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# The prioritization of terrestrial biomes for invasive alien plant control in South Africa

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## *Tables and Figures*

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The photographs appearing on the cover were taken by Greg Forsyth and David Le Maitre.

# Executive Summary

1. This report presents the outcome of a prioritization exercise, aimed at ranking South Africa's 9 terrestrial biomes adapted from Mucina and Rutherford (2006), in terms of their importance with respect to the need to control invasive alien plants.

2. The biomes included here (in order of surface area) are the (moist and arid) savanna, Grassland, Nama Karoo, Fynbos, Succulent Karoo, Albany Thicket, Indian Ocean Coastal Belt, desert and forest. The "azonal vegetation" biome was not included in the study due its fragmented nature. These areas were incorporated into the surrounding biomes.

3. A total of 23 invasive alien plant species were recognised as important across all of the biomes, and these species were used in the prioritization process.

4. We used the Analytic Hierarchy Process (AHP) to facilitate a process of prioritization. AHP is a multiple criteria decision-making tool for setting priorities when both qualitative and quantitative aspects of a decision need to be considered.

5. Biomes were prioritized based on a set of established criteria. A total of three main criteria, eight sub-criteria and seven sub-sub-criteria were identified and weighted. The extent and density of invasive alien plants was assigned the greatest weight (60%). The value of ecosystem services, and the social consequences of invasive alien plant clearing programmes were assigned equal priority (20% each), and current water yield carried more than half of the weight allocated to ecosystem services (10.6 out of 20%).

6. Each biome was compared to each other biome with regard to each criterion. These comparisons were of two types. First, where data were available for a given criterion (seven out of 11 criteria), comparisons were carried out using proportions related to these data. Secondly, where data were not available (the remaining four criteria), comparisons were made using expert consensus.

7. The prioritization exercise led to the Indian Ocean Coastal Belt, Fynbos, Moist Savanna and Grassland biomes receiving the highest priority. Forest, Arid Savanna, Succulent Karoo, Nama Karoo, Albany Thicket and desert received the lowest priorities.

8. Overall, the indications are that funding levels are aligned with priorities at the highest level. The comparison of the planned expenditure for the 2009/10 financial year and the priorities defined by this study indicates that the projects, by and large, are funded in accordance with priorities with one notable exception being the Indian Ocean Coastal Belt.

We recommend that the broad patterns of funding should remain in place, but that the funding situation in the Indian Ocean Coastal Belt should be reviewed, taking into account the KwaZulu/Natal Province's funding, to ascertain whether an adjustment in funding would be appropriate.

# 1. Introduction

The Working for Water programme addresses the significant problem of invasive alien plants, while at the same time using the opportunity to create employment and alleviate poverty. The Working for Water programme's strategic plan for the period 2008 – 2012 recognizes that the relative importance of the impacts of invasive alien plants will differ between biomes at a national level. It also recognizes that impacts depend further on the extent of the exploitation of water, and on patterns of land use. Given these, the potential (positive) impact of an invasive alien plant control programme will differ on a biome basis. This has led to the recognition that investment in invasive alien plant control projects need to be prioritized, and several projects have sought to do this for primary catchments within biomes (van Wilgen *et al*. 2008a) and quaternary catchments within priority primary catchments (Forsyth *et al*. 2009). The question of how the terrestrial biomes themselves should be prioritized as a basis for allocating the national budget for alien plant clearing projects also needs to be addressed, and this report presents the outcome of a prioritization exercise for the terrestrial biomes of South Africa. The report is based on the use of multi-criteria decision analysis, and should be read in conjunction with earlier reports of similar prioritization exercises at finer scales (van Wilgen *et al*. 2008a; Forsyth *et al*. 2009).

# 2. Methods

## 2.1 Selection of biomes

The decision in earlier studies (van Wilgen *et al*. 2008a; Forsyth *et al*. 2009) to use biomes (as opposed to, for example, provinces) as a basis for prioritization was a logical one. Biomes tend to be associated with a particular set of ecosystem services, and they tend to be invaded by a particular set of invasive alien plants. These earlier reports were based on the vegetation map produced by Low and Rebelo (1998). However, a more recent digital map, with improved mapping of biomes, has been produced by Mucina and Rutherford (2006), and has been used as a basis for this report (Figure 1, Table 1). In addition, a new biome (the Indian Ocean Coastal Belt), has been recognised, and the thicket biome (which was included in the savanna biome in our first prioritization, van Wilgen *et al*. 2008a) was reduced to the Albany Thicket which is confined to the Eastern Cape. We divided the Savanna biome into two parts; moist and Arid Savanna following the method described in van Wilgen *et al.* 2008a. The Forest biome was not included as a separate biome by van Wilgen *et al*. (2008a) because the total area is very small and spread across many biomes. The limited extent of the individual forest patches means that they rarely occupy most of a quaternary catchment and would, therefore, rarely result in them affecting the prioritization of a catchment. However, the specialists whose inputs we used in the prioritization argued strongly that the Forest biome should be kept separate and this has been done.

