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Tuva BIORAP – a rapid biodiversity assessment and archaeological survey of the upper Tuva catchment

Alivereti Naikatini¹ and Mereia Tabua²

Conference Paper for the R2R Regional Steering Technical Committee
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Abstract - The Global Environment Facility (GEF) funded Fijian Government's Ridge to Reef (R2R) project focuses on activities at the catchment level for six catchments: three on Viti Levu (Tuva, Waidina and Ba) and three on Vanua Levu (Tunuloa, Vunivia and Labasa). The Upper Tuva Catchment is an important area for the preservation of biodiversity in the drier southwestern side of Viti Levu. The overall survey was conducted to compile a flora and fauna assessment of the forests and the riverine ecosystems in the Upper Tuva Catchment and an archaeological survey in accordance with Fiji R2R Project Activity 1.1.2.11. Findings from the survey include, intact patches of native forest in the Upper Tuva Catchment, flora that are rare or threatened, endemic fauna, and culturally significant archaeological sites. These indicate a need for forest rehabilitation, biodiversity monitoring, and formal protection of the Upper Tuva forest.

Recommendations:

The R2R Technical Consultation is invited to discuss the paper and provide suggestions on the application of BioRap methodology, and implications of results for R2R planning and management of the Upper Tuva Catchment.

¹ Senior Technician and PhD Candidate, The Institute of Applied Sciences, University of the South Pacific

² Scientific Officer and Bryophyte Specialist, The Institute of Applied Sciences, University of the South Pacific



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1. Introduction

Tuva is one of six priority catchments for the Fiji R2R Project, the other five being: the Ba, Labasa and Waidina catchments on Viti Levu; and the Tunuloa and Vunivia catchments on Vanua Levu. Tuva catchment was selected as an example of heavily degraded catchment of critical importance to the ecological health of one of Fiji's most important cultural, touristic and coastal areas, and an area that is a priority for biodiversity conservation and improved land management in order to enhance sustainable livelihoods, increase carbon sequestration and reduce erosion, flash flooding and downstream sedimentation and provide vital ecosystem services to an expanding population. The upper portion of the catchment, which has remaining intact forested areas, was the focus of a multi-taxa biodiversity assessment carried out in April 2019.

Furthermore, previous archaeological work in the Upper Tuva catchment has been limited to only two archaeological sightings conducted in 1970. In the lower Tuva Catchment area, tourism development has been a major threat to the state and preservation of archaeological sites in the area. This is particularly concerning because most coastal lands are either leased or freehold properties, which contain remnants of potentially significant archaeological and cultural heritage sites belonging to nearby villages, the development of which warranted pre-development assessment.

2. The Tuva Catchment

The Tuva catchment straddles the two administrative provinces of Ba and Nadroga-Navosa, covering an area of almost 260 km² (26,000 ha). It falls in the transition zone between the Viti Levu Moist Forest and Viti Levu Dry Forest biotic provinces, and considered part of the Mt Evans–Nausori Highlands sub-biotic province of Fiji (Olson *et al.* 2010). Its main tributary, the Tuva River, reaches the ocean on the southwestern coast of Viti Levu at Likuri harbor, between the villages of Batiri and Lomawai and to the west of the small offshore Likuri Is. (renamed Robinson Crusoe Island), the site of an important tourist resort, and near Bourewa, which is believed to be the site of the first human settlement in Fiji.

The Upper Tuva catchment forest is part of a network of vegetation systems that is critical to hydrological and biological connectivity between Mt Koroba and Mt Namedra, the two highest mountains in southwestern Viti Levu, and riparian, lowland and coastal and lowland forests; and the

³ Senior Technician and PhD Candidate, The Institute of Applied Sciences, University of the South Pacific

⁴ Scientific Officer and Bryophyte Specialist, The Institute of Applied Sciences, University of the South Pacific

remaining native lowland forest in the vicinity of Nawaqadamu, Uto and Vunamoli Villages in the Rukuruku District, resembles the remnants of native forest that once covered the landscape from the lowlands of Ba Province to Mt Koroba which, in turn connected with the Nausori Highland plateau area.

