4 Using Local Spatial Biodiversity Plans to Meet the Sustainable Development Goals

Falko Buschke, Toka Mosikidi, Aliza le Roux, Lefu Mofokeng, and Bram Vanschoenwinkel

Abstract

The Sustainable Development Goals (SDGs) represent global development ambitions, but achieving these goals depends on local-level application. Many local governments, especially in countries with emerging economies, lack the capacity and resources to integrate SDGs into municipal planning. The feasibility of local implementation is particularly challenging in areas with rugged topography and international borders, such as the Thabo Mofutsanyana District Municipality, South Africa, into which the city of Phuthaditjhaba falls. Here we explore the suitability of existing spatial biodiversity plans for local application in the six local municipalities within Thabo Mofutsanyana District. We considered four plans related to biodiversity and ecosystem services, including international maps of (1) Key Biodiversity Areas and (2) Strategic Water Source Areas; a national (3) Protected Area Expansion Strategy; and a provincial map of (4) Critical Biodiversity Areas. Although these plans were not designed specifically to meet the SDGs, we show that they can be repurposed to address seven of the 17 SDGs. Next, we summarised the spatial coverage of each plan across the six local municipalities and evaluated the opportunities and shortcomings of using these plans for local application. Our findings guide local officials on the most efficient way to plan for the SDGs using currently available spatial products.

Keywords

Protected areas · Planning · Ecosystem services · Land-use · Biodiversity

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4.1 Local Application of the Sustainable Development Goals

The Sustainable Development Goals (SDGs) articulate a shared vision for international development. The 17 SDGs define development using multiple indivisible criteria of economic progress, poverty alleviation and environmental protection. Achieving these multidimensional goals will require complete transformation of global socio-ecological systems (Sachs et al. 2019; Reyers and Selig 2020; Leclère et al. 2020) because current development pathways are causing widespread environmental degradation (Steffen et al. 2015; Díaz et al. 2019). Although the SDGs are detailed enough to build global consensus amongst nations, their success ultimately depends on local-scale implementation (Gao and Bryan 2017; Jiménez-Aceituno et al. 2020; Moallemi et al. 2020). A sustainable future will remain out of our grasp unless global ambitions are translated into actionable local policies (Irwin et al. 2018).

There are two general strategies for streamlining local implementation towards the SDGs. The first is to downscale global SDGs by defining science-driven sub-targets tailored to specific local contexts (Gao and Bryan 2017). This strategy redefines higher level aspirations in terms that are more relevant to local stakeholders, policymakers and practitioners, who can then devise new approaches for implementation (Jiménez-Aceituno et al. 2020; Moallemi et al. 2020). Although this strategy ensures that plans are tailored for SDG implementation, it would have to be compatible with existing policies, laws and institutions. By contrast, the second strategy is identifying existing local plans and policies and then evaluating whether these can be repurposed to meet higher-level SDGs. This latter approach has been followed for sector-specific energy (Fuso Nerini et al. 2018) and climate change (Fuso Nerini et al. 2019) policies, which have been re-interpreted through the lens of the SDGs. The advantage of repurposing existing policies and plans is that it ensures compatibility with current laws and institutions.

An effective starting point for repurposing existing plans and policies is to focus on those governing land-use. Although the SDGs are supposed to be indivisible, there are obvious trade-offs between individual goals (McGowan et al. 2019; Kroll et al. 2019), which can manifest as land-use conflicts (Gao and Bryan 2017). In such instances, the pursuit of one goal might jeopardise other goals. For example, land-use change for infrastructure development could contribute to economic growth (SDG 8), resilient infrastructure (SDG 9) and sustainable cities (SDG 11), while simultaneously polluting water sources (SDG 6) and destroying habitat (SDG 15).

Land-use conflicts may be exacerbated when landscapes have complex topography or straddle geopolitical boundaries (Payne et al. 2020; Vinca et al. 2020). Habitat heterogeneity means that landscape patches are less interchangeable, which makes identifying and managing potential trade-offs more difficult. Similarly, cross-boundary land-use management is complicated by differing legal frameworks and political priorities. Therefore, avoiding trade-offs between incompatible land-use policies are especially important in mountainous areas that cover more than one geopolitical jurisdiction.

Despite the importance of biodiversity for sustainable development (Blicharska et al. 2019; Bawa et al. 2020), attaining environmental SDGs may actually jeopardise the integrity of biodiversity (Reyers and Selig 2020; Zeng et al. 2020). This is partly because the SDG indicators focus on threats to biodiversity, rather than the actual state of biodiversity (Zeng et al. 2020). Moreover, the SDGs tend to consider socioeconomic systems as uncoupled from ecosystems, so socio-ecological interdependencies are not considered explicitly by the SDG framework (Reyers and Selig 2020). The consequence of this is that biodiversity is declining to the extent that it might be unable to support future human development aspirations (IPBES 2019; Díaz et al.

2019). Therefore, efforts to realign existing local plans and policies to meet the SDGs should prioritise safe-guarding biodiversity.

