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Managing a threatened savanna ecosystem (KwaZulu-Natal Sandstone Sourveld) in an urban biodiversity hotspot: Durban, South Africa

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Background: The city of Durban in the province of KwaZulu-Natal (KZN), South Africa, falls within a global biodiversity hotspot. KwaZulu-Natal Sandstone Sourveld (KZNSS) is a savanna vegetation type endemic to KZN. KZNSS is endangered; about 90% has been totally modified and 0.1% of the original extent is adequately protected. In response, eThekwini Municipality, Durban's local government authority, has developed approaches to improve the conservation status of KZNSS and other biodiversity.

Objectives: To describe eThekwini Municipality's work in contributing to securing and managing KZNSS and other biodiversity. This information will contribute to an increased understanding of local government's role in biodiversity conservation and should be relevant to other local governments as well.

Method: Statistics from the municipality's GIS database and work done and insights gained over about 30 years are presented.

Results: By 2012, about 54% of Durban's original vegetation was transformed and a further 17% was highly degraded. Combined efforts have resulted in 3.06% of the eThekwini Municipal Area enjoying some form of legal protection for environmental purposes with proclaimed protected areas covering 0.6% of the municipal area. Nearly 8% of areas identified as environmentally significant by the municipality are managed as appropriate.

Conclusion: Increased and coordinated implementation efforts with a focus on priorities are needed from all role players if biodiversity is to be adequately conserved in Durban. Local government in South Africa can be an important contributor in biodiversity conservation, especially with regard to tools available in terms of its local planning mandate.

Introduction

Humanity lives in an increasingly urban world. In the 1900s, only 14% of the world's population lived in urban areas, but by 2008 this number had increased to 50% (Population Reference Bureau 2012). It is estimated that by 2050 roughly 70% of the global population will be urban (Cities and Biodiversity Outlook n.d.). Africa is the most rapidly urbanising continent, and it is expected that shortly after 2030 it will have surpassed the 50% urban threshold (Pieterse & Parnell 2014).

As cities grow in number and size, they are making increasing demands on earth systems. Cities are thus at the forefront of the biodiversity challenge and 'worldwide, urban expansion is one of the primary drivers of habitat loss, and species extinction' (Seto *et al*. 2011:1). This loss of biodiversity also has negative impacts on the cities themselves as biodiversity is linked to the health and well-being of urban communities and acts as an important buffer (by providing protection and reducing vulnerability) against extreme events and slow onset disasters (Díaz *et al*. 2006). This is particularly relevant to African cities where a large percentage of the population are poor and live in informal, often poorly serviced settlements and are directly dependent on natural systems to meet their basic needs (Cities and Biodiversity Outlook n.d.).

The critical role of cities and local governments in biodiversity conservation is recognised by the Convention on Biological Diversity, for example, in COP 10 Decision X/22 (n.d.). Finding ways of integrating functional and viable biodiverse systems into cities is therefore an increasingly relevant

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challenge. Whereas techniques to undertake conservation assessments and identify implementation priorities have advanced rapidly (Ban *et al*. 2013; Game, Kareiva & Possingham 2013; Margules & Pressey 2000), action to secure and manage threatened ecosystems has received less attention (Knight *et al*. 2008; Rodriguez *et al*. 2011).

Although urbanisation and global environmental change pose significant challenges, they also provide unique opportunities for innovation (McDonald *et al*. 2015). Using the case study of KwaZulu-Natal Sandstone Sourveld (KZNSS), a threatened savanna/grassland ecosystem in Durban, South Africa, some of the challenges and progress made in securing and managing this ecosystem by local government (eThekwini Municipality) in an urban context are highlighted. Specifically, this paper aims to (1) describe the pressures faced by a threatened ecosystem in the Durban metropolitan area, (2) illustrate some of the challenges of protecting and managing threatened ecosystems in an urban context and (3) demonstrate the growing and important role of local authorities in biodiversity conservation assessments and in taking action to counter pressures on local biodiversity. This case study provides insights, which may be especially applicable to local governments in developing countries with threatened ecosystems and high levels of biodiversity in their jurisdictions.

Durban's socio-economic and ecological context

Durban is the third largest city in South Africa after Johannesburg and Cape Town, respectively (Statistics South Africa 2011), and has the largest and busiest port in Africa. Covering an area of ~2300 km^2, the metropolitan area has a population of approximately 3.5 million with an annual growth rate of around 1% (EThekwini Municipality 2013a). Among South Africa's cities, Durban has the highest percentage of people in poverty (EThekwini Municipality 2013b), and high levels of inequality, with a Gini Coefficient of 0.63 in 2012 (EThekwini Municipality 2015).

Although Durban is regarded as mostly urban (EThekwini Municipality 2013a), rural and peri-urban land uses characterise a significant portion of the metropolitan area. This is in part as a result of the legacy of apartheid and institutionalised segregation policies that marginalised people and forced them to live in areas away from the urban centre (Turok 2001). In addition, the Municipal Demarcation Board incorporated large areas of tribal land into the municipal boundaries, and as a consequence, local government in Durban (eThekwini Municipality) has been placed in the situation of having to accommodate hereditary chiefs, who employ traditional governance systems, alongside democratically elected councillors.

From a biodiversity perspective, Durban is situated in the Maputaland-Pondoland-Albany (MPA) Region, one of 35 global biodiversity hotspots (Critical Ecosystem Partnership Fund n.d.; Mittermeier *et al*. 2005). The MPA Region is home to more than 7000 species of vascular plants, 25% of which are endemic to the Region (van Wyk & Smith 2001). Durban lies approximately at the centre of this region, and its varied climate, physiography, geology, soils and biogeographical position have resulted in a wide range of terrestrial and aquatic ecosystems that support a rich diversity of organisms. This rich natural resource base has been impacted by rapid urbanisation, including high levels of unauthorised development, competing governance arrangements and pressures such as poverty and the need for basic services. As a result, development priorities often supersede environmental and biodiversity concerns in decision-making and all but the most inaccessible areas have been impacted by anthropogenic activity (Roberts 2008).

