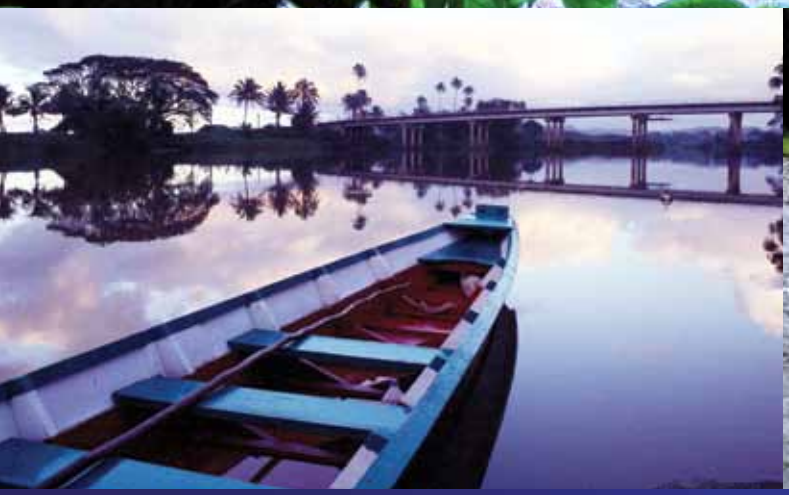
catalogue of

RIVERS

FOR PACIFIC ISLANDS



WMO

EUROPEAN UNION

UNESCO
United Nations Educational, Scientific and Cultural Organization

SPC
Secretariat of the Pacific Community
Applied Geoscience and Technology Division (SOPAC)

Acknowledgments

The compilation of information from around the Pacific and publication of this document is the result of a large number of people.

SPC would like to thank the following people for their contribution in making this publication possible.

Llyod Smith, Komal Raman, David Turner, and Linda Yuen for collation of the country and hydrological information.

Edwin Liava'a for production of many of the maps.

Marc Overmars for the initial discussions and ongoing support of the project.

Peter Sinclair, Llyod Smith, Amit Singh, Tiy Chung, and Bruce Stewart (WMO) for their contribution to the editing of the document.

Qoriniasi Bale Jr of 57 Creative for the graphic design and layout of the publication

Jan Stefan, Kevin Petrini, and Rajendra Prasad who provided support from within UNESCO to finance and assist in the completion of the publication.

Finally the staff of the National Hydrological Services and their directors in each of the Pacific Island Countries for their support in providing access to the information and their assistance in review of the document.

