



Nile Basin Initiative

Potential areas for irrigation development



Burundi

Potential for Irrigation Development Moso Area Burundi

The Nile Basin Initiative (NBI), under the Nile Equatorial Lakes Subsidiary Action Program (NELSAP) and the project Regional Agricultural Trade and Productivity Project (RATP) has undertaken a study entitled "Assessment of the Irrigation Potential in Burundi, Eastern DRC, Kenya, Rwanda, Southern Sudan, Tanzania and Uganda". The study was categorized as "preparation for a development program" and has a strategic perspective.

During 2011-2012 an overall assessment on the potential to develop irrigation has been undertaken by a consortium headed by Future-Water and WaterWatch (Netherlands). Based on these analyses 35 high potential areas have been selected. This note provides the highlights of one of these areas.

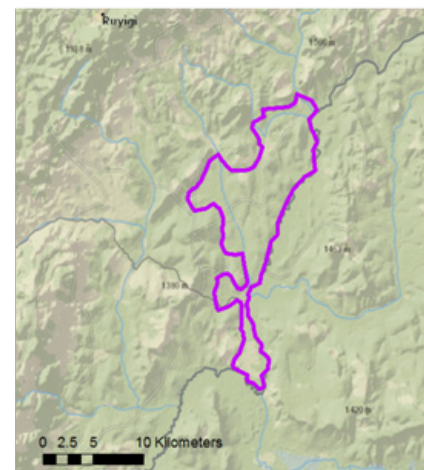


Overview

Moso focal area borders to Tanzania in the East. The area is partly situated in the Rutana province and the Ruyigi province. The focal area stretches along the Rumpungu River, which is the boundary between Burundi and Tanzania. Upstream the elevation of the valley bottom is around 1170 m and the valley descends towards the South towards 1140 m. The area includes the western banks of the Rumpungu River, and one branch coming from Buhonga village. The plains surrounding the river are nearly flat, and therefore very vulnerable for flooding. Slopes vary, but are limited in most of the area to 3%. The hills captured between the two branches of the river have some steeper slopes, but stay mostly under the 10%.

Land and Water Resources

Soils consist mainly of silty loam build up from Schist-quartzite, sandstone and limestone. The steep slopes are generally much eroded, and have therefore a very thin soil. Soils in the valley are deep, and somewhat poorly drained. In the valley the percentage of organic material in the top soil is high, while on the slopes on the sides the organic material is limited to around 1%. Water storage capacity in the area is quite good with 125-150 mm/m. Soils tend to be very fertile. Land productivity in Moso focal area is the lowest off all focal areas. NDVI values range from 0.45 in the mountains in the North, to 0.6 in the most Southern point and the North West. These low NDVI values can be explained by the sparsely vegetated hills and the high seasonal variation of land productivity. The coefficient-of-variation is very high, except directly along the river side. This indicates that agricultural activities depend very much on rainfall. The climate of the area can be characterized as warm with constant temperatures during the year ranging from about 17°C to 28°C. Annual average precipitation is 1176



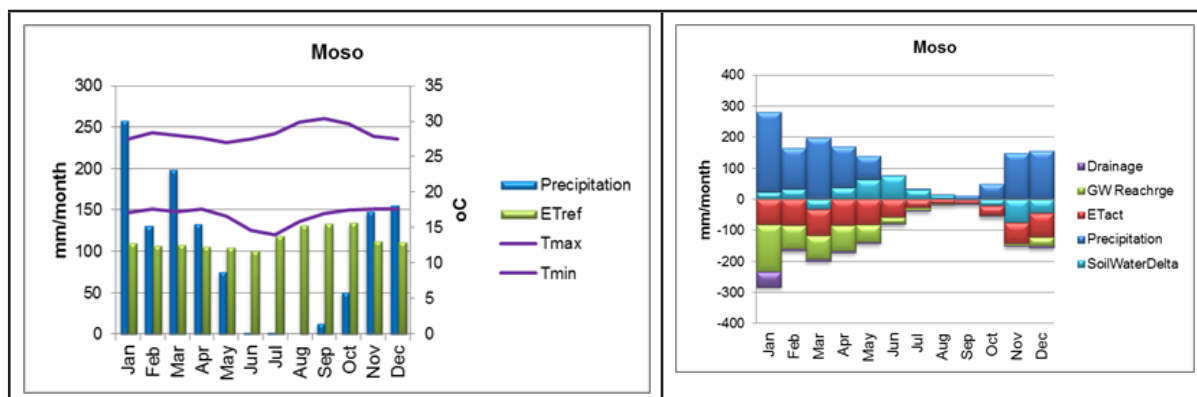
Burundi at a Glance
(World Development Indicators 2010)