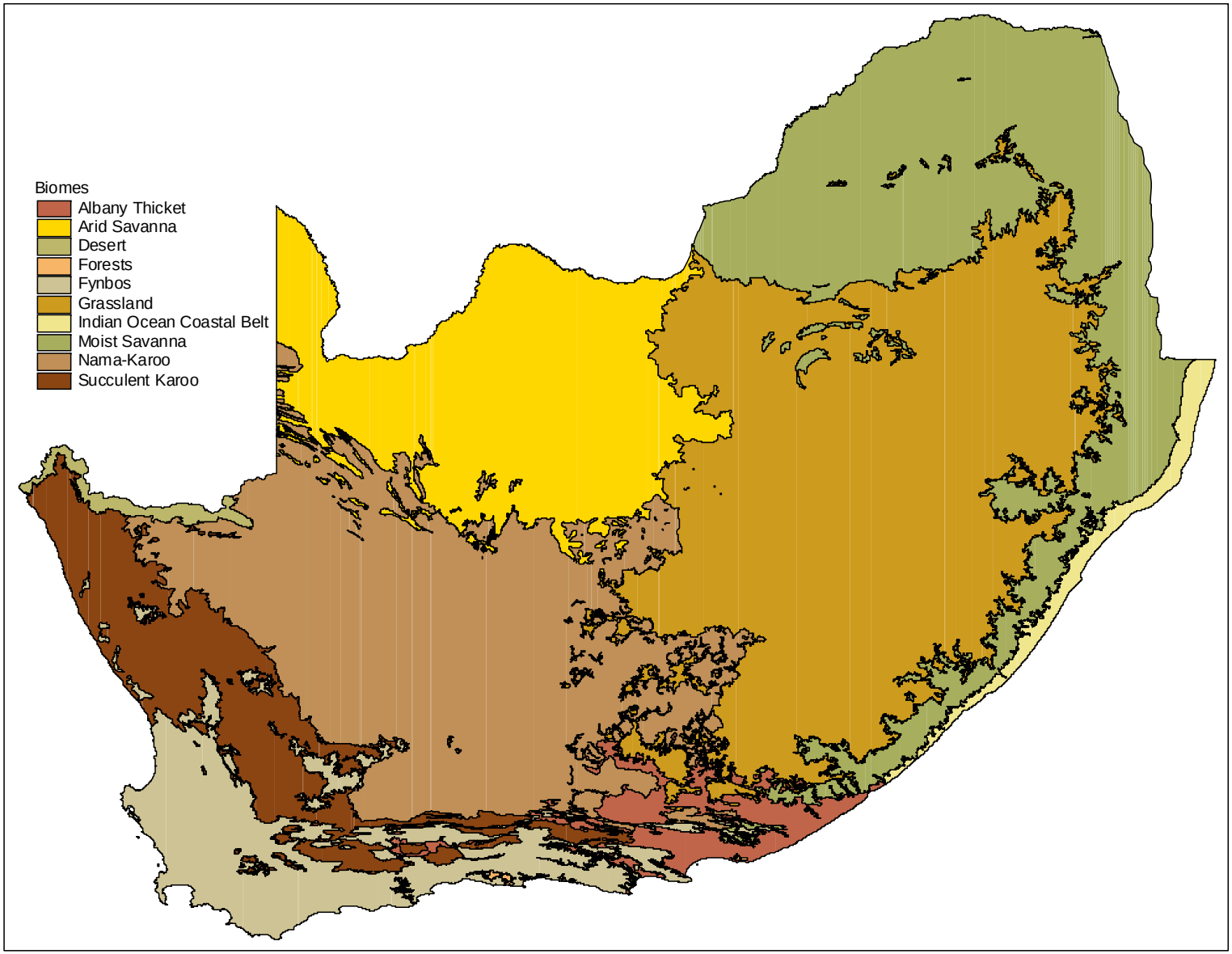


**Figure 1. Major terrestrial biomes in South Africa, Lesotho and Swaziland (after Mucina and Rutherford 2006).**

**Table 1. The extent of terrestrial biomes in South Africa, Lesotho and Swaziland ranked by area ($km^2$)**

| Terrestrial biome | Area ($km^2$) |
|---|---|
| Forest | 4 714 |
| Desert | 7 165 |
| Indian Ocean Coastal Belt | 14 281 |
| Albany Thicket | 29 127 |
| Succulent Karoo | 83 283 |
| Fynbos | 92 721 |
| Nama Karoo | 248 280 |
| Grassland | 354 593 |
| Savanna (Moist and Arid) | 412 544 |

