ZAMBIA ENVIRONMENTAL MANAGEMENT AGENCY

THE REPUBLIC OF ZAMBIA

Conservation Plan for Lukanga Swamp and Upper Kafue Basin

Progress Report No. 1

February 2020

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Financing

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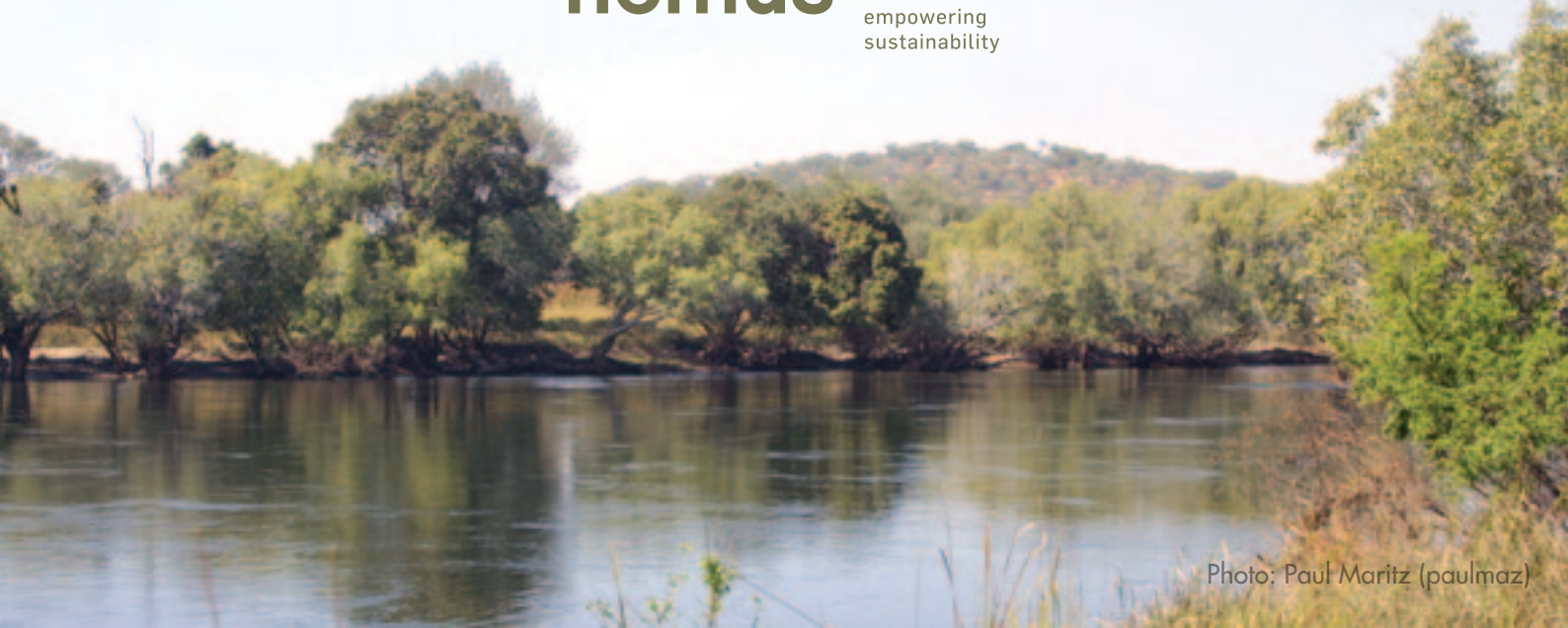


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CONSERVATION PLAN FOR LUKANGA SWAMP AND UPPER KAFUE BASIN

Progress Report No. 1

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ACRONYMS

CSO – Central Statistical Office
ES – Ecosystem Services
FDL – Food and Drugs Laboratory
FRA – Forest Resource Assessment
GDP – Gross Domestic Product
GMA – Game Management Area
IBRD – International Bank for Reconstruction and Development
IDA – International Development Association
ILUA – Integrated Land-Use Assessment
IMWI – International Water Management Institute
LCCS – Land Cover Classification System
LMP – Lukanga Management Plan
LWCS – Lusaka Water and Sewerage Company
MCDSS-SWD – Ministry of Community Development and Social Services, Social Welfare Department
MFL – Ministry of Fisheries and Livestock
MLNR – Ministry of Lands and Natural Resources
MMMD – Ministry of Mines and Minerals Development
MWDSEP – Ministry of Water Development, Sanitation and Environmental Protection
NBSAP – National Biodiversity Strategy and Action Plan
NCCRS – National Climate Change Response Strategy
NGP – National Gender Policy
NHSP – National Health Strategic Plan
NP – National Park
NPCC – National Policy on Climate Change
PNV – Potential Natural Vegetation
SNAP – Second National Agricultural Policy
UNFCCC – United Nations Framework Convention on Climate Change
WARMA – Water Resources Management Authority
WB – World Bank
WHO – World Health Organization
WWF – World Wildlife Fund for Nature
ZABS – Zambia Bureau of Standards
ZCCN – Zambia Climate Change Network
ZEMA – Zambia Environmental Management Agency
ZMERIP – Zambia Mining and Environmental Remediation and Improvement Programme
ZLA – Zambia Land Alliance

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1. Introduction

The present document is the Progress Report No. 1 of the *Consultancy for the Development of a* ***Conservation Plan for Lukanga Swamp and Upper Kafue Basin***, conducted by Nemus – Gestão e Requalificação Ambiental, Lda., for Zambia Environmental Management Agency (ZEMA).

The assignment is being conducted with the support of the World Bank (WB), under the Zambia Mining and Environmental Remediation and Improvement Programme (ZMERIP).

The main **purpose of the consultancy** is to develop a Conservation Plan for the Lukanga Swamp considering all the impacts that may arise from its catchment and from the Upper Kafue Basin.

So, the focus of the Conservation Plan is the Lukanga Swamp, represented by "Lukanga Swamps Ramsar Site" (Ramsar, 2005); wider **study areas** of the plan, to take into account the sources of impacts on Lukanga Swamp and its catchment; include Lukanga Swamp sub-catchment and Kafue River Basin upstream, all represented in Figure 1. Wider context analyses consider all the districts crossed by the above study areas:

- Chililabombwe, Chingola, Kalulushi, Kitwe, Luanshya, Lufwanyama, Masaiti, Mpongwe, Mufulira and Ndola districts, in Copperbelt Province;
- Chibombo, Kabwe, Kapiri Mposhi, Mumbwa and Ngabwe districts, in Central Province.

The development of the Conservation Plan for Lukanga Swamp and Upper Kafue Basin is being conducted in six phases:

- Phase 1: Planning;
- Phase 2: Scoping and data collection
- Phase 3: Characterization and assessment;
- Phase 4: Development of tools and recommendations for management;
- Phase 5: Presentation and dissemination of results;
- Phase 6: Final presentation and capacity building.

Progress Report No. 1 is the first of two reports to be submitted in Phase 2.

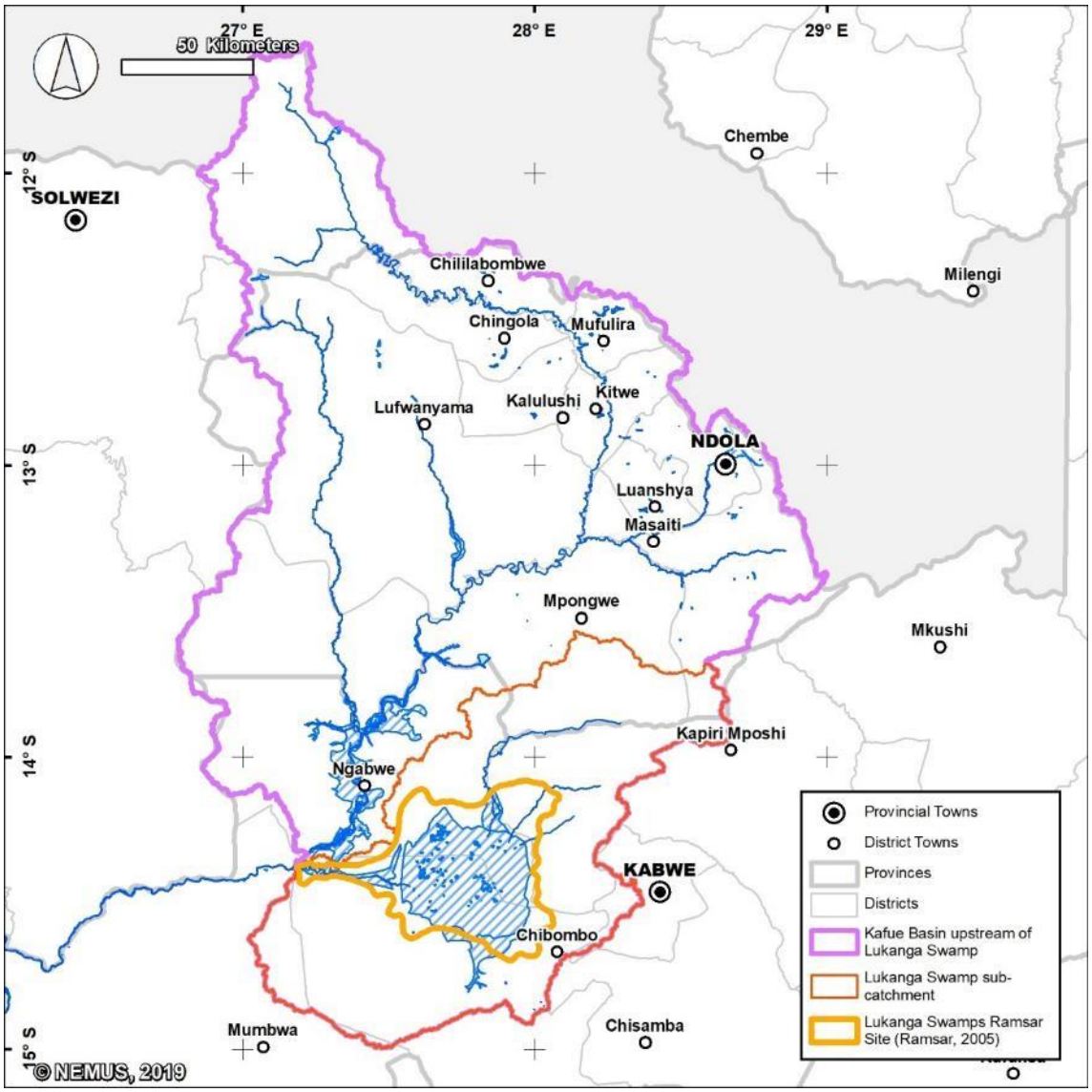


Figure 1 – Location of Lukanga Swamp and wider study areas of the Conservation Plan; administrative and hydrographic frameworks

The **scoping and data collection phase** (**Phase 2**) is one of the most important of the assignment's execution, since it sets the way for subsequent work, having as main objectives:

- Data collection for the characterization of the study area's reference, or baseline, conditions, in respect to the biophysical, socio-economic and governance systems;
- Definition of the following main issues: the ecosystem types and services that will be assessed and the associated indicators and assessment

methods; as well as the spatial scope of this assessment and the conduction of the on-site data collection.

Aiming to present the assignment progress and the items specified in the Inception Report, **Progress Report No. 1** is organised according to the following structure:

- Chapter 1 – Introduction;
- Chapter 2 – Project progress;
- Chapter 3 – Main results to date;
- Chapter 4 – Concluding remarks;
- Chapter 5 – References.

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2. Project progress

This document is the first of two reports to be submitted in Phase 2: Scoping and data collection of the development of the Conservation Plan for Lukanga Swamp and Upper Kafue Basin.

This means that Phase 1: Planning is over, which was marked by the approval of the Inception Report (D1) by ZEMA, on the 31st October 2019. During Phase 1, a preliminary and a final version of the Inception Report were submitted to ZEMA, on the 27th August 2019 and on the 18th October 2019, respectively.

The figure below **updates the work schedule** for the assignment, highlighting the current phase and deliverable.

Table 1 – Updated work schedule (February 2020)

PHASES	2019				2020						2021	
	OCT			FEB		MAY		DEC			JAN	FEB
Phase 1 – Planning	D1											
Phase 2 – Scoping and data collection			D2		D3							
Phase 3 – Characterization and assessment						D4						
Phase 4 – Integration								D5		D6 D7		
Phase 5 – Presentation											D8	
Phase 6 – Capacity building												

Legend:
D1 – Inception Report
D2 – Progress Report No. 1
D3 – Progress Report No. 2
D4 – Progress Report No. 3
D5 – Progress Report No. 4
D6 – Progress Report No. 5
D7 – Draft Report
D8 – Final Report

The activities included in Phase 2 are presented below, according to their **progress**.

Table 2 – Status of the activities involved in Phase 2 of the development of the Conservation Plan for Lukanga Swamp

	Status	
	Done	**In progress**
Activities	• In-desk data collection • Preliminary assessment of data availability and identification of needs • Definition of geographical and time frames for ecosystem service assessment and field campaigns • Field work, including field sampling, meetings with stakeholders and key informant interviews • Selection and identification of ecosystem types • Stakeholders Consultation Workshop (W1) • (M2) Meeting 2 • Progress report No. 1 (D2)	• Field work data processing • Characterisation of ecosystem types • Selection of ecosystem services • Selection of indicators and methods for assessment • Social surveys • Review of information gaps • Progress report No. 2 (D3)

The degree of achievement of the physical-financial schedule (**expenditure report**) of the assignment for this period is presented in Figure 2, including the duration of the activities, % of implementation and their allocation of monthly and accumulated costs.

PROJECT: CONSULTANCY FOR THE DEVELOPMENT OF A CONSERVATION PLAN FOR LUKANGA SWAMP AND UPPER KAFUE BASIN
CLIENT: Zambia Environmental Management Agency
Assignment duration: Aug/19 to Feb/21

Assignment period: Project commissioning to 30/12/2019

N.°	Tasks/ Deliverables			Physical-Financial Schedule																			Total
	Activities	Duration	% completed	Aug-19	Sep-19	Oct-19	nov/19	Dec-19	jan/20	Feb-20	mar/20	Apr-20	May-20	jun/20	jul/20	Aug-20	Sep-20	Oct-20	nov/20	Dec-20	jan/21	fev/21	
Phase 1 – Planning		**1,5 months**	**100%**	**11,0%**		**1,5%**																	12,5%
	Preparation of D1	1,5 month	100%																				
D1	*Inception report*		100%																				
Phase 2 – Scoping and data collection		**6 months**	**82%**		**7,0%**	**8,0%**	**7,0%**	**6,0%**															28,0%
	In-desk data collection	6 months	100%																				
	Assessment of data availability and needs	3 months	100%																				
	Field work and social surveys (dry season)	1,5 months	100%																				
	Selection and identification of ecosystem types	3 months	100%																				
	Characterisation of ecosystem types	2 months	25%																				
	Selection of ecosystem services	1 month	50%																				
	Selection of indicators and methods for assessment	2 months	0%																				
	Stakeholder consultation workshop (W1)	1 month	100%																				
	Preparation of D2	2 months	100%																				
D2	*Progress report #1 (week 12)*	*2 months*	*100%*																				
	Field work data processing; Integration of findings	3 months	60%																				
	Preparation of D3	2 months	0%																				
D3	*Progress report #2 (week 24)*	*2 months*	*0%*																				
Phase 3 – Characterization and assessment		**3 months**	**0%**																				0,0%
	Field work and social surveys (wet season)	1,5 months	0%																				
	Selection of indicators and methods for assessment	3 months	0%																				
	Characterization of the study area	3 months	0%																				
	Identification of trends, drivers and impacts	3 months	0%																				
	ES assessment	3 months	0%																				
	Cost-benefit analysis	2 months	0%																				
	Assessment of future scenarios	2 months	0%																				
	Assessment of data needs	3 months	0%																				
	Preparation of D4	3 months	0%																				
D4	*Progress report #3 (week 36)*	*1 month*	*0%*																				
Phase 4 – Integration		**7 months**	**0%**																				0,0%
Phase 5 – Presentation		**1 month**	**0%**																				0,0%
Phase 6 – Capacity building		**1 month**	**0%**																				0,0%
Financial progress (%)				**11,0%**	**18,0%**	**27,5%**	**34,5%**	**40,5%**															

Figure 2 – Degree of achievement of the physical-financial schedule for the study period

Three **field work** campaigns were conducted in this period:

- the first, in July 2019, aimed to get a first assessment of the Swamp, including a visit to several villages and fishing communities in the swamps' margins; fieldwork also included reconnaissance of Kafue river and exploring its margins and the physical and ecological interactions between Lukanga Swamps and Upper Kafue River Basin;
- the second, in September 2019, included water, sediment and ecological sampling around Lukanga Swamp and in the Copperbelt Province, among other field data collection;
- the third, in October 2019, included ecology, water and sediment sampling in the Copperbelt Province and deeper in Lukanga Swamp, vegetation sampling, imagery and social data collection, among other field data.

Results from the data collection and processing/analysis conducted so far are summarized in the next chapter (chapter 3).

During the site visits conducted so far, stakeholder and community interviews were also conducted. The first **Stakeholders Consultation Workshops** (actually W1 and W2) were held in Lusaka (29th October 2019) and Kitwe (1st November 2019). **Meeting 2** (**M2**) with ZEMA took place on the 30th October 2019. The stakeholder consultations conducted so far are further described in Appendix 3.

Next steps; **ongoing challenges** include:

- Fieldwork data processing – processing, analysing and integrating the primary data collected (e.g. results from laboratory analyses of water, sediment and vegetation samples, community interviews and drone imagery) represents a challenge; solution: to make the most out of this activity, its results will be presented in Progress Reports No. 1, No. 2 and No. 3 and the next and last field campaign will be scheduled to May 2020, so that it allows to complete and clarify any gaps and doubts from these analyses;
- Secondary data collection – key information holders were engaged during and after the Stakeholders Consultation Workshop (W1), namely through formal information requests at the beginning of December 2019, but only a few provided information so far; to progress this challenge, a follow up is already being conducted, through email, phone and/or meetings, but an

institutional involvement from ZEMA would be crucial in this process, as already suggested by some of the stakeholders;

- Social survey planning – visits to local communities for the conduction of focus group discussions couldn't be scheduled along with the field visits carried out until October; meanwhile, the so-called "lean (peak hunger) period" (Chibuye, 2011) and the rainy season started, so these social surveys were being planned to February 2020 (towards the end of the hungry and rainy seasons and still in Phase 2 – Scoping and data collection) and April or May 2020 (next field sampling campaign and in time to be considered in Phase 3 – Characterization and assessment); the solution for this challenge was already in place by the time this report was first submitted: as some areas were still accessible and ZEMA, through the project, could provide food and drinks during the meetings, these surveys got their kick-off in December 2019; their planning is also further described in Appendix 3.

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3. Main results to date

3.1. Planning and legal framework

The main government policies relevant to wetland conservation are summarized in Table 3.

Table 3 – Policy documents relevant to wetland conservation

Policy document	Description / goals relevant to wetland conservation
Lukanga Management Plan (LMP – Chabwela *et al*., 2010)	The vision of the LMP is "to have a well-managed Lukanga Wetland and catchment area that significantly contributes to the local and national economy, and provides goods and services that enhance the social wellbeing for current and future generations without compromising environmental integrity by 2030".
National Policy on Wetlands (Ministry of Lands and Natural Resources, 2018)	The vision of the Policy is "a functional, productive and resilient wetland system that will contribute to addressing climate change maintenance of biodiversity, provision of ecosystem goods and services and sustainable livelihoods". In order to achieve the vision, the overall objective of this Policy is to preserve and conserve wetland resources and protect the wetland environment in order to ensure sustainable utilization of Zambia's wetlands. In pursuit of this overall objective, the two thematic areas of focus for this policy are (1) wetland conservation and protection and (2) sustainable socio-economic utilisation.

Policy document	Description / goals relevant to wetland conservation
Vision 2030 (Government of the Republic of Zambia, 2006)	The National Long-Term Vision 2030 (Vision 2030) is Zambia's first ever written long-term plan, expressing Zambians' aspirations by the year 2030. The Vision is operationalised through five-year development plans starting with the Fifth National Development Plan (2006-2010). The Zambian people's vision is to become "A Prosperous Middle-Income Nation by 2030". Sector visions and targets/goals include: • "Clean and safe water supply and sanitation for all by 2030" with "Fully integrated and sustainable water resource management" • "A productive environment and well conserved natural resources for sustainable socioeconomic development by 2030"
Seventh National Development Plan 2017-2021 (Ministry of National Development Planning, 2017)	The Seventh National Development Plan departs from sectoral-based planning to an integrated (multisectoral) development approach under the theme "Accelerating development efforts towards the Vision 2030 without leaving anyone behind". Under "Development Outcome 7: Improved water resources development and management", several strategies will be undertaken during the Plan period to address water development and management challenges with a view to increasing availability of water resources for utilisation by productive sectors, for enhanced health of the ecosystem and sustainable economic growth.

Policy document	Description / goals relevant to wetland conservation
National Water Policy (Ministry of Energy and Water Development, 2010)	The National Water Policy of 2010 is a revision of the National Water Policy (1994) in order to provide a comprehensive framework for sustainable development, management and utilisation of the water resources. It envisages to embrace modern principles of water resources management and to deal with the daunting challenges of poverty reduction. Its Vision is “To optimally harness water resources for the efficient and sustainable utilisation of this natural resource to enhance economic productivity and reduce poverty”. The Policy recommends the implementation of measures to address challenges such as “Climate Change” (one of the “Cross-sectoral issues” identified), including the following: • Assessing and monitoring the potential impact of climate change on ecosystems especially woodlands, forests and wetlands; • Supply of clean and safe water to communities to prevent water borne diseases that come with floods/droughts; • Developing and promoting alternative energy sources to fuel-wood and technologies in order to reduce the use of fuel-wood and woodlands, forests and wetlands.
National Policy on Environment (Government of the Republic of Zambia, 2009)	The overall vision of the National Policy on Environment is to provide a framework management guide for the management of Zambia’s environment and natural resources so as to ensure that they are managed on a sustainable basis and retain their integrity to support the needs of the current and future generation without compromising either of the two. Underlying the entire Policy is the Government's commitment to reduce poverty and achieve sustainable development for the Nation as a whole on the basis of "development without destruction". Among the guiding principles it is stated that “When biotic resources are used, it will ensure that such use will be wise, sustainable and consistent with maintaining the integrity of ecosystems and ecological processes”. One of the proposed strategies for the water sector is to “Review existing information on wetlands and dambos and, where necessary, undertake further studies in order to develop guidelines for their proper utilisation”.

Policy document	Description / goals relevant to wetland conservation
Second National Biodiversity Strategy and Action Plan (NBSAP-2) – 2015-2025 (Ministry of Lands, Natural Resources and Environmental Protection, 2014)	Zambia's NBSAP-2 covers the period 2015-2025, and its vision is "By 2025, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy environment and delivering benefits essential for all Zambians and the Zambian economy." The Strategic Goals and Targets of Zambia's NBSAP2 include reducing the direct pressures on biodiversity and promoting sustainable use (Strategic Goal B), aiming that "By 2025, areas under agriculture, aquaculture and forestry (…) are managed sustainably, ensuring conservation of biodiversity" (Target 7). One of the "Strategic Interventions" under Target 7 is to "Promote management of wildfires in biodiversity areas such as forests, GMAs, NPs and wetlands".
National Policy on Climate Change 2016 (NPCC; Ministry of Lands, Natural Resources, and Environmental Protection, 2016)	The NPCC has been developed to support and facilitate a coordinated response to climate change issues in the country. It also aims to contribute to the achievement of the overall objective of the United Nations Framework Convention on Climate Change (UNFCCC) which is "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". Specific objectives include: • To promote mainstreaming of climate change into policies, plans and strategies at all levels in order to account for Climate Change risks and opportunities in decision making and implementation; • To promote investments in climate resilient and low carbon development pathways in order to generate co-benefits and provide incentives for addressing climate change more effectively.

Policy document	Description / goals relevant to wetland conservation
National Climate Change Response Strategy (NCCRS – Government of the Republic of Zambia – Ministry of Tourism, Environment and Natural Resources, 2010)	The NCCRS has also been developed to support and facilitate a coordinated response to climate change issues in the country. The NCCRS' mission is "to ensure that the most vulnerable sectors of the economy are climate proofed, and sustainable development achieved through the promotion of low carbon development pathways." In the long term the goal is to ensure climate change is mainstreamed in all sectors by 2030. The objectives of the NCCRS' are related to priority sectoral adaptation and mitigation actions needed to achieve the Strategy's vision of a Prosperous Climate Change Resilient Economy. They include: • Land Use (Agriculture and Forestry): To develop sustainable land use systems to enhance agricultural production and ensure food security under the changing climate; • Water: To ensure sustainable management and resiliency of water resources under the changing climate; • Health and Social Infrastructure: To protect people and health from climate change and climate variability; • Mainstreaming: To mainstream climate change in all the key sectors of the economy.
National Food and Nutrition Policy (Ministry of Health, 2006)	The principal goal of the National Food and Nutrition Policy is to achieve sustainable food and nutrition security and to eliminate all forms of malnutrition in order to have a well-nourished and healthy population that can effectively contribute to national economic development. Policy (specific) objectives include: • To develop and implement policies and programmes that will ensure adequate nutrition, food security, food quality and safety at individual, household, community and national level; • To incorporate nutrition issues into developmental programmes.

Policy document	Description / goals relevant to wetland conservation
Second National Agricultural Policy (SNAP – Ministry of Agriculture and Ministry of Fisheries and Livestock, 2016); fisheries policy currently falls within the National Agricultural Policy, though a stand-alone fisheries policy is being developed (Ministry of Fisheries and Livestock in SADC Secretariat, 2016)	This Policy is the responsibility of the Ministries of Agriculture, and that of Fisheries and Livestock, providing policy guidelines for the development of the agriculture sector – which refers to crops, livestock and fisheries sub-sectors – in Zambia. Furthermore, the SNAP seeks to be in line with the new political environment in the country. The Vision of the Second National Agricultural Policy is: "An efficient, competitive and sustainable agricultural sector, which assures food and nutrition security, increased employment opportunities and incomes." Objective 8 of the SNAP – "To promote the sustainable management and use of natural resources" – includes the following measures: • Decentralize capture fisheries management to communities; • Promote sustainable utilization of rangeland (grassland ecosystem) and pastures for livestock production; • Promote sustainable fishing methods; • Promote programmes and appropriate technologies/methods for sustainable utilization of fisheries resources.
National Health Policy (Government of the Republic of Zambia, 2012) and National Health Strategic Plan 2017-2021 (NHSP – Ministry of Health, 2017)	General objectives of the National Health Policy include promoting "awareness among Government employees and the community at large that, health problems can only be adequately solved through multi-sectoral collaboration involving such sectors as Education, Agriculture, Water, Private Sector". Specific objectives include promoting "hygiene, universal access to safe water, acceptable sanitation and food safety in order to reduce the incidence of environmentally related diseases" and scaling-up interventions aimed at combating and controlling communicable diseases, including prevention, treatment and care.

Policy document	Description / goals relevant to wetland conservation
National Gender Policy 2014 (Ministry of Gender and Child Development, 2014)	This policy is the revised version of the National Gender Policy (NGP) of 2000. The ultimate objective of this Policy is to create a Zambian society which has achieved the Vision of 'A nation where there is gender equity and equality for sustainable development'. One of its guiding principles is "accountability for gender mainstreaming", meaning that "stakeholders both public and private are required to account for gender mainstreaming in the implementation of their policies, programmes and activities.

Additionally, as a **Ramsar site** Lukanga Swamp is also governed by the 1971 International Treaty on Wetlands (Mapedza *et al.,* 2011).

Table 4 summarizes the wetland management legal framework, outlining the enabling Acts and a brief description of each one of them.

Table 4 – Wetland management legal framework

Enabling Act	Purpose / relevance to wetland conservation
Water Resources Management Act No. 21 of 2011	The Act provides for the protection, preservation and conservation of wetlands and headwaters.
Environmental Management Act No. 12 of 2011	The Act provides for declaration of wetlands as ecologically sensitive areas and for their protection.
Fisheries Act No. 22 of 2011	The Act provides for the sustainable development of fisheries and a precautionary approach in fisheries management, conservation, utilisation and development, stating that any area of a commercial fishing area may be declared as a fisheries reserve if the Minister considers that special measures are necessary to "protect, preserve or rehabilitate the fish habitat, related ecosystems including wetlands, lakes, lagoons, nursery and spawning areas, which are essential to maintaining the integrity of an ecosystem, species or assemblages of species".
Lands Act of 1995 (Chapter 184 of the Laws of Zambia; date of consolidation/reprint: 2006)	The Act provides for the management and administration of land in Zambia on which wetlands are located.

Enabling Act	Purpose / relevance to wetland conservation
The Forests Act No. 4 of 2015	The Act provides for protection and conservation of forests and trees which in turn protect wetlands.
The Wildlife Act No. 15 of 2015	The Act provides for the implementation of the Convention on Wetlands of International Importance especially as Waterfowl Habitat, the Convention on Biological Diversity, the Lusaka Agreement on Cooperative Enforcement Operations Directed at Illegal Trade in Wild Fauna and Flora and other international instruments to which Zambia is party.
Zambia Development Agency Act No. 11 of 2006	The Act establishes the Zambia Development Agency and the Trade and Industrial Development Fund and makes provision in general for economic development in Zambia. Before authorizing development, the Board of the Agency shall have regard to, among other things, the impact the proposed investment is likely to have on the environment and, where necessary, the measures proposed to deal with an adverse environmental consequence.
National Heritage Conservation Commission Act No. 173 of 1989	The Act provides for the conservation of ancient, cultural and natural heritage, relics and other objects of aesthetic, historical, prehistorical, archaeological or scientific interest.
Disaster Management Act No. 13 of 2010	The Act establishes and provides for the maintenance and operation of a system for the anticipation, preparedness, prevention, coordination, mitigation and management of disaster situations and the organisation of relief and recovery from disasters; provides for the declaration of disasters; provides for the responsibilities and involvement of the members of the public in disaster management.
Public Health Act of 1930 (2006) (Chapter 295 of the Laws of Zambia)	The Act provides for the prevention and suppression of diseases and generally to regulate all matters connected with public health in Zambia.

Enabling Act	Purpose / relevance to wetland conservation
Mines and minerals Act No. 11 of 2015	The Act revises the law relating to the exploration for, mining and processing of, minerals and provides for safety, health and environmental protection in mining operations. It establishes, for instance, that "where any harm or damage is caused to the environment or biological diversity, compensation shall include the cost of reinstatement, rehabilitation or clean-up measures which are incurred and where applicable, the costs of preventive measures".
Local Government Act No.2 of 2019	The Act provides for an integrated local government system; gives effect to the decentralisation of functions, responsibilities and services at all levels of local government; ensure democratic participation in, and control of, decision making by the people at the local level; revises the functions of local authorities; provides for the role of traditional leadership in democratic governance.
The Urban and Regional Planning Act No. 3 of 2015	An Act to establish procedures for integrated planning in a devolved system of governance so as to ensure multi-sector cooperation, coordination and involvement of different levels of ministries, provincial administration, local authorities, traditional leaders and other stakeholders in urban and regional planning; ensure sustainable urban and rural development by promoting environmental, social and economic sustainability in development initiatives and controls at all levels of urban and regional planning.
Tourism and Hospitality Act No. 13 of 2015	The Act provides for the sustainable development of the tourism industry through effective tourism planning, management, promotion and coordination to ensure sustainable tourism. This includes ensuring "that tourism does not deprive local communities and wildlife of access to land resources, especially along the banks and shores of rivers, dams, lagoons and lakes which they need for their livelihood and survival".

Source: National Policy on Wetlands (2018).

3.2. Socioeconomic background

In this section a brief social and economic characterisation of the broader geographic scope of the assignment is presented. It includes the population and demography characterisation, the social background and, finally, a description of the most relevant economic aspects of the territory under analysis.

As established in the Inception Report, the study area includes five districts of the Central Province (Chibombo, Kabwe, Kapiri Mposhi, Mumbwa and Ngabwe) and all the ten districts of the Copperbelt Province (Chililabombwe, Chingola, Kalulushi, Kitwe, Luanshya, Lufwanyama, Masaiti, Mpongwe, Mufulira and Ndola). Therefore, the analysis is focused primarily at the district level and, more broadly, at the province level. Nevertheless, it will also include a comparison with the whole country.

The information presented below is essentially based on the 2010 Census of Population and Housing (CSO, 2012, 2013 and 2014).

However, Ngabwe only became a district after the 2010 Census. In fact, Ngabwe was only declared a district in 2013, until that time it was part of Kapiri Mposhi district, corresponding to Ngabwe and Mukubwe Wards (Lusaka Voice, 2013). Therefore, when the existing data is not available at the ward level, Ngabwe's information is not displayed.

3.2.1. Population and demography

From 2000 to 2010, Zambia's population grew at an average rate of 2.8 percent per year, reaching 13,092,666 persons (CSO, 2012a). In 2010, 60 percent of the country's total population was residing in rural areas (Figure 4).

The total population for the districts under analysis in 2010 was about 23 percent of the whole Zambia's population, according to the 2010 Census of Population and Housing (CSO, 2013a and 2014b) and considering the part of the Kapiri Mposhi district that became Ngabwe District[1].

Table 5 and Table 6 present the population for Central and Copperbelt Provinces, respectively, as well as the annual growth rate between 2000 and 2010 and the population density.

Table 5 – Total population (*De jure) for Central Province Districts within the study area (2000 – 2010)**

Province District	Population		Annual Growth Rate (2000-2010)	Density (2010) (pop/km^2)
	2000	2010		
Central Province	1,012,257	1,307,111	2.6%	11.8
Chibombo District	241,612	303,519	2.3%	37.1
Kabwe District	176,758	202,360	1.4%	130.8
Kapiri Mposhi District	194,752	253,786	2.7%	24.1
Mumbwa District	158,861	226,171	3.6%	11.4
Ngabwe District	n.a.	21,238	n.a.	3.3

*Note: "De Jure Population" refers to usual household members present and usual household members temporarily absent at the time of the census (institutional populations in places such as hospitals or health centres, prisons and academic institutions like universities, colleges and boarding schools are counted as members of their usual household) (CSO, 2014a).
Legend: n.a. = data not available.

Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2012a and 2013a) and City Population (2019).

Between 2000 and 2010, there was a **population** increase in all the districts under analysis. In Central Province, Mumbwa was the District that registered a higher average grow rate, 3.6 percent per year. In Copperbelt Province, in turn, Mpongwe's population grew at an average rate of 3.8 percent per year between 2000 and 2010. In Kitwe and

[1] Ngabwe and Mukubwe Wards.

Chililabombwe Districts the population also grew at a higher average rate than Zambia's population (3.2 percent and 3.1 percent per year, respectively).

The country is sparsely populated with a **density** of 17.4 persons per square kilometre (CSO, 2012a). The density for Central Province is even lower, with 11.8 persons per square kilometre (City Population, 2019). On the opposite way, as Table 6 shows, Copperbelt Province has a density of 63 persons per square kilometre. Kitwe and Ndola Districts are among the most densely populated, with approximately 641 and 468 persons per square kilometre, respectively.

Table 6 – Total Population (*De jure*) for Copperbelt Province districts within the study area (2000-2010)

Province District	Population		Annual Growth Rate (2000-2010)	Density (2010) (pop/km^2)
	2000	2010		
Copperbelt Province	1,581,221	1,972,317	2.2%	63.0
Chililabombwe District	67,533	91,833	3.1%	92.1
Chingola District	172,026	216,626	2.3%	125.5
Kalulushi District	75,805	100,381	2.8%	97.4
Kitwe District	376,124	517,543	3.2%	640.5
Luanshya District	147,908	156,059	0.5%	166.4
Lufwanyama District	63,185	78,503	2.2%	6.9
Masaiti District	95,581	103,857	0.8%	29.1
Mpongwe District	64,371	93,380	3.8%	10.9
Mufulira District	143,930	162,889	1.2%	130.2
Ndola District	374,757	451,246	1.9%	467.6

Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2014b) and City Population (2019).

Table 7 and Table 8 show the Central Statistical Office's (CSO) population and demographic projections regarding the Central and Copperbelt Provinces' districts, for the period between 2011 and 2035 (CSO, 2013c). According to these estimates, Central and Copperbelt Provinces will have approximately 2,565,450 and 3,823,642 inhabitants in 2035, respectively.

The population in the Central Province districts near Lukanga Swamp will increase 82.8% between 2011 and 2035, reaching 926,994 persons (CSO, 2013c). Despite population increase, the projections for the annual population growth rate indicate that,

from 2020, the growing trend will be at a slower pace in some of the districts under analysis, such as Chibombo, Kabwe and Kapiri Mposhi (see Table 7).

Table 7 – Total population projections for Central Province districts within the study area (2011-2035) (Medium Variant projection)

Province District	Population			Projected Annual Population Growth Rate	
	2011	2020	2035	2011-2020	2020-2035
Central Province	1,355,775	1,734,601	2,565,450	2.5%	2.5%
Chibombo District	156,708	194,778	271,991	2.2%	2.1%
Kabwe District	101,599	113,993	133,547	1.3%	1.0%
Kapiri Mposhi District	131,088	167,744	245,952	2.5%	2.4%
Mumbwa District	117,658	163,870	275,504	3.3%	3.3%
Ngabwe District	n.a.	n.a.	n.a.	n.a.	n.a.

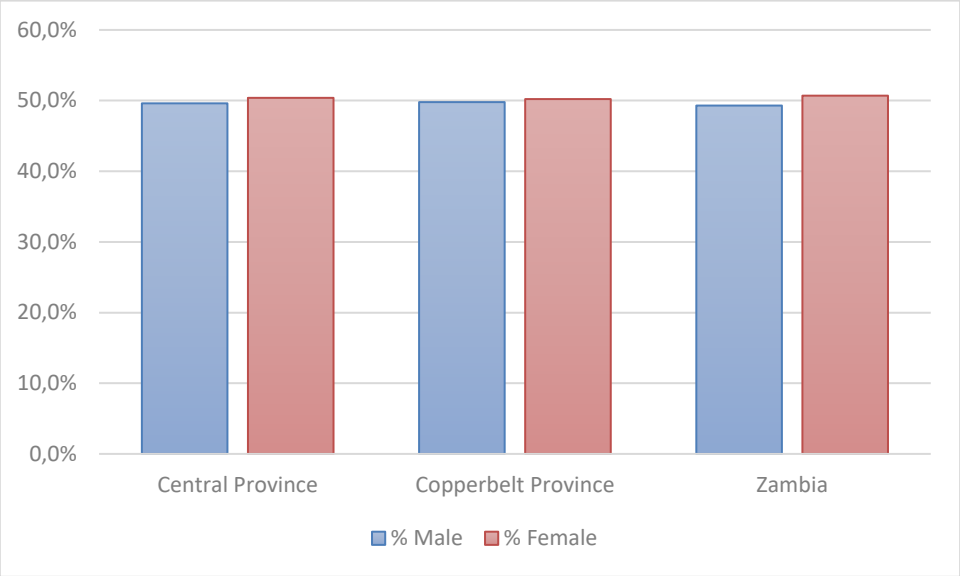
Source: Adapted from Zambia Population and Demographic Projections 2011-2035 (CSO, 2013c).

Table 8 – Total population projections for Copperbelt Province districts within the study area (2011-2035) (Medium Variant projection)

Province District	Population			Projected Annual Population Growth Rate	
	2011	2020	2035	2011-2020	2020-2035
Copperbelt Province	2,143,413	2,669,635	3,823,642	2,2%	2,3%
Chililabombwe District	100,395	134,272	213,929	3,0%	3,0%
Chingola District	235,519	293,959	417,590	2,2%	2,2%
Kalulushi District	109,524	143,032	219,084	2,7%	2,7%
Kitwe District	566,131	762,950	1,223,870	3,0%	3,0%
Luanshya District	167,533	177,934	192,474	0,6%	0,5%
Lufwanyama District	85,268	105,156	146,443	2,1%	2,1%
Masaiti District	111,738	122,024	138,536	0,9%	0,8%
Mpongwe District	102,543	145,239	254,133	3,5%	3,6%
Mufulira District	175,753	199,095	240,307	1,3%	1,2%
Ndola District	489,009	585,974	777,276	1,8%	1,8%

Source: Adapted from Zambia Population and Demographic Projections 2011-2035 (CSO, 2013c).

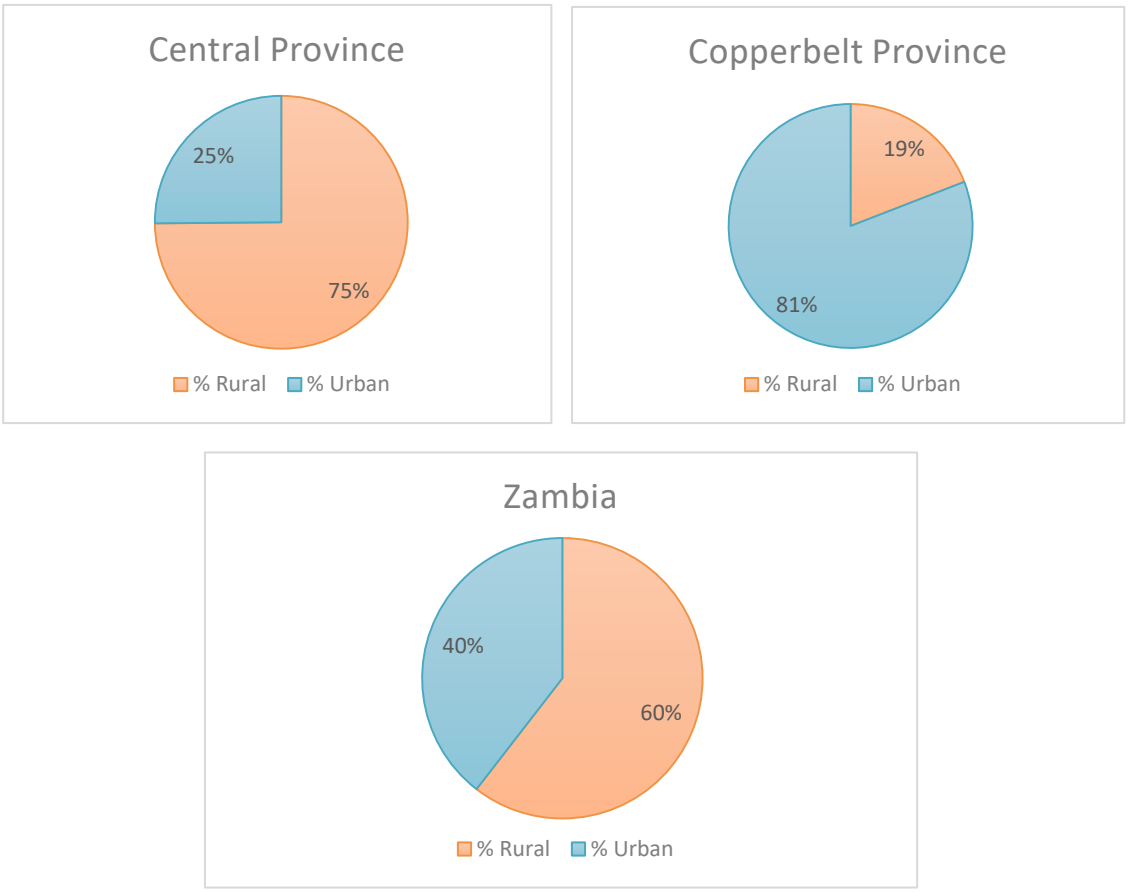
In what concerns **gender distribution**, the territories under analysis have a similar profile. Although there is a slight difference between the number of male and female individuals, the population was almost equally distributed, as Figure 3 shows. In 2010, women represented 50.4 percent and 50.2 percent of total population in Central and Copperbelt provinces, respectively. At the district level the distribution was very similar. In Kabwe, the district where the population was more unequally distributed, women represented 51.2 percent of total population.



Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2012a, 2013a and 2014b).

Figure 3 – Percent distribution of the population (*De jure*) by gender for Central Province, Copperbelt Province and Zambia (2010)

On the other hand, the provinces within the study area had very distinctive profiles in what concerns **rural/urban distribution**. In 2010, Central Province, where the Lukanga Swamp is located, was mostly rural, with ¾ of its population living in rural areas. In contrast, Copperbelt Province was mainly urban, with 81 percent of its total population residing in such areas (see Figure 4).

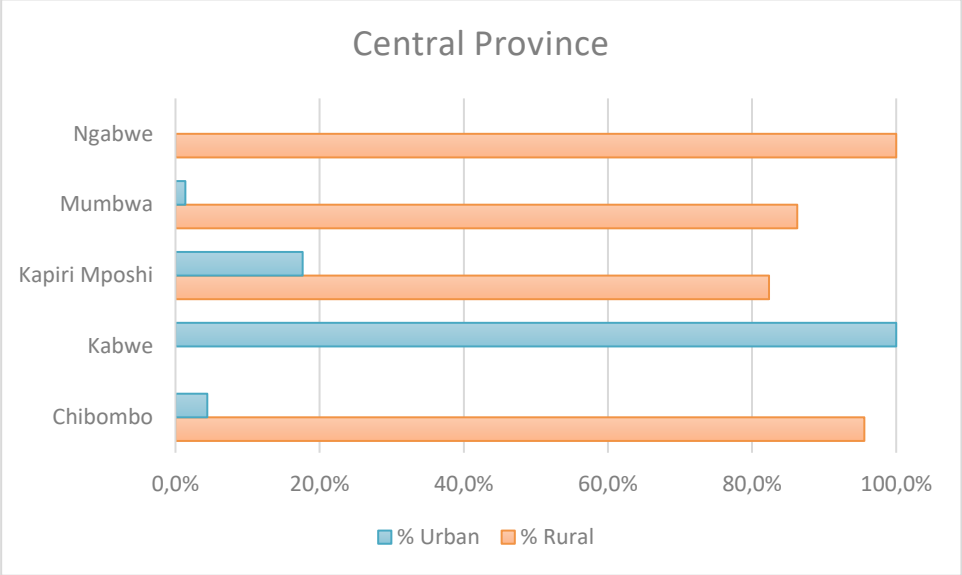


Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2012a, 2013a and 2014b).

Figure 4 – Percent distribution of the population (*De jure*) by rural/urban areas for Central Province, Copperbelt Province and Zambia (2010)

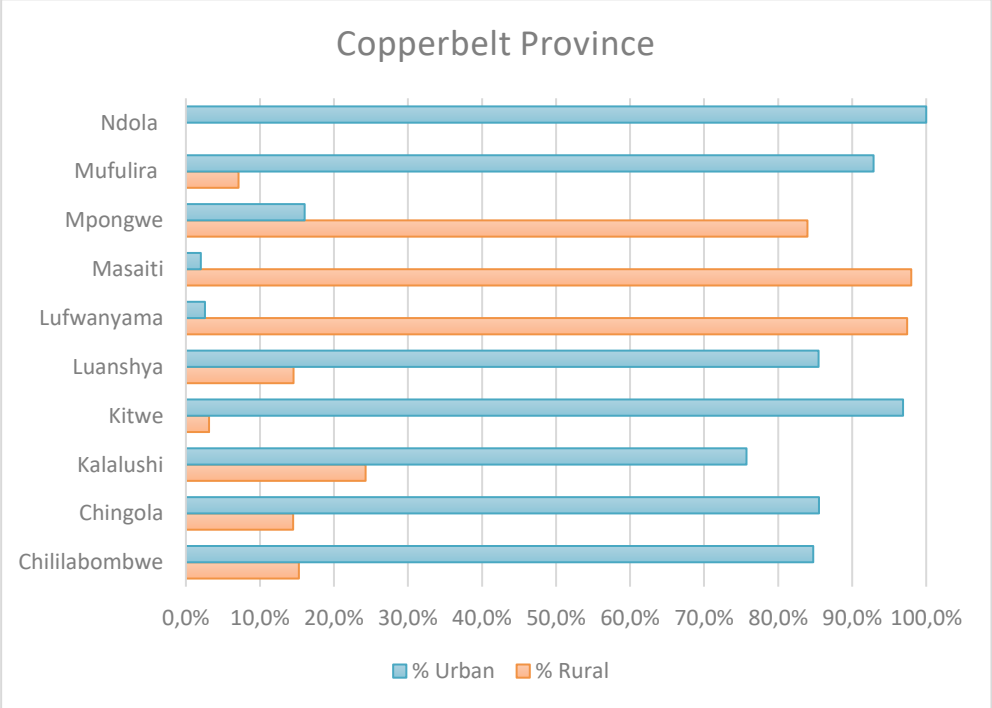
Figure 5 shows the percent distribution of the population by rural/urban for Central Province districts within the study area, in 2010. Although Central Province was mainly rural, in Kabwe the population was 100 percent urban, in 2010. The other districts were essentially rural, with more than 80 percent of their population residing in rural areas in 2010 (CSO, 2013a).

