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Opinion Notes

Beyond species lists - Endemics and their use in environmental management in Namibia

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Abstract
Endemics are used as indicators of conservation importance because of their limited distribution ranges and thus risk of extinction. Environmental impact assessments therefore often use endemics to identify environmentally sensitive areas and to guide development decisions. However, endemic-rich countries such as Namibia will need to go beyond national level endemism to develop appropriate criteria for the protection and management of endemics in the course of development projects. With the aim to achieve greater transparency in environmental assessments, a tool is introduced which uses level of endemism appropriate to the impact area and a selection of red list criteria to determine appropriate management actions.

Keywords: biodiversity and environmental impact assessment, indicators, mitigation, Namib endemics, risks, scale, target species

Introduction
Because of their limited ranges endemics are often used as indicators of conservation importance. Conservation planning, for example, relies on information about their distribution to determine conservation priorities (e.g. Lovett *et al.* 2000; Cavieres *et al.* 2002; Allen 2007). Nowadays biodiversity assessments form an important part of the environmental assessments process and endemics are often used to identify and delineate environmentally sensitive areas and to guide development decisions (Koziell & Omosa 2003; Slootweg & Kolhoff 2003; Wegner *et al.* 2005). However, in developing countries the information on endemics is often only available at a national level, as field work has not been sufficient to obtain a good understanding of the distribution and abundance of endemics in the area in question (e.g. Barnard 1998; Simmons *et al.* 1998). While coarse resolution data may be adequate to undertake regional assessments and investigate broad patterns (e.g. Cowling & Lombard 1998; Taplin & Lovett 2003); it poses challenges when trying to use endemics to influence management decisions at a local level. The question for environmental practitioners arises

regarding management actions to prescribe when endemics are affected by proposed developments. Unlike some countries (e.g. EPA Western Australia 2009), there are no guidelines in Namibia how to define "species of conservation importance", definitions vary widely and different approaches are used. Does the mere occurrence of an endemic plant or animal at the site to be developed warrant to stop the development, for example (Business and Biodiversity Offsets Programme 2009)? Or can mitigation measures be developed and implemented for all endemic species? Can all impacts on endemics be managed to assure minimal damage? Only few environmental assessments in developing countries which incorporate biodiversity aspects have successfully implemented mitigation measures, because the technical, ecological and economic feasibility of the suggested measures are not sufficiently evaluated (UNDP, UNEP & GEF 2001). Prioritising target species for interventions is one way of ensuring that appropriate measures are developed.

Besides maintaining ecologically functioning ecosystems, the ultimate purpose of environmental management actions related to biodiversity, is to avoid losing entire species, and to minimise the impact on species of conservation importance (Matsuda 2003; BBOP 2009). The likelihood of this to happen, increases as the distribution range of a species becomes smaller. Small distribution ranges occur naturally (Magurran & Henderson 2003), or are often created by human activities encroaching on habitats that contain many species associated with a certain type of habitat (Millennium Ecosystem Assessment 2005). Sessile endemic species, such as endemic plants in the terrestrial- or benthic organisms in the marine context are thus always candidates for special protection or management actions during environmental assessments (Tyler-Walters *et al.* 2008). Typically, endemics are used during environmental assessments (1) to identify sensitive habitats, often delineated as "no-go" conservation areas to be kept out of bounds during the development of a site, (2) to develop special species management - (e.g. translocation and restoration) and monitoring plans for the affected endemics, or (3) to develop suggestions for more detailed study, if available information is believed to be too fragmentary.

In endemic-rich areas, such as the Namib Desert (Robinson 1978; Werger 1978), endemics always occur in the area to be assessed (e.g. Burke 1997; Mannheimer 2006) and developing management actions for all of these is neither feasible, nor warranted, unless there is a risk of extinction of certain species. Prioritising these will help to develop feasible management actions. This study with examples from the Namib Desert illustrates how using different levels of endemism can facilitate identifying priority species and provides a practical tool for using level of endemism in biodiversity assessments.

