

Spatial Analysis of Wetland and Poverty Indicators

In order to sustainably manage wetland resources, decision-makers need to know how they are being used and how these uses affect their capacity to provide products and services now and in the future. In addition, managing wetlands for the purposes of poverty reduction requires information on the location of wetland resources (and their use and condition) in relation to the location of people and poor communities.

This section explores how maps of poverty distribution can be combined with maps of selected wetland indicators to improve the information and analytical base for such decision-making. It relies on two indicators capturing different aspects of wetland use, namely: diversity of wetland products and combined impacts of wetland uses.

Even though the analysis was limited mostly to provisioning services (regulating services are not well accounted for in the National Wetlands Information System, see Box 2), the importance of spatial analysis of wetland regulating services is introduced in Box 3.

DIVERSITY OF WETLAND PRODUCTS

Over 70 percent of all wetlands in Uganda are used for three purposes: water collection, livestock grazing, and natural tree harvesting. This and other analyses of the 13 main uses provided a first broad overview of the varied benefits Ugandans obtain from their wetlands and highlighted national use patterns. However, more detailed wetland use data from the National Wetlands Information System can advance these analyses and contribute additional insights for wetlands management and poverty reduction. For example, harvesting of natural herbaceous vegetation, which is one of the 13 main uses, can be disaggregated into 6 products: harvesting of food, fuel, building material, craft material, mulch material, and medicines (see Table 2 for examples of products for each wetland use). The National Wetlands Information System has documented up to 24 different products in selected wetlands (out of a possible 37 products listed in the standardized wetlands inventory). The average number of products obtained from a wetland in Uganda ranges between 7 and 8 different products.

Examining the number of wetland products provides an analyst with information to gauge the level of product diversification from a wetland. Product diversification is one way of increasing the environmental income from

wetlands. Typically, options to raise income from wetland resources are limited:

- Harvest larger quantities of the same marketable product;
- Harvest a new marketable product;
- Increase the returns from a product by adding value: for example by converting raw papyrus to a craft product; or improving the quality: for example by improving the processing of honey;
- Introduce payment for ecosystem services such as pollution removal or water regulation (hydrological flows).

Decision-makers can use indicators that measure the diversity of wetland products to pinpoint areas where further product diversification can provide new economic opportunities and where diversification appears to have reached an upper limit.

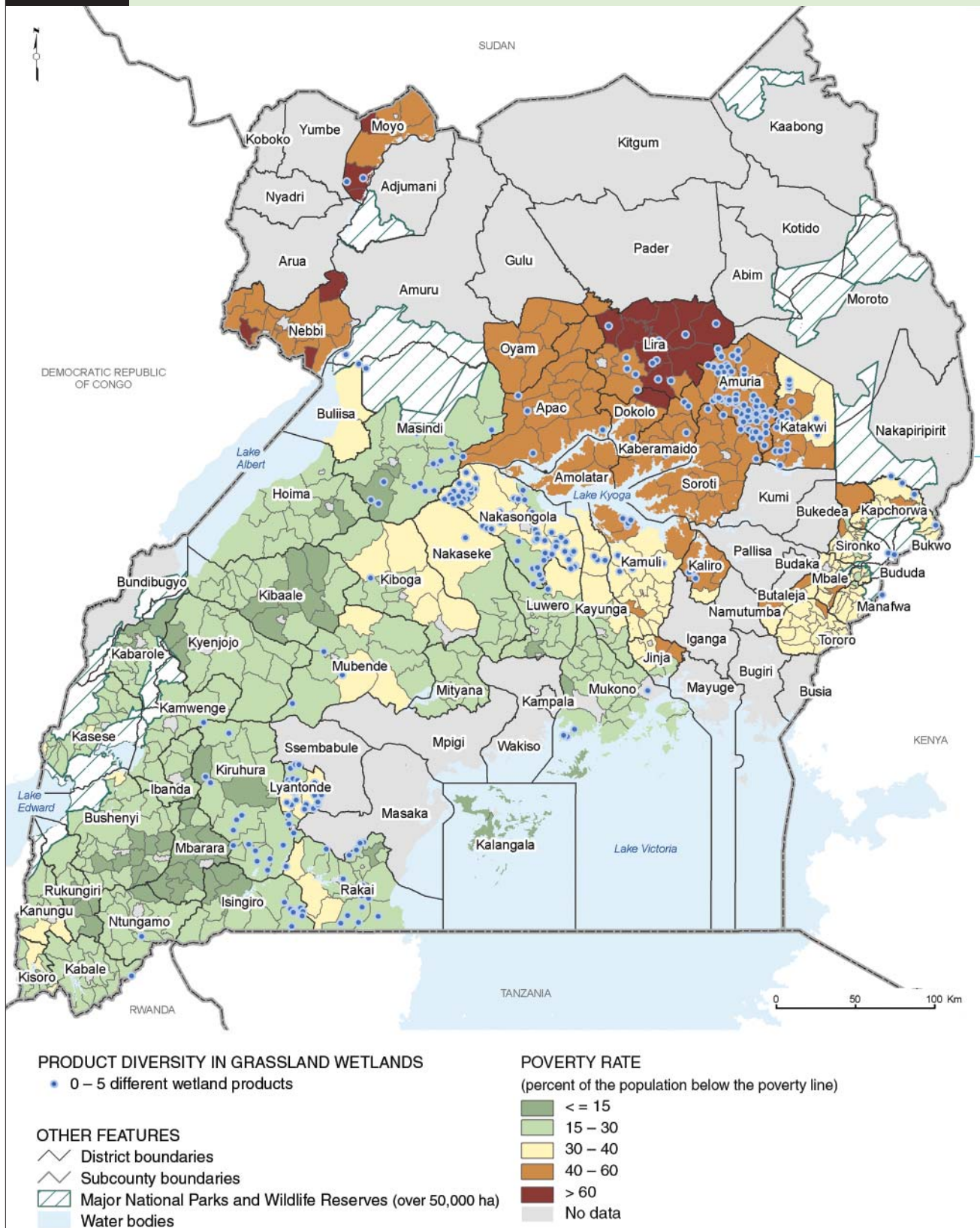
The number of different products that could be potentially obtained from a wetland is closely related to the type of vegetation cover and level of wetness. For example, wetlands in grasslands can supply a much broader array of products than shrublands (WID, 2006). For this reason, the following analysis comparing the diversity of wetland products to the level of poverty in the surrounding communities is focused on such grassland wetlands. They are the most common wetland type, representing more than half of all wetlands in Uganda (see Figure 1). Most of these grassland wetlands are located north and south of Lake Kyoga. A smaller number are further south clustering in Rakai, Kiruhura, and Lyantonde Districts.

