The Saloum Agricultural Ecoregion

Overview

The Saloum Agricultural Region has experienced the greatest decline in its biodiversity than any other ecoregion in Senegal. While there are still a few pockets of high biodiversity, most – perhaps 90 percent – has been lost to habitat destruction, driven by the cultivation of peanuts and other crops. We can track these changes through the modification of vegetation cover and the dynamics of land use and land cover change (LULC).

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As shown on the ecoregions map in section 1, the Saloum Agricultural Region lies within the Coastal Sudanian Climatic Region. Its coastal climate sets it apart as unique from the vast continental Sudanian Climatic Region. Higher year-round humidity and less extreme temperatures provide a niche for flora and fauna of both Sudanian and Guinean affinities. Although generally included in the 'Peanut Basin,' it can be distinguished from the latter by its higher rainfall and greater floristic and agricultural diversity. Figure 1 provides a Landsat satellite view of the ecoregion that comprises 13 classified forests and part of a national park (Fathala Forest within the Sine Saloum National Park).

A Century of Change

In the past 100 years, the LULC of the Saloum Agricultural Region has progressed from a biologically diverse deciduous Sudanian woodland (Pélissier, 1966) with scattered clearings associated with human settlements, to an agricultural parkland with considerable on-farm diversity of trees, to the open and impoverished agricultural parkland we see today. Pockets of high biodiversity still provide testimony to its once-rich status. Lawesson (1995) found a total of 89 woody species from numerous sites in the protected Fathala Forest. In a recent field study, Sambou (2004) found 73 woody species in the Patako Classified Forest, including 8 species characteristic of the Guinean Climatic Zone to the south.

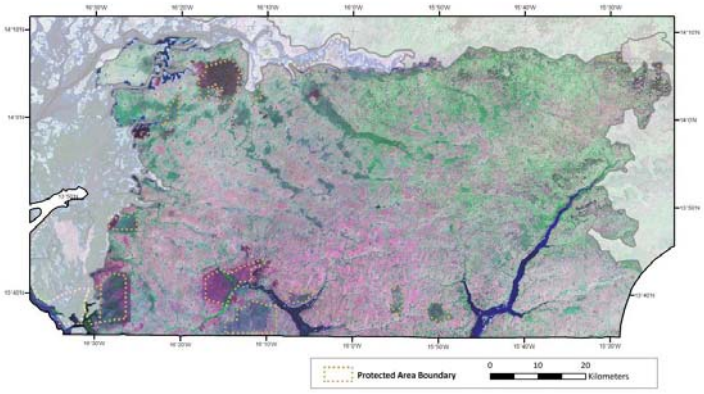


Figure 1. A Landsat satellite view of the Saloum Agricultural Region in November 2000. Note the predominance of agriculture as the main land cover (light tones). Protected areas stand out as dark patches owing to their relatively dense vegetation cover.

Aerial photographs from 1943 (Figure 2) provide a glimpse of the last vestiges of the woodland that once blanketed the region. Tree cover, as shown in these historical photos, ranges from 40 to 70 percent. Today, most tree species found in farmers' fields are relics of the ancient woodland. Only a few protected wooded savannas remain and tree cover in these areas has decreased to 10 to 20 percent.

The agricultural expansion into the former woodlands is quite recent. Peanut production began to make inroads between 1900 and 1940, but the area under cultivation was small and scattered. Expansion increased dramatically in the 1950s and 1960s. By the 1990s, the transformation was complete, leaving only a few patches of protected woodlands. The analysis of Argon and Corona satellite photographs from the 1960s and Landsat TM

Figure 2. A portion of an aerial photograph taken in October 1943 just west of the Koular Bolon. Small agricultural clearings were carved out of a Sudanian woodland, whose woody cover ranged from 40 to 70 percent.

images from the 1990s provides clear evidence of the more recent land use and land cover changes (Tappan et al., 2000a). The pair of maps in Figure 3 depicts the stark contrast in land resources shown from the analysis of time-series imagery. Mounting population pressures, drought, and national policies that