Materials and Methods

Study area

The Namib Desert on southern Africa's west coast stretches for just over 1,000 km from south of the Orange River in South Africa to southern Angola. Two contrasting climate regimes reign in the Namib Desert. The southern hemisphere's temperate cyclone system influences the south and this area receives winter rains regularly. The vegetation there is typical of southern Africa's Succulent Karoo Biome (Burke *et al.* 2002). The central and northern part of the Namib Desert, however, falls within southern Africa's summer-rainfall regime and the vegetation is characterised by ephemeral grassland and localised patches of shrubland (Jürgens *et al.* 1997). The high level of endemism typical of the Succulent Karoo Biome (Cowling & Hilton-Taylor 1999) is also reflected in the southern Namib, particularly amongst plants. The central and northern Namib on the other hand, harbour lower numbers of endemic species, but endemics are often very abundant, forming the dominant vegetation (Burke 2007).

Data analysis

Plant species lists from environmental assessments for mining developments across the Namib Desert were analysed with regard to occurrence of Namibian, Namib and local endemics as well as near-endemic plant species. The sites ear-marked for mining developments were, from south to north: Sendelingsdrif, Skorpion and Pocket Beaches (all three southern Namib) and Rössing and Trekkopje (both central Namib). Based on the investigation of distribution records from published sources (Craven 2002), the National Herbarium's plant specimens database and own observations, different levels of endemism were assigned to the recorded plant species. Namibian endemics were defined as occurring within Namibia's political borders and near-endemics as occurring in the Gariep Centre and Kaokoveld centres of endemism as described by van Wyk & Smith (2001), but within the borders of the Namib Desert. Namib endemics were defined as occurring in the Namibian part of the Namib Desert and local endemics as occurring within the central or southern Namib respectively, following Giess' (1971) definition of subdivisions of the Namib Desert. Comparisons between different levels of endemism were made.

Development of assessment tool

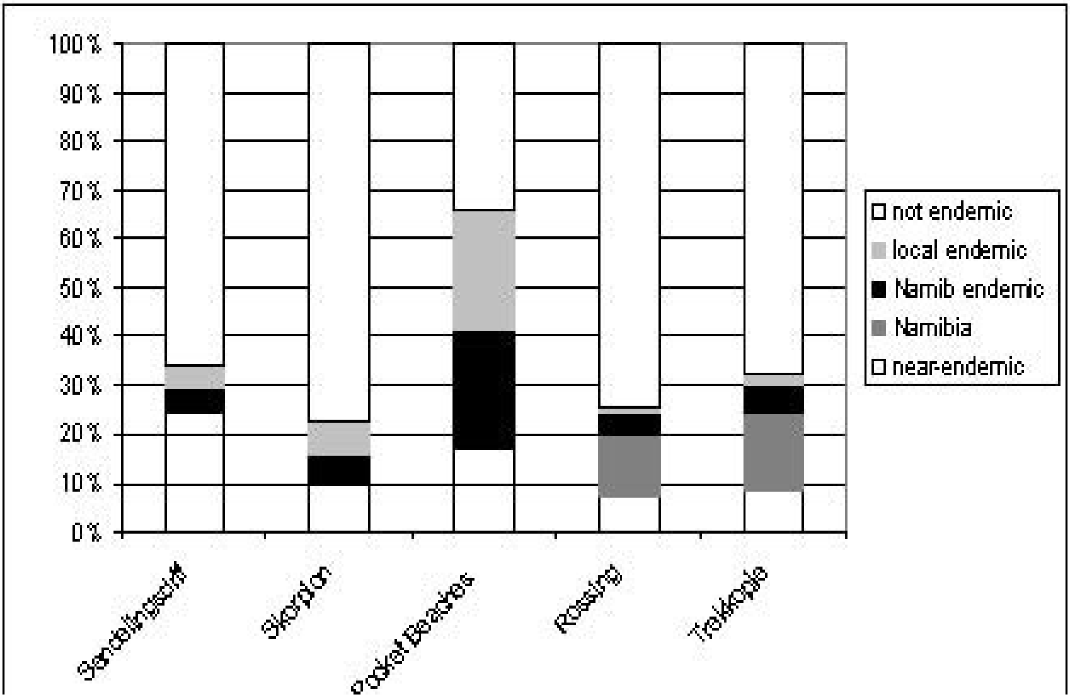
An assessment tool to link level of plant endemism with management actions was developed, using the guidelines of the South African National Biodiversity Institute (Driver *et al.* 2009) as a basis, but adapted to the Namibian situation. This takes the status of biodiversity knowledge as well as the nature of Namibia's flora into account. In the Namibian context level of endemism is considered the base criterion, because (1) endemism is one of the key aspects of Namibia's flora, and (2) Namibia's red list for plants (Loots 2005) would require some further refinement to make it useful for this purpose. For example, many "rare" species (IUCN 2001) have presently not been assessed. Therefore endemics provide a more robust indicator.