Published Date: January 2012

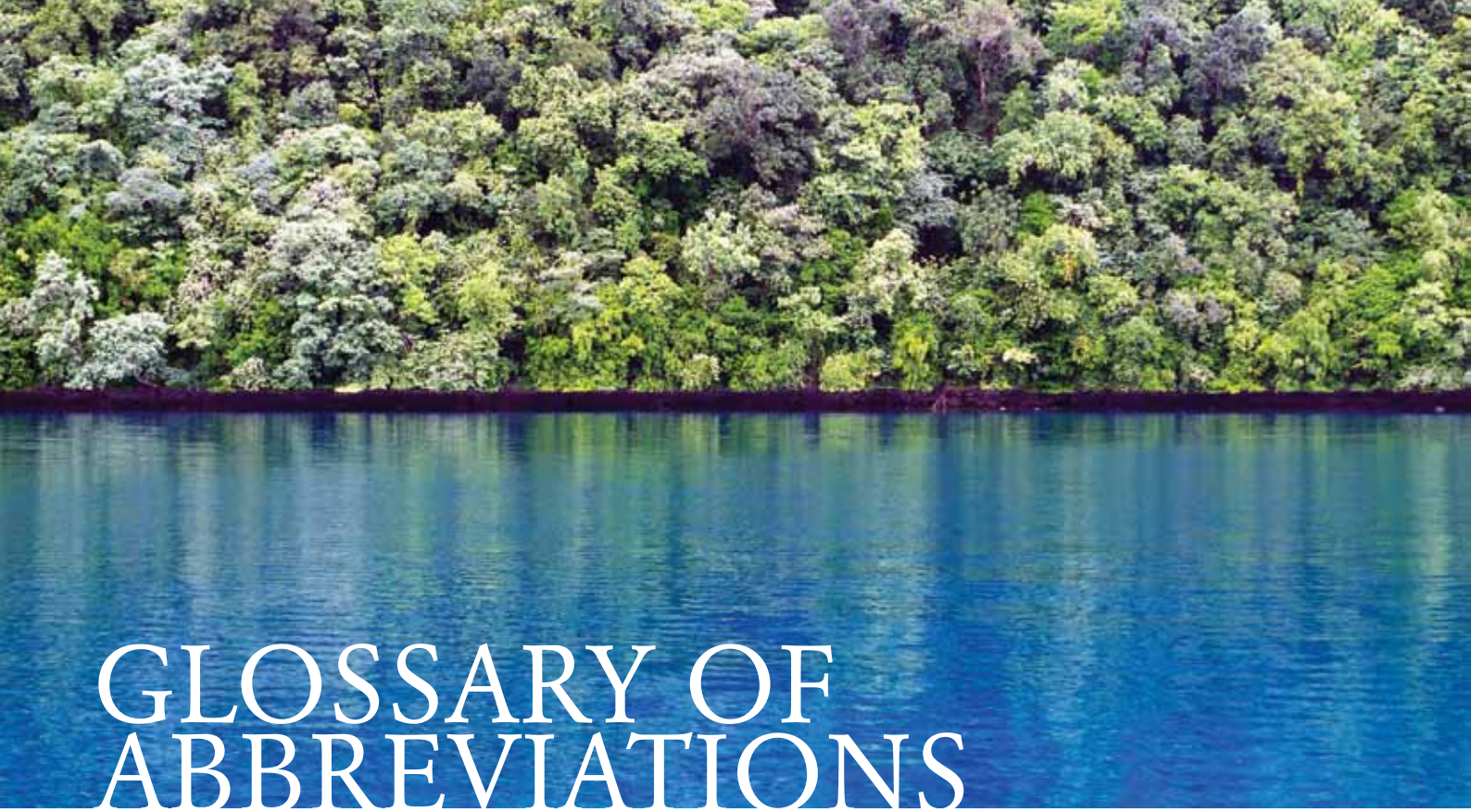
CONTENTS

Navua River at Nabukelevu, flood warning station

Nan Modal ruins, Pohnpei, FSM

Guadalcanal Plains, Solomon Islands

Sarakata Hydroelectric Power Plant Intake, Santos, Vanuatu



GLOSSARY OF ABBREVIATIONS

Rock Islands, Palau

4WD	Four Wheel Drive Vehicle
ADCP	Acoustic Doppler Current Profile
AusAID	Australian Agency for International Development
BWR	Bureau of Water Resources - Solomon Islands
CIA	Central Intelligence Agency
CSP	Conservation Society of Pohnpei – Federated States of Micronesia
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DGMWR	Department Geology, Mines & Water Resources - Vanuatu
DME	Department of Mines and Energy – Solomon Islands
DTCI	Department of Transport, Communication and Infrastructure - Federated States of Micronesia.
DWW	Department of Water Works - Cook Islands
EDF 8	8th European Development Fund
EPC	Electric Power Corporation - Samoa
EQPB	Environment Quality Protection Board - Palau
ENSO	El Nino Southern Oscillation
EU	European Union
FEA	Fiji Electricity Authority
FSM	Federated States of Micronesia
FMS	Fiji Meteorological Service
FWS	Flood Warning System.
GDP	Gross Domestic Product
GEF	Global Environment Fund
GS1	Gauging Station No. 1
GPRS	General Packet Radio Service
HYCOS	Hydrological Cycle Observing System
IHP	International Hydrology Program - UNESCO
IFD	Intensity, Frequency and Duration Analysis
IWRM	Integrated Water Resource Management
ITCZ	Inter-tropical Convergence Zone
LAWRM	Department of Land and Water Resource Management - Fiji

LNG	Liquefied Natural Gas
MNRE-WRD	Ministry of Natural Resource and Environment, Water Resource Division - Samoa.
MSL	Mean Sea Level
NCD	National Capital District – Port Moresby PNG
NGO	Non Governmental Organisation
NHS	National Hydrological Services
NIWA	National Institute for Water and Atmospheric Research
NOAA	National Ocean and Atmospheric Administration
NWS	National Weather Service – Papua New Guinea
NZAID	New Zealand Government's International Aid & Development Programme
PICs	Pacific Island Countries
PNG	Papua New Guinea
PPL	PNG Power Limited
PWD	Public Works Department
PUC	Public Utilities Corporation - Pohnpei
RSMC	Regional Specialised Meteorological Centre
SIMS	Solomon Islands Meteorological Service
SMEC	Snowy Mountains Electricity Commission
SOPAC	Applied Geosciences and Technology Division of SPC
SPC	Secretariat of the Pacific Community
SPREP	South Pacific Regional Environment Programme
SPCZ	South Pacific Convergence Zone
SWA	Samoan Water Authority
SW	Surface Water
TIDEDA	Time Dependent Data
UNESCO	United Nations Educational, Scientifc & Cultural Organisation
UNELCO	Union Electrique du Vanuatu
UN	United Nations
UNDP	United Nation Development Program
UNICEF	United Nations International Children's Fund
USA	United States of America
USGS	United States Geological Survey
VIBA	Vanuatu Island Bungalow Association
VMS	Vanuatu Meteorological Service
WaSSP	Water Sector Support Programme
WAF	Water Authority of Fiji
WERI	Western Environmental Research Institute -University of Guam
WHO	World Health Organisation
WMO	World Meteorological Organisation
WMO/UNICEF JMP	World Meteorological Organisation/United Nations International Children Fund Joint Monitoring Programme

