Crops and Cropping Strategies to Maintain Food Security under Changing Weather Conditions in Papua New Guinea

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Introduction

PNG climate varies considerably due El Niño Southern Oscillation (ENSO) and global climate change impacts. Crop production is influenced by excess and deficit moisture resulting in low yields and/or crop failure in affected areas. PNG's stable food crop are tuber and root crops such as sweet potato *(Ipomoea batatas)*, Taro *(Colocasia esculenta)*, and Yam *(Dioscorea nummularia)*. These shallow root crops are vulnerable to yield loss under soil moisture excess and deficit scenarios. Information on the crop growing environment under these extreme climate conditions in PNG is missing, which is the basis for recommendations on suitable crops and crop management practices.

This study aims to identify and evaluate the soil moisture retention characteristic curves, available water capacity and crop water requirement (ETc) under different climatic scenarios. Various software packages and tools to generate weather data and soil moisture retention curves were evaluated for their suitability in the PNG context.

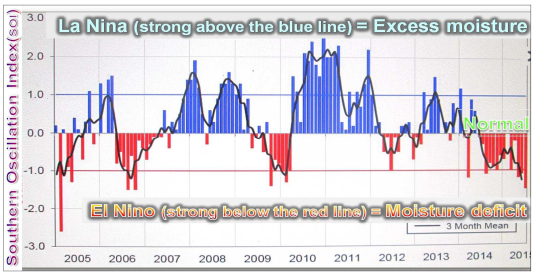

Figure 1. SOI gives an indication of the development and intensity of El Niño or La Niña events (ENSO) in the Pacific Ocean (Source: NIWA, 2013)

Figure 2. Food production under different climatic scenarios in contrast with food demand by the growing population

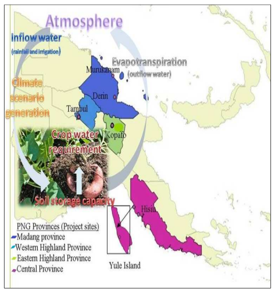

Figure 3 Projects sites in PNG and the key parameters of the soil-plant and atmosphere continuum selected for this study.

Materials and Methods

The study mainly considered the interdependently linked system of moisture flow between the soil, plant and atmosphere for suitable crop and cropping strategies under extreme environmental conditions in PNG. Parameters in three key areas were measured and analyzed.

1. Soil moisture retention curve (Relationship between water content and matric potential)

Figure 4. Soil moisture retention curves generated through Hyprop device.

A) **Hyprop** device is a laboratory evaporative method. Saturated undisturbed soil sample are inserted into a sensor unit (tensiometers) and placed on a weighing scale connected to PC measuring moisture content and matric potential.

B) **RETC** software uses the soil texture and bulk density as minimum input data to generate curves.

2. Weather Scenario Generation

Scenarios	Sources/ Tools	Comments
Past wet and dry	PNG National Weather Service	1997 (dry) and 2000 (wet)
Long term average	PNG NWS (1996-2014) & NewLocClim Software	NewLocClim used to generated unavailable weather data through interpolation
Future (2020)	MarkSim tool	Used CSIRO-Mk 3.6.0 model

Figure 5. Sources and tools of meteorological data for weather scenario generation. These tools were also evaluated for their suitability in PNG context.

3. Crop water requirement (ETc) determination

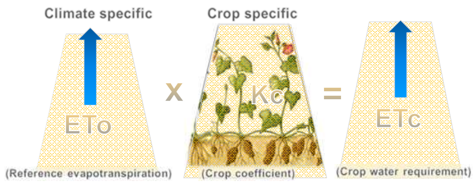

Figure 6. ETo was calculated with FAO-Penman-Monteith equation using weather data generated for specific climatic scenario and utilizing different tools. Kc for tuber crop in the tropical zone was derived from literature.