Analysis of the number of products obtained from grassland wetlands reveals that 25 percent of such wetlands supply up to 6 products; another quarter supply 6 to 9 products; the third quarter supply 10 or 11 products; and the last quarter supply 12 to 24 products (as calculated from the National Wetlands Information System).

Map 5 displays all the sample points in grassland wetlands with the lowest product diversity (0–5 different products), with the purpose of identifying locations where boosting wetland product diversity is an option that could benefit a large number of poor. In contrast, Map 6 (page 18) shows the sample points with the highest product diversity (12–24 different products) to indicate locations where product diversification may be close to an upper limit. Both maps also display the poverty rate for each rural subcounty.

Map 5

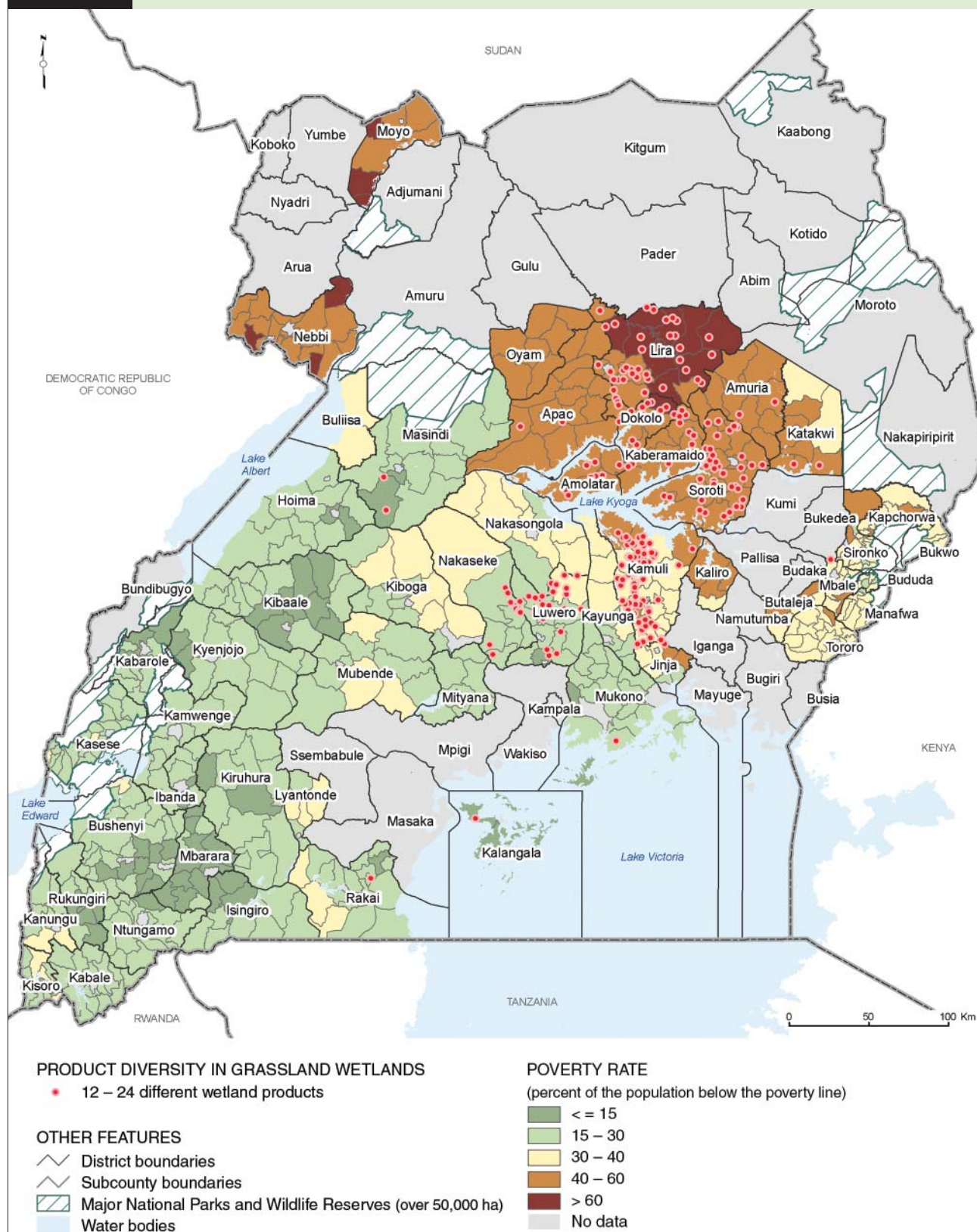
POVERTY RATES IN GRASSLAND WETLANDS WITH LOW PRODUCT DIVERSITY



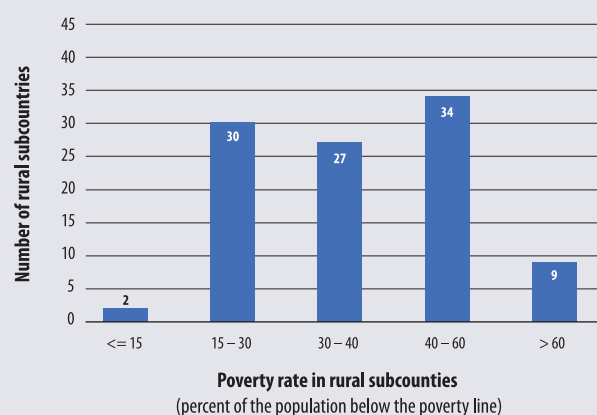
Sources: International boundaries (NIMA, 1997), district administrative boundaries (UBOS, 2006a), subcounty administrative boundaries (UBOS, 2002a), water bodies (NFA, 1996; NIMA, 1997; Brakenridge et al., 2006), product diversity in grassland wetlands (WID, 2006), and rural poverty rate (UBOS and ILRI, 2008).

Map 6

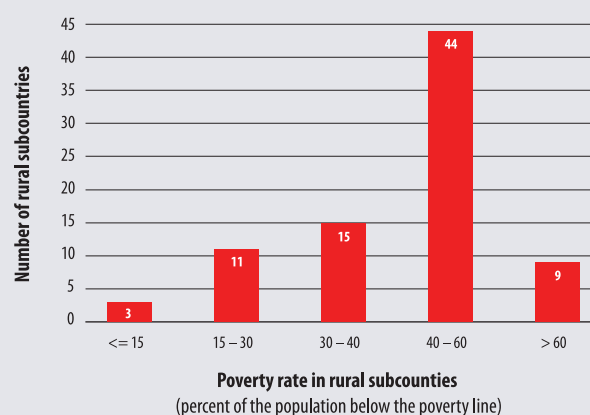
POVERTY RATES IN GRASSLAND WETLANDS WITH HIGH PRODUCT DIVERSITY



Sources: International boundaries (NIMA, 1997), district administrative boundaries (UBOS, 2006a), subcounty administrative boundaries (UBOS, 2002a), water bodies (NFA, 1996; NIMA, 1997; Brakenridge et al., 2006), product diversity in grassland wetlands (WID, 2006), and rural poverty rate (UBOS and ILRI, 2008).

Figure 3**POVERTY DISTRIBUTION FOR GRASSLAND WETLANDS WITH LOW PRODUCT DIVERSITY**

Source: Authors' calculation based on WID, 2006 and UBOS and ILRI, 2008.

Figure 4**POVERTY DISTRIBUTION FOR GRASSLAND WETLANDS WITH HIGH PRODUCT DIVERSITY**

Source: Authors' calculation based on WID, 2006 and UBOS and ILRI, 2008.

Emerging Patterns

Comparing both maps, a number of patterns emerge:

- Wetlands with low product diversity (blue points) spread across all regions where grassland wetlands have been documented in the National Wetlands Information System.
- Grassland wetlands with highest product diversity (red points), however, are almost exclusively located north and south of Lake Kyoga.
- Poverty rates in the surrounding communities for both subsets of wetlands cover the full range of values from the lowest to the highest poverty levels.
- However, those wetlands with the highest product diversity (red points) are mostly in the poorest subcounties (shaded in brown) northeast and southeast of Lake Kyoga.

Figures 3 and 4 summarize the relationship between levels of poverty and product diversity from these two maps. The number of subcounties in each of the five poverty rate classes varies between the low and high diversity set of wetlands. Subcounties that have wetlands with low product diversity show predominantly poverty rates between 15 and 60 percent. On the other hand, the subcounties with highest product diversity of wetland products are concentrated in the 40–60 percent poverty rate class.

