

Researcher:	Linton Winder and Glenn Aguilar
Project Title:	Focus on Fiji: GIS Mapping to Support Conservation Planning
Project Code:	GL Code: 273500
Date of Report:	15 March 2013

Please delete the instructions in italics prior to submitting your report.

Executive Summary

Summarise highlights of the project, including aims/objectives, overall approach, findings, achievements, and conclusions.

In collaboration with the Institute of Applied Science of the University of the South Pacific in Suva, Fiji, the project conducted research on the development of a Geographic Information System for biodiversity conservation, development planning and environmental management. The objectives of the research include the characterization of the spatial distribution of key organisms that are of conservation interest, the determination of the effects of environmental perturbations such as climate change and contributing models that support mitigation strategies and conservation prioritization.

Three workshops were conducted to enhance the capability of partner researchers at USP to process their survey data, develop Species Distribution Models (SDM) and perform the advanced analysis required to publish the results as scientific articles in international, peer-reviewed journals. The first workshop developed the geodatabase design and prepared existing survey data for the software tools involved. The second workshop focused on enhancing the basemaps and using SDM to produce suitability maps for the species data. The third workshop involved further processing of the models, adding capabilities for climate change scenarios and producing output maps that depict the distribution of the species selected.

The project resulted in several models describing the nature of spatial relationships between the species investigated and environmental factors that exists at their geographic location. The GIS models, specifically the SDM, produced outputs that depicted the suitability distribution of insects of the order Coleoptera, two endangered Fiji tree frogs, native birds, mangroves and freshwater organisms. The output maps provide useful tools that identified areas for future monitoring, support initiatives for conservation such as the establishment of protected areas and identify areas requiring priorities for management. This project is viewed as a critical first step in the process of engaging with researchers in Fiji and the wider South Pacific in an effort to offer solutions to biodiversity concerns that are within the focus and capabilities of the Department of Natural Sciences.

Background

Summarise the background to the project, the need for it and why it's important.

The Fiji Islands are home to an extraordinary range of animals and plants. Recently, considerable progress has been made in databasing a large collection of botanical records (in collaboration with LandCare through NZAid funding) and (for the first time) a systematic survey of beetles (supported by the UK's Darwin Initiative). The respective databases contain spatial coordinates that identify the geographical location of where each specimen was sampled. To date, this information has not been integrated into a GIS-based system, although these data provide a fantastic potential platform for creating a vital tool for conservation management and planning purposes. The creation of a GIS using the available data in Fiji, complemented by readily download global databases of species occurrence records, environmental conditions and climate change scenarios provided an opportunity to develop relevant models describing the spatial conditions of indicator and threatened species in Fiji. These models are needed for providing the knowledge required in the decision making process to address concerns in biodiversity management.

Aims and Objectives

List the aims and objectives of the project and note if they changed during the project.

Using a GIS-based approach, we investigated the distribution of flora (forest trees and shrubs) and fauna (specifically longhorn beetles – Family Cerambycidae) within the Fiji Islands to determine:

1. Extent and spatial distribution of key species of conservation interest;
2. Risk that species distribution will be compromised by environmental perturbations, with special reference to climate change;
3. Mitigation strategies and conservation prioritisation to ameliorate risk.

Methodology

Summarise the overall approach taken and why this approach was chosen over other options considered.

The approach taken involved developing models through engaging with researchers in Fiji who were working on specific species of importance to biodiversity conservation. Based at the Institute of Applied Science of the University of the South Pacific, constructive research collaboration was established through the provision of capability enhancement, GIS development, spatial analysis and research article development. Three trips were made to Suva, Fiji to accomplish each of the phases of the project which included:

1. Data collection and geodatabase design - Collected data with spatial information was checked for accuracy, spatial consistency and conformity with available existing shapefiles. The data sources consist of the South Pacific Regional Herbarium Specimen Database for plants and the Darwin Initiative Database for insects. Important species that need to be focused on were determined as well as the spatial and temporal extent of the analysis. Parallel to data checking, the design of the geodatabase was also developed.
2. Basemap and model development - The database was then merged with existing official shapefiles or maps of the islands to create the GIS. Results of this component included valuable basemap required for analysis, modelling and simulation work particularly for climate change predictions. Since the Fiji Islands is bisected by the International dateline and most default projects split the islands at opposite ends of outputs, extra processing was conducted to transform the basemaps to the Fiji Map Grid in order to provide a map that

shows the island as an entire archipelago. Species distribution modelling (SDM) was conducted to determine the suitability of areas for particular species based on bioclimatic conditions that exist in the area.

