AN ASSESSMENT OF THE IMPACTS OF THE SELI HYDROPOWER PROJECT ON THE LIVELIHOODS OF THE COMMUNITIES DOWNSTREAM OF BUMBUNA, SIERRA LEONE.

Prepared For

JOULE AFRICA

Report Prepared by

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AN ASSESSMENT OF THE IMPACTS OF THE SELI HYDROPOWER PROJECT ON THE LIVELIHOODS OF THE COMMUNITIES DOWNSTREAM OF BUMBUNA, SIERRA LEONE.

1 INTRODUCTION

1.1 Background

The Seli Hydropower Project ("Seli HPP" and/ or "the Project") is located on the Rokel-Seli River, north-east Sierra Leone. The project consists of an extension to the current Bumbuna Hydropower Project and the construction of a new hydropower Dam at Yiben, located approximately 30 km upstream of the Bumbuna Dam, illustrated in Figure 1-1.

In addition to preparing the resettlement action plan for the Seli HPP, SRK Consulting (UK) Limited ("SRK") has been contracted by Joule Africa ("Joule"), hereinafter also referred to as the "Company" or the "Client", to prepare an assessment of the downstream livelihood impacts resulting from the Seli HPP.

The Rokel-Seli catchment extends through the Northern Province of Sierra Leone in a broadly north-east/south-west orientation. It has a drainage area of 8,236 km^2 and is of critical importance to the economy of Sierra Leone.

The river supplies water to the existing Bumbuna Dam (completed in 2009), the Addax Bioenergy project, a number of operational/planned large scale mining projects as well as for agriculture, fisheries, artisanal and small-scale mining (ASM). The combination of existing flow regulation at Bumbuna and downstream industrial abstraction, compounded by seasonal variations, impact on the availability of water for livelihood use.

Once operational the Seli HPP will revise the existing regulated flow of the Rokel River and further reduce the natural seasonal variations observed in the river volume and flow. Such flow regulation may impact on livelihoods dependent on the river and associated riparian habitat extending along the Rokel River.

This study focuses on the Rokel catchment below Bumbuna covering an area of 4,764 km^2. A cumulative effect assessment (CEA) has been carried out to determine the livelihood impacts resulting from existing large scale developments in the three districts of Tonkolili, Bombali and Port Loko within which the Rokel catchment below Bumbuna is located and how these impacts will be modified by the Seli HPP.

The study draws on available literature and reports, a remote sensing study (using a combination of freely available global datasets and Landsat data covering the catchment area), a ground truthing exercise to support the remote sensing and a livelihoods survey of a sample of ten potentially affected communities identified through the remote sensing.

The findings of the study are used to determine the Valued Environmental Components (VECs) already impacted upon by the existing developments and how these will be affected by the Seli HPP.

A high level social management plan has been prepared detailing potential mitigating actions and opportunities to improve the livelihoods of the communities along the Rokel River potentially affected by the Seli HPP.

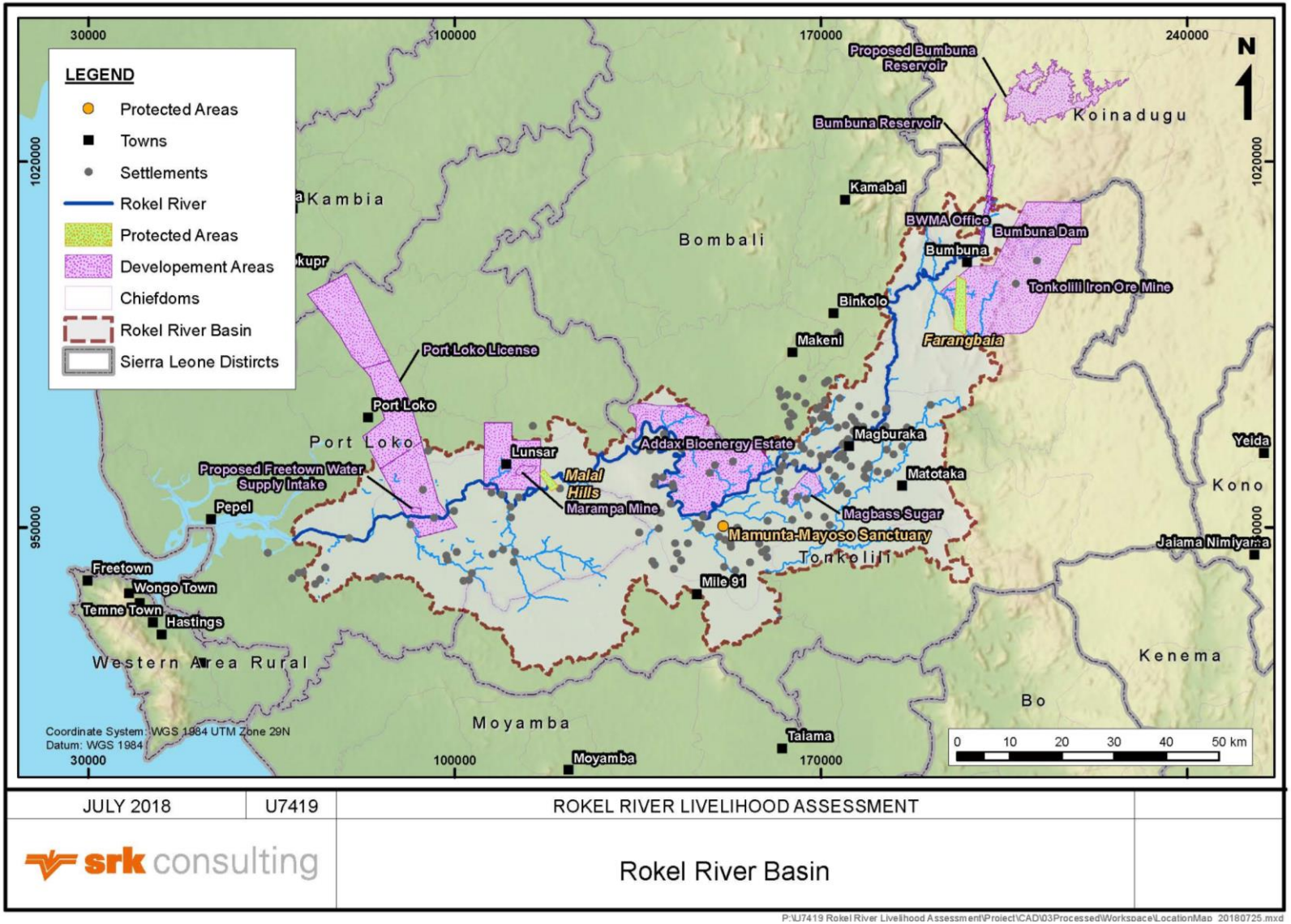

Figure 1-1: The Rokel River basin

2 STUDY METHODOLOGY

2.1 Study Area

The geographical extent of the study includes the length of the Rokel River basin (i.e. catchment) between Bumbuna dam and the Sierra Leone Estuary.

2.2 Existing Activities and Pressures

Existing activities and pressures along the Rokel River were determined through a desktop study of available literature, a remote sensing study of the river basin from Bumbuna through to the mouth of the estuary, and a livelihoods survey.

2.2.1 Desktop study

A desktop study of the existing biophysical and social setting was conducted along with a review of existing and planned large-scale developments along the Rokel River, using their environmental and social impact assessments and stakeholder analysis, where available. In addition to the Seli HPP and Bumbuna extension Project, a number of other large developments were identified within the districts of Tonkolili, Bombali and Port Loko that are affected by and/or depend on the Rokel River. These were the Bumbuna Hydropower Project, Tonkolili Iron Ore mine, the Addax Bioenergy operation, the Magbass Sugar Plantation, the Cape Lambert Marampa Iron Ore project, the London Mining iron ore mine (currently not operational) and the planned Port Loko Bauxite mine.

The desktop study provided information to support a stakeholder analysis. This in turn was used to determine which stakeholders are, or will be, directly or indirectly affected by the Seli HPP.

2.2.2 Natural resource use and livelihoods assessment

Remote sensing and ground truthing

Remote sensing and ground truthing of existing natural resource use along the basin was carried out using multispectral and visual data along the entire Rokel River basin to classify existing natural resource use by developments and communities along the Rokel River. This information was “ground-truthed” during a site visit. Ten sites along the Rokel River were identified for ground truthing.

Livelihoods Survey

A livelihoods survey was carried out with groups of men and women separately as well as one mixed group from a purposive sample of ten communities along the Rokel River.

The survey gathered information on natural resource use, in terms of access, control and ownership of natural resources as well as seasonal variations in livelihood activities. This provided an understanding of how local communities use the river and the surrounding land for their livelihoods. The sample of communities and ground truthing sites are shown in Figure 2-1.

2.3 Valued Environmental and Social Components (VECs)

The IFC (2013) defines impact receptors as Valued Environmental and Social Components (VECs). VECs may be directly or indirectly affected by a specific development and the cumulative impacts of a number of developments.

They are considered to be important in assessing risks as the ultimate recipient of impacts and include biophysical and social components, bridged by ecosystem services.

Using data analysed from the desktop study, remote sensing and livelihoods survey, the VECs were identified. These include both biophysical and social components affected by the existing developments.

2.4 The Cumulative Effects Assessment

Cumulative effects are those that result from the successive, incremental, and/or combined effects of developments when added to other existing, planned and future developments. A cumulative effects assessment requires identification of VECs and how they will change or be affected.

The cumulative effects of the existing developments on the VECs were scored according to their significance rating in their respective ESIAs, before Seli HPP and on a post-development scenario, to determine how the Project would affect livelihoods of the downstream communities. This information was then used to prepare a high level social management plan.

2.5 Study Limitations and Assumptions

The key limitations and assumption related to this study relate to availability of data:

- The Tonkolili mining operation was identified as an important development to consider in the study. An ESIA for the existing operation was not available so relevant information regarding these operations was sourced from the Strategic Environmental Assessment of the artisanal mining sector in Sierra Leone (Environmental Protection Agency and National Minerals Agency, 2016) and the Bumbuna II ESIA (ERM, 2017) and an ESIA for a planned bauxite mine in Tonkolili that was not developed.
- The former London Mining-owned Marampa mine (now owned by SL Mining Ltd) was also identified as an important development. The ESIA for this project was also not available, however SRK was able to access the ESIA for the adjacent Cape Lambert Marampa Iron Ore Project. The impacts from this ESIA have been assumed as representative for consideration in the CEA.
- The full ESIA reports for the Addax Bioenergy operation were not available. Instead, the Addax Environmental, Social and Health Impact Assessment executive summary, and the Addax Environmental and Social Management Plan executive summary were used.
- The livelihoods survey was carried out in ten communities, determined through the remote sensing as representative. Surveys were carried out with one mixed gender group and separate groups of men and women in the ten communities to represent an overview of the diversity of existing livelihoods and their dependencies on the river basin.
- Limited water release flow data was available from Bumbuna I Dam. Likewise, no abstraction data was available for Addax or other abstractors below the dam and upstream of the Addax uptake, including Magbass Sugar and Tonkolili iron ore mine.

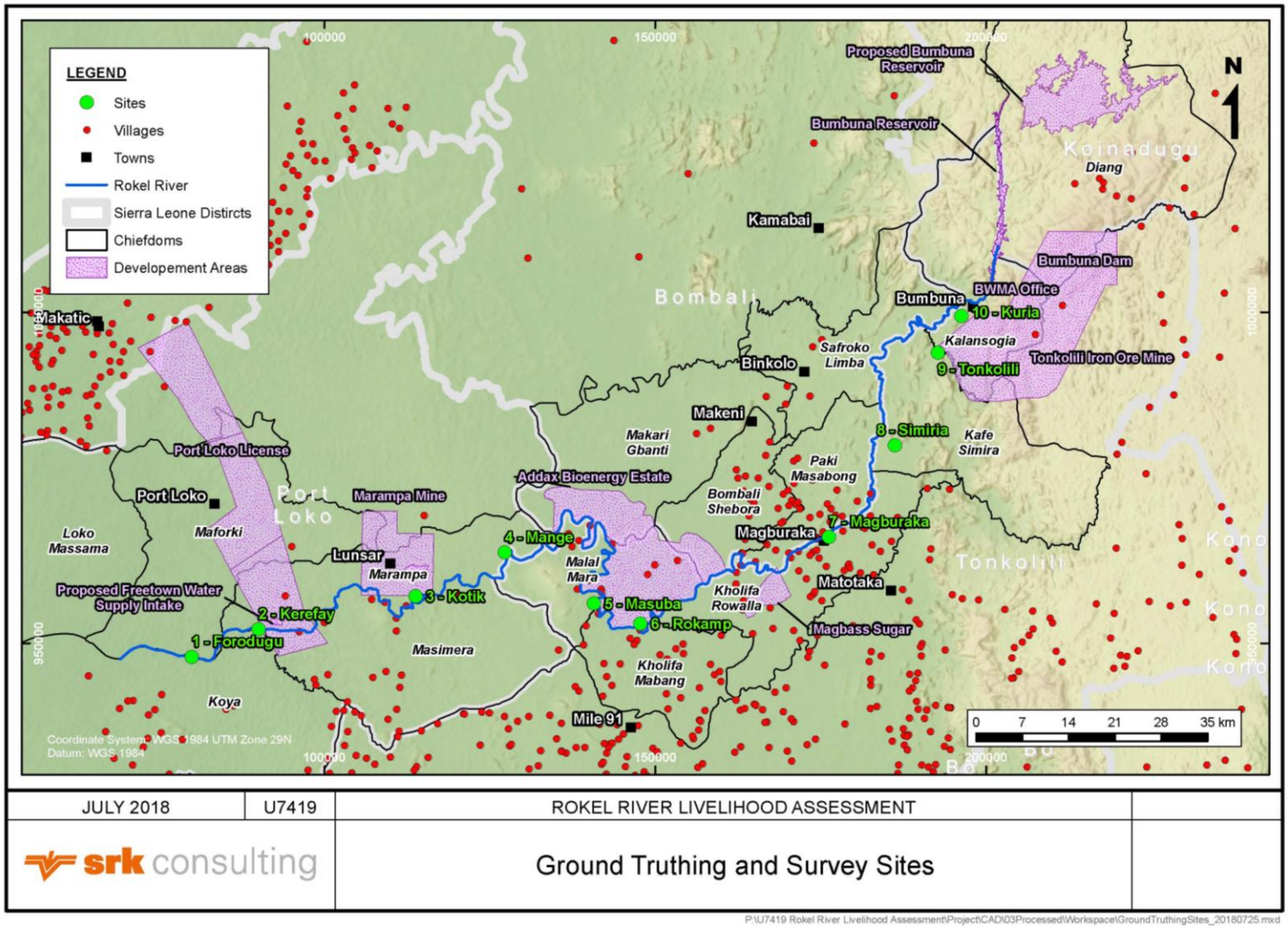

Figure 2-1: Study area and ground truthing sites.

3 DESK TOP STUDY FINDINGS

3.1 Project Setting

Available documentation, reports and data were sourced and reviewed to describe the biophysical(environmental) and social project setting.

3.1.1 Biophysical Setting

Geology and hydrogeology

The Rokel River is one of the major rivers in Sierra Leone and drains the north-east highlands, flowing in a south-westerly direction to discharge into the Atlantic Ocean. The geology of the Rokel River basin comprises predominantly granite-greenstone terrain of Archean age with younger geological formations towards the coast. Hydrogeologically the Archean terrain rocks have negligible primary porosity and groundwater is restricted to the upper weathered/transitional horizons and fractures, including faults, joints and fissures. Groundwater is therefore discontinuous in its occurrence.

Climate and hydrology

The climate is tropical, with an average temperature of 27°C. There is a rainy season from May to October and a dry season from November to April with rainfall ranging from 7 mm in the driest month (February) to 944 mm in the wettest month (August) (weather-base.com, 2018). Average rainfall at Makeni, Bombali Region, is 2,914 mm per annum (long term mean from 1921 to 2013; Ministry of Water Resources, 2015).

