

The Rufford Foundation

Final Report

Congratulations on the completion of your project that was supported by The Rufford Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. The Final Report must be sent in **word format** and not PDF format or any other format. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. Please note that the information may be edited for clarity. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Caroline G. Staub
Project title	Hydrologic processes on small islands: linkages between climate, human activity and water availability in Mauritius
RSG reference	13418-1
Reporting period	May 2013-May 2014
Amount of grant	£ 5880
Your email address	carogstaub@ufl.edu
Date of this report	April 19, 2014

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Collect and compile hydro-climatological data from in various disparate and inaccessible locations, and convert from paper to digital format.			X	I navigated complex politics within private, governmental and non-profit sector organisations in order to obtain hydro-climatological data including six decades of rainfall from 23 stations, 18 years of stream flow, spatial data on soil, reservoirs, rivers, dams, canals, irrigation areas, hydro-electric plants and water demand.
Identify local, regional and global drivers of precipitation in Mauritius over the past 80 years		X		I used as much data as I managed to access but could not get 80 years-worth of data for 86 stations. The identification of local (landscape) drivers of variability required a high density of stations, which was only available for the 2000- 2011 time period. However, I managed to identify regional and global scale (climate) drivers of rainfall over the past 60 years.
Engage stakeholders and experts to discuss the linkages between water/climate/human activity in Mauritius over time, as well as of projected change in water demand		X		I could not arrange a meeting with all stakeholders together. However, I spoke to the Meteorological Services, Water Resources Units, and Sugar Estate Agronomists separately and learnt a lot in the process. I also managed to access a master plan on the current and future management of water resources in Mauritius, which will guide the scenario building stage of the hydrological model.
Use hydrologic modelling to simulating reservoir levels under different rainfall, land use and demand scenarios		X		I have started working on the hydrologic model but have not yet completed the task. The challenging part consists of bridging the long-term dataset, and the more densely distributed but short-term dataset in such a way as to maximize the advantages of both for input into the hydrological model.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

N/A

3. Briefly describe the three most important outcomes of your project.

- Data accessibility - data were for the most part buried in archives and had to be transcribed into excel. Some of them I had to buy, and some of them I could not get, because data fees are big business, unaffordable to researchers with limited funds. After spending 3 years looking for data I still had two gaps. I finally found where to find the missing stations. However when I got to Mauritius, the Meteorological Services Official who had guaranteed the availability of the data apologised and said he actually could not find them. Politics make data availability difficult in Mauritius. Meanwhile, making data available for free for research purposes is critical in order to further understand some of these issues, and many other pressing concerns like flash floods and sea level rise.
- Scientific evidence: Local (biophysical factors) explain almost 70% of mean annual rainfall on the landscape, but there are complex topographic regimes at play. The high density of rainfall monitoring stations on the island is therefore a critically important asset and ensuring data continuity is very important for water resources allocation. I provide a spatially explicit model of rainfall distribution for the island from 2000-2010 based on the interaction of important landscape factors. The model is an important input for models used by hydrologists, climate modellers, water managers, species distribution, disease, pest control modellers, to state only a few.
- My work highlights that El Nino Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD) and Subtropical Indian Ocean Dipole (SIOD) (ocean/atmospheric drivers of rainfall variability at the inter annual scale) are associated with important rainfall anomalies in Mauritius – anomalies which differ from those identify in South Africa. These findings have important implications for long range weather forecasts which currently rely on climate models calibrated using scientific evidence derived for areas located in mainland Africa. Rainfall response to these climate oscillations is more severe in some parts of the island than others. I provide spatially explicit estimates of rainfall response to ENSO, IOD and SIOD for Mauritius, allowing for different strategies in different regions. Our findings also act as fodder for the formulation of new scientific questions in the realms of hydro-climatological modelling and water resources management.

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

The most important contribution came from the members of Mauritius Meteorological Society who pointed me towards a large online archive of digital meteorological data for Mauritius, which none of the private and public sector agencies I spoke to knew about. I have used it extensively for my research and have sent it on to other researchers.