Durban Metropolitan Open Space System and systematic conservation assessment

EThekwini Municipality has an evolving open space plan that has guided local approaches to biodiversity protection and management over the last three decades (Roberts *et al*. in press). The Durban Metropolitan Open Space System (D'MOSS) consists of a network of areas with high biodiversity value and was first adopted by the erstwhile Durban City Council in 1989. The current version of D'MOSS is approximately 75 000 ha in extent and has undergone several revisions because of improvements in conservation science, and because of social, economic and political drivers of change (Roberts *et al*. in press). Over time, the planning underpinning D'MOSS has progressed from focusing on species and habitat protection to include the recognition of the value of ecosystem services. New tools such as resource economics and better conservation prioritisation methodologies, e.g. systematic conservation assessment (SCA), have assisted in improving the scope and accuracy of the plan. An increasing focus on implementation of the plan, including the restoration of ecosystems, and growing concerns relating to the impacts of climate change have also influenced the underlying approach to the plan.

As early as 1998, D'MOSS was included in the eThekwini Municipality's Integrated Development Plans and Spatial Development Frameworks. In the 2000s, it was integrated into the full hierarchy of municipal spatial plans. The strategic objective of D'MOSS is to ensure appropriate protection and management of all land important for the representation and persistence of significant biodiversity and the supply of ecosystem services important for human well-being. This will be achieved by various means (some of which are described below) and in collaboration with relevant stakeholders, for example, in partnership with the provincial conservation agency, landowners and community-based organisations.

As well as integrating biodiversity concerns into local level plans, there has also been a drive to improve the vertical integration of biodiversity policies and plans across spheres

of government. In this regard, eThekwini Municipality, the local government responsible for the eThekwini metropolitan area or Durban, has a co-operation agreement with Ezemvelo KwaZulu-Natal (KZN) Wildlife, the provincial conservation agency, regarding the development of a fine-scale SCA and a biodiversity sector and bioregional plan for Durban. Preparation of a fine-scale SCA was seen as a significant opportunity to improve biodiversity planning given it was to possible to prepare the eThekwini Municipality's plan at a scale of 1:5000 (versus the provincial plan with a resolution of 1:50 000) and using the superior local data versus provincial scale data (Mclean *et al*. 2016). The outputs of eThekwini Municipality's SCA have formed the basis of the latest version of the D'MOSS layer, and the intention is to include the product in the provincial systematic conservation plan.

Despite forming part of the Municipality's spatial plans, only 9.34% of the 74 672 ha included in D'MOSS, or 3.06% of Durban's ~2300 km^2, enjoys some form of legal protection (EPCPD 2016). The area enjoying 'legal protection' includes proclaimed and unproclaimed private or public nature reserves, properties that have been bought through the local government's biodiversity land acquisition programme, sites where sensitive portions have been protected by conservation servitudes as a result of development application processes and sites that have been rezoned to zones created for conservation purposes. The area proclaimed under the *National Environmental Management: Protected Areas Act* (NEM: PAA) (Act 57 of 2003) is much smaller and amounts to only about 0.6% of Durban (EPCPD 2016), which is considerably lower than the national figure of 6.5% in 2011 (Driver *et al*. 2012). The overall level of protection is much less than in Cape Town where 17% of the municipal area is formally conserved, although that number is boosted by the inclusion of much of the Table Mountain chain in a national park (Rebelo *et al*. 2011). Nonetheless, Durban's significant and highly threatened biodiversity has attracted less national and global interest and has a lower level of investment from provincial and national government and national and international non-governmental organisations (Rebelo *et al*. 2011).

KwaZulu-Natal Sandstone Sourveld

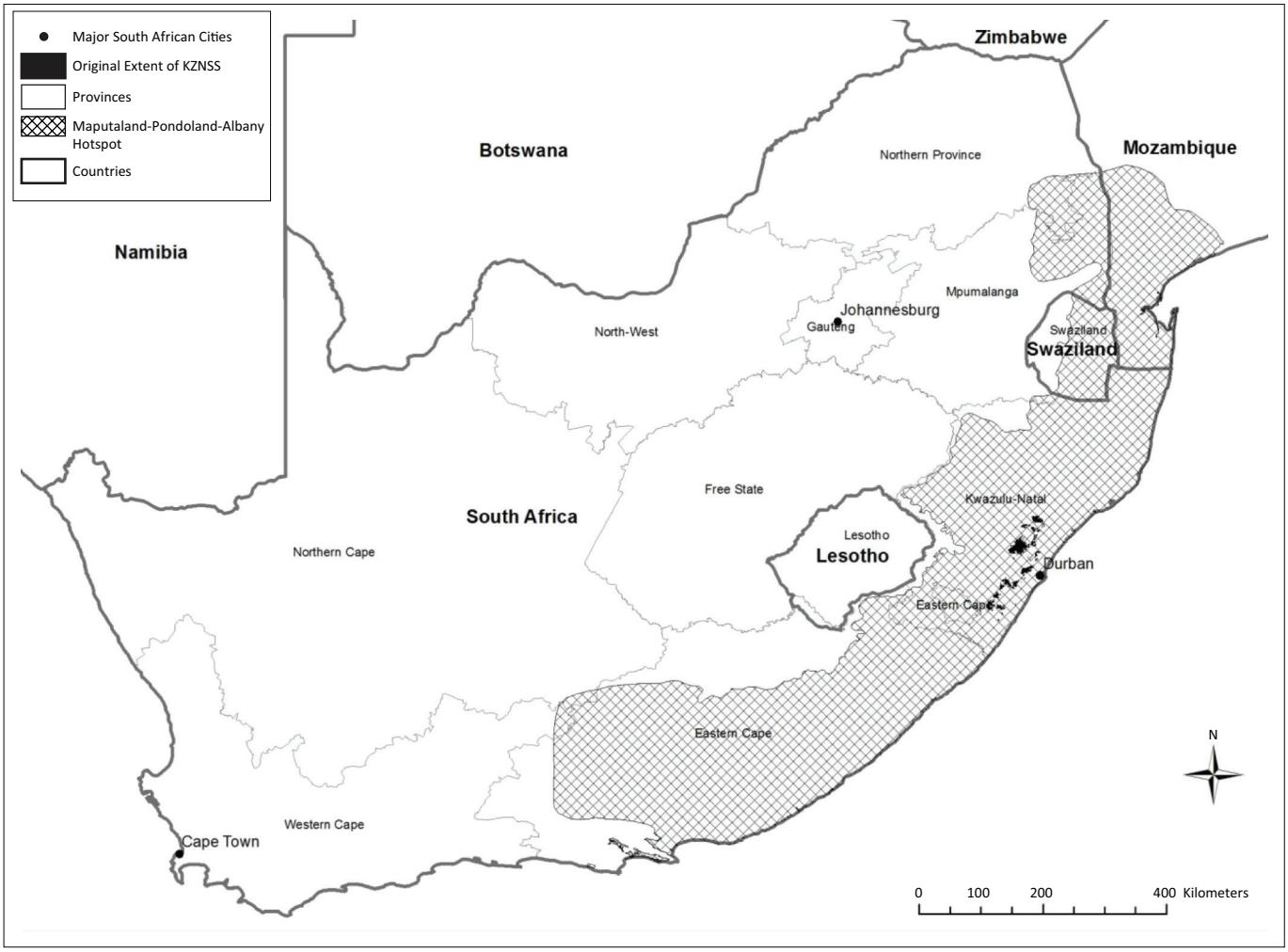
National biodiversity targets based on the species–area relationship have been set for all South African vegetation types (Desmet & Cowling 2004). The national conservation target for KZNSS is 25% of its original extent based on the area needed to represent a single occurrence of at least 75% of the species that occur in the vegetation type (Rouget *et al*. 2005). The approach to target setting does not consider ecological processes, which would increase the target area (Jewitt 2011). Rouget *et al*. also warn that as more data become available and targets are refined they tend to increase.

