugated metal roofing and gutters. The relatively large capacity, 55 gal drum cans enabled some bathing in household areas, whereas previously this activity had been done in the sea or in streams. Cement tanks for catchment storage and for piped-in seep water are increasingly common (Photo 9).

The present uses of drum cans and cement tanks are examples of how larger amounts of fresh water at or near households have encouraged non-traditional patterns of fresh water consumption. With the advent of piped-in water available to villagers twenty-four hours a day, such as is now taking place in Map, consumption of even greater quantities of fresh water can be anticipated. For example, stream side showers using piped-in seep water are increasingly common (Photos 10 and 11), and household laundry is also done using this water source. Washing machines and flush toilets (with septic tanks) are beginning to be installed, and some outdoor kitchens have a pipe and sink. Waste water from washing activities flows into the ground at the site or along open stream channels.

Taro Patch Wells

Traditionally, shallow wells (luwed) were dug into the mud of taro patches located in stream beds or lowlying areas where the water table was relatively high. Water from these wells was used for cooking, drinking, and some bathing. In some villages, individual household taro patch wells were the main source of fresh water. I saw no taro patch wells in use during the fieldwork for this project. People did point out where such wells have been dug in the past, but they are no longer visible. The Yapese say they no longer need to use them.

Seeps

Natural springs and seeps in Map (awchen e ran, "eye of water") are generally recharged through rainfall. However, some seem not to be much affected by droughts while others are. Traditionally seeps and springs were, and today continue to be, important sources of fresh water for agriculture and domestic uses as noted above. During interviews I

Photo 7. Mu'ut ni ga, Waned Village, Map Island.

Photo 8. Coconut shell rain-water catchment, Waned Village, Map Island.

Photo 9. Cement water tank in Waned Village, Map Island.

Photo 10. Streamside shower in Amin Village, Map Island.

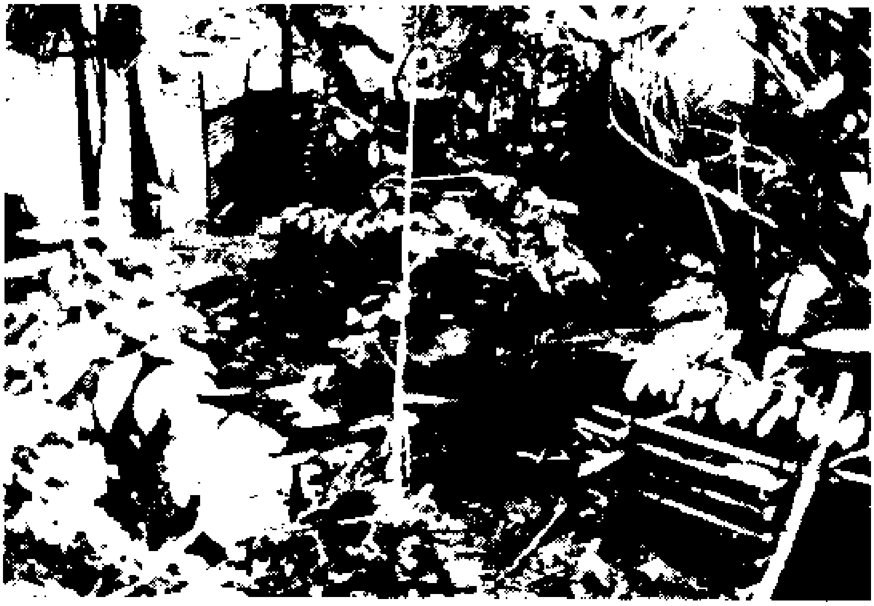

Photo 11. Streamside shower in Waned Village, Map Island.

Photo 12. Developed hillside seep in Toruw Village, Map Island.

collected two stories about seeps and the names and village localities of forty-six seeps in Map (Appendix C; Table 2).

Many of Map's seeps are located on hillsides, in both forested and open grassland settings. Many tend to be found at approximately 25m elevation. However, some seeps are found a few feet under the sand along the shoreline near the high tide mark, and I recorded one in a coastal mangrove swamp. Often a seep is directly associated with a hillside taro patch, which is watered by that seep. In especially abundant taro patch seeps, excess water was channeled away to control the amount of water in the taro patch. The most productive of these hillside seeps are being developed for community water supplies in conjunction with gravity-flow tanks and PVC piping.

Traditionally seeps were kept very clean and constantly cleared of debris. This was the responsibility of the owner of the land where they were located. The Yapese complain that many of the taro patch and other types of seeps are no longer maintained, and that foreign pests such as frogs and insects have spoiled them.

As each taro patch in Yap had a status ranking, so had the seep associated with it. Similarly, seeps located on other types of land, for example, in the interior grasslands or at the shore, all had rank derived from the rank of the land parcel where they occur. An individual's access to springs and seeps was carefully regulated through status ranking. Thus only the highest ranking persons were allowed directly to take water from the highest ranked seeps. The concepts of <u>tabgul</u> (ritual purity) and ritual contamination (<u>ta'ay</u>) were involved to validate this convention. If a seep was of very high rank it was considered extremely <u>tabgul</u>; therefore, those without such ritual purity (for example, young women or low caste persons) would contaminate the water if they approached it at its source. Accordingly, those with lower status ranking were only allowed to take water from such seeps at great distance, if at all.

If a village had only one seep, individual access was controlled through the use of a series of descending levels, as follows. At its source, the seep would be tapped with a section of large-diameter bamboo (<u>mor</u> in Yapese), two or three meters long, from which the top longitudinal third had been removed. This partially-open, tubular conveyance was held in place horizontally by supports made from crossed and tied uprights (Photo 13). The water flowed away from the seep along the bamboo tube and then fell from its distal end into another bamboo section of similar length placed just below. This was the point at which those with highest status ranking (very old, chiefly men) would take their water. The second section of bamboo conveyed the water down the hillside to another juncture with another length of bamboo, at which point those of lower status ranking (e.g., younger men) could take their water, and so on down the hill. Additional sections of bamboo conveyed the water further from its source to lower junctures corresponding to the descending order of status ranked persons of the village, until finally the water joined a stream. At this point the lowest ranking persons, those considered the most <u>ta'ay</u>, could take the water. People carried water to their household in bamboo sections and coconut shells.

Photo 13. Bamboo conveyance for freshwater in Amin Village, Map Island.

Photo 14. Drainage channels on both sides of major pathway in interior Toruw Village, Map Island.

Table 2. Seeps in Map Island by village.

