to be less sensitive to smaller scale habitat disruptions. Other taxonomic groups might be better for investigating the impact of land use changes in these hotspots of biodiversity.

Amphibians are important components of species assemblages of many terrestrial ecosystems, often having a diverse number of species occupying a range of niches. Amphibians are often considered to be good habitat indicators, given their usually relatively narrow environmental tolerance. The limited tolerance of amphibians means that populations can rapidly change in response to ecosystem change (Stuart et al. 2004). Almost one-third of the world's ca. 6,000 amphibian species are threatened by extinction, with 168 species recently recorded to have gone extinct. Such recent and rapid declines, greater than for any other vertebrate group, are correlated with a number of factors (Stuart, et al. 2004). Among these factors, habitat change seems to be connected to many amphibian population declines.

The use of amphibians in conservation studies ranges from focusing on single species to whole assemblages being used as indicators 'measuring' broader changes (Stuart et al. 2004). Because patterns of their diversity strongly match areas identified as 'hotspots', amphibians seem to be important potential indicators of species and habitat diversity. For Ethiopian amphibians, however, we are hindered by a poor understanding of their diversity and distribution (Largen, 2001). Despite this, previous work has revealed a comparatively high diversity for Africa, particularly located in the mountain regions of Ethiopia. The paucity of detailed information on Ethiopian highland amphibian biology is particularly worrying given the amount of natural habitats that are increasingly being lost in Ethiopia (Taddese, 2001). These habitat losses pose a serious risk to amphibian species, which have highly restricted and fragmented habitat ranges. Understanding how habitat change is impacting amphibian communities, and by inference other taxonomic groups, requires basic data on the range of species.

We have initiated a project that aims to improve understanding of amphibian diversity and distribution. This will be achieved by using traditional taxonomic approaches, DNA assessment of populations, and GIS data. With these data we will be able to better understand the distribution of amphibian species in the highlands of Ethiopia and their taxonomic and conservation status. Eventually, this data will be utilised to address questions on how amphibian communities are responding to land use changes and predicted climate change. Preliminary evidence from our work conducted in the Bale mountains, a hotspot of amphibian diversity, suggests that there has been significant recent change to forest habitats. We are currently investigating the influence on the species endemic to Harenna forest in the Bale Mountains and how amphibian distribution and diversity has changed compared to historical records. Our work has also been extended over the rift to the south west forests of Ethiopia (Figure 1). The new data is being used to address the evolutionary history of the rift-mountains, and how the formation and changes in the rift have influenced organismal diversification.

Over the coming years, our work will map species units across the Ethiopian highlands in order to gain a better understanding of amphibian populations. We will utilise this information to assist in assessing conservation priorities across the rift-mountains. At specific sites we will also assess how land-use changes have impacted biological communities. Mitigation and adaptive strategies in the conservation of mountain ecosystems rely on quantitative data on physical and biological systems – our project aims to contribute towards this goal.

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PARADISE LOST? Conservation of Mount Marsabit Forest Ecosystem, Northern Kenya

Wario R. Adano

The mountain, the lowlands and the forest ecosystem

Marsabit Mountain rises from northern Kenya's vast low-lying arid region. During the dry season, the surrounding lowlands are expanses of desert-like environments, often dotted with patches of dry grass and leafless thorny shrubs. In the lowlands, temperatures are over 30 degrees Centigrade and the mean annual rainfall is hardly 300 millimetres. However, around the mountain, the temperature is always about 26 degrees Centigrade and the mean annual rainfall is about 800 millimetres. The mountain's lush vegetation and biodiversity-rich forest ecosystem is very different from the surrounding lowlands and is considered one of Kenya's most ecologically-sensitive biodiversity hotspots.

Over the millennia, the coolness of the mountain has created a small 'tropical cloud forest' on its misty peaks. The forest's

Buffalos at Sokorte Dika in Marsabit forest. Photo: R Eva.

The famous Lake Paradise (Sokorte Guda) during a 'normal' year. Photo: R Eva.

tall moss and lichen-laden trees trap moisture from the low clouds and the thick early morning mists to recharge underground aquifers and replenish the water sources within the mountain. The forest ecosystem both creates and protects the water; while two crater lakes (Sokorte Dika and Sokorte Guda) serve as small surface reservoirs: the porous mountain is an enormous invisible one.

Human settlement and conservation

Until colonial times, the mountain was used by pastoralists from the surrounding lowlands for grazing as a last resort in the dry season. In the early 20th century, the British established a small administrative post at the forest's edge on the north western slopes of the mountain. They strictly controlled settlement in the tiny town to a handful of traders and farmers who were encouraged to grow crops for the station.

