# PRIORITISING ALIEN INVASIVE PLANTS IN THE UPPER TSITSA RIVER

## Catchment T35 A-E Prioritisation Plan

**TSITSA PROJECT**

Nicholaus Huchzermeyer; Pippa Schlegel & Bennie van der Waal

December 2018

environmental affairs
Department:
Environmental Affairs
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The research has been funded by the Department of Environmental Affairs: Environmental Programmes – Natural Resource Management Programmes. Directorate – Operational Support and Planning.

# EXECUTIVE SUMMARY

The prioritisation of alien vegetation in Catchment T35 A-E follows on the mapping report from Huchzermeyer *et al*. (2018). A total of 37 dominant alien taxa were identified of which 27 fall within Category 1-3 as per the National Environmental Management Biodiversity Act (NEMBA) Act 10 of 2004- Alien and invasive Species (AIS) regulations, which were gazetted on 1 August 2014, and therefore need management.

Invasive alien plant control requires the allocation of limited resources to control and eradicate invasive species to an extent that maximises benefits to both the environment and local stakeholders (Le Maitre *et al.,* 2012). This report sought to develop an approach that could assist managers and planners in the Working for Water Program and the Tsitsa Project to prioritise their activities within Catchment T35 A-E.

According to van Wilgen *et al.* (2008a) the criteria identified for the national prioritisation of invasive alien species in the grassland biome included impacts on ecosystem services, especially for grazing and water resource potential, biodiversity, fire hazard and erosion, and the impact of removal of alien species that carry some benefit.

In the upper Tsitsa River catchment five major criteria were identified as the basis for the prioritisation of the areas that should be targeted in order to improve livelihoods, biodiversity, surface water and groundwater recharge. These were: (i) presence of alien vegetation; (ii) previously cleared alien vegetation points that are exhibiting regrowth; (iii) local stakeholder inputs and productive land (safety, abandoned fields and grazing); (iv) riparian zones and drainage lines around villages, (v) canopy density of 50% or lower. Further prioritisation was conducted using a scoring system of alien vegetation polygons which fall in one or more of the above categories. The result is prioritised alien woody plant polygons in Catchment T35 A-E that should be targeted in a top-down approach for control by the Working for Water Program or for the release of bio-control agents.

The report provides a preliminary prioritisation of alien vegetation, which is dominated by Acacia species, in Catchment T35 A-E following a top-down approach with a focus on biodiversity and social considerations including community voice and livelihoods.

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A brief background on why alien vegetation is prioritised nationally is given (van Wilgen *et al*., 2008b). This includes its effects on surface water yield and groundwater recharge, biodiversity and social considerations such as safety, grazing and uses.

The report provides a preliminary prioritisation of alien vegetation in Catchment T35 A-E following a top-down approach with a focus on biodiversity and social considerations including community voice and livelihoods.

# 2. BACKGROUND INFORMATION

## 2.1. National prioritisation

### *2.1.1. Invasive Alien Plants (IAPs) categories*

According to South African regulations there are a total of 559 alien species that are categorised as invasive and a further 560 species that are listed as prohibited and may not be introduced into South Africa. Below is a brief explanation of the four categories of IAPs as per the National Environmental Management Biodiversity Act (NEMBA) Act 10 of 2004-Alien and invasive Species (AIS) regulations, which were gazetted on 1 August 2014.

**Table 1: National IAPs Categories**

| Category | Definition |
|---|---|
| **1a** | Those invasive species requiring **compulsory control.** Remove and destroy. Any specimens of Category 1a listed species need, by law, to be eradicated from the environment. No permits will be issued. |
| **1b** | Those invasive species requiring **compulsory control** as part of an invasive species control programme. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management programme. No permits will be issued. |
| **2** | Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Category 2 plants to exist in riparian zones. |
| **3** | Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Category 3 plants to exist in riparian zones. |

### 2.1.2. Surface water yield and groundwater recharge

In most of South Africa, invasions by alien woody plants are commonly confined to riparian strips (river banks and valley bottoms) (Versfeld *et al.,* 1998). Invasive Alien Plant species (IAPs) reduce the availability of water through a reduction in mean annual runoff (MAR) which results in a reduction in water yield (Görgens & Van Wilgen, 2004). Invasive alien plants are estimated to be using the equivalent of 6.7% of the mean annual surface runoff of South Africa (Le Maitre *et al*., 2000). Cullis *et al*. (2007) studied the impacts of invasive alien plants on total water yield in high rainfall catchments and riparian zones of South Africa. They found that the total impact of upland IAPs on the total surface water yield of the country, which included the yield from major dams, minor dams and run-of-river yield, was currently approximately 172 x 106 $m^3/a$ and could go up to as much as 1 410 x 106 $m^3/a$ in the future. The impact varies between water management areas.

### 2.1.3. Biodiversity

Global biodiversity and ecosystem functioning is threatened by the spread of invasive alien plant species (Vitousek, 1990; Mooney & Cleland, 2001) and is possibly only surpassed by the complete destruction of an ecosystem (Raghubanshi *et al.,* 2005). If not addressed the threat of alien plants can be escalated by continued human-induced impacts (Ewel *et al*., 1999). Therefore, the prioritisation and management of alien and invasive plant species requires immediate attention.

Poona (2001) states that invasive species are difficult to manage using a single approach as their pattern of invasion differs for different landscape units and zones of invasion (Sanz-Elorza *et al*., 2006) and that the distribution of alien plants in any given area is variable (Thiébaut, 2005). In addition, the continued invasion of alien plants into new areas is causing a homogenisation of flora and a reduction in biodiversity (Atkinson & Cameron, 1993). Effects on biodiversity include changes in biogeochemical cycling (Vitousek, 1994), transforming soil surfaces by altering germination sites and surface micro-climates (Pritekel *et al*., 2005), causing severe erosion and degradation of soils (Enright, 2000) and can contribute to global change and species extinction (Richardson & van Wilgen, 2004).

### 2.1.4. Social considerations (Safety, Grazing, Fuel, and Building uses)

Invasive species affect both natural and socio-economic environments globally. IAPs affect humans in several ways. IAPs provide economic, aesthetic, cultural and medicinal value and in many ways have become part of social traditions. However, the threat that IAPs pose to ecosystems and biodiversity is commonly overshadowed by the economic incentives of importing and cultivating alien species (Baskin, 2006).

To the local communities in the rural parts of the Drakensberg region of South Africa, two woody IAP species, namely, Acacia mearnsii and Acacia dealbata, represent a resource (de Neergaard, 2005; Ngwenya, 2016; Lunderstedt *et al*., 2017). They are used as a primary heat source, building material and a source of income from the sale of firewood (de Neergaard, 2005). It is therefore important to take local stakeholder considerations into account. This requires a balance between clearing stands of alien vegetation that easily spread into the surrounding landscape and keeping contained woodlots for local resource use (de Neergaard, 2005).

## 2.2. Regional Prioritisation (Catchment T35 A-E)

### 2.2.1. Quaternary catchment prioritisation

Invasive alien plant control requires the allocation of limited resources to control and eradicate invasive species (Le Maitre *et al.,* 2012). Le Maitre *et al.* (2012) used the Analytic Hierarchy Process (AHP) to facilitate the prioritisation of clearing of quaternary catchments throughout South Africa based on species and area. AHP is a multiple criteria decision-making tool encompassing both quantitative and qualitative aspects for setting priorities at a national and regional level (Le Maitre *et al.,* 2012). Figure 1 depicts the generic synthesis prioritisation model created by Le Maitre *et al.* (2012). Catchment T35 A-E falls within high to very high priority.

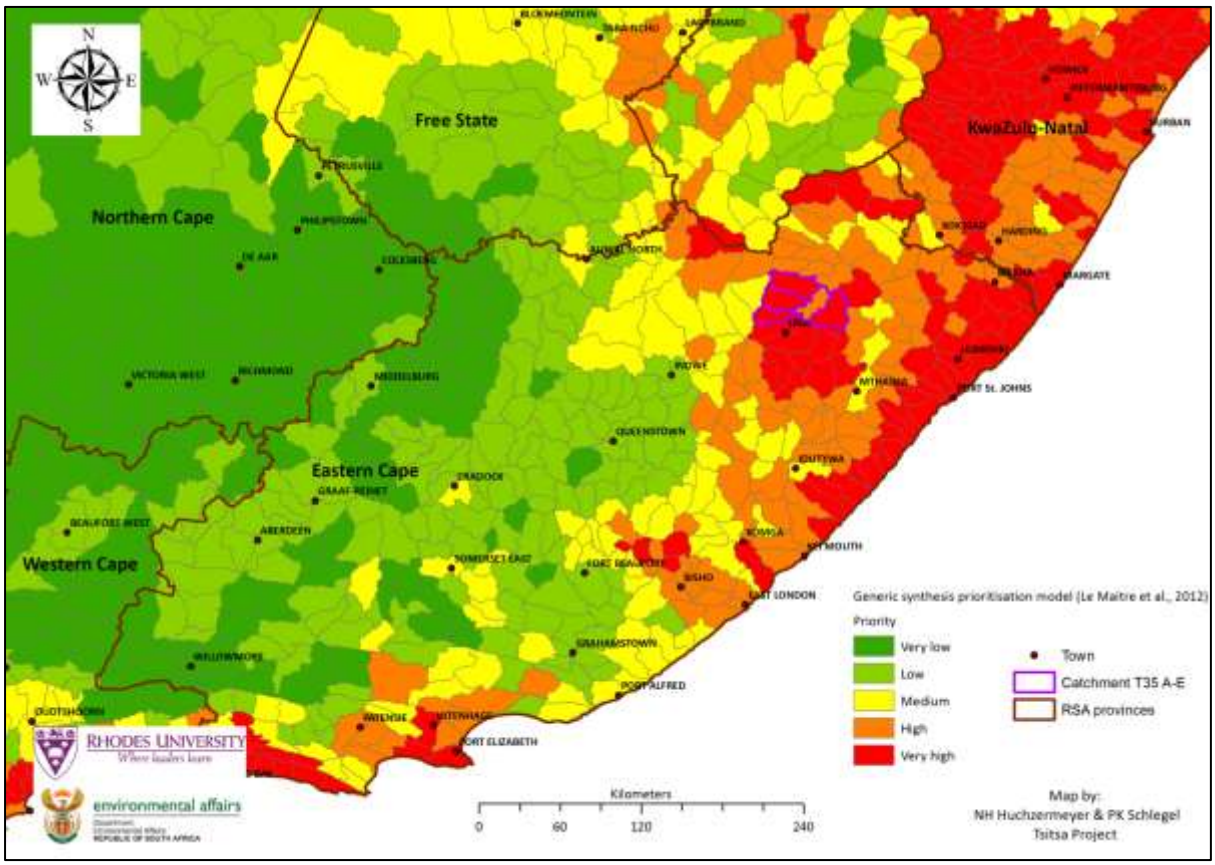



**Figure 1: Generic synthesis prioritisation for Working for Water (Le Maitre *et al.,* 2012)**

### 2.2.2. Biodiversity within Catchment T35 A-E

Mean annual runoff, water quality, biodiversity and natural resource use all contribute to the high priorities seen in quaternary catchments such as Catchment T35 A-E (Forsyth *et al.,* 2011)

Strategic Water Source Areas (SWSAs) are areas of importance for generating South Africa's water (SANBI, 2017). In Catchment T35 A-E the SWSAs can be protected by reducing the negative impacts of invasive alien plants

Critical Biodiversity Areas (CBA's) are terrestrial and aquatic features in the landscape that are required to meet biodiversity targets for ecosystems, species and ecological processes (SANBI, 2018). Therefore, they are critical for conserving biodiversity and maintaining ecosystem functioning (Berliner *et al.,* 2007). CBA's can be classified into the following sub-categories (SANBI, 2017):

- CBA1: These are irreplaceable or near-irreplaceable for meeting biodiversity targets (i.e. there are very few or no other options for meeting biodiversity targets for the features associated with these areas).
- CBA 2: These are areas that have been selected as the best option for meeting biodiversity targets, based on complementary, efficiency, connectivity and/or avoidance of conflict with other land or resources uses.

Grasslands are one of the most threatened and least protected biomes in South Africa. In addition with climate conditions changing this biome will be restricted to higher altitudes where conditions will remain more optimal (van Wilgen *et al.,* 2008b). It is clear that reducing alien vegetation invasions in Catchment T35 A-E will aid in protecting the already sensitive environment (Figure 2 and Figure 3).

