



PACIFIC ISLANDS SCIENCE, TECHNOLOGY AND RESOURCES NETWORK CONFERENCE

19-22 November 2019
Holiday Inn, Suva, Fiji

ABSTRACTS BOOKLET



Landslides were experienced following the 5.3 magnitude earthquake event of 20 October 2019 near Kadavu, evidence of which can be seen on the northwest flank of Ului Nabukelevu (Mount Washington), Kadavu Island. See overleaf for a snapshot of the geology of Kadavu. [Drone footage was acquired through the SPC]



[The island motifs used here is a collage of island designs that are representative of the Pacific Region. Individual motifs are based on various popular island designs. Images have been downloaded from the "Tapa Cloths from the Pacific and Artwork" website: www.tapapacifica.com, accessed 10 November 2016. The use of the images are gratefully acknowledged.]

PREFACE

The Science, Technology and Resources (STAR) Network was founded in 1984 as a joint initiative between SOPAC¹ and IOC/UNESCO². STAR met annually for nearly three decades in conjunction with the SOPAC Governing Council Meeting. SOPAC provided secretariat support to STAR until its suspension in 2010. SOPAC became a new division of the Pacific Community (SPC) and internal policy did not require divisions to hold annual meetings, therefore STAR did not meet for three years. In April 2015 at a Regional Geoscience Steering Group Meeting an agenda item considered the future of STAR. Subsequently, the inaugural meeting of the revitalised STAR was held in Nadi, 6-8 June 2016. At the conclusion of the STAR 2016, the STAR Business meeting decided:

- to strongly support the continuation of STAR because of its value in refreshing and animating scientific alliances and showcasing useful work, techniques and instrumentation that may be adapted to address development issues of the Pacific;
- to further explore how STAR could become more independent in particular with respect to administration and financial matters;
- that for the future of STAR to be sustained, STAR needed to secure ownership by the Pacific islands, hence Malakai Finau, [then] Director of Mineral Development of Fiji, was reaffirmed as the STAR Chair to take forward the independence and reinvigoration causes; and
- requested the Pacific Community Geoscience Division to support the Chair of STAR with convening a June 2016 STAR Conference and future STAR Conferences where conference fees would be charged as a start to searching for a model for STAR's independence.

The Government of Fiji is now into its fourth year of chairing and convening successful STAR Conferences and the Committee is pleased with the expanded scope of the papers submitted for the 2019 event.

The STAR 2019 Conference will include presentations convened at the Holiday Inn, Suva, Fiji, from 19th to 21st November; and field events to be held in the Suva Harbour and its environs. The overall theme of STAR 2019 is "**Water, Water Everywhere – Nor Any a Drop to Drink**". This booklet is the collection of abstracts of papers to be presented during three days of presentations.

The STAR Steering Committee has worked over the past year to plan the STAR 2019 Conference programme and field events/trips. We hope the 4 days are professionally fulfilling for each participant and we wish you a pleasant stay in Fiji (for the visitors).

STAR Steering Committee Members (2019):

Permanent Secretary, Fiji Ministry of Lands and Mineral Resources, **Josefa Caniogo (Chair)**
Deputy Secretary, Fiji Ministry of Lands and Mineral Resources, **Raijeli Taga**
Director, Geoscience, Energy, and Maritime Division (GEM) (of SPC), **Andrew Jones**
Technical Adviser (Fiji) & former Director of SOPAC, **Russell Howorth**
Senior Advisor Marine Geophysics, GEM (SPC), **Robert Smith**
Manager, Mines Division, **Raymond Mohammed**
Team Leader – Geoinformatics, GEM (SPC), **Wolf Forstreuter**
Manager, Geological Survey Division, **Rigieta Ravuiwasa**
Principal Investigator, Australian Volcanological Investigations, **Paul Taylor**
Divisional Administrator, Geoscience, Energy, and Maritime Division (SPC), **Litia Waradi**
MRD Environment Officer, Fiji Ministry of Lands and Mineral Resources, **Sereima Koli**
MRD Accounts Officer, **Temalesi Raqitawa**
Consultant to the STAR Steering Committee, **Mereseini Lala Bukarau**

¹ SOPAC: Pacific Islands Applied Geoscience Commission

² IOC/UNESCO: Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization

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ABSTRACTS

[in alphabetical order of author(s) names]

ANTONIOU & OTHERS

The value of geophysics in understanding the variability of groundwater systems in low carbonate islands

Andreas Antoniou¹, Peter Sinclair¹, Amini Loco¹, Anesh Kumar¹

¹*Pacific Community (SPC), Suva, Fiji*

Email: andreaa@spc.int, Peters2@spc.int, aminisitail@spc.int, aneshk@spc.int

Fresh groundwater in low carbonate islands normally occurs within the upper unconsolidated sediments as a lens-shaped body that is buoyantly supported by dense underlying saline water. The thickness of a freshwater lens generally depends on the recharge rate, the width of the island, the hydraulic conductivity of the sediments, the depth of the Thurber Discontinuity, and the presence (or absence) of a reef flat plate. Various examples from the Pacific are presented where recent investigations using Electrical Resistivity Tomography for the quantification of fresh groundwater resources have indeed revealed that island width alone is not enough of an indication for the thickness of a freshwater lens. In Tuvalu, for example, resistivity responses along relatively wide islands (Vaitupu, Motulalo) have indicated the presence of limited groundwater whereas resistivity models along smaller islands (Fale, Lakena) have suggested the presence of significantly thick freshwater lenses with high development potential for potable and other domestic purposes. High resolution profiles depicting the spatial distribution in the resistivity of subsurface media can reveal patterns and provide insights on the genesis and evolution of carbonate island hydrogeology/geomorphology and freshwater lens development. The value of drilling logs and groundwater monitoring bores is once again highlighted as a means of calibrating resistivity results and extrapolating along modelled survey profiles.

AZAD & CHAND

Water Quality Monitoring for Foreshore Development – Nawi Island

Mohammed Zaved Azad, Nileshni Chand

Mineral Resources Department, 241 Mead Road, Nabua, Suva, Fiji

Email: mohammed.azad@govnet.gov.fj; nileshni@govnet.gov.fj

Nawi comprises of three freehold islands (Nawi, Nawilailai, Korovesa) situated in Savusavu. The developer (Nawi Island Ltd) has 27.6 hectares of Foreshore Development Lease and is currently developing a marina and resort. As the development is deemed to have significant environmental impact on the surrounding marine ecosystem, it is important to monitor the water quality around the islands.

Traditionally the reason for the assessment of the quality of an environment has been to substantiate suitability for intended use. Monitoring the background quality of foreshore water environments is also now widely carried out to provide a means of evaluating impacts from any developments being done within the foreshore zone. In regulatory monitoring programmes, factors such as sampling frequency, analytical methods, data analysis, interpretation and reporting, sample site selection is taken into consideration.

The Environment Division of the Mineral Resources Department has undertaken monitoring of the foreshore around the island which includes ten water sampling locations at various points. The collected

water samples are analyzed for physical water quality parameters which also include heavy metal testing and Bacto analysis.

This presentation will discuss the monitoring methods, compare results of the analysis and share the challenges involved in conducting water quality monitoring of large scale foreshore developments.

CHOTTU & OTHERS

Namara District Fiji, Off-Grid Water Supply System Design

Francis John Chottu¹, Daniel Perking, Fred A. Osifelo, Kemueli Vatucawaqa, Alfie Davise

School of Building & Civil Engineering, Fiji National University (FNU)

¹*cho2frany600@gmail.com*

Namara District, Tailevu, Fiji has had a water issue for more than four to five decades without reliable, clean water supply system due to its location far from the Suva-Nausori water grid and local, low-productivity aquifers for ground water. Consequently villagers rely only on rain water harvesting and water carting twice a week, with some limited, supplementary groundwater supply.

This study, using a design period of 20 years, has explored the feasibility of an off-grid standalone water supply system. A blend of both quantitative and qualitative data from both primary and secondary sources was generated from site surveys of elevation and water quality and dialogue with residents of Namara District and their respective *Mata ni Tikina* or District Administrator and village headman (*Turani*). With all these data the results were then met and tested by simulation through gravity feed and Epanet software and checked through calculation to deliver the outcome.

The study indicates that Namara district could have two schemes, -: scheme A could cater for six villages including nearby settlements and scheme B with one village and nearby settlement. To work, scheme A requires a minimum of three bore with a 2.7L/s yield (one existing two new ones proposed), one Ferro cement Twin Major reservoir with 90m³ capacity each, and six respective Rota intermediate tanks per village capacity. The system will rely on pumping for water transfer from groundwater bore uphill to the reservoir and gravity feed for distribution. A rainwater hybrid harvesting system will be integrated with the system through each household tank overflow pipe to a junction tank and through an EPS filter pipe network with separate pumps. The system is flexible and can be integrated with a future main water grid system if connection is made available. This proposed approach of off-grid water supply is considered to be feasible with the 20 year design period and could be applied to other rural areas with similar water issues in the region.

Keyword: Namara District, Off-grid Water Supply, Twin Reservoir, Intermediate Rota tank, Hybrid rain harvesting.

COREREGA & OTHERS

Using GIS to Identify Suva Schools exposed Tsunami Risk and their Distance to Safe Zones

Inia Corerega¹, Brown Luahiti¹, Aisea Tivakanoa¹, Evie Packett^{1,2}

¹University of South Pacific, Laucala Campus, Tagimoucia Place, Suva, Fiji

²Australian National University, Acton, Canberra, 2600, Australia

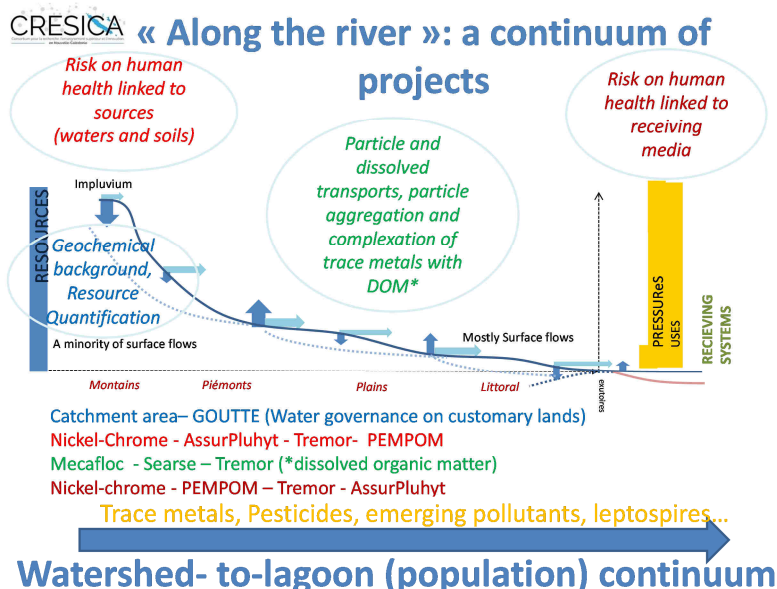
Email: s11097150@student.usp.ac.fj, s11114840@student.usp.ac.fj, s11119986@student.usp.ac.fj, eviepackett@live.com.au

Tsunamis are destructive natural disasters that can cause serious loss of life (Imamura et al., 2019). Although tsunamis are rare in Fiji, preparation for their occurrence is still a part of a comprehensive disaster management plan. Thus, it is important to gain an understanding of tsunami risk to schools in the Suva area. This project combines various data sources using GIS technologies to identify which schools are below 15m above mean sea level (AMSL) which is the Ministry of Education's definition of at-risk of tsunami damage. Further, this project identifies "safe-zones" using Fiji's National Disaster Management Office's definition. The distances from at-risk schools to these safe zones for then calculated to determine the most vulnerable areas. These results will be used by the Ministry of Education for their planning purposes.

DUPOUY & OTHERS

The "Along the River" program: a research and innovation project focusing on the integrated management of water, its uses and its governance in New Caledonia

Cécile Dupouy¹, Francine Baumann², Séverine Bouard³, Cyrille Goirant⁴, Hugues Lemonnier⁵, Yves Letourneur⁶, Michaël Meyer⁶, Claire Tatin⁷



¹IRD, Center of Noumea, BPA5 CEDEX

²CHT, Noumea, New Caledonia

³IAC, CRN-TM, Pouembout, New Caledonia

⁴Institut Pasteur, Noumea, New Caledonia

⁵IFREMER, Noumea, New Caledonia

⁶UNC, Noumea 98848, New Caledonia

⁷CRESICA, Noumea, New Caledonia

Email: cecile.dupouy@ird.fr,

francine.baumann2@gmail.com, bouard@iac.nc,

cgoarant@pasteur.nc, hugues.lemonnier@ifremer.fr,

yves.letourneur@unc.nc, michael.meyer@univ-nc.nc,

claire.tatin@cresica.nc

Water, at the crossroad of a range of challenges, is the program's guiding principle. The topic of water effectively opens up a channel for structuring research with cross-sectoral and inter-institutional scope that meets the needs of New Caledonia and its policy-makers, for all of whom water management is a major

concern. In scientific terms, water issues are linked to CRESICA's three main pillars: development of natural capital, health, and resource and space governance. The program is based on several strategic approaches that bring together local authorities, private and research stakeholders. The "Along of the River" program combines several specific objectives to this theme, such as:

- establish an assessment of existing knowledge related to the water management issue through a scientific diagnosis on hydrological issues, mobilizing the skills and data of scientists and those of local authorities departments;
- gather scientific knowledge on water path on the Watershed to lagoon (population) continuum, through cross-sectional projects;
- characterize hydrosystems (quality, quantity, operation, impact monitoring);
- understand water governance processes on customary lands in order to produce the new knowledge needed to define a shared water policy in a context of water-environment-agriculture-health cross-disciplinary competences.

More generally, all this knowledge will be put into perspective with regard to societal issues, water uses and governance methods at work. The idea is to support public decision-making by integrating a prospective on anthropogenic impacts and climate change. The "Along of the River" program comprises two components: 1) a continuum of projects examining trace metals, pesticides, emerging pollutants and leptospires from the Massif to Recipient Systems (from the mine to the lagoon/human population), which includes 7 projects (Catchment area, ASSURPLUHYT, PEMPOM, TREMOR, Nickel-Chrome, MECAFLOC and SEARSE); 2) the Water Governance within Customary Lands project (GOUTTE).

FORSTREUTER

History of GIS & Remote Sensing support at the grass root level for Pacific Island Countries

Wolf Forstreuter

Pacific GIS and Remote Sensing Council, P.O. Box 3786, Samabula, Suva, Fiji Islands
 Email: wolf.forstreuter@gmail.com



Remote Sensing Unit at Fiji Forestry in 1991



Fiji GIS&RS user meeting in 1993

The first GIS and remote sensing unit in Fiji was established in the inventory section of the Forestry Department, isolated outside of the Suva city area. Monthly GIS & RS meetings were established bringing GIS users together. The meetings were held as informal as possible to attract starters of new GIS projects to share their ideas and at the same time hear lessons learned in Pacific environment. These informal meetings grew fast as several Suva based organisations and Government Departments established GIS units in the nineties. To have a more formal body, Fiji Lands Department created the Fiji Land Information Council. The Council met always a day after the GIS & RS User Group to discuss the ideas of these more informal meetings. SOPAC as regional organisation had soon assisted GIS&RS development institutionally

and also financially. To help the GIS&RS group a GIS&RS newsletter was created (1993) and an e-mail distribution list (1995). These vehicles developed as an outreach to other Pacific Island Countries.