Village Name	Number of Seeps	Seep Name	Notes/Commencs
Bechiyal	4	Wade'	located in interior, has highest elevation of all four seeps in this village, has highest rank of all Bechiyal seeps, very sacred; young women could take water from secondary outflow from this seep, called Ponelal ("5 wings") located near mangroves at lower elevation
		Fanaayong	located in interior, at lower elevation than Wade', has next highest rank, was used by Rumung people during droughts, very sacred
		Dil'ing	located in interior, third-ranked, has longest "trail" before joining stream, at its lowest end water could be taken by young women
		Chil'ey	located on sandy shore near Dilmet islet and beside the border with Toruw Village, very sacred
Plaw	7	Talawal	located in interior, inside a taro patch, seep is ditched with a bamboo conveyance which joins a stream draining runoff away from taro patches; water can be seen bubbling up at the bottom of seep, very sacred
		Gal'	located in interior, in a taro patch, a well has been dug here, very sacred (see Appendix 3)
		Mowal	located in interior, used only by young women and women in menstrual seclusion
		Chingching	located in interior, above a taro patch, a dirt channel was dug to convey seep water to the taro patch, very sacred, this seep has been developed to supply the village tank
Cho'ol	2	Tiri'	located in interior, inside a taro patch, used in levels according to status ranking of individual, the lowest level used by young women and people from Numdul Village
		'Kay	very large seep inside a taro patch in valley, seep actually "belongs" to Numdul because a woman from that village found it, although technically it is in a valley in Cho'ol (see Appendix 3)

Table 2. continued.

Wacholab	1	Ma'ach	relatively close to sand beach, formerly accessed by levels, currently being developed, part of Ulibong estate although Biyich estate in Cho'ol used this seep
Waloy	1	Lugifin	located in interior, dries up in drought, belonged to all people not just one estated, accessed by bamboo conveyance in levels
Toruw	1	Binyuw	located in interior, inside taro patch
Waned	3	Thetch	located in interior, always good flow even during drought
		Uchuwe'	located in interior, reduce flow during drought, older people used first level, young women used second level
		Gamachay	located in interior, reduced flow during drought
Waref	1	Waref	located in interior, upper place reserved for Waned people's use, lower place for Waref people, now a developed seep
Amin	17	Darikan	used by women in menstrual seclusion
		Tamin'ag	located in interior savanna, used by women in menstrual seclusion
		Wade'	very sacred, used by very old men and women, now a developed seep
		Malaw	located in a taro patch, very sacred
		Mpuy	located in a taro patch, second ranked
		Dayrech	located in a taro patch
		Tarmaluw	located in a taro patch, very sacred, used by very old men and women
		Tulul	
		Gufnuw	
		Tuguwguw	
		Dinew	had two levels, used by less aged men and women

Table 2. Continued.

		Laneburey	seep flows into taro patch and then is channeled to join main stream, this channel never dries out, water used by women in menstrual seclusion
		Miteren	located in taro patch, very sacred, used by very old men and women
		Demeruk	second ranked
		Watnaw	located in interior savanna, channeled to river in village
		Bugulrum'un	
		Walngacha'	extremely sacred seep, used only by a magician-priest named Ganini, located in a taro patch, accessed by a long stick to which a coconut shell was attached, priest could not look into water at his own reflection
Malon	7	Pof	highest ranked
		Tilngiy	third ranked
		Tanegalunglung	third ranked
		Tayid ni ga'	highest ranked, most sacred, near a large taro patch of same name
		Mak'ef	used by young men, old women
		Fi'thikemor	
		Maloway	used by young women and women in menstrual seclusion
Talngith	2	Bulerar	flows into largest taro patch in village, now being developed
		Angyey	flows up out of rocks in interior savanna

If a village had more than one seep, some of them were of tabgul status and hence designated solely for high ranking persons while other seeps would be less tabgul and therefore accessible to lower ranked persons. It should be added that pathways leading to or near seeps were also classified as appropriate only for the use of specific social categories of persons. Fresh water thus was carefully managed, the rules for its use tending to discourage profligacy and to minimize overt competition for this precious resource, particularly when in short supply.

Ditches, Channels, and Streams

A complex series of ditches, channels (won in Yapese), and streams (nlul) links village garden plots from the interior uplands to the coastal lowlands. The two major functions of these linear facilities are (1) to keep surface water (rainfall runoff) from damaging growing plants (rather than to distribute water to them) and (2) to prevent or minimize erosion from sheet wash in garden plots. These functions are necessary in Map's hilly topography and seasonal climate; runoff can be heavy during intense or prolonged storms. Channels are also vulnerable toward the end of the dry season when soil is loose and friable.

All streams and ditches and most channels are open and shallow. Some of the smaller channels may be covered with stone slabs where they cross a pathway in a residential area. Other channels have underground portions. An underground drainage channel connecting two taro patch drains on opposite sides of a wide pathway is said to have existed in Toruw Village but through lack of maintenance has ceased to function. Partial village boundaries are sometimes formed by such channels, which also may serve as pathways during the dry season some channels run parallel to major paths (Photo 14).

The typical cross-section of the larger ditches, channels and streams is square. In some of the upland ditches running between raised garden mounds, water has down-cut along center of the ditch, creating a V-shaped channel-within-a-channel. In non-forested areas a series of inter-mound ditches may drain into a widened ditch-depression among the garden mounds. Colocasia taro is planted in these features while sweet potatoes grow on adjacent mounds. The placement of water-loving plants in ditches and depressions among garden mounds can be seen also in forested settings.

There is considerable continuity between traditional farming practices and those of the present. Thus the gardens and their related water control facilities are "archaeological" as well as contemporary. However, due to a number of factors, primarily fewer farmers using less land, they have deteriorated considerably since pre-European contact times. For example, older Yapese say that the ditches which now sometimes exceed a meter in width, running between hillside garden plots, used to be very narrow (ca. 10 cm wide) and were deliberately kept so. The purpose of keeping the ditches narrow was to minimize soil loss from upland garden plots and to prevent too great a silt load in the lower elevation drainage channels and streams. Table 3 shows the measurements of ditches in five areas of raised garden mounds in northern Map.

Table 3. Ditch widths in five garden mound areas in northern Map Island.

