The impact of oil palm on land cover and land use in Kalangala and Buvuma: trends and future predictions

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Summary

This assessment undertaken in July-August 2018 involved the collation of Landsat satellite images obtained from the National Forestry Authority, verified by extensive ground-truthing in both districts, and other field observations. The CLUMondo model using logistic regression was used to make predictions on future land use changes. This contributes to our understanding of the impacts of oil palm development in Kalangala, and especially on conversion of natural forests and non-compliance regarding respect for the 200 m lake buffer zone. Projections should be used to guide further developments, especially regarding the proposed implementation of the new ten-year National Oil Palm Project (NOPP).

Kalangala – Fully stocked tropical high forests have been significantly displaced by oil palm on Bugala Island since year 2000, declining from 58% to 20%, while oil palm increased from 0 to 28%. Grasslands were also significantly reduced by more than half. Modelling future changes to year 2030 predicted an increase in oil palm from 28% to 36%, with losses in all other land uses. In addition, oil palm plantations surround most remaining tropical high forests, creating hard boundaries without buffers that make the forests more vulnerable to edge disturbance.

Buvuma – Conversion of land cover from natural vegetation has been indiscriminate on Buvuma Island resulting in complete obliteration of some forest reserves, with some now entirely under subsistence agriculture and settlement. The obliteration was accelerated by the announcement of the new oil palm project in 2005. Evictions of communities previously occupying Mabira and Butamira Forest Reserves on the mainland also led to a population influx that decimated natural vegetation and riparian/buffer zones, converting them to subsistence farmland. Actualization of the oil palm project to the proposed scale will reduce agricultural land by 50% with serious implications on the supply of food and the general livelihoods of local communities.

Comparison – There is more riparian/buffer zone vegetation in Kalangala than in Buvuma. Whereas 68% of the buffer zones in Kalangala consisted of natural vegetation including tropical high forest, woodland, bushland, impediments and grassland, Buvuma had only 39% of the lake buffer zone with natural vegetation with the rest being subsistence farmland. Additionally, remaining forest reserves are generally better protected in Kalangala than in Buvuma, but however, with increasing pressure. Protected forests in Kalangala have relatively fully stocked tropical high forest whereas the few remaining forest reserves in Buvuma are all degraded. Prediction models illustrate that most of the remaining forest in Buvuma would be lost by 2030 even in the event of no oil palm with major implications on ecosystem services. However, the model projects minimal agriculture in the event of full-scale implementation of oil palm, bringing doubts of strained food security and livelihoods.

Implications – To improve the living standards of communities without compromising the natural resource base or hindering implementation of planned projects, an integrated approach is required that factors in food security and ecosystem services through participatory land use planning including all stakeholders. Rehabilitation of degraded forest reserves and riparian buffers through restoration efforts can also further enhance community buy-in.

Methodology

The main aims of this research were fourfold. These were to: (i) use current land use maps produced in earlier studies in 2017 and 2018, and existing oil palm investments maps (nursery sites, nucleus estate sites, recreation facilities etc.) to model impacts of oil palm, (ii) collect ground truthing data for the analyses and update the land cover/use map of Kalangala, (iii) project scenarios in line with the time frame of NOPP, and (iv) map the forests and buffer zones and identify whether these are sufficiently and effectively protected.

The study covered the Kalangala landscape, which includes Kalangala and Buvuma districts (Appendix 1). Focus was on the main islands of both districts i.e. Bugala island in Kalangala district and Buvuma island in Buvuma district. An earlier study carried out in this landscape (Nangendo, 2018; Ssemmanda and Opige, 2018) showed that land cover changes in the two districts did not follow the same trajectory and the major drivers of cover change varied significantly. To fully explore these differences, the report will be presented in separate sections for each district.

Challenges encountered when undertaking fieldwork included inaccessibility of some areas due to problems of access with poor or no road infrastructure over large parts, especially in Buvuma district. Also, planned collection of additional ground truth data on smaller islands was not possible due to high water levels during the period of study. There was also some hostility from communities especially those living inside protected areas, and others who feared losing their land to the oil palm company.

Mapping the extent of oil palm

The most recent land use/land cover maps were produced by National Forestry Authority based on 2015 Landsat images used as the base maps to guide the ground truthing. Land use/land cover maps for 1990, 2000, 2005 and 2010 were also obtained from the National Forestry Authority. This was supported by stratified purposive sampling to collect ground truth data. Selection of data collection sites was guided by the 2015 land cover/land use map, protected area boundaries, identified land cover/use changes within the landscape, and knowledge gained from interaction with the district officers, palm oil company officials and other local government officers. In all, 87 data collection points were identified in Kalangela district (Appendix 2) and 61 points were identified in Buvuma district (Appendix 3). GPS points were also collected for other features which had not been identified on the 2015 map, including the location of markets and trading centers.

The 2015 land cover/use map and the map of the collected ground truth points were over laid on the most recent, and cloudless, Landsat image in December 2017 to identify areas of misclassification and areas that had changed since the preparation of the 2015 map, i.e. those that had been converted to other land cover/use or that had regenerated. Areas that had been misclassified were renamed, and areas that had changed from one land cover/use to another were delineated and assigned the correct name.

To complement land cover change maps generated in the earlier study (Nangendo, 2018), data on existing infrastructure including nursery sites, nucleus estate sites and recreation facilities was collected during fieldwork. This involved consultations, and field visits with district officers (planners, environment, agriculture and forestry officers) or local government officers who could show the fieldwork team the location of existing and planned infrastructure, provide information on agricultural development plans, and on nature protection and conservation sites. Personnel from the palm oil company were also consulted to obtain better knowledge of current and planned oil palm related infrastructure and nursery locations. In addition, GPS coordinates of infrastructure and agricultural enterprises were taken, and incorporated into land cover/use maps where features or facilities were large enough to be mapped.

Using the forest reserve boundary map, areas within gazetted forest estates were extracted from the updated land cover/use maps of Kalangala and Buvuma districts. Area and percentage under each vegetation cover class was calculated. To evaluate the integrity of the forest reserves, the identified land cover/use classes and their percentage coverage within the protected area were related to the vegetation types expected to occur within a forest reserve. For the lake buffer zone, the area covering the recommended 200 m buffer distance was clipped, and land cover/use within it was assessed for appropriateness as a buffer area cover.

