PROJECT PROGRESS REPORT

By

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Submitted to: Director General, ACMAD

Prepared (Month/Year): July 2022

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ACRONYMS

ACRONYM	Full Name
ACMAD:	African Centre for Meteorological Applications and Development
CSIR:	Council for Scientific and Industrial Research
ECMWF	European Centre for Medium Range Weather Forecast
EU	European Union
FAREI	Food and Agricultural Research and Extension Institute
FOCUS	Full-value chain Optimised Climate User-centric Services
HQ	Head Quarters
IA	Irrigation Authority
IPCC	Intergovernmental Panel on Climate Change
HPC	High-Performance Computer
MMS	Mauritius Meteorological Services
MSIRI **MCIA**	Mauritius Sugar Industry Research Institute Mauritius Cane Industry Authority
PTM	Project Team Member
SADC	Southern African Development Community
SFWF	Small Farmers Welfare Fund
WMO	World Meteorological Organisation
WRU	Water Resources Unit

1. CS 8 General information

Target country	Mauritius
Contributes to ACMAD Strategic Goal	
Lead Institutions	CSIR/MMS
Other Institutions	
Project Coordinator at ACMAD	Mr. Gamedze Sunshine
Project Executive at ACMAD	Dr. Andre Kamga FOAMOUHOUE
CS 8 overall Project coordinator	Dr. Ram Dhurmea
Overall CS8 Project team members at ACMAD	N/A
Implementing entities	WMO, ACMAD, CSIR
Collaborating Partners	WRU/FAREI/MSIRI

2. Brief Overview Focus Africa Project.

Focus-Africa, with a funding of 7 million Euros, is a project for the Southern Africa Region funded by the European Commission, under the EU Research and Innovation programme "Horizon 2020". It aims at delivering tailored climate services in the Southern African Development Community (SADC) region in four key sectors: agriculture and food security, water, energy and infrastructure. The full-value chain of climate services is expected to be demonstrated by piloting eight case studies in six countries involving a wide range of end-uses and beneficiaries. The case studies will illustrate how the use of climate science, forecasts and projections can maximize socio-economic benefits to specific national private and public sectors in the region. Pathways to scale-up the pilot cases are included for the whole African continent through the Regional Climate Fora.

2.1 Objectives

The overarching objectives of FOCUS-Africa are

1. To advance the way in which climate information (from historical records to seasonal forecasts and projections, also exploring decadal forecasts) is processed and used in decision making, including policy making for its direct uptake by the regional and national climate services providers;
2. To characterize end-use requirements through regular engagement with stakeholders and active players in the sectors, and ensure that lessons learned are upscaled to other countries in Africa, but also Europe, and other regions of the world, measured via standard analytics;

3. To contribute to the advancement of the scientific knowledge via publications and reports such as those relevant for the IPCC, through the innovative science developed by FOCUS-Africa in support of improved ways to use climate information such as better identification and characterisation of extremes for the historical period and calibrated multi-variable approaches to climate predictions and projection.

The full value chain of climate services will be demonstrated by piloting eight case studies in six countries involving a wide range of end-uses and users. For case study 8 (CS8) Mauritius and South Africa has been selected to look at the Water Sector and Agricultural Sector respectively.

3. Brief description of Case Study 8.

Over the past decades the pattern of rainfall has changed over Mauritius. Short duration heavy rainfall as well as month to month variability have been increasing. These changes are making the managing of water resources for all domestic, industrial and agricultural use challenging for the Water Resource Unit.

Methodology will involve:

- Establish framework for ongoing collaborations between water authority and meteorological services
- Investigate use of seasonal forecasts at sub-seasonal timescales; develop related drought indices
- Improve statistical downscaling of seasonal forecasts, using observed temperature and rainfall data

Present	FOCUS-Africa development
3 and 6-month seasonal forecast with a simple downscaling analogue model	**Develop tool for monitoring and forecasting drought indices** **Develop mobile phone platform for dissemination of forecasts**

4. Progress report for July 2022

4.1 Overview

WP/Task	Deliverable	Achievements	Remarks
WP 4: Tools and methods for seasonal forecasts, decadal predictions and climate projections	D 4.1: Downscaling long-term climate forecasts for Mauritius and support validation, increase temporal resolution and development of drought indices to feed into CS 8.	Generation of forecast for June July and August in two domains.	To move to "ncl" scripts rather than "Python" scripts for better map resolution. Working in collaboration with CSIR
	D 4.2: Develop drought indices from model outputs and develop threshold for triggering drought or wet conditions alert.	Decile Index being worked out as a second dry/wet conditions indicator.	Preliminary analysis being focussed on 11 stations
WP 6: Assess socio-economic value of the prototypes and prepare their exploitation	D 6.2 Organise interviews with end-users in the country and facilitate the identification/involvement of local stakeholders in relation to the ex-ante analysis of the current socio-economic situation of case study 8	Survey questionnaire devised for Water Sector to assess importance of weather and climate forecast	Some preliminary discussions were held in June, Once a suite of products have been obtained discussions would be engaged on suitability of different products

4.2 D 4.1: Downscaling long-term climate

Assessment of the model output for the month of July and verification of June forecast against observed data (Annex II).