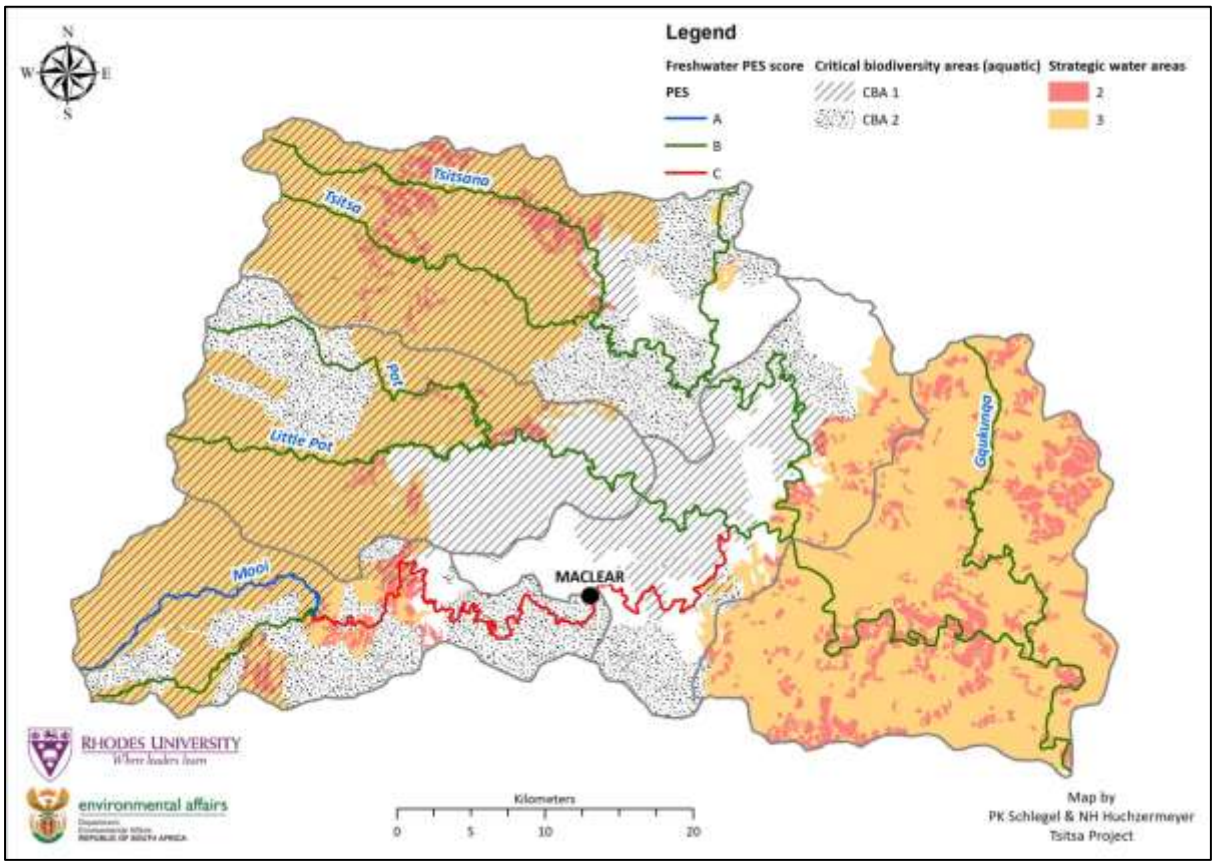



**Figure 2: Strategic water areas, critical biodiversity areas (aquatic) and freshwater Present Ecological State (PES) score in Catchment T35 A-E**

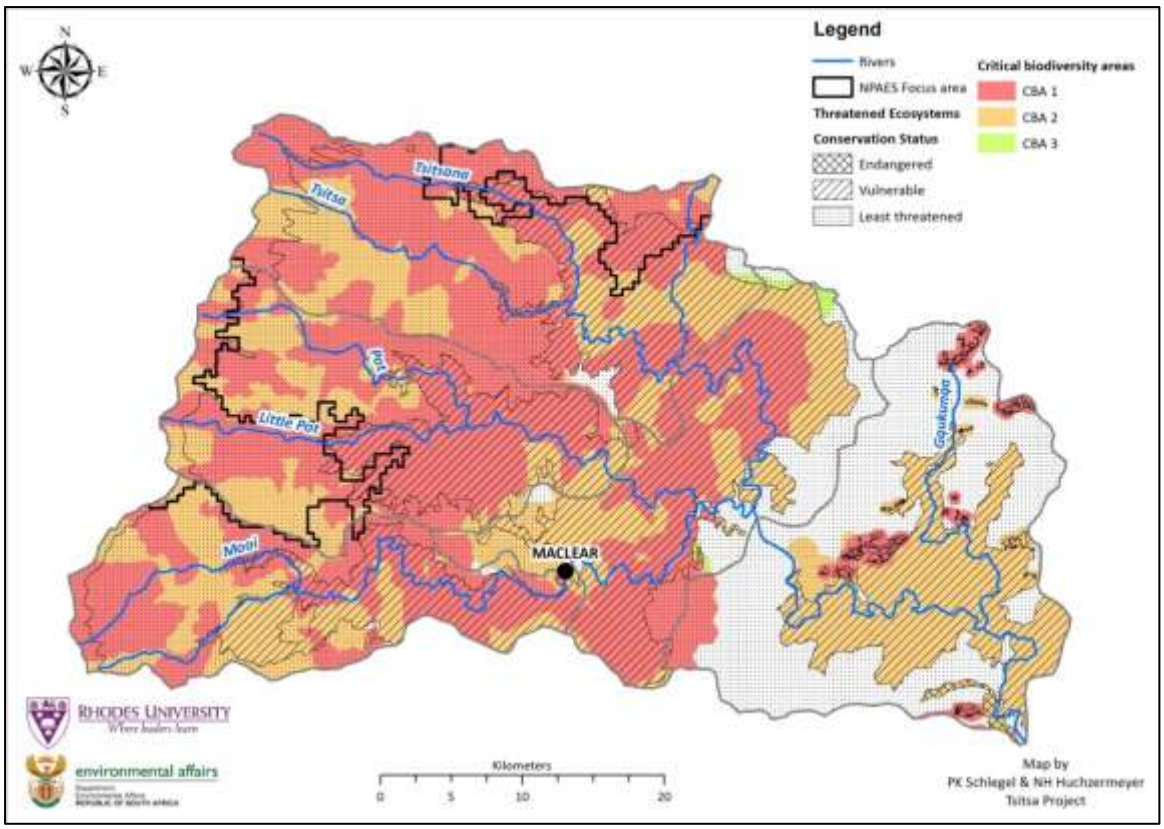



**Figure 3: Critical biodiversity areas (terrestrial), threteatened ecosystems and National Protected Area Expantion strategy that fall within Catchment T35 A-E.**

### *2.2.3. Multi-Criteria Decision Analysis for prioritising clearing in Catchment T35 (Mantel et al., 2018)*

Mantel *et al*. (2018) prioritised the clearing of invasive alien vegetation through a cost-benefit analysis. Mantel *et al*. (2018) described that the benefits of clearing include improved biodiversity, ecosystem services (water provision and improved grazing), logs for the PG Bison wood mill in Ugie, firewood and materials for communities and new areas for crop cultivation, housing and schools. The costs of clearing can be associated with the density of alien invasions, management costs and accessibility to areas. Mantel *et al.* (2018) adopted a Multi-Criteria Decision Analysis (MCDA) approach to prioritise invasive alien plants (IAP) at a 250 meter resolution in Catchment T35 using the following criteria:

- **Total IAP average density (%)** obtained from the National Invasive Alien Plant (NIAP) dataset
- **Soil erodibility** K-factor obtained from the 2007 South African Atlas of Climatology and Agrohydrology
- Riparian areas
- **Abandoned cultivation** derived from the National Land Cover 2000 and the National Invasive Alien Plant (NIAP) dataset.

The priority clearing map is not yet finalised as updated NIAP data needs to be obtained and for the results to be effectively used a budgeting tool needs to be developed (Mantel *et al.,* 2018).

# 3. METHODS: PRIORITISING ALIEN VEGETATION AT A SUB-REGIONAL SCALE

## 3.1. Prioritisation of alien vegetation with an emphasis on improved biodiversity and livelihoods

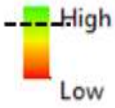
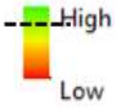
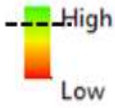
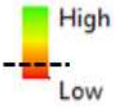
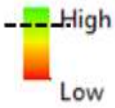
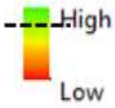
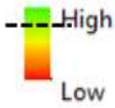
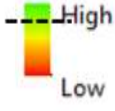
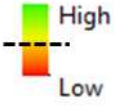
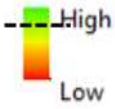
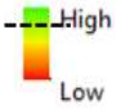
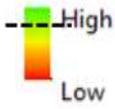
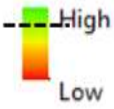
Spatial datasets need to be developed to better prioritise areas within quaternary catchments. Datasets should relate to mean annual runoff, groundwater trends, wetland areas, threatened ecosystems and rivers, cultural use features, grazing resources and the density and number of invasive plants (Forsyth *et al*., 2011).

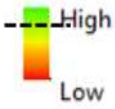
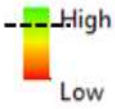
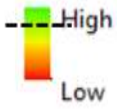
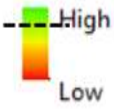
Woody vegetation in Catchment T35 A-E was mapped by Huchzermeyer *et al*. (2018). Alien vegetation can easily be extracted and prioritised. Details of the alien vegetation types that occur in Catchment T35 A-E can be found in Appendix 2 and 3.

Geldenhuys *et al.* (2016) advised that alien clearing be limited to areas invading range and agricultural land, as well as forests and areas near pathways that are associated with criminal activity. They further mention the importance of alien trees for building and fuel material, and their role in protecting indigenous forests from over harvesting for building materials.

A preliminary prioritisation of alien vegetation was conducted with an emphasis on improving livelihoods and taking the community voice (Lunderstedt *et al*., 2017) into consideration (Table 2).

**Table 2: Sub-regional prioritisation of alien vegetation in Catchment T35 A-E**

| Category | Description | Biophysical/ecosystem benefit | Livelihood benefit (increased grazing, recuperation of productive land) | Surface water yield and groundwater recharge benefit (biophysical and livelihood benefit) | Viability with limited resources |
|---|---|---|---|---|---|
| **All alien vegetation** | Removal and management of all alien woody vegetation within Catchment T35 A-E |  |  |  |  |
| **Intersection with previously cleared points** | Re-growth in previously cleared areas should be targeted to ensure that the aliens are completely eradicated at a lower cost i.e. invest more time into areas that have already undergone a time and monitory investment |  |  |  |  |
| **Local stakeholder input** | Alien vegetation intersecting a 500 meter buffer around 'problem' points identified by communities<br>Alien vegetation has several uses for local communities for example, firewood and building materials (Lunderstedt *et al.*, 2017). However, local communities identified areas which they would like removed as they are either security risks to them, inaccessible or are reducing grazing potential. |  |  |  |  |
| **Intersection in a 50 meter buffer around riparian zones and drainage lines which fall within a 1 kilometre buffer of village boundaries** | Local communities expressed concerns with alien vegetation which proves a security risk as criminals hide within them and people are not able to walk freely (Lunderstedt *et al.*, 2017). The 'problem' alien vegetation was predominantly identified along rivers and drainage lines around the villages |  |  |  |  |

| | | | | | |
|---|---|---|---|---|---|
| **Low canopy density** | Outlying, expanding and fairly recent populations of alien vegetation should be prioritised to try and reduce their rate of spread.<br>These areas commonly have a lower canopy density because they are less established. Stands of alien trees that have been established for a while grow very densely and are expensive to target with limited resources.<br>Classified alien vegetation with a canopy density of 50% or less was extracted. |  |  |  |  |

## 3.2. Top-down approach to prioritising alien vegetation

Further prioritisation was conducted using an unweighted scoring system of alien vegetation polygons which fall in one or more of the categories in Table 2. Figure 4 depicts alien vegetation (largest category) and a further four categories for alien vegetation prioritisation. None of the mapped and classified polygons fall under all five categories. If a particular polygon can be classified under any four categories it receives a priority score of 4 (very high priority). If a polygon only falls under three categories it receives a priority score of 3 (high priority). If a polygon falls under two polygons (e.g. alien vegetation and identified by local input) it receives a priority score of 2 (moderate priority). If a polygon only falls under 1 category (i.e. alien vegetation) but none of the other categories it receives a priority score of 1 (low priority). If a top-down approach is taken vegetation scored with a high priority can be targeted first.

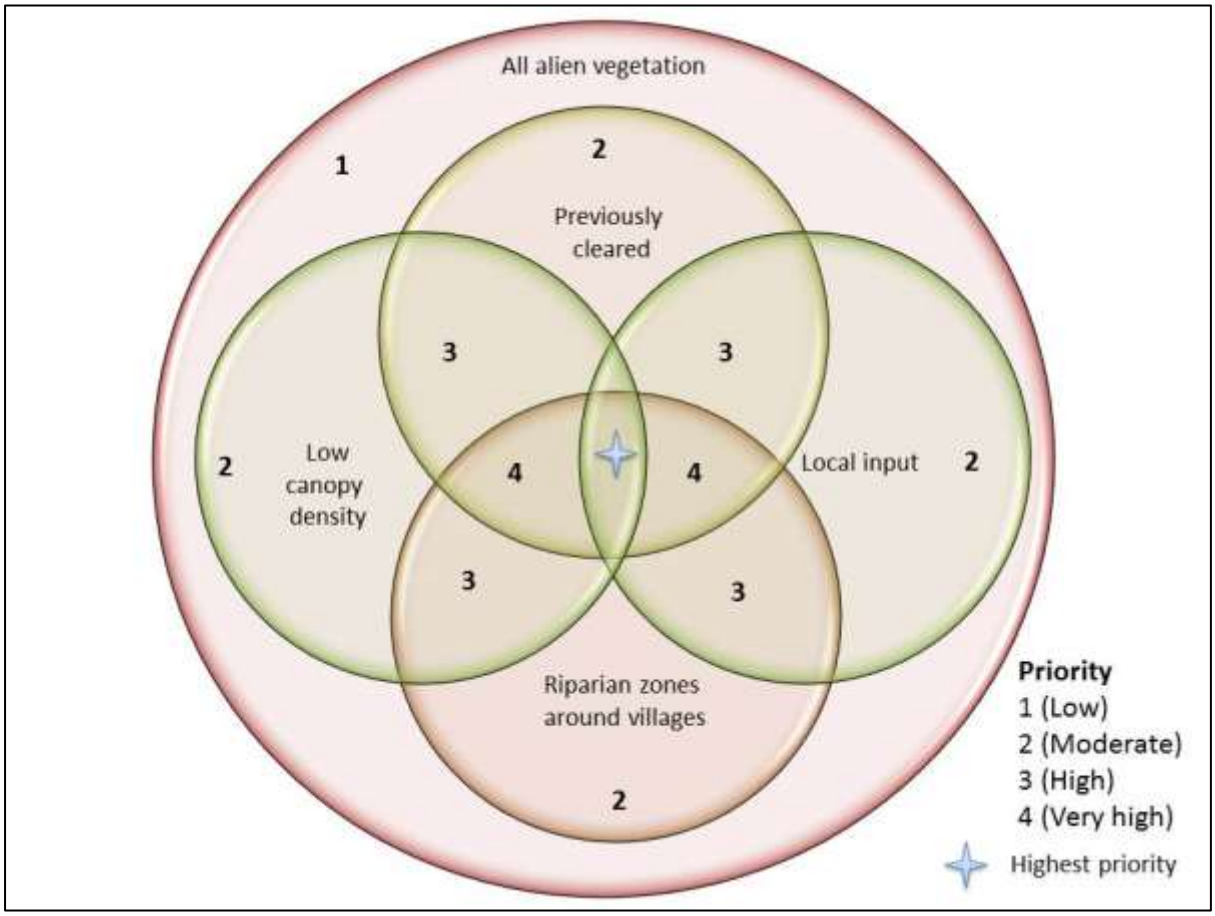



**Figure 4: Framework for prioritising alien vegetation in Catchment T35 A-E**

## 3.3. Preliminary focus areas in Catchment T35 A-E

Preliminary focus areas (sub-catchments) in Catchment T35 A-E were drafted by the Tsitsa Project (Van der Waal, 2018). These priority sub-catchments are largely based on avoiding further degradation and inputs from local communities. Various interventions over the next few years will be focused in these areas including wetland rehabilitation and abandoned field restoration. Therefore it would be intuitive to include the alien vegetation management within these identified areas. These focus areas can be a 'starting' point for the top down approach given in section 3.2.