The rural/urban distribution for the districts of Copperbelt Province is presented in Figure 6. Once again, even though Copperbelt's population is mainly urban, there are districts with a different behaviour. In fact, Mpongwe, Masaiti and Lufwanyama had more than 80 percent of the population living in rural areas, in 2010. The remaining districts, in turn, were essentially urban.



Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2013a).

Figure 5 – Percent distribution of the population (*De jure*) by rural/urban areas for Central Province Districts within the study area (2010)



Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2013b and 2014b).

Figure 6 – Percent distribution of the population (*De jure*) by rural/urban areas for Copperbelt Province Districts within the study area (2010)

The percent **distribution of the population by age group** is presented in Table 9.

Table 9 – Percent distribution of the population (*De jure*) by age group for Central Province, Copperbelt Province and Zambia (2010)

Age group	Zambia	Central Province	Copperbelt Province
0 - 4	17.2%	17.5%	14.7%
5 - 9	14.6%	15.0%	12.8%
10 - 14	13.6%	14.1%	13.4%
15 - 19	11.7%	12.0%	12.9%
20 - 24	9.1%	8.9%	9.8%
25 - 29	8.1%	7.4%	8.7%
30 - 34	6.4%	6.0%	6.9%
35 - 39	5.2%	0.5%	5.6%
40 - 44	3.6%	3.5%	3.9%
45 - 49	2.9%	2.8%	3.2%
50 - 54	2.2%	2.2%	2.5%
55 - 59	1.5%	1.5%	1.8%
60 - 64	1.3%	1.3%	1.4%
65+	2.6%	2.8%	2.3%

Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2012a, 2014a and 2014b).

Table 9 shows that Zambia has a young population, with 45.4 percent of persons aged bellow 15 years, in 2010. The **median age**, in 2010, was 16.9 years, higher in urban areas (18.7 years) than in rural areas (15.6 years) (CSO, 2012a).

The proportion of the population aged bellow 15 years was higher in the Central Province (46.6 percent). Also, the median age in Central Province was lower than that of the country as a whole (16.3 years in 2010). As in Zambia, the median age in urban areas was higher when compared to rural ones (18.3 years against 15.6 years, in 2010) (CSO, 2014a).

In Copperbelt Province, in turn, the proportion of the population aged below 15 years was 40.9 percent, lower than that for Zambia. This may be due to the fact that Copperbelt is essentially urban, as Figure 4 shows. In this province, the median age was also higher in urban areas than in rural ones (18.8 years against 16.6 years, in 2010).

3.2.2. Social background

According to the Census of Population and Housing, Central Province had 235,560 **households** in 2010 and Copperbelt Province had 371,125 households (CSO, 2012a). Together, these provinces represented 24.1 percent of the total number of households in Zambia.

Table 10 and Table 11 present the number of households, for both provinces and their districts as well as for Zambia, by sex of head of household and its average size.

Table 10 – Households by sex of head of household, rural/urban and average size for Central Province Districts within the study area (2010)

Province District	Total	Average size	Household Headship		Rural/Urban	
			Male	Female	Rural	Urban
Central Province	235,560	5.5	185,348	50,212	170,714	64,846
Chibombo District	53,179	5.7	41,767	11,412	50,566	2,613
Kabwe District	39,862	5.1	30,002	9,860	0	39,862
Kapiri Mposhi District	45,977	5.5	36,329	9,648	37,235	8,742
Mumbwa District	39,142	5.8	30,306	8,836	32,655	6,487
Ngabwe District	4,059	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2012b, 2014a and 2014b).
Legend: n.a. = data not available.

Table 11 – Households by sex of head of household, rural/urban and average size for Copperbelt Province Districts within de study area (2010)

Province District	Total	Average size	Household Headship		Rural/Urban	
			Male	Female	Rural	Urban
Copperbelt Province	371,125	5.3	295,018	76,107	74,541	296,584
Chililabombwe District	17,326	5.3	14,325	3,001	2,936	14,390
Chingola District	39,657	5.5	32,297	7,360	6,251	33,406
Kalulushi District	19,203	5.2	15,609	3,594	4,911	14,292
Kitwe District	96,666	5.4	77,506	19,160	3,530	93,136
Luanshya District	29,043	5.4	22,468	6,575	4,878	24,165
Lufwanyama District	15,597	5.0	12,422	3,175	15,197	400
Masaiti District	20,511	5.1	16,045	4,466	20,104	407
Mpongwe District	17,350	5.4	13,761	3,589	14,339	3,011
Mufulira District	30,065	5.4	23,757	6,308	2,395	27,670
Ndola District	85,707	5.3	66,828	18,879	0	85,707

Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2012b, 2013b and 2014b).

In 2010, the **average household size** was higher in Central Province (5.5 persons per household) than in Copperbelt Province (5.3 persons per household). Both of the provinces had more persons per household in average, when compared to the average household size of the country as a whole (5.2 persons per household) (CSO, 2012b).

Regarding **household headship**, Table 10 and Table 11 show that, in all the territories under analysis, the number of male headed households was higher than female headed ones, as expected. Female headed households represented 21.3 percent of the households in Central Province, in 2010, while in Copperbelt Province the proportion of female headed households was slightly lower, 20.5 percent of households (CSO, 2014a and 2014b). In Zambia, in turn, the female headed households represented 22.5 percent of the total households, in 2010 (CSO, 2012b).

In what concerns **education**, in 2010, Copperbelt's population had, in average, a higher level of education when compared to the Central Province population. The literacy rate for adult population (15 years and older) was higher in Copperbelt Province than in Central Province (93.5 percent against 89.1 percent) (CSO, 2014a and 2014b). At national level, the adult literacy rate was lower, only 80.3 percent of the population aged 15 years and older was able to both read and write, in 2010 (CSO, 2012a).

Table 12 – Education characteristics for Central Province Districts within the study area (2010)

Province District	Literacy rate (% 15 years and older)	Highest education level completed (% 25 years and older)			
		None	Primary	Secondary	Tertiary
Central Province	89.1%	0.4%	54.7%	34.4%	10.5%
Chibombo District	83.7%	1%	60.4%	31.5%	7.5%
Kabwe District	92.8%	1%	30%	46.9%	22.8%
Kapiri Mposhi District	83.1%	0.8%	58%	34.3%	7.4%
Mumbwa District	85.6%	0.5%	58%	33.5%	8.2%
Ngabwe District	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2014a).
Legend: n.a. = data not available.

Considering the rural/urban distribution, the **adult literacy** rate was higher in urban areas (92.4 and 95.8 percent in Central and Copperbelt provinces, respectively) than in rural ones (81.2 and 82.6 percent in Central and Copperbelt provinces) (CSO, 2014a and 2014b). In addition, Males had a higher literacy rate (89.2 and 96.1 percent in Central and Copperbelt provinces, respectively) than females (79.9 and 90.9 percent in Central and Copperbelt provinces, respectively) (CSO, 2014a and 2014b).

Furthermore, Table 12 and Table 13 show that of the population aged 25 years and older in Copperbelt Province, 48.2 percent had completed secondary school (grade 8 to 12) (CSO, 2014a). In Central Province, in turn, the **highest completion rate** was for primary education (grade 1 to 7) at 54.7 percent of the population aged 25 years and older (CSO, 2014b).

Table 13 – Education characteristics for Copperbelt Province Districts within the study area (2010)

Province District	Literacy rate (% 15 years and older)	Highest education level completed (% 25 years and older)			
		None	Primary	Secondary	Tertiary
Copperbelt Province	93.5%	0.2%	31.5%	48.2%	20%
Chililabombwe District	94.7%	0.2%	25.7%	53.8%	20.4%
Chingola District	95.1%	0.1%	27.3%	51.9%	20.7%
Kalulushi District	93.6%	0.3%	30.9%	48.5%	20.4%
Kitwe District	96.1%	0.1%	26.8%	51.3%	21.7%
Luanshya District	94.8%	0.2%	27.9%	50.4%	21.5%
Lufwanyama District	79.1%	0.4%	63.4%	29.9%	6.3%
Masaiti District	82.6%	0.4%	61.0%	32.7%	5.9%
Mpongwe District	84.1%	0.2%	58.3%	34.1%	7.4%
Mufulira District	94.7%	0.2%	26.8%	51.4%	21.6%
Ndola District	94.6%	0.2%	29.6%	47.3%	22.9%

Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2014b).

In 2010, Bemba was the widely used **language** of communication in Central and Copperbelt provinces as well as in Zambia, spoken by 31.8 percent of the population in Central Province, 83.9 percent of the population of Copperbelt Province and 33.5 percent of the population of the whole country (CSO, 2012a, 2014a and 2014b). However, this was not the most spoken language in all the districts of the study area. In Chibombo, Lenje was spoken by a higher proportion of the population (31.9 percent) and in Mumbwa the most spoken language, in 2010, was Tonga (30.3 percent) (CSO, 2014a). In Copperbelt's districts, Lamba was the widely used language in Lufwanyama, Masaiti and Mpongwe, spoken by 58.3, 64.1 and 64.5 percent of the population, respectively (CSO, 2014b).

Bemba was also the largest **ethnic group** in Copperbelt Province (accounting for 35.9 percent of the provincial population) as well as in Zambia (representing 21.0 percent of the country's population) (CSO, 2012a and 2014b). In Central Province, in turn, the Lala ethnic group represented the largest group, with 20.3 percent of the provincial population (CSO, 2014a).

Finally, regarding **religious affiliations**, Protestants represented 81.6 and 75.7 percent of the population of Central and Copperbelt provinces, respectively (CSO, 2014a and

2014b). At national level, the proportion of Protestants was 75.3 percent, in 2010 (CSO, 2012a). Catholicism was the second religion with more affiliates, representing 14.0 percent of the population of Central Province, 20.7 percent of the population of Copperbelt Province and 20.2 percent of national population (CSO, 2012a, 2014a and 2014b).

3.2.3. Economic background

Table 14 presents the economic activity status of the population aged 12 years and older for both provinces and districts within the study area, in 2010.

In Central Province, in 2010, of the population aged 12 years and older, 412,017 were in the **labour force,** of which 77.9 percent were in rural areas and 22.1 percent were in urban ones (CSO, 2013a). In Copperbelt Province, in contrast, only 23 percent of the labour force were in rural areas and 77 percent were in urban ones.

As Table 14 shows, in Central Province 11.9 percent of the economically active individuals were unemployed, in 2010. In Copperbelt Province the **unemployment** rate was quite higher, with 21.9 percent of the labour force unemployed, while at national level the proportion was 13 percent (CSO, 2012a and 2013b).

The urban unemployment rate was higher than the rural unemployment rate both at municipal and regional levels. In Central Province, in 2010, urban unemployment rate for the population with 12 years and older was 23.7 percent, while rural unemployment rate was 9.4 percent. In Copperbelt Province urban unemployment represented 26.4 percent of the total urban labour force (aged 12 years and older) compared to 7.2 percent in rural areas (CSO, 2013b). At national level, urban unemployment rate was 22.1 percent while rural unemployment rate was 7.4 percent (CSO, 2012a).

In what concerns the gender distribution of unemployment, there are differences between the provinces under analysis. In Copperbelt Province, the unemployment rate among male population with 12 years and older was 20.8 percent compared to 24.2 percent among the female population (CSO, 2013b). In Central Province, in turn, male unemployment represented 13.4 percent of the male labour force with 12 years and older, while female unemployment rate was 11.8 percent, in 2010 (CSO, 2013a). Also, at national level, male unemployment rate was higher than the female one (13.5 and 12.4 percent, respectively) (CSO, 2012a).

Table 14 – Usually working population (De Facto*) by economic activity status for Central and Copperbelt provinces (2010)

Province District	Population 12 years and older	Economically active			Economically inactive			
		Total labour force	Employed	Unemployed	Total	Full time Housewife/ Homemaker	Full time student	Other
Central Province	754,850	412,017	362,862	49,155	342,833	94,724	180,709	67,400
Chibombo District	173,027	88,941	76,991	1,195	84,086	26,133	38,265	19,688
Kabwe District	132,584	56,956	42,278	14,678	75,628	20,088	41,087	14,453
Kapiri Mposhi District	144,832	86,326	78,503	7,823	58,506	15,566	33,768	9,172
Mumbwa District	124,053	71,011	64,460	6,551	53,042	13,772	29,864	9,406
Ngabwe District	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Province District	Population 12 years and older	Economically active			Economically inactive			
		Total labour force	Employed	Unemployed	Total	Full time Housewife/ Homemaker	Full time student	Other
Copperbelt Province	1,278,711	655,758	512,184	143,574	622,953	170,449	348,956	103,548
Chililabombwe District	59,753	28,744	21,315	7,429	31,009	9,775	16,660	4,574
Chingola District	140,744	68,916	52,425	16,491	71,828	21,392	39,388	11,048
Kalulushi District	64,414	33,533	27,079	6,454	30,881	8,485	17,483	4,913
Kitwe District	341,144	169,157	123,444	45,713	171,987	47,569	96,663	27,755
Luanshya District	104,471	47,185	32,826	14,359	57,286	14,093	32,714	10,479
Lufwanyama District	45,112	30,141	28,175	1,966	14,971	3,048	8,982	2,941
Masaiti District	62,206	39,903	37,681	2,222	22,303	4,247	13,956	4,100
Mpongwe District	53,735	45,187	44,469	718	8,548	746	6,379	1,423
Mufulira District	107,994	49,314	36,778	12,536	58,680	15,745	32,134	10,801
Ndola District	299,138	143,678	107,992	35,686	155,460	45,349	84,597	25,514

*Notes: “De Facto Population” refers to household members and visitors who spent the census night at a household; “De Jure Population” is not used in the analysis of data on various social, economic and health characteristics as some variables would be missing for individuals who were absent from the household at the time of the census (CSO, 2013a). n.a. = data not available.

Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2012a, 2013a and 2013b).

Table 15 and Table 16 show the percent distribution of usually working population 12 years and older **by employment status** for Central Province and Copperbelt Province, respectively.

Table 15 – Percent distribution of usually working population 12 years and older by employment status for Central Province districts within the study area (2010)

Province District	Employment Status			
	Employer	Employee	Self Employed	Unpaid Family Worker
Central Province	0.7%	18.4%	46.6%	34.3%
Chibombo District	0.9%	17.8%	48.5%	32.8%
Kabwe District	1.9%	52.8%	37.3%	8.0%
Kapiri Mposhi District	0.5%	11.3%	53.7%	34.5%
Mumbwa District	0.2%	11.5%	45.0%	43.2%
Ngabwe District	n.a.	n.a.	n.a.	n.a.

Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2013a).

Table 16 – Percent distribution of usually working population 12 years and older by employment status for Copperbelt Province districts (2010)

Province District	Employment Status			
	Employer	Employee	Self Employed	Unpaid Family Worker
Copperbelt Province	1.2%	44.4%	35.8%	18.6%
Chililabombwe District	1.3%	62.5%	27.6%	8.6%
Chingola District	1.5%	54.5%	30.0%	14.0%
Kalulushi District	0.8%	45.2%	30.3%	23.7%
Kitwe District	1.6%	56.0%	37.0%	5.4%
Luanshya District	1.3%	49.7%	34.7%	14.3%
Lufwanyama District	0.3%	7.0%	43.6%	49.1%
Masaiti District	0.3%	6.4%	48.9%	44.4%
Mpongwe District	0.2%	9.8%	33.2%	56.8%
Mufulira District	1.4%	52.8%	33.6%	12.2%
Ndola District	1.5%	55.3%	36.0%	7.2%

Source: Adapted from Zambia 2010 Census of Population and Housing (CSO, 2013b).

In Central Province, of the employed population, the highest percentage was self-employed, representing 46.6 percent. The same happens in all the Central Province

districts under analysis, except for Kabwe in which 52.8 percent of the total usually working population was employee. Zambia had the same employment status distribution with 44.1 percent of the employed population self-employed and the employees representing only 22.3 percent (CSO, 2012a).

On the other hand, in Copperbelt Province most of the employed population was employee (44.4 percent), except for the rural districts. As Table 16 shows, in Masaiti the highest percentage of the employed population was self-employed (48.9 percent) and in Lufwanyama and Mpongwe "unpaid family worker" represented the majority of the usually working population (49.1 and 56.8 percent, respectively).

Regarding employment distribution **by industry**, in 2010, agriculture industry accounted for 66.5 percent of the usually working population, in Zambia (CSO, 2012a). In fact, the distribution of the usually working population 12 years and older by industry shows that the "Agriculture Hunting Forestry and Fishing" sector accounts for 72.1 percent of the usually working population in Central Province (CSO, 2013a). In Copperbelt Province, this proportion was smaller (32.5 percent), nevertheless agriculture was still the industry with a higher percentage of employment (CSO 2013b).

At the district level, most of the districts had the same distribution, with agriculture industry accounting for the majority of the usually working population, in 2010. However, there were some exceptions. In Kabwe, a Central Province district, the highest percentage of working population was for "Community Social and Personal services", with 26.7 percent. In Copperbelt Province, the exceptions were in Chililabombwe, where most of the employment was in "Mining and Quarying" industry (39.1 percent) and in Kitwe and Ndola districts, where employment in "Wholesale & Retail trade Restaurants and Hotels" industry represented 26.2 and 23.1 percent of the working population, in 2010, respectively.

Even though "Agriculture Hunting Forestry and Fishing" was the industry with the higher percentage of usually working population, in 2010, "Wholesale & Retail trade Restaurants and Hotels" was the most significant in terms of **Gross Value Added** (CSO, 2015).

Gross Value Added by economic activity at current prices for Zambia between 2010 and 2015 is presented in Table 17. The Gross Value Added for "Wholesale & Retail trade Restaurants and Hotels" was 17,590.5 million ZMK, in 2010, and 41,129.8 million ZMK, in 2015, which represents 18.1 and 22.4 percent of GDP, respectively (CSO, 2015).

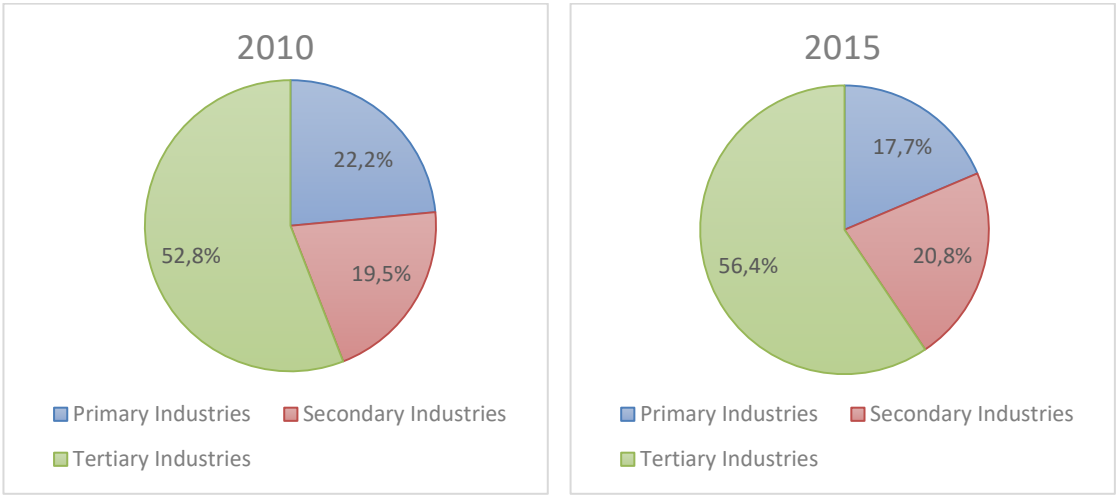
Table 17 – Gross Value Added by Economic Activity at Current Prices for Zambia (2010-2015; in Million ZMK)

Industry	2010	2011	2012	2013	2014	2015
Agriculture, forestry and fishing	9,158.7	11,001.6	12,236.7	12,449.3	11,325.5	9,133.9
Mining and quarrying	12,428.7	17,515	19,057	25,686.8	24,449.6	23,244.2
Primary industries	21,587.4	28,516.6	31,293.7	38,136.1	35,775.1	32,378.1
Manufacturing	7,367.3	8,570.7	9,288.6	9,362.6	11,393	13,794.5
Electricity generation and supply	1,623.8	2,420.2	2,317.9	2,202.7	3,963.3	5,664.4
Water supply and sewerage	160.2	363.2	392.3	499.7	329.8	373.2
Construction	9,761.3	10,407.6	10,965.3	11,588.2	14,898.6	18,353.4
Secondary industries	18,912.6	21,761.7	22,964.1	23,653.2	30,584.7	38,185.5

Industry	2010	2011	2012	2013	2014	2015
Wholesale and retail trade	17,590.5	22,370.2	25,828.8	33,126.4	36,415.9	41,129.8
Transportation and storage	5,705.9	4,945.6	5,667	5,099.8	5,997.7	7,290.4
Accommodation and food services	1,599.4	1,764.9	2,447.4	2,695.4	2,754.5	3,075
Information and communication	1,587.5	3,335.7	4,142.9	4,106.2	3,836	5,329.8
Financial and insurance services	3,977.9	3,736.7	4,099.6	4,416.1	5,256.3	7,098.7
Real estate	4,012.1	4,498.7	5,042.7	5,600.6	6,875.8	8,840.7
Professional, scientific and technical services	1,505.5	1,482.3	2,417.2	2,655.8	2,858.2	2,641.9
Administrative and support service	1,577.7	1,185	1,040.8	1,330.7	1,282.3	1,638.1
Public administration and defence; compulsory social security	3,905.4	3,481	6,484.2	7034	7,351.8	8,103.1
Education	6,818.5	7,687.4	9,265.3	11,007.6	13,085.7	14,383.2
Human health and social work	1,900.2	1,842.2	2,225.9	1,800.9	2,175.2	2,403.7
Arts, entertainment and recreation	368.1	336.1	304.1	507.6	520.9	570.4
Other services	787.7	791.6	864.1	959.2	983.6	885
Tertiary industries	51,336.4	57,457.4	69,830	80,340.3	89,393.9	103,389.8
Total for the economy	91,836.3	107,735.8	124,087.6	142,129.6	155,753.8	173,953.4
Taxes less subsidies on products	5,379.6	6,296.8	7,185.9	9,200.9	11,298.7	9,427.7
Gross Domestic Product (GDP) at market prices	97,215.9	114,032.5	131,273.5	15,1330.5	167,052.5	183,381.1

Source: Adapted from National Accounts of Zambia (CSO, 2015).

In fact, as Figure 7 illustrates, the tertiary industries had the highest percentage share of GDP, accounting for over half of the GDP in both 2010 (52.8 percent) and 2015 (56.4 percent). In 2010, primary industries were the second more significant **industry sector**, representing 22.2 percent of GDP. In 2015, in turn, there was a decrease in primary industries share of GDP coupled with an increase in the Construction and Manufacturing industries (see Table 17) which led to an increase for secondary industries share of GDP, overcoming primary industries in 2015 (from 19.5 percent, in 2010, to 20.8 percent, in 2015) (CSO, 2015).



Source: Adapted from National Accounts of Zambia (CSO, 2015).

Figure 7 – Gross Value Added percentage shares at current prices by Industry Sector for Zambia (2010; 2015)

The **industrial specialization** within Central and Copperbelt provinces in 2015 is presented in Table 18. As for Zambia, "Wholesale and retail trade" industry was the major industry in Central Province contributing more than 30 percent to the respective Provincial GDP, in 2015. The second major industry was "Agriculture, forestry and fishing" accounting for 14.6 percent of GDP in the same year (CSO, 2015).

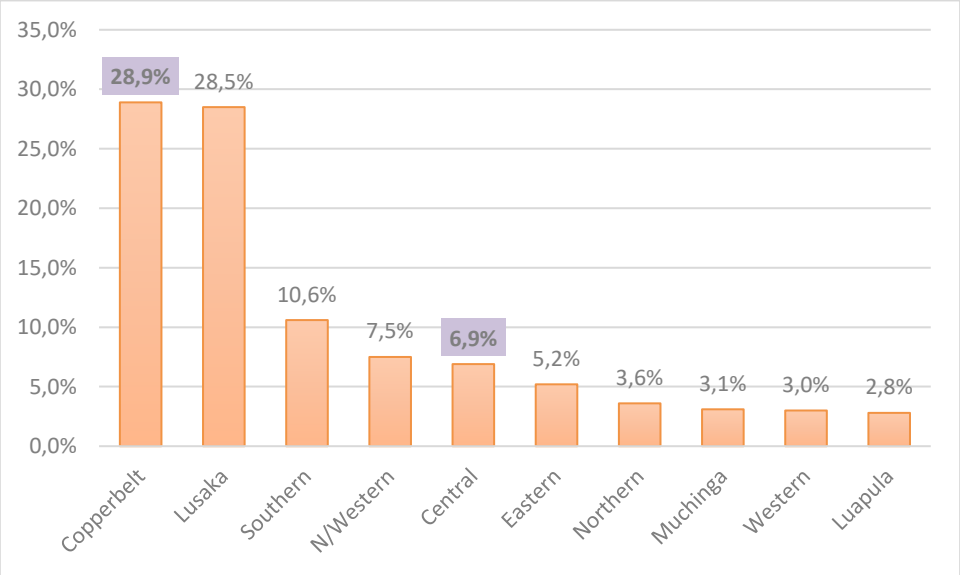
In Copperbelt Province, in turn, "Mining and quarrying" was the major industry with a contribution of 25.6 percent to the provincial GDP, followed by "Wholesale and retail trade" industry contributing 17.7 percent, in 2015 (CSO, 2015).

Table 18 – Gross Value Added percentage shares at current prices by economic activity within Central and Copperbelt Provinces and Zambia (2015)

Industry	Central Province	Copperbelt Province	Zambia
Agriculture, forestry and fishing	14.6%	3.5%	5.0%
Mining and quarrying	0.0%	25.6%	12.7%
Manufacturing	0.7%	12.7%	7.5%
Electricity generation and supply	0.9%	0.3%	3.1%
Water supply and sewerage	0.1%	0.4%	0.2%
Construction	8.9%	5.9%	10.2%
Wholesale and retail trade	32.4%	17.7%	22.3%
Transportation and storage	2.6%	7.1%	4.0%
Accommodation and food services	0.3%	0.3%	1.7%
Information and communication	3.6%	2.8%	2.9%
Financial and insurance services	3.9%	4.4%	3.9%
Real estate	7.1%	2.5%	4.8%
Professional, scientific and technical services	0.0%	0.4%	1.4%
Administrative and support service	0.4%	0.9%	0.9%
Public administration and defence; compulsory social security	4.1%	4.7%	4.4%
Education	10.8%	5.3%	7.8%
Human health and social work	1.2%	0.8%	1.3%
Arts, entertainment and recreation	0.0%	0.3%	0.3%
Other services	0.7%	0.2%	0.5%
Total for the economy	92.5%	95.9%	94.9%
Taxes less subsidies on products	7.5%	4.1%	5.1%
Gross Domestic Product (GDP) at market prices	100.0%	100.0%	100.0%

Source: Adapted from National Accounts of Zambia (CSO, 2015).

The **provincial contribution to the Gross Value Added**, in 2015, is presented in Figure 8. Copperbelt Province was the major contributor to the Gross Value Added, in 2015, in Zambia, representing almost 30 percent of the national GDP. Central Province was in fifth place in the provincial ranking with a contribution of 6.9 percent to the national GDP.



Source: Adapted from National Accounts of Zambia (CSO, 2015).

Figure 8 – Provincial contribution to the Gross Value Added at current prices (2015)

Finally, Table 19 shows the contribution to the Gross Value Added **by industrial activities** for Central and Copperbelt Provinces, in 2015. In the first place, the results demonstrate that, in 2015, Central and Copperbelt provinces together contributed with more than 40 percent of the "Agriculture, forestry and fishing" Gross Value Added, leading the industry. Secondly, Copperbelt Province dominated most industries, contributing with more than a half to the Gross Value Added of "Mining and quarrying" (58.4 percent), "Water Supply and sewerage" (55.2 percent) and "Transportation and storage" (51.7 percent) industries, in 2015. "Manufacturing" was also dominated by Copperbelt Province with a contribution of 48.9 percent.

Table 19 – Central and Copperbelt contribution to the Gross Value Added at current prices by economic activity (2015)

Industry	Central Province	Copperbelt Province
Agriculture, forestry and fishing	20.2%	20.5%
Mining and quarrying	0.0%	58.4%
Manufacturing	0.6%	48.9%
Electricity generation and supply	2.1%	2.8%
Water supply and sewerage	4.9%	55.2%
Construction	6.1%	16.9%
Wholesale and retail trade	10.0%	22.9%
Transportation and storage	4.6%	51.7%
Accommodation and food services	1.1%	6.0%
Information and communication	8.6%	27.7%
Financial and insurance services	6.9%	33.1%
Real estate	10.1%	14.8%
Professional, scientific and technical services	0.2%	7.9%
Administrative and support service	3.4%	28.8%
Public administration and defence; compulsory social security	6.4%	30.6%
Education	9.5%	19.4%
Human health and social work	6.5%	17.8%
Arts, entertainment and recreation	0.0%	29.0%
Other services	10.1%	14.8%
Total for the economy	6.7%	29.2%
Taxes less subsidies on products	10.0%	22.9%
Gross Domestic Product (GDP) at market prices	6.9%	28.9%

Source: Adapted from National Accounts of Zambia (CSO, 2015).

3.3. Socio-economic characterization of Lukanga Swamp

3.3.1. Governance

As stated by McCartney *et al*. (2011) Lukanga Swamp is managed following the National Wetlands Policy. The **National Policy on Wetlands** (2018) aims to promote "a coordinated approach to management and conservation of wetland ecosystems in Zambia" in order to address its degradation.

The **Ministry responsible for Natural Resources** is in charge of supervising the implementation of this Policy, as well as leading the inter-agency coordination on the management of wetlands in the country. In fact, the implementation and management of wetlands involve several institutions and stakeholders. Besides the presence of Zambian government, through its ministries and agencies, there is also a group of **non-governmental organizations** working in Lukanga, such as the World Wide Fund for Nature (WWF), the International Water Management Institute (IMWI), Development Aid from People to People (DAPP) and BirdLife International (Kachali, 2007 and Mapedza *et al*., 2012).

The fact that natural resource management, and particularly in this case wetland management, is fragmented in several government institutions and different regulations is often pointed out as contributing to natural resource degradation (Kachali, 2007 and DSI, 2008). Furthermore, government authorities are often absent from the territory and therefore **local communities** are the actual managers of the wetlands (McCartney *et al.*, 2011).

Indeed, as most of the land in Zambia that is controlled under customary rights, the Lukanga Swamp and its catchment are under the traditional land system (Chabwela *et al*., 2010). This means that chiefs are very important stakeholders, not only being responsible for allocation of land but also in interpreting government policy and mobilizing the population for development programs (Chabwela *et al*., 2010). Traditional leaders thus remain very influential, being also responsible for giving permission to cultivate land, access to water and collect plants from the wetland and its surrounding areas (Mapedza *et al*., 2011 and McCartney *et al*., 2011).

There are five chiefs in the Lukanga – namely Ngabwe, Mukubwe, Chipepo, Liteta and Chitanda –, who preside over the predominantly Lenje speaking people (MCDSS-SWD, written communication, December 2019).

3.3.2. Communities characterization

According to Kachali (2007), there are three main tribal groups living in and around Lukanga swamps: Lenje, Tonga and Bemba. The Lenje and Tonga people represent 25% of the total population in the area (Chabwela *et al*., 2010).

The **Lenje** are the largest (as mentioned before) and oldest tribal group in Lukanga, mainly composed by **subsistence farmers** who claim to be the "local residents" (Mapedza *et al*., 2012). During the rainy season they grow maize, while during the dry season they cultivate vegetables. Their main activities also include burning charcoal, livestock rearing (namely cattle, goats and chickens) and fishing.

Lukanga swamp is not only a source of soil, water and plant resources, but is also linked to religious rights and traditional norms of this group. Therefore, they are not welcoming to outsiders, having some conflicts with outsiders' fishermen who are getting the benefits of selling fish in town (Kachali, 2007).

The **Bemba** culture is linked to fishing. In fact, according to Kachali (2007) this activity was the main reason for the migration of Bemba group, arriving to the Lukanga swamps around the 1960's. This community is composed by two main groups: the resident **fishermen** and the migrant fishermen. While the first group have tried to integrate into the local community, the migrant fishermen live in town and only come to Lukanga in the fish open season. Therefore, they tend to have less respect for traditional norms and conservation of natural resources. Besides fishing, some Bemba also grow crops during the fish ban season.

For Bemba group, Lukanga swamp is a source of fish resources and land. In contrast with the Lenje group, Bemba have less of a spiritual connection to the wetland (Kachali, 2007).

Finally, the **Tonga** are **cattle keepers**, but similarly to the other two traditional groups mentioned above, they also grow crops (Kachali, 2007). They migrated from the southern province motivated by the persistent droughts of the early 1990s and were the latest group arriving to Lukanga. Since they belong to the same linguistical group as the Lenje, they have less conflicts with them. However, the growth of their cattle population has caused some tensions between them and the local community.

According to Kachali (2007) analysis, for Tonga group, Lukanga swamp is an important source of pasture and water for their animals and crops.

There are other groups within the swamps that include the Luvale, Lozis and Lambas, among others (Kachali, 2007; see box below).

Testimony from Davy Malichi, aged 58 years, migrant to Lukanga Swamps

Mr. Davy Malichi is Luvale by tribe. He worked in Mopani Copper Mines in Mufulira, Copperbelt as an underground miner before he retired after working for 15 years. After his retirement from the Mines, he first went to settle in Solwezi, Northwestern Province before he relocated to Kabosha Village under Chief Chitanda in 1995.

Mr. Malichi has been fishing in Lukanga Swamps for almost 25 years. He recalls that the fishing harbour was located right near the village and when the swamps flooded, the waters were reaching the uplands. He says that with climate change, the rainfall was not performing well. The Lukanga Swamp is not keeping water and many of the boreholes in the Kabosha village have dried up.

He points out that there are over 100 fishing ponds in Lukanga swamps. It is the biggest wetland in Zambia as compared to Bangweulu Swamps. He observed that the fish yield is declining due to overfishing. Many fishermen from as far as Luapula and Northwestern provinces have migrated to Lukanga Swamps. He says there are more people in these fishponds on Lukanga Swamps than on the mainland Kabosha Village. He recalls the time he has been on the Swamps; the national census has never been done to ascertain the population of people on the swamps.

When he arrived in Kabosha Village, there were many animals and birds freely grazing on the shores of the Lukanga Swamps, such as hippopotamus, impalas, crested cranes and many other birds' species. The drought of 1995, forced these animals to migrate deep in the swamps. He noted that invasion of the weeds called javans was not severe in the Lukanga Swamps at the time. Not until now they have negatively affected the fishing in the swamps. BirdWatch has introduced foreign insects as an ecological control on the spreading of the Javan weeds.

Traditionally, he says, women are not allowed to go into Lukanga Swamps to fish. It is against the ancestors for fear that fish will disappear from the fishing ponds.

Source: Malichi (personal communication, October 2019).

The exact number of villages in Lukanga swamp is not known. Table 20 presents the 36 villages settled in the Kapiri Mposhi side of the swamp (Chabwela *et al*., 2010), though there are other villages settled in the Ngabwe, Mumbwa and Chibombo sides of the swamp. Noted villages in the side of Ngabwe are Kilwa, on the island, and Chishimu village, on the mainland. In the side of Mumbwa, are Chiyokona and Mweshi villages. In the side of Chibombo district, there is Kabosha village.

Table 20 – Villages in Kapiri Mposhi side of Lukanga Swamp

Area	Nr. of villages	Names
Kapoka	2	Tulamuombe, Mubinganyama
Chishimu	11	Mashiko, Kanakamsaka, Memba, Mukumbo, Chilonga, Ndinga, Ndeya, Linoma, Chisumpa, Sembulute, Mukoko
Malipilo	7	Mumba, Kasempa, Shipokola, Malipilo, Kapiri, Kaponda, Mulenga
Kaponde	5	Kaponde, Zwao, Bwema, Mukamulomo, Muyanje
Waya	2	Waya, Mungalaba
Lyombe/Ntumba	6	Tobongo, Nyenda, Lyombe, Mukatasha, Mwalumwaya, Champanga
Kaswende	3	Kaswende, Ngwena, Shambona

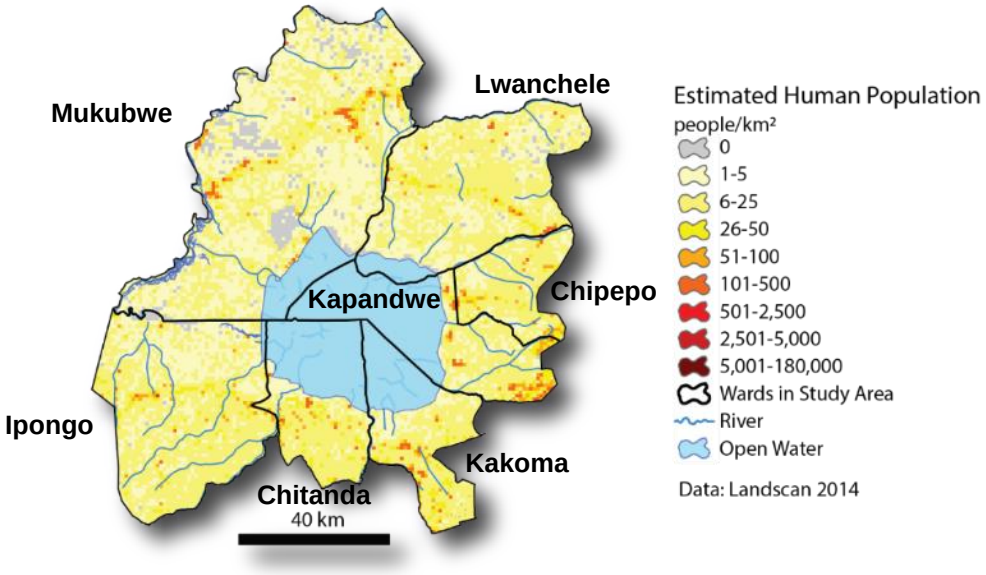
Source: Chabwela *et al*. (2010).

In their study, Mapedza *et al*. (2012) visited two study sites: Kapukupuku and Waya.

Kapukupuku is located 101 km north of Lusaka, in Keembe Constituency at Chibombo District. According to the authors, this community is formed by 150 households and has no infrastructure. Most of Kapukupuku residents are fishermen migrants and women from Luapula, Northern and Western provinces.

Waya, in turn, is located at Kapiri Mposhi constituency, in Kapiri Mposhi district, 50 km west of Kabwe, in Central Province. The community has 642 households who live from subsistence farming and fishing. In contrast with Kapukupuku community, this one has two schools, a big health centre, a police station and an office of the Fisheries Department (Mapedza *et al*., 2012).

Figure 9 and Table 21 show projected population for the year 2018 for wards in Lukanga Swamps – Chipepo, Chitanda, Ipongo, Kahoma, Kapandwe, Lwanchele and Mukubwe (MLNR, 2019).



Source: Adapted from MLNR (2019).

Figure 9 – Projected population distribution for wards in Lukanga Swamp for the year 2018

Table 21 – Projected population for wards in Lukanga Swamp for the year 2018

Ward	Projected Population for 2018
Chipepo	18,556
Chitanda	16,264
Ipongo	12,824
Kakoma	24,113
Kapandwe	4,990
Lwanchele	19,584
Mukubwe	20,140
Total	**116,471**

Source: MLNR (2019).

According to the Social Welfare Department of the Ministry of Community Development and Social Services (written communication, December 2019), the area (Lukanga Swamp) has a population of about 58,000 people, including many retrenched miners from Kabwe (that have come to settle in fishing camps such as Waya and Kaswende), Tonga people from the southern province (where agricultural life has been ravaged by drought and cattle diseases) and seasonal migration of fishermen.

3.3.3. Economic activities

The main economic activities in the communities living in and around Lukanga Swamp are farming, charcoal production, livestock rearing and fishing.

According to Kachali (2007), **farming** is the most common livelihood strategy in the Lukanga catchment. Maize and sweet potatoes are the main crops grown, but riparian communities also raise groundnuts, cotton and different types of beans (Kachali, 2007). Even though farming is mainly practiced at subsistence level, the area has high potential for commercial farming (Chabwela *et al*., 2010).

Charcoal burning or wood sales are not only an additional income source and coping mechanism during periods of poor harvest, but also a method to benefit from cleaning new fields for agriculture. According to Kachali (2007) survey, 22% of respondents are involved in this activity. The increasing population and demand for charcoal from Lusaka, Kabwe and the Copperbelt are pressuring the use of unsustainable practices, such as deforestation (Kachali, 2007 and Chabwela *et al*., 2010).

Livestock rearing is also pointed out as a common coping mechanism in periods of drought and natural disasters (Kachali, 2007). In addition, according to Tonga's tradition, livestock is viewed as a form of wealth storage, but this use is becoming rarer as the need to gain cash is higher in today's economy. The growing livestock population is leading to an increasing competition for pasture, which leads to overgrazing practices. These practices, in turn, can cause serious degradation of wetlands, due to soil erosion, loss of vegetation cover and deforestation. Cattle, goats and chickens are the most reared species (MLNR, 2019). It is estimated that approximately 60 000 herds of cattle use the Lukanga swamp area at one time of the year (Chabwela *et al*., 2010).

As it was mentioned before, the Lukanga swamp is also inhabited by **fishing** communities, such as Bemba group. The Lukanga Management Plan estimates that there are approximately 173 fishing camps, with a population of 1,292 fishers and an average of 2 canoes per fishing camp (Chabwela *et al*., 2010). In fact, the fishery resources of the wetland are an important source of income for fishermen who sell their fish in Kabwe, Lusaka and along the Copperbelt (Kachali, 2007 and Mapedza *et al*., 2012). Moreover, fish is also pointed out as the most preferred mean of exchange for goods and services (Chabwela *et al*., 2010). The economy of the region is mainly based on fishing industry, with nearly every inhabitant being a fisherman and fish being the major diet of Lukanga swamp communities (Chabwela *et al*., 2010). The most common

species are: tilapia, barbel and catfish (Mapedza *et al*., 2012). According to Mapedza *et al*. (2012), Lukanga wetlands are estimated to produce 1,710 tonnes of fish annually. As the number of fishermen in Lukanga is increasing, in part to the fact that it is very difficult to exclude new users, the pressure to use unsustainable methods, such as mosquito's net, also grows, starting a reinforcing loop (Kachali, 2007). According to the Social Welfare Department of the Ministry of Community Development and Social Services (written communication, December 2019), it has also "become nearly impossible to (…) police the fish ban due to inadequate manpower from the department of fisheries".

3.4. Ecological assessment

The geographical scope of the ecology component of the Conservation Plan for Lukanga Swamp and ecosystem services (ES) assessment, herein designated as “study area”, comprises the following units of territorial analysis:

- Intervention area – represented by the “Lukanga Ramsar Site” (Ramsar, 2005);
- Surrounding area – defined as a 10 km buffer around Lukanga Ramsar Site, to account for the wetland’s surrounding terrestrial ecosystems’ diversity.

The main component and basis for the ecological assessment, in the context of conservation planning, is the identification and classification of ecologically vulnerable areas, the first step of which is the production of habitats cartography.

The following sections describe the steps undertaken to produce the Habitats Map presented in Appendix 1.

3.4.1. Concepts

Ecosystems can be defined as “dynamic [complexes] of plant, animal, and microorganisms’ communities and their non-living environment inter-acting as [functional units]. Humans may be an integral part of an ecosystem, although ‘socio-ecological system’ is sometimes used to denote situations in which people play a significant role, or whether the character of the ecosystem is heavily influenced by human action” (Potschin-Young *et al*., 2018).

Land-cover refers to “the physical coverage of land, usually expressed in terms of vegetation cover or lack of it” (Potschin-Young *et al*., 2018).

A habitat is, in turn, defined as a territory unit which, given physical conditions, supports the development of a specific biological community (Alves *et al.*, 1998; Timberlake *et al*., 1993; Potschin-Young *et al*., 2018). The development of vegetation (plant communities) into structural units of known composition serves as an indicator of the abiotic conditions of a particular area, as well as of its potential use by fauna and by human communities (Timberlake *et al*., 2000), thus providing an appropriate proxy for habitat classification.

In addition, the degree of distance/approximation of vegetation's characteristics to pristine values defines three main typologies of land-cover, amongst which habitats distribute themselves according to their characteristics: natural areas, semi-natural areas (modified) and artificial/humanized areas.

Natural areas are those that maintain original conditions, and therefore vegetation types (referring to composition, structure and abundance) and associated faunal resources represent in majority or totality, the original values.

Semi-natural areas are characterized by vegetation composed of different species than those that composed the original assemblages; there is a predominance of introduced vegetation, as these are managed by humans. These include managed land, such as cultured areas, small to large-scale, and tree plantations.

Artificial/humanized areas display a profound degree of alteration: natural conditions and faunal values are totally distant from original values, and vegetation, when present, is anthropic and mainly opportunistic; in these areas, soil permeability is usually low, and land use is associated with human presence.

Given the above, it is safe to assume that the adoption of habitat classes as cartographic units is representative of land cover and ecosystem units, both broader in nature, and will be based primarily in the classification of the area's vegetation cover.

3.4.2. General literature overview of vegetation types

The Lukanga Swamp is set in the Great African Plateau, touching on the ecoregions of the Central Zambezian Miombo Woodland to the north, and both Kalahari Acacia Woodland and Southern Miombo Woodland ecoregions to the south (Burgess *et al*., 2004). It is set within the region classified by White (1983) as the Zambezian regional centre of endemism, the second largest phytochorion in Africa, showcasing a wide range of vegetation types, and with a tropical climate characterized by a long dry season and intense summer rainfall (from November to April).

Typical woodland habitats of the Zambezian region dominate the terrestrial landscape, which is interrupted by Zambezian seasonally flooded grasslands, permanent swamps and rivers, of the Kafue Freshwater Ecoregion (Scott, 2015). Variations of the territory's topographic and hydrological features – such as depressions - impose an interruption of

the woodland climate-related climax vegetation in the form of distinctive azonal vegetation units, shaped by the topographically originated environmental gradients in edaphic water content and water depth. In addition to these natural elements, traditional human-mediated disturbance regimes such as seasonal burning, harvesting and cultivation, further shape the existing vegetation.

White, in over 15 years of collaboration with UNESCO, produced a Vegetation Map of Africa, which includes 80 major vegetation units, mapped at a broad scale (1:5 000 000), and a descriptive memoir of these (White, 1983). He describes 16 major physiognomic divisions, defined specifically for the African context, the diagnostic features of which are the height and density of the main growth forms, subordinated to other features when necessary. These are arranged in five (5) main categories: formations of regional extent (such as forests, woodland, bushland and grassland, among others), transitional formations of local extent (such as transition woodland), edaphic formations (such as herbaceous freshwater swamp and aquatic vegetation), formations of distinct physiognomy but restricted distribution (bamboo), and unnatural vegetation (anthropic landscapes).

The major vegetation type of the Zambezian region is the **woodland**, consisting of open stands of trees of at least 8 m height, with a canopy cover of 40% or more, but never with inter-locking crowns and usually with a field layer of heliophilous grasses. While it is generally interpreted as the climatic climax vegetation, some is thought to be secondary, deriving from the replacement of dry forest by historical disturbance, and an increasing proportion is currently altered by anthropogenic activities such as cultivation and fire (White, 1983; Forestry Department, 2016). Under limiting conditions, dominant species may form scrub woodland, with reduced height. Two main types were mapped for the region in study by White (1983), the miombo and the North Zambezian undifferentiated woodland and wooded grassland.

