

Final Project Evaluation Report

Your Details	
Full Name	Dylan Michael Jacklin
Project Title	The potential use of plant species within critically endangered Renosterveld for the phytoremediation of glyphosate and fertiliser
Application ID	23296-1
Grant Amount	£5000
Email Address	dmjacklin@gmail.com
Date of this Report	01/10/2018

1. 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
Design and construct an experimental phytoremediation system.				The experimental laboratory system that was used to evaluate the remediation capabilities of plant species worked successfully.
Identify, extract, transport, translocate and develop plant species from the Overberg region.				The selected species all survived this process and displayed positive pollutant removal characteristics.
Identify and compare four alien invasive species currently implemented in biofiltration treatments trains, with four Renosterveld species.				In comparing the indigenous with the alien invasive plant species, it was concluded that one community was not significantly more effective than the other, thus the more invasive plants may be substituted for the less invasive indigenous species if need be.
Identify a rank order of Renosterveld species, influenced by individual species' capability to remediate various pollutant parameters.				A rank order was successfully established for the 14 Renosterveld species, this indicates which plant species would be most effective for pollutant remediation, supporting heterogeneity and biodiversity initiatives.
Integrating identified species in the physical environment.				In progress: The Overberg Renosterveld Conservation Trust is currently undertaking a massive Watercourse Restoration project. As the project develops plant species that contribute to the natural ecosystem will be preferred. Thus it is crucial to know which plants contribute with regard to their individual ecosystem services. The findings of this project will play a critical role in this decision.
Education, sharing of knowledge and conveying the findings of the project with relevant				In progress: The findings have been presented to two organisations in the biodiversity and water industry and undergraduate students at

<p>conservation initiatives.</p>			<p>Stellenbosch University. The Overberg Renosterveld Conservation Trust has also received the findings with who I am in contact with going forward. I am further set to present the findings at the Western Cape Wetlands Forum in the near future. Academically: Two Water and Environmental Engineering Honours projects and one Master's thesis have been planned to continue the work done and use the constructed laboratory phytoremediation system. Added to this academic interest is the completion of a Civil Engineering final year student project focused on the purification capabilities, analysing chemical oxygen demand, of Renosterveld plants. I have further been given the option of continuing similar research to obtain my PhD in Engineering, dependent on funding. I have further made contact with the Western Cape Government and the Department of Environmental Affairs and Development Planning whom have both requested of me to present the findings.</p>
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2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.

(i) Initially certain species that were included in the study were not restricted with regard to plant extraction from the field. However, with the application of permits it was found that their protective status changed, thus no permit could be issued for them. Some plant species were further excluded as their physiology indicated weak traits for pollutant removal.

- A decision was made to include a variety of other species, all naturally occurring within Renosterveld.

(ii) Soil excavated from the field site displayed high concentrations of clay. This restricts water movement throughout the growth chambers, both water porosity and permeability decreases.

- To ensure water movement through the growth chambers, the soil was mixed with a handful of pebbles for each plant. Consistency was established by mixing all the soil in an industrial pan mixer prior to translocation into the growth chambers.

(iii) The fertiliser that was selected due to its application popularity on Canola in the Overberg was not mixed according to the exact concentrations as displayed on the product label.

- For this study it is critical to know exactly what concentrations the influent pollutant is made up of, thus chemical grade substances (ammonium chloride, potassium nitrate and di-potassium hydrogen phosphate) were used.

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

- a) The vegetation evaluated (plant species that naturally occur in Renosterveld) consistently removed agricultural pollutants more effectively than the un-vegetated soil controls.
- b) In comparing less invasive indigenous plant species with the more invasive alien plant species, neither of the two communities were significantly more effective than the other. However, both communities were significantly more effective than the un-vegetated soil. This indicates that indigenous plant species may be substituted for their more invasive alien counterparts in sustainable urban drainage systems, biofiltration treatment trains, constructed wetlands and wastewater treatment facilities.
- c) Implementing indigenous plant species, that include excellent and poor pollutant remediators, creates a mutualistic relationship. The vegetation hinders surface and subsurface flow rates, establishing ideal conditions for nutrient sorption to roots, where N, P and Glyphosate are extracted, translocated, metabolised or volatilised by plants.

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

The proposed vegetative buffers for river corridors adjacent to cultivated land, will extract pollutants from runoff prior to pollutant deposition into watercourses. Further improving water quality, restraining cyanobacterial bloom establishment, with eutrophication and salinization processes regulated. This will in turn ameliorate the water quality of the freshwater systems, of which many farmers (commercial and artisanal) and the downstream rural communities rely. The improvement of water quality further decreases the cost of treatment necessary.

