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Enhancing Invasive Alien Plant Species Management Through Participatory GIS: A Spatial Analysis of Species Distribution on Rodrigues Island, Mauritius

Reshma Sunkur

Doctoral School, University of Technology, Mauritius, La Tour Koenig, Port Louis 11134, Mauritius; sunkurr@umail.utm.ac.mu

Abstract

Invasive alien species (IAS) are a significant threat to ecosystems worldwide, in particular island ecosystems where ecological resilience is limited. Spatially explicit and locally informed strategies are crucial on small islands to effectively manage IAS. The present study uses an integrated approach to map and manage IAS on Rodrigues Island, Mauritius, using a combination of field surveys, participatory mapping, and spatial analysis tools. Field data was collected in four sites on Rodrigues, namely Cascade Pigeon, Cascade St Louis, Mourouk Valley, and Golden Bat Reserve, supported by participatory mapping and Inverse Distance Weighting (IDW) interpolation in ArcGIS. The results revealed firstly that invasion hotspots were concentrated in previously disturbed areas, especially in Mourouk Valley and Cascade Pigeon, where *Furcraea foetida*, *Leucaena leucocephala*, and *Millettia pinnata* co-occur. Secondly, grassland zones exhibited minimal invasion, indicating their potential as natural buffer zones for conservation. Thirdly, the integration of stakeholder knowledge through Participatory GIS (PGIS) enhanced the accuracy and contextual understanding of the spatial analysis. Fourthly, the IDW interpolation method demonstrated high precision with low root mean square error (RMSE) values and minimal spatial error ($\leq$0.5 m). Finally, the study underscores the importance of adaptive, site-specific monitoring and management strategies that combine spatial tools and local knowledge. These findings provide a replicable framework for IAS management in other island ecosystems facing similar ecological challenges, contributing to national and international biodiversity conservation efforts, including Sustainable Development Goal 15—Life on Land.

Keywords: invasive alien species; GIS; participatory mapping; conservation; Rodrigues

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1. Introduction

Invasive alien species (IAS) are one of the most pressing threats to global biodiversity and ecosystem health [1]. IAS are species introduced, either intentionally or accidentally, to regions outside their native range that negatively affect native biodiversity, ecosystem services and human well-being [2]. These species often proliferate rapidly, displacing native species, altering ecosystems and imposing significant social and economic costs [3]. The Convention on Biological Diversity (CBD) identifies IAS as one of the main drivers of species extinction globally, impacting around 40% of endangered species [4]. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) further reports that IAS are among the top five drivers of biodiversity loss globally, underscoring the urgency of effective monitoring and management strategies [1]. With the accelerating

pace of globalization, land use change, and climate change, the effective management of IAS is now increasingly critical [1].

Worldwide, the ecological and economic impacts of IAS are massive. For example, the spread of lionfish (*Pterois volitans* and *P. miles*) in the Western Atlantic and Caribbean has resulted in an alarming decline in native reef fish populations, impacting coral reef resilience and food security for local communities [5]. Managing IAS has proved to be very costly, with estimates exceeding 1.4 trillion USD annually, reflecting losses in fisheries, agriculture, forestry, and ecosystem services [6].

On islands, such as those in the Indian Ocean, native species suffer more from IAS impacts compared to continental species, as native species of islands lack the morphological and behavioral characteristics to deal with IAS [7]. Consequently, islands account for a higher proportion of global extinctions caused by IAS compared to continental areas [4]. In the Galapagos Islands, for instance, the introduction of invasive rats, goats, and plants has led to widespread habitat degradation and decline of unique species [8].

Recent advances in geospatial technologies have expanded the capacity to monitor, model, and predict IAS distributions with spatial modeling techniques such as Maximum Entropy (MaxEnt) and Random Forest and interpolation methods like Inverse Distance Weighting (IDW) and Kriging being widely used to analyze spatial invasion patterns and predict spread probabilities [9–12]. However, these models, while powerful, often lack the inclusion of socio-ecological perspectives that are crucial for adaptive management in data-limited regions. In this context, Participatory Geographic Information Systems (PGIS) have emerged as an effective approach that integrates stakeholder and community knowledge into spatial mapping frameworks, promoting co-production of environmental data and fostering local ownership in IAS management [13–15]. Yet, applications of PGIS remain underexplored within small island states, where combining local insights with geospatial precision could improve decision-making and conservation outcomes.

Existing research in the Western Indian Ocean (WIO) region has primarily focused on documenting IAS presence or implementing localized control measures [16,17]. There remains a significant research gap in linking participatory mapping with quantitative spatial modeling to provide integrated, site-specific insights that support restoration and management planning. Addressing this gap is essential for developing adaptive IAS management strategies that reflect both ecological dynamics and community-based realities.

In the Western Indian Ocean region, IAS pose substantial threats to island nations' biodiversity and ecosystem services that underpin local economies. On the island of Mauritius, also known as the Land of the Dodo, with its unique biodiversity and high rates of endemism, significant ecological losses have occurred as a result of IAS [18]. The introduction of the black rat (*Rattus rattus*) and strawberry guava (*Psidium cattleianum*) among other species, has devastated native habitats and species [19]. Rodrigues, a dependency of Mauritius, also faces similar challenges from IAS such as *Leucaena leucocephala* (white leadtree) that encroaches on native forests and agricultural lands and *Vachellia nilotica* (prickly acacia) whose widespread distribution has significantly affected the health of communities and led to socio-economic challenges [20]. However, while several studies have examined IAS ecology and its impacts in island ecosystems, limited attention has been given to spatially explicit, community-informed mapping approaches that integrate both scientific and local knowledge for management. While invasive fauna such as rodents and goats have also contributed to ecological degradation in island systems [18], this study focuses exclusively on invasive alien plant species to better understand their spatial distribution and management implications.

The aim of this study was to enhance the management of IAS on Rodrigues Island, Mauritius, by integrating Participatory Geographic Systems (PGIS) into spatial analysis

workflows. Specifically, this study introduces an innovative hybrid PGIS-GIS framework that combines participatory mapping, field surveys, and spatial interpolation (IDW) to map IAS distribution and identify invasion hotspots. Given the limitations of top-down approaches and the value of local ecological knowledge [21], the research aims to empower conservation practitioners to actively participate in identifying, mapping, and monitoring the distribution of IAS in island ecosystems. Specifically, the research aims to assess the current spatial distribution and spread patterns of priority IAS using field-based participatory mapping techniques, promote community-based engagement and awareness to foster locally adapted IAS management strategies, and provide spatial decision-support tools to inform policymakers and conservation managers of targeted interventions, proper resource allocation, and prioritizing management zones. By combining spatial modeling with participatory approaches, the study offers a replicable methodological contribution that enhances IAS monitoring and informs conservation policy in island ecosystems [1].

2. Materials and Methods

2.1. Case Study Area

Rodrigues Island is a 108 km^2 autonomous outer island of the Republic of Mauritius found some 560 km east of mainland Mauritius (Figure 1). It is of volcanic origin and, together with Mauritius and Reunion, forms part of the Mascarene Islands. It is recognized globally for its rich biodiversity and unique endemic species, with 150 native plant species, of which 47 occur only on that island, while 72 are Mascarene endemics [22]. Rodrigues has been heavily affected by the introduction and proliferation of floral IAS such as *Lantana camara* and *Opuntia* spp. which threaten native flora and disrupt local ecosystems [17,19,23]. IAS compete aggressively with native species for space, nutrients, and light, and colonize native habitats. Given the unique ecological setting of Rodrigues, IAS impacts are more pronounced, as natives are very vulnerable to habitat loss. Rodrigues, which was once covered with lush valleys of palm trees and ebonies, is now one of the most degraded tropical islands in the world as a result of IAS dominance following on from historic habitat destruction [24].

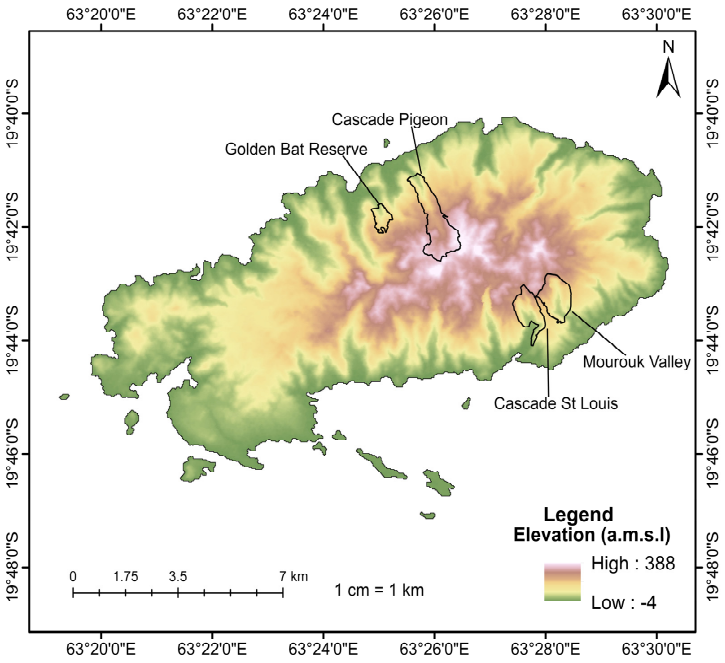


Figure 1. Digital Elevation Model (DEM) of the case study area, Rodrigues Island, in the south-west Indian Ocean, with selected sites for IAS distribution assessment, namely, Cascade Pigeon, Golden Bat

Reserve, Mourouk Valley, and Cascade St Louis. Elevation values are expressed in meters above mean sea level (a.m.s.l).