The miombo is an open woodland dominated by three genera on the canopy, *Brachystegia*, *Julbernardia* or *Isoberlinia*, and a field layer of herbaceous species, usually sparse. It develops on freely drained and acid soils. In the region of the African Plateau, the miombo is often altered by agricultural practices such as the chitemene, and presents reduced floristic and structural complexities. White (1983) classifies the miombo as either wetter or drier, and the study area falls within the wetter region, which is characterized by more than 1 000 mm of annual rainfall.

The North Zambezian undifferentiated woodland and wooded grassland is an open woodland vegetation, of the savanna type, described by White as characteristically lacking the miombo and mopane dominants (*Colosphospermum mopane* in the latter), as it undergoes a rapid turnover of the floristic composition over short distances, being inclusively more biodiverse than these two (Kindt *et al*., 2011a). This vegetation is also designated as munga woodland, a term introduced either by Fanshawe (1971, *in* Forestry Department, 2016) or White (Kindt *et al*., 2011a), after the Tonga word for savanna and for the vernacular name of straight-thorned acacias. Some communities are also referenced as *Acacia-Combretum*, based on dominant genera (Edmonds, 1976, *in* Chabwela *et al*., 2017; Trapnell *et al*., 1950, in Kindt *et al*., 2011a). *Combretum* wooded grassland is possibly equivalent to this class, "especially where [it] occurs in catena sequences in between Miombo woodland and edaphic grassland" (Kindt *et al*., 2011). This vegetation consists of broad-leaved *Combretum* species associated with *Terminalia* species.

Other woodland types are referenced as occurring in the region, such as the Chipya, which shares its distribution with the wetter miombo, according to White (1983). The designation of chipya originated from the Bemba term cipya, by Trapnell (1950, *in* White, 1983), who assigned it to formations of trees, also lacking the miombo dominants, mixed in well-developed grass (White, 1943). Three herbaceous species are widespread, *Aframomum alboviolaceum*, *Pteridium aquilinum* and *Smilax anceps* (White, 1983). It is a fire-induced type of savanna woodland, whereby fire-tolerant tree species are maintained through seasonal intense fires of the grass layer (Forestry Department, 2016), and is possibly a degradation stage of climax forested habitats such as dry evergreen forest and transition woodland (Kindt *et al*., 2011a). It can vary greatly in terms of structure, from very open to closed woodland, being a "complex mosaic representing different stages of degradation and reestablishment of the original vegetation" (Kindt *et al*., 2011a).

Forested habitats such as the Baikiaea (Chabwela *et al.,* 2017), a subtype of the Zambezian dry deciduous forest and scrub forest distinguished by its almost pure canopy of *Baikiaea plurijuga* (Kindt *et al*., 2011a), are the potential climatic vegetation of the region, typically occurring in areas that experience a long season of low atmospheric humidity. It is in part characterized by its thicket understorey, the mutemwa (Fanshawe, 1971, *in* Forestry department, 2016). These are references as occurring only in small patches in the region of the Lukanga Swamp, however, having been replaced by other woodland vegetation due to human influence.

Another major vegetation class is the **grassland**, a structurally simple formation dominated by an herbaceous field layer. Pure grasslands of the Zambezian region occur as the edaphic climax vegetation of seasonally and permanently waterlogged soils, such as in river floodplains and depressions with increased water retention ability, as is the case of the Lukanga Swamp. Secondary grassland also occurs, but is maintained by fire and usually contains trees (White, 1983).

In depressions that accumulate water year-round and are permanently flooded to shallow depths, extensive grasslands occur of emergent macrophyte species (rooted in the substrate with stems emerging out of the water), often reeds, such as *Cyperus papyrus* or *Phragmites australis*, forming the **herbaceous freshwater swamp**. In zones of greater depth, truly **aquatic vegetation** develops, completely submerged or not, either floating or rooted in the substrate. Floating islands of grass occur as well, usually with the species *Vossia cuspidata* forming mats of distinctive vegetation (White, 1983).

Wetlands of the Zambezi basin in general are increasingly being altered by the propagation of invasive aquatic weeds, such as the Kariba weed, *Salvinia molesta*. This is the case of the palustrine area of the Lukanga wetland, the first record of this weed dating to 2009 (Kafue River Trust, 2020). Because this is a surface floating macrophyte, its capacity to disperse is high in areas where emergent vegetation is less dense. In addition, it is an aquatic fern that reproduces asexually through fragmentation of the rhizome (McFarland *et al*., 2004), and thrives in low flowing or standing waters. It can multiply rapidly and form extensive and dense monotypic mats up to 1 m thick, which affect human movement and the swamp's abiotic conditions and living organisms. Since it is not attached to the substrate, it occurs either in mats or just drifting in open water, being particularly difficult to map. Mapping of the weed's distribution through remote sensing is being done under a BirdWatch Zambia project currently attempting to control the invasion, and, according to this project, the coverage of the swamp's surface area has increased from 1.82% in 2010 to 7.23% in 2017 (BirdWatch Zambia, 2019).This project consists of the introduction of the Javani beetle, *Cyrtobagous salviniae*, as a biocontrol measure. The bug was first introduced in October 2018, and monitoring is currently underway for the assessment of this programme's impact (Kafue River Trust, 2020).

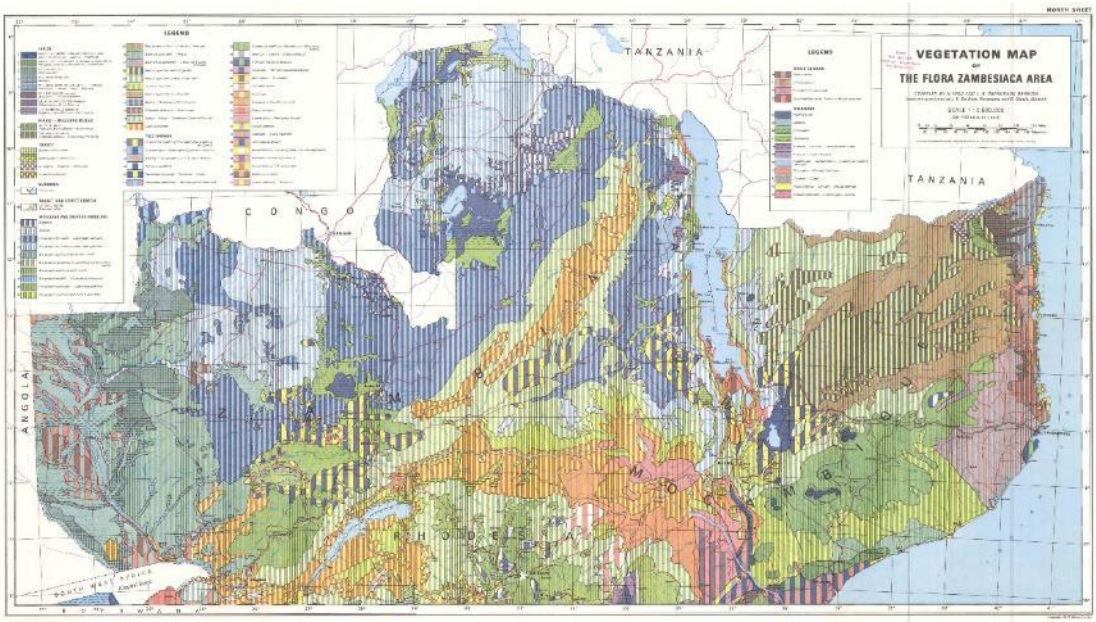
On plains of shallower seasonal flooding, pure edaphic grassland often forms a mosaic with very sharply defined islands of thickets on termite mounds, also termed "Termite savanna" or Termitaria. As the miombo woodland occurs on freely drained soils, it is only

able to permeate towards the seasonally flooded grassland plains on better drained sites, such as the termite mounds, creating this distinctive transition landscape (Chabwela *et al.*, 2017; Kindt *et al*., 2011b). Several different floristic compositions make up the termitary, however, usually similar to the composition of woodland vegetation in the proximity. This habitat type holds an extremely rich flora in Zambia. In the studied region, **shrubland** or **thicket** vegetation – open or closed stands of shrubs up to 2 m in height (White, 1983) – is mainly present in termite mounds.

3.4.3. Existing classifications of the study area's vegetation cover

One of the inherent difficulties of producing habitat maps is the lack of clear legends, or uniform classification systems (Di Gregorio *et al*., 2016; Timberlake, 2000). Several studies have been made in the past to describe and map the extent of structural and compositional variability of vegetation within Zambia.

The "Vegetation Map of the Flora Zambesiaca Area", compiled by Wild and Barbosa (1967), at a 1:2 500 000 scale (Figure 10), classifies the central main swamp area as *Papyrus* surrounded by *Hyparrhenia* grassland, while surrounding woodland vegetation is classified as *Brachystegia floribunda-Julbernardia globifora* to the northwest, *Brachystegia floribunda-Julbernardia paniculata* both in the northeast and southwest, and *Pterocarpus angolensis-Pericopsis-Acacia* tree savanna in the southeast.

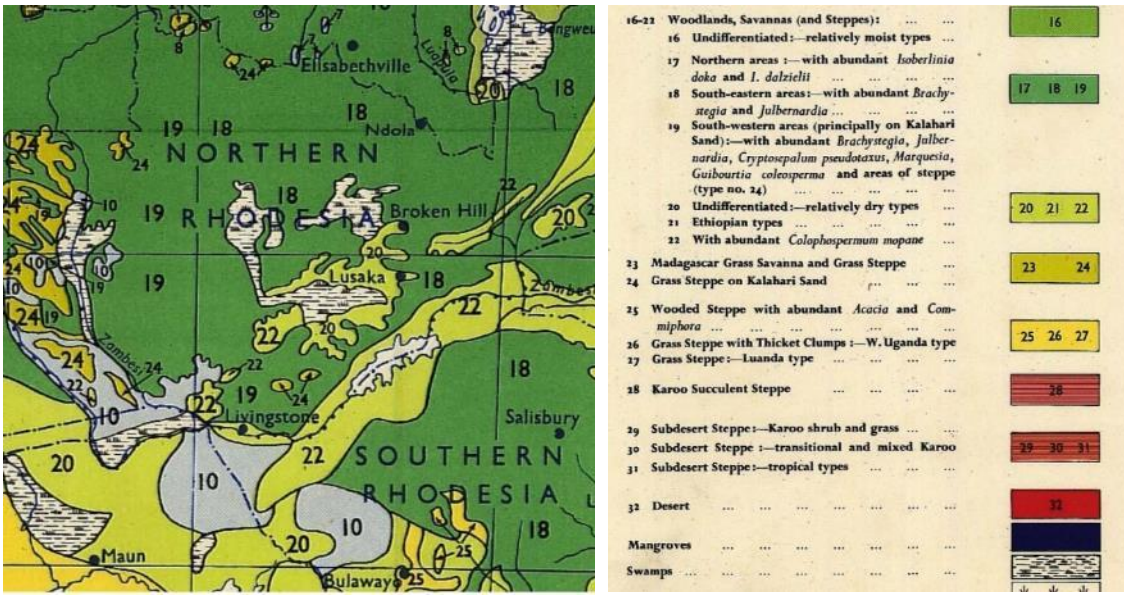


Source: Wild and Barbosa (1967)

Figure 10 – Vegetation map of the Flora Zambesiaca Area (north sheet)

In White's UNESCO Vegetation Map of Africa, mentioned before, the central area of the Lukanga swamp is mapped as unit 75 – *swamp and aquatic vegetation*, surrounded by unit 64 – *Zambezian edaphic grassland*, which is surrounded, in turn by unit 25 - *Zambezian woodland, wetter miombo*, and in the south, in a small portion, by unit 29, *North Zambezian undifferentiated woodland and wooded grassland*.

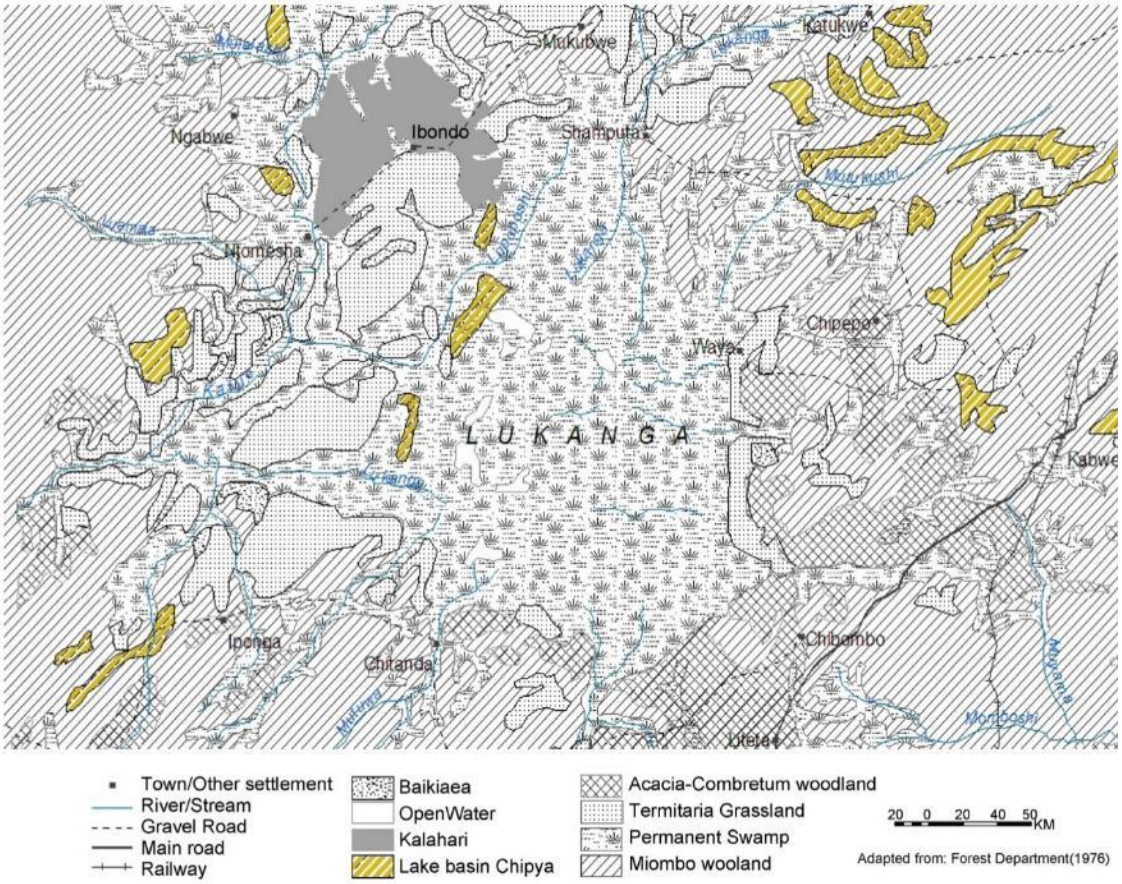
In the "Vegetation Map of Africa, South of the Tropic of Cancer" (Aubérville *et al*., 1987), the region in study is divided between "Woodlands, Savannas (and Steppes)" vegetation, in particular, "18 - South-eastern areas: with abundant *Brachystegia* and *Julbernardia*", and "20 - Undifferentiated: - relatively dry types", surrounding an area of "swamps" (Figure 11).



Source: Aubérville *et al*. (1987).

Figure 11 – Extract from the Vegetation map of Africa, South of the Tropic of Cancer

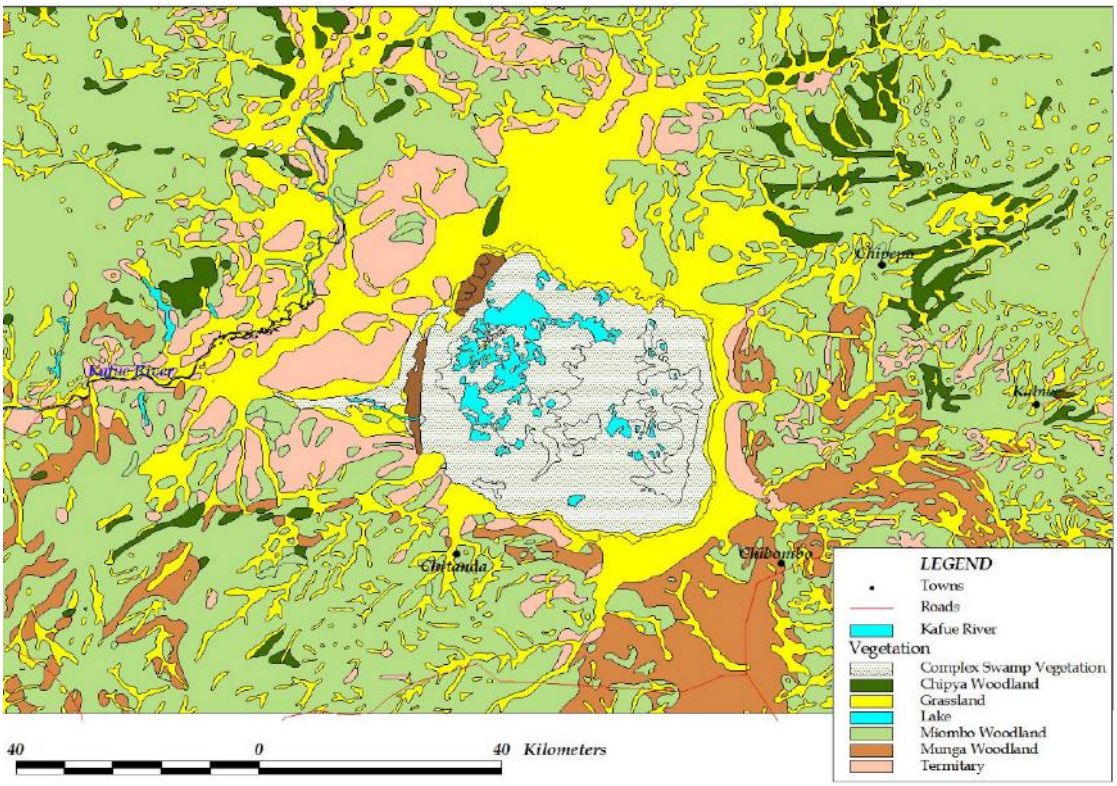
Edmonds' classification (1976) – originally based on Fanshawe's system – produced a finer resolution map of Zambia's vegetation, at 1:500 000 (adapted by Chabwela *et al*., 2017; Figure 12). In his classification, he introduces Lake basin Chipya as a new type, aggregates into one mapping unit all termitary vegetation, and into another, all grassland vegetation. According to this map, the wider study region is composed of both dry evergreen and dry deciduous closed forest, i.e., Lake basin Chipya and Baikiaea, respectively, and open forest with grass, or woodland, i.e., the Miombo, Kalahari and Munga (or *Acacia-Combretum*). The central area, the Lukanga Swamp, is mapped as Termitaria and swamp associated grassland. These formations' composition was further studied by Chabwela *et al*. (2017), who confirmed the predominance of *Brachystegia* woodland and *Acacia-combretum* in the woody vegetation to the north, south and west.



Source: Chabwela *et al.* (2017).

Figure 12 – Adaptation of Edmond's 1976 *The Republic of Zambia Vegetation Map* (1:500 000) for the region in study

In the Lukanga Swamp Management Plan (Chabwela, 2010), woodland vegetation is mapped as miombo, munga and chipya, while wetland vegetation is mapped as grassland and complex swamp vegetation (Figure 13).



Source: Chabwela (2010).

Figure 13 – "The Vegetation of the Lukanga Swamp", from the Lukanga Management Plan

The harmonized version of the **VECEA Potential Natural Vegetation Map for Eastern Africa** (van Breugel *et al.*, 2015) was also consulted. The original VECEA project produced a map predicting the potential distribution of indigenous plant species, aiming at increasing the understanding of indigenous tree species' distribution in the region, to improve smallholder productivity, as well as to promote agricultural productivity and conservation of flora and fauna (Lileso *et al*., 2011). It consists of a breakdown of White's 1:5 000 000 map, through a process of collation, digitization and harmonisation of existing nomenclatures, maps and description efforts for the region's vegetation. This is a map of Potential Natural Vegetation (PNV) – "vegetation structure that would become established if all successional sequences were completed without interference by man under the present climatic and edaphic conditions, including those created by man" (van der Maarel, 2005, in Lileso *et al*., 2011) – and its information must be used accordingly.

The mapping of the Zambian region by the VECEA team is primarily based on the work by Edmonds (1976) (including a total of 17 classes), whose classification was based on that of Fanshawe and associated descriptions (1971), as already mentioned. In the spatial raster data (van Breugel *et al*., 2015), the study area's vegetation is assigned to seven (7) different classes, namely:

- Forests:
  - Zambezian dry deciduous forest and scrub forest (Fn);
  - Woodlands and wooded grasslands:
  - Wetter miombo woodland (Wmw);
  - Zambezian chipya woodland (Wy);
  - North Zambezian undifferentiated woodland (Wn);
- Others:
  - Edaphic grassland on drainage-impeded or seasonally flooded soils + freshwater swamp (g/X);
- Compound vegetation types:
  - Bush groups, typically around Termitaria, within grassy drainage zones (g/T);
- Water.

The 2015 land-cover map for the study area from **Copernicus Global Land Service**'s Sentinel-2 spectral imagery classification was also used (CGLS, 2015). The base classification follows that of the UN FAO Land Cover Classification System (LCCS) (Di Gregorio *et al.*, 2016), where land features are classified into elements along a hierarchy of **physiognomy** and **structural** properties – i.e., "the overall appearance of a vegetation element", and "the spatial distribution pattern of growth forms in a plant community, […] which defines the horizontal and vertical arrangements of vegetation elements (growth forms etc)", respectively. The subdivision of different elements is supported by the description of land features' characteristics, such as seeding time, grazing, management practices etc. (Di Gregorio *et al*., 2016). The consulted data set includes the following land cover classes within the study area:

- Closed forest:
  - Evergreen broadleaved (very minimal);
  - Deciduous broadleaved;
  - Unknown type (very minimal);

- Open forest:
  - Deciduous broadleaved;
  - Unknown type;
- Other Land Cover:
  - Shrubland;
  - Herbaceous vegetation;
  - Herbaceous wetland;
  - Cropland;
  - Built-up;
  - Permanent water bodies.

Finally, the **Zambian Integrated Land-Use Assessment** (ILUA), composed of Phases I (2005-2008) and II (2010–2016), re-classified the country's vegetation based on FAO's Forest Resource Assessment (FRA) classification system, and mapped the country's land-cover through extensive field surveys, interviews, direct observations and interpretation of spectral imagery.

This project re-classified Zambian natural terrestrial vegetation into "major vegetation and other land" and "forests and land use classes" across the following FRA's four broad categories (FRA, 2020):

- Forest: >0.5 ha, >10% canopy cover, 5 m height at maturity; "may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground; or open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10%", such as African woodlands;
- Other Wooded Land: >0.5 ha, 5-10% canopy cover, or shrubs/bushes => 10% canopy cover;
- Other Land: <5% canopy cover or shrubs/bushes <10%; "land not classified as forest or other wooded land as defined above. Includes agricultural lands, meadows and pastures, built-on areas, barren lands, etc.";
- Inland water: "area occupied by major rivers, lakes and reservoirs".

Table 22 includes ILUA's vegetation classification for the Zambian territory across these three levels, i.e., "FRA (land) class", "major vegetation and other land", and "Forests and land use classes".

Table 22 – Zambian land categories and vegetation classification

FRA (land) class	Major vegetation and other land	Forests and land use classes
Forest land	Dry evergreen forest	*Parinari* forest and Copperbelt chipya
		Marquesia forest
		Lake basin chipya
		Chryptosepalum forest
		Kalahari sand forest
	Dry deciduous forest	*Baikiaea* forest and deciduous thicket
		Itigi forest
	Moist evergreen forest	Montane forest
		Swamp forest
		Riparian forest
	Forest woodlands	*Miombo* woodland on plateau
		Miombo woodland on hills
		Kalahari woodland on sands
		Mopane woodland on clay
		Munga woodland on heavy soils
	Forest plantations	Broad leaved forest plantation (*Eucalyptus*)
		Coniferous forest plantation (*Pine*)
Other wooded land	Wooded grasslands (including pans and shrubs with some trees)	Termitary vegetation and bush groups
		Shrubs/ thickets

FRA (land) class	Major vegetation and other land	Forests and land use classes
Other land	Grasslands	Dambos and floodplains
		Marshland and swamps
	Bare land	Barren land
		Sandy dune
		Bare rock / outcrop
	Cultivated and managed land	Annual crop
		Perennial crop
		Pasture land
		Fallow
	Built-up areas	Urban
		Rural
	Inland water	Lakes, Rivers, Dams

Source: Shakachite *et al*. (2016).

ILUA's Phase II **land-cover** map (Forestry Department, 2016) classified Zambia according to the six (6) classes of the Intergovernmental Panel on Climate Change scheme, through the supervised classification of LandSat 5 thematic mapper (TM) images with a spatial resolution of 30 m for the 2014 epoch (using the maximum likelihood method), namely:

- 1, **Forests**: "this is land covered both by natural and planted forest meeting the threshold of 10% canopy cover growing over a minimum area of 0.5 ha with trees growing above 5 m height";
- 2, **Grassland**: "land that includes wooded rangeland that may be covered mainly by grasslands, plains, *dambos*, pans found along major river basins and water channels";
- 3, **Cropland**: "land actively used to grow agriculture (annual and perennial) crops which may be irrigated or rain feed for commercial, peasant and small-scale farms around urban and rural settlements";
- 4, **Wetlands**: "land which is waterlogged, may be wooded such as marshland, perennial flooded plains and swampy areas (surface water bodies included)";
- 5, **Settlements**: "land covered mainly by densely populated and organized or irregular settlement patterns surrounding cities. towns, chiefdoms and rural centres commonly referred to as urban and rural built-up areas";

- 6, **Other land**: “barren land covered by natural bare earth/ soil such as sandy dunes, beach sand, rocky outcrops and may include old open quarry sites for mines and related infrastructure outside settlements”.

This land-cover map classifies the study area into four (4) of these classes, namely, forests, grassland, cropland and wetland (Figure 14).

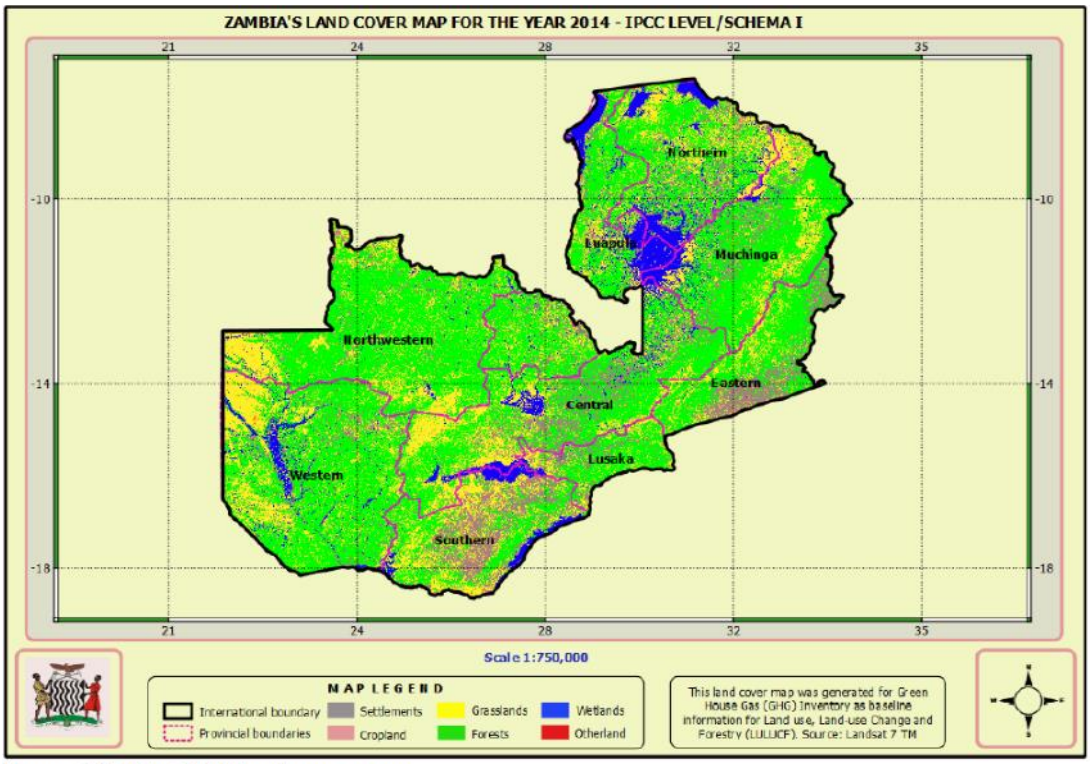


Figure 10: The 2014 land cover map

Source: Shakachite *et al*. (2016).

Figure 14 – ILUA II land-cover map, 2014

In most of the maps that were considered, especially historical ones (Figure 10, Figure 11 and Figure 12), swamp vegetation and seasonally flooded grasslands are aggregated.

Mapping different types of wetland habitat is particularly problematic, as these are made-up of complex patterns of azonal vegetation developed in response to particular landforms and hydrogeomorphic regimes (Beilffuss *et al.*, 2001). Different hydrogeomorphic properties support different communities, so that even minimal differences in the hydrological regime across the wetland – such as depth, persistence of inundation, etc. – will incur in significantly different communities. The types here in question pose an even greater challenge, as they consist of dynamic mosaics of

floristically different vegetation that occasionally intermix, almost exclusively composed of the herbaceous layer, characteristically lacking woody species, and often undistinguishable from remote sensing.

The Ramsar Convention's definition[2] of wetlands accounts for hydrological criteria, however, it is considered to be generally too broad. A mixed approach, combining hydrological characteristics with biological aspects is preferred, as was undertaken by Timberlake (2000), for instance, who adopted Breen's (1991) definition, given it offers biological elements – such as plant species – as defining characteristics: "land where an excess of water is the dominant factor determining the nature of soil development and the types of animal and plant communities living at the soil surface. It spans a continuum of environments where terrestrial and aquatic systems intergrade".

3.4.4. Habitats classification and mapping

The habitats map produced compiles the maximum amount of available information regarding vegetation cover and other land cover data into visually interpretable cartographic units, and follows ILUA's vegetation classification system (Table 22).

It combines the classification of structural elements of the vegetation through aerial photography, field observations aiming to confirm the physiognomic aspect of habitat classes, with additional elements such as the degree of human influence (naturality) and hydrological regime, and draws on existing accounts of these criteria in published reports, maps and literature.

Based on FRA (land) classes and ILUA's major vegetation classes, existing information (c.f., 3.4.2. General literature overview of vegetation types, and 3.4.3. Existing classifications of the study area's vegetation cover), and field observations (Figure 15), and in accordance with the assignment's objectives – conservation planning and ecosystem services assessment – five major habitat classes were devised in the study area: forest land; wooded grassland; grassland; anthropic landscapes and inland water.

[2] "A transitional area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salty, including areas of marine water the depth of which at low tide does not exceed six metres" (Ramsar Convention on Wetlands).

These were further subdivided into 11 habitat subclasses in accordance to ILUA's "Forests and land use classes", as follows:

- **1- Forest land**:
  - 11: *Miombo* woodland;
  - 12: Baikiaea forest and deciduous thicket;
  - 13: Lake Basin Chipya;
  - 14: Munga or Miombo woodland;
- **2- Wooded grassland:**
  - 21: Termitaria;
- **3- Grassland**:
  - 31: Edaphic grassland;
  - 32: Permanent swamp;
- **4- Anthropic landscapes**:
  - 41: Cultivated and managed land;
  - 42: Rural built-up land;
- **5- Inland water**:
  - 51: Lakes;
  - 52: Rivers.

The classification of different forest vegetation in terms of floristic composition is based on existing accounts. Edaphic grassland refers to ILUA's "Dambos and floodplain" vegetation class.

The cartography of the study area's habitats was produced through visual classification of orthophotos according to the classes listed above, to the maximum level of classification possible, which was then complemented with ground truthing by aerial reconnaissance (using a drone) and spot assessments in September and October of 2019 (Figure 15).

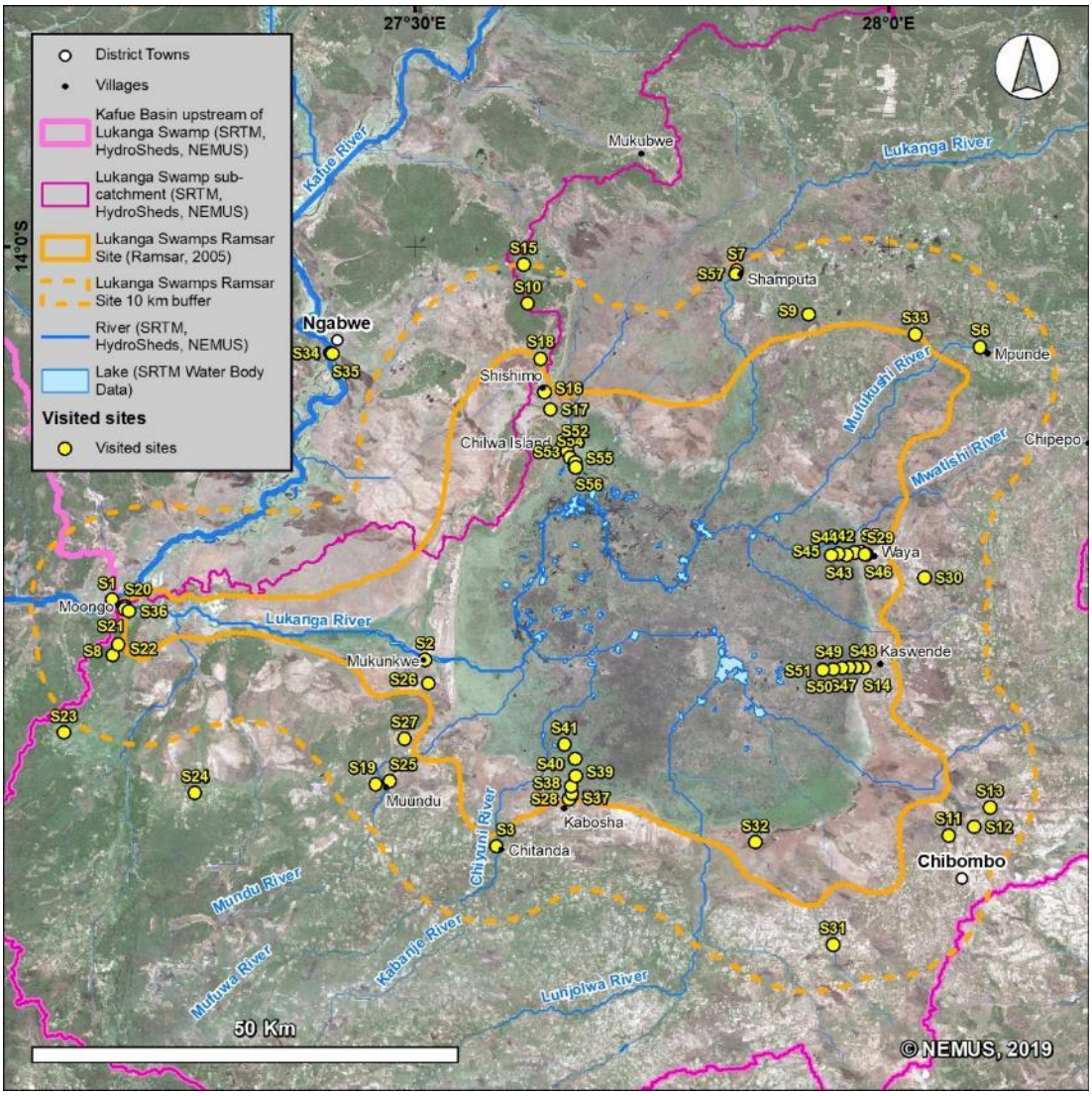


Figure 15 – Sites visited in September and October 2019 for ground truthing of cartographic units

Cartographic units were digitized to polygons in GIS environment from aerial photography superimposed with the ground truthing data and the following visual aids:

- Global Land Cover classification (10m resolution) from Sentinel 2 spectral images dating to 2015 (which uses the UN FAO Land Cover Classification System (LCCS));
- Zambia Land Cover raster data from the ILUA project Phase II, dating to 2014;
- Existing vegetation maps;
- Simplified version of the Potential Natural Vegetation Map for Eastern Africa (VECEA).

During the field surveys in September and October 2019, a total of 56 sites were visited and classified according to major habitat classes (level 1) and, when possible, to subclasses (level 2).

The major habitat classes are illustrated in Figure 17 to Figure 30. The locations represented in these are indicated in Figure 16.

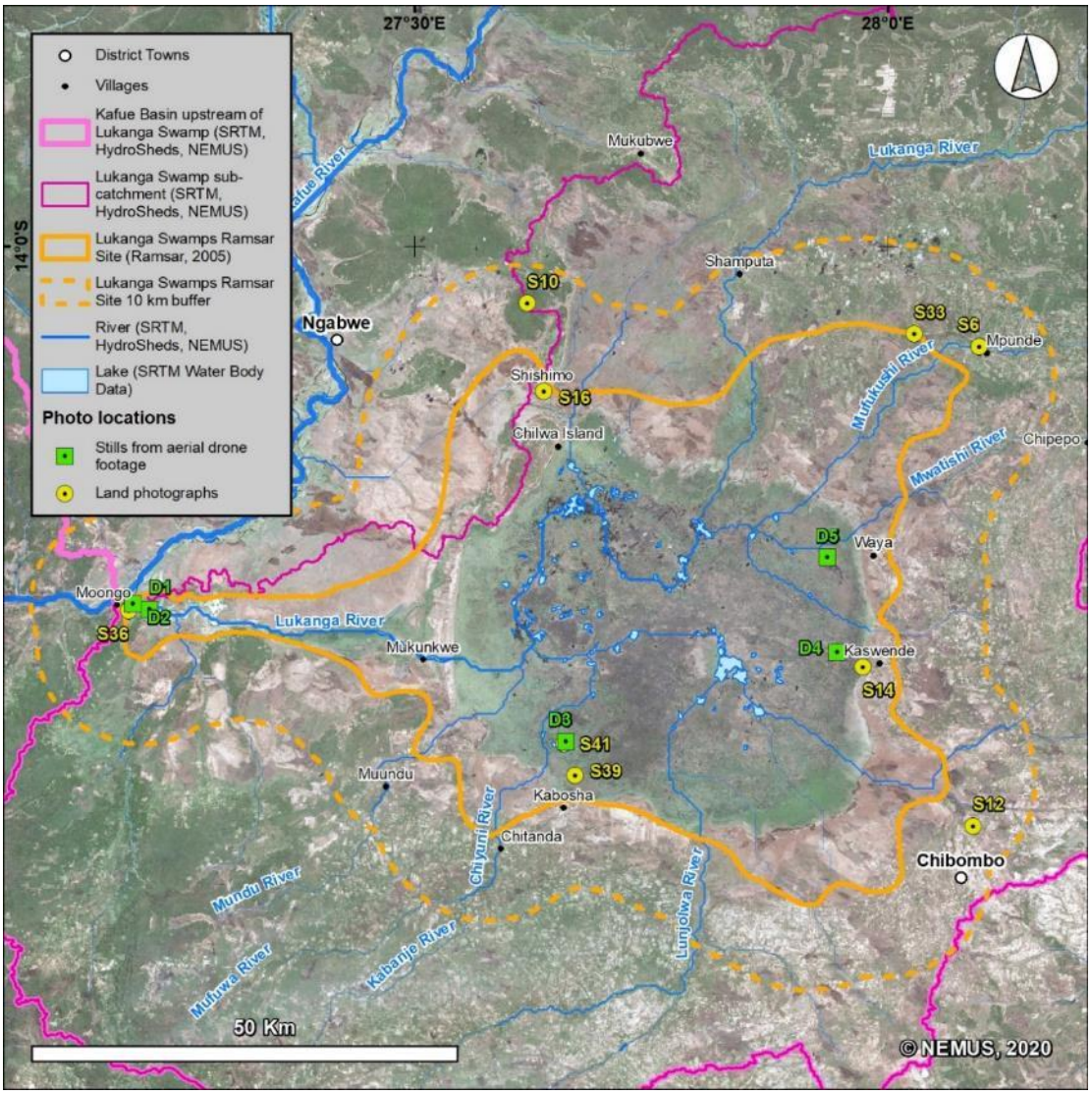


Figure 16 – Locations of the photos illustrative of the major habitat classes



Source: Nemus, 2019

Figure 17 – Four of the major classification units near Moongo village, 1: forest land, 3: grassland, 4: anthropic landscapes, and 5: inland water (D1, 14º23'00.5''S, 27º13'11.4''E)



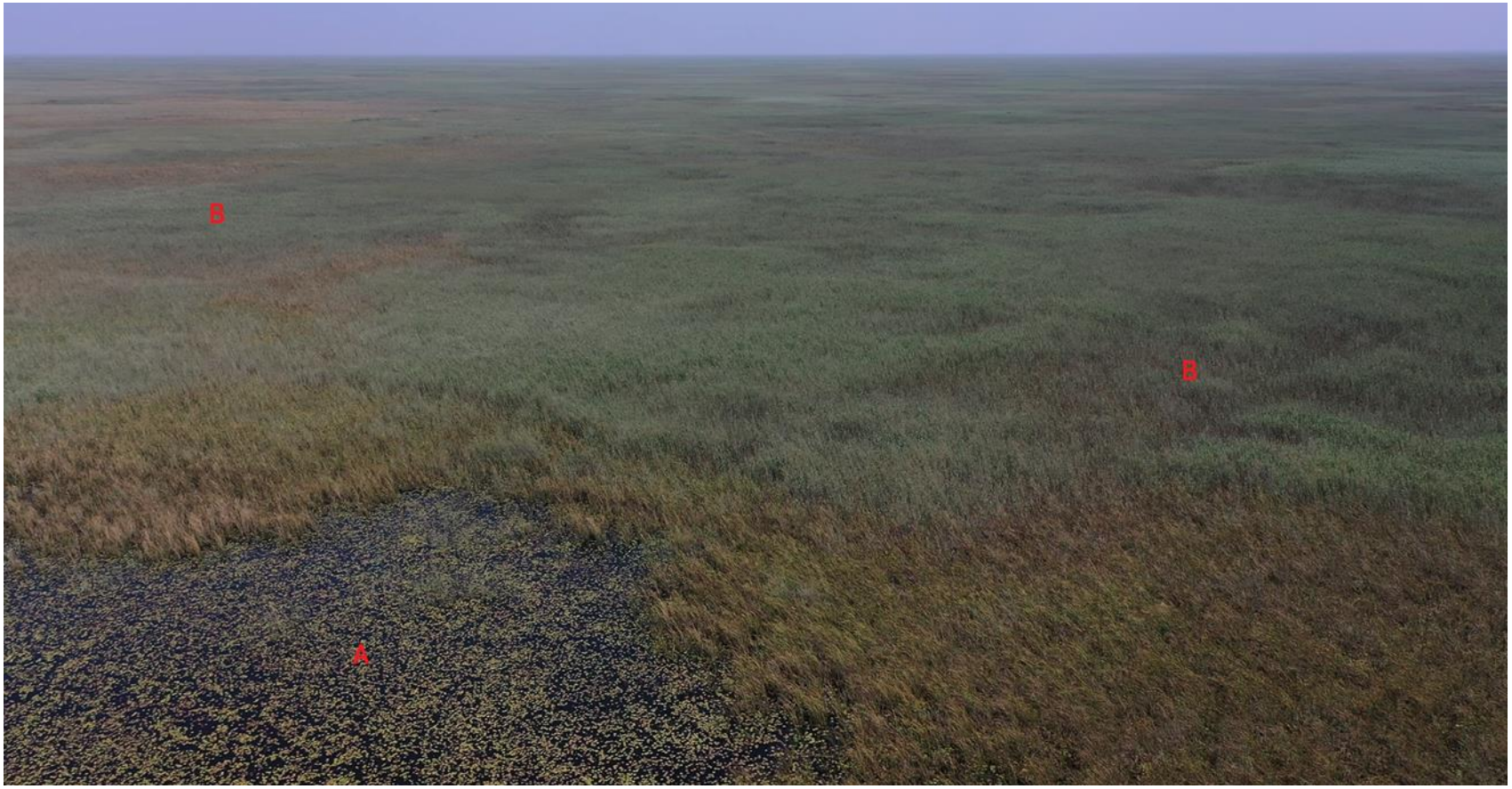
Source: Nemus 2019

Figure 18 – Termitaria vegetation (2: wooded grassland) in the floodplains near the Moongo village (D2, 14°22'39.7200"S, 027°12'08.5680"E)



Source: Nemus, 2019

Figure 19 – Lake (5: inland water) within the permanent swamp off the village of Kabosha (D3, 14°31'23.8800"S, 027°39'35.5680"E)



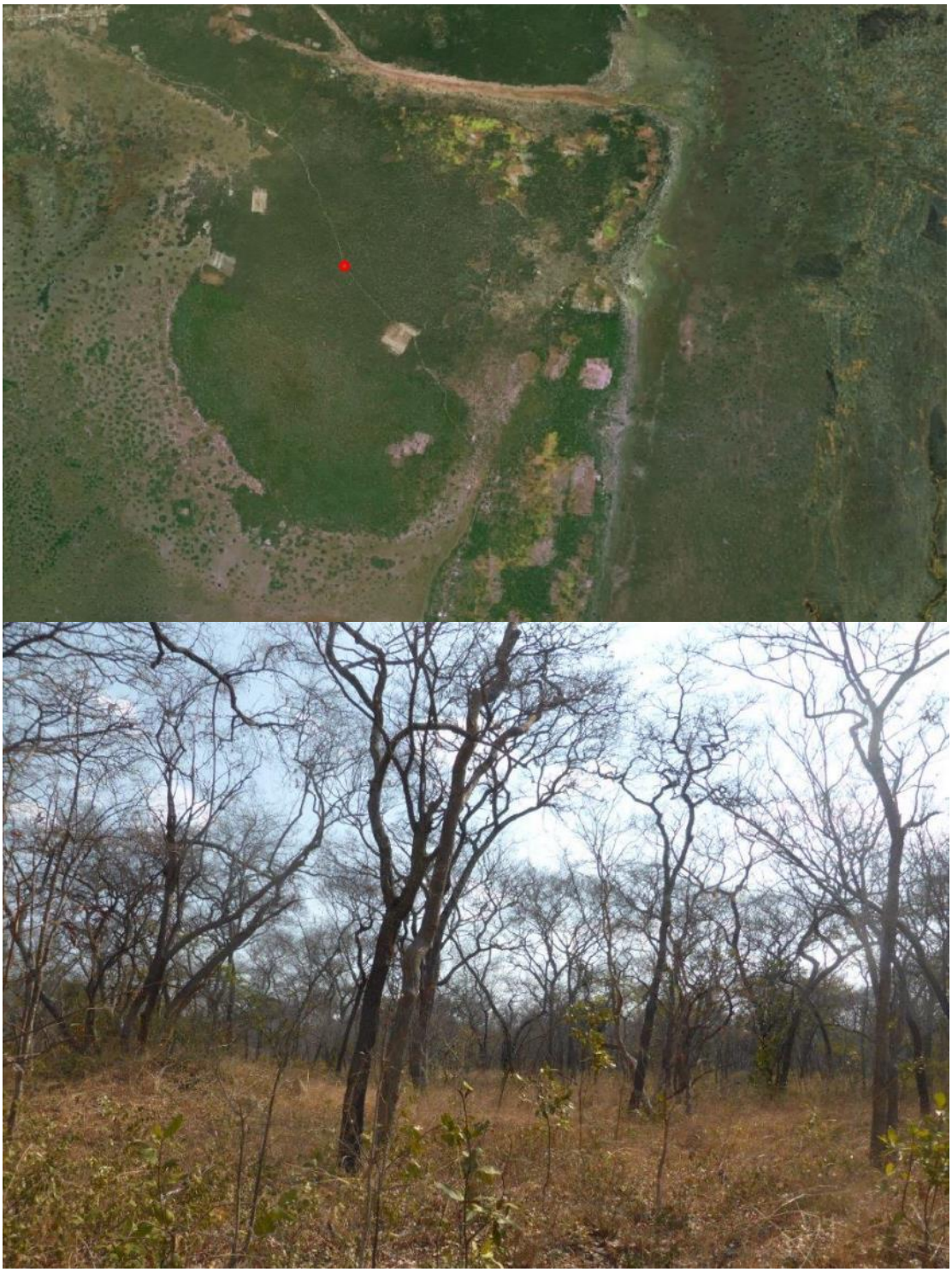
Source: Nemus, 2019

Figure 20 – Permanent swamp (3: grassland) off the village of Kaswende, highlighting two of its main growth forms: A) floating-leaved macrophytes and B) emergent macrophytes (D4, 14°25'44.0400"S, 027°56'47.1840"E)