The CLUMondo model

This is a dynamic and spatially explicit land-use model which simulates land use and land cover changes, based on land-use change drivers (Verburg, 2015). The CLUMondo model is a continuation of CLUE models that simulate diverse land-use types, and at the same time also assess options of simulating different scenarios which can be used to evaluate the impact of land cover changes on local level conditions (Verburg et al., 2002). Figure 1 shows the lay out of the model. The CLUMondo model is free to use, from www.environmentalgeography.nl/site/data-models/models/clumondo-model/

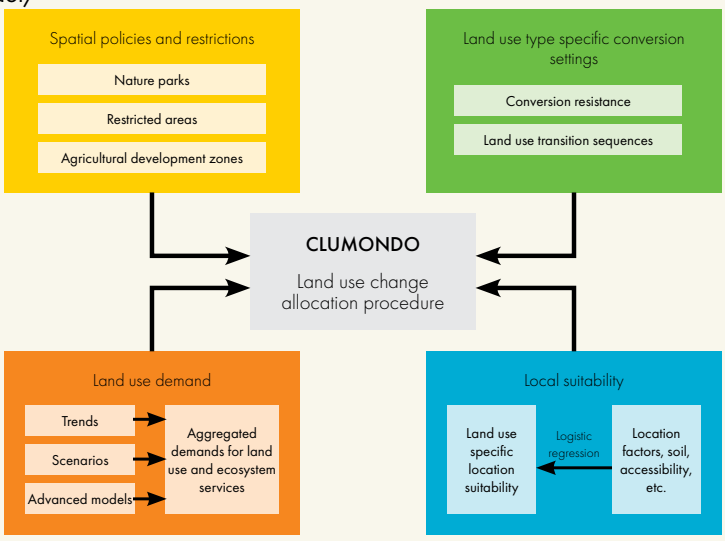

Figure 1: Structure of the information flow in the CLUMondo model (Adapted from Verburg, 2015).

The CLUMondo model uses logistic regression to make predictions. Since the company that established oil palm on Bugala island is the same one that will lead the introduction of oil palm on Buvuma island, it was assumed that they will use the same development model. The logistic regression of oil palm location developed for Bugala island in Kalangala district was, therefore, also used for Buvuma island. The variables used in the logistic regression included soil clay content, protection status (not protected areas), distance to a road, distance to the lake, slope, and elevation. Wetlands were not included amongst the predicting variables since they are already protected by the laws of Uganda (section 107 of the National Environmental Act Cap 153).

Project scenarios to meet the time frame of the NOPP

The agreement to start growing oil palm was signed in 2002 between the Government of Uganda and Oil Palm Uganda Limited (OPUL), a BIDCO subsidiary based on Kalangala island, marking the start of plantation establishment (See Figure 3), currently covering 28% of the area of the island. The Government of Uganda plans to have 10,000 ha of Bugala island under oil palm by 2030.

In Buvuma district, no oil palm plantations have so far been established, except for trial plots. The government plans to have 10,000 ha of oil palm in Buvuma island by 2030 (Abonyo et al., 2007). Given that land cover/land use is evolving, it is important to assess what the landscape may look like by 2030, to guide development plans. Scenario modelling using CLUMondo predicted how the landscape will change under two scenarios, i.e. if no oil palm was established on Buvuma island, referred to as the business as usual scenario, and a second that assumed that all of the planned 10,000 ha of oil palm were established by 2030.

The land cover maps of 2017 were clipped to Bugala island from Kalangala district and Buvuma island from Buvuma district. These were then converted from shapefile to raster format and resampled to 100 m resolution. For modelling purposes, some of the land cover classes (e.g. wetlands, open water, and built up areas) were grouped and assigned a single class called 'others', as compared to other classes, these were considered as not suitable for conversion to oil palm plantations.

Kalangala district

Kalangala district has a land mass area of 46,830 ha, more than half of which in on main island of Bugala (27,000 ha). Whereas all islands in the district were mapped, ground truth data collection was only carried out on the main island, which is the main focus of this study. Figure 2-2017 shows the district's land cover/use status in 2017. Oil palm plantations is now the dominant land cover on the main island. Most of the areas that are not under oil palm plantation are either protected tropical high forests or subsistence farmland. On the smaller islands, there still exists fully stocked tropical high forest outside of protected areas.

Land use mapping and oil palm extent

A total of 86 land cover/use points and 31 facilities and infrastructure sites were mapped in Kalangala (see Figures 3-1 and 3-2 in Appendix). Both the land cover/use, and the facilities and infrastructure ground truth maps were used to update the land cover/use maps. All facilities and infrastructure that was big enough to be mapped and was spectrally separable on the Landsat image was delineated and included in the land cover/use map.

The land cover/use change analysis carried out in an earlier study (Figure 2) show that land cover/use has changed significantly over the years (see also Nangendo, 2018).

Land cover has changed from being predominantly covered with tropical high forest in 1990 to a higher diversification (Figure 2). Oil palm was first mapped in 2005 covering a small area of Bugala but by 2017, it had the highest coverage within the island (Figure 2). Most of the areas that are not protected are either oil palm or subsistence farmland. Although smaller islands still have fully stocked tropical high forest outside protected areas, it is beginning to be converted to subsistence agriculture and depleted tropical high forest. Islands to the far east are dominated by a combination of depleted tropical high forest, grassland and subsistence farmland.

Considering the whole Kalangala district landscape, fully stocked tropical high forest had the highest percentage area coverage (22%), followed by oil palm plantations (16%, synonymous with 'uniform farmland') and subsistence farmland (15%) (Table 1). On the other hand, when only Bugala island was considered, oil palm plantation had the highest coverage (28%) followed by tropical high forest, fully stocked and subsistence farmland with 20 and 17 percent respectively. This means direct oil palm impact is mainly on Bugala island and not yet on the surrounding smaller islands.

