AN ASSESSMENT OF SALTWATER INTRUSION IN BABAI PITS AND SOME WATER SUPPLY PROJECTS ON MAKIN, BUTARITARI AND ABAIANG, REPUBLIC OF KIRIBATI

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SUMMARY

A visit was made to the atolls of Makin, Butaritari and Abaiang, Republic of Kiribati 4-21 November 1995 in order to assess salt water intrusion in babai pits and assess some water supply projects being implemented as part of the UNCDF Outer Islands Community Water Supply Program. The visit was part of SOPAC's work program for Kiribati under the Water and Sanitation Program.

The dying of babai (giant taro) on Kiebu islet, Makin Atoll, is caused by overflowing of the brackish central water pond during heavy rains. It is recommended that the water pond be retained through the construction of a water retaining wall and the use of vegetation to induce sedimentation. This can be done as a community self-help project with some assistance from the Government.

On Butaritari the problems with saltwater intrusion in babai pits do not exist anymore.

On Makin it was recommended that handpumps are an appropriate solution for provision of freshwater from the groundwater lens. Measurements were taken and an initial design made.

On Butaritari, the use of rainwater catchments, although inadequate to supply fresh drinking water throughout the year given the available roof area, is recommended. The chosen design should be monitored closely to see if the system is maintained and appropriate.

On Abaiang, currently more water is being produced by the solar powered pumps than is being used. It is possible to turn off the pump to prevent overflowing of the elevated distribution tanks but this is not being done. It is recommended that the electrical conductivity of the water supply be closely monitored to prevent overpumping and subsequent saltwater intrusion.

Maintenance will be crucial for the success of the water supply projects on these three atolls. The present set-up is likely to fail for several reasons. More emphasis on community education and ownership issues is needed. Present staff members do not have the time and background to provide this training. Additional input from a community-oriented staff member is needed.

To gather more information on the existing and future trends in quality of the water supplies in Kiribati it is recommended that PWD staff spend half to one day on each island visit testing for thermotolerant coliform bacteria using the recently acquired portable OXFAM kit.

Diarrhoeal diseases are prevalent and contribute to one of the highest infant and child mortalities in the Pacific Island Countries. A major constraint in health education is inappropriate latrine facilities. The need for a low-cost latrine appropriate for use in Kiribati needs to be addressed urgently. A workshop, where all involved agencies contribute, should be organised to assess this problem and to initiate the trial of several designs considered to be appropriate. SOPAC can organise such a workshop if requested by the Government.

ASSESSMENT OF BABAI PITS ON MAKIN AND BUTARITARI

Over the past years several complaints have been received from the islands Makin and Butaritari, the northernmost islands of Western Kiribati, that babai plants (giant taro, *Cyrtosperma*) were dying due to saltwater intrusion. Therefore, the Permanent Secretary of the Ministry of Works and Energy requested SOPAC, to make available the services of the Land and Water Engineer to come over and asses the problems. Problems were reported on Kiebu, an islet of Makin, and near the villages Ukiangang and Keuea on Butaritari. Kiebu was visited on 6 November, Ukiangang on 10 November and Keuea on 15 November 1995 (Annex 1).

Babai, together with breadfruit, is the traditional staple food on the islands in Western Kiribati. At present people depend more and more on imported rice, but on the northernmost islands babai is still widely grown. Babai together with other taro (*Colocasia*) is cultivated in pits placed in woven baskets (Plate 1). To create the pits a top layer of sand is removed until more clayish soil is reached. The plants are grown just above the groundwater level and depend on the freshwater lens for their growth. Taro has a low saltwater tolerance and inundation with brackish water causes them to die. At the time of the visit there had been no significant rainfall for the past 2 months, therefore the freshwater lens was very thin, especially on Kiebu. As a result of evapotranspiration a thin salt layer had formed on the soil in the pits at the time of the visit.

Kiebu

Kiebu is a small islet south of Little Makin island with 403 inhabitants. Babai is grown in a central depression east of the village. Two village water supply wells are situated at the northeastern edge of the babai area. A large open water pond exists in the middle of the area, while babai is cultivated in pits surrounding three sides of the pond (Plate 2). Plants were seen to be suffering from the current drought but were not dying.

Plate 1: Babai is grown in pits.

Plate 2: The open water pond on Kiebu.

According to the villagers their problem lies in the central open water pond. During the first heavy rains after a period of drought, usually once a year, the water overflows into their babai pits. The saltwater content of this water is more than the plants can stand and many plants die. The villagers have attempted to retain the water pond by building a small dam of coral rocks around it, but the dam is not very high and not looked after (Plate 3). The pond area seems to become bigger with each flood and villagers are forced to go further away to plant babai. Every year several of the pits nearest to the pond are deserted and new pits are excavated further away from the pond. The Sanitarian Aide thought the pond had actually been used as a fish pond; it is definitely not used as such now and considering the closeness of the ocean, there is no need for a fish pond. It is also not clear whether the pond is artificial or natural. The pond is shallow and, apart from the top centimetres, very muddy.

On 6 November 1995 the fresh water lens on Kiebu was found to be very thin. In the two village wells, just outside the babai area, the electrical conductivity ranged from 900 μS/cm at the top of the water table to 5000 μS/cm at a depth of 50 cm. This is well beyond drinking standards and more than taro plants can tolerate. Conductivity in the open pond varied from 1770 to 2100 μS/cm indicating brackish conditions.

Plate 3: The remains of the retaining wall made by villagers.

The situation can possibly be explained assuming that with heavy rainfall the open pond collects more rainwater and faster than the surrounding area where the vegetation intercepts part of the rainfall. This results in a water level rise and subsequent overflowing into the surrounding area where babai is cultivated. The babai then becomes inundated with brackish water. The high salt concentration of the pond water results from evaporation; the open water evaporation is presumed to be higher than the evapotranspiration of the cultivated area.