Prioritisation using endemics

A total of 624 plant species were included in the analysis. Overall, 36 local endemics, 13 Namib endemics, 45 Namibian endemics and 66 near-endemics were counted. The southern Namib sites (Sendelingsdrif, Skorpion and Pocket Beaches) harboured by far the most local endemics, including coastal endemics such as *Eremothamnus marlothianus* and *Marlothiella gummifera* as well as inland endemics such as *Bulbine namaensis* and *Pteronia pomonae*. Only five local endemics were present at the central Namib sites, including the succulents *Aloe namibensis* and *Hoodia pedicellata*.

As expected, the percentage of endemic plant species at different levels of endemism varied across sites (Figure 1). At the three southern Namib sites (Sendelingsdrif, Skorpion and Pocket Beaches) only local endemics and near-endemics were recorded. The two central Namib sites, however, show marked differences between levels of endemism (Figure 1). With regard to risk of extinction only local, and under certain circumstances Namib- and near-endemics would possibly be threatened by developments, and these are therefore important indicators for environmental assessments.

Figure 1: *Percentage plant endemics at different sites across the Namib Desert (local endemics = occurring in southern Namib or central Namib only; total species included in analysis: Sendelingsdrif: 41, Skorpion: 192, Pocket Beaches: 70, Rössing: 138 and Trekkopje: 183).*



Endemics and management actions in Namibia

Environmental assessments, particularly in the developing world, suffer from lack of transparency when it comes to assessing impacts on biodiversity (e.g. Ortega-Rubio *et al.* 2001; Mandelik *et al.* 2005). There is much debate regarding suitable indicators for biodiversity assessments (e.g. Lunt 2003; Cabeza *et al.* 2007) and how best to integrate these in the environmental assessment process (Wegner *et al.* 2005; Business and Biodiversity Offsets

Programme 2009). Avoiding the risk of extinction is the overarching goal and therefore endemics are good indicators during the environmental assessment process, provided that the level of endemism is appropriate to the impact area. A standard process of categorisation achieves greater transparency and, at a broad level, comparisons can be made across sites. One example of such a standard process is the biotope method, which arose out of the necessity to incorporate a measure of impacts on biodiversity in life-cycle assessments across different operations (Kyläkorpi *et al.* 2005), and which was then further developed with emphasis on a framework approach which takes site-specific conditions into account (Burke *et al.* 2008). In this approach levels of plant endemism constituted one important criterion in the biodiversity evaluation process at the landscape level.

Systematic approaches to the environmental assessment process are thus crucial to achieve greater transparency. With the purpose to introduce more transparency in environmental and biodiversity assessments in Namibia, recommended management actions related to level of endemism, and incorporating selected red-list criteria, are introduced (Table 1). The tool provides a 2-step process, whereby the level of endemism facilitates the narrowing down of species lists to those requiring more in-depth study. For those, the "additional criteria" require information on subpopulation, number of known sites and number of individuals. Good distribution records are the basis for undertaking such assessments with a reasonable level of confidence (e.g. Fraser *et al.* 2003), and this often poses a challenge in poorly collected areas. However, where such information is available, such as in the Namib Desert where information on distribution of plant species can be obtained from national databases, incorporating greater levels of detail regarding endemics is feasible.