2.2. Site Selection

Four sites were selected for the assessment based on their ecological importance, conservation value, and vulnerability to IAS encroachment, as shown in Table 1. Mourouk Valley (77 ha), Cascade Pigeon (200 ha), Cascade St Louis (110 ha), and Golden Bat Reserve (141 ha) represent a diversity of habitats in Rodrigues with rare and endemic species, dry forest remnants, and important faunal habitats [22]. As an example, some of Rodrigues' native flora and fauna can still be found in the remaining patches of native forests at Cascade Pigeon and Cascade St Louis. In contrast, Mourouk Valley has suffered significant ecological degradation, yet it is still home to species of conservational concern, providing opportunities for restoration. As for Golden Bat Reserve, designated for the protection of the endangered Rodrigues fruit bat (*Pteropus rodricensis*), it is a critical conservation area of the island, highlighting the need to manage IAS for the protection of its sensitive ecosystem [20].

Table 1. Sites selected for the assessment and the sizes in ha.

Site	Size (ha)
Mourouk Valley	77
Cascade Pigeon	200
Cascade St Louis	110
Golden Bat Reserve	141

2.3. Species Selection

A total of 28 invasive alien plant species were initially identified on Rodrigues Island from the national IAS inventory, field observations, and expert consultations with the Rodrigues Forestry Service and the UNDP-GEF IAS Project Team. These included both widespread and localized species occurring across different vegetation types. The following predefined selection criteria were then systematically applied to this candidate pool:

- Importance: The significance of the species in terms of its rate of spread and overall impact on the ecosystem.
- Feasibility: Priority was given to species that could be easily identified during field surveys.
- Potential to Spread: Species with a high propensity to spread rapidly and widely were prioritized. This criterion also considered the mode of spread (e.g., via wind, animals, or human activity) and the species' preferred habitats for invasion.
- Equilibrium Status: The extent to which the species has already established itself within the ecosystem.

Each species was assessed against these criteria using literature records, prior spatial data, and local expert input. Species meeting at least three of the four criteria were retained for mapping, while those with restricted occurrence, insufficient field data, or low management relevance were excluded.

This structured approach ensured the analysis focused on species that pose the most significant ecological threats, resulting in a final selection of 12 priority invasive alien plant species, which together account for the majority of the island's invaded areas. The selected species are listed in Table 2. This transparent filtering approach ensured that the selected species represented both ecological significance and management urgency within the context of Rodrigues' degraded landscapes.

Table 2. Details of the selected invasive alien species for Rodrigues.

SN	Scientific Name	Common Name	Occurrence Region
1	*Albizia lebbeck*	Siris	Mourouk Valley, Golden Bat Reserve
2	*Samanea saman*	Monkey Pod Tree	Mourouk Valley, Golden Bat Reserve, Cascade St Louis
3	*Eucalyptus* spp.	*Eucalyptus*	Cascade Pigeon, Golden Bat Reserve, Mourouk Valley
4	*Furcraea foetida*	Aloès	Cascade Pigeon, Golden Bat Reserve, Mourouk Valley
5	*Tabebuia pallida*	Tecoma	Cascade Pigeon, Cascade St Louis, Golden Bat Reserve, Mourouk Valley
6	*Litsea sebifera*	Bolly beech	Golden Bat Reserve, Mourouk Valley, Cascade St Louis
7	*Leucaena leucocephala*	Acacia	Mourouk Valley, Cascade St Louis
8	*Ravenala madagascariensis*	Ravenale	Cascade Pigeon
9	*Rubus rosifolius*	Framboise	Cascade Pigeon
10	*Syzygium jambos*	Jamrosa	Cascade Pigeon
11	*Vachellia nilotica*	Prickly Acacia	Cascade Pigeon, Cascade St Louis, Golden Bat Reserve
12	*Millettia pinnata*	Pongame	Golden Bat Reserve, Mourouk Valley, Cascade St Louis

2.4. Field Surveys

The sites were surveyed from 21 to 25 October 2024 and GPS coordinates of each species were collected in the field with the mobile application GPS Waypoints Version 3.13 by Blue Cover Technologies. GPS coordinates were recorded at an accuracy level between 2.5 and 3 m. Data collection was conducted along line transects, which followed tracks used to access the different sites. However, due to the inaccessibility of most of the areas, it was challenging to capture the necessary GPS points on the ground. To overcome this, a DJI FC3682 drone (Da-Jiang Innovations, Shenzhen, China) was deployed to survey valleys and mountain flanks. The drone operated with a focal length of 6.7 mm, a resolution of 9 megapixels, and a field of view of 73.7 degrees. Flights were conducted at an average altitude of approximately 330 m above sea level, with varying distances above ground at the different sites based on local topography (Figure 2). By capturing geotagged images, the drone ensured precise geospatial data for mapping.

However, adverse weather conditions during the mission limited flight opportunities and reduced the number of images captured, leading to incomplete spatial coverage in certain areas. Given the tight field schedule and logistical challenges of rescheduling, the survey was completed within the available timeframe. These practical limitations highlight the inherent difficulties of conducting systematic spatial sampling in rugged island environments, where steep slopes, dense vegetation, and unpredictable weather can constrain data completeness despite careful planning [25,26].



Figure 2. (**a**) Drone operation during field mapping at Mourouk Valley. (**b**) Participatory mapping with Rodrigues forestry officers. (**c**,**d**) Training of field officers in GPS and GIS mapping for IAS data collection. (Images Source: R.S (main author) and Sameer Kaudeer).

The software ExifTool version 13.11 was utilized to extract metadata from the drone images, including GPS coordinates. The software was operated through its command-line interface, allowing for efficient extraction and processing of metadata from multiple images simultaneously. This approach streamlined the workflow and ensured the accurate capture of geospatial information for subsequent analysis. All collected GPS coordinates were compiled and organized into a database and exported as KML files to ArcMap Desktop (ESRI, Redlands, Redlands, CA, USA, version 10.6.1.) for spatial analysis.

2.5. Participatory GIS Mapping

Participatory GIS mapping sessions were organized with key conservation officers to integrate local knowledge into the spatial analysis process. These sessions provided a platform for stakeholders to share their insights on species distribution and habitat conditions in the landscape, thereby enriching the accuracy and relevance of the mapping outputs.

Google Earth Pro was used as the base map for the assessment. The imagery used corresponds to airbus satellite images acquired in 2023 and 2024 with a spatial resolution of approximately 0.5 m. The images were examined at a standard viewing altitude of 100–300 m to enable accurate identification of plant species and landscape features during participatory mapping sessions. Observed data collected during fieldwork and drone surveys were also presented to stakeholders for validation, allowing for the identification of discrepancies and adjustments to ensure alignment with on-ground realities. By incorporating stakeholder contributions, the participatory GIS mapping approach not only enhanced the precision of the maps but also fostered a sense of ownership and collaboration

among participants, ensuring the practical applicability of the results for invasive alien species management.

Figure 2a illustrates drone operation for capturing invasive alien plant species at Mourouk Valley, Figure 2b participatory mapping exercises with Rodrigues forestry officers, Figure 2c,d the training sessions with relevant stakeholders on the use of GIS to collect species presence points during field visits for future monitoring.

2.6. Data Analysis

To ensure the validity and accuracy of the collected data, all GPS points obtained from field surveys and drone imagery were systematically overlaid onto Google Earth Pro for verification. This process allowed for a visual inspection of point locations to confirm their alignment with the designated study sites. Data cleaning was conducted to remove erroneous or misclassified points, including those that fell outside the study boundaries, were inaccurately georeferenced, or resulted from technical issues such as GPS drift and network errors. Points that were improperly recorded due to mobile application malfunctions or drone positioning inaccuracies were excluded. Additionally, duplicate points and outliers were identified and filtered to enhance dataset reliability. This validation process ensured that only high-quality, accurately georeferenced data were retained for subsequent spatial analysis, thereby improving the precision of species distribution mapping and ecological assessments.

ArcGIS version 10.6 was used to process the spatial data and generate detailed species distribution maps. All collected GPS points (field surveys, drone images) were overlaid onto the OpenStreet base map, and shapefiles were created with attributes 'species scientific names', 'common names', 'latitude', 'longitude', and 'location descriptions'. The final shapefiles were developed to spatially represent the distribution of invasive alien species, enabling detailed mapping and analysis for informed decision-making. Then, the Inverse Distance Weighting (IDW) method was applied to estimate species presence at the selected sites. This interpolation technique assumes that points closer to the observed data carry more weight in influencing the estimated values compared to points farther away. The method was used where the number of observed points was two or more. A radius of 500 m around each observed GPS point was applied to calculate the likelihood of species presence and a power of 2 was set, which is the common default mode in IDW and reflects a reasonable spatial decay, thereby emphasizing nearby observations, with weights decreasing with the square of distance. The IDW method effectively filled gaps in the dataset by generating a continuous surface that predicted the potential spread of species into unsampled areas, offering valuable insights into their likely distribution across the landscape. Species distribution maps were developed by overlaying species zones identified through participatory mapping and the IDW interpolation method. To enhance accuracy and contextual understanding, additional features such as rivers, reservoirs, roads, tracks, and houses were incorporated into the maps. To produce the final IAS distribution maps, it was deemed necessary to group several species into a single category to improve map readability and reflect ecological realities observed in the field. In areas where multiple invasive or native species co-occurred within the same spatial extent—often in transitional or mixed vegetation zones—it was not possible to accurately delineate each species at the mapping scale used. Grouping these overlapping species into composite categories (e.g., *Eucalyptus*/Mixed Native Species) therefore ensured cartographic clarity while still representing the dominant vegetation structure. This approach acknowledges the ecological overlap that occurs in restoration or disturbed areas where species distributions are intermingled.

The degree of error was also estimated using a proportional scaling method, where the GPS accuracy range of ±2.5 to 3 m was used as a reference. The spatial error in meters was calculated by scaling the mean IDW values to the known precision range, assuming a linear relationship between these values and GPS errors. To achieve this, a scaling factor was applied, where the estimated error was determined using the following formula:

$$\text{Estimated Error (m)} = \text{Mean IDW Value} \times \text{Scaling Factor}$$

The scaling factor was adjusted based on the known GPS error, typically 3 m per 0.001 deviation. This approach allowed for a consistent estimation of spatial errors, ensuring that variations in IDW values were proportionally translated into real-world positional inaccuracies.