Decision-makers can draw the following conclusions from the overlays in Maps 5 and 6:

- Coincidence of high poverty rates (brown subcounties) with high wetland product diversity (red points, Map 6).** The wetlands in a large number of the poorer subcounties northeast of Lake Kyoga appear to be close to the

observed upper limits of product diversification, making it a less viable option to reduce poverty. Wetlands with high product diversity need close monitoring to ensure their sustainable use. This is especially important in subcounties with very high poverty rates. If the high number of different products obtained is found to go beyond the capacity of wetlands to provide products and services, decision-makers and communities need to find alternatives to overexploitation. For example, this could involve training in more sustainable resource use or facilitating efforts to provide value-added products (e.g., organizing papyrus harvesters and providing technology to produce papyrus briquettes for energy supply).

- Coincidence of high poverty rates (brown subcounties) with low wetland product diversity (blue points, Map 5).** Sustainable product diversification could be an option for poverty reduction in the grassland wetlands further away from Lake Kyoga, most of them in northeastern Uganda in Amuria and Katakwi Districts.
- Coincidence of low poverty rates (green subcounties) with low wetland product diversity (blue points, Map 5).** Boosting product diversification is also an option for grassland wetlands west of Lake Kyoga, in Masindi District; and in the southern half of the country, in Kihuhura, Isingiro, and Rakai Districts. To achieve pro-poor benefits, however, interventions need to target poor households more precisely, since poverty rates of the surrounding subcounties are just 15–30 percent (compared to 40–60 percent in the northern wetlands).
- Coincidence of low poverty rates (green subcounties) with high wetland product diversity (red points, Map 6).** If monitoring shows that wetlands are being pushed beyond their capacity to provide products and services

Box 3**MAPPING CASE STUDY: COORDINATING WETLANDS MANAGEMENT AND HEALTH INTERVENTIONS TO IMPROVE SANITATION, DRINKING WATER, AND HEALTH**

An important contribution of wetlands to human well-being is their ability to function as a natural wastewater treatment facility. Due to a combination of substrate, plants, litter, and a variety of micro-organisms, wetlands can help treat human waste (Langergraber and Haberl, 2004). Given that in 2006-07, 41 percent of rural households in Uganda lacked adequate sanitation facilities and 37 percent of rural Ugandans did not have access to a safe water source within 1.5 kilometers (MWE, 2007), the contribution of wetlands in filtering pollutants is crucial to public health. For example, the consumption of contaminated water often leads to outbreaks of water-related diseases, resulting in illness and deaths. Water-related diseases accounted directly for eight percent of deaths in 2002 (WHO, 2006), and unclean water can be especially deadly for infants and young children. Diarrheal diseases are a major killer of children, and were responsible for 17 percent of all deaths of children under 5 years in Uganda (WHO, 2006).