Population	8.4 million
Population below the poverty line (1.25 USD)	81.3 %
GDP	1.6 billion USD
GDP Per Capita	190.5 USD
Agriculture as a % of GDP	49%

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Socio-economic Factors

Most of the area is in Kinyinya commune, which has an average population density of 153 inhabitants/km². The people within Karusi province are extremely young, with approximately 65% of the population being under the age of 25. The active labor force in Ndurumu area is therefore less than half of the total population. This focal area covers the Western shores of Rumpungwe River and one of the tributaries. Within both valleys there are no settlements. Some houses are built on the slopes going up from the valleys. These houses are rather scattered, but since their number is small, it should be possible to work around when designing an irrigation system. With the design of any irrigation scheme, it is advised to limit any population displacement; as the displacements of people will not have a positive impact on the people's involvement and contribution to the irrigation development. Infrastructure in the area is poorly developed. A tarmac road is crossing through Kinyinya, but the areas towards the river can only be reached by dirt roads, which are not always good accessible. Farmers have low knowledge in irrigation and farmer's cooperation's.



Average climate conditions and water balances for the area based on various global and local datasets, satellite information and advanced modeling approaches.

Irrigation and Crop Potential

Irrigation is not practiced much, and fertilizer is hardly used in this focal area. Although the large diversity of crops grown in the region, the average yields within the Moso focal area are just below Burundian average. Probably this can be blamed to the irregular yields within the valley, in which flooding is a major problem for stable high yields. However, compared to African standards, the yields in the Moso focal area for both rice and vegetables are above average. Yields within the focal area are expected to increase above the world's average when irrigated. Rice can at least double in yield towards 60% of the highest obtainable, and vegetables are expected to double and increase towards 25% of the highest obtainable in the world.

Benefit-Costs Analysis

A first-order benefit-cost analysis is undertaken for the area. Information for this is based on various sources such as FAO publications, IFPRI publications, local expertise and data. A full benefit-costs analysis has to be undertaken in a sub-sequent feasibility study for the area. The following table shows that based on the benefit-costs analysis for the area investments in irrigation are very positive.

Investment Costs	
Irrigation infrastructure (US\$/ha)	8,000
Social infrastructure (US\$/farmer)	500
Accessibility infrastructure (million US\$)	2.0
Operational Costs	
O&M irrigation (US\$/ha/yr)	60
Extension service (US\$/farmer)	10
O&M roads (US\$/yr)	40,000
Summary	
Initial investments (million US\$)	63.8
O&M costs (million US\$/yr)	0.577
Net benefits per year (million US\$/yr)	16.871
IRR (Internal Rate of Return)	34.2%

The initiative of this study was taken by Regional Agricultural Trade and Productivity Project (RATP) of the Nile Basin Initiative (NBI). Financial support was provided by the Canadian International Development Agency (CIDA). The study was undertaken by a large consortium headed by FutureWater and WaterWatch (Netherlands). More details is available from a series of reports and databases.

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Potential for Irrigation Development Ndurumu Area Burundi

The Nile Basin Initiative (NBI), under the Nile Equatorial Lakes Subsidiary Action Program (NELSAP) and the project Regional Agricultural Trade and Productivity Project (RATP) has undertaken a study entitled "Assessment of the Irrigation Potential in Burundi, Eastern DRC, Kenya, Rwanda, Southern Sudan, Tanzania and Uganda". The study was categorized as "preparation for a development program" and has a strategic perspective.

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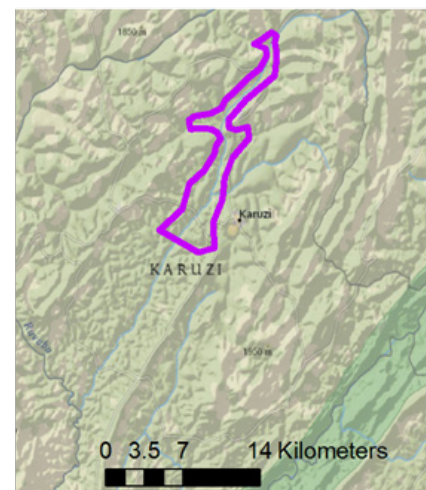


Overview

Ndurumu Focal area is located within Karuzi Province and covers the upstream part of Murarangaro River. This area covers the valley and the foothills on the side. Within the focal area the valley descends 90 meters, from 1570 m to 1480 m above sea level. From the valley bottom to the sides the terrain is going up rather steeply, especially in the northern and narrow part of the focal area. Elevation difference is limited mostly to 50 meters within the cross section of the valley. Slopes in the area are diverse. Most of the slopes are under the 5%. At some small ridges, however, slopes can increase to an occasional 20%.