Measurements

CUMECS	Cubic Metres per Second
CUSECS	Cubic Feet per Second
ML/day	Million litres per day
ML	Million Litres
MW	Mega Watts
Km	Kilometres
Km^2	Kilometre squared.
m^3/s	Cubic metres per second
mm	Millimetres

Waterfall upper Vaisigano River, Upolu, Samoa

PREFACE

The well known line from Samuel Taylor Coleridge's Rime of the Ancient Mariner, "Upon a painted ocean, Water, water, every where, And all the boards did shrink; Water, water, every where, Nor any drop to drink," paints a picture that could very easily apply to the Pacific Islands. The Pacific Ocean covers more than a third of the Earth's surface and contains more than half of its water. The Pacific Islands comprise 20,000 to 30,000 islands lying south of the Tropic of Cancer in the Pacific Ocean.

Pacific Island countries have uniquely fragile water resources due to their small size, lack of natural storage, competing land use and vulnerability to natural hazards. Islands in the Pacific have limited freshwater resources, increasing population pressures and increased vulnerability due to climate change. Better understanding of island hydrology is required for improved water resource management. On these small islands, sustainable management of scarce and often threatened freshwater supplies will only be possible if there is a sound hydrological information base. This is particularly the case in support of disaster risk reduction from floods for which the region is susceptible, especially during tropical depressions and cyclones. This document aims to characterize the type of rivers systems found within the region.

Despite this, many Pacific Islands Countries don't have sufficient hydrological data to help them plan for droughts and floods, prevent water contamination and water borne diseases, and better develop infrastructure, industry and urban growth. The data that currently exists is patchy and needs updating through data collection programmes by well resourced National Hydrological Services.

This document provides, for the first time, an important hydrological information foundation by reviewing the available data sets for Pacific Island Countries, and compiling them into a consistent style and format. Whilst the datasets are somewhat limited they provide a valuable understanding of the rivers, settings and reliance within the region. I firmly believe that it will be a valuable and highly sought after source of information for a range of users from professionals in the field through to government offices in planning and development as well as the general community within, and interested in, the Pacific.

I commend the document to your use.

Avinash Tyagi
Director
Climate and Water
World Meteorological Organisation
Geneva, October 2011

Nanpil River, Pohnpei, FSM

INTRODUCTION

The freshwater resources of the Pacific Islands are diverse, from islands where large rivers abound to countries where no surface water resources exist and whose people rely solely on rainwater for their potable and economic needs.

Common to all of these countries however is the need for easily accessible, relevant, and reliable water resources information to guide the development of future water needs. While domestic and potable needs dominant water use in the Pacific, there is growing demand and interest in hydro electric power generation, industrial use (mining, mineral water abstraction, light industry), and irrigation. Demands on the limited water resources are expected to increase in all areas into the future. Pacific Island countries are increasingly being required to make decisions on competing water demands, conflicting landuse, and social and economic impacts. Robust policies based on relevant, timely and accessible water resources information are required to support communities and government as they address the issues of sustainable water management practices for current and future generations.

Whilst many of the Pacific islands are blessed with abundant rainfall, it is not evenly distributed, making the Pacific countries susceptible to floods and droughts. The limited water storages, small land area, isolation, and less developed infrastructure reduce the resilience of these countries to cope with increasingly frequent climatic events of drought and flooding. In the larger islands the steeper terrain coupled with intense rainfall can often result in "flash" flooding which can have severe and sudden impacts on communities and infrastructure. Other issues including increasing levels of urban migration, population growth, and inappropriate or competing landuse activities, places additional pressure on the already limited and stressed water resources.