Area Observed and Crops Planted	Ditches Aligned with Slope (meters)	Ditches Aligned across Slope (meters)
Toruw interior between Niul and Waref (sweet potatoes)	3.0	1.3
Waned-Dingin hillside near coast (turmeric, yams)	1.1 2.1 1.1	4.4 (taro patch between mounds)
	$\bar{x}$=1.4	
Toruw interior at grassland/forest edge, along Amin path (yams, tapioca, turmeric)	2.8 3.2 (serves as a path between mounds)	n.d.
	$\bar{x}$=3.0	
Toruw interior, beside path to Bechiyal, recently burned grassland (fallow)	3.2	3.2 2.3 2.1 4.4 (taro patch?)
		$\bar{x}$=3.0
Toruw interior, open grassland between two forested hillsides (fallow)	1.6 1.4 3.1 1.4	2.0 1.9 1.6 1.7 5.1 (taro patch between mounds)
	$\bar{x}$=1.9	$\bar{x}$=2.5

The lower elevation channels and streams diverted runoff so that it would not flood lowlying taro patches and carry off valuable topsoil from them. The design of these drainage channels shows a sophisticated understanding of water flow mechanics. For example, erosion of stream banks and bottoms from fast moving water during periods of intense runoff has been minimized by the use of step-like drops in the stream channels. This prevents excessive acceleration of the water as it flows down hills, where slopes range from 6 to 30%.

Other features which slow the downhill acceleration of water are large holes in the floor of the channel, continuous bends in the channel course, and greater channel width at lower elevation and smaller channel width at higher elevation. Another device used in the drainage channels to minimize erosion is stone buttressing of channel sides. This was observed on some upland garden mounds (Photo 15 and at lower elevations where stream widths are greatest (Photos 16 and 17).

Water Control Facilities Associated with Taro Gardening

Majorie V.C. Falanruw, a biologist who has lived in Yap for many years, maintains that the extensive lowland taro swamps act as biological filters for upland, waterborne sediment (Falanruw, 1980, in press). This filtering effect keeps the lagoon waters clean and the natural shoreline communities, which are important feeding grounds for immature reef and lagoonal species, intact. Thus it appears that the deliberate modification of natural swamps and estuaries by the prehistoric Yapese, for agricultural purposes, has not resulted in major damage or significant alteration of basic ecological relationships that existed prior to man's advent in the islands. It is eloquent testimony against the charge too frequently encountered in the scientific and popular literature that so-called primitive peoples, particularly Pacific islanders, rampantly destroyed their environment, with the implication that only modern industrialized man has an effective understanding and control of the natural world (see, for example, Fosberg, 1960, Barrau, 1961, Spriggs, 1981, Olson and James, 1982, Kirch, 1982, Amadon, 1986). If anything, the opposite seems to be true at the ecosystem level, as the Yap case illustrates.

According to the Yapese, a taro patch should not be perfectly level but have a high and a low side, to help guide the water out. When there are several taro patches in a row, descending down a hillside, they all should have the same "tilt," toward a shared drainage channel which parallels the alignment of taro patches. In flatland settings, the floor of the taro patch will tilt toward the internal drainage channel(s). This design feature is consistent with the need to maximize through-flow of water, preventing stagnation which damages taro plants and appears to favor the taro worm (ngal) (M.V.C. Falanruw, pers. comm).

For a large taro patch several meters on a side, there should be a diversion stream or channel on each side, leading water along the outside margin (Photo 19). Eventually these smaller streams flow into larger ones which lead excess water out to sea. Sometimes such streams occurred naturally but have been improved upon, for example by stone buttressing (Photo 16, 17 and 20) and by altering the natural course to accommodate

Photo 15. Stone and coral buttressing on side of raised garden mound, interior Toruw Village, Map Island.

Photo 16. Wide stream channel stone buttressing in Waned Village, Map Island.

existing gardens and house sites (Photo 18). On the inside margin of the taro patch are smaller ditches dug into the mud and sometimes lined with rocks, designed to drain excess water away from the growing plants. These small ditches ideally run completely around the inside perimeter of the taro patch (Photo 19). For smaller taro patches (a few meters square) not in the direct path of heavy runoff from above, an out-flow channel at one of the lower corners serves to empty excess water from the plot (Photo 21).

Figure 4 shows a large taro patch complex in Waned Village, illustrating many of these features. This agricultural complex of some 5 ha lies behind the main residential part of the village. It incorporates several small and two very large taro patches; the latter are called mu'ut ni ga ("the large taro patch"; Photo 7) and mu'ut ni chig ("the small taro patch"). Parts of these large taro patches are owned by different people; accordingly, they are subdivided with spits of land (yib), and by rows of boulders, trees and taro plants. The major yib are shown on the figure as rectilinear intrusions of land into, or as an island in, the main body of the taro patch. Sometimes a residence was built on such a land feature. The yib facilitated entry into the taro patch interior and served as resting places and temporary storage locations.

Table 4 summarizes the channel measurements made in the five streams feeding into and out of the complex, as well as measurements taken in a sample of the shorter drains which convey excess water from smaller taro patches into the larger streams. Figures 5-9 show the relationships among channel width, channel depth, and water level in these streams.

Channel measurements were taken at every major bend in the stream, judged from standing in the center of the stream. A compass and 30 meter tape were used for distance and azimuth measurements, and the tape and straight bamboo rods were used for depth and width measurements. The actual distances between each two consecutive measurement loci along each stream are not depicted in the graphs; rather, equal arbitrary units representing the average measurement interval (ami) have been used along the horizontal axis. They provide a standard reference dimension against which to array channel width, depth, and water depth.

In the Main Stream (Figure 5) the ami was 10.69 m. As we progressed up this long stream, the measurement interval tended to become shorter, reflecting more acute curves in the stream as elevation increased. Thus, near the mouth of the stream and up to the point where it forked, the ami was 14.68m while after the fork, continuing upstream to the last measurement taken, it was 8.90m. In general ami tended to be smaller at the higher elevations of streams.

The probable course of the Main Stream before it was diverted to its present, more southerly outlet to the sea is shown in Figure 4. People in Waned say the diversion of this stream was undertaken by the women of the village sometime in the past in order to create more land. Evidence for land building efforts exists along the beach in this area in the form organic debris fill in conjunction with stone and coral groins built perpendicular to the shore (Photo 22 and 23). These groins and the men's house platform nearby (Figure 4) have acted as "sand-catchers", encouraging the progradation of the shoreline.

Figure 4. Waned Village taro patch complex.

Table 4. Summary of channel measurements (in meters).

Short drains from taro patch to stream

	$\bar{x}$	s.d.	
Channel Width	1.16	.35	(n=18)
Channel Depth	.36	.17	(n=14)
Water Depth	.08	.08	(n=14)
Length	3.90	2.29	(n=6)

Main stream (total length = 556; ami = 10.69; see Fig. 5)

	$\bar{x}$	s.d.
Channel Width	3.50	2.24
Channel Depth	.89	.32
Water Depth	.32	.25

Artificial stream (total length = 122; ami = 10.15; see Fig. 6)

	$\bar{x}$	s.d.
Channel Width	1.89	.37
Channel Depth	.58	.22
Water Depth	.14	.05

Table 4. Continued.

