EXECUTIVE SUMMARY

INTRODUCTION

Alien plant invasions are recognised as a major threat to the natural resources of South Africa, and particularly to the water resource. A national programme 'Working for Water', under the auspices of the Department of Water Affairs and Forestry, is aimed at bringing the problem of plant invasions under control. This umbrella programme operates at a level of approximately R150 million per year and now includes a number of additional water management bodies such as water boards and city councils. The programme needs to operate at maximum efficiency by concentrating in those areas of greatest need and where the risks of invasion to the sustainability of the resource are highest.

Despite widespread recognition of the problem posed by plant invasions , and excellent local knowledge and understanding of risks in some regions and impacts on some sectors, there has never been a comprehensive assessment of the full extent of invasion, nor of the associated impacts and costs. This is partly explained by the biological dynamics - invasions are spreading at an exceptional rate and existing cover is likely to more than double over the next 20 years. Conventional survey methods have difficulty keeping pace.

This project has put in place a picture of the major known occurrences of alien invaders, at a scale of 1:250 000, based primarily upon the knowledge of natural resource experts from across South Africa. The survey concentrated on woody, alien species (particularly trees) which are likely to use more water than indigenous vegetation, but data on herbaceous and aquatic species have been included where they have been mapped. All the mapped data have been captured in a Geographic Information System (GIS) and includes details of species composition and density. From this information the nature and degree of invasion can be calculated for each province, water scheme, or catchment. The expected water-use of invaders has been calculated using a relationship between biomass and streamflow reductions. Costs to clear (in 1997/8 Rands) have been estimated from the current experience of managers in the field. Some guidelines for prioritizing the catchments requiring clearing operation have also been provided.

This project provides an active database. The potential of this data can only be partially realized through this report. The maximum benefits will be best achieved if the data itself is used as both baseline and management tool, and is regularly updated and improved. For consistency the scientific names of species have been used at all times. A list of recognised common and scientific names has been included in Appendix 1.

OBJECTIVES

The objectives of the project, as agreed to by the steering committee appointed by the Water Research Commission, are listed below:

- To determine the nature, extent and distribution of alien invaders in South Africa at a national scale.
- To assess the impacts which these invaders may have on the water resource.
- To assess the costs of managing the current problem of alien invaders (in bringing them under control) and the costs of maintaining the landscape in a condition where invasive species are kept under control.
- To assess the costs of failure to bring alien invaders under control, i.e. to assess the consequences and costs of unchecked further invasion.
- To determine how long it will take to achieve satisfactory control.
- To prioritise the areas which should be targeted first in a national programme to control alien invaders. Water is viewed as the primary issue upon which this prioritization will be based, but other implications must be considered.
- To identify gaps in the national knowledge base, and to determine research priorities.
- To use scenario planning in determining how to take the invader control programme forward into the long-term future (e.g. the clearing of lightly vs. densely invaded areas).
- To develop a vision for the future with regard to the clearing of alien invading plants.

METHODOLOGY AND RESULTS

Invasions of alien plants were mapped and digitised and stored within a GIS (*Arc/Info*) at a scale of 1:250 000 for almost the entire country. Mapping was on the basis of expert knowledge, along with the addition of existing databases for some limited areas. Species and densities were recorded for each of the more than 6 000 invaded areas (polygons) captured. The primary aim was to gather information on the woody species which are likely to use more water than the indigenous vegetation but a limited amount of data on herbaceous aquatic species has also been included. The water-use of herbaceous and aquatic invaders was not calculated in this analysis. From these GIS records it is possible to determine the extent and distribution of each species within each catchment and for each province. Incremental water use by invading species has also been determined at the level of tertiary catchment in addition to the total water costs to each province and the country. The results are summarised in Table 1.