To summarise the developments, documented through presentations in the GIS & RS meetings throughout the year, a Fiji GIS&RS User Conference was conducted first time in 1998. Through SOPAC based projects the idea of GIS&RS user groups were transferred to other Pacific Island Countries and at the same time the Conference developed into a regional User Conference. From 2003 onwards SOPAC increased its role in the management of the Conference, which then steadily grew. However, members the conference management as well as the local GIS & RS user groups kept being volunteers highly motivated but not formally structured.

In 2017, SPC, which had taken over SOPAC some years before, was not able to further host the independent budget of the Conference and requested the Conference Committee to manage the finances as an autonomous body. This was a turning point where the Pacific GIS and Remote Sensing Council (PGRSC) was formally founded. Today, this Council not only conducts the Pacific Islands GIS & RS User Conference but also hosts an independent website, manages the Pacific Islands GIS & RS Newsletter and the e-mail distribution list GIS-PacNet. Besides formal members the link of PGRSC to the Pacific Island Countries are Country Focal Points, which are representatives of the local GIS & RS user groups. These groups with their meetings are in most countries voluntary, however, now connected to PGRSC with its information supply. PGRSC is also the regional Pacific member of the International Society of Photogrammetry and Remote Sensing (ISPRS). Even operating on grass root level the local GIS&RS groups have a link.

GUNATHILAKE, SINGH & ERENE (Poster)

Identification of growth and yield of Cassava (*Manihot esculenta*) and Dalo (*Colocasia esculenta*) under integrated farming

Champathi Gunathilake¹, Indra Singh¹, Ilaitia Erene¹

¹College of Agriculture, Fisheries & Forestry, Fiji National University, P.O. Box 1544, Nausori, Fiji
Email: cchampathi@gmail.com

Integrated farming system (IFS) can be define as a farming of more than one crop together in same area of field where farmers aims at increased productivity, profitability, sustainability, balanced food, clean environment, recycling of resources, and income round the year. There are a variety of traditional and modern farming systems used in the South Pacific for crop and livestock production however, there are few crops are integrated in local farmers. Therefore, this study was focus to identify best practice for integration of Cassava (*Manihot esculenta*) and Dalo (*Colocasia esculenta*) crops that are the main food crops in South Pacific regions. Ridges and farrows cultivation system was adopted for this crop integration trial i.e. Cassava and Dalo cultivated in ridges and farrows in same field (Cassava cultivated in ridge and Dalo cultivated in farrows). Results showed that optimum gap between two ridges was 3.5 m for better yield from both crops. Significant difference of the yield of both crops was not observed in comparison to mono cropping of both crops. However, pest and diseases attack was less in both crops under integrated farming system in comparison to mono cropping. Even though interested farming of Dalo and Cassava was not reported high yield, it has lot of advantages such as efficient use of land, fertilizer and other resources in comparison to mono cropping. Therefore, finally it can be concluded that Dalo and Cassava integrated farming system provides food security to the nation by efficient use of limited land resource.

*1 Corresponding author: Champathi Gunathilake, College of Agriculture, Fisheries & Forestry, Fiji National University, P.O. Box 1544, Nausori, Fiji

HAWKINS

Providing a Baseline for Future Change for South Pacific

Mick Hawkins

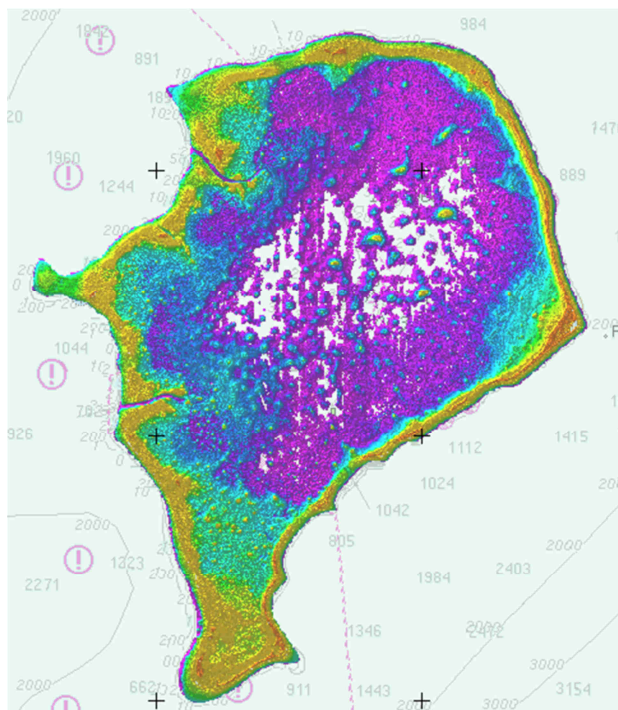
¹Fugro Australia Marine Pty Ltd. 7 Valetta Rd. Kidman Park, South Australia, Australia
Email: m.hawkins@fugro.com

The South Pacific nations require modern and integrated coastal management systems to ensure economic, social, environmental and population pressures are managed in a coherent and coordinated way. Government can drive policy to allow investment in comprehensive accurate datasets whilst leveraging more sophisticated analysis techniques to deliver better decisions and business intelligence for the coastal zone.

As seen in recent storms affecting the regions coastlines, coastal communities must understand and adapt to the stronger waves, winds and surges impacting the coastal environment. The first step in this understanding is the identification of risks to coastal populations and infrastructure. Remote sensing technology can be used to compile accurate, comprehensive baseline datasets across the coastline to better understand this dynamic environment.

In 2019, Fugro conducted airborne lidar bathymetric surveys over Tuvalu, Fiji and the Marshall Islands. The survey objectives were to provide fundamental data to support the implementation of the coastal management reforms to deliver high resolution sea bed datasets to the governments of these nations that will enable better decision workflows for planning and management of coastal infrastructure and natural environments.

This presentation will review the technology and processes used to capture a seamless state-wide dataset of coastal assets and adjoining sediment compartments to enable suitable coastal zone modelling.



Fugro LADS HD lidar bathymetry coverage of Funafuti

HUANG

Tailings retreatment practice at Vatukoula Gold Mine Ltd

Yi Huang

Vatukoula Gold Mines Pte Ltd, Private Mail Bag, PO Vatukoula, Fiji
Email: Yi.h@vgmal.com.fj

Vatukoula Gold Mines Limited has been doing tailing retreatment for the last four years. The tailing material come from the tailing dams #2 and #3 in which the tailing had been stored there for more than 50 years. By using digger and truck, the tailing material stored in #2 dam or #3 Dam is delivered to its Vatukoula Gold Mines ore treatment plant (VTP). In VTP, the final product – gold bar has been produced after the tailing has gone through the processes such as leach, CIP, elution and precipitation. This tailings reclamation and retreatment project is considered as a supplement of the current VGML mining operation.

As such, the venture's operating cost is estimated at F\$26.62/tonne for tailing retreatment with a net profit of F\$27.99 per tonne of tailing retreated.

The tailing retreatment has been practiced for more than four years in VGML now. It not only increases the new life for this 84 years old mining operation and gains revenue, but also puts this tailing material into a better built and monitored tailing dam from the current location in which the dam was not well designed and constructed since it was done 50 years ago and the standard was much lower at that time compared to today's standard in terms of environmental protection and safety.

- (a) The tailing retreatment is a kind of environmental friendly activity since it relocates the tailing material from a 50 years old lower standard facility into a newly built facility with today's technology and standard.
- (b) With today's market gold price and technology, tailing retreatment is economic viable business. It brings in profit into mining company and provides more employment opportunity for local community.
- (c) The tailing retreatment can be environmental friendly and no safety risk. In last four years operation. There was zero environmental and safety incidents.

Therefore, tailing retreatment is good mining business. With today's technology and market, it is very profitable. It also eliminates the potential environmental and safety.

KAUFUSI

Remote detection of volcanic eruption and tracking pumice rafts in the Kingdom of Tonga

Titie Kaufusi

Ministry of Lands and Natural Resources, P.O. Box 5, Geology Vaololoa, Nuku'alofa, Tonga
Email: tkaufusi@naturalresources.gov.to, titie.afuhia.i.vaha@gmail.com



Tonga's pumice raft on the 9th of August 2019.
(Source: NASA Worldview website)

Pumice rafts are formed from violent explosions of submarine underwater volcanoes. This has been a major concern for most of the coastal communities due to the introduction of algae blooms and also its impact on maritime transportations in the Pacific Region. A volcanic eruption occurred in the Kingdom of Tonga on the 9th of August resulted in the formation a pumice raft of 20 x 40 km in size drifting towards the Western Pacific Ocean. This paper will account for determining the source of the volcanic eruption along the Tonga volcanic arc and the drifting of the Pumice rafts. Tracking maps of the Pumice rafts and the location of the volcanic eruption were based on imageries from the NOAA/CIMSS Volcanic Cloud Monitoring website and the NASA Worldview website. The Ministry of

Lands and Natural Resources tracked the pumice raft from its source of eruption westward towards Fiji. The raft has moved at 15 km per day due to prevailing wind and the equatorial currents. This paper is

essential for future references to guide early advice to other Pacific Islands about potential hazards of Tonga's Pumice rafts.

KHAN & TUILOMA

Landowners engagement in mining and the socio-economic benefits

Kitty Khan, Noa Tuiloma

Mineral Resources Department, Nabua, Suva, Fiji

Email: noa.tuiloma@mrd.gov.fj

Landowners engagement in mining is basically the involvement or participation of people in a community into a particular mining project. In Fiji, about 85% of the land is natively owned. The land cannot be sold or surrendered and access for mining and exploration requires the consent or the support of the traditional landowners or lease owners. Much of these lands are highly prospective, resulting in much exploration and mining work occurring unavoidably close to indigenous communities. A significant proportion of the mines and exploration sites in Fiji in close proximity to indigenous communities and so are visible and easily heard. Residents can daily observe mining operations and rehabilitation work in progress.

In Fiji, addressing Community/Landowner issues can be complex. Most of the mining projects are in rural outlying areas where subsistence living is still the norm, environmental problems quickly become social issues. This is where landowners' engagement takes place to engage landowners in the process during a mining project.



Landowners cannot be forced to "participate" in a project which affect their lives but should be given the opportunity where possible. They will see a genuine opportunity to better their own lives and for the community as a whole.

Landowners will want to know a planned mine is not going to upset their lifestyle and will not cause great damage to the environment around them or to the wider environment. Their engagement in meetings and how to be part of the project and for the regulators to look from the landowners' own eyes on how they see the projects as well, this will improve the standard of promoting the mining sector in Fiji.

KOLIYAVU (Poster)

Snapshots of CDOM and Chlorophyll dynamics in Laucala Bay, Fiji Islands

Timoci Koliyavu

Pacific Centre for Environment and Sustainable Development, University of the South Pacific, Suva, Fiji
Email: koliyavu@yahoo.com

The study of ocean color is an emerging tool for ocean managers. Water quality and carbon stock assessment within the aquatic environment are crucial components for understanding the impacts of climate change. Exploring the seasonal variations of CDOM, turbidity, SPM, and chlor-a within the Fiji waters are some of the many components of water quality assessments. Microalgae such as phytoplankton's which account for 50% of the Earth's photosynthetic activity (NASA, 2009) and 25% of the Global Primary Production (GPP) are one of the Biological Quality Elements (BQE) used in the EU Water Framework Directive (WFD) to assess the ecological status of coastal and transitional waters. Today, biomass measured in chlorophyll a (chlor-a) and biovolume of autotrophic and mix trophic species is used in some countries in the assessment criteria for coastal phytoplankton (Hoglander et al., 2013). CDOM and chlor-a studies as such not only act as good indicators of natural or local climate forcings but also reveals to a much greater effect the indices for induce anthropogenic pollution which visualizes the various sources environmental changes within the aquatic system. Unfortunately, knowledge about such studies which is crucial for coastal/ocean managers are not integrated in a comprehensive way; information are rather scattered in various publications and databases, or partially assessed. The study intends to compile all information into ocean color data maps for ease access and pilot such studies as a baseline for future long term monitoring of the health of the Fiji waters.

KOROISAMANUNU & LEWANAVANUA

Water Sampling at the Amex Resources Limited mine site

Vani Koroisamanunu, Sovaia Lewanavanua

Mineral Resources Department, 241 Mead Road, Nabua, Suva, Fiji Islands
Email: vani.dakuwaqa@govnet.gov.fj, sovaia.lewanavanua@govnet.gov.fj

Economic development has been identified as one of the main objectives of developed and developing nations worldwide. With the global demand for raw materials for steel manufacturing and the construction industry, the mining and export of metalliferous ore such as iron sands have been greatly exploited.

In Fiji, rich resources of iron sands are found on the surface of the Ba River delta, in the Western region of Viti Levu with AMEX Resources Limited as the first iron ore sands project. With emphasis on sustainable mining practices, the Environment Division of the Ministry of Lands and Mineral Resources closely monitor the company in accordance with the Environment Management Act 2005 (EMA 2005).

Environment monitoring activity includes site assessments and water sampling along strategic locations within the mining lease boundary along Ba River delta and the Lautoka Port site where the mined ores are transported to via barge vessels.

Water samples are collected to test for physical parameters; analysis including water temperature, water conductivity, dissolved oxygen (DO), pH, total dissolved solids (TDS), total suspended solids (TSS) and turbidity, whereas the chemical parameters included the concentration of sulphate, phosphate and nitrate.

Water sampling conducted for AMEX Resources Limited is mainly to ascertain whether the iron sand tailings discharged from the permitted mining activity into the surrounding environment affects the water quality.

KUMAR

Micro-organisms in potable water supply

Sobha Devi Kumar

Water Authority of Fiji, Suva, Fiji

Email: sdevi@waf.com.fj

Research and development needs now to become critical as water supplies are becoming close to communities increasing in population and decreasing in sanitation facilities. Health care and economic burden increases as water systems get contaminated or depleted due to many a reasons. Humans can prevent or take preventative actions.



Water is being harvested from rural sources and supplied to urban areas thus pathogen transfers are inevitable as some pathogens like giardia and cryptosporidium could contaminate the water supply systems. Scientific research is now being overtaken through applied research in many cases where physical examinations are preferred or are protracted due to limited technology and investigation facilities. Any outbreak would be a threat with potential to affect a large portion of the population.

KUMAR & BAKABAKA

River gravel extraction monitoring and compliance

Neechal Kumar, Eroni Bakabaka

Mineral Resources Department, Private Mail, GPO, Suva, Fiji

Email: neechal.kumar@govnet.gov.fj, eroni.bakabaka@govnet.gov.fj

River sand, aggregate and rocks have become a very common and cheap source of material for Fiji's construction and road building industries. There are currently a total of 38 active licences Fiji wide with many new companies investing and applying for river gravel and sand extraction license. These operations have placed a significant environmental stress on the freshwater ecosystems.

The Environment Division conducts monitoring and compliance inspections with accordance to the relevant legislations. When undertaking monitoring programmes, aspects such as sampling frequency, analytical methods, data analysis, interpretation and reporting is taken into consideration.

The Environment Division also ensures compliance with gravel license conditions issued by the Department of Lands which is the approving authority. Assessment for compliance includes verification of tally records and royalty payments, extraction within the designated boundary.

This presentation aims to discuss on the monitoring and compliance of River gravel extraction in Fiji and also analysing the water quality.