The accuracy of the maps was assessed using the Root Mean Square Error (RMSE). RMSE measures the difference between the predicted values from the interpolation and the actual observed GPS points of species collected during field surveys. This was performed by selecting a set of validation points, comparing their real-world recorded values with the estimated values from the IDW model, and calculating the RMSE value.

A lower RMSE value indicated a higher level of accuracy, ensuring that the interpolated maps closely reflected real-world species distributions. This method provided a quantitative measure of map reliability and helped refine the spatial analysis by adjusting interpolation parameters where necessary.

3. Results

From Table 3 it can be observed that 231 occurrence points were collected at Mourouk Valley, 39 points at Cascade Pigeon, 47 points at Cascade St Louis, and 198 points at the Golden Bat Reserve. A total of 515 data points were thus collected across the four sites in Rodrigues as shown in Table 4.

Table 3. Number of presence points of species collected at each site.

Mourouk Valley	Cascade Pigeon	Cascade St Louis	Golden Bat Reserve
231	39	47	198

The number of points collected for the 12 species at the different locations are listed below:

Table 4. Number of points collected per species based on different methodologies.

Species	Method	
	Mobile Application	Drone
Albizia lebbeck	06	06
Samanea saman	02	06
Eucalyptus spp.	04	05
Furcraea foetida	18	82
Tabebuia pallida	27	101
Litsea sebifera	07	79
Leucaena leucocephala	07	35
Ravenala madagascariensis	04	-

Table 4. *Cont.*

Species	Method	
	Mobile Application	**Drone**
Rubus rosifolius	02	-
Syzygium jambos	03	-
Vachellia nilotica	07	25
Millettia pinnata	12	77

3.1. Species Distribution Maps

Species distribution maps for all species at the respective sites were produced as shown in Figures 3 and 4. Estimated IAS presence intensity refers to the relative abundance or density of IAS at a particular site based on where the species was observed. Red in the color scheme of the legend refers to where the species was most observed, while yellow areas had fewer observations. It is worth noting that intensity here is not a measure of count but rather an interpolated estimation.

At Cascade Pigeon, based on Figure 3, it can be seen that *Furcraea* shows a high density in the north-central area. *Ravenala* looks widespread, with a higher density in the southern tip, but the overall intensity is low. Similarly, *Syzygium* is mostly concentrated in the south of the site. *Tabebuia* seems to have a moderate distribution site-wise and a slightly higher intensity in the south. The results reflect the sampling methodology, which was focused on the eastern and southern regions of the site due to better accessibility.

As for Mourouk Valley, *Albizia* seems to be concentrated in the central region of the site. *Furcraea*, *Millettia*, and *Tabebuia* dominate the northeastern area of the valley. *Leucaena* shows a strong central presence, as does *Litsea*, though it is less widespread. *Samanea* is also most intense in the center and less distributed towards the sides of the valley.

Due to the low number of presence points collected at Cascade St Louis, the model was run for only two species. Based on the maps, it can be noted that *Tabebuia* is fairly widespread with a higher intensity in the north and lower density southwards. *Vachellia* also dominates the site with a stronger presence in the northeast region.

As for Golden Bat Reserve, *Eucalyptus* has a high concentration at the center and spreads outwards. *Furcraea* is mainly found in the north-central region. *Litsea* and *Millettia* show patchy presence in the north of the site. *Samanea* is fairly evenly distributed across the landscape but more concentrated in the center. *Tabebuia* has a generally low intensity and peaks in the north. As for *Vachellia*, it is centered towards the northeast.

3.2. Model Accuracy

Spatial interpolation using IDW revealed distinct patterns in the spatial distribution of invasive alien plant species across the four study sites. The mean IDW values (Table 5) varied between locations, reflecting differences in IAS density and spatial clustering. Positive values correspond to areas with high concentrations of invasive plants, while lower or near-zero values denoted sparsely invaded or transitional zones. These results suggest that species aggregation is closely linked to past disturbance regimes, soil exposure and vegetation structure. Overall, the pattern indicates that IAS distribution on Rodrigues is shaped by both ecological gradients and anthropogenic pressures, particularly in areas previously subjected to agricultural activities or grazing. While the IDW method provided a robust estimation of species distribution, minor deviations in areas with sparse data suggest opportunities for further refinement and validation.

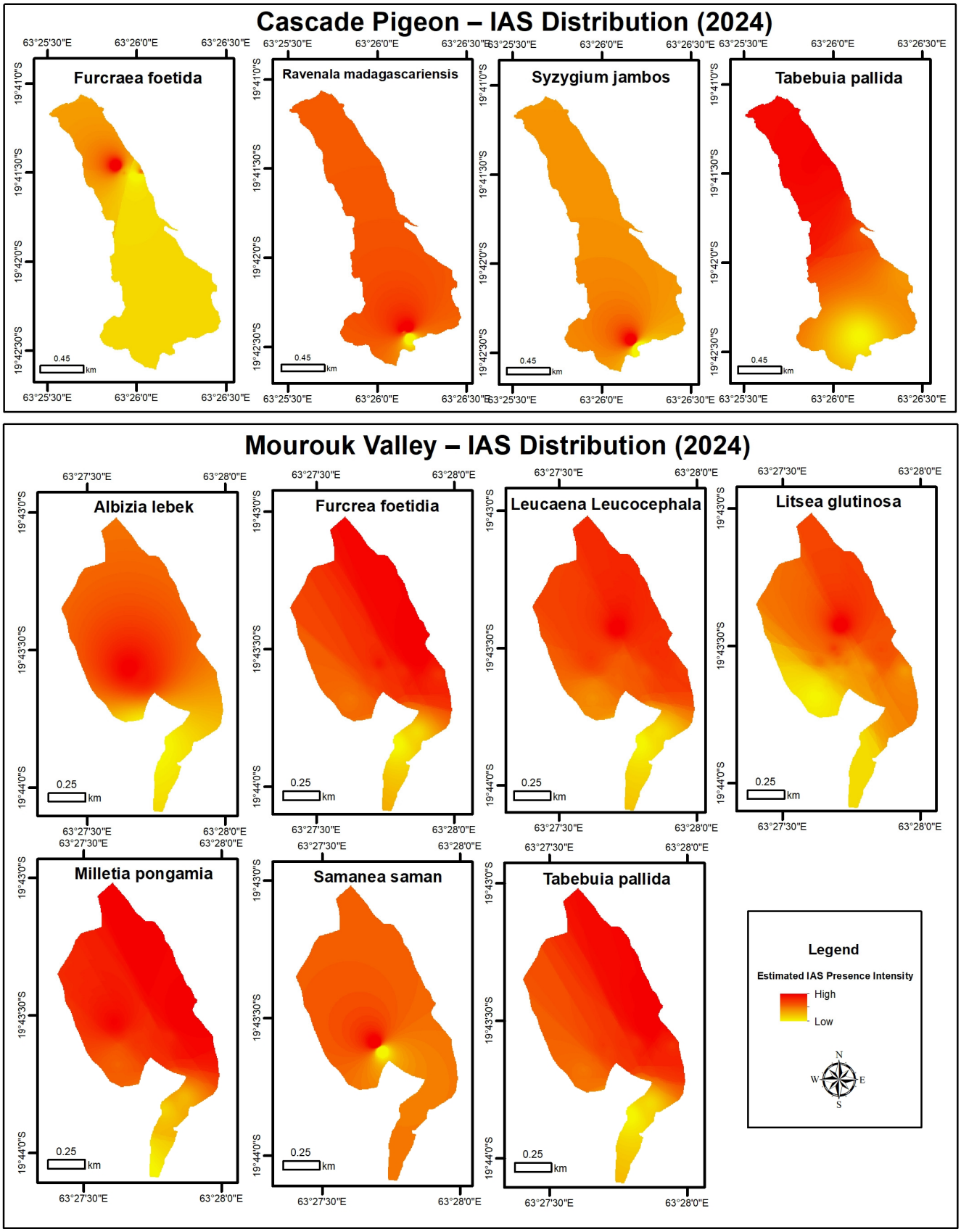


Figure 3. IAS distribution maps at Cascade Pigeon and Mourouk Valley based on observed field data and IDW approach using ArcGIS.