Source: Nemus, 2019

Figure 21 – Fish camp inside the Lukanga Swamp, off Waya (D5, 14°19'43.3200"S, 027°56'09.1680"E)



Source: Nemus, 2019

Figure 22 – 1: Forest land (S10, 14° 3'36.87"S; 27°37'9.24"E)



Source: Nemus, 2019

Figure 23 – 1: Forest land (S33, 14° 5'33.50"S; 28° 1'39.77"E)



Source: Nemus, 2019

Figure 24 – 2: Wooded grassland (S6, 14°31'11.53"S; 27°29'19.28"E)



Source: Nemus, 2019

Figure 25 – 3: Grassland (S16, 14° 9'12.56"S; 27°38'11.39"E)



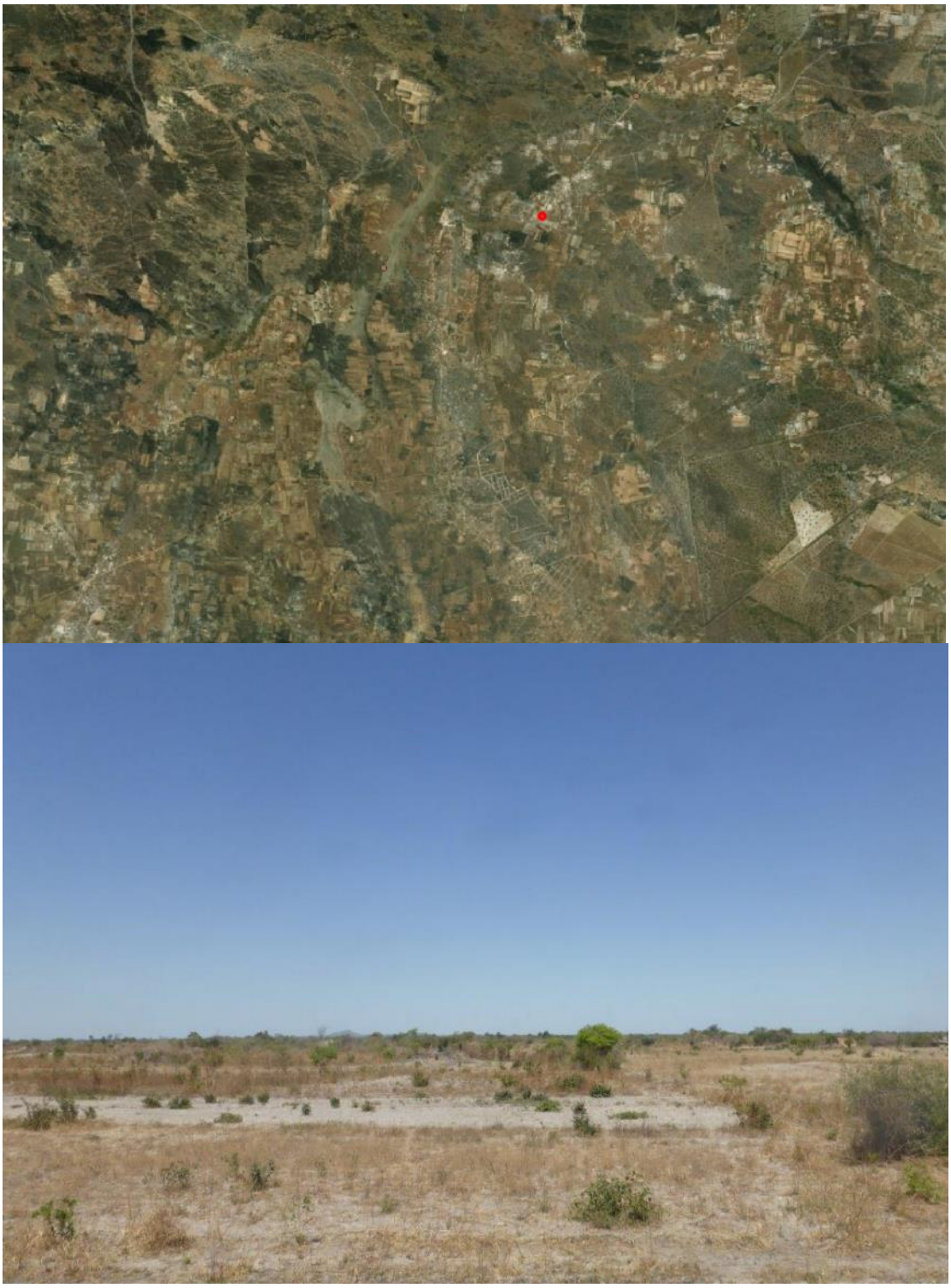
Source: Nemus, 2019

Figure 26 – 3: Grassland (S14, 14°26'41.10"S; 27°58'25.37"E)



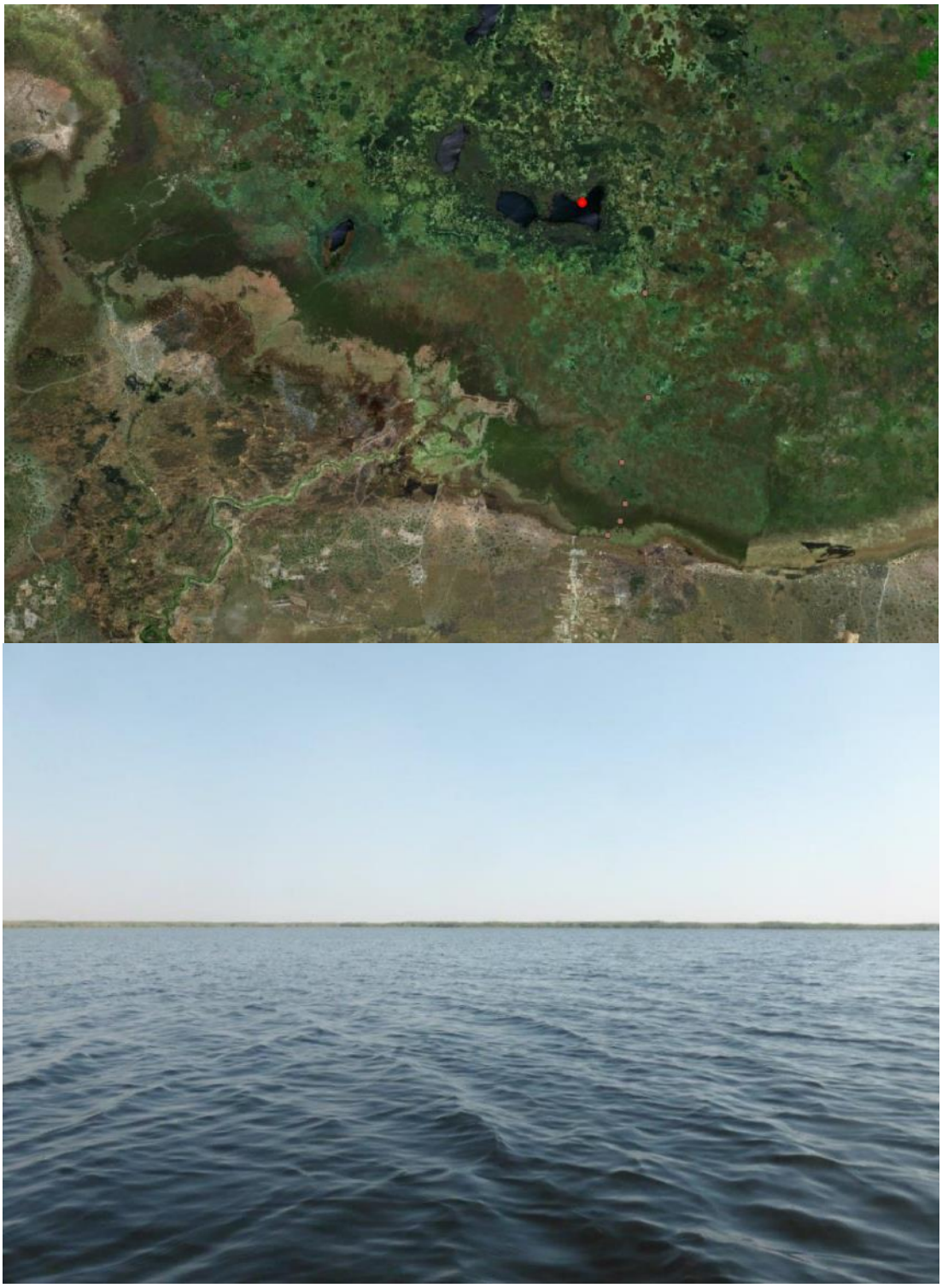
Source: Nemus, 2019

Figure 27 – 3: Grassland (permanent swamp vegetation) (S39, 14°33'32.19"S; 27°40'10.37"E)



Source: Nemus, 2019

Figure 28 – 4: Anthropic landscape (cultivated land) (S12, 14°36'45.53"S; 28° 5'25.47"E)



Source: Nemus, 2019

Figure 29 – 5: Inland water (S41, 14°31'31.85"S; 27°39'29.09"E)



Source: Nemus, 2019

Figure 30 – 5: Inland water (S36, 14°23'5.51''S; 27°11'52,97''E)

3.5. Contamination assessment

3.5.1. Methodology

The present chapter details the methods used to assess chemical contamination in different media of the Lukanga Swamp and Upper Kafue Basin. More information about the parameters analysed and laboratory procedures can be found in Appendix 2.1.

The assessment of the contamination existing in the Lukanga Swamp and upper Kafue river uses primary data specifically obtained for this purpose, but also data from other previous studies that have been carried out in Zambia, particularly in the Copperbelt area.

Physical and chemical data were obtained in surface water, groundwater, stream/swamp sediments and leaves from *Phragmites* spp in two campaigns conducted in September and October 2019.

The procedures used in those campaigns and their results are presented in the sections below.

3.5.1.1. Field sampling and sample preparation

The two field campaigns were done between 6 and 14 of September 2019 and between 10 and 23 of October 2019.

During these campaigns the following type and number of samples were collected (Figure 31 and Figure 32):

- Surface water (42 samples);
- Groundwater (14 samples);
- Stream/swamp sediments (21 samples);
- Leaves (*Phragmites* spp.) (10 samples).



Figure 31 – Acquiring *in-situ* surface water parameters (left) and collecting leaves of *Phragmites* spp. in a stream (right)



Figure 32 – Acquiring groundwater samples from well (left) and collecting sediment sample in the Kafue River (right)

The location of sampling points for the different media are depicted in Figure 33, Figure 34, Figure 35 and Figure 36. The station reference may use “Oc” or “S” after the station number as an indication of the month when the sample was collected: October or September 2019, respectively.

Geographical coordinates and a description of the different sampling stations can be found in Appendix 2.2.

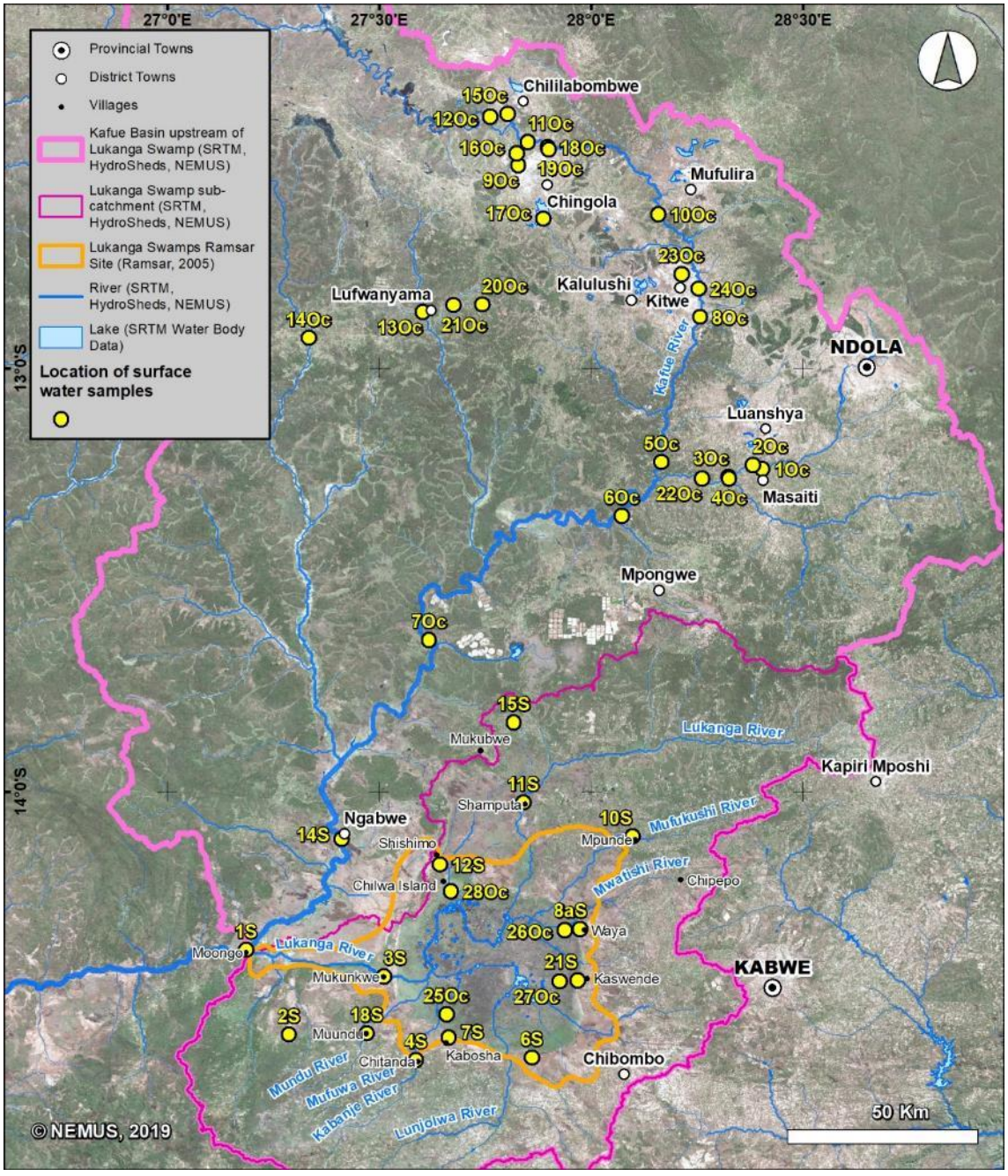


Figure 33 – Location of stations where surface water samples were collected

Surface water was collected in streams from the Upper Kafue River Basin or at the Lukanga Swamp area (including the actual swamp and streams draining into it). In the Upper Kafue River Basin, the sampling focused in the streams affected by mining activities, however the other basins (Lufwanyama, Lusiwishi and Kafulafuta rivers) were also sampled.

Groundwater was collected in wells from villages surrounding the Lukanga Swamp since is not reasonable that groundwater from the Upper Kafue River Basin affects the Lukanga Swamp.

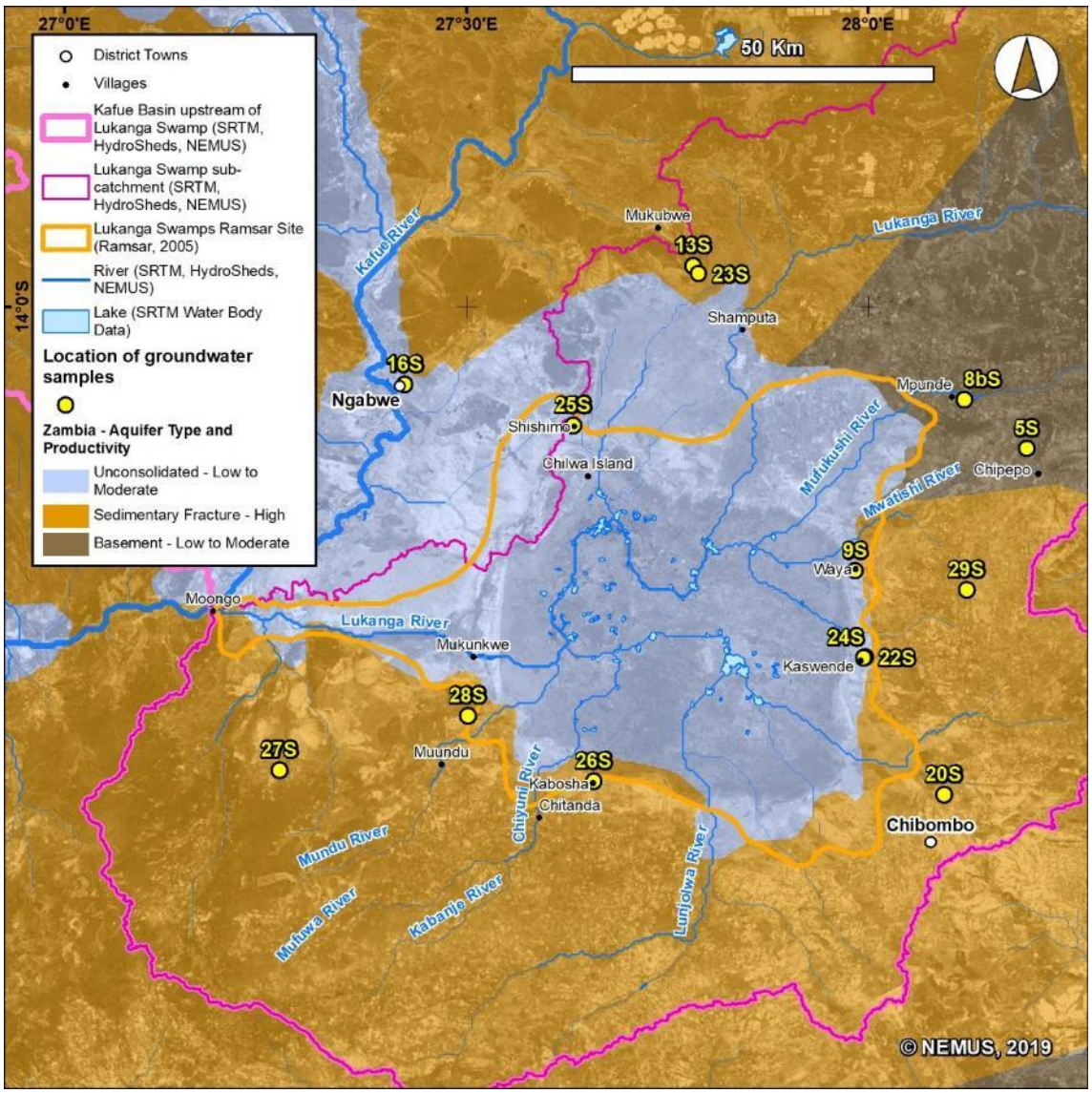


Figure 34 – Location of stations where groundwater samples were collected

Sediment samples were collected in the two main areas: Lukanga Swamp area and areas of the Copperbelt Province more affected by mining activities. It was not possible to collect sediment samples in the inner part of the swamp because its floor is covered by a thick layer of plant material.

Leaves of *Phragmites* spp. were collected in the Lukanga Swamp area and at the Copperbelt province. Sampling of leaves in the Copperbelt will allow to understand how this plant behaves in areas where contents of metals are certainly high in the soil. Stations where leaves were collected were also sampled for surface water.

After collection, water and sediment samples were maintained in cooled conditions until analyses were performed. Leaves were cleaned from dust with tap water and dried before analyses were performed.

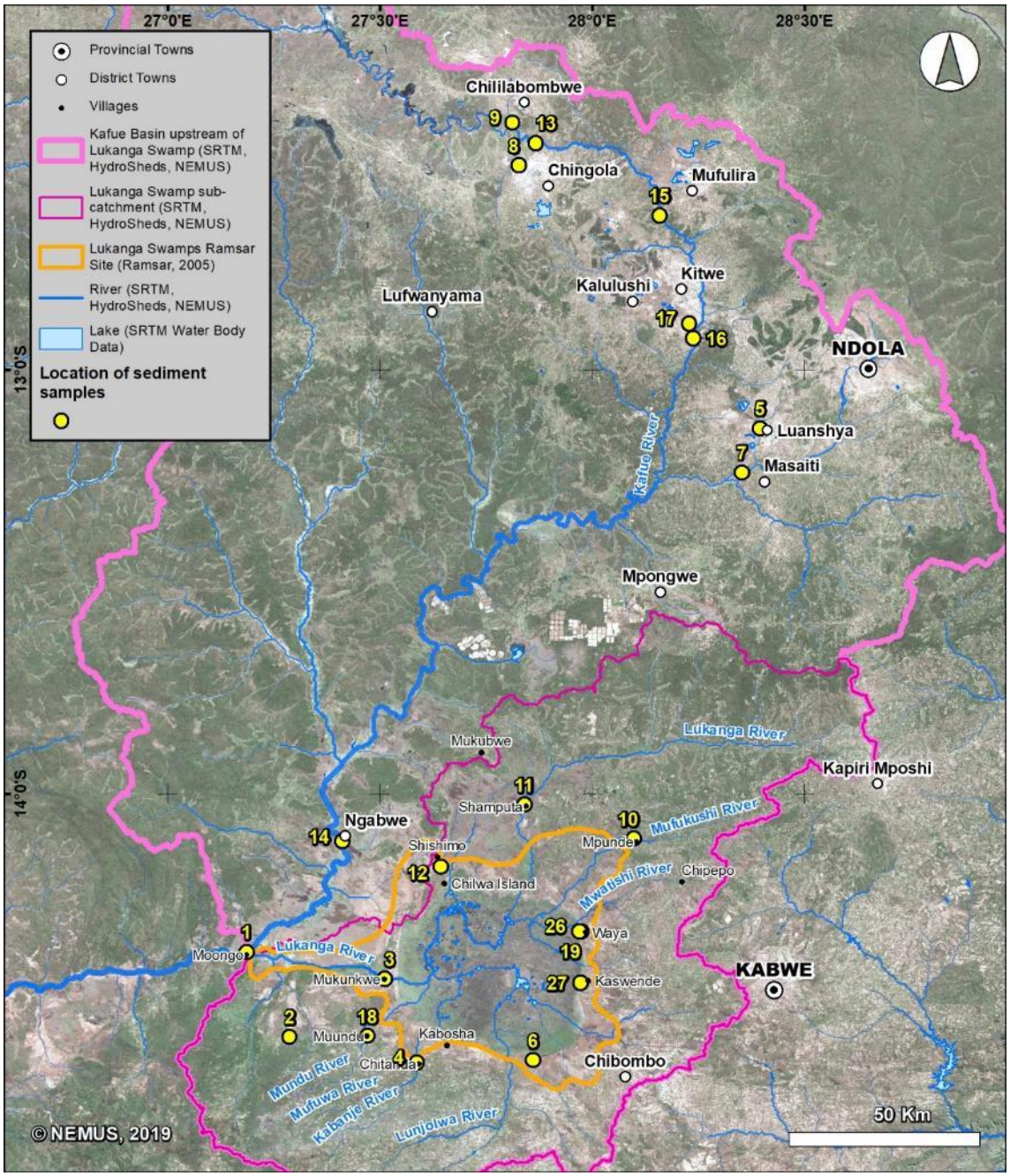


Figure 35 – Location of stations where sediment samples were collected

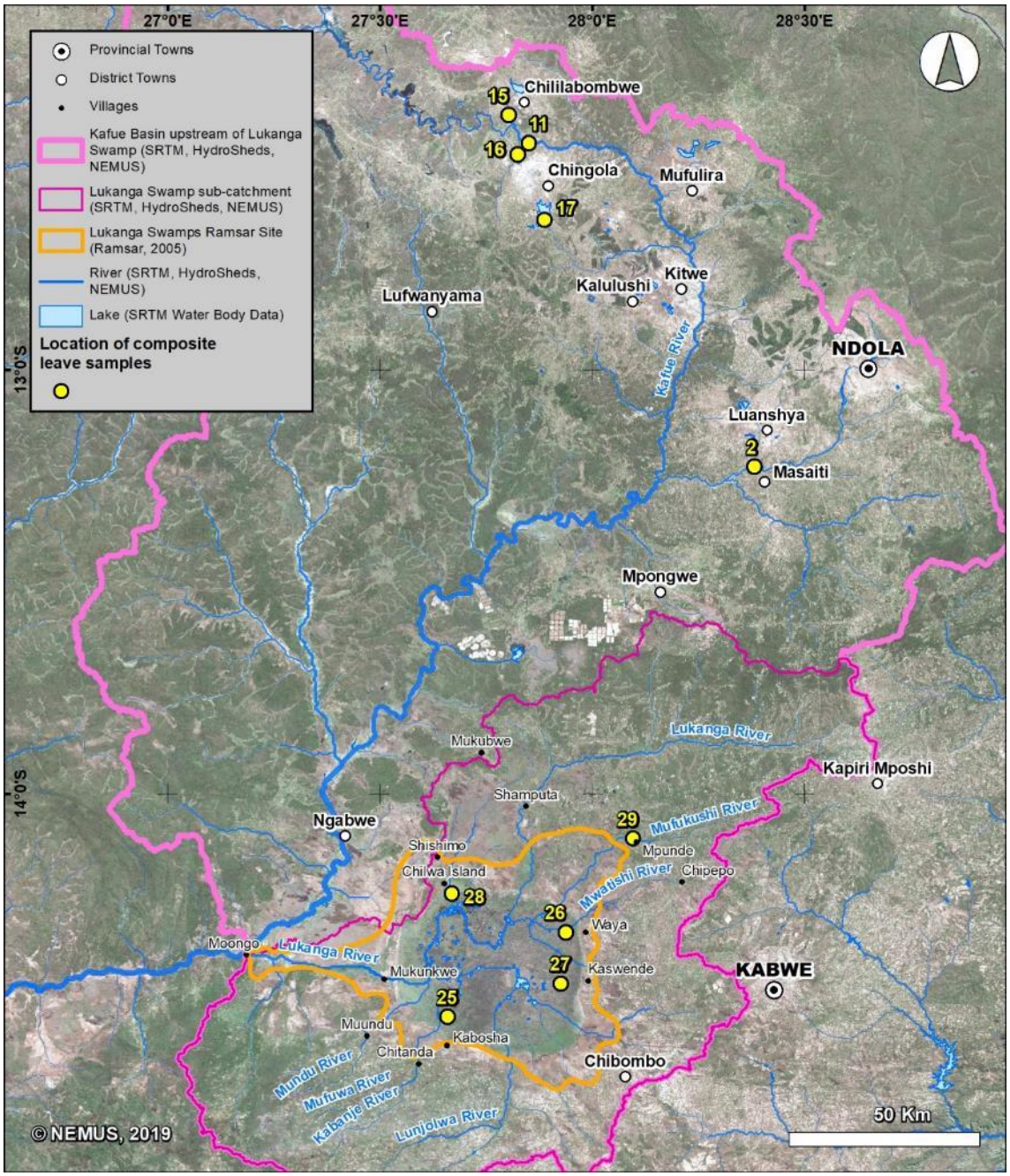


Figure 36 – Location of stations where composite leaf samples were collected

3.5.2. Results and discussion

3.5.2.1. Water samples

A) Groundwater (well water)

Fourteen groundwater samples were collected in wells from villages around the Lukanga Swamp. According to the hydrogeological map, samples were collected in wells dug in different lithological units: Basement Complex: undifferentiated (1), Katanga Supergroup (8), Quaternary Alluvium (4) and Tertiary: Kalahari Group (1).

Parameters analysed *in situ* were pH, dissolved oxygen, conductivity and temperature:

- pH – 6.6 (5.7 to 7.4);
- Dissolved oxygen – 30% (21% to 40%);
- Conductivity – 326 µS/cm (47 µS/cm to 812 µS/cm);
- Temperature – 25ºC (21 ºC to 28ºC).

While pH and dissolved oxygen show a relatively small range of values and characteristic from groundwater, conductivity values span a wide range of values.

It is not certain what causes this differentiation in conductivities because values seem not specifically associated with the dominant lithologies. In fact, two wells were sampled in Kaswende, supposedly dug in the same lithologies, and both samples show conductivities somewhat different (243 and 495 µS/cm). Curiously, the one with higher conductivity is closed and used for drinking purposes, while the other is an open well just used for irrigation and washing of clothes, utensils and tools.

Nevertheless, conductivity values never exceeded the threshold considered for drinking purposes in the ZABS (1500 µS/cm).

Original results from the laboratories are in Appendix 2.3. and analysed parameters are shown in maps in Appendix 2.4.

Chemical oxygen demand (COD) is constantly below 4 mg/l, which is an indication of the low amount of organic matter in the water. The most common application of COD is in quantifying the amount of oxidizable pollutants found in water.

Biochemical oxygen demand (BOD) is commonly below 1 mg/l. Only samples 5S (north of Chipepo), 23S (between Shamputa and Mukubwe), 25S (Shishimo) show 1 mg/l,

1 mg/l and 2 mg/l, respectively. These are anyway acceptable values for drinking purposes which means low contents of biologically oxidized organic matter.

As for the nutrients analysed, phosphorus shows concentrations higher than 0,1 mg/l in samples 28S (between Muundu and Mukunkwe), 25S (Shishimo), 26S (Kabosha) and 29S (between Waya and Kabwe). This value is however arbitrary and is used to show the four highest values. All values are still lower than the threshold value defined for drinking purposes (1 mg/l) by ZABS.

Nitrates vary greatly between 0.04 mg/l and 80.7 mg/l. The threshold value defined for drinking purposes (45 mg/l) by ZABS/WHO is only exceeded in the following samples: 28S (between Muundu and Mukunkwe), 29S (north of Chibombo) and 20S (between Waya and Kabwe), with 80.7 mg/l, 67.9 mg/l and 61.0 mg/l, respectively.

With regard to metals (and metalloids), Hg and As are consistently below detection limits, 0.3 mg/l and 0.2 mg/l, respectively. However, the threshold values defined for drinking purposes by ZABS/WHO are both lower than these values (0.001 mg/l and 0.01 mg/l, respectively), so it is still unknown if these samples are good for drinking purposes considering these elements.

Cobalt concentrations vary between 0.001 and 9.400 mg/l. The threshold value defined for drinking purposes by ZABS is 0.05 mg/l, and 7 samples have higher concentrations than this value: 16S (Kabosha), 20S (north of Chibombo), 22S (Kaswende), 24S (Kaswende), 25S (Shishimo), 27S (in the road between Muundu and Moongo), 29S (north of Chibombo).

Cromium concentrations vary between 0.0003 mg/l and 0.4810 mg/l. The threshold value defined for drinking purposes by ZABS is 0.05 mg/l, and 3 samples have higher concentrations than this value: 24S (Kaswende), 25S (Shishimo), 29S (north of Chibombo).

Copper concentrations vary between 0.024 and 0.202 mg/l. All concentrations found are below the threshold value defined for drinking purposes by ZABS/WHO (2 mg/l). Considering other guidelines for human consumption (0.05 mg/l in the Portuguese Law) all but one sample (5S) surpass this value.

Nickel concentrations vary between 0.0011 and 6.7005 mg/l. The threshold value defined for drinking purposes by WHO is 0.07 mg/l, and 6 samples have higher concentrations than this value: 13 (between Shamputa and Mukubwe), 20 (north of Chibombo), 23

(between Shamputa and Mukubwe), 25S (Shishimo), 27 (in the road between Muundu and Moongo), 29S (north of Chibombo).

Lead concentrations vary between 0.297 mg/l and 1.655 mg/l. Twelve samples have concentrations above the threshold value defined for drinking purposes by ZABS/WHO (0.01 mg/l). The remaining two samples show values below the detection limits.

Zinc concentrations vary between 0.006 mg/l and 0.986 mg/l. All samples show concentrations below the threshold value defined for drinking purposes by ZABS (3 mg/l).

Organic compounds were analysed only in samples 23S (between Shamputa and Mukubwe), 24S (Kaswende) and 26S (Kabosha). For these three samples values of 16 Polycyclic Aromatic Hydrocarbons (PAH), 5 Hexachlorocyclohexanes (HCH) and Hexachlorobenzene (HCB) were below detection limits, 0.370 µg/L, 0.050 µg/L and 0.005 µg/L, respectively.

The following table summarizes the parameters that do not respect guideline values for water for drinking purposes (ZS, WHO). As one may see from the table, the main problem of the quality of groundwater is related with concentrations of metals, particularly of Cd and Pb. High concentrations of nitrates and low pH also occur in some groundwater samples. The search for the causes of these high values will be developed afterwards.

Table 23 – List of all 14 groundwater samples and parameters that exceed guideline values for drinking purposes

Samples	Parameters
5S – North of Chipepo	Cd, Pb(?)
8bS – South of Mpunde	Cd, pH, Pb
9S – Waya	Cd(?), Pb
13S – Between Mukubwe and Shamputa	Cd, Pb, Ni
16S – Ngabwe	Cd, pH, Pb
20S – North of Chibombo	Cd, Nitrates, Pb, Co, Ni
22S – Kaswende	Cd(?), Pb, Co
23S – Between Mukubwe and Shamputa	Cd, Pb, Ni
24S – Kaswende	Cd(?), pH, Pb, Co
25S – Shishimo	Cd, pH, Pb, Co, Ni
26S – Kabosha	Cd(?), pH, Pb
27S – Road between Moongo and Muundu	Cd, Pb, Co, Ni

Samples	Parameters
28S – Between Muundu and Mukunkwe	Cd, pH, Nitrates, Pb(?)
29S – Between Waya and Kabwe	Cd, Nitrates, Pb, Co, Ni

Note: (?) - means that detection limit is higher than guideline value.

B) Surface water

Forty-two surface water samples were collected in water streams throughout the whole upper Kafue river basin and in the Lukanga Swamp.

Parameters analysed *in situ* were pH, dissolved oxygen, conductivity and temperature:

- pH – 7.7 (6.2 to 9.1);
- Dissolved oxygen – 79% (19% to 192%);
- Conductivity – 674 µS/cm (47 µS/cm to 6039 µS/cm);
- Temperature – 24ºC (16ºC to 29ºC).

Given the wide geographical range of these different samples, it is no surprise the wide range of pH, dissolved oxygen and conductivity values found. Particularly the low values of dissolved oxygen and high values of conductivity are a warning for contamination or specific conditions.

Conductivity values are generally higher in the Copperbelt Province, probably due to the higher content of metals. The highest value (6039 µS/cm) was found immediately downstream of the Muntimpa dam. In the Copperbelt Province, values above 1000 µS/cm were also found in the Chingola River (1785 µS/cm), in the Mushishima River (1079 µS/cm) and in the Mindolo stream in Kitwe (1646 µS/cm). However, higher values than 1000 µS/cm were also found in the Southeast part of the Lukanga Swamp, close to Kaswende (samples 21S and 28Oc).

Contents of dissolved oxygen lower than 50% occur essentially in some areas of the Lukanga Swamp and in streams draining into it. Outside the Lukanga Swamp area, it was also found in the Mindolo stream in Kitwe.

Chemical oxygen demand (COD) varies between 3 mg/l and 121 mg/l, but there are 6 surface water samples with COD below 4 mg/l (the detection limit for one the laboratories). In the Lukanga Swamp area values are lower in streams draining into the

swamp, and in the Kafue River (< 8 mg/l). Inside the swamp values increase (> 15 mg/l) and reach the highest value of 121 mg/l.

In the Copperbelt Province COD values are commonly higher than 15 mg/l, probably because of wastewater coming from cities and villages.

Biochemical oxygen demand (BOD) varies between 1 mg/l and 26 mg/l, but seven surface water samples show BOD values below 1 mg/l, all of them in the Lukanga Swamp area. In the Lukanga Swamp area, values follow a similar pattern to COD: lower values in streams draining into the swamp, and in the Kafue River (<= 1 mg/l), and generally higher values inside the swamp.

In the Copperbelt Province BOD values are commonly higher than 3 mg/l, probably also because of wastewater coming from cities and villages.

As for the nutrients analysed, phosphorus shows a wide range of values from 0.0002 mg/l to 1.500 mg/l, with mean concentration of 0.316 mg/l. In the Lukanga Swamp area, concentrations tend to be lower than 0.100 mg/l, while in the swamp is the opposite. In the Copperbelt Province concentrations are consistently higher than 0.100 mg/l.

Nitrates range from 0.007 mg/l to 104.08 mg/l with mean concentration of 8.98 mg/l. The highest concentrations are found in the Lukanga Swamp area (> 15 mg/l). These values may occur inside the swamp but also in water streams draining into the swamp. In the Copperbelt Province concentrations above 2 mg/l occur in Kitwe and upstream from this city. Between this area and the Lukanga Swamp area (middle section of the Kafue River, Kafulafuta River Basin, Lufwanyama River and Luswishi River) concentrations are lower than 2 mg/l.

With regard to metals (and metalloids), Hg and As are consistently below detection limits, 0.3 and 0.05 mg/l and 0.2 and 0.01 mg/l, respectively.

Cobalt concentrations vary between 0.0009 mg/l and 4.997 mg/l, with mean value of 0.245 mg/l. In the Copperbelt Province concentrations seem very much related to mining areas. In the Lukanga Swamp area, concentrations vary from <0.0005 mg/l to >0.1000 mg/l.

Chromium concentrations vary from 0.0001 mg/l to 0.0145 mg/l, with mean concentration of 0.005 mg/l. Chromium in the Copperbelt Province is consistently below 0.001 mg/l,

while in the Lukanga Swamp area concentrations reach 0.0145 mg/l in the Mufukushi River.

Copper concentrations vary from 0.020 mg/l to 0.957 mg/l, with mean value of 0.198 mg/l. Copper concentrations higher than 0.100 mg/l occur in the Copperbelt area close to Chingola and in southwest part of the Lukanga Swamp area.

Nickel concentrations vary from 0.001 mg/l to 0.162 mg/l, with mean value of 0.043 mg/l. The highest value was found just downstream from the Muntimpa dam, however, the second highest (0.124 mg/l) occurred in the Lukanga Swamp.

Lead concentrations vary from 0.01 mg/l to 1.86 mg/l, with mean value of 0.80 mg/l. It is worth noting that 26 water surface samples have concentrations below detection limit (0.01 mg/l). Concentrations are consistently higher in the Lukanga Swamp compared to those found in the Copperbelt Province.

Zinc concentrations vary from 0.01 mg/l to 0.979 mg/l, with mean value of 0.239 mg/l. It is worth noting that 21 water surface samples have concentrations below detection limit (0.006 mg/l). As for Pb, concentrations are consistently higher in the Lukanga Swamp compared to those found in the Copperbelt Province. In this previous area the highest value occurred again just downstream from the Muntimpa dam.

Water uses and comparison to guideline values

Fishing is obviously the main activity practiced in the swamp, and fishermen use its water for drinking purposes while in the swamp. Surface water of the Lukanga Swamp and streams draining into the swamp are also used for drinking by grazing animals and bathing/recreational use.

Table 24 shows standard and guideline values for different parameters analysed in water samples for drinking and irrigation. Guideline values defined for minimum environmental quality defined in the Portuguese Law were also used to have reference values for COD, BOD and P, and have a less demanding perspective on water quality.

Table 24 – Guideline and standard values for different water uses

Parameter	Drinking water		Irrigation water	Minimum Environmental Quality
	Zambian Standard	WHO Guideline	FAO Guideline	Portuguese Law Decree 236/98
pH	6.5 – 8.5	6.5 – 8.5	6.5 – 8.4	5.0 – 9.0
Conductivity (µS/cm)	1500	-	700 - 3000**	-
Chemical Oxygen Demand (mg/L)	-	-	-	30.0***
Biochemical Oxygen Demand (mg/L)	-	-	-	5.0
Nitrates (NO3-)	44.3	50	22.15 – 132.9**	-
Phosphorus	-	-	-	1.0
As (mg/l)	0.01	0.01	0.1¥	0.1
Cd (µg/L)	0.003	0.003	0.01¥	0.01
Cr (mg/L)	0.05	0.05	0.1¥	0.05
Co (mg/l)	0.5	-	0.05¥	-
Cu (mg/l)	1.0	2.0	0.2¥	0.1
Hg (mg/l)	0.001	0.006	-	0.001
Pb (mg/L)	0.01	0.01	5¥	0.05
Zn (mg/L)	3.0	-	2.0¥	0.5

Notes: ǂ Maximum values recommended assuming there will be physical treatment and disinfection of the water to be potable;
* Recommended maximum value assuming physical and chemical treatment for tuning and disinfection of the water to be potable
** Interval corresponds to “slight to moderate” degree of restriction class; ¥ Recommended Maximum Concentration; *** According to the Portuguese Law, it must be below 30 mg/l to be able to be treated for human consumption

Almost all water samples have problems for the different uses analysed. Exceptions are 1Oc (Kafubu River – upstream from Luanshya River), 15Oc (Lubengele Stream), 18Oc (Kafue River – upstream from Chingola, and immediately upstream from the public water abstraction plant) (Table 25).

The analysis of surface water for the different uses will be further developed in Progress Report No. 2.

Table 25 – Analysis of surface water samples for different water uses considering different guidelines values

Sta./Param.	pH	Cond.	COD	BOD	NO3-	P	As	Cd	Cr	Co	Cu	Hg	Pb	Zn	S/GNC
1S	8.26	483	<4	<1	10.05	0.0031	<0.2	0.23	0.009	0.0009	0.3247	<0.3	0.2664	0.2247	**ZS** (Cd, Pb) **WHO** (Cd, Pb) **FAO** (Cu) **PL** (Cu)
2S	7.62	268	<4	1	0.13	0.0034	<0.2	0.41	0.002	0.0600	0.1034	<0.3	1.346	<0.002	**ZS** (Cd, Pb) **WHO** (Cd, Pb) **FAO** (Cd, Co) **PL** (Cd, Cu, Pb)
3S	7.51	218	13	1	21.45	0.0012	<0.2	0.17	0.003	0.001	0.207	<0.3	0.7376	0.3348	**ZS** (Cd, Pb) **WHO** (Cd, Pb) **FAO** (Cd, Cu) **PL** (Cd, Cu, Pb)
4S	7.51	474	<4	<1	30.54	0.3023	<0.2	0.23	0.001	0.0021	0.0618	<0.3	0.8018	0.1177	**ZS** (Cd, Pb) **WHO** (Cd, Pb) **FAO** (Cd, NO3) **PL** (Cd, Pb)
6S	6.64	347	43	1	4.01	0.043	<0.2	<0.005	0.014	<0.0005	0.0521	<0.3	0.3473	0.2153	**ZS** (Pb) **WHO** (Pb) FAO **PL** (COD, Pb)
7S	6.94	283	23	4	11.23	0.0071	<0.2	0.11	0.0041	0.0891	0.0843	<0.3	1.856	0.3516	**ZS** (Cd, Pb) **WHO** (Cd, Pb) **FAO** (Cd, Co) **PL** (Cd, Pb)
8aS	7.89	684	39	<1	10	0.0065	<0.2	0.24	0.0001	0.102	0.088	<0.3	0.8624	0.295	**ZS** (Cd, Pb) **WHO** (Cd, Pb) **FAO** (Cd, Co) **PL** (Cd, COD. Pb)
10S	7.34	161	8	1	11.9	0.0065	<0.2	0.05	0.0145	0.0369	0.6669	<0.3	0.0467	0.9794	**ZS** (Cd, Pb) **WHO** (Cd, Pb) **FAO** (Cd, Cu) **PL** (Cd, Cu, Zn)
11S	7.18	196	17	1	17.01	0.0002	<0.2	0.22	0.0021	<0.0005	0.0646	<0.3	0.9295	<0.002	**ZS** (Cd, Pb) **WHO** (Cd, Pb) **FAO** (Cd) **PL** (Cd, Pb)
12S	7.43	320	4	<1	12.87	0.034	<0.2	0.03	0.0011	<0.0005	0.0891	<0.3	1.089	0.4835	**ZS** (Cd, Pb) **WHO** (Cd, Pb) **FAO** (Cd) **PL** (Cd, Pb)
14S	8.36	505	<4	1	14.76	0.002	<0.2	0.19	<0.0001	0.1002	0.0591	<0.3	1.203	0.2149	**ZS** (Cd, Pb) **WHO** (Cd, Pb) **FAO** (Cd, Co) **PL** (Cd, Pb)

Sta./Param.	pH	Cond.	COD	BOD	NO3-	P	As	Cd	Cr	Co	Cu	Hg	Pb	Zn	S/GNC
15S	7.21	707	<4	<1	0.0067	0.024	<0.2	<0.005	0.0084	0.0177	0.0773	<0.3	1.244	0.6944	**ZS** (Cd, Pb) **WHO** (Cd, Pb) **FAO** (Cond.) **PL** (Pb, Zn)
18S	7.48	452	<4	<1	53.56	0.0932	<0.2	0.10	<0.0001	0.0129	0.957	<0.3	1.157	0.0933	**ZS** (Cd, Pb, NO3) **WHO** (Cd, Pb, NO3) **FAO** (Cd, Cu, NO3) **PL** (Cd, Cu, Pb)
21S	8.05	1324	85	<1	104.08	0.174	<0.2	0.23	<0.0001	0.0125	0.0746	<0.3	0.8908	0.3269	**ZS** (Cd, NO3, Pb) **WHO** (Cd, NO3, Pb) **FAO** (Cd, Cond, NO3) **PL** (Cd, COD, Pb)
1Oc	6.86	398	2.5	1.4	1.54	0.3	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	< 0.006	ZS WHO FAO PL
2Oc	6.94	393	19	11.1	1.21	0.2	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	< 0.006	ZS WHO FAO **PL** (BOD)
3Oc	7.2	391	13	10.8	1.90	0.3	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	< 0.006	ZS WHO FAO **PL** (BOD)
4Oc	6.95	349	17	8.6	1.64	0.2	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	< 0.006	ZS WHO FAO **PL** (BOD)
5Oc	8.47	576	26	11.1	1.36	0.2	< 0.01	< 0.001	< 0.001	0.002	0.02	< 0.05	< 0.01	< 0.006	ZS WHO **FAO** (pH) **PL** (BOD)
6Oc	8.16	552	15	14.7	1.66	0.6	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	< 0.006	ZS WHO FAO **PL** (BOD)
7Oc	8.13	533	29	25.6	1.80	0.2	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	0.089	ZS WHO FAO **PL** (BOD)
8Oc	6.16	628	14	11.4	3.95	0.7	< 0.01	< 0.001	< 0.001	0.014	< 0.01	< 0.05	< 0.01	< 0.006	**ZS** (pH) **WHO** (pH) **FAO** (pH) **PL** (BOD)

Sta./Param.	pH	Cond.	COD	BOD	NO3-	P	As	Cd	Cr	Co	Cu	Hg	Pb	Zn	S/GNC
9Oc	8.67	1785	22	5.4	7.76	< 0.1	< 0.01	< 0.001	< 0.001	0.098	0.66	< 0.05	< 0.01	< 0.006	**ZS** (Cond, pH) **WHO** (pH) **FAO** (Cond, Co, Cu, pH) **PL** (BOD, Cu)
10Oc	7.73	590	19	13	2.01	0.1	< 0.01	< 0.001	< 0.001	0.001	0.03	< 0.05	< 0.01	< 0.006	ZS WHO FAO **PL** (BOD)
11Oc	7.76	528	56	9.2	2.25	0.3	< 0.01	< 0.001	< 0.001	0.016	0.17	< 0.05	< 0.01	< 0.006	ZS WHO FAO **PL** (COD, Cu, BOD)
12Oc	7.96	221	20	6.6	1.05	0.4	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	0.01	< 0.006	ZS WHO FAO **PL** (BOD)
13Oc	8.1	423	16	11.9	1.50	0.4	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	< 0.006	ZS WHO FAO **PL** (BOD)
14Oc	7.87	431	15	11.4	1.31	0.2	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	0.007	ZS WHO FAO **PL** (BOD)
15Oc	7.46	230	14	3.3	2.08	0.3	< 0.01	< 0.001	< 0.001	< 0.001	0.03	< 0.05	< 0.01	< 0.006	ZS WHO FAO PL
16Oc	7.36	1079	50	10.3	1.57	0.4	< 0.01	< 0.001	< 0.001	0.025	0.13	< 0.05	< 0.01	< 0.006	ZS WHO **FAO** (Cond) **PL** (BOD, COD, Cu)
17Oc	7.49	6039	40	12	1.81	0.5	< 0.01	< 0.001	< 0.001	4.997	0.42	< 0.05	0.02	0.024	**ZS** (Co, Pb, Cond) **WHO** (Pb) **FAO** (Co, Cu, Cond) **PL** (Cu, COD)
18Oc	8.01	493	13	1.3	2.35	0.2	< 0.01	< 0.001	< 0.001	0.014	0.08	< 0.05	< 0.01	< 0.006	ZS WHO FAO PL
19Oc	7.4	552	25	21.8	15.05	0.5	< 0.01	< 0.001	< 0.001	0.005	0.11	< 0.05	< 0.01	< 0.006	ZS WHO FAO **PL** (BOD, Cu)

Sta./Param.	pH	Cond.	COD	BOD	NO3-	P	As	Cd	Cr	Co	Cu	Hg	Pb	Zn	S/GNC
20Oc	7.84	47	19	13.6	0.28	0.5	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	0.029	ZS WHO FAO **PL** (BOD)
21Oc	7.84	248	21	13.6	0.95	0.5	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	< 0.006	ZS WHO FAO **PL** (BOD)
22Oc	8	389	37	10.8	0.95	0.6	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	< 0.006	ZS WHO FAO **PL** (COD, BOD)
23Oc	7.26	1646	16	11.9	2.23	0.3	< 0.01	< 0.001	< 0.001	0.016	< 0.01	< 0.05	< 0.01	< 0.006	**ZS** (Cond) WHO **FAO** (Cond) **PL** (BOD)
24Oc	7.5	646	36	22.9	2.70	0.8	< 0.01	< 0.001	< 0.001	0.001	< 0.01	< 0.05	< 0.01	< 0.006	ZS WHO FAO **PL** (COD, BOD)
25Oc	7.93	410	27	8.7	3.23	0.62	< 0.01	0.001	< 0.001	0.002	< 0.01	< 0.05	< 0.01	0.012	ZS WHO FAO **PL** (BOD)
26Oc	7.85	789	49	14.8	3.54	1.04	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	0.014	ZS WHO **FAO** (Cond) **PL** (COD, BOD, P)
27Oc	8.02	1263	121	12.0	6.37	1.50	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	0.034	**ZS** (Cond) WHO **FAO** (Cond) **PL** (COD, BOD, P)
28Oc	9.12	269	15	6.5	1.41	0.39	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.05	< 0.01	< 0.006	**ZS** (pH) **WHO** (pH) **FAO** (pH) **PL** (BOD)

Notes: Conductivity is expressed in µS/cm and the other are in mg/l; S/GNC – Standard/Guideline Non-Compliance.