Case study of the application of EM34 geophysical surveys in assessing fresh groundwater potential in Onotoa atoll – Republic of Kiribati

Anesh Kumar¹, Amini Loco¹, Peter Sinclair¹, Andreas Antoniou¹, Areke Tiareti²

¹*Pacific Community (SPC), Suva, Fiji*

²*Ministry of Infrastructure and Sustainable Energy, Betio, South Tarawa, Kiribati*

Email: aneshk@spc.int, aminisital@spc.int, Peters2@spc.int, andreaa@spc.int

Climate change has been attributed to an increase in frequency and intensity of extreme hydro-meteorological conditions, including droughts and overtopping experienced in the Pacific. Low-lying atolls, with elevations less than 5 m and communities with a historical dependence on shallow fresh groundwater lenses, are highly susceptible to the impacts of drought and seawater inundation. Onotoa atoll, located in the southern Gilbert Islands of Kiribati, with population of 1,519, receives relatively less rainfall than other parts of Kiribati, and 85% of all households is reliant on groundwater from shallow wells (Census 2015).

In collaboration with the Kiribati Government, The Pacific Community undertook groundwater investigations using EM34 for 7 villages of Onotoa. Water quality sampling for *E.Coli* from household wells, installation of an automatic raingauge, and well survey data used to supplement the geophysics. The assessments helped to identify thickest parts of freshwater lens and advise the community on water resource development opportunities aimed at improving the supply of potable water during extended dry periods.

EM34 geophysics is rapid and cost-effective assessment technique, indicating lateral and vertical variation in bulk conductivity. The surveys are relatively easy to undertake, with results that are indicative of the presence and relative thickness of fresh groundwater. The confidence in interpretation of EM34 measurements is greatly improved as results can be calibrated against known freshwater lens thicknesses from monitoring bores in similar hydrogeological settings, such as found in Bonriki, South Tarawa, Kiribati. Support was provided to the Government of Kiribati's water resources staff to develop their capacity to plan and undertake water resource assessments. The Onotoa assessment included 48 EM-34 survey lines across width of the islets, at a separation of 200 m, with measurements taken every 20 m along each traverse using the horizontal dipole.

Resulting information was processed and GIS-based maps generated indicating the variability in thickness and extent of fresh groundwater lens. These were shared with the community to assist them with their planning for future water supply needs, especially during extended dry periods. Two of the villages demonstrated poor groundwater potential and are vulnerable to groundwater salinisation during droughts, which may require investigation of alternative options, including desalinisation. Survey information for the remaining villages identified areas of thicker fresh groundwater potential that could guide future water supply investments, such as infiltration galleries and communal well systems.

This case study highlights application of EM34 geophysics as a tool to identify fresh groundwater potential in atolls across the Pacific.

Natural hazards, radio wave detection and their effect on ocean-mesosphere-lower thermosphere region in the South Pacific region

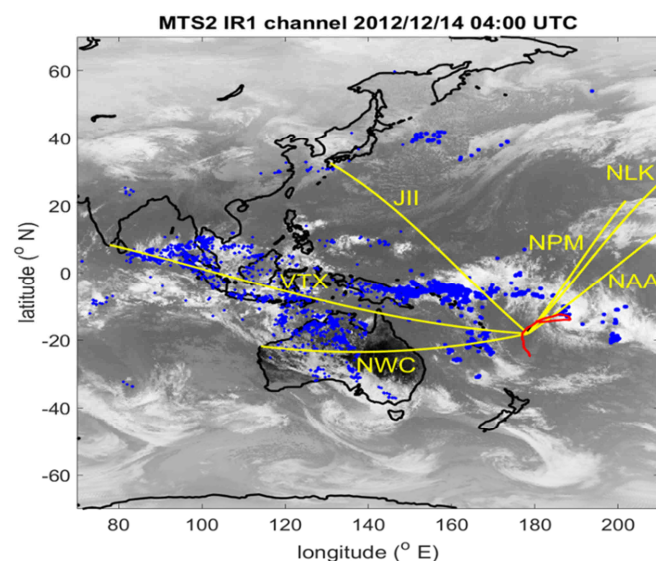
Sushil Kumar, Paolo A.A.L. Redoblado

School of Engineering and Physics, University of the South Pacific, Suva, Fiji

Email: kumar_su@usp.ac.fj, skumar6873@gmail.com

The extreme weather events such as tropical cyclones (TCs) and pose a serious threat to tourism and long-term sustainability of particularly small island countries such as in the South Pacific Region. It is essential to understand the emerging trends and patterns of natural hazards, find possible ways of preventing potential

natural hazards from becoming disasters, and minimizing the impacts of disasters. For example, two recent cyclones: Evan, 9-19 December 2012 and Winston, 7-25 February 2016 affected Fiji, Samoa, and Vanuatu, Fiji, Tonga, with estimated damage of about 1.0 and 1.4 billion damages.



Apart from bio-geo-physical and environmental (climate) and infrastructure (including communication technologies) damages by TCs, the convection and strong thunderstorms associated with the TCs generate atmospheric gravity waves that propagate upwards and outwards to mesosphere-lower thermosphere (MLT) region at 60-130 km altitude and produce perturbations therein.

Results on the temporal evolution of lightning discharges associated with selected TCs in the South Pacific Region using World-Wide Lightning Location Network (WWLLN) lightning data, their detection and ocean-MLT perturbations using Very Low Frequency (VLF) radio signals received at Suva (18.1°S, 178.4°E), Fiji, will be presented.

LILFORD & BEAVIS

Confronting Complexity in Issues of Environmental Degradation and Management – The case of Gold Rock Quarry, Fiji

Oliver Lilford¹, Dr Sara Beavis²

¹*Australian National University/University of the South Pacific,
Email: s11180947@student.usp.fj.ac or u6057184@anu.edu.au*

²*Australian National University <sara.beavis@anu.edu.au>*

Island coastal catchments are inherently complex socio-ecological systems comprising multidimensional and multi-scalar processes that operate from land to sea. Increasingly, this complex interconnectivity is being recognised as critical to appropriately managing catchment development activities. Analysing the development of Gold Rock Quarry (GRQ) in the Dawasamu catchment, Fiji, this paper highlights the importance of confronting such complexity to better manage highly impactful in-river mining activities.

Systematically reviewing the GRQ environmental impact assessment (EIA), as well as the environmental, socio-economic, political and legislative context in which it emerged, this paper demonstrates that the failure of the EIA to adequately address the complexity of the catchment and the quarry's place within this system has precipitated a variety of unacknowledged and thus unaddressed socio-ecological impacts. Given the scale and economic significance of GRQ, as well as plans to further develop in-river gravel mines in Fiji, this review offers important insights into the present limitations in managing in-river gravel extraction activities. In identifying these limitations, opportunities for future improvements on the understanding of and approaches to managing in-river gravel extraction are also provided.

----- LOCO & OTHERS

Testing innovative technologies for Atoll groundwater mapping

Amini Loco¹, Peter Sinclair¹, Andreas Antoniou¹, Anesh Kumar¹

¹*Pacific Community (SPC), Suva, Fiji*

Email: aminisita@spc.int, Peters2@spc.int, andreasa@spc.int, aneshk@spc.int

The atoll's increasing vulnerability to ENSO-driven droughts and their water-related impairments prompted the assessment of the electrical resistivity tomography (ERT) and ground penetrating radar (GPR) to generate subsurface models that inform/guide drought response actions and investments with confidence. The ABEM Terrameter resistivity kit and the Mala Easy Locator Pro WideRange GPR (dual frequency, 160 and 670 MHz) were tested on Nukulau Island, Fiji, and on South Tarawa, Kiribati. The test was conducted under high rainfall conditions with the identification of the water table and the estimation of freshwater lens thickness being the main objectives.

On Nukulau island, high resolution ERT data was generated with the Res2DInv software with a distinctive lateral and vertical variation in resistivity exhibiting an estimated freshwater lens thickness of up to 7 m atop basal saline water. Clear distinction between unsaturated and saturated zones (water table) was easily made. Contrasts between saturated materials at depth based on salinity levels and the possible presence of undulating and porous limestone was easily noticed – calibration of these models was made through known depth and salinity records from similar atoll settings.

The respective GPR survey was completed faster and the data processing, using the RadExplorer software, required signal improvement techniques, such as background removals, and assigning appropriate velocity values to subsurface materials at different depths and salinity composition, converting arrival time models to depth models. The model showed similar freshwater lens shape with a lens thickness of 3.5 m, 50 % less than the ERT model estimation.

The second GPR traverse was undertaken in Bonriki in South Tarawa, Kiribati. Two monitoring bores along the profile provided freshwater lens thickness of up to 18 m before decreasing to 7 m towards the end. GPR results, again, showed a reduced lens thickness of up to 6 m. GPR is limited in confidently defining the lens, possibly attributed to the limited signal strength and penetration of the two frequencies as opposed to the detailed depth-varying ERT. The availability of monitoring bores to provide known depth and salinity measurements are critical to both methods to allow for calibration. Further, the identification of the water table can be difficult during the wet season and in moderate to high vegetation areas due to the increased moisture content in the unsaturated zone coupled with the influence of the capillary fringes causing reflections, and thus, increasing uncertainties of around 0.2 m as tested in similar conditions elsewhere.

MANN

The Tuvatu Gold Project, Viti Levu, Fiji

Stephen Mann

*Managing Director, Lion One Metals Limited, PO Box 11112, Nadi Airport, Fiji
Email: smann@liononeltd.com*

Lion One Limited is the wholly owned Fijian subsidiary of Lion One Metals Limited, a Canadian and Australian Stock Exchange listed explorer which is transitioning into a gold miner.

The Company's core asset is the Tuvatu gold project, located 17km from the Nadi International Airport, on the island of Viti Levu, Fiji. Lion One has tenure totalling 140 km² over the Navilawa Caldera, one of a number of 4.8 million year old volcanic centres aligned along the northeast- southwest striking Viti Levu lineament.

The Tuvatu gold deposit consists of a series of north-south, east-west, and northwest-southeast steeply dipping mineralised lodes and a series of relatively flat east dipping lodes, hosted in an alkaline suite of rocks, dominated by a large monzonitic intrusion. To date, the Company has delineated a JORC and 43-101 compliant inferred and indicated mineral resource of 4,965,000 tonnes @ 5.71 g/t Au for 911,300 ounces Au, but expects further exploration to significantly increase that figure.

Following the approval of the Environmental Impact Report in 2013, and the grant of the Mining Lease and Surface Lease in 2016, The Company has constructed a world class geochemical and metallurgical laboratory, and purchased drilling assets to ensure the continuation of low cost and efficient mineral exploration, whilst developing the mining operation targeted to be operational by January 2021.

Nevertheless, developing such an operation on a small island in the middle of the Pacific has its challenges. In conjunction with its stakeholders, the Company hopes to successfully meet those challenges and develop an operation which will have a long term, positive effect on Fiji.

Using Stream Clay BLEG Sampling to Find New Orebodies – Lion One's Tuvatu Project as a Case Study

Stephen Mann

*Managing Director, Lion One Metals Limited, PO Box 11112, Nadi Airport, Fiji
Email: smann@liononeltd.com*

Lion One Limited owns the Tuvatu gold project in the Navilawa Caldera, 15km east of Nadi, Fiji. To date, the Company has defined a gold resource of 911,300 ounces at a grade of 5.71 g/t Au at Tuvatu, in the southern half of the caldera. Following the grant of SPL1512, the Company now has tenure over the entire volcanic centre and is aiming to assess its whole tenement holding for further gold deposits in the quickest manner.

Assuming it is the right environment, stream sediment sampling is generally regarded as the quickest method of assessing the prospectivity of an area. To this end, Lion One is sampling the clay component from stream sediments to identify further gold deposits in the area, using a method which was developed in 1980, and which has been used successfully around the globe by the largest to smallest companies to help discover a number of world class gold deposits since the 1990's.

Stream sediment sampling has been a common exploration tool for decades, but it is difficult to compare a result from one stream to the next, and often analytical techniques did not have low enough levels of detection to prioritise catchment areas.

Clay BLEG sampling is a method of stream sediment sampling and assaying that is designed to build a true quantitative analysis of the stream catchments. The method is rigorous and standardised, and allows for direct comparisons between various catchments.

The Tuvatu area is considered a particularly good place for the application because of the geology, steeply incised drainages which flow all year round, and the high rates of weathering.

Sample sites are determined by the nature of the drainage, with one sample being collected from each main drainage system of approximately 5km². Samples are collected by a trained team of geologist and field technicians, and analysed by an independent commercial laboratory. Analysis of BLEG samples use very low detection limits so typically very low order anomalies can be detected.

Although the collection and processing of a single sample can take several hours, large areas can be tested for relatively low cost. Lion One is confident that anomalies generated over the past few months, and those still to be generated from the current programme will produce significant major gold targets for future exploration.

MCMURTRY & OTHERS

Continuous Monitoring of Volcanic Unrest and Large Earthquakes: Field-Portable Helium Isotope Detectors as New Geochemical Tools

Gary McMurtry¹, James DeLuze², David Hilton³ and James Blessing⁴

¹*Dept. Oceanography, SOEST, University of Hawaii at Manoa, Honolulu, HI 96822 USA*

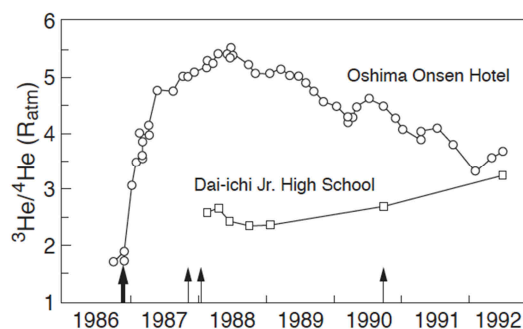
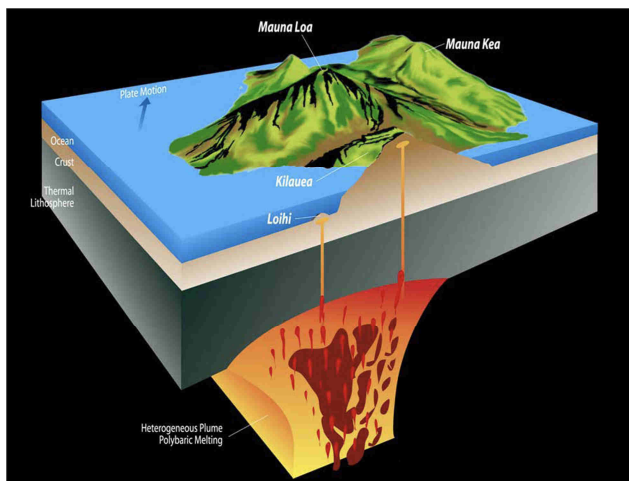
²*Fusion Energy Solutions of Hawaii, Honolulu, HI 96826 USA*

³*Scripps Institution of Oceanography, University of California, San Diego, CA 92093 USA*

⁴*MKS Instruments, Inc., Santa Clara, CA 95054 USA*

Email: garym@soest.hawaii.edu, jrdeluze@icloud.com, drhilton@ucsd.edu, James_Blessing@mksinst.com

Because of the primordial signature of the helium isotope ratio in Earth's mantle, Earth Scientists have found it useful to compare and monitor the ³He to ⁴He mass abundance ratio in rocks, sediments and volatiles such as free gases and those dissolved in water. In some cases, helium can vary like a strain gauge monitor, but with deep mobility in the Earth's crust and upper mantle; in other cases, high ratios can indicate the primordial signature of magma batches from a heterogeneous plume and magma reservoir. Several shallow magmatic emplacements and volcanic



Left: plume model drawing (Kurz et al., 2004); Right: time-series graph (Sano et al., 1995), arrows = earthquakes.

