JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF WORKS AND ENERGY
REPUBLIC OF KIRIBATI

A STUDY OF UTILIZATION OF PHOTOVOLTAICS FOR RURAL ELECTRIFICATION IN THE REPUBLIC OF KIRIBATI

FINAL REPORT
MAIN REPORT

MARCH 1994

YONDEN CONSULTANTS CO., LTD.

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REPUBLIC OF KIRIBATI
A STUDY OF UTILIZATION OF PHOTOVOLTAICS FOR
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FINAL REPORT, MAIN REPORT
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FINAL REPORT

MAIN REPORT

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FINAL REPORT
FOR A STUDY ON UTILIZATION OF PHOTOVOLTAICS
FOR RURAL ELECTRIFICATION IN REPUBLIC OF KIRIBATI

C O N T E N T S

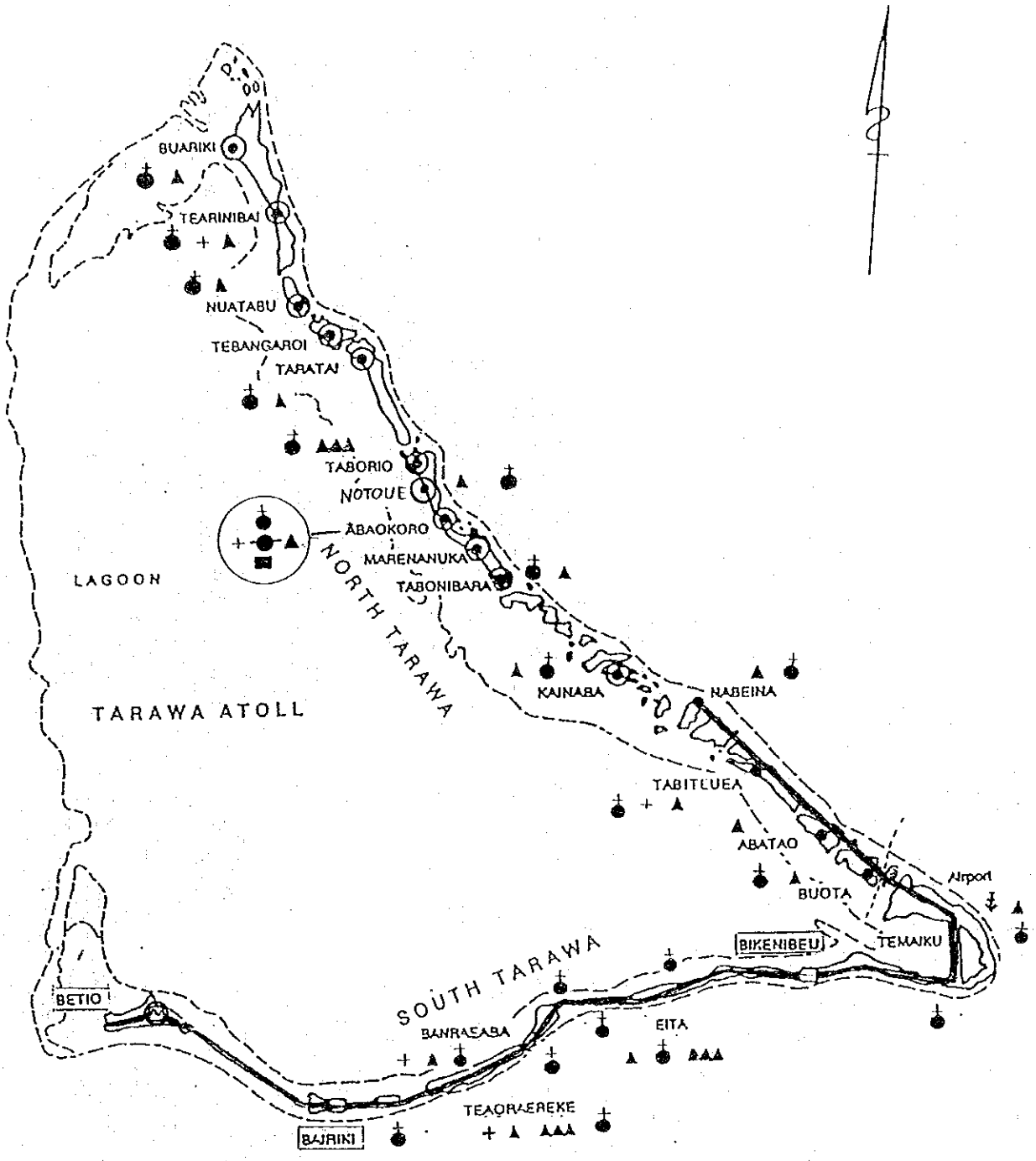
A B B R E V I A T I O N

4C	YONDEN CONSULTANTS CO Ltd.
AC	ALTERNATIVE CURRENT
AGM	ASSISTANT GENERAL MANAGER
Ah	AMPERE-HOUR
C/D	CHARGE AND DISCHARGE
DC	DIRECT CURRENT
EC	EUROPEAN COMMUNITY
EEZ	EXCLUSIVE ECONOMIC ZONE
FL	FLUORESCENT LIGHT
FOB	FREE ON BOARD
GDP	GROSS DOMESTIC PRODUCT
GNP	GROSS NATIONAL PRODUCT
HH	HOUSEHOLD
IEEJ	INSTITUTE OF ENERGY ECONOMICS, JAPAN
JICA	JAPAN INTERNATIONAL COOPERATION AGENCY
KOC	KIRIBATI OIL COMPANY
Kwh	KILO WATT-HOUR(1,000WATT-HOUR)
LED	LIGHT EMITTING DIODE
MFEP	MINISTRY OF FINANCE AND ECONOMIC PLANNING
MWE	MINISTRY OF WORKS AND ENERGY
Mwh	MEGA WATT-HOUR(1,000,000WATT-HOUR)
NEDO	NEW ENERGY AND INDUSTRIAL TECHNOLOGY DEVELOPMENT ORGANIZATION
NFB	NO-FUSE BREAKER
NPO	NATIONAL PLANNING OFFICE
O&M	OPERATIONS AND MAINTENANCE
PPM	PARTS PER MILLION
PUB	PUBLIC UTILITY BOARD
PV	PHOTOVOLTAIC(S)
RERF	REVENUE EQUALIZATION RESERVE FUND
SEC(KSEC)	SOLAR ENERGY COMPANY(KIRIBATI-)
SPMS	SOUTH PACIFIC MARINE SERVICE
TML	TE MAUTARI Ltd.
UK	UNITED KINGDOM
UNDP	UNITED NATIONS DEVELOPING PROGRAMME
VCR	VIDEO CASSETTE RECORDER
Voc	VOLTAGE OF OPEN CIRCUIT
pcs.	PIECES