Lack of proper sanitation facilities introduces human pollutants into the vicinity of a household's living space. It increases the risk of disease, especially if contaminants are transported via hydrological flows to nearby households relying on open sources of drinking water such as lakes, streams, or shallow uncovered wells. If households do not have access to water treatment facilities, they have to rely exclusively on ecosystems to clean their water, either through dilution or filtering of pollutants.

In many cases, a wetland can mitigate the risk of contamination. The capacity of a wetland to filter human pathogens and improve drinking water supplies depends on a number of factors, including the type of pollutant, the overall pollutant load, the hydrological flows, the type of wetland, and the health

of the wetland. These relationships are generally examined in specific studies that incorporate detailed information on pollutant sources, drinking water withdrawals, and hydrological models reflecting water flows and filtering functions of wetlands.

The Ministry of Health and the Wetlands Management Department can combine their respective data to identify communities at risks of water-borne diseases because of unsafe drinking water sources and lack of proper sanitation. Together they can locate wetlands neighboring such communities and explore the contribution of these wetlands in filtering human pollutants. The following example showcases such data integration and analysis.

The Sezibwa wetland system is one of the four proposed sites to monitor long-term ecological and socioeconomic trends in Uganda's wetlands. Map 7A shows the location and extent of this system. It is located south of Lake Kyoga and composed of two permanent wetlands (shown in orange) following the Victoria Nile River and the Sezibwa River and a multitude of smaller seasonal wetlands (shown in purple), the latter representing two-thirds of the total area of the system. The map also displays where people collect or use water from their wetland (based on data from the National Wetlands Information System). Similar to the national picture, both seasonal and permanent wetlands are used for water provision but that source of water is defined as unsafe (MWE, 2007).

Map 7B shows the density of households without sanitation facilities (based on data from the 2002 Uganda Population and Housing Census) for each parish neighboring this wetland system. This density indicator can be interpreted as a proxy to delineate source areas of higher potential pollutant loads (bacteria, pathogens, etc.). The upper reaches

of the Sezibwa system following the boundaries of Kayunga, Jinja, and Mukono Districts have the highest density of households without sanitation facilities (shades of dark green).

Map 7C combines Map 7A and Map 7B. This simple overlay provides the following insights:

- People relying on open water sources in the vicinity of high pollutant source areas are at higher risk of contracting water-borne diseases (blue points on dark green parishes). This risk is greatest in the southern parts of Kayunga District.
 - The filtering function of wetlands may be most valuable in areas with the highest pollutant loads and a high number of unsafe water withdrawal sources (although more detailed hydrological studies may suggest other locations and only selected wetlands).
- It is important to point out that wetland management alone cannot substitute for investing in adequate sanitation facilities, safe sources of drinking water, and efforts to promote better hygiene behavior. However, closer collaboration between wetland management and environmental health interventions could help mitigate the risk of vulnerable communities:
- Wetland management interventions may need to prioritize conservation of wetlands where their water treatment function is most valuable and thus support the Ministry of Health in its fight against water-borne diseases.
 - On the other hand, the water and sanitation sector may want to prioritize new sanitation infrastructure and safe drinking water sources where the pollutant load is too high for the carrying capacity of wetlands to filter pollutants.

