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FIELD TRIP REPORT

Rapid assessment of wetland management issues and nature-based solutions in the crater lakes around Lake Itasy

Mark Grindley and Basile Andriambeloson
WWT Madagascar

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Funding partners

Abstract This field trip report documents a two-day field site visit by the authors to ten volcanic crater lakes and associated wetlands in the region of Lake Itasy, approximately 80km west of Antananarivo. One small reservoir in an upper catchment serving nineteen villages was also visited. It was not possible to assess the biodiversity values of the lakes, although there is some anecdotal evidence that fish and avian biodiversity are significant. However, the lakes provide several human-use values, particularly water for cattle and human use (bathing and laundry), and fish. Land use in the catchments of the lakes is dominated by free-grazing of zebu and sloping-land agriculture (maize, beans, casava, rice), with paddy rice in the lower areas and on marginal lake sediments. Nearly all the lakes are subject to sedimentation, some quite extensive, and *lavaka* are widespread. In some cases, crops on steep slopes were actively being washed away at the time of the visit. Some limited terracing and agroforestry was evident (to combat erosion?). These and other solutions to the erosion problem are discussed in this brief report, and some research questions are proposed.

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About the authors Mark Grindley is Senior Project Manager with WWT in UK, and Jean Basile Andriambeloson is Field Coordinator for WWT in Lake Sofia.

Author contact(s) mark.grindley@wwt.org.uk, basile.andriambeloson@wwt.org.uk

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Cover image(s) Typical landscape in the Itasy basin, with mixed rice and maize predominating in the low-lying areas, but heavily-grazed hillsides with extensive riling gully and *lavaka* formations. © Mark Grindley/WWT (2024)

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iii. Acronyms and Abbreviations

COGELI	Comite de Gestion du Lac Itasy
VOI	Vondron'Olona Ifotony (local community association)
WWT	Wildfowl & Wetlands Trust

iv. Acknowledgements

WWT would like to thank Dr Jean Freddy RANAIVOARISOA (University of Antananarivo) and RAZAFIMAHATRATRA Nirina ANDRIANDRAMPIANDRA the Regional Head of Tourism in the Itasy Region for organizing and guiding the WWT team to explore the richness of Itasy's Crater lakes and the importance and the uses of its watersheds. Without forgetting the local communities hosting living in lakesides, we sent you our warmest thanks. We would like to thank the VOI ANGELA for their efforts in managing lake Andranomena and to encourage them to continue in this direction. WWT would also like to express our infinite thanks, our satisfaction to achieve this activity and our deepest gratitude to all our funders.

1 Introduction

Two staff from WWT (the authors) were invited to visit several volcanic lakes in the region of Lake Itasy by an academic colleague from Antananarivo University, and his friend, the Inter-regional director of tourism for the Itasy Region (see Acknowledgements). They accompanied the authors on a two-day site visit from 3 to 4 February 2024, with the intention of viewing several of the volcanic lakes and learning about some of the management challenges they face.

1.1 Lake locations

#	Name	Lat	Lon	Notes
1	Lake Lavarano	46.71553759	-18.92186494	
2	Lake Ibisy	46.72304578	-18.92373305	
3	Lake Manandona	46.69757	-18.88875	
4	Lake Mandetika	46.7446	-18.85544	
5	Lake Itasy	46.73349763	-19.03174414	
6	Lake Ilempo	46.75321398	-19.01835818	
7	Lake Mahiatrondro	46.7245267	-19.01863203	
8	Lake Andranoratsy	46.72767	-18.99906	
9	Lake Andranotoraha	46.73985	-18.94959	
10	Lake Andronomena	46.66389	-18.90094	
	Jirama Dam	46.73653	-18.9506	Near by the Lake Andranotoraha
	Nursery	46.72566	-19.00079	Near by the Lake Ranoratsy

Detailed Google Earth images of each lake are provided in Annexe 1.