Stream at NW corner of Muut ni Ga (total length = 113; ami = 7.03; see Fig. 7)

	$\bar{x}$	s.d.
Channel Width	1.31	.57
Channel Depth	.27	.15
Water Depth	.02	.03

Lower central stream (total length = 223; ami = 7.53; see Fig. 8)
Downstream from beach-pool (total length = 75)

	$\bar{x}$	s.d.
Channel Width	2.14	.88
Channel Depth	.42	.09
Water Depth	.21	.17

Upper central stream (total length = 148; ami = 9.23; see Fig. 9)

	$\bar{x}$	s.d.
Channel Width	1.86	.42
Channel Depth	.52	.27
Water Depth	.22	.23

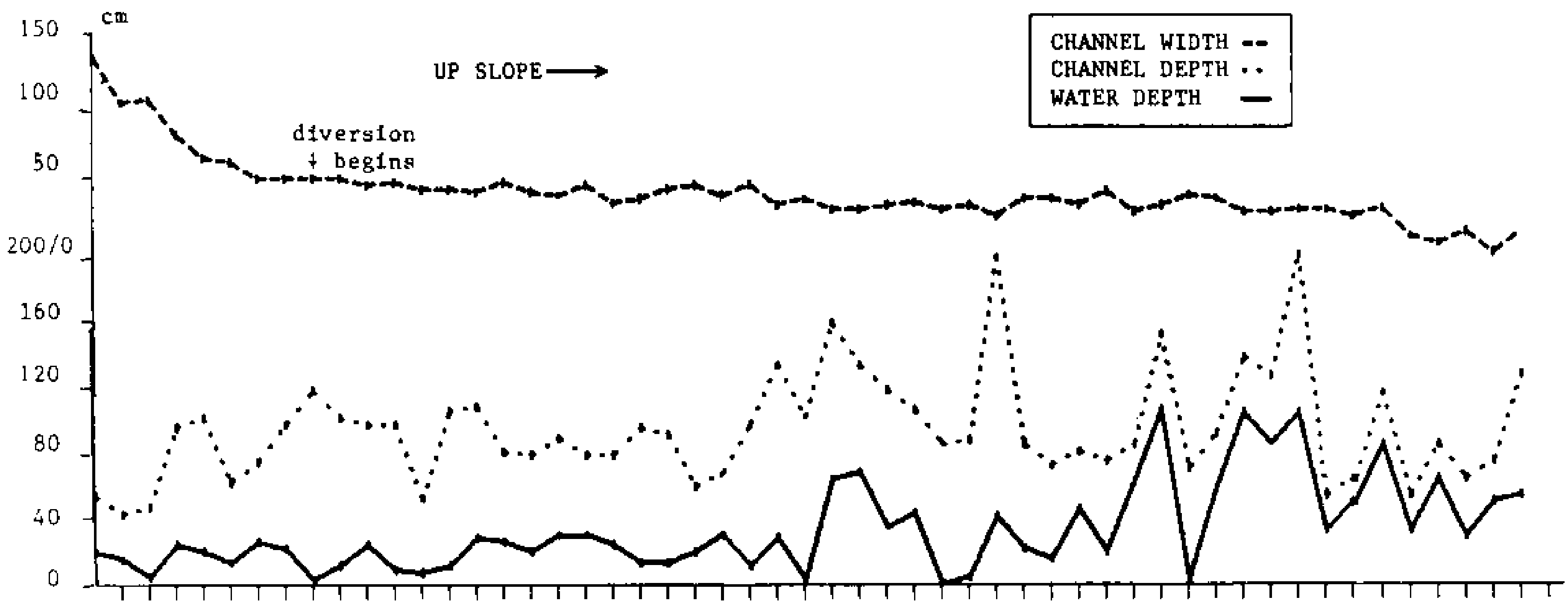

Figure 5. Graph of channel width, channel depth, and water depth with increasing elevation, Main Stream Waned Village, Map Island.

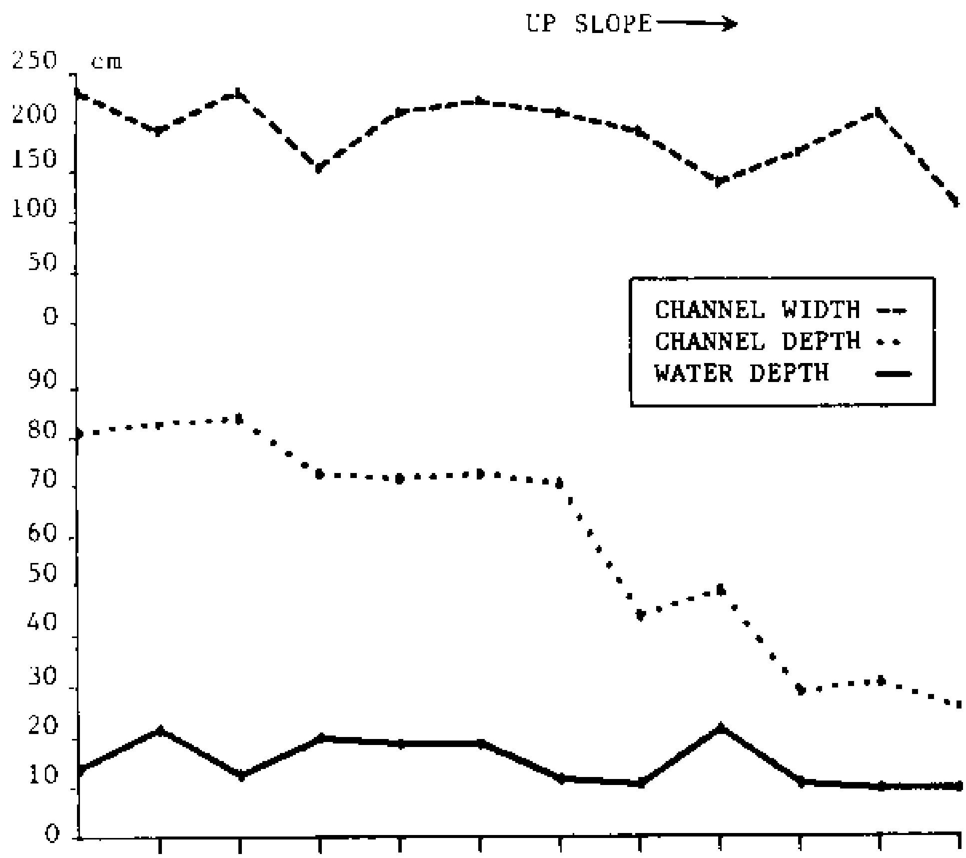

Figure 6. Graph of channel width, channel depth, and water depth with increasing elevation, Artificial Stream, Waned Village, Map Island.