In this study, we examine whether existing biodiversity plans at a local level can be repurposed to meet the SDGs. We focus on six local municipalities in South Africa, which are adjacent to the international border with Lesotho. These six municipalities comprise a mixture of land-uses across complex mountainous terrain, making them susceptible to negative development trade-offs. For instance, prioritising land for smallholder farming might meet food security goals, but could jeopardise the supply of ecosystem services (e.g. increased erosion can worsen sedimentation in water bodies). To consider policies across varying scales of governance, we consider four existing plans for biodiversity and ecosystem services, which have been developed internationally, nationally, and provincially. In the following sections, we begin by describing the four existing biodiversity plans, paying particular attention to their opportunities and shortcomings for meeting the SDGs. We then present maps for each of these plans and summarise how they might affect the six municipalities differently. Lastly, we provide a roadmap for stakeholders, practitioners and policymakers on how existing biodiversity plans should be applied to meet the SDGs. Combined, this can guide local efforts to manage land-use for sustainable development.

4.2 Methods

Our study focused on six local municipalities in the Thabo Mofutsanyana District Municipality, central South Africa (Fig. 4.1a). South Africa has a multi-sphere government at the national, provincial and local levels. Local government is split into district municipalities, which focus on integrated planning and supplying bulk utilities; with nested local municipalities, which focus on town planning and local service delivery to residents. The six local municipalities (Fig. 4.1b) in this study are: Dihlabeng (which includes the main towns Bethlehem and Clarens), Maluti-a-Phofung (main towns Phuthaditjhaba and Harrismith), Mantsopa (main town Ladybrand), Nketoana (main town Reitz), Phumelela (main town Vrede), and Setsoto (main towns Senekal and Ficksburg). These municipalities are predominantly rural and agriculture is the main land-use. However, some towns have large and growing populations in desperate need of development. For example, according to the 2011 national census, Phuthaditjhaba has a population of approximately 55,000 people of which 30% are younger than 14 years old and only one third of adults have completed their secondary schooling. Thus, the need for sustainable development is urgent.

The biophysical environment of Thabo Mofutsanyana District Municipality can be classified as temperate grassland, with habitat heterogeneity caused by elevation and rainfall gradients that both increase from west to east (Fig. 4.1b). This climatic and topographical variation means that the biodiversity of the six local municipalities is not interchangeable and needs to be managed in a spatially explicit way. To this end, we consider four spatial biodiversity plans developed at different scales of governance and varying levels of detail. The first of these is a map of *Critical Biodiversity Areas* (CBA), developed by the provincial governmental department responsible for the environment (this is also referred to as the Free State Spatial Biodiversity Plan). The second plan is an international map of *Key Biodiversity Areas* (KBA), which was originally devised by Birdlife International and is currently being updated by the South African National Biodiversity Institute (SANBI) and BirdLife South Africa. The third is a national map of legally protected areas as well as areas earmarked for future protected area expansion. This map was developed by the national government Department of Environment, Forestry and Fisheries. The fourth map is a regional map of *Strategic Water Source Areas* (SWSA) in South Africa and neighbouring countries developed by the South African Council for Scientific and Industrial Research.