3. Objective

The remaining forested areas in the Upper Tuva Catchment are remnants of Tropical Dry Forest, one of Fiji's most threatened ecosystems (Keppel and Tuiwawa 2007), which should be considered for future protection. The objectives of the study conducted were to:

- Document the different vegetation types and habitat types present in the Upper Tuva study area
- Carry out a multi-taxa biodiversity assessment of the upper Tuva catchment
- Carry out an associated archaeological survey to assess the time-depth historical cultural importance of the area

4. Methodology

4.1 Vegetation Survey

The main scope of the vegetation survey was to survey the forested area in the headwater and Upper Tuva catchment area which is in the vicinity of Vunamoli and Uto villages in the Rukuruku District, Ba Province. The assessment of the vegetation focused almost exclusively on forested areas, rather than non-forested areas. For the habitat-typing the most prominent topographical feature of the forested area was used and categorized as follows:

- Slope and Ridge top - forested area found on slopes with gradients ranging from 10 to 85 degrees and those found on top or along ridges of mountains or ranges. The width of such ridges could range from less than meter, up to 20 meters, with an undefined length.
- Flat - forested areas with gradients ranging from 0 to 10 degrees. These areas also included raised river flats and flood plains.

The quantitative assessments of different forest types were based on the methodology devised by Tuiwawa (1999), which uses between four and ten 10m x 10m plots to sample and record tree and other plant species along a transect. This validates if a tree species assemblage assessed is representative of the forest type.

4.2 Multi-taxa Biodiversity Assessment

i) Flora - The flora survey comprised two main parts. Firstly, checklists were compiled via a literature survey of A.C. Smith's *Flora Vitiensis Nova* and by searching the South Pacific Regional Herbarium's database for plants previously recorded from the study area. The second part involved field survey and collection where plants were sampled opportunistically while hiking and from within vegetation plots in the Upper Tuva forests and the areas surrounding Mt. Koroba.

ii) Terrestrial insects - A number of key habitat types within secondary forests (i.e. within gully, slopes and ridges) and a pine plantation were surveyed within selected vegetation plots to maximise the

chance of encountering individuals of focal species as well as to adequately sample the diversity of insects. Leaf litter surveys were conducted targeting different habitat types (i.e. gully, slopes and ridges). 50m transects were sampled within each vegetation sub-plots and leaf litter sampling was undertaken at 50m intervals using 1m² quadrats. This sampling technique specifically targets insects dwelling in leaf litter which have important ecological functions in the decomposition, nutrient cycling, predation etc. Nocturnal surveys targeting night active insects were sampled using light traps.

iii) Freshwater macroinvertebrates and flora -Samples were collected across a total of 10 sites using a kicknet. The sites were selected to cover a variety of micro-habitat types within different freshwater bodies in the Upper Tuva Catchment, in order to assess macro-invertebrate community composition that is representative of the area.

iv) Freshwater fish - A total of nine sampling stations were sampled during this survey, each station being about 100 – 150 meters in length. The stations included six at the headwaters and three in the mid-catchment. Depending on the characteristics of the site, a large seine net, a medium pole seine net, or observations using mask and snorkel, were used to collect fauna from the river or stream. Approximately one hour was spent sampling at each site.

v) Herpetofauna – Herpetofauna were assessed using sticky traps, night transect active search, and daytime active and opportunistic search. Sticky traps were placed at 50m intervals along a 1km transect and left overnight. Night searches were conducted at least 30 minutes after sunset for two hours, along streams and creeks. The main target species for night searches were the two Fiji endemic frogs. Daytime active and opportunistic search involved checking sticky traps and searching under debris, dead wood, fallen branches, under rocks/boulders and under dead bark.

vi) Birds - The survey was carried out both systematically and opportunistically. The systematic survey involved the Variable Circular Plot Method. Opportunistic bird surveys were also carried out, which included bird observations outside the morning bird counts surveys, while moving from one area to another, and while resting.

vii) Mammals—Three methods comprised the mammal survey. The rodent surveys followed the similar methods developed by the Pacific Invasive Initiative (Resource Kit for Rodent and Cat Eradication). The trapping stations were placed together with the herpetofauna survey stations. Each station contained two snap traps baited with roasted coconut and a mammal cage baited with tuna flakes. A total of 16 stations were established, 50m apart, to cover a large section of the upland forest next to Vunamoli village. Visual sightings were recorded for the presence of rodents, mongoose and cats, most of which were carried out after 4pm during active periods. Visual sightings of bats were also conducted at dawn and dusk from lookout points. Community discussions with village elders and pig hunters were also an opportunity to gather valuable information on the location of bat roosts and caves.

4.3 Archaeological Survey

General areas and specific locations of archaeological sites were documented and mapped based on community discussions and surface reconnaissance.