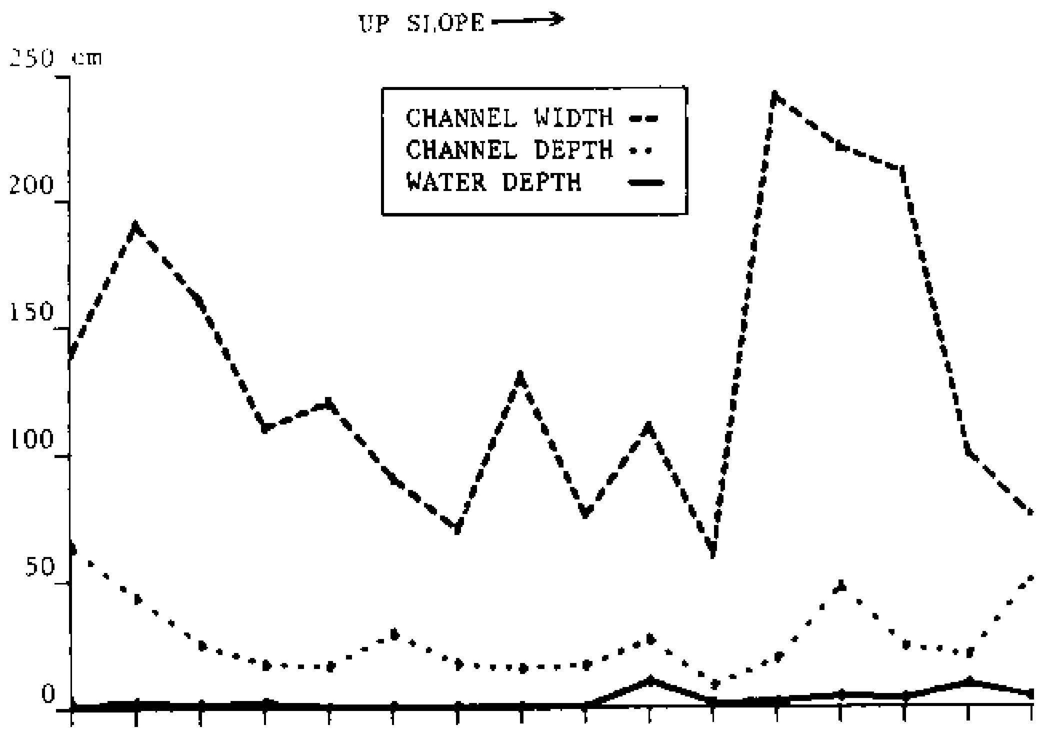

Figure 7. Graph of channel width, channel depth, and water depth with increasing elevation, Stream at Mu'ut ni ga (northwest corner), Waned Village, Map Island.

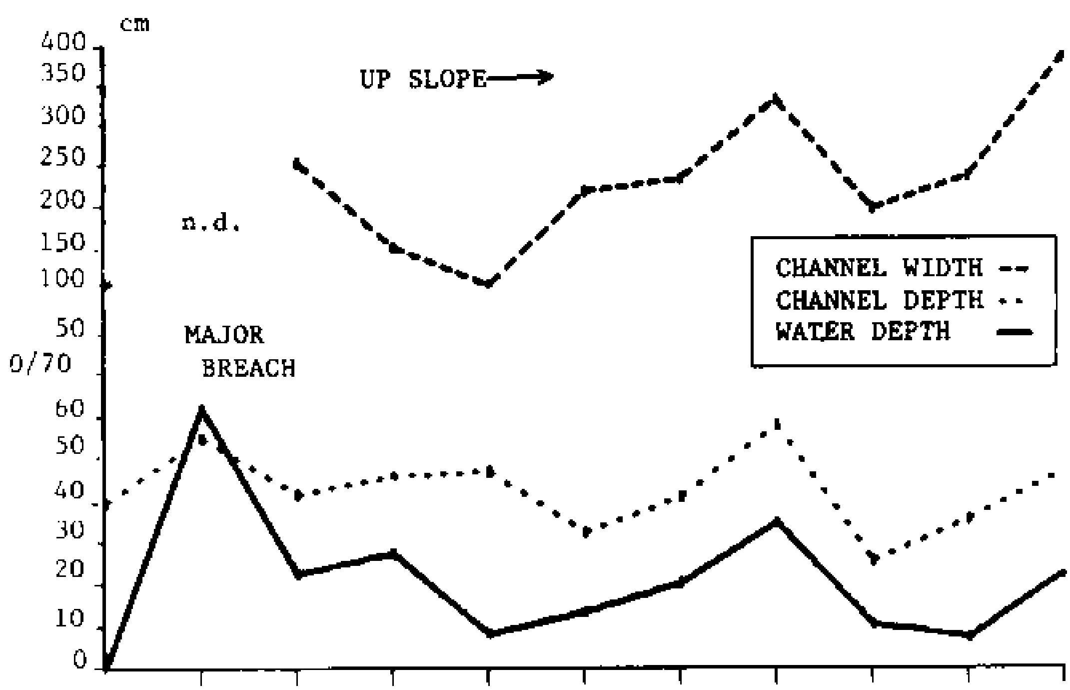

Figure 8. Graph of channel width, channel depth, and water depth with increasing elevation, Lower Central Stream, Waned Village, Map Island.