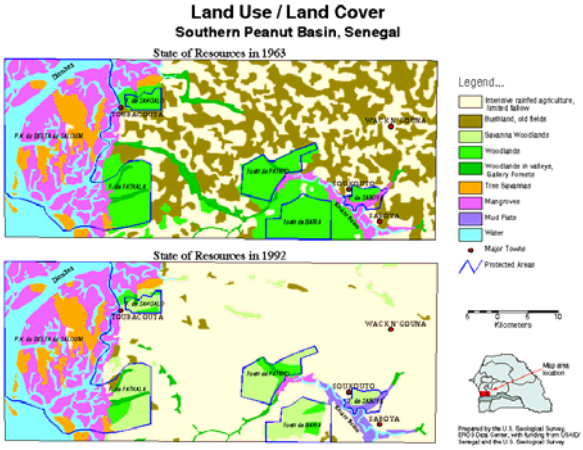


Figure 3. Maps depicting the final stage of agricultural transformation that has swept across the Saloum Agricultural Region, driving a major decline in vegetation biodiversity and loss of animal habitat. The maps were produced from interpretations of an Argon satellite photograph (1963) and a Landsat image (1992).

encouraged peanut production have resulted in the demise of the centuries-old bushland-fallow agricultural system.

By the 1990s, virtually all arable land was under cultivation, with little use of fallow or other soil conservation practices (Tappan et al., 2000a). A 1994 airborne video survey (Wood et al., 1995) found that tree cover had declined to less than two percent over most of the region. Furthermore, most rural people are no longer within walking distance of the few remaining woodlands – traditional sources of food, fiber, firewood, and medicine.

We mapped and analyzed land use and land cover trends using time-series imagery from 1968, 1984, and 1999 for this ecoregion. This period covers the final stage of the region's complete facelift from biologically diverse woodland to agricultural parkland. Figure 4 shows the trends for major LULC classes.

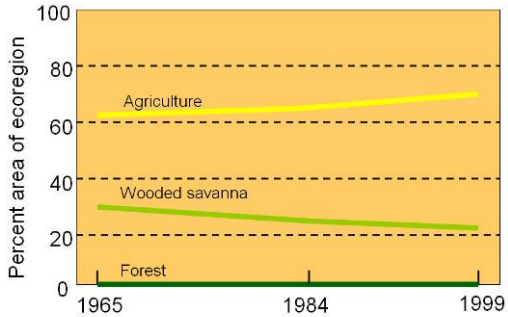
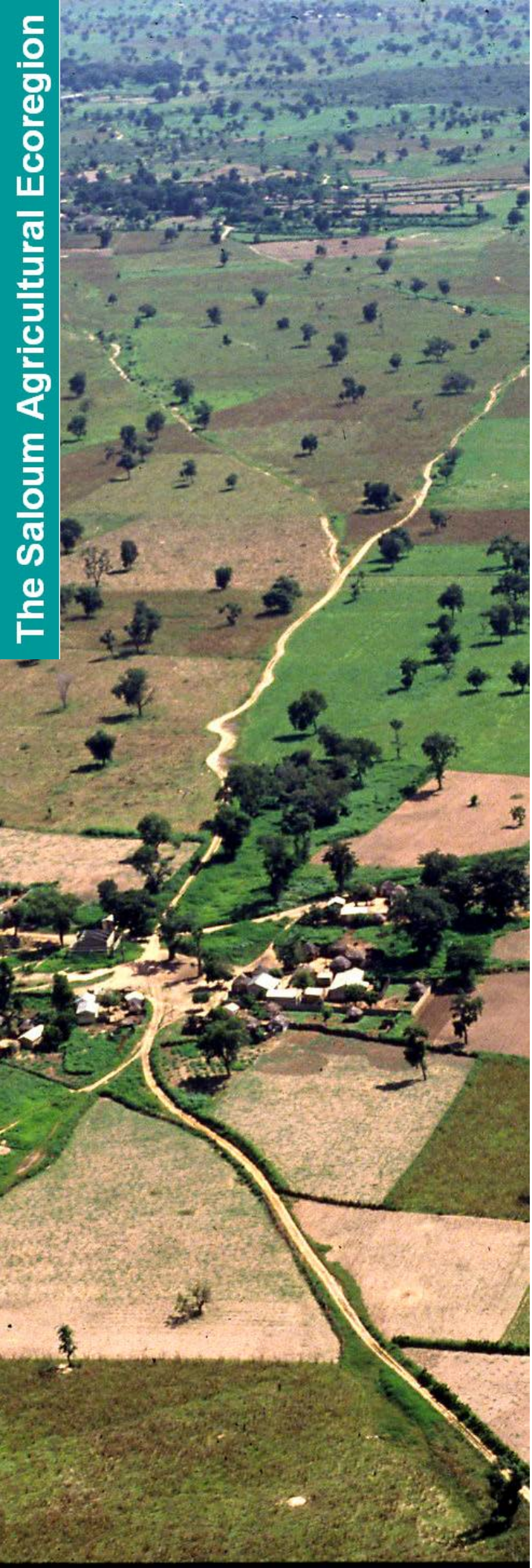