## 3.4. Dominant alien species in prioritised polygons

Using the mapped and classified data from Huchzermeyer *et al.* (2018), dominant alien species and their proportions in different levels of prioritised alien vegetation was extracted.

# 4. RESULTS & KEY RECOMMENDATIONS

The results for different levels and categories of alien vegetation prioritisation are given below.

## 4.1. Alien vegetation

Alien vegetation in Catchment T35 A-E covers 7 235 ha (10 204 polygons). Out of this 525 ha (143 polygons) are woodlots (Figure 5). This is a large area to target and to maximise the allocation of limited resources to control the alien vegetation, it needs to be further prioritised as described in the sections below.

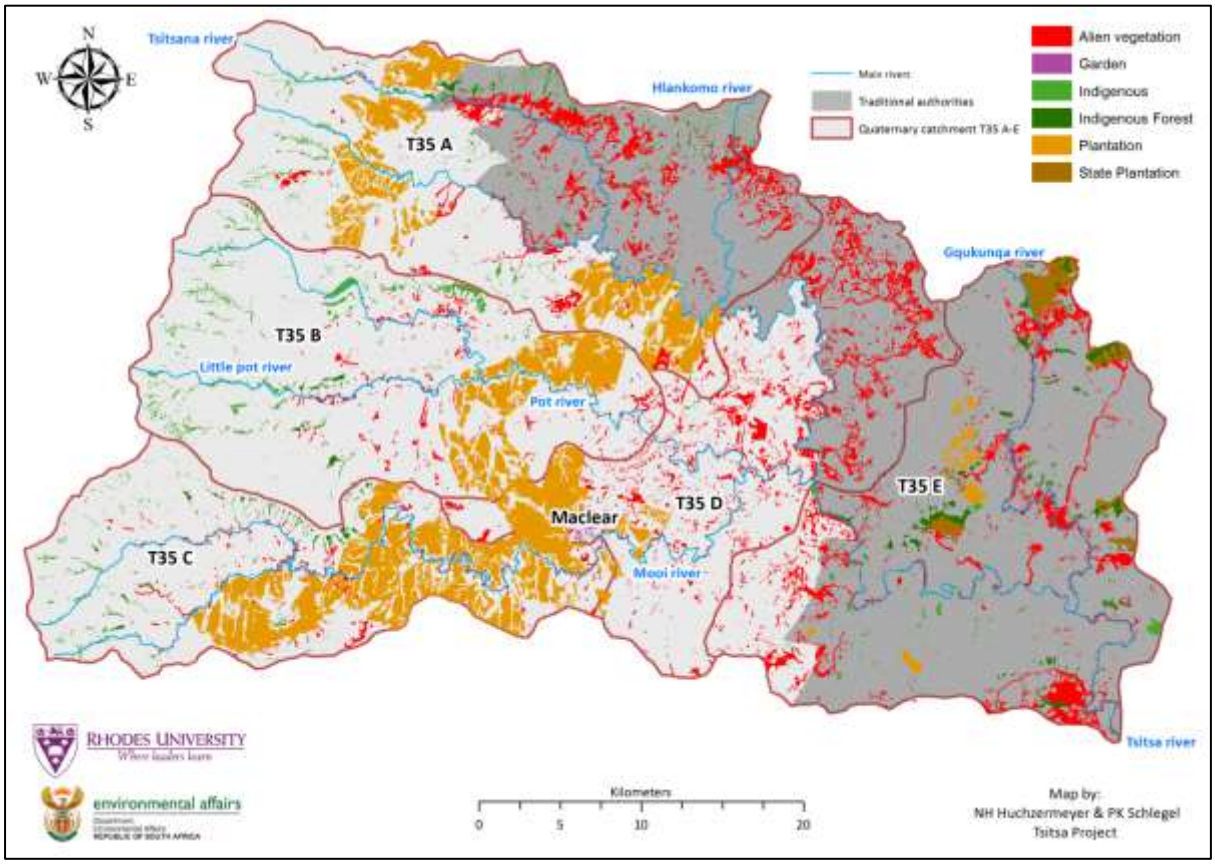



Figure 5: Alien vegetation extracted from the woody vegetation in Catchment T35 A-E

Figure 6 shows groundwater recharge (DWAF, 2006) in Catchment T35 A-E. Recharge figures are based on the chloride mass-balance method. It should be noted that the coverage of chloride measurements in rainfall in South Africa is incomplete and that this method comes with inherent errors (DWAF, 2006).

However, when looking at the general trends of groundwater recharge across Catchment T35 A-E it is clear that alien vegetation occurs in conjunction with areas with lower groundwater recharge values. Therefore any area chosen for alien vegetation clearing and management should show positive benefits to groundwater recharge.

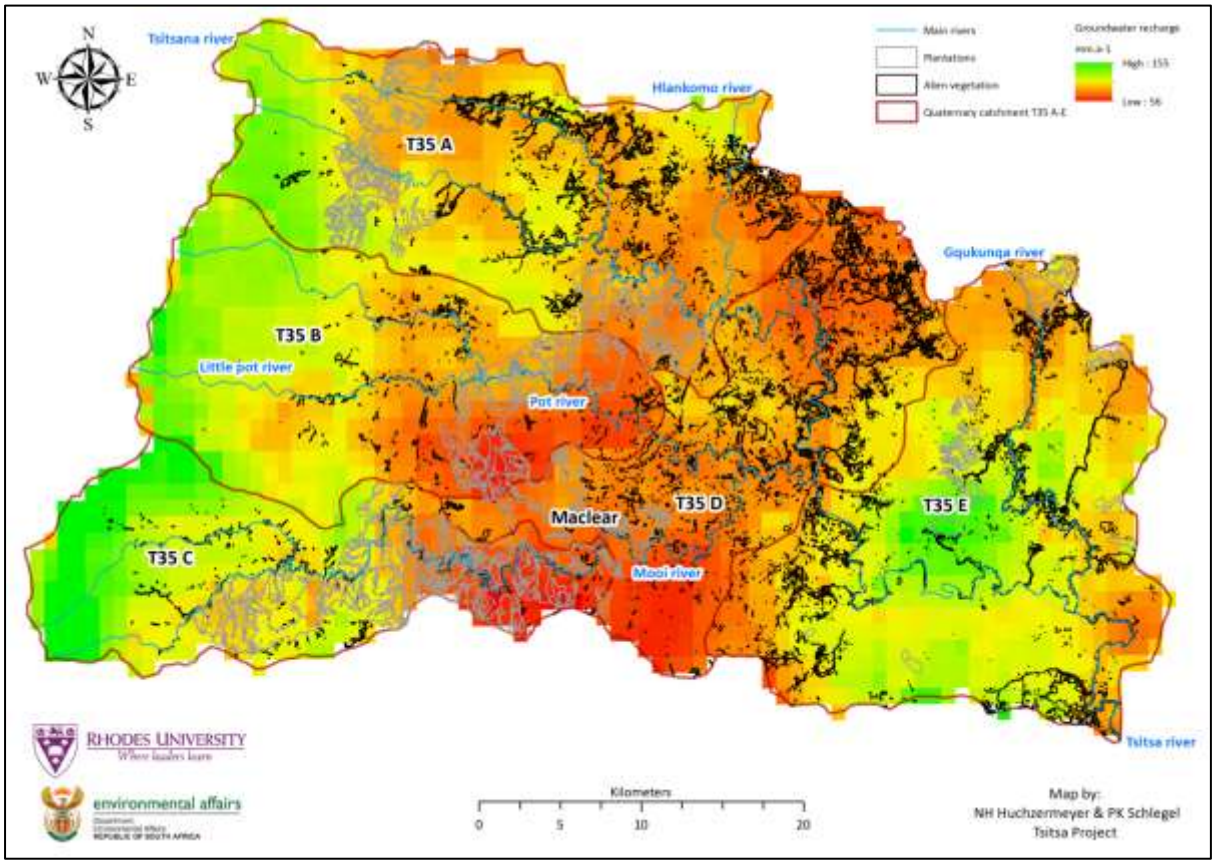



**Figure 6: Groundwater recharge in Catchment T35 A-E (DWAF, 2006)**

## 4.2. Previously cleared alien vegetation

Alien vegetation that intersect previously cleared alien vegetation points makes up 1 617 ha (1 301 polygons) (Figure 7). These can be easily targeted as they should have at least undergone one treatment meaning that the plants are re-growth and should consist of young to medium aged trees.

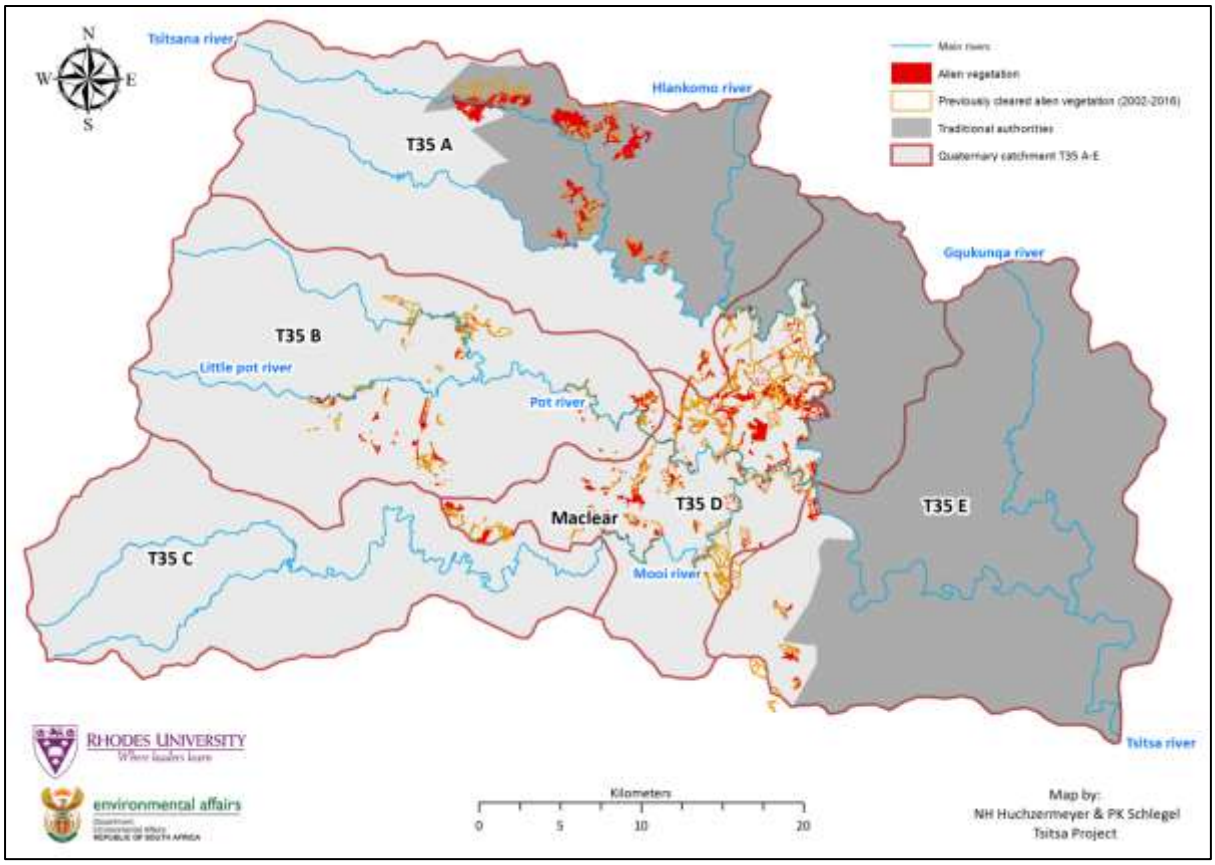



**Figure 7: Alien vegetation that intersects with previously cleared alien vegetation points**

## 4.3. Local stakeholder input

Alien vegetation that intersects 'problem' points identified by the community makes up 1 182 ha (359 polygons) (Figure 8). These alien species can be targeted to increase land productivity and grazing potential. The identified points are mostly grasslands and abandoned fields that are being encroached upon by invasive species.