5. Results

5.1 Vegetation Survey

Of the nine principle vegetation types (Mueller-Dombois and Fosberg; 1998) recorded for Fiji, four were observed in the study area. These were: 1) Lowland Forest, 2) Upland Forest, 3) Grassland 'talasiga', including degraded grass-fermland and scrub; and 4) human modified/disturbed vegetation (secondary forest and plantation forests, mainly pine forest). The two habitat types within the lowland forest were characterized as slope forest habitat and secondary river flat or riparian forest habitat. The three forest types in the Upland Forest were characterized as ridge top forest, slope forest, and river flat forest.

5.2 Multi-taxa Biodiversity Assessment

i) Flora –A preliminary checklist of the flora from the study area recorded 16 bryophytes, four of which were liverworts and twelve were mosses; 42 pteridophytes, of which three were lycophytes and 39 were ferns; and 173 vascular plant species from three gymnosperm families and 70 angiosperm families. A total of six taxa encountered were considered important due to their rarity and threatened status, botanical significance and listing on the IUCN Red List (2012), the CITES List and the Fiji Endangered and Protected Species Act (2015). These six taxa are *Agathismacrophylla* (Lindl.) Mast. (dakuamakadre), *Dacrydiumnausoriense* de Laub. (yaka), *Podocarpusneriifolius* D. Don (kuasi), *Cycasseemannii* Braun (logologo or roro), *Pterocymbiumoceanicum* A.C.Sm. (ma or yanita), and *Degeneriavitiensis* l.W.Bailey&A.C.Sm. (vavaloa ormasiratu).

ii) Terrestrial insects - A total of 338 insect species were sampled. Of these, from within the focal taxa, 8 Coleopteran (beetle) families and 10 Formicidae (ant) genera were sampled. The most abundant taxa sampled using the leaf litter sampling techniques were the Family Formicidae (ants) within the genera *Camponotus* and *Technomyrmex*. There were no focal taxa of conservation significance found other than the sighting of Fiji's endemic swallowtail butterfly, *Papilio schmeltzii*, which has a widespread distribution throughout Fiji.

iii) Freshwater macroinvertebrates and flora - Macrophytes were only observed in the stream running through the Vunamoli Village (Ba Province) and Vagadra Village (NadrogaNavosa Province). The species tentatively identified included ribbon weed, *Hydrilla verticillata*; patchy growths of water hyacinth, *Eichhorniacrassipes*, was common along stream bank edges at Qokawa Creek; and a curly pondweed species, *Potamogeton crispus* (c.f) was also documented near the Qokawa Waterfall (100m wide). Additionally, a total of 1,478 macroinvertebrate individuals, comprising 51 species were recorded from the ten sampling stations. Insects represented 59% of the total taxa; decapod crustaceans (10 shrimp, 2 prawn taxa and 1 crab species) represented 25%; and molluscs and worms were represented by 6 and 2 taxa respectively.

iv) Freshwater fish - Eight species from four different families were observed during the survey. These are *Awaousguamensis*, *Anguilla marmorata*, *Anguilla obscura*, *Redigobius leverii*, *Sicyopterus lagocephalus*, *Sicyopterus zosterophorum*, *Kuhliarupestris*, and *Oreochromis mossambicus*. The majority of the species found in the upper catchments were native species, especially freshwater eels and gobies from the families Gobiidae and Anguillidae.

v) Herpetofauna – Survey efforts recorded four reptiles and one amphibian, including one Fijian endemic which was the Fijian green tree skink. The other three reptiles were the blue-tailed copper striped skink,

oceanic gecko, and pacific slender-toed gecko. The only amphibian recorded was the introduced, invasive cane toad.

vi) Birds - A total of 33 species of birds were recorded during the survey. This consists of the three Viti Levu endemic bird species, 14 Fijian endemic species, 10 species that are native to the region, and 6 introduced species. The highest number of species, 28, were recorded in the Lowland Forest habitat, followed by 27 species in the Upland-Cloud habitat, and, as expected, the lowest number, 16 species, was recorded in the Grassland habitat. The three Viti Levu endemics recorded were the giant honeyeater, the golden dove, and the masked-shining parrot.

vii) Mammals - The two bat species, the Samoa and Pacific fruitbats or flying foxes, bekaand bekavulaor beka lulu (*Pteropus samoensis* and *P. tonganus*) were sighted as fly-overs within the study site, but none were observed to be actively roosting nearby. Although *P. samoensis* was sighted over the upland forests flying across to the ridge adjacent to the study site, only two individuals were sighted during the survey. *P. tonganus* was recorded around the edges of the forests and close to the village. The invasive mammals recorded included the two main species of rodents, the Polynesian and black rats (*Rattus exulans* and *R. rattus*), the small Indian Mongoose (*Herpestes auropunctatus*), and The Indian brown mongoose (*Herpestes fuscus*), although this species was sighted in the lower Nawaicoba area on the drive up to Vunamoli Village. Feral pigs and feral cats were also sighted.