Figure 4. LULC trend from 1965 to 1999 in the Saloum Agricultural Region. Much of the region's transformation from woodlands to agriculture occurred in the half century before the period shown.

Although the numbers show only a moderate increase in agricultural area (61 percent in 1968 and 69 percent in 1999), they do not reflect the sharp decline in the use of traditional bush fallow, because fallow was included as a component of the agricultural landscape in the area measurements taken from the imagery.



Biodiversity at field sites

In 1983, we established 23 field sites across the ecoregion to collect vegetation data in support of a national vegetation map. The sites were not fixed plots, each covered approximately 4 hectares. As an indicator of biodiversity, we inventoried all woody species at each site. In 1994 and 1998, we returned to 14 of these sites to assess changes in vegetation cover and composition (biodiversity). In the classified forests, we observed relative stability with an average of 8 tree species per site in both periods. On the agricultural parklands, the diversity of tree species decreased on the average from 8.2 to 5.4 tree species per site over the 15-year period. Figure 5 shows the trends in shrub and tree species at the sites.

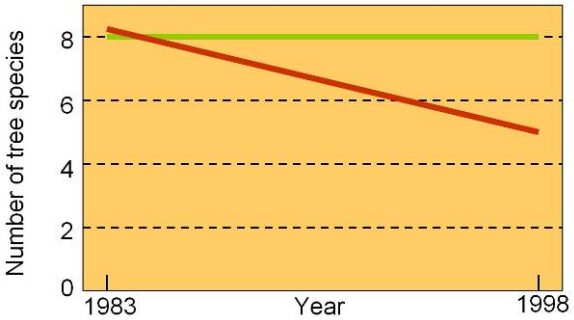


Figure 5: Trends in the number of tree species at woodland sites (green) and agricultural sites (brown) in the Saloum Agricultural Ecoregion, from 1983 to 1998.

With its relatively abundant annual rainfall (600-700 mm), its rich biological heritage, and deep loamy sands, there is great potential to maintain good agricultural production while preserving a high diversity of on-farm parkland trees. In figure 6, we see an example of a well-diversified agricultural parkland where farmers have maintained a good variety of trees. These include fruit-bearing trees (*Cordyla pinnata*, *Sclerocarya birrea*) and the highly valued P*terocarpus erinaceus*, used in furniture and artisanal applications.

Figure 6. An example of a well-managed, relatively dense agricultural parkland, with a diverse variety of trees valuable for fruit, service wood, firewood, artisanal and medicinal uses; site assessment: good tree cover; good biodiversity; west of Nioro, June 1983.

Figure 7. A 10-year comparison of an agricultural parkland near Keur Mandiaye showing the loss of field trees and lack of tree regeneration (top: January 1994; bottom: December 2004).. High value trees like Pterocarpus erinaceus have all but disappeared as trees are cut for their wood, leaving behind a landscape dominated by Cordyla pinnata and Combretum glutinosum. 1994 Site assessment: fair vegetation cover; fair biodiversity; 2004 site assessment: poor tree cover; poor biodiversity.

Returning to many sites in 1994, 1998 and 2004, we observed a widespread loss of field trees, leading to much more open and sometimes treeless landscapes. The region's tree parkland is in great decline, and ironically, the tree densities found today are much lower than in the central Peanut Basin where the climate is much drier. Figure 7 illustrates the trend of declining field trees, and the lack of managed natural regeneration.