5. Are there any plans to continue this work?

An opportunity has arisen to pursue my PhD in a similar study, however this will only be possible if I receive appropriate funding for the project and living cost. There are however planned Honours and Masters Studies that will implement the findings and the constructed phytoremediation system. These studies will focus on storm water remediation and Renosterveld phytoremediation.

One article has been submitted to WaterSA for publication with another planned in the near future. This will aid in spreading project awareness.

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

As previously discussed, the sharing and education of relevant role players is a major objective of this study and is in progress.

The findings have been presented to two organizations in the biodiversity and water industry. The Overberg Renosterveld Conservation Trust has also received the findings with who I am in contact with going forward. I am further set to present the findings at the Western Cape Wetlands Forum in the near future. Academically: Two Water and Environmental Engineering Honours projects and one Master’s thesis have been planned to continue the work done and use the constructed laboratory phytoremediation system. Added to this academic interest is the completion of a Civil Engineering final year student project focused on the purification capabilities, analysing chemical oxygen demand, of Renosterveld plants. I have further been given the option of continuing similar research to obtain my PhD in Engineering, dependent on funding.

I have further made contact with the Western Cape Government and the Department of Environmental Affairs and Development Planning whom have both requested of me to present the findings.

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

From receipt the grant was used for 8 months and included the registration of the postgraduate studies required to successfully complete the project. The project was completed in September of 2018, 3months earlier than expected.

8. Budget: 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. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.

Exchange rate used as £0.054 for ZAR1, as of 02 October 2018.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Raw Materials	951	755	196	Amount saved by building the entire system from scratch.
Rent for Cultivation (includes registration to the academic institution)	1200	2507	1307	The amount exceeds the budgeted amount due to a miscalculation of the registration costs required to gain access to

				the space needed for the project.
Fertiliser & Herbicide	0	40	40	The majority of the substances were donated to save costs, however a small amount was bought.
Chemical Reagents & Equipment	1891	1911	20	One extra round of sampling was required to ensure statistically sound results.
Sourcing of plant species	780	74	706	Expenditure was decreased by collecting 90% of the plants from the field, to make up for the amounts spent on registration.
Transport cost	178	228	50	One extra trip to the field site was deemed necessary to present the findings of the study to the Overberg Renosterveld Conservation trust.

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

It is important to share the information that I have gained with the proposed projects in the near future. As the laboratory phytoremediation system displayed excellent results, many similar studies can utilise this as their base for experimentation. Further, the necessary information must be successfully transferred to the conservation organisations that can implement the findings in the physical environment. It is important to further investigate the effectiveness of Renosterveld phytoremediation in a field setting. An evaluation to explore the ecosystem response of aquatic-, as well as terrestrial-plant and animal species as a result of the integration of the species under study must be implemented and a cost analysis is recommended to determine the feasibility of active river corridor restoration, implementing efficient phytoremediators, at specific locations.

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

The Rufford logo was used in the submission of the Master’s thesis, which is loaded on the Stellenbosch University archives; with acceptance it will become available across academic institutions.

With the submission of the articles, the Rufford foundation will achieve publicity as they are clearly acknowledged for their valuable assistance to the successful completion of the project.

With every presentation that I have done and am planning to do in the near future, the Rufford logo is clearly visible throughout the presentation.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

Mr Dylan Jacklin - MSc Student Stellenbosch University: Project Lead

Dr Isobel Brink - Water and Environmental Engineering: Supervisor

Mr Jannie de Waal - Geography and Environmental Studies: Supervisor

Dr Odette Curtis - Director, Overberg Renosterveld Conservation Trust: Dr Curtis assisted with species inclusion and the different management strategies of Renosterveld.

Mr Jannie Groenewald - Manager, Overberg Renosterveld Conservation Trust: Mr Groenewald assisted all the field excursions and is an expert in Renosterveld vegetation.

Mr Johann van Niewoudt - Laboratory Manager, Stellenbosch University: Mr Niewoudt guided the construction of the experimental laboratory phytoremediation system.

Mr Johann van Biljon - Director, GreenIntaba: Mr Van Biljon advised with regard to species selection, sourcing and extraction.

Mr Erick van Schalkwyk - Laboratory Technician, LCMS Central Analytical Facilities: Mr Van Schalkwyk is somewhat an expert in herbicide products and further analysed the Glyphosate concentrations with the effluent solution.

12. Any other comments?

I would like to extend my most sincere gratitude towards the Rufford Foundation for the opportunity and immense support for the duration of the project. Without whom this project would not have been as successful (or possible). I genuinely hope that we have the opportunity of working together in the future, as I know the partnership is beneficial to both parties.