Eruptions, as well as earthquakes, have been documented to show synchronous and precursory changes in the $^3\text{He}/^4\text{He}$ ratio of their volatile emissions, in both gases and fluids. The timescales of these predictive $^3\text{He}/^4\text{He}$ ratio anomalies can range from years to within periods of a few days or less. To date, the only means to sample for He isotopes is using conventional collection techniques with sample return to the laboratory. However, real-time, in situ analysis is necessary to detect any rapid changes in time for effective hazards response and planning. We have made considerable progress in development of an in situ He isotope analysis system, with initial monitoring results at Mammoth Lakes, CA (Long Valley Caldera) and some intriguing high ratios measured in lower East Rift Zone steaming vents prior to the 2018 eruption and summit collapse of Kilauea Volcano.

Locally-generated Tsunami Events Preserved in the Rock and Deposit Record at Ka Lae (South Point) and Other Sites in the Hawaiian Islands

Gary McMurtry¹, Luis Dasilveira², Emilio Herrero-Bervera³

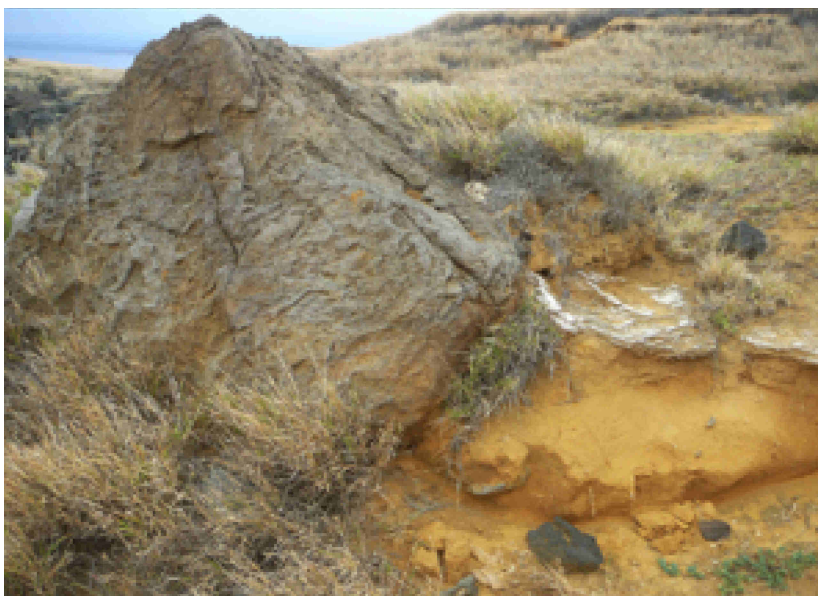
¹Dept. Oceanography, SOEST, University of Hawaii at Manoa, Honolulu, HI 96822 USA

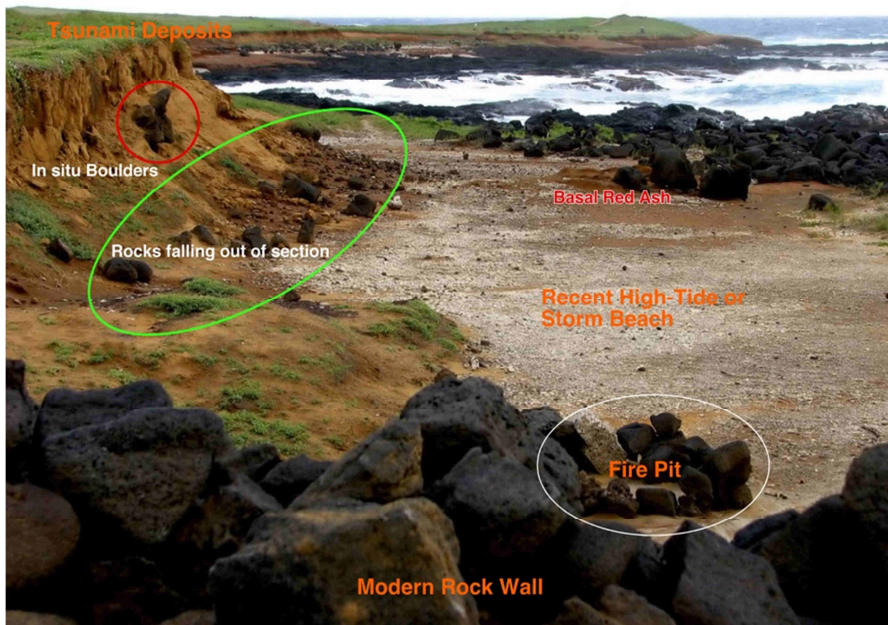
²Dept. Earth Sciences, SOEST, University of Hawaii at Manoa, Honolulu, HI 96822 USA

³Hawaii Institute of Geophysics and Planetology, SOEST, University of Hawaii at Manoa, Honolulu, HI 96822 USA

Email: garym@soest.hawaii.edu, luis@hawaii.edu, herrero@soest.hawaii.edu

Deposits in the Hawaiian Islands preserve the record of past tsunami events. These range in size from <10 m runup to megatsunami class (>100 m runup) depending upon deposit location and size of ocean displacement. At Ka Lae (South Point) on the Island of Hawaii, we discovered very late Pleistocene megatsunami deposits that included large, few-m diameter boulders resting upon 10-m cliffs that range in age from >93 ka (U-series age on abutting palesol) to the 120 ka age of the underlying Kahuku Basalt. We studied the Natural Remanent Magnetization of in-situ lavas and these boulders. Whilst in-situ lavas were characterized by values agreeable with the Geocentric Axial Dipole formula, loose lava





blocks showed a total disagreement with the expected inclination, which indicates that they deposited by an event such as a megatsunami. Near present sea level, we discovered >2 m thick layers of reworked Pahala Ash containing basalt and calcareous sand and shell, basalt cobbles and boulders to >1 m in diameter, all with inland extent >100 m from the present coast. Ages of included corals range from 246 to 978 years BP (n=10). These deposits could be further evidence for the 1425- 1665 AD tsunami event found in sinkhole deposits on the Island of Kauai (Butler et al., 2014) or are older corals reworked during local seismic tsunami events in either 1868 or

1975. At elevations of up to 27 m ASL, sections within the Pahala Ash also contain similar deposits that presently cannot be constrained in age beyond 12 to 93 ka. These likely record another large tsunami event there, with runup to >30 m.

MCWALTER (Video)

The Last Mile – A documentary film directed by Marco Venditti for Oilsearch Ltd showing corporate response to 2018 Earthquake

Michael McWalter

*Oilsearch Ltd, P.O. Box 842, Port Moresby, Papua New Guinea
Email: michael.mcwalter@oilsearch.com*

In the aftermath of the terrible magnitude 7.5 earthquake that occurred in the Hela Province of Papua New Guinea (PNG) on 26 February 2018, at 3:44 a.m. local time, our company – Oil Search Ltd, a PNG registered oil and gas company, went rapidly into action when few, if any organisations, were providing any help at all. We had supplies lines established through the Gulf of Papua and every helicopter available in the country at our disposal to bring first responder aid and help to the people in whose lands we operate our oil and gas fields. The earthquake's epicenter was 10 kilometres west of the town of Komo where our LNG Project airstrip sits high in the mountains and considerable damage was incurred by our oil and gas production facilities in the area. We have subsequently commissioned a documentary film about the earthquake and our response. It is a very meaningful tale of compassion and relief for our communities amongst whom we work, and clearly tells an excellent story of good corporate social responsibility in very difficult circumstances.

Monitoring spatial and temporal variability in geochemistry, water quality and hydrological inputs into alkalinity and pH levels along the Ba River

Nicholas Metherall¹⁺²⁺³, Sara Beavis², Timoci Koliyavu²

¹Australian National University, ²University of the South Pacific,

³Additional research affiliations: Water Authority Fiji, Mineral Resources Department, District Office Ba

Email: nicholas.metherall@gmail.com

Key words: watershed processes, environmental monitoring, Ba River, hydrology, pH, alkalinity, coastal ocean acidification, geochemistry, ridge to reef

The wider literature has found that while acidification in the open ocean is more causally linked to anthropogenic emissions, acidification of the coastal ocean is more causally linked to watershed processes. Ridge to reef watershed management projects have recently emerged in the context of limited environmental impact evaluation and monitoring across Fiji. The complexity of watershed processes makes it difficult to undertake environmental monitoring and to disaggregate the impacts of sources of point and non-point pollution. Trialling of new tools and experimental frameworks is needed to address these environmental monitoring gaps.

The research attempts to monitor spatial and temporal variability in water quality inputs into alkalinity and pH to shed light on the following questions: (1) how can a spatial transect of geochemistry and water quality be used to monitor watershed processes which influence pH? (2) What influences does sugarcane crushing season have on water quality (pH) in the lower reaches and estuary of Ba River catchment?

Spatial data was collected through an 80 km water quality transect of the Ba River in the dry season and at the beginning of the wet season. Temporal data was collected using data loggers both upstream and downstream of point source pollution sites.



Map 1. Ba Catchment and water quality and hydrology sampling sites.

Quantifying the effects of dry season aggregate extraction on downstream turbidity and sediment transport: a water quality and hydrology assessment of Dawasamu River

Nicholas Metherall¹⁺²⁺³, Sara Beavis², Oliver Lilford¹⁺²

¹Australian National University, ²University of the South Pacific

³Additional research affiliations: Water Authority Fiji, Mineral Resources Department, District Office Ba

Email: nicholas.metherall@gmail.com

Key words: turbidity, suspended sediment concentration, sediment transport, hydrology, environmental impact assessments, ridge to reef

River ecosystems are conserved within limited ranges of turbidity and suspended sediment concentrations (SSC). Determining the sources of disturbance, their significance and subsequent impacts on water quality is complicated by numerous watershed processes and variables which are difficult to quantify.

In Fiji, river gravel extraction has acute environmental and social impacts on riverine and downstream estuarine ecosystems. Golden Rock Investment Limited (GRIL) operating in Dawasamu River constitutes the largest example of aggregate extraction and stone crushing in Fiji. This study uses a Before After Control Impact (BACI) experiment combining measurements of turbidity and SSC with measurements of streamflow velocity and the hydraulic dimensions of the stream channel to calculate levels of discharge and sediment transport. The purpose of the study is to assess the effects of GRIL aggregate extraction on turbidity and sediment transport levels in Dawasamu River during the dry season baseflow recession period. The BACI experiment found that the turbidity ranges over the control and treatment periods, respectively, were 2.50 – 8.00 NTU and 5.00 - 408.50 NTU. The correlation coefficient for turbidity and suspended sediment concentration (r^2) was 0.74. Projections estimated a sediment transport rate of 91.00 (kg/day) or 2.48 (t/km²/y) under a 5.00mm daily average rainfall scenario. However, longer-term projections are limited since they are unable to take into account the flushing effects of periodic heavy rains. The study sheds light on a causative link between aggregate extraction and passive ongoing high levels of turbidity and sediment transport during the baseflow recession period.



Map 1. Dawasamu gravel extraction sites before and after operations (SPC, 2018).

PACKETT & METHERALL

Lessons from the Qfield: novel field data collection methodologies using QFIELD for QGIS

Evie Packett^{1,2}, Nicholas Metherall^{1,2}

¹University of South Pacific, Laucala Campus, Tagimoucia Place, Suva, Fiji

²Australian National University, Acton, Canberra, 2600, Australia

Email: eviepacket@live.com.au, nicholas.metherall@gmail.com

Background: Qfield is a new open-source, free application which when combined with QGIS allows for researchers to automatically upload a range of inputs into data fields over a QGIS basemap.

Aims: This study assesses the strengths and limitations of using Qfield in the field. This assessment includes:

- 1) A comparison of GPS location services compared to established, licenced technologies
- 2) Strengths of QField and key areas of use
- 3) Weaknesses of the app in its current edition and areas to improve

This study also aims to present to hydrological data collected and stored using QField and analysed using QGIS.

Methods: The study draws from field data collected during a science expedition in hydrogeochemistry, hydrology and water quality monitoring. The case studies included the Nadarivatu highlands and the Ba upper catchment of Viti Levu. These data are gathered and collated through fields functions in QField.

Comparison has shown a range of trade offs between different tools and methods. While QField shows substantial potential to streamline data collection and processing within certain research designs, it is still in the early to mid development stages and therefore has a few areas to improve.

Results: GPS precision comparison to be determined.

PACKETT & VEITATA

Utilising Google Earth Engine to track mangrove recovery post cyclone_Winston

Evie Packett^{1,2}, Makereta Veitata¹

¹University of the South Pacific, Laucala Campus, Tagimoucia Place, Suva, Fiji

²Australian National University, Acton, Canberra, 2600, Australia

Email: eviepackett@live.com.au, s11111416@student.usp.ac.fj

Tracking vegetation recovery post-destructive weather events via remote sensing requires access to and processing of satellite imagery, which can be expensive and time-consuming. The open-source, cloud computing software, Google Earth Engine (GEE), streamlines this process and minimises the resources required to do temporal analysis of land cover change. This project demonstrates the power and simplicity of using GEE by utilising this software to analyse mangrove forest cover in Viti Levu Bay before Cyclone Winston, post-cyclone, and throughout the following years. The results visualise the widespread damage that Winston inflicted on these mangrove systems. Further, mosaics created by GEE aid analysis of spatial patterns of regrowth, providing insights into preferred paths for regrowths. These images were then classified using a supervised classification process to extract mangrove land cover and reveal changes. This project uses both LandSat8 and Sentinel imagery accessed through the GEE library. The visual analyses of these images were verified using an Unmanned Aerial Vehicle (UAV) RGB image. This project shows that GEE can be used for low-cost, simple, spatial-temporal analysis of mangrove recovery post-cyclone events accessible even by scientists with no remote sensing background.

RACACA & ELLIOTT

The City of Rockingham Coastal Hazard Risk Management and Adaptation Plan (CHRMAP)

Nasi Racaca¹, Natalie Elliott¹

¹The City of Rockingham

Email: Nasi.Racaca@rockingham.wa.gov.au

The City of Rockingham has over 37 km of coastline. The adjacent land, known as the coastal zone, supports a variety of recreation, conservation, residential and commercial land uses. The coastal zone is highly valued by the community and underpins the City's identity, prosperity and lifestyle. The City's coastal zone is already subject to the impacts of coastal hazards, such as erosion and inundation, and it is expected that the vulnerability of these areas may increase in the future due to the predicted effects of climate change and sea level rise.

The Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) provides a long term view of the potential future coastal hazards for the City, and highlights pathways to adapt to the changing future oceanic and coastal conditions. The CHRMAP aims to ensure the City is well placed to deal with impacts to the coastal zone, if and when those hazards arise.

The CHRMAP process is designed to be ongoing, with regular updates associated with the emergence and collection of new information. Development of the City's CHRMAP has followed the requirements of Western Australian State Planning Policy No. 2.6: State Coastal Planning Policy (SPP2.6) and supporting guideline documents.

A coastal hazard assessment was undertaken to determine potential extents of coastal erosion and inundation hazards over future planning timeframes to 2110. A risk and vulnerability assessment was then applied according to different sectors, with results highlighting the most vulnerable assets and areas along the City's coastline, for which a more detailed investigation of adaptation options was undertaken.

The CHRMAP acknowledges the challenges associated with managing risks in a dynamic coastal environment, together with the need to balance environmental, social and economic values to ensure the long term sustainable use and management of the City's unique coastline.