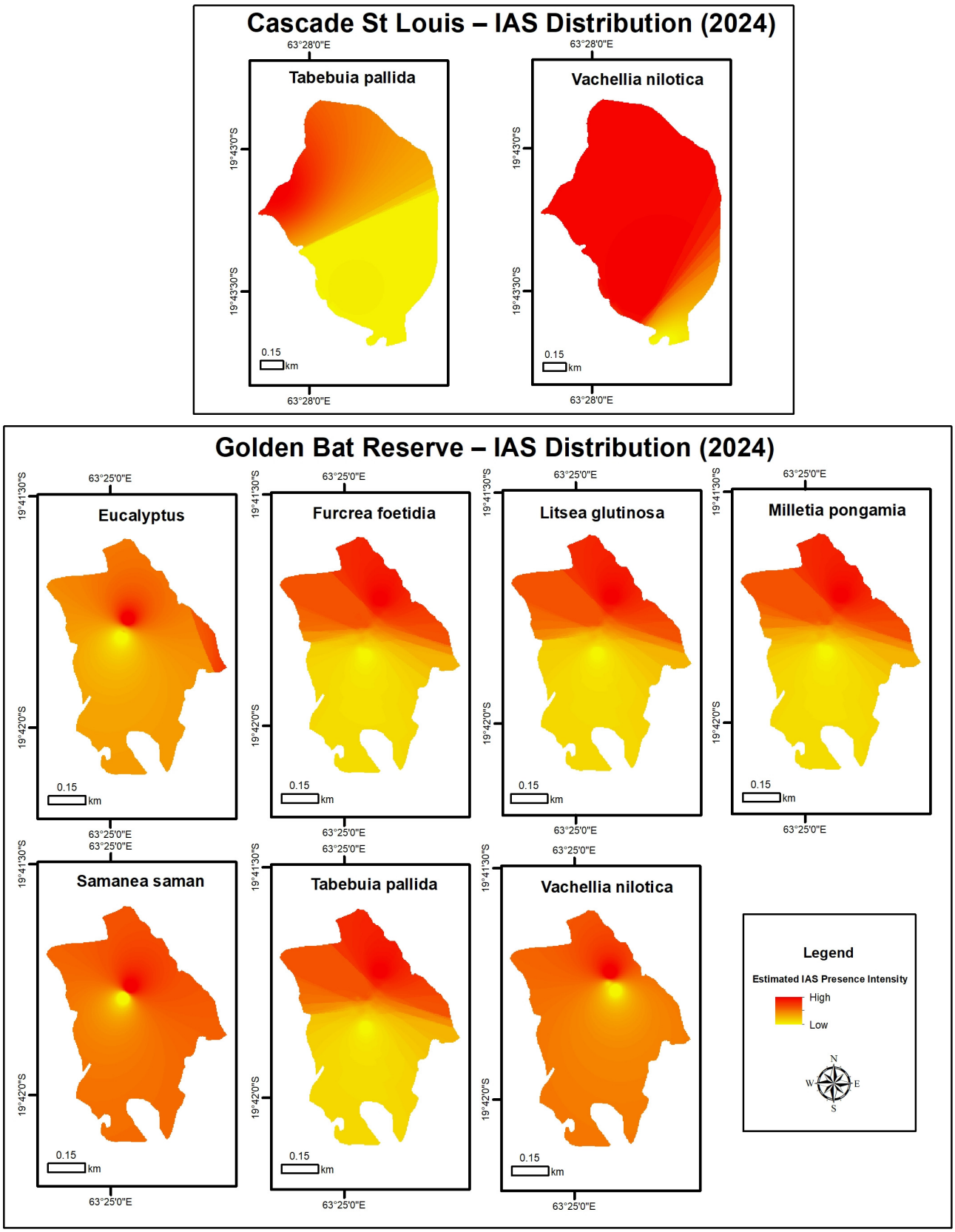


Figure 4. IAS distribution maps at Cascade St Louis and Golden Bat Reserve based on observed field data and IDW approach using ArcGIS.

Table 5. Mean values of the IDW interpolation method per species and site.

Species	Mourouk Valley	Cascade Pigeon	Cascade St Louis	Golden Bat Reserve
Albizia lebbeck	1.55×10^{-9}	-	-	-
Samanea saman	0.01	-	-	4.90
Eucalyptus spp.	-	-	-	−0.01
Furcraea foetida	-6.06×10^{-5}	0.01	-	-1.23×10^{-5}
Tabebuia pallida	-5.74×10^{-5}	-6.15×10^{-5}	-9.72×10^{-6}	-1.52×10^{-5}
Litsea sebifera	5.23×10^{-7}	-	-	-1.82×10^{-5}
Leucaena leucocephala	-7.83×10^{-5}	-	-	
Ravenala madagascariensis	-	−0.01	-	-
Rubus rosifolius	-	-	-	-
Syzygium jambos	-	4.56×10^{-5}	-	-
Vachellia nilotica	-	-	-2.24×10^{-5}	-3.39×10^{-5}
Millettia pinnata	-8.03×10^{-5}	-	-	-1.04×10^{-5}

The estimated error analysis for species distribution mapping across Mourouk Valley, Cascade Pigeon, Cascade St Louis, and Golden Bat Reserve using the IDW interpolation method reveals generally high spatial accuracy, with most species exhibiting errors below 0.5 m (Table 6). Mourouk Valley and Cascade St Louis recorded the lowest mean errors ($\leq$0.3 m), indicating strong agreement between the interpolated and observed GPS data. The Golden Bat Reserve also demonstrated reliable IDW estimates ($\leq$0.1 m), although isolated species such as *Eucalyptus* showed higher deviations (12.72 m) due to limited sampling points and uneven distribution. Cascade Pigeon displayed moderate deviations ($\leq$0.5 m), suggesting that additional ground-truthing could further improve precision.

Table 6. Estimated error in meters based on the mean IDW values per species and site.

Species	Mourouk Valley	Cascade Pigeon	Cascade St Louis	Golden Bat Reserve
Albizia lebbeck	0.000005 m (~0 mm)	-	-	-
Samanea saman	26.61 m	-	-	0.15 m (~15 cm)
Eucalyptus spp.	-	-	-	12.72 m
Furcraea foetida	0.18 m (~18 cm)	0.31 m (~31 cm)	-	0.037 m (~4 cm)
Tabebuia pallida	0.17 m (~17 cm)	0.18 m (~18 cm)	0.029 m (~3 cm)	0.045 m (~5 cm)
Litsea sebifera	0.00157 m (~1.6 mm)	-	-	0.054 m (~5 cm)
Leucaena leucocephala	0.23 m (23 cm)	-	-	
Ravenala madagascariensis	-	0.39 m (~39 cm)	-	-
Rubus rosifolius	-	-	-	-
Syzygium jambos	-	0.14 m (~14 cm)	-	-
Vachellia nilotica	-	-	0.067 m (~7 cm)	0.102 m (~10 cm)
Millettia pinnata	0.24 m (~24 cm)	-	-	0.031 m (~3 cm)

The analysis of the RMSE for the IDW interpolation method demonstrated high predictive accuracy in estimating species distribution across study sites (Table 7). Most RMSE

values were extremely low, confirming that the interpolated values closely matched the observed data. Higher accuracy was achieved in well-sampled areas, while species with fewer occurrence points showed slightly higher errors due to uneven data distribution. For example, *Albizia* recorded minimal RMSE values, indicating excellent interpolation precision, whereas species with higher RMSE values reflected localized uncertainties associated with limited sampling. Overall, the results confirm that the IDW interpolation approach provided reliable and robust spatial predictions for invasive alien plant species mapping, though denser sampling would further enhance model accuracy.

Table 7. Root Mean Square Error values for the interpolation in per species and site.

Species	Mourouk Valley	Cascade Pigeon	Cascade St Louis	Golden Bat Reserve
Albizia lebbeck	3.89×10^{-7}	-	-	-
Samanea saman	0.02	-	-	8.49×10^{-5}
Eucalyptus spp.	-	-	-	0.01
Furcraea foetida	0.01	0.01	-	6.73×10^{-5}
Tabebuia pallida	0.01	0.01	6.28×10^{-5}	6.46×10^{-5}
Litsea sebifera	0.01	-	-	6.2×10^{-5}
Leucaena leucocephala	0.01	-	-	-
Ravenala madagascariensis	-	0.01	-	-
Rubus rosifolius	-	-	-	-
Syzygium jambos	-	0.01	-	-
Vachellia nilotica	-	-	0.01	8.33×10^{-5}
Millettia pinnata	0.01	-		6.77×10^{-5}

3.3. Final IAS Distribution Maps

Once stakeholder input was incorporated, the maps were finalized as shown below.

From Figure 5, it is observed that *Ravenala* and *Syzygium* dominate the southern half of Cascade Pigeon. *Furcraea* and *Tabebuia* are scattered in the central northern region, while *Rubus* and *Vachellia* have a localized presence. *Eucalyptus* dominates the western and northern part of the site.

At Mourouk Valley (Figure 6), the valley is dominated by a mix of *Millettia*, *Tabebuia*, *Litsea*, *Leucaena*, and *Furcraea*. *Albizia* and *Samanea* patches occur in localized regions. The outer tip of the valley is mainly dominated by *Leucaena* and *Litsea*.

At Cascade St Louis (Figure 7), *Vachellia* dominates the central west region while *Leucaena*, *Millettia*, and *Litsea* appear to be widespread within the valley and on the eastern sides. *Tabebuia* and *Samanea*'s presence are more localized in the western and central regions, respectively.

The dominant IAS at Golden Bat Reserve (Figure 8) are *Millettia*, *Furcraea, and Vachellia* which are located within and on the eastern outskirts of the valley. *Eucalyptus* is found in the northwest and in scattered patches.