The seasonal variations in rainfall result in distinct changes in the Rokel River's volume and flow. In the wet season the river is swollen with a high flow rate. In the dry season, flow is decreased, and the river is much lower, exposing the river banks.

The mean annual river flow at Bumbuna, Tonkolili District, prior to the commissioning of Bumbuna I Dam was 112.9 m^3/s (based on data between 1971 - 1978).

The flow is highly seasonal with mean monthly discharge in the month of September of 330.5 m^3/s and in March only 6.1 m^3/s (Ministry of Water Resources,2015) The average annual flow rate since the construction of the dam is 66m^3/s.

The water quality of the Rokel River is good. The water is well oxygenated and within WHO standards. It has a well-balanced pH and only modest levels of available nutrients such as nitrogen and phosphorus.

The majority of domestic water needs are supplied by untreated surface water or groundwater, mostly from the Rokel River and its tributaries, wells and/or boreholes. The towns tend to have public taps/ stand pipes and some houses have piped water. Sources of drinking water in the districts along the Rokel River are given in Figure 3-1.

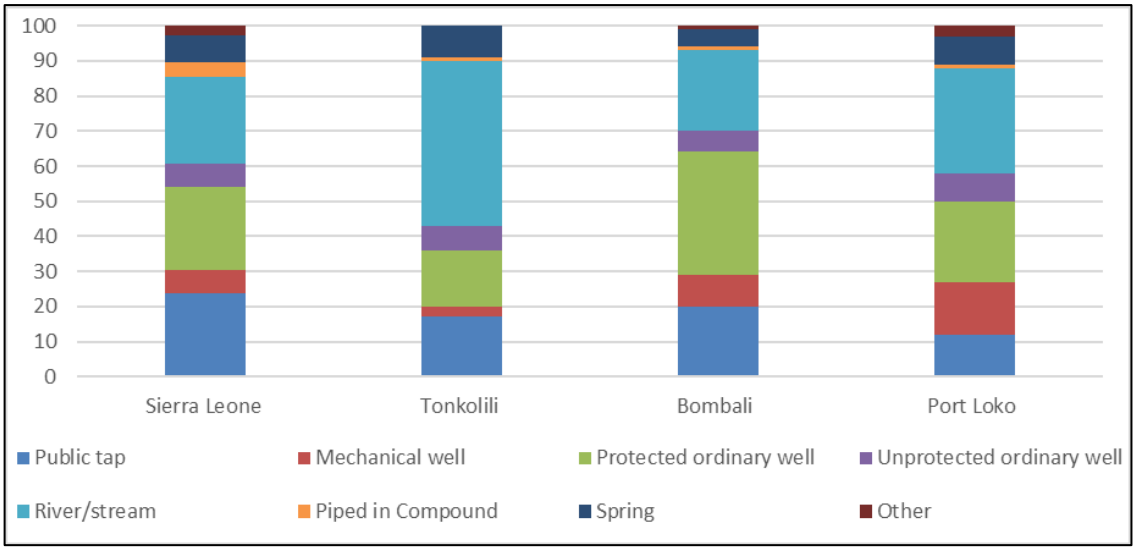

Figure 3-1: Primary drinking water sources[1]

Topography and soils

Sierra Leone is divided into four main ecoregions which lie in parallel bands. The Rokel River is sourced in the highlands and empties into the Sierra Leone estuary, thus flowing through the different ecoregions. From north-east to south-west these ecoregions comprise:

- In the north-east are the Koinadugu and Kono Plateaus (KKP). A number of isolated mountains exist, including Mount Bintumani, which reaches 1,948 m. The KKP is characterised by a mosaic of woodland and savannas, interspersed with cropland.
- To the south-west and lying parallel to the KPP are the Interior Plains (IP). This area makes up the majority of Sierra Leone and is characterised by lowland plains, woodland, savannahs and farmland.
- Several high mountain zones exist within the KKP and IP creating the Montane Forest Zones (MFZ), dominated by tropical rain forests.
- Finally, adjacent to the shoreline are the Coastal Plains (CP), interspersed with the Mangrove Forest (MF) zones. The area is generally low-lying, excluding the Western African Peninsular, where the capital, Freetown is located, which rises from 200 m to 1,000 m above the surrounding area.

Soils are characterised by extensively weathered topsoil with a distinctive duricrust development. The lowland area towards the coast is dominated by strongly weathered ferrosols with low nutrient levels. Parts of this area experience seasonal flooding from the Rokel River which bring some nutrients to the land. The upland area in the east has a partial cover of soil which can harden irreversibly when exposed to sunlight and air. Elsewhere there are shallow soils over hard rock with bedrock close to the surface.

[1] https://www.statistics.sl/images/StatisticsSL/Documents/final-results_-2015_population_and_housing_census.pdf

Biodiversity and conservation

- Within the Rokel River catchment between Bumbuna and the Sierra Leone Estuary there are a number of protected areas. These include National Parks, Forest Reserves and a Ramsar Site. Those of specific interest, within the study area are briefly summarised below and are illustrated in Figure 1-1:
- Farangbaia Forest Reserve – This is a hunting prohibited forest reserve located in the Tonkolili district. There appears to be little formal protection of the rainforest ecosystem within the reserve as much of the area has become farmland and bush forest, with a number of active sawmills.
- Mamunta-Mayoso sanctuary – A game reserve located in Tonkolili District is one of the few areas in the country that protects the threatened dwarf crocodile, as well as being home to over 250 bird species. Eight species of primates are also known to occur including the endangered western chimpanzee.
- Malal Hills – Another hunting-prohibited forest reserve of classified forest. Located in the Port Loko district covering an area of 3.4 km2. Limited information is available on this reserve, with the IUCN management category, the status year and management authority unreported.
- Sierra Leone River Estuary – The estuary, located in the Western Area and Port Loko districts is Sierra Leone's only Ramsar site. Established in 1999 the site covers an area of 295,000 ha. Included in the site is 19% of Sierra Leone's total mangroves. It is also a habitat for more than 1% of the global population of at least 8 bird species.

3.1.2 Social Setting

The Rokel River flows through three districts between Bumbuna and the Atlantic Ocean; Tonkolili, Bombali and Port Loko, as illustrated in Figure 1-1. Sierra Leone is a small country with a population of around 7 million, with 59% living in rural areas and 41% in urban areas. The population of the three districts within which the Rokel River catchment is located is predominantly rural and amounts to just over 1.7 million people, as summarised in Table 3-1 The population is young, with more than 50% under 30 years of age, as illustrated in Figure 3-2.

These districts have four main groups: Temne, Mende, Limba, Kono and Krio and the dominant ethnicity is Temne. English is the official language however there are at least 23 other living languages in the country. Krio is spoken as a second language by 97% of Sierra Leoneans and is the mother tongue of 10.5% of the population, who mostly reside in Freetown.

Religion is an important part of Sierra Leonean culture and numerous churches and mosques can be found in most communities. Shrines and grave sites constitute important cultural places, alongside sacred areas associated with traditional beliefs.

Table 3-1: Population in Sierra Leone and the three Districts along the Rokel River

Sierra Leone	Tonkolili District	Bombali District	Port Loko District
7,092,113	531, 435	606,544	615,376

Source: Statistics Sierra Leone, 2015

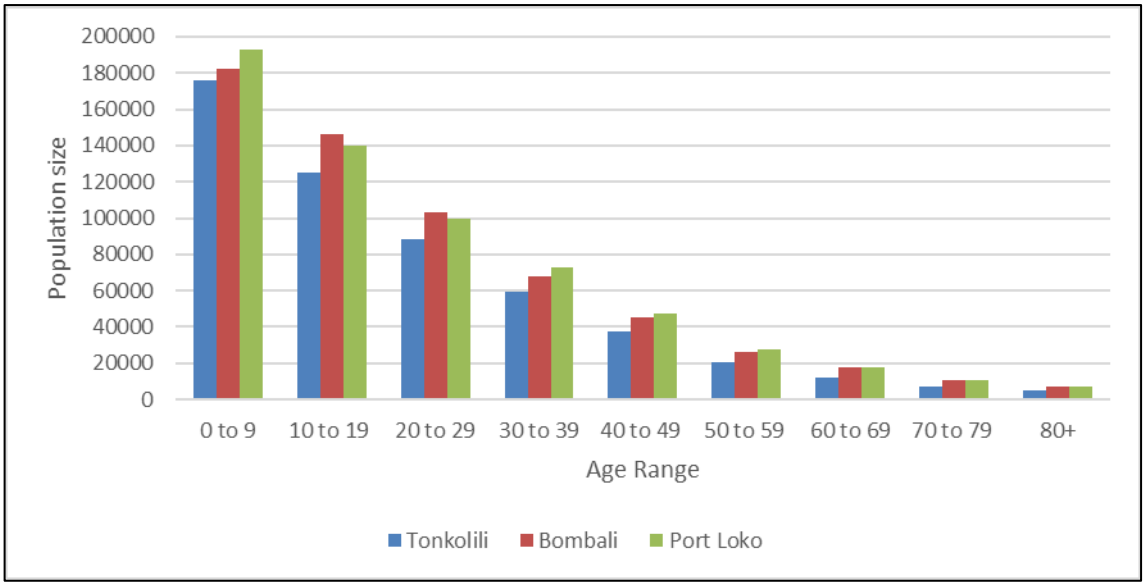

Figure 3-2: **Age structure within the Districts along the Rokel River[2]**

District overview

Tonkolili district is strategically located in the centre of Sierra Leone and incorporates the Rokel River at Bumbuna. Magburaka is the capital of this district and Mile 91 is the commercial centre. The population of the district is predominantly Muslim, with a Christian minority. The district has both highlands and lowlands. The highlands rise up to 700 feet; the lowlands, once covered in forests, have been mostly cleared for agricultural production, both subsistence and commercial vegetable and rice production. There are two large scale agribusinesses: the Magbass sugar complex and the Gari cassava plant at Robinke. Roads in the district are poor and likewise access to markets.

The Rokel River demarks the boundary between Tonkolili and Bombali districts. Bombali is the second largest district in Sierra Leone, with Makeni as its capital and largest settlement. The district is ethnically diverse, with two dominant groups the Temne and Limba. During the war (1991-2002) the district was a rebel stronghold and experienced considerable displacement, destruction and trauma through the conflict. Much of the district is still covered in Savannah woodland with a lack of basic services, water, power and a poor road network within the district restricting economic development outside of Makeni, which is linked to Freetown by the Makeni Lunsar highway, which passes through Port Loko District.

Port Loko District borders Bombali to the east and Tonkolili to the north and is the fourth most populous district in the country. Lunsar is the district's capital and largest town.There are five other major towns including Port Loko and Lungi, which is where the country's only airport is located. The population is predominantly Muslim and of Temne ethnicity. This district is well connected with good road network between the major towns, including the Lunsar Makeni highway mentioned above.

[2] https://www.statistics.sl/images/StatisticsSL/Documents/final-results_-2015_population_and_housing_census.pdf

Education and skills

Education is a legal requirement in Sierra Leone for all children from six years old, until they have completed three years of secondary schooling. There is a national shortage of schools and teachers, and the net primary enrolment rate is 57.5%. Educational attainment is higher among boys compared to girls at all three school levels. Literacy rates for the three districts are summarised in Figure 3-3. Tonkolili has the highest literacy rates, which can, in part be attributed to Magburaka, the districts capital, status as the Northern Province's educational centre.

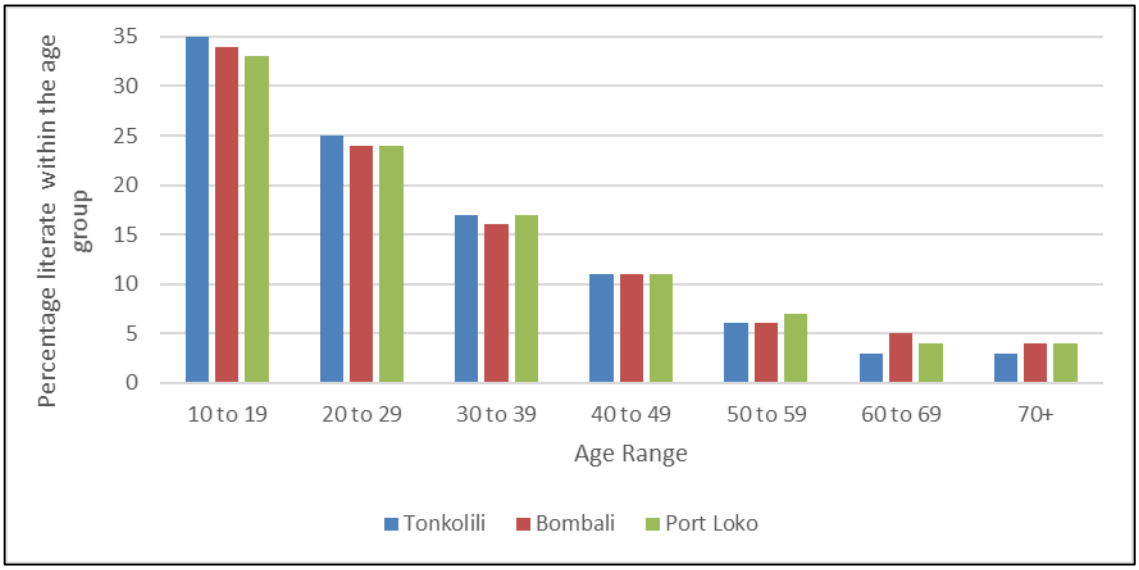

Figure 3-3: **Literacy levels by age group and district.** [3]

Food security and livelihoods

Poverty and exposure to international food price volatility are the underlying causes of vulnerability in Sierra Leone (OCHA 2016)[4]. Tonkolili is significantly affected by food insecurity with 74% of the district's households regarded as food insecure. In 2015 The Ebola outbreak eroded rice production through the containment measures preventing people from tending their farms. In Tonkolili rice, cassava and sweet potato are the staple crops and the livelihood for more than 80% of the population. ASM activity is also undertaken, predominantly as a seasonal activity near the Rokel River. In a Strategic Environmental Assessment of the Artisanal Mining Sector in Sierra Leone an anecdotal reference stated, "people now depend on gold mining because farming had never benefited them the way gold is at present" (Environmental Protection Agency and National Minerals Agency, 2016).

The percentage of food insecure households in Bombali was 25.5% in 2015. Livelihoods comprise the production of food crops. Rice, cassava and sweet potatoes are the staple food crops while groundnuts, peppers and tobacco are grown for sale. The land, characterised by open bush and grassland, is also suitable for livestock rearing, although theft during the civil war hindered this livelihood activity.

[3] https://www.statistics.sl/images/StatisticsSL/Documents/final-results_-2015_population_and_housing_census.pdf
[4] https://www.humanitarianresponse.info/en/operations/sierra-leone

Port Loko, as a main business hub of the country, was severely affected by movement restrictions during the peak of the Ebola outbreak. The Port Loko farming community was heavily affected by the Ebola crisis. The district has suffered a high number of Ebola deaths. Large scale mining operations in Port Loko and Lunsar (i.e. Marampa mine) provided employment up until the Ebola outbreak which coincided with mine related issues resulting in the retrenchment of employees. In Sierra Leone, 60% of the youth population (under 25) are unemployed, attributed to low levels of literacy and a lack of employment opportunities. A summary of the food and farming activities is presented in Figure 3-4.