## 2.2 Priority species within biomes

We compiled a list of the most important invasive alien plant species across the country by combining a list of the five most important species as prioritized for each biome by van Wilgen *et al.* (2008a) (Table 2). When the five most important species in each of the original biomes was combined, it resulted in a list of 19 species. This combined list did not include prioritized species for the new biomes, namely the Indian Ocean Coastal Belt, Albany Thicket, Desert and Forest biomes. For the Indian Ocean Coastal Belt we added *Caesalpinia decapetala* and *Cestrum laevigatum*. In the Forest biome we added *Rubus fruticosus* and *Rubus cuneiformis.* Invasions in the Desert biome are not well documented so we included two species from the top 5 in the Nama Karoo which are known to occur there. For the Albany Thicket we added *Echinopsis spachiana* and *Opuntia aurantiaca* as potentially important species based on the distribution maps in Henderson (2000) and species listed by Masubelele *et al.* (2009). Cactaceae, particularly those without biocontrol, are important invaders of thicket but we do not have suitable potential distribution data for those taxa at present. Only established invasive alien species were considered in the species selection and analysis (i.e. emerging species were not included) as this study was specifically focused on aiding Working for Water in the funding prioritization for established species. Emerging species detection and control is funded separately, although also by Working for Water. The final list of priority species amounted to 23 species (Table 2).

*Table 2/...*

**Table 2. The invasive alien plant species which were allocated the highest priority for clearing operations in the terrestrial biomes in South Africa (adapted from van Wilgen *et al*. 2008a).**

| Species | Albany Thicket | Desert | Fynbos | Forest | Grassland | Indian Ocean Coastal Belt | Nama Karoo | Savanna (arid) | Savanna (moist) | Succulent Karoo |
|---|---|---|---|---|---|---|---|---|---|---|
| *Acacia longifolia* (long-leafed wattle) | | | ✓ | | | | | | | |
| *Acacia mearnsii* (Black wattle) | | | ✓ | | ✓ | | | | | |
| *Acacia pycnantha* ( golden wattle) | | | ✓ | | | | | | | |
| *Arundo donax* (Spanish reed) | | ✓ | | | | | ✓ | | | ✓ |
| *Caesalpinia decapetala* (Mauritius thorn) | | | | | | ✓ | | | | |
| *Cereus jamacaru* (queen-of-the-night) | | | | | | | | ✓ | | |
| *Cestrum laevigatum* (inkberry) | | | | | | ✓ | | | | |
| Chromolaena odorata (Triffid weed) | | | | | | ✓ | | | ✓ | |
| *Echinopsis spachiana* (torch cactus | ✓ | | | | | | | | | |
| *Eucalyptus camaldulensis* (red river gum) | | | | | ✓ | | ✓ | | | ✓ |
| *Lantana camara* (Lantana) | | | | ✓ | | ✓ | | | ✓ | |
| *Melia azederach* (syringa) | | | | | | | | ✓ | ✓ | |
| *Nerium oleander* (oleander) | | | | | | | | | | ✓ |
| *Opuntia aurantiaca* (jointed cactus) | ✓ | | | | | | | | | |
| *Parthenium hysterophorus* (parthenium) | | | | | | | | | ✓ | |
| *Pinus spp* (pinaster, radiata and halepensis) | | | ✓ | | | | | | | |
| *Pinus patula* (patula pine) | | | | | ✓ | | | | | |
| *Pinus eliottii* (slash pine) | | | | | ✓ | | | | | |
| *Populus canescens* (Poplar trees) | | | ✓ | | | | ✓ | ✓ | | ✓ |
| *Prosopis glandulosa* (Mesquite) | | ✓ | | | | | ✓ | ✓ | | ✓ |
| *Psidium guajava* (guava) | | | | | | ✓ | | | ✓ | |
| *Rubus cuneifolius* (American bramble) | | | | ✓ | ✓ | | | | | |
| *Rubus fruticosus* (European blackberry) | | | | ✓ | | | | | | |
| *Schinus molle* (pepper tree) | | | | | | | ✓ | ✓ | | |

## 2.3 Process to weight criteria and prioritize biomes

We used the Analytic Hierarchy Process (AHP) to facilitate a process of prioritization (Saaty 1990). AHP is a multiple criteria decision-making tool for setting priorities when both qualitative and quantitative aspects of a decision need to be considered, and for achieving group consensus. The technique was developed in the 1970's by Dr Thomas Saaty, a mathematician, and enables users to deal with the intuitive, the rational and the irrational, and with risk and uncertainty in complex settings.