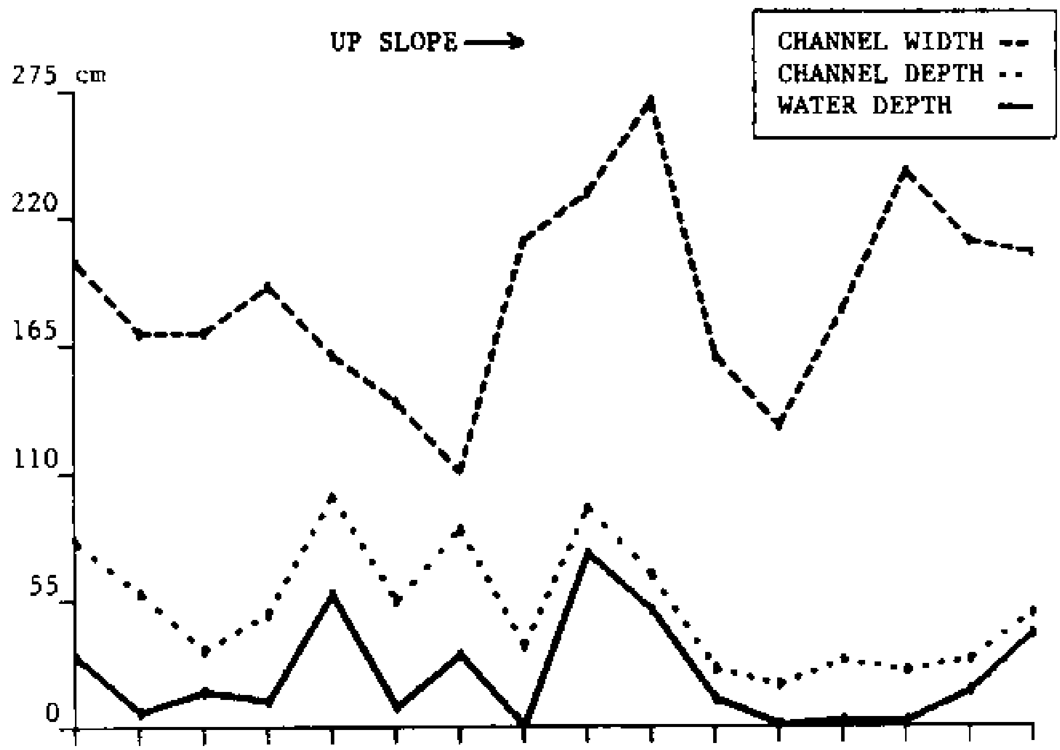

Figure 9. Graph of channel width, channel depth, and water depth with increasing elevation, Upper Central Stream, Waned Village, Map Island.

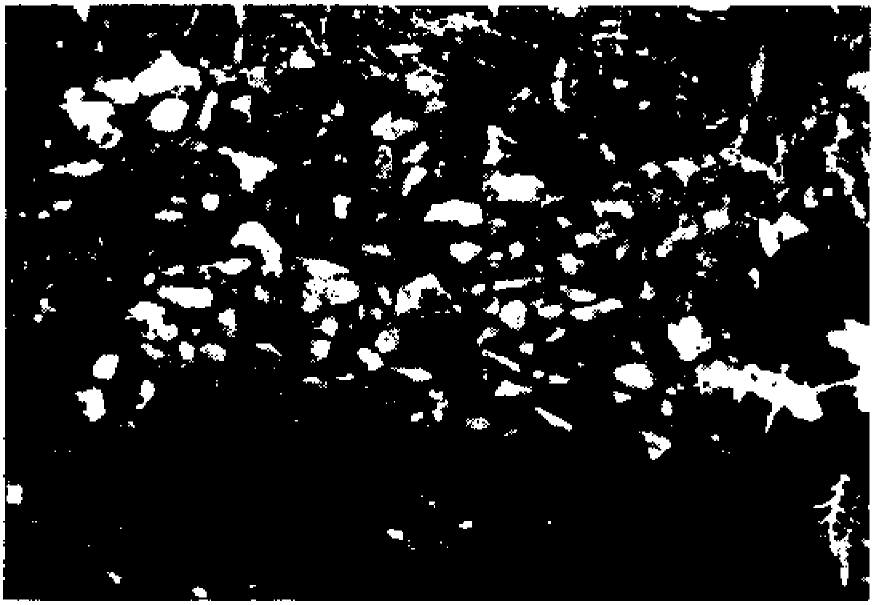

Photo 17. Wide stream channel stone buttressing in Waned Village, Map Island.

Photo 18. Main stream at origin of Artificial Stream flowing to right (behind coconut tree), Waned Village, Map Island.

Photo 19. Diversion channel on inside margin of large taro patch, Waned Village, Map Island.

Photo 20. Main Stream, Waned Village, Map Island.

Photo 21. Short drain from small taro patch to Main Stream, Waned Village, Map Island.

Photo 22. Organic debris thrown along shore edge above high tide mark at left-center, Waned Village, Map Island.

Photo 23. Stone and coral groin during low tide at Waned Village, Map Island.

Photo 24. Breach in earthen walkway between taro patch and stream in Waned Village, Map Island.

On the same sandy beach as the stone groins, where the now-diverted stream used to flow into the sea, there are two large stumps of mangrove trees (Figure 4) which can be seen at low tide. I thought it possible that these trees had been killed as a result of the lack of fresh water outflow in this area after the stream outlet had been changed. I reasoned that if the date of their death could be determined through radiocarbon assay, we might have an estimate of when the stream had been diverted.

Two wood samples (one taken from each stump) were processed by Beta Analytic, Inc, of Coral Gables, Florida, in May 1986. The results were disappointing; both samples were found to be essentially modern. This could mean the stream diversion is quite recent, or that the death of the trees had nothing to do with the stream diversion. It may have only been related to relatively recent beach progradation. In any case, a more direct method of dating the Main Stream diversion in Waned is needed.

Another dating question is how old the Waned taro patch complex itself may be, as an agricultural site. Small diameter corings up to 2.7m deep were taken at four sites in the complex. This procedure yielded evidence for a mangrove forest community antedating the present use of the complex fo taro growing. The cores presently are undergoing palynological analysis, and suitable samples will be selected for radiocarbon dating. If the mangrove soil layer can be dated, we will at least have a maximum age for the overlying taro growing soil layers in the complex. It is also possible that some of the basal layers of soils referrable to taro growing can be dated by radiocarbon assay as well.

Facilities Deterioration

Effective and appropriate design features of Map's water management technology and land use system notwithstanding, maintaining the ditches, channels and streams requires constant vigilance and appropriate action by landowners. Most rainstorms produce some runoff, and heavy or continuous rains result in intense period of downslope water flow. Heavy runoff can wash out some of the smaller water channels entirely. These constantly have to be repaired to prevent soil loss and/or oversilting of taro patches and streams.

The Yapese insist that only dirt and some rocks should be used to shore up the sides of ditches between upland garden plots, and that it is the responsibility of individual families to maintain their portions of the complex drainage system. Herein lies the problem for Yap's deteriorating water control facilities and garden plots: only around 20% of the taro gardens are under active cultivation and the proportion of currently used dryland gardens is even smaller. This means there are many unused and therefore unmaintained ditches, channels, and streams.