Assuming the above explanation is correct the problems can be avoided by retaining the brackish water in the pond, just as the villagers have been trying to do. If the pond is not retained it will grow bigger and the villagers will eventually lose their babai pits. Several methods of retaining can be considered, though a combination of a simple water retaining wall and increase of vegetation to help build up sedimentation seems an appropriate solution. This can be constructed by the villagers using local materials, over a period of several months. A design has been suggested by Mr Win, UNDP/PWD Water Engineer. During the work it is recommended that a PWD supervisor assist the villagers. This way costs can be kept to a minimum

The water retaining wall designed by Mr Win is made of local coral rocks, smaller aggregate and sand (Figure 1). A plastic liner can be used to make it water tight. See figure below for wall design. Full details on the design can be obtained at the Public Works Department in Betio.

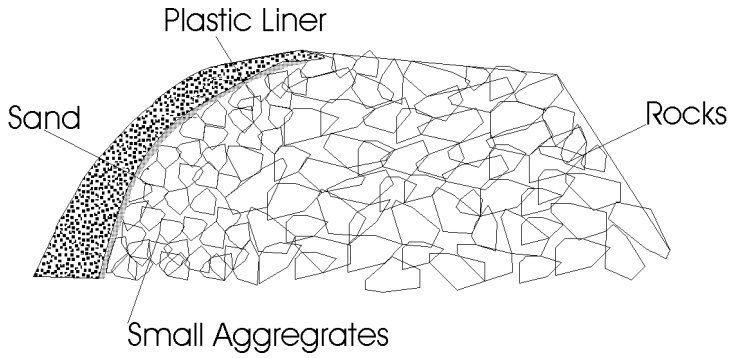


Figure 1: Water retaining wall is made of local coral rocks.

Open water space can easily expand by eroding it's shores either during storms, or while overflowing occurs during periods of higher than normal rainfall. The newly constructed wall will also be subject to erosion, and it's lifetime will depend to a large extent on the maintenance. Vegetation is a natural way of reducing the effects of erosion and can therefore control, and possibly reverse the expansion of the pond. It is therefore recommended that trees be planted inside the wall in an attempt to control the size of the pond. As the water in the pond is brackish the vegetation has to be a salt-tolerant species. Some mangrove trees (*Rhizophora sp.*) were found growing at the edge of the pond. Mangrove is found throughout Kiribati and it is widely recognised as a sediment trapper and soil binder. It also plays an important role in coastline protection (Woodroffe, 1992). It is recommended that seedlings of this mangrove are collected and planted around the pond. As the mangrove depends on brackish water it is not expected to have an effect on the fresh water lens. Other plants can be used to create the same effect. Eventually the pond will be overgrown by vegetation which will help to stop flooding. Additional benefits can be expected from the vegetation. Mangroves in Kiribati are used for fuelwood, structural material (posts and poles), seaweed cultivation and fishtrap stakes, dyes for preserving and colouring canoe sails and clothing, leaves and flowers for garlands and leis, and scent for coconut oil. *(Information from E. Teunissen, South Pacific Forestry Development Program, Tarawa).*

Success of the above solution for the saltwater problems at the babai pits on Kiebu mainly depends on the participation of the villagers. Government can provide technical assistance through PWD, but the villagers will have to do the work.

Butaritari

Problems with the babai pits on Butaritari were earlier mentioned by Htun Win (1994) and Gillie (1994). For the pits at Ukiangang Point, Gillie suggested that inland alternatives for babai growing should be sought instead of shore protection. During a visit by Htun Win, accompanied by an Agricultural Officer and the Council Clerk, it was concluded that problems with the babai were not because of saltwater intrusion but possibly resulting from white flies.

Together with the new Council Clerk and Agricultural Officer, Ukiangang Point was visited on 10 November 1995. It seems that this area is no longer used for babai pits. The people have

presumably moved out after the latest seawater intrusion and found other, more suitable areas for cultivating babai. The water in the swampy area just behind the shoreline was found to be brackish (3300 µS/cm). No babai cultivation would be possible under these conditions.

In discussions with the Council Clerk, the Agricultural Officer and during the Island Council meeting with representatives from all villages, no problems with babai pits could be identified anywhere on Butaritari. It was therefore concluded that problems of saltwater intrusion in babai pits do not exist anymore.

ASSESSMENT OF SOME WATER SUPPLY PROJECTS ON

MAKIN, BUTARITARI AND ABAIANG

The United Nations Capital Development Fund (UNCDF) has been funding the Outer Islands Community Water Supply Program (KIR/87/C02) since 1987. The Community Water Supply Program is implemented by the Public Works Department of the Kiribati Government. Under the UNDP Support to Outer Island Development Program (KIR/93/001) a UN Water Engineer is attached to the Public Works Department. SOPAC's Regional Water Supply and Sanitation Program supports the work in Kiribati through technical backstopping.

An assessment of the following components of the Outer Islands Community Water Supply Program was made during the November, 1995 visit and the outcomes are reported below:

1) Kiebu, Little Makin
   - existing wells and handpumps
2) Makin
   - existing water supply and measurements for handpumps installation
3) Ukiangang, Butaritari
   - existing wells and handpumps
4) Butaritari, all villages
   - existing water supply and measurements for rainwater catchment systems
5) Nuotaea and Council area, Abaiang
   - completed solar system and system under construction

Water Supply on the outer islands has always been the responsibility of the families. Each household has one hand dug well, sometimes shared by 2 or 3 households. Wells are shallow (3-5 metres deep) and were traditionally lined with flat stones but concrete rings are now common (Plate 4). Wells are open and water is fetched by rope and container; a variety of containers is used such as buckets, corned beef tins, small buoys and old tea pots. Other methods of water abstraction are by simple handpumps (Tamana pump), electrical pumps (on solar or generator power) or the handpumps installed by the project (Southern Cross diaphragm). Maintenance of all pumps seems to be a problem.

Plate 4: An improved well in Kiebu, with footvalve and cover.