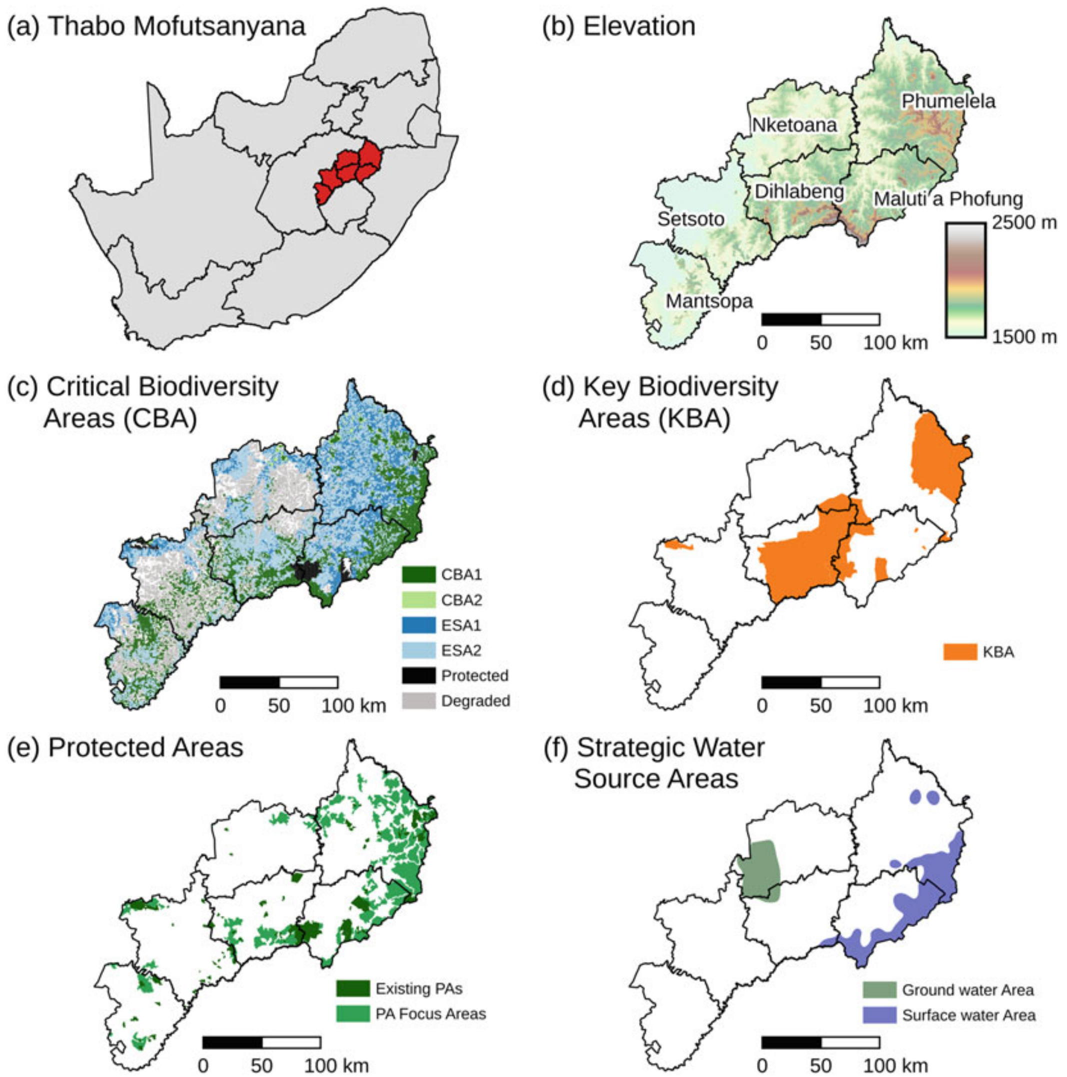

Fig. 4.1 Geographical distribution of biodiversity features in the six local municipalities of Thabo Mofutsanyana District Municipality. **a** The position of Thabo Mofutsanyana District in South Africa, and **b** the elevation and location of the six local municipalities. **c** Critical Biodiversity Areas (CBA) and Ecological Support Areas (ESA), **d** Key Biodiversity Areas (KBA), **e** Existing protected areas and protected area focus areas, and **f** Strategic Water Sources Areas (SWSA) for surface and ground water

We elaborate on the characteristics of each of these biodiversity plans in subsequent subsections.

4.2.1 Critical Biodiversity Areas

CBA are maps developed through a systematic conservation planning process (Margules and Pressey 2000; Kukkala and Moilanen 2013). Systematic conservation planning entails (i) dividing the landscape into planning units, (ii) mapping biodiversity features, (iii) identifying conservation targets for each biodiversity feature, and (iv) using a prioritisation algorithm to select the smallest and most spatially efficient set of ecologically connected planning units that meet targets for all the biodiversity features.

Planning units that are most essential for meeting biodiversity targets—referred to as irreplaceable—are classified as CBAs. By comparison, planning units that meet targets for biodiversity features, but which have potential substitutes elsewhere in the landscape (i.e. are more replaceable) are classified as Ecological Support Areas (ESA). The degree of irreplaceability can be used to further subdivide CBA and ESA into two levels each (CBA1, CBA2, ESA1, and ESA2). In South Africa, systematic conservation planning has evolved technically to the point where social and development objectives are incorporated into CBA maps (Buschke et al. 2019a, b; Botts et al. 2019). This means that the final prioritisation of planning units avoids areas that are likely to be developed in the future or which would carry a high opportunity cost if managed exclusively for biodiversity. Thus, CBA maps can be valuable tools for land-use planning by directing development away from areas of irreplaceable biodiversity.

The CBA map used in this study (Fig. 4.1c) is the official biodiversity plan of the Free State Provincial Department of Economic, Small-Business, Tourism and Environmental Affairs (Collins 2017), which represents the irreplaceability of hexagonal 100-hectare planning units. As input biodiversity features, the plan includes distributions of threatened and endemic plants, invertebrates and vertebrates; the extent of terrestrial and freshwater ecosystem types; migratory corridors; and areas of significant ecological and evolutionary processes, such as areas for climate change resilience and adaptation, and unique geological features (Collins 2017). CBA maps receive legal force from the environmental impact assessment (EIA) regulations in terms of the National Environmental Management Act 107 of 1998. In practice, this indicates that any proposed development within a CBA area will trigger an environmental authorisation process and any development without approval from the authorising government agency will be considered illegal (SANBI 2017). CBA have also been integrated into land-use schemes under the Spatial Planning and Land Use Management Act 16 of 2013, which categorises land use zoning and regulations for entire municipalities. Therefore, CBA are directly linked to existing legislation within South Africa and would align with existing institutions if repurposed to contribute to the SDGs.

4.2.2 Key Biodiversity Areas

KBA are sites important for the global persistence of biodiversity (IUCN 2016). Thus, they have much in common with CBA, but they differ in several important ways (Smith et al. 2019). While both CBA and KBA identify geographical areas of significant biodiversity, KBAs are not prioritised according to their relative ability to meet biodiversity targets nor do they consider socio-economic objectives (Smith et al. 2019). They, therefore, represent a biodiversity-centred view of the landscape, without considering other competing land-uses. This means that KBA can coincide spatially with high intensity land-uses, such as commercial agriculture (Buschke et al. 2020). Moreover, individual KBAs are considered equally significant for biodiversity, so it is not possible to rank one KBA above another.

Designating KBA boundaries vary because KBA are defined as sites that can realistically be managed as a single unit (IUCN 2016). This could be based on natural features, like water catchments; or geopolitical features, such as municipal boundaries or formal protected areas. Once the management unit is identified, it can be classified as a KBA if it contains a considerable proportion of the global distribution of (a) at least one threatened species, (b) geographically restricted biodiversity, (c) ecologically intact communities, (d) significant biological processes (e.g. breeding aggregations), or (e) irreplaceable biodiversity (IUCN 2016). This biodiversity-centred form of spatial planning means that KBAs tend to overlap closely with areas prioritised through systematic conservation planning, but imperfectly so (Plumptre et al. 2019).