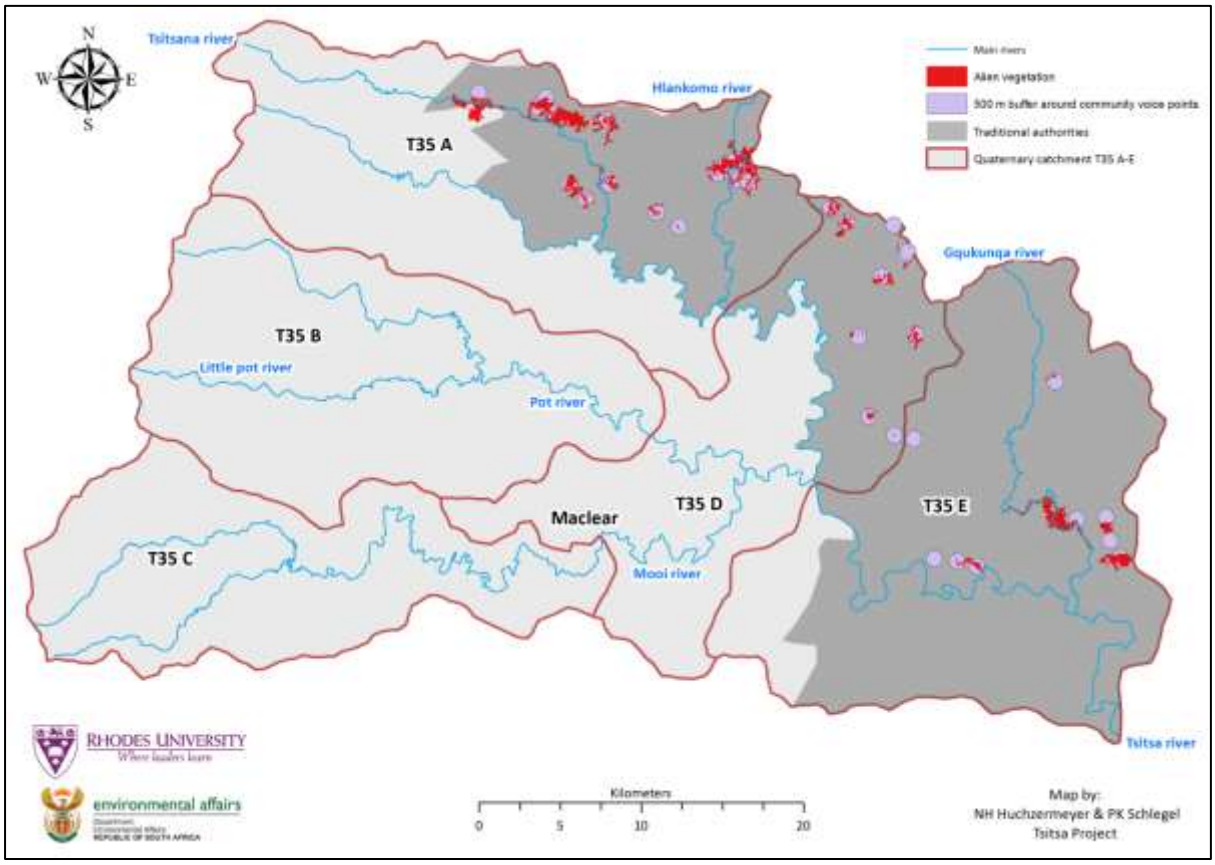



**Figure 8: Alien vegetation intersecting a 500 meter buffer around 'problem' points identified by communities**

## 4.4. Riparian zones and drainage lines around villages

Alien vegetation that intersects a 50 meter buffer around riparian zones and drainage lines which fall within a 1 kilometre buffer of village boundaries make up 3 746 ha (2 418 polygons) (Figure 9). These areas are important as a starting point to reduce encroachment and spread of alien vegetation in riparian zones and drainage lines whilst reducing the potential for criminal activities on the local communities in the thick alien tree stands within villages.

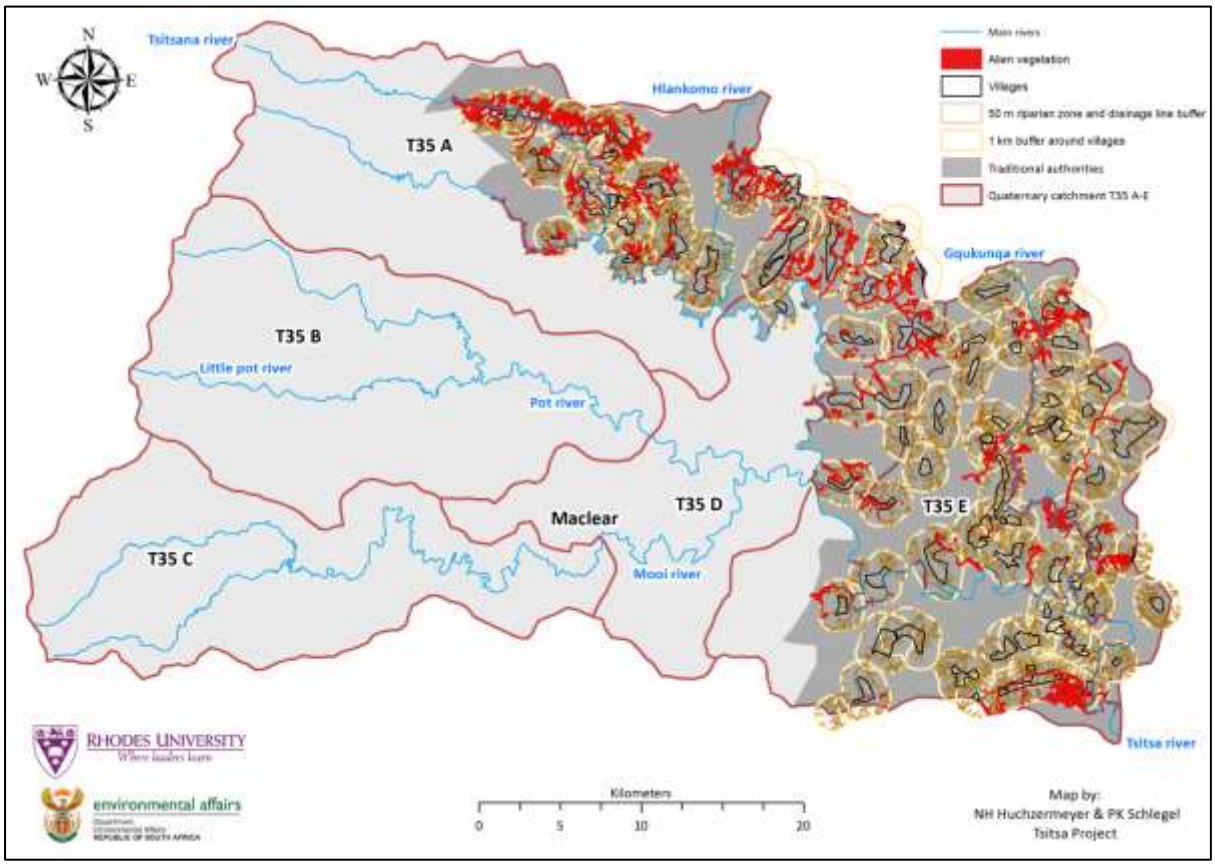



**Figure 9: Alien vegetation intersecting a 50 meter buffer around riparian zones and drainage lines which fall within a 1 kilometer buffer of village boundaries**

## 4.5. Canopy density

Classified alien vegetation in Catchment T35 A-E that exhibits a canopy density of 50% or less make up an uncondensed area of 776 ha (2 448 polygons) and a condensed area of 326 ha. Alien vegetation that exhibits 41-50% canopy density make up a condensed area of 114 ha (369 polygons) 1671, alien vegetation that exhibits 31-40% canopy density make up a condensed area of 199 ha (1 671 polygons) and alien vegetation that exhibits 5-30% canopy density make up a condensed area of 13 ha (408 polygons).

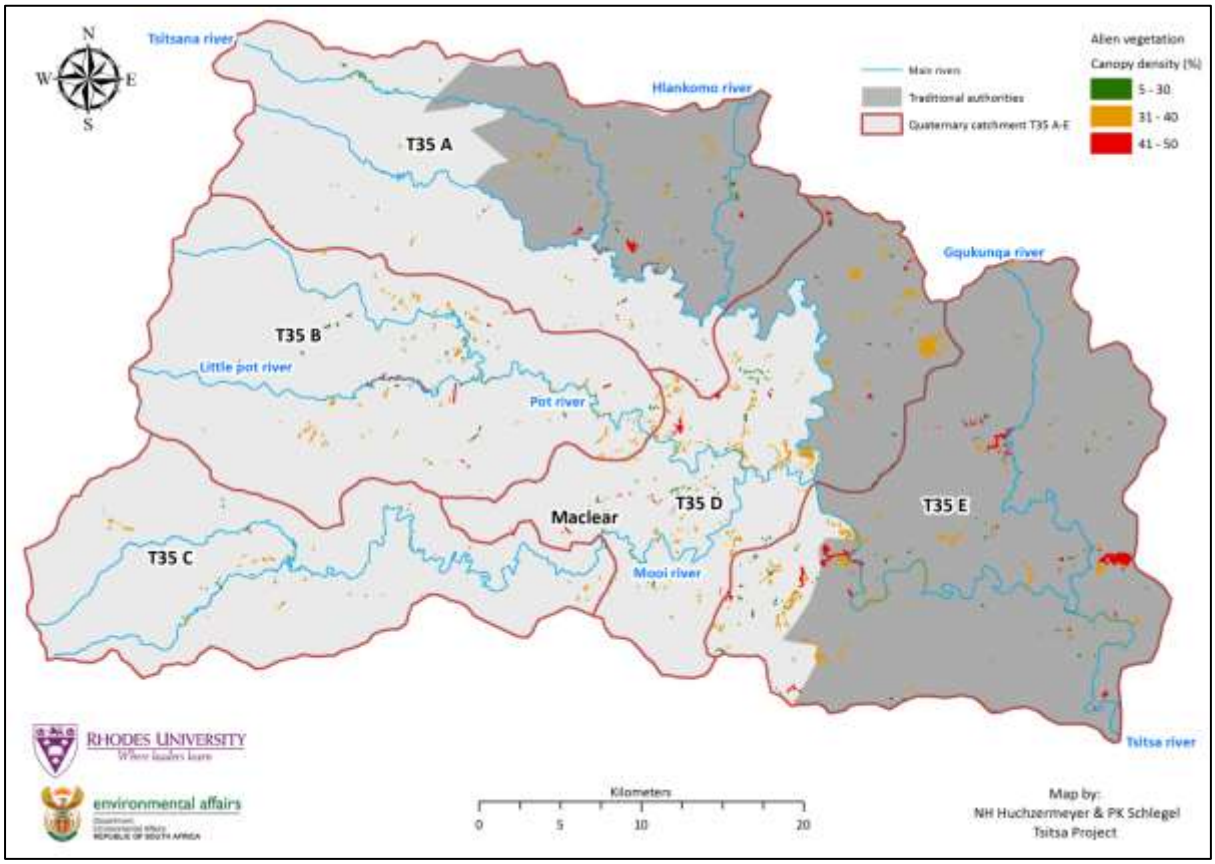



**Figure 10: Alien vegetation in Catchment T35 A-E that exhibits a canopy density of 50% or less**

## 4.6. Option 1: Overall priority of Alien Vegetation in Catchment T35 A-E

Table 3 and Figure 11 depict the proportions that each category of prioritised alien vegetation covers in Catchment T35 A-E.

Low priority alien vegetation makes up 30% of the alien vegetation area, moderate priority vegetation 45%, high priority vegetation 19% and very high priority 6%. It is recommended that the alien vegetation management is approached in a top-down manner in which very high priority alien vegetation polygons are targeted first. Section 4.7 suggests starting points for alien clearing.

Table 3: Summary of the different levels of prioritisation of alien vegetation in Catchment T35 A-E

| Priority | No. patches of alien vegetation | Uncondensed Area H (ha) | Percentage (%) uncondensed area of alien vegetation |
|---|---|---|---|
| **Low** | 4 775 | 2 170 | 30 |
| **Moderate** | 4 384 | 3 263 | 45 |
| **High** | 993 | 1 344 | 19 |
| **Very High** | 52 | 457 | 6 |

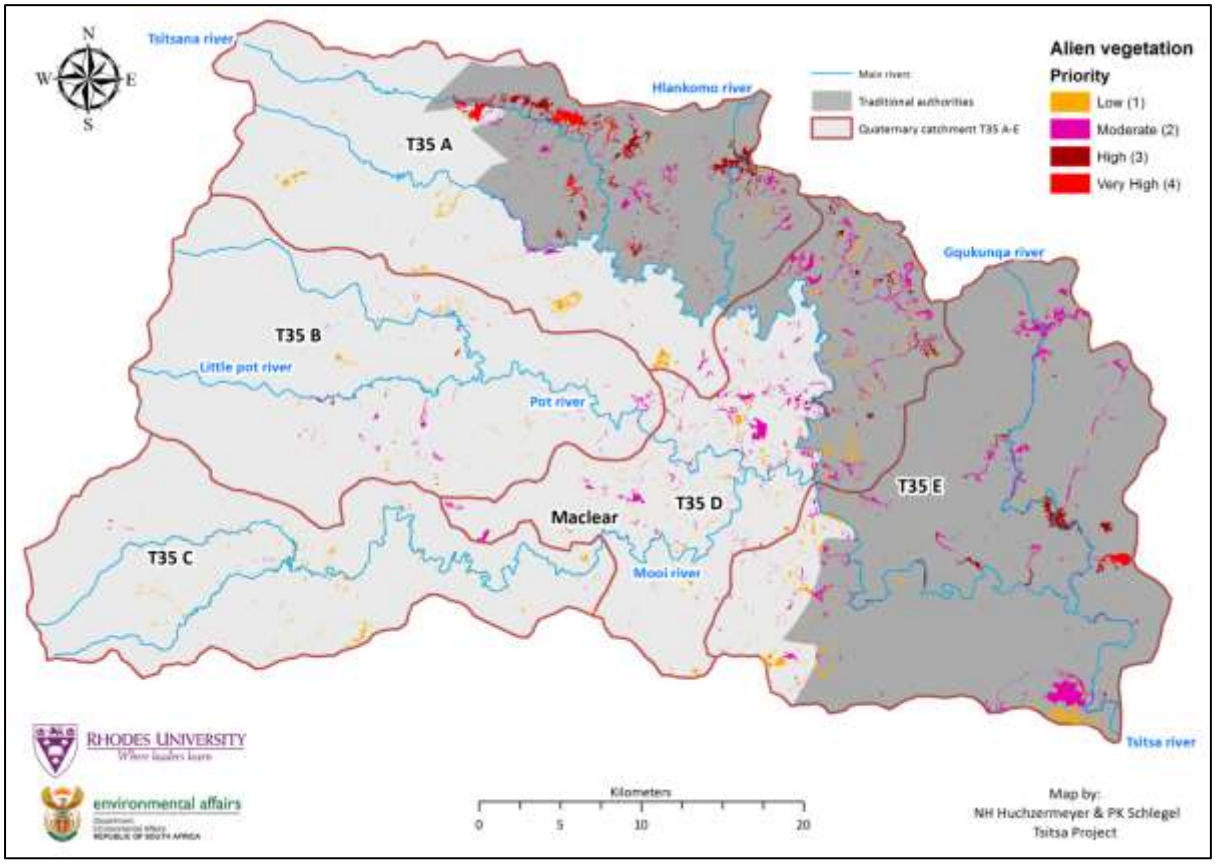



Figure 11: Alien vegetation prioritised according to the number of categories its falls under in Catchment T35 A-E

## 4.7. Option 2: Alien vegetation found within preliminary focus zones

Table 4 and Figure 12 depict the proportions that each category of prioritised alien vegetation covers in the preliminary focus areas in Catchment T35 A-E.