5.3 Archaeological Survey

In total, the survey documented and described 25 sites. An additional 10 sites were already registered and described by the Fiji Museum from previous surveys. However, the majority of the sites were located in the lower Tuva catchment area. The sites inspected during this survey in the Upper Tuva Catchment included two hill fortifications (Vunasevula and Deva) and the old village site at Nakurukuru, on the opposite of the river from Vunamoli Village.

6. Discussion

6.1 Vegetation Survey

In the Upper Tuva Catchment, the upland forest vegetation is restricted to patches in the vicinity of Mt. Koroba. Although still composed of mainly indigenous tree species, these forest remnants are classified as secondary forest, due to selective logging in the past and the increasing presence of introduced species, such as the raintree, vaivaimoce (*Albiziasaman*), after which successional regeneration has allowed the forest to recover to a more mature natural state. The most intact patches of native forest in the Tuva Catchment, are found in the Upper Tuva Catchment in the vicinity of Vunamoli, Tuva and Vunamoli Villages.

Almost all other forested areas (excluding Pine Forest areas) in the catchment are now dominated by introduced trees, especially the raintree, vaivaimoce (*Albiziasaman*, formerly *Samaneasaman*) and the African tulip tree, pasiu or pisipisi (*Spathodeacampanulata*), which means that they remain secondary degraded forests. The Upland-Cloud forest in the vicinity of Mt. Koroba should also be considered for protection both because of its distinctive biodiversity and the diverse ecosystem services, such as plant and animal habitat and water sequestration. Mt. Koroba is the only true Cloud Forest habitat for the

Tuva Catchment. Although not technically within the Tuva Catchment study area, it is the highest peak in the surrounding area and contains Cloud Forest habitat which is a key component of the water cycle of surrounding areas, and provides ecological connectivity with the higher elevation areas within the Tuva Catchment.

6.2 Multi-taxa Biodiversity Assessment

i) Flora - The flora results already show promising diversity, even though the Upper Tuva Catchment had been logged approximately 10—20 years ago. This is reflected particularly in the findings, related to the six species that are considered important due to their rarity, limited geographical distribution, threatened status and listing on the IUCN Red List (2012), CITES List and the Fiji Endangered and Protected Species Act (2015). The unexpected encounter of a few of these priority species, and those plants never studied previously such as the bryophytes, during this baseline survey is indicative for the need of a follow up and more detailed study required in the upland and cloud forest areas on Mt. Koroba and other high elevation areas not surveyed. Poorly managed farming activities are likely to destroy the habitats of species that are already categorised as vulnerable, endangered, near threatened and rare. Furthermore, the occurrence of the high, largely endemic species diversity in the genus *Psychotria* and families Rubiaceae and Euphorbiaceae suggest that the Upper Tuva forests area is a regenerating forest system.

ii) Terrestrial insects - The diversity of focal taxa within the Coleopteran families is very low (i.e. 8 families recorded) and suggests that the system is quite disturbed. Usually a good diversity of coleopteran families within a forest system provides a good indication of ecosystem services being supported such as soil processing, pollination, herbivory, decomposition, seed dispersal etc. Opportunistic surveys along the riparian systems focusing on the Order Odonata (dragonflies and damselflies) also suggested a disturbed system and the fauna sampled were common species associated with human settlements having a wide distribution e.g. *Orthetrum serapia*.

iii) Freshwater macroinvertebrates and flora - Species of particular conservation significance that were identified included: endemic damselflies, *Nesobasis* spp.; gastropod spring snails, *Fluviopupa* spp; and an endemic shrimp *Caridinadevaneyi*. The submerged curly pondweed, *Potamogeton crispus* is a useful wetland plant native to Fiji and Australia. It has been observed to provide habitat for native dragonfly and damselfly naiads, shrimps, mayflies and snails.

iv) Freshwater fish - The overall fish diversity, biomass and abundance were poor, probably due to overfishing, use of destructive fishing methods, and the impacts of logging. The Tuva River is in poor condition in terms of ecological functioning. The rivers in the upper catchment are in slightly better condition in terms of water quality, than the lower reaches of the rivers, because the upper catchment is still largely covered by intact forest. The general decline of these rivers, particularly in the lower reaches, is due to poorly managed subsistence agriculture in the lower catchments, human settlement waste, overfishing and destructive fishing practices.