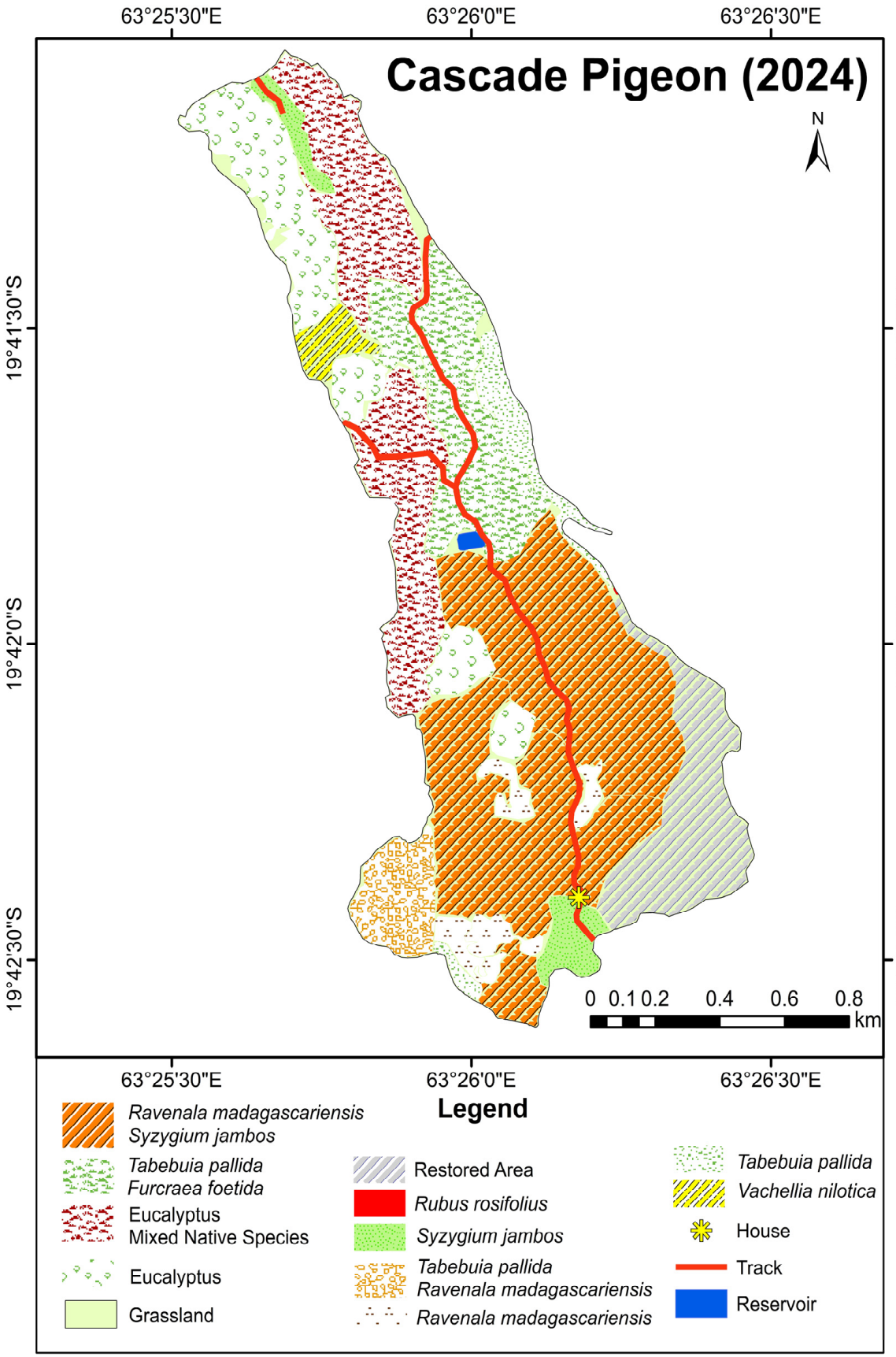


Figure 5. Species distribution map of IAS at Cascade Pigeon produced through IDW interpolation and participatory GIS.

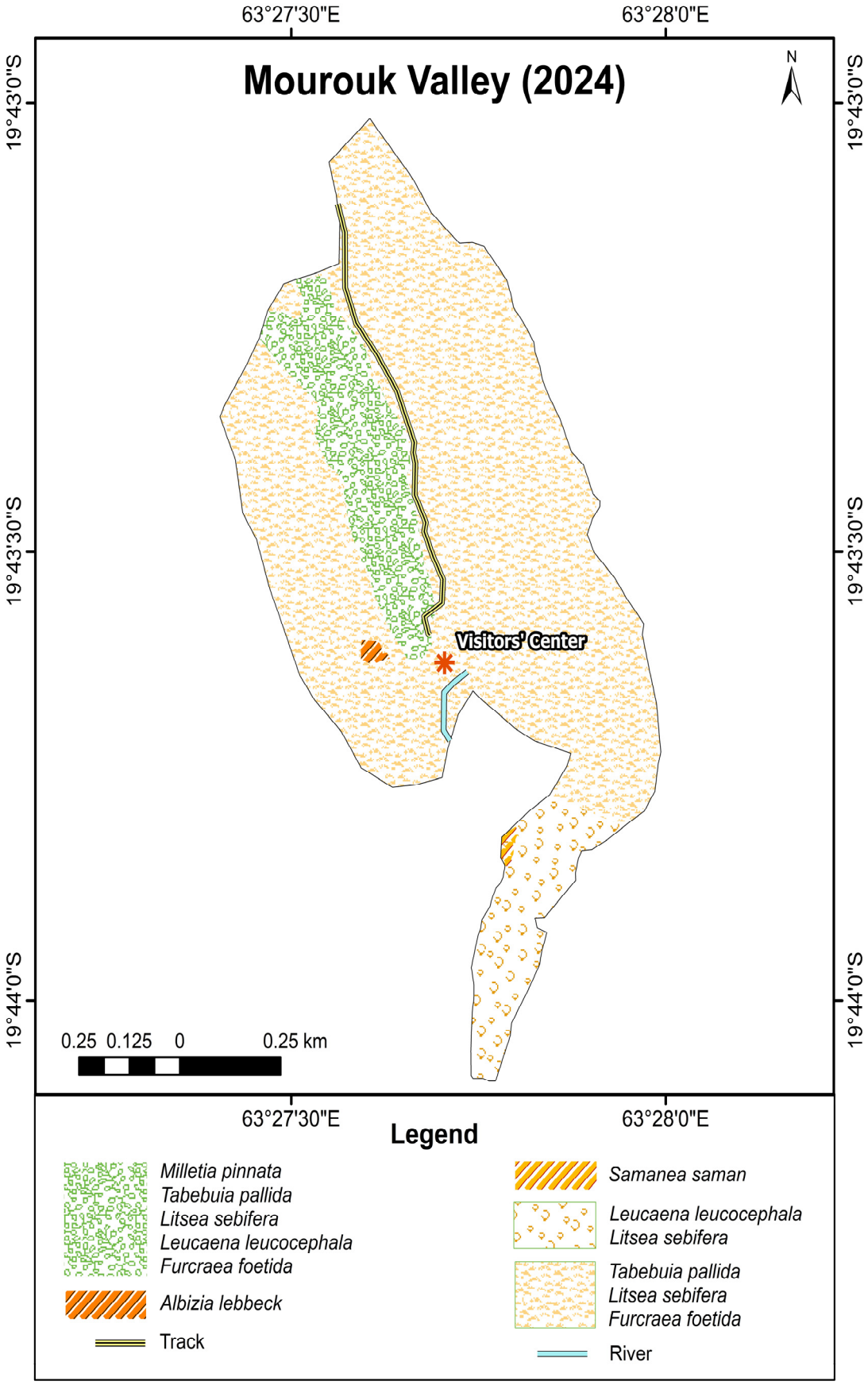


Figure 6. Species distribution map of IAS at Mourouk Valley produced through IDW interpolation and participatory GIS.

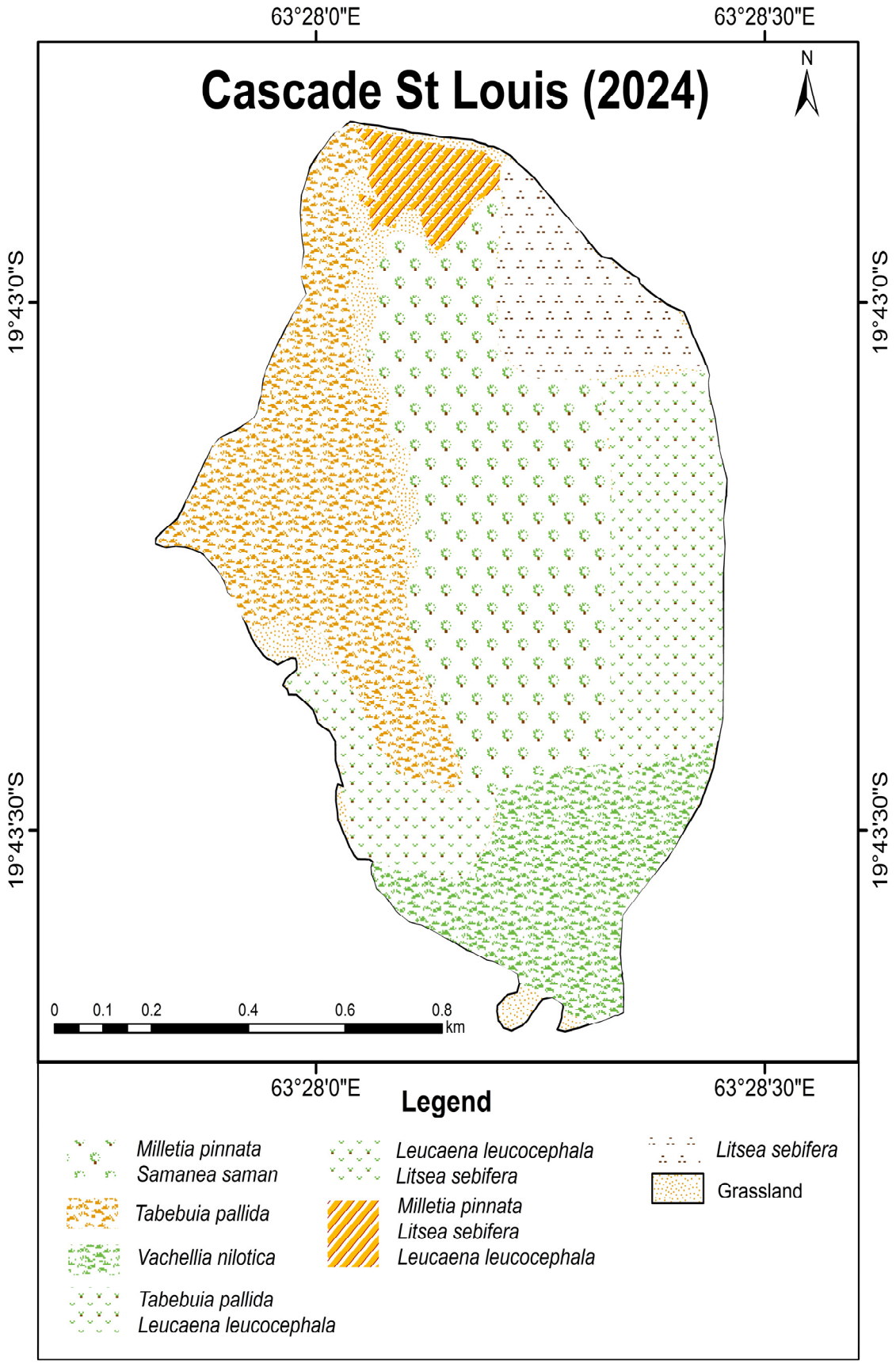


Figure 7. Species distribution map of IAS at Cascade St Louis produced through IDW interpolation and participatory GIS.