Land and Water Resources

Soils in the area are silty clay loam, and formed by alluvial processes. The river flows through the area, and the variation in discharge over the year causes quite some erosion and flooding. The area is swampy and is subsequently poorly drained. The availability from organic carbon in the top soil increases from North to South. In the North carbon ranges between 1.2 and 2%, and towards the South more than 2% can be found. The available water storage capacity in the North is in the range of 125-150 mm/m and towards the South more than 150 mm/m. Furthermore, the soil is slightly acid. No measures have been taken to prevent or reduce erosion. Some measurements are in place e.g. around Karuzi. The Ndurumu marshland has a high land productivity with and yearly average NDVI of 0.62, which is roughly 10% above Burundian average. NDVI is highest on the slopes surrounding the swamp, with values that reach 0.67. In the Northern part of the area, and in the valley in the South, the land productivity is around 0.6. The climate of the area can be characterized as relatively warm with constant temperatures during the year ranging from 16oC to 27oC. Annual average precipitation is 1081 mm and reference evapotranspiration 1402 mm per year.

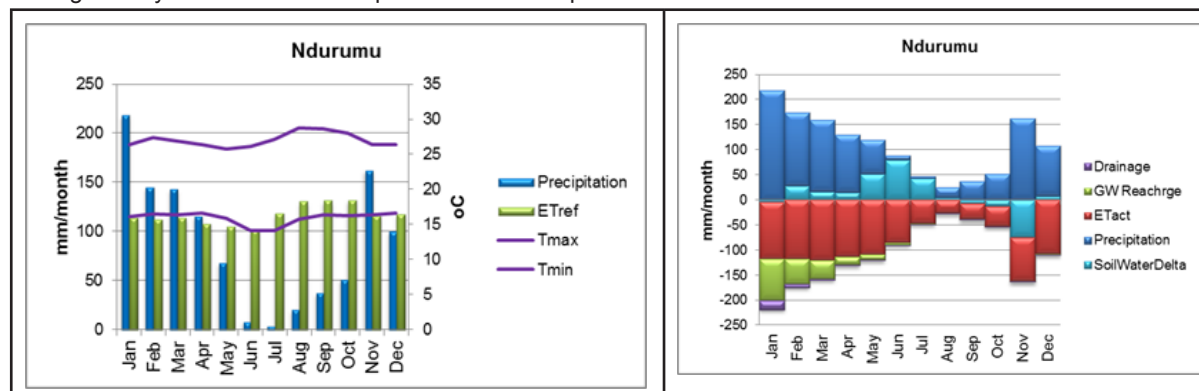


Burundi at a Glance
(World Development Indicators 2010)

Population	8.4 million
Population below the poverty line (1.25 USD)	81.3 %
GDP	1.6 billion USD
GDP Per Capita	190.5 USD
Agriculture as a % of GDP	49%

Socio-economic Factors

The population density in Ndurumu focal area is quite low with 237 people/km². The people within Karusi province are extremely young, with approximately 64.9% of the population being younger than 25. The active labor force in Ndurumu area is therefore less than half of the total population. Within the swamp nobody lives, while on the slopes surrounding the swamp, houses are scattered around. These houses do limit the irrigation possibilities on the slopes. However, the valley should be irrigated first, and with the remaining water a certain area on the slopes can be irrigated. Preferably, the fields for pressurized irrigation are linked together. As the displacements of people will not have a positive impact on the people's involvement and contribution of the irrigation development, it is advised to look into this issue in more detail. Infrastructure is well to quite well developed, and the tarmac road from Gitega to Muyinga is passing by the area. This creates market opportunities and allows for an easy construction of an irrigation system. There are no protected areas reported within the focal area.



Average climate conditions and water balances for the area based on various global and local datasets, satellite information and advanced modeling approaches.