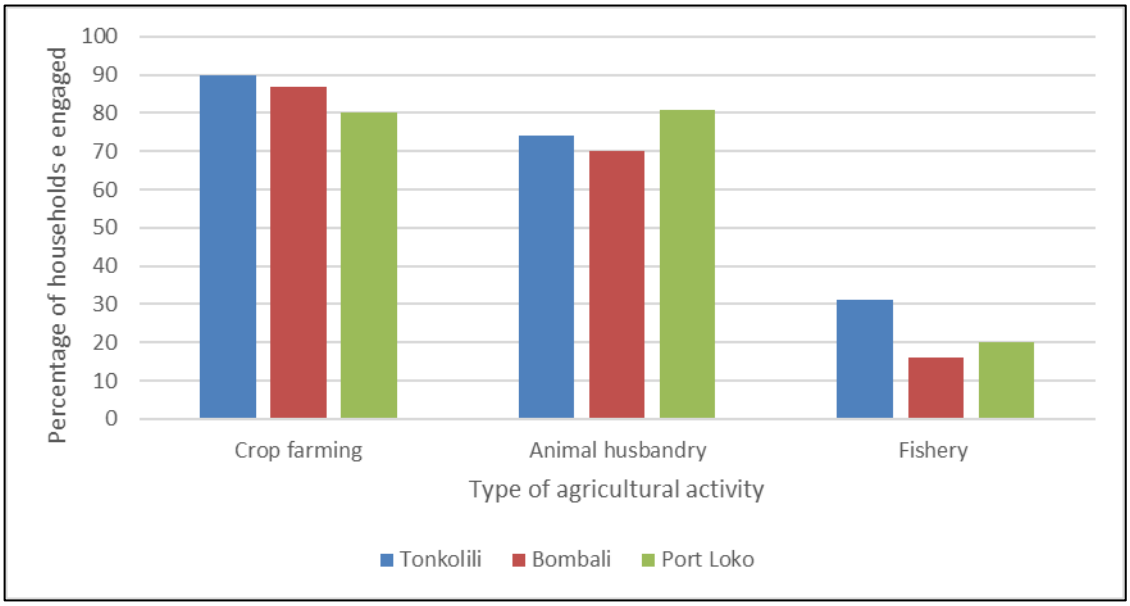

Figure 3-4: Food and farming activities across the districts[5]

Healthcare provision

Healthcare in Sierra Leone is insufficient to meet the needs of the population. Some of the barriers include; access to services and facilities, limited funding, poor nutrition and sanitation and human capacity.

Healthcare provision is through a mixture of government, private and non-governmental organisations (NGOs). The Ministry of Health and Sanitation responsible for health care decentralised provision after the civil war to try an increase its coverage. Traditional medicine forms part of the primary health care system in Sierra Leone. There are approximately 4 medical doctors, 70 nurses and 5 midwives per 100,000 inhabitants.

Communicable diseases such as malaria, yellow fever, onchocerciasis (river blindness), diarrhoea and pneumonia generate the largest share of the disease burden in Sierra Leone (65%) and are the highest cause of mortality. Non-communicable diseases (29%) and injuries (6%) are also increasing in significance. Port Loko and Tonkolili suffered greatly with the Ebola crisis.[6]

[5] https://www.statistics.sl/images/StatisticsSL/Documents/final-results_-2015_population_and_housing_census.pdf
[6] https://www.humanitarianresponse.info/en/operations/sierra-leone

Water and Sanitation (WASH)

Domestic toilet facilities are usually either communal pits (62%) or private pits (22%). On average around 2% of houses across these three districts have a private, flushing toilet. The Sierra Leone Demographic and Household Survey 2013 indicated that 44% of households did not have hand washing (water, soap or cleansing agents) facilities within the household, while only 11% have the full range of hand washing facilities at the household level.

During the Ebola outbreak, a nationwide campaign for hand washing (with soap, chlorinated water or hand sanitizer) was launched. Only 68% of the schools across the three districts have toilet facilities in the compound and the conditions and cleanliness vary widely across different schools.

3.2 Stakeholder Identification and Analysis

A desk top stakeholder analysis was carried out to identify the stakeholder groups and their interests in the developments along the Rokel River. These are summarised in Table 3-2.

Table 3-2: Stakeholder group analysis summary

Stakeholder group	Location	Interest
GoSL Ministries: Ministry of Agriculture, Ministry of Local Government, Ministry of Lands, Ministry of Health and Sanitation, Country Planning and the Environment, EPA and several other MDAs	Government of Sierra Leone, Freetown.	Govern the entire area through which the Rokel flows. Different ministries have various interests in the project. Interested in development prospects and potential opportunities for improvement in their department. They also have concerns regarding negative impacts related to their department. They have a high influence over Project development.
Local Government – District council and respective chiefdoms along the Rokel Paramount chiefs of 13 chiefdoms along the Rokel River	**Tonkolili District**: Kalansogia, Kafe Simira, Kholifa Rowalla, Malal Mara, Kholifa Mabang, **Bombali District**: Safroko Limba, Makari Gbanti, Bombali Shebora and Paki Massabong **Port Loko District:** Maforki, Marampa, Koya, Massimera,	Decentralised arm of government. Responsible for development in the Ward. Elected representative of the people; traditional leaders. Interested in development opportunities and whether their ward could experience negative impacts and land tenure.
Farmers	Along the Rokel.	Farm the land, inland valley swamps, hills and riparian valleys
Fishermen	Along the Rokel.	Fishing occurs in various places along the Rokel. Fish species are affected by changes in river flow.
Artisanal miners	Along the Rokel.	Generate an income through mining (gold, sand and gravel) along the Rokel River bed
Local community (youth, women, men, elderly)	Communities in each chiefdom.	Engage in a range of livelihood activities along the Rokel River including agriculture, fishing and artisanal mining. Different demographic groups may have different roles and may express different levels of vulnerability.
Ferry drivers/companies	Along the Rokel.	Ferries/barges run along the Rokel and provide a transport route for people.
Private companies	Along the Rokel.	Private companies/ developments along the Rokel depend on the river as a water source.

3.3 Existing and Planned Developments Identified Along the Rokel River

The Rokel is a microcosm of competing demands for water from rural and urban domestic users, industry, energy and agriculture, together with the risks of water pollution which accompany all these uses. The existing and planned large developments are illustrated in Figure 1-1. These are in addition to the water supplies for rural villages and small towns which are needed for domestic use, agricultural production and ASM.

3.3.1 Existing large developments

The Bumbuna hydroelectric power dam in the Tonkolili District is located 2 km upstream of the Bumbuna falls. The project began construction in the 1990's but was abandoned in 1997 because of the war,and was eventually commissioned in November 2009. It is a large run-of-river scheme consisting of an 88 m high rockfill dam with a 50 MW powerhouse at the foot of the dam, connected to Freetown by a 200 km long 161 kV single circuit transmission line.

The reservoir has a surface area of 21 km^2 and a maximum operating capacity of 350 Mm^3. As well as power generation, the dam is capable of holding 35 Mm^3 of water used for flow regulation and downstream flood control. The spillways through left and right bank tunnels have a total design discharge of 3,000 m^3/s. The power plant is rated at 50 MW (through two turbines) but the scheme has rarely achieved this level of power generation to date.

Tonkolili Iron Ore Mine in the Tonkolili District is owned and operated by African Minerals and Shandong Iron and Steel Group at Tonkolili. The mine was in full production by 2014 to exploit the biggest iron ore deposit in Africa and the third largest in the world. The project is located in the hills around Bumbuna, Mabonto and Bendugu. In July 2018 the operations were put on hold due to a financial dispute between the two owning companies.

Complant Magbass Sugar Company in the Tonkolili District, is a subsidiary of the China National Complete Plant Import Export Corporation (Complant), a Chinese company operating a sugar production facility in Magbass with approximately 2,000 ha of sugarcane plantation and an associated irrigation scheme rehabilitated by the company in 2003.

Addax Bioenergy Development in the Bombali and Tonkolili Districts, is an integrated agricultural and renewable energy project producing fuel ethanol and electricity. It abstracts water from the RokelSeli River for irrigation of sugar cane used to produce around 90,000 m^3 of ethanol per annum. The development is located approximately 15 km west of the town of Makeni in the Chiefdoms of Makari Gbanti and Bombali Shebora in the Bombali District and in the Chiefdom Malal Mara in the Tonkolili District.

The Marampa mine, located near Lunsar, Port Loko District, is a brownfield haematite iron ore mine with a 319 km^2 exploration licence that borders the Marampa mining lease, which was mined extensively between 1933 and 1975 by the Development Corporation of Sierra Leone (DELCO). The mine gained a mining licence agreement in late 2017 and mining is reported to restart with the new owner's in mid-2018. The adjacent Marampa Iron Ore Project remains undeveloped.

3.3.2 Planned large developments

The Seli HPP scheme in Tonkolili and Koinadugu Districts will generate 143 MW of power and will consist of two elements:

- Bumbuna Extension, Tonkolili District, will be able to generate 88 MW of power (2 x 42 MW turbines and another smaller 4 MW turbine, known as the environmental flow powerhouse, located in the Bumbuna Phase I water outlet) and will use the same reservoir as the existing Bumbuna Phase I HEP but with separate intake, turbines and 36 km of new transmission line (to be provided by the Government of Sierra Leone).

- Yiben dam, Koinadugu District, will be constructed 28 km upstream of Bumbuna Phase I dam and is designed to generate 55 MW (2 x 27.7 MW turbine units) of power. The reservoir created by the dam will be approximately 115 km^2 in surface area.

The Port Loko bauxite development is a planned bauxite mine which has a licenced asset in Port Loko District with a number of mining camps at Yenkisa, Lungi, Tekeya and Mamaliki. The bauxite deposits are positioned very close to the Rokel River and it is anticipated that the river will be used for transporting the ore for processing.

There are also current plans / intentions to extend Freetown's water supply, based on abstraction from the Rokel/Seli River in Port Loko District approximately 24 km upstream of Freetown.

4 NATURAL RESOURCE USE AND LIVELIHOODS ASSESSMENT

In order to understand existing land use and to be able to determine how local livelihoods may be affected by the Seli HPP, it was important to understand the degree and diversity of existing natural resource use and associated livelihoods as well as the effect of existing water demands on the volume and flow of the river across the seasons. This was done through a combination of undertaking a remote sensing study of natural resource use and a livelihoods survey of a sample of villages in close proximity to the Rokel River.

4.1 Remote Sensing Assessment of Land Use and Livelihood Activities Along the Rokel

Natural resource use data was obtained from Landsat 15 m resolution multispectral image data. Landsat satellite p201r054 and p202r054 images with spectral bands 1 to 7 and Google Earth for the years 2012-17.

These images were for the months January (2017) and February (2016) for the dry season and July (2016) and November (2017) for the wet season. These were chosen as the most cloud free images available across the two zones of the analysis area. These images were then processed to determine land use. A supervised classification was carried out to illustrate how the river changes in the wet and dry seasons and to determine which areas demonstrated significant change in natural resource use between wet and dry season.

The seasonal variation in natural resource use along the Rokel River, at a chiefdom level, determined by the remote sensing is illustrated in

Figure 4-1and Figure 4-2

Focussing on the river sediment trails were also identified using visual and multispectral data to determine extent of artisanal mining that took place in or near the river and also on the river bank. The findings of this analysis are detailed in Figure 4-3.