The KBA map used in this study (Fig. 4.1d) is from the Key Biodiversity Area Partnership (http://www.keybiodiversityareas.org/), a partnership of 13 international conservation organisations. The eight KBA in the study area (Alexpan, Ingula, Golden Gate, Grassland, Murphy, Rooiberge-Riemland, Sterkfontein, Willem-Pretorius) were originally classified by BirdLife International as Important Bird Areas because they contain globally threatened and globally significant congregations of bird species (Buschke et al. 2020). These Important Bird Areas were subsequently integrated into the KBA system, which is currently being updated by SANBI and BirdLife South Africa to include other taxonomic groups besides birds.

Currently, KBAs do not have specific legal standing in South Africa. However, this is likely to change in the upcoming decade because KBAs have taken a central position in negotiations of the post-2020 Global Biodiversity Framework under the Convention on Biological Diversity (Open-ended Working Group on the post-2020 Global Biodiversity Framework 2020). Target 2 of the draft version of the post-2020 framework aims to "*by 2030, protect and conserve through well connected and effective system of protected areas and other effective area-based conservation measures at least 30 per cent of the planet with the focus on areas particularly important for biodiversity*." The implication is that KBA would represent the "*areas particularly important for biodiversity*" (e.g. Visconti et al. 2019). If this draft target is ratified by the Convention on Biological Diversity, then as a signatory to the convention, South Africa would commit to protecting KBA; thereby preventing harmful land-uses across these sites. This need not entail the establishment of formal protected area, but could include other effective conservation measures (Donald et al. 2019), such as biodiversity stewardship agreements (Wright et al. 2018). Therefore, KBA could constrain future sustainable development options through land-use restrictions, but they could also create opportunities for land-owners to diversify their incomes through private protected areas.

4.2.3 Protected Areas and Protected Area Focus Areas

Protected areas are the cornerstone of biodiversity conservation (Le Saout et al. 2013; Watson et al. 2014). These are areas of land that are managed exclusively for the purpose of conserving plants, animals and ecosystem services. Although the focus of protected areas is on conserving nature, in South Africa's National Environmental Management Protected Areas Act 57 of 2003 allows for these areas to also enhance nature-based tourism, provide sustainable access to natural resources and generally contribute to economic development. Moreover, the Act allows for varying levels of protection, including national parks managed by South African National Parks, provincial protected areas, local nature reserves managed by municipalities, as well as private protected areas.

As a signatory to the Convention on Biological Diversity, South Africa committed to protecting 17% of terrestrial land by 2020. However, it fell well short of this target (Buschke et al. 2019b) and set out to identify focus areas that should be prioritised for protected area expansion (Department of Environmental Affairs 2016). Focus areas overlap closely with CBA, but preference is given to sites nearer to existing protected areas or sites to potentially link existing protected areas in a connected network.

The protected area spatial dataset used in this study (Fig. 4.1e) is from the National Protected Areas Registry developed in accordance with Section 10 of the Protected Areas Act 57 of 2003. This registry is the official governmental source of information used to report to the Convention on Biological Diversity. We distinguished between existing protected areas, which are formally proclaimed and managed according to the Protected Areas Act 57 of 2003; and protected area focus areas, which are predominantly private farmland with reasonable ecological intactness (Department of Environmental Affairs 2016). Protected area focus areas do not have formal legal protection, but they ought to be managed in a way that avoids high impact land-uses so as to maintain the option of future protection. Moreover, private land-owners might benefit from committing contractually to managing their land as voluntary biodiversity stewardship areas, which are also recognised by the Protected Areas Act 57 of 2003. This would make them eligible for financial incentives, such as tax rebates, for the duration of their stewardship contracts (Wright et al. 2018).

4.2.4 Strategic Water Source Areas

Ecosystem services are the benefits humans gain from nature. Although conservation planning has advanced considerably in the last three decades, incorporating ecosystem services into these plans have lagged behind (Villarreal-Rosas et al. 2020). An essential provisioning service is the reliable supply of clean freshwater. Strategic Water Source Areas (SWSA) are geographical regions that are disproportionately important for supplying clean freshwater and contributing to society and the economy (Nel et al. 2017). These SWSA can be further sub-divided into areas that are important for surface water supply and those important for ground water recharge. Surface water SWSAs are mountain catchments that generate disproportionate water runoff from precipitation compared to lower lying areas, combining the topographical and meteorological aspects of a landscape (Le Maitre et al. 2018a). In comparison, ground water SWSA represent areas of disproportionate importance for ground water recharge (based on run-off and geology-modulated infiltration rates) as well as ground water demand (based on human dependency on ground water sources) (Le Maitre et al. 2018a).

This study used an updated dataset of SWSA developed by the South African Council for Scientific and Industrial Research (Fig. 4.1f) (Nel et al. 2017; Le Maitre et al. 2018a). This included one ground water SWSA (Arlington SWSA) and portions of four different surface water SWSAs (the Maloti, Northern Drakensberg, Upper Vaal and Ekangala SWSAs). The Maloti and Northern Drakensberg SWSA extend across the national border with Lesotho and in combination support approximately a quarter of the South African population and a third of the gross value added to the national economy (Nel et al. 2017). Currently, SWSA are not directly protected by specialised legislation. However, they can be incorporated into land-use planning schemes—such as spatial development frameworks and integrated development plans—which do have legal protection (Le Maitre et al. 2018b). Furthermore, SWSAs also justify land-use management as outlined by national ecosystem guidelines, which recommend that high altitude grassland be managed as water production landscapes (SANBI 2013).