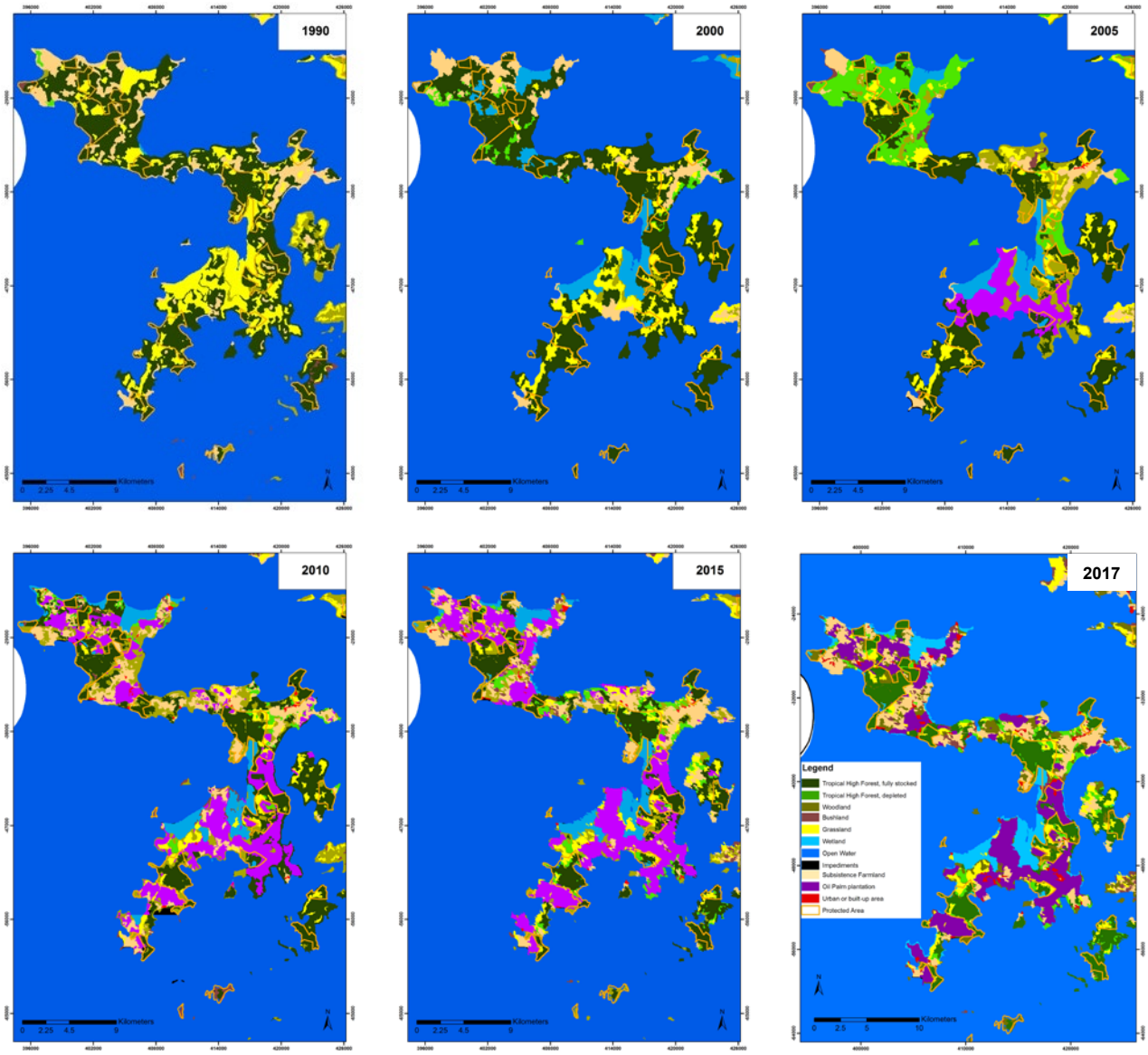

Figure 2: Changes in land cover/use between 1990 and 2017. The 1990 to 2005 maps were obtained from the mapping department of National Forestry Authority (NFA). The 2017 map was the result of ground truthing and updating the 2015 NFA map.

Table 1: Percentage land cover/land use in Kalangala district as a whole, and Bugala island specifically, 2018.

Land cover/use	Kalangala district (%)	Bugala Island (%)
Bushland	2	1
Grassland	13	6
Impediments	0	0
Subsistence farmland	15	17
Tropical high forest, depleted	9	5
Tropical high forest, fully stocked	22	20
Uniform farmland	16	28
Urban or built-up areas	2	2
Wetland	7	11
Woodland	14	10

Forest reserves and water buffer zones

Integrity of forest reserves

Most protected areas are still about half covered by fully stocked tropical high forest (see Figure 2-2017). Extraction of land cover/use of protected areas from the district map showed that within forest reserves, fully stocked tropical high forest had the highest percentage (53%), followed by woodland (14%) and grassland (12%) (Table 2). Oil palm growing in Kalangala district has, therefore, had low impact on land reserved for forest, and which has remained relatively unchanged since 1990.

Table 2: Coverage of each land cover/use type within protected areas in Kalangala district

Land cover/use	Area (ha)	%
Bushland	61	1
Grassland	1027	12
Impediments	1	0
Open water	515	6
Subsistence farmland	225	2
Tropical high forest, depleted	621	7
Tropical high forest, fully stocked	4627	53
Uniform farmland	185	2
Urban or built-up areas	86	1
Wetland	213	2
Woodland	1227	14

Integrity of buffer zone protection

Information about the acceptable buffer zone for the lake and rivers was obtained from the Ministry of Water and Environment 2003 statutory instrument, and a 200 m buffer was applied. To evaluate the integrity of the buffer zones, the identified land cover/use classes and their percentage coverage within the buffer area were related to the vegetation types expected to occur within a buffer zone.

Table 3: Land use/cover types within the 200 m lake buffer zone on Bugala island

Land cover/use	Area (ha)	%
Bushland	127	3
Grassland	166	3
Impediments	29	1
Subsistence farmland	656	14
Tropical high forest, depleted	395	8
Tropical high forest, fully stocked	946	20
Uniform farmland	694	13
Urban or built-up areas	170	4
Wetland	1026	21
Woodland	609	13

Wetland (21%) and fully stocked tropical high forest (20%) have the largest percentage covers, followed by subsistence farmland (14%) and oil palm plantations (14%) (Table 3). Overall, natural vegetation composed of tropical high forest, woodland, bushland, impediments and grassland constitutes 68% of the lake buffer in Bugala island. Of this, areas within the depleted tropical high forest, a transitional forest status, constitute 8% of the buffer, and these may be converted to subsistence farmland if protection of the buffer is not improved. It needs to be noted, however, that two land cover/use types that take third place in percentage coverage are both a conversion from natural cover. Also, urban or built-up areas covered 4%. Overall, converted land cover constitutes 32% (see Figure 3).

