Kiribati Water Resources Assessment & Management Project

NONOUTI, KIRIBATI
WATER RESOURCES ASSESSMENT

Prepared by

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for

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Promotion of Effective Water Management Policies and Practices

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Rainfall, Recharge & Yield – Kiribati islands.xls referred to in Table 1 is available on CD.
Copies can be requested from the SOPAC Secretariat

INTRODUCTION

This report provides results of a brief assessment of groundwater resources and water supply systems at selected parts of Nonouti atoll, Kiribati from 11 to 18 October 2003 as part of the Technical Assistance to the Republic of Kiribati for National Water Resources Assessment and Management (Asian Development Bank TA 6031 REG) – Promoting Effective Water Management Policies and Practices. The visit was made in conjunction with other members of the Project team and a representative of the Water Engineering Unit of the Ministry of Works and Public Utilities.

The overall purpose of the project visit was to seek the views of the community about water supply and water resources issues, to assess current water supply systems and to undertake a preliminary water resource assessment for Nonouti.

Nonouti in the Southern Gilbert group is the third largest in the group after Tabiteuea and Tarawa, with a land area of 19.9 km^2. The island, shown in Figure 1, is bow shaped and approximately 50 km long with a half loop at each end. On the northern side a series of islands exist which are difficult to reach since they are cut off by several passages without causeways. The population on Nonouti according to the 2000 census is 3,176.

The majority of the villages with high population are immediately south and north of the airport, which is situated between Rotima and Autukia. The Island Council's office is located in Matang as well as the main hospital.

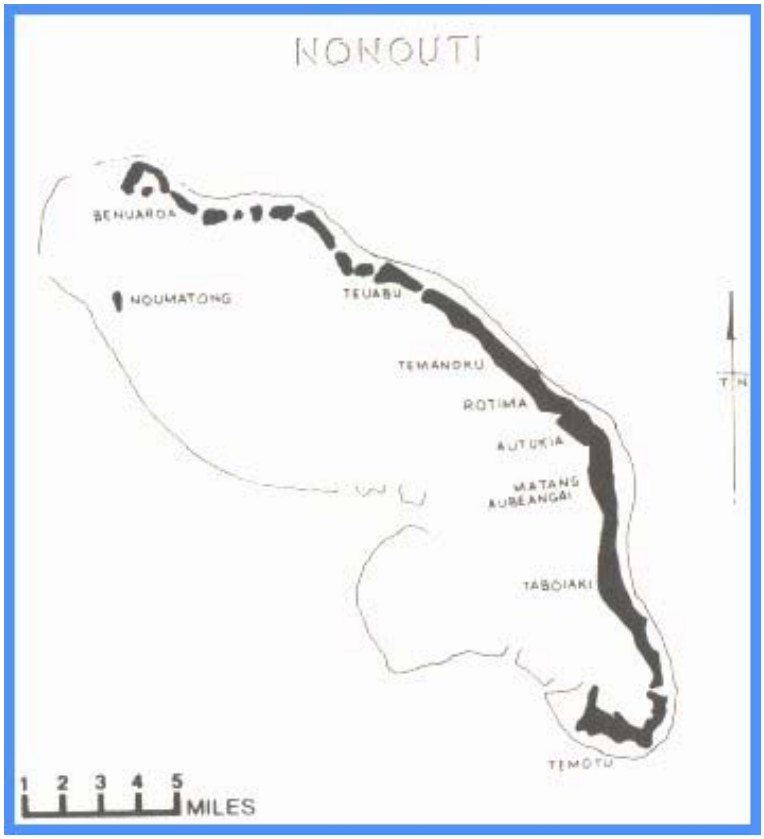

Figure 1. Nonouti.

WATER RESOURCES

There is little information on the water resources on the island of Nonouti. Rainfall has not been recorded since 1990 since the rainfall gauge stationed at the secondary school at Rotima broke and was never replaced. An average annual rainfall of 1,507 mm was calculated, based on earlier data from 1953-1990 (station J62000).

Based on rough calculations the probable lens area and sustainable yield can be estimated as 9.56 km^2 and 1,722 m^3/day, respectively, as calculated by Falkland (2003) based on estimates by Shalev (1992) are shown below:

Table 1. Nonouti Statistics.