4.3 D 4.2: Drought Climatology for Mauritius

Decile Index is being generated as another index for dry/wet conditions (Annex I).

4.4 D 6.2 Assessing socio-economic value of forecast

Formal survey being planned with users prior to formal engagements to discuss the economic value of the different products. Questionnaire for Water Sector devised (Annex III).

5 Challenges and Opportunities

1. MMS to work in close collaboration with CSIR to move all WARF Set Up in “ncl Scripts” rather that “Python Scripts”.

6 Way forward

Grid point verification

The verification would be carried out using the collocated observed value and extracting the model value at these locations. This would be demonstrated through different Model Output Statistics.

Drought Climatology based on Decile Index

The Decile Index would be computed for 122 Rainfall stations and spatial maps plotted. This would be compared with the SPI Maps.

ANNEXES

Annex I: Characterising dry and wet conditions using Decile Index

1.0 Introduction

After SPI, the Decile Index is being considered as second index for characterizing the dry and wet conditions.

The Decile Index (DI) was first introduced by Gibbs & Maher (1967). They used the concept of rainfall deciles to study meteorological drought in Australia. The basic principle of DI and its application had been provided in the handbook of drought indicators and indices, WMO No 1173 (Svoboda (2017)). Monthly precipitation totals from a long-term record were first ranked from highest to lowest to construct a cumulative frequency distribution. The distribution was then splitted into 10 parts (tenths of distribution or deciles). The first decile indicated the precipitation value not exceeded by the lowest 10% of all precipitation values in the record. The second decile was between the lowest 10% and 20% and so on up to the 90% which represented the upper deciles. In this method, the 50% decile represented the median of the record. Therefore, by comparing the amount of precipitation in a month (or during a period of several months) with the long-term cumulative distribution of precipitation amounts in th at period, the severity of drought could be assessed. The classification of DI with respect to meteorological drought monitoring had been summarised in the table below:

Table 1: Decile Index Classes (Gibbs & Maher (1967))

Decile Index Range	**Rainfall amount category**
Decile 1 to 2	Well Below Normal
Decile 3 to 4	Below Normal
Decile 5 to 6	Near Normal
Decile 7 to 8	Above Normal
Decile 8 to 9	Well Above Normal

The work of Morid (2006) further improved the DI classes. They used the classification of Standardised Precipitation Index (SPI) which was developed by Mckee et al. (1993) to group DI classes accordingly. The results of Morid et al had been summarised in the table below:

Table 2: Classification of SPI and Deciles range into groups (Morid (2006))

Classifications	SPI Range	Deciles (%)
Extremely Wet	≥ 2	≥ 90
Very Wet	1.50 to 1.99	80 to 90
Moderately Wet	1.00 to 1.49	80 to 70
Normal	−0.99 to 0.99	30 to 70
Moderately Dry	−1.00 to −1.49	20 to 30
Very Dry	−1.5 to −1.99	10 to 20
Extremely Dry	≤ −2.00	≤ 10

2.0 Data

For a preliminary analysis 11 rainfall stations have been selected as shown in map in Fig. 1.