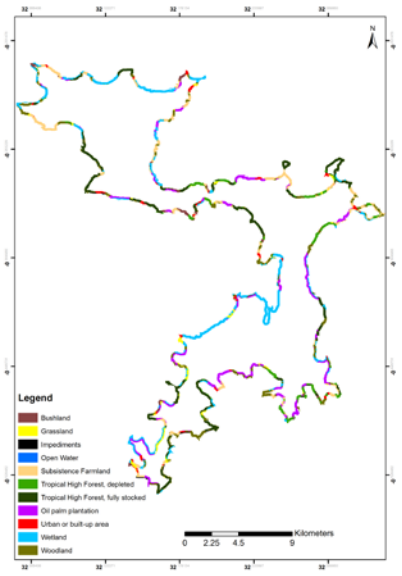

Figure 3: Distribution of land cover/use classes within the buffer area of Bugala island, 2018

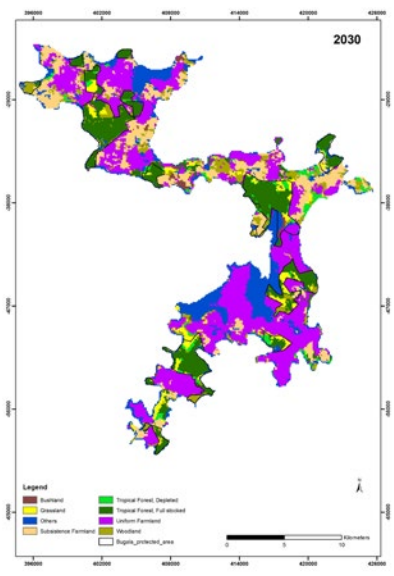

Figure 4: Predicted land cover/use of Bugala island by 2030

Projected scenarios to 2030

The Government of Uganda plans to have a total of 10,000 hectares of oil palm planted in Bugala island by 2030, with 7290 ha having already been planted. Based on the land cover trends (Figure 2 and Table 4a), oil palm has been the major driver of land cover/use change on Bugala island, percentage coverage having consistently increased over the years, and by 2017 had the highest percentage cover (28%) on Bugala island. It was therefore found necessary to explore only one plausible scenario, i.e. how land cover/use of Bugala island will have changed by 2030 when all the planned 10,000 ha of oil palm have been planted.

Land cover/use in 2017 was used as the starting point for the scenario modelling. In 2030, the area on Bugala island that would have not been converted to oil palm plantation would be mainly covered by tropical high forest within the protected areas, or subsistence farmland. The increase in oil palm coverage between 2018 and 2030 will lead to a reduction in almost all land cover/use classes, except the fully stocked forest and 'others' which will increase in size (Table 4b).

Table 4a: Land cover/use percentage of Bugala island between 1990 and 2017

Name	1990	2000	2005	2010	2017
Tropical high forest, fully stocked	57	58	27	26	20
Tropical high forest, depleted	0	3	19	3	5
Woodland	1	2	16	16	10
Bushland	0	0	1	2	2
Grassland	27	14	10	5	6
Wetland	0	11	9	9	10
Subsistence farmland	15	12	6	15	17
Oil palm plantations	0	0	11	24	28
Urban or built-up areas	0	0	0.1	1	2
Impediments	0	0	0	1	0

Table 4b: Land cover/use percentage of Bugala island between 2017 and 2030

	2017	2030
Tropical forest, fully stocked	20	17
Tropical forest, depleted	5	3
Woodland	10	7
Bushland	2	1
Grassland	6	5
Subsistence farmland	17	15
Oil palm plantations	28	36
Others	12	16

Key observations from Kalangala district

1. Land cover of Kalangala district has changed significantly, especially since 2005 on Bugala island where oil palm has displaced other vegetation, especially fully stocked tropical high forest.
2. Some parts of the lake buffer zone had been converted from naturally occurring vegetation to other land cover types such as subsistence farmland and oil palm plantations. Such areas will need to be restored.
3. Between 2000 and 2017, 38% of the fully stocked tropical high forest has been converted to other uses, mainly oil palm plantations, subsistence farmland, and urban or built-up areas.
4. Forest reserves have hard boundaries, i.e. have no buffer areas of similar vegetation outside the forest reserve boundary. So, if any further disturbance ever occurs along the forest edge, it will be within the forest reserve. Most forest reserves are surrounded by oil palm plantations.

Buvuma district

Buvuma district has a total land area of 29,889 km^2 with more than two thirds being the Buvuma island (21,692 km^2). Whereas all islands in the district were mapped, ground truth data collection was only carried out on the main island, Buvuma. Subsistence farmland is the dominant land use on Buvuma island. Most protected areas have also been converted to subsistence farmland except on the western and southern part of the island where a number of forest reserves are still covered by depleted forest or a woodland-grassland mosaic. The smaller islands are manly covered by depleted tropical high forest or grassland (Figure 5).

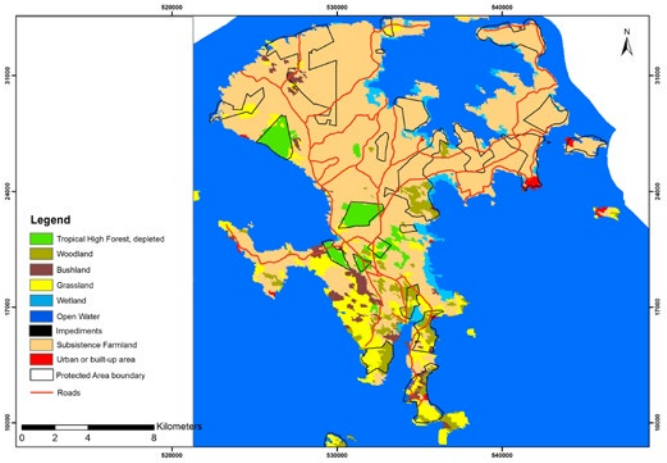

Figure 5: Land cover/use map of the study area based on 2017 Landsat satellite images

Land acquisition for oil palm

The government plans to have planted 10,000 ha of oil palm in Buvuma by 2030. Of this, BIDCO has expressed a commitment to establish a nucleus estate of 5000 ha, with the remaining 5000 ha to be mainly established by smallholder growers. Figure 6 shows all areas that have been or are being acquired for oil palm cultivation. They

are all outside the protected area estate and the main land use outside protected areas is subsistence farmland. It is, therefore, mainly subsistence farmland that has been acquired for oil palm cultivation. The area for oil palm cultivation is well distributed over the whole island.