4.2.5 Analysis

The 17 SDGs are sub-divided into 169 targets (8–12 targets per SDG), which are monitored using 232 unique indicators. We evaluated the potential and consequences of repurposing existing biodiversity plans to meet the SDGS using a two-step process. First, we reviewed all the SDGs and their sub-targets and linked these conceptually to the four spatial biodiversity plans: CBA, KBA, protected areas and SWSA. Linkages were based on whether the biodiversity plans can be used towards meeting the SDG sub-targets, either because they represent key ecological features defined by sub-targets and their indicators, or because they can support or constrain activities designed to meet the SDG sub-targets. Therefore, we do not consider all the possible ways these biodiversity plans could affect the SDGs; focussing instead on the explicit links between these plans and the existing SDG monitoring framework (i.e. the 17 SDG, their 169 sub-targets, and 232 indicators). Once we linked each plan to relevant SDGs, we ranked each of the biodiversity plans based on how many SDGs they can contribute towards. The second step of this process was a geographic summary of four spatial biodiversity plans in the six local municipalities within Thabo Mofutsanyana District. This allowed us to compare the six local municipalities in terms of the four biodiversity plans and make recommendations on how local stakeholders, practitioners and policymakers can use existing plans to guide their progress towards the SDGs.

4.3 Results and Discussion

4.3.1 Linking Biodiversity Plans to Sustainable Development Goals

There were direct links between existing spatial biodiversity plans and seven of the SDGs (Fig. 4.2). We only considered links where a biodiversity plans could be interpreted through a specific sub-target or monitoring indicator for the SDGs. This meant that indirect links were not considered in our assessment. For example, we did not include indirect links between the biodiversity plans and SDG 3 (*Good Health and Wellbeing*) even though managing wild species effectively would reduce the likelihood of zoonotic spill-over effects and limit pathogen transmission (IPBES 2020). However, the indicators for the sub-target associated with communicable diseases (Target 3.3) focus specifically on incidents or treatments of diseases, so they cannot be linked to biodiversity maps directly. Therefore, it is likely that our assessment underestimates all the ways biodiversity plans can support the SDGs indirectly.

SDG 2 aims to achieve zero hunger by 2030 and is particularly relevant to Thabo Mofutsanyana District, which has a strong agricultural sector. CBA can be repurposed to support Target 2.4 because it could ensure that food production maintains ecosystems and strengthens the capacity for adaptation to extreme weather, drought, flooding and other disasters. For example, mountains and rocky outcrops, which are identified as CBA, serve as refuges where invertebrates can persist during periods of drought (Buschke et al. 2020). Such resilience is needed to maintain the socio-ecological integrity of food production landscapes (Kremen and Merenlender 2018).

SDG 6 strives for clean water and sanitation. CBA, protected areas and SWSA can all be repurposed to support Target 6.6, which entails protecting water-related ecosystems. Moreover, SWSA also support Target 6.4 by ensuring freshwater supplies and Target 6.5 by identifying areas for cross-boundary integrated water resources management. The interbasin transfer of water from Lesotho to South Africa has considerable benefits for both countries, but these benefits are not without risk (Matete and Hassan 2006; Nel et al. 2017). For instance, while the transfer of water to South Africa has economic significance for many sectors (Matete and Hassan 2006), it still depends on healthy catchments to supply regulating ecosystems services and ensure that water stays unpolluted until it reaches end-users (Cumming et al. 2017).

SDG 8 promotes decent work and economic growth. Protected areas contribute to Target 8.9 by supporting policies to promote sustainable tourism, create jobs and promote local culture. Tourist visits to protected areas globally generate US$600 billion in in-country expenditure and US $250 billion consumer surplus annually (Balmford et al. 2015). Although tourism is encouraged by the South African Protected Areas Act 57 of 2003, the benefits of tourism are not constrained by the boundaries of these protected areas. Tourism in the Thabo Mofutsanyana District Municipality provides economic multipliers because tourism revenue tends to move between towns and local municipalities (Buschke and Seaman 2014). Thus, the overall contribution of protected areas to employment and the economy likely outweighs direct expenditures.

SDG 9 aims for sustainable industry, innovation and infrastructure. The CBA map supports Target 9.1 by guiding the sustainable design of infrastructure for economic development and human well-being. Because CBAs speak to the EIA regulations in terms of the National Environmental Management Act 107 of 1998, they directly affect the authorisation of infrastructure development projects. Thus, CBAs provide a direct mechanism for applying a spatially-