The prioritization of biomes involves the assessment of quantifiable and subjective criteria which are not normally directly comparable. A way of dealing with this complexity is to rank the various criteria in terms of their importance relative to each other; for example, are the effects of invasive alien plants on water resources more or less important than the impact of clearing projects on poverty? Once criteria have been ranked, the candidate biomes are scored on a scale from low to high in terms of each criterion. The product of this exercise is a list of biomes that are prioritized in terms of their contribution to the criteria.

We used Expert Choice decision support software (Anon. 2002) to facilitate the selection process. This involved setting a goal, breaking the goal down into its constituent parts and assigning relative weights to each of these in order to arrive at ranked criteria. Scoring was on a relative basis comparing each biome to each other biome relative to each criterion. Relative scores for each choice are computed within each level of the hierarchy. Scores are then synthesised using a model contained in the Expert Choice software. The process yields a composite score for each choice at every level as well as an overall score.

## 2.4 Selection and weighting of criteria

Criteria for the prioritization of terrestrial biomes for the purposes of invasive alien plant control were identified and weighted in a workshop involving 20 experts from around the country. Criteria were nested, resulting in three levels (main criteria, sub-criteria and sub-sub criteria). Expert Choice software was used to rank criteria by comparing main criteria to each other, sub-criteria to each other within main criteria and so on.

## 2.5 Comparison of biomes

Once the criteria had been identified and weighted, each biome was compared to each other biome with regard to each criterion. These comparisons were of two types. First, where data were available for a given criterion, comparisons were carried out using proportions related to these data. For example, one criterion used the number of priority species present in a biome as a criterion for comparison. Data on the number of species per biome could be derived from an atlas (Henderson 1998), and comparisons were made based on numbers obtained from the atlas. The weight assigned to a given biome was a proportion equal to the number of species in that biome divided by the sum of the number of species in all biomes. Secondly, where data were not available, comparisons were made using expert consensus. For example, one criterion used the relative impact of invasive alien species, and no data on this were available. This necessitated a pair-wise comparison of each biome to each other biome with regard to the relative level of impact.

# 3. Results

## 3.1 The agreed goal for prioritization

The workshop participants agreed on the following goal for the prioritization exercise: "To prioritize the spatial allocation of resources for controlling invasive alien plants at a national level".

## 3.2 Identification and weighting of criteria

A total of three main criteria, eight sub-criteria and seven sub-sub-criteria were identified and weighted (Table 3). The workshop participants assigned by far the greatest weight (60%) to the extent and density of invasive alien plants, both with regard to current levels of invasion, as well as potential future levels. The value of ecosystem services, and the social consequences of invasive alien plant clearing programmes were assigned equal priority (20% each), and current water yield carried more than half of the weight allocated to ecosystem services (10.6 out of 20%).

*Table 3/...*

**Table 3. Nested criteria identified as significant for the purposes of prioritizing terrestrial biomes. Higher-level criteria are divided into sub-criteria, and the relative weightings are given for each. Sources of data, and approaches to the assignment of values to terrestrial biomes for the purposes of prioritization with regard to the control of invasive alien plants.**

| Criterion | Sub-criterion | Sub-sub-criterion | Weight (%) | Value assigned to biomes | Source of data |
|---|---|---|---|---|---|
| Extent and density of invasive alien plants | Current extent of invasion | Number of species | 6.7 | The mean number of priority invasive alien plant species per quarter degree square within the biome. There were 23 priority invasive alien plant species (see Table 2) Each QDS was allocated to a biome based on its centre being in the biome, except for the forest biome where the QDS's that intersected the forest patches were used. | South African Plant Invaders Atlas (see Henderson 1988), which records the presence and absence of invasive alien plant species by quarter degree square (QDS). |
| | | Impact of species | 46 | Based on expert opinion and consensus | None |
| | Potential extent of invasion | Number of species | 0.5 | The mean number of priority invasive alien plant species per grid cell. Priority species were derived from a combined list of the five species that could potentially cover the largest area in each individual biome. | Climate envelope modelling was used to map the potential range of invasive alien plant species in grid cells (see Rouget *et al* 2004). |
| | | Impact of species | 4.9 | The proportion of predicted reduction in water yield from a given biome to the total predicted reduction for all biomes. | The impact of invasive alien plants on surface water resources was taken from an earlier study on their impacts on a range of ecosystem services, see van Wilgen *et al* (2008b). |
| | | Comparative rate of spread | 2 | The proportion of the number of priority invasive alien plant species that are wind and bird-dispersed species. | None |
| Value of natural | Water yield | Current water yield | 10.6 | The proportion of surface water runoff from the biome to all runoff in South | Water Resources 2005 data obtained from a Water Research Commission study (see |