Low priority alien vegetation makes up 23% of the uncondensed alien vegetation area in the focus sub-catchments, moderate priority vegetation 51%, high priority vegetation 22% and very high priority wetlands make up 4% within the focus sub-catchments. It is recommended that the alien vegetation management is approached in a top-down manner in which high priority alien vegetation polygons are targeted first. Low priority alien vegetation polygons close to villages can be managed as woodlots for local resources.

**Table 4: Summary of the different levels of prioritisation of alien vegetation within focus sub-catchments in Catchment T35 A-E**

| Priority | No. patches of alien vegetation | Uncondensed Area H (ha) | Percentage (%) uncondensed area of alien vegetation in sub-catchments |
|---|---|---|---|
| **Low** | 1 149 | 505 | 23 |
| **Moderate** | 1 040 | 1 112 | 51 |
| **High** | 311 | 480 | 22 |
| **Very High** | 4 | 83 | 4 |

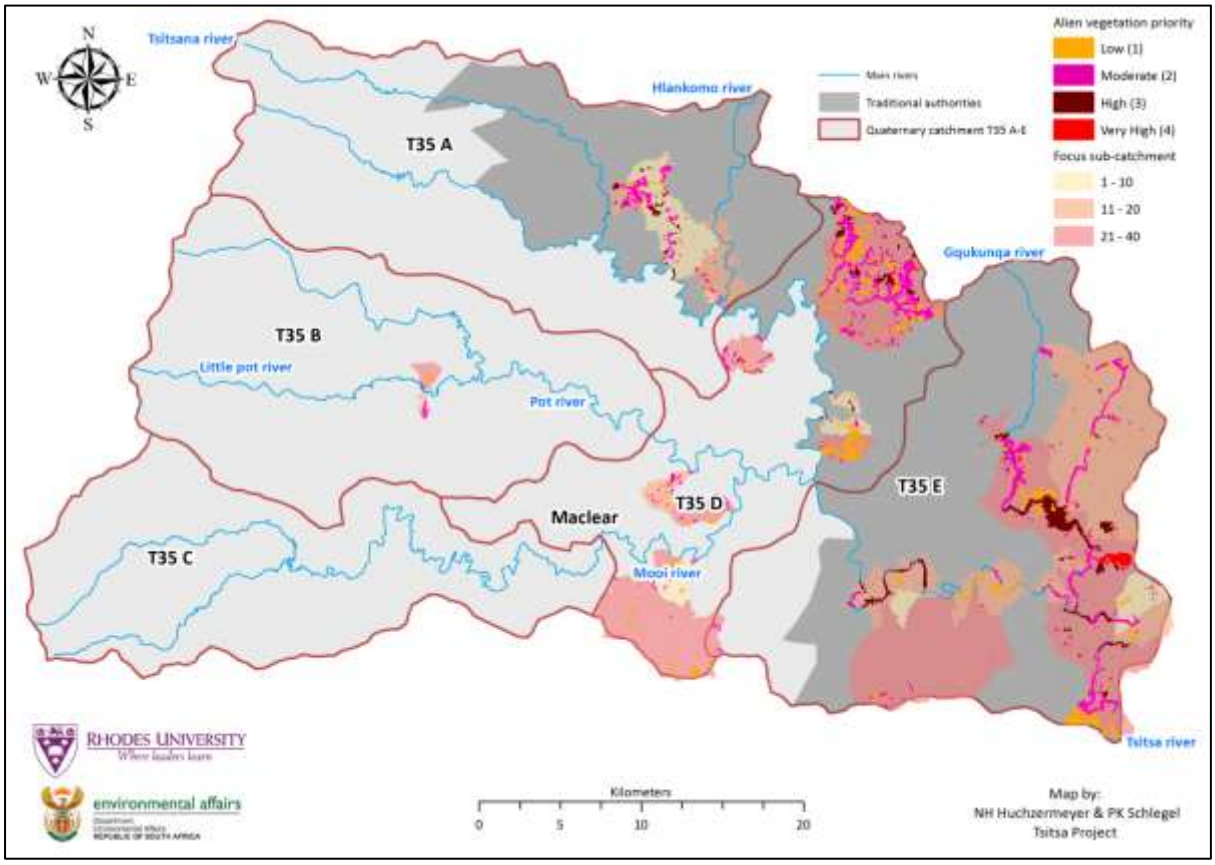



**Figure 12: Prioritised alien vegetation found within prioritised zones/sub-catchments**

## 4.8. Dominant alien species in prioritised polygons

The following section describes the trend in dominant species in different levels of prioritised alien vegetation. It must be noted that this data only depicts the dominant species (makes up the greatest proportion of the species present) in each polygon and that each polygon can consist of multiple invasive plant species.

It is clear that Black/green wattle and Silver wattle dominate the alien vegetation in Catchment T35 A-E.

### *4.8.1. Low priority*

Table 5 and Figure 13 show the dominant species and their location (Figure 14) in low priority alien vegetation polygons in Catchment T35 A-E. The dominant species found in alien vegetation polygons are mostly Black/green wattle (41%) followed by Silver wattle (38%). The remaining species shown in Table 5 make up a significantly smaller proportion of the uncondensed area of alien vegetation.

**Table 5: Summary of dominant species found in low priority alien vegetation polygons in Catchment T35 A-E**

| Dominant species | No. patches of alien vegetation | Uncondensed Area H (ha) | Percentage (%) uncondensed area of alien vegetation |
|---|---|---|---|
| **Silver wattle** | 1 605 | 816 | 38 |
| **Black wattle** | 75 | 48 | 2 |
| **Green wattle** | 77 | 26 | 1 |
| **Black/green wattle** | 2 349 | 900 | 41 |
| **Mauritius thorn** | 24 | 1 | <1 |
| **Eucalyptus** | 78 | 107 | 5 |
| **Pine** | 8 | 12 | 1 |
| **Cedar** | 1 | <1 | <1 |
| **Poplar** | 123 | 91 | 4 |
| **Syringa** | 1 | <1 | <1 |
| **Black locust** | 1 | 1 | <1 |
| **Rose** | 5 | 2 | <1 |
| **Bramble** | 4 | <1 | <1 |
| **Bamboo** | 1 | <1 | <1 |
| **Indigenous encroached by aliens** | 274 | 130 | 6 |
| **Unverified alien** | 148 | 38 | 2 |

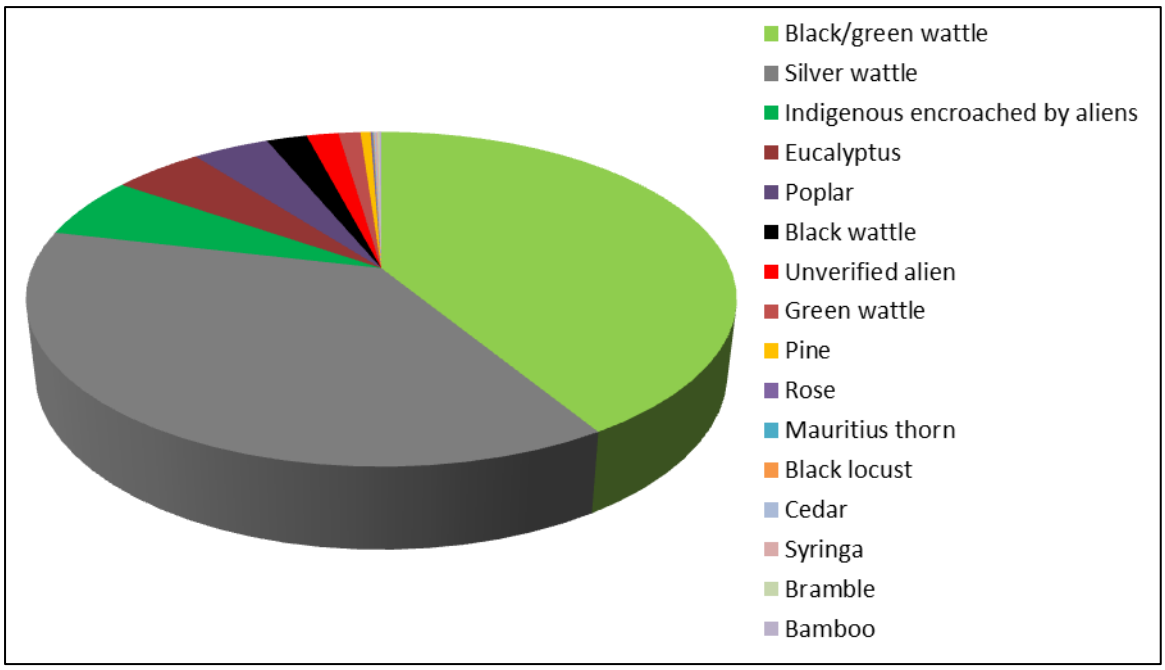



**Figure 13: Proportions of dominant species in low priority alien vegetation polygons in Catchment T35 A-E**

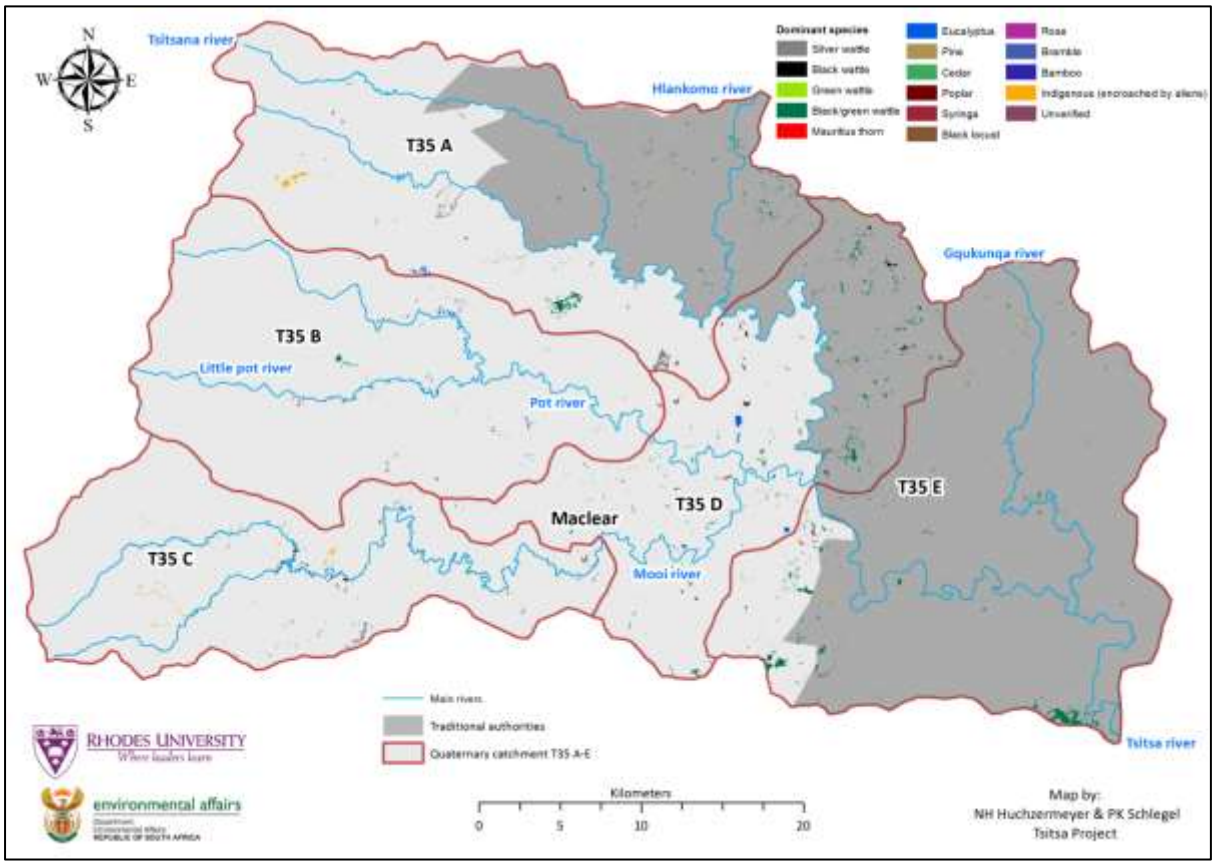



**Figure 14: Location of low priority alien vegetation polygons showing dominant species in Catchment T35 A-E**

### 4.8.2. Moderate priority

Table 6 and Figure 15 show the dominant species and their location (Figure 16) in moderate priority alien vegetation polygons in Catchment T35 A-E. The dominant species found in alien vegetation polygons are mostly Black/green wattle (44%) followed by Silver wattle (38%). The remaining species shown in Table 6 make up a significantly smaller proportion of the uncondensed area of alien vegetation.