This Catalogue of Rivers for Pacific Islands provides a snapshot of the characteristics of major streams and rivers and the available water resources data for eight Pacific Island Countries, Cook Islands, Fiji, Federated States of Mircronesia, Palau, Papua New Guinea, Samoa, Solomon Islands, and Vanuatu. These countries have been selected for the significant surface water resources they have, and which they predominantly use for much of their water needs. This publication is a catalogue of the type of surface water information that can be found in the Pacific, providing an insight into characteristics of rivers within the Pacific and the difficulties Pacific countries face in the collection and maintenance of reliable hydrological data.

The Catalouge of Rivers for Pacific Islands has been made possible through the support of UNESCO' s International Hydrology Program (IHP). Additional support came from the European Union (EU), and the Secretariat of the Pacific Community's Applied Geoscience and Techniology Division (SPC/SOPAC), for the funding and technical support during the

implementation of the foundation project, Pacific Hydrological Cycle Observing System (HYCOS), from 2007 to 2010.

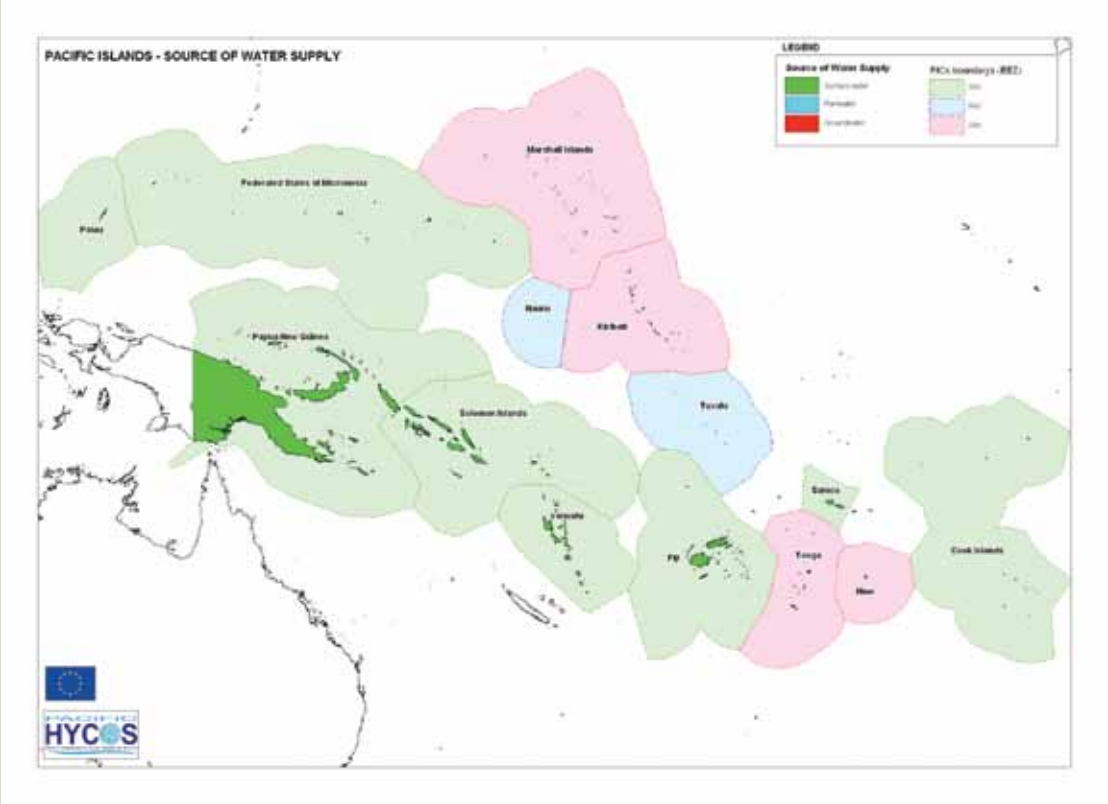
The Pacific HYCOS project was the first Pacific basin wide project to look at data collection and water resources information systems (surface water, groundwater and rainfall) with assessments being undertaken to a common standard across 14 Pacific Island Countries. Pacific HYCOS invested in equipment, training and capacity development, communications, and data management systems to assist the National Hydrological Services (NHS's) in all 14 countries to establish or retain hydrological sites and collect hydrological data efficiently to provide information for the sustainable development of their water resources. The data presented in this publication was made available to the Pacific HYCOS project through the support of the individual countries, and whilst it cannot be considered long term, continuous or in some cases particularly reliable, it is an accurate reflection of what is currently available within the Pacific.

The support and generosity offered by the hydrological officers, and their agencies, across all 14 countries, during the implementation of the Pacific HYCOS project, and their assistance in producing this publication is gratefully appreciated.