Table 1: *Guidelines for developing management actions based on a 2-step process using level of endemism in Namibia and additional criteria commonly used in red list assessments.*

Level of endemism	Additional criteria	Recommendation
Local	Species range < 2000 km^2	No further loss of natural habitat
Namib	(1) Subpopulation affected not within threatened ecosystem or (2) not known from less than 10 sites or (3) not less than 1000 individuals of this species exist.	Limited habitat loss permitted, but restoration of viable population or offset required (e.g. effective protection of adequate number of subpopulations)
	If the antonym of one of the above applies	No further loss of natural habitat
Namibia	Subpopulation affected not within threatened ecosystem	Limited habitat loss permitted
	If the antonym of above applies	No further loss of natural habitat

Near-endemic	Species range < 2000 km^2	No further loss of natural habitat
	Species range > 2000 km^2 and (1) Subpopulation affected not within threatened ecosystem or (2) more than 1000 individuals of this species exist or (3) known from more than 10 sites	Limited habitat loss permitted
	If the antonym of (1), (2) or (3) apply	No further loss of natural habitat

Applying the tool to the case studies presented, no loss of habitat would be permitted for 2 plant species at Sendelingsdrif, 12 at Skorpion, 17 at Pocket Beaches, 1 at Rössing and 4 at Trekkopje, if a species range of less than 2,000 km^2 is assumed for all these species. This would, however, need to be determined for all these species and is considered feasible for the numbers affected. An additional Namib- and near-endemic 10 plant species at Sendelingsdrif, 18 at Skorpion, 12 at Pocket Beaches, 16 at Rössing and 23 at Trekkopje, would require further investigation with regard to the type of ecosystem affected, the number of sites recorded elsewhere, the position of subpopulations and a statement whether the number of individuals per species can reasonably be assumed to exceed 1,000. The number of species requiring such further information is not excessive in any of the study areas. At Rössing a further 17 and at Trekkopje 28 Namibian endemics affected by the development would have to be evaluated with regard to their position in a threatened ecosystem.

Current practice

In the central Namib prioritising management actions for species with the most limited ranges has, for example at Rössing Uranium, resulted in a field-based, detailed red-list assessments and species management plans for the most critical species (Loots 2009). A transboundary red-list assessment for a very rare, near-endemic was also initiated and supported by Namdeb at Sendelingsdrif. However, this did not follow a process of prioritisation based on level of endemism, but was based on the fact that limited distribution records existed for one species that would be affected by the proposed mine and thus, following the precautionary principle, a significant threat to the plant had to be assumed (Burke 2004). In this case eliminating near-endemics from further prioritisation for management actions would have been risky, as the threat of extinction of a species existed before further field work indicated a wider distribution of the near-endemic plant. However, the guidelines in this paper would have identified these species for further investigation.

Conclusion

More transparency in biodiversity assessments can be achieved, if clear criteria are used for selecting appropriate indicators and prioritising target species for intervention. Because of their limited range and thus greater risk of extinction, plant endemics are useful indicators, and a combination of level of endemism and selected criteria used in red list assessments, is proposed as a practical tool to prioritise.

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References

Allen, G. R., 2007. Conservation hotspots of biodiversity and endemism for Indo-Pacific coral reef fishes. Aquatic Conservation: Marine and Freshwater *Ecosystems* 18: 541 - 556.

Barnard, P., (ed.) 1998. Biological diversity in Namibia - a country study. Namibian National Biodiversity Task Force, Windhoek.

Burke, A., 1997. Coastal vegetation between Chameis and Baker's Bay, Sperrgebiet. Report for Namdeb, EnviroScience, Windhoek.