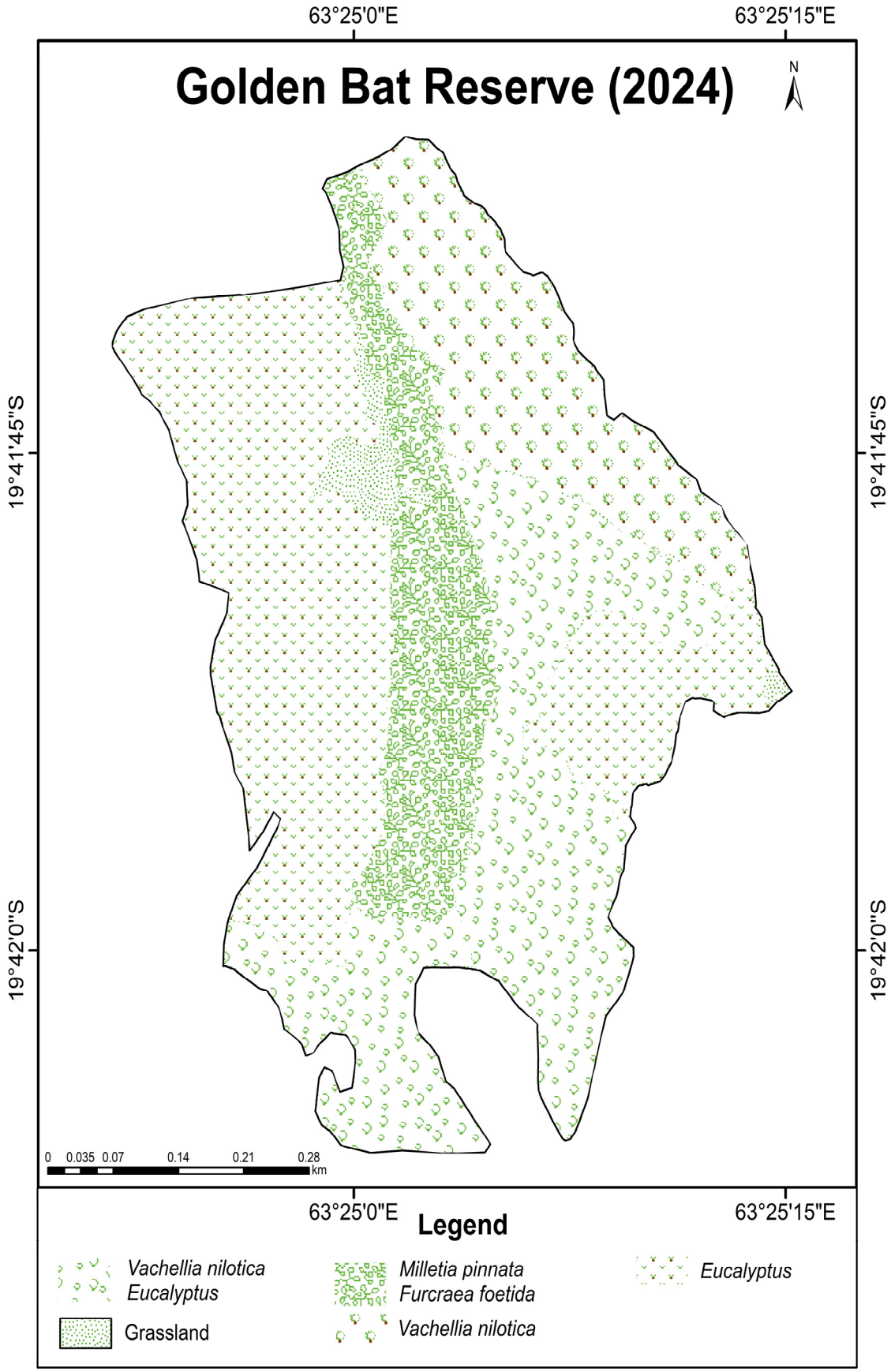


Figure 8. Species distribution map of IAS at Golden Bat Reserve produced through IDW interpolation and participatory GIS.

4. Discussion

4.1. Spatial Distribution Patterns of IAS at the Four Sites of Rodrigues Island

The present findings show clear spatial clustering of IAS across the four study sites of Rodrigues Island. It can be seen that the presence of IAS is especially pronounced in disturbed or secondary habitats like degraded slopes, road verges and scrublands—as represented by all the sites—which today dominate much of the island as a result of anthropogenic pressure [24]. In fact, Rodrigues' environment—which is characterized by a dry sub-humid to semi-arid climate, intensive land clearing, and a fragmented native forest system isolated into ridge crests and micro-reserves—provides little resistance to invading species [19,23]. Species such as *Tabebuia* or *Samanea*, introduced as ornamental plants and for agroforestry purposes, have been able to colonize adjacent landscapes outside of their predetermined range, while nitrogen-fixing species such as *Leucaena*, *Vachellia*, and *Albizia* have a competitive advantage on surrounding species through their capability to alter soil nutrient dynamics [27,28].

Of the twelve species mapped, *Tabebuia* and *Furcraea* were the most widespread, occurring intensely in Cascade Pigeon and Mourouk Valley. As these sites are characterized by open scrubland with past agricultural use and disturbed forest edges, they provide ideal conditions for IAS spread. The spatial dominance of *Furcraea* in Mourouk Valley especially corresponds to zones with thin, eroded soils and livestock grazing activities which provide perfect ground for this drought-resistant species to spread, particularly with its ability to reproduce by vegetative propagation [29]. Likewise, the spread of *Leucaena* and *Albizia* at Mourouk Valley and Cascade St Louis support the pattern of altered soil chemistry as mentioned above. The central region of Golden Bat Reserve also showed multiple invasions by *Leucaena*, *Millettia*, and *Samanea*, reflecting the long-term disturbance history of the zone, especially since it is a bat roosting site where bats could have played a significant role in seed dispersal [30]. At Cascade St Louis, *Vachellia* dominated the southern part and *Litsea* the degraded plateaus, suggesting that past human activities could have facilitated the establishment of these species in disturbed zones. In contrast, species like *Albizia* and *Samanea* occurred in patches in Mourouk Valley, suggesting limited dispersal capacity or more recent introductions. *Eucalyptus* species, introduced for timber and erosion control, now dominate Golden Bat Reserve and the northern region of Cascade Pigeon, raising ecological concerns due to the species' allelopathic properties and ability to suppress understory vegetation [31]. *Ravenala* and *Syzygium*, observed mainly at Cascade Pigeon, form dense thickets that possibly suppress native regeneration in these disturbed regions [32]. Additionally, species like *Syzygium* that produce fleshy fruits can attract animals that facilitate seed dispersion. *Rubus* was found in an isolated patch at Cascade Pigeon along road tracks and erosion-prone slopes, which suggests its preference for disturbed microhabitats, but when established, it can be very problematic to control. Collectively, the twelve species mapped illustrate how historical introductions such as *Eucalyptus* and naturalized species like *Syzygium* exploit different ecological niches resulting in the observed invasion dynamics in Rodrigues. To be sure, the IAS patterns observed in this study align with other oceanic island ecosystems where IAS establish in ecotonal zones [33], thereby reflecting both ecological suitability and historical land use at each of the studied sites.

4.2. Model Reliability and Participatory GIS Mapping

The accuracy and reliability of the IAS spatial distribution patterns observed in the present study were notably shaped by the amount of GPS data collected, underscoring the influence of sampling bias on interpolation outputs. For instance, in Cascade Pigeon, higher sampling in the southern region due to accessibility constraints resulted in higher

IAS presence intensity estimates through the IDW interpolation method. While the IDW methodology is useful, it is also sensitive to spatial sampling bias, with under-sampled regions such as the north of Cascade Pigeon appearing as low-intensity zones irrespective of actual species presence [12,33]. Therefore, to check the reliability of the species distribution model, accuracy metrics, including mean values, estimated spatial error, and RMSE, were calculated. The mean IDW values at the four sites (Cascade Pigeon, Cascade St Louis, Mourouk Valley, Golden Bat Reserve) were very small (± 0.0001) indicating a strong agreement between the interpolated surfaces of the model and actual presence points. For example, the value for *Litsea* was near-zero indicating precise likely distribution. The minor negative values, such as those for *Millettia*, indicate slight underestimations, possibly due to sparse data. Slightly positive deviations as for *Syzygium* reflect moderate overestimation, likely arising from denser sampling. Similarly, the estimated error in meters was low at all the sites for most species, reflecting the high spatial accuracy, in particular at Cascade St Louis, where all errors were under 0.1 m for almost all species. In Mourouk Valley, errors for *Furcraea* and *Leucaena* ranged between 0.01 and 0.3 m, indicating minimal spatial deviation from actual collected data. Conversely, *Samanea* had a value of 26.61 m, directly reflecting sparse data due to accessibility reasons, a case which is also noted for *Eucalyptus* (value of 12.72 m) in the Golden Bat Reserve because of clustered occurrences, thus affecting local predictions. To further validate these findings, the RMSE values were very low (close to and less than 0.01) at the four sites for most species. For instance, *Albizia* had an RMSE value of 3.89×10^{-7} in Mourouk Valley, confirming the reliability of the model. Again, *Samanea* and *Eucalyptus* had higher RMSE values, corroborating earlier observations. These results indicate the robustness of the IDW approach, particularly in well-sampled areas, while also indicating the need for even data collection to avoid under- and over-estimations of species distributions [12].