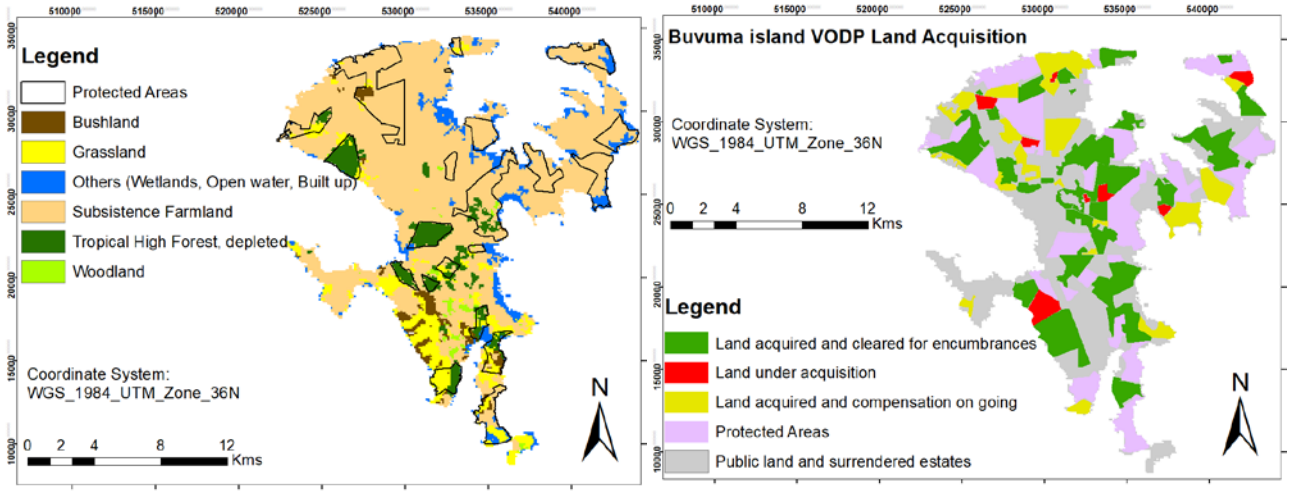

Figure 6: The 2017 land cover map of Buvuma island (left) and the VODP land acquisition status map (right)

Land use mapping and oil palm

For Buvuma district, a total of 65 land cover/use points and 34 facilities and infrastructure sites were mapped (Appendix 5). Both the land cover/use, and the facilities and infrastructure ground truth maps were used to update the land cover/use maps. All facilities and infrastructure that was big enough to be mapped and was spectrally separable on the Landsat image was delineated and included in the land cover/use map.

Subsistence farmland land use is the dominant class, especially on the main island. Whereas the northern and central parts of the main island is dominated by subsistence farmland, the south most part is dominated by a grassland-woodland mosaic. The smaller islands are dominated by depleted tropical High forest and grassland. Landing sites and urban or built-up areas were the main developments mapped. There was also a large expanse in the northern part of Buvuma island that had been cleared for setting up an oil palm nursery. The land cover change maps generated in the earlier study (Nangendo et al., 2018), and Figure 10 below, show that land cover/use in Buvuma has changed drastically over the years. The main driver of land cover/use was subsistence agriculture expansion.

Comparing the 1990 land cover map (Figure 7) where the dominant cover was fully stocked tropical high forest, and the 2017 land cover map (Figure 5) where the dominant land cover/use is subsistence farmland, shows that most of the area has been converted to subsistence farmland, even within protected areas. Forest reserves that have not been cleared for agriculture, however, have been significantly degraded (Plate 1). Most drastic changes in land cover/use were first mapped in 2005. There is a large expanse of grassland on the south western part of the main island which has survived being degraded (Figure 5), perhaps because there are large expanses of rocky areas (Plate 2).

