

Land-use planning & biological invasions

Mathieu Rouget considers how careful planning can reduce problems with invasions.

The South African population increased by 1.3% in 2013 – another 70 000 people added to the population each year if this rate of increase continues. This growing population will need more land for agriculture, settlements, transport and other forms of infrastructure. New roads will be built, crop fields will expand and new residential areas will be planned. Much of this change in land use will affect wild space – natural areas. People also require natural areas to provide important services such as water purification and recreation. Keeping the balance between infrastructure development and nature is complex, and many factors need to be considered. This is what we call land use planning – the allocation of land to specific activities, including agriculture, settlement, transport, factories and open spaces.

Human activities can result in the movement (intentionally or accidentally) of plants and animals to areas where they would not occur naturally. Over millennia, plants and animals have been introduced to many parts of the world. In South Africa, many species of pines, eucalyptus and wattles have been introduced to provide wood for timber and pulp. Sometimes introduced species can spread and become invasive, especially after changes in land use or disturbance. For example, as agricultural areas have been abandoned in the KwaZulu-Natal midlands, wattle has spread. Pines planted for commercial use have spread into the mountains of the Western Cape.

There is a link between human activities, land-use planning and biological invasions. This article focuses on the linkages between land-use planning and plant invasions, using examples from South Africa. It shows how the lack of appropriate land-use planning can lead to plant invasions and how the current distribution of invaded areas can inform future land use and

human activities. The specific focus is on impacts on natural resources, including biodiversity.

Inadequate land-use planning in the past – an important factor in plant invasions

Plant invasions often represent the legacy of the past. Previous agricultural practices, or past socio-economic needs, largely explain the patterns of plant invasions. Examples include prickly pear (*Opuntia ficus-indica*), originally introduced to provide fodder for animals and now a major invader of rangelands, and certain Australian wattles, introduced to South Africa to stabilise sand dunes and now highly invasive in many habitats.

The lack of strong environmental regulations and land-use planning guidelines in the past has resulted in many unsustainable developments. During the expansion of forestry plantations in the 1950s, many mountainous areas were planted with gums or pines in places that were too steep for harvesting or where the climate was unsuitable, and as a result these plantations were abandoned. Because the trees were never harvested, they started to spread into the surrounding natural grasslands in the Drakensberg or fynbos in the Cape, where they invaded mountain catchments, which are the main water-source areas for our country. Because pines and eucalyptus use more water than natural vegetation, this resulted in a decrease of water flow, which was up to 40% in some catchments. Appropriate land-use planning would have looked at whether or not the area was suitable for these plantations and steep areas, climatically unsuitable areas or riparian (land next to rivers) areas would have been left unplanted.

If well planned and well managed, the impacts of large-scale forestry plantations on natural resources can be



minimised. At the planning stage, avoiding sensitive areas (such as riparian areas) or areas with high invasion risk will reduce the impacts. Once plantations are established, proper management (including clearing of self-sown saplings and fire control) can reduce plant invasions.

Planning for agricultural expansion – the case of ZZ2

What we already know about the extent – including the potential future extent – of plant invasions can help us to make decisions around land-use planning and management. These decisions can be made at the level of local farms, but also nationally.

ZZ2 is one of the largest farming enterprises in the country, with the main farming operations located in the Koedoe's river valley in the Limpopo province. ZZ2 manages over 40 000 ha of land in a small water catchment and currently farms 10 000 ha. Most of the upper catchment is invaded by a mixture of wattles, eucalyptus and pines as a result of past failed farming efforts, which has led to the land being abandoned.

To keep up with increasing demand for avocados, ZZ2 started to expand their orchards in the upper parts of the catchment to benefit from the cooler climates in these areas. Given a choice of densely invaded areas, marginal lands, and natural vegetation (composed of bushveld, grassland and forest), most farmers would have avoided invaded areas to expand their activities. In other words, they would have farmed the more easily cleared natural vegetation. However, wise planning from ZZ2 led to the expansion of avocado orchards in densely invaded areas. ZZ2 invested heavily in clearing the upper catchment by mechanically removing alien trees to restore indigenous grasslands and plant new orchards. Although hundreds of hectares were cleared, only a portion was used for avocado orchards, and the remaining area was restored to grassland.