TABLES & FIGURES

1. Figures

2. Tables



TARAWA ATOLL

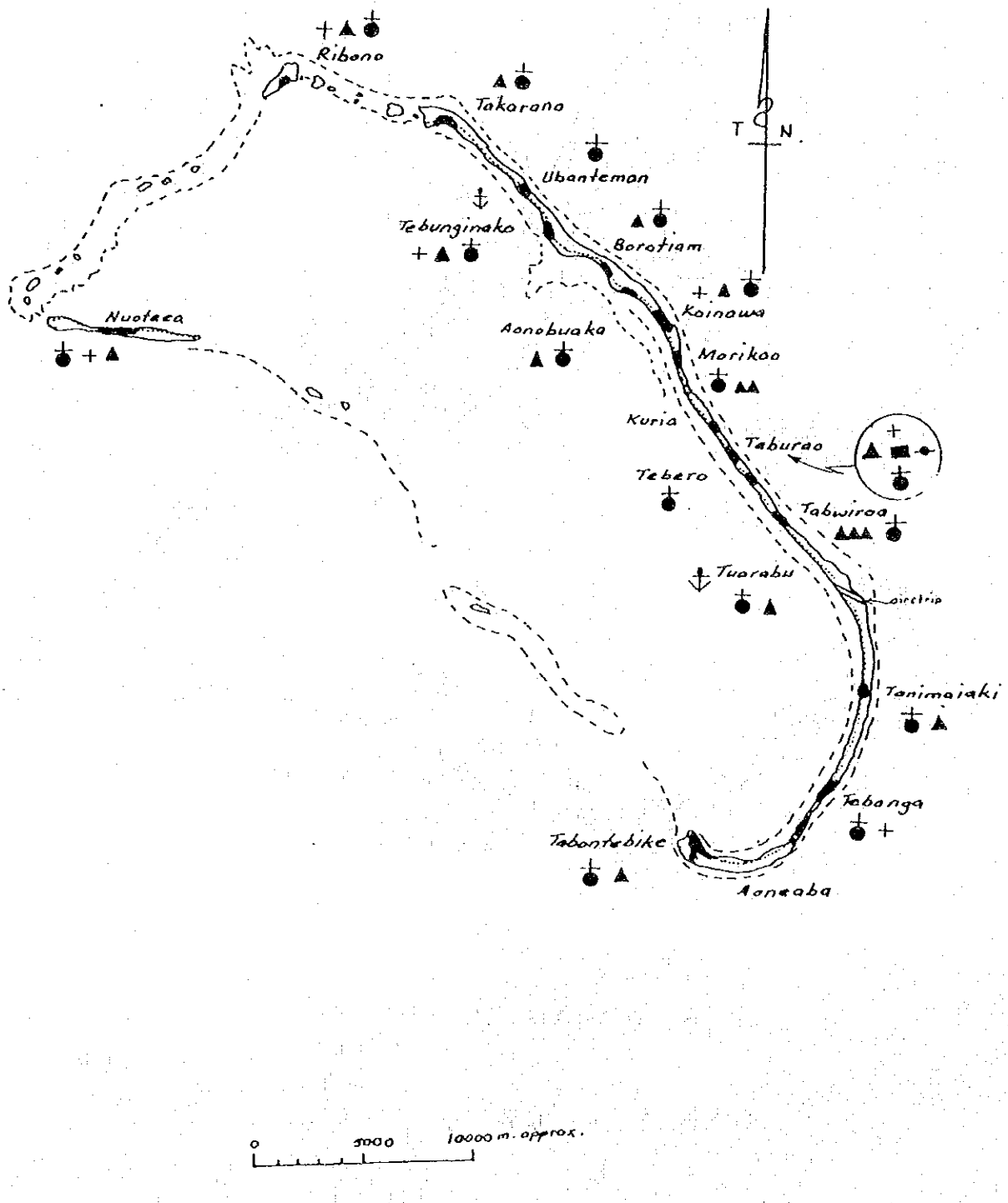
0 1 2 4 6 8 10 km

LEGEND

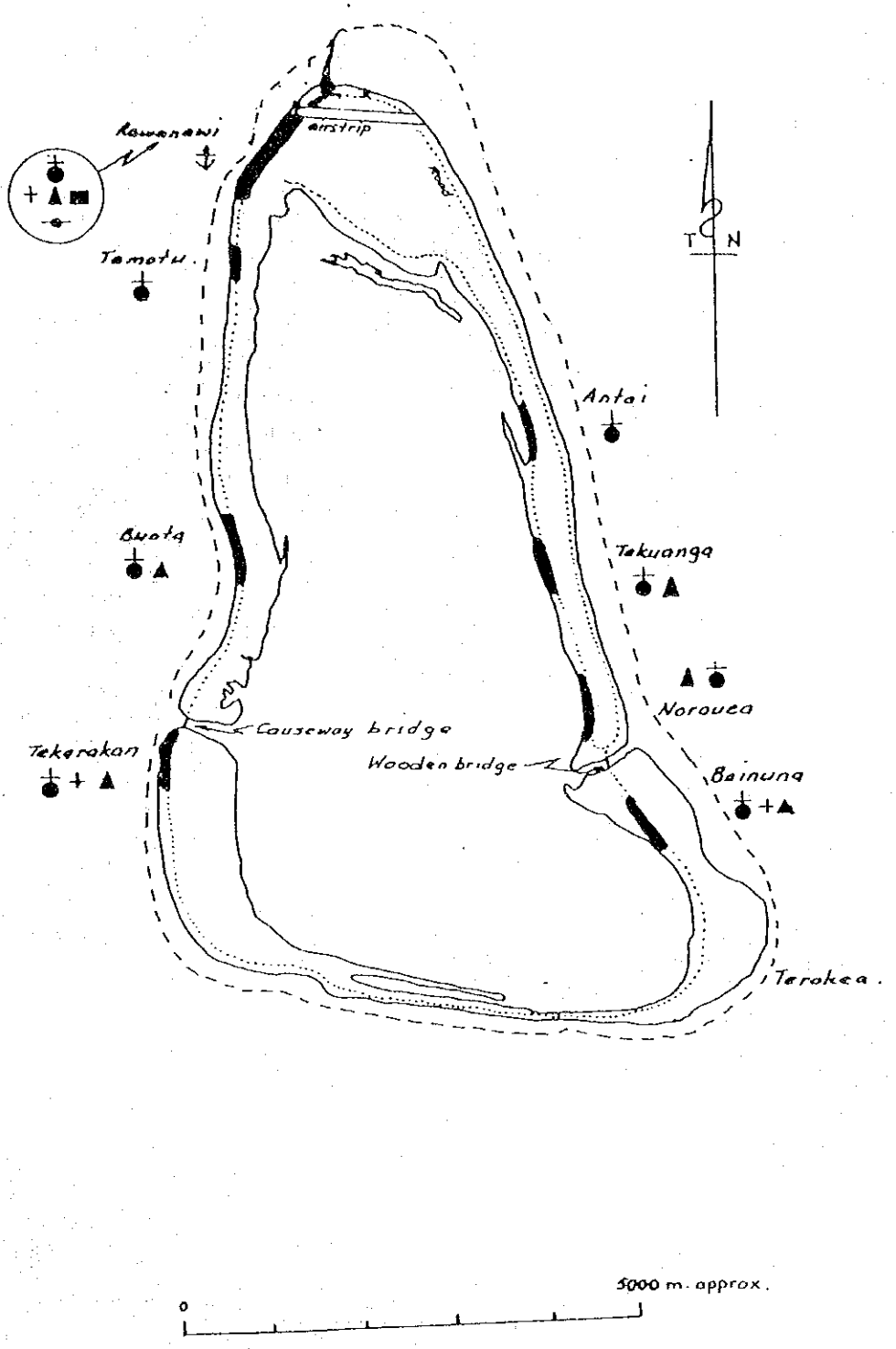
- Church
- Police
- Rest House
- Anchorage
- Clinic
- Hotel
- Generator
- Primary School
- Community High School
- Secondary School
- Administration Center
- Local Concil