Average Annual Rainfall (mm) [1]	Total Land Area (km^2) [2]	Probable Lens Area (km^2) [3]	Population (2000) census [4]	Estimated Sustainable Yield (m^3/day) [5]	Estimated Daily Yield per person (L/p/d) [5]
1,507	19.9	9.56	3,176	1,722	542

Notes:

1. **Rainfall data from summary in spreadsheet 'Rainfall, Recharge & Yield – Kiribati islands.xls'.**
2. **Areas from Kiribati Statistical Yearbook, 2002.**
3. **Probable lens areas from Shalev (1992).**
4. **Populations from Kiribati Statistical Yearbook, 2002.**
5. **Estimated sustainable yields (total and per capita) were calculated in spreadsheet 'Rainfall, Recharge & Yield – Kiribati islands.xls'.**

The projected water demand for the year 2004 was calculated for Nonouti as part of the 10-year draft water master plan with a low projection of 93 m^3/d and high 104 m^3/d (Shalev, 1992).

According to information from the Island Council and a report from the United Nations three inhabited northern islets of Nonouti, Abamakoro, Tebuange and Matabou experience severe saline water intrusion to the freshwater lens in periods of drought. An earlier assessment of the available water resources was made by UNDP on two islets Matabou and Teuabu where 17 Electrical Resistivity (ER) soundings were conducted (Hallet, 1992).

The study concluded that the islands of Abamakoro, Tebuange are too narrow to have a substantial freshwater lens. On Matabou (maximum width of approx. 300 m) the survey indicated a freshwater thickness of 5 m and a safe yield of 18 m^3/day, just enough to supply the population 30 L/p/d. On Teuabu (maximum width of approximately 700 m) a thickness was found varying between approximately 7 and 23 m sufficient for a daily extraction rate of 95 m^3/day. The Water Engineering Unit (WEU) of the Public Works Department (PWD) proposed at that time to construct a 15-km pipeline to supply the northern islands with water from Teuabu but this never materialized.

A special visit was paid to the northern islands of Tebuange and Matabou to assess the current situation and a more detailed report is documented separately.

An Electrical Conductivity (EC) meter is available to the water technician of Nonouti, Mr *Teimarane Teiroro*, but no regular measurements have been carried out to date and no record has been kept of any measurements. EC readings were taken with a SOPAC-owned meter Hanna Instruments (HI 9033) from selected wells in the village of Rotima and selected villages throughout Nonouti (see Table 2). Since almost all villages are located on the lagoon side of the island, those wells were selected located as far as possible towards the shoreline. GPS readings were taken at the exact location of each well and are available in a separate spreadsheet (available from the Secretariat on request).

Table 2. Electrical Conductivity measurements (September 2003).

Village	Electrical Conductivity (µS/cm)	Water level/ Depth of well (m below ref)
Abamakoro	No visit	No visit
Tebuange I	2510	2.2 / 2.6
Tebuange II	2680	2.0 / 2.3
Matabou	1940	1.5 / 1.9
Tekarobi	975	1.3 / 1.7
Tabonteba	771	1.0 / 1.5
Bikeititi	626	1.2 / 1.6
Tekonoka	910	1.1 /' 1.6
Tetua	800	1.2 / 1.5
Rotuma I	1180	1.2 / 1.7
Rotuma II	1250	–
Rotuma III	1400	–
George Eastman Sec. Sch.	1340	–
Tebatabuki	782	–
Makauro	1295	–
Umantenewei	670	–

Note: yellow = well water; dark yellow = pump water

From the above one can conclude that the salinity of groundwater is a problem in the northern islands of Nonouti with current EC readings of water from their only source, exceeding 2,500 µS/cm. This equates to chloride concentrations well above the WHO guidelines for drinking water of 250 mg/l. Other values measured on Nonouti indicate potable water from Teaubu towards the south until Taboiaki. Regular measurements of selected wells should be performed on a quarterly basis by the water technician.

When EC readings are compared with rough estimates for the width of the island, measured from the well site to the ocean, some correlation can be detected. The graph below in Figure 2 shows fresher water (lower EC readings) in the wider parts of the island.