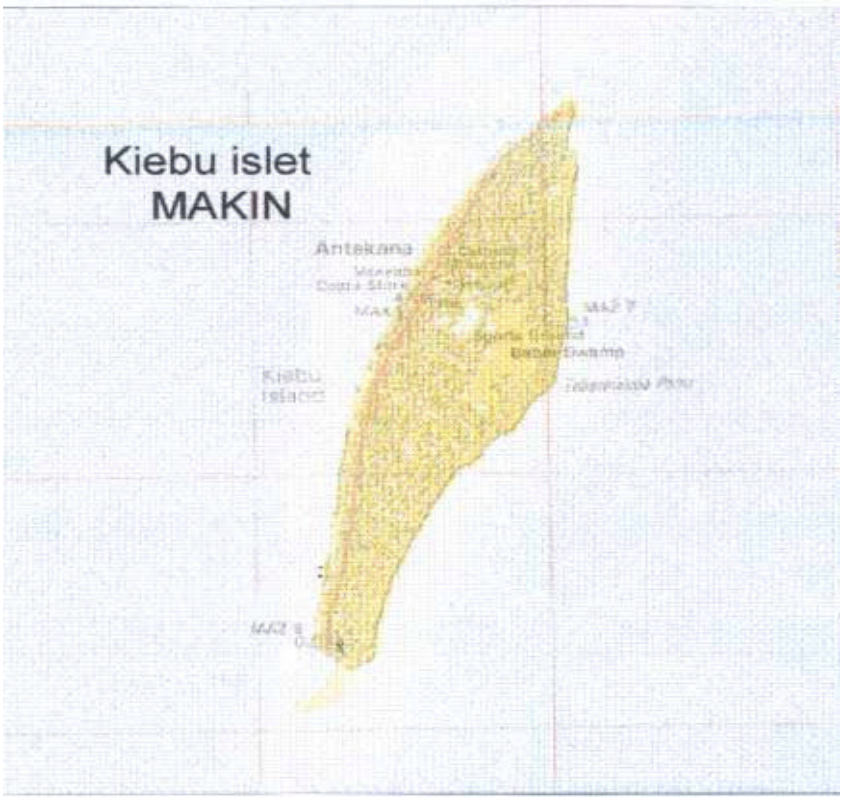
As most houses have thatched roofs, roof rainwater catchments are not widely used. However government health centres, some churches and some private homes use roof catchments for rainwater. Again, maintenance seemed to be a problem with many of the rainwater catchment systems found.

The UNCDF Community Water Supply Program has mainly been installing Southern Cross diaphragm handpumps. Water is pumped from dug wells outside the village, this is to minimise the risk of contamination by human activities. The wells are lined and covered. The distance from the wells to the handpump in the village is a maximum of 750 m. A maximum of three wells is connected to one foot valve. Initially 1 pump was installed for as many as 10 households. For the newer installations this has been reduced to 1 pump for 3 households. Kiebu and Ukiangang villages had their pumps installed under the initial set-up in the early 1990s. For Makin the new criteria were used. (See the respective sections for details on the operation of the handpump systems).

The other component of the Community Water Supply Program is the solar pumping system, where a gallery type well is dug outside the village and water is pumped with a solar powered mono-pump. Only four systems have been installed so far, a fifth is under construction. (Details on this system are given in the section on Abaiang).

Kiebu

At Kiebu village most pumps were found in working order, and some were being used almost continuously. A major problem seemed to be the freshwater lens; as it had not rained for at least 2 months, only a very thin layer of fresh water was available. As the footvalves in the wells are placed near the bottom, they were drawing brackish water. The maximum salinity limit for potable water can be taken as 2500 μS/cm, following Falkland's (1992) study of the freshwater lens of Tarawa. This is approximately an equivalent chloride concentration of 600 mg/l. PWD uses 3000 μS/cm as the limit for potable water in Kiribati. Only one well had an electrical conductivity below 3000 μS/cm at the depth of the footvalve. All other wells were considered unacceptable for drinking.



Map 1: Kiebu islet, Makin

Table 1: Electrical Conductivity in micro Siemens/cm for wells in Kiebu.

	well 1	well 2	well 3	well 4
at water table	900	950	600	700
at bottom of well	2000	5000	10000	7000
depth of water (m)	0.45	0.5	0.55	0.7

As a result the villagers have taken off the covers of the wells and use them to draw drinking water by buckets, as the thin top layer is still fresh. This of course means that water is likely to be contaminated, which was confirmed by coliform testing of a few water samples (refer to Table 2). The villagers do not have much choice however. As the wells are located outside the village, not too much water will be collected this way. Handpumps are still being used for non-drinking water.

Table 2: Biological water quality testing on Makin and Butaritari, Kiribati.

sample taken from	volume filtered ml	count	Thermotolerant Coliform/100ml	contamination	comments
Kiebu, Makin					
handpump from well 1	50	130	260	yes	
"	100	>200	>200	yes	
handpump from well 2	100	9	9	slight	both wells were found un-covered
Makin					
raditional open well at Tetabo	50	68	136	yes	used by one household
"	100	150	150	yes	
open well with protection wall, C.church	50	>200	>400	yes	used by many households
"	100	>200	>200	yes	
open well with wall at Aonuka	50	yellow, polluted,	no count		used by many households
"	100	yellow, polluted,	no count		
open well with protection wall, KPC church	50	80	160	yes	
"	100	93	93	yes	
open well electrical pumped, resthouse	50	3	6	slight	
raintank resthouse	100	yellow, polluted,	no count		after first rain

From the above samples, although only few, it can be concluded that the intensiveness of use of the wells relates to the severeness of the contamination. In other words: the number of containers that are used in the well together with other floating objects found in certain wells cause the contamination. This sustains the need for well protection and use of handpumps.