3.5.2.2. Sediment samples

Chemical and physical analyses were performed to the 21 sediment samples collected in the Lukanga Swamp area and the upper Kafue River. Grain-size data and specific weight are shown in Table 26. Concentrations of metals and metalloids are shown in Table 27, concentrations of organic compounds and total organic carbon in Table 29.

A) Grain-size analysis

Grain-size analysis shows that “sand” and “loamy sand” dominate sediment analysed. However, sediment samples span from a classification of clay (maximum value of 50% in sample 6) to sand (maximum value of 94% in sample 15).

Table 26 – Specific weight and grain-size classification of sediment samples collected in the Lukanga Swamp area and Upper Kafue River Basin

Sta./Param.	Specific weight (g/l)	Grain-size (%)				Classification*
		< 2 µm	2 - 63 µm	63 µm - 2 mm	> 2 mm	
1	2179	43	27	26	4	Clay
2	2565	5.8	15.2	76	3	Loamy Sand
3	2190	<1	15	73	11	Loamy Sand
4	2556	<1	3.8	93.2	2	Sand
5	2716	2.8	59.2	25	13	Silt Loam
6	2147	50	15	24	11	Clay
7	2338	29	7	45	19	Sandy Clay Loam
8	2419	8	55	11	26	Silt Loam
9	2570	<1	12	80	7	Sand
10	2141	49	19	21	11	Clay
11	2546	<1	5.5	90.5	3	Sand
12	2071	14	26	16	44	Sandy Loam
13	2487	15	21	64	0	Sandy Loam
14	2514	1.9	3.8	92.3	2	Sand
15	2514	<1	4.2	93.8	1	Sand
16	2256	34	42	14	10	Clay Loam
17	2505	8.5	19.5	67	5	Sandy Loam
18	2432	24	22	46	8	Sandy Clay Loam
19	2300	30	21	38	11	Sandy Clay Loam
26	1821	26	10	17	47	Sandy Clay Loam
27	2114	11	14	39	36	Sandy Loam

*Classification according to Figure 37

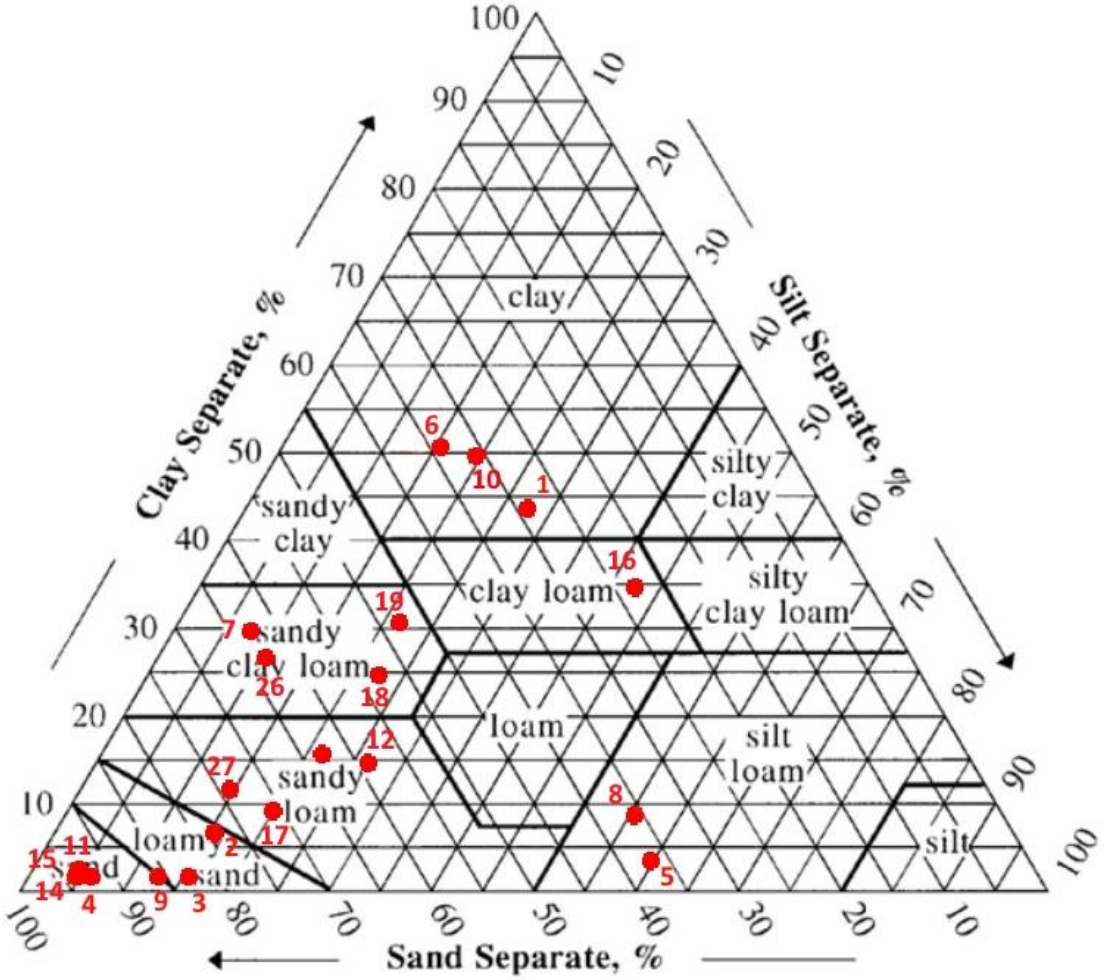


Figure 37 – Sediment texture classification triangle plot for sediment samples collected in the Lukanga Swamp area and Upper Kafue River Basin

B) Chemical analyses

Major elements Al and Fe show average low concentrations of 1.8% (range from 0.1% to 4.5%) and 1.9% (0.2% - 8.5%), respectively. In accordance, concentration of clay-sized particles is also relatively low (average = 17%, range = <1% - 50%). In fact, there is a slight correlation (0.79) between clay-sized particles and Al (Table 30).

These sediments have low contents of aluminosilicates and are probably enriched in other types of minerals such as quartz, carbonates or even sulphides. In accordance, Vrana (1974) for the Area South of the Lukanga Swamp states that most of the area is

covered by eluvial soils of the Plateau type, which are fine- to medium-grained sandy soils, with low content of clay at the surface.

Copper is the metal with the highest concentrations (average of 888 mg/kg), followed by Co (average of 91 mg/kg), Cr (average of 34 mg/kg) and Zn (average of 30 mg/kg).

Metal concentrations are in fact higher in the Copperbelt area in comparison to the Lukanga Swamp, respectively (average values):

- Cu – 2247 vs. 44 mg/kg;
- Co – 222 vs. 10 mg/kg;
- Zn – 59 vs. 13 mg/kg*;
- Cr – 47 vs. 34 mg/kg;
- Ni – 19 vs. 14 mg/kg;
- Pb – 14 vs. 7 mg/kg*;
- Fe – 2.5 vs. 1.7 mg/kg;
- Al – 2.0 vs. 1.8 mg/kg.

* More than half of the samples have concentrations below the detection limits so these average values must be looked at with caution.

Except for sample 16 (Copperbelt), Cd and Hg concentrations are consistently below detection limits.

Through the correlation analysis between metals (Table 28) one may conclude that:

- Fe, Cr, Co and Ni are those with more correlations with other metals;
- Fe in these samples seems to represent better oxides than aluminosilicates;
- As, Co, Cr and Cu are associated to oxides;
- Ni, but also Cr and Zn seem associated to aluminosilicates.

Table 30 shows correlations between metals and COT, and clay and fine-grained content, and these agree with the above conclusions. It is not possible to evaluate the importance of carbonates or sulphides in relation to these metals.

Table 27 – Elemental concentrations (mg/kg) of sediment samples collected in the Lukanga Swamp area and Upper Kafue River Basin

Sta./Param.	Al	As	Cd	Co	Cu	Cr	Fe	Pb	Hg	Ni	Zn
1	2.70	<4	<0.2	19	190	29	1.4	<10	<0.05	18	<20
2	0.46	<4	<0.2	4.7	6.8	23	1.9	<10	<0.05	4.5	<20
3	0.15	<4	<0.2	<1.5	<5	5	0.17	<10	<0.05	<3	27
4	0.96	57	<0.2	20	49	170	8.5	<10	<0.05	31	26
5	2.90	8.8	<0.2	570	2600	140	6.4	<10	<0.05	24	51
6	2.80	<4	<0.2	6	39	29	0.83	<10	<0.05	19	<20
7	4.30	<4	<0.2	30	180	55	1.4	10	<0.05	32	45
8	1.30	5.5	<0.2	180	3700	19	2.1	10	<0.05	17	40
9	1.20	4.4	<0.2	140	5000	14	1.4	<10	<0.05	13	38
10	4.50	<4	<0.2	10	55	20	0.93	14	<0.05	14	<20
11	0.17	<4	<0.2	4.1	8.7	12	0.65	13	<0.05	<3	<20
12	3.50	<4	<0.2	13	42	30	0.59	<10	<0.05	28	<20
13	1.60	<4	<0.2	86	1300	24	1.60	10	<0.05	15	24
14	0.22	<4	<0.2	7.7	92	<10	0.28	<10	<0.05	<3	<20
15	0.28	<4	<0.2	160	800	18	0.72	<10	<0.05	6	<20
16	3.10	7.6	0.53	450	3300	43	3.20	60	0.24	34	250
17	0.89	6.1	<0.2	160	1100	63	3.20	<10	<0.05	8.8	<20
18	1.30	5.5	<0.2	8.4	13	24	1.40	<10	<0.05	9.9	<20
19	2.40	7.5	<0.2	16	28	50	2.50	<10	<0.05	19	<20
26	2.30	<4	<0.2	11	30	34	1.10	15	<0.05	19	<20
27	1.40	<4	<0.2	4.9	15	15	0.62	<10	<0.05	11	<20

Note: When concentration was below detection limit, calculations were done considering half of the detection limit

Table 28 – Spearman correlations between different metals analysed in sediment samples

Metals	Al	As	Co	Cu	Cr	Fe	Pb	Ni	Zn
Al	1.00								
As	0.25, p 0.54	1.00							
Co	0.32, p 0.15	0.28, p 0.51	1.00						
Cu	0.28, p 0.22	-0.31, p 0.45	0.90, p 0	1.00					
Cr	0.55, p 0.01	0.90, p 0	0.51, p 0.02	0.22, p 0.33	1.00				
Fe	0.22, p 0.35	0.94, p 0	0.66, p 0	0.45, p 0.04	0.72, p 0	1.00			
Pb	0.30, p 0.52	-	-0.04, p 0.94	-0.26, p 0.57	0.19, p 0.69	-0.04, p 0.94	1.00		
Ni	0.80, p 2E-05	0.74, p 0.03	0.51, p 0.02	0.36, p 0.11	0.78, p 3E-05	0.49, p 0.02	0.26, p 0.57	1.00	
Zn	0.67, p 0.07	-	0.69, p 0.06	0.40, p 0.32	0.21, p 0.61	0.19, p 0.65	-	0.59, p 0.12	1.00

Note: Correlation coefficients of As, Zn and Pb were calculated considering only values above detection limits; grey correlations mean that, by normal standards, the association between the two variables would not be considered statistically significant.

Sediments collected in the Lukanga Swamp area are characterised by high contents of organic carbon (organic matter) with average value of 2.9% (<0.1% - 5.7%). On the other hand, sediments collected in the Copperbelt area show low contents of organic matter (average TOC of 0.8%; range between <0.1% and 3.3%). Regarding metals, COT only correlates significantly with Al (Table 30). This correlation is higher if samples from the Lukanga and Copperbelt areas are analysed separately (not shown).

Table 29 – Total organic carbon (%) and organic compounds (mg/kg for PAH and µg/kg for PCB and HCB) of sediment samples collected in the Lukanga Swamp area and Upper Kafue River Basin

Sta./Param.	TOC	PAH	PCB	HCB	Sta.	TOC	PAH	PCB	HCB
1	3.3	<0.18	4.9	<0.5	**12**	5.7	<0.45	4.9	<1
2	0.78	<0.18	4.9	<0.5	**13**	1.1	0.42	4.9	<0.5
3	3.0	<0.18	4.9	<0.5	**14**	<0.2	<0.18	4.9	<0.5
4	<0.2	<0.18	4.9	<0.5	**15**	0.31	<0.18	4.9	<0.5
5	<0.2	0.23	4.9	<0.5	**16**	3.3	0.58	9.4	<0.5
6	3.5	<0.18	4.9	<0.5	**17**	0.46	<0.18	4.9	<0.5
7	1.2	<0.18	4.9	<0.5	**18**	1.4	<0.18	4.9	<0.5
8	<0.2	<0.18	4.9	<0.5	**19**	2.1	<0.18	4.9	<0.5
9	<0.2	<0.18	4.9	<0.5	**26**	9.1	<0.36	4.9	<0.74
10	5.0	<0.27	4.9	<0.5	**27**	3.8	<0.27	4.9	<0.51
11	<0.2	<0.18	4.9	<0.5	-	-	-	-	-

Notes: Grey cells represent samples were organic compounds are higher than detection limits; Stations 20 to 25 are not missing; these station numbers were used to maintain the same station number for all media analyses.

Polycyclic Aromatic Hydrocarbons (PAH) concentrations are below the detection limits in most of the samples. Exceptions correspond to samples 5, 13 and 16. These were collected in the Copperbelt area. The same occurs with Polychlorinated Biphenyl (PCB), the exception being sample 16. These samples were collected in main rivers (Kafue for

sample 13 and 16, and Luanshya for sample 5), close to urban areas of Chillabombwe, Kitwe and Luanshya, respectively.

About Hexachlorobenzene (a toxic fungicide) concentrations were always below detection limits.

Table 30 – Spearman correlations between metals and organic carbon and grain-size parameters

Metals	COT	% clay	% fine-grained fraction
Al	0.56, p 0.03	0.79, p 2E-05	0.78, p 3E-05
As	-	0.01, p 0.98	0.06, p 0.89
Co	-0.35, p 0.21	0.02, p 0.93	0.26, p 0.25
Cu	-0.21, p 0.46	0.02, p 0.94	0.24, p 0.29
Cr	-0.03, p 0.91	0.39, p 0.08	0.36, p 0.11
Fe	-0.44, p 0.10	0.11, p 0.64	0.27, p 0.23
Pb	-	0.48, p 0.27	0.42, p 0.34
Ni	0.48, p 0.07	0.51, p 0.02	0.53, p 0.01
Zn	-	0.51, p 0.19	0.71, p 0.05

3.5.2.3. Leaves

Bulk concentrations of metals in the analysed leaves follow the pattern: [Zn] > [Cu] > [Cr] ~ [Co] ~ [Ni] > [Pb] ~ [As] > [Hg] ~ [Cd]. Results from analyses performed in leaves are summarised in Table 31.

Table 31 – Elemental concentration in composite leaf samples (in mg/kg)

Sta./Param.	As	Cd	Co	Cu	Cr	Pb	Hg	Ni	Zn
28 - Luk	0.0089	0.0034	0.024	1.5	0.40	0.170	0.0032	0.23	**30**
29 - Luk	0.036	0.0010	0.18	6.6	**1.10**	0.098	0.0045	0.65	26
27 - Luk	0.120	0.0017	0.023	3.9	0.40	0.290	0.0035	0.36	16
25 - Luk	0.110	0.0013	0.013	1.0	0.13	0.049	0.0040	0.10	21
26 - Luk	0.031	0.0020	0.022	3.6	0.24	**0.300**	0.0028	0.18	15
16 - CoBelt	**0.330**	**0.0036**	0.46	12	**1.10**	0.160	0.0036	0.47	7.9
2 - CoBelt	0.011	0.0009	0.049	5.4	**1.10**	0.028	0.0026	**1.00**	11
11 - CoBelt	0.140	0.0022	**1.10**	**19**	**1.10**	0.063	0.0030	0.87	7.5
15 - CoBelt	0.084	0.0030	0.41	12	0.75	0.100	**0.0049**	0.44	11
17 - CoBelt	0.048	0.0021	0.99	11	0.58	0.072	0.0043	0.34	14
AVG – Luk	*0.061*	*0.002*	*0.052*	*3.320*	*0.454*	*0.181*	*0.004*	*0.304*	*21.60*
AVG - CoBelt	*0.123*	*0.002*	*0.602*	*11.880*	*0.926*	*0.085*	*0.004*	*0.624*	*10.28*

Notes: Stat. – Station; Param. – Parameters; Luk – Samples collected in the Lukanga Swamp area; CoBelt – Samples collected in the Copperbelt Province.
Underlined concentrations are minimums and **bold concentrations** are maximums for that specific element.

In the same way as it happens for sediments, there is a predominance of maximum concentrations in the Copperbelt Province and of minimum concentrations in the Lukanga Swamp area (Table 31). In fact, only Pb and Zn behave the other way around.

The comparison between both areas becomes easier when analysing them through box plots for the different elements (Figure 38, Figure 39, Figure 40 and Figure 41). Through these it becomes clear that distributions of Zn, Cu and Co are indeed different in the two areas. Sampled leaves from the Lukanga Swamp area have higher concentrations of Zn, while sampled leaves from the Copperbelt Province have higher concentrations of Cu and Co.

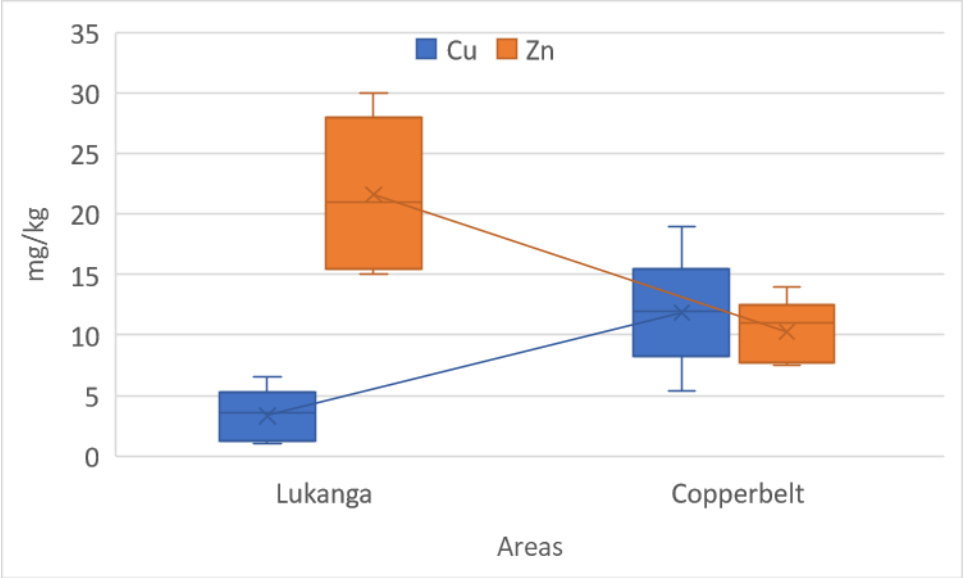


Figure 38 – Concentration distributions of Cu and Zn for the Lukanga and Copperbelt areas

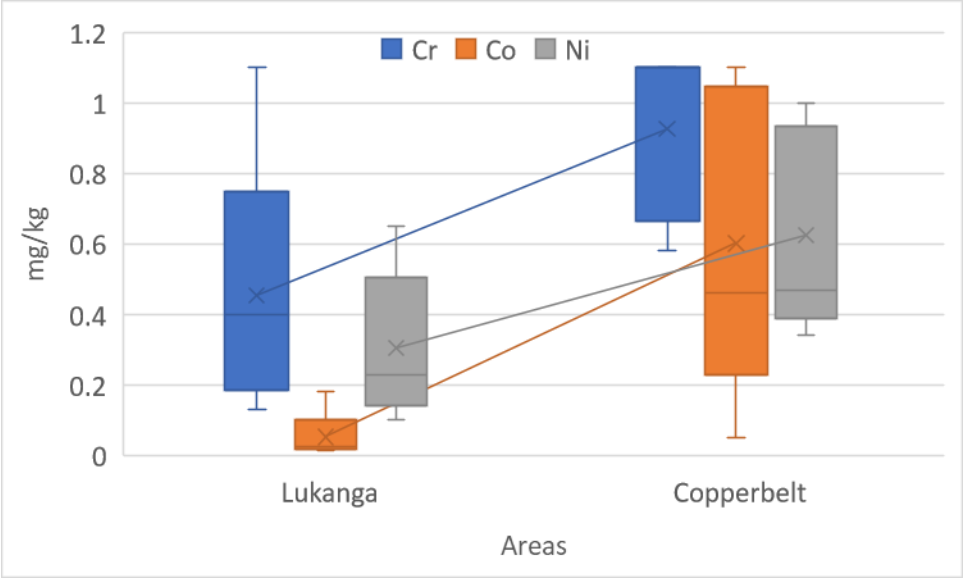


Figure 39 – Concentration distributions of Cr, Co and Ni for the Lukanga and Copperbelt areas

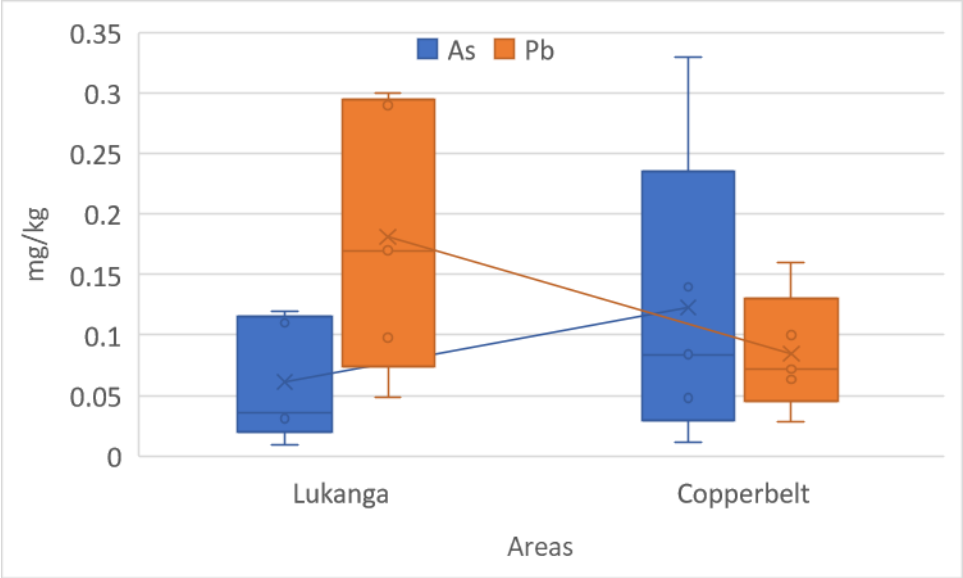


Figure 40 – Concentration distributions of As and Pb for the Lukanga and Copperbelt areas

Mean concentrations of As, Cr, Ni, Cd and Hg are also higher in the Copperbelt Province but both distributions intercept greatly, so the distinction is less clear (Figure 39, Figure 40 and Figure 41). On the other hand, Pb seems also to be higher in the Lukanga Swamp area (Figure 40).

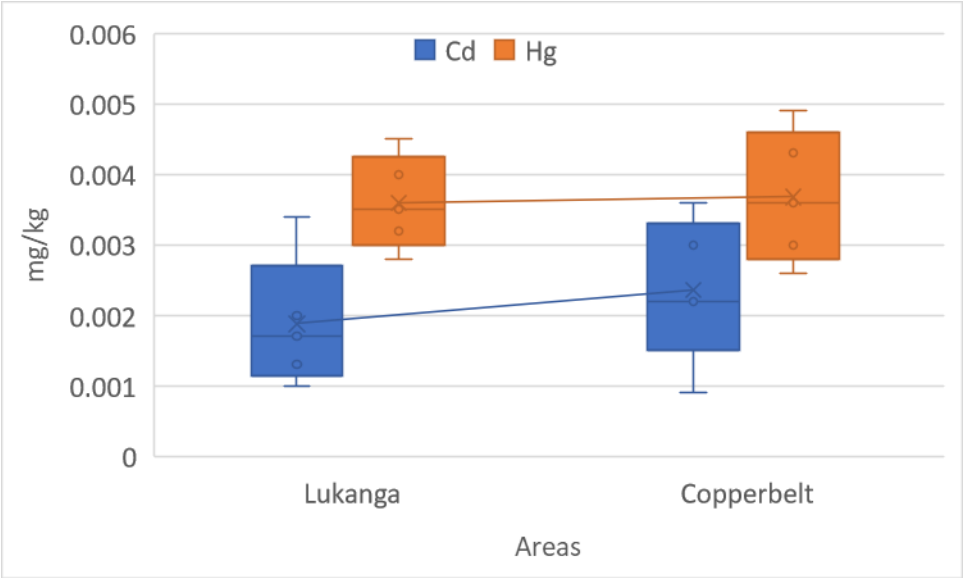


Figure 41 – Concentration distributions of Cd and Hg for the Lukanga and Copperbelt areas

3.5.3. Final considerations

A campaign to collect surface water, groundwater, sediment and leaf samples in the Lukanga Swamp area and Upper Kafue River Basin was performed in September and October of 2019. The results here presented refer to this campaign.

Surface water analyses show that parameters can greatly vary from the Copperbelt Province to the Lukanga Swamp area. Conductivity, COD and BOD show higher values in the Copperbelt Province, while nitrates, Cr, Pb and Zn are clearly higher in the Lukanga Swamp area. Contents of dissolved oxygen lower than 50% occur essentially in some areas of the Lukanga Swamp. Both areas show high concentrations of Cu (>0.1 mg/l) in specific sectors (Chingola and Southwest zone, in the Copperbelt and Lukanga Swamp, respectively).

Groundwater samples were only collected in villages around the Lukanga Swamp. The comparison between the concentrations found and guideline concentrations for water for drinking purposes (ZABS, WHO) show that none of the 14 wells studied satisfy the guidelines for this kind of use. The main problem of the quality of groundwater is related with concentrations of metals, particularly of Cd and Pb. High concentrations of nitrates also occur in some groundwater samples.

Grain-size analysis done in sediments shows that “sand” and “loamy sand” are the main type of sediment. Metal concentrations are higher in the Copperbelt area in comparison to the Lukanga Swamp, respectively (average values): Cu – 2247 vs. 44 mg/kg; Co – 222 vs. 10 mg/kg; Zn – 59 vs. 13 mg/kg, to give some examples.

Through the correlation analysis between metals one may conclude that: Fe in these samples seems to represent better oxides than aluminosilicates; As, Co, Cr and Cu are associated to oxides; Ni, but also Cr and Zn seem associated to aluminosilicates.

Bulk concentrations of metals in the analysed leaves follow the pattern: [Zn] > [Cu] > [Cr] ~ [Co] ~ [Ni] > [Pb] ~ [As] > [Hg] ~ [Cd]. In the same way as it happens for sediments, there is a predominance of maximum concentrations in the Copperbelt Province and of minimum concentrations in the Lukanga Swamp area. However, Pb and Zn behave the other way around.

4. Concluding remarks

With the approval of the Inception Report (D1) by ZEMA, on the 31st October 2019, the *Consultancy for the Development of a Conservation Plan for Lukanga Swamp and Upper Kafue Basin* entered Phase 2 – Scoping and data collection.

This Progress Report No. 1 (D2) is the first of two reports planned for Phase 2 and, as the progress reports to come, it aimed to present the **assignment progress** and a summary of main results to date. In Phase 2, this means the status of the data collection and processing/analysis conducted so far (chapter 2).

The field work undertaken to date was primarily focused on hydrological and ecological parameters and provided a wealth of information which will support the biophysical characterization of the Lukanga Swamp.

The collected material from a total of 87 sampling stations is currently being processed and analysed, and will allow for:

- the production of detailed cartography,
- the characterization of existing habitats,
- the assessment of ecological systems' conservation status,
- the analysis of interdependencies between the ecological and hydrological systems,
- the assessment of the external pressure acting on ecological and hydrological systems, in particular those of anthropic origin such as from riverine and swamp communities,
- contamination analysis and the assessment of spatial relationships between different geographical areas.

Social engagement and mobilization have been initiated and are ongoing. The first round of focus group discussions took place in December 2019 with the populations of Kabosha and Muchoko, in the Lukanga Swamp's periphery. Two (2) stakeholder consultation workshops have been conducted, mobilizing a total of 54 entities from Lusaka and Kitwe; seven (7) meetings with relevant partners and key information holders have been conducted, and, finally, five (5) key informant interviews were done along with the field reconnaissance and sampling work around the wetland.

While fieldwork has progressed as planned and allowed the development of the socioeconomic background and characterisation, ecological and contamination assessments presented in chapter 3, secondary data collection has not yet delivered as expected: of the more than 30 key stakeholders/organisations to whom formal requests were sent, only five provided information so far – Social Welfare Department (of the Ministry of Community Development and Social Services), Lukanga Water Supply & Sanitation Company Limited, Mulonga Water and Sewerage Company, NFC Africa Mining and Konkola Copper Mines PLC.

The ongoing work would be significantly enriched by several data in the possession of some of the already contacted entities. For this, a request is made once more for ZEMA's collaboration to facilitate access to this information. The following data, for which an additional effort is requested, are considered a priority:

- From ZEMA:
    - Lukanga Swamp, its catchment and Upper Kafue River Basin boundaries/limits and other available geographical information concerning these study areas, such as land use (except for Lukanga Swamp Ramsar site map);

- From WARMA:
    - Available water quantity and quality monitoring data and reports;

- From the Ministry of Mines and Minerals Development (MMMD):
    - Available water quantity and quality monitoring data and reports;
    - Results from the project for integrating climate change in water resources monitoring, by the Government of Zambia, represented by the Ministry of Mines, Energy and Water Development, with support from the German Development Cooperation (2012-2017); according to Hunink *et al*. (2017), several reports are available:
        - Socio-economic baseline,
        - Water quality [GFA/DHI: Water Quality of the Kafue River., 2016],
        - Water demands and Infrastructure,
        - Hydrology,
        - Climate Change impact analysis on Water Resources.

As for the **main results to date**:

- Socioeconomics – besides the socioeconomic background and characterization of Lukanga Swamp and of the wider Kafue Basin upstream, key stakeholders were mapped and invited to the first consultation workshop; meetings were held with key information holders, as well as key informant interviews and focus group discussions with local communities. The socio-economic characterization shows that Lukanga Swamp has a population of about 58,000 people, including many retrenched miners from Kabwe, Tonga people from the southern province and seasonal migration of fishermen. The main economic activities in the communities living in and around Lukanga Swamp are farming, charcoal production, livestock rearing and fishing.
- Ecology – initial field reconnaissance was followed by the production of a habitats map using orthophoto's classification and subsequent field verifications (including drone usage). Based on existing vegetation and land cover data, field observations, and following the Zambian Integrated Land-Use Assessment (ILUA)'s vegetation classification system, five major habitat classes were devised in the study area: forest land; wooded grassland; grassland; anthropic landscapes and inland water. These were further subdivided into 11 habitat subclasses following ILUA's "Forests and land use classes". The field data collected allowed to understand the ecosystems' dynamics, their status and conservation, cause-effect relations between the principal causes that contribute to the degradation of ecosystems and the relationships between socio-economic and ecological systems.
- Water and sediment quality – Surface and groundwater quality, sediment and leaf sampling and analyses were performed covering Lukanga Swamp and the Kafue basin upstream, including 87 sampling stations distributed along the study areas to properly characterise the upper and middle Kafue and the connections with Lukanga Swamp and its catchment. The field sampling results are being complemented by a hydrological analysis to understand the hydrodynamics of the Lukanga Swamp and its catchment. The assessment so far shows that surface water characteristics can greatly vary from the Copperbelt Province to the Lukanga Swamp area. Conductivity, COD and BOD show higher values in the Copperbelt Province while nitrates, Cr, Pb and Zn are higher in the Lukanga Swamp. The main problem with groundwater quality around the Lukanga Swamp concerns

concentrations of metals, particularly of Cd and Pb. Metal concentrations in the sediments are higher in the Copperbelt area when compared to Lukanga Swamp. Concentrations of metals in the analysed leaves also show a predominance of maximum concentrations in the Copperbelt Province and minimum concentrations in the Lukanga Swamp, though Pb and Zn behave the other way around.

Summing up, the **assignment is globally on track**, given the following status of the activities involved in Phase 2 (Scoping and data collection):

- Concluded tasks –
  - In-desk data collection;
  - Preliminary assessment of data availability and identification of needs (review of information gaps);
  - Definition of geographical and time frames for ecosystem service assessment and field campaigns;
  - Selection and identification of ecosystem types;
  - Stakeholders Consultation Workshop (W1);
  - Meetings with stakeholders and key informant interviews;
  - (M2) Meeting 2;
  - Progress report No. 1 (D2);
- Other tasks (in progress) –
  - Field work and data processing;
  - Social surveys;
  - Characterisation of ecosystem types;
  - Selection of ecosystem services;
  - Selection of indicators and methods for assessment;
  - Progress report No. 2 (D3).

Phase 2 is thus ongoing and the proposed solutions (especially ZEMA's involvement in the formal requests for information) will allow to progress the identified challenges (secondary data collection, fieldwork data processing and social survey planning) until the beginning of Phase 3.

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Appendixes

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Appendix 1 – Habitats map

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27°0'0"E
27°10'0"E
27°20'0"E
27°30'0"E
27°40'0"E
27°50'0"E
28°0'0"E
28°10'0"E
14°0'0"S
14°10'0"S
14°20'0"S
14°30'0"S
14°40'0"S

Ngabwe
Shampoda
Mpongwe
Shishimo
Chiwa Island
Chipepo
Wanja
Kasweneke
Mpongwe
Mukuluwa
Mumbo
Kabosha
Chitanda
Chibombo

GCS WGS 1984 • Datum: WGS 1984

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- District Towns
- Villages
- Lukanga Swamps Ramsar Site (Ramsar, 2005)

HABITATS

1 - FOREST LAND
- 11 - Miombo
- 12 - Baikiaea forest and deciduous thicket
- 13 - Lake Basin Chipya
- 14 - Munga or Miombo woodland

2 - WOODED GRASSLAND
- 21 - Termitaria

3 - GRASSLAND
- 31 - Edaphic grassland
- 32 - Permanent swamp

4 - ANTHROPIC LANDSCAPES
- 41 - Cultivated and managed land
- 42 - Rural built-up land

5 - INLAND WATER
- 51 - Lakes
- 52 - Rivers

nemus
empowering sustainability

Projected	Maria Espirito Santo
Verified	Maria Espirito Santo
Designed	Gonçalo Dumas
Approved	Pedro Bettencourt

CONSERVATION PLAN FOR LUKANGA SWAMP AND UPPER KAFUE BASIN

Progress Report 1

Habitats

Scale	1:175 000
Number	1
Graphic scale	0 2 500 5 000 m
Date	December 2020
Page	1/1
Code	T19024-2002_HABITATS_A11

Appendix 2 – Contamination assessment: procedures and sampling

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Appendix 2.1 – Parameters analysed and laboratory procedures

A) Water samples

All stations sampled for surface water and groundwater were also analysed for temperature, pH, conductivity and dissolved oxygen with a YSI professional plus probe (Figure 33).

All water samples were analysed for parameters listed in Table 32, while only selected samples (>1/3) were analysed for parameters in Table 33. The reason for this selection is that parameters from Table 33 are not expected to be contaminants in the study area.

Parameters from Table 32 were analysed by Food and Drugs Laboratory (FDL - Zambia), Lusaka Water and Sewerage Company (LWSC) and Alfred H Knight Zambia Limited (AHK), while those parameters from Table 33 were analysed by ALS Controlvet – Portugal.

Table 32 and Table 33 also refer the method used to determine a given parameter and its detection limit.

Table 32 – Parameters analysed for all 56 water samples, methods used and detection limits

Parameter	Method	Detection Limit (mg/l)
Arsenic (As)	ICP (both labs)	0.001 (AHK) and 0.2 (FDL)
Cobalt (Co)	ICP (both labs)	0.001 (AHK)
Copper (Cu)	ICP (both labs)	0.01 (AHK)
Chromium (Cr)	ICP (both labs)	0.001 (AHK)
Lead (Pb)	ICP (both labs)	0.01 (AHK)
Mercury (Hg)	Hydride Generation Cold Vapor AAS (by AHK)	0.05 (AHK) and 0.3 (FDL)
Nickel (Ni)	ICP (both labs)	0.002 (AHK)
Zinc (Zn)	ICP (both labs)	0.006 (AHK)
Biochemical Oxygen Demand (BOD5)	Dissolved Oxygen determination done Electrometrically after 5-day incubation test (both labs)	0.1 (AHK) and 1 (LWSC)

Parameter	Method	Detection Limit (mg/l)
Chemical Oxygen Demand (COD)	Refluxing and Spectrophotometric (both labs)	4 (LWSC) and 5 (AHK)
Nitrate	Ultraviolet Spectrophotometry (by AHK)	0.07 (AHK)
Phosphorus	Colorimetry (by AHK)	0.1 (AHK)

Notes: AHK – Alfred H Knight Zambia Limited; LWSC – Lusaka Water and Sewerage Company; FDL - Food and Drugs Laboratory

Table 33 – Parameters analysed for selected water samples (21)

Parameter	Method	LOR[4] (µg/l)
Sum of 16 PAH[1]	W-PAHGMS01[2]	0.370
Hexachlorobenzene (HCB)	W-OCPECD01[3]	0.005
Sum of 5 Hexachlorocyclohexanes (HCH)	W-OCPECD01[3]	0.050

Notes:
[1] Polycyclic Aromatic Hydrocarbons; [2] Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values; [3] Determination of organochlorine pesticides and other halogen compounds by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values. [4] Limit of Reporting.

A) Sediment samples

All 21 sediment samples were analysed for concentrations of metals, organic compounds and total organic carbon. Grain-size analysis was also performed in these samples.

These analyses were carried out in SYNLAB Analytics & Services B.V. (The Netherlands). Table 34 presents the method used to determine a given parameter and its detection limit.

Table 34 – Parameters analysed in sediment samples, methods used and detection limits

Parameter	Method	Detection Limit
Aluminium (Al)	Digestion according to NEN 6961 and measurement according to NEN-EN-ISO 17294-2 (application of ICP-MS)	-
Arsenic (As)	Idem	< 4 mg/kg
Cadmium (Cd)	Idem	< 0.2 mg/kg
Cobalt (Co)	Idem	<1.5 mg/kg
Copper (Cu)	Idem	<5 mg/kg
Chromium (Cr)	Idem	<10 mg/kg

Parameter	Method	Detection Limit
Iron (Fe)	Idem	-
Lead (Pb)	Idem	<10 mg/kg
Mercury (Hg)	Idem	<0.05 mg/kg
Nickel (Ni)	Idem	<3 mg/kg
Zinc (Zn)	Idem	<20 mg/kg
COT	According to NEN-EN 13137	<0.2 mg/kg
Total PCB (7)	Own method, extraction with acetone / hexane and analysis with GC-MS	<7 µg/kg
PAH (9 OSPAR)	Idem	<0.18 mg/kg
Hexachlorobenzene (HCB)	Own method, analysis with GC-MS	<0.5 µg/kg

B) Leaves

Ten composite samples of leaves (*Phragmites* spp.) were collected in two areas: the Lukanga swamp and in streams of the Copperbelt area. Trace elements analysed in leaves are listed in Table 35.

Table 35 – Parameters analysed in leaves, methods used and detection limits

Parameter	Method	Detection Limit (mg/kg)
Arsenic (As)	Sample preparation with HNO3- and pressure digestion; Analysis DIN EN ISO 17294:2017-01	<0.001
Cadmium (Cd)	Idem	<0.0005
Cobalt (Co)	Idem	<0.01
Copper (Cu)	Idem	<0.05
Chromium (Cr)	Idem	<0.05
Lead (Pb)	Idem	<0.05
Mercury (Hg)	Sample preparation with HNO3- and pressure digestion; DIN EN 15763:2010-04	<0.001
Nickel (Ni)	Sample preparation with HNO3- and pressure digestion; Analysis DIN EN ISO 17294:2017-01	<0.05
Zinc (Zn)	Idem	<0.05

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Appendix 2.2 – Description of the sampling stations

Table 36 – Sampling stations of groundwater and surface water

Station No.	X	Y	Description of sampling station
5S	-14.17699600	28.19719000	Well not covered nor sealed near a house. Germs were readily identified in the water. Close to Chipepo.
8bS	-14.11610900	28.11901000	Sealed well in a common area near Mpunde.
9S	-14.32914200	27.98374500	Sealed well in Waya.
13S	-13.94923200	27.78176800	Sealed well in a common area near between Mukubwe e Shamputa.
16S	-14.09690600	27.42346300	Sealed well near Lufubu.
20S	-14.60787600	28.09438600	Sealed well in a common area north of Chibombo.
22S	-14.43639700	27.99655600	Sealed well near Kaswende.
23S	-13.95900400	27.78917200	Sealed well in a common area near between Mukubwe e Shamputa.
24S	-14.43702600	27.99458400	Well not covered nor sealed near Kaswende. Locals say they don't use this water for drinking purposes.
25S	-14.14779700	27.63297300	Sealed well in Shishimo.
26S	-14.59084300	27.65837100	Sealed well in Kabosha with a solar pump. Water was stored in a container.
27S	-14.57748800	27.26712600	Well not covered nor sealed near Mushingashi River.
28S	-14.50943500	27.50210100	Well not covered nor sealed half-way south of Mwanakabwata.
29S	-14.35262200	28.12233100	Sealed well near the road between Waya and Kabwe. There were some houses and stores near the well.
1S	-14.372917	27.18543	Surface water sample collected in the Kafue River. The point is immediately downstream from the junction with the Lukanga River.
2S	-14.572744	27.287036	Surface water sample collected in the Mushingashi River. The stream had few centimetres of water depth and the riverbed is mainly sandy sediment. There was developed vegetation inside the small channel.
3S	-14.436256	27.510353	Surface water sample collected in the Lukanga River, 3.5 km downstream from the swamp outlet.

Station No.	X	Y	Description of sampling station
4S	-14.63323	27.586285	Surface water sample collected in the Mufuwa River, immediately to the west of Chitanda. The stream had few centimetres of water depth.
6S	-14.628043	27.859676	Surface water sample collected in the southeast margin of the Lukanga Swamp; in a channel that is close and hydraulically connected to the swamp; according to the data obtained in situ this channel probably is fed by groundwater (spring).
7S	-14.580316	27.664694	Surface water sample collected in the swamp few hundred meters offshore (near Kabosha). The sampling point was defined when the water appeared clear and transparent.
8aS	-14.323974	27.973234	Surface water sample collected in a human-made channel that connects the swamp to the small port of Waya. At the time of sampling the channel was very shallow (30 – 50 cm water depth).
10S	-14.10578	28.097192	Surface water sample collected in the right margin of the Mufukushi River, close to Mpunde.
11S	-14.025083	27.839621	Surface water sample collected in the right margin of the Lukanga River, near the road between Shamputa and Mukubwe.
12S	-14.171957	27.642776	Surface water sample collected in the channel that separates the Chilwa Island from Shishimo.
14S	-14.112375	27.410839	Surface water sample collected in the left margin of the Kafue River, near Lufubu. Sandy sediments were observed in the sampling point.
15S	-13.836129	27.817638	Surface water sample collected near Chisanga in a spring that drains to the Lukanga River.
18S	-14.570536	27.471297	Surface water sample collected in the Muundu River. The bed of the river is sandy and green algae are visible.
21S	-14.445407	27.968228	Surface water sample collected in the swamp few hundred meters offshore (near Kaswende). The sampling point was defined when the water appeared clear and transparent.
1Oc	-13.237226	28.404075	Surface water sample collected in the Kafubu River upstream from the bridge of the road that connects Masaiti with Luanshya.

Station No.	X	Y	Description of sampling station
2Oc	-13.227906	28.381211	Surface water sample collected in the Kafubu River around 4,5 km downstream from station 1Oc, and immediately downstream from the junction between this river and the Luanshya River.
3Oc	-13.255308	28.323819	Surface water sample collected in the Kafubu River around 8 km downstream from station 2Oc, and immediately upstream from the junction between this river and the Kafulafuta River.
4Oc	-13.259282	28.325365	Surface water sample collected in the Kafulafuta River around 1 km upstream from the junction of this river with the Kafubu River.
5Oc	-13.220429	28.165779	Surface water sample collected in the Kafue River around 8 km upstream from the junction of the Kafubu River with this river. Near this station people were in the river fetching water and swimming.
6Oc	-13.347787	28.072473	Surface water sample collected in the Kafue River around 33 km downstream from station 5Oc. The station is where the road from Nuala encounters the Kafue river. Here people cross the river to the other side in a small boat.
7Oc	-13.64159	27.61706	Surface water sample collected in the Kafue River around 115 km downstream from station 6Oc. The station is where the road from Munkumpu encounters the Kafue river. Here people cross the river to the other side in a small boat or in a barge.
8Oc	-12.878031	28.257556	Surface water sample collected in the Kafue River around 50 km upstream from station 5Oc. The station is near the bridge where the road between Kitwe and Ndola crosses the river.
9Oc	-12.518833	27.82831	Surface water sample collected in the Chingola River immediately upstream from the bridge that crosses the river north of the junction between T3 and T5 roads. Water with a brownish colour. Downstream from the sampling station earthworks could be seen in the riverbank.
10Oc	-12.635245	28.159062	Surface water sample collected in the Kafue River upstream from Kitwe and upstream from a plant of water abstraction in the river.