1.1 Pacific Environment

The attached map of the Pacific illustrates the considerable variation in size and distribution of the island groups throughout the Pacific Ocean. Delivery of hydrological support services continues to pose a significant challenge for projects, such as Pacific HYCOS, as well as for the respective NHS agencies, especially given their depleted institutional, capacity and financial resourcing situations. The Island groups are very widely dispersed and range from low coral atolls with water sources limited to fragile aquifers and rain water harvesting to high island countries with abundant surface water reserves.

Pacific Islands Countries showing location and predominant water sources



Waterfall, Tabercheding River, Palau

One of the unique aspects of the Pacific is the isolation of islands, both, between countries and within countries, and the relatively small, albeit often dense populations, which brings its own challenges. Isolation coupled with discrete water sources makes monitoring and management of water sources problematic with regard to access and coordination of resources, management and operation.

A small population with limited access to higher education opportunities further reduces the skill set which the countries and islands can draw upon. People are often called upon to perform more than one role, limiting their effectiveness.

However this isolation can also mean that in many cases the resources are often close to being in their natural state in comparison to the resources in more developed countries. Similarly the understanding of these resources is still developing, and as the reliance and development of these water sources increases, it is important to understand these rivers while they are still in a relatively natural state and from which existing and future changes can be compared against.

1.2 National Hydrological Services

The Pacific Island Agencies identified, correct at the time of publication, are responsible for collection and management of surface water Hydrological data:

Cook Islands – Ministry of Infrastructure and Planning, Water Works Division

Federated States of Micronesia – Department of Transport, Communications and Infrastructure

Fiji Islands – Water Authority of Fiji

Palau – Environmental Quality and Protection Board

Papua New Guinea – Department of Environment and Conservation

Samoa – Ministry of Natural Resources and Environment, Water Resource Division

Solomon Islands –Ministry of Mines, Energy, and Rural Electrification

Vanuatu – Department of Geology Mines and Water Resources

Of significance is that National Meteorological Services and National Geological Surveys in the Pacific are professionally staffed and well resourced and trained in comparison to National Hydrological Services (NHS's), who are normally part of a larger national agency, for example in Papua New Guinea, where hydrological services are part of the Department of Environment and Conservation. The result is limited visibility and financial support for hydrological services at a national level, with limited application of hydrological data for planning and decision making. In some countries there was no hydrological monitoring being carried out and the activities of NHS are severely restricted. At best only a few stations can be operated due to limited funding and demands on staff to perform in other capacities. An outcome of this minimal support and presence is that in general very little usable or reliable surface water hydrological information is available for the Pacific. The WMO publication (Report No 49 WMO – No 1003 2006) has been used to assist the NHS's in addressing, planning and mitigating these shortfalls.

2. PACIFIC HYCOS PROJECT

The Pacific HYCOS Project was implemented over four years, from 2007 to 2010. It was a regional water resources management initiative to improve assessment, management and protection of freshwater resources, by assessing water resources and building rainwater, surface water and groundwater monitoring networks for pilot river basins and aquifers.

The overall objective of the Project was to develop a sustainable level of capacity in participating Pacific island countries to monitor and assess the status and trend of their water resources, and to provide the water-related design data, information and hazard warnings needed to support national social, economic and infrastructural development and environmental protection.

Specifically the project assisted the participating countries to develop the human and institutional capacity to measure and assess the status and trend of national water resources and to provide adequate warnings of water-related hazards through the establishment or re-establishment of basic hydrological monitoring, databases and information systems, that provide national, sectoral and catchment users with relevant information on their water resources.

The hydrological data and information targeted for collection during the Pacific HYCOS project supported integrated catchment and water resource management and planning, sustainable development, and the Millennium Development Goals, in Pacific island nations.

Pacific HYCOS was implemented in 14 member countries including Cook Islands, Federated States of Micronesia, Fiji Islands, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

The project was managed by the Pacific Islands Applied Geoscience Commission (SOPAC) and implemented in partnership with the World Meteorological Organisation, Fiji Meteorological Service and the United Nations Educational, Scientific and Cultural Organisation (UNESCO).

3. WATER RESOURCE DATA IN THE PACIFIC

It has been most evident for many years that Although some countries operated reasonably robust hydrological operations up until the early to mid 1990's, this is no longer the case. Over the last decade, with few exceptions, surface water resource data in the Pacific Islands has been deficient and limited in its application. With little visibility, declining support, limited physical and financial resources, the networks that were previously in place have largely collapsed. In 2007, when the Pacific HYCOS project began, only the Cook Islands, Fiji Islands and Samoa had any operational surface water level stations.