MAP 20.4

ABAIANG ISLAND

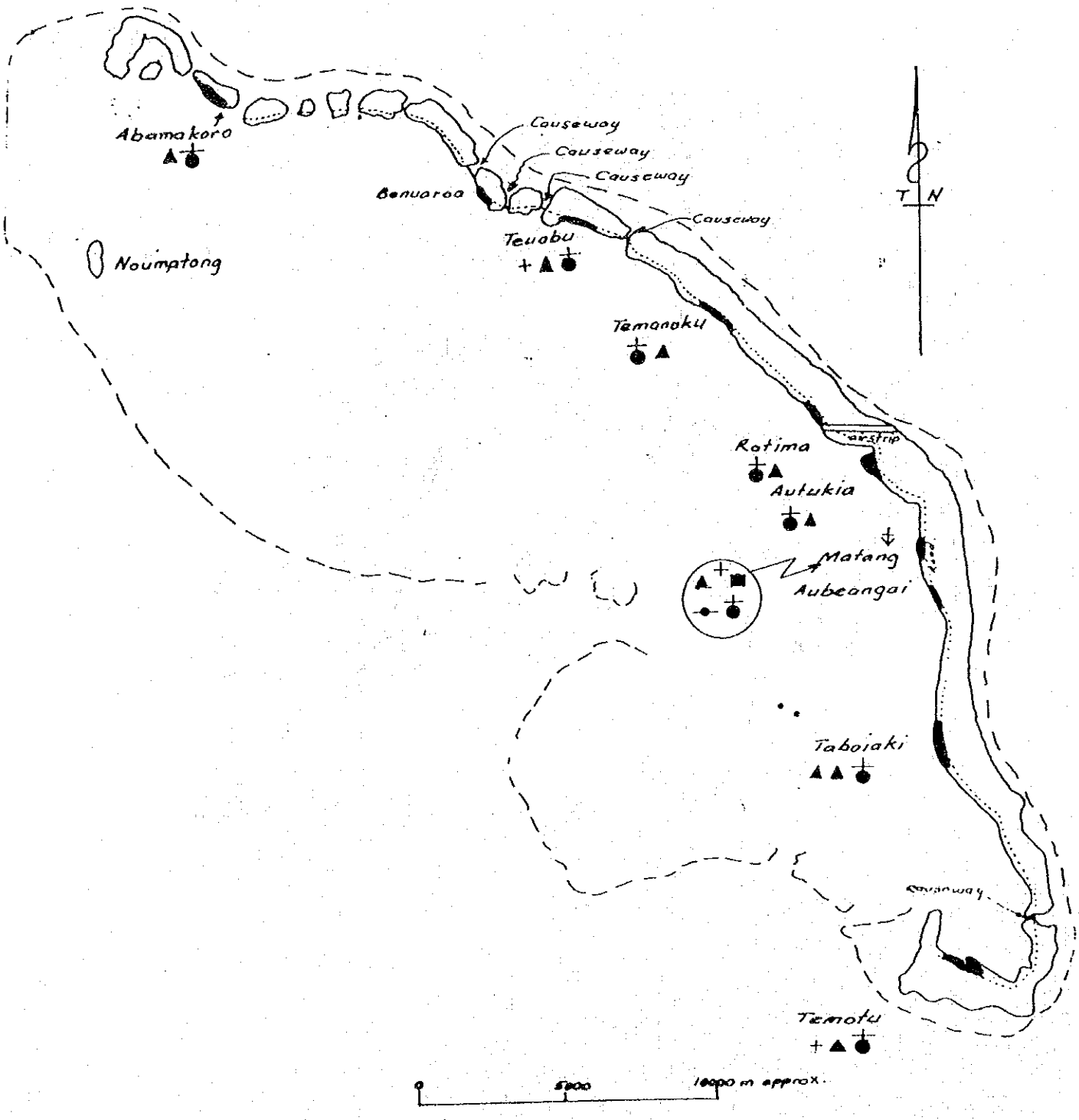


MAP 20.3 MARAKEI ISLAND



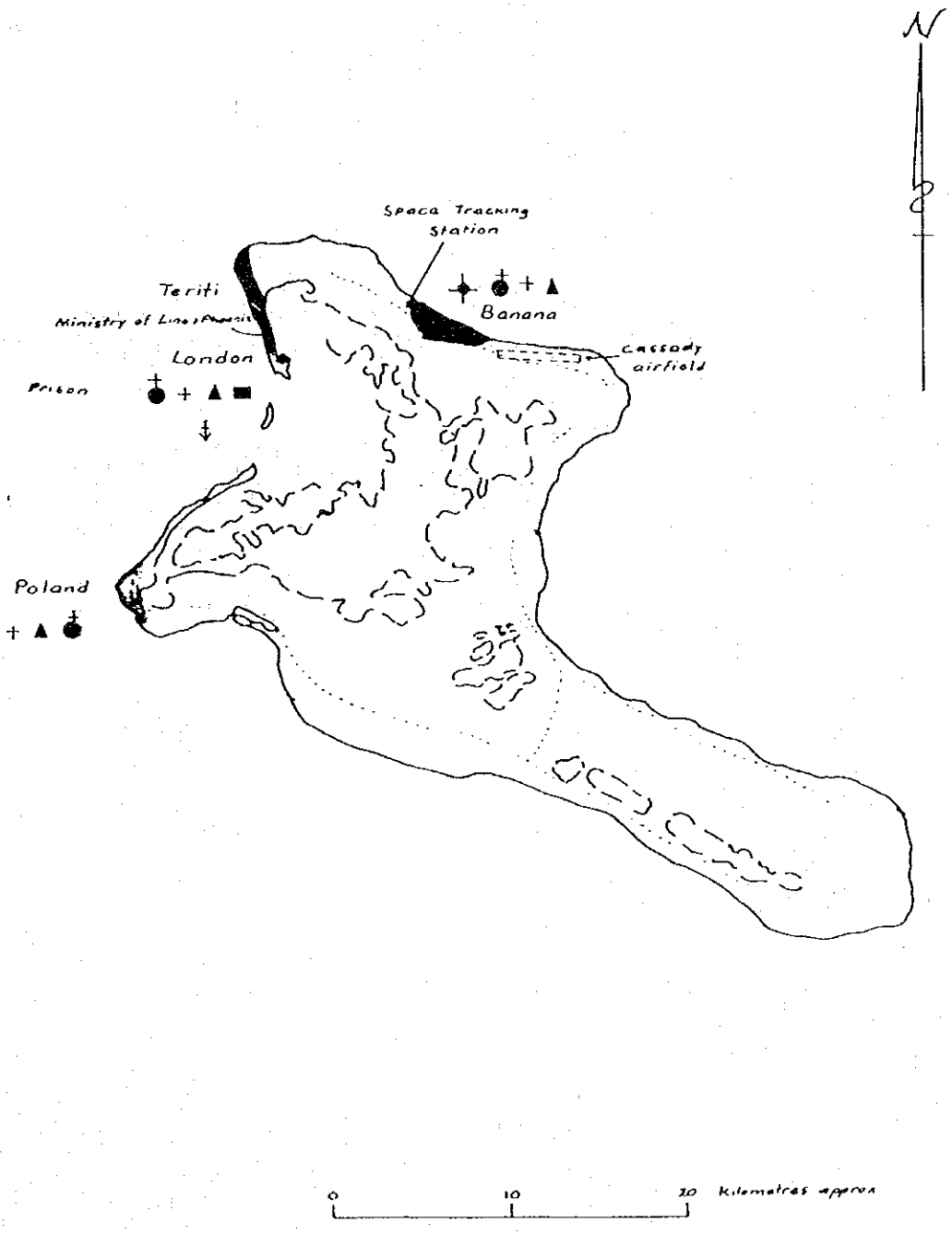
MAP · 20.12

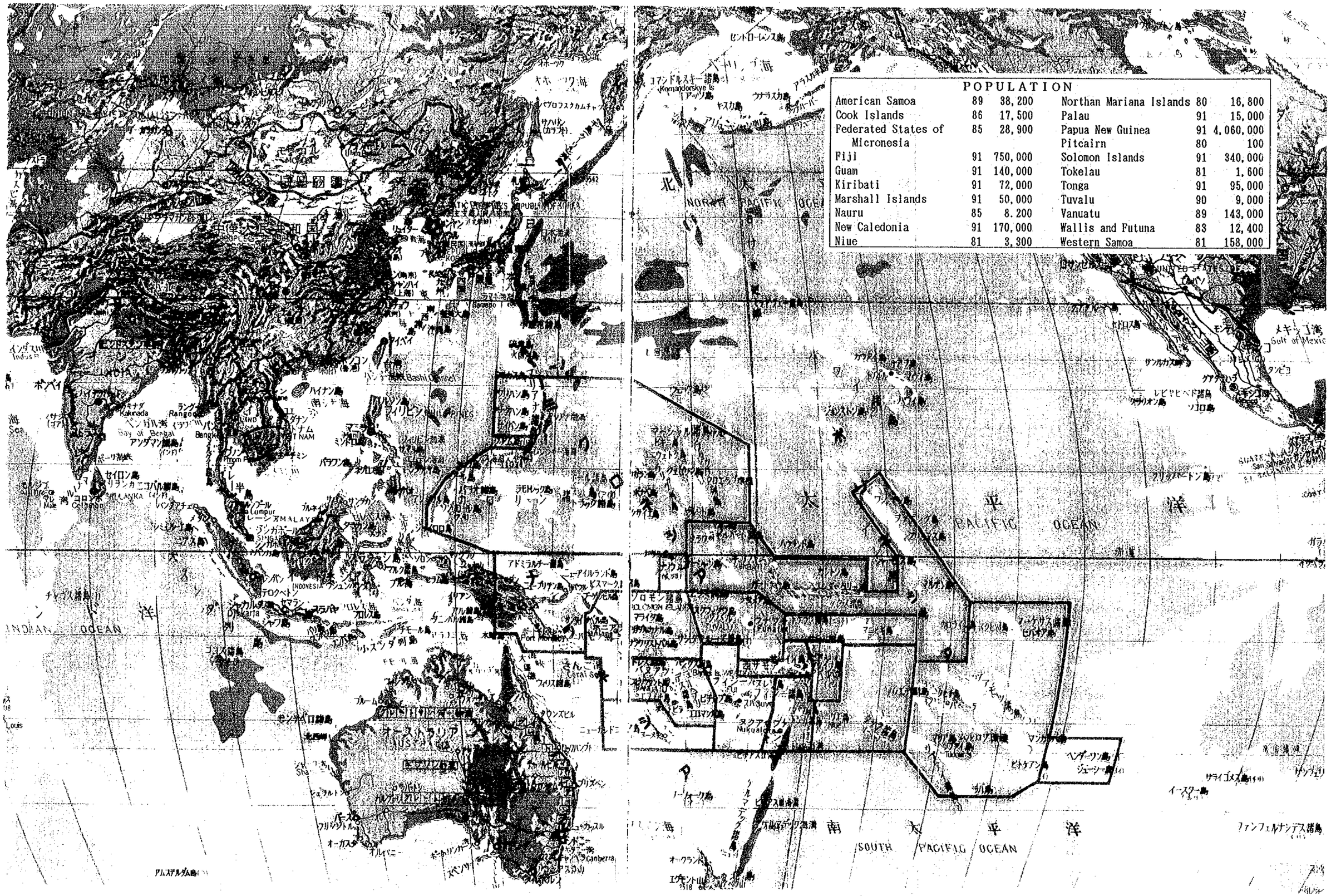
NONOUTI ISLAND



KIRITIMATI

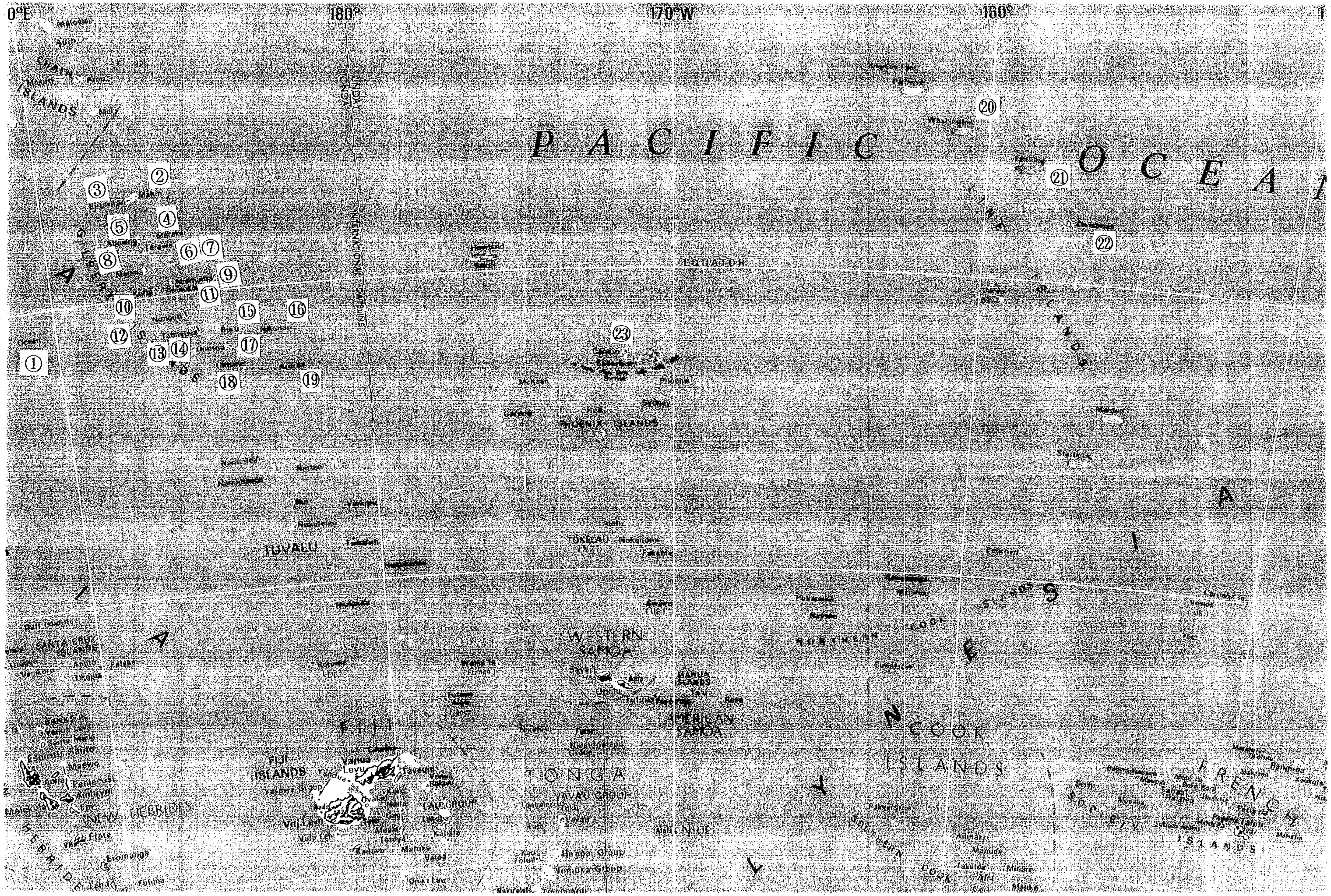
(CHRISTMAS ISLAND)





POPULATION

American Samoa	89	38,200	Northan Mariana Islands	80	16,800
Cook Islands	86	17,500	Palau	91	15,000
Federated States of Micronesia	85	28,900	Papua New Guinea	91	4,060,000
			Pitcairn	80	100
Fiji	91	750,000	Solomon Islands	91	340,000
Guam	91	140,000	Tokelau	81	1,600
Kiribati	91	72,000	Tonga	91	95,000
Marshall Islands	91	50,000	Tuvalu	90	9,000
Nauru	85	8,200	Vanuatu	89	143,000
New Caledonia	91	170,000	Wallis and Futuna	83	12,400
Niue	81	3,300	Western Samoa	81	158,000