v) Herpetofauna—The herpetofauna recorded for the Upper Tuva Area is indicative of a degraded system. The absence of Fiji's endemic frog species, the Fiji tree frog and the Fiji ground frog, are also indications of the disturbed status of the forest system. Rehabilitation of the degraded habitats in the Upper Tuva Catchment, would be essential for herpetofauna diversity in this area to recover over the long term.

vi) Birds - As expected more native and endemic bird species were recorded in the forested habitats, in both the Lowland and Upland Forest. Grassland and adjacent gully forests had the fewest native and endemic species but the most introduced species. Although the native forest habitats (Lowland and Upland) recorded in the Upper Tuva Catchment are secondary because of past logging activities, there remains a healthy bird diversity. To protect this diversity, there is a need to protect both the remaining lowland native forest in the vicinity of Vunamoli, Uto and Nawaqadamu Villages and the Upland-Cloud Forest, including the Mt Koroba area.

vii) Mammals - The loss of roosts for both fruitbats (*Pteropustonganus* and *Pteropussamoensis*) is of concern given the ecological role that they play in seed dispersal and pollination and the restoration of biodiversity (Fujita and Tuttle, 1991). Their decrease or loss from the area may ultimately lead to the loss of plant diversity in these forests which are also now impacted by non-native flora. After Cyclone Winston in 2016, the *Pteropustonganus* was noted to have disappeared from their roosts possibly in search of food in areas that was less impacted by the cyclone. Also, the invasion of ecosystems by invasive species, particularly invasive mammals, is viewed as one of the most serious causes of biodiversity loss. The impacts by feral pigs, rats and cats can be felt by native skinks and ground frogs from habitat destruction and direct mortality. The Small Indian mongoose (*H. auropunctatus*) has been implicated for the loss of many of Fiji's ground dwelling birds in Viti Levu and Vanua Levu. Its presence and the high encounter rates around the village and edges of the forest indicate it is well established. For the forests of Vunamoli to be protected or conserved, invasive species control and management needs to be a priority.

6.3 Archaeological Survey

All the surveyed archaeological sites are now protected under Cap 264: Preservation of Objects of Archaeological and Palaeontological Interest (POAPI) Act. Most of the archaeological sites are clearly visible and are intact while others have been destroyed by human induced impacts such as logging and livestock grazing. There are also natural impacts resulting from exposure to natural elements overtime such as rain, cyclones and landslides. It is recommended that, the Fiji Museum team revisit the sites after 2 or 3 years to inspect the changes overtime (plants recovery rate after the 10 days' assessment to indicate people's access into these areas and their response to the awareness briefings that were also undertaken during the survey).

7. Conclusion

Based on the vegetation survey and biodiversity assessment, a monitoring system should be established for the Upper Tuva forest and the remnant forests of the Upper Tuva Catchment need to be protected. A forest rehabilitation programme should be developed for this area, with a focus on water catchment management and the conservation of riparian vegetation to support terrestrial insects as well as freshwater fish and invertebrate diversity. Rehabilitation of the degraded habitats and protection efforts in the Upper Tuva Catchment, would be essential for herpetofauna and bird diversity. Also, the Tuva headwaters forest system, especially those areas at a higher elevation towards Mt. Koroba constitutes a significant source of plant diversity.

Therefore, the Upland-Cloud forest of Mt Koroba should be designated as a Protected Area at the National Level because of its important contribution to the ecosystem services to the Tuva, Nadi, Mid-

Sigatoka and other smaller surrounding catchments that rely on Mt Koroba as their Cloud Forest and main headwater source. Most importantly the protection of the Mt Koroba and the surrounding forest will ensure the continued provision of ecosystem services, such as carbon and water sequestration; hydrological and erosion control, and plant and wildlife habitat, of considerable cultural and livelihood importance. As the Cloud Forest system for the Tuva catchment, Mt Koroba is critical to the maintenance of a healthy water cycle in an arid and highly degraded area of Viti Levu. Community engagement and involvement is vital in ensuring the long-term success of forest protection.

Furthermore, the archaeological assessment revealed valuable information pertaining to the different mataqali landowners within the study area and neighbouring communities that are historically linked to the land. Various findings of cultural assets were able to ascertain that these ancestral sites conveyed immeasurable knowledge and understanding of the history pertaining to traditional and cultural developments, linked closely to the identity of its people. It depicts the movement and settlement patterns of their ancestors and the forms of survival which defined their everyday lives. Such history must be preserved, whether tangible or intangible, to safeguard these important aspects of material history of the vanua of the Tuva catchment.

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