Below is a transcript from Mr Edley Michaud, Human Resources Manager at United Basalt Products (UBP) Mauritius, and member of the Mauritius Meteorological Society, following my talk at the 5th International Conference on Climate Change: Impacts and Responses in July 2013:

1. July 27, 2013

Dear Ms Staub,

My deep appreciation for your most interesting talk delivered on the variability in rainfall in Mauritius. As a Weather hobbyist such research increase much our knowledge and how daily measurement from rain added value to researchers worldwide.

Regards

Edley Michaud

The Mauritius Meteorological Services face major challenges with long range weather forecasting, because little science is available on the links between ocean/atmospheric processes in the Indian Ocean and rainfall anomalies on Mauritius. They understood the value of my work, and despite the fact that they were limited in their ability to help with data due to complex politics within the organisation, they still facilitated data collection, and archival work. I also discussed preliminary results with them and managed to fix a problem in my rainfall model thanks to their insight on rainfall trends. Members of the Mauritius Water Resources Unit and Statistics Office were also generous with data and insight on the way hydrological data are collected and catalogued in Mauritius.

Agronomists from the three major sugar estate agronomists provided assistance with data collection, and discussed my project in light of the struggle that they face with irrigation during anomalously dry periods, and the current battle over water rights on the island. Below is a transcript from Marc Lincoln, group agronomist for Terragri Ltd., Mauritius:

2. June 8 2012,

Bonjour Caroline,

Je suis heureux de constater que des jeunes s'intéressent à cette ressource qui est si précieuse pour la survie même de l'humanité. La guerre de l'eau a déjà commencé et Terra est déjà engagé dans cette lutte pour conserver des droits acquis. Depuis quelques années, par mesure d'économie nous avons délaissé notre station météo. Néanmoins nous récoltons journallement des données pluviométriques à travers une vingtaine de stations installées aux quatre coins des terres de la compagnie (autour de 6000 hectares). Donc c'est avec plaisir qu'on pourrait se rencontrer pour en discuter.

In English:

“Good to hear that young people are taking interest in our valuable water resources. A water war has started here in Mauritius and Terra (the company) is engaged to fight for our rights. For financial reasons we have had to dispose of one of our stations but we have 20 stations collecting daily rainfall across the 6000 ha estate. I would be happy to discuss the matter with you.”

Three University of Mauritius undergraduates helped me scan, photograph, digitise and transcribe an extensive amount of hydro meteorological data in exchange for research experience on a doctoral research project.

5. Are there any plans to continue this work?

I intend to work alongside decision makers to help them integrate science into their decision making process, which will hopefully help solve water allocation, water related infrastructure and disaster

management problems faster and more efficiently.

I want to feed my estimated rainfall anomalies into a simple water balance model, to compute changes on the landscape during ENSO/IOD/SIOD events when accounting for demand for water from different sectors (domestic, industrial, agricultural). In essence, I will explore plausible “what if” scenarios of water availability in the face of climate variability.

6. How do you plan to share the results of your work with others?

1) I will get my work covered by the local newspapers *Le Mauricien* or *L’Express* for broad local exposure.

2) I will present this work at the University of Mauritius, where the academic community working in conservation operates from. Vincent Florens, head of the Biosciences Department at the University of Mauritius and one my referees on this grant has shown interest in my work and I look forward to linking further with his network in the future. I already started disseminating my results with the Wildlife Conservation Community by giving a talk on my work at the Mauritius Wildlife Foundation Mauritius Headquarters in Vacoas, Mauritius on August 2nd 2013.

3) I have shared the large data archive of meteorological data with independent researchers and research officers at the Sugar Research institute (MSIRI). Once I am done, I will make the dataset, approaches and results used in this study available on my website for free for the benefit of my own work and that of others. It is important that people be directed towards freely accessible data until the government becomes proactive with respect to this.