180°
170°W
160°
PACIFIC OCEAN
EQUATOR
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
⑬
⑭
⑮
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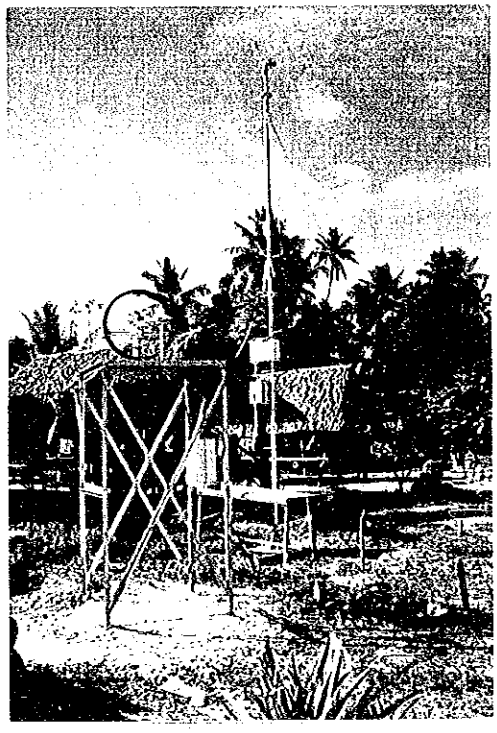
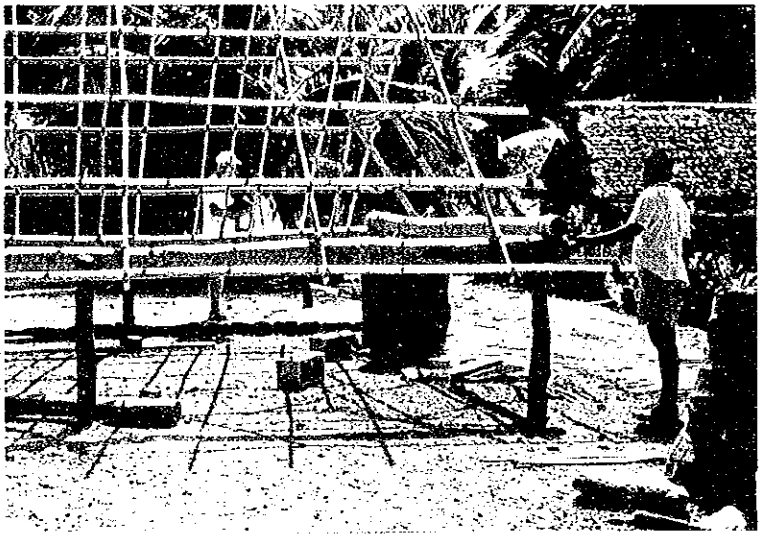
㉑
㉒
㉓
CHAIN ISLANDS
Makin
Tarawa
Ocean
Washington
Sydney
Hull
PHOENIX ISLANDS
TOKELAU
TUVALU
SANTA CRUZ ISLANDS
Tikopia
Espiritu Santo
Maewo
Pentecost
Ambrym
Malekula
NEW HEBRIDES
Efate
Eromanga
Tanna
Futuna
FIJI
FIJI ISLANDS
Vanua Levu
Taveuni
Yasawa Group
Ovalau
Viti Levu
Vatu Lele
Totoya
LAU GROUP
Lakeba
Kabara
Matuku
Vatoa
Ono-i-Lau
WESTERN SAMOA
Savai'i
Upolu
Apia
Tutuila
Pago Pago
MANUA ISLANDS
Tau
Rose
AMERICAN SAMOA
TONGA
VAVAU GROUP
Vavau
Ha'apai Group
Nomuka Group
NIUE
NORTHERN COOK ISLANDS
Suwarrow
COOK ISLANDS
SOUTHERN COOK
Atiu
Mauke
Mitiaro
FRENCH
Bora Bora
Raiatea
Moorea
Papeete
Tahiti
SOCIETY ISLANDS