Participatory GIS mapping was therefore a key tool to produce accurate IAS spatial distribution maps at the four sites based on both field observations and stakeholder knowledge, as already shown in the literature, e.g., [18,34,35]. These PGIS maps offered finer contextual understanding of species distribution, as seen in Mourouk Valley, where the mapped distribution of *Millettia*, *Leucaena*, and *Litsea* showed co-occurrence patterns and land use histories in overlapping regions, which were previously used for agriculture and later abandoned, reflecting how historical land use continues to affect current invasion dynamics. Interestingly, at Cascade Pigeon, PGIS revealed distinct patches of *Ravenala* and *Syzygium* near former human infrastructure, details which were not captured in the IDW maps alone. At Golden Bat Reserve, IDW outputs showed high-intensity zones for *Samanea* and *Furcraea*, but the PGIS map highlighted their spatial overlap with grassland zones and bat roosting sites, thereby illustrating the value of overlaying PGIS and IDW results. At Cascade St Louis, the patterns of IDW interpolation were consistent with PGIS mapping for *Tabebuia* and *Vachellia*, aligning with zones of concentrated field sampling and visible invasion fronts. PGIS was critical for mapping IAS spatial distribution at Cascade St Louis, since field surveys were limited due to the steep terrain and drone surveys could not be covered, resulting in the capturing of few GPS species presence points. Local stakeholder knowledge was of prime importance to identify invasion hotspots and historical land use patterns that would have been overlooked in the IDW model. Local forestry officers and conservation workers contributed significant site-specific knowledge based on their long-term observations and familiarity with the landscapes. Given the challenging accessibility of the studied sites, which consist mainly of steep terrain and rugged valleys with dense vegetation, thereby restraining systematic surveys, together with the lack of data on IAS spatial distribution, the PGIS approach was especially valuable to map invasion patterns [13]. Such input helped delineate discrete IAS zones with a level of spatial accuracy

that would have been difficult to achieve with point-based sampling or even remote sensing techniques alone. By integrating the local ecological knowledge with geospatial tools, PGIS improved the accuracy of the IAS distribution maps in Rodrigues while at the same time fostering stakeholder ownership and support for management interventions [14]. This type of hybrid approach aligns with current best practices in IAS monitoring, especially for island ecosystems, where data availability, field access, and ecological complexity pose significant challenges [30,36].

4.3. Enhancing IAS Management on Rodrigues Island Using PGIS Mapping

The PGIS maps thus produced in the present study highlight the ongoing degradation of the sparse native vegetation on Rodrigues Island and the pressing need for site-specific management interventions, especially in ecologically sensitive sites like Mourouk Valley and Golden Bat Reserve. The combined effects of high-impact species like *Leucaena*, *Millettia*, and *Furcraea*, which can significantly change soil dynamics, reduce native regeneration, and disrupt trophic levels, is particularly alarming [37]. The functional traits of these species, such as their nitrogen-fixing ability (*Leucaena*) and vegetative propagation (*Furcraea*), allow them to rapidly invade disturbed landscapes, resulting in ecological shifts.

The inner valley of Mourouk, where these species co-exist, reveals invasion hotspots necessitating immediate containment and restoration. In contrast, grassland patches at Cascade St Louis and Golden Bat Reserve showed lower IAS invasion, suggesting their potential as buffer zones. As it is, the reserves on Rodrigues are very small and embedded within a landscape that is already highly invaded, making them vulnerable to continual pressure from surrounding IAS-dominated habitats. Right now, the proportion of land area under formal protection in Rodrigues is far below international targets and even within these protected areas, invasive species largely dominate the landscapes, thus limiting conservation value and ecological integrity. It is therefore imperative to move beyond managing isolated reserves and adopt a more integrated landscape approach, such as vegetation mapping in adjacent environments, for more informed planning of long-term buffer zone management and for identifying more areas for potential reserve expansion. Reinforcing buffer zones with native species, creating firebreaks, or excluding IAS vectors could potentially help maintain biodiversity reservoirs and prevent the spread of IAS from adjacent disturbed zones [38].

Nonetheless, as pointed out by Zhang et al. [39], shifting invasion trajectories and changing niche dynamics could render these grasslands vulnerable in the future, thereby requiring adaptive management strategies. The study's spatial outputs also reveal that high IAS intensity zones often correspond with human infrastructure such as tracks, houses, and degraded slopes, as seen at Cascade Pigeon and Mourouk Valley, highlighting the role of anthropogenic corridors in aiding in propagule dispersal.

The results of this study highlight the urgent need to tackle IAS in Rodrigues, especially in eco-sensitive regions like Cascade Pigeon, Cascade St Louis, Mourouk Valley, and Golden Bat Reserve. Several critical hotspots where species such as *Leucaena*, *Furcraea*, and *Millettia* co-occur have been identified, often in previously degraded and abandoned pastoral land, requiring intensive management such as mechanical removal, ecological restoration with native species, or even biocontrol trials [40]. Very importantly, to maintain the ecological integrity of non-invaded sites like grasslands, management interventions should focus on preventing IAS invasion by implementing early detection and rapid response systems. Since invasion patterns in Rodrigues are strongly influenced by past land uses, management actions must be site-specific and tailored to the local context [41,42]. For example, in Cascade Pigeon, species like *Syzygium* were closely associated with homestead zones, suggesting the need for tailored outreach and more robust invasive plant removal programs,

which are currently being undertaken in the zone. In Cascade St Louis, stakeholder engagement was key in producing the highly accurate PGIS maps, underscoring the value of stakeholder input in designing effective IAS interventions. As continued collaboration with the forestry staff will be essential for long-term IAS management in Rodrigues, a workshop on GIS mapping of IAS was organized on the 27 October 2024 to train staff on the use of the mobile application GPS Waypoints to collect data on ground. The training also included procedures for data storage, transferring to Google Earth for spatial visualization and saving GPS points for updating future maps. The initiative aimed to build local capacity to ensure the continued monitoring and management of IAS in Rodrigues.

4.4. Limitations and Recommendations

While the study provides valuable insights, some limitations must be acknowledged. Firstly, given time constraints, GPS presence points were not evenly collected due to the inaccessibility of most of the sites; the accuracy of the IDW outputs could have thus been influenced. As a result, regions with sparse data could have produced predictions with lower confidence, potentially underestimating species presence. It is therefore recommended to conduct systematic surveys in all regions, including hard-to-access areas, over appropriate time-scales to increase the number of samples, which will also improve model accuracy. Secondly, while PGIS enhanced spatial coverage, it remains qualitative and is subject to bias from stakeholders' familiarity with the terrain. Consequently, it is suggested that future studies follow a standardized approach with documentation from stakeholder input (including who provided the input, their level of familiarity with the terrain, the basis of their knowledge) and potential biases through data triangulation with field validation such as GPS ground-truthing and/or complementary quantitative data such as remote sensing products or ecological surveys to enhance the replicability and credibility of participatory mapping. And lastly, because of time and resource constraints, species abundance data could not be included, which would have added depth to the study. To better evaluate ecological impacts and prioritize control activities, it is recommended that future studies integrate species abundance and density data.

Additionally, it is highly recommended that a more integrated landscape approach be adopted to reinforce the resilience of Rodrigues' unique ecosystems, since current reserves are typically small and dominated by invasive species. Mapping adjacent landscapes will help guide long-term buffer zone management and identify opportunities for reserve expansion, thereby creating more effective ecological networks. Such an approach would also be relevant to the nature reserves on mainland Mauritius Island, which face similar ecological pressures and are of similar sizes. Furthermore, the present methodology could also be extended to larger protected areas like the approximately 67 km^2 Black River Gorges National Park (BRGNP) in Mauritius to inform spatial planning within the park itself and surrounding buffer zones. A broader extension of this approach would allow for the proactive, adaptive management of IAS at multiple scales, thereby enhancing conservation outcomes in both Rodrigues and Mauritius.

5. Conclusions

The present study demonstrates the effectiveness of participatory mapping with spatial analysis tools like IDW interpolation to enhance the mapping and monitoring of IAS in remote and data-limited island environments like Rodrigues. By integrating local stakeholder knowledge with field surveys and geospatial modeling, the study produced detailed species distribution maps at Cascade Pigeon, Cascade St Louis, Mourouk Valley, and Golden Bat Reserve in Rodrigues, with each site reflecting site-specific invasion dynamics influenced by ecological disturbance.

The key conclusions are as follows:

1. Integrated Approach Efficiency: The combination of PGIS and spatial interpolation IDW proved effective for mapping IAS in data-scarce island contexts, producing reliable outputs even under limited field conditions.
2. Site-Specific Invasion Patterns: Distinct spatial patterns were identified at each site, with *Leucaena leucocephala*, *Millettia pinnata*, and *Furcrae foetida* emerging as dominant invasive species in ecologically sensitive areas.
3. Buffer-Zone Potential: Grassland zones showed minimal invasion, indicating their potential as natural buffer areas that could be prioritized for ecological restoration.
4. Model Reliability: Low RMSE values and minimal spatial error confirmed the robustness and accuracy of the IDW interpolation for species-distribution estimation.
5. Participatory Validation: The PGIS approach significantly improved map accuracy, particularly in inaccessible terrains such as Cascade St Louis, by incorporating local ecological knowledge.
6. Management Implications: The integration of geospatial tools and participatory mapping offers a replicable, adaptive framework for IAS management in small island states, supporting progress towards Sustainable Development Goal 15—Life on Land.

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Data Availability Statement: GPS coordinates collected and used in the study can be made available upon request. All software utilized in the assessment are detailed in the manuscript.