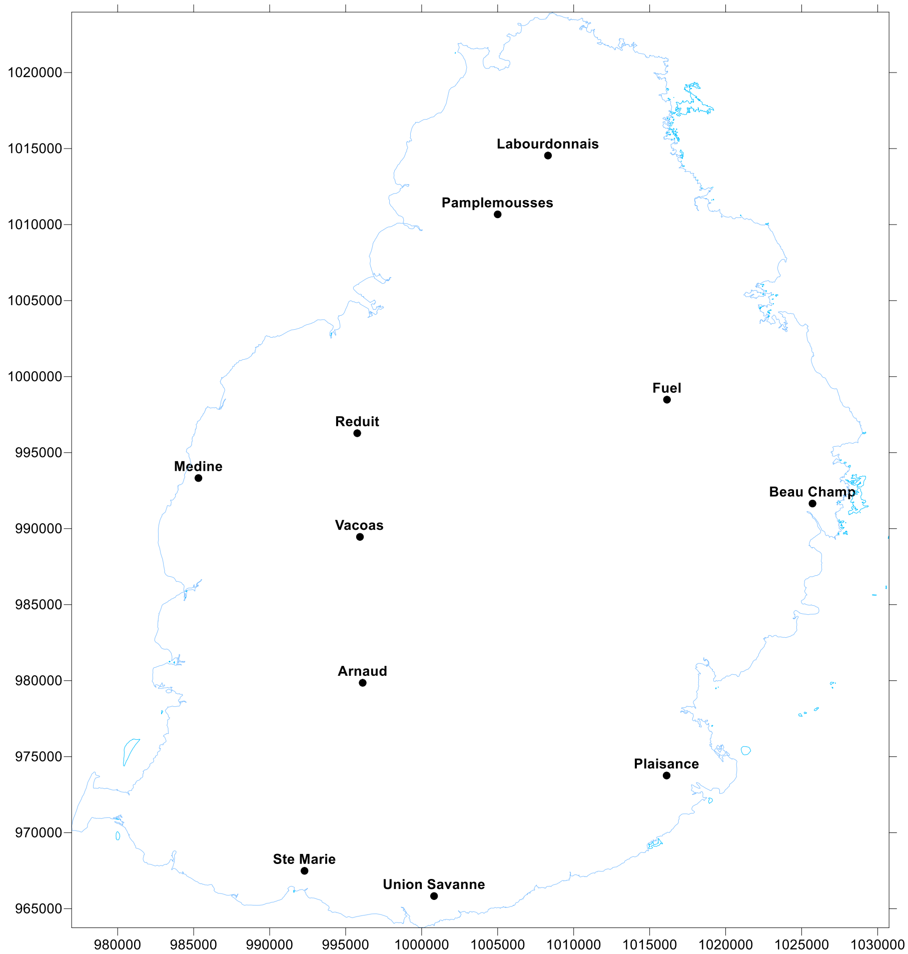

Fig. 1: Spatial distribution of the 11 selected stations

3.0 Methodology of DI Calculation

The methodology of deciles is simple as described in the work of Morid (2006). It consists of splitting a data set into groups of 10ths which means that each group will contain 10% of the dataset. The approach adopted by Morid (2006) is as follows:

Step 1: The number of available data, n is determined. In our case, it is the number of rainfall values for each station.

Step 2: The data is sorted in ascending order.

Step 3: An assumption which is being considered is that rainfall values are considered as ungrouped data (i.e. raw data which are not organised), hence the formula to calculate the deciles is as follows:

$$D_i = (n + 1) * \frac{i}{10}$$

Where, i is the decile number to be calculated ranging from 1, 2, 3, ...9,

n is the number of data available in the sample.

Step 4: The sample data is then categorised into different Decile value, i.e. $D1$ for 1^{st}Decile, $D2$ for 2^{nd} Decile, and so on.

4.0 Results

Using the above methodology, rainfall deciles for summer, winter and annual rainfall in Mauritius have been constructed and categorized according to Gibbs & Maher (1967). Fig. 2 represents the deciles of summer rainfall. The vertical axis represents summer rainfall which has been recorded in Mauritius. The horizontal axis shows the decile distribution. The median is obtained at D5 with a value of 1014mm. The lowest decile (D1) shows a value of 739.8mm which falls in the well below normal category whereas the highest decile (D9) shows a value of 1419.6mm which falls in the well above normal category. The different deciles and their respective categories have been summarized in Table 3.