Trends in Biodiversity through Land Cover Modification

Time-series maps of LULC are an important part of assessing how land resources are changing. However, it can miss another dimension of change – the modification of land cover over time. Land cover modification is a major driver of biodiversity change. For example, a woodland in 1975 may still be mapped as a woodland in 2000, occupying the same land area, but it may have undergone significant changes in its attributes. It may have become degraded by human pressure, reducing the tree density and biological diversity of its plant communities. Land cover modification can be subtle, and monitoring it usually requires field observations and high resolution imagery. Woomer et al. (2004) found that most of the woody biomass and carbon losses in Senegal from 1965 to 2000 were due to land cover modification rather than LULC change.

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Although we do not have a complete picture of land cover modification in this ecoregion, we can provide two examples that illustrate significant changes from 1965 to 2005. Figure 8 presents a pair of images comparing the two main land cover types in this ecoregion: open woodland and agricultural parkland. Note that in both land cover types, tree cover has declined significantly. The diversity of shrubs and trees has likely declined as well, although no time-series records exist on species composition for this particular area. National agricultural policies in the 1960s and 1970s

encouraged farmers to clear their fields of most trees to facilitate crop planting, weeding, and harvesting.

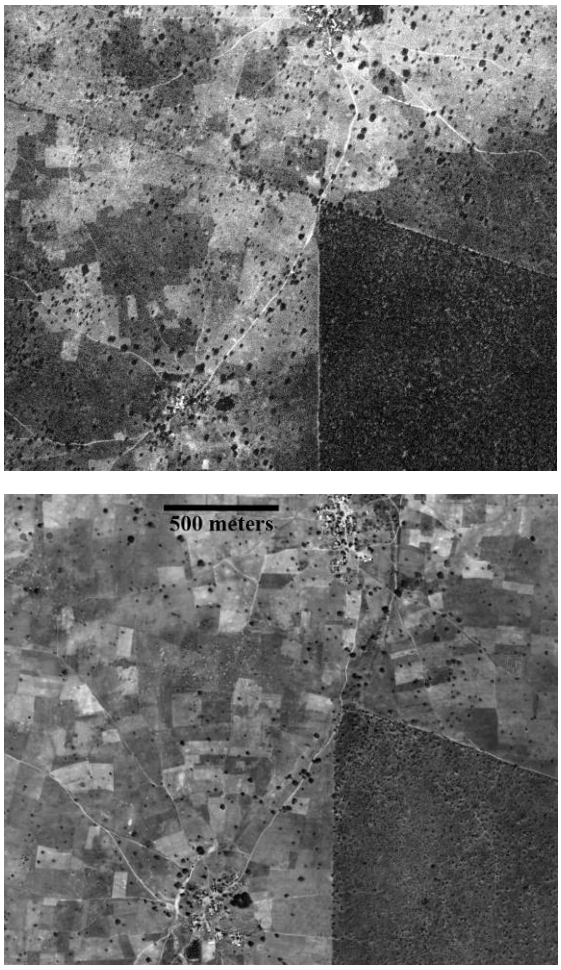


Figure 8. Comparison of a Corona satellite photograph (1965, top) and a Quickbird satellite image (2005, bottom) showing trends in an open woodland (Forêt Classée de Saboya, dark area at right) and an agricultural parkland in the Soukouto terroir. Tree cover in the protected forest declined from 48 to 11 percent, while in the agricultural parkland tree cover decreased from 8 percent to 1 percent. Farmers in Soukouto can list dozens of tree species that have become rare or locally absent. 2005 image source: Google Earth.

In contrast to the *Forêt Classée de Saboya*, the *Forêt Classée de Patako* provides an example of a protected area with good vegetation cover (25 percent overall) and fairly high biodiversity with at least 73 woody species (Sambou, 2004). The forest is stable, with considerable regeneration of most species. If properly managed, this forest has good potential as a source of woodfuel, with secondary uses as a source of service wood and artisanal wood. At least 7 species are of economic interest for non-wood products, primarily fruit. The central portion of this forest is endowed with a gallery forest, occupying the upper reaches of the Koular Bolon. This gallery forest is among the most biodiverse habitats left in the ecoregion. The dense, evergreen tree cover, year-round source of food and water provides shelter to several species of monkeys and other small mammals. Figure 9 shows a 2005 satellite image of Patako's gallery forest.