RACHMAN & QOMARIYAH

Investigating the littoral transport of sediment along the Nasese coastline, Suva, Fiji Islands

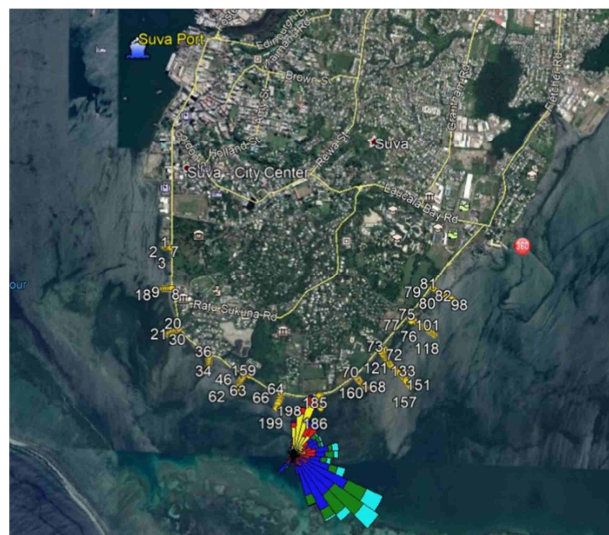
Cyril Bernard Rachman¹, Yuyun Qomariyah²

¹Lecturer, Coastal Engineering, Department of Civil Engineering, Fiji National University, Fiji Islands

²Lecturer, Urban and Regional Planning, Department of Civil Engineering, Fiji National University, Fiji Islands

Email: cyril.rachman@fnu.ac.fj, yuyun.qomariyah@fnu.ac.fj

The proposed research aims to investigate the current Nasese Coastline area from the impact of Littoral transport, a term used for the transport of non-cohesive sediments, i.e. mainly sand, along the foreshore and the shoreface of Nasese due to the action of the breaking waves and the longshore current. The littoral transport is also called the longshore transport or the littoral drift. The theoretical concept coastal sediment properties can then be used to evaluate properties of sediment on site to avoid serve impacts towards the Suva Port in the future. The method is site experiment through surveying and generating of coastal profiles was carried out as well as a particle size distribution (PSD) testing. Along with this, about 1464 hours of Wind data for the months of November and December 2019 was used to generate the frequency of the magnitude of Wind and the Direction using Wind Rose Plots for Meteorological Data. It was concluded that the movement of the sediments through the Coastal Profiles and the PSD agrees with the output generated Wind Directions. Therefore, Suva Port, may consider this situation in terms of the routine maintenance of dredging in order to sustain the acceptable depth of the Sea Port.



Rural Water Infrastructure on the Mainland and Outer Island in Fiji

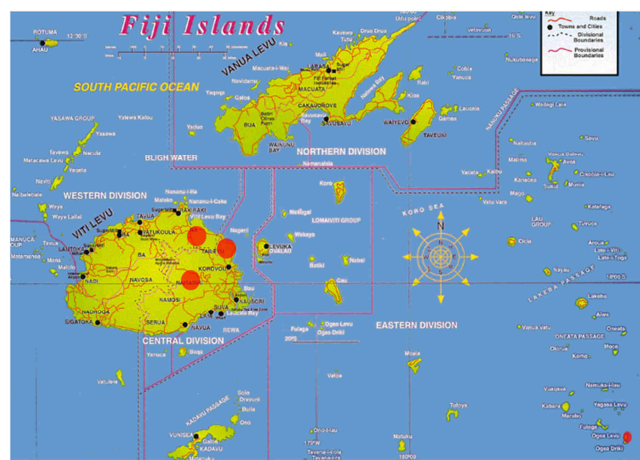
Cyril Bernard Rachman¹, Yuyun Qomariyah²

¹Lecturer, Coastal Engineering, Department of Civil Engineering, Fiji National University, Fiji Islands

²Lecturer, Urban and Regional Planning, Department of Civil Engineering, Fiji National University, Fiji Islands

Email: cyril.rachman@fnu.ac.fj, yuyun.qomariyah@fnu.ac.fj

Water is one of the major basic needs for those who live in cities and villages that humans cannot live without. In many countries, the supply of clean water which is mostly managed by the Water Authorities only serves Urban areas, where as rural areas are still often inaccessible by water supply providers. The purpose of the research is to examine the method of providing clean water in rural areas in Fiji on the main and outer islands and identify the existing conditions of the water infrastructure, so that it can be used as a reference in providing sufficient clean water in terms of quality and quantity.



Based on the results of our study, we have discovered that all villages on the mainland depend on springs for clean water sources, but in a village on the outer islands, it depends on rain water due to poor quality of the spring' water. In general, the system of distribution of clean water is the same, from the water source to the reservoir and distributed to the houses through different types of methods, but interestingly for villages in Tailevu the villagers must come to the reservoir because there is only one water reservoir for 6 villages. Good water infrastructure that can be operated, managed and maintained by the villagers is needed so that they can be self-sufficient in obtaining water.

RAM & OTHERS

Engineering geological and geomorphological investigation of slope failures along roads in Viti Levu, Fiji Islands

Arishma R. Ram¹, Martin S. Brook¹, Shane J. Cronin¹

¹The University of Auckland, Auckland, New Zealand

Email: aram836@aucklanduni.ac.nz, m.brook@auckland.ac.nz, s.cronin@auckland.ac.nz

In the nation of Fiji, especially on the main island of Viti Levu, landslides repeatedly damage key pieces of infrastructure such as arterial roads. A three phase-study was undertaken to gain an understanding of the properties, processes and mechanisms of landslides in tropical residual soils of Fiji focussing along three roads in Viti Levu (Kings Road, Lololo Road and Namosi Road). The first phase of the study looked at landslide characteristics along Kings Road in the aftermath of a Tropical Cyclone. This road of national importance is repeatedly affected by landslides during major rainfall events. In the second phase, engineering properties of tropical residual soils of varying parent lithologies prone to landslides along roads in Viti Levu were examined while the third and the final phase involved investigating a case study landslide (Kasavu) to obtain detailed understanding of landslide processes and mechanisms in the Fiji environment.

The landslides along studied roads in Viti Levu were numerous, but small, shallow rotational and translational earth and debris landslides that transform into flows. They were triggered mostly by tropical cyclones and long-duration rainstorms. Residual soils most prone to slope failure along roads in Viti Levu are cohesive, plastic, sensitive, have low permeability and low residual strength. Failures are mostly driven

by the formation of a perched water table during heavy rainfall, leading to excess pore-water pressures to trigger the landslide. Computer modelling showed how the Kasavu Landslide materials were highly sensitive to increasing groundwater levels, with failure mechanisms varying in different parts of the landslide. No relationship was apparent between the engineering properties of failure-prone residual soils and underlying lithologies, but this requires further study. Tropical cyclones and floods affect Fiji annually, hence a proactive approach is needed to managing landslides hazards along Fiji's trunk routes by relevant authorities.



RAQISIA

Data Management System for Groundwater

Keleni Raqisia

*Geospatial Unit, Fiji Mineral Resources Department
Email: kelenister@gmail.com*

The aim of data management at the Fiji Mineral Resources Department is to ensure data is safely stored, backed up, adequately described, discoverable and easily accessed. To support the work of groundwater services and studies in the department, the Geospatial Unit has implemented an integrated Spatial Data Infrastructure to complement their work. This presentation discusses about the data management implementation at the Department, the status of data management before and the types of support provided to the Hydrogeological Section, and the use of web services to allow further dissemination and promotion of the departments' hydrogeological data and to discuss the advantages of using such an integrated SDI.



Earthquake and Landslide Assessment: Mount Washington, Nabukelevu District, Kadavu

Rigietia Ravuiwasa¹, Sakaraia Malodali², Mohammed Zaved³

¹Geological Survey Division, Mineral Resources Department, Fiji

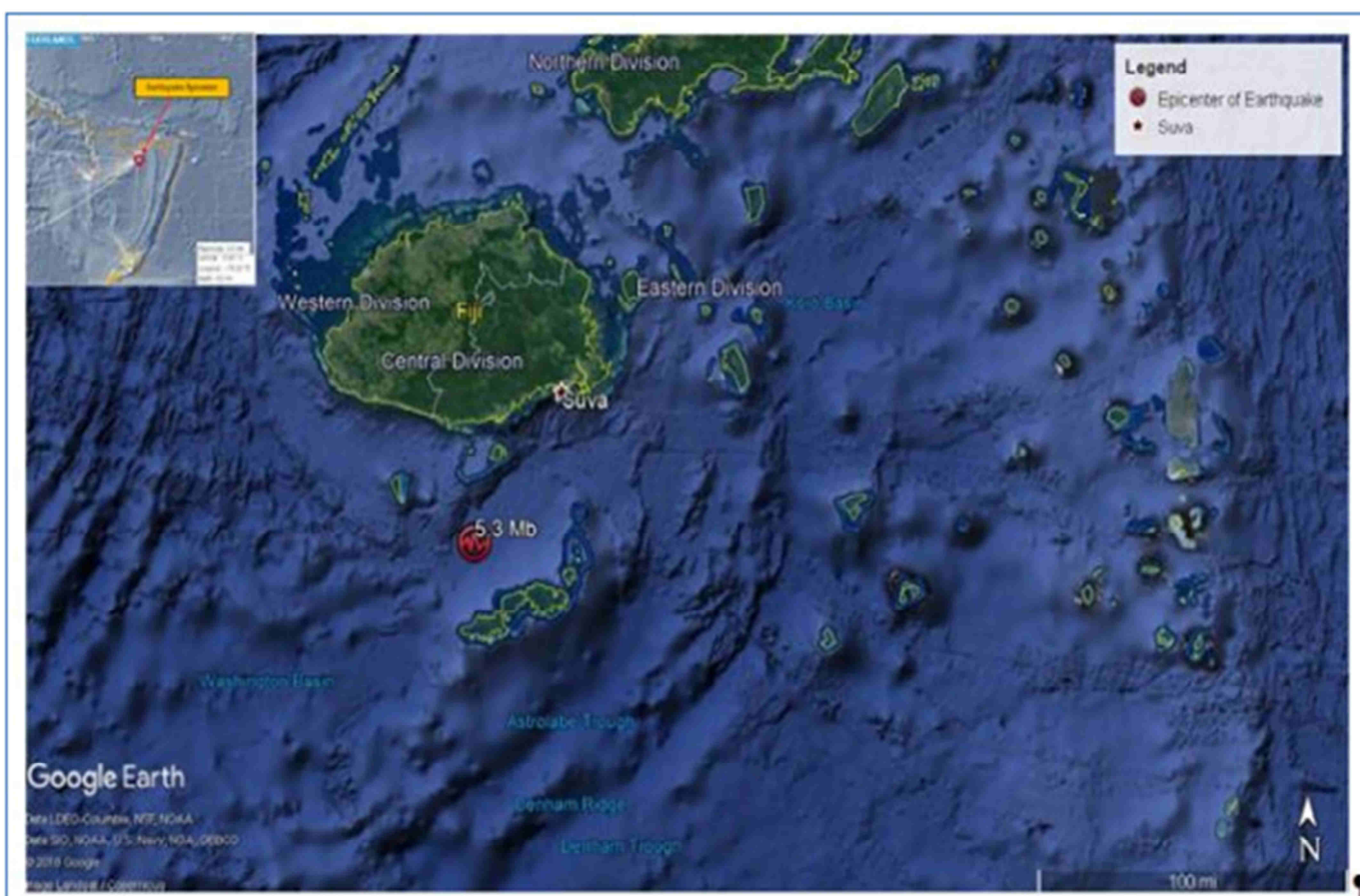
²Seismology Section, Mineral Resources Department, Fiji

³Environment Division, Ministry of Lands and Mineral Resources, Fiji

Email: rigietia.ravuiwasa@govnet.gov.fj, sakaraia.malodali@govnet.gov.fj, mohammed.azad@govnet.gov.fj

Kadavu Island located approximately 100 kilometres south of Suva, Fiji experienced an earthquake of 5.3 magnitude with the epicenter located 26 km NNW from Vunisea, Kadavu and at a depth of 10 km [refer to map].

Following the earthquake; Mount Washington or Ului Nabukelevu with a height of 805 m was subjected to landslides. A preliminary assessment was conducted with the other relevant agencies or organisations to ascertain the risks and damages following the earthquake event.



A total of 9 villages namely Lomaji village, Taleulia village, Dagai village, Tawava village, Kabariki village, Nasau village, Daviqele village, Qaliira village and Nabukelevu i ra village, Busa settlement and schools in the Nabukelevu District were surveyed within the 3 days of assessment.

Through this preliminary assessment; the MRD team with other relevant stakeholders were able to identify and map the landslides behind the villages and the schools and the risks associated with rock falls and landslides, confirm ground stability, collect water samples for analysis from the village main water sources and conduct earthquake and tsunami awareness to all the communities close to Mt Washington.

Further detail assessment is recommended to map the bathymetry around the area [mainly the epicenter site and the associated platforms], identify the magnitude of the risks and the hazards following the main earthquake and the continuous tremors and the potential hazards that may arise in future.

ROGER & OTHERS

Tsunami in New Caledonia: from the update of the catalogue to the December 5, 2018 event

Jean Roger, Bernard Pelletier, Jérôme Aucan, Bruce Thomas

¹Institut de Recherche pour le Développement, New Caledonia

Email: jean.roger@ird.fr, bernard.pelletier@ird.fr

New Caledonia is located in the southwestern Pacific in an active seismic zone. Like other Pacific Islands, it is subject to damaging tsunamis. A number of tsunamis have been reported in New Caledonia, sometimes mingled with storm surges. A recent update of the tsunami catalogue documents 37 tsunamis which have reached New Caledonia since 1875. Some of them show amplitudes of 2 m and more but most of them exhibit amplitudes of less than 50 cm. These tsunamis have been triggered by earthquakes located not only at the nearby Vanuatu subduction zone, but also farther in the Pacific Ocean, as in Japan or Chile (Figure 1).

The most recent tsunami which affected New Caledonia occurred on December 5, 2018. It was triggered by a Mw 7.5 earthquake located in the southern part of the Vanuatu subduction zone. The tsunami was recorded by most of the tide gauges in New Caledonia and Vanuatu, the Loyalty Islands being firstly concerned. Field observations report wave heights of more than 2 m at the Isle of Pines, New Caledonia, and more than 4 m at Aneytum, South Vanuatu. Numerical modeling of the tsunami using seafloor deformation calculated with the moment tensor solution from GCMT provides travel times and amplitudes in good agreement with witnesses observations and recorded data.

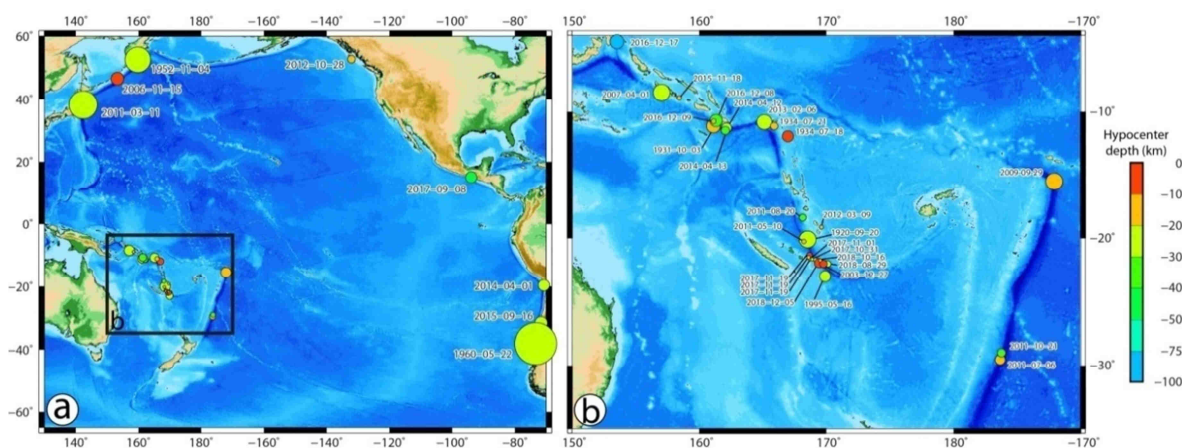


Figure 1: Location of the earthquakes epicenter having triggered tsunamis reported or recorded in New Caledonia. a) Over the whole Pacific Ocean highlighting source locations of transoceanic tsunami; b) at a regional scale, highlighting regional and local sources (Roger et al., 2019).