| Criterion | Sub-criterion | Sub-sub-criterion | Weight (%) | Value assigned to biomes | Source of data |
|---|---|---|---|---|---|
| resources and ecosystem services | | | | Africa. | Middleton and Bailey, 2008). |
| | | Potential water yield (considering possible effects of climate change) | 1.5 | The proportion of adjusted mean annual surface runoff in a biome to all adjusted runoff in South Africa. | Data were taken from a study on the potential impacts of climate change on the water resources of South Africa, see Schulze *et al.* (in press). |
| | Grazing | | 4.6 | Grazing potential. We used estimates of the mean livestock production potential (in large livestock units per $km^2$) to represent the potential of un-invaded vegetation to support livestock production | Areas of homogenous grazing potential (Scholes, 1998) |
| | Biodiversity | | 1.7 | Threatened vegetation types | Threatened vegetation types were mapped by Mucina and Rutherford (2006). |
| | Useful indigenous products | | 1.5 | Based on expert opinion and consensus | None |
| Social consequences | Proportion of poor rural people | | 5 | Percentage of population living below the minimum living level | South African geospatial analysis platform (Naudé *et al.*, 2007) |
| | Loss of fuel wood | | 15 | Based on expert opinion and consensus | None |

### 3.3 Using criteria to prioritize biomes

We were able to locate databases that could be used objectively to compare biomes with each other with regard to 8 of the 12 sub-criteria groupings identified (Table 3). The application of the rules in Table 3 produced the proportional values in Table 4. While to allocation of values based on data are as objective as possible, these values need to be interpreted with caution in some cases, as indicated in the examples below.

Relatively high water yield values were allocated to the Forest and Indian Ocean Coastal Belt biomes, as these areas experience relatively high rainfall. The most important water catchment areas in Fynbos and Grassland received lower values, because both of the latter biomes span a wide range of rainfall conditions, from moist to fairly arid, while the former biomes do not. The Fynbos and Succulent Karoo biomes are well known as biodiversity hotspots of global importance. However, these two biomes scored the second and third lowest values for this criterion, which at first may seem surprising. However, much of the Fynbos and Succulent Karoo biomes have not been mapped as threatened by Mucina and Rutherford (2006), as both biomes contain large areas of untransformed vegetation. Other biomes, for example the Moist Savanna, Grassland, Nama Karoo and Indian Ocean Coastal Belt have large transformed or degraded areas, and many subtle vegetation subdivisions, leading to a high area of threatened vegetation.

*Table 4/...*

**Table 4. Proportional values (%) assigned to 10 terrestrial biomes for each of 12 criteria used in the prioritization of biomes for invasive alien plant control.**