3. Analysis and modelling - Spatial analysis involving global (Moran's I) and local regression (Anselin's, Getis Ord-Gi*, GWR) was conducted to characterize distribution, density, clustering and relationships between and among the species. SDM modelling involving environmental and other factors sourced from global and local datasets was conducted on each of the organisms to produce suitability maps for the entire archipelago. The maps created provides critical basic infrastructure for future research and is a valuable resource for management and conservation efforts.

Outcomes/findings

Explain the end result of your research. Did you achieve against the aims and objectives set? Depending on the project, it might include research results, findings, evaluation results, data, etc. If the project created something tangible like software, an artwork or a piece of equipment, describe it.

The research produced several major contributions to knowledge about the spatial characteristics of important species. Using species distribution modeling (SDM), the effort generated databases, basemaps and suitability maps for the following important organisms:

1. Insects of the Order Coleoptera (beetles)
2. Two endangered frog species: *Platymantis vitianus* and *P. vitiensis*
3. Birds from several bird surveys
4. Freshwater organisms from 5 transects
5. Marine organisms from protected areas

The models resulted from the application of several SDM tools that used the existing data from the Museum as well as presence data gathered by researchers from assessment surveys. This was complemented with available bioclimate and environmental data from online resources.

The approach used in this research is one of the first applications of modeling to be applied to Fiji for conservation purposes. Results of the models showed areas where conservation monitoring is highly desirable and even protected areas may be recommended. The use of an ensemble method produced maps that represented a consensus of algorithms on the suitability of areas for a specific algorithm. An example output of ensemble algorithms is shown, drawing upon the data and analysis of Ms. Hilda Sakiti – Tawa of the Institute of Applied Science of USP. (Figure 1). Another output is the spatial characterization of endangered species such as the Fiji tree frog (*Platymantis vitianus*) where hotspots of its occurrence were identified in the models developed using the data of Ms. Tamara Osborne of the Faculty of Science of USP (Figure 2). These models meet the objective of determining the extent and spatial distribution of key species of conservation interest. (Objective 1)