Burke, A., 2004. *Juttadinteria albata* - global red list assessment. Report for Namdeb Diamond Corporation, Oranjemund.

Burke, A., 2007. Plant endemism in the central Namib Desert. *Evolutionary Ecology Research* 9: 283-297.

Burke, A., Du Plessis, W. & Strohbach, B. 2002. Vegetation types in Namibia. Supplementary data to Environmental Atlas of Namibia, Ministry of Environment and Tourism, Windhoek.
[http://www.dea.met.gov.na/data/Atlas_web.htm#4Vegetation]

Burke, A., Kyläkorpi, L., Rydgren, B. & Schneeweiss, R. 2008. Testing a Scandinavian biodiversity assessment tool in an African desert environment, *Environmental Management* 42: 698-706.

Business and Biodiversity Offsets Programme (BBOP) 2009. Biodiversity Offset Design Handbook. BBOP, Washington, D.C.
http://pdf/usaid.gov/pdf-docs/PNAD0648.pdf

Cabeza, M., Arponen, A. & Van Teeffelen, A. 2007. Top predators: hot or not? A call for systematic assessment of biodiversity surrogates. *Journal of Applied Ecology* 45: 976-980.

Cavieres, L. A., Arroyo, M. T. K., Posadas, P., Marticorena, C., Matthei, O., Rodriguez, R., Squeo, F. A. & Arancio, G., 2002. Identification of priority areas for conservation in an arid zone: application of parsimony analysis of endemicity in the vascular flora of the Antofagasta region, northern Chile. *Biodiversity & Conservation* 11: 1301-1311.

COWLING, R. M. & HILTON-TAYLOR, C. 1999. Plant biogeography, endemism and diversity. In: DEAN, W. R. J. & MILTON, S. J. (eds) The Karoo: ecological patterns and processes, pp. 42-85, Cambridge University Press.

COWLING, R. M. & LOMBARD, A. 1998. A strategic and systematic framework for conserving the plant life of the succulent Karoo. Institute for Plant Conservation, Cape Town.

CRAVEN, P., 2002. Phytogeography of Namibia: a taxon approach to the spermatophyte flora. MSc thesis, University of Stellenbosch, South Africa.

DRIVER, M., RAIMONDO, D., MAZE, K., PFAB, M. F. & HELME, N. A. 2009. Applications of the Red List for conservation practitioners. In: D. RAIMONDO, L. VON STADEN, W. FODEN, J. E. VICTOR, N. A. HELME, R. C. TURNER, D. A. KAMUNDI & P. A. MANYAMA (eds). Red List of South African Plants. *Strelitzia* 25: 41-52. South African National Biodiversity Institute, Pretoria.

EPA WESTERN AUSTRALIA (2009) Sampling of short range endemic invertebrate fauna for environmental impact assessment in Western Australia. Environmental Protection Authority Western Australia.
[http://epa.wa.gov.au/EPADocLib/2953_GS20SRE250509.pdf]

FRASER, J. L., THOMPSON, G. G. & MORO, D. 2003. Adequacy of terrestrial fauna surveys for the preparation of Environmental Impact Assessments in the mining industry of Western Australia. *Ecological Management & Restoration* 4: 187-192.

GIESS, W. 1971. A preliminary vegetation map of South West Africa. *Dinteria* 4: 1-114.

IUCN 2001. IUCN Red list categories and criteria: version 3.1. IUCN Species survival commission. Gland, Switzerland and Cambridge, U.K.

JÜRGENS, N., BURKE, A., SEELY, M. K. & JACOBSEN, K. 1997. Desert. In: COWLING, R. M., RICHARDSON, D. M. & PIERCE, S. M. (eds) Vegetation of southern Africa, pp. 189-214. Cambridge University Press, Cambridge.

KOZIELL, I. & OMOSA , E. 2003. Room to maneuvre? Mining, biodiversity and protected areas. World Business Council for Sustainable Development. London (WBCSD) and IIED.