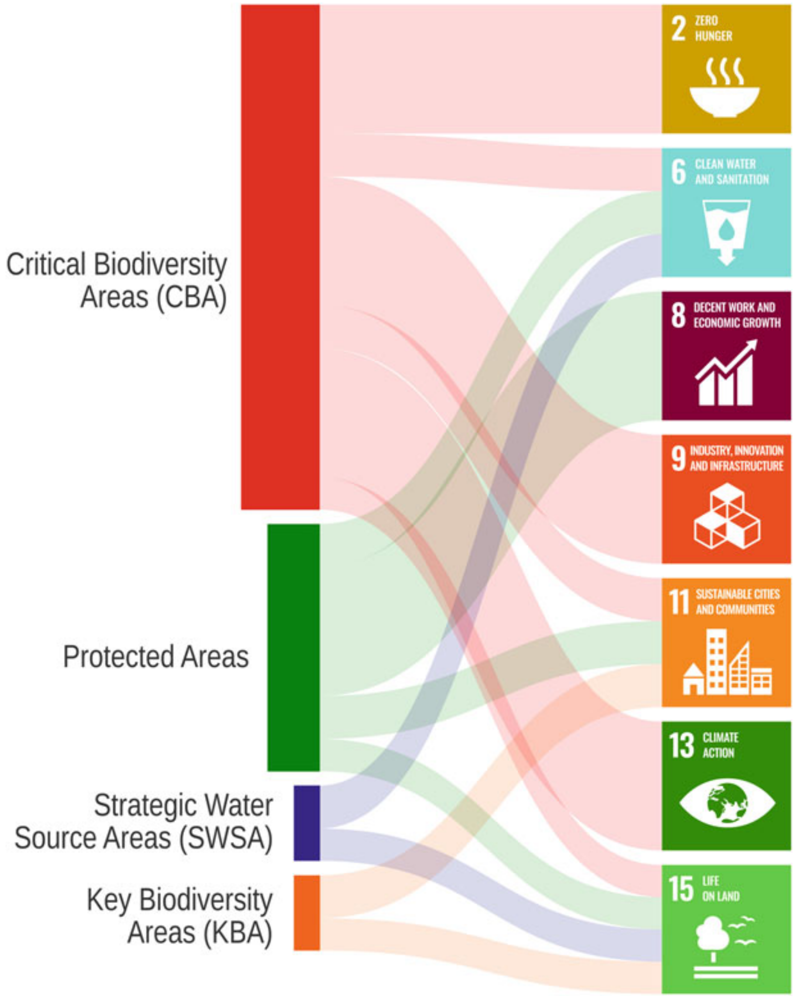

Fig. 4.2 The conceptual links between four spatial biodiversity plans and the Sustainable Development Goals (SDG). Spatial biodiversity plans are ranked according to the number of links to the SDGs, which are represented by the width of the coloured bars. The widths of the semi-transparent flows are determined by the proportional contribution of each plan to specific SDGs

explicit mitigation hierarchy during economic development activities (e.g. Arlidge et al. 2018; Bull et al. 2020). The benefits of this are twofold: first, it prevents unsustainable infrastructure development in sensitive ecosystems; and, second, it directs development towards least sensitive areas, reducing the regulatory risks to investors (Dempsey 2013).

CBAs, protected areas, and KBA can be used to meet SDG 11: sustainable cities and communities. This is because all three spatial biodiversity plans strength efforts to protect and safeguard the world's natural and cultural heritage (Target 11.4). Although the contributions of these plans to natural heritage are obvious given their original purposes, links to cultural heritage need elaboration. At the minimum, nature provides opportunities for education, recreation, harvesting and cultural expression (Mace et al. 2012). Nature also underpins relational values, which are not present in plants and animals as objects, but which are derived from the way people relate to nature (Chan et al. 2016). While relational values, like feeling a sense of place in a mountainous landscape, are often intangible, they can manifest themselves through the way people express their culture (Makombe and Nyambi 2021). A notable local example is San rock art, which is prevalent in the sandstone caves throughout Thabo Mofutsanyana District (Mol and Viles 2010; Grab et al. 2011).

SDG 13 aims to promote sustainable climate action and could be supported by CBA, which contributes to Target 13.1 by strengthening the resilience and adaptive capacity to climate related hazards and natural disasters. This is because systematic conservation planning accommodates corridors for climate-mediate migration (Rouget et al. 2006) and prioritises habitat features that provide refuge to species (Buschke et al. 2020). While there are other ways that biodiversity contributes nature-based solutions for climate change mitigation (e.g. carbon storage, drought resilience and flood water regulation), these links between the spatial biodiversity plans and the SDG sub-targets are only indirect.

It is unsurprising that all four spatial biodiversity plans link conceptually to SDG 15, which aspires to sustain life on land. This is because the plans were designed specifically to focus on terrestrial biodiversity. Therefore, they can be directly linked to the SDG targets to conserve and restore ecosystems (Target 15.1), combat desertification (Target 15.3), conserve mountain ecosystems (Target 15.4), and protect biodiversity and natural habitats (Target 15.5). They can also be linked indirectly to promoting access to genetic resources (Target 15.6), eliminating poaching (Target 15.7), preventing invasive alien species (Target 15.8), and integrating biodiversity into government planning (Target 15.9). These indirect contributions depend on these plans being used to support related initiatives, such as prioritising land for eradicating invasive species or implementing anti-poaching initiatives within protected areas.

4.3.2 Spatial Coverage of Biodiversity Features

The six local municipalities each cover over half a million hectares on average (Fig. 4.3a), with Phumelela in north-east being the largest (818,349 ha) and Mantsopa in the south-west the smallest (429,059 ha). These local municipalities are too large to be managed as homogenous units and should instead be sub-divided based on their ecological characteristics.

Although the median elevation for the six local municipalities is consistently higher than 1,600 m above sea-level, certain municipalities are more mountainous than others (Fig. 4.3b). Dihlabeng (containing the Witteberge and the Rooiberge mountain ranges) included peaks exceeding 2600 m above sea-level, and Maluti-a-Phofung (which incorporates the Rooiberge and Drakensberg ranges) has peaks exceeding 3200 m above sea-level. Phumelela (which is on the western slopes of the Drakensberg range) boasts the highest median elevation, but few high-altitude peaks (maximum = 2207 m above sea-level). By comparison, Mantsopa, Nketoana and Setsoto are generally less mountainous with more uniform topography. These flatter areas are more suitable for cultivation, which explains why these municipalities contain a higher proportion of degraded land caused by agricultural transformation (Fig. 4.3c).