| Criteria | Terrestrial biomes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Indian Ocean Coastal Belt | Fynbos | Moist Savanna | Grassland | Forest | Arid Savanna | Succulent Karoo | Nama Karoo | Albany Thicket | Desert |
| Current number of invasive alien species | 17.8 | 15.6 | 9.1 | 9.3 | 23.3 | 2.3 | 4.7 | 3.0 | 13.0 | 1.7 |
| Current impact of invasive alien species | 27.0 | 20.6 | 16.6 | 11.3 | 2.1 | 5.8 | 5.1 | 4.5 | 2.7 | 4.1 |
| Potential number of invasive alien species | 15 | 9.1 | 12.9 | 11.4 | 14.3 | 7.2 | 3.9 | 7.3 | 16.9 | 1.8 |
| Potential impact of invasive alien species | 23.0 | 14.5 | 31.3 | 10.1 | 0.1 | 5.7 | 1.2 | 12.4 | 0.5 | 1 |
| Comparative rate of spread | 26.4 | 20.5 | 11.6 | 14.5 | 4.6 | 5.3 | 3.5 | 5.6 | 5.2 | 2.6 |
| Current water yield | 27 | 13.4 | 8 | 12.8 | 31.6 | 0.4 | 1 | 0.6 | 5 | 0.05 |
| Potential water yield | 34.8 | 10.4 | 7.6 | 12.1 | 30.0 | 0.3 | 0.7 | 0.4 | 3.5 | 0.04 |
| Grazing potential | 28.2 | 2.8 | 14.1 | 10.4 | 1.1 | 14.3 | 7.9 | 13.5 | 4.1 | 3.4 |
| Biodiversity | 24.2 | 2 | 36.4 | 11.4 | 0.8 | 2.1 | 0.2 | 18.7 | 0.5 | 3.4 |
| Useful indigenous products | 21.3 | 4.2 | 13.9 | 26.2 | 10.9 | 4 | 4.8 | 5.2 | 7.3 | 2 |
| Proportion of poor rural people | 15.2 | 8.8 | 14.7 | 5.3 | 6.4 | 12.2 | 8.5 | 11.3 | 5.4 | 12 |
| Loss of fuel wood | 19.9 | 14.9 | 10.4 | 2.0 | 28.3 | 7.1 | 3.6 | 4.4 | 7.3 | 2.1 |

### 3.4 Prioritization of terrestrial biomes

The prioritization exercise led to the Indian Ocean Coastal Belt, Fynbos, Grassland and Moist Savanna biomes receiving the highest priority (Figure 2). Forest, Nama Karoo, Albany Thicket and Arid Savanna received the lowest priorities. The biomes are discussed in order of priority below, in relation to the proportional values presented in Table 4.

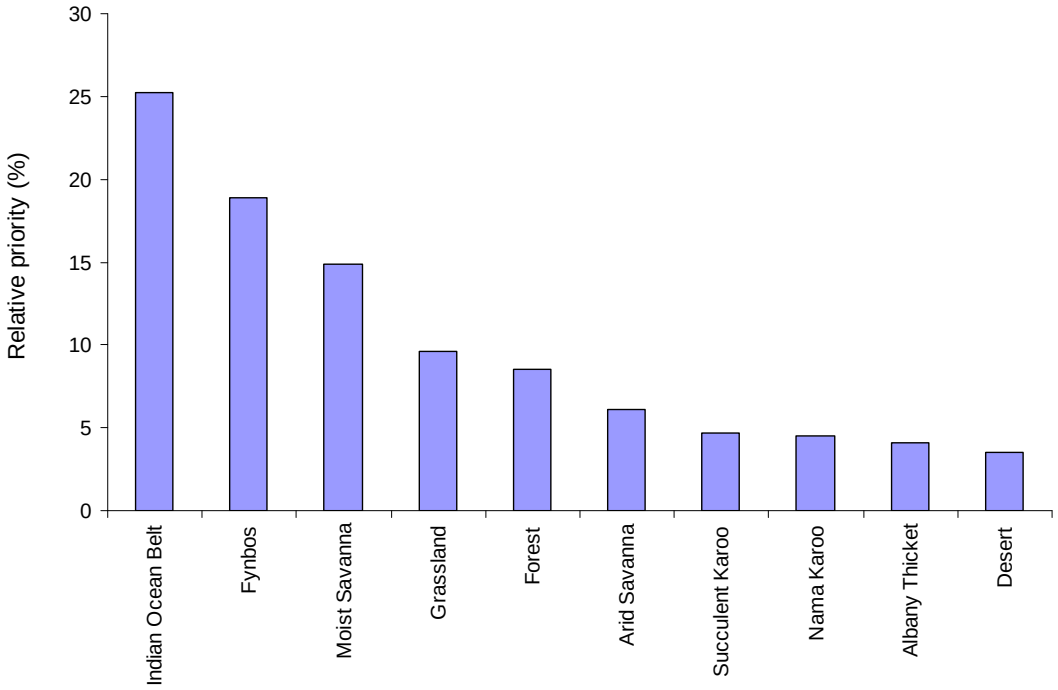


**Figure 2. South Africa's terrestrial biomes ranked according to their relative importance for controlling invasive alien plants.**

*Indian Ocean Coastal Belt*: This biome scored the highest value for the current number and impact of invasive species, and these criteria carried by far the highest weight (46%). It also scored very highly on most other criteria. Workshop participants were adamant that this biome is under serious threat from invasions, and that it warrants attention. This biome occurs along the KwaZulu/Natal and Eastern Cape (Wild Coast) coasts, and is densely populated. Muchina and Rutherford (2006) list cultivation and afforestation as the greatest threats to the biome, followed by alien invasive plants, which are "a major and growing threat", with triffid weed (*Chromolaena odorata*) noted as "the main problem plant". Urbanization and dune mining are additional threats.