Alien invaders occupy a total area of 10.1 million ha (6.82%) of South Africa and Lesotho. These invasions were often at low densities (<5% canopy cover) but if the plant invaders are 'condensed' (e.g. 100 ha with 5% cover of alien plants would be condensed to 5 ha with 100% cover), the occupied area is the equivalent of 1.7 million hectares, or 1.4% of the total landscape. To put this into perspective, the condensed invaded area is greater than that of Gauteng and about 20% greater than the total area of commercial plantations. Riparian invasions are found throughout all the provinces although extensive landscape invasions have also been mapped within the Western Cape. This has important implications for water use as riparian zone species generally have relatively free access to water and therefore are often consumptive users. The data on the invaded areas exclude plantations and woodlots but do include invaders occurring within them.

Table 1: **Summary by province of the areas invaded by alien plants, impacts on mean annual runoff and costs of clearing and control. The condensed area is the total area adjusted to bring the cover to the equivalent of 100%. The costs of control are based on a 20-year clearing programme, a rate of expansion of the total invaded area of 5% per year, an annual budget of R600 million, and have been discounted at 8.0% per year. (For more information see the text.)**

Province	Area (ha)	Invaded area (ha)		Mean annual runoff (millions of m^3)	Incremental water-use		Estimated costs of clearing (millions of Rands)
		Total	Condensed		(millions of m^3)	(%)	
Eastern Cape	16 739 817	671 958	151 258	9 998.76	558.19	5.58	564.36
Free State	12 993 575	166 129	24 190	3 546.10	86.19	2.43	99.13
Gauteng	1 651 903	22 254	13 031	551.97	53.93	9.77	44.97
KwaZulu-Natal	9 459 590	922 012	250 862	12 517.61	575.74	4.60	597.48
Lesotho	3 056 978	2 457	502	4 647.19	1.88	0.04	1.29
Mpumalanga	7 957 056	1 277 814	185 149	6 303.01	446.29	7.08	372.81
Northern Cape	36 198 060	1 178 373	166 097	910.94	150.86	16.56	869.77
Northern Province	12 214 307	1 702 816	263 017	3 383.63	297.70	8.80	410.13
North West	11 601 008	405 160	56 232	1 081.57	95.40	8.82	232.07
Western Cape	12 931 413	3 727 392	626 100	6 555.18	1 036.82	15.82	2 250.56
RSA+Lesotho	124 803 708	10 076 365	1 736 438	49 495.96	3 303.00	6.67	5 442.57

Terrestrial, woody, alien invaders are estimated to use a total of 3 300 million m^3 of water over the entire country in a single year. This is approximately 6.7% of the estimated mean annual runoff (MAR) for the country or about 75% of the naturalised MAR of the Vaal River system. In contrast, commercial

plantations occupy approximately 1.44 million hectares and use an estimated 1 399 million m^3 (3.2% of MAR). On a unit area basis the incremental water use of dense alien invaders is the equivalent of 1 900 m^3 per hectare per year compared with 930 m^3 for commercial plantations. Invading species therefore occupy a greater land area and also consume significantly more of the national water resource than the entire commercial forestry industry. The impacts could also be significantly higher, on a percentage basis, during drought periods, as the riparian invaders will still have free access to water. This would be particularly important for rural and urban communities which depend on river flow because they do not have the infrastructure needed to store water.

Water use by invaders also has been summarised into component water use by different species, and into water use for each tertiary catchment and each province. The most widespread genus is *Acacia* and it is the acacias, eucalypts, and pine species which use most of the water. *Prosopis* species are the sixth highest water users nationally and by far the greatest water users in the Northern Cape province. There are a number of instances where the estimated volume of water used by invaders exceeds the expected water production from a tertiary catchment, particularly in arid catchments where the MAR is often less than five mm. Although the water use estimates for these arid areas may be in excess of local production, they are realistic as the invaders are maintained by access to groundwater or water from riparian zones. This allows them to access water which is accumulated elsewhere and thus to maintain high water-use rates all year round.