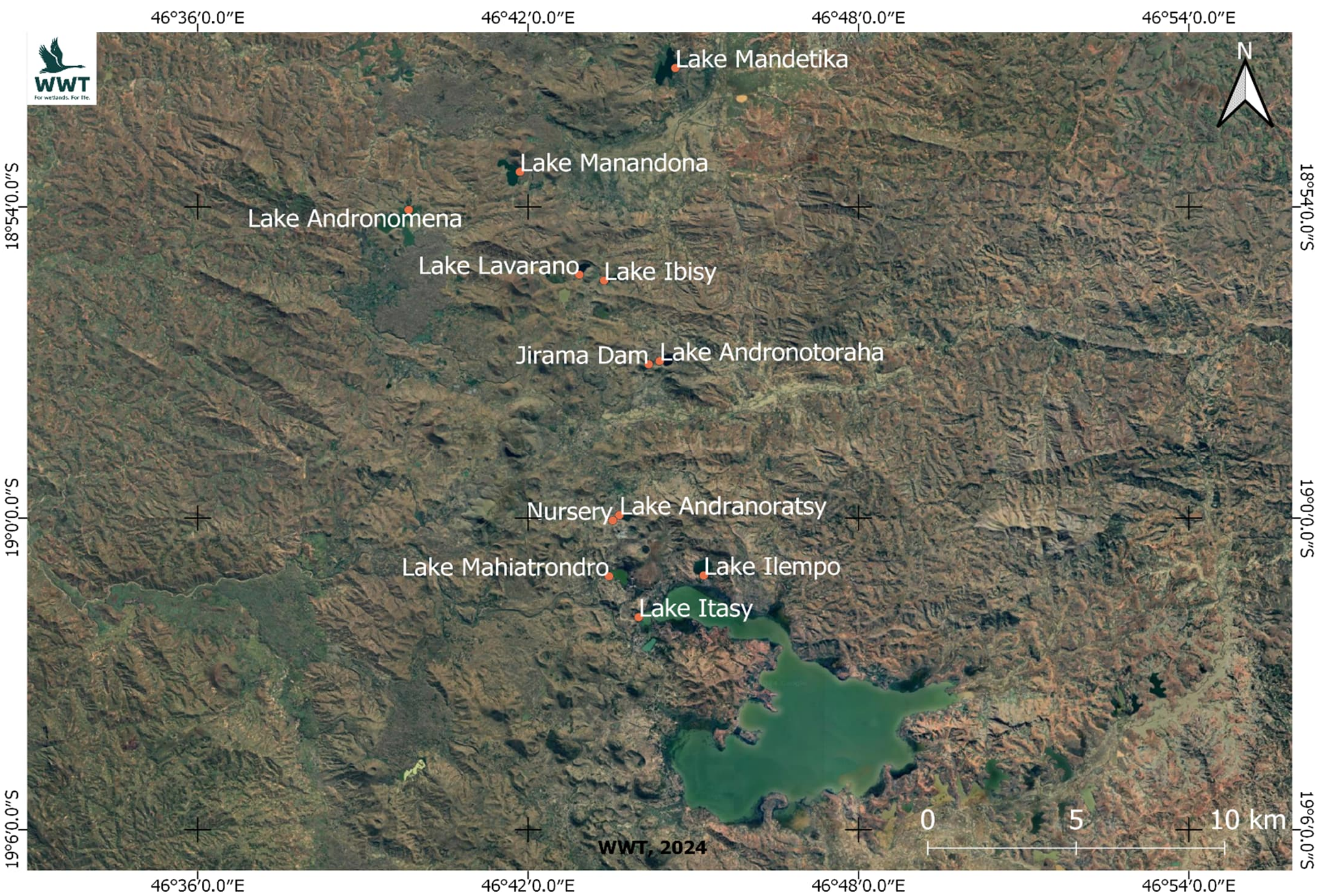

Figure 1. Overview map showing the lakes visited

1.2 Images of main sites

Figure 2. Small crater lake Lavarano on road between Antananarivo and Lake Etasy

Figure 3. Small crater Lake Mananando in the Atolampy Village– extensive areas of silt are now being used for farming

Figure 4. Medium-sized Lake Manandona in the Atolampy village receiving silt from surrounding slopes but still important for fishing

Figure 5. Wier on the Ibizy River in the Ambohimandroso Village, indicating how widespread the siltation of watercourses is in the region

Figure 6. The relatively clear lake at the Lake Mandentika in the Ampefy Ifanja village, from where water hyacinth had been cleared by the community

Figure 7. Itasy Lake, which is seeing widespread siltation. The new land is used for farming and housing

Figure 8. At Ilempo Lake the water level has been reduced by local people to increase crop land

Figure 9. Lake Mahiatrondro in Ankorondrano, Analavory…

Figure 10. Crater lake at the lake Andranoratsy in Ambatomitsangana village – one of the clearer lakes due to its small size and vegetated basin

Figure 11. Diversion dam feeding Analavory city, showing extensive sediment buildup

Figure 12. Relatively large crater lake at the Lake Andranotsitoraha in Ankotrabe, Analavory District, showing terracing by a commercial farm

2 Summary of main site characteristics

The following represents a summary of our observations over this very rapid survey, combined with inputs received from our hosts and some of the community members who were encountered.