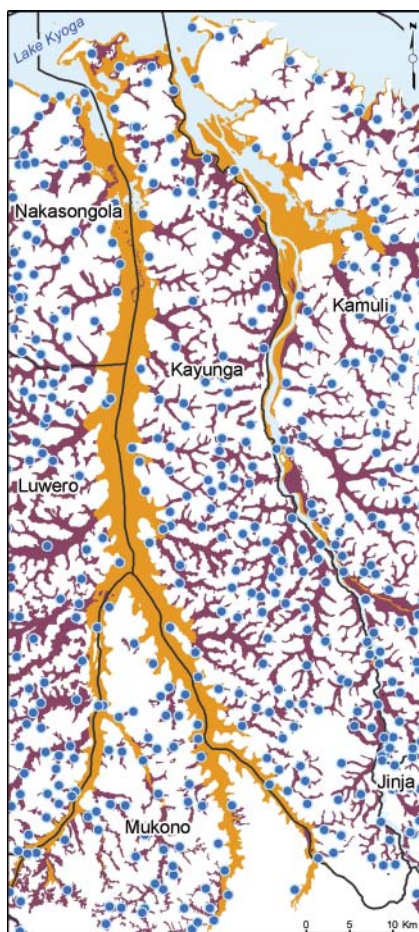
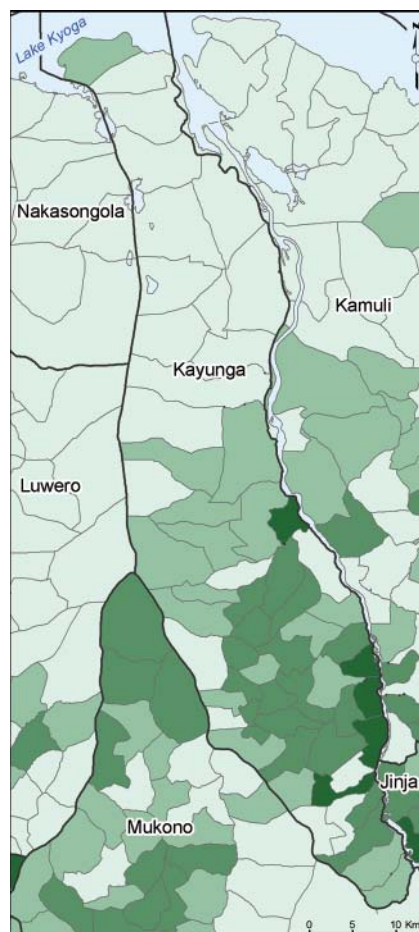
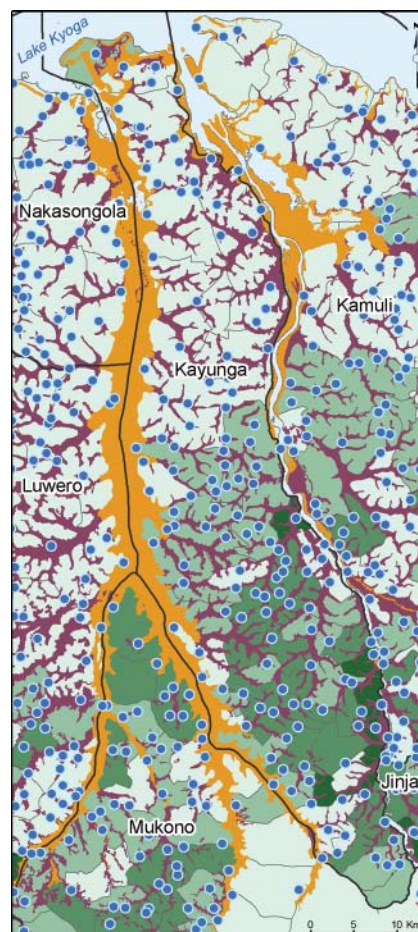
in some areas, decision-makers should study the possibility of restricting access to wetland resources and carefully managing current use in those areas. Wetland users from non-poor households may be more tolerant of such management interventions because they may have alternative and multiple livelihood options.

MEASURING THE COMBINED IMPACTS OF WETLAND USES

The Uganda National Wetlands Policy commits the Government to “the conservation of wetlands in order to sustain their ecological and socio-economic functions for the present and future well-being of the people” (MNR, 1995). Government agencies and community-based wetland resource user groups thus need to know where existing exploitative practices undermine productivity and threaten future supplies of wetland products and services.

Map 7

LINKING WETLANDS AND SANITATION IN THE SEZIBWA WETLAND SYSTEM

A – Sezibwa wetland system
and water collection and useB – Lack of
sanitation facilitiesC – Integration of wetland
and health considerations

USE OF WETLAND

- Water collection and use

WETNESS TYPE

- Permanent wetland
- Seasonal wetland

DENSITY OF HOUSEHOLDS

WITHOUT SANITATION FACILITIES

(number of households without latrine per sq. km)

- < = 10 (low pollutant load)
- 10 – 15
- 15 – 30
- 30 – 370 (high pollutant load)

OTHER FEATURES

- District boundaries
- Parish boundaries
- Water bodies



Sources: District administrative boundaries (UBOS, 2006a), parish administrative boundaries (UBOS, 2002b), water bodies (NFA, 1996; NIMA, 1997; Brakenridge et al., 2006), use of wetland (WID, 2006), wetness type (NFA, 1996), and density of households without sanitation facilities (authors' calculation based on UBOS, 2002b).

The standardized wetlands inventory for the National Wetlands Information System can provide these data because it classifies each wetland use according to its level of impact on the wetland system. This information can be converted into an index to classify each wetland according to the combined impacts of all wetland uses (see Box 4).

This index can help to manage wetland resources more optimally. Wetlands with an index reflecting no or low impacts from their use are closer to a sustainable use pattern and more likely to continue to provide benefits to Ugandans, now and in the future. In contrast, wetlands classified as being highly impacted by use are at greater risk of undermining their future supply of wetland products and services. Depending on the range of different wetland uses and the level of associated impacts, wetland degradation can lead to decreased water quality, depleted fuel sources, curtailed crop yields, or diminished fish catches.

Map 8 highlights the wetlands with a combined impact from all uses of no or low impact. Almost 8 percent of the wetlands inventoried in the National Wetlands Information System show no impacts from current use and are shown as dark blue points in Map 8. These used but non-impacted wetlands are concentrated in Amuria, Kat-akwi, Soroti, and Kaberamaido Districts, areas with more traditional land use and lower population densities (NFA, 1996; UBOS, 2002b).

In contrast, Map 9 (page 24) displays all those wetlands whose index value indicates medium to very high impacts resulting from wetland use. Lira District has the greatest

number of wetlands with very high impact use (red points). A large number of these wetlands can also be found in Dokolo, Amolatar, and Jinja Districts. High wetland impacts can also be found in the districts of Ntungamo, Kisoro, Kyenjojo, Kamwenge, Tororo, Mbale, and Moyo.

Comparing Map 8 and Map 9 reveals that the great majority of wetlands in the districts of Kiruhura and Mubende and the eastern parts of Kamuli District are exposed to low impacts (turquoise points, Map 8). These districts have fewer wetlands with medium to very high impacts (green and yellow points, Map 9). On the other hand, most wetlands in Luwero District are highly impacted (yellow points, Map 9) with very few no or low level impact (blue and turquoise points, Map 8). Wetlands in Kayunga and Nakasongola Districts are represented by a mix of turquoise, yellow, and green points, reflecting low, medium, and high level impact.