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References

1. Roy, H.E.; Pauchard, A.; Stoett, P.; Renard Truong, T.; Bacher, S.; Galil, B.S.; Hulme, P.E.; Ikeda, T.; Sankaran, K.V.; McGeoch, M.A.; et al. *Summary for Policymakers of the Thematic Assessment Report on Invasive Alien Species and Their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*; IPBES Secretariat: Bonn, Germany, 2023.
2. IUCN. Invasive Alien Species and Climate Change. Issues Brief. 2025. Available online: https://iucn.org/sites/default/files/2025-03/invasive-alien-species-and-climate-change-feb.-2025-update.pdf (accessed on 10 April 2025).
3. Wittenberg, R. Invasive alien species—A threat to global biodiversity and opportunities to prevent and manage them. In *Western Corn Rootworm: Ecology and Management*; Vidal, S., Kuhlmann, U., Edwards, C.R., Eds.; CAB International: Wallingford, UK, 2005; pp. 1–28.
4. CBD. Convention on Biological Diversity: Invasive Alien Species. 2021. Available online: https://www.cbd.int/ (accessed on 27 January 2025).
5. Côté, I.M.; Smith, N.S. The lionfish *Pterois* sp. invasion: Has the worst-case scenario come to pass? *J. Fish Biol.* **2018**, *92*, 660–689. [CrossRef]

6. Pimentel, D.; Zuniga, R.; Morrison, D. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecol. Econ.* **2005**, *52*, 273–288. [CrossRef]
7. Russell, J.C.; Meyer, J.Y.; Holmes, N.D.; Pagad, S. Invasive alien species on islands: Impacts, distribution, interactions and management. *Environ. Conserv.* **2017**, *44*, 359–370. [CrossRef]
8. Mauchamp, A. Threats from alien plant species in the Galápagos Islands. *Conserv. Biol.* **1997**, *11*, 260–263. Available online: https://www.jstor.org/stable/2387299 (accessed on 10 April 2025). [CrossRef]
9. Li, J.; Heap, A.D. Spatial interpolation methods applied in the environmental sciences: A review. *Environ. Model. Softw.* **2014**, *53*, 173–189. [CrossRef]
10. Phillips, S.J.; Anderson, R.P.; Schapire, R.E. Maximum entropy modeling of species geographic distributions. *Ecol. Model.* **2006**, *190*, 231–259. [CrossRef]
11. Cutler, D.R.; Edwards, T.C.; Beard, K.H.; Cutler, A.; Hess, K.T.; Gibson, J.; Lawler, J.J. Random forests for classification in ecology. *Ecology* **2007**, *88*, 2783–2792. [CrossRef]
12. Elith, J.; Leathwick, J.R. Species distribution models: Ecological explanation and prediction across space and time. *Annu. Rev. Ecol. Evol. Syst.* **2009**, *40*, 677–697. [CrossRef]
13. Chambers, R. Participatory mapping and geographic information systems: Whose map? Who is empowered and who disempowered? Who gains and who loses? *Electron. J. Inf. Syst. Dev. Ctries.* **2006**, *25*, 1–11. [CrossRef]
14. McCall, M.K.; Dunn, C.E. Geo-information tools for participatory spatial planning: Fulfilling the criteria for "good" governance? *Geoforum* **2012**, *43*, 81–94. [CrossRef]
15. Azzurro, E.; Cerri, J. Participatory mapping of invasive species: A demonstration in a coastal lagoon. *Mar. Policy* **2021**, *126*, 104412. [CrossRef]
16. Baider, C.; Florens, F.B.V.; Baret, S.; Beaver, K.; Matatiken, D.; Strasberg, D.; Kueffer, C. Status of plant conservation in oceanic islands of the Western Indian Ocean. In Proceedings of the 4th Global Botanic Gardens Congress, Dublin, Ireland, 13–18 June 2010.
17. Florens, F.B.V. Conservation in Mauritius and Rodrigues: Challenges and achievements from two decades of NGO work. In *Lost Land of the Dodo*; Cheke, A., Hume, J., Eds.; T & AD Poyser: London, UK, 2008.
18. Cheke, A.S.; Hume, J.P. *Lost Land of the Dodo: The Ecological History of Mauritius, Réunion, and Rodrigues*; Yale University Press: New Haven, CT, USA, 2008.
19. Baider, C.; Florens, F.B.V. Control of invasive alien weeds averts imminent plant extinction. *Biol. Invasions* **2011**, *13*, 2641–2646. [CrossRef]
20. Sunkur, R.; Mauremootoo, J. Spatio-temporal Analysis of an Invasive Alien Species, *Vachellia* nilotica, on Rodrigues Island, Mauritius, Using Geographic Information Systems and Remote Sensing Techniques. *Indones. J. Earth Sci.* **2024**, *4*, A835. [CrossRef]
21. Eicken, H.; Danielsen, F.; Sam, J.M.; Fidel, M.; Johnson, N.; Poulsen, M.K.; Lee, O.A.; Spellman, K.V.; Iversen, L.; Pulsifer, P.; et al. Connecting top-down and bottom-up approaches in environmental observing. *BioScience* **2021**, *71*, 467–483. [CrossRef] [PubMed]
22. CHM (Clearing-House Mechanism). Status and Threats—Terrestrial Biodiversity. Government of Mauritius, 2023. Available online: http://chm.govmu.org/status-and-threats/terrestrial (accessed on 10 April 2025).
23. Strahm, W.A. *Plant Red Data Book for Rodrigues*; Mauritian Wildlife Foundation: Vacoas, Mauritius, 1999.
24. Republic of Mauritius. *National Biodiversity Strategy and Action Plan 2017–2025*; Ministry of Agro-Industry and Food Security: Port Louis, Mauritius, 2017. Available online: https://www.cbd.int/doc/world/mu/mu-nbsap-v2-en.pdf (accessed on 10 April 2025).
25. Chambers, R. *Whose Reality Counts? Putting the First Last*; Intermediate Technology Publications: London, UK, 1997; Available online: https://www.jstor.org/stable/44257385 (accessed on 10 April 2025).
26. Yoccoz, N.G.; Nichols, J.D.; Boulinier, T. Monitoring of biological diversity in space and time. *Trends Ecol. Evol.* **2001**, *16*, 446–453. [CrossRef]
27. Sharma, P.; Kaur, A.; Batish, D.R.; Kaur, S.; Chauhan, B.S. Critical insights into the ecological and invasive attributes of *Leucaena* leucocephala, a tropical agroforestry species. *Front. Agron.* **2022**, *4*, 890992. [CrossRef]
28. CABI. *Albizia* lebbeck (sirisa). In *Invasive Species Compendium*; CAB International: Wallingford, UK, 2023. [CrossRef]
29. Kueffer, C.; Daehler, C.C.; Torres-Santana, C.W.; Lavergne, C.; Meyer, J.-Y.; Otto, R.; Silva, L. A global comparison of plant invasions on oceanic islands. *Perspect. Plant Ecol. Evol. Syst.* **2010**, *12*, 145–161. [CrossRef]
30. da Silveira, M.C.; Silveira, M.; Medeiros, L.S.; Aguiar, L.M. The role of feeding roosts in seed dispersal service bats provide in urban areas. *Biotropica* **2024**, *56*, e13291. [CrossRef]
31. FAO. *Global Forest Resources Assessment 2005: Thematic Study on Forest Restoration: Current Patterns and Future Opportunities*; Forest Resources Assessment Programme, Working Paper 83; FAO: Rome, Italy, 2005; Available online: https://www.fao.org/4/y5901e/y5901e07.htm (accessed on 10 April 2025).
32. Russell, J.C.; Innes, J.G.; Brown, P.H.; Byrom, A.E. Predator-Free New Zealand: Conservation Country. *BioScience* **2017**, *67*, 820–829. [CrossRef]

33. Fourcade, Y.; Engler, J.O.; Rödder, D.; Secondi, J. Mapping species distributions with MAXENT using a geographically biased sample of presence data: A performance assessment of methods for correcting sampling bias. *PLoS ONE* **2014**, *9*, e97122. [CrossRef]
34. Mataruse, T.P.; Nyikahadzoi, K.; Fallot, A.; Perrotton, A. Using participatory mapping for a shared understanding of deforestation dynamics in Murehwa district, Zimbabwe. *Cah. Agric.* **2024**, *33*, 15. [CrossRef]
35. Chan, C.M.; Owers, C.J.; Fuller, S.; Hayward, M.W.; Moverley, D.; Griffin, A.S. Capacity and capability of remote sensing to inform invasive plant species management in the Pacific Islands region. *Conserv. Biol.* **2025**, *39*, e14344. [CrossRef] [PubMed]
36. Shackleton, R.T.; Adriaens, T.; Brundu, G.; Dehnen-Schmutz, K.; Estévez, R.A.; Fried, J.; Larson, B.M.; Liu, S.; Marchante, E.; Marchante, H.; et al. Stakeholder engagement in the study and management of invasive alien species. *J. Environ. Manag.* **2019**, *229*, 88–101. [CrossRef] [PubMed]
37. Vujanović, D.; Losapio, G.; Milić, S.; Milić, D. The impact of multiple species invasion on soil and plant communities increases with invasive species co-occurrence. *Front. Plant Sci.* **2022**, *13*, 875824. [CrossRef]
38. Pyšek, P.; Hulme, P.E.; Simberloff, D.; Bacher, S.; Blackburn, T.M.; Carlton, J.T.; Dawson, W.; Essl, F.; Foxcroft, L.C.; Genovesi, P.; et al. Scientists' warning on invasive alien species. *Biol. Rev.* **2020**, *95*, 1511–1534. [CrossRef]
39. Zhang, L.; Zhu, M.; Wan, Y.; Liu, X. Multiple invasion trajectories induce niche dynamics inconsistency and increase risk uncertainty of a plant invader. *Ecosphere* **2023**, *14*, e4483. [CrossRef]
40. Tataridas, A.; Jabran, K.; Kanatas, P.; Oliveira, R.S.; Freitas, H.; Travlos, I. Early detection, herbicide resistance screening, and integrated management of invasive plant species: A review. *Pest Manag. Sci.* **2022**, *78*, 3957–3972. [CrossRef]
41. IUCN. *Guidelines for Invasive Species Planning and Management on Islands*; Alan, T., Ed. and Translator; IUCN: Cambridge, UK; Gland, Switzerland, 2018. [CrossRef]
42. Republic of Mauritius. *Good Practice Guide to Native Forest Restoration in Mauritius*; Ministry of Agro Industry: Port Louis, Mauritius; Food Security: Port Louis, Mauritius, 2018.

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