4) I am presenting and promoting my work at conferences both in Mauritius and abroad. I presented my work at the 5th International conference on Climate Change on July 18th-19th 2013 in Mauritius, at the Association of American Geographers Annual meeting in Tampa Florida (April 8th-12th 2014).

5) I am preparing to send my research out for publication in peer-reviewed scientific journals including the *International Journal of Climatology*, the *Journal of Hydrology* and *Applied Geography*, in order to gain exposure to the local and international scientific community.

7. Timescale: Over what period was The Rufford Foundation grant used? How does this compare to the anticipated or actual length of the project?

May 2013-December 2014. Seven months more than expected.

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Item	Budgeted Amount in GBP	Actual Amount in USD	Difference	Comments
Equipment - GPS	100	100	0	
Equipment - 1000 GB Hard Drive	80	57	-23	

Subsistence salary - hire 1 person for 30 days (40 pounds/day) for data entry, and organisation	1200	400	-800	The girls managed to devote all their time to data entry so the work took less time than anticipated.
Equipment for meetings - photocopies, printing, snacks GBP 20/personx10 200 0 200	200	40	-160	
Fees associated with outstanding data e.g. rainfall, stream flow (GBP 25/station/year for 40 stations) 1000 0 1000	1000	109	-891	The Meteorological Society pointed me towards an archive of data that was already online, and could be accessed free of charge. There were gaps that I could have filled by buying missing years of data but these were withheld from me. The reason was that the Meteorological Services had decided to take time to review prices, and that the data I had asked for would take too much time for them to compile.
Digitizing Tablet Wacom Intuos4 Medium PTK640	0	120	+120	Used to digitise old paper maps
Hydrology model (WEAP) student license fee	160	166	+6	Waited to make more efficient use of the tie I had the license for and price went up in the meantime
Contracting work with engineer that developed hydrologic model (GBP60 per hour)x35hrs	0	2070	+2070	Invaluable support for the hydrologic modelling part of the work, in progress
Transportation (flight) 1 return ticket (June-August 2013): Gainesville, Florida - Mauritius - Gainesville2540	2540	2300	-240	

(1900) + 1 one way ticket (May 2014): Gainesville –				
Transportation (in Mauritius) - Fuel + repairs	600	520	-80	
Total	5880	5882	+2	

9. Looking ahead, what do you feel are the important next steps?

The important next steps may be classified into two categories; science and governance.

Science

- What is the un-met water demand on the island under different plausible scenarios of climate variability and population growth? I am working with an expert hydrological modeller in California to combine the science derived from my work with water demand projections to come up with the answer. Specific sub questions include:
- What is the un-met water demand during interacting ENSO and SIOD events, as experienced in Mauritius in 1998/99?
- What would it be if Mauritius experienced two consecutive sets of ENSO/SIOD interactions?
- What do the two previous scenarios look like in 2025 when population density and demand for water have gone up?

Governance

- What is the best way to translate the science into governance? Specifically, what are some of the barriers that keep water managers from including the science (e.g.) climate forecasts in their approaches?
 - Attitudes, perspectives, factors governing decision making.
- I would also like to work with social scientists to devise a survey to be sent to water managers and decision makers to find out about this and about the ways in which the science would be most effectively translated into management.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the RSGF receive any publicity during the course of your work?

Yes, within my presentations at the University of Florida, at a national US conference (Association of American Geographers (Tampa, 2013)), and in Mauritius at the International Conference on Climate Change: Impacts and Responses (Port Louis, 2013), the Mauritius Meteorological Services (July 2013) and the Mauritius Wildlife Foundation (Aug 2013). I have recommended grants from the Rufford Foundation to students at the University of Florida, as well NGO agents in Mauritius.

11. Any other comments?

I would like to thank the foundation for the funding. It allowed me to collect as much data as there is available out there at the moment. I am making the most of it and will ensure that future research benefit as well.