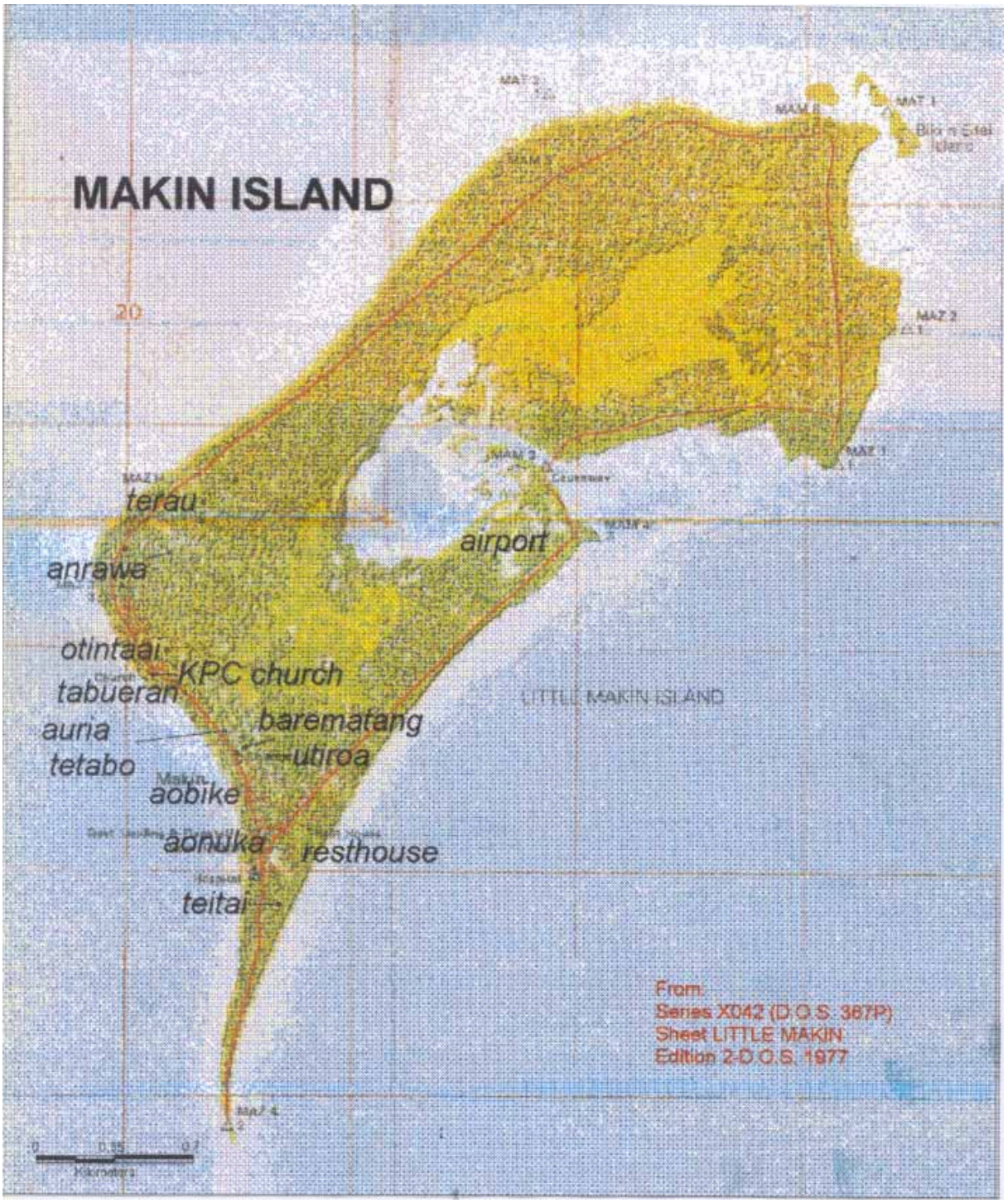
Ukiangang, Butaritari					
well 1, open, no working pumps	50	7 or 66	14 or 132	yes	7 real yellow, the remaining pinkish-yellow
well2, pump 4	100	119	119	yes	small dark yellow dots
well2, pump 5	100	88	88	yes	small dark yellow dots
well2, pump 6	100	11	11	yes	small dark yellow dots well has broken cover
well 4, pump 10	100	1	1	slight	many pink spots

Only 4 out of 12 pumps were working, hence no more samples could be taken. It seems that pumps with greater distance to the wells have cleaner water (pump 6 and pump 10). However none of the pumps supplied safe water and boiling is still recommended.

Makin

Makin is a small island (Map 2) with most people living on the southern and western side of the island. Approximate population is 1400 people. For water supply they rely on hand dug wells and a few rainwater catchment systems. Most households have a hand dug well or share it with 2 or 3 families. Wells are lined and have a concrete wall around it but all wells are open. Water is extracted by buckets and other containers. Most well water is contaminated (see section on water quality). People say they boil their drinking water and especially the fresh toddy (sap from young coconut shoot - mixed with water) is thoroughly boiled in the morning to be served the rest of the day. However, children and other thirsty people drink small amounts directly from the well when the need arises. Few latrines were found on the island as most people prefer to use the beach.

As of yet no project activities have been undertaken on Makin. The purpose of this visit was to determine which components of the Community Water Supply Program can be implemented in Makin. Options are rainwater catchment systems or handpumps.



Map 2: Makin island

A rapid survey of open hand dug wells in Makin was conducted. The Electrical Conductivity ranged from 345 to 2600 µS/cm with most wells between 600 and 1000 µS/cm (Table 3). Although people mentioned the fact that the water was becoming saltier due to the drought of recent months, there appeared no real problem as they considered the water still drinkable. It was therefore decided that the wells are suitable for installation of handpumps.

Table 3: Makin Wells.

		Location	Temperature (Centigrades)	Electrical Conductivity microSiemens/cm
well	28	Teinibike		
well	27	Anrawa		
well	26	Tebangan		
well	25	Terau		
well	24	Teuninrabu		
well	23	Anrawa	28	700 ± 67
well	22		28	650 ± 64
well	21		28	650 ± 64
well	20	Anrawa/hospital	29	500 ± 55
well	19	Primary School	28.5	1280 ± 101.8
well	18	Teitinako	28.5	750 ± 70
well	17		28.5	1160 ± 94.6
well	16	Otintaai	28	750 ± 70
well	15		29	920 ± 80.2
well	14		28	800 ± 73
well	13	Tabueran	28	700 ± 67
well	12	Tetabo	28.5	820 ± 74.2
well	11	Auria - Tetabo		690 ± 66.4
well	10	Barematang	28.5	890 ± 78.4
well	9	Barematang	28.5	860 ± 76.6
well	8	Tebikentaake	29	700 ± 67
well	7	Aobike	28	345 ± 45.7
well	6	Taberanaobike	28	1000 ± 85
well	5	Aonuka	28	1000 ± 85
well	1	Noatabu	29	1020 ± 86.2
well	2	Norauea	28	880 ± 77.8
well	3	Teitai	29	2600 ± 181
well	4	School	28	880 ± 77.8
		Resthouse		650 ± 64

Water from various wells was tested for thermotolerant coliform bacteria, an indicator of faecal contamination, using the Oxfam field test kit. Results can be found in Table 2.
All water samples showed contamination, however, there were significant differences in contamination levels between wells that were intensively used and wells that were used by one family only, and between wells where rope and bucket was used or a pump. The trend is that more users, with rope and buckets, result in the severest contamination but an open well with an electrical pump was found to be fairly clean. To create cleaner wells the direct contact

between the users and the water, through rope and bucket and other floating objects, should be discouraged. The results from this test support the need for protected wells with handpumps.