Station No.	X	Y	Description of sampling station
11Oc	-12.464895	27.851301	Surface water sample collected in the Kafue River, downstream from Chililabombwe and junction with the Michichima River.
12Oc	-12.405138	27.761694	Surface water sample collected in the Kafue River upstream from the junction between this river with the Lubengele River. This is the furthest upstream station where surface water was collected. The riverbed in the station area is sandy with frequent rocky outcrops.
13Oc	-12.866697	27.603139	Surface water sample collected in the Lufwanyama River near the bridge from M18. People were fetching water and water has a milky look even upstream from station.
14Oc	-12.927097	27.333666	Surface water sample collected in the Luswishi River near the bridge from M18. Sandy riverbed with abundant vegetation in the margins. Water looked transparent.
15Oc	-12.398043	27.802978	Surface water sample collected in the Lubengele River 2.3 km upstream from the junction of this river with the Kafue River.
16Oc	-12.49137824	27.82398378	Surface water sample collected in the Muchichima River, 3.8 km upstream from the junction of this river with the Kafue River.
17Oc	-12.645849	27.887393	Surface water sample collected immediately downstream from the Muntimpa Dam. It is a small channelled stream. White precipitates where observed in plants near the water.
18Oc	-12.477025	27.897877	Surface water sample collected in the Kafue River, 6,3 km downstream from station 11Oc. Rocky outcrops are frequent in river. Station is immediately upstream from a plant of water abstraction in the river.
19Oc	-12.481348	27.899956	Surface water sample collected in the Nchanga River, a small river that connects with the Kafue River just 520 m downstream from station 18Oc. Station is 350 m upstream from the junction of this river with the Kafue River.
20Oc	-12.849233	27.742413	Surface water sample collected in the Filando River, a small river that connects with the Katembola River 5.3 km downstream.

Station No.	X	Y	Description of sampling station
21Oc	-12.850402	27.675129	Surface water sample collected in the Katembola River, near M18 road and 730 m downstream from a constructed dam (already visible in satellite images after Jul. 2017 but not in Oct. 2016).
22Oc	-13.25919673	28.26155597	Surface water sample collected in the Kafulafuta River, 15 km upstream from the junction with the Kafue River. It is the furthest downstream station from this river. Frequent rock outcrops in the riverbed.
23Oc	-12.777151	28.213468	Surface water sample collected in the Mindolo River. Station is located in the urban area of Kitwe.
24Oc	-12.811088	28.253964	Surface water sample collected in the Kitwe River. Station is located 620 m upstream from the junction with the Kafue River.
25Oc	-14.52568473	27.65935248	Surface water sample collected in the Lukanga Swamp. Station is in an open water lake inside the swamp area, around 7 km offshore (Kabosha).
26Oc	-14.32614182	27.93779847	Surface water sample collected in the Lukanga Swamp. Station is in an area less dense with vegetation inside the swamp, around 5 km offshore (Waya).
27Oc	-14.44749891	27.92578096	Surface water sample collected in the Lukanga Swamp. Station is in an area less dense with vegetation inside the swamp, around 6 km offshore (Kaswende).
28Oc	-14.23494239	27.66963503	Surface water sample collected in the Lukanga Swamp. Station is in an open water lake inside the swamp area, around 4.5 km offshore (Chilwa Island).

Table 37 – Location and description of the sediment sampling stations

Station No.	X	Y	Description of sampling station
1	27.18543	-14.372917	Inside water near the left margin of the Kafue River. The point is downstream from the junction with the Lukanga River.
2	27.287036	-14.572744	Inside water in the Mushingashi River. The stream had few centimetres of water depth and the riverbed is mainly sandy sediment. There was developed vegetation inside the small channel.
3	27.510353	-14.436256	Inside water in the left margin of the Lukanga River, 3.5 km downstream from the swamp outlet.
4	27.586285	-14.63323	Inside water in the Mufuwa River, immediately to the west of Chitanda. The stream had few centimetres of water depth.
5	28.39472222	-13.13777778	Inside water in the Luanshya River. The sampling point is immediately downstream from the treatment plant of the Baluba mine (close to the Buteko Avenue).
6	27.859676	-14.628043	Inside water in the southeast margin of the Lukanga Swamp; in a channel that is close and hydraulically connected to the swamp; according to the data obtained *in situ* this channel probably is fed by groundwater (spring).
7	28.35230515	-13.24166389	Inside water in the Kafubu River, upstream of its connection with the Kafulafuta River.
8	27.82730972	-12.51699716	Sample collected inside water in the Chingola River, close to the bridge of the T3 highway that crosses that river.
9	27.81222222	-12.41611111	Sample collected inside water in the left margin of the Kafue River in the junction of this river with the smaller Lubengele River.
10	28.097192	-14.10578	Sample collected inside water in the right margin of the Mufukushi River, close to Mpunde.
11	27.839621	-14.025083	Sample collected inside water in the right margin of the Lukanga River near the road between Shamputa and Mukubwe.
12	27.642776	-14.171957	Sample collected inside water in the channel that separates the Chilwa Island from Shishimo. The material collected from the bed of the channel had a high percentage of plant fragments.

Station No.	X	Y	Description of sampling station
13	27.86672231	-12.46415859	Sample collected inside water in the Kafue River, downstream from Chililabombwe and junction with the Michichima River.
14	27.410839	-14.112375	Sample collected inside water in the left margin of the Kafue River, near Lufubu. Sandy sediments were observed in the sampling point.
15	28.15888889	-12.635	Sample collected inside water in the right margin of the Kafue River downstream from Mopani Mine (Mufulira) and upstream from Kitwe.
16	28.23805556	-12.92472222	Sample collected inside water in the right margin of the Kafue River downstream from Luangwa.
17	28.22805556	-12.89	Sample collected inside water in a stream that connects to the Kafue River upstream from the sampling station 16. The station is immediately downstream from another pole of the Mopani mine in Luangwa.
18	27.471297	-14.570536	Sample collected inside water in the Muundu River. The bed of the river is sandy and green algae are visible.
19	27.973234	-14.323974	Sample collected inside water in a human-made channel that connects the swamp to the small port of Waya. At the time of sampling the channel was very shallow (30 – 50 cm water depth). Fishing canoes and “banana boats” were frequently crossing the channel.
26	27.96899606	-14.32329357	Sample collected inside water in the Lukanga Swamp, near Waya. This is a channel from the swamp that develops offshore after the human-made channel referred in the sampling station 19.
27	27.97269244	-14.44498657	Sample collected inside water in the Lukanga Swamp, around few hundred meters from the shore (near Kaswende).

Table 38 – Location and description of stations where composite samples of leaves were collected

Station No.	X	Y	Description of sampling station
2	-13.227906	28.381211	Left margin of the Kafubu River, around 4,5 km downstream from station 1Oc (Table 36), and immediately downstream from the junction between this river and the Luanshya River.
11	-12.464895	27.851301	Right margin of the Kafue River, downstream from Chililabombwe and junction with the Michichima River. Sample was collected in a sandbank immediately after a bridge from the main road T3.
15	-12.398043	27.802978	Inside the bed of the Lubengele River, 2.3 km upstream from the junction of this stream with the Kafue River.
16	-12.49137824	27.82398378	Right margin of the Muchichima River, 3.8 km upstream from the junction of this river with the Kafue River. Plants where leaves where collected are in a sandy substrate.
17	-12.645849	27.887393	Inside the stream immediately downstream from the Muntimpa Dam. It is a small channelled stream. White precipitates where observed in plants near the water.
25	-14.52568473	27.65935248	Station is defined as the path done from the shore until an open water lake inside the Lukanga Swamp, around 7 km offshore (Kabosha).
26	-14.32614182	27.93779847	Station is defined as the path done from the shore until an area with less dense vegetation around 5 km offshore (Waya).
27	-14.44749891	27.92578096	Station is defined as the path done from the shore until an area with less dense vegetation around 6 km offshore (Kaswende).
28	-14.23494239	27.66963503	Station is defined as the path done from the shore until an open water lake inside the swamp area, around 4.5 km offshore (Chilwa Island).
29	-14.105051	28.095597	Surface water sample collected in the Lukanga Swamp. Station is in an open water lake inside the swamp area, around 7 km offshore (Kabosha).

Appendix 2.3 – Laboratory results

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Rev No. 03	Copy No. 1
Document No. 1	
Date issued : 18/09/2015	
Effective date : 21/09/2015	

CERTIFICATE OF ANALYSIS

CLIENT

Client name: Nemus (Consultants for ZEMA).
Attention: Pedro Bettencourt

Physical Address: C/o Plot No. 6975, Suez Road
Lusaka

Telephone:

LABORATORY

Certificate No.: *563. (3441-3468) – 09.19*
Date of issue: *October 14, 2019*
Date of sampling: *September 15, 2019*
Date samples received: *September 15, 2019*
Date **analysis commenced:** *September 15, 2019*
Number of pages: 3
Fax:

Notes

'NTU" = Nephelometric Turbidity Units
'-'= Not analysed
'ND' = Not done
'MDL' = Method detection limit
'QC' = Quality Control
'COND' = Conductivity
'BOD' = Biochemical Oxygen Demand
'COD' = Chemical Oxygen Demand
'TDS' = Total Dissolved Solids

Remarks

'S' = Satisfactory according to Public Sewer Discharge Standards
'U' = Unsatisfactory according to Public Sewer Discharge Standards

Method of analysis

pH, Conductivity and TDS: Electrometric
Turbidity: Nephelometric
COD: Refluxing and Spectrophotometric.
BOD: Dissolved Oxygen determination done Electrometrically.

Signature: ……**Designation:** *Senior Chemist*

Date : *October 14, 2019.*

LUKANGA SWAMP - KAFUE RIVER WATER QUALITY – SEPTEMBER 2019

PHYSICAL - CHEMICAL ANALYSIS

		Parameters & Results					
Lab No.	**Sample ID**	pH	COND (µS/cm)	TDS (mg/L)	Turbidity NTU	BOD (mg/L)	COD (mg/L)
3441	1	8.27	555	278	1.30	< 1	< 4
3442	2	8.30	566	283	1.55	1	< 4
3443	3	8.11	261	135	1.46	1	13
3444	4	8.31	553	276	3.12	< 1	< 4
3445	5	7.61	142	71	5.95	1	< 4
3446	6	7.43	404	202	1.68	1	43
3447	7	7.88	348	175	2.07	4	23
3448	8a	8.31	768	382	3.65	< 1	39
3449	8b	7.22	134	67	0.31	< 1	< 4
3450	9	7.87	874	437	26.2	< 1	< 4
3451	10	7.99	202	101	4.31	1	8
3452	11	7.84	243	122	1.88	1	17
3453	12	8.07	382	192	2.84	< 1	4
3454	13	7.83	412	206	9.65	< 1	< 4
3455	14	8.05	586	292	1.85	1	< 4
3456	15	7.91	770	385	0.17	< 1	< 4
3457	16	7.18	89	44	8.51	< 1	< 4
3458	18	8.02	535	265	3.85	< 1	< 4
3459	20	7.69	391	196	6.87	< 1	< 4
3460	21	8.41	1 414	708	0.56	< 1	85

Key

BOD: Biological Oxygen Demand
COD: Chemical Oxygen Demand
COND: Conductivity
TDS: Total Dissolved Solids
NTU: Nephelometric Turbidity Units

		Parameters & Results					
Lab No.	**Sample ID**	pH	COND (µS/cm)	TDS (mg/L)	Turbidity NTU	BOD (mg/L)	COD (mg/L)
3461	22	7.47	550	275	5.37	< 1	< 4
3462	23	8.01	434	216	2.77	1	< 4
3463	24	7.40	288	144	4.29	< 1	< 4
3464	25	6.55	98	49	37.2	2	< 4
3465	26	7.81	522	262	3.54	< 1	< 4
3466	27	7.98	59	29	0.80	< 1	< 4
3467	28	7.08	311	63	24.7	< 1	< 4
3468	29	7.59	625	311	6.74	< 1	< 4

Key

BOD: Biological Oxygen Demand
COD: Chemical Oxygen Demand
COND: Conductivity
TDS: Total Dissolved Solids
NTU: Nephelometric Turbidity Units

Signature: ..... **Designation:** *Senior Chemist*

Date: *October 14, 2019.*

Telephone : 252855/252875
Telefax : 252875

In reply please quote:

No.....

W1906-W1933

REPUBLIC OF ZAMBIA

MINISTRY OF HEALTH

FOOD AND DRUGS CONTROL LABORATORY
P.O. BOX 30138
LUSAKA

11th November, 2019.

WATER CHEMISTRY ANALYSIS REPORT

Customer Details : NEMUS LDA
C/O ZEMA
P.O BOX 35131
LUSAKA

Date of sampling : 16/09/2019

Date of receipt : 16/09/2019

Date of Analysis commenced : 17/09/2019

Date of Analysis completed : 25/09/2019

Analysis Requested for : Routine Analysis

Customers Ref:	Laboratory Ref:	Sample Description
01	W1906	Swamp water
02	W1907	Swamp water
03	W1908	swamp water
04	W1909	Swamp water
05	W1910	SWAMP WATER
06	W1911	SWAMP WATER
07	W1912	SWAMP WATER

Sign: SF. Chuma

PT0:

08a	W1913	SWAMP WATER
08b	W1914	SWAMP WATER
09	W1915	SWAMP WATER
10	W1916	SWAMP WATER
11	W1917	SWAMP WATER
12	W1918	SWAMP WATER
13	W1919	SWAMP WATER
14	W1920	SWAMP WATER
15	W1921	SWAMP WATER
16	W1922	SWAMP WATER
18	W1923	SWAMP WATER
19	W1924	SWAMP WATER
20	W1925	SWAMP WATER
21	W1926	SWAMP WATER
22	W1927	SWAMP WATER
23	W1928	SWAMP WATER
24	W1929	SWAMP WATER
25	W1930	SWAMP WATER
26	W1931	SWAMP WATER
27	W1932	SWAMP WATER
28	W1933	SWAMP WATER

PHYSICAL AND CHEMICAL EXAMINATIONS DONE

PARAMETER	W1906	W1907	W1908	W1909	W1910	ZABS/WHO
Lead (mg/l)	**0.2664**	**1.346**	**0.7376**	**0.8018**	0.0000	**0.01**
Cadmium(mg/l)	**0.2326**	**0.4114**	**0.1722**	**0.2275**	**0.0426**	**0.003**
Chromium(mg/)	0.0090	0.0020	0.0030	0.0010	0.0110	**0.05**
Copper(mg/l)	0.3247	0.1034	0.2070	0.0618	0.0236	**2**
Phosphorus (mg/l)	0.0031	0.0034	0.0012	0.3023	0.0123	**1.0**
Zinc mg/l	0.2247	0.000	0.3348	0.1177	0.9234	**3**
Cobalt mg/l	0.0009	**0.0600**	0.0010	0.0021	0.0000	**0.05**
Nickel mg/l	0.0778	0.0000	0.0181	0.0101	0.0011	-
Mercury mg/l	0.00	0.00	0.00	0.00	0.00	**0.001**

01/10/19

Sign: SF.IC

PTO:

Arsenic mg/l	0.00	0.00	0.00	0.00	0.00	**0.01**
Nitrates mg/l	10.0451	0.1294	21.45	30.54	15.04	**45-50**

PARAMETER	**W1911**	**W1912**	**W1913**	**W1914**	**W1915**	**ZABS/WHO**
Lead (mg/l)	**0.3473**	**1.856**	**0.8624**	**1.283**	**1.378**	**0.01**
Cadmium(mg/l)	0.00	**0.1066**	**0.2401**	**0.0285**	0.00	**0.003**
Chromium(mg/)	0.0140	0.0041	0.0001	0.0003	0.00	**0.05**
Copper(mg/l)	0.0521	0.0843	0.0880	0.0715	0.0786	**2**
Phosphorus (mg/l)	0.0430	0.0071	0.0065	0.0024	0.0180	**1**
Zinc mg/l	0.2153	0.3516	0.295	0.0481	0.5980	**3**
Cobalt mg/l	0.00	**0.0891**	0.1020	0.0180	0.0010	**0.05**
Nickel mg/l	6.7005	0.0542	0.0013	0.0588	0.0412	**-**
Mercury mg/l	0.00	0.00	0.00	0.00	0.00	**0.001**
Arsenic mg/l	0.00	0.00	0.00	0.00	0.00	**0.01**
Nitrates mg/l	4.0091	11.23	10.00	24.07	19.04	**45-50**

01/11/19

Sign: SF Kamau

PTO:

PARAMETER	W1916	W1917	W1918	W1919	W1920	ZABS/WHO
Lead (mg/l)	**0.0467**	**0.9295**	**1.089**	**1.203**	**1.203**	**0.01**
Cadmium(mg/l)	0.0469	0.2229	**0.0310**	**0.1898**	**0.1898**	**0.003**
Chromium(mg/)	0.0145	0.0021	0.0011	0.00	0.00	**0.05**
Copper(mg/l)	0.6669	0.0646	0.0891	0.0529	0.0591	2
Phosphorus (mg/l)	0.0065	0.0002	0.0340	0.0054	0.0020	1
Zinc mg/l	0.9794	0.00	0.4835	0.0223	0.2149	3
Cobalt mg/l	0.0369	0.00	0.00	0.0297	0.1002	**0.05**
Nickel mg/l	0.00	0.00	0.074	0.0884	0.0342	-
Mercury mg/l	0.00	0.00	0.00	0.00	0.00	**0.001**
Arsenic mg/l	0.00	0.00	0.00	0.00	0.00	**0.01**
Nitrates mg/l	11.90	17.01	12.87	13.02	14.76	**45-50**

01/11/19

Sign: SF. Kamau

PT0:

PARAMETER	W1921	W1922	W1923	W1924	W1925	ZABS/WHO
Lead (mg/l)	**1.244**	**0.7554**	**1.157**	**1.132**	**0.8908**	**0.01**
Cadmium(mg/l)	0.00	0.0378	**0.0957**	**0.0611**	0.2316	**0.003**
Chromium(mg/)	0.0084	0.0061	0.00	0.00	0.00	**0.05**
Copper(mg/l)	0.0773	0.0750	0.957	0.1189	0.0746	**2**
Phosphorus (mg/l)	0.0240	0.0184	0.0932	0.1760	0.1740	**1**
Zinc mg/l	0.6944	0.0056	0.0933	0.3219	0.3269	3
Cobalt mg/l	0.0177	0.1145	0.0129	**9.4003**	0.0125	**0.05**
Nickel mg/l	0.0751	0.0454	0.0406	0.0884	0.1239	
Mercury mg/l	0.00	0.00	0.00	0.00	0.00	**0.001**
Arsenic mg/l	0.00	0.00	0.00	0.00	0.00	**0.01**
Nitrates mg/l	0.0067	0.0416	**53.56**	**61.04**	**104.08**	**45-50**

01/11/19

Sign: SF Kam

PT0:

PARAMETER	W1926	W1927	W1928	W1929	W1930	ZABS/WHO
Lead (mg/l)	**1.272**	**0.2971**	**1.655**	**0.5326**	**0.9860**	0.01
Cadmium(mg/l)	0.00	**0.1679**	0.00	**0.0397**	0.00	**0.003**
Chromium(mg/)	0.0321	0.0221	0.1101	0.4814	0.00	**0.05**
Copper(mg/l)	0.0955	0.0988	0.0707	0.2021	0.1045	**2**
Phosphorus (mg/l)	0.0890	0.0450	0.0045	0.3780	0.1843	**1**
Zinc mg/l	0.4862	0.4021	0.7891	0.9860	0.00	**3**
Cobalt mg/l	**5.8006**	0.0031	0.00	0.00	0.001	**0.05**
Nickel mg/l	0.0461	0.1053	0.0536	6.7005	0.0632	
Mercury mg/l	0.00	0.00	0.00	0.00	0.00	**0.001**
Arsenic mg/l	0.00	0.00	0.00	0.00	0.00	**0.01**
Nitrates mg/l	11.06	40.03	34.01	23.45	5.067	**45-50**

01/11/19

Sign: SF 1

PT0:

PARAMETER	W1931	W1932	W1933	ZABS/WHO
Lead (mg/l)	**0.7216**	0.00	**1.461**	**0.01**
Cadmium(mg/l)	**0.0683**	**0.0912**	**0.0086**	**0.003**
Chromium(mg/)	0.0106	0.00	0.1301	**0.05**
Copper(mg/l)	0.0912	0.0945	0.0855	**2**
Phosphorus (mg/l)	0.0034	0.7340	0.1330	**1**
Zinc mg/l	0.0304	0.0393	0.3218	**3**
Cobalt mg/l	**8.6004**	0.0414	**5.800**	**0.05**
Nickel mg/l	0.1344	0.0327	0.1339	-
Mercury mg/l	0.00	0.00	0.00	**0.001**
Arsenic mg/l	0.00	0.00	0.00	**0.01**
Nitrates mg/l	24.90	**80.74**	**67.91**	**45-50**

01/11/19

Sign: SF. Kaoma

PTO:

REMARKS

The results are as stated.

Note: The standards used are for drinking water

Sumbukeni Kowa (Dr)

Consultant

01/11/19

Sign:

PT0:

ALS Controlvet

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13866 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159096 / 19**

Produto: Água Naturais
Referência: Amostra 1
A colheita de amostra não foi efectuada pela Controlvet.

Acondicionamento: frasco
Nº Entrega: 1527/2019

Ensaio	Método	Resultado	Unidade
(a) Parâmetros físico-químicos	Descrição em anexo	Resultado em anexo.	.

Método interno equivalente é aquele que tem a mesma área de aplicação (parâmetros e matrizes) e que cumpre as características de desempenho, obtendo resultados comparáveis ao(s) método(s) normalizado(s) junto indicado(s)

Tondela
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Eugénia Silva

Técnica Superior de Laboratório
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Data Emissão: 04-10-2019

N.º de Análise:	QH / 13866 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159096 / 19**

Produto: Água Naturais
Referência: Amostra 1
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Notas

Lista de abreviaturas: NE- Número estimado; UFC- Unidades formadoras de colónias; LQ – Limite de quantificação; LD – limite de detecção; V.L. – Valor Limite; V.R. – Valor Recomendado; VP - Valor Paramétrico; C - Conforme; A - Aceitável; NC - Não Conforme; Unid. - Unidade; DO - Densidade óptica.

O ensaio assinalado com (s) foi subcontratado e não é acreditado.
O ensaio assinalado com (a) foi subcontratado e é acreditado.
Nos resultados assinalados com (k) os microrganismos estão presentes, mas inferiores a 3xdiluição (quando aplicável).
Nos resultados assinalados com (y) os microrganismos estão presentes, mas inferiores a 4xdiluição.
Para os ensaios assinalados por tecnicas de cálculo a metodologia seguida pode ser disponibilizada a pedido.

Este Relatório de Ensaio refere-se apenas às amostras analisadas.
Proibida a reprodução parcial deste documento.

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

CERTIFICATE OF ANALYSIS

Laboratory sample ID	: **PR1999997009**	**Work Order**	: **PR1999997**
		Issue Date	: 03-Oct-2019
Amendment	: **1**		
Customer	: **CONTROLVET - Seguranca Alimentar, S. A.**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Subcontratacao Ensaios	Contact	: Client Service
Address	: Zona Industrial de Tondela ZIM II - Lote 6 3460-070 Tondela Portugal	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: Subcontratacao.Ensaios@alsglobal.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Project	: ECF 2019E/155	Page	: 1 of 3
Order number	: ----	Date Samples Received	: 24-Sep-2019
		Quote number	: PR2015CONSE-PT0006 (PT-254-15-0938)
Site	: ----	Date of test	: 24-Sep-2019 - 03-Oct-2019
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples. If the section "Sampled by" of the Certificate of analysis states: "Sampled by Customer" then the results relate to the sample as received.
Amendmend No. 1: Change of COA format as per clients request. This Amendmend No. 1 supersedes test report No. PR1999997 dated 3.10.2019

Signatories

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2018

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

L 1163

Analytical Results

Sub-Matrix: **WATER**

Parameter	Method	LOR	Unit	Laboratory sample ID: QH/13866/2019 Client sampling date / time: [23-Sep-2019] Result	MU
Polycyclic Aromatics Hydrocarbons (PAHs)					
Naphthalene	W-PAHGMS01	0.100	µg/L	<0.100	----
Acenaphthylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Acenaphthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Fluorene	W-PAHGMS01	0.020	µg/L	<0.020	----
Phenanthrene	W-PAHGMS01	0.030	µg/L	<0.030	----
Anthracene	W-PAHGMS01	0.020	µg/L	<0.020	----
Fluoranthene	W-PAHGMS01	0.030	µg/L	<0.030	----
Pyrene	W-PAHGMS01	0.060	µg/L	<0.060	----
Benz(a)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Chrysene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(b)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(k)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(a)pyrene	W-PAHGMS01	0.020	µg/L	<0.020	----
Indeno(1.2.3.cd)pyrene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(g.h.i)perylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Dibenz(a.h)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Sum of 16 PAH	W-PAHGMS01	0.370	µg/L	<0.370	----
Sum of PAH (MoE)	W-PAHGMS01	0.19	µg/L	<0.19	----
Sum of 6 PAH (WHO)	W-PAHGMS01	0.090	µg/L	<0.090	----
Sum of 4 PAH	W-PAHGMS01	0.040	µg/L	<0.040	----
Organochlorine Pesticides					
Hexachloroethane	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobutadiene	W-OCPECD01	0.010	µg/L	<0.010	----
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene	W-OCPECD01	0.020	µg/L	<0.020	----
1.2.3.4-Tetrachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Pentachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Trifluralin	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Alpha	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobenzene (HCB)	W-OCPECD01	0.0050	µg/L	<0.0050	----
Hexachlorocyclohexane Beta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Gamma	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Delta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Epsilon	W-OCPECD01	0.010	µg/L	<0.010	----
Alachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Aldrin	W-OCPECD01	0.0050	µg/L	<0.0050	----
Telodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Isodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-cis	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-trans	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
alpha-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----

4.4`-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
Dieldrin	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
Endrin	W-OCPECD01	0.010	µg/L	<0.010	----
beta-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
Methoxychlor	W-OCPECD01	0.010	µg/L	<0.010	----
Dichlobenil	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 3 tetrachlorobenzenes	W-OCPECD01	0.030	µg/L	<0.030	----
Sum of 4 hexachlorcyclohexanes	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 4 isomers DDT	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 6 isomers DDT	W-OCPECD01	0.060	µg/L	<0.060	----
Sum of endosulfanes	W-OCPECD01	0.020	µg/L	<0.020	----
Sum of 5 hexachlorocyclohexanes	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 27 OCPs + 3 CBs	W-OCPECD01	0.290	µg/L	<0.290	----
Sum of 29 OCPs + 3 CBs	W-OCPECD01	0.350	µg/L	<0.350	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty. The MU does not include sampling uncertainty.

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Na Harfe 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-OCPECD01	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1) Determination of organochlorine pesticides and other halogen compounds 12) by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values.
W-PAHGMS01	CZ_SOP_D06_03_161 (US EPA 8270D, US EPA 8082A, CSN EN ISO 6468, US EPA 8000D, samples preparation as per CZ_SOP_D06_03_P01 chap. 9.1). Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

ALS Controlvet

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13858 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159083 / 19**

Produto: Água Naturais
Referência: Amostra 3
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Ensaio	Método	Resultado	Unidade
(a) Parâmetros físico-químicos	Descrição em anexo	Resultado em anexo.	.

Método interno equivalente é aquele que tem a mesma área de aplicação (parâmetros e matrizes) e que cumpre as características de desempenho, obtendo resultados comparáveis ao(s) método(s) normalizado(s) junto indicado(s)

Tondela
Zona Industrial Tondela - ZIM II Lote 2 e 6
3460-070 Tondela
Telef.: 232817817
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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13858 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159083 / 19**

Produto: Água Naturais
Referência: Amostra 3
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Notas

Lista de abreviaturas: NE- Número estimado; UFC- Unidades formadoras de colónias; LQ – Limite de quantificação; LD – limite de detecção; V.L. – Valor Limite; V.R. – Valor Recomendado; VP - Valor Paramétrico; C - Conforme; A - Aceitável; NC - Não Conforme; Unid. - Unidade; DO - Densidade óptica.

O ensaio assinalado com (s) foi subcontratado e não é acreditado.
O ensaio assinalado com (a) foi subcontratado e é acreditado.
Nos resultados assinalados com (k) os microrganismos estão presentes, mas inferiores a 3xdiluição (quando aplicável).
Nos resultados assinalados com (y) os microrganismos estão presentes, mas inferiores a 4xdiluição.
Para os ensaios assinalados por tecnicas de cálculo a metodologia seguida pode ser disponibilizada a pedido.

Este Relatório de Ensaio refere-se apenas às amostras analisadas.
Proibida a reprodução parcial deste documento.

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

CERTIFICATE OF ANALYSIS

Laboratory sample ID	: **PR1999997001**	**Work Order**	: **PR1999997**
		Issue Date	: 03-Oct-2019
Amendment	: **1**		
Customer	: **CONTROLVET - Seguranca Alimentar, S. A.**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Subcontratacao Ensaios	Contact	: Client Service
Address	: Zona Industrial de Tondela ZIM II - Lote 6 3460-070 Tondela Portugal	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: Subcontratacao.Ensaios@alsglobal.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Project	: ECF 2019E/155	Page	: 1 of 3
Order number	: ----	Date Samples Received	: 24-Sep-2019
		Quote number	: PR2015CONSE-PT0006 (PT-254-15-0938)
Site	: ----	Date of test	: 24-Sep-2019 - 03-Oct-2019
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples. If the section "Sampled by" of the Certificate of analysis states: "Sampled by Customer" then the results relate to the sample as received.
Amendmend No. 1: Change of COA format as per clients request. This Amendmend No. 1 supersedes test report No. PR1999997 dated 3.10.2019

Signatories

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2018

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

L 1163

Analytical Results

Sub-Matrix: **WATER**

Parameter	Method	LOR	Unit	Laboratory sample ID: QH/13858/2019 Client sampling date / time: [23-Sep-2019] Result	MU
Polycyclic Aromatics Hydrocarbons (PAHs)					
Naphthalene	W-PAHGMS01	0.100	µg/L	<0.100	----
Acenaphthylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Acenaphthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Fluorene	W-PAHGMS01	0.020	µg/L	<0.020	----
Phenanthrene	W-PAHGMS01	0.030	µg/L	<0.030	----
Anthracene	W-PAHGMS01	0.020	µg/L	<0.020	----
Fluoranthene	W-PAHGMS01	0.030	µg/L	<0.030	----
Pyrene	W-PAHGMS01	0.060	µg/L	<0.060	----
Benz(a)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Chrysene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(b)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(k)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(a)pyrene	W-PAHGMS01	0.020	µg/L	<0.020	----
Indeno(1.2.3.cd)pyrene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(g.h.i)perylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Dibenz(a.h)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Sum of 16 PAH	W-PAHGMS01	0.370	µg/L	<0.370	----
Sum of PAH (MoE)	W-PAHGMS01	0.19	µg/L	<0.19	----
Sum of 6 PAH (WHO)	W-PAHGMS01	0.090	µg/L	<0.090	----
Sum of 4 PAH	W-PAHGMS01	0.040	µg/L	<0.040	----
Organochlorine Pesticides					
Hexachloroethane	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobutadiene	W-OCPECD01	0.010	µg/L	<0.010	----
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene	W-OCPECD01	0.020	µg/L	<0.020	----
1.2.3.4-Tetrachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Pentachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Trifluralin	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Alpha	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobenzene (HCB)	W-OCPECD01	0.0050	µg/L	<0.0050	----
Hexachlorocyclohexane Beta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Gamma	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Delta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Epsilon	W-OCPECD01	0.010	µg/L	<0.010	----
Alachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Aldrin	W-OCPECD01	0.0050	µg/L	<0.0050	----
Telodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Isodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-cis	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-trans	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
alpha-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----

4.4`-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
Dieldrin	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
Endrin	W-OCPECD01	0.010	µg/L	<0.010	----
beta-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
Methoxychlor	W-OCPECD01	0.010	µg/L	<0.010	----
Dichlobenil	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 3 tetrachlorobenzenes	W-OCPECD01	0.030	µg/L	<0.030	----
Sum of 4 hexachlorcyclohexanes	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 4 isomers DDT	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 6 isomers DDT	W-OCPECD01	0.060	µg/L	<0.060	----
Sum of endosulfanes	W-OCPECD01	0.020	µg/L	<0.020	----
Sum of 5 hexachlorocyclohexanes	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 27 OCPs + 3 CBs	W-OCPECD01	0.290	µg/L	<0.290	----
Sum of 29 OCPs + 3 CBs	W-OCPECD01	0.350	µg/L	<0.350	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty. The MU does not include sampling uncertainty.

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Na Harfe 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-OCPECD01	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1) Determination of organochlorine pesticides and other halogen compounds 12) by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values.
W-PAHGMS01	CZ_SOP_D06_03_161 (US EPA 8270D, US EPA 8082A, CSN EN ISO 6468, US EPA 8000D, samples preparation as per CZ_SOP_D06_03_P01 chap. 9.1). Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

ALS Controlvet

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13864 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159094 / 19**

Produto: Água Naturais
Referência: Amostra 7
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Ensaio	Método	Resultado	Unidade
(a) Parâmetros físico-químicos	Descrição em anexo	Resultado em anexo.	.

Método interno equivalente é aquele que tem a mesma área de aplicação (parâmetros e matrizes) e que cumpre as características de desempenho, obtendo resultados comparáveis ao(s) método(s) normalizado(s) junto indicado(s)

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Data Emissão: 04-10-2019

N.º de Análise:	QH / 13864 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159094 / 19**

Produto: Água Naturais
Referência: Amostra 7
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Notas

Lista de abreviaturas: NE- Número estimado; UFC- Unidades formadoras de colónias; LQ – Limite de quantificação; LD – limite de detecção; V.L. – Valor Limite; V.R. – Valor Recomendado; VP - Valor Paramétrico; C - Conforme; A - Aceitável; NC - Não Conforme; Unid. - Unidade; DO - Densidade óptica.

O ensaio assinalado com (s) foi subcontratado e não é acreditado.
O ensaio assinalado com (a) foi subcontratado e é acreditado.
Nos resultados assinalados com (k) os microrganismos estão presentes, mas inferiores a 3xdiluição (quando aplicável).
Nos resultados assinalados com (y) os microrganismos estão presentes, mas inferiores a 4xdiluição.
Para os ensaios assinalados por tecnicas de cálculo a metodologia seguida pode ser disponibilizada a pedido.

Este Relatório de Ensaio refere-se apenas às amostras analisadas.
Proibida a reprodução parcial deste documento.

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

CERTIFICATE OF ANALYSIS

Laboratory sample ID	: **PR1999997007**	**Work Order**	: **PR1999997**
		Issue Date	: 03-Oct-2019
Amendment	: **1**		
Customer	: **CONTROLVET - Seguranca Alimentar, S. A.**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Subcontratacao Ensaios	Contact	: Client Service
Address	: Zona Industrial de Tondela ZIM II - Lote 6 3460-070 Tondela Portugal	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: Subcontratacao.Ensaios@alsglobal.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Project	: ECF 2019E/155	Page	: 1 of 3
Order number	: ----	Date Samples Received	: 24-Sep-2019
		Quote number	: PR2015CONSE-PT0006 (PT-254-15-0938)
Site	: ----	Date of test	: 24-Sep-2019 - 03-Oct-2019
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples. If the section "Sampled by" of the Certificate of analysis states: "Sampled by Customer" then the results relate to the sample as received.
Amendmend No. 1: Change of COA format as per clients request. This Amendmend No. 1 supersedes test report No. PR1999997 dated 3.10.2019

Signatories

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2018

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

L 1163

Analytical Results

Sub-Matrix: **WATER**			*Laboratory sample ID*	**QH/13864/2019**	
			Client sampling date / time	[23-Sep-2019]	
Parameter	*Method*	*LOR*	*Unit*	**Result**	**MU**
Polycyclic Aromatics Hydrocarbons (PAHs)					
Naphthalene	W-PAHGMS01	0.100	µg/L	<0.100	----
Acenaphthylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Acenaphthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Fluorene	W-PAHGMS01	0.020	µg/L	<0.020	----
Phenanthrene	W-PAHGMS01	0.030	µg/L	<0.030	----
Anthracene	W-PAHGMS01	0.020	µg/L	<0.020	----
Fluoranthene	W-PAHGMS01	0.030	µg/L	<0.030	----
Pyrene	W-PAHGMS01	0.060	µg/L	<0.060	----
Benz(a)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Chrysene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(b)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(k)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(a)pyrene	W-PAHGMS01	0.020	µg/L	<0.020	----
Indeno(1.2.3.cd)pyrene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(g.h.i)perylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Dibenz(a.h)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Sum of 16 PAH	W-PAHGMS01	0.370	µg/L	<0.370	----
Sum of PAH (MoE)	W-PAHGMS01	0.19	µg/L	<0.19	----
Sum of 6 PAH (WHO)	W-PAHGMS01	0.090	µg/L	<0.090	----
Sum of 4 PAH	W-PAHGMS01	0.040	µg/L	<0.040	----
Organochlorine Pesticides					
Hexachloroethane	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobutadiene	W-OCPECD01	0.010	µg/L	<0.010	----
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene	W-OCPECD01	0.020	µg/L	<0.020	----
1.2.3.4-Tetrachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Pentachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Trifluralin	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Alpha	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobenzene (HCB)	W-OCPECD01	0.0050	µg/L	<0.0050	----
Hexachlorocyclohexane Beta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Gamma	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Delta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Epsilon	W-OCPECD01	0.010	µg/L	<0.010	----
Alachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Aldrin	W-OCPECD01	0.0050	µg/L	<0.0050	----
Telodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Isodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-cis	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-trans	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
alpha-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----

4.4`-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
Dieldrin	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
Endrin	W-OCPECD01	0.010	µg/L	<0.010	----
beta-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
Methoxychlor	W-OCPECD01	0.010	µg/L	<0.010	----
Dichlobenil	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 3 tetrachlorobenzenes	W-OCPECD01	0.030	µg/L	<0.030	----
Sum of 4 hexachlorcyclohexanes	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 4 isomers DDT	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 6 isomers DDT	W-OCPECD01	0.060	µg/L	<0.060	----
Sum of endosulfanes	W-OCPECD01	0.020	µg/L	<0.020	----
Sum of 5 hexachlorocyclohexanes	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 27 OCPs + 3 CBs	W-OCPECD01	0.290	µg/L	<0.290	----
Sum of 29 OCPs + 3 CBs	W-OCPECD01	0.350	µg/L	<0.350	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty. The MU does not include sampling uncertainty.

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Na Harfe 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-OCPECD01	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1) Determination of organochlorine pesticides and other halogen compounds 12) by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values.
W-PAHGMS01	CZ_SOP_D06_03_161 (US EPA 8270D, US EPA 8082A, CSN EN ISO 6468, US EPA 8000D, samples preparation as per CZ_SOP_D06_03_P01 chap. 9.1). Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

ALS Controlvet

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13865 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159095 / 19**

Produto: Água Naturais
Referência: Amostra 10
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Ensaio	Método	Resultado	Unidade
(a) Parâmetros físico-químicos	Descrição em anexo	Resultado em anexo.	.

Método interno equivalente é aquele que tem a mesma área de aplicação (parâmetros e matrizes) e que cumpre as características de desempenho, obtendo resultados comparáveis ao(s) método(s) normalizado(s) junto indicado(s)

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Data Emissão: 04-10-2019

N.º de Análise:	QH / 13865 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159095 / 19**

Produto: Água Naturais
Referência: Amostra 10
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Notas

Lista de abreviaturas: NE- Número estimado; UFC- Unidades formadoras de colónias; LQ – Limite de quantificação; LD – limite de detecção; V.L. – Valor Limite; V.R. – Valor Recomendado; VP - Valor Paramétrico; C - Conforme; A - Aceitável; NC - Não Conforme; Unid. - Unidade; DO - Densidade óptica.

O ensaio assinalado com (s) foi subcontratado e não é acreditado.
O ensaio assinalado com (a) foi subcontratado e é acreditado.
Nos resultados assinalados com (k) os microrganismos estão presentes, mas inferiores a 3xdiluição (quando aplicável).
Nos resultados assinalados com (y) os microrganismos estão presentes, mas inferiores a 4xdiluição.
Para os ensaios assinalados por tecnicas de cálculo a metodologia seguida pode ser disponibilizada a pedido.

Este Relatório de Ensaio refere-se apenas às amostras analisadas.
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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

CERTIFICATE OF ANALYSIS

Laboratory sample ID	: **PR1999997008**	**Work Order**	: **PR1999997**
		Issue Date	: 03-Oct-2019
Amendment	: **1**		
Customer	: **CONTROLVET - Seguranca Alimentar, S. A.**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Subcontratacao Ensaios	Contact	: Client Service
Address	: Zona Industrial de Tondela ZIM II - Lote 6 3460-070 Tondela Portugal	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: Subcontratacao.Ensaios@alsglobal.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Project	: ECF 2019E/155	Page	: 1 of 3
Order number	: ----	Date Samples Received	: 24-Sep-2019
		Quote number	: PR2015CONSE-PT0006 (PT-254-15-0938)
Site	: ----	Date of test	: 24-Sep-2019 - 03-Oct-2019
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples. If the section "Sampled by" of the Certificate of analysis states: "Sampled by Customer" then the results relate to the sample as received.
Amendmend No. 1: Change of COA format as per clients request. This Amendmend No. 1 supersedes test report No. PR1999997 dated 3.10.2019

Signatories

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2018

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

L 1163

Analytical Results

Sub-Matrix: **WATER**			*Laboratory sample ID*	**QH/13865/2019**	
			Client sampling date / time	[23-Sep-2019]	
Parameter	*Method*	*LOR*	*Unit*	**Result**	**MU**
Polycyclic Aromatics Hydrocarbons (PAHs)					
Naphthalene	W-PAHGMS01	0.100	µg/L	<0.100	----
Acenaphthylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Acenaphthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Fluorene	W-PAHGMS01	0.020	µg/L	<0.020	----
Phenanthrene	W-PAHGMS01	0.030	µg/L	<0.030	----
Anthracene	W-PAHGMS01	0.020	µg/L	<0.020	----
Fluoranthene	W-PAHGMS01	0.030	µg/L	<0.030	----
Pyrene	W-PAHGMS01	0.060	µg/L	<0.060	----
Benz(a)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Chrysene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(b)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(k)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(a)pyrene	W-PAHGMS01	0.020	µg/L	<0.020	----
Indeno(1.2.3.cd)pyrene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(g.h.i)perylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Dibenz(a.h)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Sum of 16 PAH	W-PAHGMS01	0.370	µg/L	<0.370	----
Sum of PAH (MoE)	W-PAHGMS01	0.19	µg/L	<0.19	----
Sum of 6 PAH (WHO)	W-PAHGMS01	0.090	µg/L	<0.090	----
Sum of 4 PAH	W-PAHGMS01	0.040	µg/L	<0.040	----
Organochlorine Pesticides					
Hexachloroethane	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobutadiene	W-OCPECD01	0.010	µg/L	<0.010	----
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene	W-OCPECD01	0.020	µg/L	<0.020	----
1.2.3.4-Tetrachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Pentachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Trifluralin	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Alpha	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobenzene (HCB)	W-OCPECD01	0.0050	µg/L	<0.0050	----
Hexachlorocyclohexane Beta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Gamma	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Delta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Epsilon	W-OCPECD01	0.010	µg/L	<0.010	----
Alachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Aldrin	W-OCPECD01	0.0050	µg/L	<0.0050	----
Telodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Isodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-cis	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-trans	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
alpha-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----

4.4`-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
Dieldrin	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
Endrin	W-OCPECD01	0.010	µg/L	<0.010	----
beta-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
Methoxychlor	W-OCPECD01	0.010	µg/L	<0.010	----
Dichlobenil	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 3 tetrachlorobenzenes	W-OCPECD01	0.030	µg/L	<0.030	----
Sum of 4 hexachlorcyclohexanes	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 4 isomers DDT	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 6 isomers DDT	W-OCPECD01	0.060	µg/L	<0.060	----
Sum of endosulfanes	W-OCPECD01	0.020	µg/L	<0.020	----
Sum of 5 hexachlorocyclohexanes	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 27 OCPs + 3 CBs	W-OCPECD01	0.290	µg/L	<0.290	----
Sum of 29 OCPs + 3 CBs	W-OCPECD01	0.350	µg/L	<0.350	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty. The MU does not include sampling uncertainty.

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Na Harfe 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-OCPECD01	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1) Determination of organochlorine pesticides and other halogen compounds 12) by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values.
W-PAHGMS01	CZ_SOP_D06_03_161 (US EPA 8270D, US EPA 8082A, CSN EN ISO 6468, US EPA 8000D, samples preparation as per CZ_SOP_D06_03_P01 chap. 9.1). Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

ALS Controlvet

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13863 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159093 / 19**

Produto: Água Naturais
Referência: Amostra 12
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Ensaio	Método	Resultado	Unidade
(a) Parâmetros físico-químicos	Descrição em anexo	Resultado em anexo.	.

Método interno equivalente é aquele que tem a mesma área de aplicação (parâmetros e matrizes) e que cumpre as características de desempenho, obtendo resultados comparáveis ao(s) método(s) normalizado(s) junto indicado(s)

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13863 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159093 / 19**

Produto: Água Naturais
Referência: Amostra 12
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Notas

Lista de abreviaturas: NE- Número estimado; UFC- Unidades formadoras de colónias; LQ – Limite de quantificação; LD – limite de detecção; V.L. – Valor Limite; V.R. – Valor Recomendado; VP - Valor Paramétrico; C - Conforme; A - Aceitável; NC - Não Conforme; Unid. - Unidade; DO - Densidade óptica.

O ensaio assinalado com (s) foi subcontratado e não é acreditado.
O ensaio assinalado com (a) foi subcontratado e é acreditado.
Nos resultados assinalados com (k) os microrganismos estão presentes, mas inferiores a 3xdiluição (quando aplicável).
Nos resultados assinalados com (y) os microrganismos estão presentes, mas inferiores a 4xdiluição.
Para os ensaios assinalados por tecnicas de cálculo a metodologia seguida pode ser disponibilizada a pedido.

Este Relatório de Ensaio refere-se apenas às amostras analisadas.
Proibida a reprodução parcial deste documento.