2.1 Lake management

Twelve Crater lakes spreading across two regions Itasy and Miarinarivo are not yet under structured management except the Lake Itasy that is already under the COGELI (Comite de Gestion du Lac Itasy) management and the Lake Andronomena is managed by the VOI ANGELA since 2001.

On the other hand, ten of the lakes visited – Lavarano, Ibisy, Mananando, Mandentika, Itasy, Ilempo, Mahiatrondro, Andranoratsy, Andranotsitoraha and Andranomena – all have fishery regulations that include a prohibition on the use of canoes. Only traditional fishing rafts made from local reeds are allowed when fishing (Figure 13). There is already also in place for all lakes a closed fishing period from September to November, during the breeding season. This regional decree is not seriously respected or enforced.

According to discussion with the notables of the villages, all lake need to set Associations such as local community association, fisherman Cooperative and other kinds of Financing programme to help to manage, to restore including Lake restoration and reforestation against lake landside erosion and to improve all land use techniques like the agro-forestry and agro-ecology.

2.2 Lake biological values

There was no time to conduct even the quickest assessment of biodiversity, so here we only list some of the main findings:

- Apart from a couple of egrets and one kingfisher, no waterbirds were observed during our visit. Ducks were said to travel daily between Itasy and a couple of the lakes, but were not observed.
- Most of the lakes showed signs of fishing; the fish that were observed in catches were mostly small.
- Due to the quite steep sides of crater lakes, little edge vegetation was observed in those lakes not suffering from siltation; where silt had collected, various marsh habitat was evident.
- We saw very little macrophyte presence in any of the lakes.

2.3 Lake human-use values

Nearly all the lakes are used for some or all of the following; fishing, washing, bathing, watering zebu. Some reed collection was reported but not observed.

Figure 13. Traditional reed rafts are the sole watercrafts allowed for fishing by local regulations across the lakes

Figure 14. Line-caught fish from an unregulated fishery at one of the lakes

2.4 Land uses

2.4.1 Lowland agriculture

The rich volcanic soils of the area are widely used for rice cultivation; paddy in river floodplains and lake basins, and some hill rice on lower slopes. The area is considered to be one of the main rice producing regions in Madagascar. Other common lowland crops include maize and casava.

2.4.2 Sloping-land agriculture

The many hillsides are widely cultivated, on slopes up to perhaps ≈45°, with a mixture of hill rice, casava, beans, maize and some others.

2.4.3 Grazing

The main livestock is zebu cattle, which are grazed widely in the region and most natural grass is very short as a result. Herds number from a handful of animals up to 20 or more, though reportedly herds were much larger (50 or more) in the not-too-distant past. To avoid theft and damage to crops, the cattle are nearly all supervised, often by children (mostly boys); this reportedly interferes with formal education. The cattle themselves do have some agricultural value, being used for draught (eg, ploughing and pulling carts), but for most they serve primarily as a store of wealth. In particular, they are important for both financing and providing meat for *Famadihana*, or the "Turning of the Bones" ceremonies, which are common in the highlands. These 'festivals' are held roughly every five to seven years, when families honour their ancestors by exhuming their remains from the family tomb and replacing their shrouds. The events are joyful, with music, food, alcohol and dancing. As *Famadihana* can be quite expensive for the hosts, reportedly some families reportedly now forego them.

Figure 15. Small herd of zebu, each with a sisal rope around its horns

2.4.4 Agroforestry

We saw several examples of mixed fruit trees (particularly papaya) with undercrops of maize and/or beans, or where maize or casava were interplanted with another crop such as rice (see **Figure 16**). The most common regime with trees included only one undercrop. These planting patterns occurred both in low-lying areas and on slopes, and may offer the potential for providing permanent or near-permanent vegetative cover to vulnerable soils. We discuss this idea in more detail below.