Increases in climate variability will affect communities and their water resources. It is expected the demand for robust and reliable hydrological data, including rainfall data, will be required to better understand the impact these stresses have on communities and their water needs. This need for quality hydrological data is strongly supported by The Pacific Regional Action Plan (2003), numerous NGO's, consultants, and donors operating within the Pacific region. It is common for consultants in the Pacific to report on the general lack of accessible water resources data and information. Data made available is often short term, incomplete, with questionable confidence and limited application. This comment can extend to the National Meteorological Services (NMS's) in regard to updated design rainfalls (IFD or intensity, frequency duration analysis) used for rainfall runoff modelling for infrastructural design and flood studies. Insufficient stream flow data, or which is has low confidence can seriously compromise infrastructure design, flood mitigation projects, water management and planning, and the design of many other projects and developments.

The hydrological archives for the Fiji Islands and Papua New Guinea are quite large with much of their historic chart data processed. However, as with many PIC's, there is still a considerable amount of non-digitised and unprocessed chart and tabular data to be added to these archives.

Ramu River below Spillway, PNG

Of the data that has been processed, a review has identified that much of it was poorly processed, with significant errors in chart interpretation of floods, including chart reversals. Where hydrological data has been relied upon for infrastructure design, the implication of these errors can affect the integrity or longevity of the infrastructure. Much of this chart data would benefit from a review and in many cases re-processing using well trained staff. The recent use of data loggers and pressure sensors has reduced these problems but fundamental errors are still evident.

Maintaining a scheduled and regular field program, with essential site maintenance and discharge measurements has historically been difficult to implement and sustain in the Pacific. Despite access to modern field equipment and training through the recent Pacific HYCOS action, NHS's continue to have difficulty in maintaining regular field visits to collect the hydrological data. Visits are often irregular, whilst some NHS's are unable to even achieve these irregular visits, resulting in inconsistent data of limited application.

This inconsistency in site visits results in frequent gaps in the datasets and few discharge measurements taken across the widely ranging flow regime. These discharge measurements are essential for developing confidence in a rating curve for the stream from which flow data cannot be generated.

The hydrological database system adopted by Pacific HYCOS and which has been in use in the Pacific for over 20 years is the Time Dependent Data system, TIDEDA. TIDEDA, has been used for initial data input processing, data editing, and archiving for surface water, groundwater and rainfall data sets.

All surface water countries have a national TIDEDA database with various levels of populated water resource data. Additionally Pacific HYCOS established a regional data archive, used to safe guard the hydrological data against data corruption within countries. It relies on the national hydrological service to share their information and is not available to a third party without the permission of the country's hydrological agency.

4. DATA PRESENTED IN THIS REPORT

The examples of data presented in this report have been sourced from the TIDEDA datasets available at the completion of the Pacific HYCOS project, and represents archived data at the Pacific Islands Regional Hydrological

Database in SPC-SOPAC located in Suva, Fiji Islands. It consists of historically archived data, recently rescued data, and data collected during the period of the Pacific HYCOS Project. As indicated there still remains for many countries a significant volume of data that needs to be rescued from paper charts, tabulated data, discharge measurement forms, spreadsheets and other formats.

Few floods have been accurately measured in the Pacific and there is limited measured flood data in any country to support flood related community risk initiatives, flood mitigation, or water related infrastructure design. Apart from some exceptions, flow data cannot be presented with any confidence, and in general water level data only is presented. A structured approach for a comprehensive review of the available data sets is required to provide greater confidence of the available data. The time needed for this review process, if supporting information and records are available, is significant and for some of the larger archives, would amount to many person years.

The data selected for this report is based on the Pacific HYCOS pilot sites. They are, in most cases, stations which were previously operational but required Pacific HYCOS support to re-establish or update the equipment for their continued operation. Data collected from Pacific HYCOS sites is limited and generally the historic data has been presented. Hydrologically a minimum of 10 years of gap free data (or up to 2% missing record) is required to define a catchments hydrological regime. Data sets of flow data of this duration do not exist in the Pacific, and the periods of best available data are presented instead.

To date, catchment mapping in most PIC's has been on a project by project basis and some of this mapping was available to Pacific HYCOS. It is recognised that the application of GIS be greatly improved upon and should be a consideration for future support.

5. COUNTRY PROFILES

The country chapters follow a generic format where possible for consistency purposes. The general format used is as follows

- background on the relative country situation, including geography, climate, social and economic settings.
- available and relevant mapping.
- general water resources and specific study catchment information, followed by specific hydrological data from the Pacific HYCOS primary stations.
- Comment on the status of the hydrological data and its application.