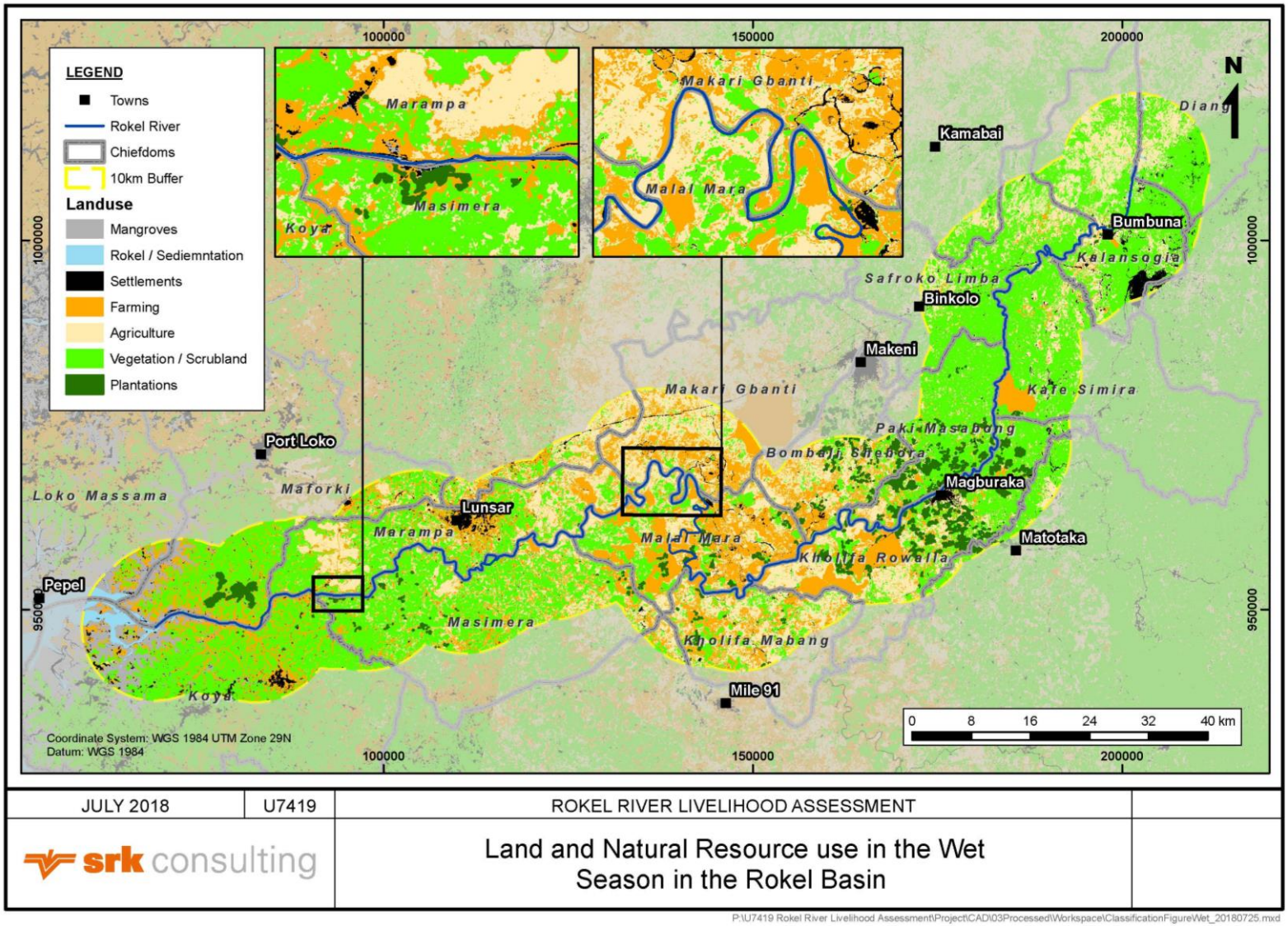

Figure 4-1: Land and natural resource use in the wet season in the Rokel Basin

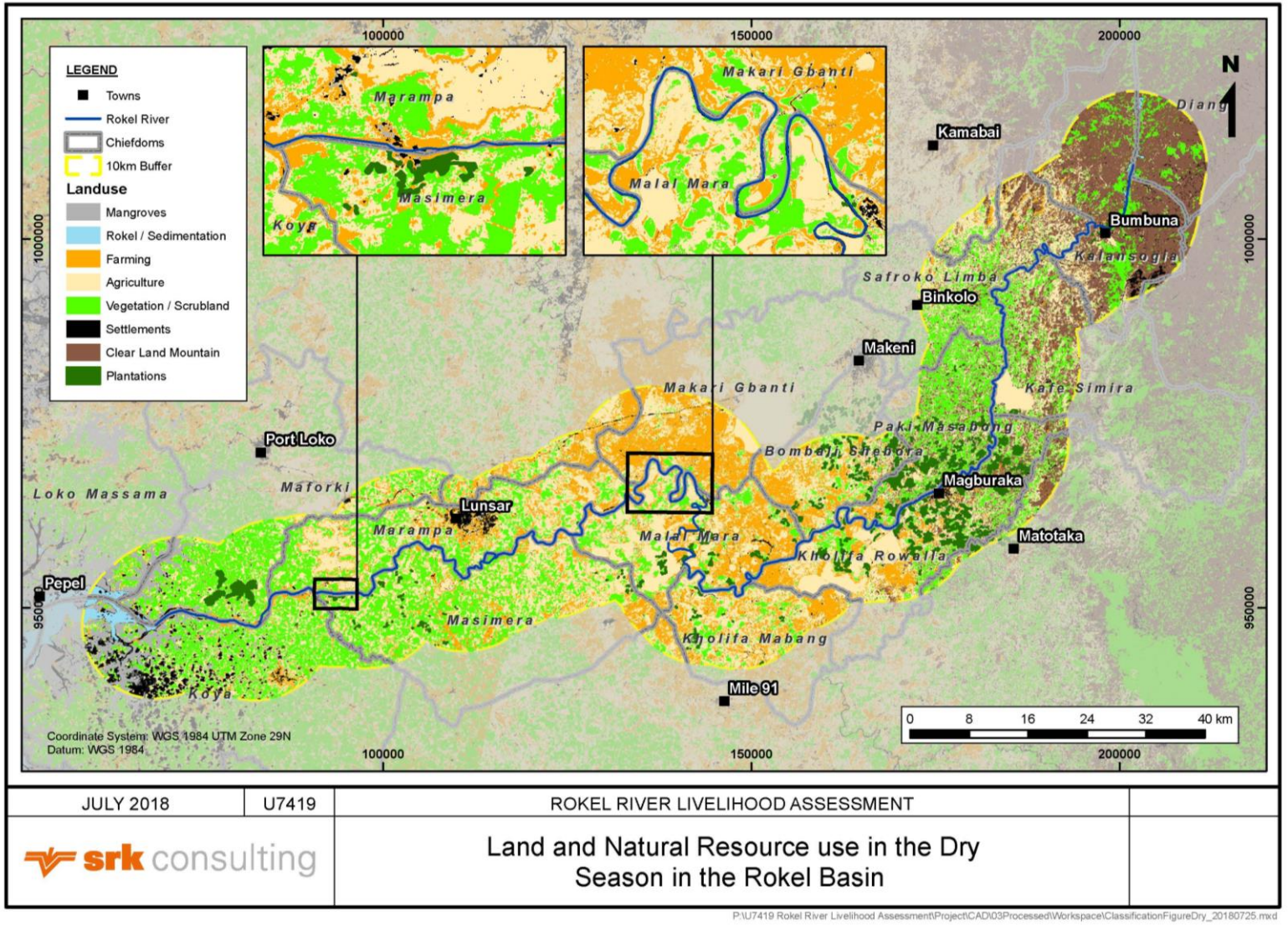

Figure 4-2: Land and natural resource use in the dry season

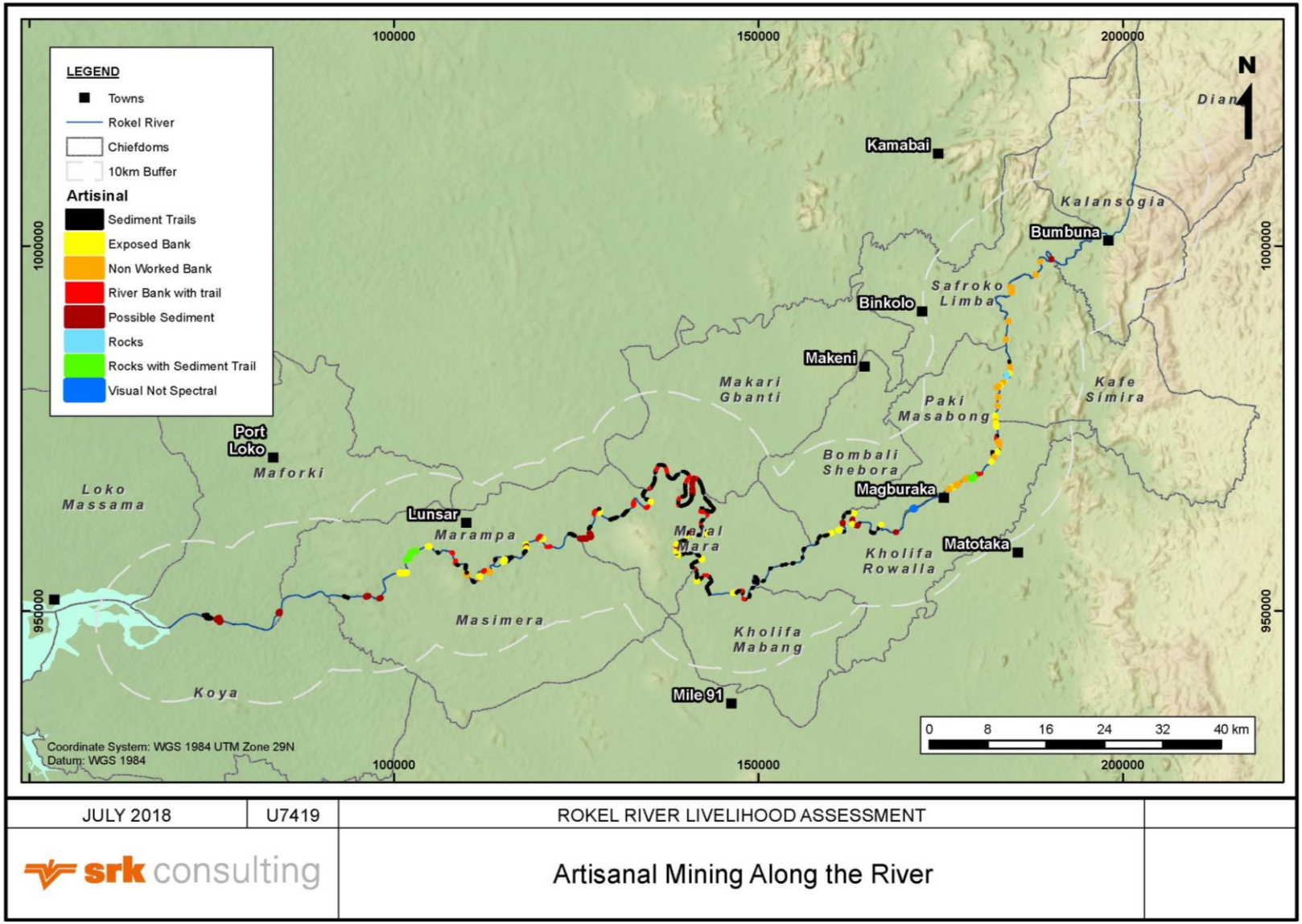

Figure 4-3: Artisanal mining along the Rokel River

Table 4-1: Remote sensing analysis of natural resource use in the wet and dry seasons at a chiefdom level.

District	Chiefdom	Wet season	Dry season
Tonkolili	Kalansogia	The predominant land use is farming. The town of Bumbuna and the Tonkolili mine are located in this chiefdom. The most intensive area of farmland around and to the west of Bumbuna.	During the dry season the area becomes a lot less vegetated and includes more barren land.
	Kafe Simira	The predominant land use is farming. This is most intensive around the road from Tonkolili to Mabonto which runs roughly north-south and 6 km east of the Rokel River. At the very south of this chiefdom there is a large (18 km^2) patch of inland valley swamp.	During the dry season the area becomes a lot less vegetated and includes more barren land.
	Kholifa Rowalla	The predominant land use is farming and plantations, which becomes more intensive as the chiefdom progresses south-west. A large (19.7 km^2) farm is present in the south-west region of the chiefdom, near the settlement of Magbass, This is the Magbass sugar plantation.	During the dry season the area becomes less vegetated and includes more barren land.
	Kholifa Mabang	The predominant land use is farming.	There are sediment trails along the meandering sections of the river which indicate the presence of artisanal mining, these grow more frequent as the river progresses west.
	Malal Mara	The predominant land use is farming and the Addax biofuel plantation. A meandering stretch of the Rokel River runs north-south through the centre of the chiefdom. The east side of the chiefdom is entirely occupied by Addax, although there are some communities within the Addax plantation area which appear to have their own farmland and plantations. The west side of the chiefdom is dominated by much less organised farmland.	Artisanal mining is also present along this meandering stretch of the river.
Bombali	Safroko Limba	The predominant land use is farming. The farming is concentrated in the north-east of the chiefdom, and around the town of Binkolo in the south-west.	During the dry season the area becomes less vegetated.
	Paki Masabong	The predominant land use is farming and plantations. The farming is concentrated in the south-west of the chiefdom, where it enters the central farming zone. The plantations are situated in the bottom half of the chiefdom nearer to the Rokel River.	During the dry season the area becomes less vegetated.
	Bombali Shebora	The predominant land use is farming. The western half of the chiefdom is situated in the central farming zone and the chiefdoms access to the Rokel River is used by Addax, which covers the southern tip of the chiefdom. The town of Makeni is situated at the northern tip of this chiefdom. The eastern part of this chiefdom contains plantations.	During the dry season the area becomes less vegetated.

District	Chiefdom	Wet season	Dry season
	Makari Gbanti	The predominant land use is Addax and farming. Two thirds of this chiefdom is situated in the interior plains of the country but almost all of the farmland that is adjacent to the Rokel River is used by Addax.	This meandering stretch of the Rokel contains stretches used for artisanal mining.
Port Loko	Marampa	The predominant land use is farming and mining. The Marampa mine is situated 3 km east from the town of Lunsar, which is in the centre of the chiefdom.	Evidence of artisanal mining along the Rokel River
	Maforki	The predominant land use is farming. This chiefdom contains the settlement of Port Loko and connected expanses of cleared land. The southern area of the chiefdom contains a large 10 km^2 plantation and flood plains.	During the dry season the area becomes less vegetated.
	Masimera	The predominant land use is farming, including a 1.7 km^2 area of regulated farmland near the village of Masimera.	There is evidence of some artisanal mining along the Rokel River, the area also includes some plantations in the western side of the chiefdom. In the dry season classification, the amount of detectable cleared land increases.
	Koya	The predominant land use is farming. The farmland is concentrated in the north of the chiefdom, around the village of Forodugu and the town of Masiaka. There are large floodplains present in this area and some mangrove swamps.	In the dry season, floodplains do not exist and the land becomes dryer.

The findings from the remote sensing study were used to determine ten ground truthing points across the three districts of Tonkolili, Bombali and Port Loko that also met the following criteria for a purposive sample of communities to participate in the livelihoods survey:

- Proximity: not more than 5 km from the Rokel River;
- Evidence from the remote sensing study of dry season river related activity such as ASM sediment trails, agriculture and inland valley swamps
- Accessible by vehicle in the dry season
- Geographical spread along the river.

Adhering to these criteria resulted in a purposive sample of the following ten villages. With the Rokel River as the boundary between the districts and the lack of useable road infrastructure in Bombali, the villages selected happened to be in the districts of Port Loko and Tonkolili detailed in Table 4-2 and illustrated in Figure 4-4.

Table 4-2: Ground truthing and livelihood survey villages

Village	Chiefdom	District
Forodogu	Koya	Port Loko
Kerefay	Koya	Port Loko
Kotic	Marampa	Port Loko
Mange	Marampa	Port Loko
Masuba	Malal Mara	Tonkolili
Rokamp	Malal Mara	Tonkolili
Magburaka	Kholifa Rowalla	Tonkolili
Simiria	Kafe Simira	Tonkolili
Tonkolili	Kafe Simira	Tonkolili
Kuria	Kalansogia	Tonkolili

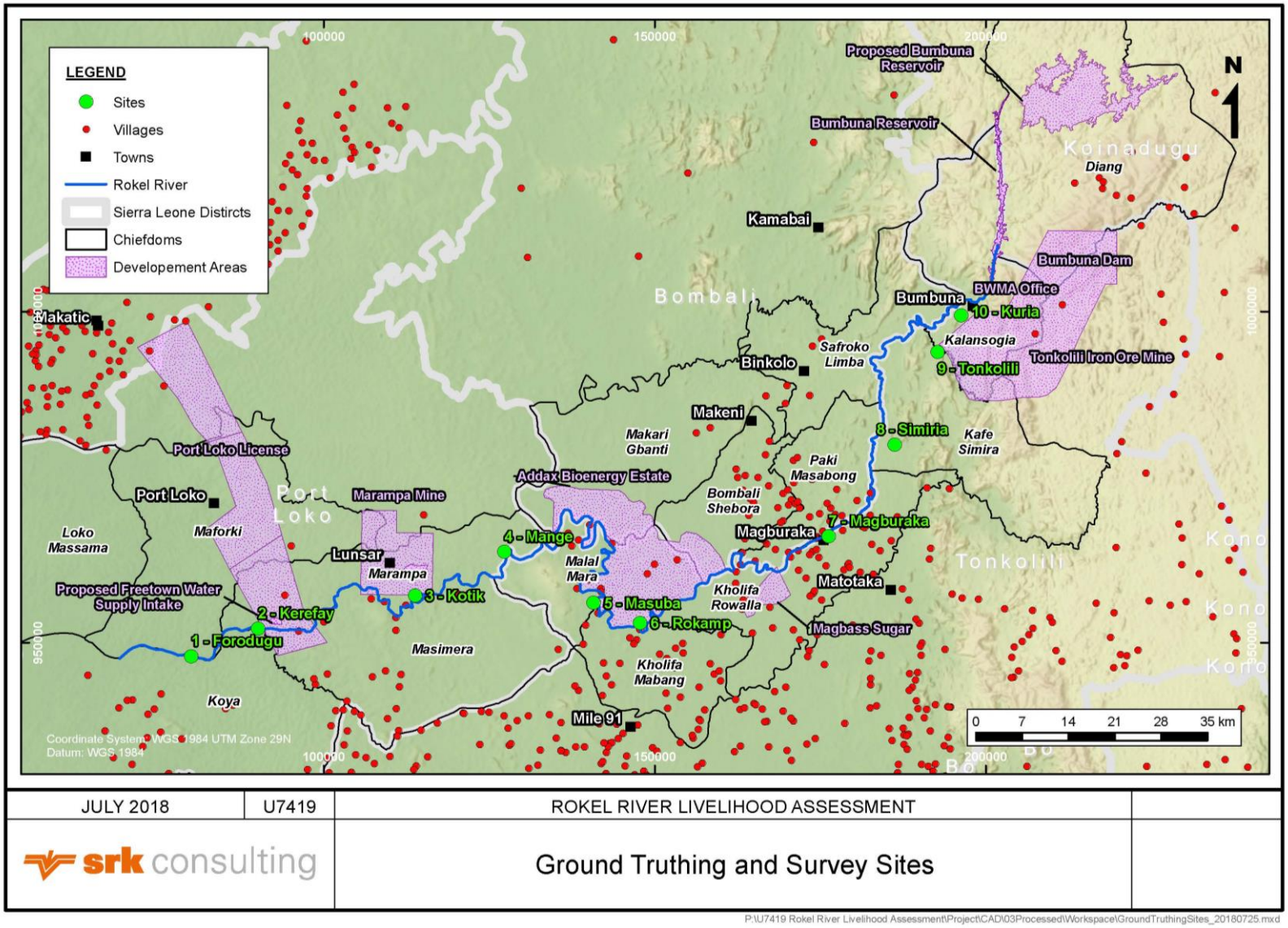

Figure 4-4: Ground truthing and survey site along the Rokel River

4.2 Livelihoods Survey

The livelihoods survey focussed on the ten identified communities downstream of Bumbuna and their existing access to, control and or ownership of natural resources within the Rokel River basin.

Based on the activities identified through the remote sensing study, a questionnaire was prepared to gather more detailed information on farming, fishing, artisanal mining activity and transport along and or across the river. The survey was undertaken with 10 different villages situated downstream of the Bumbuna dam along the Rokel River during April 2018, which was in the dry season so the activities being undertaken would be the ones most probably affected by the flow change resulting from the Seli HPP. The location of these villages is shown in Figure 4-4.