Figure 16. Maize and hill rice are intercropped among trees

2.4.5 Terracing

We observed multiple examples of terracing, which can be summarised into three types:

- Rough contour planting of annual crops, though whether the terraces were constructed or formed naturally is not currently clear.
- 'Accidental' terracing, where a lateral feature such as a wall or living fence (ie, hedge) had resulted in the up-slope accumulation of soil.
- Deliberate construction of multiple terraces for (commercial?) agricultural production; these used a mixture of rocks – which are readily available on many slopes – and shrubs.

In the latter two cases, the most widespread plant was the fibre-producing succulent, sisal, which is originally from Mexico, but is now a commercial export from several countries including Madagascar, but is used locally mostly for rope manufacture – the ropes being commonly used for managing *zebu*. In all, three species (or cultivars) were indicated to be grown locally, having slightly different characteristics and processing requirements for rope production, but they are otherwise similar. Sisal is a hardy plant that grows relatively fast and all year round, and has a shallow, fibrous root system that is a maximum of about 60cm deep, and is apparently very effective at retaining soil, particularly if planted laterally across slopes. The plant flowers only once in its lifetime, at about 12 years, when it produces a huge single stalk of several metres in height, but it is readily multiplied through division. It also becomes very dense as it grows, and supports spines along its thick leaves, making it an ideally fencing plant that zebu do not easily cross.

For these reasons, it was seen in a number of applications, planted directly as a living fence along roadsides, on top of rock piles (presumably to strengthen them while giving greater overall height), and on the upper portions of embankments and cuttings. Although it We did not however see it in use as

***Figure 17**. Terraces just above Lake Andranoratsy in the Ambatomitsangana village, Analavory district, built with rock with maize or round bean plant on the top of the cutting*

3 Threats and challenges to sustainable wetland management

Several challenges face the communities in this region, as expressed specifically by those we met, indicated by our hosts, or observed directly. The nature and causes of these issues are undoubtedly complex, so the following is a mercenarily simplified summary of the main threats to the wetlands we visited.

3.1 Sedimentation

All the lakes are probably receiving sediment inflows from their catchments, but in some the volume of material being deposited is greatly outweighing any natural or human mechanism of removal. Indeed sediment is not only deposited in lakes but also covers transport infrastructure in low-lying areas such as roads, bridges, culverts, dams and so on, and is a major challenge to local livelihoods. Several of the lakes show huge sediment fans and sand/soil bars, which are frequently turned into agriculture. In a few cases, natural wetland habitat has colonised the deposits. An example of a natural volcanic lake which does not suffer from the same intensive land use in its catchment – Lake Bemanevika – suggests what these lakes might have formerly looked like, and perhaps could if restored (Annexe 2: Comparison map and satellite image of Lake Bemanevika).

Figure 18. *Lavaka scar the far slopes, allowing maize to be grown on sediments on the lake shore At the lake Mananando, in Anosibe Iranja)*

3.2 Erosion

Soil erosion was evident in at least two forms; riling and lavaka, although the relationship between the two is not at this point known. In both cases, they occur on moderate to steep slopes, and appear to be closely associated with areas of little or no natural vegetation. Some lavaka appear to be quite old and have regrown after stabilising, and may even be cultivated, but in most cases the eroded areas are effectively lost to human use since they are steeper and lacking in topsoil. From an agricultural perspective, erosion causes major loss in land quality and availability. Understanding the processes of hill erosion and the factors driving it appears to be one of the main priorities for both wetland protection and the long-term viability of much agriculture in this region.

Figure 19. Rill erosion on moderate slows renders them unsuitable for planting surrounding landside of the Lake Lavarano in the Angilomby Village

Figure 20. A less common cross-slope erosion scar showing attempts to slow water flow with large rocks in Ambatomitsanagana Village

3.3 Zebu grazing

The widespread grazing of zebu at current levels appears to conflict with soil conservation goals as it requires large areas of land that could otherwise be (re)forested – especially on steep slopes. (Anecdotally, herdspersons have removed trees planted under a government watershed protection project from grazing lands in around Lake Andranotoraha.) Grazing may also be a direct or indirect driver of annual burning, eg, because burning is used to improve grazing quality, or because it maintains grasslands rather than more mixed landcovers that might be more resistant to fire.