**Table 6: Summary of dominant species found in moderate priority alien vegetation polygons in Catchment T35 A-E**

| Dominant species | No. patches of alien vegetation | Uncondensed Area H (ha) | Percentage (%) uncondensed area of alien vegetation |
|---|---|---|---|
| **Silver wattle** | 1 340 | 1 241 | 38 |
| **Black wattle** | 145 | 177 | 5 |
| **Green wattle** | 149 | 59 | 2 |
| **Black/green wattle** | 1 912 | 1 423 | 44 |
| **Mauritius thorn** | 29 | 1 | <1 |
| **Eucalyptus** | 137 | 148 | 5 |
| **Pine** | 17 | 4 | <1 |
| **Cedar** | 5 | 1 | <1 |
| **Poplar** | 97 | 95 | 3 |
| **Oak** | 35 | 9 | <1 |
| **Willow** | 3 | 1 | <1 |
| ***Celtis* (Stinkwood)** | 1 | <1 | <1 |
| **Syringa** | 4 | <1 | <1 |
| **Honey locust** | 1 | <1 | <1 |
| **Black locust** | 4 | <1 | <1 |
| **Agave** | 6 | <1 | <1 |
| **Prickly Pear** | 5 | <1 | <1 |
| **Bugweed** | 2 | <1 | <1 |
| **Rose** | 1 | <1 | <1 |
| **Bramble** | 2 | <1 | <1 |
| **Indigenous encroached by aliens** | 399 | 94 | 3 |
| **Unverified alien** | 89 | 11 | <1 |

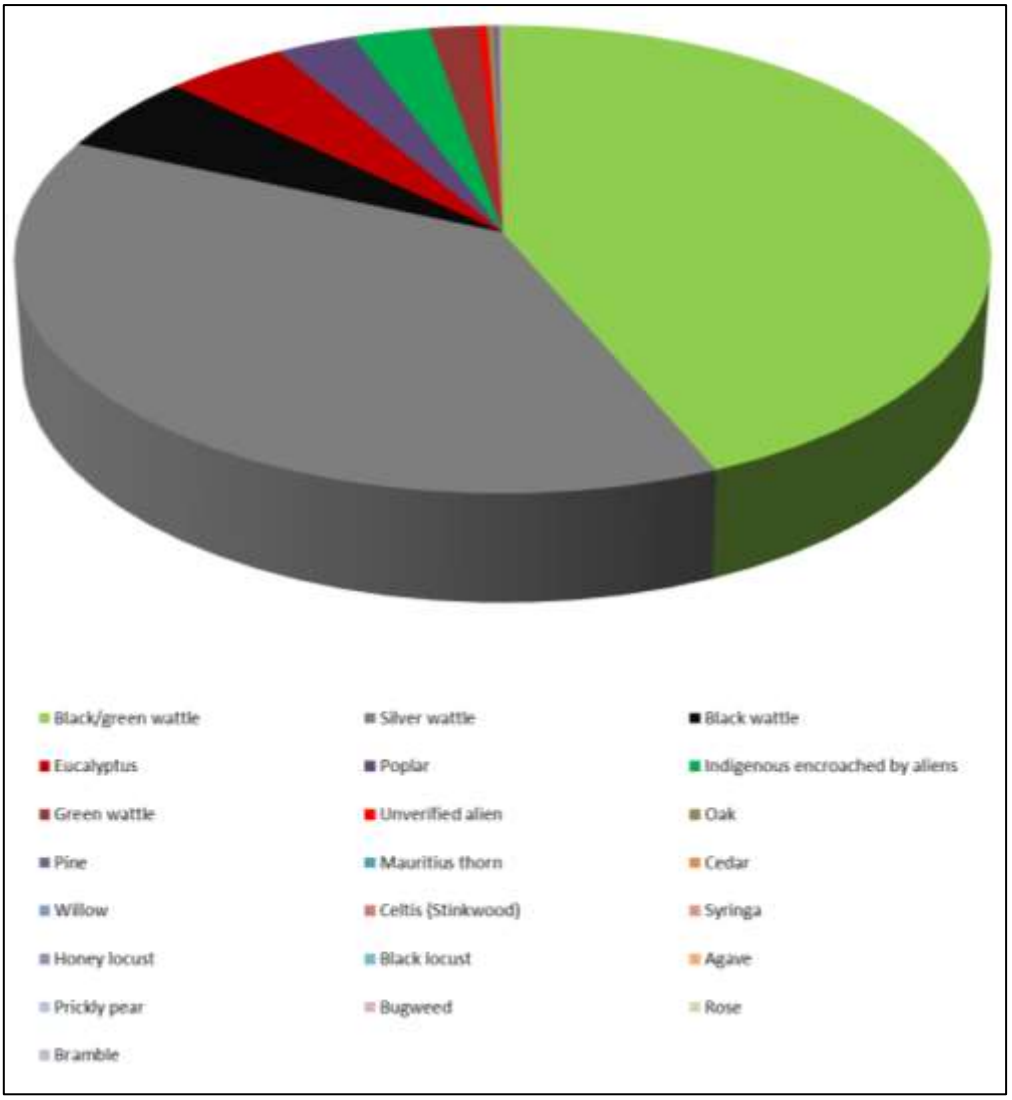



**Figure 15: Proportions of dominant species in moderate priority alien vegetation polygons in Catchment T35 A-E**

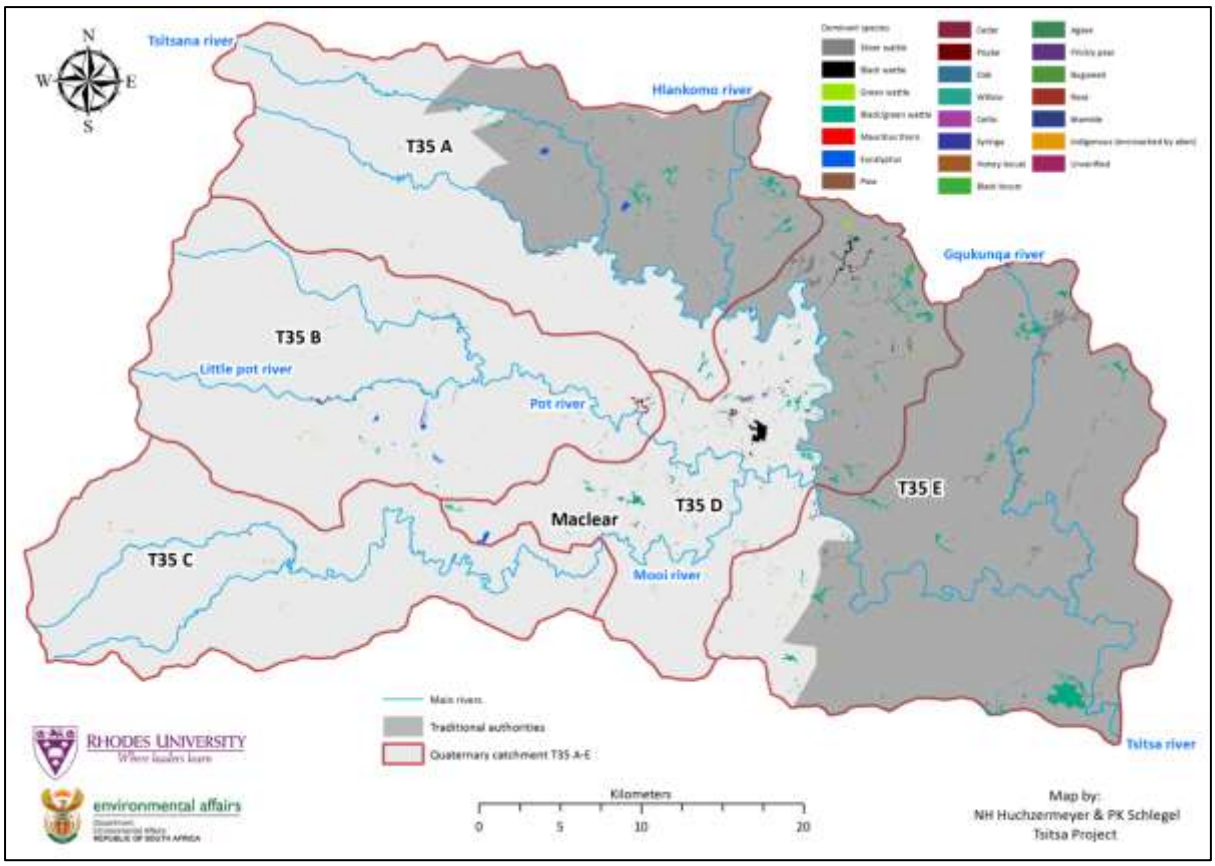



**Figure 16: Location of moderate priority alien vegetation polygons showing dominant species in Catchment T35 A-E**

### *4.8.3. High priority*

Table 7 and Figure 17 show the dominant species and their location (Figure 18) in high priority alien vegetation polygons in Catchment T35 A-E. The dominant species found in alien vegetation polygons are mostly Black/green wattle (53%) followed by Silver wattle (38%). The remaining species shown in Table 7 make up a significantly smaller proportion of the uncondensed area of alien vegetation.

**Table 7: Summary of dominant species found in high priority alien vegetation polygons in Catchment T35 A-E**

| Dominant species | No. patches of alien vegetation | Uncondensed Area H (ha) | Percentage (%) uncondensed area of alien vegetation |
|---|---|---|---|
| **Silver wattle** | 423 | 509 | 38 |
| **Black wattle** | 23 | 15 | 1 |
| **Green wattle** | 67 | 61 | 5 |
| **Black/green wattle** | 382 | 716 | 53 |
| **Eucalyptus** | 30 | 14 | 1 |
| **Pine** | 3 | 1 | <1 |
| **Poplar** | 11 | 10 | 1 |
| **Syringa** | 2 | <1 | <1 |
| **Indigenous encroached by aliens** | 51 | 18 | 1 |

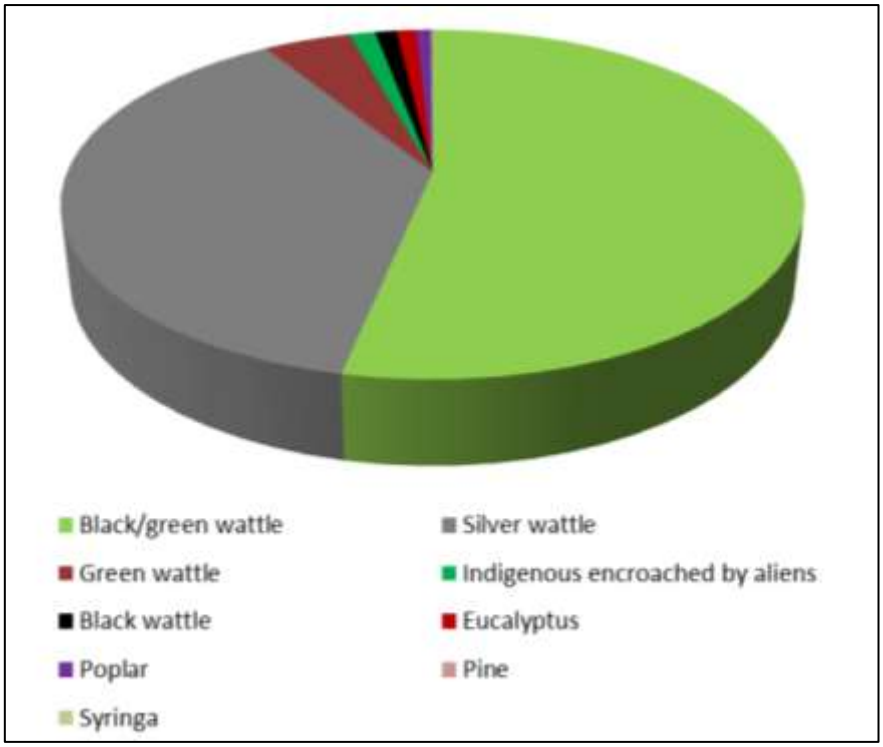



**Figure 17: Proportions of dominant species in high priority alien vegetation polygons in Catchment T35 A-E**

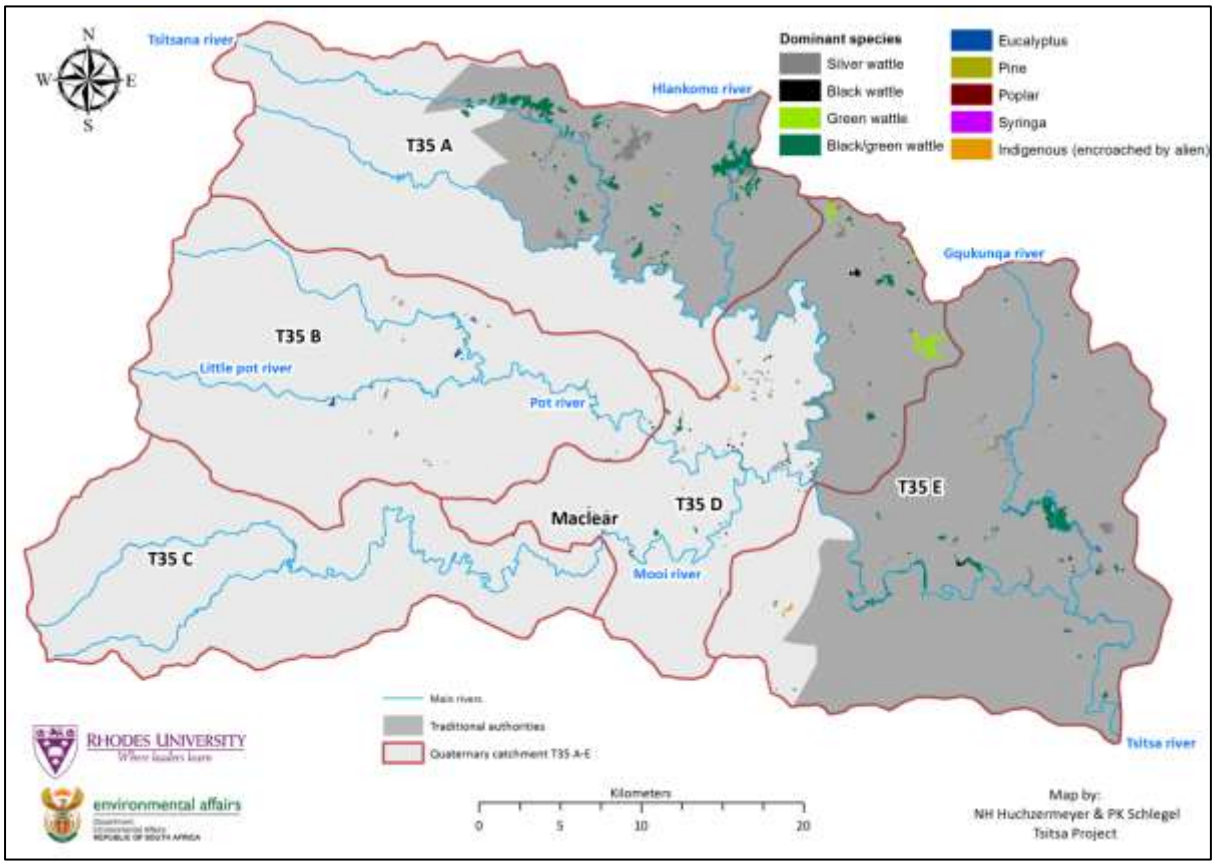



**Figure 18: Location of high priority alien vegetation polygons showing dominant species in Catchment T35 A-E**

### 4.8.4. Very high priority

Table 8 and Figure 19 show the dominant species and their location (Figure 20) in very high priority alien vegetation polygons in Catchment T35 A-E. The dominant species found in alien vegetation polygons are Black/green wattle (73%) followed by Silver wattle (23%).