The importance of aerospace methods in the study of landscapes transformation (in the case of adjacent areas of the Aydar-Arnasay lakes system)

Nilufar Sabirova

Department of Geography and Ecology, Samarkand State University 140104, Samarkand, Uzbekistan

Email: nilufar.samsu@gmail.com

The paper describes the processes of influence on the landscape transformation of the Aydar-Arnasay lake systems by aerospace methods. Information on changes in the water level in the lake and the landscape is obtained from Landsat software. Rising water levels in the lake over the years have been observed on the USGS and GEE websites.

Aerospace methods are considered one of the most necessary methods on researching and mapping landscapes and getting information about them. Territorial differentiation and diversity of landscapes manifest through space images. Using cosmic images on determining the change areals and the effects in human activities or natural factors increases the accuracy of the research. When using space images, they allow simultaneously determining the landscape boundaries, their quantitative and qualitative characteristics that cannot be always determined by field observations alongside the processes occurring in the landscape.

The object of our research is the landscapes adjacent to Aydar-Arnasay lakes system. These territories include Mirzachul (Arnasay, Dustlik, Mirzachul, Pakhtakor, Zafarobod districts of Djizak region) and the eastern part of Kyzylkum (Nurota district of Navoi region and Forish districts of Djizak region) from the natural geographical point of view (Fig. 1).

Keywords: landscape, satellite imagery, landscape transformation, Landsat, satellite.



Fig. 1. Study area. Aydar-Arnasay lakes system (2017 year)

<https://earthexplorer.usgs.gov/>

Increasing Water Access Resilience for semi-urban communities in the Pacific Islands through solar-powered systems: financial sustainability and replication mechanism, the case of Norsup-Lakatoro

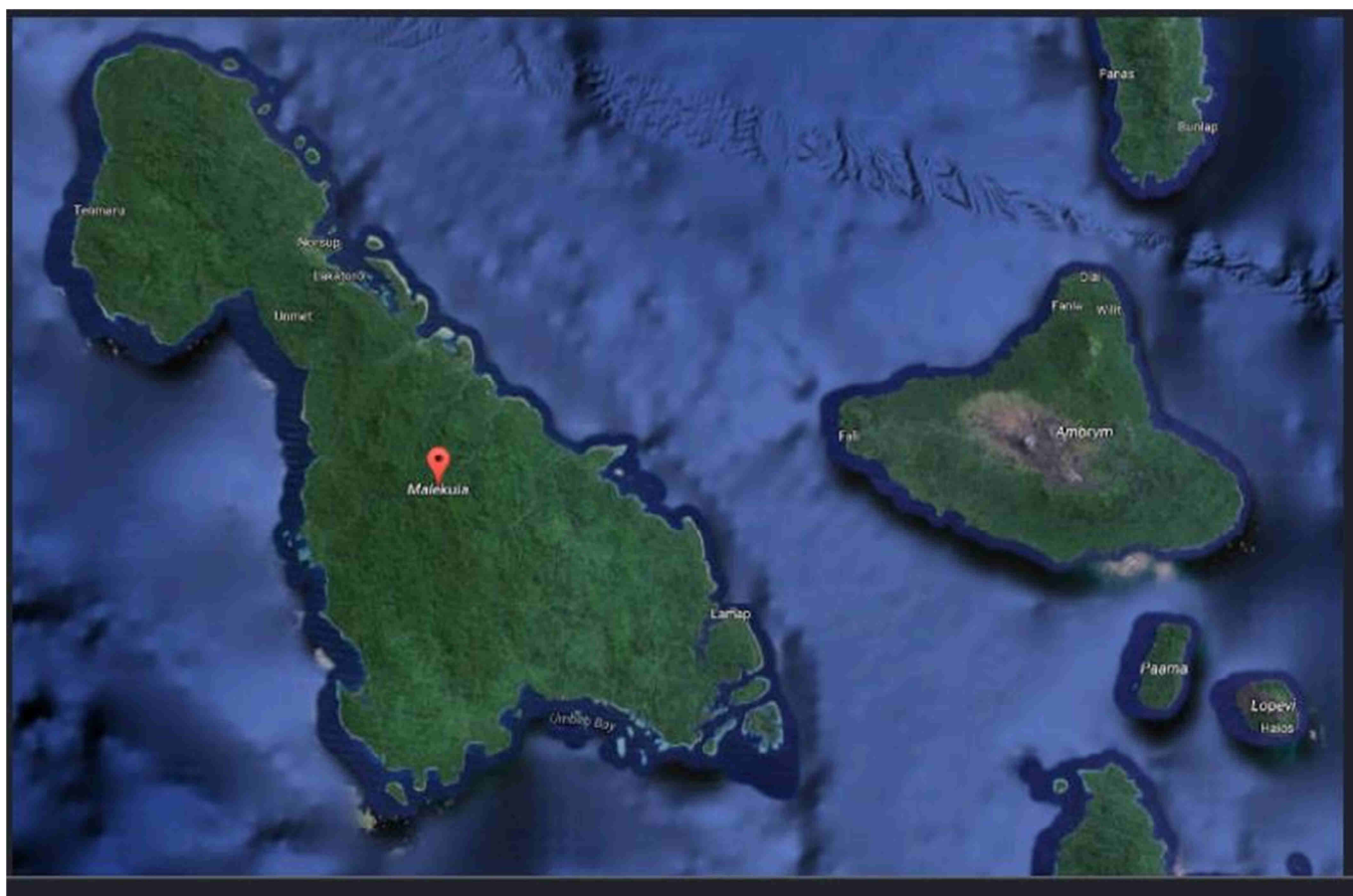
Erickson Sammy¹, Eva Diaz Ugena²

¹Director of the Department of Water Resources – Ministry of Lands and Natural Resources, PMB 9001, Port Vila, Vanuatu

²Project Manager, Global Green Growth Institute – Vanuatu Country Program, Department of Water Resources – Ministry of Lands and Natural Resources, PMB 9001, Port Vila, Vanuatu

Email: esammy@vanuatu.gov.vu, eva.ugena@gggi.org

The boreholes providing water to Norsup – Lakatoro (Main city of Malekula island in Vanuatu), are connected to the grid, nevertheless water shortages sometimes happen as the electricity bill is expensive and the water department is not always able to pay at once, even if the system is metered and individual bills are paid. Hybrid solar water pumps would decrease the burden of the electricity bill and reduce CO₂ emissions, as electricity from the grid is produced through diesel generator (even if initially copra was aimed to be the fuel, market prices made it to be substituted by diesel). The savings generated by the solar powered system could be invested not only in the system maintenance, but also in the creation of a financial mechanism allowing other nearby rural communities to improve their access to water through solar systems.



The Government of Luxemburg, in cooperation with GGGI (Global Green Growth Institute) and the DoWR (Department of Water Resources) will fund a study to ascertain the different possibilities of such mechanism and analyze their viability.

Increasing water access resilience for rural communities in the Pacific Islands through solar powered systems: West Ambrym case study

Erickson Sammy¹, Eva Diaz Ugena²

¹Director of the Department of Water Resources – Ministry of Lands and Natural Resources, PMB 9001, Port Vila, Vanuatu

²Project Manager, Global Green Growth Institute – Vanuatu Country Program, Department of Water Resources – Ministry of Lands and Natural Resources, PMB 9001, Port Vila, Vanuatu

Email: esammy@vanuatu.gov.vu, eva.ugena@gggi.org

Ambrym in Vanuatu is a persistently degassing island volcano whose inhabitants harvest rainwater for their potable water needs, being this water polluted by the volcano degassing activity (high prevalence of dental fluorosis). The most arid part of the island is West Ambrym, which has been classified as highly vulnerable area related to water access. In addition to rainwater harvesting tanks there are hand pumps, boreholes were drilled and hand pumps installed in 2012, all of them are in a bad condition (due to the corrosive atmosphere and water). Groundwater is at the brackish limit and saltwater intrusion is a real threaten, gravity schemes are not possible because of long distance to springs.



How to secure water access for those populations in a climate change context? Manual pumps are going to be replaced by Solar Pumps with the financial support of the Government of Luxembourg and small solar desalination units (robust and simple operation units) are being analyzed as the only one possibility of having fresh water all year round in a climate change context. The challenge is sustainability: community involvement, good quality materials and establishing a strong value chain (from supplier to consumer) are the keys being explored.

Unlocking Data Insights in the South Pacific to Mitigate Impact of Climate Change and Sea Level Rise

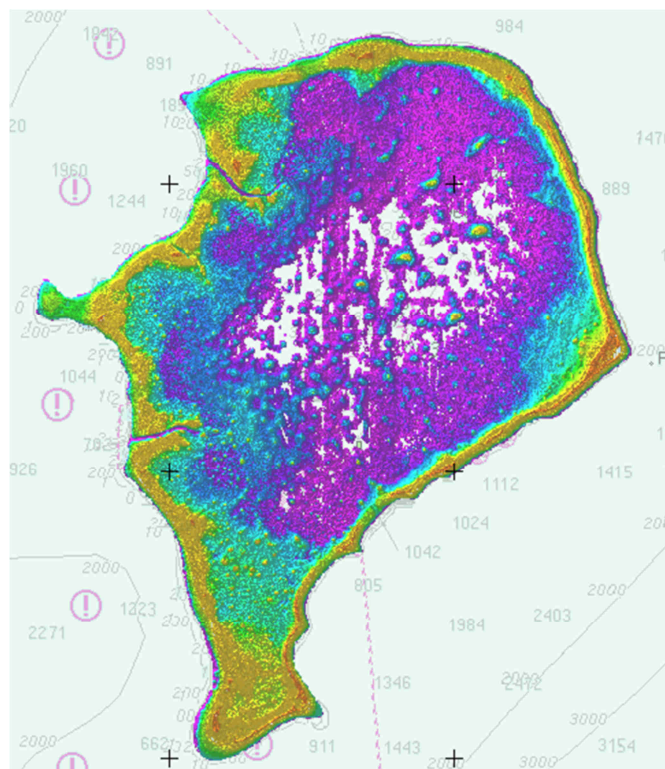
Paul Seaton¹, Mark Sinclair¹, Mick Hawkins¹

¹Fugro Australia Marine Pty Ltd, 7 Valetta Rd, Kidman Park,
South Australia, Australia

Email: m.hawkins@fugro.com, p.seaton@fugro.com

Climate change events are impacting Asia Pacific communities. Rising sea levels, salt water inundation, increased storms activity and wave surges are impacting coastal communities at an increasing frequency. To ensure a liveable future for these communities, development decisions that are both sustainable and inclusive of disaster risk mitigation measures are needed.

A key step in this process is the identification of risks to coastal populations and infrastructure. Airborne LiDAR Bathymetry is one tool that can be used to compile accurate, comprehensive baseline datasets across the coastline to better understand this dynamic environment. Comprehensive accurate datasets are able to leverage sophisticated analysis techniques to provide tools for improved decision making for communities and the environment in coastal zones.

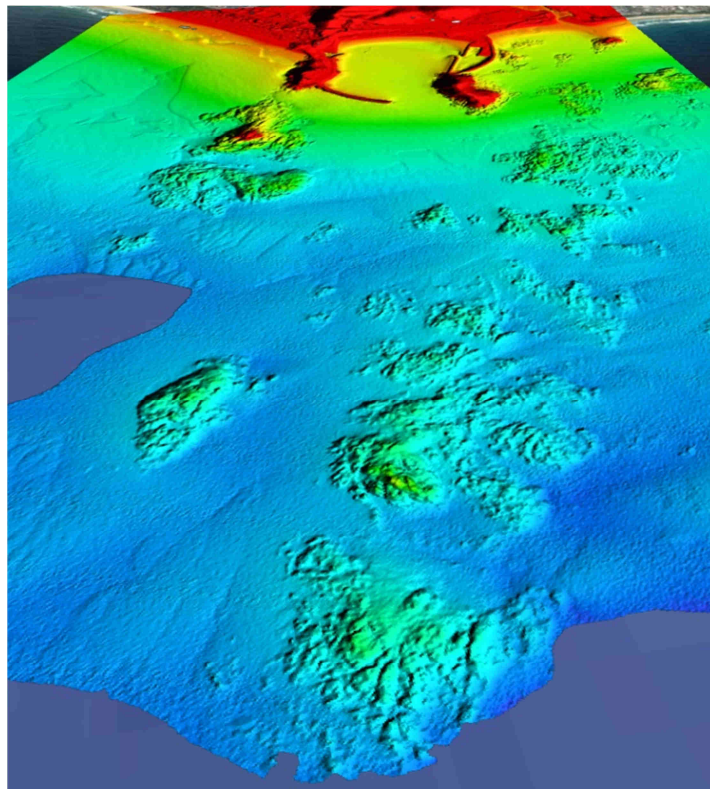


Large Scale Airborne Lidar Bathymetric Mapping Projects for Coastal Zone Management

Mark Sinclair¹, Paul Seaton¹, Mick Hawkins¹

¹Fugro Australia Marine Pty Ltd. 7 Valetta Rd. Kidman Park, South Australia, Australia
Email: m.hawkins@fugro.com

The NSW Office of Environment and Heritage recently commissioned a survey of NSW coastal areas, covering 48 sediment compartments utilising Airborne Lidar bathymetry technology to survey the coastal environment to water depths of 30 metres. The project aims to provide fundamental data to support the implementation of the coastal management reforms and will deliver high resolution sea bed mapping for the NSW coast. This data is critical for coastal zone modelling necessary to inform the development of coastal management programs that are required to protect the NSW coastline and coastal assets



Fugro LADS HD lidar bathymetry coverage of Coffs Harbour

Fugro have been advancing bathymetric capabilities through usage of Airborne Lidar Bathymetry, Satellite Derived Bathymetry, Autonomous Vessels and deep machine learning for rapid product turn around. These new technologies allow for highly detailed base line mapping of the shallow nearshore waters in a safe manner with zero impact on the local habitats.

High definition topographic and bathymetric base line data can be invaluable for conducting environmental change and modelling, changes in habitat and analysis of the effects of sea-level rise and storm damage. This presentation will review the technology and processes used to capture a seamless state-wide dataset of coastal assets and adjoining sediment compartments to enable suitable coastal zone modelling.

SINCLAIR & OTHERS

Evidence based approach to water supply development in volcanic islands – case study Tanna, Vanuatu

Peter Sinclair¹, Amini Loco¹, Andreas Antoniou¹, Anesh Kumar¹

¹Pacific Community (SPC), Suva, Fiji
Email: Peters2@spc.int, aminisitail@spc.int, andreasa@spc.int, aneshk@spc.int

In 2017 the Geoscience, Energy and Maritime division of SPC, in collaboration with the Department of Water Resources of Vanuatu conducted groundwater investigation surveys using geophysics in the island of Tanna, Vanuatu. The surveys were part of the broader suite of the KfW-funded SPC's recovery activities in response to cyclone Pam. SPC has been assisting the Vanuatu government to increase the resilience of water supply systems through rehabilitation and expansion and to address sanitation and hygiene challenges.