6. TECHNOLOGIES USED

Unlike other countries, such as those in South East Asia, there has been no use in the Pacific of trained gauge readers living on site to act as caretakers and to read a rain gauge or a river or stream's water level gauge board on a daily basis. All Pacific data has been recorder based data measured on a paper chart, punched tape or more recently in electronic data loggers. In general there is no manual backup system used throughout the Pacific with a strong reliance on using instrumentation.

6.1 Historic

The earliest records of scheduled hydrological data collection within the Pacific are in Papua New Guinea during the Australian Colonial period where data collection activities commenced in the 1950's. The technology used during this period set the early standard for the PIC's.

Water levels were collected using stilling wells and float and weight chart recorders, operating strip charts for periods of up to one month between changes. Nitrogen gas bubbler systems and some pressure sensor based systems were also used. Some limited use was made of punched or magnetic tape and circular chart recorders. Rainfall data was collected using a range of

Local use of water La Colle River, Efate, Vanuatu

instruments but all were chart based. They ranged from siphoning gauges, tipping buckets or just manually read storage gauges. Data was extracted manually from these water level and rainfall charts and tabulated on paper tables for review and analysis.

The advent in the 1980s of electronic data loggers, electronic pressure transducer sensors, and improved gas bubbler systems, introduced new, and potentially more reliable, instrumentation for remote area data collection. Issues over site access, reliable power supplies, servicing intervals and human capacity, for this technology and electronics, did however compromise sustainable data sets being collected. As experienced elsewhere the introduction of computers improved the capture and analysis of datasets as well as quality assurance procedures and data archiving.

Stream flow gauging was done with current meters using the wading method, from moving boat or from a manned or un-manned gauging cableway using single or double drum winches. Both the Price type (cup) meter and the Propeller type (screw) current meters were used. There is no evidence of suspended sediment or bed load being measured on any of the rivers in the Pacific for any substantial period. Other commonly sampled surface water quality parameters including; dissolved oxygen, pH, turbidity, temperature, conductivity, nutrients, and biological and macro invertebrate sampling is available only for limited sites, normally as a result of specific project work.

6.2 Present

The Pacific HYCOS project adopted the view that existing technologies that were in use by Pacific island countries would continue to be used where appropriate, and to minimise unnecessary change where it was not warranted or requested. Technologies and equipment offered have been standardised across all participating countries to assist with training and serviceability within the region.

The following technologies were adopted and are currently in use. This new equipment was advanced to all of the surface water PIC's and they are now fully equipped to undertake the diverse activities associated with hydrological data collection.

Measurement of water level	
Gas bubbler system	Combined air compressor and sensing unit developed by Environmental Systems and Services Model 6100P, logging to UNIDATA 6004 multi channel data logger, solar powered using 40 aH batteries and 15 A panels
Float and weight system	Combined shaft encoder and datalogger unit logging rainfall also, developed by NIWA Model Hydrologger 2001, solar powered using 12 aH batteries and 5A panel
Telemetry	Both sensing systems are capable of logging rainfall and with the installation of a communications modem, are fully compatible with telemetry systems (GPRS, radio)
Software	Common to both systems is the Starlog management software which runs the logger from which the data is easily imported to TIDEDA . Rugged field PC's were also advanced to all NHS's
Support equipment	In order to undertake construction and Operational and Maintenance (O&M), considerable tools, support equipment and security housings were issued to the NHS's along with manuals, standard operating procedures, logbooks etc were provided
Measurement of stream and river discharges	
Heavy duty current meter	Propeller type meters were purchased with slow and fast water propellers, spare parts and calibration tables. The OSS B1 is manufactured by Hydrological Services in Australia.
Light duty current meter	Propeller type meters were purchased with slow and fast water propellers, spare parts and calibration tables. The OSS PC1 is manufactured by Hydrological Services in Australia.
Support equipment	Wading rods, counter units, tail fins, sounding weights, single and double drum winches, bridge/boat boards, bridge "A" frames, cable way components, suspended sediment samplers, gauging cards spare parts, manuals, standard operating procedures
Software	The TdGauge software was issued to all PIC's for calculation and archiving of discharge measurements. It is fully compatible with the TIDEDA database system

While the benefits of the Acoustic Doppler Current Profilers (ADCP) are clearly demonstrated in many developed countries, their application in the Pacific maybe of limited value given the significant expense for operation and maintenance required.

