## POLITECNICO DI MILANO- DIIAR

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# Carried out activities in Nauru

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From the 24th of November to the 1st of December 2010 Politecnico di Milano, represented by Dr. L. Alberti and Dr. M. Cantone, visited for the first time the Nauru island. The objectives of this journey were:

- to meet Nauru's Public Authorities dealing with the island water resources

- to start the collection of a series of hydrogeological data that were not available in previous studies.

# 1 Meetings with local public authorities

During the days spent in Nauru it was possible to know personally: local public authorities, managers of the NRC company (Nauru Rehabilitation Company), some member of SOPAC (Pacific Islands Applied Geoscience Commission) and International Monetary Fund (IMF).

The 25th of November, at the government offices of Department of Commerce, Industry & Environment (CIE), it was possible to know the Project Manager Haseldon Buraman and the Project Coordinator Mavis Brechtefeld Depaune who have shown their expertise and the available data. This department mainly deals with environmental monitoring of public and private wells and also records the values of temperature and rainfall. The CIE has provided rainfall and temperature data collected in recent years and many reports about groundwater edited in collaboration with SOPAC technicians. Furthermore CIE provided a detailed report concerning private wells and cesspits position and characteristics. A database concerning this information was not yet available but the maps contained in the report give a good idea of the wells distribution and Electrical Conductivity values of groundwater from November 2009 to April 2010.

The Nauru Rehabilitation Company (NRC), managed by CEO Vinci Clodumar, is responsible for rehabilitation of Nauru Island after the phosphate overexploitation; at the head quarter, located in the Meneg District, Vinci Clodumar and Benedict Abouke have shown the NRC intents and the data they hold. The NRC manages about 35 wells and piezometers to monitor groundwater levels and salinity; in recent years Benedict Abouke, jointly with Peater Sinclair from SOPAC, has continuously monitored many of those piezometers and wells in order to understand the evolution of the water table and salt concentrations in response to rainfall events. The NRC has provided to Politecnico hydrogeological data, many stratigraphic logs and raw data concerning Digital Terrain Model of Nauru island modelling. Unfortunately data concerning hydraulic conductivity of limestone aquifers and costal sands were not available.

In Nauru was present a SOPAC consultant (David Duncan) and some officer of International Monetary Fund (Andrew McIntire et others) who pointed out problems and difficulties in developing projects in situ. They also listed the main projects developed on the island and gave indications to find reports about them. From these meetings clearly rose up that an important issue to reach the project goals is the involvement in the

project (e.g. as supervisors) of some organizations that in last years had carried out projects concerning water management.

The 26th of November a meeting was held at the NRC head quarter in order to present the Expo 2015-Nauru Project driven by Politecnico and funded by the Municipality of Milan. The meeting was attended by the CEO of NRC (Vinci Clodumar), a delegate of CIE (Haseldon Buraman), a SOPAC member (David Duncan) and an AMU delegate (Miss. A.Tiata).

Briefly resuming, the Expo 2015-Nauru Project work program is divided in two main parts: (http://www.como.polimi.it/nauru/aim-of-the-project.html): the first is dedicated to groundwater and saltwater intrusion modeling in reason to ensemble all the available data, highlight the knowledge lacks and the monitoring/experimental activities necessary to improve the comprehension of the Nauru groundwater system behavior and to implement a tool able to support the Nauru groundwater resources management. The development of the second part should be chosen on the basis of the modeling activities results, but indicatively the available funds could be used for: groundwater monitoring network improvement, field wells test design and construction, groundwater exploitation improvement through new infrastructures and organization of a dedicated session during the SOPAC Conference in July 2012 (www.SOPAC.org).

After the presentation, during the open discussion, it had risen that the Expo 2015-Nauru Project represents a good chance for Nauru Public Authorities to prosecute the SOPAC work done until July 2010 by Peter Sinclair and Benedict Abouke. What emerged in SOPAC investigation is that Jacobson and Hill study (1997) and the model they implemented were too general to well represent the island hydrogeology. It is clear that up to now there is a lack in knowledge of the hydraulic conductivity values in different sectors of the island (Top Side, Buada Lagoon and costal plain) and it is necessary to plan a series of pumping tests and the prolongation of the monitoring activity developed by Peter Sinclair. The meeting concluded with this agreement:

- Politecnico di Milano will prepare a list of monitoring activities to be performed in 2011

- B. Abouke of NRC will be the responsible of this monitoring activity and of the data transmission to Politecnico

- Next meeting in Nauru island is indicatively fixed for July 2011

## 2 Field activities

The field activities were carried out by Politecnico in collaboration with the NRC technicians, exactly with Benedict Abouke's staff. The 26th of November a pumping test in well T1 was performed in order to obtain hydrogeological parameters of the Topside area. The test was done using the pump available in NRC. The piezometer S8 (5 m far from T1) was used as monitoring well for the pumping effect, while piezometer S10 (123 m far from T1) was used to monitor the natural fluctuations of the water table., After about 6 hours a recovery test was performed in the same wells. Unfortunately, both tests did not give good results because of the too low maximum pumping rate of the available pump (0,85 l/s). In the monitoring well was observed a water level variation caused only by tidal fluctuations. The test just gave a rough indication of high values of hydraulic conductivities (> $1 \cdot 10\text{-}3$ m/s).