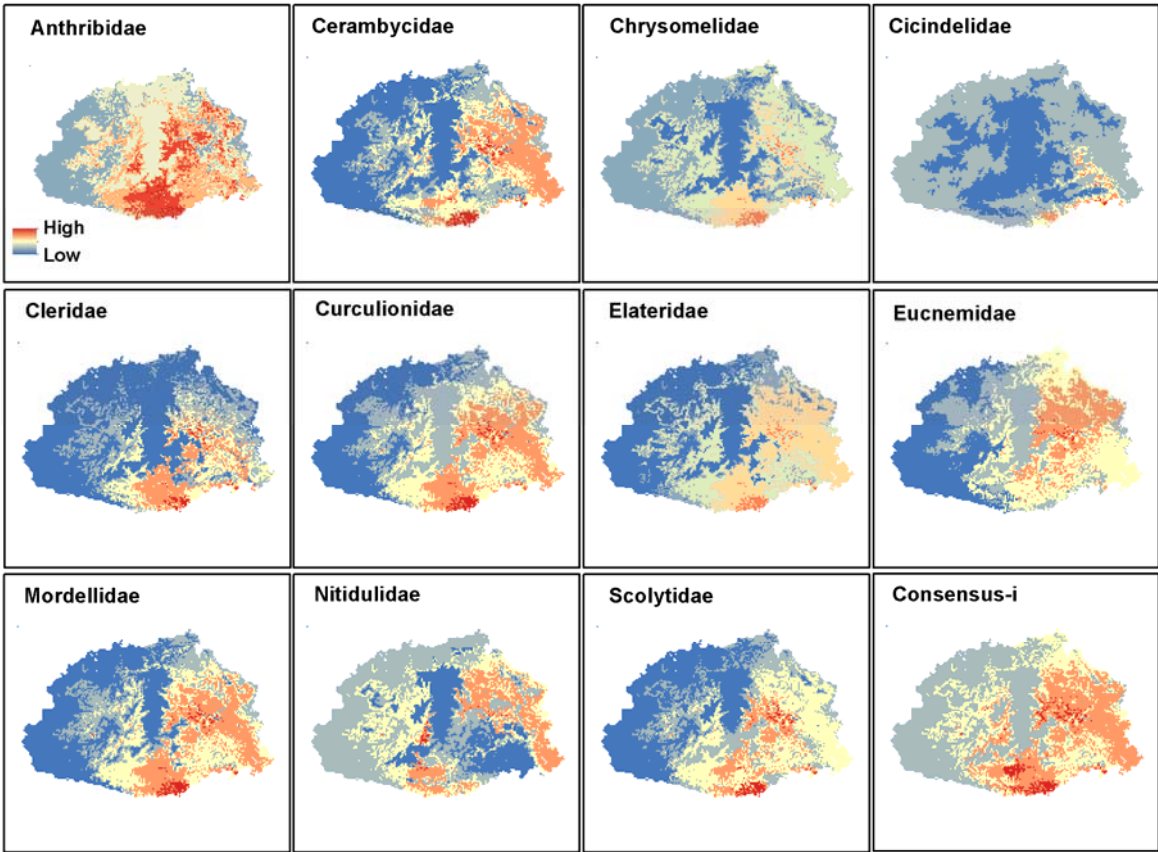


Figure 1. Habitat suitability maps of Families of beetles (Order Coleoptera) showing ensembled outputs from several commonly used species distribution models (SDM)

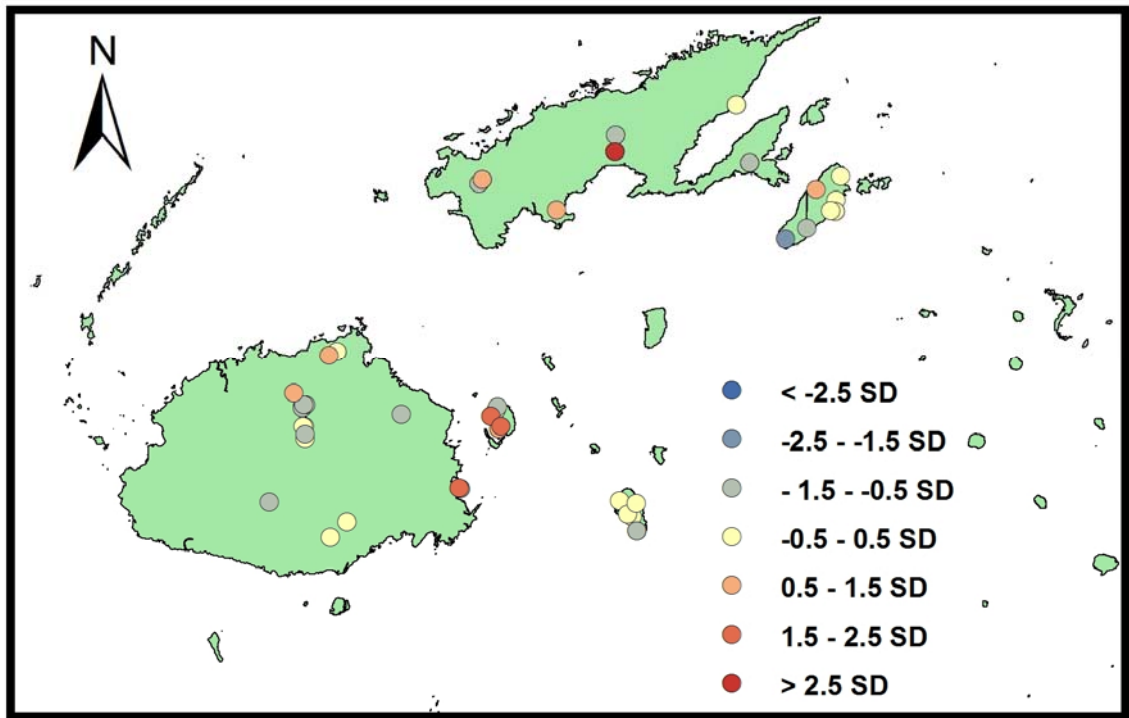


Figure 2. Hotspot distribution of the Fiji tree frog (*Platymantis vitianus*) in the Fiji Islands.