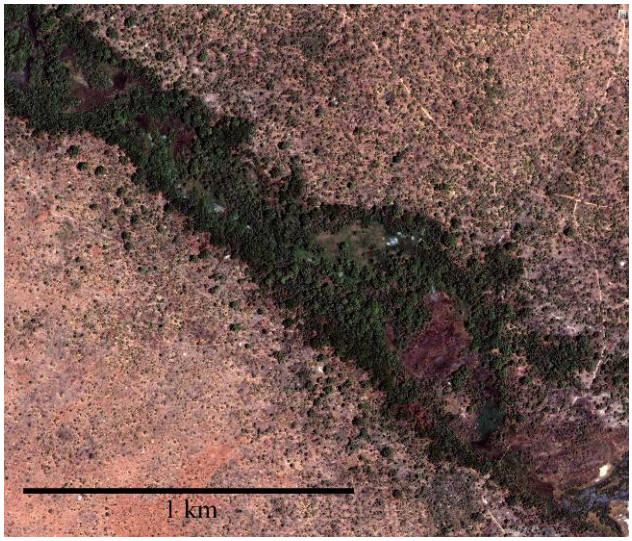


Figure 9. A gallery forest extends through the central part of the Forêt Classée de Patako, representing one of the most biologically diverse habitats in the ecoregion. This Quickbird satellite image, taken in 2005, shows the dense, evergreen structure of the gallery forest, in contrast to the surrounding wooded savanna. Image source: Google Earth.

We conducted semi-structured interviews in eleven villages between 1994 and 1998. These served to utilize local people's indigenous knowledge, particularly on changes in natural resources and biodiversity. The interviews also gave us a longer history (3 to 4 decades) on biodiversity trends than the time-series data from our sites. The recurring theme from most interviews was that there has been a decline in tree species in the protected forests due mainly to drought and frequent fires, particularly since 1968. To this many

informants add charcoal production by outsiders, and artisans seeking valuable wood. They were also keenly aware of the loss of tree species in agricultural parklands, and listed dozens of species that have become rare or locally absent. They primarily blame government policies for encouraging the cultivation of groundnuts, especially tree and stump removal. The practice of fallowing has become infrequent which adds to the pressure on trees, and prevents regeneration. They also cite illegal tree-cutting by outsiders for service wood and firewood. They add that drought has also taken its toll on field trees.

Natural Resource Management and Biodiversity

Natural resource management (NRM) in agricultural regions is one of the best ways to maintain a healthy level of biodiversity on farmland, and to preserve a least some of the natural wilderness in managed forested areas. The Saloum Agricultural Region is known for some of the best successes in NRM in Senegal, thanks to the concerted efforts of farmers, local cooperatives, NGOs, and other partners in development. We have already seen the positive impact of farmers that maintain a diversity of field trees.

One of the more impressive examples of a practice that conserves vegetation cover and diversity in agricultural regions is the use of exclosures, or *mise en défens*. Exclosures protect an area of land for the long-term, allowing natural regeneration to take hold. In contrast to woodlots that typically use one exotic tree species, exclosures contain much of the natural diversity of vegetation species found in a region. Exclosures usually develop into relatively dense stands of tress, shrubs and grasses, following a complex pattern of ecological succession. Some exclosures are the result of individual landholders, but most are the result of a community decision. The reasons for establishing an exclosure vary, but the main reasons are for forest products including medicine, food and fiber, and for dead fuel wood. Some exclosures stem from religious or cult origins. Owing to their vigorous, dense vegetation cover, exclosures are readily visible on aerial and even satellite imagery. Figure 10 shows a one-hectare exclosure that was fenced off for six years for research purposes when the aerial photograph was taken. The reconstitution of the vegetation after 6 years of protection was quite significant in terms of structure and cover. However, in that short period, the floristic diversity was only slightly greater than the surrounding fallow land.