Of the nine national vegetation types that occur in Durban (Mucina & Rutherford 2006), KZNSS has received special attention from the Environmental Planning and Climate Protection Department (EPCPD) of eThekwini Municipality. This vegetation type was prioritised because of high levels of transformation and degradation, low levels of protection and the fact that opportunities still exist for conservation action that will soon be lost because of urban development pressures. Knowledge of the vegetation type is limited. It was first described in Mucina & Rutherford (2006) and since then few publications have added to this knowledge base (see for example Drury *et al.* 2016; Ground *et al.* 2016, this issue). KZNSS is endemic to the province of KwaZulu-Natal, originally covering 179 671 ha (Jewitt 2011) and has been classified in the savanna biome (Figure 1). The biome affiliation is, however, borderline, and it could be included in the grassland biome instead (Mucina & Rutherford 2006).

Acocks (1988), and others such as Moll (1976) and Mucina and Rutherford (2006), considered sub-escarpment grasslands, including KZNSS, to be 'false' veld types that were created by the destruction of large areas of forest by Iron Age farmers. Others, for example, Bond and Parr (2010), make a cogent argument for most local grasslands being ancient, and more extensive at the last glacial maximum (i.e. overall forest cover has increased not decreased in the past 20 000 years) and persisting as an alternative ecosystem state in forest/grassland mosaics for millennia. Although the activities of Iron Age farmers doubtless had localised impacts on woody vegetation in Durban, creating young and secondary grasslands at a local scale (Whitelaw 1991), ancient grasslands were much more extensive and common at a broader scale in the past, a fact borne out by inter alia historical accounts, old paintings and the earliest comprehensive aerial photography from 1937 (Boon, Mclean & Ground, in press).

KZNSS occurs on shallow, nutrient-poor, acidic, sandy soils, which are well drained and derived from Natal Group sandstone (NGS). In the distribution of KZNSS, the mean annual precipitation is 934 mm and the mean annual temperature is 17.2 C (Mucina & Rutherford 2006). Frost in Durban is very infrequent, but fog is probably an important moisture source for this vegetation type. KZNSS is found on flat, or sometimes rolling, plateaux created by resistant NGS and deeply incised rivers as well as at the contact zone between NGS and granite and gneiss below sandstone scarps. Mucina and Rutherford (2006) give an altitudinal range of 500–1100 m above sea level. However, the floristics and structure of remnant bushclump savanna above and below the coastal scarp, a significant physiographic feature at about 450 m above sea level (asl), appear very similar. This suggests that KZNSS occurred more extensively on NGS at lower altitudes than shown on national vegetation maps (Ground, Slotow & Ray-Mukherjee in press; Mclean *et al*. 2016). Where figures are presented for KZNSS in the Durban/eThekwini metropolitan area in this account, they were calculated using areas above and below the 450 m contour (Table 1), whereas provincial and national statistics are based on the distribution presented in Mucina and Rutherford (2006), that is, only above 500 m asl.

KZNSS is species rich with scattered bushclumps, forbs and geoxylic suffrutices. Grass: tree ratios are unstable and the relative proportions vary depending on a number of factors,



Source: Originator Mclean, C. 2015. Using ArcGIS 10.1. Original extent of KZNSS from Mucina & Rutherford 2006. Maputaland-Pondoland-Albany Hotspot from Mittermeier *et al.* 2011

FIGURE 1: Map of South Africa showing the Maputaland-Pondoland-Albany Hotspot region and the original extent of KwaZulu-Natal Sandstone Sourveld (KZNSS).

TABLE 1: Transformation and degradation rates for KZNSS in Durban.

Original extent of KZNSS	66 611 ha	100.00%
KZNSS above 450 m contour	32 540 ha	48.85%
KZNSS below 450 m contour	34 070 ha	51.15%
Area transformed	56 806 ha	85.28%
Remaining in good condition	7023 ha	10.50%
Remaining in intermediate condition	1998 ha	3.02%
Remaining in degraded/restorable condition	784 ha	1.20%

Source: EPCPD (2016)

KZN SS, KwaZulu-Natal Sandstone Sourveld.

Original extent based on the predicted former distribution of KZNSS c. 1850.

Transformation rates based on 2012 aerial photography mapped at a scale of 1: 5000.

Transformed areas have been completely altered, whereas degraded areas retain significant natural vegetation and largely intact soils.

especially fire. In the absence of fire, models suggest that most of eastern South Africa would be covered by trees (Bond, Midgely & Woodward 2003a). Many non-graminoid KZNSS plants have large underground storage organs and flower soon after fire, thus avoiding competition with grasses. Other species grow taller than the grass sward and flower later in the growing season. Where there is protection from fire driven by hot, dry Berg or Fohn winds, trees become established as forest patches and on termitaria and rocky outcrops, forming a bushclump savanna (or bushveld), and as forest patches (Geldenhuys 1994).