Irrigation and Crop Potential

Yields in Burundi are among the highest in the NELSAP countries. Irrigation is not practiced much, and fertilizer is hardly used. Within the Ndurumu focal area the yields are above Burundian average yields. Within the valley the stream is not much regulated, which does have a negative impact on yields. Professionalizing the current rice irrigation can nearly double the yields within one growing cycle. Besides this, yields will be much more stable over the years and rice can be grown twice a year, depending on the water availability. From cabbage and eggplant there are currently no statistics available in FAOstat. However, it is expected that, based on the field visits, potential yields for cabbage will be 30-40% of the highest obtainable, and for eggplant around 10% of the highest obtainable yield.

Benefit-Costs Analysis

A first-order benefit-cost analysis is undertaken for the area. Information for this is based on various sources such as FAO publications, IFPRI publications, local expertise and data. A full benefit-costs analysis has to be undertaken in a sub-sequent feasibility study for the area. The following table shows that based on the benefit-costs analysis for the area investments in irrigation are very positive.

Investment Costs	
Irrigation infrastructure (US\$/ha)	5,000
Social infrastructure (US\$/farmer)	500
Accessibility infrastructure (million US\$)	0.5
Operational Costs	
O&M irrigation (US\$/ha/yr)	60
Extension service (US\$/farmer)	10
O&M roads (US\$/yr)	10,000
Summary	
Initial investments (million US\$)	24.5
O&M costs (million US\$/yr)	0.330
Net benefits per year (million US\$/yr)	3.495
IRR (Internal Rate of Return)	14.2%

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Potential for Irrigation Development Nyamuswaga Area Burundi

The Nile Basin Initiative (NBI), under the Nile Equatorial Lakes Subsidiary Action Program (NELSAP) and the project Regional Agricultural Trade and Productivity Project (RATP) has undertaken a study entitled "Assessment of the Irrigation Potential in Burundi, Eastern DRC, Kenya, Rwanda, Southern Sudan, Tanzania and Uganda". The study was categorized as "preparation for a development program" and has a strategic perspective.

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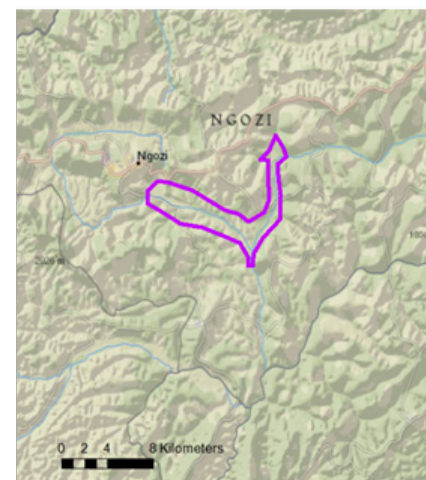


Overview

Nyamuswaga focal area covers the upstream part of the Nyamuswaga catchment. The focal area is wrapped in the valleys, which are quite flat. The elevation difference from top to bottom of the valley is approximately 30 m, with elevations of 1560 m in the western end of the focal area, and 1530 in the south. Elevations increase more rapidly from the valley into the hills and foothills. Then the highest point approaches 1620 m. These exceptional points, however, will not be considered for irrigation within this pre-feasibility study. Slopes in the valley are limited to 1-2%. Slopes at the side of the valley, going up to the hills are steep on most places, reaching over the 15%.

Land and Water Resources

Soils are silty to clayey, heavy and fertile. On the slopes, soils are shallow and prone to erosion. Currently, there are no measures to prevent the soil from eroding. In the valley the soil is rather flat, deep, and poorly draining. The soil is non-saline and slightly acid. The available water holding capacity in the North is more than 150 mm/m, while the South has values of 125-150 mm/m. On the slopes with the more shallow soils, the water holding capacity is even more limited. The organic carbon in the top-soil is between 1.2 and 2% in the North, and over 2% in the South. Land productivity in Nyamuswaga is highest of all the focal areas. On average the NDVI is 0.64, compared to a Burundian average of 0.56. In the North and in the valley in the western branch, land productivity is a bit lower with averages around 0.6. On the slopes the NDVI is higher with averages around 0.67. The variation in land cover is most stable in the southern point, and the slopes in the west. The climate of the area can be characterized as relatively warm, with constant temperatures during the year ranging between 15°C and 26°C. Average annual precipitation is 1195 mm and