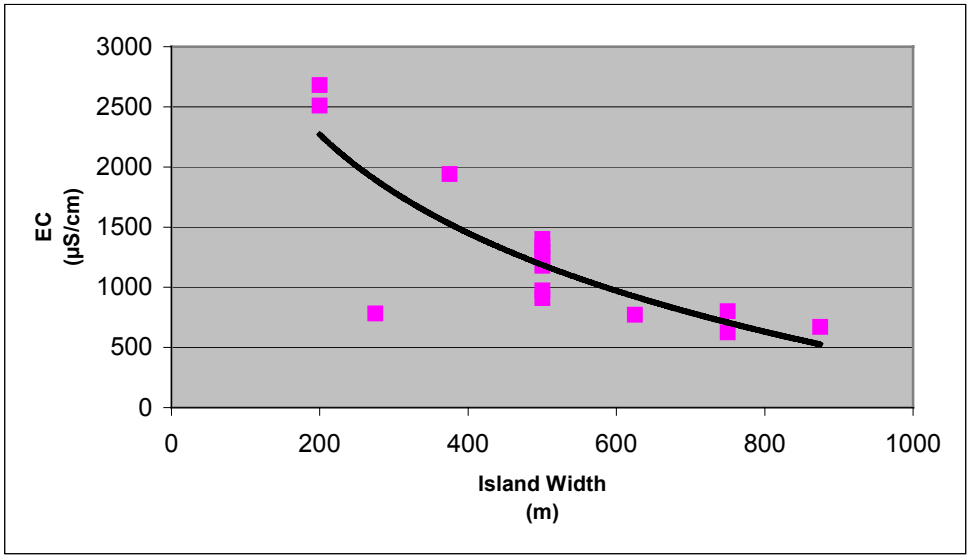

Figure 2. Conductivity vs. Island Width Nonouti.

WATER SUPPLY SYSTEMS

The water supply on Nonouti, like elsewhere in Kiribati's outer islands, exists mainly of shallow open wells located in or near the villages. A bucket or the locally produced *Tamana* pump is used to extract water and make it available to the household. A common feature in Nonouti is water distribution via half-cut open buoys or bottles at the well site connected to PE or PVC pipes to deliver water at the sanitation facility, bathing area or kitchen.

Improved water supply systems were mainly introduced under the Outer Islands Community Water Supply Project in the 1990s, funded by the United Nations Capital Development Fund (UNCDF). This project was carried out in 3 phases where in total 83 hand pumps, 8 solar pumps, 12 tanks, 49 wells and 40 taps were installed in 19 villages of Nonouti.

A caretaker, or water technician, was appointed as part of the project. Manuals were distributed on service and maintenance of the hand pumps and solar pumping systems as well as a booklet on clean water and sanitation and community involvement. Maintenance reports from the water technician have not been available since 26 June 2002 but an update of the condition of the systems is provided in Table 3.

Table 3. Updated maintenance report on Nonouti water supply systems (situation as of September 2003).

Village / School	Population	Description of the Water Supply System	Condition of the Water Supply System
Abamakoro	118	1 well, 4 hp, 2 tanks	4 hp not working
Teitinikarawa Pri Sch		1 well, 3 hp	3 hp not working
Tebuange and Matabou (Benoaroa)	130	2 wells, 2 hp, 2 tanks	1 rwh working, 2 hp not working
Tenanoraoi		1 well, 3 hp	2 hp working, 1 hp not working
Tabiang		1 well, 4 hp	2 hp working, 2 hp not working
Teuabu	313	8 wells, 10 hp	3 hp working, 7 hp not working
Temwanoku	280	5 wells, 12 hp	2 hp working, 10 hp not working
Routa Pri Sch		1 sp, 1 well, 3 taps, 1 tank	1 sp not working
Peace Corps Pri Sch		2 sp, 1 well, 10 taps, 1 tank	2 sp working
Rotuma	725	8 wells, 10 hp	2 hp working, 8 hp not working
George Eastman Sec Sch		1 sp, 1 well, 12 taps, 2 tanks	1 sp working
Autukia	136	2 wells, 4 hp	2 hp working, 2 hp not working
Tauraoi Pri Sch		1 sp, 1 well, 6 taps, 1 tank	1 sp not working
Matang	600	6 wells, 12 hp	3 hp working, 9 hp not working
Amy Pri Sch		1 sp, 1 well, 4 taps, 1 tank	1 sp not working
Taboiaki	698	5 hp	1 hp working, 4 hp not working
Tekabanei Pri Sch		1 sp, 1 well, 2 taps, 1 tank	1 sp not working
Temotu	176	5 wells, 10 hp	4 hp working, 6 hp not working
Tiantaake Pri Sch		1 sp, 1 well, 3 taps, 1 tank	1 sp not working
Mwakauro		1 well, 4 hp	4 hp not working
Total no of water supply systems	**91**	8 sp, 83 hp, 12 tanks, 49 wells, 40 taps	3 sp working, 21 hp working
Total population	**3,176**		38 % sp and 25 % hp working

Note: sp=solar pump; hp=hand pump; white=village; yellow=primary school; dark yellow=secondary school

According to this latest information over ¾ of the hand pumps is not longer working and 5 of the 8 solar pumps have broken down.

With regards to the choice of technology the following observations can be made:

Handpumps

During the 1st phase of the UNCDF project, Southern Cross diaphragm pumps were selected on the basis of their ability to draw low discharges from up to 750 m, which was thought essential to allow extraction from areas well away from habitation. In practice, very few of the hand pumps were located at such long distances.