Transformation and degradation of KZNSS

Rates of loss of natural habitat are particularly high in KwaZulu-Natal averaging 1.2% per annum between 1994 and 2011 (Jewitt *et al*. 2015), and 'assuming habitat transformation occurs in the same manner, it is estimated that by 2050, 45% of the landscape will remain in a natural state' (Jewitt *et al*. 2015:6). Land cover mapping at a scale of 1:5000 for the eThekwini Municipality's systematic conservation assessment has shown that by 2012 about 54% of the original vegetation in Durban was totally modified and 17% highly degraded (Mclean *et al*. 2016).

According to Mucina and Rutherford (2006), 68% of the original extent of KZNSS has been irreversibly transformed for cultivation (mainly sugarcane), forestry, urban development and road building. This is much higher than the national average of 18% transformation for all vegetation types and is consistent with findings that loss of natural habitat is greatest where economic activity is concentrated (Driver *et al*. 2012). KZNSS is categorised as Endangered in terms of the *National Environmental Management: Biodiversity Act* (Act 10 of 2004), but more recent provincial figures

indicate that about 90% of KZNSS has been lost and the vegetation type should be classified as Critically Endangered because the remaining area is less than the conservation target (Jewitt 2011).

In Durban, transformation and degradation figures support the suggestion that KZNSS is more threatened than its national classification as Endangered suggests. Figure 2 shows the extent of the loss of this vegetation, and Table 1 reveals that less than 15% of Durban's KZNSS remains; thus, the Municipality cannot achieve its pro rata share of the national 25% target. Threats are exacerbated because developable land is constrained because of Durban's often steep and incised topography.

Like Cape Town, Durban is a 'low-choice planning domain' (Holmes *et al*. 2012) for most vegetation types, and opportunities to avoid the local extinction of this vegetation type are extremely limited, requiring complete protection of the remaining habitat. This is an unlikely scenario given ongoing development pressures.

In addition to complete transformation, many remnant KZNSS patches have been degraded through, inter alia, altered fire and grazing regimes and nutrient enrichment (Carbutt 2005; Mucina & Rutherford 2006; Scott-Shaw & Morris 2014). There is also an ongoing trend for grassland to be replaced by woody vegetation. This is probably caused by altered fire regimes, either too frequent fires with insufficient fuel for hot burns or less frequent fires because of landscape fragmentation (O'Connor, Puttick & Hoffmann 2014). Furthermore, in the past few decades, increased atmospheric carbon concentration has probably favoured the proliferation of woody species over grasses and herbaceous species (Bond, Midgely & Woodward 2003b; O'Connor *et al*. 2014). As an example, between 1937 and 2013, the Scarp Forest at Longshadows Gorge (part of the Krantzkloof Nature Reserve) on the Molweni River has increased from 49 to 108 ha at the expense of KZNSS (Boon 2015). These results are similar to those reported by O'Connor *et al*. (2014) who reviewed the causes of bush encroachment in southern Africa and found that encroachment was fastest in small protected areas and slowest in areas under communal land tenure. At best, just over 10% of the original extent of KZNSS in Durban remains in good condition (Table 1) based on the estimated coverage of alien invasive plants and extent of soil erosion (Table 2) (EPCPD 2016). Small amounts remain in intermediate and degraded, but potentially restorable condition. The restoration of grassland is probably a limited option, however, as KZNSS appears to be difficult (or impossible) to restore as has been found for coastal grassland elsewhere in the province (Zaloumis & Bond 2011).

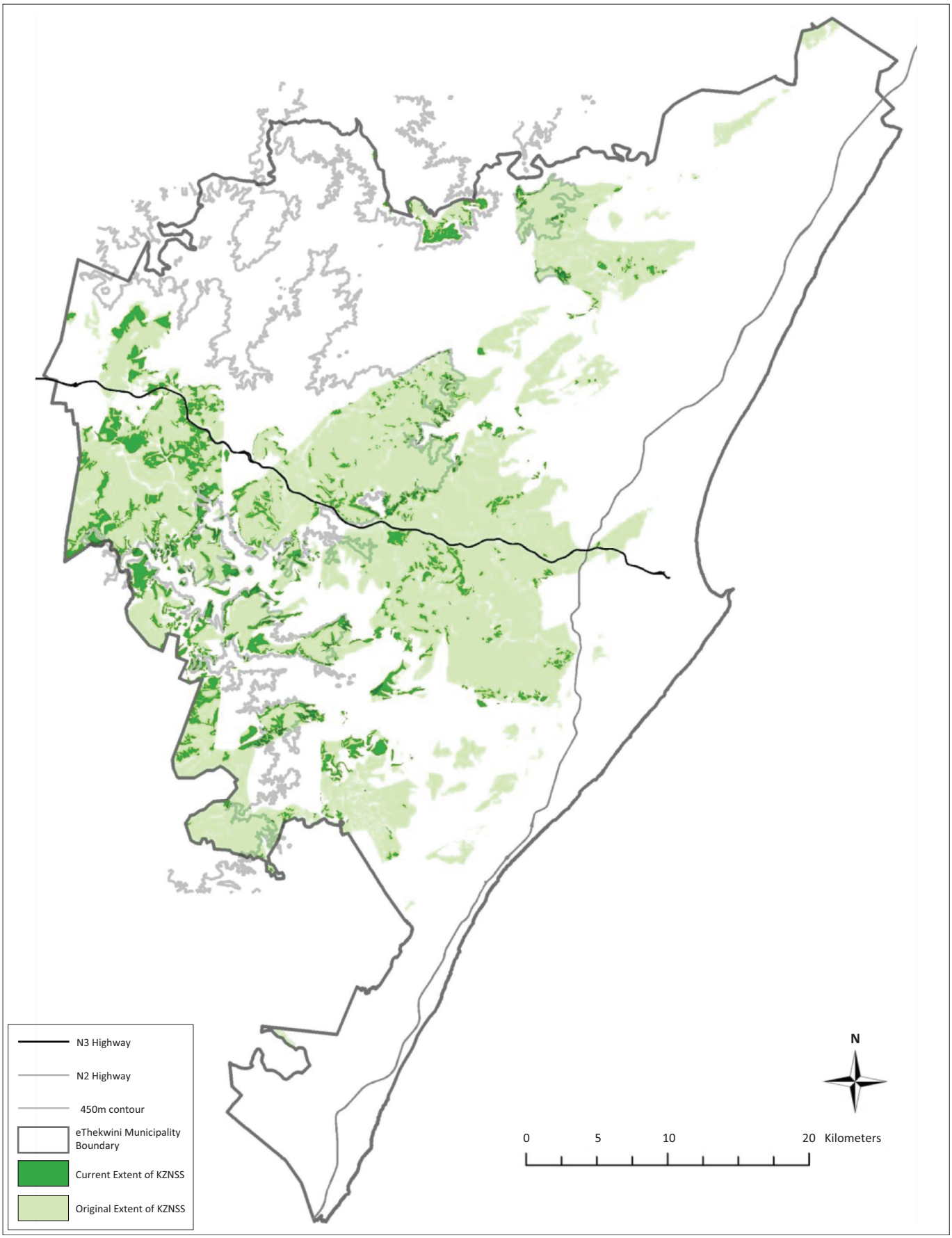
Given the prevailing situation in Durban, it is clear that the local target shortfall will have to be achieved outside of the city's boundaries where transformation rates are also high. Transferring the biodiversity responsibilities of a relatively well-resourced local government to less-resourced local governments is inequitable unless a method can be devised that is acceptable and benefits all significant stakeholders. Currently, there does not appear to be any strategic approach to adjust pro rata contributions to conservation targets across local government boundaries, although this would seem to be an important part of any overall strategy to conserve KZNSS.