At each village three different groups within the community were asked a series of questions relating to their use of the Rokel River and the effect it has on their livelihoods. One group comprised of only females, one group of only males and one group with a mixture of males and females. This split was designed to explore if there were any differences between the males, females and mixed groups. The results showed that there were not any significant differences in the responses of males, females or mixed groups and so this has not been explored further within the analysis.

Most of the villages were small communities of between 200 and 600 people except for Forodogu and Magburaka which both had populations in excess of 5000 people.

4.2.1 Agriculture

The remote sensing identified features such as plantations, cultivated land and inland valley swamps throughout the whole basin. The lowland area known as the interior plains is an area of concentrated farmland.

The survey explored the type of land that the communities used for farming. Almost all of the groups farmed on inland valley swamps, cultivated hillside and floodplains with one group in Magburaka and in one Kuria not using swamps. Another group in Kuria did not use cultivated hillside and another different group in Kuria also did not farm on floodplains.

All of the groups from Rokamp and Magburka undertook their agricultural activities within 1 km of the Rokel River and the majority of the groups farmed within 2 km of the river (Figure 4-5). Stakeholders from Kuria and Forodugu were those who farmed furthest from the river. The survey also explored who undertook agricultural activities within the communities and the results reinforce the importance of agricultural activity in these communities. Every group identified men, women and children as being involved in agricultural activities and almost every group said that men women and children work both independently and together on the land. This demonstrates the importance of agriculture not only to the economy but also to the cultural fabric of these communities.

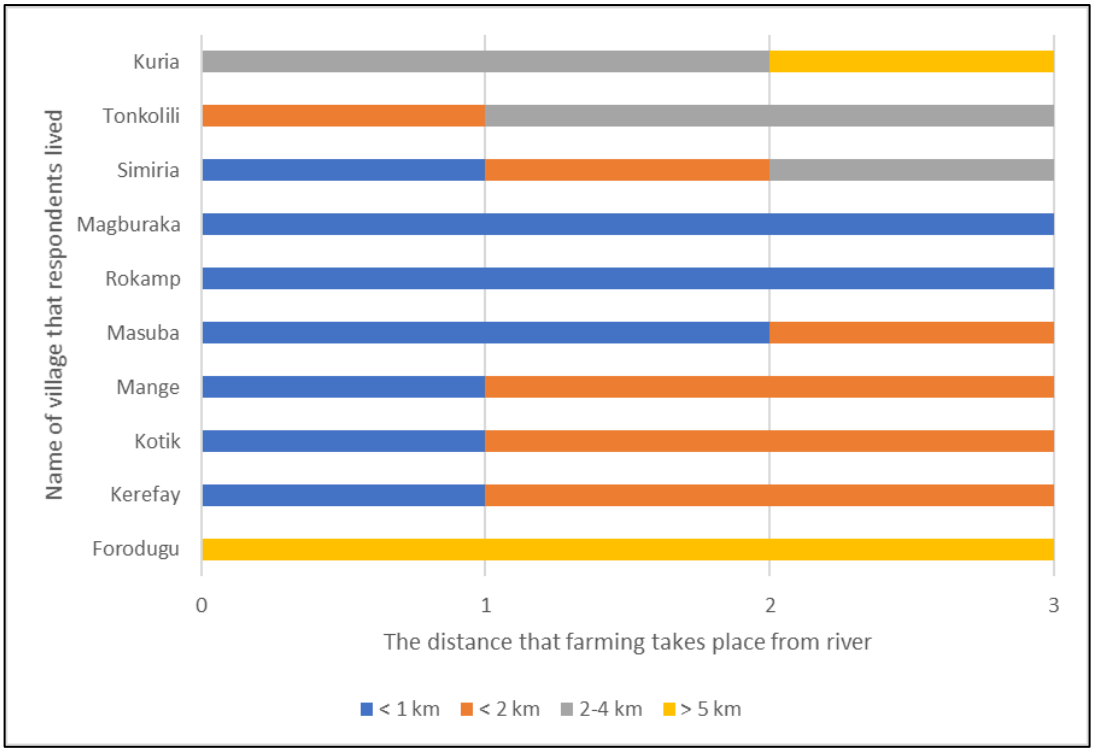

Figure 4-5: Distance of agricultural activity from the Rokel River by location.

All of the survey participants worked as households on their agricultural activities, with the vast majority also working as individuals and employees. Participants in Tonkolili, Mange and Simiria also worked as sharecroppers.

Crops

The survey explored whether the types of crops grown by local groups varied between the wet and the dry season. In the wet season, when the ground is more saturated with water, the most popular crops grown include okra, konsho beans, cassava beans, tomatoes, rice, potato, jakato bitterballs (a bitter tasting vegetable that are often used in cooking), benniseed, peppers, maize, krain krain, groundnuts, coco yam, broad beans, pumpkin, eggplant, chinese yam, upland rice, yam, sweet peppers, cucumbers and couscous.

The most popular dry season crops, where water is reduced, include peppers, okra, krain krain, maize, potato, cassava, groundnuts, tomatoes, sweet peppers, eggplant, and cucumbers. There was therefore little difference between the most popular crops in the dry and the wet season but there were some crops which were far grown by less groups in the dry season as compared to the wet. The type of crops which vary most significantly by season can be seen in Figure 4-6 which also demonstrates the importance of rice, yams and jakato bitterballs.

Palm oil production was also undertaken in the villages of Forodogu, Kerefay, Kotik, Mosuba and Rokamp and this was verified by the ground truthing survey.

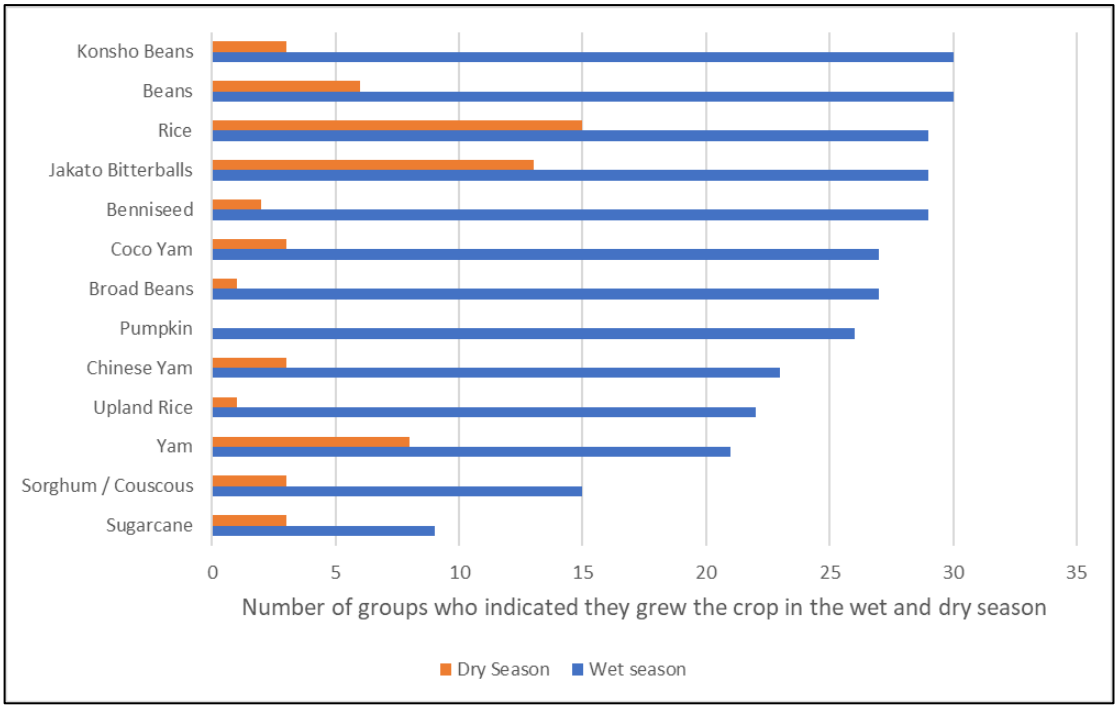

Figure 4-6: Crops which have the greatest variation in yield between the wet and dry seasons

Whilst there was a difference between the types of crops grown in the dry and the wet season, it was the yield and growth of crops which appears to be the most significant difference in crop growing between the two seasons. This was evident when the groups were asked about the main benefit of the rainy season.

All the groups indicate that their crops grow better, that they have higher yields and a good harvest from the rainy season. Some groups also mentioned that there was also less time spent watering the crops or making irrigation measures in the rainy season, so they had more time to sell any surplus production. The groups also said that the water supply was 'cleaner' during the wet season.

4.2.2 Fishing

A fish survey was carried out on the Rokel / Seli river around Bumbuna by MRAG Ltd and Nippon Koei, UK (2006). This survey showed that more fish were present in the dry season and the sites of Magburaka and below Bumbuna Falls had the highest number of species in both the wet and dry seasons.

The livelihoods survey undertaken by SRK also explored the role that fishing played in the livelihoods of communities along the Rokel. Only three of the thirty groups surveyed did not take part in fishing. Two of these groups were female and the other male. Of those groups who did catch fish, the vast majority caught more fish in the dry season. The only exception to this was in Tonkolili and Foroduga where all of the groups said they caught more fish in the wet season.

During the survey, images of 22 fish caught for consumption, identified through the MRAG study, were shown to the groups, who were asked how their fish catches varied across the seasons. Across all of the groups, the average number of fish caught per day during the dry season was 60 and this figure dropped to 40 in the wet season.

There was however very little perceived difference in the types of fish that were caught in the wet and the dry season, which would suggest the change in river flow and volume does not affect people's consumption of fish by type. However, while the average number of fish caught in the wet and dry season across the different groups does not vary dramatically, there is a considerable impact from the seasons when fishing activity is compared across each of the different areas.

Figure 4-7 shows the difference in the numbers of fish caught per day in the wet and dry seasons by area. It is quite clear from this data that areas such as Simiria, Rokamp, Masuba, Kerefay, Kotic and Kuria catch more fish in the dry season. The groups in Magburaka catch a lot more fish per day compared to the other areas but that is likely to be attributed to the size of the settlement. They also catch nearly 8 times as many fish per day in the dry season compared to the wet so any change could have significant impacts here.

However, this pattern is reversed in the areas of Tonkolili and Forodugu, where very few fish are caught in the dry season compared with the wet season. The groups in Forodugu also catch more fish than almost all of the other areas but again this would be attributed to the size of the settlement.

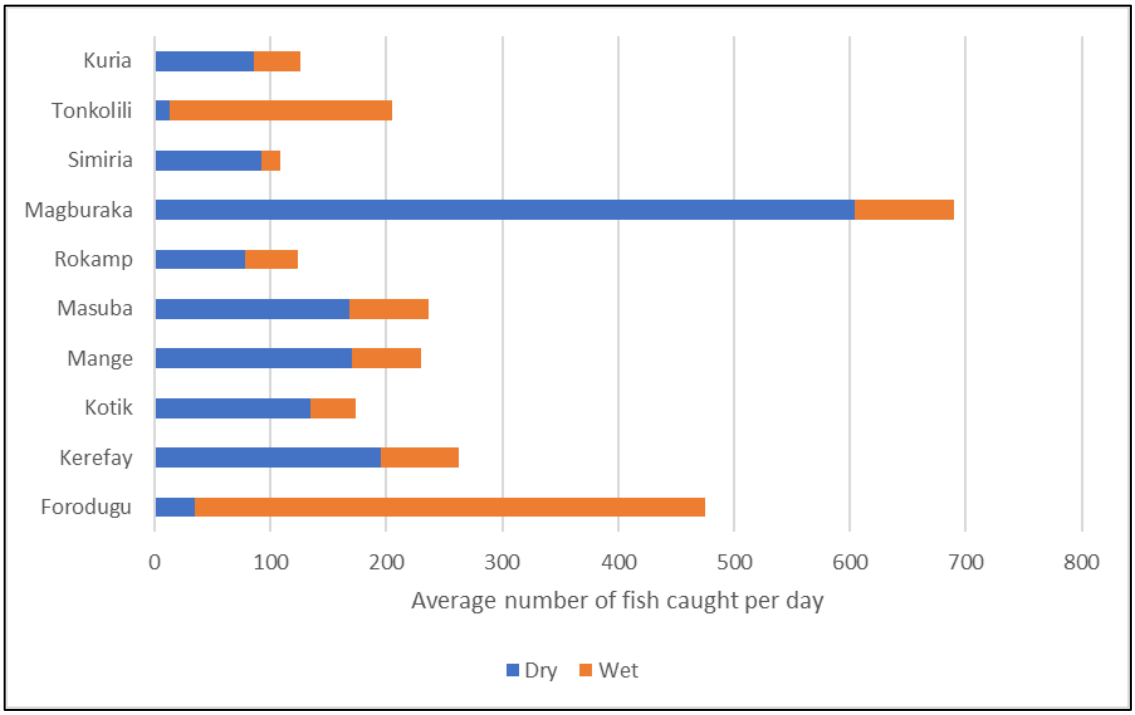

Figure 4-7: Number of fish caught per day in the wet and dry season by location.

4.2.3 Artisanal mining

The remote sensing study identified potential ASM sites along the Rokel River through the presence of exposed river banks and sediment trails in the river. The livelihoods survey, guided by the remote sensing, focussed on verifying the presence of artisanal mining along the river basin. Findings from the survey suggest that individual men and women engage in artisanal and small-scale mining (ASM) within the study area. A Strategic Environmental Assessment (SEA) conducted on the artisanal mining sector in Sierra Leone (Environmental Protection Agency and National Minerals Agency, 2016) found that, in the northern region of Sierra Leone, artisanal mining is predominantly for gold and that mining activities involve men, women and children.

The livelihoods study found that most of the artisanal miners did not have a licence but they operate under the licence of their financial supporters. The financial supporters provide lines of credit for miners to carry out their activities based on verbal agreements that all proceeds are sold to them when repayment of credit is made. The land owners are usually families and communities who give authority to those interested in conducting mining activities. The survey determined prevalence, mineral mined, location of mining activity and incomes generated.

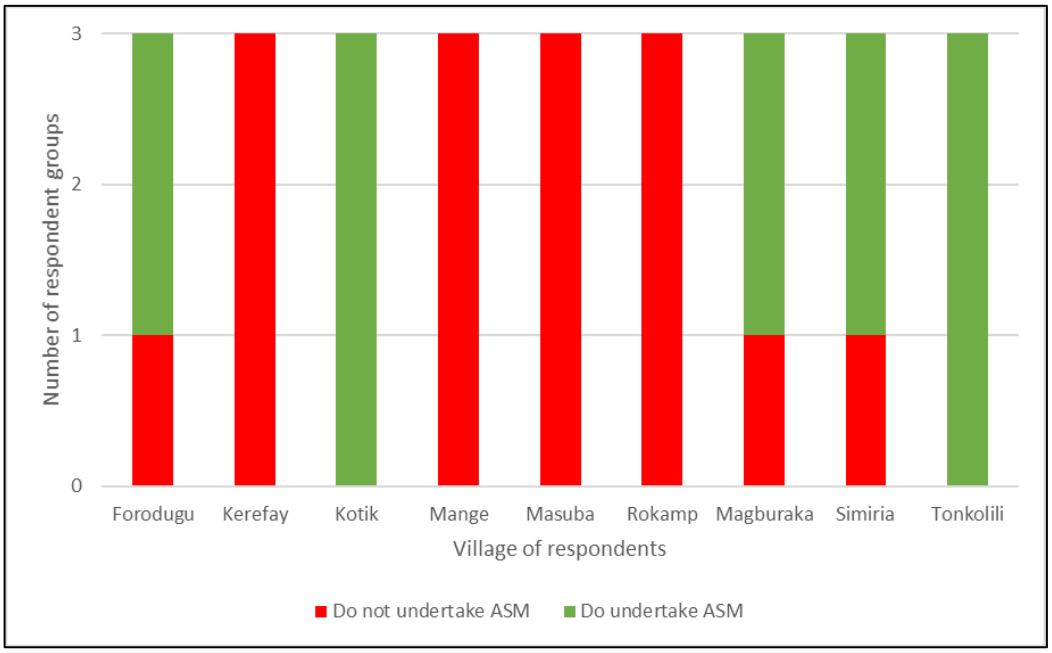

Figure 4-8: Locations where artisanal mining takes place along the Rokel.