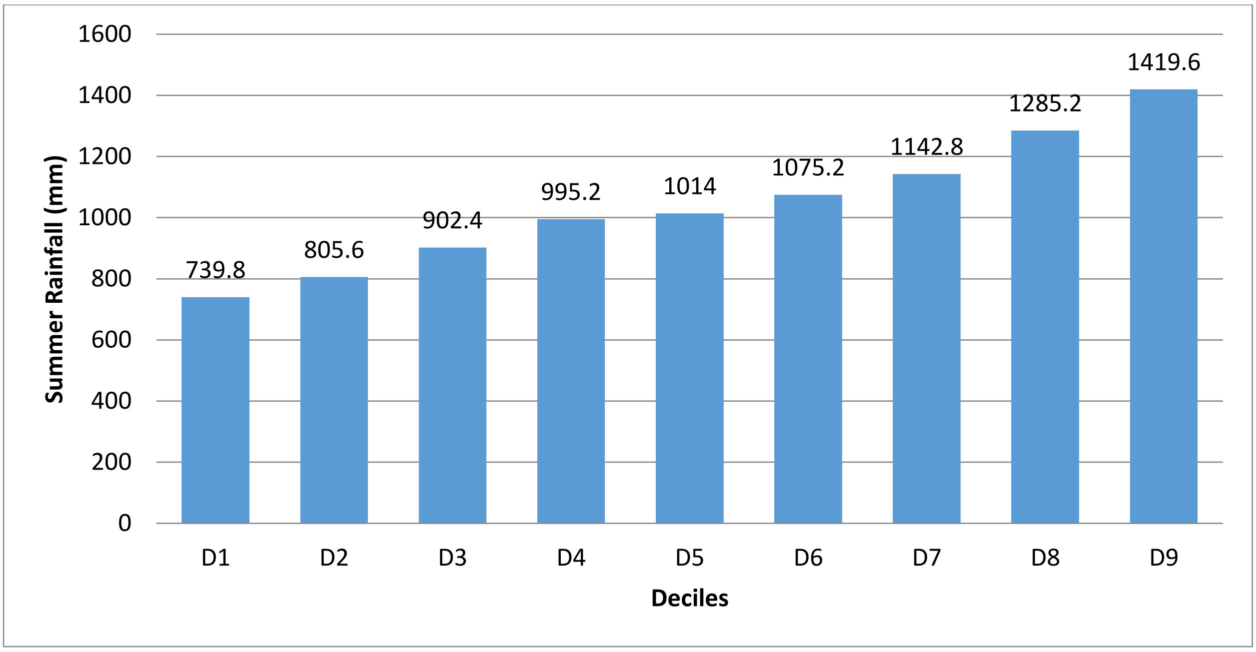

Fig. 2: Summer Rainfall Deciles

Table 3: Summary of results for Summer Rainfall Deciles

Deciles	Category	Summer Rainfall (mm)
1 - 2	Well Below Normal	739.8 to 805.6
3 – 4	Below Normal	902.4 to 995.2
5 – 6	Near Normal	1014 to 1075.2
7 – 8	Above Normal	1142.8 to 1285.2
8 – 9	Well Above Normal	1285.2 to 1419.2

Fig. 3 represents the deciles of winter rainfall. The median is obtained at D5 with a value of 516 mm. The lowest decile (D1) shows a value of 383.4 mm and 10% of the values in the first decile are less than 383.4 mm which falls in the well below normal category. The highest decile (D9) shows a value of 800 mm which falls in the well above normal category. The different deciles and their respective categories have been summarized in Table 3.

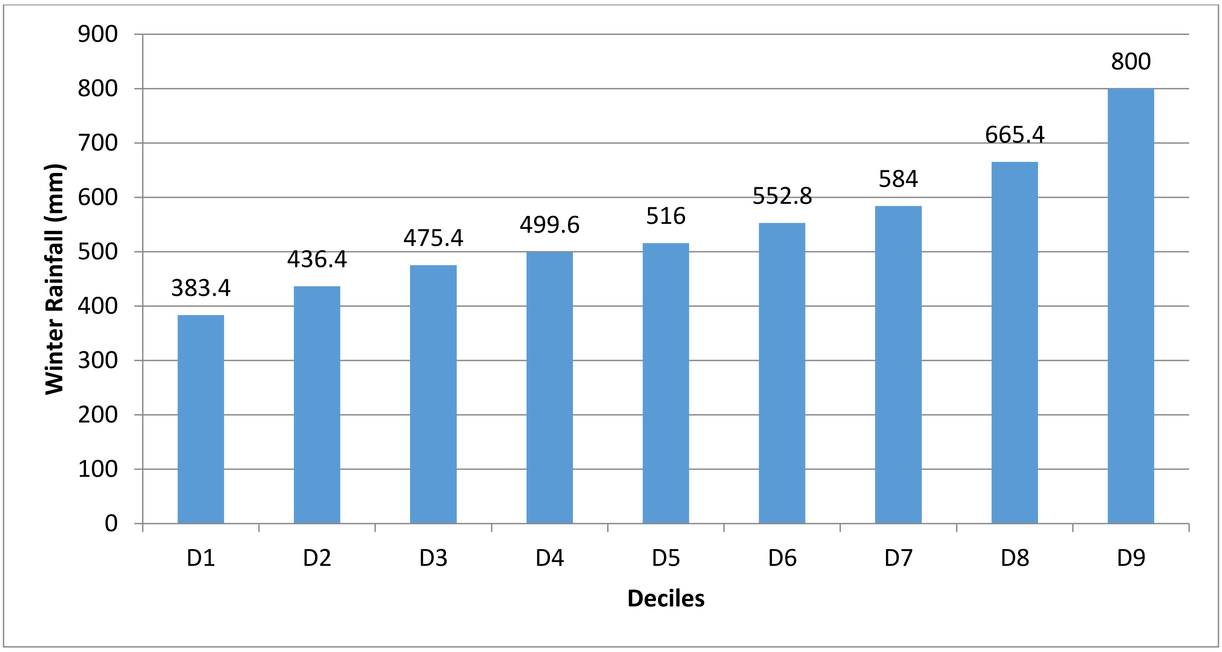

Fig. 3: Winter Rainfall Deciles

Table 4: Summary of results for Summer Rainfall Deciles

Deciles	Category	Winter Rainfall (mm)
1 - 2	Well Below Normal	383.4 to 436.4
3 – 4	Below Normal	475.4 to 499.6
5 – 6	Near Normal	516 to 552.8
7 – 8	Above Normal	584 to 665.4
8 – 9	Well Above Normal	665.4 to 800

Fig. 4 represents the deciles of annual rainfall. The median is obtained at D5 with a value of 1567 mm. The lowest decile (D1) shows a value of 1244.6 mm which falls in the well below normal category whereas the highest decile (D9) shows a value of 2092.8 mm which falls in the well above normal category. The different deciles and their respective categories have been summarized in Table 5.