Electrical Resistivity Tomography (ERT) profiles were conducted in various locations of North and Central Tanna to assess the groundwater potential of the volcanic deposits and identify suitable drilling targets for community water supply wells. The highly porous/fractured nature of the volcanic rocks poses challenging conditions for groundwater to accumulate at reachable drilling depths as it has been generally observed that groundwater percolates deep into the basal aquifer and subsequently discharges to the sea through coastal brackish springs which are spread around the coast. In North Tanna, the geophysics suggested a number of targets related to perched aquifers and structurally controlled fractured aquifers similar to the ones encountered in the islands of Hawaii. In Central Tanna, the geophysics suggested higher groundwater potential associated with highly weathered volcanic deposits covered by younger volcanics.

In 2019, funding was secured through the EU-funded Building Safety and Resilience in the Pacific project to undertake drilling and bore construction in Tanna within the framework of a drilling regional training programme for the Pacific. Five successful bores were constructed with groundwater yields varying between 0.8 and 1.6 L/sec, offering huge benefits for the communities of Central Tanna which limited rainwater harvesting, and unprotected stream water source, prone to droughts and not always at close proximity. The drilling suggested the presence of a relatively productive aquifer within weathered volcanic flows at depths between 20 and 50 m, perched over older permeable ash deposits.

SINGH, McKEOWN & TERRY

Responses of a high altitude wetland to late-Holocene environmental changes in Taveuni, Fiji

Kunal Singh¹, Michelle McKeown², James Terry³

¹*University of the South Pacific, Fiji, Suva*

²*Landcare Research, New Zealand, Christchurch*

³*Zayed University, Dubai, United Arab Emirates*

Email: singh_ku@usp.ac.fj, McKeownM@landcareresearch.co.nz, James.Terry@zu.ac.ae

Palaeoenvironmental research on wetlands, such as peatlands and lakes provides long-term environmental information on how these systems have changed through time. In order to protect wetlands we need to explore how they have altered in the past and what is driving these changes. A plethora of research has been undertaken on tropical mountain lake and peatland ecosystems in the mid-latitudes in the Northern Hemisphere; however, less work has been carried out in tropical locations, particularly so in the Pacific. This paper presents the results of palaeoenvironmental investigations on a high elevation crater wetland in Taveuni, Fiji.

Sediment and peat cores were extracted from the Lake Tagimaucia water body and the surrounding peatland. We employed a multi-proxy approach in this study where organic indicators (peat humification and bulk density), physical variables (grain size analysis) and bulk geochemistry (C/N, $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) were performed to interpret changes through time.

The high altitude wetland ecosystem is sensitive to climatic perturbations, largely driven by hydrological and temperature variabilities. The findings also show inconsistencies in lake and peat chronology, possibly due to sediment mixing and the presence of floating algal mats in the water body.

Physico-Chemical Properties of Some Selected Soils of the Sigatoka Region, Viti Levu, Fiji

Indra R. Singh¹, Nisha Zuree, Champathi Gunathilake, Saula Koro

*College of Agriculture, Fisheries and Forestry, Fiji National University, P.O. Box 1544, Nausori, Fiji Islands
Email: indrarajsingh@gmail.com, zurennisha90@gmail.com, cchampathi@gmail.com, saula.koro@fnu.ac.fj*

The physical and chemical properties of soils are very important parameters to assess the quality of soil. Soil physical and chemical properties also play a vital role in crop productivity. In this study twenty soil samples were collected from farmers' fields of village Kabisi, Cuvu, Yadua and Malomalo of Sigatoka region to determine soil properties. Soil samples were collected, processed and analysed for the parameters viz., soil texture, structure, soil colour, bulk density (BD), particle density (PD), percent pore space, water holding capacity, soil pH, electrical conductivity (EC), organic carbon (OC) content. Obtained results showed that soils of study area were sandy loam to clay loam in texture with granular to sub-angular blocky structure, the mean bulk density was 1.2 Mg m⁻³, porosity 43 percent, and water holding capacity 42 percent. Further, laboratory results indicated that the soils were slightly acidic to neutral (mean pH=6.6) and non-saline in nature with low organic carbon content (mean 1.6 percent). This study suggests the necessity to apply organic manures and liming material, with recommended doses of fertilizer for enhancing the crop productivity in the study area.

^{*1}Corresponding author: Indra R. Singh, College of Agriculture, Fisheries and Forestry, Fiji National University, P.O. Box 1544, Nausori, Fiji. Email: indrarajsingh@gmail.com

SINGURA & OHBA

Unearthing tephra deposit and petrological trace of subvolcanic magma dynamics of two active intra-caldera volcanoes north of Rabaul volcanic complex-Papua New Guinea

Lloyd Singura¹, Tsukasa Ohba¹

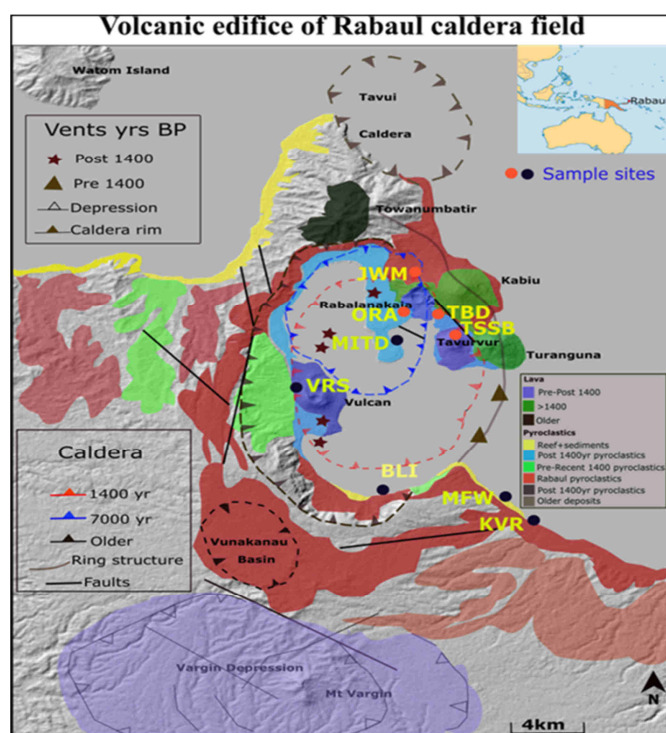
¹Akita University-Japan

Email: lloyd.singura@upng.ac.pg or lsingura@gmail.com

This study aims to characterize tephra and identify subvolcanic magma dynamics of the 300-700 years BP silently active Rabalanakaia volcano, in conjunction to the restless Tavurvur < 5 kilometers apart, at the northern tip of Rabaul Volcanic Complex, Papua New Guinea.

Rabalanakaia has been silent after its last activity 700 years ago. Tavurvur on the other end after its 1878 initial recorded activity has been restless in the last 100 years with plinian/sub-plinian and strombolian eruptions occurring in 1937, 1994, 2006 and 2014 with intermittent activities almost tri-annually.

Eight (8) tephra horizons were sampled opposite the Japanese Peace Memorial (JPM) < 2 km kilometers



southwest of the Rabalanakaia crater in Rabaul. Tavurvur samples were sampled at the old Rabaul airport (ORA-1994 eruptive), at Matupit Island (1937) eruptives and the 2014 violent strombolian scoria bombs at the summit. Seven units of the JPM samples are tholeiitic basalts showing progressive Fe enrichment successively with evolved mafics that grades into the calc-alkaline andesitic unit 8 at the top of the column. Tavurvur on the other hand showed an inversed system of increasing mafic minerals.

Keywords: Tephra, intracaldera volcanoes, crystal fractionation, magma mixing, restless volcano, Rabaul, caldera complex

SMITH

Socio-economic sustainability in mining through innovation – The implementation of shrinkage stopping mining methods at Vatukoula Gold Mine, Fiji

Jack A. Smith

Vatukoula Gold Mines Plc. Ltd

Email: jack.s@vgml.com.fj

Over the last two decades there has been growing interest in the socio-economic sustainability of mining in Vatukoula, Fiji. The sudden and brief closure of Vatukoula gold mine from December 2006 to August 2007 after 70 years of continuous operation tested the very foundation surrounding the sustainability of mining and the influence mining can have on the socio-economic framework of a community. Some twelve (12) years on, mining is still and well underway at Vatukoula with gold production looking to ramp up within the next 18-36 months. Bar the brief hiatus in 2007, testament to the mines' longevity has been its ability to innovate through adopting new techniques and mining practices; in which the latter forms the basis of this paper.

This paper looks at the implementation of shrinkage stopping at Vatukoula gold mine (Figure 1), the impact it has had on mining, and the influence it has made towards the socio-economic outlook of mining in one of the longest operating mines in the world. The implementation of shrinkage stopping at Vatukoula comes in response to ever increasing mining costs, depletion of *easy* high grade reserves and absolute commitment to zero harm.

Coupled with the lowest operating cost and the highest rate of productivity in terms of tonnes per man-hour, shrinkage stopping has enabled the efficient, safe and economic exploitation of steep ore bodies at Vatukoula. This increased capability has resulted in a notable increase in ore reserves that has further extended the life-of-mine. By 2022 shrinkage stopping will account for more than 20% of all ore tonnes

mined at Vatukoula. An increase in mine-life would have a direct impact on the people and local businesses in and around Vatukoula. Thus by continuously seeking to innovate and adopt new techniques and practices, like shrinkage stopping, the mine will continue to put itself in the best position to stay in operation for as long as possible.

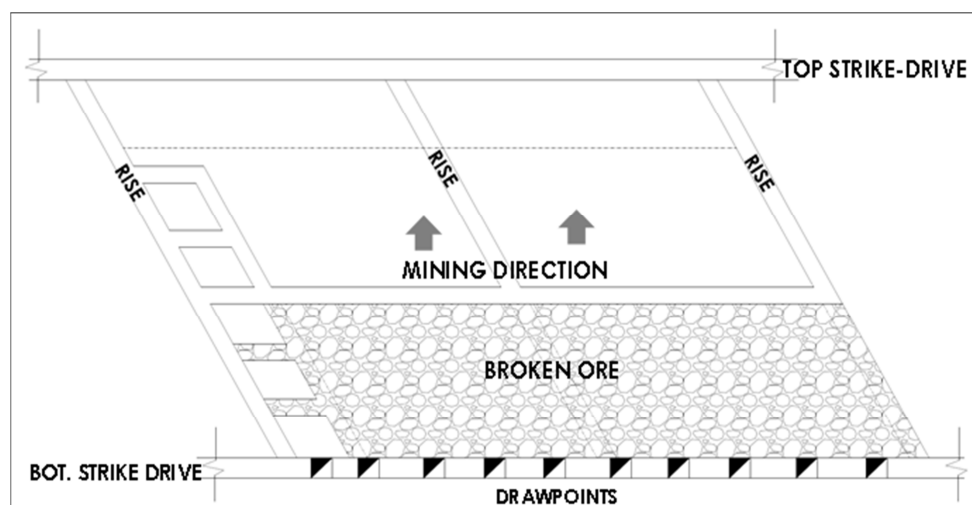


Figure 1 – Shrinkage stopping method utilized at Vatukoula gold mine.

Geophysical and Geological Investigations for Infrastructure Development, Fanga'Uta Lagoon

Robert Smith, Gary Lee

Geoscience, Energy and Maritime Division

Pacific Community (SPC)

Email: roberts@spc.int

When dealing with coastal communities where the threats of sea level rise, tsunamis, and inundation from storms and cyclones are events that impinge on humanity, practical solutions for mitigating or adapting to climate change and coastal hazard impacts can only be realised if there is detail in the science to understand the past, present and the future. Here we present results of a survey that began with a simple mapping exercise of the lagoon with a goal to evaluate the most suitable location for a bridge to facilitate rapid evacuation of the Tongatapu coastal city and populace in the event of a tsunami.

Understanding coastline and lagoon behavior that responds to a complex set of variables that govern how the coastal zone acts over logarithmic time scales cannot be looked at from any one perspective but requires an interdisciplinary approach.

Such connectivity must be understood if adaptable climate change solutions linked to infrastructure needs are to be successfully implemented. The results of this study are based on marine seismic reflection, terrestrial seismic refraction, bathymetric, oceanographic and conductivity depth profile data, with composition analysis of 41 samples from 21 holes drilled in the lagoon area, and an additional 20 marine samples collected for geochemical analysis of trace and heavy metal pollutants. Lidar and image analysis provide an excellent backdrop to the interpretation presented.



STONE & McLACHLAN

Ocean Metals and the Future of the Pacific Islands

Gregory Stone¹, PhD, Corey McLachlan¹

DeepGreen <www.deep.green>

Email: ¹Greg@deep.green, ²Corey@deep.green

The green transition, rising living standards in the developing world and adding another 3 billion people this century mean that we will need hundreds of millions of tonnes of base metals. While most metals are highly recyclable, we currently don't have nearly enough metal in the system to be able to meet all of our needs. Not unlike fossil fuels, conventional metal production from land-ores generates a host of global scale negative environmental and social externalities like tropical deforestation and habitat destruction, toxic tailings, carbon dioxide and particulate emissions, loss of human life and irreversible damage to human health and biodiversity. After analysing the life cycle impacts of a variety of sources on land and in the ocean, we believe that producing the missing stock of base metals from the deep ocean polymetallic nodules would make it possible to dramatically reduce environmental and social impacts of metal production.

Please join us to learn more about the life cycle analysis of this new industry and how it compares to terrestrial mining. We will explore the environmental and economic opportunities and cautions to be considered and the prominent role that Pacific States have in this new industry.

TABUABISATAKI

Importance of Global Navigations Satellite Systems (GNSS) to Positioning Infrastructure – Fiji

Asakaia Tabuabisataki

G.P.O. Box 2222, Government Building, Suva, Fiji

Email: asakaia.tabua@govnet.gov.fj

There is growing dependence on the global reference frame (ITRF) and satellite positioning including GNSS and GPS.

Fiji recognizes the growing demand for more precise positioning services, the economic importance of the global geodetic reference frame and the need to improve positions infrastructure. Various sectors will benefit from precise and update positions infrastructure base from GNSS is Land management agencies in managing geospatial information, Asset owners in maintaining and monitoring ancillaries and their performance, Disaster Management agencies for monitoring temporal changes and disasters and Navigation with international accreditation agencies demanding extremely accurate positional control (e.g. ground based augmented systems).

Fiji is a developing country, precise positioning base on GNSS can contribute to the improvement in Return on Investment. Developed countries such as Australia have greatly benefits in investing in precise positioning. Area of machine control with construction and agriculture with high accuracy positioning benefits approx.

AUD21billion in the next 20 years (Source: TOPCON) and area of search and rescue, saving 3 lives annually @ AUD2.6 million/statistical life (Source: CASA, Australian Government). In USA area of commercial surface

transportation, saving approx. USD10.3 billion from the total USD126.4 billion/annum estimate (Source: NDP Consulting Group, Washington).

It is forecasted that in the coming years Positioning Infrastructure (PI) will be very critical for sustainable and economic development in Fiji.

TADULALA, RAQISIA & RAHIMAN

Lineament Analysis and Groundwater Characteristics of Upper Sigatoka Valley Catchment and NE Lower Tailevu Coastal Catchment

Malakai Tadulala, Keleni Raqisio², Tariq Rahiman³

¹Ministry of Lands and Mineral Resources Department, Private Mail Bag, Suva.

²Mineral Resources Department, Lot 241 Mead Rd, Nabua, City- Suva, Fiji

³Australian Institute of Geoscientists., PO Box 576, CROWS NEST NSW 1585, Australia - Country

Email: m.tadulala@govnet.gov.fj, keleni.raqitawa@govnet.gov.fj

Lineaments is characterised as a vector that displays geological structures either fault, fractures, watersheds and it can also be either be a barrier or conduits of groundwater yield. Using Landsat ETM -7, DTM, Google Satellite, available literature for reviews, QGIS 3.0 and available plugin tools (geotrace) to extract lineaments as our basis of groundwater characteristics and yield.