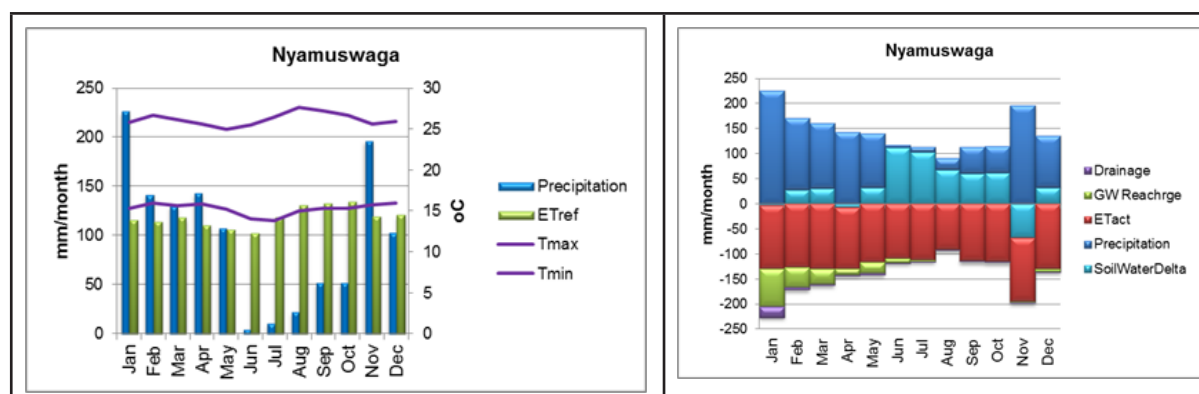
Burundi at a Glance
(World Development Indicators 2010)

Population	8.4 million
Population below the poverty line (1.25 USD)	81.3 %
GDP	1.6 billion USD
GDP Per Capita	190.5 USD
Agriculture as a % of GDP	49%

reference evapo-transpiration 1426 mm per year.

Socio-economic Factors

Within the Nyamuswaga focal area, the population density is above the Burundian average with 450 people/km². The people within Ngozi province are extremely young, with 65% of the population being under the age of 25. The active labor force in Nyamuswaga area is therefore less than half of the total population. Due to high flood risks in the valley, nobody lives there. Just on the slopes going up, there are some houses built along the roads. These roads and houses are mostly built along the contour lines, and can be avoided when designing a pressurized irrigation system. People in the area have some experience with irrigation, as some partial irrigation schemes are already present. This increases the coop capacity of the people, as they are aware of the benefits which irrigation will bring. With the design of any irrigation scheme it is advised to limit any population displacement. The exact numbers of effected houses can only be known after designing the scheme, which is beyond the scope of this pre-feasibility study. Infrastructure in the area is not developed well. Dirt roads are present, but these are often in poor condition. Tarmac roads are not far, and Ngozi is connected to the highway towards Rwanda. Within this focal area there are no protected areas.



Average climate conditions and water balances for the area based on various global and local datasets, satellite information and advanced modeling approaches.

Irrigation and Crop Potential

Yields in Nyamuswaga are the highest of all focal areas, and reach 115% of the average yields in Burundi. Rice is the dominant crop, and will remain dominant. Within the valley, rice is currently grown under partial irrigation. However, improving the irrigation system will enhance productivity and may double yields. Depending on the water availability rice can be grown in two growing cycles per year, which could double the yields. Potatoes have a rather low yield within Burundi, compared to Africa and the world. The potential to increase yields is high, and yields can easily increase towards 15-20% of the highest obtainable yields. Unfortunately, no data is available in FAOstat for cabbage and tomatoes. However it is expected that both crops do have a large potential.

Benefit-Costs Analysis

A first-order benefit-cost analysis is undertaken for the area. Information for this is based on various sources such as FAO publications, IFPRI publications, local expertise and data. A full benefit-costs analysis has to be undertaken in a sub-sequent feasibility study for the area. The following table shows that based on the benefit-costs analysis for the area investments in irrigation are very positive.