**Table 8: Summary of dominant species found in very high priority alien vegetation polygons in Catchment T35 A-E**

| Dominant species | No. patches of alien vegetation | Uncondensed Area H (ha) | Percentage (%) uncondensed area of alien vegetation |
|---|---|---|---|
| **Silver wattle** | 23 | 122 | 27 |
| **Black wattle** | 1 | <1 | <1 |
| **Green wattle** | 6 | 2 | <1 |
| **Black/green wattle** | 23 | 333 | 73 |

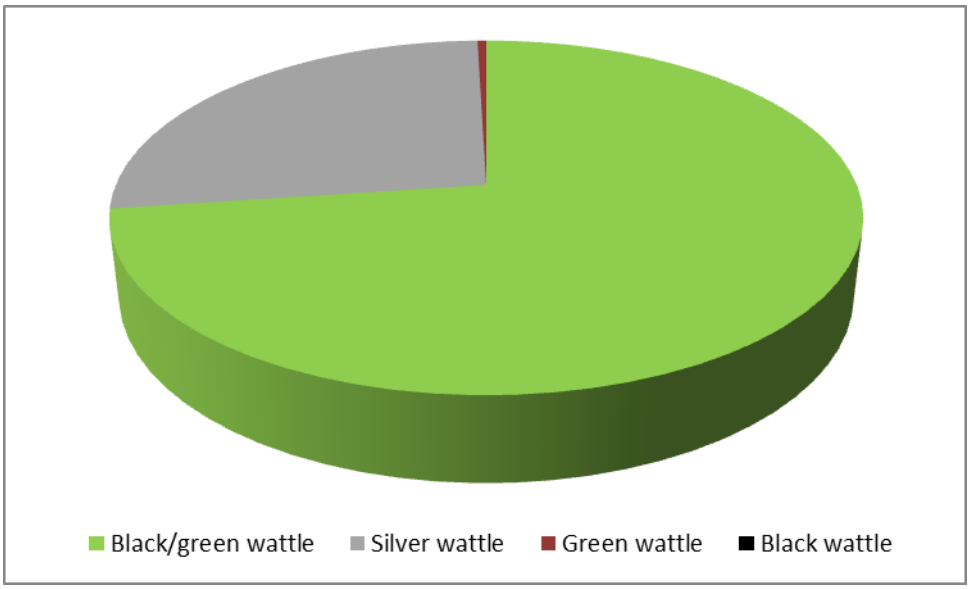



**Figure 19: Proportions of dominant species in very high priority alien vegetation polygons in Catchment T35 A-E**

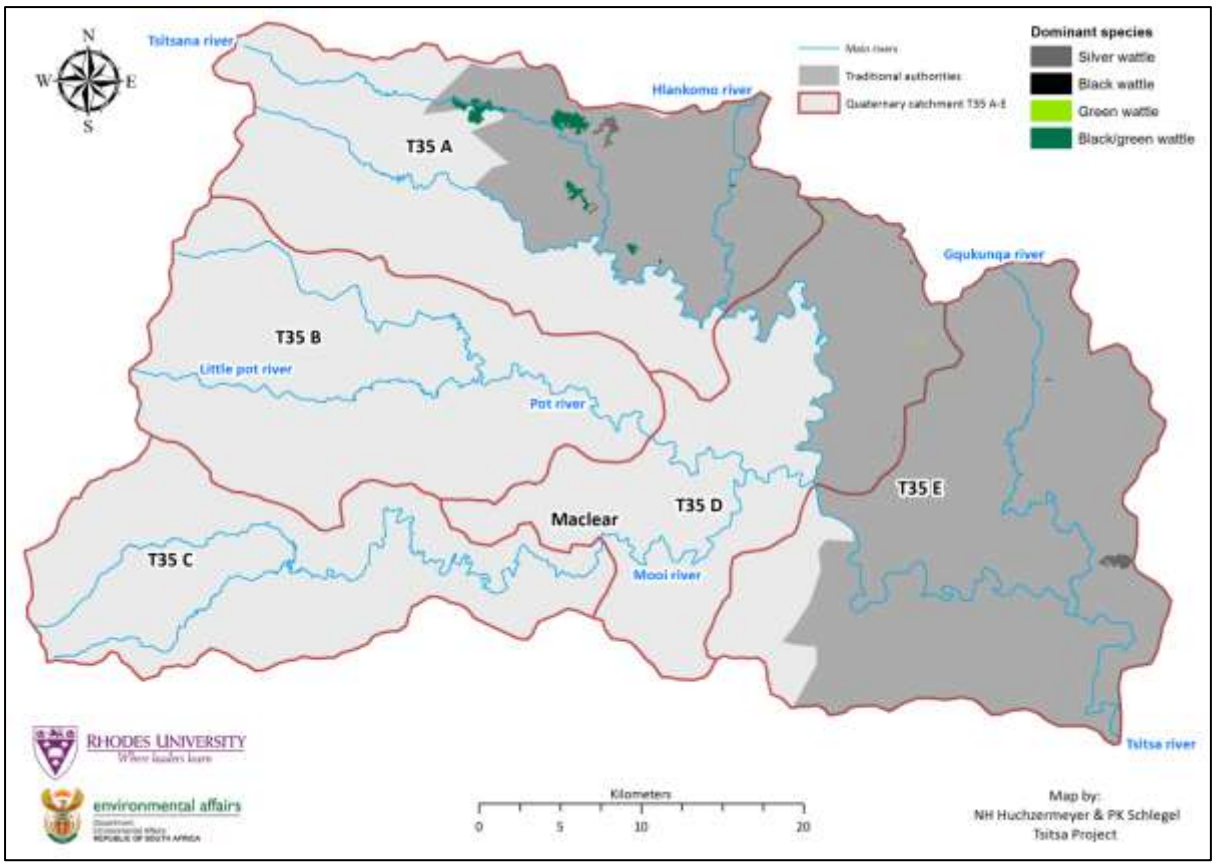



**Figure 20: Location of very high priority alien vegetation polygons showing dominant species in Catchment T35 A-E**

### 4.8.5. Priority vegetation in focus sub-catchments

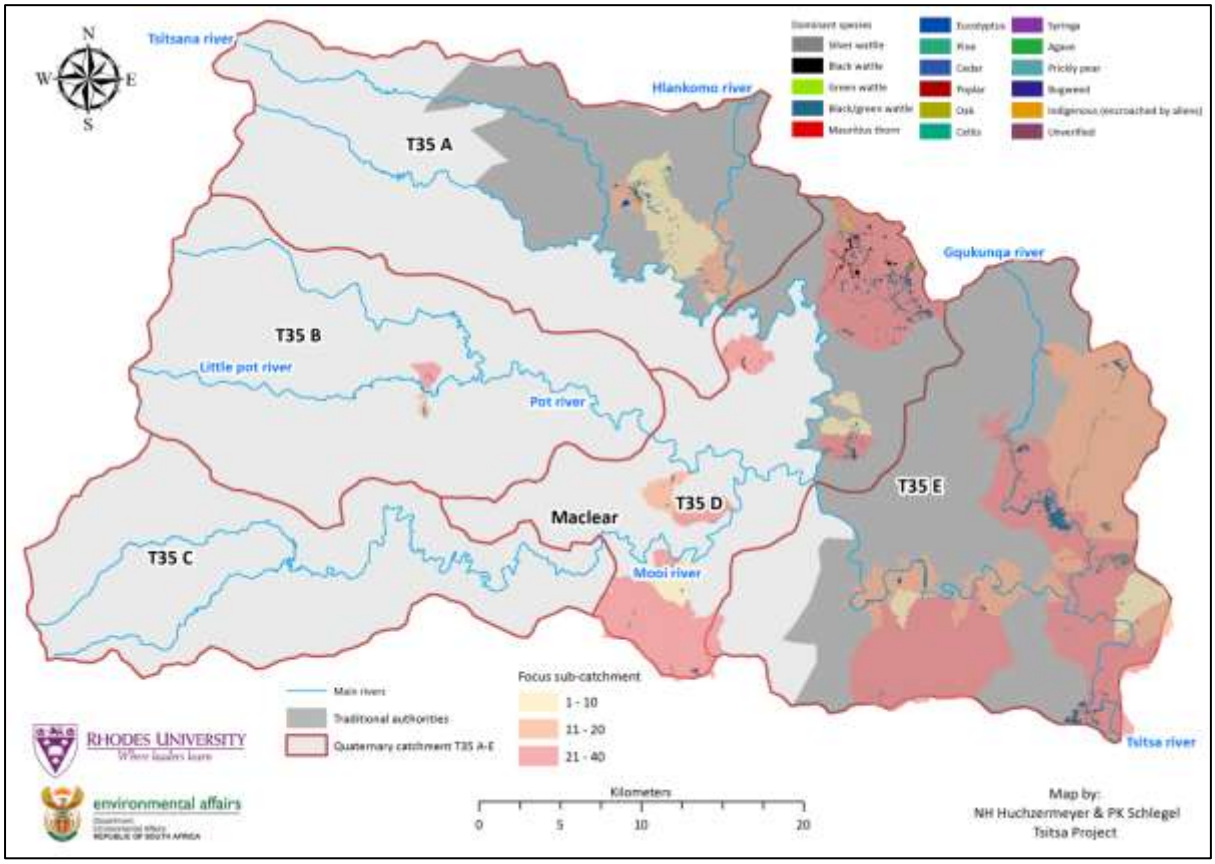



**Figure 21: Location of alien vegetation polygons showing dominant species in focus sub-catchments in Catchment T35 A-E**

## 5. CONCLUDING REMARKS

There are various ways to prioritise alien vegetation in Catchment T35 A-E. However, to optimise alien vegetation management with limited resources it is important to use a top-down approach to manage alien vegetation in such a way that it maximises benefits to both the local stakeholders (livelihoods) and biodiversity (ecosystems).

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# APPENDICES

## Appendix 1: Spatial dataset

This data is available in .shp and .kml format to allow the user to interact with the data at various scales and run queries. The database column headings and units are given in Table 9 below.

**Table 9: Spatial dataset for the prioritised alien vegetation found in Catchment T35 A-E**

| File name: Alien Vegetation T35 A-E | |
|---|---|
| **Description** | Prioritised alien vegetation in Catchment T35 A-E |
| **Data Origin** | Woody vegetation T35_A_E layer |
| **Scale Captured** | - Remote sensing from: RapidEye satellite imagery with 5 meter resolution dated 31.10.2017 (Image numbers: 20171031_083145_3524821_Rapideye-2; 20171031_083149_3524720_Rapideye-2; 20171031_083149_3524721_Rapideye-2).<br>- Digitising at a scale of 1: 10 000 |
| **Date Captured** | - Remote sensing: 31/10/2018<br>- Digitising: Off 2015/2016 aerial images<br>- Field verification and classification: 01/2018 (T35E) & 08/2018 (T35A-D) |
| **Layer Properties** | |
| **Feature Type** | Vector format (polygon) |
| **Projection** | |
| **Projection Name** | Geographic Coordinate System – GCS_WGS_1984 |
| **Datum** | D_WGS_1984 |
| **Prime Meridian** | Greenwich |
| **Angular Unit** | Degree |

| Attribute Fields | |
|---|---|
| **Field Name** | **Description** |
| **FID** | Feature Identification |
| **Shape** | Polygon |
| **Type** | Category (level 1 classification) |
| **Area_ha** | Area of each polygon in hectares |
| **D_species** | Dominant species (explanation of codes available in report) |
| **Point_name** | Reference point (field data)/unverified |
| **C_D** | Percent overall canopy density |
| **Photo** | Photo number (photo available on request: nicky.huchzermeyer@gmail.com) |
| **Descriptio** | Description of area of invasion |
| **S*_Y** | Percent coverage of alien species that is young |
| **S*_M** | Percent coverage of alien species that is medium |
| **S*_O** | Percent coverage of alien species that is old |
| **S*** | Species |
| **Indig** | Indigenous |
| **I_notable** | Any observations regarding indigenous vegetation |
| **Used** | Significant signs of use |
| **Priority_1** | Alien vegetation intersecting a 50 meter buffer around riparian zones and drainage lines which fall within a 1 kilometre buffer of village boundaries |
| **Priority_2** | Alien vegetation intersecting a 500 meter buffer around 'problem' points identified by communities |
| **Priority_3** | Alien vegetation intersecting with previously cleared polygons |
| **Priority_4** | All alien vegetation |
| **Priority_5** | Alien vegetation that exhibits a canopy density of 50% or less |
| **Priority** | Unweighted scoring system of alien vegetation polygons which fall in one or more of the priorities (1-5) |