Costs to clear terrestrial alien invaders have been determined for each of the major species and the data have been used to estimate the overall costs of clearing, if all the control operations could be completed 'instantaneously'. The cost of clearing dense stands of tall trees (invaders such as pines, eucalypts and acacias, identified as the country's major problem species) is in the order of R5 500 per hectare, although this may vary considerably depending on region, method employed, and accessibility. Applying these figures to all invading species countrywide suggests that the costs of mounting a one-year, 'once-off' eradication campaign would be in the order of R6.97 billion (including follow-up costs). This is obviously impossible in practice. If invaders are conservatively estimated to spread at a rate of 5% per year, a 20-year control programme would cost in the order of R600 million per year and the total cost (Net Present Value) would be R5.44 billion (Table 1). A delay of 10 years in launching this programme would increase these costs by at least 55%. Savings of the order of 20-30% could be achieved by successfully implementing biocontrol on a number of the major woody species, or by focussing only on water-using invaders. Long-term maintenance will always be necessary and will probably cost about R30 million per year.

These costs need to be seen in context. The high costs of the initial clearing and follow-up will be spread over a few years in a particular area but the additional water released will be available for alternative uses in perpetuity. When expressed on the basis of the amount of water that could be saved during the 20-year control programme alone, the total costs would be 45 cents per m^3. Other benefits include employment and the concomitant social and economic upliftment, the restoration of natural systems and their ecosystem services, and conservation of the natural biodiversity on which much of our tourism industry depends.

Nevertheless, the high direct costs of clearing emphasize the importance of prioritizing where and how funds are spent, ensuring maximum return on investment, and also the need to look for alternative approaches in dealing with the problem. Greater investment in biocontrol is one important strategy that is recommended, as is the need for the authorities to shift responsibility away from government programmes towards the individual land-owner and communities.

Which areas should be cleared first? There are so many variables which affect this decision that any one answer is decidedly risky. The highest priorities are undoubtedly in the high-yielding catchments of the Drakensberg escarpment from the Eastern Cape through to the Soutpansberg, and the mountain areas of the south-western Cape. The most significant impacts simply in terms of water are in the arid Namaqualand coastal region, the areas of the Karoo invaded by *Prosopis*, and the coastal lowlands of the south-western Cape. These areas, particularly the Karoo, cannot be ignored because the invaders will have an impact on groundwater which is the primary, or sole source of water for many communities. Some areas which appear lightly invaded in this assessment (e.g Gauteng) are critical because they lie on the watersheds of major river systems - in this case the Vaal, Limpopo and Olifants River systems.

Decisions on action must, however, be based on the principle of maximum return on investment taking into account the full costs and benefits. This may require more effort to be spent on lightly invaded catchments, which do not yet appear to be a problem, than on heavily invaded catchments where a water shortage is already being experienced. Catchments at risk of rapid invasion also become critical in such an assessment. Data on the rate of spread and the costs of clearing corroborates the argument that preventative measures must be taken to prevent the densification and expansion of currently lightly invaded areas. An analysis of the literature on the rates of invasion indicates that many important species can double in extent over the next 10-20 years and that for some species (e.g. *Mimosa pigra*) such a doubling can be as rapid as one to two years. The only real limit to expansion is the availability of land. With the cost of eradication increasing from R825 to R5875/ha between light and dense invasions the cost implications are obvious.

RECOMMENDATIONS

Our recommendations fall into two main groups:

- recommendations for action:
  - promoting and facilitating public awareness and fostering active public participation in alien plant control and mapping of invasions by creating a framework for community and public participation in the management of invaders; and
  - using this database as the foundation for establishing an effective and readily accessible information system on alien plant invasions, their impacts and what can be done to control measures.
- recommendations for research into:
  - key aspects of the biology of alien invaders and their control (including rehabilitation);
  - developing better models for the assessment of the impact of invaders on water and other natural resources, and evaluating the extent to which the water used by alien invaders may have been implicitly included in the recent (1990) estimates of naturalised mean annual runoff;
  - improving our understanding of rates of invasion;
  - improving existing, and developing new control methodologies and achieving better integration;
  - the costs of control and the factors that influence control in different situations; and
  - obtaining better information on the full social and economic costs and benefits of alien plant clearing operations to put the clearing costs into perspective.

Recommendations for action are focussed on the use of information, the need to maintain and update the database, and the establishment of an open information line. Specific tasks include the mapping of areas cleared of invaders, the standardization of data-capture methodology, and the use of the Internet as a mechanism for information sharing.