Investment Costs	
Irrigation infrastructure (US\$/ha)	5,000
Social infrastructure (US\$/farmer)	500
Accessibility infrastructure (million US\$)	1.0
Operational Costs	
O&M irrigation (US\$/ha/yr)	60
Extension service (US\$/farmer)	10
O&M roads (US\$/yr)	20,000
Summary	
Initial investments (million US\$)	19.0
O&M costs (million US\$/yr)	0.260
Net benefits per year (million US\$/yr)	3.837
IRR (Internal Rate of Return)	23.0%

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Potential for Irrigation Development Nyanza lac Area Burundi

The Nile Basin Initiative (NBI), under the Nile Equatorial Lakes Subsidiary Action Program (NELSAP) and the project Regional Agricultural Trade and Productivity Project (RATP) has undertaken a study entitled “Assessment of the Irrigation Potential in Burundi, Eastern DRC, Kenya, Rwanda, Southern Sudan, Tanzania and Uganda”. The study was categorized as “preparation for a development program” and has a strategic perspective.

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Overview

Nyanza lac focal area is situated in the southern point of Burundi within the Makamba province. The southern point of the focal area is tipping at the border with Tanzania. The area covers the plains going slightly up from Lake Tanganyika towards the mountains in the East. The elevation varies from 830 m above sea level at the eastern and northern part, towards 767 m at the lake. Overall the area is ascending gradually from West to East, with the exception of some prolonged foothills, reaching completely towards the lake. Slopes vary between 0 and 10%, but on average slopes are under three percent.

Land and Water Resources

Soils in Nyanza lac are mainly formed under Fluvial and Eluvial processes. Soils are sandy loam on the hills and foothills, and loamy clay in the lower areas. Soils in the lower areas have been used for agriculture for a long time, and are improved by repeated plowing and the humus runoff from the slopes of Mumurwa in the East. Therefore the topsoil has, with over 2%, a relative high percentage of organic carbon. Drainage is slightly poor in the lower areas, but the higher areas in the foothills are better drained. The topsoil is with a pH between 4-5.5 acid to slightly acid. The water holding capacity is large with over 150 mm/m. Erosion takes place as there are hardly any anti-erosion measures. The land productivity in Nyanza lac is with an NDVI of 0.61 about 10% above the Burundian average (0.56). Average land productivity is highest in the upstream part of the focal area, and along the streams. The climate of the area can be characterized as relatively warm with constant temperatures during the year ranging from about 17oC to 27oC, with lower minimum temperatures during June and July. Annual average precipitation is 1055 mm and reference evapotranspiration



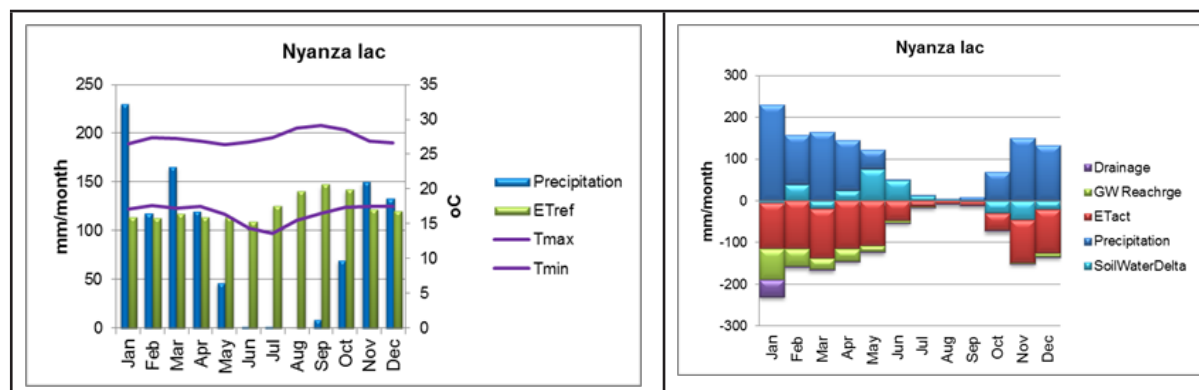
Burundi at a Glance (World Development Indicators 2010)

Population	8.4 million
Population below the poverty line (1.25 USD)	81.3 %
GDP	1.6 billion USD
GDP Per Capita	190.5 USD
Agriculture as a % of GDP	49%

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Socio-economic Factors

The population density within the Nyanza lac focal area is below the Burundian average, with only 266 people/km². Most people within Makamba province are extremely young, with approximately 67% of the population being under the age of 25. The active labor force in Nyanza commune is therefore less than half of the total population. People in the area are mainly living along the roads and in the villages. When developing an irrigation scheme it is advised to design the scheme in such a way that population displacement is not or hardly needed. However, the houses in some areas are scattered around, which will either restrict the irrigation possibilities, or minimal displacements are needed. People in the area have some experience with irrigation, as some irrigation schemes are already present. This increases the coop capacity of the people, as they are aware of the benefits that irrigation delivers. With the design of any irrigation scheme, it is advised to limit any population displacement. The infrastructure in the area is quite good, but completely focused on Burundi. Tanzania is just a few kilometers away, but the road to the border is not continued on Tanzania's side. Besides agriculture, fishing is one of the other main activities.