## Appendix 2: dominant species observed and mapped in Catchment T35 A-E (Huchzermeyer *et al*., 2018)

**Table 10: Details of dominant species observed and mapped in Catchment T35 A-E**

| Genus | Species | Common name | Image | IAPs Category | Notes for T35 A-E |
|---|---|---|---|---|---|
| **Indigenous** | Spp. | |  | n/a | Forest patches and other trees, shrubs and bushes.<br>Commonly threatened by invasive species<br>Shrubs and bushes contributing to bush encroachment in disturbed areas |
| ***Acacia*** | *dealbata* | Silver Wattle |  | 2 | Dominant IAP in riparian zones<br>Thick stands along tributaries of the Tsitsa River<br>Can be found interspersed with indigenous trees and shrubs along the Tsitsa River |

| | | | | | |
|---|---|---|---|---|---|
| ***Acacia*** | *mearnsii* | Black Wattle |  | 2 | Invades riparian zones<br>Dense stands found on mountain slopes<br>Co-exists with Green wattle<br>Found in village gardens, farmsteads and urban areas |
| ***Acacia*** | *decurrens* | Green Wattle |  | 2 | Invades riparian zones<br>Dense stands found on mountain slopes<br>Co-exists with Black wattle<br>Found in village gardens, farmsteads and urban areas |

| | | | | | |
|---|---|---|---|---|---|
| ***Acacia*** | *Spp.* | Combination of Green and Black Wattle |  | 2 | Dense stands often contain both black and green wattles making it difficult to distinguish between the two from a distance. In the photo green wattle is flowering (August, 2018) |
| ***Caesalpinia*** | *decapetala* | Mysore or Mauritius thorn |   | 1b | Very common in drainage lines, gullies and on hillslopes in Catchment T35 E<br>Creates dense stands<br>Also found around road culverts and old kraals |

| | | | | | |
|---|---|---|---|---|---|
| ***Eucalyptus*** | *spp.* | Various Eucalyptus |  | Various species with different Listings | Single trees often in and around village gardens and farmstead<br>Also found in plantations and woodlots<br>Found in urban areas |
| ***Pinus*** | *spp.* | Pine |  <br>  | 2 | Found in plantations<br>Not actively invading except around plantations<br>Single trees found in villages and farmsteads |

| | | | | | |
|---|---|---|---|---|---|
| ***Juniperus*** | *Spp.* | Cedar |  | 3 | Found in village, urban and farmstead gardens |
| ***Casuarina*** | *Spp.* | Horsetail tree |  | 2 | Found in and proximal to urban centres |

| | | | | | |
|---|---|---|---|---|---|
| ***Populus*** | *spp.* | Grey Poplar<br>Match Poplar |  <br>  | 2<br>1b (in riparian zones) | Poplar stands found on hillslopes, in old fields and riparian zones particularly in the upper and middle catchments<br>Found in semi-urban and urban areas |

| | | | | | |
|---|---|---|---|---|---|
| ***Ligustrum*** | *Spp.* | Privet |  | 1b | Found in village, urban and farmstead gardens |
| ***Querces*** | *Spp.* | Oak |  | Not listed | Found in village, urban and farmstead gardens<br>Commonly found in riparian zones |
| ***Grevillea*** | *robusta* | Silky oak |   | 3 | Found in village garden |

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| ***Salix*** | *Spp.* | Willow |  | 2 | Not common in lower catchment. More common in riparian zones in the middle and upper catchments<br>Found in riparian zones and around houses |
| ***Cotoneaster*** | *Spp.* | Cotoneaster |  | 3 | Found in riparian zones in the middle catchment |
| ***Pyracantha*** | *angustifolia* | Yellow firethorn |  | 3 | Found on hillslopes in the middle catchment |

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| ***Celtis*** | *australis* | Nettle or Hackberry tree |  | | Found in riparian zones in the lower catchment<br>Found in urban areas |
| ***Melia*** | *azedarach* | Syringa |  | 3 (urban areas)<br>1b (elsewhere) | Common tree in village, urban and farmstead gardens<br>Also seen in Riparian zones in the lower catchment |
| ***Gleditsia*** | *triacanthos* | Honey locust |  | 1b | Common tree in villages and disturbed areas e.g. gullies |

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| ***Robinia*** | *pseudoacacia* | Black locust |  | 2 | Stands found in the upper catchment |
| ***Jacaranda*** | *mimosifolia* | Jacaranda |  | 1b | Found in village, urban and farmstead gardens |

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| ***Un-identified*** | | |  | | Found at old homestead |
| ***Schinus*** | *molle* | Pepper tree |  | 1b | Found in village gardens |

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| ***Un-identified*** | | Possibly Strawberry guava (*Psidium cattleianum)* |   | | Found in old farmstead |
| ***Platanus*** | *Spp.* | Plane tree | | | Urban- Maclear |

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| ***Lagerstroemia*** | *indica* | Pride of India |  | | Urban- Maclear |
| ***Nerium*** | *oleander* | Oleander |  | 1b | Found in village garden |
| ***Fruit trees*** | | e.g. peach, lemon tree |  | | Most common garden trees |

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| ***Agave*** | *Spp.* | Agave |  | Category 3 in the Western Cape, not on national list | Found on hillslopes and around houses |
| ***Opuntia*** | *ficus-indica* | Sweet Prickly Pear |  | 1b | Found in villages, gullies and on hillslopes |
| ***Cereus*** | *jamacaru* | Queen of the night |  | 1b | Seen in gardens |

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| ***Echinopsis*** | *spachiana* | Torch cactus |  | 1b | Found in villages and disturbed areas |
| ***Solanum*** | *mauritianum* | Bugweed |  | 1b | Mostly in gardens or disturbed areas |

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| ***Rosa*** | *rubiginosa* | Sweetbriar |  | 1b | Found in and around plantations |
| ***Rubus*** | *Spp.* | Brambles |  | 1b | Found in and around plantations. Commonly dense thickets encroaching drainage lines |
| | | Bamboo |  | | Farmsteads and urban gardens |

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| | | Palm species |  | | Urban- Maclear |
| ***Cirsium*** | *vulgare* | Scotch Thistle |  | 1b | Disturbed areas e.g. cultivated lands or roadsides |
| ***Xanthium*** | *spinosum* | Spiny Cocklebur |  | 1b | Disturbed areas e.g. cultivated lands or roadsides |

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| ***Datura*** | *Spp.* | Thorn Apple |  | 1b | Disturbed areas e.g. cultivated lands or roadsides |
| ***Unidentified*** | | |   | | Disturbed areas e.g. cultivated lands, roadsides and drainage lines |

## Appendix 3: Recorded and probable alien plants in Catchment T35 A-E (Clark, 2017)

**Table 11: Recorded and probable alien plants in Catchment T35A-E (Clark, 2017)**

| Genus | Species | Common name | Categories, Notes & Comments |
|---|---|---|---|
| ***Acacia*** | *dealbata** | Silver Wattle | Category 2. The most silvery-leaved of the typical 'wattles'. |
| ***Acacia*** | *mearnsii** | Black Wattle | Category 2. Easy to confuse with *A. decurrens*. |
| ***Acacia*** | *decurrens* | Green Wattle | Category 2. Easy to confuse with *A. mearnsii*. |
| ***Agave*** | *americana* | American Agave | *Agave americana* subsp. *americana* var. *expansa* is Listed as Category 3 in the Western Cape, but not elswhere, although certainly shows invasive tendencies in most dry areas in South Africa. Difficult to know how this differs from the 'usual' American Agave. Complex taxonomy in the American Agavaceae. |
| ***Arundo*** | *donax** | Spanish Reed | Category 1b. Not to be confused with our smaller, indigenous *Phragmites australis* (Common Reed). |
| ***Atriplex*** | *inflata* | Sponge-fruit Saltbush | Category 1b. Typical invader of karroid flats and degraded arid areas. |
| ***Cirsium*** | *vulgare* | Scotch Thistle | Category 1b. Common ruderal weed in disturbed grasslands. |
| ***Cotoneaster*** | *pannosus** | Silver-leaf Cotoneaster | Category 1b. A montane invader becoming problematic along the eastern Escarmpment (from the Amatholes up to the Wolkberg); also an emerging problem in the Grahamstown area; also problematic in the eastern Free State, and probably the KZN Midlands. |
| ***Cotoneaster*** | *franchetii* | Orange Cotoneaster | Category 1b. |
| ***Cuscuta*** | *campestris* | Common Dodder | Category 1b. Taxonomy and identification difficult given identical-looking indigenous species potentially present. |
| ***Cuscuta*** | *suaveolens* | Lucerne Dodder | Category 1b. Taxonomy and identification difficult given identical-looking indigenous species potentially present. |
| ***Datura*** | *ferox* | Large Thorn Apple | Category 1b. Common weed of agricultural and disturbed lands. |
| ***Datura*** | *stramonium* | Common Thorn Apple | Category 1b. Common weed of agricultural and disturbed lands. |
| ***Echium*** | *plantagineum* | Patterson's Curse | Category 1b. Common montane invader along tracks and roads. |
| ***Eucalyptus*** | spp.* | Various Gums | Various species with different Listings. Noted here due to general high water abstraction rates, and naturalised in parts of the Catchment. |
| ***Gleditsia*** | *triacanthos* | Honey Locust | Category 1b. Montane and Highveld invader, especially along watercourses. |
| ***Juniperus*** | *virginiana* | Red Cedar | Category 3 in the Eastern Cape. Locally invasive in parts of the eastern Free State and Lesotho – an emerging problem plant. A species to flag as a potential future challenge in the Catchment. |
| ***Lepidium*** | *draba* | Hoary Cardaria | Category 1b. |

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| ***Ligustrum*** | *ovalifolium* | Californian Privet | Category 1b in the Eastern Cape. A potential garden escapee from e.g. Maclear. |
| ***Ligustrum*** | *sinense* | Chinese Privet | Category 1b in the Eastern Cape. A potential garden escapee from e.g. Maclear. |
| ***Ligustrum*** | *vulgare* | Common Privet | Category 1b in the Eastern Cape. A potential garden escapee from e.g. Maclear. |
| ***Melia*** | *azedarach* | Syringa | Category 3 in urban areas; Category 1b elsewhere. Possibly common in the Catchment, particularly the lower reaches. |
| ***Nasturtium*** | *officinale* | Watercress | Category 2. Common water-plant in streams and rivers of the eastern Great Escarpment, forming extensive colonies. Very typical along watercourses in montane Eastern Cape areas. |
| ***Nerium*** | *oleander* | Oleander | Category 1b. More of a problem in more humid, coastal areas. Less likely to be a problem in the Catchment, but potentially present in the lower reaches. |
| ***Opuntia*** | *ficus-indica* | Sweet Prickly Pear | Category 1b. Probably under effective biocontrol. Low priority and concern. |
| ***Pinus*** | *halepensis* | Aleppo Pine | Category 3. Invasive in the Great Winterberg, and in the Sunshine Coast area. Potentially a problem in the Catchment. |
| ***Pinus*** | *patula* | Patula Pine | Category 2. A dominant local plantation species. Highly invasive in montane grassland. After the typical wattles is one of our most problematic montane invasive species. |
| ***Pinus*** | *pinea* | Stone Pine | Not Listed. Unlikely to be a concern in the Catchment. |
| ***Populus*** | x *cansescens** | Grey Poplar | Category 2. Although its preference for riparian zones immediately upgrades it to Category 1b in most cases. Very common in montane and Highveld catchments in South Africa. Very hard to manage; forms an extensive sucker network than takes many repeated applications of a systemic herbicide to control. |
| ***Populus*** | *deltoides* | Match Poplar | Not Listed. Not a major invader. Unlikely to be of concern. |
| ***Populus*** | *nigra* var. *italica* | Lombardy Poplar | Not Listed. Not a major invader. As above. |
| ***Pyracantha*** | *angustifolia* | Yellow Firethorn | Category 1b. Vigorous montane invader from Grahamstown inland to the Drakensberg, on the eastern Highveld, as well as north through montane KZN, Mpumalanga and Limpopo. |
| ***Quercus*** | *robur* | English Oak | Not Listed. Not likely to be a problem in the Catchment. |
| ***Robinia*** | *pseudo-acacia** | Black Locust | Category 1b. A major invader in moist eastern & montane grasslands and Highveld. |
| ***Rosa*** | *rubiginosa* | Sweet Briar | Category 1b. A highly invasive rose prevalent in the Eastern Cape escarpment region, the Maluti-Drakensberg and eastern Free State. |
| ***Rubus*** | *cuneifolius* | American Bramble | Category 1b. Part of a complex suite of brambles present in South Africa: some are invasive, some are indigenous, and some are hybrids between them. Requires specialist knowledge to separate them and make appropriate recommendations. This species is the most probable invasive bramble present. It is potentially present in high volumes around towns, farmsteads, in plantations, along forested valleys, and anywhere with permanent moisture. |
| ***Rubus*** | *flagellaris* | Bramble | Category 1b. Part of a complex suite of brambles present in South Africa: some are invasive, some are indigenous, and some are hybrids between them. The likelihood of its presence in the |

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| | | | Catchment unknown (Henderson's 2001 map lumped these *Rubus* species together). |
| ***Rubus*** | *fruticosus* | European Blackberry | Category 2. Part of a complex suite of brambles present in South Africa: some are invasive, some are indigenous, and some are hybrids between them. The likelihood of its presence in the Catchment unknown (Henderson's 2001 map lumped these *Rubus* species together). |
| ***Rubus*** | x *proteus* | American Bramble (hybrid) | Category 1b. Part of a complex suite of brambles present in South Africa: some are invasive, some are indigenous, and some are hybrids between them. The likelihood of its presence in the Catchment unknown (Henderson's 2001 map lumped these *Rubus* species together). |
| ***Salix*** | *babylonica** | Weeping Willow | Not Listed, but an aggressive invader of riparian zones in cool montane and Highveld wetland areas. A riparian transformer that destabilises river banks and causes stream blockage from the accumulation of its broken tree debris. |
| ***Salix*** | *fragilis* | Crack Willow | Not Listed. But an aggressive invader of riparian zones in cool montane and Highveld wetland areas. A major problem in Lesotho. A riparian transformer that destabilises river banks and causes stream blockage from the accumulation of its broken tree debris. Easily confused with our indigenous Safsaf Willow (*S. mucronata*), so identification should be done by a specialist. |
| ***Xanthium*** | *spinosum* | Spiny Cocklebur | Category 1b. Common weed of disturbed areas. |
| ***Xanthium*** | *strumarium* | Large Cocklebur | Category 1b. Common weed of disturbed areas. |