Results and Discussion

Moisture retention curves generated with two different methods for the seven project sites in PNG

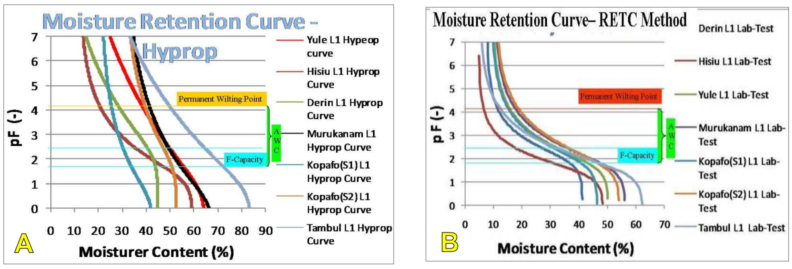

Figure 7. Results for the moisture retention curves derived using the two different methods.

Crop water requirement (ETc) under different climatic scenario in different agroecological zones in PNG

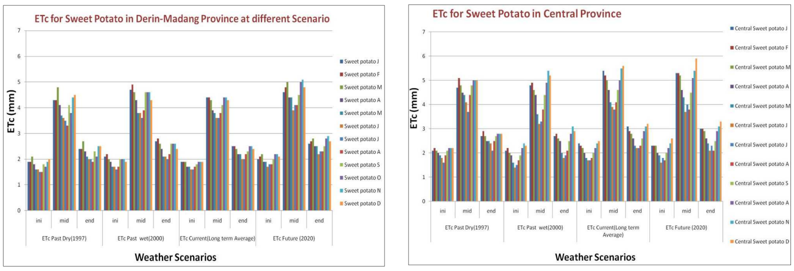

Figure 8. ETc for sweet potato under different weather scenario.

Rainfall under different scenario and crop water requirement

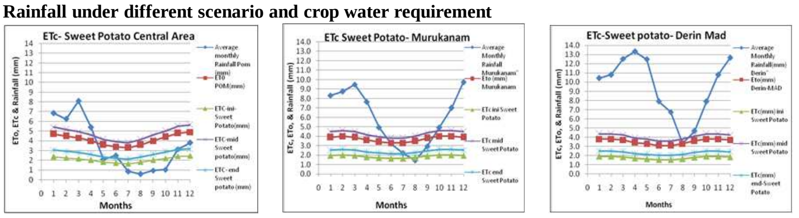

Figure 9. ETc for sweet potato with precipitation under long term average scenario for selected sites in PNG. The three sites represent wet, dry and moderate agro ecological zones

- Hyprop generated curves more accurately reflect the soil structure, texture and organic matter content compared to curves generated with RETC. The Hyprop method curve used for the determination of soil moisture storage capacity for the seven project sites as shown in figure 7 is recommended.
- Trends show that temperature and crop water requirements are steadily increasing from the past to present. Future projections suggest continuing trend.
- Generated rainfall data utilizing available and public domain tools and software packages showed different trends compared with results published by Pacific Climate Change Science Program.
- Crop water demand for different climatic scenario and crop development stages were identified as shown in figure 8.
- Intensity and duration of moisture deficit and excess was identified for different agro ecological zones and climatic scenarios (figure 9)

Conclusions/Recommendations

- Hyprop generated reasonable curves but needs constant power supply. On the other hand the RETC curves reflects soil properties only for light textured soils. Further research and evaluation is recommended.
- Crop and cropping strategies were recommended according to the local soil storage capacity, under specific climatic scenario and agro ecological zone
- The tools and software packages used to generate weather data for different climatic scenarios show different trends for some scenarios compared to the results published by the Pacific Climate Change Science Program. This indicates that the quality of generated data highly depends on the quality of available real time data and density of weather station network for data interpolation. Further research and evaluation is recommended.
- Temperature rise may have effect on ETc but may be compensated by high rainfall and cloud cover.
- The study results will be used as input data for Hydrus simulation of soil water balance.

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Finally photo credits for Ipomoea batatas, drought affected areas and weather station to J. Pakatul, IOM and the www.waterindex.com.