KYLÄKORPI, L., RYDGREN, B., ELLEGARD, A., MILIANDER, S., GRUSELL, E. 2005. The biotope method 2005. Vattenfall Business Services Nordic AB.

Loots, S. 2005. Red Data Book of Namibian Plants. Southern African Botanical Diversity Network Report No. 38. SABONET, Pretoria and Windhoek.

Loots, S. 2009. Assessment and Management of red list and endemic plant species at Rössing Uranium mine, Namibia. Report for Rössing Uranium Ltd.

Lovett, J. C., Rudd, S., Taplin, J. & Frimodt-Moller, C. 2000. Patterns of plant diversity in Africa south of the Sahara and their implications for conservation management. *Biodiversity and Conservation* 9: 33-42.

Lunt, I. D. 2003. A protocol for Integrated management, monitoring, and enhancement of degraded *Themeda triandra* grasslands based on plantings of indicator species. *Restoration Ecology* 11: 223-230.

Magurran, A. E. & Henderson, P. A. 2003. Explaining the excess of rare species in natural species abundance distributions. *Nature* 422: 714-716.

Mandelik, Y., Dayan, T. & Feitelson, E. 2005. Planning for Biodiversity: the Role of Ecological Impact Assessment. *Conservation Biology* 19: 1254-1261.

Mannheimer, C. 2006. Environmental Impact Assessment of the proposed Trekkopje Uranium project - Specialist contribution vegetation. Enviro Dynamics, Windhoek.

Matsuda, H. 2003. Challenges posed by the precautionary principle and accountability in ecological risk assessment. *Envirometrics* 14: 245-254.

Millennium Ecosystem Assessment, 2005. Ecosystems and human wellbeing: Biodiversity Synthesis. World Resources Institute, Washington D.C.

Ortega-Rubio, A., Salinas-Zavala, C. A., Lluch-Cota, D., Troyo-Diéguez, E. 2001. A new method to determine the level of the environmental impact assessment studies in Mexico. *Environmental Impact Assessment Review* 21: 73-81.

Robinson, E. R. 1978. Phytogeography of the Namib Desert of South West Africa (Namibia) and its significance to the discussions of the age and uniqueness of this desert. *Palaeoecology of Africa* 10: 67-74.

Simmons, R. E., Griffin, M., Griffin, R. E., Marais, E. & Kolberg, H. 1998. Endemism in Namibia: patterns, processes and predictions. *Biodiversity and Conservation* 7: 513-530.

Slootweg, R. & Kolhoff, A. 2003. A generic approach to integrate biodiversity considerations in screening and scoping for EIA. *Environmental Impact Assessment Review* 23: 657-681.

Taplin, R. D. & Lovett, J. C. 2003. Can we predict centres of plant species richness and rarity from environmental variables in sub-Saharan Africa? *Botanical Journal of the Linnean Society* 142: 187-197.

Tyler-Walters, H., Rogers, S. I., Marshall, C. E. & Hiscock, K. 2008. A method to assess the sensitivity of sedimentary communities to fishing activities. *Aquatic Conservation: Marine and Freshwater Ecosystems* 19: 285 - 300.

UNDP, UNEP & GEF (2001) The integration of biodiversity into national environmental assessment procedures. National Case Studies. Biodiversity planning support programme. www.unep.org/bpsp/EIA/Case%20Studies/India.pdf.

Van Wyk, A. E. & Smith, G. F. 2001. Regions of floristic endemism in Southern Africa. Umdaus Press, Hatfield, South Africa.

Wegner, A., Moore, S. A. & Bailey, J. 2005. Consideration of biodiversity in environmental impact assessment in Western Australia: practitioner perceptions. *Environmental Impact Assessment Review* 25: 143-162.

Werger, M. J. A. 1978. The Karoo Namib region. In: M. A. J. Werger (ed.) Biogeography and Ecology of southern Africa. Dr. W. Junk, The Hague, pp.231-299.