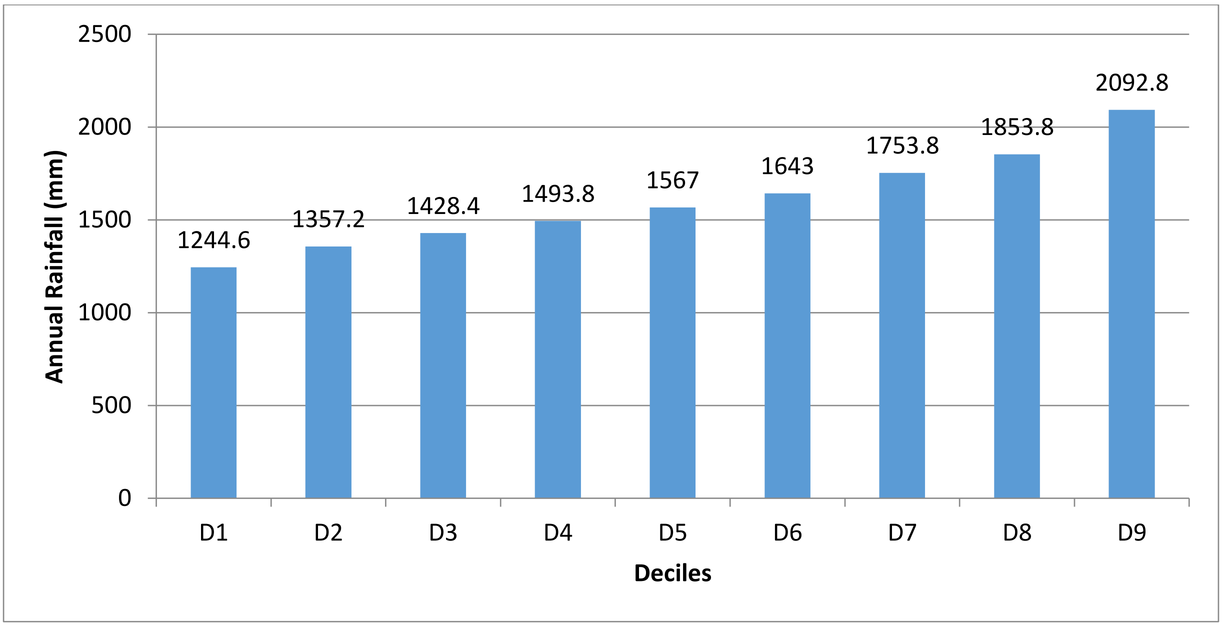

Fig. 4: Annual Rainfall Deciles

Table 5: Summary of results for Annual Rainfall Deciles

Deciles	Category	Winter Rainfall (mm)
1 - 2	Well Below Normal	1244.6 to 1357.2
3 – 4	Below Normal	1428.4 to 1493.8
5 – 6	Near Normal	1567 to 1643
7 – 8	Above Normal	1753.8 to 1853.8
8 – 9	Well Above Normal	1853.8 to 2092.8

Further Work: The decile would be computed for each and every 122 stations under study and spatial maps plotted. This will establish climatology dry/wet conditions similar to that using the SPI. These two sets of maps would then be compared.

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Gibbs, W. & Maher, J. (1967). *Rainfall Deciles as Drought Indicators*. Bureau of Meteorology.

Mckee, T. B., Doesken, N. J. & Kleist, J. (1993). The relationship of drought frequency and duration to time scales. pp. 17–22.

Morid, Saeid; Smakhtin, V. M. M. (2006). . *International Journal of Climatology* **26**, 971–985.

Svoboda, Mark Fuchs, B. (2017). Handbook of Drought Indicators and Indices. *World Meteorological Organisation* **1173**, 155–208.

Annex II: Rainfall and Temperature Forecast for JJA

The rainfall forecast for the months of June, July and August in two different domains are shown in Fig. 1.