Of the ten communities visited, six engaged in artisanal mining activity with this activity being most prevalent in Tonkolili and Kotik as illustrated in Figure 4-8.

In Forodugu, Magburaka and Kotik aggregates (i.e. sand and gravel) and clay were mined. In Tonkolili, Kuria and Simiria alluvial gold was mined and in Tonkolili there was also mining for diamonds, as illustrated in Figure 4-9.

Aggregates, such as sand and gravel, were mined exclusively along the river edge. This was a dry season activity, except in Magburaka, where it continued throughout the year.

Gold and diamond mining was regarded as a dry season activity. In Simiria and Kayida, alluvial mining of gold took place away from the Rokel River in areas that flood in the wet season. In Tonkolili the edges of the Rokel and Tonkolili rivers as well as the river bank areas on the ground above the river were dug and panned.

The value of these ASM activities varied depending on the activity and quantity of resource in the area. The size of the settlement also needs to be taken into consideration with these results as Magburaka and Forodogu have much greater populations. A summary of the ASM activity, villages involved and proximity to the Rokel River is presented in Table 4-3.

Table 4-3: ASM activity along the Rokel River

Town	Area of Mining	Type of Mineral mined	Daily income (LE) per group	USD Average ($1= LE8,000)
Katick (Kotik)	Edge of river	Sand & gravel	50-70,000	$8
Magburaka	Edge of river and in the river	Sand, gold and gravel	120-150,000	$17
Simira	River bank above the river	Gold	50-70,000	$8
Tonkolili	Edge of the river and behind the river	Gold and diamonds	300-400,000	$44
Forodugu	River bank above the river	Sand and gravel	300-400,000	$44
Kuria	River bank above the river	Gold	120-150,000	$17

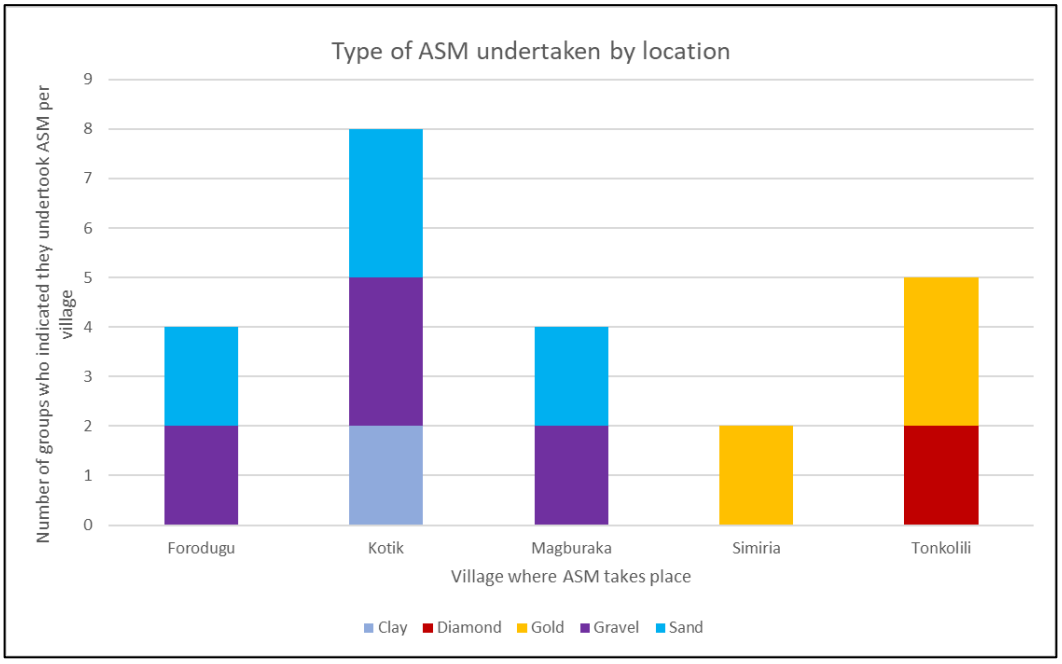

Figure 4-9: Type of artisanal mining activity undertaken by location.

When asked whether they undertook ASM elsewhere, all but one of the groups said that they did, in places such as Bolia, Basa, Yarawaya, Kassikoro, Darakula, Damage, Kondoyadi, Yengbemba, Makoreh, Magbunie, Mamaso, Gbana Sorie, Keletor, Gbenekoro, Kagblisa, Kabumba, Manampeh and Masimera. These locations were mapped wherever possible and can be seen in Figure 4-10.

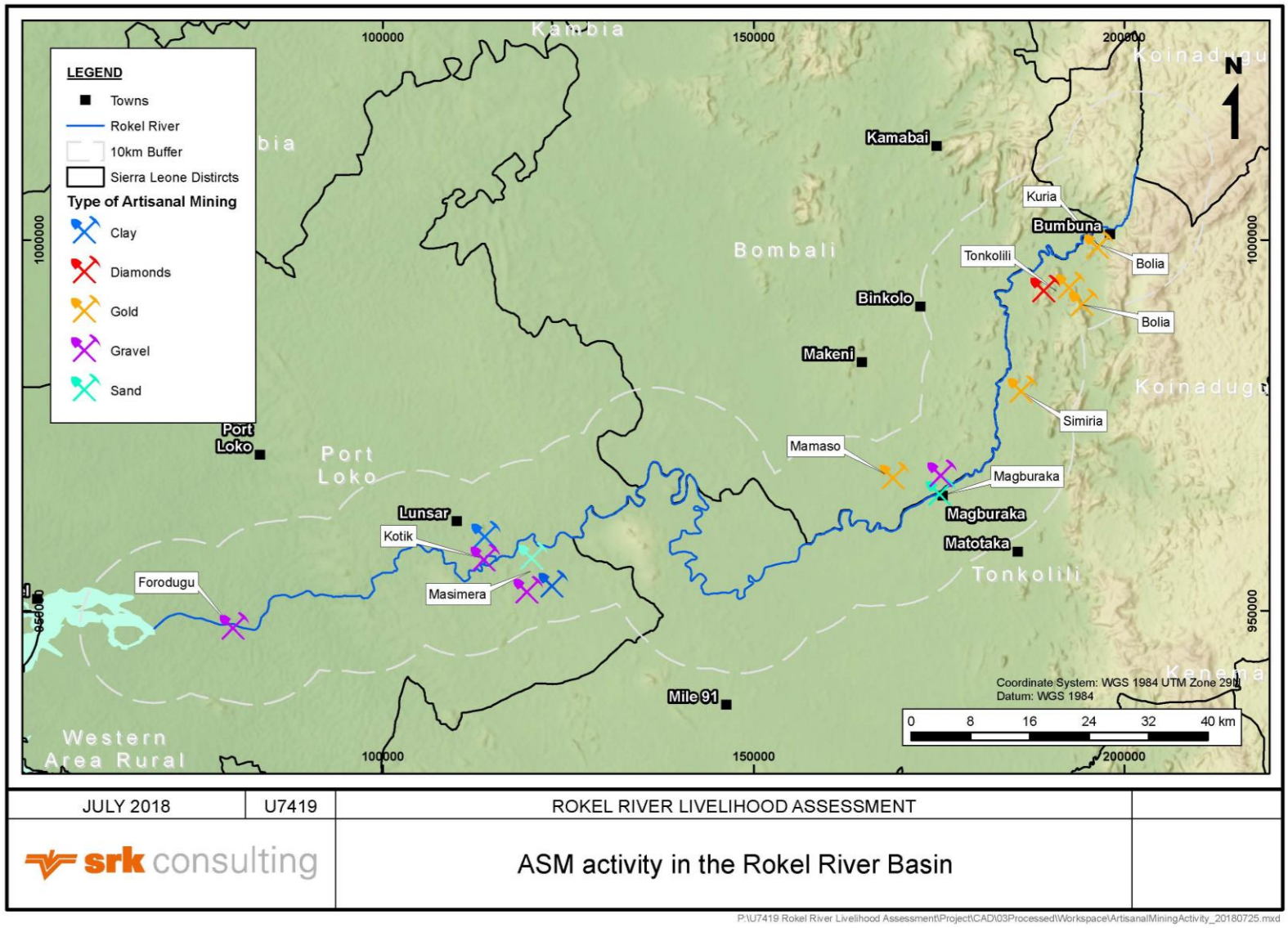

Figure 4-10: Artisanal mining activity along the Rokel River basin

4.2.4 Transport

The livelihoods survey explored whether the communities used the river for travel to support their livelihood activities as well as how they crossed the river in the different areas.

The majority of the groups interviewed used either boats or bridges, or crossed the river on foot, or a combination of all three. Two of the groups in Forodugu indicated that this question was not applicable while the other group crossed streams and ponded areas using local bridges and sticks. The other method that some stakeholders mentioned was by using canoes (Figure 4-11).

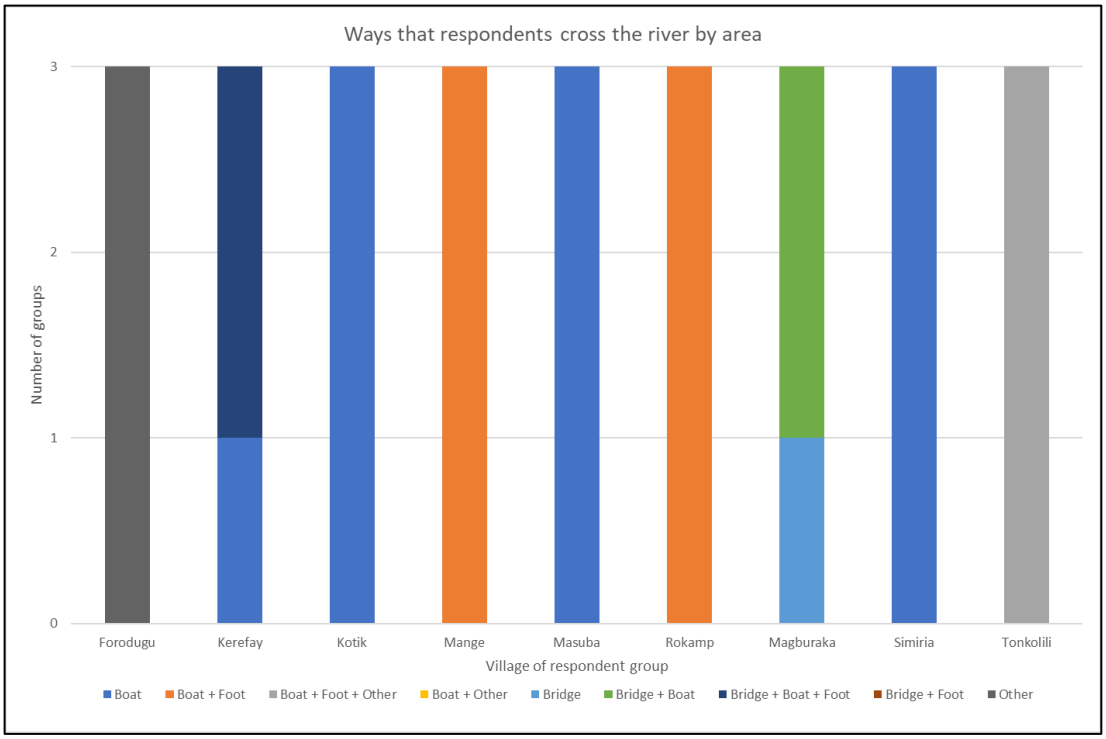

Figure 4-11: The ways in which groups cross the Rokel River by area.

Over half of the groups indicated that the way that they cross the Rokel River changed from the wet to dry season. This change was more prominent in certain areas. All the groups in Kerefay, Magburaka, Mange and Rokamp indicated that they changed how they crossed the river by season as well as two of the groups in Simiria and Tonkolili. One group in Kuria also said the way they crossed the river changed by season (Figure 4-12).

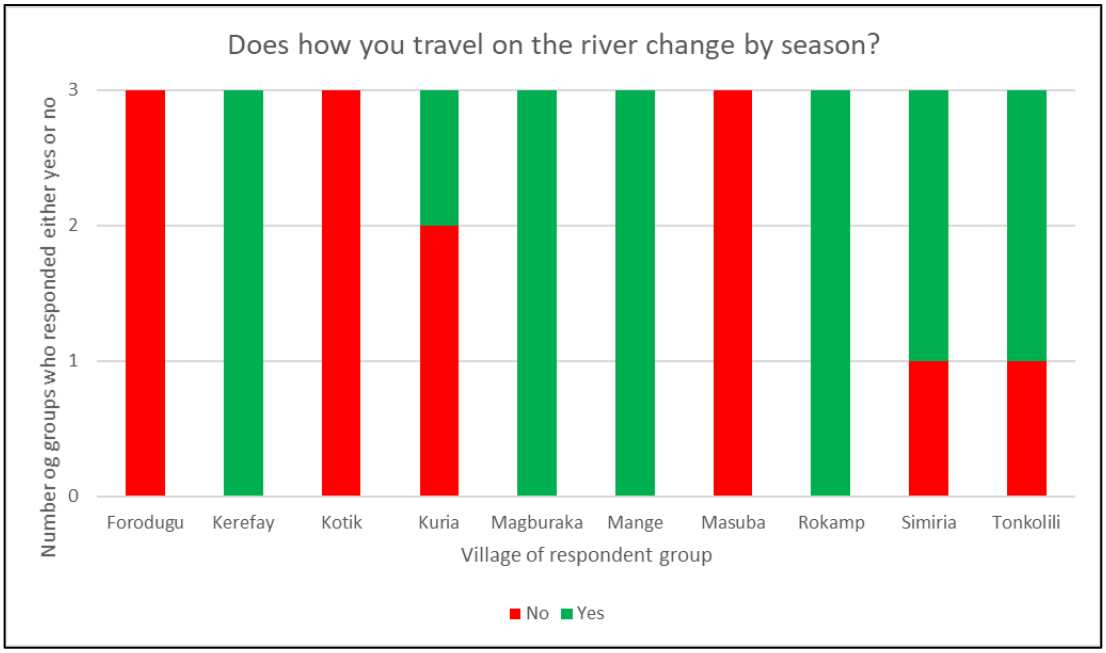

Figure 4-12: Seasonal variations in river crossings.

Of the groups that did travel on the river over 50% said that their travel was affected by the seasons and that travel on the river was much more difficult and dangerous in the wet season. This meant that the frequency of trips as well as number of people travelling was significantly impacted by the increased water levels and stronger currents and consequently less people used the river for travel during the wet compared to the dry season.

Almost all the groups did travel on the river using either canoes or some form of paddle boat. The only exception to this was all of the groups in Forodugu and one of the interviewee groups in Magburka and another in Tonkolili who said that they did not travel on the river.

For those who did travel on the river the vessels were either privately or community owned depending on the area.