While these maps showing the impacts from all wetland uses can help planners to locate potential wetland resources at risk and identify those that are more sustainably used, they can also be combined with Uganda's poverty maps to illuminate the linkages between poverty and potential wetland degradation. Map 10 (page 26) is an example of this approach. Here, all the wetlands at greatest risk of degradation are selected (shown as red points in Map 9) and overlaid with the poverty level in the surrounding subcounties. It displays the location of these wetland sample points and the poverty rate for the neighboring 60 rural subcounties.

Box 4

CONSTRUCTING AN INDEX OF COMBINED IMPACTS OF WETLAND USES

The field surveys for Uganda's National Wetlands Information System assigned for each of the possible 37 wetland products an impact level (defined as high, moderate, low, or no impact on the wetland system). This information provides the foundation for an index that measures the combined impacts of all wetland uses.

To calculate this index, scores of 3, 2, 1, and 0 were assigned to the respective impact levels on the wetland system and then summed for all documented wetland products for each wetland sample point. These sample points can then be mapped to indicate which wetlands are highly impacted by use and which are less so.

Index values for the 5,000 sample points range between 0 and 41. For the purpose of the analysis, these index values were grouped into five classes: no impact (index value of 0), low impact (index value between 1 and 5), medium impact (index

value between 6 and 10), high impact (index value between 11 and 20), and very high impact (index value between 21 and 41). For a wetland to fall in the "no impact" category (index value of 0), wetland inspectors had to assign the "no impact on the wetland system" to all documented products.

Each impact category can reflect various use patterns: For example, a community may extract five different products, each assigned as being "low impact" (associated with an impact score of 1) and resulting in an index value of 5 for the sampled wetland. Another community may extract three different products, one assigned as being "high impact" (impact score of 3) and the other two as being "low impact" (each with an impact score of 1) resulting also in an index value of 5.

One limitation of this index of combined impacts comes from the fact that it weighs impacts equally even though a number of wetland uses, such as

mineral extraction or conversion to cropland, affect ecosystem functions very broadly and often irreversibly, undermining the supply of other ecosystem services. Future revisions of the index could apply different weights to these uses to reflect their greater impact on a wetland's capacity to provide products and services (see Table 2).

A second limitation lies in the timeliness of the data, which were collected between 1997 and 2001. In urban areas such as Kampala, property values and population size—all important drivers influencing wetland use—have been changing rapidly, making the collected data quickly obsolete. To reflect the current situation on the ground, data collection for the National Wetlands Information System has to be carried out more frequently, especially in peri-urban and other areas prone to rapid land-use change.

Map 8

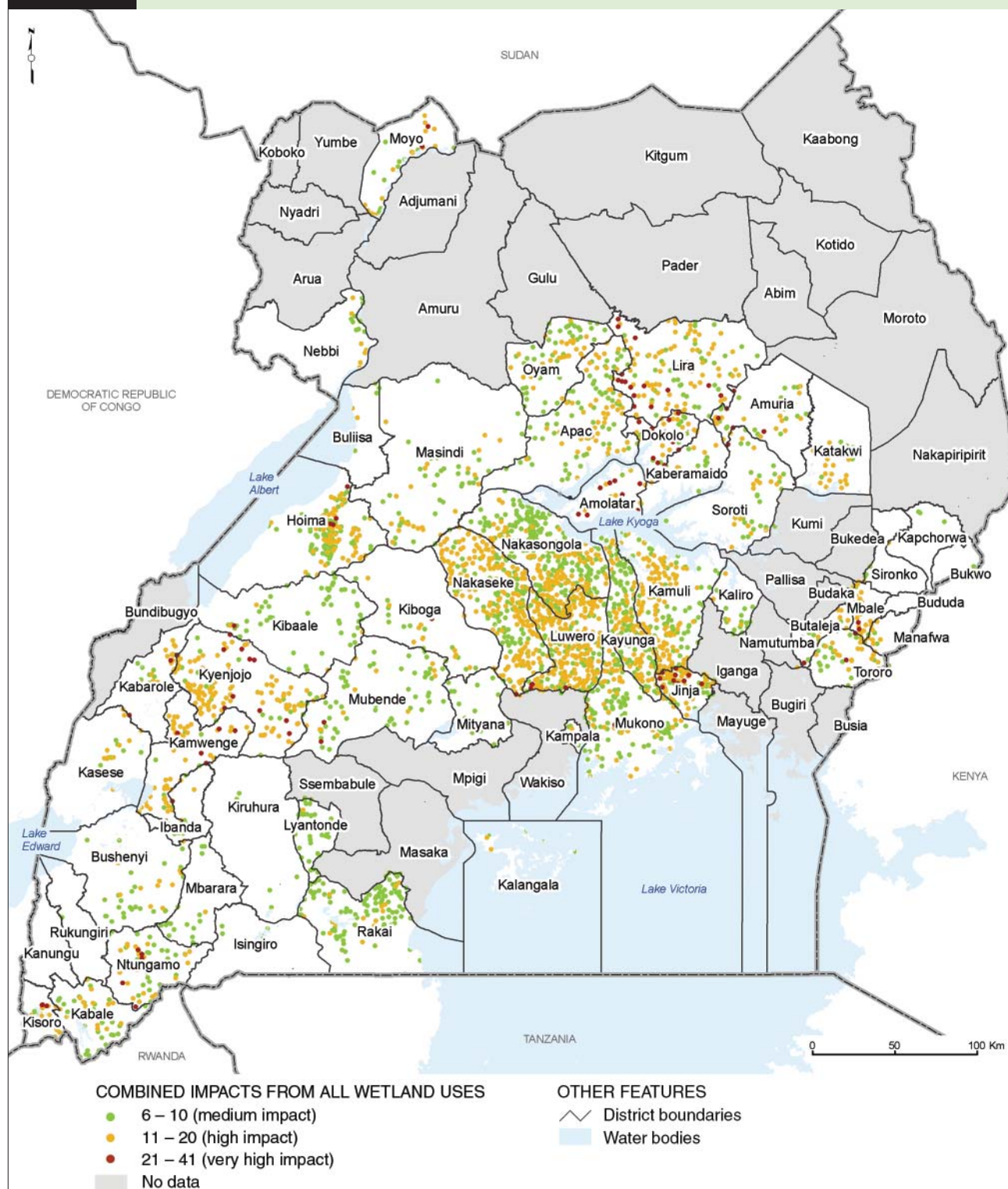
WETLANDS WITH NO OR LOW IMPACTS FROM ALL WETLAND USES, 1997–2001



Sources: International boundaries (NIMA, 1997), district administrative boundaries (UBOS, 2006a), water bodies (NFA, 1996; NIMA, 1997; Brakenridge et al., 2006), and combined impacts from all wetland uses (authors' calculation based on WID, 2006).