Protection of KZNSS

A further significant challenge to meeting conservation targets for this vegetation type is that 66% of KZNSS in Durban (above and below the 450 m contour) is privately or communally owned (EPCPD 2016), which increases protection and management difficulties. Areas formally administered by local government (i.e. falling within town planning schemes and under the jurisdiction of eThekwini Municipality) occupy 36.1% of Durban (EPCPD 2016). Of the KZNSS located within the scheme areas, only 490.8 ha of the 3025 ha are zoned in a way that may prevent transformation (EPCPD). Thirty-eight percent of the remainder of the city is comprised of rural and semi-rural, communal areas administered by the Ingonyama Trust Board, an entity responsible for the administration of land for members of the tribes and communities living on the land (EPCPD). Planning tools are largely ineffectual in communal areas, which contain 4205 ha (37.8%) of the remaining KZNSS in Durban (EPCPD). This is a problem given that large parts of these semi-rural areas are developing rapidly because of the provision of some municipal services and infrastructure (e.g. tarred roads, electricity and water) in relatively remote areas, the availability of cheap land and the possibility of avoiding property taxes, a fact exploited by some relatively wealthy homeowners. The remaining 26.1% of Durban falls into non-scheme rural and agricultural areas, administered jointly by local and provincial government (EPCPD).

Levels of protection of KZNSS are currently inadequate as is the case generally for grasslands countrywide (Driver *et al*. 2012). Mucina and Rutherford (2006) state that 0.2% of the original extent of KZNSS is statutorily conserved by Ezemvelo KZN Wildlife, in the Krantzkloof and Vernon Crookes Nature Reserves, the latter falling outside of Durban. This appears to be an overestimate as Jewitt (2011), working at the provincial scale, gives the conserved area as 194 ha or 0.1% of the original extent. A further 286.5 ha is proposed for proclamation as part of a private stewardship nature reserve, but the proclamation process has stalled (I. Johnson personal communication, 12 May 2015). A number of municipal- and privately owned areas are also conserved, but not statutorily, and therefore, they are excluded from national and provincial statistics.

It is against this backdrop of high levels of threat and low levels of protection that Durban has developed a number of traditional and innovative approaches to improve the conservation status of KZNSS and other biodiversity values in the city (Roberts *et al*. 2012). These include town planning tools, biodiversity impact assessment, land acquisition, nature reserve proclamations, biodiversity stewardship, property taxes, environmental rates certificates and environmental special rating areas (Figure 3).



Source: Originator Mclean, C. 2015. Original extent of KZNSS in Durban from Boon, R., Ground, L. & Mclean C., In press. Current extent of KZNSS from EPCPD, 2016 KZN SS, KwaZulu-Natal Sandstone Sourveld.

FIGURE 2: Map of Durban showing the original and current extent of KZNSS including areas below the 450 m contour.

TABLE 2: Categories used to describe the ecological condition of each polygon in natural or semi-natural condition when mapping Durban's land cover.

Categories	Descriptions
Good	Vegetation appears natural with little or no degradation evident
Intermediate	Limited degradation evident: <50% of the area (polygon) has low (5%–33%) to moderate (33%–66%) estimated levels of alien plan infestation and/or limited soil exposure (<33% of the area)
Degraded	Extensive degradation evident: >50% of the area (polygon) has moderate (34%–66%) to high (67%–100%) estimated cover of alien invasive plants and/or extensive soil erosion (>33% of area)