Average climate conditions and water balances for the area based on various global and local datasets, satellite information and advanced modeling approaches.

Irrigation and Crop Potential

Yields in Nyanza lac are just above Burundi's average. However, the nearly unlimited water source of Lake Tanganyika creates a large potential for irrigated agriculture. The future potential crops include cassava, eggplant and oil palms. Yields of the most dominant crop, oil palm, are around the world's average, and can still increase slightly, but are expected to increase towards 65% of the world's highest obtainable yield. The production of cassava has a higher potential and it is expected that yields can increase towards the world's average, which means that yields can nearly triple. For eggplant no data is available within FAOstat, however, the area is assessed to be suitable for eggplant and it is expected that yields will reach just around the world's average when irrigated.

Benefit-Costs Analysis

A first-order benefit-cost analysis is undertaken for the area. Information for this is based on various sources such as FAO publications, IFPRI publications, local expertise and data. A full benefit-costs analysis has to be undertaken in a sub-sequent feasibility study for the area. The following table shows that based on the benefit-costs analysis for the area investments in irrigation are very positive.

Investment Costs	
Irrigation infrastructure (US\$/ha)	6,000
Social infrastructure (US\$/farmer)	500
Accessibility infrastructure (million US\$)	1.0
Operational Costs	
O&M irrigation (US\$/ha/yr)	60
Extension service (US\$/farmer)	10
O&M roads (US\$/yr)	20,000
Summary	
Initial investments (million US\$)	40.8
O&M costs (million US\$/yr)	0.455
Net benefits per year (million US\$/yr)	7.097
IRR (Internal Rate of Return)	19.2%

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Potential for Irrigation Development Ruvubu River Area Burundi

The Nile Basin Initiative (NBI), under the Nile Equatorial Lakes Subsidiary Action Program (NELSAP) and the project Regional Agricultural Trade and Productivity Project (RATP) has undertaken a study entitled “Assessment of the Irrigation Potential in Burundi, Eastern DRC, Kenya, Rwanda, Southern Sudan, Tanzania and Uganda”. The study was categorized as “preparation for a development program” and has a strategic perspective.

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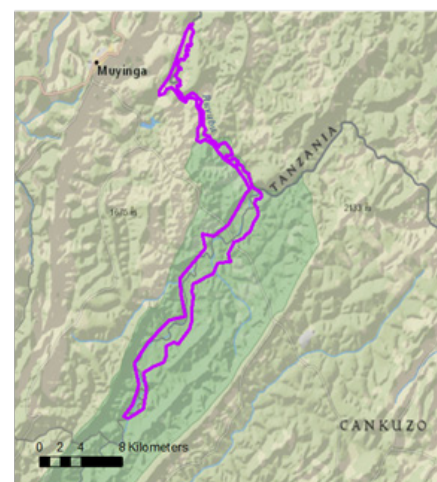


Overview

This long stretched focal area is situated at the Eastern side of Burundi, and covers the border region with Tanzania in the North, all the way along Ruvubu River. The Southern part of the focal area is located at the border between Cankuzo province and Muyinga province. The area covers the Ruvubu Valley and is therefore relatively flat. Elevations vary between 1360 m in the South to 1345 m in the North. On both sides of the valley the land is ascending towards elevations over 1500 m. Slopes within the valley are low, with slopes limited to 4%.

Land and Water Resources

This focal area is completely wrapped around the Ruvubu River, and soils are therefore formed through alluvial processes. In the river valley the soil is loamy, while on the foothills the soils are more silty clay. Drainage is somewhat poor on the slopes and moderate in the riverbed. The soil is non-saline and slightly acid. Organic carbon in the top soil can reach over 2%. The available water storage capacity is very high with 150 mm/m. Moderate erosion is reported, however, due to the current land use and slope not much erosion is expected other than alluvial. The area has an above Burundian average NDVI of 0.62. The land directly bordering the river has lower land productivity compared to the land further away from the river. However, the land located on a short distance from the river has high NDVI values (0.75). The NDVI within the Northern tip of the area decreases to 0.5. The coefficient-of-variation is low nearby the river, and slightly higher towards the hills around. The climate of the area can be characterized as warm with constant temperatures during the year ranging from 17oC to 28oC. Average annual precipitation is 1110 mm and reference evapotranspiration is 1381 mm per year.