*Fynbos*: This biome was rated second highest with regard to the current impact of invasive alien species. It also scored highly in terms of water yield. It received a very low score for biodiversity, despite it being a global centre of endemism and a recognised biodiversity "hotspot". This is because much of the area (mainly in the mountains) remains intact which means that it contained a smaller proportion of vegetation mapped as threatened (the method we used to evaluate biodiversity). Invasive alien plants are a major threat to the biome, notably pines. In a recent review (van Wilgen 2009), it was noted that, in the first decade of operations, the Working for Water programme cleared only 4.5% of the estimated

area invaded by pines. At this rate of clearing the spread and eventual domination of pines will not be arrested. The termination of research into the biological control of pines (Lennox *et al*. 2009) means that the prospect of bringing pine invasions under control has been further reduced. According to van Wilgen (2009), "solving the problem of controlling fire-adapted invasive alien pines in the fynbos remains the largest challenge to managers concerned with the conservation of fynbos ecosystems".

*Moist savanna*: This biome was rated fairly high in terms of the current and potential impact of invading alien plants and it received the highest score of all biomes for biodiversity. The biome has been substantially transformed by agriculture, and thus contains a high proportion of threatened vegetation types.

*Grassland*: The Grassland biome was allocated relatively high scores with regard to most criteria. The Grassland biome covers a large area, and includes some of the most important water catchment areas in the country. Grassland has also been converted in many places to other forms of land use, and thus has a large area of threatened vegetation. Mucina and Rutherford (2006) list the main threats to the biome as continuous transformation due to agriculture, afforestation, mining and urban expansion. They do not mention invasive alien plants as a threat. Most on the invasive alien species that are regarded as important in grassland ecosystems are riparian invaders (such as wattles), although true grassland invaders such as pom-pom weed (*Campuloclinium macrocephalum*) are also gaining prominence.

*Forest*: The forest biome received a moderate priority in our exercise. Although the current extent of invasion was rated as high, the impact of invasions (an expert opinion) was rated low, and this carried the most weight. The high value for the current number of invasive alien plant species in the forest biome is partly an artifact of the method we employed to list species associated with the forest biome, namely that all of the species in any quarter degree square that intersected the forest patches were used. As forest patches never fill a complete quarter degree square, these lists would have contained additional species from surrounding (non-forest) vegetation types.

*Arid Savanna*: Arid Savanna received relatively high scores for impacts on grazing potential (the dominant form of land-use in this biome), as well as for the proportion of poor rural people living there. However, it did not score highly on the remaining criteria. Mesquite (*Prosopis glandulosa*) is arguably the most significant invasive alien plant species in this biome. It is probably having a significant impact on ground water resources increasing the vulnerability of the agricultural sector and rural communities to drought (Le Maitre, 1999).

*Succulent Karoo*: The Succulent Karoo biome was rated as only moderately important with regard to most criteria, except for the loss of fuel wood. As was the case with Fynbos, it received a very low score for biodiversity. Succulent Karoo is also a recognised biodiversity "hotspot" (and only one of two arid hotspots in the world), but much of the area remains intact so it contains a smaller proportion of vegetation mapped as threatened (the method we used to evaluate biodiversity). Mesquite (*Prosopis glandulosa*) is also arguably the most significant invasive alien plant species in this biome.

*Nama Karoo*: This biome did not rate highly in the prioritization exercise. The only criteria that added some weight to the biome were grazing potential, numbers of poor people, and overall potential impacts. As with the previous two biomes, mesquite (*Prosopis glandulosa*) is a significant invasive alien plant species. In addition, many other species (such as cacti without biocontrol agents available, *Opuntia* and other genera) as well as unpalatable (or poisonous) alien herbs (such as *Atriplex lindleyi*, *Salsola kali*, *Limonium sinuatum*, *Argemone ochroleuca* and *Schkuhria pinnata*) can diminish the productivity of the land (Mucina and Rutherford 2006). Finally, invasion by the alien perennial fountain grass (*Pennisetum setaceum*) could introduce fire to this otherwise fire-free biome, with negative impacts for ecosystem productivity (Rahlao *et al* 2009).