Sign for Inception Report
March 1992

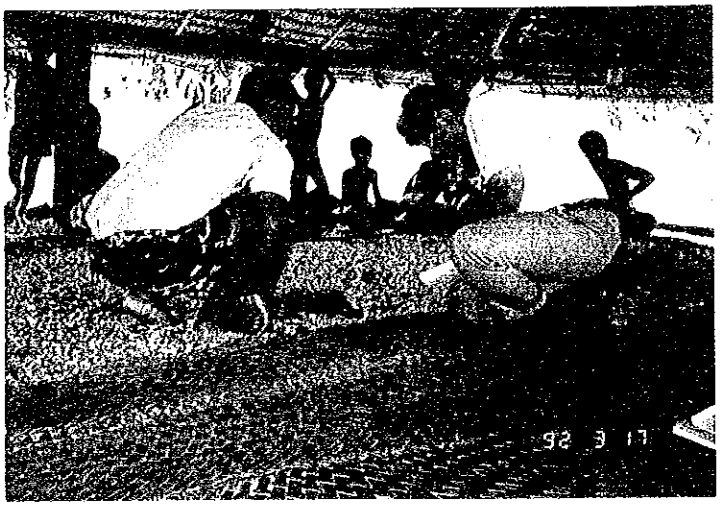


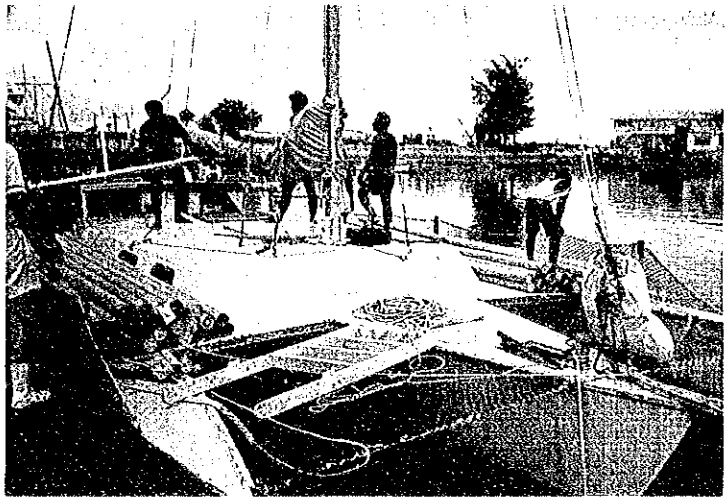
Meteorological Observation
System



Measurement for Detail Design
Size of House

Measurement for Detail Design
Luminous Intencity



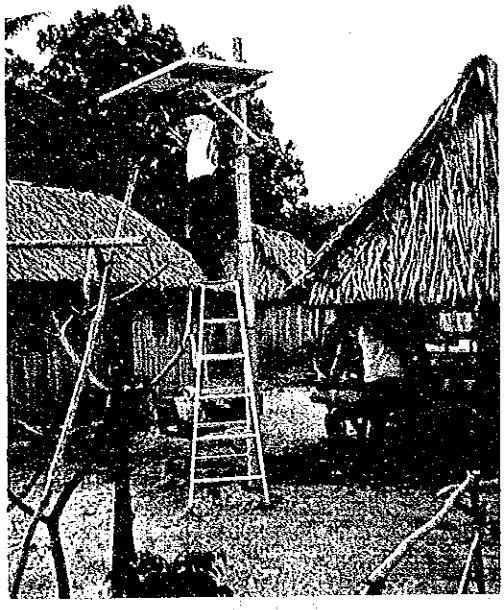


Transportation of Material
South Tarawa to North Tarawa

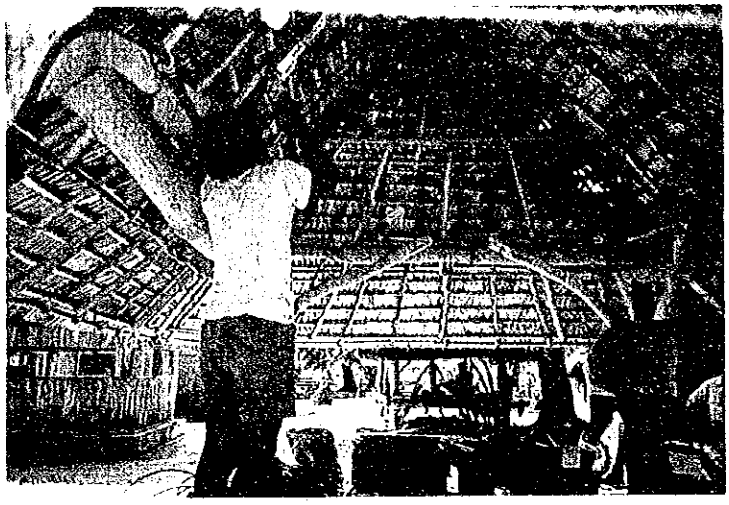
Transportation of Material
In North Tarawa

Assemble of Components

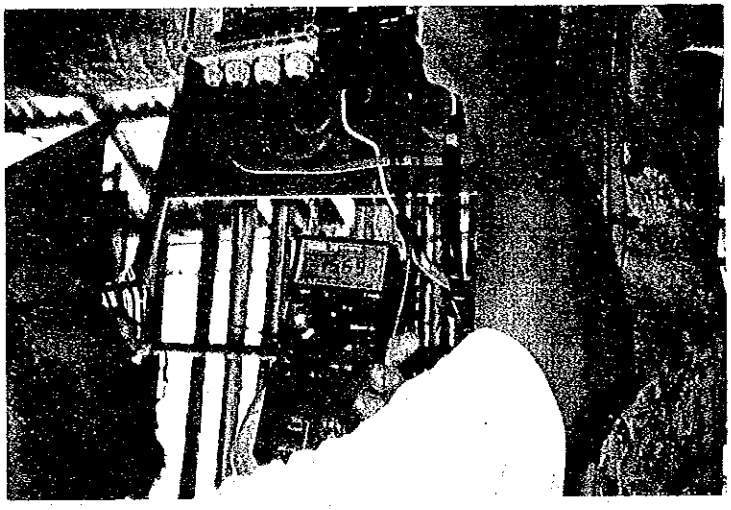
Installation of PV Module



Wiring of PV system
Outside of the House



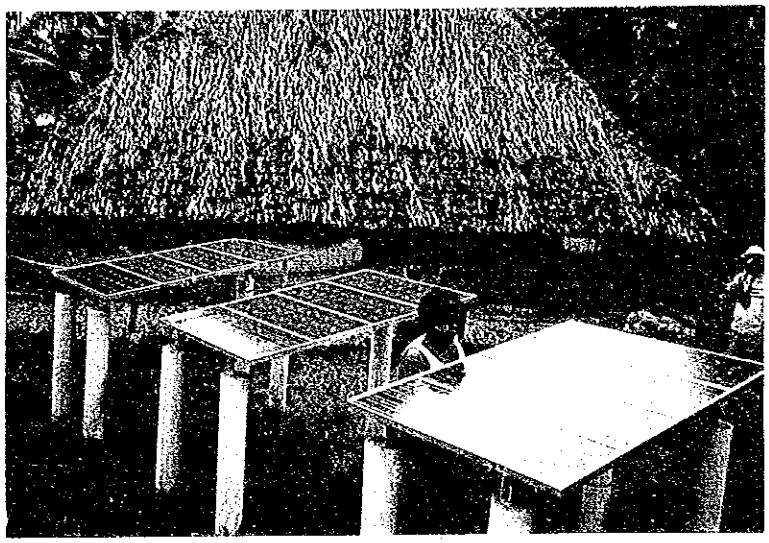
Wiring of PV system
Inside of the House



Check the system

Lighting of PV

Installed PV Panels
For Households



Installed PV Panels
For Maneaba

Night scenaries of
PV Electrified Households

Night scenaries of
PV Electrified Households

PREFACE

In response to a request from the Government of the Republic of Kiribati, the Government of Japan decided to conduct a Study of Utilization of Photovoltaics for Rural Electrification in the Republic of Kiribati and entrusted the study to the Japan International Cooperation Agency(JICA).

JICA sent to the Republic of Kiribati a study team headed by Dr.Masahide Takahashi of Yonden Consultants Co. Ltd., five times during the period from March 1992 to February 1994.

The team held discussions on the project with officials concerned of the Government of the Republic of Kiribati, installed the pilot plant of photovoltaics electricity supply systems at the study area and conducted the survey. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the rural electrification program in the Republic of Kiribati and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Kiribati for their close cooperation extended to the team.

March 1994

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

OUTLINE OF THE STUDY

I. Object of the study