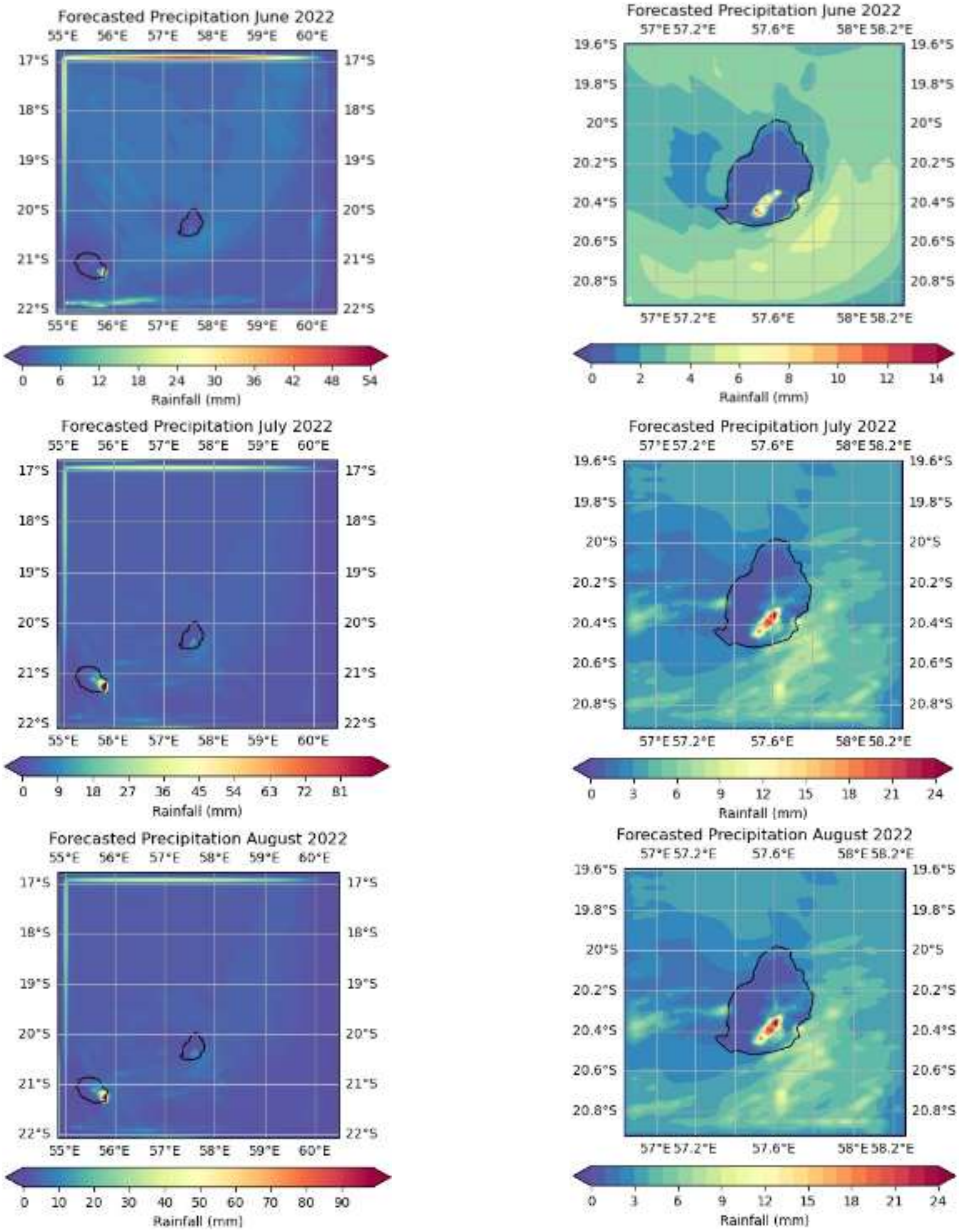

Fig. 1: Rainfall forecast for June, July and August in 6 km domain (left) and 2 km domain (right).

The temperature forecast for the months of June, July and August in two different domains are shown in Fig. 2.