Map 9

WETLANDS WITH MEDIUM TO VERY HIGH IMPACTS FROM ALL WETLAND USES, 1997–2001



Sources: International boundaries (NIMA, 1997), district administrative boundaries (UBOS, 2006a), water bodies (NFA, 1996; NIMA 1997; Brakenridge et al., 2006), and combined impacts from all wetland uses (authors' calculation based on WID, 2006).

As Map 10 shows, highly impacted wetlands are spread widely across Uganda, and the proportion of the subcounty population falling below the rural poverty line includes all poverty levels. Wetlands with very high impacts from use are located in subcounties with lower poverty levels (shaded in green) mainly in the southwestern part of the country. But highly impacted wetlands are also situated within poorer subcounties, mostly north of Lake Kyoga in Lira, Amuria, Dokolo, and Amolatar Districts (shades of brown and yellow), but also in Jinja District, where farmers grow rice in wetlands.

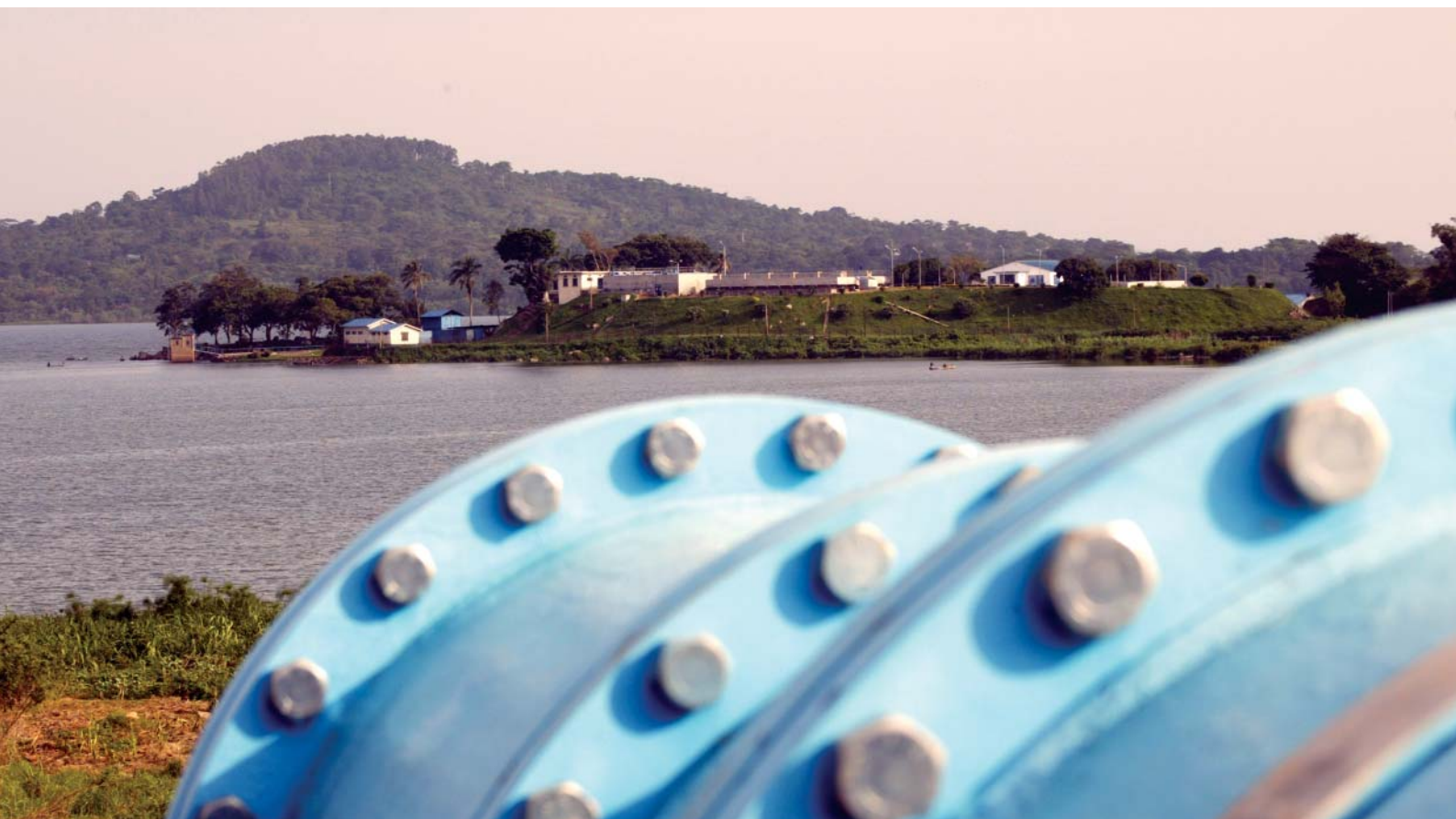
This means that based on the existing data from the National Wetlands Information System and the most recent poverty map, there is no straightforward relationship between poverty levels and potential wetland degradation. High impact from wetland use occurs in both poor and better-off subcounties.