(1) Clear the problems in rural electrification and desire for electrification of village people.
(2) Compare the PV system and Diesel generation system, suggest the plan of rural electrification and organizational arrangement.
(3) Install and operate the pilot plant to verify the sustainability of rural electrification plan by PV system.
(4) Suggest the full-scale rural electrification plan based on the experience of the pilot plan.

II.History of the study

(1) March 1988 "The study of utilization of solar energy in the South Pacific Island Country"
Conducted by Mr.Nonouti to introduce the Japanese technology on Photovoltaics for rural electrification in South Pacific Countries funded by NEDO.
(2) November 1989 Submitted "Terms of Reference for Technical Assistance of PV rural electrification" from Republic of Kiribati.
(3) December 1989 JICA Project Formation Mission Study
Nominated three Islands for PV electrification such as:
Nonouti, Marakei, and North Tarawa
(4) March 1991 JICA Preliminary Study Mission
The place of pilot plant was decided in North Tarawa by the request of the Republic of Kiribati.
(5) March 1992 The main study started (Inception Report)
The main consultant Yonden Consultants Co Ltd.
Institute of Energy Economics, Japan and South Pacific Institute for Renewable Energy(French Polynesia) collaborated.
(6) June 1992 the Second Visit
Designed 55 Household and one Maneaba
Installed Weather Observation Instruments in North Tarawa

(7) January 1993 the Third visit

Installed Pilot Plant in six villages of North Tarawa

55 Households and One Maneaba

Installed system:

	Household	Maneaba
PV array	60w x 2	60w x 12
Battery	100Ah x 1	100Ah x 4
Light	11w FL x 1 7w FL x 2 1w LED x 1	20w FL x 4
Controller	1	2

(8) July 1993 the Fourth visit

Survey the Pilot Plant and check the institutional system for maintenance, they worked well but pointed out some problems.