*Albany Thicket*: This biome received the second-lowest priority in our prioritization exercise. Although it currently and potentially houses invasive alien species, it did not score highly on the other criteria. The biome is largely threatened by degradation. Invading alien plants are prone to invade the degraded parts of the biome. Managing these invasions involves not only clearing, but also a substantial, labour-intensive and long-term effort in rehabilitation (Mucina and Rutherford 2006).

*Desert*: The desert biome was rated the least important with regard to most criteria, except for the loss of fuel wood because there are almost no alternative sources of wood in dry land environments. The biome is confined to the lower Orange River Valley and the few rural communities living there are situated near the Orange River and therefore have access to surface water. The biome's low priority is therefore justified.

# 4. Discussion and recommendations

## 4.1 Funding of clearing projects in priority biomes

Working for Water does not currently allocate budgets according to biomes, but rather by provinces. We derived an estimate of the funding allocated to biomes by overlaying the positions of funded projects on a spatial data layer of the biomes. The comparison of the planned expenditure for the 2009/2010 financial year and the priorities defined by this study indicates that the projects, by and large, are funded in accordance with priorities with one notable exception (the Indian Ocean Coastal Belt, see Figure 3). These amounts include all Working for Water-funded projects countrywide, and they include substantial additional funding allocated by the KwaZulu/Natal Province (the only province to do so).

While the Indian Ocean Coastal Belt receives little funding compared to its priority as determined in this exercise, this needs to be viewed in the light of other considerations. First, it is possible that Working for Water may wish to scrutinise the criteria used here, and they may arrive at a different conclusion. Overall, the indications are that funding levels are aligned with priorities at the highest level.

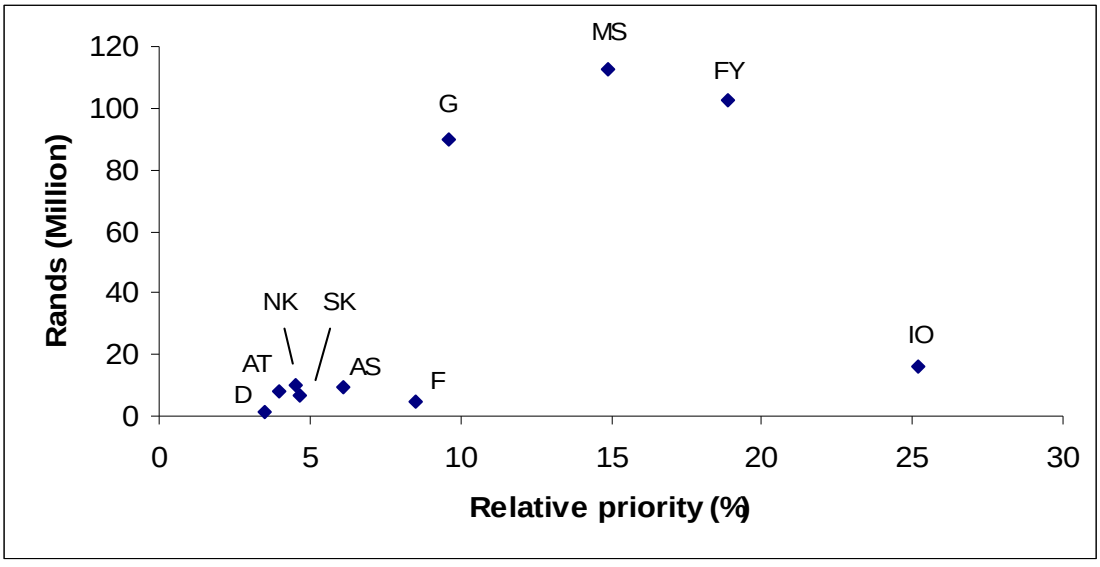


**Figure 3. The 2009/2010 budget for invasive alien plant clearing projects in the main terrestrial biomes of South Africa in relation to priorities identified in this study (see Figure 2). The biomes are: F = forest; AT = Albany Thicket; AS = Arid Savanna; NK = Nama Karoo; SK = Succulent Karoo; D = desert; MS = Moist Savanna; G = Grassland; FY = Fynbos; IO = Indian Ocean Coastal Belt.**

## 4.2 Recommendations

The rationale for conducting a project that would prioritize biomes in terms of their importance with regard to invasive alien plant clearing was that it should be a logical first step for a national programme like Working for Water. The study has indicated that the current allocation to biomes is in line with priorities, with the exception of the Indian Ocean Coastal Belt. We recommend therefore that the broad patterns of funding should remain in place, but that the funding situation in the Indian Ocean Coastal Belt should be reviewed, taking into account the KwaZulu/Natal Province's funding as well.

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