With the better capability and knowledge on SDM of our Fiji partners combined with the availability of basemaps, occurrence data and environmental layers, a process for scenario building for climate change risk analysis for Fiji biodiversity was established and several scenarios are part of publications being readied. (Objective 2)

The output maps contribute to the formulation of strategies for biodiversity conservation by defining the extent of species suitability, describing the characteristics of distribution and presenting in intuitive fashion the probability of presence of the species of interest. (Objective 3). The ensemble of ensemble models for Coleoptera (Figure 3) also identifies an altitudinal transect on the south eastern Viti Levu within low to upland forested areas and most suitable for Coleoptera. As the transect extends to higher altitudes (cloud forest) the suitability is reduced to medium suitability. The results of this study ties in well with the already established PABITRA (Pacific- Asia Biodiversity Transect) sites for Fiji (Mueller-Dombois and Daehler 2005) and further warrants that the transect is an excellent representation for the protection of much of Fiji's rich and unique biodiversity. Therefore in terms of Protected Areas identified, it would be wise for planners and managers to protect along this altitudinal transect on the south eastern site of Viti Levu from low- upland- cloud forests to ensure that host specific taxa are protected.

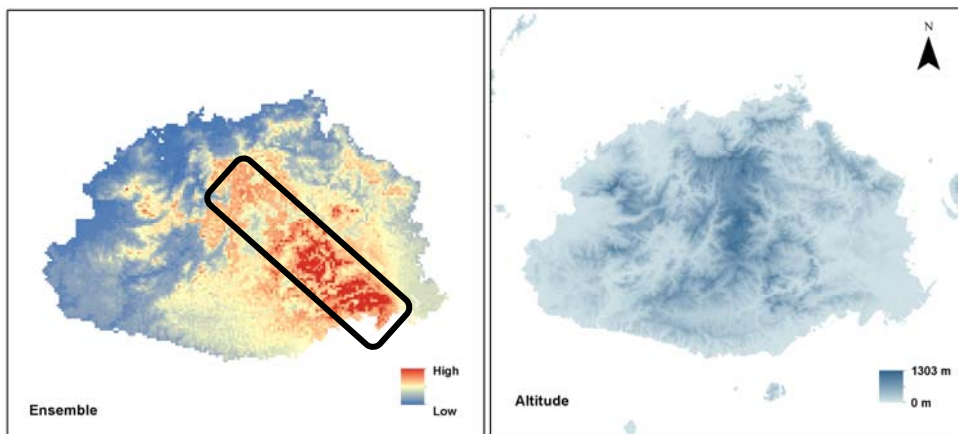


Figure 3. Identified area for biodiversity monitoring and representation of Fiji Biodiversity

Conclusions

Briefly summarise any conclusions that can be drawn from the research.

The research project contributed models that describe the potential distribution of several species of conservation interest in the Fiji Islands. These models will support conservation planning and management. More so, local capability to develop a Geographic Information System for biodiversity conservation was enhanced and a valuable relationship established between Unitec and the University of the South Pacific. This combination of enhancing local technical expertise and application of advanced approaches in GIS is seen as a key ingredient to ensure a sustainable effort for supporting decision making for biodiversity management. The ability of researchers in Fiji to work in collaboration with us in the production of high quality models and outputs with only a few focused sessions is evident of future prospects for bigger projects and continuing engagement.

Implications

Indicate who will benefit from the research, how, and why. Consider the future implications of your work and how others can build on it. What are the implications for other stakeholders, for

users, or for the community? What work could be undertaken to build on your research or carry it further?

The research will directly benefit the environmental planners in Fiji who can now identify areas where monitoring efforts can be focused on because of the high probability of occurrence for the species selected. The models provide initial guidance on the extent or boundaries of protected areas, information that is critically required for any development or management plan. Also, research activities related to the species concerned can be focused in the areas identified as hotspots, this has the benefit of optimizing the limited resources available to assessment surveys. In terms of the communities in Fiji, the output maps of species distribution will serve as tools for education and information because maps are highly effective tools in presenting information. The research can be viewed as an excellent start to a long term effort in establishing a research and collaboration network not only with Fiji but also with the South Pacific community. Further work can be undertaken to model other species using a variety of conditions and further elaboration of climate change scenarios. Change in scale, either focusing on individual islands or examining an entire region such as the South Pacific, is highly desirable because the conditions and problems in biodiversity are quite similar. Other modeling approaches could also be tested for relevance, efficiency and performance to determine and improve modeling practice for the region.

Recommendations (optional)

List any specific recommendations for the teaching, learning, or research communities.