Nevertheless, Map 10 can be useful to flag certain subcounties where close coordination between wetlands management and poverty reduction efforts could be beneficial for both wetlands and human well-being. For example, in subcounties with high poverty rates of 40-60 percent (shaded in light brown) and a great number of highly impacted wetlands, additional or more intensive use could threaten the future supply of benefits. This in turn could negatively impact poor families who depend on wetlands

for their livelihoods or fall back on these resources in emergencies. Improved wetlands management that results in a more optimal combination of products and services (one that lowers the overall impact on the wetland system while maximizing the revenue) could reduce the risk of resource degradation and negative well-being impacts for poor households. Conversely, creating new economic opportunities outside of the wetland sector may permit some families to reduce dependence on resource extraction with low returns and high impacts, resulting in both improvements in well-being and lower resource pressure on wetlands.

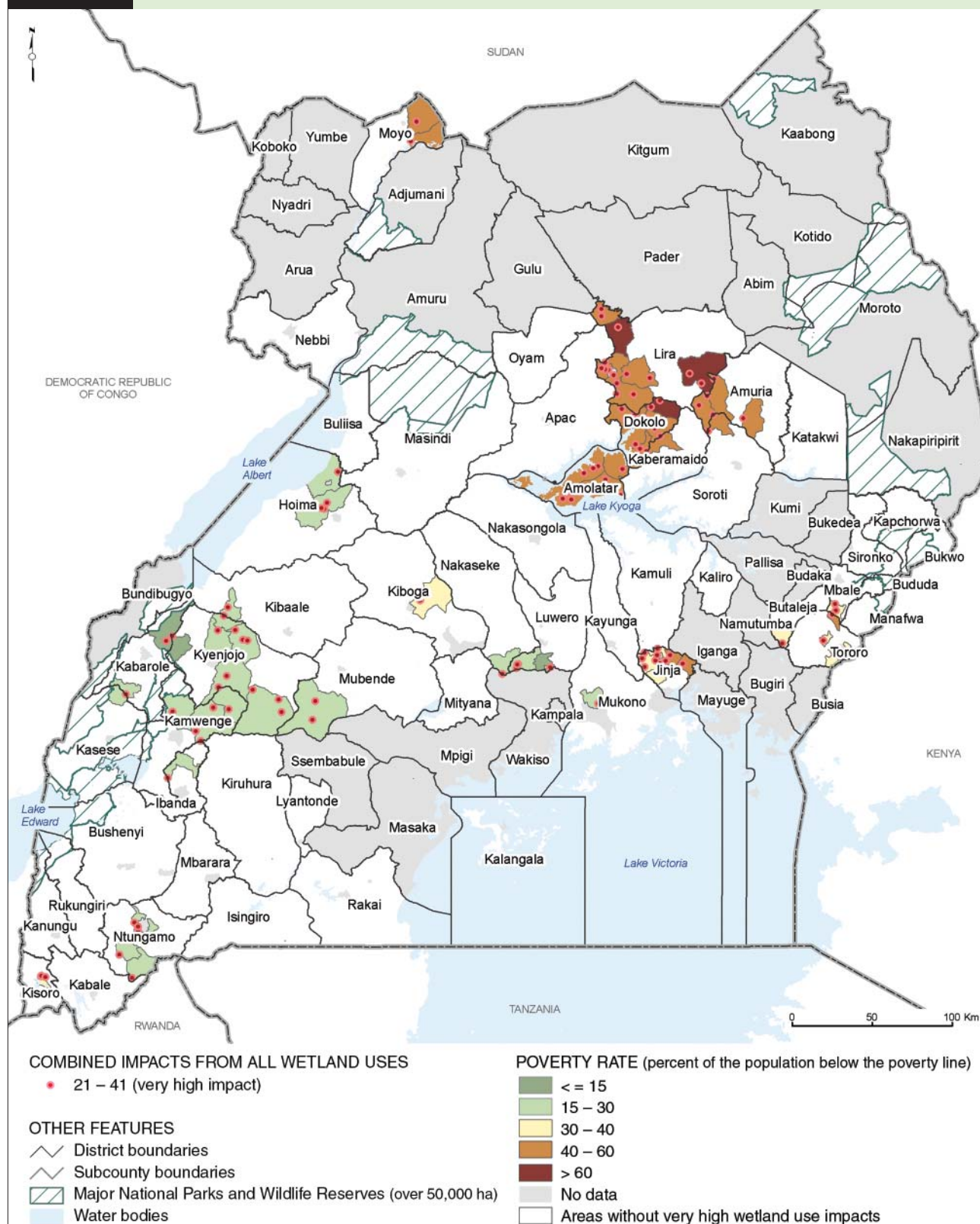
In subcounties with highly impacted wetlands but low poverty rates, the presence of alternative income-generating activities and livelihood strategies is more likely. This suggests that any strategy to change and optimize the combination of wetland uses or to restore a wetland could build on greater assets and capabilities of households in these subcounties.

Map 10 represents just one example that analyzes the relationship between wetland use impacts and poverty. Other useful analyses are also possible. For example, a different map overlay could pinpoint where wetlands exposed to no or low impacts coincide with high poverty levels and could lead to further investigation of the reasons behind this pattern.



Map 10

POVERTY RATES IN SUBCOUNTIES WITH VERY HIGH WETLAND USE IMPACTS



Sources: International boundaries (NIMA, 1997), district administrative boundaries (UBOS, 2006a), subcounty administrative boundaries (UBOS, 2002a), water bodies (NFA, 1996; NIMA, 1997; Brakenridge et al., 2006), combined impacts from all wetland uses (authors' calculation based on WID, 2006), and rural poverty rate (UBOS and ILRI, 2008).