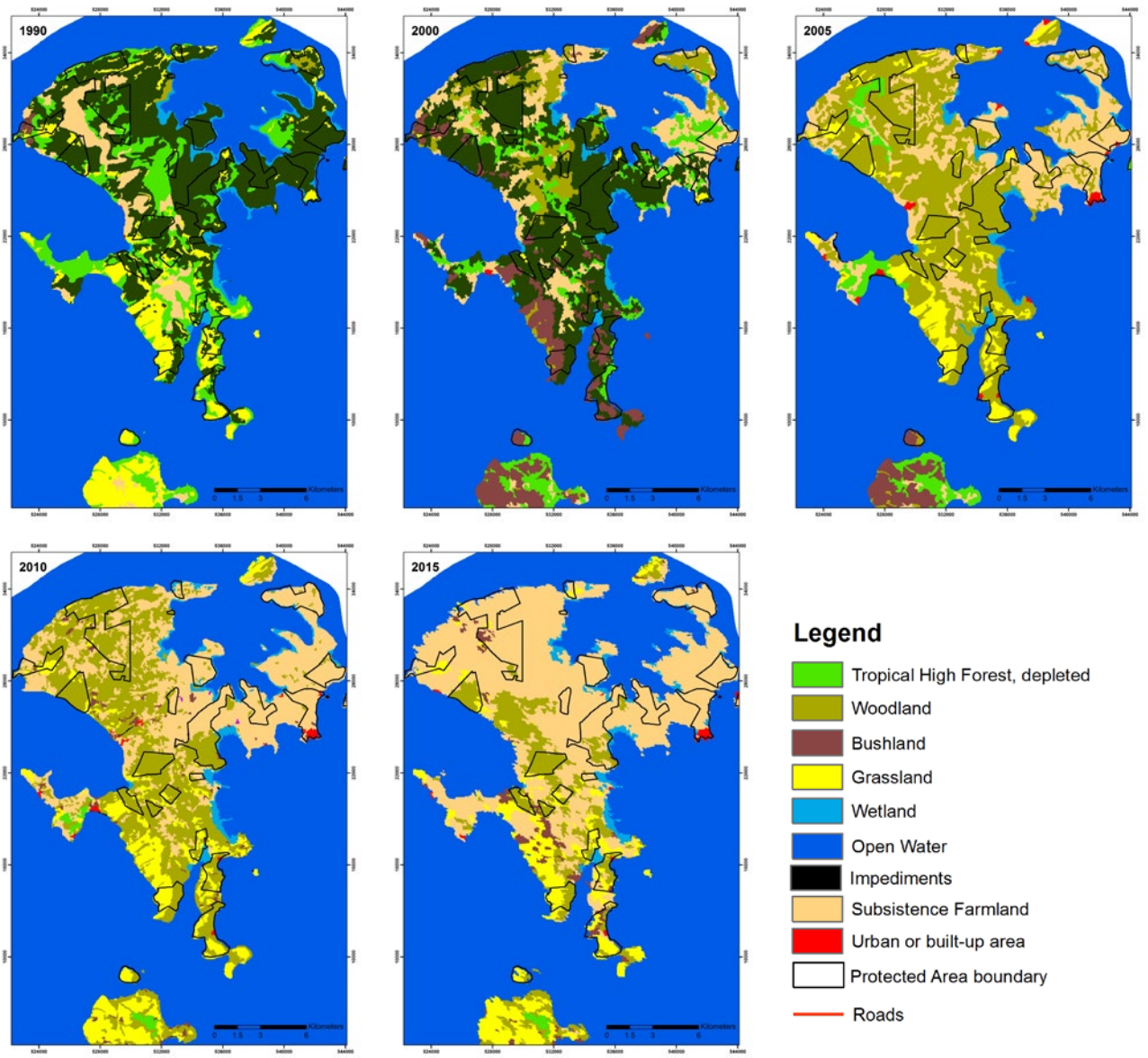

Figure 7: Land cover variation between 1990 and 2015 in Buvuma district (1990 to 2005 maps from the National Forestry Authority, the 2017 map results from ground truthing and updating the 2015 map.

Plate 1: A recently cleared forested area (left); and a cleared area within a forest reserve (right)

Plate 2: A rocky area in the southern part of Buvuma island covered by grassland

Considering land cover for the whole district and then for Buvuma island alone, subsistence farmland had the highest percentage in both. The percentage was, however, higher for Buvuma island (72.5%) than for the whole district (55.5%). This was followed by the same classes. i.e. grassland (19%) and depleted tropical high forest (12%) for the whole district and 9% and 7% respectively for Buvuma island alone (Table 5).

Table 5: Percentage land cover/use of Buvuma district and Buvuma island

Land cover/use	Buvuma district (%)	Buvuma island (%)
Bushland	3	3
Grassland	19	9
Impediments	0	0
Subsistence farmland	56	72
Tropical high forest, depleted	12	7
Urban or built-up areas	2	3
Wetland	4	5
Woodland	4	1

Although areas have already been acquired for oil palm growing (Figure 8) and as evidenced by Vegetable Oil Development Project (VODP) boundary markers encountered during ground truthing (Plate 3a), most land is still partially used for agriculture. Areas that have been abandoned are overgrown with weeds. There is also an oil palm growing trial site on Buvuma island and its crop had already started fruiting (Plate 3b).

Plate 3a: An area acquired for planting oil palm growing (left).

Plate 3b: Oil palm at a trial plot site on Buvuma island (right).

Forest reserves and water buffer zones

Integrity of forest reserves

Whereas in 1990 most of the forest reserves were covered by fully stocked tropical high forest, by 2005 they had been greatly depleted to the extent that they were mapped as woodlands (Figure 7). By 2017, all forest reserves in the north and north-east of Buvuma main island, which hosts the largest number of forest reserves, had been converted to agriculture. Forests in the central and southern part of Buvuma main island, if not converted to subsistence agriculture, were either depleted or a mosaic of woodland and grassland. Extraction of land cover/use from forest reserve areas as included in the district map showed the dominant land use within reserves as subsistence agriculture (58%) followed by depleted tropical high forest (12%) and grassland (10%). There were also some urban or built-up areas (settlements) within forest reserves (Table 6). In Buvuma district, there is much land reserved for forests, but it is not necessarily covered by forest.

Table 6: Coverage of each land cover/use class within the protected area of Buvuma district

Land cover/use	Area (ha)	%
Bushland	139	2
Grassland	644	10
Open water	360	6
Subsistence farmland	3683	58
Tropical high forest, depleted	754	12
Urban or built-up areas	73	1
Wetland	90	2
Woodland	585	9

Integrity of Buvuma island lake buffer zone

Information about the acceptable buffer zone for the lake and rivers was obtained from the Ministry of Water and Environment 2003 statutory instrument, and a 200 m buffer was applied. To evaluate the integrity of the buffer zone, an assessment of the percentage coverage of each land cover/use classes within the buffer area was carried out (Figure 8), showing subsistence farmland had the highest cover (54%) followed by wetland (21%) and grassland (10%) (Table 7). Overall, natural vegetation composed of tropical high forest, woodland, wetland, bushland and grassland constitutes only 39% of the buffer zone, the other 61% being subsistence farmland and urban or built-up area.

Table 7: Land cover/use that occur within the 200m buffer zone to the lake for Buvuma island

Land cover/use	Area (ha)	%
Bushland	128	4
Grassland	374	10
Subsistence farmland	1936	53
Tropical high forest, depleted	137	4
Urban or built-up areas	271	7
Wetland	751	21
Woodland	22	1

Plate 4: Crops established within the lake buffer zone, leaving no natural vegetation buffer at all

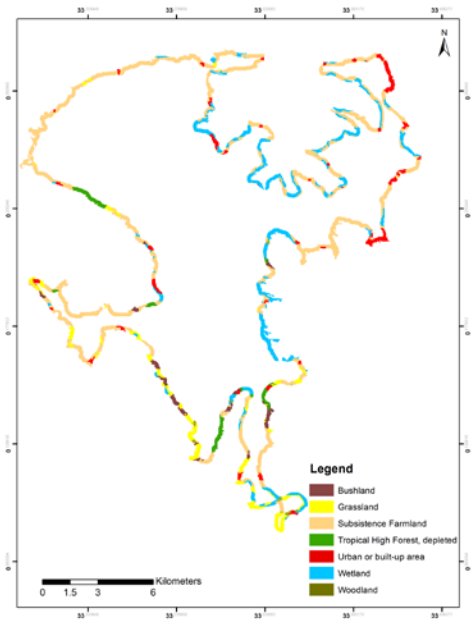

Figure 8: Land cover/use distribution within the lake buffer zone of Buvuma island, 2018

Projected scenarios to 2030

Land over/use of Buvuma island has been consistently changing. The main driver as shown in Figure 7 and Table 8 is subsistence farmland. Predicting project scenarios for Buvuma island would, therefore, necessitate exploring what the land would have looked like by 2030 if no oil palm is established on the island (referred to as 'business as usual'), and if all the planned 10,000 hectares of oil palm plantation were established.