Ecological research is inherently long term in nature with the models and outputs produced requiring continuous updating and analysis. Input from monitoring data, updates in the modeling tools and related available data are all dynamic and requires continuous analysis and engagement so that this work and previous efforts are not wasted. In this sense, a commitment to long term research and a consistent level of support to engage with established relationships is critically required. Value should be placed first and foremost on the recognition of opportunities that will enhance constructive collaborative research with individuals and institutions with problems that need the most attention.

There is a tremendous opportunity to build an effective long term partnership with researchers at USP. We are pursuing funding opportunities and will seek external funding. This training has provided a platform for increasing Unitec's profile in the South Pacific – one participant said that she thought that the workshop was "*the best one ever*". We will build on this foundation and actively pursue further opportunities to collaborate.

Publications and dissemination

Provide specific details. Include internal dissemination (eg participation in Unitec's Research Symposium). If these differ from those anticipated in your original application, please explain.

Articles for submission:

1. *Ecography*: Aguilar, G.D1., Sakiti-Waqa, H. and Winder, L. 2013. Ensemble species distribution modelling of Coleoptera in Viti Levu, Fiji
2. *Diversity and Distributions*: Osborne T., Aguilar G.D., Tuiwawa M, and Winder L. Two Frogs, One Tale - Species Distribution Modelling For Fiji's *Platymantis*

Conferences where outputs will be presented:

1. 12th Pacific Science Intercongress (Suva Fiji), 8-12 July 2013
2. Unitec Research Symposium, October 2013

3. NETS2013 – New Zealand Biosecurity Institute (Greymouth) 2013, 31 July – 1 August,

Articles in Newspapers (USP and Suva News): Forthcoming article in Advance has been proposed.

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Workshop looks at biodiversity and conservation planning through Geographic Information System mapping [Back to News »](#)



Workshop participants with Dr Glenn Aguilar (second from left) and Professor Linton Winder (third from right).

A five-day training workshop on the use of Geographic Information System (GIS) mapping for biodiversity and conservation planning was successfully organised by the Institute of Applied Sciences (IAS) at the University of the South Pacific.

The workshop, which was held from 13 - 17 February 2012, was conducted by academics, Dr Glenn Aguilar and Professor Linton Winder from the Unitec Institute of Technology in New Zealand.

The training provided an introduction to Species Distribution Modeling (SDM) which is advocated as an increasingly powerful tool in conservation biology.

The Director of IAS, Professor William Aalbersberg highlighted that the knowledge and skills gained from the workshop will facilitate in the provision of valuable information necessary for conservation and biodiversity policy making in Fiji and the region.

The workshop provided the first phase of training aimed at equipping staff and post graduate students of the South Pacific Herbarium and environment units of IAS and the Biology department of the Faculty of Science, Technology and Environment at USP, with the skills in analyzing species distribution data gathered from biodiversity surveys using GIS.

Such a workshop, Professor Aalbersberg said, is seen as the beginning of future collaboration work between USP and the Unitec Institute of Technology.

The training included the processes from data collection (i.e. species distribution data) and ground truthing on the field using a Global Positioning System (GPS), visualization of spatial information and then an introduction to spatial statistical analysis and SDM.

The modeling technique uses distribution data to associate species usually to a set of abiotic variables, for example; climate data, soil type and elevation. This is to further predict presence probabilities of species for un-surveyed sites.

Modeling techniques such as these are used when species distribution data are scarce and usually fill in gaps in distribution maps, identify sites with a potentially high conservation value and more recently to assess impacts of climate change.

This news item was published on 28 Feb 2012 10:21:58 am. For more information, please contact

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References (if applicable)

List any references to the work of others you have cited. Provide URLs for any materials available on the web.

Mueller-Dombois, D. and ., Daehler, C. C. ., 2005. The PABITRA Project: Island Landscapes under Global Change. – Pac. Pacific Sci., 59: 133- 139.

Appendixes (optional)

Two final draft papers are attached which are now ready to be submitted.

Reminders:

- You must notify the URC of publications when they occur (via email to bmassey@unitec.ac.nz).
- Please keep in mind that in addition to the committee, your report may be viewed by the Chief Executive, HoDs and/or external stakeholders.
- Any problems or issues that you would prefer not to highlight in this report can be discussed, in confidence if requested, with Brenda Massey, Grants and Funding Advisor or Associate Professor Simon Peel, Dean, Research and Postgraduate Studies.

Please email your completed report to bmassey@unitec.ac.nz.

APPENDIX 1 – DRAFT PAPERS (IN FINAL DRAFT FORM READY FOR SUBMISSION)

SUBMITTED AS PDFs.