On arrival in Makin members of the Island Development Council had just completed a small survey to install 18 Tamana handpumps. This survey only covered the more densely populated area near the Council offices. Considering this request and finding that not many suitable roofs for rainwater collection exist it was concluded that the Community Water Supply Program should provide Makin with handpumps. However the total number of pumps will be higher than18 and the type of pumps will be the Southern Cross diaphragm pump as installed on Kiebu. The Sanitarian Aide is familiar with this pump and can lead all preparation works for the actual installation. He should also be able to maintain the pumps as this will be the Council's responsibility (see also section on maintenance). Another justification for handpumps follows from the attitude of the people in Makin: contrary to other islands in Kiribati there seemed to be no problem in sharing wells and most people willingly agreed to have their well sealed to have a handpump installed to be shared with 3 families.

Together with members of the Island Development Council a new survey was conducted; wells and handpump sites were selected and measurements taken for pipes etc. Details on the number of handpumps and other material can be obtained from PWD, Betio.

Ukiangang

Ukiangang is located on the southwestern point of Butaritari. It has a population of 685 people and it is the only village that has benefited from the UNCDF project to date.

Handpumps were installed in Ukiangang in the early 1990s. The present number of pumps is 12 with 4 hand dug wells outside the village. All pumps were checked during the visit and only four of the twelve were working. Coliform tests were performed for those pumps that delivered water. The following table shows the results of the survey.

Table 4: Results of Handpump survey Ukiangang, 13 November 1995.

Pump	Well	Working	Comment	
Pump1	well1	NO	check footvalve	needs grease
Pump2	well1	NO	needs bolts and nuts	
Pump3	well1	NO	check footvalve	no user, pump needs relocating
Pump4	well2	YES		
Pump5	well2	YES		
Pump6	well2	YES	needs new bolts and nuts	
Pump7	well3	NO	change diaphragm	
Pump8	well3	NO	plunger rod to be reconnected to plate	
Pump9	well3	NO	taken apart, waiting for bolts and nuts	
Pump10	well4	YES		
Pump11	well4	NO	pipe cut at construction site	
Pump12	well4	NO	pipe cut at construction site	

In Ukiangang most problems with the handpumps result from poor maintenance. There was also a remarkable difference between pumps located near one separate household and those pumps in the middle of a community. The few pumps near one separate house were well looked after with one example where private bolts and nuts were used to keep the pump working. The policy of the project however is not to give pumps to individual households but place them in communal places, where maintenance is local government's responsibility. The issue of maintenance is further discussed in a separate section of this report.

To assist Ukiangang it was decided in the Island Council meeting that the village representative will receive a set of tools and will be responsible for the Ukiangang handpumps. As a caretaker he has to request assistance when needed from the Sanitarian Aide who lives in another village. Spare parts still have to be requested by the Sanitarian Aide through the Island Council.

Although from the survey it appears that the pumps are failing, the users are still very happy with their pumps. They would like to see them repaired, some people actually repair the pumps themselves. As these pumps were given under the old set-up there is an average of 10 families using one pump, however, not all people in the village have easy access to a pump. The village requested 6 more pumps. Better access to pumps can be achieved by relocating 3 pumps, as at present not all pumps are located at places where they can be fully used.

Plate 5: Traditional I-Kiribati houses are not very suitable for roof collection.

Plate 6: Local rainwater catchment system (using a buoy).

Butaritari

Apart from the handpumps in Ukiangang, the other villages in Butaritari have not received any input from the project. This visit aimed to assess the present water supply, the villages' needs and the options for further development by the UNCDF Project. A proposal for the construction of rainwater tanks was made by the Island Council more than a year ago. No further action had been taken yet.

Hand dug wells on Butaritari were found to be mainly family owned. Attitude towards sharing wells seemed different than on Makin. The idea of having one's well sealed off with a handpump to share it with two neighbours was not as warmly welcomed as on Makin. The need for an improved water system however was evident, as many wells were contaminated. Many people on Butaritari including users of the handpumps in Ukiangang village confirmed they boil water for consumption. But, hygiene practices such as hand washing with soap are poor, and water borne diseases are prevalent. One factor in improving this situation would be improved water facilities.

Considering the proposal of the Council for rainwater tanks, and the high rainfall on the island, a survey to assess the potential for roof catchment was carried out in all villages but Ukiangang.

The rainfall data since 1945 were collected from the Meteorological Officer on Butaritari but several years are incomplete. Taking the 567 months of which records exist, there were 203 months with over 300mm of rainfall (35.8%). Less than 100mm was recorded in 11.8% of the months (Table 5).

Table 5: Distribution of monthly rainfall for 1945-1995.

mm/month	no. of months	%	cumulative	reverse
> 300	203	35.8	35.8	100.0
200 - 300	125	22.0	57.8	64.2
150 - 200	85	15.0	72.8	42.2
100 - 150	87	15.3	88.2	27.2
80 - 100	22	3.9	92.1	11.8
60 - 80	20	3.5	95.6	7.9
40 - 60	10	1.8	97.4	4.4
0 - 40	15	2.6	100.0	2.6
	567			

The only roofs in Butaritari that are suitable for rainwater catchment are the roofs of churches and Maneabas (community hall). Churches are usually high and elevated tanks could be constructed (Plate 7). Maneabas are low and therefore not the entire roof would be used to feed an elevated tank (Plate 8). All suitable roofs on Butaritari were measured and the results are given per village in Table 6.