Measurement of rainfall	
Rainfall sensor unit	Tipping bucket rain gauges TB3, manufactured to Australian Bureau of Meteorology standards has been used. The TB3/0.5 mm rain gauge is manufactured by Hydrological Services in Australia. In some cases standard rain gauges SRG manufactured by Hydrological Services in Australia have been provided
Rainfall data loggers	The ML1 data logger manufactured by Hydrological Services in Australia has been adopted, due to its robust and reliable nature and can be fitted within the rain gauge casing. It has a 10 year battery life and capacity for 100,000 rainfall events
Support equipment	Calibration equipment, software, manuals and standard operating procedures. The WinComlog software allows for easy import into TIDEDA.

7. REFERENCES

CIA; 2011 World Fact Book; https://www.cia.gov/library/publications/the-world-factbook/

SOPAC, 2003; Pacific Regional Action Plan - SOPAC/ADB

SOPAC, 2007;Pacific HYCOS Implementation Plan – SOPAC

SOPAC, 2010; Pacific HYCOS Final Report – SOPAC

SPC PRISIM 2011; http://www.spc.int/prism/

Ward G, Ashcroft P, 1998; Samoa: Mapping the Diversity; Institute of Pacific Studies, USP

WHO/UNICEF 2010; Progress on Sanitation and Drinking water: 2010 Update Joint Monitoring Programme for Water Supply and Sanitation. ISBN 978 92 4 156395 6

WMO, June 1997; Water Resources Assessment Handbook for Review of National Capabilities

WMO, 2003; "Hydrological Data Management Present State and Trends" – WMO No. 964 2003

WMO, 2005; WHYCOS Guidelines - WMO/TD-No. 1282

WMO, 2006; "Guidelines on the Role, Operation and Management of National Hydrological Services" – WMO Operational Hydrology Report No 49 WMO – No 1003 2006

Replaced and New Technologies

A Stevens A71 Strip chart recorder installed in Samoa, using a stilling well and float and weight system. These were one of the primary instruments collecting data up until the 1990's, this one was still operational in Samoa in 2007. The A71 can also be used with gas bubbler systems. With good operational standards, they can still collect high quality data but the charts need digitising , replaced by digital loggers.

A recording rainfall gauge (circa 1950's) in Goroka, Papua New Guinea Highlands, using a Stevens A71 strip chart recorder with a float and weight system. These installations have been replaced with considerably more compact tipping bucket gauges and data loggers.

Papua New Guinea, Myola Lakes, Kokoda Track 1990, servicing an early tipping bucket rain gauge and MACE data logger, an early solid state storage system.

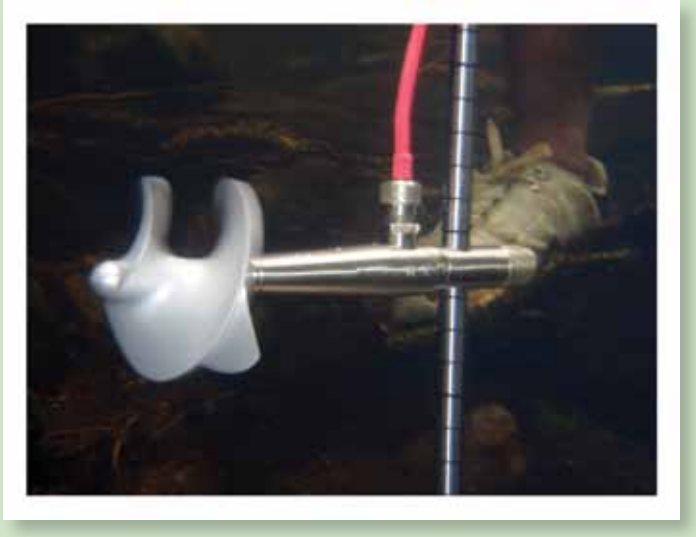
NHS technician configuring a Pumpro and Unidata system on the Nanpil River in FSM. A standard configuration showing data logger and pump/sensor and power module within security housing

A stilling well using high grade sewer pipe installed in the Solomon Islands, Rove Stream, using a Hydrologger with a float and weight system. Showing a compact rugged personal computer, used for data downloads and data processing.

The river end of a gas bubbler system, Nanpil River. It needs to be suitably located and built exceptionally strong to minimise damages in extreme floods, a typical mounting system using chemical rock bolts.

Tabercheding River, Palau, setting up for an un-manned cableway discharge measurement using an OSS-B1 current meter and 23 kg sounding weight.

Tabercheding River, undertaking discharge measurement using a single drum San sounding winch



A OSS PC1 current meter in use in the Cook Islands, used for undertaking discharge measurements on small streams

NHS technician at the Tina River, Solomon Islands servicing a TB3 raingauge. Note the compact nature of the ML1 data logger (the blue box).