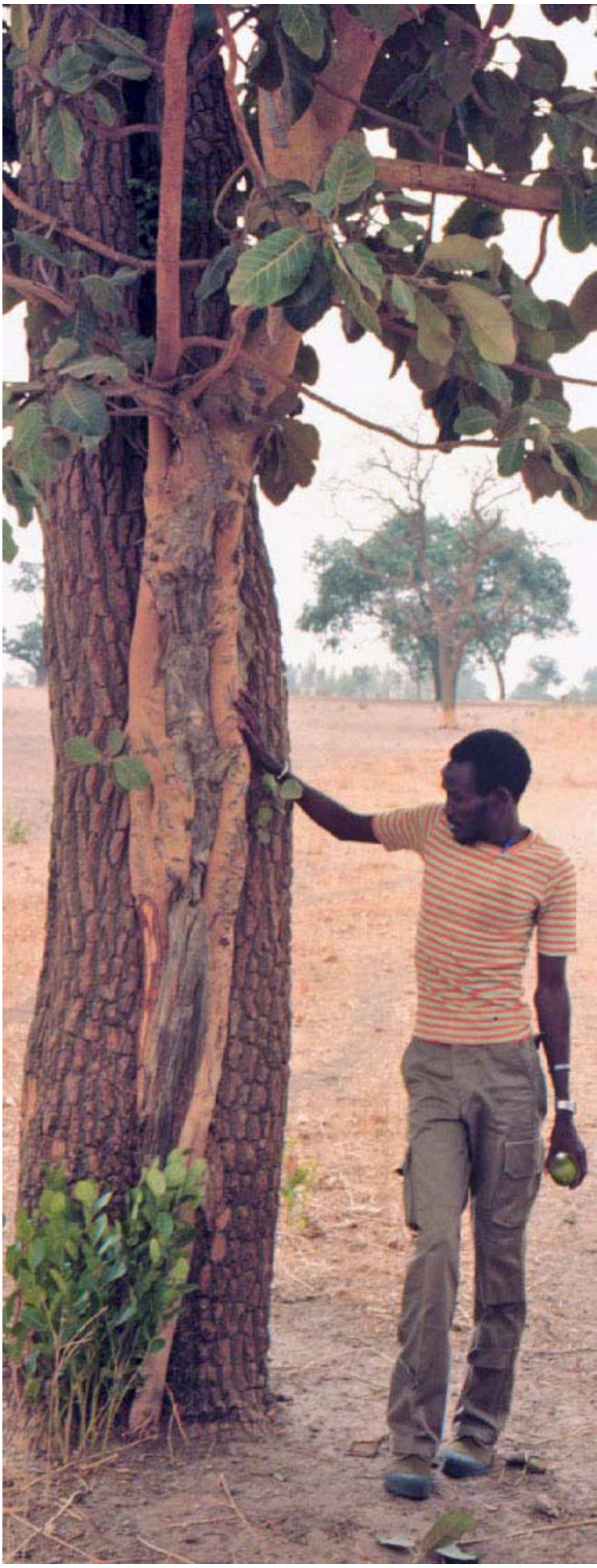
Figure 10. An aerial view (top) of natural regeneration of vegetation on a one-hectare plot (foreground) after 6 years of protection in an exclosure established for research, southeast of Thyssé Kaymor. At a different location, the aerial view (at bottom) shows a sacred forest protected by a village for over a century.

The Saloum Agricultural Region has seen perhaps the greatest decline in biodiversity of any of Senegal's ecological regions. It maintains just a small fraction of its original richness. The main driving force of change appears to be one of human activity. The combined factors of cultivation practices that

have not maintained adequate vegetation cover and tree diversity, wall-to-wall cultivation with little or no use of fallow, and inadequate investments in soil fertility and erosion control are driving a system of labor-led extensification.

Several “hotspots” of high biodiversity can still be found in a few protected gallery forests in the Patako Classified Forest and in the Fathala Forest Reserve.

As agriculture expanded across the land, the vegetation resources that remain are largely a reflection of (a) traditional practices that have always protected and maintained some of the vegetation cover and diversity for local uses, (b) NRM practices that maintain or even increase the vegetation cover and diversity, and (c) natural regeneration that provides some degree of resilience in the ecosystems even after conversion from natural to agricultural land cover.

On the positive side, the region still has tremendous potential for regaining some of its original biodiversity. Several “hotspots” of high biodiversity can still be found in a few protected gallery forests in the Patako Classified Forest and in the Fathala Forest Reserve

In terms of impact, no doubt the greatest of NRM interventions include the classified forests in this region. However, for the near future, an intervention that holds great potential is farmer-managed natural regeneration of on-farm field trees. The spread effect of this practice by thousands of farmers would go a long way to restoring some of the biodiversity of this once-rich region.