Table 8: Percentage land cover change on Buvuma island

Land cover/use	1990	2000	2005	2010	2017
Tropical high forest, fully stocked	53	50	0	0	0
Tropical high forest, depleted	19	9	4	1	7
Woodland	1	10	54	43	1
Bushland	0	8	0	2	3
Grassland	12	0.4	10	10	9
Wetland	6	4	4	5	5
Subsistence farmland	8	18	28	42	72
Uniform farmland	0	0	0	0	0
Urban or built-up areas	0	0.1	1	1	3

The 10,000 ha oil palm coverage scenario

In Buvuma island, oil palm trial plots are doing well and were used as the 2017 land cover/use starting points for the oil palm scenario modelling. The assumption is that by 2030, all the 10,000 ha of oil palm will have been established as proposed in the government plan (Abonyo et al., 2007, KADINGO, 2009). It will mainly cover the western side of the island and generally avoids protected areas, even those that are already under subsistence farmland (Figure 9), and by 2030, oil palm would cover 46% of the island Table 9).

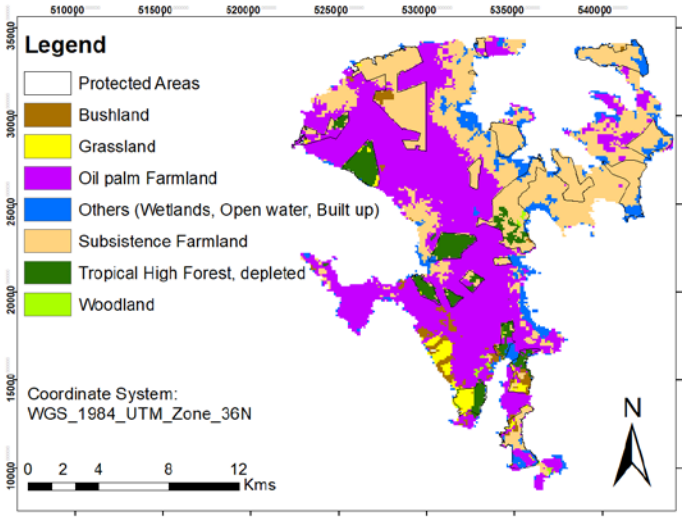

Figure 9: Oil palm distribution on Buvuma island with a total area of 10,000 ha by 2030

Business as usual, no oil palm established

The business as usual scenario indicates how land cover/use would have changed by 2030 if no oil palm is introduced on the island. The scenario was guided by land cover/use trends between 1990 and 2015, which already show that subsistence farmland increased the most over these years (Table 9). The scenario modelling revealed that subsistence farmland will increase from 67% in 2017 to 85% by 2030.

Table 9: Trend of expansion of subsistence farmland of Buvuma island, and projected to 2030 if no oil palm is planted.

Year	Area (ha)	%
1990	1785	8
2000	3767	18
2005	6035	28
2010	9052	42
2015	14566	68
2030	18145	85

Figure 10 shows that subsistence agriculture expansion would not only occupy unprotected areas, but also lead to clearing of a number of protected areas that in 2017 still had forest cover. Also, all the woodland would be lost. Grassland would mainly remain in one area which had also been observed during the ground truthing fieldwork to have a lot of rock outcrops (Plate 2).

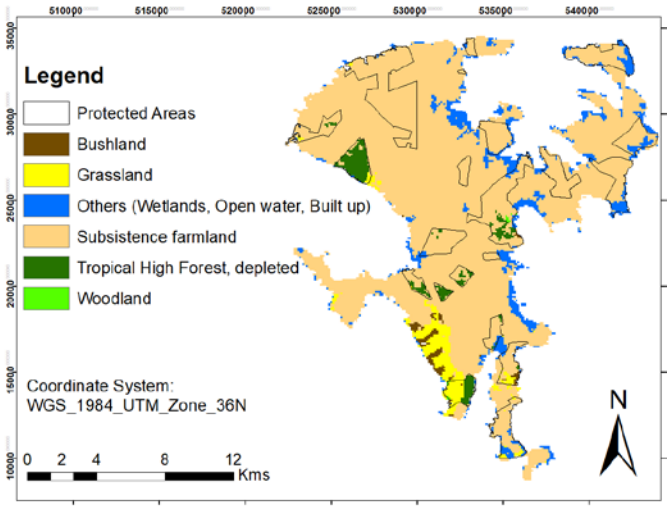

Figure 10: Business as usual scenario map for 2030

Comparing land cover/use changes under the two scenarios shows that if all the planned oil palm was planted, all land cover types would lose part of their coverage to oil palm, but subsistence farmland would lose the most (Table 10). Percentage coverage of subsistence farmland under the 10,000 ha scenario would be reduced from 72% to 36%. On the other hand, under the business as usual scenario, it would have been the opposite, and subsistence would have increased from 72% to 85%.

Table 10: Comparison of area cover change between 2017and 2030 under two scanarios

Land cover class	Land cover 2017 ha (%)	Business-as-usual (no oil palm) by 2030 ha (%)	10,000 ha of oil palm scenario by 2030 ha (%)
Bushland	589 (3%)	187 (1%)	466 (2%)
Grassland	1884 (9%)	768 (4%)	406 (2%)
Oil palm farmland	0 (0%)	0 (0%)	9956 (46%)
Subsistence farmland	15548 (72%)	18146 (85%)	7655 (36%)
Tropical high forest -depleted	1462 (7%)	579 (3%)	1136 (5%)
Woodland	211 (1%)	15 (0%)	75 (0%)
Others	1761 (8%)	1761 (8%)	1761 (8%)

The scenario assessment shows that there is still high demand for agricultural land in Buvuma island. Unlike in Bugala island where there was still much uncultivated land at the time of introduction of oil palm, oil palm will displace communities from established agricultural land, with significant food security implications, and options of how to sustain the livelihoods of displaced communities will need to be explored.