In the next days (27th - 28th of Nov) measurements of groundwater levels and salinity were carried out in order to obtain an accurate representation of the hydraulic head and concentration distributions: these measurements have been done in the southern part of the island during the 27th morning and, the next morning, in the northern part, in order to have level and concentration data referred to comparable tidal levels.

To collect data necessary for the calibration of two mathematical cross-sectional models, a detailed salinity survey was carried out from 29th to the 30th of November. The electrical conductivity at interval of one meters depth was measured in each piezometer. The electrical conductivity was also measured in the Anabar Lagoon located in the Northen area of the island, and in the Buada Lagoon, in the South. Close to the airport, the electrical conductivity was measured in the Maqua Cave.

Because of the continuous changing of groundwater levels due to tidal fluctuations, it was deem to be useful to monitor a piezometer along the coast (T2) and one in the topside area (S10) to check the time lag in groundwater response. The data collected in three days allowed the reconstruction of the maximum and minimum tide levels and their variations.

# 3 Monitoring activities 2011 program

In this chapter the monitoring activities suggested by the Politecnico di Milano. In December 2010 the following items were communicated to B. Abouke (NRC):

**Water level and EC measurements in T1**

Program the correct data and time and place the data logger CD3000 in well T1, 2 m below the water table.

FIRST STEP: for the first week set the CD 3000 to collect a measures every 30min. After 1 week download the data. We will use this data to get the tide signal in the Top side.

SECOND STEP: after the first step reset the CD 3000 to store measures every 2 h and leave it in T1 for 1 year. Anyway every month download the data and please send it to us. It is suggested to download the data using a notebook to avoid to move the data-logger (otherwise every time you download you risk to change the depth where you placed it). We will use these data to monitor water table movement and correlate it with rain events that you will measure for 1 year in the rain gouge.

**Water level and EC measurements in S3**

Program the correct data and time and place the data logger CD3000 in piezometer S3, 2 m below the water table.

Set the CD 3000 to store measures every 2 h and leave it in S3 for 1 year. Anyway every month download the data and please send it to us. It is suggested to download the data using a notebook to avoid to move the data-logger (otherwise every time you download you risk to change the depth where you placed it).

We need to ensure that water table never sinks below the instrument depth or we risk that the data-logger crashes.

We will use these data to monitor water table movement and correlate it with rain events and the pond infiltration.

**Rain gouge measurements**

As you have done for T. Falkland (SOPAC), continue to measure for 1 year every day the water thickness in the rain gouge close to T1. Store the data in T. Falkland spreadsheet and e-mail it to us every month.

Please get the data also from the automatic rain gouge in the NRC workshop and send it to us every month.

**Buada Lagoon**

Concrete lunch path: ask to the survey service to measure the level of the point on the lunch path that we used to measure Buada Lagoon level.

EC and depth measure: please try to find the deepest point of the lagoon and here measure the EC ad temperature every 1 meter from the water level to the bottom.

**Pumping tests**

We have chosen some wells pairs where water table depth is small so you should be able to perform pumping tests with your pump (2,5 l/s). You need to start the test early in the morning in order to use the working day as long as possible. When you perform pumping test we need to be sure that the data-logger in T1 is properly working.

Wells O11-E5:

— place the pump in O11 and put the discharge water tube as far as possible;

— place the ST data-logger in E5 1 m below the water table and set it to get data every 30 seconds;

— just 1 minute before to switch on the pump measure the level in O11 and E5 and then start the pumping test;

— take measures in O11 following our time-sheet;

— measure the pumping rate using the bucket 5 minutes after the starting and then once every hour;

— as indicated in the time-sheet, collect manually water levels in E5 using the water meter; be careful to don't move the data-logger, otherwise it will get wrong data;

— measure the EC in O11 and E5 as indicated in the time-sheet;

— often control the fuel of the generator to avoid any shut down of the pump;

— after 9 hours measure manually water levels in E5 and O11 and then suddenly stop the pump;

— measure water table rising in O11 following the time-sheet;

— after 1 hour you can stop to measure;

— live the data logger in E5 for next 24 h after the power off of the pump.

**Monitoring wells external steel cases**

It is suggested to drill a small hole (about 3 mm diameter) at the base of each well external steel case in reason to drain the rain water that accumulates inside.

**EC and water level campaigns**

You can realize one EC and level campaign every 2 months in all wells; every month you can check the EC value and water level at the bottom in the middle of the well and at the depth of water table in these following wells:

S18- S1- S21-S24-S12-S2-S4-S3-E2-S8-T1-S10-E8-T2-E3.