In the village of Toruw, I observed certain lowland taro patches which have lost nearly all their topsoil due to a lack of channel maintenance. At upper elevations in Toruw, taro has been planted in widened parts of a natural stream bed which runs between steep, forested slopes. The drainage channel for these taro patches runs along one side of the stream. A lack of channel maintenance in this area has resulted in frequent flooding of the stream-bed taro patches and breaching of the channel. Breaches in other channels and in raised earthen walkways along channels in Waned are now common (Photo 24 and 25). Some of these date from before World War II (Photo 26).

The neglect of channel maintenance due to a low rate of garden utilization follows directly from the history of demographic conditions on Yap. Drastic population reduction has occurred since significant European contact began about one hundred fifty years ago (Hunt et al, 1954). From an archaeologically estimated pre-contact population of 25,000 persons (Hunter-Anderson, 1983:89-91), the indigenous Yapese population declined to ca. 8,000 at the turn of the century and reached its lowest point at the end of World War II, when there were less than 3,000. Now some 6,000 strong, Yap's population continues to increase through high birth rates. However, the present population remains small relative to the apparent carrying capacity of the land under the traditional subsistence system.

Not only are there few people actively farming Yap's relatively abundant developed agricultural land; these farmers are older adults who comprise a relatively small proportion of the total population. The rapid post-war growth rate has produced an age distribution opposite from that probably characteristic of the traditional Yapese adaptive system. There apparently has occurred an historic shift from relatively few children and many adults to proportionately more young and fewer adults.

From recent population statistics on the Federated States of Micronesia, of which Yap is a member state, the proportion under the age of 15 years is approximately 40 per cent (U.S. Dept. of State, 1984:79). The implications of this shift in age structure for understanding the deteriorating fresh water control facilities in Yap, aside from much reduced usage, are as follow. Whereas previously when there were few dependents, a large proportion of the population was available to work and maintain the system; now there are few productive adults and many non-working dependents. The deterioration is likely to continue unless deliberate efforts are made to reverse this process.

CONCLUDING REMARKS

Can future conflicts be anticipated between agricultural and domestic uses of fresh water as rural populations continue to increase in Yap? This study has indicated that conflicts are unlikely if, as modernization proceeds, fresh water usage in the two spheres continues to be separated.

It was found that Yapese farmers have the indigenous technology to control surface runoff and ground water to prevent soil erosion in garden plots through a system of shallow, open, gravity-flow ditches, channels, and modified streams with final egress into the sea at a few points along the coast. As most of these channels flow only seasonally, and during droughts not at all, they have been unreliable for domestic water supplies. Hillside seeps, shallow taro patches wells, and household catchments are the traditional sources for household fresh water.

Previously household consumption rates were very low, probably on the order of 2-3 gal per person per day (if that much) prior to the widespread

Photo 25. Temporary repair of major breach in Main Stream at upper elevation, Waned Village, Map Island.

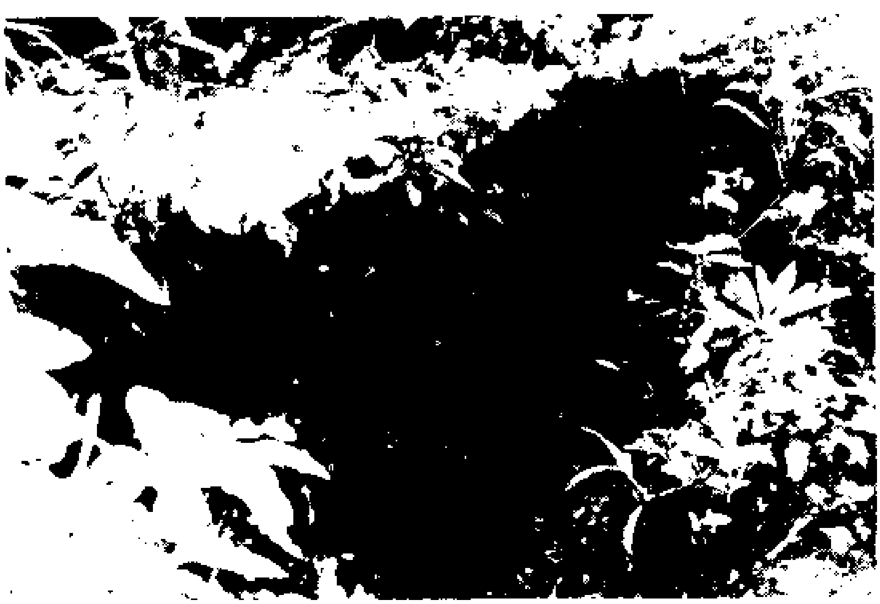

Photo 26. Major breach in Lower Central Stream, Waned Village, Map Island.

use of the clothing and the adoption of other water-demanding aspects of a Western lifestyle. Recent technical development of village water delivery systems is making large amounts available to individuals. The Yap government estimates ca 50 gal per person per day is presently consumed in the villages (Ed Bretton, pres. comm). Nonetheless these increases in themselves do not seem to threaten agricultural uses of fresh water, which are aimed at promoting adequate flow-through in taro patches and adequate drainage between swidden garden mounds. However, increased fresh water consumption by individuals is part of an overall pattern of modernization which includes rural electrification and has as its basis a wage economy, which tends to discourage a continuance of subsistence agriculture.

The future of agriculture on Yap is an unknown. The option appears to exist for villagers to repair and systematically maintain some portion of the prehistoric system of channels, ditches and streams as population rises and more of the available agricultural land is brought back into production. However, the trend is toward increased participation in wage work in town, now viewed as near necessity for many families. In this tropical setting where food storage is not commonly practiced, traditional farming methods require small labor inputs almost daily, for harvesting small amounts at a time and general garden maintenance. Occasionally large labor inputs by groups of cooperating relatives are necessary too, such as when a new garden is established on a piece of land that has lain fallow for several years. I have no statistics on this but my impression is that working for wages removes at least one adult from each extended family from regular agricultural labor, thereby increasing the work load on the remaining family members.

Younger adults tend to take jobs in town more frequently than older adults, and thus some of the physically ablest workers are unavailable to help with farm work and a disproportionate amount of the increased work load is being borne by the elderly. Furthermore, as new families are formed, often both the husband and the wife take jobs in town, which precludes their participating fully in traditional village farming and in the reciprocal labor exchanges it entails. Yet the low wages typical of Micronesia, coupled with the high prices of imports, barely pay for all their expenses, so the pressure exists for both to keep working, even if children are born. Such couples end up relying on their relatives who remain in the village during the day for some of their local food and childcare, and on the weekends they work doubly hard as part-time subsistence farmers and fishermen. Another factor is the educational system which takes children from the village for the better part of each weekday. The school schedule makes more difficult the learning of subsistence agriculture techniques and knowledge. Traditionally these are passed on in the village setting by relatives and involve active participation in agricultural activities during the day.