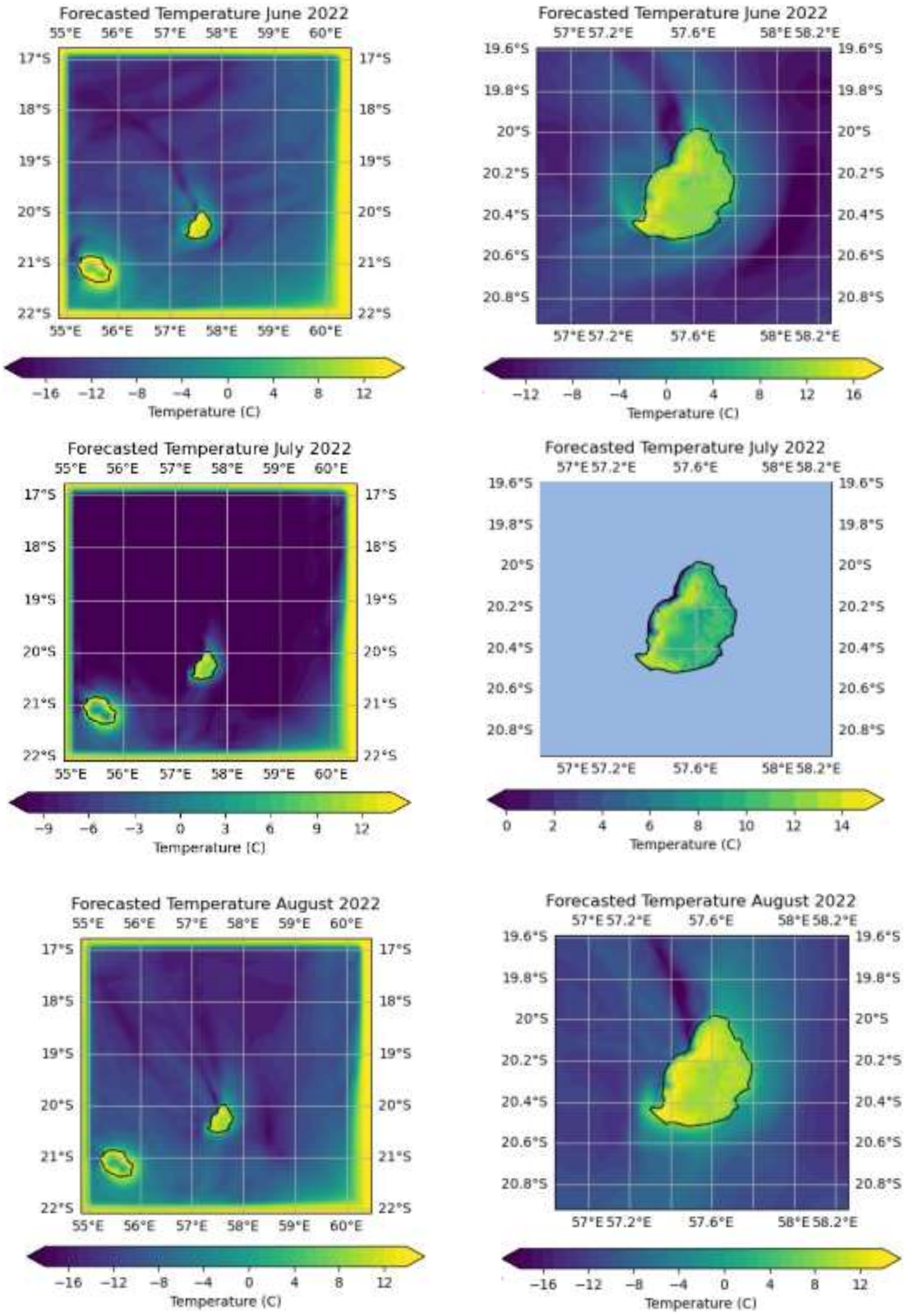

Fig. 2: Rainfall forecast for June, July and August in 6 km domain (left) and 2 km domain (right).