The long-term benefits of ZZ2 investment are still to be

seen, but one would expect improvements in the ecosystem services, biodiversity and agriculture production of the upper catchment. With reduction in the density and extent of alien trees, ecosystem functioning will improve, resulting in greater water supply (especially during the dry period) downstream. The ecological and economic benefits of such clearing operation are being monitored to determine the long-term effects.

Sound land-use planning involves careful consideration of the short-term and long-term benefits of any land-use change. The ZZ2 case study shows that investing in clearing upper catchments of invasive species can result in a win-win situation for agriculture, ecosystem functioning and biodiversity and that agriculture and biodiversity conservation can mutually benefit from each other. Without ZZ2 intervention, the catchment would still be invaded, with reduced water flow and negative impacts on biodiversity and farming activities.

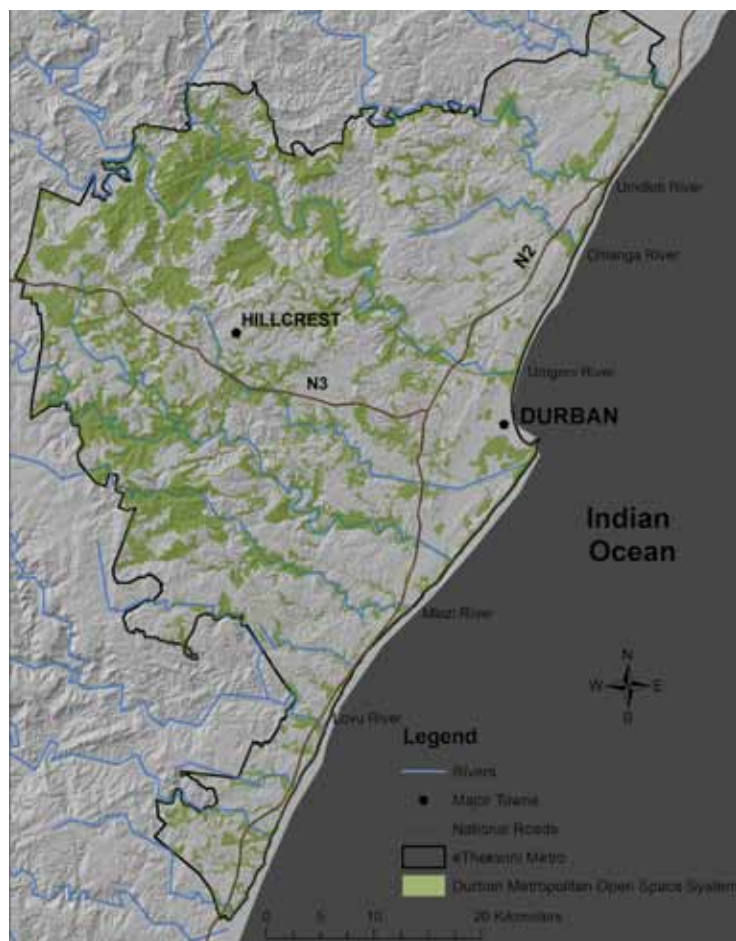
Ecosystem services

Ecosystem services are the benefits that people get from undisturbed, or little disturbed, ecosystems. Examples are clean drinking water and decomposition of wastes. The Millennium Ecosystem Assessment in the early 2000s grouped ecosystem services into four broad categories: provisioning – such as the production of food and water; regulating – such as the control of climate and disease; supporting – such as nutrient cycles and crop pollination; and cultural – such as spiritual and recreational benefits.

Wetlands are important in assimilating wastes.