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

CERTIFICATE OF ANALYSIS

Laboratory sample ID	: **PR1999997006**	**Work Order**	: **PR1999997**
		Issue Date	: 03-Oct-2019
Amendment	: **1**		
Customer	: **CONTROLVET - Seguranca Alimentar, S. A.**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Subcontratacao Ensaios	Contact	: Client Service
Address	: Zona Industrial de Tondela ZIM II - Lote 6 3460-070 Tondela Portugal	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: Subcontratacao.Ensaios@alsglobal.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Project	: ECF 2019E/155	Page	: 1 of 3
Order number	: ----	Date Samples Received	: 24-Sep-2019
		Quote number	: PR2015CONSE-PT0006 (PT-254-15-0938)
Site	: ----	Date of test	: 24-Sep-2019 - 03-Oct-2019
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples. If the section "Sampled by" of the Certificate of analysis states: "Sampled by Customer" then the results relate to the sample as received.
Amendmend No. 1: Change of COA format as per clients request. This Amendmend No. 1 supersedes test report No. PR1999997 dated 3.10.2019

Signatories

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2018

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

L 1163

Analytical Results

Sub-Matrix: **WATER**

Parameter	Method	LOR	Unit	Laboratory sample ID: QH/13863/2019 Client sampling date / time: [23-Sep-2019] Result	MU
Polycyclic Aromatics Hydrocarbons (PAHs)					
Naphthalene	W-PAHGMS01	0.100	µg/L	<0.100	----
Acenaphthylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Acenaphthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Fluorene	W-PAHGMS01	0.020	µg/L	<0.020	----
Phenanthrene	W-PAHGMS01	0.030	µg/L	<0.030	----
Anthracene	W-PAHGMS01	0.020	µg/L	<0.020	----
Fluoranthene	W-PAHGMS01	0.030	µg/L	<0.030	----
Pyrene	W-PAHGMS01	0.060	µg/L	<0.060	----
Benz(a)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Chrysene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(b)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(k)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(a)pyrene	W-PAHGMS01	0.020	µg/L	<0.020	----
Indeno(1.2.3.cd)pyrene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(g.h.i)perylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Dibenz(a.h)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Sum of 16 PAH	W-PAHGMS01	0.370	µg/L	<0.370	----
Sum of PAH (MoE)	W-PAHGMS01	0.19	µg/L	<0.19	----
Sum of 6 PAH (WHO)	W-PAHGMS01	0.090	µg/L	<0.090	----
Sum of 4 PAH	W-PAHGMS01	0.040	µg/L	<0.040	----
Organochlorine Pesticides					
Hexachloroethane	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobutadiene	W-OCPECD01	0.010	µg/L	<0.010	----
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene	W-OCPECD01	0.020	µg/L	<0.020	----
1.2.3.4-Tetrachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Pentachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Trifluralin	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Alpha	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobenzene (HCB)	W-OCPECD01	0.0050	µg/L	<0.0050	----
Hexachlorocyclohexane Beta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Gamma	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Delta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Epsilon	W-OCPECD01	0.010	µg/L	<0.010	----
Alachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Aldrin	W-OCPECD01	0.0050	µg/L	<0.0050	----
Telodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Isodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-cis	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-trans	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
alpha-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----

4.4`-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
Dieldrin	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
Endrin	W-OCPECD01	0.010	µg/L	<0.010	----
beta-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
Methoxychlor	W-OCPECD01	0.010	µg/L	<0.010	----
Dichlobenil	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 3 tetrachlorobenzenes	W-OCPECD01	0.030	µg/L	<0.030	----
Sum of 4 hexachlorcyclohexanes	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 4 isomers DDT	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 6 isomers DDT	W-OCPECD01	0.060	µg/L	<0.060	----
Sum of endosulfanes	W-OCPECD01	0.020	µg/L	<0.020	----
Sum of 5 hexachlorocyclohexanes	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 27 OCPs + 3 CBs	W-OCPECD01	0.290	µg/L	<0.290	----
Sum of 29 OCPs + 3 CBs	W-OCPECD01	0.350	µg/L	<0.350	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty. The MU does not include sampling uncertainty.

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Na Harfe 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-OCPECD01	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1) Determination of organochlorine pesticides and other halogen compounds 12) by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values.
W-PAHGMS01	CZ_SOP_D06_03_161 (US EPA 8270D, US EPA 8082A, CSN EN ISO 6468, US EPA 8000D, samples preparation as per CZ_SOP_D06_03_P01 chap. 9.1). Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

ALS Controlvet

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13860 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159089 / 19**

Produto: Água Naturais
Referência: Amostra 14
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Ensaio	Método	Resultado	Unidade
(a) Parâmetros físico-químicos	Descrição em anexo	Resultado em anexo.	.

Método interno equivalente é aquele que tem a mesma área de aplicação (parâmetros e matrizes) e que cumpre as características de desempenho, obtendo resultados comparáveis ao(s) método(s) normalizado(s) junto indicado(s)

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Zona Industrial Tondela - ZIM II Lote 2 e 6
3460-070 Tondela
Telef.: 232817817
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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13860 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159089 / 19**

Produto: Água Naturais
Referência: Amostra 14
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Notas

Lista de abreviaturas: NE- Número estimado; UFC- Unidades formadoras de colónias; LQ – Limite de quantificação; LD – limite de detecção; V.L. – Valor Limite; V.R. – Valor Recomendado; VP - Valor Paramétrico; C - Conforme; A - Aceitável; NC - Não Conforme; Unid. - Unidade; DO - Densidade óptica.

O ensaio assinalado com (s) foi subcontratado e não é acreditado.
O ensaio assinalado com (a) foi subcontratado e é acreditado.
Nos resultados assinalados com (k) os microrganismos estão presentes, mas inferiores a 3xdiluição (quando aplicável).
Nos resultados assinalados com (y) os microrganismos estão presentes, mas inferiores a 4xdiluição.
Para os ensaios assinalados por tecnicas de cálculo a metodologia seguida pode ser disponibilizada a pedido.

Este Relatório de Ensaio refere-se apenas às amostras analisadas.
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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

CERTIFICATE OF ANALYSIS

Laboratory sample ID	: **PR1999997003**	**Work Order**	: **PR1999997**
		Issue Date	: 03-Oct-2019
Amendment	: **1**		
Customer	: **CONTROLVET - Seguranca Alimentar, S. A.**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Subcontratacao Ensaios	Contact	: Client Service
Address	: Zona Industrial de Tondela ZIM II - Lote 6 3460-070 Tondela Portugal	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: Subcontratacao.Ensaios@alsglobal.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Project	: ECF 2019E/155	Page	: 1 of 3
Order number	: ----	Date Samples Received	: 24-Sep-2019
		Quote number	: PR2015CONSE-PT0006 (PT-254-15-0938)
Site	: ----	Date of test	: 24-Sep-2019 - 03-Oct-2019
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples. If the section "Sampled by" of the Certificate of analysis states: "Sampled by Customer" then the results relate to the sample as received.
Amendmend No. 1: Change of COA format as per clients request. This Amendmend No. 1 supersedes test report No. PR1999997 dated 3.10.2019

Signatories

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2018

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

L 1163

Analytical Results

Sub-Matrix: **WATER**			*Laboratory sample ID*	**QH/13860/2019**	
			Client sampling date / time	[23-Sep-2019]	
Parameter	*Method*	*LOR*	*Unit*	**Result**	**MU**
Polycyclic Aromatics Hydrocarbons (PAHs)					
Naphthalene	W-PAHGMS01	0.100	µg/L	<0.100	----
Acenaphthylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Acenaphthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Fluorene	W-PAHGMS01	0.020	µg/L	<0.020	----
Phenanthrene	W-PAHGMS01	0.030	µg/L	<0.030	----
Anthracene	W-PAHGMS01	0.020	µg/L	<0.020	----
Fluoranthene	W-PAHGMS01	0.030	µg/L	<0.030	----
Pyrene	W-PAHGMS01	0.060	µg/L	<0.060	----
Benz(a)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Chrysene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(b)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(k)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(a)pyrene	W-PAHGMS01	0.020	µg/L	<0.020	----
Indeno(1.2.3.cd)pyrene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(g.h.i)perylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Dibenz(a.h)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Sum of 16 PAH	W-PAHGMS01	0.370	µg/L	<0.370	----
Sum of PAH (MoE)	W-PAHGMS01	0.19	µg/L	<0.19	----
Sum of 6 PAH (WHO)	W-PAHGMS01	0.090	µg/L	<0.090	----
Sum of 4 PAH	W-PAHGMS01	0.040	µg/L	<0.040	----
Organochlorine Pesticides					
Hexachloroethane	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobutadiene	W-OCPECD01	0.010	µg/L	<0.010	----
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene	W-OCPECD01	0.020	µg/L	<0.020	----
1.2.3.4-Tetrachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Pentachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Trifluralin	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Alpha	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobenzene (HCB)	W-OCPECD01	0.0050	µg/L	<0.0050	----
Hexachlorocyclohexane Beta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Gamma	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Delta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Epsilon	W-OCPECD01	0.010	µg/L	<0.010	----
Alachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Aldrin	W-OCPECD01	0.0050	µg/L	<0.0050	----
Telodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Isodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-cis	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-trans	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
alpha-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----

4.4`-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
Dieldrin	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
Endrin	W-OCPECD01	0.010	µg/L	<0.010	----
beta-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
Methoxychlor	W-OCPECD01	0.010	µg/L	<0.010	----
Dichlobenil	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 3 tetrachlorobenzenes	W-OCPECD01	0.030	µg/L	<0.030	----
Sum of 4 hexachlorcyclohexanes	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 4 isomers DDT	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 6 isomers DDT	W-OCPECD01	0.060	µg/L	<0.060	----
Sum of endosulfanes	W-OCPECD01	0.020	µg/L	<0.020	----
Sum of 5 hexachlorocyclohexanes	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 27 OCPs + 3 CBs	W-OCPECD01	0.290	µg/L	<0.290	----
Sum of 29 OCPs + 3 CBs	W-OCPECD01	0.350	µg/L	<0.350	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty. The MU does not include sampling uncertainty.

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Na Harfe 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-OCPECD01	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1) Determination of organochlorine pesticides and other halogen compounds 12) by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values.
W-PAHGMS01	CZ_SOP_D06_03_161 (US EPA 8270D, US EPA 8082A, CSN EN ISO 6468, US EPA 8000D, samples preparation as per CZ_SOP_D06_03_P01 chap. 9.1). Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

ALS Controlvet

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13859 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159086 / 19**

Produto: Água Naturais
Referência: Amostra 18
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Ensaio	Método	Resultado	Unidade
(a) Parâmetros físico-químicos	Descrição em anexo	Resultado em anexo.	.

Método interno equivalente é aquele que tem a mesma área de aplicação (parâmetros e matrizes) e que cumpre as características de desempenho, obtendo resultados comparáveis ao(s) método(s) normalizado(s) junto indicado(s)

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13859 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159086 / 19**

Produto: Água Naturais
Referência: Amostra 18
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Notas

Lista de abreviaturas: NE- Número estimado; UFC- Unidades formadoras de colónias; LQ – Limite de quantificação; LD – limite de detecção; V.L. – Valor Limite; V.R. – Valor Recomendado; VP - Valor Paramétrico; C - Conforme; A - Aceitável; NC - Não Conforme; Unid. - Unidade; DO - Densidade óptica.

O ensaio assinalado com (s) foi subcontratado e não é acreditado.
O ensaio assinalado com (a) foi subcontratado e é acreditado.
Nos resultados assinalados com (k) os microrganismos estão presentes, mas inferiores a 3xdiluição (quando aplicável).
Nos resultados assinalados com (y) os microrganismos estão presentes, mas inferiores a 4xdiluição.
Para os ensaios assinalados por tecnicas de cálculo a metodologia seguida pode ser disponibilizada a pedido.

Este Relatório de Ensaio refere-se apenas às amostras analisadas.
Proibida a reprodução parcial deste documento.

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

CERTIFICATE OF ANALYSIS

Laboratory sample ID	: **PR1999997002**	**Work Order**	: **PR1999997**
		Issue Date	: 03-Oct-2019
Amendment	: **1**		
Customer	: **CONTROLVET - Seguranca Alimentar, S. A.**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Subcontratacao Ensaios	Contact	: Client Service
Address	: Zona Industrial de Tondela ZIM II - Lote 6 3460-070 Tondela Portugal	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: Subcontratacao.Ensaios@alsglobal.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Project	: ECF 2019E/155	Page	: 1 of 3
Order number	: ----	Date Samples Received	: 24-Sep-2019
		Quote number	: PR2015CONSE-PT0006 (PT-254-15-0938)
Site	: ----	Date of test	: 24-Sep-2019 - 03-Oct-2019
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples. If the section "Sampled by" of the Certificate of analysis states: "Sampled by Customer" then the results relate to the sample as received.
Amendmend No. 1: Change of COA format as per clients request. This Amendmend No. 1 supersedes test report No. PR1999997 dated 3.10.2019

Signatories

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2018

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

L 1163

Analytical Results

Sub-Matrix: **WATER**

Parameter	Method	LOR	Unit	Laboratory sample ID: QH/13859/2019 Client sampling date / time: [23-Sep-2019] Result	MU
Polycyclic Aromatics Hydrocarbons (PAHs)					
Naphthalene	W-PAHGMS01	0.100	µg/L	<0.100	----
Acenaphthylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Acenaphthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Fluorene	W-PAHGMS01	0.020	µg/L	<0.020	----
Phenanthrene	W-PAHGMS01	0.030	µg/L	<0.030	----
Anthracene	W-PAHGMS01	0.020	µg/L	<0.020	----
Fluoranthene	W-PAHGMS01	0.030	µg/L	<0.030	----
Pyrene	W-PAHGMS01	0.060	µg/L	<0.060	----
Benz(a)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Chrysene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(b)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(k)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(a)pyrene	W-PAHGMS01	0.020	µg/L	<0.020	----
Indeno(1.2.3.cd)pyrene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(g.h.i)perylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Dibenz(a.h)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Sum of 16 PAH	W-PAHGMS01	0.370	µg/L	<0.370	----
Sum of PAH (MoE)	W-PAHGMS01	0.19	µg/L	<0.19	----
Sum of 6 PAH (WHO)	W-PAHGMS01	0.090	µg/L	<0.090	----
Sum of 4 PAH	W-PAHGMS01	0.040	µg/L	<0.040	----
Organochlorine Pesticides					
Hexachloroethane	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobutadiene	W-OCPECD01	0.010	µg/L	<0.010	----
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene	W-OCPECD01	0.020	µg/L	<0.020	----
1.2.3.4-Tetrachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Pentachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Trifluralin	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Alpha	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobenzene (HCB)	W-OCPECD01	0.0050	µg/L	<0.0050	----
Hexachlorocyclohexane Beta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Gamma	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Delta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Epsilon	W-OCPECD01	0.010	µg/L	<0.010	----
Alachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Aldrin	W-OCPECD01	0.0050	µg/L	<0.0050	----
Telodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Isodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-cis	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-trans	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
alpha-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----

4.4`-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
Dieldrin	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
Endrin	W-OCPECD01	0.010	µg/L	<0.010	----
beta-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
Methoxychlor	W-OCPECD01	0.010	µg/L	<0.010	----
Dichlobenil	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 3 tetrachlorobenzenes	W-OCPECD01	0.030	µg/L	<0.030	----
Sum of 4 hexachlorcyclohexanes	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 4 isomers DDT	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 6 isomers DDT	W-OCPECD01	0.060	µg/L	<0.060	----
Sum of endosulfanes	W-OCPECD01	0.020	µg/L	<0.020	----
Sum of 5 hexachlorocyclohexanes	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 27 OCPs + 3 CBs	W-OCPECD01	0.290	µg/L	<0.290	----
Sum of 29 OCPs + 3 CBs	W-OCPECD01	0.350	µg/L	<0.350	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty. The MU does not include sampling uncertainty.

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Na Harfe 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-OCPECD01	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1) Determination of organochlorine pesticides and other halogen compounds 12) by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values.
W-PAHGMS01	CZ_SOP_D06_03_161 (US EPA 8270D, US EPA 8082A, CSN EN ISO 6468, US EPA 8000D, samples preparation as per CZ_SOP_D06_03_P01 chap. 9.1). Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

ALS Controlvet

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13868 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159098 / 19**

Produto: Água Naturais
Referência: Amostra 21
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Ensaio	Método	Resultado	Unidade
(a) Parâmetros físico-químicos	Descrição em anexo	Resultado em anexo.	.

Método interno equivalente é aquele que tem a mesma área de aplicação (parâmetros e matrizes) e que cumpre as características de desempenho, obtendo resultados comparáveis ao(s) método(s) normalizado(s) junto indicado(s)

Tondela
Zona Industrial Tondela - ZIM II Lote 2 e 6
3460-070 Tondela
Telef.: 232817817
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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13868 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159098 / 19**

Produto: Água Naturais
Referência: Amostra 21
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Notas

Lista de abreviaturas: NE- Número estimado; UFC- Unidades formadoras de colónias; LQ – Limite de quantificação; LD – limite de detecção; V.L. – Valor Limite; V.R. – Valor Recomendado; VP - Valor Paramétrico; C - Conforme; A - Aceitável; NC - Não Conforme; Unid. - Unidade; DO - Densidade óptica.

O ensaio assinalado com (s) foi subcontratado e não é acreditado.
O ensaio assinalado com (a) foi subcontratado e é acreditado.
Nos resultados assinalados com (k) os microrganismos estão presentes, mas inferiores a 3xdiluição (quando aplicável).
Nos resultados assinalados com (y) os microrganismos estão presentes, mas inferiores a 4xdiluição.
Para os ensaios assinalados por tecnicas de cálculo a metodologia seguida pode ser disponibilizada a pedido.

Este Relatório de Ensaio refere-se apenas às amostras analisadas.
Proibida a reprodução parcial deste documento.

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

CERTIFICATE OF ANALYSIS

Laboratory sample ID	: **PR1999997011**	**Work Order**	: **PR1999997**
		Issue Date	: 03-Oct-2019
Amendment	: **1**		
Customer	: **CONTROLVET - Seguranca Alimentar, S. A.**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Subcontratacao Ensaios	Contact	: Client Service
Address	: Zona Industrial de Tondela ZIM II - Lote 6 3460-070 Tondela Portugal	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: Subcontratacao.Ensaios@alsglobal.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Project	: ECF 2019E/155	Page	: 1 of 3
Order number	: ----	Date Samples Received	: 24-Sep-2019
		Quote number	: PR2015CONSE-PT0006 (PT-254-15-0938)
Site	: ----	Date of test	: 24-Sep-2019 - 03-Oct-2019
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples. If the section "Sampled by" of the Certificate of analysis states: "Sampled by Customer" then the results relate to the sample as received.
Amendmend No. 1: Change of COA format as per clients request. This Amendmend No. 1 supersedes test report No. PR1999997 dated 3.10.2019

Signatories

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2018

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

L 1163

Analytical Results

Sub-Matrix: **WATER**

Parameter	Method	LOR	Unit	Laboratory sample ID: QH/13868/2019 Client sampling date / time: [23-Sep-2019] Result	MU
Polycyclic Aromatics Hydrocarbons (PAHs)					
Naphthalene	W-PAHGMS01	0.100	µg/L	<0.100	----
Acenaphthylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Acenaphthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Fluorene	W-PAHGMS01	0.020	µg/L	<0.020	----
Phenanthrene	W-PAHGMS01	0.030	µg/L	<0.030	----
Anthracene	W-PAHGMS01	0.020	µg/L	<0.020	----
Fluoranthene	W-PAHGMS01	0.030	µg/L	<0.030	----
Pyrene	W-PAHGMS01	0.060	µg/L	<0.060	----
Benz(a)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Chrysene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(b)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(k)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(a)pyrene	W-PAHGMS01	0.020	µg/L	<0.020	----
Indeno(1.2.3.cd)pyrene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(g.h.i)perylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Dibenz(a.h)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Sum of 16 PAH	W-PAHGMS01	0.370	µg/L	<0.370	----
Sum of PAH (MoE)	W-PAHGMS01	0.19	µg/L	<0.19	----
Sum of 6 PAH (WHO)	W-PAHGMS01	0.090	µg/L	<0.090	----
Sum of 4 PAH	W-PAHGMS01	0.040	µg/L	<0.040	----
Organochlorine Pesticides					
Hexachloroethane	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobutadiene	W-OCPECD01	0.010	µg/L	<0.010	----
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene	W-OCPECD01	0.020	µg/L	<0.020	----
1.2.3.4-Tetrachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Pentachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Trifluralin	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Alpha	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobenzene (HCB)	W-OCPECD01	0.0050	µg/L	<0.0050	----
Hexachlorocyclohexane Beta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Gamma	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Delta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Epsilon	W-OCPECD01	0.010	µg/L	<0.010	----
Alachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Aldrin	W-OCPECD01	0.0050	µg/L	<0.0050	----
Telodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Isodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-cis	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-trans	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
alpha-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----

4.4`-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
Dieldrin	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
Endrin	W-OCPECD01	0.010	µg/L	<0.010	----
beta-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
Methoxychlor	W-OCPECD01	0.010	µg/L	<0.010	----
Dichlobenil	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 3 tetrachlorobenzenes	W-OCPECD01	0.030	µg/L	<0.030	----
Sum of 4 hexachlorcyclohexanes	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 4 isomers DDT	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 6 isomers DDT	W-OCPECD01	0.060	µg/L	<0.060	----
Sum of endosulfanes	W-OCPECD01	0.020	µg/L	<0.020	----
Sum of 5 hexachlorocyclohexanes	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 27 OCPs + 3 CBs	W-OCPECD01	0.290	µg/L	<0.290	----
Sum of 29 OCPs + 3 CBs	W-OCPECD01	0.350	µg/L	<0.350	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty. The MU does not include sampling uncertainty.

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Na Harfe 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-OCPECD01	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1) Determination of organochlorine pesticides and other halogen compounds 12) by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values.
W-PAHGMS01	CZ_SOP_D06_03_161 (US EPA 8270D, US EPA 8082A, CSN EN ISO 6468, US EPA 8000D, samples preparation as per CZ_SOP_D06_03_P01 chap. 9.1). Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

ALS Controlvet

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13867 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159097 / 19**

Produto: Água Naturais
Referência: Amostra 23
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Ensaio	Método	Resultado	Unidade
(a) Parâmetros físico-químicos	Descrição em anexo	Resultado em anexo.	.

Método interno equivalente é aquele que tem a mesma área de aplicação (parâmetros e matrizes) e que cumpre as características de desempenho, obtendo resultados comparáveis ao(s) método(s) normalizado(s) junto indicado(s)

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13867 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159097 / 19**

Produto: Água Naturais
Referência: Amostra 23
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Notas

Lista de abreviaturas: NE- Número estimado; UFC- Unidades formadoras de colónias; LQ – Limite de quantificação; LD – limite de detecção; V.L. – Valor Limite; V.R. – Valor Recomendado; VP - Valor Paramétrico; C - Conforme; A - Aceitável; NC - Não Conforme; Unid. - Unidade; DO - Densidade óptica.

O ensaio assinalado com (s) foi subcontratado e não é acreditado.
O ensaio assinalado com (a) foi subcontratado e é acreditado.
Nos resultados assinalados com (k) os microrganismos estão presentes, mas inferiores a 3xdiluição (quando aplicável).
Nos resultados assinalados com (y) os microrganismos estão presentes, mas inferiores a 4xdiluição.
Para os ensaios assinalados por tecnicas de cálculo a metodologia seguida pode ser disponibilizada a pedido.

Este Relatório de Ensaio refere-se apenas às amostras analisadas.
Proibida a reprodução parcial deste documento.

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

CERTIFICATE OF ANALYSIS

Laboratory sample ID	: **PR1999997010**	**Work Order**	: **PR1999997**
		Issue Date	: 03-Oct-2019
Amendment	: **1**		
Customer	: **CONTROLVET - Seguranca Alimentar, S. A.**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Subcontratacao Ensaios	Contact	: Client Service
Address	: Zona Industrial de Tondela ZIM II - Lote 6 3460-070 Tondela Portugal	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: Subcontratacao.Ensaios@alsglobal.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Project	: ECF 2019E/155	Page	: 1 of 3
Order number	: ----	Date Samples Received	: 24-Sep-2019
		Quote number	: PR2015CONSE-PT0006 (PT-254-15-0938)
Site	: ----	Date of test	: 24-Sep-2019 - 03-Oct-2019
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples. If the section "Sampled by" of the Certificate of analysis states: "Sampled by Customer" then the results relate to the sample as received.
Amendmend No. 1: Change of COA format as per clients request. This Amendmend No. 1 supersedes test report No. PR1999997 dated 3.10.2019

Signatories

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2018

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

L 1163

Analytical Results

Sub-Matrix: **WATER**

Parameter	Method	LOR	Unit	Laboratory sample ID: QH/13867/2019 Client sampling date / time: [23-Sep-2019] Result	MU
Polycyclic Aromatics Hydrocarbons (PAHs)					
Naphthalene	W-PAHGMS01	0.100	µg/L	<0.100	----
Acenaphthylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Acenaphthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Fluorene	W-PAHGMS01	0.020	µg/L	<0.020	----
Phenanthrene	W-PAHGMS01	0.030	µg/L	<0.030	----
Anthracene	W-PAHGMS01	0.020	µg/L	<0.020	----
Fluoranthene	W-PAHGMS01	0.030	µg/L	<0.030	----
Pyrene	W-PAHGMS01	0.060	µg/L	<0.060	----
Benz(a)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Chrysene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(b)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(k)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(a)pyrene	W-PAHGMS01	0.020	µg/L	<0.020	----
Indeno(1.2.3.cd)pyrene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(g.h.i)perylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Dibenz(a.h)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Sum of 16 PAH	W-PAHGMS01	0.370	µg/L	<0.370	----
Sum of PAH (MoE)	W-PAHGMS01	0.19	µg/L	<0.19	----
Sum of 6 PAH (WHO)	W-PAHGMS01	0.090	µg/L	<0.090	----
Sum of 4 PAH	W-PAHGMS01	0.040	µg/L	<0.040	----
Organochlorine Pesticides					
Hexachloroethane	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobutadiene	W-OCPECD01	0.010	µg/L	<0.010	----
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene	W-OCPECD01	0.020	µg/L	<0.020	----
1.2.3.4-Tetrachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Pentachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Trifluralin	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Alpha	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobenzene (HCB)	W-OCPECD01	0.0050	µg/L	<0.0050	----
Hexachlorocyclohexane Beta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Gamma	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Delta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Epsilon	W-OCPECD01	0.010	µg/L	<0.010	----
Alachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Aldrin	W-OCPECD01	0.0050	µg/L	<0.0050	----
Telodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Isodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-cis	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-trans	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
alpha-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----

4.4`-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
Dieldrin	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
Endrin	W-OCPECD01	0.010	µg/L	<0.010	----
beta-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
Methoxychlor	W-OCPECD01	0.010	µg/L	<0.010	----
Dichlobenil	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 3 tetrachlorobenzenes	W-OCPECD01	0.030	µg/L	<0.030	----
Sum of 4 hexachlorcyclohexanes	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 4 isomers DDT	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 6 isomers DDT	W-OCPECD01	0.060	µg/L	<0.060	----
Sum of endosulfanes	W-OCPECD01	0.020	µg/L	<0.020	----
Sum of 5 hexachlorocyclohexanes	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 27 OCPs + 3 CBs	W-OCPECD01	0.290	µg/L	<0.290	----
Sum of 29 OCPs + 3 CBs	W-OCPECD01	0.350	µg/L	<0.350	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty. The MU does not include sampling uncertainty.

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Na Harfe 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-OCPECD01	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1) Determination of organochlorine pesticides and other halogen compounds 12) by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values.
W-PAHGMS01	CZ_SOP_D06_03_161 (US EPA 8270D, US EPA 8082A, CSN EN ISO 6468, US EPA 8000D, samples preparation as per CZ_SOP_D06_03_P01 chap. 9.1). Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

ALS Controlvet

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13861 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159091 / 19**

Produto: Água Naturais
Referência: Amostra 24
A colheita de amostra não foi efectuada pela Controlvet.

Acondicionamento: frasco
Nº Entrega: 1527/2019

Ensaio	Método	Resultado	Unidade
(a) Parâmetros físico-químicos	Descrição em anexo	Resultado em anexo.	.

Método interno equivalente é aquele que tem a mesma área de aplicação (parâmetros e matrizes) e que cumpre as características de desempenho, obtendo resultados comparáveis ao(s) método(s) normalizado(s) junto indicado(s)

Tondela
Zona Industrial Tondela - ZIM II Lote 2 e 6
3460-070 Tondela
Telef.: 232817817
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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13861 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159091 / 19**

Produto: Água Naturais **Acondicionamento:** frasco
Referência: Amostra 24 **Nº Entrega:** 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Notas

Lista de abreviaturas: NE- Número estimado; UFC- Unidades formadoras de colónias; LQ – Limite de quantificação; LD – limite de detecção; V.L. – Valor Limite; V.R. – Valor Recomendado; VP - Valor Paramétrico; C - Conforme; A - Aceitável; NC - Não Conforme; Unid. - Unidade; DO - Densidade óptica.

O ensaio assinalado com (s) foi subcontratado e não é acreditado.
O ensaio assinalado com (a) foi subcontratado e é acreditado.
Nos resultados assinalados com (k) os microrganismos estão presentes, mas inferiores a 3xdiluição (quando aplicável).
Nos resultados assinalados com (y) os microrganismos estão presentes, mas inferiores a 4xdiluição.
Para os ensaios assinalados por tecnicas de cálculo a metodologia seguida pode ser disponibilizada a pedido.

Este Relatório de Ensaio refere-se apenas às amostras analisadas.
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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

CERTIFICATE OF ANALYSIS

Laboratory sample ID	: **PR1999997004**	**Work Order**	: **PR1999997**
		Issue Date	: 03-Oct-2019
Amendment	: **1**		
Customer	: **CONTROLVET - Seguranca Alimentar, S. A.**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Subcontratacao Ensaios	Contact	: Client Service
Address	: Zona Industrial de Tondela ZIM II - Lote 6 3460-070 Tondela Portugal	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: Subcontratacao.Ensaios@alsglobal.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Project	: ECF 2019E/155	Page	: 1 of 3
Order number	: ----	Date Samples Received	: 24-Sep-2019
		Quote number	: PR2015CONSE-PT0006 (PT-254-15-0938)
Site	: ----	Date of test	: 24-Sep-2019 - 03-Oct-2019
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples. If the section "Sampled by" of the Certificate of analysis states: "Sampled by Customer" then the results relate to the sample as received.
Amendmend No. 1: Change of COA format as per clients request. This Amendmend No. 1 supersedes test report No. PR1999997 dated 3.10.2019

Signatories

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2018

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

L 1163

Analytical Results

Sub-Matrix: **WATER**

Parameter	*Method*	*LOR*	*Unit*	*Laboratory sample ID* / *Client sampling date / time* QH/13861/2019 [23-Sep-2019] Result	MU
Polycyclic Aromatics Hydrocarbons (PAHs)					
Naphthalene	W-PAHGMS01	0.100	µg/L	<0.100	----
Acenaphthylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Acenaphthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Fluorene	W-PAHGMS01	0.020	µg/L	<0.020	----
Phenanthrene	W-PAHGMS01	0.030	µg/L	<0.030	----
Anthracene	W-PAHGMS01	0.020	µg/L	<0.020	----
Fluoranthene	W-PAHGMS01	0.030	µg/L	<0.030	----
Pyrene	W-PAHGMS01	0.060	µg/L	<0.060	----
Benz(a)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Chrysene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(b)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(k)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(a)pyrene	W-PAHGMS01	0.020	µg/L	<0.020	----
Indeno(1.2.3.cd)pyrene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(g.h.i)perylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Dibenz(a.h)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Sum of 16 PAH	W-PAHGMS01	0.370	µg/L	<0.370	----
Sum of PAH (MoE)	W-PAHGMS01	0.19	µg/L	<0.19	----
Sum of 6 PAH (WHO)	W-PAHGMS01	0.090	µg/L	<0.090	----
Sum of 4 PAH	W-PAHGMS01	0.040	µg/L	<0.040	----
Organochlorine Pesticides					
Hexachloroethane	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobutadiene	W-OCPECD01	0.010	µg/L	<0.010	----
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene	W-OCPECD01	0.020	µg/L	<0.020	----
1.2.3.4-Tetrachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Pentachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Trifluralin	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Alpha	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobenzene (HCB)	W-OCPECD01	0.0050	µg/L	<0.0050	----
Hexachlorocyclohexane Beta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Gamma	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Delta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Epsilon	W-OCPECD01	0.010	µg/L	<0.010	----
Alachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Aldrin	W-OCPECD01	0.0050	µg/L	<0.0050	----
Telodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Isodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-cis	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-trans	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
alpha-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----

4.4`-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
Dieldrin	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
Endrin	W-OCPECD01	0.010	µg/L	<0.010	----
beta-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
Methoxychlor	W-OCPECD01	0.010	µg/L	<0.010	----
Dichlobenil	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 3 tetrachlorobenzenes	W-OCPECD01	0.030	µg/L	<0.030	----
Sum of 4 hexachlorcyclohexanes	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 4 isomers DDT	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 6 isomers DDT	W-OCPECD01	0.060	µg/L	<0.060	----
Sum of endosulfanes	W-OCPECD01	0.020	µg/L	<0.020	----
Sum of 5 hexachlorocyclohexanes	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 27 OCPs + 3 CBs	W-OCPECD01	0.290	µg/L	<0.290	----
Sum of 29 OCPs + 3 CBs	W-OCPECD01	0.350	µg/L	<0.350	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty. The MU does not include sampling uncertainty.

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Na Harfe 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-OCPECD01	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1) Determination of organochlorine pesticides and other halogen compounds 12) by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values.
W-PAHGMS01	CZ_SOP_D06_03_161 (US EPA 8270D, US EPA 8082A, CSN EN ISO 6468, US EPA 8000D, samples preparation as per CZ_SOP_D06_03_P01 chap. 9.1). Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

ALS Controlvet

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13862 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159092 / 19**

Produto: Água Naturais
Referência: Amostra 26
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Ensaio	Método	Resultado	Unidade
(a) Parâmetros físico-químicos	Descrição em anexo	Resultado em anexo.	.

Método interno equivalente é aquele que tem a mesma área de aplicação (parâmetros e matrizes) e que cumpre as características de desempenho, obtendo resultados comparáveis ao(s) método(s) normalizado(s) junto indicado(s)

Tondela
Zona Industrial Tondela - ZIM II Lote 2 e 6
3460-070 Tondela
Telef.: 232817817
Fax: 232817819

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Data Emissão: 04-10-2019

N.º de Análise:	QH / 13862 / 19
Data Colheita:	-
Data Receção:	21-09-2019
Data Início Ensaio:	21-09-2019
Data Fim Ensaio:	04-10-2019
Código Cliente:	7401

Exmo(s) Sr(s):
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unidade: Nemus – Gestão e Requalificação Ambiental, Lda.

Identificação da Amostra: **159092 / 19**

Produto: Água Naturais
Referência: Amostra 26
Acondicionamento: frasco
Nº Entrega: 1527/2019
A colheita de amostra não foi efectuada pela Controlvet.

Notas

Lista de abreviaturas: NE- Número estimado; UFC- Unidades formadoras de colónias; LQ – Limite de quantificação; LD – limite de detecção; V.L. – Valor Limite; V.R. – Valor Recomendado; VP - Valor Paramétrico; C - Conforme; A - Aceitável; NC - Não Conforme; Unid. - Unidade; DO - Densidade óptica.

O ensaio assinalado com (s) foi subcontratado e não é acreditado.
O ensaio assinalado com (a) foi subcontratado e é acreditado.
Nos resultados assinalados com (k) os microrganismos estão presentes, mas inferiores a 3xdiluição (quando aplicável).
Nos resultados assinalados com (y) os microrganismos estão presentes, mas inferiores a 4xdiluição.
Para os ensaios assinalados por tecnicas de cálculo a metodologia seguida pode ser disponibilizada a pedido.

Este Relatório de Ensaio refere-se apenas às amostras analisadas.
Proibida a reprodução parcial deste documento.

Tondela
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Telef.: 232817817
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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

CERTIFICATE OF ANALYSIS

Laboratory sample ID	: **PR1999997005**	**Work Order**	: **PR1999997**
		Issue Date	: 03-Oct-2019
Amendment	: **1**		
Customer	: **CONTROLVET - Seguranca Alimentar, S. A.**	Laboratory	: ALS Czech Republic, s.r.o.
Contact	: Subcontratacao Ensaios	Contact	: Client Service
Address	: Zona Industrial de Tondela ZIM II - Lote 6 3460-070 Tondela Portugal	Address	: Na Harfe 336/9 Prague 9 - Vysocany 190 00 Czech Republic
E-mail	: Subcontratacao.Ensaios@alsglobal.com	E-mail	: customer.support@alsglobal.com
Telephone	: ----	Telephone	: +420 226 226 228
Project	: ECF 2019E/155	Page	: 1 of 3
Order number	: ----	Date Samples Received	: 24-Sep-2019
		Quote number	: PR2015CONSE-PT0006 (PT-254-15-0938)
Site	: ----	Date of test	: 24-Sep-2019 - 03-Oct-2019
Sampled by	: client	QC Level	: ALS CR Standard Quality Control Schedule

General Comments

This report shall not be reproduced except in full, without prior written approval from the laboratory.
The laboratory declares that the test results relate only to the listed samples. If the section "Sampled by" of the Certificate of analysis states: "Sampled by Customer" then the results relate to the sample as received.
Amendmend No. 1: Change of COA format as per clients request. This Amendmend No. 1 supersedes test report No. PR1999997 dated 3.10.2019

Signatories

Testing Laboratory No. 1163
Accredited by CAI according to
CSN EN ISO/IEC 17025:2018

Signatories		*Position*
Zdeněk Jirák		Environmental Business Unit Manager

L 1163

Analytical Results

Sub-Matrix: **WATER**			*Laboratory sample ID*	**QH/13862/2019**	
			Client sampling date / time	[23-Sep-2019]	
Parameter	*Method*	*LOR*	*Unit*	**Result**	**MU**
Polycyclic Aromatics Hydrocarbons (PAHs)					
Naphthalene	W-PAHGMS01	0.100	µg/L	<0.100	----
Acenaphthylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Acenaphthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Fluorene	W-PAHGMS01	0.020	µg/L	<0.020	----
Phenanthrene	W-PAHGMS01	0.030	µg/L	<0.030	----
Anthracene	W-PAHGMS01	0.020	µg/L	<0.020	----
Fluoranthene	W-PAHGMS01	0.030	µg/L	<0.030	----
Pyrene	W-PAHGMS01	0.060	µg/L	<0.060	----
Benz(a)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Chrysene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(b)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(k)fluoranthene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(a)pyrene	W-PAHGMS01	0.020	µg/L	<0.020	----
Indeno(1.2.3.cd)pyrene	W-PAHGMS01	0.010	µg/L	<0.010	----
Benzo(g.h.i)perylene	W-PAHGMS01	0.010	µg/L	<0.010	----
Dibenz(a.h)anthracene	W-PAHGMS01	0.010	µg/L	<0.010	----
Sum of 16 PAH	W-PAHGMS01	0.370	µg/L	<0.370	----
Sum of PAH (MoE)	W-PAHGMS01	0.19	µg/L	<0.19	----
Sum of 6 PAH (WHO)	W-PAHGMS01	0.090	µg/L	<0.090	----
Sum of 4 PAH	W-PAHGMS01	0.040	µg/L	<0.040	----
Organochlorine Pesticides					
Hexachloroethane	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobutadiene	W-OCPECD01	0.010	µg/L	<0.010	----
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene	W-OCPECD01	0.020	µg/L	<0.020	----
1.2.3.4-Tetrachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Pentachlorobenzene	W-OCPECD01	0.010	µg/L	<0.010	----
Trifluralin	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Alpha	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorobenzene (HCB)	W-OCPECD01	0.0050	µg/L	<0.0050	----
Hexachlorocyclohexane Beta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Gamma	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Delta	W-OCPECD01	0.010	µg/L	<0.010	----
Hexachlorocyclohexane Epsilon	W-OCPECD01	0.010	µg/L	<0.010	----
Alachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachlor	W-OCPECD01	0.010	µg/L	<0.010	----
Aldrin	W-OCPECD01	0.0050	µg/L	<0.0050	----
Telodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Isodrin	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-cis	W-OCPECD01	0.010	µg/L	<0.010	----
Heptachloroepoxide-trans	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
alpha-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----

4.4`-DDE	W-OCPECD01	0.010	µg/L	<0.010	----
Dieldrin	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
Endrin	W-OCPECD01	0.010	µg/L	<0.010	----
beta-Endosulfan	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDD	W-OCPECD01	0.010	µg/L	<0.010	----
2.4-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
4.4`-DDT	W-OCPECD01	0.010	µg/L	<0.010	----
Methoxychlor	W-OCPECD01	0.010	µg/L	<0.010	----
Dichlobenil	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 3 tetrachlorobenzenes	W-OCPECD01	0.030	µg/L	<0.030	----
Sum of 4 hexachlorcyclohexanes	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 4 isomers DDT	W-OCPECD01	0.040	µg/L	<0.040	----
Sum of 6 isomers DDT	W-OCPECD01	0.060	µg/L	<0.060	----
Sum of endosulfanes	W-OCPECD01	0.020	µg/L	<0.020	----
Sum of 5 hexachlorocyclohexanes	W-OCPECD01	0.050	µg/L	<0.050	----
Sum of 27 OCPs + 3 CBs	W-OCPECD01	0.290	µg/L	<0.290	----
Sum of 29 OCPs + 3 CBs	W-OCPECD01	0.350	µg/L	<0.350	----

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, delivery date in brackets without a time component will be displayed instead. Measurement uncertainty is expressed as expanded measurement uncertainty with coverage factor k = 2, representing 95% confidence level.

Key: LOR = Limit of reporting; MU = Measurement Uncertainty. The MU does not include sampling uncertainty.

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Descriptions*
Location of test performance: Na Harfe 336/9 Prague 9 - Vysocany Czech Republic 190 00	
W-OCPECD01	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1) Determination of organochlorine pesticides and other halogen compounds 12) by gas chromatography method with ECD detection and calculation of organochlorine pesticides and other halogen compounds sums from measured values.
W-PAHGMS01	CZ_SOP_D06_03_161 (US EPA 8270D, US EPA 8082A, CSN EN ISO 6468, US EPA 8000D, samples preparation as per CZ_SOP_D06_03_P01 chap. 9.1). Determination of semi volatile organic compounds by gas chromatography method with MS or MS/MS detection and calculation of semi volatile organic compounds sums from measured values

A `*` symbol preceding any method indicates laboratory or subcontractor non-accredited test. In the case when a procedure belonging to an accredited method was used for non-accredited matrix, would apply that the reported results are non-accredited. Please refer to General Comment section on front page for information. If the report contains subcontracted analysis, those are made in a subcontracted laboratory outside the laboratories ALS Czech Republic, s.r.o.
The calculation methods of summation parameters are available on request in the client service.