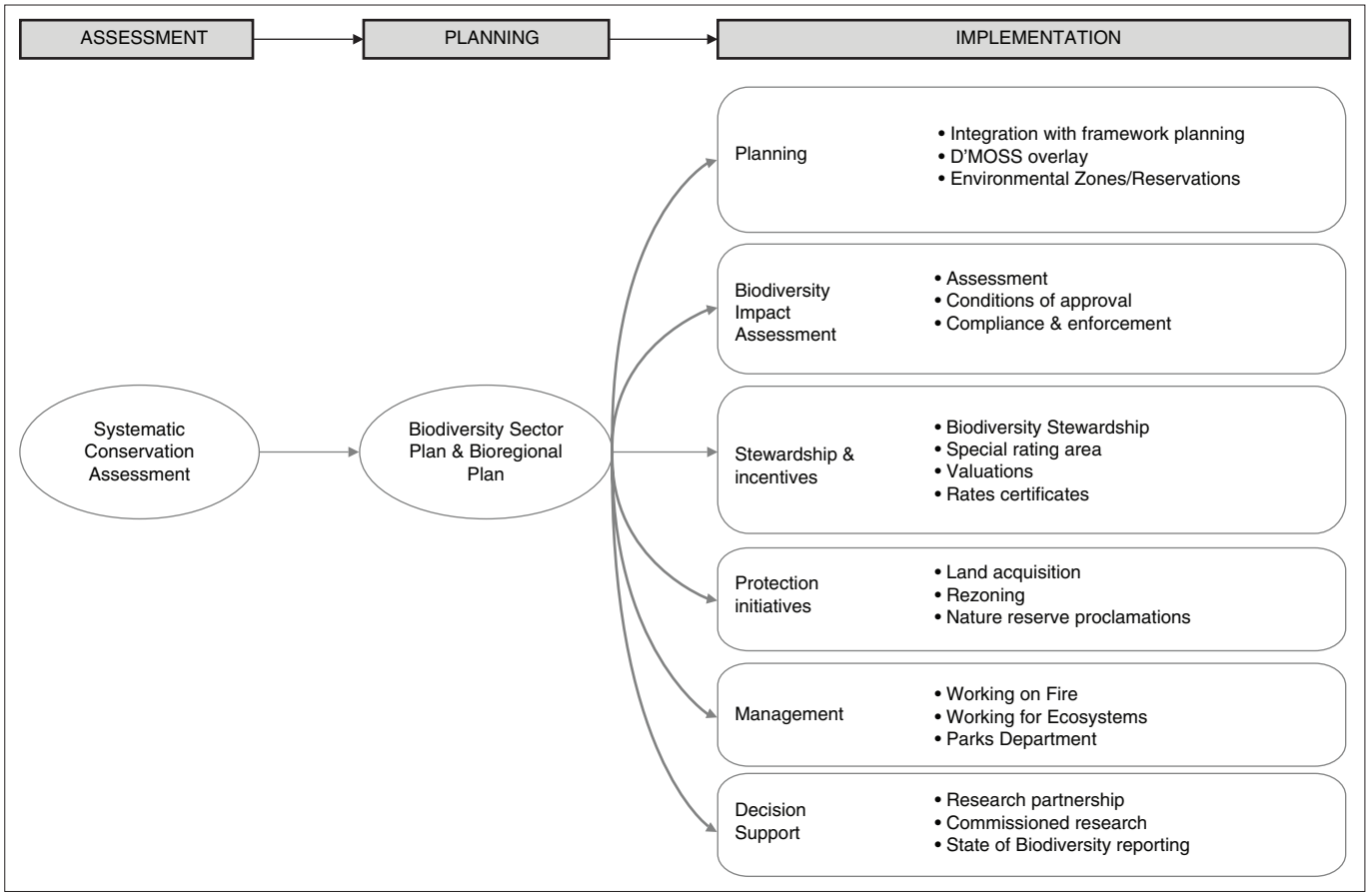
Source: Mclean *et al.* (2016)

Implementation efforts to conserve KZNSS

Land-use planning

EThekwini Municipality has a hierarchical package of spatial plans, which start with the city's strategic Integrated Development Plan (IDP) and Spatial Development Framework and which find detailed spatial expression through local level schemes (formerly town planning schemes). The 2014–2015 IDP includes D'MOSS as part of a programme that aims to ensure the long-term sustainability of the natural resource base. Earlier spatial plans for sub-regions of Durban showed D'MOSS as a layer over other land uses. In some cases, the potential land uses are incompatible with the environmental qualities of the site leading to uncertainty about the future development potential of the land. More recently, D'MOSS has been included as a land use, especially in parts of Durban which lack schemes and where no development rights have been granted as yet.

Although D'MOSS has appeared in the city's strategic plans since 1998, many of the local level schemes were developed many years ago (some as early as the 1950s), with little environmental input and as a result the perceived development 'rights' they confer often conflict with more recent environmental plans, policy and law (Roberts *et al*. 2012). If the development notionally permitted by the schemes was fully realised, it would be impossible to conserve Durban's biodiversity adequately. This has led to conflict during development application processes, when development has been refused or limited in environmentally sensitive areas, apparently contradicting what is permitted by the schemes (Roberts *et al*. 2012). In order to proactively address this disjuncture, D'MOSS was included in all municipal schemes on 9 December 2010 as a controlled development layer. This is the first for a South African city. The scheme regulations require that all planning applications in or adjacent to D'MOSS are assessed for potential



Source: Cockburn, J., 2015

KZN SS, KwaZulu-Natal Sandstone Sourveld.

FIGURE 3: Graphical representation of the relationship between assessment and planning and various implementation instruments used by eThekwini Municipality to protect and manage KZNSS.

biodiversity impacts. The amendment to the schemes was approved after extensive public consultation involving owners of approximately 18 000 properties (Roberts *et al*. 2012). The successful inclusion of D'MOSS in all spatial plans stems in part from the location of the EPCPD in a planning unit, an institutional opportunity that has been effectively utilised. As a consequence, eThekwini Municipality's Treasury and Real Estate Departments can now consider potential environmental restrictions when property values and taxes are calculated and developers are prompted to consider the environment earlier in their development plans.

The inclusion of D'MOSS in the schemes has been viewed by some as illegally curtailing existing property rights. As a result, an application was made by a landowner to the High Court of South Africa to have the resolution of the city council set aside. The applicant argued that the introduction of D'MOSS into the Municipality's schemes was unconstitutional and that local government's actions exceeded its powers as it lacked the authority to legislate on biodiversity related matters, which it was contended are the exclusive sphere of national and provincial government. The court agreed with local governments' argument that legislating for the environment through municipal planning (a local government competence) was permissible and that the D'MOSS amendments were in no way a transgression of national and provincial government competencies (Le Seuer vs eThekwini Municipality & Others 2013).

In recent years, eThekwini Municipality has also introduced a Conservation Zone and Environmental Conservation Reserve into all of its schemes. The Conservation Zone is used for environmental protection on private land, whereas the Environmental Conservation Reserve is used for state land including conservation land owned by local government. The reservation was introduced to differentiate land with a conservation purpose from Public Open Space, which permits various uses, some incompatible with environmental protection. The Conservation Zone regulations allow possible relaxation of the minimum property size and the required 25-m buffer from D'MOSS areas, and the transfer of potential rights from the Conservation Zone portion of split zoned sites to the developable portion. These provisions minimise the impact on development potential and protect environmentally sensitive land.