Before the installation of pumps in Kiribati was completed the manufacturer of the Southern Cross pumps announced that the model supplied would be taken out of production. Spare parts were stocked in limited quantities at the Water Engineering Unit in Tarawa and additional parts from the manufacturer would only become available at an increased cost and would have to be ordered through the Public Works Department.

Spare parts and funding were mentioned as the main constraints of the households in Nonouti to maintain the hand pumps. Then, as part of the UNCDF project, the appointed water technician had limited capacity to prevent the breakdown over time of the Southern Cross hand pumps mainly due to the difficulty in accessing spare parts. The Water Engineering Unit (WEU) assisted as long as possible with very limited financial means to address existing problems (identified mainly through the water technician's maintenance reports) and limited availability of spare parts. The stock with remaining parts for the Southern Cross pump is now almost depleted.

There was no other mechanism set up by the project nor the Island Council to look after operation and maintenance of the systems at island level or to create a larger degree of ownership.

Systems implemented as part of the UNCDF project are still regarded as being government-owned and as such responsibility for maintenance lies entirely outside the community or households.

As a result many of the PE pipe systems have been taken out of the ground and are now being used for other purposes such as the water delivery from the well to the household via the buoy system. The standpipes and other leftovers of the Southern Cross Pump can be found abandoned or are replaced by the locally produced *Tamana* pump. The latter is frequently done with the assistance of the water technician.

The *Tamana* pump (in other areas known as Marakei pump) is made of PVC pipe and fittings and can be locally produced. It is an excellent example of a community-managed system with the financing, building, ownership, operation and maintenance by individual households. The water technician assists households with purchase of material, installation and repairs of *Tamana* pumps. Further improvements of the design should be investigated to increase the durability of these systems. It is estimated that around 100 *Tamana* pumps have been installed on Nonouti at a cost of circa AU$50 each.

Solar pumps

The 2nd Phase of the UNCDF project saw the installation of medium and large solar pumping systems at the George Eastman Secondary School, which included a relatively short infiltration gallery with a solar pump. The medium-sized system consists of a 0.33 Hp solar-powered pump/motor connected to four solar panels. The system at the secondary school in Rotima seems to experience no problem and is kept in good condition with adequate protection from vandalism and regular maintenance by the water technician. The storage capacity of the system with two 5,000 L tanks proves insufficient since the tanks are overflowing in day time and fall dry during the night.

Water supply at most primary schools was addressed during the 3rd Phase of the UNCDF project where small-scale solar pumping systems were installed consisting of 0.125 Hp solar-powered pump/motors connected to a single solar panel. The systems proved to be very fragile and pumps frequently broke down due to sediment being sucked in the pump. Almost all these systems (5 out of 7) on Nonouti are not longer working. The spare part programme of the WEU for this type of pump is planned to be scrapped.

Rainwater harvesting

Very few rainwater-harvesting schemes were implemented as part of the UNCDF project. Most houses on Nonouti have thatched roofs making rainwater collection practically impossible. Where corrugated roofs exist only occasionally use is made of full guttering and optimal storage. The mostly-used 5000 L PE storage tanks seem to perform well. The guesthouse in Nonouti has one unused tank at the moment. Several churches on Nonouti have successfully-operating rainwater harvesting systems.

SANITATION AND WATER QUALITY

Pit latrines have been widely installed with financial assistance of the Island Council and technical support from the water technician and the Health Officer. Although awareness on the positioning of the pit latrine in relation to the well (20-25 metres and not in-line) seems generally present in the community, demonstration on the use of the latrine is still required since a large majority of the population still prefers to go to the beach instead.

Pigpens should also be located away from the well and not in-line. Village wardens check the pigpens and fences for well protection and fines can be issued through the water technician and court clerk if pigs are found unattended or protection of the well is inadequate.

Water quality of the groundwater can be tested upon request from the Health Officer to the Ministry of Health in Tarawa. This is occasionally done when many cases of diarrhoea are reported but the test results seem never to get transmitted back to the outer island. Monthly reports on diagnosed cases are provided to the Ministry of Health (MoH). More information on water quality testing should be collected from MoH as well as the village statistics on water-related diseases.

SUSTAINABILITY

From the update on the maintenance of the systems one can conclude that the majority of the systems installed as “improved water supply system” is no longer working after a period of 6-8 years.

Several causes can be provided for the lack of sustainability of this project with most importantly:

- Lack of ownership of the systems by the community;
- Inappropriate technology choice;
- Lack of institutional arrangements; and
- Insufficient government support.