Verification model forecast for June

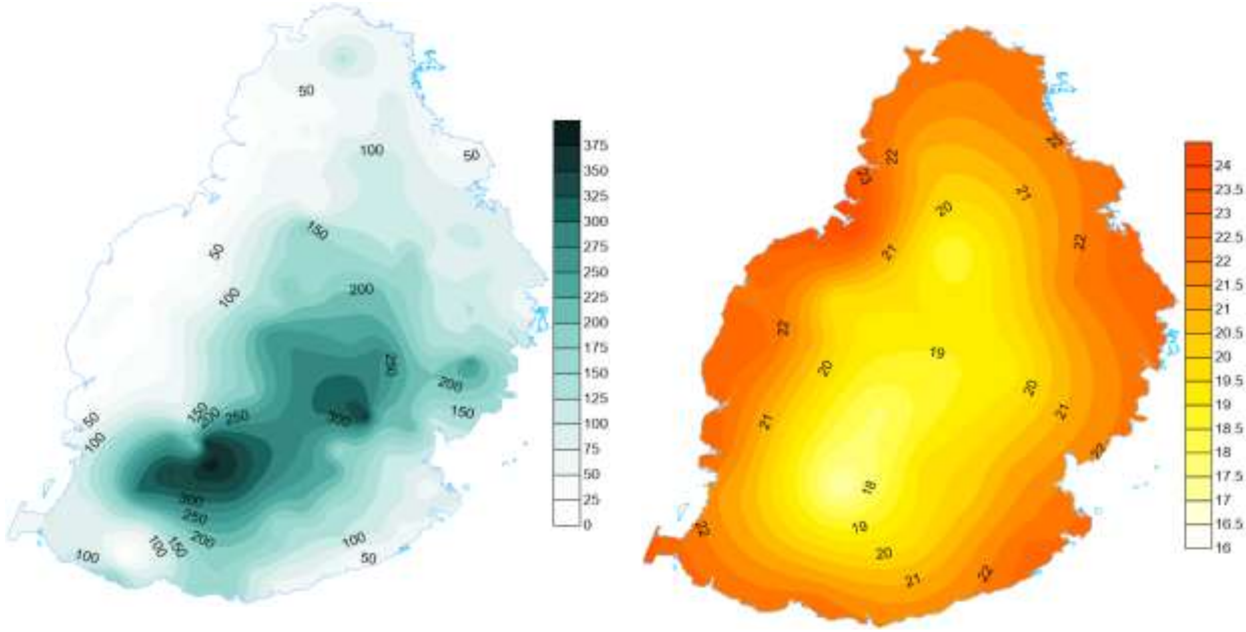

Fig. 3: Observed Distribution: Rainfall (left) and Temperature (Right).

Remarks:

1. The model output does not look to provide realistic forecast at this resolution. Currently WARF Model on server at Mauritius Meteorological Services is being run with Python Script. The capacity of the server allows to run the model at such spatial resolution. Exchange with CSIR is underway to run the WARF using ncl Scripts. This will allow for maps with better spatial resolution to be generated;
2. The model is generating negative surface temperatures which should not be the case at this latitude;
3. The rainfall distribution is more or less well captured by the model but amount is much underestimated.

Annex III: Survey Questionnaire for the Water Sector

A WP6 Meeting was held on 14 July to initiate discussion on the socio-economic aspect of the CS 8.

Were present:

1. Dhurmea K.Ram (MMS)
2. Bucha Krishna (MMS)
3. Ilaria Vigo (BSC)
4. Sebastien Grey (WMO)

The discussions was around engaging with users/stakeholders to assess the suitability of products being developed and eventual co-development.

It was taken note that products are still being generated. So far, at the MMS, we have had challenges with hardware and sometime software. But during the month of July and August we expect to make good progress as work is being done in conjunction with CSIR. Upon availability of sufficient products MMS would be able to initiate discussions with users. It is expected that such a first discussion could be carried out in September.

For now MMS is planning to carry a small survey on the importance of weather and climate forecast in the Water and Agriculture Sector.

Mauritius Meteorological Services

Focus Africa Project

Survey on socio-economic value of weather and climate forecast to the Water Sector in Mauritius

Organisation Name:

Name of Focal Person:

Address:

Tel: **Fax:** **Email:**

N.B: Only brief and concise answers in bullet form is expected from respondent.

1. What is the mandate of the organisation?
2. For how many years does the organistion exist?
3. How many reservoirs are there in Mauritius?
4. What is the total storage capacity of the reservoirs?
5. How many catchment areas are there?
6. Which are the most important? And why?
7. In conducting your operations, with what other organisations do you work in close collaboration?
8. How the is water management affected by climate change and climate variability?
9. What are the adaptive actions that the organisation usually takes?
10. Do you use weather/climate information currently delivered by the Mauritius Meteorological Services (MMS)?
    Which of the information/products you find more useful?
    How do you think these products may be further tailored to your needs, i.e. type and format of products, frequency of products etc.?
11. Is the MMS the only source of weather/climate information for your organisation?
12. How often and thru what means is the information from MMS monitored?
13. Are the seasonal forecasts issued by the MMS useful?
14. If yes, how is the institution currently benefitting from seasonal forecasts from the MMS?
15. In what format do you want the information to be delivered? (eg. reports, maps etc...)
16. Do you think that the MMS should provide higher resolution seasonal forecasts?

What is the temporal resolution that could best fit your different operations?

17. What are the socio-economic sectors that depend on outputs from your institution?
18. What is on an average year the total amount of water made available for the different sectors?

    Is farming/agriculture the greatest and more sensible users of water resources?
19. How much water is currently available for energy production or industrial use?
20. On average, how many events/periods of shortages in water distribution per year does the country usually undergo?
21. Do you think MMS products could help in identifying measures for better water management. How?
22. How extreme climate (torrential rain, droughts, floods etc…) affect the management of water resources?
23. Are there any national policies in place that caters for the integration of climate risk and/or climate information in water resources management? If yes, what are the policies?

24. What are the measures currently being taken in case of drought?
25. How much water on average is released in a year presenting climate extremes?

    Year having excess rainfall:

    Year having deficient rainfall:
26. Is there any need to construct more reservoirs to meet the increasing water demand in Mauritius?
27. Does the organisation conduct and co-ordinate research and investigation on the economic impact of water resource management in Mauritius?

    How does the organisation do it?

    Could the input from MMS be more beneficial in any such research being conducted?
28. What are the main challenges facing the water sector?

    What major challenges do you face in water resource management from a meteorological and hydrological perspective?
29. How can these challenges be countered/addressed?
30. Any additional comments:

Thank you very much for your collaboration

End