Planning applications and biodiversity impact assessment

Since D'MOSS has been included in the Municipality's scheme provisions, any planning application for a site included in or immediately adjacent to D'MOSS must be assessed by the EPCPD. This is additional to any requirements for environmental authorisation, which may be 'triggered' in terms of the National *Environmental Management Act* (Act 107 of 1998) Environmental Impact Assessment Regulations. The eThekwini Municipality is the decision-maker in planning applications and a commenting authority in environmental applications. Including environmental considerations in planning applications ensures that local government's interests are covered and that small-scale developments, which do not require assessment in terms of national legislation, do not have a significant local or cumulative environmental impact. Development of critical biodiversity areas, including KZNSS in good and intermediate condition, is not supported unless circumstances are exceptional (e.g. for strategic infrastructure) and options to avoid and mitigate impacts have been thoroughly investigated. Portions of development sites, which are excluded from development, may be protected through conditions of approval including conservation servitudes or appropriate zoning. EPCPD also has a small, but growing, compliance and enforcement function, which is tasked with working with various regulatory authorities to take action on priority biodiversity compliance issues.

Land acquisition

Land acquisition is regarded as an important method for securing environmentally significant areas (Czech 2002; Press, Doak & Steinberg 1996) and has been a key tool in protecting biodiversity in Durban, especially when there are no other options for protecting environmental values. The selection of sites to be acquired is based on a prioritisation system using biodiversity conservation value and other criteria such as land value, willingness of landowners to sell and distance to already managed areas. Between 2002 and 2011, approximately R2 million per annum was allocated to land acquisition for biodiversity conservation purposes, although in some years this amount was exceeded using savings from other departments. In 2011, the figure was increased to R3.15–R3.5 million per annum to keep pace with increasing land prices and development pressures. In just over a decade, with a relatively small annual budget, approximately 619 ha of priority biodiversity areas have been acquired (EPCPD 2016). More specifically, of the total area of land acquired for conservation since 2002, 42% or 263 ha was KZNSS (EPCPD). Most of the acquired properties have been rezoned to Environmental Conservation Reserve and are now managed as part of the Municipality's natural resource management programmes (see Management of KZNSS).

Despite the success of the acquisition programme, it is not possible or desirable to purchase all at-risk ecosystems. A suite of targeted and varied land-use management interventions is therefore essential to protect areas of significance (Roberts *et al*. 2012).

Biodiversity stewardship

Biodiversity stewardship is a tool that provides a hierarchy of conservation categories to private and communal landowners to voluntarily conserve land of high biodiversity importance (Cadman *et al*. 2010). This is performed by entering into contractual agreements with conservation authorities, and the hierarchy provides for varying levels of biodiversity protection, technical management support, incentives and benefits to landowners (Cadman *et al*. 2010).

Durban's Biodiversity Stewardship Programme was initiated in 2012 and is based on the provincial programme. In Durban, the biodiversity stewardship approach builds partnerships and incorporates technical and traditional knowledge systems to empower, guide and incentivise landowners to manage environmental assets on their properties. The stewardship approach often costs less than acquisition of land for biodiversity protection (Driver *et al*. 2012). A local government policy for the implementation of biodiversity stewardship projects has been developed to ensure that stewardship projects undertaken by different departments are aligned to a single set of goals, principles and procedures. One of the key principles is to use the SCA to guide stewardship site selection, and KZNSS will thus be a focus for biodiversity stewardship projects.

As part of its stewardship programme, local government is collaborating with Ezemvelo KZN Wildlife to proclaim 11 municipal nature reserves in terms of the NEM: PAA, the first of which, Roosfontein Nature Reserve, was proclaimed on 9 October 2015. The areas to be proclaimed currently have varying levels of legal protection ranging from none to zoned Public Open Space or Environmental Conservation Reserve. The proclamation will result in better legal protection of the sites and will allow their areas to be included in the calculation of national statistics for the conservation status of vegetation types. Of the nature reserves that are in the process of being proclaimed, six include areas of KZNSS totalling approximately 190 ha (EPCPD 2016). In addition, local government plans to proclaim the 263 ha of KZNSS that have been acquired in the land acquisition programme, and this with the 190 ha will represent the largest combined area of protected KZNSS under one landowner.

The stewardship programme also has four pilot implementation sites, which are being used to gain an understanding of the specific challenges related to conservation in areas with traditional governance systems. One of these projects, at Inanda Mountain, includes an additional 210 ha of KZNSS (EPCPD 2016), which is one of the largest tracts of KZNSS in the municipal area. Some progress has been made with engaging local stakeholders, but attempts to formalise a partnership with senior traditional authority leadership have so far been unsuccessful and the area remains under serious threat.

Property taxes, municipal valuations and environmental rates certificates

Property taxes in Durban are levied in terms of the local government: *Municipal Property Rates Act* (Act 6 of 2004). The taxation rate is determined by the municipal valuation of the property and a factor applied, which varies depending on the category of property. Prior to the 1 July 2012 municipal valuation roll, the impact of potential environmental restrictions on the use of property was not taken into account in determining the municipal valuation of a property. In addition, the highest multiplication factor is applied to vacant land in order to encourage development. In the case of environmentally sensitive land, this produced a perverse incentive whereby landowners were encouraged to develop environmentally significant land to escape punitive property taxes. Furthermore, when development applications were lodged for these properties, development was often refused or curtailed on environmental grounds. In order to address this disjuncture, proposals were made to the Municipality's Real Estate and Treasury Departments, which resulted in the application of nominal values to land affected by D'MOSS, effectively removing the tax burden on the affected landowners. However, as land identified as part of D'MOSS is not automatically precluded from development, local government carries the risk that landowners who pay reduced property taxes may be granted permission to develop land included in D'MOSS. An amendment to the valuation approach could address this shortfall by increasing the property tax rebate for landowners who commit the D'MOSS-affected portions of their property to a conservation land use and decreasing it for those that do not.

In addition to reducing the rates paid on land affected by D'MOSS, local government has made provision for the issuing of environmental rates certificates to exempt from rates land affected by D'MOSS that is legally protected and managed for conservation purposes. The introduction of this incentive has, however, provided only limited relief because environmental constraints were later factored into municipal property valuations meaning that only nominal rates are charged on environmentally sensitive land. Distinguishing between lands identified as part of D'MOSS and land that is also protected and managed for conservation purposes will make this incentive more meaningful.