The study area chosen is a comparative analysis between Upper Sigatoka Valley Catchment and NE Lower Tailevu Coastal Catchment. The study area composed of major and minor lineaments of N-S, NE-SW, E-W, ENE-WSW, NNW-SSE. Exploratory boreholes were drilled at these said catchments, boreholes sites that falls within the major lineament exhibited high yield boreholes 1-10 L/s on the Alluvium formation (unconsolidated sediments). While boreholes that are far away from lineaments structure shows a low groundwater yield 0.3-1 L/s are geologically known as consolidated sediments formation; Nacua sandstone, Vatukoro greywacke bedrock.

Hence, groundwater potential is high given that it falls within the proximity of major and minor lineaments as conduits of groundwater yield, but groundwater potential is low if far away from lineament structures that may be a barrier to control groundwater yield.

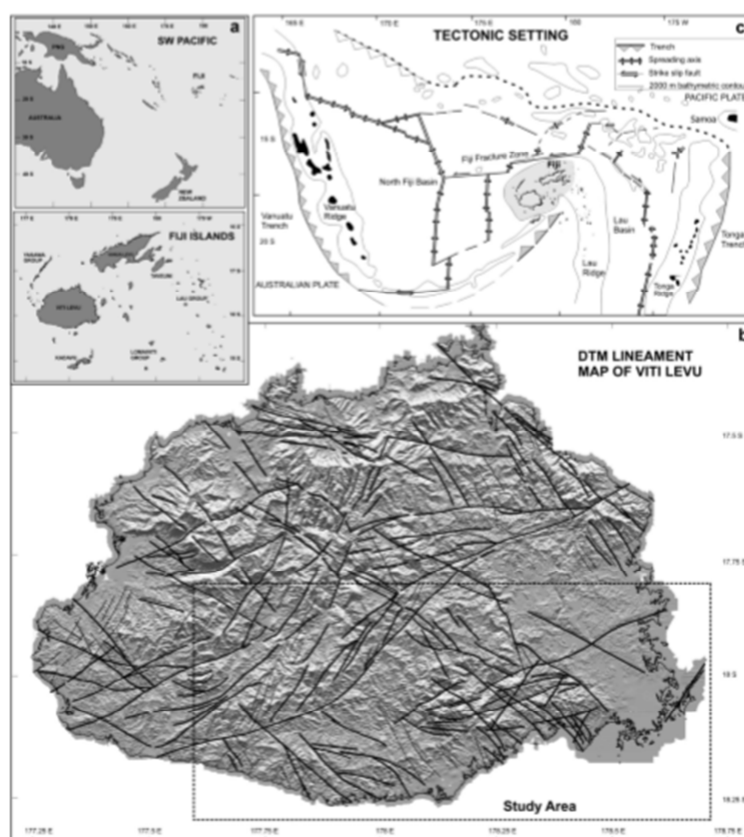


Figure 1 (a) Location on Fiji in the SW Pacific and the main islands of the Fiji archipelago. (b) Synoptic lineament map of Viti Levu based on 20 m resolution digital terrain model, illumination is from the N, 30° from the horizontal. Studied area is outline in the SE. (c) Tectonic setting of Fiji. (Tariq, 2009; pp 63)

TAN, CELIS & NESBITT

Cirianiu: The Epithermal Gold Project that Unlocked a District

Roberto Tan, Roman Celis, Michael Nesbitt

G.P.O. Box 2222, Government Building, Suva, Fiji

Email: asakaia.tabua@govnet.gov.fj

Cirianiu lies in NE Vanua Levu in a region of Miocene-Pliocene volcanism partly controlled by a set of now NE-ENE trending arc parallel structures formed parallel to the off-shore subduction zone. Arc parallel structures include the Nubu and the Nasavu Faults and the Nubu Fault is interpreted to have participated in the formation of a NE trending graben which has focused alteration and mineralization at Cirianiu. Nubu Fault transects Cirianiu about 1 km NW of Qiriyaga Hill, but with a trend of 063° on the regional data or 058.5° in outcrop where visited, whereas the graben described below displays a dominant trend of 048° on the aeromagnetic data, with segments varying to 025° (Corbett 2012).

Cirianiu has been explored by various companies since the mid 1970's. In 2010, Kalo Exploration Ltd undertook an exploration program, with the concept that the mineralised structures were vertically oriented, and angle drilling was required. Using this model, Kalo quickly encountered high grade gold in mineralised vertical structures. Using this knowledge, Kalo expanded the Cirianiu project, discovering new prospects within the region. Kalo has established a 15 km long mineralized corridor, trending NE-SW.

TAYLOR & OTHERS

Recent Volcanic Activity in the Kingdom of Tonga

Paul Taylor¹, Taaniela Kula², Titie Kaufusi², Scott Bryan³, Andrew Fletcher³

¹*Australian Volcanological Investigations, PO Box 49 Phillip Mall, West Pymble, NSW, 2073, Australia*

²*Geological Services Unit, Ministry of Lands, Survey & Natural Resources, Nuku'alofa, Kingdom of Tonga*

³*School of Earth, Environmental & Biological Sciences, Queensland University of Technology, Brisbane, Queensland, Australia*

Email: avitaylor@optusnet.com.au, tkula@naturalresources.gov.to, titie.afuhia.i.vaha@gmail.com, scott.bryan@qut.edu.au, a20.fletcher@qut.edu.au

The Kingdom of Tonga, in the South West Pacific region form part of the Pacific Rim of Fire and has subjected to a long period of volcanism of different types. The Tofua Volcanic Arc (TVA) forms a prominent tectonic feature in the SW Pacific and is a classic example of an active oceanic island arc. The arc comprises a series of several dozen active, dormant, and extinct, subaerial and submarine volcanic centres that have formed on a N-S trending submarine ridge, between latitudes 14.5°S and 26°S. In the northern and central parts, the arc is located 40-50 km W of the Tonga Platform. Active volcanism has been occurring along almost the entire length of the TVA since its initiation after the formation of the Lau Basin between 3 Ma and 5 Ma.

Recent activity has occurred from predominantly submarine volcanic centres, producing large rafts of pumice and occasionally forming sub-aerial islands. Periods of activity in the region of *Hunga Tonga* and *Hunga Ha'apai* in 2009 and 2015 resulted in the formation of several short-term and sustained volcanic islands. The island formed during the 2015 eruption still exists today.

In recent months two periods of volcanic activity were observed. The first was a "giant pumice raft" reported to be the size of Manhattan Is was observed was to the west of the Vava'u Island group during the period mid to late August. The source of this pumice was not immediately known as no activity had been observed or reported in the area prior to the sighting. Unreported/unobserved activity is not

uncommon as the TVA is located some distance to the west of the inhabited island of the Tonga Group. Where did the pumice come from?

The second period of activity was reported to have occurred at the frequently active centre, known as *Metis Shoal* or which is locally referred to as *Lateiki*. This volcano has been active many times over the past 100 years often forming small islands, but due to the nature of the material produced the structures have been destroyed very quickly, often within months, by the ocean currents.

Both periods of activity were reported extensively in the international media and some very detailed reports of the products have appeared on the social media reported by passing yachts.

TAYLOR, PETTERSON & CRONIN

Volcanic Hazard Maps: Their development and use in Volcanic Environments of the South West Pacific

Paul Taylor¹, Shane Cronin², Michael Petterson³

¹*Australian Volcanological Investigations, PO Box 49 Phillip Mall, West Pymble, NSW, 2073, Australia*

²*School of Environment, Auckland University, 23 Symonds Street, Auckland, New Zealand*

³*School of Science, Auckland University of Technology, St Pauls Street, Auckland, New Zealand*

Email: avitaylor@optusnet.com.au, s.cronin@auckland.ac.nz, michael.petterson@aut.ac.nz

Numerous hazards are associated with volcanoes and an understanding of their nature and likely effects is important for the communities that may live around them. Volcanic hazard maps form an integral part of the process to reducing the risk to vulnerable populations living in environments subjected to periods of volcanic activity. Volcanic hazard maps have evolved over the years from very simple maps that describe the effects of single eruptions to more complex and comprehensive visually impressive diagrams that describe all the hazards that may be produced from a volcanic centre.

The South West Pacific region forms part of the Pacific Rim of Fire and has subjected to a long period of volcanism of different types. The authors have been instrumental in developing a series of volcanic hazard maps for many of the regions active volcanic systems that exist in the Solomon Islands, Vanuatu, Fiji, Samoa and The Kingdom of Tonga.

This paper will showcase many of the maps that have been developed and show the effects of the numerous hazards that affect the areas around the individual volcanic centres. Initially, the work was undertaken for academic purposes however, the value of such work was quickly seen for its importance in assessing the risk from future activity. How have these maps been used by the individual countries? In some cases, they have been integrated into their disaster management processes, however, in other cases they have remained virtually unknown or unused, thus leaving populations at considerable risk from future activity.

What is needed in the region to ensure that these valuable tools are used to reduce the risk to vulnerable communities living on and around the active volcanic systems?

Developing GIS-based Soil Erosion Map using RUSLE model for Naitasiri Province, Fiji

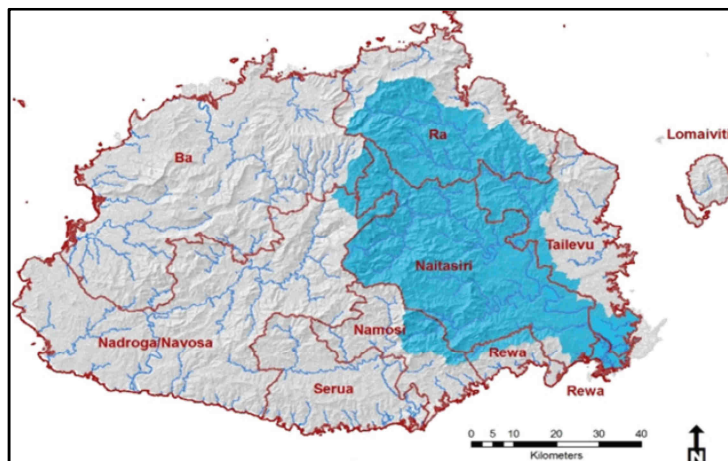
Swetha Thammadi¹, Sateesh Pisini², Jimaima Lako³

¹Lecturer, College of Engineering Science and Technology, Fiji National University, Fiji

²Principal Lecturer, College of Engineering Science and Technology, Fiji National University, Fiji

³Associate Professor and Associate Dean – Research, College of Engineering Science and Technology, Fiji National University, Fiji
Email: swetha.thammadi@fnu.ac.fj, sateesh.pisini@fnu.ac.fj

Soil erosion is one of the most serious environmental problems in the world today and with decreased soil fertility causes the destruction of our natural ecosystems like pastures, forests and agricultural ecosystems. It is accelerated by natural disasters due to climate change, land use, land cover and steep slopes. According to Morrison et.al, 1990 on Soil Erosion in Fiji – Problems and Perspectives, Fiji loses an average of 50 tons of soil a hectare annually, almost four-times the globally accepted level for tropical countries". Increased soil erosion results in the decrease in soil fertility, loss of land, increased runoff due to rainfall, large flow of sediments, deteriorated drinking water quality, lower groundwater recharge, more flooding, resulting in financial loss and increased costs of rehabilitation.



CRISP has mapped potential erosion risks in North Viti Levu using USLE (Universal Soil Loss Equation) and GIS model with focus on Coral Reefs which are sensitive to erosion. But no study has been done so far in Naitasiri province which has Rewa River, the largest river in Fiji which takes up about one-third of the total land area of Viti Levu. The Rewa watershed receives high rainfall, and the catchment has the highest runoff coefficient for the major rivers in Fiji. Flooding of the Rewa River and delta causes massive losses, to the local people and to the nation in terms of damage to infrastructure, economic costs of rehabilitation and financial assistance to affected communities. The study aims at developing a Soil Erosion map using RUSLE (Revised Universal Soil Loss Equation) and GIS demarcating the areas prone to erosion risks. Further, mitigation measures would be proposed and an adaptation framework developed for the communities affected by soil erosion.

VAKAWALETABUA

Suva rivers Monitoring in Support of the Assimilative Study of the Laucala Bay, Suva

Sereiseini Dikalouniwai Vakawaletabua

Water Authority of Fiji

Email: sereiseini.d@waf.com.fj

The Greater Suva Urban Area (GSUA) includes Suva City and the neighbouring towns of Lami, Nasinu and Nausori with their respective peri-urban areas in a continuum. The GSUA comprises the capital city of Fiji, Suva City, and three municipal towns namely Lami, Nasinu and Nausori Towns. The GSUA is the country's largest urban area holding the estimated 57 per cent (244,000 people) of the national urban population in 2007. The urban area covers 4000 hectares and forms part of the larger Suva-Nausori Corridor. The GSUA is the country's economic centre generating an estimated 30 per cent of the national gross domestic

product. Suva City produces almost 70 tons of waste (including green waste) per day and 70% of GSUA residents do not have proper sewage.

Laucala Bay is a remarkable body of water because of its rich diversity of habitats within a relatively small area. These include mudflats, mangrove forests, seagrass beds, coral cays and coral reefs, all of which contribute in their own ways to Laucala Bay's capacity to assimilate the pollutants from GSUA Rivers. In addition, during periods of heavy rainfall, storm water transports litter from streets and domestic rubbish placed in creeks into the lagoon. Five rivers drain the greater part of the GSUA: Nasinu, Samabula, Vatuwaqa, Tamavua and Lami Rivers. Poor water quality management in the GSUA may cause: marine biodiversity degradation – adverse effects on food security and livelihoods; public health risks – scabies, diarrhoea, leptoviruses, and poor access to drinking water.

Water Authority of Fiji proposes to undertake this project. WAF is a Commercial Statutory Authority (CSA) under the ambit of the Public Enterprise Act. It is responsible for providing access to quality drinking water to over 144,000 residential and non-residential metered customers reaching over 800,000 people nationwide. This includes Rotuma, rural areas and the outer islands.

VATUCICILA

The Importance of Developing an Environmental Baseline Study – Tuvatu Gold Project

Sereana Vatucicila

*Environment Officer, Lion One Limited, P.O. Box 11112, Nadi Airport, Fiji
Email: sereana.r@liononeltd.com*

A credible environmental baseline system helps indicate if current operations and development have drastically changed the quality of the natural environment. Lion One Limited (Fiji) has collected over eight (8) years of water quality data from its Special Prospecting Licenses (SPL). This data has been used to develop a baseline water quality profile of existing water bodies in the prospect areas prior to mining. This presentation provides information on the sampling and monitoring programs undertaken by the Company.

A robust and reliable baseline relies on a combination of analyses and as such the Company assays for not only the physical parameters and heavy metals but also the microbiological status of water bodies. Complementing these data is a monthly flow-rate study which has indicated the impacts of seasonal changes on water quality over the years. Maintenance and monitoring of water quality is performed regularly to update the baseline water quality profile and the Company's environmental management response capabilities. Water samples are collected from water bodies adjacent to key areas of mining such as the underground adit, stockpile and processing sites as well as the proposed tailings dam. From originally sending samples to the Mineral Resources Geochemical Laboratory, the Company has shifted assaying to Auckland based Watercare Laboratory Services which preferably have lower limits of detection.

Lion One Limited (Fiji) complies with both Fiji and International water quality standards and continuously engages with regulatory authorities and relevant stakeholders to maintain high standards of operations.