Plate 7: Churches can provide large roof catchment

Plate 8: Maneaba have low roofs but can still be used to collect rainwater

In most villages, except near the airport, the average roof area available per person is 1 m^2. This will be less taking into account the population growth (Annex 2). Using a design criteria of 10 litres per person per day, which should be enough for consumption, the available roof area is low and will only supply each person with 10 litres per day for a third of the time (36% of the months). To guarantee 10 litres per person per day in 90% of the months a roof area of 5 m^2 per person is needed (Figure 2).

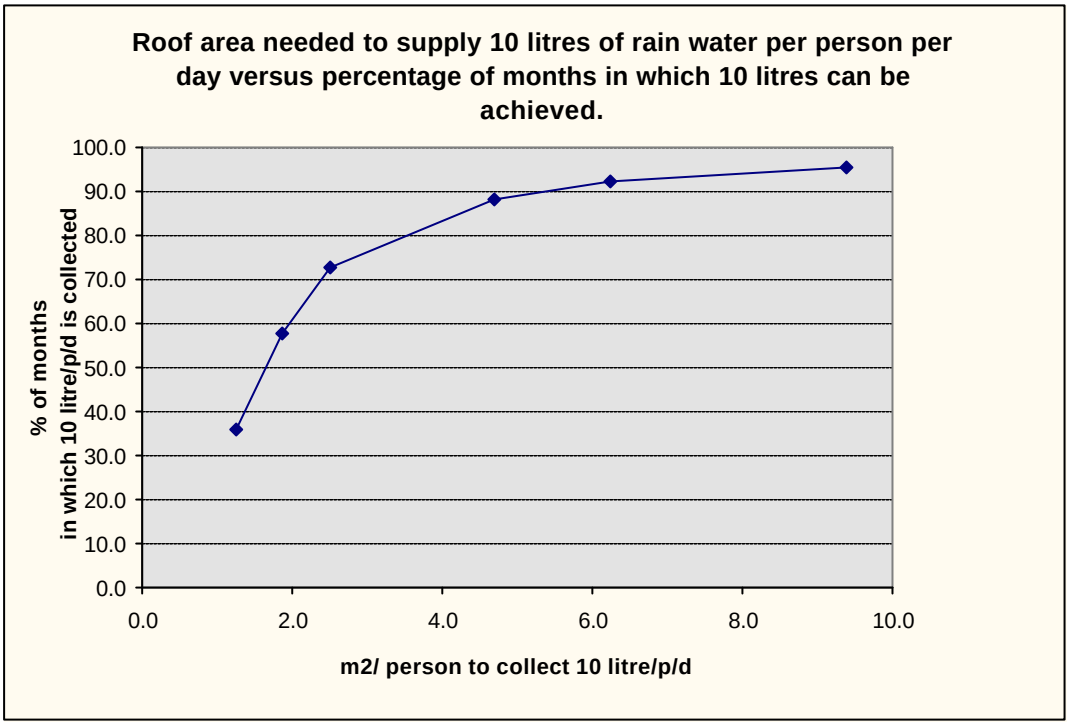


Figure 2: Roof area needed to supply 10 litres of rain water per peson per day.

Nevertheless, it was decided that it is better to use the available roof areas and supply the population with as much clean water as possible. The total amount to be delivered to the village will depend on the total tank size, but it is estimated that storage of one week is feasible. For a village of 500, this is 35000 litres (7700 imperial gallons), several tanks can be constructed.

As villages are scattered, distances to the collecting buildings can be 500m or more. Since people are used to having a hand dug well close to the house it was decided to reticulate the water from the elevated tanks by gravity. Therefore taps will be constructed at a reasonable distance from most households. The taps will be of a selfclosing type.

The use of rainwater will certainly improve the quality of available drinking water on Butaritari. However the proposed design has several weaknesses. As the system is not guaranteed to supply water all year around, taps are likely to be abandoned or even broken while dry. By having many taps instead of only one tap at the tank itself, the chances of broken taps are higher. Only one broken tap will cause the tank to drain when rainfall starts. A main valve at the tank is included in the design to close reticulation if needed. If all taps are going to be

maintained properly the system should work fine. This requires the full support and understanding of the community, and therefore community education.

Other options could be:

- to have taps only at the tanks; when people see that the water comes directly from a tank they are more likely to realise that their supply is finite.
- to have water piped from the elevated tank into lower level tanks near the houses, and have taps on these tanks.
- to construct additional roof catchment, however this is not included in the present project.

If the Butaritari rain catchment project goes ahead it is important that it be monitored closely to see whether this design is appropriate for Kiribati.

Table 6: Roof catchment measurements, Butaritari.

Village	building	roofsize m2	total roof area Available per village m2	roof area (m^2) per person in*: 1990	1995	2000
Ukiangang N		*3 handpumps*				
Ukiangang S		*9 handpumps*				
Onomaru			**556**	1.3	1.1	1.0
	Catholic church	276				
	Church maneaba	144				
	Public maneaba	136				
Temanokunuea			**486**	1.0	0.9	0.7
	Council maneaba	286				
	Hospital	60				
	House medical	140				
Tabukinmeang			**915**	2.0	1.7	1.5
	Catholic church	611	(can also supply Temanokunuea)			
	KPC church	177				
	KPC maneaba	128				
Antekana			**1340**	5.8	5.0	4.3
	Airport building	1240				
	Maneaba	100				
	House airstrip	54	(for school and dispensary)			
Tabonuea			**204**	0.8	0.7	0.6
	Catholic church	144				
	Store	60				
Tanimaiaki			**330**	0.9	0.8	0.7
	Church	190				
	Store	60				
	Private house	80				
Tanimainiku			**235**	1.0	0.9	0.8
	Church	175				
	Private house	60				
	Nakiroro Clinic	42				
	Anginibeatoa PS	232	3000 gallon tank to be repaired			
Keuea			**280**	0.9	0.8	0.6
	Catholic church	136				
	Maneaba	64				
	Private house	80				
Kuma			**595**	1.1	0.9	0.8
	Catholic church	179				
	KPC church	210				
	Private house	111				
	Maneaba	96				
	PS	192				
Bikati			**234**	1.1	1.0	0.8
	Maneaba	72				
	Catholic church	63				
	KPC church	99				
	PS	*1 handpump,*	*1 rainwater tank*			

* population estimates using 1990 census and 3% annual growth

Abaiang

The UNCDF Project has recently been installing solar powered infiltration well systems. Two were visited, a completed system was visited on Nuotaea islet, and a system under construction in the Council area.