A further opportunity provided by the *Municipal Property Rates Act* is for the formation of special rating areas (SRA) for the provision of 'top-up' services to specific areas. The 325-ha Giba Gorge Environmental Precinct (GGEP) was established in 2009 and is seemingly the first SRA in South Africa focusing on conservation management. The project aims to develop a partnership between citizens and local government to manage an area for conservation and recreation. A committee, including a local government representative and four permanent conservation management staff, oversee the area. Management activities include controlling invasive alien plants, fire management, field ranger patrols, provision of trails and amenities and communication. Funding is raised from landowners through a levy and a contribution from local government, which also owns part of the Gorge. Since the formation of the SRA, there has been a significant improvement in the management of the Precinct, with possible increases in property values, and user numbers have increased considerably. The Municipality and other stakeholders are currently considering replicating this successful model in an area that adjoins a provincial conservation area.

Management of KZNSS

The management of D'MOSS in Durban is undertaken by various departments and agencies and overall 7.96% of

D'MOSS is managed (EPCPD 2016). Durban's Parks Leisure and Cemeteries Department manages a number of municipal nature reserves and other municipal-owned areas included in D'MOSS, some of which include KZNSS. The Department does not, however, have sufficient resources to increase the areas under its management (e.g. those newly acquired for conservation) or to implement best practice programmes focused on the management of fire-dependent ecosystems. As a result in 2009, EPCPD initiated local Working on Fire (WoF) and Working for Ecosystems (WfE) programmes to manage and rehabilitate areas of KZNSS and other vegetation types outside of the Parks, Leisure and Cemeteries Department's jurisdiction. WoF and WfE have social co-benefits through alleviating poverty and developing skills in the previously disadvantaged people employed in the programmes. In the 2012/2013 financial year, the eThekwini Municipality spent nearly R11 million on these programmes. Work is focused on the control of invasive alien plants and the use of fire to maintain grassland condition. In order to improve standards of management, the programme has initiated the use of a veld (grassland) condition assessment (VCA) tool. This VCA, developed by Trollope (1989), aims to assess veld condition in relation to some functional characteristic, for example, the potential of the veld to produce grass forage, or fuel, or to resist soil erosion, with the objective of providing relevant management guidelines. Currently, the VCA technique is based on graminoid diversity and biomass data, although non-graminoids make up about 80% of grassland plant richness in the province (Uys, Bond & Everson 2003), and veld condition scores are not very good predictors of forb species richness in KZNSS (Scott-Shaw & Morris 2014).

Building science–policy–practice partnerships

The state of knowledge of urban ecosystems is generally poor within local governments in Africa. Sustainable land-use planning and decision-making should, however, be underpinned by credible scientific research and supported by a sound knowledge base (Cilliers *et al*. 2014). This is a recognised concern in Durban as well, and as a result, local government has initiated the development of the Durban Research Action Partnership (D'RAP) between eThekwini Municipality and the University of KwaZulu-Natal (UKZN). This research partnership provides relevant scientific research and knowledge support for the numerous interventions described above. Transdisciplinary research partnerships such as this can provide a link between scientific research and biodiversity management and conservation (Reyers *et al*. 2010; Sitas *et al*. 2014), and can assist in providing the necessary knowledge, skills and capacity often lacking in biodiversity conservation and environmental management at the local level in South Africa (Roberts *et al*. 2012; Sitas *et al*. 2014). The current focus of the partnership is the KZNSS Research Programme. The goal of the research programme is to contribute to increased knowledge and understanding of the KZNSS ecosystem in the context of global environmental change, specifically climate change. In addition to this, the partnership aims to build local capacity in biodiversity, environmental management and climate change adaptation (see Taylor *et al.* 2016, this issue). The lessons learnt through this process have been synthesised to develop a model of success factors for successful implementation of transdisciplinary research–action partnerships (Cockburn *et al*. 2016). By developing suitable knowledge, and building skills in research and management of threatened ecosystems in the local context, the D'RAP partnership contributes to the sustainable management and conservation of the threatened KZNSS ecosystem in Durban and ensures that environmental practice and decision-making are informed by science and that scientific research is informed by the needs of practitioners.

Way forward

Many of Durban's biodiversity assets are threatened, and the high level of transformation and degradation of KZNSS is an indicator of this state. Yet the situation would undoubtedly be worse if it were not for the fact that in Durban local government has been an important role player in biodiversity conservation planning and implementation for decades. The relevance of local government in biodiversity conservation in South Africa is likely to increase, especially in better resourced local authorities, given that local planning is the responsibility of local government and this is a key toolset for achieving biodiversity conservation objectives at a local level. Given the scale of the challenge, if biodiversity conservation targets are to be met in South Africa, local government and other role players, like landowners and civil society, will need to be fully involved as relevant partners in biodiversity conservation initiatives, which focus on conservation priorities.

EThekwini Municipality has been relatively successful in its efforts, and local government work in Durban has in recent years arguably exceeded those of other spheres of government directly mandated to protect biodiversity. For example, in Durban, more KZNSS is conserved by local government than by Ezemvelo KZN Wildlife at the provincial level. A key factor in the Municipality's success has been that conservation assessment and much of the related implementation work is carried out in-house and by one department (EPCPD), which has the strategic advantage of being placed in the unit responsible for municipal planning. On the contrary, in Durban, the Parks, Leisure and Cemeteries Department, which has the main responsibility for natural resource management, lacks sufficient expertise and resources to take on additional responsibilities. The fact that the two key biodiversity focused departments are located in different units makes co-ordination difficult, and a way must be found to overcome this issue. An additional challenge lies in improving collaboration with neighbouring municipalities and key stakeholders outside of local government, especially the Ingonyama Trust Board and leadership in areas falling under traditional authorities. Work in the Municipality's nascent stewardship programme needs to rapidly strive to find ways to collaboratively secure biodiversity in communal (and other) lands before much is lost to rapid development. In continuing its work, the Municipality must continue to do

what it does well, maintain its emphasis on implementation and in particular ensure the EPCPD's work (and that of other stakeholders) is sharply focused on conservation priorities identified in defensible prioritisation processes (Game *et al*. 2013) and documented in its Biodiversity Sector Plan, which is under development.

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The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

Authors' contributions

R.B. was the project leader. J.C., E.D., N.G., L.G., C.M. and D.R. wrote parts of the paper and contributed conceptually. M.R. and R.S. made conceptual contributions.

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