Although five of the six local municipalities included more than 20% coverage of CBAs 1 & 2 (Fig. 4.3c), these areas tended to be in more mountainous portions of the landscape (Fig. 4.1 c). For example, the Drakensberg in Phumelela and Maluti-a-Phofung were classified as CBAs, as were the Witteberge and Rooiberge in Dihlabeng. The CBAs in Mantsopa were also associated with mountain ranges, in this instance the Korannaberg inselberg on the northern sections of the municipality (Fig. 4.1c). The close association between mountains and CBA can be attributed to their lower likelihood of transformation (due to rocky substrates and steep slopes) and their disproportionate role in landscape-wide ecological processes (Buschke et al. 2020).

The contiguous municipalities of Dihlabeng, Maluti-a-Phofung and Phumelela had the highest proportional coverage by KBA (Fig. 4.3d). This is primarily due to the Rooiberge-Riemland KBA in Dihlabeng and Maluti-a-Phofung, and the Grasslands KBA in Phumelela. These two large KBA cover extensive areas that include sandstone outcrops, which provide nesting sites for globally vulnerable species like the southern bald ibis, *Geronticus calvus*; and high altitude wetlands, which supply habitat to critically endangered species like the wattled crane, *Bugeranus*

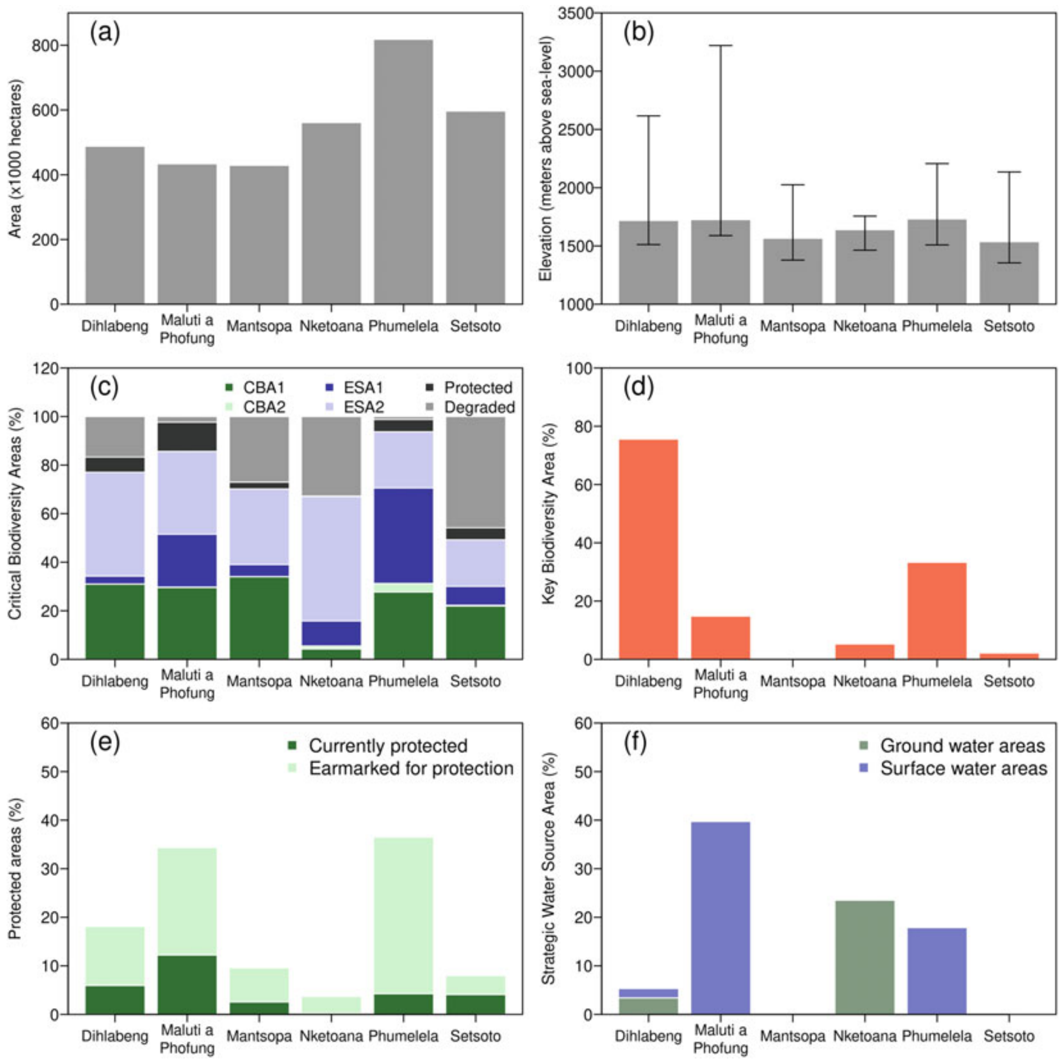

Fig. 4.3 The geographic characteristics of spatial biodiversity plans of six local municipalities within Thabo Mofutsanyana District Municipality. **a** The surface area of each local municipality in hectares. **b** The median elevation across municipalities, with minimum and maximum elevation as error bars. **c** The percentage coverage of features from the map of Critical Biodiversity Areas, which includes two levels of Critical Biodiversity Areas (CBA 1 & 2) and Ecological Support Areas (ESA 1 & 2). **d** The percentage coverage of Key Biodiversity Areas. **e** The percentage coverage of protected areas and focus areas earmarked for protected area expansion. **f** The percentage coverage of Strategic Water Sources Areas for ground and surface water

