

## **CHAPTER 8: CONCLUSION**

### **8.1 Success of research outcomes**

The main objectives of this study involved the assessment of the floristic diversity and distribution patterns as well as their environmental determinants of the western Central Bushveld (WCB). The purpose of this comprehensive floristic analysis was to determine the conservation importance of the WCB and to demarcate priority areas for conservation.

An additional objective was to collect plant vouchers to fill some of the floristic knowledge gaps with regard to the under-sampled Quarter Degree Grids (QDG) of the WCB. This has been especially rewarding for the Heritage Park as the sampling status of 5 QDGs could be significantly increased. For both, Heritage Park and Impala Bafokeng Mining Complex, a total of 966 voucher specimens have been collected.

A total of 2,368 plant species and infraspecific taxa within 839 genera and 204 families have been recorded for the study area which covers about 33,750 km<sup>2</sup>. The following floristically important plant taxa could be identified within the WCB flora: 367 useful and medicinal, 246 problem plant, 58 bush encroachment indicator, 43 Red Data, 21 endemic and 10 Protected Tree species.

The distribution pattern of plant taxa richness could be successfully modeled by interpolation. Plant taxa richness clearly increases from the north towards the south and south-west of the study area. As expected the spatial distribution of plant richness could be related to present climatic (temperature, rainfall and evaporation) and physical environmental (topography, geology and soil) gradients.

Existing and sampled plant species data has been found to be adequate for modelling of plant conservation hotspots for most of the study area. Additional collection of plant vouchers in the Heritage Park revealed that the rural and remote landscapes under-represented in the collection data cannot be viewed as devoid of plant diversity, but that these areas harbour a species-rich flora with significant numbers of threatened species and plants of great socio-economic importance.

Four categories of conservation hotspots with increasing species diversity and conservation priority were identified for the WCB; the demarcated hotspots of high phyto-diversity and vulnerability value demonstrated to correspond well with those of endemic and Red Data species:

- 1) The highest priority exists for the area directly bordering the western Magaliesberg Nature Reserve, where 70% to 100% of the WCB flora is found.
- 2) The second highest priority was assigned to areas south of Zeerust, west of Brits and north-east of Rustenburg including the southern part of the Impala Platinum mine; 53% to 69% of the WCB flora was recorded here.
- 3) The third highest priority was allocated mainly the rest of the greater Rustenburg area towards Pilanesberg and Brits, including the northern part of Impala Platinum; 43% to 52% of the WCB is found here.
- 4) And the fourth highest priority most importantly includes areas in the central Heritage Park and to areas north and south of Pilanesberg National Park, where 34% to 42% of the WCB flora exists.

A specific objective of the study was to assess the floristic and conservation importance of the Heritage Park and Impala Bafokeng Mining Complex. Both study areas have been found to be comparatively species rich in the context of the savanna and western Central Bushveld flora. Although they constitute only 0.4% and 0.05% of the savanna core area, they encompass 20% and 24% of its flora. More significantly, the Heritage Park and Impala Platinum conservation initiatives represent 48% and 60% of the WCB flora.

For the Heritage Park, a total of 1,143 species and infraspecific taxa have been documented within 468 genera and 121 families. The Heritage Park was specifically identified as a hotspot for useful and medicinal plants (64%) as well as for Protected Trees (70%); furthermore, 33% and 35% of the WCB endemic and Red Data species are found. However, concerning are the locally alarming signs of vegetation change in the Heritage Park: 142 problem plant and 39 bush encroachment species were recorded. Vegetation degradation could be mainly related to crop cultivation and subsistence farming.

The parallel hills and associated lowlands of the Heritage Park support a larger phyto-diversity than the surrounding plains. As a result, the Heritage Park extension area is highly complementary to the existing protected areas as it still contains large areas of natural

vegetation, and thus will contribute significantly to the protection of phyto-diversity in the region.

Impala Platinum has been identified as a prime hotspot for the conservation of phyto-diversity and threatened plants. The mining area is found on a gradient of increasing species diversity and conservation importance. A total of 1,410 species and infraspecific taxa were documented within 609 genera and 171 families. Furthermore, Impala Platinum holds 24% and 44% of the endemic and Red Data plants recorded for the WCB flora, as well as 70% and 71% of the Protected Tree and useful plant species.

This high phyto-diversity can be attributed to the exceptional topographical, geological, edaphic and vegetation characteristics of the Bushveld Complex. The norite koppies and associated turf thornveld of the plains can be named as an example. They are located on the unique Bushveld Igneous Complex and are dominated by endemic vegetation types, namely the Zeerust Thornveld (SVcb 3), Marikana Thornveld (SVcb 6) and Norite Koppies Bushveld (SVcB7). These unique habitats are threatened and need urgent conservation attention. However, mining of platinum-group metals from the Rustenburg Layered Suite and increased invasion of problem plants and bush encroachers due to the industrial activities pose a major threat to this conservation hotspot.

As a result of the incomplete and biased floristic dataset for the WCB, the key objective of this study was to test the applicability of extrapolation and standardization of known QDG plant distribution data for the purpose of developing more concrete spatial models. This has been largely successful.

Floristic data could be effectively extrapolated to enhance the sampling status of under-sampled QDGs. This was successful for both standardization profiles, and thus hypothesis 1 has been proven.