These reasons were already recognised as early as 1995 long before the official closure of the programme. In a mission report by Burke (1995), mention was made of the identified risks being:

- Target beneficiaries are not well motivated to work voluntarily; and
- Island Council lack financial resources or motivation to maintain the water supply systems.

Possible solutions for the issues above were provided as increasing public awareness through a campaign and the setting up of an expenditure budget at the WEU for the maintenance of the facilities.

The above recommendations have either not been followed through or did not have the desired effect. It should be noted that in 1995 the Government of Kiribati made a 10,000 $ provision for the establishment of a revolving fund to stock spare parts and it was thought that the Island Councils would pay for shipping costs from Tarawa to the outer islands. The lack of ownership and involvement of the community in the UNCDF project was earlier reported for other islands by Mourits (1996).

According to the UNDP/UNCDF Project agreement Island Councils should play a key role in the implementation of rural water supply and sanitation schemes. The councils had the responsibility for the basic maintenance of hand pumps and contribute voluntarily labour and local materials under agreement with the Public Works Department (Shalev, 1992). The above indicates the intention to create ownership of the project through the island council. Combined with the limited community consultation and participation in the planning and implementation phases of this project the institutional arrangements have proved to be unsuccessful. For future water supply projects other mechanisms/models such as community-management (as opposed to the intended community participation) should be investigated.

A meeting with the Island Council (including the health officer, agricultural officer, water technician, community worker, women’s group worker) revealed that improved communication regarding water and health at island level was needed. The lack of transport and funds to execute duties assigned to respective parties were mentioned as major constraints. The establishment of an island water and sanitation committee was suggested to address main problems and facilitate existing roles and responsibilities.

RECOMMENDATIONS

Based on the visit to Nonouti, Falkland (2003) and other documents the following recommendations can be made:

- A new rain gauge should be shipped to the water technician and he should be encouraged to provide monthly reports to the Water Engineering Unit.
- New maintenance sheets and rainfall data sheets should be made available to the water technician.
- A well survey sheet for regular EC measurements should be designed and a monitoring schedule should be introduced including measurements at pumped water supplies (every 3 months).
- The health officer and the water technician should exchange information on water quality on a regular basis and jointly identify problem areas/villages. Water quality testing at public water supplies should be performed at least once a year and can include bacteriological tests and basic water chemistry parameters.
- The Island Council should be encouraged to make transport available for the above tasks.
- The Water Engineering Unit should assist the water technician in Nonouti with upgrading the existing hand pump systems by the provision of left-over spare parts for the Southern Cross units.
- More robust pumps should replace the malfunctioning 0.125 Hp solar pumps at primary schools or the systems should be re-designed altogether.
- Review both solar and hand pumps, list manufacturers and purchase/operating costs and make recommendations for improvements for current systems (sp 0.33 hp/0.125hp and Southern Cross/*Tamana* pumps). Note that the European Union is planning the provision of solar systems for individual households on the outer islands of Kiribati.
- The storage capacity of the water supply system at the secondary school should be increased (one extra 5,000 L tank).
- A detailed water resources assessment should be made for the whole island with particular emphasis on the situation in areas where saline water is known to occur in periods of drought, as well as at primary schools, the hospital and the larger villages. These investigations should include geo-electrical or electromagnetic surveys, drilling of groundwater monitoring boreholes, groundwater table monitoring, recharge estimation, water quality tests and estimation of sustainable yields.
- The performance of water supply systems and the water resources affected by pumping systems should be monitored on a regular basis.
- Rainwater harvesting should be promoted for all buildings with corrugated roofs. Full guttering should be utilised where possible and regular maintenance carried out. Rainwater catchment analyses can be carried out when implementation is planned at a larger scale.
- The introduction, application and financing of alternative pump systems like the *Tamana* pump should be further explored. Further improvements of the design should be investigated to increase the durability of these systems.
- Options for community self-improvement such as introduction of subsidies for construction of rainwater harvesting systems or *Tamana* pumps should be further explored.

- Training needs for the water technician were identified on operation and maintenance of solar pumping systems and electronics and alternative hand pump systems. General training on well surveys, water quality, sanitation and awareness should be added to this.
- A training programme should be developed on operation and maintenance of water supply systems for the water-engineering unit (training for trainers) with special emphasis on community-managed systems.
- The roles of the Island Council and government specialists (such as the health officer, agricultural officer, water technician, community worker and women's group worker) should be reviewed with respect to water and sanitation. Options for setting up an island water and sanitation committee should be explored including review of roles and responsibilities of parties.
- Options for ownership of newly-introduced systems are provided by Falkland (2003).

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