carunculatus, and the white-winged flufftail, *Sarothrura ayresi* (Taylor et al. 2015). Despite the global significance of these areas, they are generally poorly protected (Fig. 4.3e) and coverage does not even approach the 17% target for 2020 set under the Convention on Biological Diversity (Buschke et al. 2019b). Only Maluti-a-Phofung exceeded 10% coverage by protected areas, mainly due to Golden Gate Highlands National Park and Sterkfontein Dam Provincial Nature Reserve. That said, the more mountainous local municipalities (Dihlabeng, Maluti-a-Phofung and Phumela) had higher proportional coverage of protected area expansion focus areas (Fig. 4.3e).

The high elevation Maluti-a-Phofung and Phumlela municipalities were more likely to overlap with the Maloti and Northern Drakensberg SWSA. However, more than 20% of the low-lying and heavily transformed Nketoana Municipality included groundwater SWSA (Fig. 4.3f). This illustrates that even landscapes with relatively uniform topography and low biodiversity can contribute to the supply of water ecosystem services.

In summary, our spatial assessment allows us to make the following context-specific land-use recommendations. In Phumelela and Maluti-a-Phofung, which include large coverage of SWSA, land-use management should aspire to preserve biodiversity and ecosystem services by managing these areas as water production landscapes. The National Ecosystem Guidelines recommend using (i) a low intensity fire management program that considers slow plant growth times and high erosion rates, (ii) restrictive grazing of bulk, rather than selective grazers at low stocking rates, and (iii) focus on sensitive plant and animal species of concern during the EIA process (SANBI 2013). Dihlabeng, with its high coverage by KBA, should prioritise managing the landscape for biodiversity, paying particular attention to plants and animals in agricultural landscapes (e.g. Buschke 2016) and keystone ecosystems that provide resilience to climate change (e.g. Buschke et al. 2020). Nketoana should be managed as a ground water production landscape, which includes maintaining interventions to enhance water infiltration by respecting buffers around wetlands, avoiding fragmentation of primary grassland, and minimising urban sprawl (SANBI 2013). Lastly, Setsoto and Mantsopa had relatively lower representation of significant biodiversity and ecosystem services, so these areas could accommodate more intensive land-uses like cultivation agriculture. However, managers in these municipalities ought to identify parts of their landscapes that are important for ecological and evolutionary processes linking plants and animals across larger scales. For example, Korannaberg, a complex isolated sandstone plateau that straddles both these municipalities, is prioritised by the CBA map as important for climate change resilience and maintaining migratory corridors between dry highveld grasslands in the western Free State and mesic highveld grassland in the eastern Free State.

4.4 Conclusion

Meeting the SDGs by the year 2030 will require substantial societal transformation (Sachs et al. 2019; Reyers and Selig 2020). Our study illustrates that these transformations need not start from a blank slate in Thabo Mofutsanyana District. Instead, spatial planning tools already exist, which can be used to meet seven of the 17 SDGs. However, the mere existence of these plans does not guarantee sustainability in the upcoming decade. In order to extract the most benefit from these existing tools, we make three recommendations.

First, stakeholders, practitioners and policymakers must educate themselves about the existence of these spatial biodiversity plans, including the characteristics of each plan as well as their strengths and weaknesses towards meeting the SDGs. We believe that this study is a useful resource for this purpose. Second, stakeholders, practitioners and policymakers would benefit from a deeper understanding of the spatial distribution of biodiversity features throughout the landscape. For coarse plans—such as KBA and SWSA—it may be sufficient to use static maps to identify relevant biodiversity features. However, the coarseness of these plans will require additional refinement to prioritise smaller landscape elements within broad areas of significant biodiversity and ecosystem services (e.g. Buschke et al. 2020). By contrast, identifying and querying more refined biodiversity plans—like CBA and protected area focus areas—might require rudimentary expertise in geographic information systems, so implementation should be coupled with technical capacity building and information transfer. Third, the spatial biodiversity plans described here should be integrated with land-use policies, regulations and legislation. Plans such as CBA maps and protected areas are already legally enforceable through the EIA regulations and the National Protected Areas Act, respectively, so the focus here should be on the enforcing current legislation more effectively. In comparison, KBA and SWSA are not legally binding unless they are interpreted through alternative policy frameworks, like spatial development frameworks and integrated development plans. This would require transdisciplinary land-use management that more accurately reflects the indivisible SDGs (McGowan et al. 2019; Kroll et al. 2019).

Ultimately, attaining a sustainable future in Thabo Mofutsanyana District Municipality requires that stakeholders, practitioners and policymakers visualise a dynamic and interdependent socio-ecological landscape. Such a vision ought to see the development of any one parcel of land as a thread in a much larger tapestry. Spatial biodiversity plans reflect this interconnectedness, so repurposing these management tools could lay a strong foundation towards meeting the SDGs in the upcoming decade. But, like any tool, their effective use will depend on the ambition and competence of land-use managers and decision-makers.

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