By increasing beta-diversity of sample plots, the standardization of QDG data significantly improved the spatial clustering of plant taxa into phytogeographic floras, especially with increasing taxonomic level. The 'Centroid Grid' profile is regarded as the suitable method for standardization as it considers natural distribution patterns of floristic elements. The resultant floristic groupings best reflect the underlying environmental patterns. Hence, hypothesis 2 proved to be effective for the modelling of floristic areas. In contrast to the 'Centroid Grid' profile, the 'Integrated Grid' profile has shown to result into a regional equalized flora that

cannot be adequately explained by natural gradients. Consequently, hypothesis 3 has proven right for the ‘Centroid Grid’ profile, but not for the ‘Integrated Grid’ profile.

The standardization of QDG data to predict spatial patterns of plant diversity was only partly successful. Low species information at the borders of the study area makes accurate modelling for those areas difficult. Furthermore, the use of standardization for spatial modelling of floristic diversity still needs to be verified in the field before it can be reliably used for conservation planning. In this respect, hypothesis 2 was only partially proven and needs to be tested in further studies.

## **8.2 Limitations of the study**

The Convention on Biological Diversity (1993) highlights the importance of conserving areas of outstanding diversity and high numbers of rare and threatened species, as well as those areas containing species of social, economic and cultural value (Davies *et al.*, 1994). But the uneven distribution of information on biodiversity and its spatial pattern has been a major impediment to the identification of priority areas for conservation in the Western Central Bushveld (WCB). This is particularly the case for the remote rural regions in the northern and north-eastern part of the study area bordering Botswana. Yet, our present environmental crisis does not allow delaying the selection of conservation areas until complete survey data is available.

An important limitation of the study is the coarse-scale resolution of QDG level floristic data. Although the distribution pattern of plant taxa richness has been modeled by interpolation, the low resolution of the data allows only a broad estimation of floristic patterns. Thus, the identified conservation hotspots give only a rough delineation of important plant areas for conservation. However, they pinpoint to gaps in the conservation network and thus invite to further more detailed floristic studies in those areas.

Sampling efforts in the WCB are generally predisposed towards more accessible geographical areas, such as urban areas, and towards areas of socio-economic interest, such as mining areas, nature reserves and other sites of cultural, environmental and scenic value. As a result, despite extra sampling efforts the floristic datasets of the WCB are still incomplete and biased as many QDGs still remain under-sampled. Consequently, such species distribution datasets have a limited capacity to serve as tool for the prioritisation of conservation areas.

Therefore, the study examined whether predicted species distribution data can assist a more precise conservation planning for the WCB. The standardization of plant diversity data resulted into an updated sampling status and improved spatial patterning. But standardization strengthened specifically already well sampled QDGs, while a successful upgrade of the sampling status at the study area borders was limited due to a lack of data. Thus, a realistic prediction of the conservation importance of those areas is not possible.

### **8.3 Recommendations for conservation management in the western Central Bushveld**

In the WCB prime conservation hotspots for phyto-diversity were mainly located in areas of high human population and land-use. As strict reservation is limited in those areas, the realization of conservation goals makes strategies for managing whole landscapes necessary (Margules & Pressey, 2000). Therefore, effective biodiversity conservation in the study area will require the integration of strict protected areas with diverse measures of off-reserve conservation. For example, urgent conservation management is recommended for the species-rich plant communities of the Norite Koppies Bushveld and the Marikana Thornveld found along the Rustenburg Layered Suite, endangered by the high anthropogenic pressure from mining, urban settlements and cultivation. The Impala Platinum biodiversity conservation initiative would contribute a great deal to the conservation of those threatened vegetation types that are only endemic to a small area in South Africa (Mucina & Rutherford, 2006), although the mosaic of use and protection across the WCB landscape needs to be ecologically as well as socially sustainable. Land-use and protection in the WCB should be structured in a way as to guarantee a successful conservation of the unique plant diversity while allowing a sustainable living for people. Especially people in the outlying rural areas depend on the wild resources as a supplement to their day-to-day livelihoods.

These conservation goals can be best achieved by community-based conservation and tourism projects. Ecologically and culturally important areas like the proposed Heritage Park have a great educational and recreational potential that will attract eco-tourism. The Heritage Park is characterized by rich plant life and landscape scenery that invites to guided walks and plant spotting. It contains sites of archaeological importance and unique geological formations, and is a melting pot of various tribes and their indigenous languages and traditional cultures. The development of the Heritage Park conservation initiative will break the socio-economic

isolation of this poor and remote part of the WCB and create a sustainable future for both people and nature.

However, it is strongly recommended that problem plants and bush encroachment is managed in the proposed Heritage Park to prevent further degradation of the natural vegetation. Moreover, the extractive use of medicinal, cultural and other plants of high use value by the local communities needs to be controlled, particularly the harvest of Protected Trees for the purpose of timber and fire wood.

## **8.4 Future studies**

Further studies are recommended that integrate a greater number of QDGs of the Central Bushveld Bioregion, and involve further data acquisition for under-sampled grids at the outskirts of the Central Bushveld. It is expected that the proposed standardization methods will work better for larger areas with the aid of plant collections in selected areas. The bioregional approach will give a better picture on the true floristic pattern and will allow floristic modelling for conservation planning.

Spatial analyses have shown that species richness patterns in the WCB are largely driven by topographic heterogeneity and associated edaphic and geological landscape attributes. Consequently, further predictive modelling in the WCB should integrate biological and environmental data. Remote environmental modelling could serve as a reliable tool to predict species richness in highly diverse but data-poor regions as suggested by Ferrier (2002).

The coarse-scale demarcated conservation hotspots invites to more detailed studies in these regions. For example floristic data should be collected for the remaining under-sampled QDGs of the Heritage Park extension area. This will aid a more realistic ranking of the proposed Heritage Park as a phyto-diversity hotspot.