At Independence in 1963, all such controls were lifted. By the 1970s, the mountain population had increased ten-fold since the 1950s. Most were former nomads from the lowlands who lost virtually all their herds to the severe droughts of the 1970s to the 1990s. The growing mountain population has created stiff competition for forest resources. The mountain ecosystem is becoming increasingly important for settling nomads, and the resources are simultaneously suffering from increasing pressure as a result.

From the 1930s, parts of Marsabit District (now about 69,000 kilometres^2) were accorded official protection by the colonial government. After Independence, part of the mountain was 'de-gazetted' to open it for settlement and by 1999, about nine percent of the total area had protected area status. This area, mostly 'the upper fertile levels' of the mountain, about three percent of the district's area, is governed by strict conservation rules where local people have restricted access and rights of usage. Their resentment towards these rules became a cause of general revolt against conservation programmes.

The economy of the ecosystem

The forest ecosystem supplies water to the ever-growing Marsabit town and enables people settled on the forest's periphery to practise rain-fed agriculture and use micro-irrigation to grow a few crops throughout the year. Most households on the mountain have permits to collect fuelwood. The lowland nomadic communities have had historical, dry-season claims to the ecosystem's resources.

The revenue generated from Kenya's protected areas is far too low to cover the costs of management. This is particularly true for Marsabit: the revenue is completely inadequate to share with the local communities or pay compensation for wildlife damage to crops and people. This is yet another reason why conservation efforts are poorly supported by the local people. The revenue obtained from the forest is, however, insignificant compared to the benefits of biodiversity, water supply, and support for rain-fed farming for the general public. Consequently, sensible conservation policies should resolve the conflicts between the conservation agencies and the local communities. The difference between these groups is that the former have a much broader set of environmental interests over and above the private interests of the local communities.

Paradise lost? The threats to the Marsabit ecosystem

Rainfall records show a consistent downward trend, the lowest amounts ever, and frequent droughts over the past four decades. This has been coupled with increasing human population, demand for arable land and use of forest resources. The result has intensified conflict between the local people and the conservation agencies over the use of ecosystem's resources. During the wet seasons, the elephants

Forest serves as a source of water for livestock during dry season. Photo: W Karen.

and buffalos have always moved out of the forest to their traditional dispersal areas. Now they trample crops and sometimes people. Fearless troops of baboons infest settled areas in Marsabit town, raiding fields and endangering children. Other wild animals also regularly attack livestock and local people retaliate. The wildlife damage understandably undermines local public support for wider conservation efforts. The ecosystem faces obvious threats that go beyond the borders of the protected areas.

The mountain's ecology has been under pressure in the past. The Sokorte Guda dried up three times in the 1930s and 1940s, while the water level in the Sokorte Dika dropped substantially. The colonial administration, alarmed particularly by the livestock grazing pressure, increased the size of the protected forest and piped water from within to the periphery where both livestock and people could use it without intruding on the forest. Given today's dense settlements around the protected areas, better management of the 'buffer zones' is the best option. Their on-going conversion to farm plots and the clearing of vegetation directly reduces the total forested area, decreasing the ecosystem's capacity to naturally trap moisture from clouds and mist. This means not only that Marsabit is faced with critical water shortages, but that rain-fed agriculture, on which all the many settled people rely and its biodiversity, is severely threatened.

What next?

This article has touched on the most obvious causes and effects of human settlement and climate change on Marsabit Mountain. There is much that we still do not understand about the delicately interwoven forest ecosystem. However, it is certain that, as the mountain population soars, so does demand for the use of forest resources. Conservation policies and policing and management practices should incorporate the 'buffer zones' and the local communities' needs for resources for their survival. Future tree planting to increase vegetation cover should consider trees which host moisture-trapping mosses and lichens. Improving the wellbeing of the ecosystem-dependent communities and promoting the wise use and management of protected areas must underline any successful conservation policy. If the pressures on the ecosystem go unabated, the small forest is in a serious danger and its roles at risk. This will also be the case for the rich biodiversity and the people who depend on the health of the Mount Marsabit ecosystem.

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Responses to Threats and Impacts on the Outstanding Biodiversity Values of Low-Altitude Mountains in South Western Australia

Anne Cochrane, Sarah Barrett and John Watson

South western Australia is the most floristically rich region on the Australian continent and is one of the world's top biodiversity 'hotspots', with some 8,000 described vascular plants including numerous endemic and threatened species. The region contains a series of isolated mountain peaks in the Stirling Range National Park that are themselves biodiversity hotspots. Although small in absolute height (~1,095 metres maximum elevation), these small mountains are the highest points in the landscape for several thousand kilometres. However, they are truly 'Himalayan' in terms of their plant diversity with some 1,517 plant species and over 80 endemics, often with narrow distribution ranges on specific mountain peaks (Figure 1, Watson and Barrett 2004).

Figure 1
The Stirling Range - low in elevation but 'Himalayan' in plant diversity (Watson & Barrett, 2004)