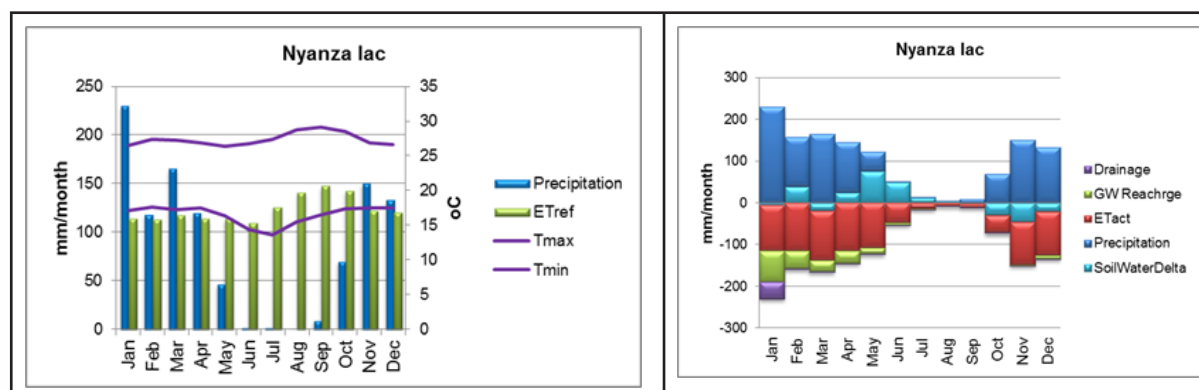


Burundi at a Glance (World Development Indicators 2010)

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Agriculture as a % of GDP	49%

Socio-economic Factors

The valley is not populated due to high flood risks. The part of the focal area that is situated within Ruvubu National park is not inhabited at all. The Northern tip of the focal area has some inhabitants, but is still very sparsely populated with 100 people/km². The people within the province of Muyinga are extremely young, with approximately 67.3% of the population being under the age of 25. The active labor force in Muyinga province is therefore less than half of the total population. Just on the slopes there are a few houses build along the roads. These houses can be avoided when designing a pressurized irrigation system. With the design of any irrigation scheme, it is advised to limit any population displacement. If it is decided to irrigate within the national park, which is not advised, farmers should be attracted to populate the area. Infrastructure in the area is poor as the nearest tarmac road is going through Muyinga town, and further away the area is only connected to dirt roads. Farmers have average knowledge in irrigation and farmer's cooperation's.



Average climate conditions and water balances for the area based on various global and local datasets, satellite information and advanced modeling approaches.

Irrigation and Crop Potential

The current yields in the area are high and well above Burundian average. Compared to the maximum obtainable yield, quite some improvements can be done to reach a realistic maximum yield. The production of rice is about 35% of the maximum yield in the world, and 75% of the world's average. Depending on the chosen irrigation system and the level of flood control, the rice yield can double towards 70% of the world's highest yield. This involves two growing cycles per year, and stable high yields over the years. Potatoes currently reach 3.2% of the world's highest, and approximately 11% of the world's average yield. It is expected that the yield of potatoes can increase towards the world's average, which means that yields can increase towards 20-25% of the highest obtainable yield. No data was available for cabbage and leek.

Benefit-Costs Analysis

A first-order benefit-cost analysis is undertaken for the area. Information for this is based on various sources such as FAO publications, IFPRI publications, local expertise and data. A full benefit-costs analysis has to be undertaken in a sub-sequent feasibility study for the area. The following table shows that based on the benefit-costs analysis for the area investments in irrigation are very positive.

Investment Costs	
Irrigation infrastructure (US\$/ha)	12,000
Social infrastructure (US\$/farmer)	500
Accessibility infrastructure (million US\$)	3.0
Operational Costs	
O&M irrigation (US\$/ha/yr)	60
Extension service (US\$/farmer)	10
O&M roads (US\$/yr)	60,000
Summary	
Initial investments (million US\$)	15.8
O&M costs (million US\$/yr)	0.137
Net benefits per year (million US\$/yr)	0.745
IRR (Internal Rate of Return)	-0.3%



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