4 Recommendations

As this was only a rapid assessment, the recommendations should be seen only as suggestions for further discussion. Since our focus was on the lakes and other wetlands, they focus primarily on the drivers of wetland degradation identified during the trip. Due to the brief nature of the trip, some solutions focus on better understanding the problems that were observed. Due to the huge scale of most of the challenges, several recommendations are also focused on solutions that are either low cost, or that should pay for themselves; this necessarily means working with nature wherever possible.

4.1 Investigate options for natural terrace formation

Terraces on lower slopes beside lakes, or at points of particular importance for sediment transport, would seem likely to significantly reduce the quantity that reaches lakes. There are several examples of terracing in the project area that could be considered, but our rapid assessment presented here would suggest that sisal offers a nature-based solution with low cost, few if any negative impacts, low maintenance costs and benefits in terms of fibre production. Since propagation techniques for this plant are well known, possible challenges would be; a) identifying a contour in the field (see below), and b) ensuring the terrace was able to resist being breached by a stream or lavaka during heavy rain. A series of terraces might therefore afford better protection in selected circumstances. But any vegetation in strips along hill contours would potentially promote terrace formation, so models using grass and other existing plants should also be considered.

4.2 Investigate options for sloping land agriculture

The approaches, techniques or technologies that are used to promote sustainable agricultural practices on sloping or hilly lands are collectively known in rural development as ‘sloping agricultural land technology’ (SALT) or contour hedgerow intercropping (agroforestry) technology (CHIAT). There is likely a large body of knowledge and experience which could be drawn upon to find solutions for the survey area and other sites with similar challenges. This might be available both formally (eg, through government extension services, or organisations such as ICRAF, FAO or ICIMOD) and informally (eg, the examples noted above, and others in the project area of which we are as yet unaware). Both SALT and CHIAT techniques share key characteristics, primarily the contour planting of permanent hedges of useful species (eg nitrogen-fixing shrubs) that trap and slowly accumulate soil until terraces are formed. Identifying possible models for specific sites (eg, using local species) and piloting them is recommended.

4.3 Investigate options for agroforestry

This relates to SALT, but would also be relevant to lower-lying areas that might still suffer from soil loss (eg, through rill erosion). Agroforestry involves the integration of trees with agricultural crops or livestock and offers multiple benefits over seasonal planting of single crops as it typically creates multiple stories in the agricultural landscape, retains vegetation cover throughout the year, and allows for a greater diversity of products from a single site. These factors can lead to increased agricultural productivity, greater diversity of food supply or income, soil improvement, resilience to climate change, improved water use, and biodiversity and habitat improvement. As with terracing and sloping land agriculture, there are likely to be multiple examples of agroforestry in the landscape – and experiences with models that did not work – that should be the starting point for any research on which models are most cost-effective and under what circumstances.

4.4 Investigate emergency options for early control of lavaka

Lavakas have significant environmental and societal impacts. They contribute to soil erosion, loss of fertile topsoil, and degradation of agricultural land, making it challenging for local communities to sustain agricultural activities, and they also lead to significant downstream impacts due to siltation. While ultimately only changes in land use and agricultural production practices will probably address this threat, there might still be relatively simple short-term measures that could be undertaken both to identify areas most susceptible to lavaka formation (thus allowing land use to be modified) and to undertake prompt remedial actions once they start to form, so that huge loss of land might be avoided.

4.5 Investigate the drivers and impacts of zebu pastoralism

The practice of cattle herding is an economic, social and cultural one, and needs to be fully understood before its role in wetland and soil degradation can be fully understood.

5 References

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Annexe 2: Comparison map and satellite image of Lake Bemanevika

Lake Bemanevika is a volcanic lake in Sofia Region which still retains much of its natural vegetation and is not currently subject to the same human pressures as the lakes visited during this assessment. It is therefore instructive to compare them, if only visually.

The Wildfowl & Wetlands Trust (WWT) is one of the world's leading conservation organisations dedicated to saving wetlands for people and wildlife. Founded in 1946 by the pioneering conservationist Sir Peter Scott, WWT's vision is a world where healthy wetland nature thrives and enriches lives.

Our mission is to conserve, restore and create wetlands, save wetland wildlife, and inspire everyone to value the amazing things healthy wetlands achieve for people and nature. WWT has been working in Madagascar since 2010 and operates under an agreement with the Ministry of Foreign Affairs.

WWT Madagascar

Lot VT 74 ter B

Andohanimandroseza, Ambanidia

Antananarivo 101, Madagascar

+261 32 62 154 15