The system consists of an infiltration gallery at some distance from the village, a solar panel providing power to a mono pump, and elevated tanks in the village supplying water through taps. As the system is still new no problems with maintenance have been recorded. A caretaker in the village looks after the pump and should be able to do small maintenance, such as changing a fuse. The solar panel is directly linked to the pump and pumping occurs only during daylight hours. A water meter is installed and during this visit pumping rate was 40 litres/minute. The system can be turned off by a main switch. During the visit however the water in the tanks overflowed from the village tank from 11 o'clock in the morning. Women were actually using the overflow for washing clothes. It is estimated that the water consumption will slowly increase, as people will get used to the greater volume of water. In the meantime it would probably be better if the system were switched off after the tanks have filled up. Therefore the key to the fenced pump area was left with the villagers.
More important will be the monitoring of the freshness of the water. Electrical conductivity was measured as 700 μS/cm and needs to be measured regularly, or whenever the island is visited by staff of the PWD, to collect information on the safe yield of the well. If an increase in the salt content is found, preventive measures, such as reducing pumping rates, need to be taken.

Plate 9: Infiltration gallery under construction.

Plate 10: Infiltration gallery after installation of solar panel and mono pump.

Plate 11: Elevated tank supplying water to village.

Plate 12: Tap stand in village.

Maintenance

The success of the UNCDF Project will depend on the effectiveness of maintenance. The Southern Cross KDC handpumps are intensively used and need constant maintenance. Maintenance is organised as follows:

- Each island has one Sanitarian Aide. This is a man from the island receiving a small salary from the PWD. The Sanitarian Aides have received training in the construction and maintenance of various components of the project. They are expected to continue the work on the island by themselves after the construction phase of the project has finished. This includes regular visits to the various villages.

- In each village a caretaker is appointed. This person is not paid any allowance. The caretaker is expected to do regular maintenance, such as greasing bolts on pumps, and to report any breakdowns to the Sanitarian Aide.

- The Sanitarian Aide receives help from Council and is expected to report to the Council any needs that arise. The Council is expected to buy spare parts. Therefore the Sanitarian Aide reports the need for spare parts to the Council, the Council then orders spare parts from the PWD in Tarawa. PWD, in their turn, have to order from overseas. The Council is advised to keep a minimum of spare parts in stock, especially those parts most frequently needed. Costs of spare parts have to be borne by the Island Council. No incentives are expected from the villagers, the users of the handpumps.

As of yet this system is not really working as described above. The first load of spare parts, to be sold to the Council, had just been ordered by the PWD. So far, the project has been supplying spare parts when needed.

Although the system has not yet failed, it has a few weak points that need to be addressed. Some of these points have already been recognised by the PWD and suggestions for change have been mentioned.

Most important point is the ownership issue. The villagers expect in most cases the Government to look after their pumps although a few individuals have shown great care for the pumps. The perceived Government ownership is a direct result from the UNCDF Project set-up. The UNDP Support to Outer Island project's aim was to strengthen government on the islands. Therefore, the project on completion of a water supply hands control over to the Island Council. Although each village has one representative to the Council, this does not necessarily mean that the villagers are part of the Council. To make maintenance of any community development a success, the first prerequisite is a sense of ownership from the people. This can be achieved by a hand-over function where the whole village is involved, the appointment of a caretaker in each village, the provision of tools and an initial set of spare parts to each village, and the formation of a village committee for the water supply who will be responsible for the purchase of spare parts from the Council. It may also be a good idea to ask for a small amount of money for the spare parts, as this usually increases people's interest and sense of ownership. The village committee should include women, as they are the main users of the supply. The committee and the caretaker, as member of the committee, should work closely with the Sanitarian Aide.

Concerning the purchase of spare parts, the PWD should have a certain number in stock at the office in Tarawa. The Councils should be educated in their responsibilities towards spare parts and the number of stock items required.

Although most of the points mentioned above seem common sense, there are many points where the UNCDF Project can fail. If the maintenance concept is not tackled adequately and timely, the various water supplies, especially the handpumps, will not survive long. Community education should have been a major component of this project. However, the highly competent staff do not have the time and skills to address this issue adequately. They are mainly involved in the technical component of the water supplies and the achievement of their targets. To set-up a proper maintenance program an additional, community oriented staff member is needed, who can work full time on this issue. As the project does not provide for this, the person may be difficult to find and to fund.

Sanitation

Sanitation is still one of the main issues, if not the most important, to be addressed in Kiribati. Diarrhoeal diseases are prevalent and contribute to one of the highest infant and child mortalities in the Pacific Island Countries.

According to a baseline study conducted by the Child Survival Project in 1994, 60% of children under 2 years of age suffered from diarrhoea in a four-week period. Inadequate supplies of clean water and poor sanitation in highly populated areas are the main contributing factors. (Saito, 1995)

Water supply and sanitation practices are essential aspects in the prevention of diarrhoeal diseases. Currently, the majority of people rely on unprotected wells as their water source. The beach is still the most common and often only option for defecation. Even those who have toilets or latrines do not use them all the time. Poor maintenance of toilets and collection of water for latrines are major deterrents. Contamination of groundwater from latrines is a serious concern, particularly in Butaritari. Cost and the perceived lack of materials are other concerns. The promotion of better sanitation practices through community participation should go hand-in-hand with the installation of an appropriate infrastructure. (Saito, 1995)

In a discussion with Mr Sean Kennedy of the Foundation for the Peoples of the South Pacific (FSP) the importance of appropriate sanitary facilities was raised. The Ministry of Health, in cooperation with the FSP, has current activities in community education on sanitation and hygiene. One of the main constraints is however, the lack of a low-cost latrine design appropriate for Kiribati. It is difficult to bring sanitation messages to the people without being able to offer them an appropriate design. The commonly introduced latrine, the water sealed pit toilet, has the major disadvantage of contaminating the groundwater lens. As most people rely on open hand dug wells and space on atolls is limited, wide spread introduction of water sealed pit toilets may not improve, and may even aggravate the existing situation.