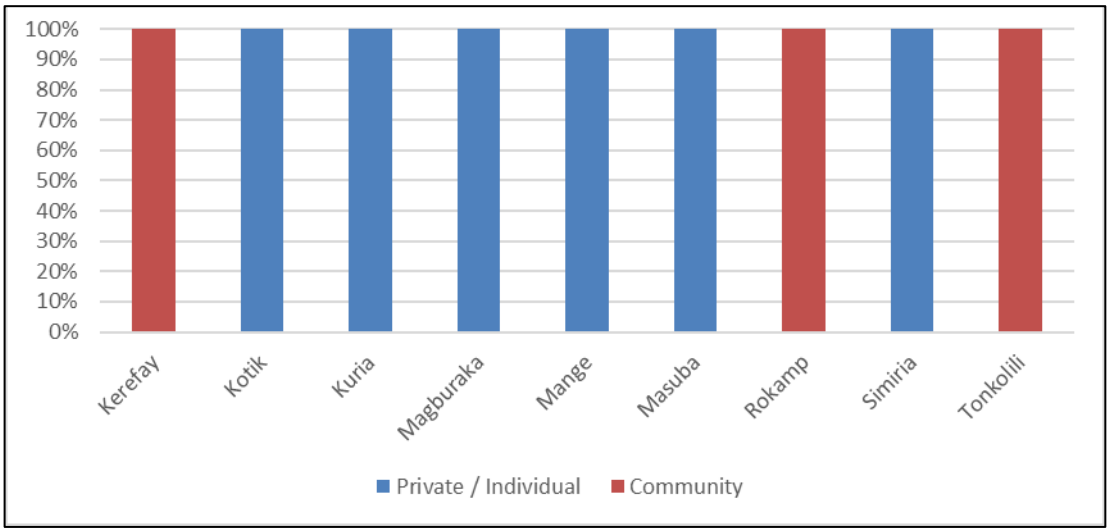

Figure 4-13: Ownership of river transport vessels.

4.2.5 Other livelihood activities

Other livelihood activities which exist in the study area were difficult to identify through remote sensing but include charcoal production, hunting, collecting timber and providing a variety of services.

The livelihoods survey explored any other livelihood activities that generated a cash income for the stakeholder groups and found that all of the communities undertook a wide range of different livelihood activities. The most popular activities are shown in Figure 4-14. However, a wide variety of other activities were mentioned by different groups including weaving, basket making, teaching, steel bending, driving and baking.

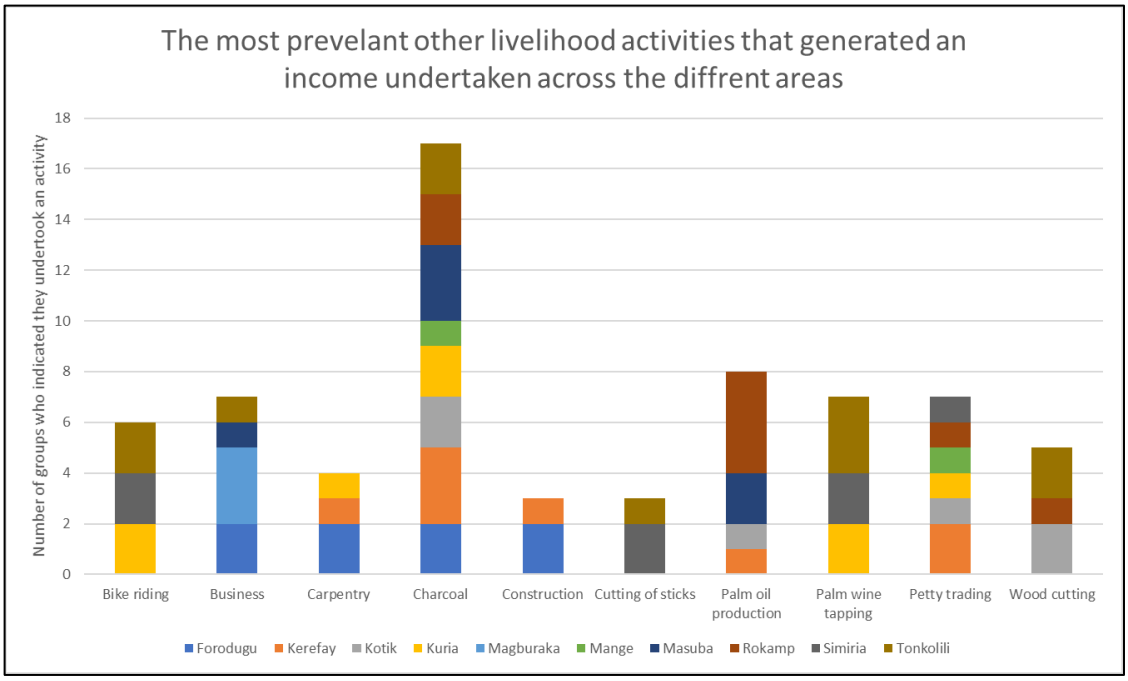

Figure 4-14: Other livelihood activities undertaken in surveyed communities.

These results show that there are a wide variety of other livelihood activities being undertaken in these areas, the majority of which are not affected by the river.

4.2.6 Bumbuna falls

Bumbuna Falls was identified as a site of potential cultural significance, as well as an important site for fishing (see Section 4.2.2). Bumbuna Falls is unable to be moved or recreated thus a potentially important cultural and provisioning ecosystem service will be lost. The significance of Bumbuna Falls was therefore explored in the livelihoods questionnaire but did not appear to hold any cultural significance to the groups who were questioned.

Only just over half of the stakeholder groups had heard of or visited Bumbuna Falls. The groups who were aware of Bumbuna Falls were all of the groups in Forodugu, Kuria and Sumiria, two of the groups in Tonkolili, Magburaka and Kerefay and only one group in Mange and Kotik. None of the groups in Masuba or Rokamp had heard of the Falls.

There was confusion between the falls, the dam and Bumbuna town as the majority of responses referred to employment opportunities and that it was a source of electricity. There was no mention of any cultural activities or cultural significance at Bumbuna falls from the survey.

5 CUMULATIVE EFFECTS ASSESSMENT

5.1 Flow Regime

The flow regime of the Rokel:Seli River has been recorded since 1970 through a UNDP funded programme. Guages are installed at Badala Bridge in Koinadugu District and at Bumbuna, Tonkolili District.

As discussed there are a number of existing developments that have altered what would be the natural flow regime between Bumbuna and the mouth of the Rokel River. The Bumbuna Dam, while rarely operating at capacity, regulates the flow volume to a certain extent. During the ground truthing, it was observed that access to the Rokel River depended on Bumbuna Dam flow regulation, especially in the dry season.

The Bumbuna ESIA specified that the dam operates to provide a minimum flow of 6 m^3/s in the dry season and 100 m^3/s in the wet season to ensure enough water for downstream users. This is currently achieved by the manually operated environmental flow bypass, which is used when water levels in the reservoir fall below operational levels for the HPP. However, anecdotal evidence suggested the minimum environmental flow is not always achieved (Ecotone, 2016).

The annual filling of the Dam at Yiben, will be used to 'top up' the Bumbuna Dam and feed the proposed tail race extension, illustrated in Figure 5-1

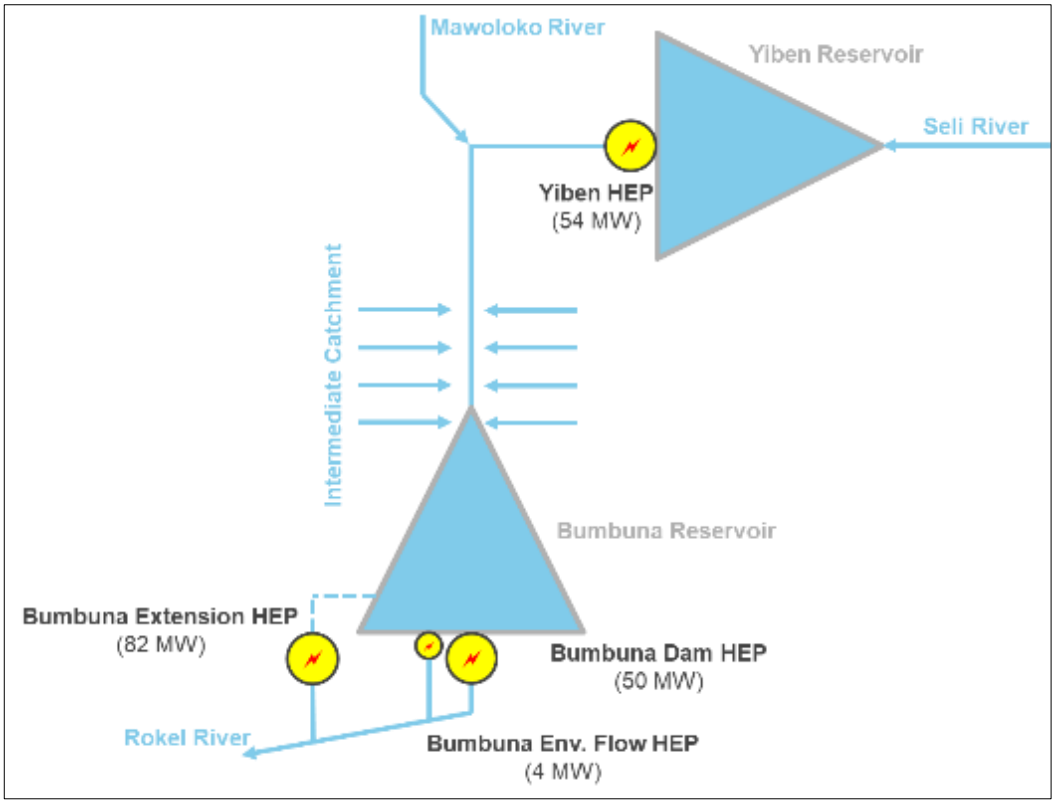

Figure 5-1: Seli HPP Schematic

The Seli HPP scheme will therefore further alter the hydrological regime of the Rokel downstream of Bumbuna with a maintained environmental flow across the seasons. The resultant loss in seasonal flow variation means that the river, which currently has a flow variation of between 6m/s to 600m/s in the dry and wet season respectively, will be regulated to an average flow of around 100m/s across the year.

It was not within the scope of this study to determine how this change in flow regulation will affect the geomorphology of the river but a more constant, regulated flow for much of the year with likely more subdued peak flow characteristics will change the natural flow dynamic of the river, reducing erosion/scouring processes associated with high flow for example (sedimentation processes will also be further affected due to the presence of the Yiben dam).

5.1.1 Surface water quantity and quality

The scale of the Addax plantation suggests the water take is particularly high for this operation. In the ESIA, it was stated that 80 million m^3 is withdrawn from the Rokel per annum. During the dry season, this is as much as 26 % of the river flow (Waterlex, 2011). According to Masafu et al (2016) there is a sufficient volume of rainfall to meet the requirements of both the Addax and Magbass plantations, however their requirement is throughout the year with peak demand in the dry season when the river flow is at its lowest. This demand pressure in the dry season in turn presents potential issues for other small-scale users of river water for agricultural purposes.

Currently, this is, in part, countered by the environmental release from the Bumbuna Dam, but as the dam does not run at capacity the difference has been described as negligible. Seli HPP, once operational, will sustain the flows during dry seasons and this will benefit all agricultural operations along the river enabling irrigation schemes to be developed.

According to the Bumbuna EIA (2003) Further downstream, as unregulated flow enters the river system from tributaries, the effect of the regulation of the dam outflow will decrease. It was anticipated that regulation of flow will delay the onset of seasonal flooding by a couple of weeks and it is assumed that this will also be the case once Seli HPP is operational.

Additional abstraction demands from the Rokel River are made from existing and planned mining developments as described above (refer to section 3.3). The Cape Lambert Marampa ESIA stated approximately 8,000m^3 of make-up water (from the Rokel River) would be required per day. The Port Loko ESIA stated that the Rokel River was the preferred water supply source for the washing plant and alumina plant but does not state precise abstraction quantities.

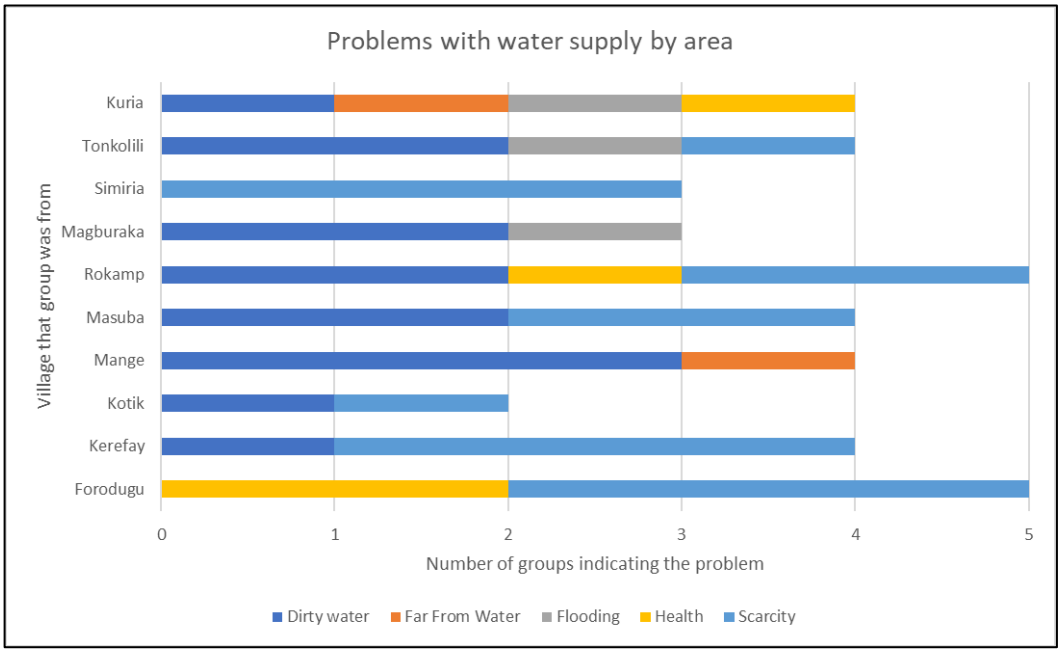

Figure 5-2: Survey responses – What problems do you have with the water supply?

During the livelihoods survey, water scarcity was an issue for groups in the majority of the areas but particularly in Simiria, Kerefay, Forodugu, Rokamp, and Masuba (Figure 5-2).

These findings were taken from responses to open ended questions with many of the groups complaining of wells and boreholes drying up in the dry season and a lack of continuous water supply throughout the year. These responses were grouped under the term ‘scarcity’.

The cleanliness of the water and resultant health problems associated with it were perceived as a problem by most of the communities who participated in the livelihood survey. This was particularly evident for the groups in Mange, Magburaka, Masuba and Tonkolili. These groups described dirty water and faecal contamination as issues with the water supply. A couple of the groups also mentioned Bumbuna releasing dirty water and the tailings from mines as contributing to the cleanliness of the water.

Issues of cholera, diarrhoea and sickness were also associated with the water supply by the communities who took part in the survey. There are clear links between health issues arising from the water and the descriptions of the dirty river water. The Seli HPP EIA states that the construction phase could impact on water quality with potential pollution of water supply (drinking/washing) and water used for irrigation. The operation of HEP is also predicted to result in a reduction of water quality and habitat diversity from environmental fish stocks and a pollution risk arising from potential surface and flow discharge.

The cleanliness of the water could be an issue a number of the groups along the Rokel, particularly in areas such as Magburaka, Mange, Masuba, Kotik, Rokamp, Simiria and Tonkolili where some groups used the Rokel for drinking water directly (Figure 5-3).