On Map there is a clear pattern of weekend fishing/weekday wage work or school among the young men and boys, and women who work for wages in town face long days after work, harvesting and preparing food. Weekends may be spent "catching up" with household chores such as handwashing the family laundry, in addition to routine gardening tasks. How long such patterns will hold is not easy to predict with certainty; I think the next generation to attain adulthood is less likely to tolerate the stresses associated with these work patterns.

These are some of the realities one sees in the Micronesian islands today as the local people become increasingly tied into the world economy. My study of the ancient water conveyance system of Yap revealed the potential of the indigenous technology to support many more people than currently inhabit the island complex, but it is clear that some key adaptive conditions have changed in the last hundred plus years. They are rapidly differentiating from those under which that technology arose and was successful in the past.

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Appendix A. Flow data for six developed seeps in Map Island.

Date Measured	Seep Name	Village Name	Time to Fill 1 gallon	Pipe Diameter
7/23/85	Fanayong	Bechiyal	49 sec	.75 in
7/23/85	Binyuw	Toruw	6 min 26 sec	.75 in
7/23/85	Waref	Waned	4.5 sec	1.50 in
7/23/85	Maach	Wacholab	19 sec	.75 in
7/25/85	Wade	Amin	6 sec	1.50 in
7/29/85	Bulerar	Taingith	43 sec	1.50 in

Appendix B. Questions asked in interviews regarding traditional water usage.

1. How many seeps are there is your village and what are their names?

2. Do the seeps in your village ever go dry or flow less strongly? Which ones?

3. Where are the seeps located -- inland, coast, vegetative zone?

4. Who were the traditional users of each fresh water source (seeps and streams and wells?)

5. What was fresh water used for (bathing, cooking, cleaning, medicine, etc.?)

6. What methods were used to capture and convey fresh water and to store it?

7. Who owned the fresh water sources (seeps, wells, streams)?

8. Who owned the water in these sources? Who could use it?

9. Were there differences in how water was used during wet and dry season?

10. Concerning the ditches in the interior grasslands, who made them and when were they first made?

11. What was the purpose of these ditches and do they connect with streams in the forest at lower elevations?

12. How was water flow through the ditches and streams controlled during the rainy season? Who was responsible for this?

13. What is the relationship of ditches and streams to taro growing and other garden areas?

14. Who was responsible for maintaining the ditches?

Appendix C. Two stories about seeps in Map Island.

This narrative was collected from Chugen, an old man from Plaw Village, on July 12, 1985. Chugen related the story in Yapese, and it was translated simultaneously by Dugchur Martin, of Toruw Village, Map.

The Story of Gal' Seep

Before, this seep, which is now called Gal', used to be called "Mu'ut", which means "taro patch". In Nimgil, in southern Yap Island, there is a village called Gal'. There was a man there, from the estate called "Lolmar", who wanted to develop his land by the sea by building a rock pier all around the shore. But there was a small channel used by a fresh water eel (gafiy) which he neglected to allow for in his construction. He worked every day, all day long, and then rested at night. In the morning he would find all his work from the previous day destroyed. He assumed it was a person doing this at night and he decided to kill him. So he waited with a torch and spear and ax, and late at night he heard the rocks falling and knew the day's work was being destroyed but he saw no one, only an eel. He followed the channel made by the eel to a big rowal tree (Pangium edule Reinw) and chopped it down, trying to kill the eel. He cut it into pieces and found underneath the roots of the tree, many baby eels. Then he left the place. The mother eel assembled herself back together and took her children with her. She traveled to a village in Tagegin, Dalipebinaw (now a municipality), to ask another eel for stone money to present to someone to ask to stay in another home. She got the stone money and proceeded to Fanif (now a municipality) but on the way she got caught in a stone fish trap. The man who owned the trap found her and was afraid but he brought her turmeric, a betel nut tree sheath, and a small bunch of young coconuts. She appeared to him in a dream and told him he would find plenty of fish in the trap the next morning. He came in the morning and checked for fish, and indeed there were plenty. The mother eel and her kids continued on to the seep called Mu'ut, in Plaw Village, Map Island. She asked Gumdaraw, the male eel who resided there, if she could stay in that seep and asked him if he could find another for himself. He replied that he would have to ask the Big Eel in Gacham (a holy place in Tamil, now a municipality) if it was all right if he left Mu'ut seep and found another one somewhere, so that the mother eel could stay at Mu'ut. The Big Eel said he had nothing to say about it, that there were eels under the hills of Fanif who could say something. The problem with the eels under the hills in Fanif was that they were blind and deaf. So he rigged up a tube to one of the deaf eels' ear and asked him about moving to a new place. The deaf eel said to go to Rumung Island, to Bulwol Village, which he did, and the mother eel stayed in Mu'ut. This seep came to be called Gal' after her original place in Nimgil. Ever since, people from Gal' Village in Nimgil cannot sleep in Plaw overnight or else the eel in Gal' seep will kill them. One such case occurred during German times. A man called Tamag slept in Plaw and dreamed of eels in his throat. He went home to Gal' and died there. Eels came out of his mouth after he died.

Appendix C. Continued.

This story was collected from Gofalan, an old man from Cho'ol Village, Map. Like Chugen, he told it in Yapese, simultaneously translated by Dugchur Martin. The story was obtained during an interview on July 19, 1985.

The Story about 'Kay Seep

Once, a long time ago, people in Numdul Village worked for Waned Village. During a drought, in the evening, Waned people asked Numdul people to clear the dead and stinking eels from Waned's stream. The Numdul women did this. One of the women felt sorry for the eels and brought one home with her, even though it was dead. She went to the hills to bury it with turmeric and a betel nut tree sheath. She loved the eel and did not want to just throw it away. She returned home and went to sleep. Nine nights later, she dreamed about the eel coming to her, thanking her for burying him. The eel in the dream told her to go to the place called 'Kay, that under the grass (called mu in Yapese) there would be something for her. She pulled up a lot of the grass there at 'Kay, but did not find anything and got disgusted. Finally she pulled a piece of mu from the middle of the taro patch where the seep was located and up shot a strong stream of water. She shouted "Oh, I am wasting water!" A man from a Cho'ol Village, Dapu estate, was climbing a tree just then. He saw her and heard her shouting. He told her to be quiet, didn't she know that she was low caste and shouldn't be making noise like that? He said "That's my land" (meaning that the seep belonged to his estate). But she said "And that's my water! Now we are going to share it." That is why the two villages, Cho'ol and Numdul, share the water from 'Kay seep.