(9) January 1994 the Fifth visit(Final visit in the study)

Will check the Pilot Plant and discuss the result of the study

III. Photovoltaics electrification in the Republic of Kiribati

(1) Installed PV system in Kiribati

Before the JICA study, there are about 280 PV systems in Gilbert Islands. Most of them are workable but not maintained satisfactorily.

(2) JICA installed 56 systems in North Tarawa and are maintaining by SEC.

(3) EC(European Community)is going to install 250 systems in Nonouti, Marakei and North Tarawa in 1994 by the fund of Lome-II.

(4) UNDP(United Nations Developing Programme) is going to install some solar pump system in rural Islands.

SUMMARY

Rural electrification in the Republic of Kiribati is now being promoted in accordance with a mid-long-term project concerning national energy supply measures. We have selected an electricity supply method to optimally match the requirements based on our survey conducted on the inhabitants needs as well as considering the specific living environment, such as economic status of each inhabitant, and considering the equatorial weather conditions in this specific geographic area.

The following shows an overview of our proposal electrification project, including its electrification method.

1.Electrification of the Republic of Kiribati and Economic Capability of Inhabitants.

(1)Electrification Plan

The Government of Kiribati is now planning a project for the purpose of improving the rural inhabitants quality of life, by changing the existing light by kerosene lamp to a highly illuminated life with electricity. This includes a view toward the future where Kiribati citizen must inevitably face the new so-called Information Age, that the nation has not experienced before.

(2)Economic Capability of Inhabitants

It is very difficult for the nation to become financially self-sufficient, although an improvement-oriented trend as to economic capability can be perceived. In particular, economic capability of each rural inhabitant is almost none. Only those with an assured fixed income are governmental officials.Other inhabitants must ultimately depend on other countries for income by going on board a tuna fishing boat or becoming a worker to mine phosphorus ore or other overseas employers. Each inhabitant may be able to gain some income by locally selling coconut or fish, in addition to income from over-seas relatives but without development of transport and markets, the sales level will remain small.

2.Daily Life of Kiribati Citizen and the Climatic Environment

In a town, for instance South Tarawa in this country, where electricity, roads and bus transportation is provided, the inhabitants are able to live in a certain degree of modernized environment. However, in North Tarawa or other

rural area where several tens of houses comprise a village and many of inhabitants have to follow a life of self-sufficiency.

Kiribati there are many islands like North Tarawa, where inhabitants live in a subsistence economy. The following shows a typical state of such inhabitants.

(1)The Life of Inhabitants

(a)During the daytime :

Processing copra, processing handicrafts or catching fish.

(b)During the nighttime:

Going to bed, or in special cases attending group social events, listening to the radio or watching TV at a video tape in a Maneaba.

The following facilities are provided for recreational or cultural gathering or for exchanging information.

(c)Maneaba :

Inhabitants often have a meeting during both the daytime or nighttime. They often have a meeting or enjoy watching a video tape under fluorescent lamps illuminated by electricity provided by a small diesel generator. They seem to be fond of enjoying video taped dramas.

(d)Others:

- The radio station in Kiribati broadcasts for several tens of minutes, starting from each of the following hours:
  7 O'clock, 12 O'clock and 19 O'clock
- Only a high quality radio receiver can receive a radio program transmitted from abroad for 24hours. Especially during the daytime, a radio program transmitted from abroad cannot be received by the public.
  Inhabitants in a larger number of houses enjoy listening to the music from the radio. Tape cassette music is popular and there are a few houses having a video cassette player.

(2)Climatic Environment

This country is hot through out the year, since an average monthly temperature is as high as 27℃ and humidity is also high. The amount of solar radiation is approximately 1.4 to 2.0 times of that recorded in Tokyo, Japan.

3.Practical Electrification Project

(1)Basic Policy and Required Conditions

It is necessary for us to conduct surveys and to give training as described below in order to assist with the Republic of Kiribati in achieving its target for the local electrification project.

(a)Survey of each household for understanding inhabitant's needs

(b)Survey of economic capability whether or not each household can afford to pay for an electricity.

(c)Environmental survey whether or not the PV system can be installed.

(d)Survey on management capability of the organization,
Kiribati will have to carry out the project and termination of the guidance meet by that company.

(e)Survey on technical capability of implementation organization
As an electrical power service company and determination of the guidance to be given to that company.

(2)Policy for Project Development

As a result of our survey on the governmental organs and the living status of the inhabitants in rural sites, we have concluded that it will be the most economic method to install a small type PV power generator system in each household. Since the households are comparatively scattered, and we have also concluded with a policy as described below, through assuming a weak economic capability of the public and insufficient experience for management of SEC, a state owned corporation.

(a)Employing a solar generator system that is consistent with the actual state of each household providing enough power to light electric lamps.

- ·Sleeping room : 11W * 1
- ·Living room : 7W * 1
- ·Dining room : 7W * 1

(b)Amount to be collected from the customer for electric supply facilities.

- ·Installation costs (one time only) : AS$ 50
- ·Service(monthly) : AS$ 9

4.State of Execution

56 solar power generator systems have been installed, since this number of systems can be managed by The Solar Energy Company (SEC), a state owned corporation of Kiribati.

(1)Number of systems that to be managed by that company

·General houses : 55

·Maneaba : 1

·Meteorological observation system: 1 set

(2)Intermediate Assessment of Solar Power Generator System

The system is being operated without problems at each household. We need to monitor condition into the future, such as the amount of electrolyte to be required by the storage battery, etc.

5.Future Policy

Although the Republic of Kiribati has abundant fishery resources due to the vast ocean surrounding the country, it can be said that Kiribati has not fully utilized these resources at this time. It can also be said that the living condition of the nation can be improved to that found other nearby countries. Our conclusion is that the rural people of Kiribati may not be able to purchase enough kerosene or petroleum to further improve there lives, since any rapid growth of the rural economy is not expected in the future. We feel that the best method is to employ a individual PV system for each household, in order to enhance the living condition of the public from the current state of dependency on kerosene lamps to a higher level, where they can enjoy the advantages and convenience of brighter electric lighting.

Our intention is to disseminate this individual PV system among other inhabitants of the Republic of Kiribati so as to contribute to the improvement of the nation's culture and life as well.

The following shows the result of the survey, state of execution and assessment of this system.