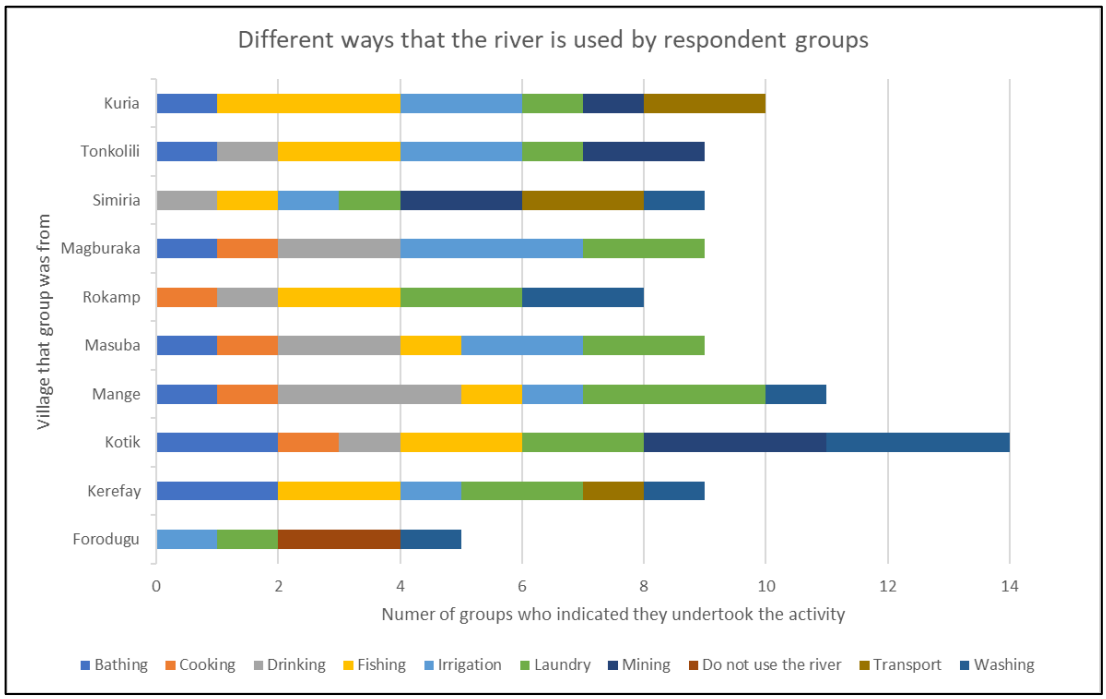

Figure 5-3: The different ways that groups use the river

5.1.2 Livelihoods

The literature review demonstrated that previous developments along the Rokel River had affected access to natural resources which could be further adversely affected by the planned developments. This is predominantly due to land taken and/or the development causing a barrier to natural resources and resultant economic displacement.

Agriculture

Agricultural activities were undertaken by all the groups surveyed and agriculture plays a significant role in these communities' lives. There are a myriad of tributaries across the Rokel catchment, each associated with extensive wetlands and inland valley swamps used for agricultural purposes. The assumption that flow regulation will delay seasonal flooding by around two weeks downstream, suggests that wet season agriculture will not be affected.

The regulated flow, during the dry season will improve access to water and in part counter the abstraction by the existing plantations that rely on the Rokel River for irrigation across the year.

Artisanal and small-scale mining

Artisanal mining could be significantly affected downstream. With the loss of river in its dry season state with regulated flow, alluvial panning may cease to exist. The livelihoods survey showed that artisanal mining was taking place along the edges of the Rokel River and its tributaries as well as away from the river, depending on the minerals being mined. It is a predominantly dry season activity, with the river becoming inaccessible during the wet season. The regulation of the river flow resulting from the project may restrict access to the river edge.

Fishing

The loss in seasonality could also affect the ecology of the river, impacting upon fishing activities in certain areas.

The type of fish caught during the wet and dry does not vary significantly but it is the variation in the amount of fish being caught during different seasons that could be most significant. Most of the groups caught more fish in the dry season and the groups in Magburaka caught significantly more fish during the dry season than any other area. However, the groups in Tonkolili and Forodugu caught the majority of their fish in the wet season and Forodugu also caught a lot more fish in general than other areas.

Any changes in the flow of the water from the Seli HPP development could therefore have a considerable impact on fishing activities in all of the areas, both on the types and number of fish being caught. The impact is likely to be most significant in the areas of Magburaka and Forodugu depending on the nature of the change.

5.1.3 Transport

All of the communities surveyed, except for Tonkolili, travelled across or along the river and experienced seasonal variations. Access across and along the river presents an opportunity for the project as the regulated flow will mean that river transport can be operated throughout the year. Access to markets was an area that prevented some communities from engaging in mineral or other trades and the regulated flow presents an opportunity to improve physical infrastructure.

5.1.4 Community health

The presence of multiple developments along the Rokel as well as plans for significant further growth puts pressure on the health and safety of local communities within the three districts which are likely to increase with the addition of further large-scale development. Population increase due to the project workforce and the potential influx of people in search of employment opportunities brings increased pressure on health facilities as well as the increased potential for the spread of disease.

When asked about some of the negative changes in their local areas, respondents to the livelihood survey cited health and disease as the most significant issues. A number of communicable diseases were recorded in the communities including Ebola, measles, lassa fever, HIV, TB, river blindness, cholera and malaria. Two of these are vector borne and related to water quality and flow. Malaria is spread by mosquitos that breed on still or stagnant water and river blindness is spread by black fly that breed on moving water. Cholera is also associated with water, usually resulting from poor sanitation.

The cleanliness of the water was also a problem for a number of the groups along the Rokel, some of whom rely on the river directly for their water supply. Some of the groups indicated that this was as a result of previous mining developments as well as Bumbuna I. Water quality is discussed in Section 5.1.1.

> "Bumbuna gives us bad water in the dry season, gives skin disease"
> "Bumbuna makes our water dirty and cannot farm along the river banks any longer"
> "Bumbuna and mining companies destroy our water and crops"

5.2 Cumulative Effects

The identified potential cumulative effects of the impact assessments from the existing and planned developments were scored between -3 and +3 depending on their impact rating in the reviewed EIA reports. Some of the reports did not include numerical ratings, in which case the information in the impact assessment and associated studies was used to indicate the significance and magnitude of each impact, allowing it to be scored with a reasonable level of confidence. Furthermore, some of the information included in the EIA studies was highly detailed, providing numerous scores for one impact. In this case, the highest score was used, in order to provide a worst-case scenario output.

Ecosystem services were not specifically identified in the impact assessment reports and therefore could not be scored in a similar way to the other VECs. However, acknowledgment of various ecosystem services is given within the other VEC categories, such as land availability (provisioning services) and water quality (regulating services).

The scores were totalled and then divided by the number of projects, giving each impact a preliminary cumulative effect rating. This process is illustrated in Figure 5-4. In addition to this score, an additional cumulative effect score was calculated, using the data from the Seli HPP ESIA. This provided data to support further study into how the Seli HPP could contribute to existing cumulative effects.

Drawing from a combination of the available literature, the livelihoods survey and the remote sensing study those effects which were likely to have the most considerable impact were further described and analysed, both in their current state and with the addition of the Seli HPP Project.

Figure 5-4: The process used to calculate each cumulative effect

These cumulative effects are demonstrated in Table 5-1.

Table 5-1: Cumulative effects ratings

VECs	Potential impact area.	Districts	Current Cumulative Impact Score	Cumulative impact score plus Seli HPP	Details
Social	Livelihoods	Tonkolili, Bombali, Port Loko	-2.5	-1.5	The change in flow regime in the Rokel with the Seli HPP will provide opportunities for improved irrigation during the dry season through increasing the availability of water across the dry season The increased and regularity of the flow may negatively affect certain dry season activities in the river bed, such as ASM.
	Transport	Tonkolili, Bombali, Port Loko	0	1	Regulated flow will mean that river transport and crossings will no longer have to manage large variations in volume and current, thus creating an opportunity for maximising use of the river as a means of transport.
	Community health	Tonkolili, Bombali, Port Loko	-1.5	-1.8	The increased flow of the river is likely to increase the incidence of river blindness through providing ideal conditions for black fly that transmit this disease to breed. It may also result in pooling of water providing conditions for mosquitos carrying malaria parasites to increase.
Biophysical	Surface water availability	Tonkolili, Bombali, Port Loko	-1.5	1	Availability of surface water will improve substantially in the dry season as the flow of the river is regulated.

6 SOCIAL MANAGEMENT PLAN

The development of Seli HPP is likely to impact upon the livelihoods of the communities downstream of the project. In order to facilitate mitigation of any negative impacts identified the livelihoods survey also included questions about livelihood change; livelihood changes that people had experienced over the last five years and livelihood changes people would like to experience. This enables high level input from the project affected communities into a social management plan to mitigate negative impacts and maximise potential opportunities.

In addition to improvements in social infrastructure and services, such as health care, education water and sanitation and electricity, improved communications and transport, access to credit and agricultural extension were identified as key contributors to improving their livelihoods and increasing their food sufficiency.

These considerations have been included in the development of a social management plan (Table 6-1) that also draws on the experience and technical skills of SRK to address the social and biophysical components of the CEA that impact on downstream livelihoods. Biodiversity VECs have not been considered as they are the focus of a separate action and management plan.

It is recommended that Seli HPP carry out additional research to determine the relevant district development plans and to see how the proposed measures in the social management plan are aligned with the respective development priorities. It is also recommended that a similar process is undertaken with major international non-governmental organisations and bilateral development agencies to determine similar shared priorities, thus enabling the downstream impacts to be managed in an effective and sustainable manner.

Table 6-1: Social Management Plan

VEC	Positive or negative effect	Detail	Proposed management action
Livelihoods: Artisanal mining	Positive and negative	Reduced access to river bank, Increased access to flood plain	Support existing artisanal gold miners working the Rokel River and flood plains affected by the project to become better organised, adopt health and safety procedures, environmental stewardship and technical skills to improve their yields from mining the flood plains; Support existing sand and gravel artisanal miners in the project affected areas to become better organised adopt health and safety procedures, environmental stewardship and technical skills required to continue to mine aggregates from the river edges; Provide access to appropriate technical and vocational training in alternative livelihood skills in the project affected communities; Improve access to microcredit by establishing mining USUSU (credit schemes) to enable project affected communities to secure loans to expand their activities in a sustainable manner.
Livelihoods: Agriculture and fishing	Positive	Increased access to water in the dry season	Provide agricultural extension support to farmers to be able to maximise opportunities provided through increased access to water for irrigation. Provide technical training and support to fishers to improve their catches across the year.
Transport	Positive	Regulated river flow	Provide microcredit (USUSU) support/ guarantees to enable affected communities to construct robust bridges at safe crossing points; Provide loans for purchase of multipurpose boats to improve access to markets, by transporting people and aggregates in the project affected communities; Provide loans for multipurpose boats that can be used as passenger boats as well as for fishing activity in the project affected communities.

VEC	Positive or negative effect	Detail	Proposed management action
Community health	Negative	Increased flow and volume of water	Engage with appropriate specialists to develop and implement community schemes to manage black fly and mosquitos in the project affected communities. Support development of community WASH (Water Sanitation and Hygiene) schemes in the project affected communities
Surface water availability	Positive	Increased access to water throughout the year	Support development of irrigation schemes for communities engaged in agricultural activities in the project affected areas; Controlled flooding during the wet season to replenish soil nutrients in the project affected areas.

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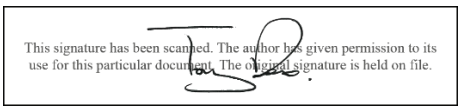

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GLOSSARY, ABBREVIATIONS, UNITS

Abbreviations

ASM	Artisanal and small-scale mining
CEA	Cumulative Effect Assessment
CP	Coastal Plains
ESIA	Environmental, Social Impact Assessment
IP	Interior Plains
HPP	Hydropower Project
ITCZ	Intertropical Convergence Zone
KKP	Koinadugu and Kono Plateaus mountains
MF	Mangrove Forest
MFZ	Montane Forest Zones
NGO	Non-Governmental Organisation
SEA	Strategic Environmental Assessment
VECs	Valued Environmental and Social Components
WHO	World Health Organisation

Units

M^3	Cubic Metres
Ms	Metres per second
M^3/s	Cubic Metres per second
Km^2	Square Kilometres

References

African Development Bank Group, (N.D). 'Addax Bioenergy Environment, Social and Health Impact Assessment, Executive Summary' [online] Available at:

https://www.afdb.org/fileadmin/uploads/afdb/Documents/Environmental-and-Social-Assessments/Addax%20Bioenergy%20-%20ESHIA%20summary%20-%20Final%20EN.pdf [Accessed Apr. 2018].

African Development Bank Group, N.D. 'Addax Bioenergy Environment and Social Management Plan, Executive Summary'

Cia.gov. (2018). *The World Factbook* — Central Intelligence Agency. [online] Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/sl.html [Accessed Apr. 2018].

Environmental Consulting Services, (2016). 'Port Loko Bauxite Mine Environment and Social Impact Assessment.

Ecotone, (2016). 'Annex E Water Resources and Ecological Flows' in Bumbuna II HPP ESIA Technical Appendices

Environmental Protection Agency and National Minerals Agency, (2016). 'Strategic Environmental Assessment of the Artisanal Mining Sector in Sierra Leone'

ERM, (2017). 'Bumbuna II Hydro Power Project Environment and Social Impact Assessment'. [online] Available at: http://selihydropower.sl/Content/documents/2.%20BBII%20ESHIA_Volume%201.pdf [Accessed April. 2018].

ERM, (2017). 'Bumbuna II Hydro Power Project Environment and Social Impact Assessment Technical Appendices'

Fao.org. (2018). Improving access to natural resources for the rural poor - A critical analysis of central concepts and emerging trends from a sustainable livelihoods perspective. [online] Available at: http://www.fao.org/docrep/006/ad683e/ad683e02.htm [Accessed April. 2018].

IFC, 2013. 'Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets' [online] Available at:

https://www.ifc.org/wps/wcm/connect/3aebf50041c11f8383ba8700caa2aa08/IFC_GoodPracticeHandbook_CumulativeImpactAssessment.pdf?MOD=AJPERES [Accessed April. 2018].

Kemp, D., Owen, J., (2015) 'Mining-induced displacement and resettlement: a critical appraisal, Journal of Cleaner Production' 87 478-488, Elsevier, www.elsevier.com/locate/jclepro

Masafu, C, K., Trigg, M A., Carter, R., and Howden, N, J, K. (2016) Water availability and agricultural demand: An assessment framework using global datasets in a data scarce catchment, Rokel-Seli River, Sierra Leone [online] Available at:

https://www.sciencedirect.com/science/article/pii/S2214581816301318 [Accessed April 2018].

Ministry of Water Resources (2015) Data and hydrological understanding generated in the Water Security project. Volume 3 of 3. Government of Sierra Leone.[online] Available at:

https://docs.wixstatic.com/ugd/bf9204_3b9dfba9e67a4223b957ed27c3713273.pdf [Accessed April 2018].

Wakeford R and Payne A.I. (2007). A Photo Guide to the fish species of the Rokel/Seli River, Sierra Leone. MRAG London.

Mansaray, A and Barrie A (2016) Utilization of Landsat Data for Quantifying and Predicting Land Cover Change in the Bumbuna Watershed in Sierra Leone [online] Available at:

https://www.scirp.org/journal/PaperInformation.aspx?PaperID=70481 [Accessed April 2018].

Nippon Koel UK & BMT Cordah Ltd, (2005). 'Bumbuna I Environment and Social Impact Assessment'. [online] Available at: http://documents.worldbank.org/curated/en/399011468777045553/pdf/E10930V-02.pdf [Accessed April. 2018].

SRK, (). 'Marampa Iron Ore Project Environment and Social Impact Statement. [online] Available at: https://s3.amazonaws.com/rgi-documents/074d35b013658f28aedc7fadb80a3720aee553fe.pdf [Accessed April. 2018].

Statistics Sierra Leone, (2015). 2015 Population and Housing Census Summary of Final Results. [online] Available at: https://www.statistics.sl/images/StatisticsSL/Documents/final-results_-2015_population_and_housing_census.pdf. [Accessed April. 2018]

Waterlex, (2011). 'Addax Bioenergy -Sugarcane-to-Ethanol Project compliance with the human right to water

Weatherbase. (2018). Sierra Leone Travel Weather Averages (Weatherbase*)*. [online] Available at: http://www.weatherbase.com/weather/city.php3?c=SL&name=Sierra-Leone [Accessed 12 Apr. 2018].

World Health Organization. (2018). Onchocerciasis (river blindness) - disease information. [online] Available at: http://www.who.int/blindness/partnerships/onchocerciasis_disease_information/en/

[Accessed April 2018].

Worley Parsons (2010). Tonkolili Iron Ore Mine stage one Environmental, Social and Health Impact Assessment. [online] Available at:

www.nma.gov.sl/resourcecontracts/contract/ocds-591adf-3141538334/.../word [Accessed April 2018].