Image: Wikimedia Commons





The DMOSS area. Image: Mathieu Rouget

Restoring degraded areas in the Greater Durban Metropolitan Area

Urban areas in Africa are growing rapidly, posing considerable challenges for sustainable land-use planning. Economic development requires new infrastructure. Adequate services are also needed. The provision of this infrastructure and services needs careful planning – particularly land-use planning.

The eThekweni Municipality is responsible for managing and regulating development through land-use planning in the city of Durban and its surrounding areas. Land-use planning is particularly important as the city is located in a global biodiversity hotspot, the Maputaland-Pondoland-Albany hotspot – which is home to plants that are found nowhere else in the world.

Cities are also known as hotspots for biological invasions. Many species are transported and introduced through air, sea and road traffic. Plant trade for streets and gardens is significant and an urban environment provides many pathways and areas for successful establishment of alien species (e.g. road verges for alien plants). It is therefore not surprising that urban areas are generally more invaded than other parts of the landscape. The eThekweni Municipality faces considerable challenges with plant invasions. With strong development imperatives and a limited budget, what measures can a local government put in place for sound environmental planning and alien plant management?

The municipal Department of Environmental Planning and Climate Protection has developed a unique system to control future infrastructure development and conserve biodiversity. Named the Durban Metropolitan Open Space System (DMOSS), this land-use planning tool identifies important and biodiversity-sensitive areas in order to maintain them in a natural state. The DMOSS guides land-use development applications towards areas that

have already been converted (i.e. with little natural habitat remaining) and minimises the impact of urban expansion on the remaining biodiversity in the municipality.

The DMOSS includes a comprehensive map of invaded areas and is regularly updated. Degraded areas that are also severely invaded (where most of the original natural ecosystem is gone) may be prioritised for infrastructure development if the terrain is suitable and if there are no other environmental constraints. However, areas that are only moderately invaded should preferably be targeted for alien plant control by the municipality as these still support high levels of biodiversity. Given its limited budget for alien plant control, research is currently taking place to identify areas where alien invasive plants should be cleared. Taking into account biodiversity importance, land tenure and ownership and degree of invasion, key areas are targeted and management plans established in partnership with private land owners, non-profit organisations, provincial and national departments.

The way forward – integrated land-use planning

These three case studies show that the development of any infrastructure or change in land use cannot take place in isolation and that proper consideration should be given to the environment. This is what we call integrated land-use planning. Over the last few decades, the South African National Biodiversity Institute has been working hard to develop planning tools which integrate land use and biodiversity.

Several provinces, notably KwaZulu-Natal, the Western Cape and Mpumalanga, have developed provincial maps that identify important areas for biodiversity. These maps are used to guide conservation efforts, inform development applications and to minimise the impacts of land use on biodiversity. Where information on plant invasions exists, this is used to direct alien plant clearing or select important biodiversity areas which are still free of invasive plant species.

These provincial assessments are conducted using Geographic Information Systems (GIS) and complex decision-making software. This software – used extensively in research in South Africa and elsewhere – combines mathematical theory, geography, land practices, ecology and socio-economic data to select the most suitable area for a given land use.

The interface between environmental conservation, land-use development and alien plant invasions provides exciting research opportunities. These often require complex partnership arrangements between science and practice. Two are currently in place in Cape Town, with the C·I·B and the City of Cape Town, and in Durban – the Durban Research Action Partnership, with UKZN and the eThekweni Municipality. Such collaboration will provide innovative solutions to tomorrow's environmental challenges. **Q**

Originally from France, Mathieu Rouget completed his PhD on alien plant invasions and conservation planning in 2002 at the University of Cape Town. He has worked for several academic and governmental organisations, including the South African National Biodiversity Institute. He currently holds the DST-NRF Research Chair in Land-Use Planning and Management at the University of KwaZulu-Natal. His work focuses on the interface between science and practice, linking biodiversity and land-use development.