Currently, only one latrine implementation project is being undertaken by the Ministry of Health. This project, initiated by the South Pacific Commission (SPC), works in the villages of North Tarawa. Although this project aims to locate pit toilets away from wells, space limitation

may make this impossible. No data is available yet regarding the success of this project and its impact, if any, on the groundwater lens.

Another toilet project is currently being undertaken by the University of Tasmania (U of T) on Kiritimati (Christmas Island). The type of toilet introduced is a composting toilet and results have been reported as promising. The major constraint of this program so far is the high costs of the prototype toilets. Local construction however, can bring the costs down considerably, and the composting toilet may be an option for other islands in Kiribati.

Another design option, suggested by engineers from the Public Works Department and the Public Utilities Board, is the use of a plastic liner in the conventional water sealed toilet pits. As of yet this design has not been tried out in Kiribati.

There is an urgent need for a low-cost latrine appropriate for Kiribati. It is therefore suggested that the several organisations involved, namely Ministry of Health, FSP, PWD, PUB, U of T and SOPAC, join hands in a trial project where various designs can be tested and ways to introduce the most appropriate design in Kiribati can be found. SOPAC can assist through finding more information on possible designs and through the organisation of a workshop/meeting, where all of the above attend.

Water quality monitoring

A monitoring program, comparing improved wells with traditional wells, will help the PWD in evaluation of the UNCDF Project, and can be useful in future rural water supply activities. The PWD has recently received an Oxfam testing kit which tests for thermotolerant coliform bacteria in a field situation. Collection of data can start by taking the kit along whenever a village is being visited. It is not recommended to make separate visits just for monitoring purpose, as the costs will be high. However, by dedicating one or half a day per island visit to the coliform testing, a significant number of data can be acquired. The test results as reported from this trip can be taken as a first data set.

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ANNEX 1: KIRIBATI TRIP LOG

Program

4 Nov 95	travel	Nadi-Tarawa
5 Nov 95	travel	Tarawa-Makin
	Well survey Makin	
6 Nov 95	Babai assessment and well survey at Kiebu islet	
7 Nov 95	Handpump design survey with Island Development Committee	
8 Nov 95	Continued survey and biological water quality testing	
9 Nov 95	Informal meeting with Island Development Committee	
10 Nov 95	Travel	Makin-Butaritari
	Babai assessment at Ukiangang village	
13 Nov 95	Rainwater catchment design survey	
	Onomaru, Temanokunuea, Tabukinmeang	
	Biological water quality testing, Ukiangang	
14 Nov 95	Meeting with Island Development Committee	
	Continued catchment survey, Antekana, Tabonuea	
15 Nov 95	Continued catchment survey, Kuma, Keuea, Tanimainiku, Tanimaiaki	
16 Nov 95	Survey Bekati islet	
17 Nov 95	travel	Butaritari-Tarawa
	visit	Public Works Department
		Public Utilities Board
18 Nov 95	Solar pump system visit Abaiang Atoll	
20 Nov 95	visit	Ministry of Natural Resources Development
		Karikirakean Mwengaroin Kiribati
		Foundation of the Peoples of the South Pacific
21 Nov 95	travel	Tarawa-Nadi

Post field Survey Meetings in Tarawa

At the Ministry of Natural Resources Development a meeting was held with the Secretary Teekabu Tikai, and Naomi Biribo, counterpart to SOPAC. The results from the study on the babai pits were discussed as well as some of the water supply issues.

A meeting was held with the Director of Karikirakean Mwengaroin Kiribati, Tiree Kabuta. KMK is the former Save the Children Fund and is active in house improvements. This involves roof improvements, rainwater tanks and kitchen improvements. The project staff includes one business economist and one technical coordinator. The KMK provides technical assistance to households. The household members have to pay for any improvements themselves. Three islands have been covered; at present KMK is working on North Tarawa, Nonouti and Nikunai. Address: KMK, PO Box 51, Bairiki, Tarawa.

At the office of The Foundation for the Peoples of the South Pacific a meeting was held with Country Director, Rita Feinberg and Health Programs Coordinator, Sean Kennedy. Issues from this meeting are discussed in the section on sanitation of this report.

ANNEX 2: POPULATION FIGURES

Estimated population based on 3% annual growth			
	1990	**1995**	**2000**
Makin	*1200*	*1291*	*1613*
Butaritari	*4208*	*4878*	*5655*
Kuma N	298	345	400
Kuma S	259	300	348
Keuea	320	371	430
Tanimainiku	224	260	301
Tanimaiaki	350	406	470
Tabonuea	249	289	335
Antekana	230	267	309
Tabukinmeang	457	530	614
Temanokunuea	493	572	663
	433	502	582
Ukiangang N	362	420	486
Ukiangang S	323	374	434
Bikati	210	243	282

ANNEX 3: LIST OF PEOPLE MET

Public Works Department - Water Unit

Htun Win	UN Water Engineer
Taboia Metutera	Water Engineer
Eita Metai	Assistant Water Engineer
Muea	Foreman

Public Utilities Board

Laszlo Erdei	Water and Sewerage Adviser

Ministry of Natural Resources Development

Tinian Reiher	Secretary
Naomi Biribo	Minerals Officer

Island Council Makin

Romiti	Assistant Clerk
Tebwaki	Treasurer
Mataweia	Sanitarian Aide
Rui Tabau	Agricultural Officer

Island Council Butaritari

Buretau	Council Clerk
Nakee	Assistant Clerk
Itintimoa	Chief Councillor
Biketara	Sanitarian Aide

Karikirakean Mwengaroin Kiribati, (KMK)
(former Save the Children Fund)

Tiree Kabuta	Director

Foundation for the People of the South Pacific, (FSP)

Rita Feinberg	Country Director
Sean Kennedy	Health Programs Coordinator