Key observations from Buvuma district

1. Land cover of Buvuma district has significantly changed. The greatest change is on the main Buvuma island, where most land has been converted to subsistence farmland by the large resident population.
2. A large part of the lake buffer zone has been converted from the natural vegetation to other land cover types such as subsistence farmland. Such areas will need to be restored.
3. Conversion of land cover from natural vegetation includes protected areas, most of which were converted to subsistence farmland. Where tropical high forest still exists, it has been depleted.
4. Should oil palm be planted at the proposed scale, it will reduce the area for agriculture by 50%, with serious implications on the supply of food and on the livelihoods of local communities.

Conclusions

Whereas most of Kalangala district used to be covered by fully stocked tropical high forest before oil palm growing began, Buvuma district was and still is dominated by subsistence agriculture. On Buvuma, oil palm will therefore, mainly replace subsistence agriculture rather than forests or other natural vegetation. And where much of the high forest in Kalangala has been replaced with oil palm, remaining forests are generally better protected than in Buvuma district. But in Kalangala, all the areas around forest reserves have been converted to other land uses, especially agriculture, with no boundary buffer of forest vegetation. Scenario modelling showed that even if oil palm was not cultivated on Buvuma island, most of the remaining forest would be lost by 2030, being converted to subsistence farmland. But with the growing of oil palm, there would be much less land available for agriculture.

Despite some lake buffer zone areas on Bugala island, Kalangala district being under uniform agriculture, the buffer area is better protected on Bugala than along lake shores of Buvuma island, where most of the buffer zone has been converted to subsistence farmland. Overall, there is more natural buffer zone vegetation in Kalangala district, where 68% of the buffer zones consisted of natural vegetation composed of tropical high forest, woodland, bushland, impediments and grassland, while Buvuma district had only 39% of its buffer zone with natural vegetation.

Recommendations

Oil palm has been produced in Kalangala for over 12 years, with many lessons learned. But to ensure mistakes are not repeated in Buvuma where planting is yet to begin, actions are needed by the government, donors and BIDCO.

1. Enforce the 200 m lakeside buffer zone and undertake sensitization of what is/isn't allowed in this area. Demarcate with marker stones, especially in Buvuma where plantations are yet to be established, and monitor closely to ensure compliance.
2. Enforce existing laws on protecting wetlands (section 107 of the National Environmental Act, Cap 153), and sensitive areas included in National Environment Act (Wetlands, River Banks Shore Lines) No. 3/2000.
3. Ensure that remaining protected forests are better conserved, and/or that sustainable forest management practices are implemented.
4. Rehabilitate degraded gazetted protected forests and riparian/ buffer zones through enrichment planting, and consider re-planting of forest buffer zones where they have been erased to avoid hard boundaries.
5. Develop effective land-use planning at landscape level in close consultation with communities and local government, and implement so that remaining land is optimally used for food and fuel security and alternative livelihoods (agriculture, community woodlots, tourism, forestry, etc.).

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Appendices

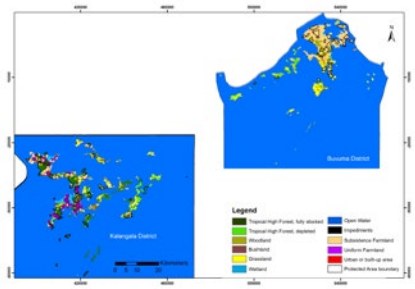

Figure 1-1: The Kalangala landscape districts displayed in their spatial location context.

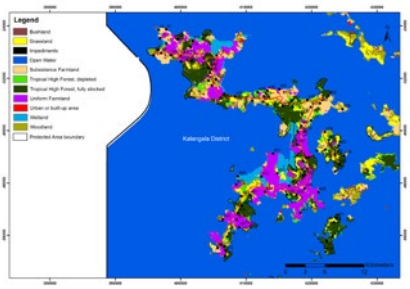

Figure 2-1: Kalangala fieldwork map showing the sites selected for ground truth data collection.

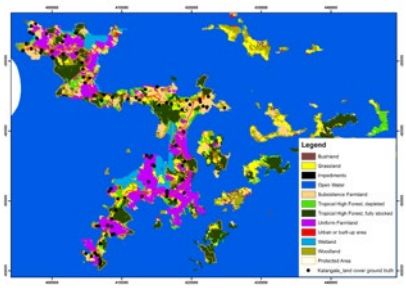

Figure 3-1: Land cover/use ground truth points collected in Kalangala. The 2015 land cover map was used as the base map.

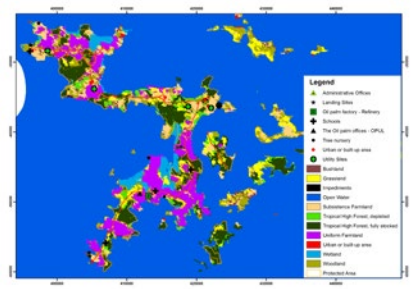

Figure 3-2: Facilities and infrastructure ground truth points collected in Kalangala. The 2015 land cover map was used as the base map.

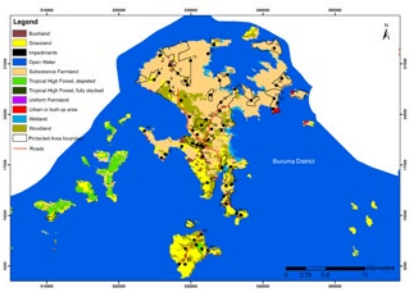

Figure 4-1: Sites in Buvuma district which were selected for ground truth data collection

Figure 5-1: Land cover/use ground truth points collected in Buvuma. The 2015 land cover map was used as the base map.

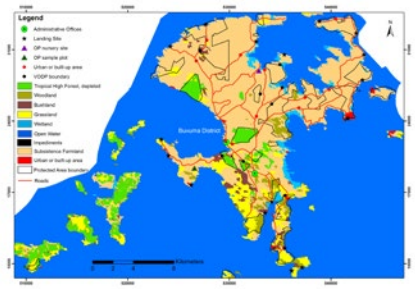

Figure 5-2: Facilities and infrastructure ground truth points collected on Buvuma island. The 2015 land cover map was used as the base map.