CERTIFICATE OF ASSAY

T0141

ALFRED H KNIGHT

REFERENCE	DATE	PAGE
ASD_Trace/77876	29-Oct-2019	1 of 9

CLIENT
MARIA GRADE- NEMUS-GESTÃO
CASH SALE

MARKS

PACKING

SEALS

CLIENT REFERENCE
WATER SAMPLES

MATERIAL DESCRIBED AS
WATER

ASSAY STATE
AS RECEIVED

SAMPLING DATE

ASSAY TYPE
PARTY

VESSEL

SAMPLE ID			1	2	3
DATE RECEIVED			23-OCT-2019	23-OCT-2019	23-OCT-2019
DATE TESTED			29-OCT-2019	29-OCT-2019	29-OCT-2019
Nitrate by AW39	(NO3-)	mg/L	1.54	1.21	1.90
Zinc by AW12	(Zn)	mg/L	< 0.006	< 0.006	< 0.006
Lead by AW12	(Pb)	mg/L	< 0.01	< 0.01	< 0.01
Nickel by AW12	(Ni)	mg/L	< 0.002	< 0.002	< 0.002
Copper by AW12	(Cu)	mg/L	< 0.01	< 0.01	< 0.01
Chromium by AW12	(Cr)	mg/L	< 0.001	< 0.001	< 0.001
Cobalt by AW12	(Co)	mg/L	< 0.001	< 0.001	< 0.001
Cadmium by AW12	(Cd)	mg/L	< 0.001	< 0.001	< 0.001
Arsenic by AW12	(As)	mg/L	< 0.01	< 0.01	< 0.01
Mercury by AG24	(Hg)	mg/L	< 0.05	< 0.05	< 0.05
Phosphorous	(P)	mg/L	0.3	0.2	0.3
Chem O2 Demand by AW33	(COD)	mg/L	< 5	19	13
Biochemical oxygen dema~	(BOD)	mg/L	1.4	7.5	10.8

K. Kalumba
Technical Signatory - Head Of Department-ASD
For and on behalf of Alfred H. Knight (Zambia) Ltd

Alfred H. Knight (Zambia) Ltd
Corner Mindola/Golf Club Roads, Nkana West, Kitwe, Copperbelt, PO Box 20303, Zambia
Tel: +260 212 226 433/434/306/428 Fax: +260 212 226 306/424 Email: AHK.Zambia@ahkgroup.com

CERTIFICATE OF ASSAY

T0141

ALFRED H KNIGHT

REFERENCE	DATE	PAGE
ASD_Trace/77876	29-Oct-2019	2 of 9

CLIENT
MARIA GRADE- NEMUS-GESTÃO
CASH SALE

MARKS

PACKING

SEALS

CLIENT REFERENCE
WATER SAMPLES

MATERIAL DESCRIBED AS
WATER

ASSAY STATE
AS RECEIVED

SAMPLING DATE

ASSAY TYPE
PARTY

VESSEL

SAMPLE ID			4	5	6
DATE RECEIVED			23-OCT-2019	23-OCT-2019	23-OCT-2019
DATE TESTED			29-OCT-2019	29-OCT-2019	29-OCT-2019
Nitrate by AW39	(NO3-)	mg/L	1.64	1.36	1.66
Zinc by AW12	(Zn)	mg/L	< 0.006	< 0.006	< 0.006
Lead by AW12	(Pb)	mg/L	< 0.01	< 0.01	< 0.01
Nickel by AW12	(Ni)	mg/L	< 0.002	< 0.002	0.002
Copper by AW12	(Cu)	mg/L	< 0.01	0.02	< 0.01
Chromium by AW12	(Cr)	mg/L	< 0.001	< 0.001	< 0.001
Cobalt by AW12	(Co)	mg/L	< 0.001	0.002	< 0.001
Cadmium by AW12	(Cd)	mg/L	< 0.001	< 0.001	< 0.001
Arsenic by AW12	(As)	mg/L	< 0.01	< 0.01	< 0.01
Mercury by AG24	(Hg)	mg/L	< 0.05	< 0.05	< 0.05
Phosphorous	(P)	mg/L	0.2	0.2	0.6
Chem O2 Demand by AW33	(COD)	mg/L	17	26	15
Biochemical oxygen dema~	(BOD)	mg/L	8.6	11.1	14.7

K. Kalumba
Technical Signatory - Head Of Department-ASD
For and on behalf of Alfred H. Knight (Zambia) Ltd

Alfred H. Knight (Zambia) Ltd
Corner Mindola/Golf Club Roads, Nkana West, Kitwe, Copperbelt, PO Box 20303, Zambia
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CERTIFICATE OF ASSAY

T0141

ALFRED H KNIGHT

REFERENCE	DATE	PAGE
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CLIENT
MARIA GRADE- NEMUS-GESTÃO
CASH SALE

MARKS

PACKING

SEALS

CLIENT REFERENCE
WATER SAMPLES

MATERIAL DESCRIBED AS
WATER

ASSAY STATE
AS RECEIVED

SAMPLING DATE	ASSAY TYPE	VESSEL
	PARTY	

SAMPLE ID			7	8	9
DATE RECEIVED			23-OCT-2019	23-OCT-2019	23-OCT-2019
DATE TESTED			29-OCT-2019	29-OCT-2019	29-OCT-2019
Nitrate by AW39	(NO3-)	mg/L	1.80	3.95	7.76
Zinc by AW12	(Zn)	mg/L	0.089	< 0.006	< 0.006
Lead by AW12	(Pb)	mg/L	< 0.01	< 0.01	< 0.01
Nickel by AW12	(Ni)	mg/L	< 0.002	0.005	0.002
Copper by AW12	(Cu)	mg/L	< 0.01	< 0.01	0.66
Chromium by AW12	(Cr)	mg/L	< 0.001	< 0.001	< 0.001
Cobalt by AW12	(Co)	mg/L	< 0.001	0.014	0.098
Cadmium by AW12	(Cd)	mg/L	< 0.001	< 0.001	< 0.001
Arsenic by AW12	(As)	mg/L	< 0.01	< 0.01	< 0.01
Mercury by AG24	(Hg)	mg/L	< 0.05	< 0.05	< 0.05
Phosphorous	(P)	mg/L	0.2	0.7	< 0.1
Chem O2 Demand by AW33	(COD)	mg/L	29	14	22
Biochemical oxygen dema~	(BOD)	mg/L	25.6	11.4	5.4

K. Kalumba
Technical Signatory - Head Of Department-ASD
For and on behalf of Alfred H. Knight (Zambia) Ltd

Alfred H. Knight (Zambia) Ltd
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CERTIFICATE OF ASSAY

sanas Testing Laboratory

T0141

ALFRED H KNIGHT

REFERENCE: ASD_Trace/77876	DATE: 29-Oct-2019	PAGE: 4 of 9
CLIENT: MARIA GRADE- NEMUS-GESTÃO CASH SALE	MARKS:	
	PACKING:	
	SEALS:	
CLIENT REFERENCE: WATER SAMPLES	MATERIAL DESCRIBED AS: WATER	
ASSAY STATE: AS RECEIVED		
SAMPLING DATE:	ASSAY TYPE: PARTY	VESSEL:

SAMPLE ID			10	11	12
DATE RECEIVED			23-OCT-2019	23-OCT-2019	23-OCT-2019
DATE TESTED			29-OCT-2019	29-OCT-2019	29-OCT-2019
Nitrate by AW39	(NO3-)	mg/L	2.01	2.25	1.05
Zinc by AW12	(Zn)	mg/L	< 0.006	< 0.006	< 0.006
Lead by AW12	(Pb)	mg/L	< 0.01	< 0.01	0.01
Nickel by AW12	(Ni)	mg/L	< 0.002	0.006	< 0.002
Copper by AW12	(Cu)	mg/L	0.03	0.17	< 0.01
Chromium by AW12	(Cr)	mg/L	< 0.001	< 0.001	< 0.001
Cobalt by AW12	(Co)	mg/L	0.001	0.016	< 0.001
Cadmium by AW12	(Cd)	mg/L	< 0.001	< 0.001	< 0.001
Arsenic by AW12	(As)	mg/L	< 0.01	< 0.01	< 0.01
Mercury by AG24	(Hg)	mg/L	< 0.05	< 0.05	< 0.05
Phosphorous	(P)	mg/L	0.1	0.3	0.4
Chem O2 Demand by AW33	(COD)	mg/L	19	56	20
Biochemical oxygen dema~	(BOD)	mg/L	13.0	9.2	6.6

K. Kalumba
Technical Signatory - Head Of Department-ASD
For and on behalf of Alfred H. Knight (Zambia) Ltd

Alfred H. Knight (Zambia) Ltd
Corner Mindola/Golf Club Roads, Nkana West, Kitwe, Copperbelt, PO Box 20303, Zambia
Tel: +260 212 226 433/434/306/428 Fax: +260 212 226 306/424 Email: AHK.Zambia@ahkgroup.com

CERTIFICATE OF ASSAY

T0141

ALFRED H KNIGHT

REFERENCE: ASD_Trace/77876	DATE: 29-Oct-2019	PAGE: 5 of 9
CLIENT: MARIA GRADE- NEMUS-GESTÃO CASH SALE	MARKS:	
	PACKING:	
	SEALS:	
CLIENT REFERENCE: WATER SAMPLES	MATERIAL DESCRIBED AS: WATER	
ASSAY STATE: AS RECEIVED		
SAMPLING DATE:	ASSAY TYPE: PARTY	VESSEL:

SAMPLE ID			13	14	15
DATE RECEIVED			23-OCT-2019	23-OCT-2019	23-OCT-2019
DATE TESTED			29-OCT-2019	29-OCT-2019	29-OCT-2019
Nitrate by AW39	(NO3-)	mg/L	1.50	1.31	2.08
Zinc by AW12	(Zn)	mg/L	< 0.006	0.007	< 0.006
Lead by AW12	(Pb)	mg/L	< 0.01	< 0.01	< 0.01
Nickel by AW12	(Ni)	mg/L	0.003	< 0.002	< 0.002
Copper by AW12	(Cu)	mg/L	< 0.01	< 0.01	0.03
Chromium by AW12	(Cr)	mg/L	< 0.001	< 0.001	< 0.001
Cobalt by AW12	(Co)	mg/L	< 0.001	< 0.001	< 0.001
Cadmium by AW12	(Cd)	mg/L	< 0.001	< 0.001	< 0.001
Arsenic by AW12	(As)	mg/L	< 0.01	< 0.01	< 0.01
Mercury by AG24	(Hg)	mg/L	< 0.05	< 0.05	< 0.05
Phosphorous	(P)	mg/L	0.4	0.2	0.3
Chem O2 Demand by AW33	(COD)	mg/L	16	15	14
Biochemical oxygen dema~	(BOD)	mg/L	11.9	11.4	3.3

K. Kalumba
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CERTIFICATE OF ASSAY

T0141

ALFREDHKNIGHT

REFERENCE: ASD_Trace/77876	DATE: 29-Oct-2019	PAGE: 6 of 9
CLIENT: MARIA GRADE- NEMUS-GESTÃO CASH SALE	MARKS:	
	PACKING:	
	SEALS:	
CLIENT REFERENCE: WATER SAMPLES	MATERIAL DESCRIBED AS: WATER	
ASSAY STATE: AS RECEIVED		
SAMPLING DATE:	ASSAY TYPE: PARTY	VESSEL:

SAMPLE ID			16	17	18
DATE RECEIVED			23-OCT-2019	23-OCT-2019	23-OCT-2019
DATE TESTED			29-OCT-2019	29-OCT-2019	29-OCT-2019
Nitrate by AW39	(NO3-)	mg/L	1.57	1.81	2.35
Zinc by AW12	(Zn)	mg/L	< 0.006	0.024	< 0.006
Lead by AW12	(Pb)	mg/L	< 0.01	0.02	< 0.01
Nickel by AW12	(Ni)	mg/L	< 0.002	0.162	< 0.002
Copper by AW12	(Cu)	mg/L	0.13	0.42	0.08
Chromium by AW12	(Cr)	mg/L	< 0.001	< 0.001	< 0.001
Cobalt by AW12	(Co)	mg/L	0.025	4.997	0.014
Cadmium by AW12	(Cd)	mg/L	< 0.001	< 0.001	< 0.001
Arsenic by AW12	(As)	mg/L	< 0.01	< 0.01	< 0.01
Mercury by AG24	(Hg)	mg/L	< 0.05	< 0.05	< 0.05
Phosphorous	(P)	mg/L	0.4	0.5	0.2
Chem O2 Demand by AW33	(COD)	mg/L	50	40	13
Biochemical oxygen dema~	(BOD)	mg/L	10.3	12.0	1.3

K. Kalumba
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For and on behalf of Alfred H. Knight (Zambia) Ltd

Alfred H. Knight (Zambia) Ltd
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CERTIFICATE OF ASSAY

T0141

ALFRED H KNIGHT

REFERENCE	DATE	PAGE
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CLIENT
MARIA GRADE- NEMUS-GESTÃO
CASH SALE

MARKS

PACKING

SEALS

CLIENT REFERENCE
WATER SAMPLES

MATERIAL DESCRIBED AS
WATER

ASSAY STATE
AS RECEIVED

SAMPLING DATE

ASSAY TYPE
PARTY

VESSEL

SAMPLE ID			19	20	21
DATE RECEIVED			23-OCT-2019	23-OCT-2019	23-OCT-2019
DATE TESTED			29-OCT-2019	29-OCT-2019	29-OCT-2019
Nitrate by AW39	(NO3-)	mg/L	15.05	0.28	0.95
Zinc by AW12	(Zn)	mg/L	< 0.006	0.029	< 0.006
Lead by AW12	(Pb)	mg/L	< 0.01	< 0.01	< 0.01
Nickel by AW12	(Ni)	mg/L	< 0.002	< 0.002	< 0.002
Copper by AW12	(Cu)	mg/L	0.11	< 0.01	< 0.01
Chromium by AW12	(Cr)	mg/L	< 0.001	< 0.001	< 0.001
Cobalt by AW12	(Co)	mg/L	0.005	< 0.001	< 0.001
Cadmium by AW12	(Cd)	mg/L	< 0.001	< 0.001	< 0.001
Arsenic by AW12	(As)	mg/L	< 0.01	< 0.01	< 0.01
Mercury by AG24	(Hg)	mg/L	< 0.05	< 0.05	< 0.05
Phosphorous	(P)	mg/L	0.5	0.5	0.5
Chem O2 Demand by AW33	(COD)	mg/L	25	19	21
Biochemical oxygen dema~	(BOD)	mg/L	21.8	13.6	13.6

K. Kalumba
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Alfred H. Knight (Zambia) Ltd
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CERTIFICATE OF ASSAY

T0141

ALFRED H KNIGHT

REFERENCE: ASD_Trace/77876	DATE: 29-Oct-2019	PAGE: 8 of 9
CLIENT: MARIA GRADE- NEMUS-GESTÃO CASH SALE	MARKS:	
	PACKING:	
	SEALS:	
CLIENT REFERENCE: WATER SAMPLES	MATERIAL DESCRIBED AS: WATER	
ASSAY STATE: AS RECEIVED		
SAMPLING DATE:	ASSAY TYPE: PARTY	VESSEL:

SAMPLE ID			22	23	24
DATE RECEIVED			23-OCT-2019	23-OCT-2019	23-OCT-2019
DATE TESTED			29-OCT-2019	29-OCT-2019	29-OCT-2019
Nitrate by AW39	(NO3-)	mg/L	0.95	2.23	2.70
Zinc by AW12	(Zn)	mg/L	< 0.006	< 0.006	< 0.006
Lead by AW12	(Pb)	mg/L	< 0.01	< 0.01	< 0.01
Nickel by AW12	(Ni)	mg/L	< 0.002	< 0.002	< 0.002
Copper by AW12	(Cu)	mg/L	< 0.01	< 0.01	< 0.01
Chromium by AW12	(Cr)	mg/L	< 0.001	< 0.001	< 0.001
Cobalt by AW12	(Co)	mg/L	< 0.001	0.016	0.001
Cadmium by AW12	(Cd)	mg/L	< 0.001	< 0.001	< 0.001
Arsenic by AW12	(As)	mg/L	< 0.01	< 0.01	< 0.01
Mercury by AG24	(Hg)	mg/L	< 0.05	< 0.05	< 0.05
Phosphorous	(P)	mg/L	0.6	0.3	0.8
Chem O2 Demand by AW33	(COD)	mg/L	37	16	36
Biochemical oxygen dema~	(BOD)	mg/L	10.8	11.9	22.9

AHK(Z) Analytical Methods

AG24 - Hydride Generation Cold Vapor AAS (Not SANAS Accredited)
AW12 - Total or Dissolved Elements by ICP
AW33 - Chemical Oxygen Demand (Not SANAS Accredited)
AW39 - Nitrate by ultraviolet spectrophotometry (Not SANAS Accredited).

K. Kalumba
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CERTIFICATE OF ASSAY

T0141

ALFREDHKNIGHT

REFERENCE	DATE	PAGE
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CLIENT
MARIA GRADE- NEMUS-GESTÃO
CASH SALE

MARKS

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SEALS

CLIENT REFERENCE
WATER SAMPLES

MATERIAL DESCRIBED AS
WATER

ASSAY STATE
AS RECEIVED

SAMPLING DATE	ASSAY TYPE	VESSEL
	PARTY	

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These test results are from samples of unknown provenance to Alfred H. Knight Zambia, and which were presented to Alfred H. Knight Zambia for chemical analysis. This certificate relates only to the test sample [s] presented to Alfred H. Knight Zambia for chemical

Sample Disposal: As per our Quality System requirements, samples will be kept in storage for six (6) months after which they will be disposed of. Please advise if you have alternative disposal instructions.

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For and on behalf of Alfred H. Knight (Zambia) Ltd

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CERTIFICATE OF ASSAY

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T0141

ALFRED H KNIGHT

REFERENCE	DATE	PAGE
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CLIENT
MARIA GRADE- NEMUS
CASH SALE

MARKS

PACKING

SEALS

CLIENT REFERENCE
WATER SAMPLES

MATERIAL DESCRIBED AS
WATER

ASSAY STATE
AS RECEIVED

SAMPLING DATE

ASSAY TYPE
PARTY

VESSEL

SAMPLE ID			25	26	27
DATE RECEIVED			23-OCT-2019	23-OCT-2019	23-OCT-2019
DATE TESTED			01-NOV-2019	01-NOV-2019	01-NOV-2019
Nitrate by AW39	(NO3-)	mg/L	3.23	3.54	6.37
Zinc by AW12	(Zn)	mg/L	0.012	0.014	0.034
Lead by AW12	(Pb)	mg/L	< 0.01	< 0.01	< 0.01
Nickel by AW12	(Ni)	mg/L	< 0.002	< 0.002	< 0.002
Copper by AW12	(Cu)	mg/L	< 0.01	< 0.01	< 0.01
Chromium by AW12	(Cr)	mg/L	< 0.001	< 0.001	< 0.001
Cobalt by AW12	(Co)	mg/L	0.002	< 0.001	< 0.001
Cadmium by AW12	(Cd)	mg/L	0.001	< 0.001	< 0.001
Arsenic by AW12	(As)	mg/L	< 0.01	< 0.01	< 0.01
Mercury by AW26	(Hg)	mg/L	< 0.05	< 0.05	< 0.05
Phosphorous	(P)	mg/L	0.62	1.04	1.50
Chem O2 Demand by AW33	(COD)	mg/L	27	49	121
Biochemical oxygen dema~	(BOD)	mg/L	8.7	14.8	12.0

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CERTIFICATE OF ASSAY

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ALFRED H KNIGHT

REFERENCE	DATE	PAGE
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CLIENT	MARKS
MARIA GRADE- NEMUS CASH SALE	
	PACKING
	SEALS
CLIENT REFERENCE WATER SAMPLES	MATERIAL DESCRIBED AS WATER
ASSAY STATE AS RECEIVED	
SAMPLING DATE / ASSAY TYPE PARTY	VESSEL

SAMPLE ID			28
DATE RECEIVED			23-OCT-2019
DATE TESTED			01-NOV-2019
Nitrate by AW39	(NO3-)	mg/L	1.41
Zinc by AW12	(Zn)	mg/L	< 0.006
Lead by AW12	(Pb)	mg/L	< 0.01
Nickel by AW12	(Ni)	mg/L	< 0.002
Copper by AW12	(Cu)	mg/L	< 0.01
Chromium by AW12	(Cr)	mg/L	< 0.001
Cobalt by AW12	(Co)	mg/L	< 0.001
Cadmium by AW12	(Cd)	mg/L	< 0.001
Arsenic by AW12	(As)	mg/L	< 0.01
Mercury by AW26	(Hg)	mg/L	< 0.05
Phosphorous	(P)	mg/L	0.39
Chem O2 Demand by AW33	(COD)	mg/L	15
Biochemical oxygen dema~	(BOD)	mg/L	6.5

AHK(Z) Analytical Methods

AW12 - Total or Dissolved Elements by ICP
AW26 - Dissolved As, Bi, Se, Sb, Sn & Hg (Not SANAS Accredited)
AW33 - Chemical Oxygen Demand (Not SANAS Accredited)
AW39 - Nitrate by ultraviolet spectrophotometry (Not SANAS Accredited).

K. Kalumba
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For and on behalf of Alfred H. Knight (Zambia) Ltd

Alfred H. Knight (Zambia) Ltd
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CERTIFICATE OF ASSAY

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T0141

ALFRED H KNIGHT

REFERENCE	DATE	PAGE
ASD_Trace/77954	06-Nov-2019	3 of 3

CLIENT MARIA GRADE- NEMUS CASH SALE	MARKS
	PACKING
	SEALS
CLIENT REFERENCE WATER SAMPLES	MATERIAL DESCRIBED AS WATER
ASSAY STATE AS RECEIVED	
SAMPLING DATE / ASSAY TYPE PARTY	VESSEL

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Sample Disposal: As per our Quality System requirements, samples will be kept in storage for six (6) months after which they will be disposed of. Please advise if you have alternative disposal instructions.

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ALS Controlvet

Correction of Previous Reports
Issue Date 29-11-2019

Analysis n.º:	QH / 15724 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178534 / 19**

Product: Natural Water
Reference: Sample 6
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
(a) Organochlorine Pesticides (OCP) for GC-ECD	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1)		
Hexachlorobenzene		<0.0050	µg/L
2,4'-DDT		<0.010	µg/L
4,4'-DDT		<0.010	µg/L
Hexachloroethane		<0.010	µg/L
Hexachlorobutadiene		<0.010	µg/L
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene		<0.020	µg/L
1.2.3.4-Tetrachlorobenzene		<0.010	µg/L
Pentachlorobenzene		<0.010	µg/L
Trifluralin		<0.010	µg/L
Hexachlorocyclohexane Alpha		<0.010	µg/L
Hexachlorocyclohexane Beta		<0.010	µg/L
Hexachlorocyclohexane Gamma		<0.010	µg/L
Hexachlorocyclohexane Delta		<0.010	µg/L
Hexachlorocyclohexane Epsilon		<0.010	µg/L
Alachlor		<0.010	µg/L
Heptachlor		<0.010	µg/L
Aldrin		<0.0050	µg/L
Telodrin		<0.010	µg/L
Isodrin		<0.010	µg/L
Heptachloroepoxide-cis		<0.010	µg/L
Heptachloroepoxide-trans		<0.010	µg/L
2.4-DDE		<0.010	µg/L
alpha-Endosulfan		<0.010	µg/L
4.4`- DDE		<0.010	µg/L
Dieldrin		<0.010	µg/L
2.4-DDD		<0.010	µg/L
Endrin		<0.010	µg/L
beta-Endosulfan		<0.010	µg/L

Tondela
Zona Industrial Tondela - ZIM II Lote 2 e 6
3460-070 Tondela
Telef.: 232817617
Fax: 232817819

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15724 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178534 / 19**

Product: Natural Water
Reference: Sample 6
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
4.4`-DDD		<0.010	µg/L
Methoxychlor		<0.010	µg/L
Dichlobenil		<0.050	µg/L
Sum of 3 tetrachlorobenzenes		<0.030	µg/L
Sum of 4 hexachlorcyclohexanes		<0.040	µg/L
Sum of 4 isomers DDT		<0.040	µg/L
Sum of 6 isomers DDT		<0.060	µg/L
Sum of endosulfanes		<0.020	µg/L
Sum of 5 hexachlorocyclohexanes		<0.050	µg/L
Sum of 27 OCPs + 3 CBs		<0.290	µg/L
Sum of 29 OCPs + 3 CBs		<0.350	µg/L
(a) PAH for GCMS	CZ_SOP_D06_03_161 (US EPA 8270, CSN EN ISO 6468, US EPA 8000D, samples preparation according to CZ_SOP_D06_03_P01 chap. 9.1, 9.4.1)		
Acenaphthene		<0.010 (LQ)	µg/L
Acenaphthylene		<0.010 (LQ)	µg/L
Anthracene		<0.020 (LQ)	µg/L
Benz(a)anthracene		<0.010 (LQ)	µg/L
Benzo(a)pyrene		<0.020 (LQ)	µg/L
Benzo(b)fluoranthene		<0.010 (LQ)	µg/L
Benzo(g.h.i)perylene		<0.010 (LQ)	µg/L
Benzo(k)fluoranthene		<0.010 (LQ)	µg/L
Chrysene		<0.010 (LQ)	µg/L
Dibenz(a.h)anthracene		<0.010 (LQ)	µg/L
Fluoranthene		<0.030 (LQ)	µg/L
Fluorene		<0.020 (LQ)	µg/L
Indeno(1.2.3.cd)pyrene		<0.010 (LQ)	µg/L
Naphthalene		<0.100 (LQ)	µg/L
Phenanthrene		<0.030 (LQ)	µg/L
Pyrene		<0.060 (LQ)	µg/L
Sum of 16 PAH		<0.370 (LQ)	µg/L
Sum of 4 PAH		<0.040 (LQ)	µg/L

Tondela
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Fax: 232817819

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15724 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178534 / 19**

Product: Natural Water
Reference: Sample 6
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

In this report change the report of Organochlorine Pesticides. Motive: laboratory change.

Equivalent internal method is one that has the same area of application (parameters and matrices) and that meets the performance characteristics, obtaining results comparable to the standard method (s)

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15724 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
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LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178534 / 19**

Product: Natural Water
Reference: Sample 6
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Notes

List of Abbreviations: EN-Estimated number; CFU-colony forming units; LQ - Limit of quantification; LD - limit of detection; LV - Limit Value; RV - Recommended Value, Pv - Parametric Value; C - According, A - Acceptable, NC - Nonconforming; Unit. - Unit, OD - Optical Density
The test marked with (s) was subcontracted and not accredited.
The test marked with (a) was subcontracted and is accredited.
In the results marked with (k) the microorganisms are present, but less than 3x dilution(if applicable).
In the results marked with (y) the microorganisms are present, but less than 4x dilution.
For the tests indicated by calculation techniques, the methodology followed can be made available on request.

This Test Report refers only to samples analyzed.
Prohibited the partial reproduction of this

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

ALS Controlvet

Correction of Previous Reports
Issue Date 29-11-2019

Analysis n.º:	QH / 15725 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178535 / 19**

Product: Natural Water
Reference: Sample 7
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
(a) Organochlorine Pesticides (OCP) for GC-ECD	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1)		
Hexachlorobenzene		<0.0050	µg/L
2,4'-DDT		<0.010	µg/L
4,4'-DDT		<0.010	µg/L
Hexachloroethane		<0.010	µg/L
Hexachlorobutadiene		<0.010	µg/L
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene		<0.020	µg/L
1.2.3.4-Tetrachlorobenzene		<0.010	µg/L
Pentachlorobenzene		<0.010	µg/L
Trifluralin		<0.010	µg/L
Hexachlorocyclohexane Alpha		<0.010	µg/L
Hexachlorocyclohexane Beta		<0.010	µg/L
Hexachlorocyclohexane Gamma		<0.010	µg/L
Hexachlorocyclohexane Delta		<0.010	µg/L
Hexachlorocyclohexane Epsilon		<0.010	µg/L
Alachlor		<0.010	µg/L
Heptachlor		<0.010	µg/L
Aldrin		<0.0050	µg/L
Telodrin		<0.010	µg/L
Isodrin		<0.010	µg/L
Heptachloroepoxide-cis		<0.010	µg/L
Heptachloroepoxide-trans		<0.010	µg/L
2.4-DDE		<0.010	µg/L
alpha-Endosulfan		<0.010	µg/L
4.4`- DDE		<0.010	µg/L
Dieldrin		<0.010	µg/L
2.4-DDD		<0.010	µg/L
Endrin		<0.010	µg/L
beta-Endosulfan		<0.010	µg/L

Tondela
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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15725 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178535 / 19**

Product: Natural Water
Reference: Sample 7
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Packaging: bottle
Work Order: 1806/2019

Test	Method	Result	Unit
4.4`-DDD		<0.010	µg/L
Methoxychlor		<0.010	µg/L
Dichlobenil		<0.050	µg/L
Sum of 3 tetrachlorobenzenes		<0.030	µg/L
Sum of 4 hexachlorcyclohexanes		<0.040	µg/L
Sum of 4 isomers DDT		<0.040	µg/L
Sum of 6 isomers DDT		<0.060	µg/L
Sum of endosulfanes		<0.020	µg/L
Sum of 5 hexachlorocyclohexanes		<0.050	µg/L
Sum of 27 OCPs + 3 CBs		<0.290	µg/L
Sum of 29 OCPs + 3 CBs		<0.350	µg/L
(a) PAH for GCMS	CZ_SOP_D06_03_161 (US EPA 8270, CSN EN ISO 6468, US EPA 8000D, samples preparation according to CZ_SOP_D06_03_P01 chap. 9.1, 9.4.1)		
Acenaphthene		<0.010 (LQ)	µg/L
Acenaphthylene		<0.010 (LQ)	µg/L
Anthracene		<0.020 (LQ)	µg/L
Benz(a)anthracene		<0.010 (LQ)	µg/L
Benzo(a)pyrene		<0.020 (LQ)	µg/L
Benzo(b)fluoranthene		<0.010 (LQ)	µg/L
Benzo(g.h.i)perylene		<0.010 (LQ)	µg/L
Benzo(k)fluoranthene		<0.010 (LQ)	µg/L
Chrysene		<0.010 (LQ)	µg/L
Dibenz(a.h)anthracene		<0.010 (LQ)	µg/L
Fluoranthene		<0.030 (LQ)	µg/L
Fluorene		<0.020 (LQ)	µg/L
Indeno(1.2.3.cd)pyrene		<0.010 (LQ)	µg/L
Naphthalene		<0.100 (LQ)	µg/L
Phenanthrene		<0.030 (LQ)	µg/L
Pyrene		<0.060 (LQ)	µg/L
Sum of 16 PAH		<0.370 (LQ)	µg/L
Sum of 4 PAH		<0.040 (LQ)	µg/L

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15725 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178535 / 19**

Product: Natural Water
Reference: Sample 7
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

In this report change the report of Organochlorine Pesticides. Motive: laboratory change.

Equivalent internal method is one that has the same area of application (parameters and matrices) and that meets the performance characteristics, obtaining results comparable to the standard method (s)

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15725 / 19
Collection Date:	-
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Client nº:	7401

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LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178535 / 19**

Product: Natural Water
Reference: Sample 7
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Notes

List of Abbreviations: EN-Estimated number; CFU-colony forming units; LQ - Limit of quantification; LD - limit of detection; LV - Limit Value; RV - Recommended Value, Pv - Parametric Value; C - According, A - Acceptable, NC - Nonconforming; Unit. - Unit, OD - Optical Density
The test marked with (s) was subcontracted and not accredited.
The test marked with (a) was subcontracted and is accredited.
In the results marked with (k) the microorganisms are present, but less than 3x dilution(if applicable).
In the results marked with (y) the microorganisms are present, but less than 4x dilution.
For the tests indicated by calculation techniques, the methodology followed can be made available on request.

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ALS Controlvet

Correction of Previous Reports
Issue Date 29-11-2019

Analysis n.º:	QH / 15726 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178536 / 19**

Product: Natural Water
Reference: Sample 8
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
(a) Organochlorine Pesticides (OCP) for GC-ECD	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1)		
Hexachlorobenzene		<0.0050	µg/L
2,4'-DDT		<0.010	µg/L
4,4'-DDT		<0.010	µg/L
Hexachloroethane		<0.010	µg/L
Hexachlorobutadiene		<0.010	µg/L
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene		<0.020	µg/L
1.2.3.4-Tetrachlorobenzene		<0.010	µg/L
Pentachlorobenzene		<0.010	µg/L
Trifluralin		<0.010	µg/L
Hexachlorocyclohexane Alpha		<0.010	µg/L
Hexachlorocyclohexane Beta		<0.010	µg/L
Hexachlorocyclohexane Gamma		<0.010	µg/L
Hexachlorocyclohexane Delta		<0.010	µg/L
Hexachlorocyclohexane Epsilon		<0.010	µg/L
Alachlor		<0.010	µg/L
Heptachlor		<0.010	µg/L
Aldrin		<0.0050	µg/L
Telodrin		<0.010	µg/L
Isodrin		<0.010	µg/L
Heptachloroepoxide-cis		<0.010	µg/L
Heptachloroepoxide-trans		<0.010	µg/L
2.4-DDE		<0.010	µg/L
alpha-Endosulfan		<0.010	µg/L
4.4`- DDE		<0.010	µg/L
Dieldrin		<0.010	µg/L
2.4-DDD		<0.010	µg/L
Endrin		<0.010	µg/L
beta-Endosulfan		<0.010	µg/L

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Eugénia Silva

Analysis n.º:	QH / 15726 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178536 / 19**

Product: Natural Water
Reference: Sample 8
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
4.4`-DDD		<0.010	µg/L
Methoxychlor		<0.010	µg/L
Dichlobenil		<0.050	µg/L
Sum of 3 tetrachlorobenzenes		<0.030	µg/L
Sum of 4 hexachlorcyclohexanes		<0.040	µg/L
Sum of 4 isomers DDT		<0.040	µg/L
Sum of 6 isomers DDT		<0.060	µg/L
Sum of endosulfanes		<0.020	µg/L
Sum of 5 hexachlorocyclohexanes		<0.050	µg/L
Sum of 27 OCPs + 3 CBs		<0.290	µg/L
Sum of 29 OCPs + 3 CBs		<0.350	µg/L
(a) PAH for GCMS	CZ_SOP_D06_03_161 (US EPA 8270, CSN EN ISO 6468, US EPA 8000D, samples preparation according to CZ_SOP_D06_03_P01 chap. 9.1, 9.4.1)		
Acenaphthene		<0.010 (LQ)	µg/L
Acenaphthylene		<0.010 (LQ)	µg/L
Anthracene		<0.020 (LQ)	µg/L
Benz(a)anthracene		<0.010 (LQ)	µg/L
Benzo(a)pyrene		<0.020 (LQ)	µg/L
Benzo(b)fluoranthene		<0.010 (LQ)	µg/L
Benzo(g.h.i)perylene		<0.010 (LQ)	µg/L
Benzo(k)fluoranthene		<0.010 (LQ)	µg/L
Chrysene		<0.010 (LQ)	µg/L
Dibenz(a.h)anthracene		<0.010 (LQ)	µg/L
Fluoranthene		<0.030 (LQ)	µg/L
Fluorene		<0.020 (LQ)	µg/L
Indeno(1.2.3.cd)pyrene		<0.010 (LQ)	µg/L
Naphthalene		<0.100 (LQ)	µg/L
Phenanthrene		<0.030 (LQ)	µg/L
Pyrene		<0.060 (LQ)	µg/L
Sum of 16 PAH		<0.370 (LQ)	µg/L
Sum of 4 PAH		<0.040 (LQ)	µg/L

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15726 / 19
Collection Date:	-
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End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178536 / 19**

Product: Natural Water
Reference: Sample 8
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

In this report change the report of organochlorine pesticides. Motive: laboratory source.

Equivalent internal method is one that has the same area of application (parameters and matrices) and that meets the performance characteristics, obtaining results comparable to the standard method (s)

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15726 / 19
Collection Date:	-
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End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178536 / 19**

Product: Natural Water
Reference: Sample 8
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Notes

List of Abbreviations: EN-Estimated number; CFU-colony forming units; LQ - Limit of quantification; LD - limit of detection; LV - Limit Value; RV - Recommended Value, Pv - Parametric Value; C - According, A - Acceptable, NC - Nonconforming; Unit. - Unit, OD - Optical Density
The test marked with (s) was subcontracted and not accredited.
The test marked with (a) was subcontracted and is accredited.
In the results marked with (k) the microorganisms are present, but less than 3x dilution(if applicable).
In the results marked with (y) the microorganisms are present, but less than 4x dilution.
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Técnica Superior de Laboratório
Eugénia Silva

ALS Controlvet

Correction of Previous Reports
Issue Date 29-11-2019

Analysis n.º:	QH / 15727 / 19
Collection Date:	-
Reception Date:	23-10-2019
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Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178537 / 19**

Product: Natural Water
Reference: Sample 10
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Packaging: bottle
Work Order: 1806/2019

Test	Method	Result	Unit
(a) Organochlorine Pesticides (OCP) for GC-ECD	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1)		
Hexachlorobenzene		<0.0050	µg/L
2,4'-DDT		<0.010	µg/L
4,4'-DDT		<0.010	µg/L
Hexachloroethane		<0.010	µg/L
Hexachlorobutadiene		<0.010	µg/L
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene		<0.020	µg/L
1.2.3.4-Tetrachlorobenzene		<0.010	µg/L
Pentachlorobenzene		<0.010	µg/L
Trifluralin		<0.010	µg/L
Hexachlorocyclohexane Alpha		<0.010	µg/L
Hexachlorocyclohexane Beta		<0.010	µg/L
Hexachlorocyclohexane Gamma		<0.010	µg/L
Hexachlorocyclohexane Delta		<0.010	µg/L
Hexachlorocyclohexane Epsilon		<0.010	µg/L
Alachlor		<0.010	µg/L
Heptachlor		<0.010	µg/L
Aldrin		<0.0050	µg/L
Telodrin		<0.010	µg/L
Isodrin		<0.010	µg/L
Heptachloroepoxide-cis		<0.010	µg/L
Heptachloroepoxide-trans		<0.010	µg/L
2.4-DDE		<0.010	µg/L
alpha-Endosulfan		<0.010	µg/L
4.4`- DDE		<0.010	µg/L
Dieldrin		<0.010	µg/L
2.4-DDD		<0.010	µg/L
Endrin		<0.010	µg/L
beta-Endosulfan		<0.010	µg/L

Tondela
Zona Industrial Tondela - ZIM II Lote 2 e 6
3460-070 Tondela
Telef.: 232817617
Fax: 232817819

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15727 / 19
Collection Date:	-
Reception Date:	23-10-2019
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Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178537 / 19**

Product: Natural Water
Reference: Sample 10
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Packaging: bottle
Work Order: 1806/2019

Test	Method	Result	Unit
4.4`-DDD		<0.010	µg/L
Methoxychlor		<0.010	µg/L
Dichlobenil		<0.050	µg/L
Sum of 3 tetrachlorobenzenes		<0.030	µg/L
Sum of 4 hexachlorcyclohexanes		<0.040	µg/L
Sum of 4 isomers DDT		<0.040	µg/L
Sum of 6 isomers DDT		<0.060	µg/L
Sum of endosulfanes		<0.020	µg/L
Sum of 5 hexachlorocyclohexanes		<0.050	µg/L
Sum of 27 OCPs + 3 CBs		<0.290	µg/L
Sum of 29 OCPs + 3 CBs		<0.350	µg/L
(a) PAH for GCMS	CZ_SOP_D06_03_161 (US EPA 8270, CSN EN ISO 6468, US EPA 8000D, samples preparation according to CZ_SOP_D06_03_P01 chap. 9.1, 9.4.1)		
Acenaphthene		<0.010 (LQ)	µg/L
Acenaphthylene		<0.010 (LQ)	µg/L
Anthracene		<0.020 (LQ)	µg/L
Benz(a)anthracene		<0.010 (LQ)	µg/L
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Benzo(b)fluoranthene		<0.010 (LQ)	µg/L
Benzo(g.h.i)perylene		<0.010 (LQ)	µg/L
Benzo(k)fluoranthene		<0.010 (LQ)	µg/L
Chrysene		<0.010 (LQ)	µg/L
Dibenz(a.h)anthracene		<0.010 (LQ)	µg/L
Fluoranthene		<0.030 (LQ)	µg/L
Fluorene		<0.020 (LQ)	µg/L
Indeno(1.2.3.cd)pyrene		<0.010 (LQ)	µg/L
Naphthalene		<0.100 (LQ)	µg/L
Phenanthrene		<0.030 (LQ)	µg/L
Pyrene		<0.060 (LQ)	µg/L
Sum of 16 PAH		<0.370 (LQ)	µg/L
Sum of 4 PAH		<0.040 (LQ)	µg/L

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Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178537 / 19**

Product: Natural Water
Reference: Sample 10
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

In this report change the report of organochlorine pesticides. Motive: laboratory source.

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EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178537 / 19**

Product: Natural Water
Reference: Sample 10
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
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Notes

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Eugénia Silva

ALS Controlvet

Correction of Previous Reports
Issue Date 29-11-2019

Analysis n.º:	QH / 15728 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178538 / 19**

Product: Natural Water
Reference: Sample 11
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
(a) Organochlorine Pesticides (OCP) for GC-ECD	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1)		
Hexachlorobenzene		<0.0050	µg/L
2,4'-DDT		<0.010	µg/L
4,4'-DDT		<0.010	µg/L
Hexachloroethane		<0.010	µg/L
Hexachlorobutadiene		<0.010	µg/L
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene		<0.020	µg/L
1.2.3.4-Tetrachlorobenzene		<0.010	µg/L
Pentachlorobenzene		<0.010	µg/L
Trifluralin		<0.010	µg/L
Hexachlorocyclohexane Alpha		<0.010	µg/L
Hexachlorocyclohexane Beta		<0.010	µg/L
Hexachlorocyclohexane Gamma		<0.010	µg/L
Hexachlorocyclohexane Delta		<0.010	µg/L
Hexachlorocyclohexane Epsilon		<0.010	µg/L
Alachlor		<0.010	µg/L
Heptachlor		<0.010	µg/L
Aldrin		<0.0050	µg/L
Telodrin		<0.010	µg/L
Isodrin		<0.010	µg/L
Heptachloroepoxide-cis		<0.010	µg/L
Heptachloroepoxide-trans		<0.010	µg/L
2.4-DDE		<0.010	µg/L
alpha-Endosulfan		<0.010	µg/L
4.4`- DDE		<0.010	µg/L
Dieldrin		<0.010	µg/L
2.4-DDD		<0.010	µg/L
Endrin		<0.010	µg/L
beta-Endosulfan		<0.010	µg/L

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Fax: 232817819

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15728 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178538 / 19**

Product: Natural Water
Reference: Sample 11
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Packaging: bottle
Work Order: 1806/2019

Test	Method	Result	Unit
4.4`-DDD		<0.010	µg/L
Methoxychlor		<0.010	µg/L
Dichlobenil		<0.050	µg/L
Sum of 3 tetrachlorobenzenes		<0.030	µg/L
Sum of 4 hexachlorcyclohexanes		<0.040	µg/L
Sum of 4 isomers DDT		<0.040	µg/L
Sum of 6 isomers DDT		<0.060	µg/L
Sum of endosulfanes		<0.020	µg/L
Sum of 5 hexachlorocyclohexanes		<0.050	µg/L
Sum of 27 OCPs + 3 CBs		<0.290	µg/L
Sum of 29 OCPs + 3 CBs		<0.350	µg/L
(a) PAH for GCMS	CZ_SOP_D06_03_161 (US EPA 8270, CSN EN ISO 6468, US EPA 8000D, samples preparation according to CZ_SOP_D06_03_P01 chap. 9.1, 9.4.1)		
Acenaphthene		<0.010 (LQ)	µg/L
Acenaphthylene		<0.010 (LQ)	µg/L
Anthracene		<0.020 (LQ)	µg/L
Benz(a)anthracene		<0.010 (LQ)	µg/L
Benzo(a)pyrene		<0.020 (LQ)	µg/L
Benzo(b)fluoranthene		<0.010 (LQ)	µg/L
Benzo(g.h.i)perylene		<0.010 (LQ)	µg/L
Benzo(k)fluoranthene		<0.010 (LQ)	µg/L
Chrysene		<0.010 (LQ)	µg/L
Dibenz(a.h)anthracene		<0.010 (LQ)	µg/L
Fluoranthene		<0.030 (LQ)	µg/L
Fluorene		<0.020 (LQ)	µg/L
Indeno(1.2.3.cd)pyrene		<0.010 (LQ)	µg/L
Naphthalene		<0.100 (LQ)	µg/L
Phenanthrene		<0.030 (LQ)	µg/L
Pyrene		<0.060 (LQ)	µg/L
Sum of 16 PAH		<0.370 (LQ)	µg/L
Sum of 4 PAH		<0.040 (LQ)	µg/L

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Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15728 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
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Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178538 / 19**

Product: Natural Water
Reference: Sample 11
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

In this report change the report of Organochlorine Pesticides. Motive: laboratory change.

Equivalent internal method is one that has the same area of application (parameters and matrices) and that meets the performance characteristics, obtaining results comparable to the standard method (s)

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15728 / 19
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EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178538 / 19**

Product: Natural Water
Reference: Sample 11
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Notes

List of Abbreviations: EN-Estimated number; CFU-colony forming units; LQ - Limit of quantification; LD - limit of detection; LV - Limit Value; RV - Recommended Value, Pv - Parametric Value; C - According, A - Acceptable, NC - Nonconforming; Unit. - Unit, OD - Optical Density
The test marked with (s) was subcontracted and not accredited.
The test marked with (a) was subcontracted and is accredited.
In the results marked with (k) the microorganisms are present, but less than 3x dilution(if applicable).
In the results marked with (y) the microorganisms are present, but less than 4x dilution.
For the tests indicated by calculation techniques, the methodology followed can be made available on request.

This Test Report refers only to samples analyzed.
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ALS Controlvet

Correction of Previous Reports
Issue Date 29-11-2019

Analysis n.º:	QH / 15729 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178539 / 19**

Product: Natural Water
Reference: Sample 12
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
(a) Organochlorine Pesticides (OCP) for GC-ECD	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1)		
Hexachlorobenzene		<0.350	µg/L
2,4'-DDT		<0.010	µg/L
4,4'-DDT		<0.010	µg/L
Hexachloroethane		<0.010	µg/L
Hexachlorobutadiene		<0.010	µg/L
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene		<0.020	µg/L
1.2.3.4-Tetrachlorobenzene		<0.010	µg/L
Pentachlorobenzene		<0.010	µg/L
Trifluralin		<0.010	µg/L
Hexachlorocyclohexane Alpha		<0.010	µg/L
Hexachlorocyclohexane Beta		<0.010	µg/L
Hexachlorocyclohexane Gamma		<0.010	µg/L
Hexachlorocyclohexane Delta		<0.010	µg/L
Hexachlorocyclohexane Epsilon		<0.010	µg/L
Alachlor		<0.010	µg/L
Heptachlor		<0.010	µg/L
Aldrin		<0.0050	µg/L
Telodrin		<0.010	µg/L
Isodrin		<0.010	µg/L
Heptachloroepoxide-cis		<0.010	µg/L
Heptachloroepoxide-trans		<0.010	µg/L
2.4-DDE		<0.010	µg/L
alpha-Endosulfan		<0.010	µg/L
4.4`- DDE		<0.010	µg/L
Dieldrin		<0.010	µg/L
2.4-DDD		<0.010	µg/L
Endrin		<0.010	µg/L
beta-Endosulfan		<0.010	µg/L

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Analysis n.º:	QH / 15729 / 19
Collection Date:	-
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Dear Sir
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EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178539 / 19**

Product: Natural Water
Reference: Sample 12
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Packaging: bottle
Work Order: 1806/2019

Test	Method	Result	Unit
4.4`-DDD		<0.010	µg/L
Methoxychlor		<0.010	µg/L
Dichlobenil		<0.050	µg/L
Sum of 3 tetrachlorobenzenes		<0.030	µg/L
Sum of 4 hexachlorcyclohexanes		<0.040	µg/L
Sum of 4 isomers DDT		<0.040	µg/L
Sum of 6 isomers DDT		0.060	µg/L
Sum of endosulfanes		<0.020	µg/L
Sum of 5 hexachlorocyclohexanes		<0.050	µg/L
Sum of 27 OCPs + 3 CBs		<0.290	µg/L
Sum of 29 OCPs + 3 CBs		<0.350	µg/L
(a) PAH for GCMS	CZ_SOP_D06_03_161 (US EPA 8270, CSN EN ISO 6468, US EPA 8000D, samples preparation according to CZ_SOP_D06_03_P01 chap. 9.1, 9.4.1)		
Acenaphthene		<0.010 (LQ)	µg/L
Acenaphthylene		<0.010 (LQ)	µg/L
Anthracene		<0.020 (LQ)	µg/L
Benz(a)anthracene		<0.010 (LQ)	µg/L
Benzo(a)pyrene		<0.020 (LQ)	µg/L
Benzo(b)fluoranthene		<0.010 (LQ)	µg/L
Benzo(g.h.i)perylene		<0.010 (LQ)	µg/L
Benzo(k)fluoranthene		<0.010 (LQ)	µg/L
Chrysene		<0.010 (LQ)	µg/L
Dibenz(a.h)anthracene		<0.010 (LQ)	µg/L
Fluoranthene		<0.030 (LQ)	µg/L
Fluorene		<0.020 (LQ)	µg/L
Indeno(1.2.3.cd)pyrene		<0.010 (LQ)	µg/L
Naphthalene		<0.100 (LQ)	µg/L
Phenanthrene		<0.030 (LQ)	µg/L
Pyrene		<0.060 (LQ)	µg/L
Sum of 16 PAH		<0.370 (LQ)	µg/L
Sum of 4 PAH		<0.040 (LQ)	µg/L

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Analysis n.º:	QH / 15729 / 19
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Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178539 / 19**

Product: Natural Water
Reference: Sample 12
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

In this report change the report of Organochlorine Pesticides. Motive: laboratory change.

Equivalent internal method is one that has the same area of application (parameters and matrices) and that meets the performance characteristics, obtaining results comparable to the standard method (s)

Técnica Superior de Laboratório
Eugénia Silva

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EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178539 / 19**

Product: Natural Water
Reference: Sample 12
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Notes

List of Abbreviations: EN-Estimated number; CFU-colony forming units; LQ - Limit of quantification; LD - limit of detection; LV - Limit Value; RV - Recommended Value, Pv - Parametric Value; C - According, A - Acceptable, NC - Nonconforming; Unit. - Unit, OD - Optical Density
The test marked with (s) was subcontracted and not accredited.
The test marked with (a) was subcontracted and is accredited.
In the results marked with (k) the microorganisms are present, but less than 3x dilution(if applicable).
In the results marked with (y) the microorganisms are present, but less than 4x dilution.
For the tests indicated by calculation techniques, the methodology followed can be made available on request.

This Test Report refers only to samples analyzed.
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Técnica Superior de Laboratório
Eugénia Silva

ALS Controlvet

Correction of Previous Reports
Issue Date 29-11-2019

Analysis n.º:	QH / 15730 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178540 / 19**

Product: Natural Water **Packaging:** bottle
Reference: Sample 13 **Work Order:** 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
(a) Organochlorine Pesticides (OCP) for GC-ECD	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1)		
Hexachlorobenzene		<0.0050	µg/L
2,4'-DDT		<0.010	µg/L
4,4'-DDT		<0.010	µg/L
Hexachloroethane		<0.010	µg/L
Hexachlorobutadiene		<0.010	µg/L
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene		<0.020	µg/L
1.2.3.4-Tetrachlorobenzene		<0.010	µg/L
Pentachlorobenzene		<0.010	µg/L
Trifluralin		<0.010	µg/L
Hexachlorocyclohexane Alpha		<0.010	µg/L
Hexachlorocyclohexane Beta		<0.010	µg/L
Hexachlorocyclohexane Gamma		<0.010	µg/L
Hexachlorocyclohexane Delta		<0.010	µg/L
Hexachlorocyclohexane Epsilon		<0.010	µg/L
Alachlor		<0.010	µg/L
Heptachlor		<0.010	µg/L
Aldrin		<0.0050	µg/L
Telodrin		<0.010	µg/L
Isodrin		<0.010	µg/L
Heptachloroepoxide-cis		<0.010	µg/L
Heptachloroepoxide-trans		<0.010	µg/L
2.4-DDE		<0.010	µg/L
alpha-Endosulfan		<0.010	µg/L
4.4`- DDE		<0.010	µg/L
Dieldrin		<0.010	µg/L
2.4-DDD		<0.010	µg/L
Endrin		<0.010	µg/L
beta-Endosulfan		<0.010	µg/L

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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15730 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178540 / 19**

Product: Natural Water **Packaging:** bottle
Reference: Sample 13 **Work Order:** 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
4.4`-DDD		<0.010	µg/L
Methoxychlor		<0.010	µg/L
Dichlobenil		<0.050	µg/L
Sum of 3 tetrachlorobenzenes		<0.030	µg/L
Sum of 4 hexachlorcyclohexanes		<0.040	µg/L
Sum of 4 isomers DDT		<0.040	µg/L
Sum of 6 isomers DDT		<0.060	µg/L
Sum of endosulfanes		<0.020	µg/L
Sum of 5 hexachlorocyclohexanes		<0.050	µg/L
Sum of 27 OCPs + 3 CBs		<0.290	µg/L
Sum of 29 OCPs + 3 CBs		<0.350	µg/L
(a) PAH for GCMS	CZ_SOP_D06_03_161 (US EPA 8270, CSN EN ISO 6468, US EPA 8000D, samples preparation according to CZ_SOP_D06_03_P01 chap. 9.1, 9.4.1)		
Acenaphthene		<0.010 (LQ)	µg/L
Acenaphthylene		<0.010 (LQ)	µg/L
Anthracene		<0.020 (LQ)	µg/L
Benz(a)anthracene		<0.010 (LQ)	µg/L
Benzo(a)pyrene		<0.020 (LQ)	µg/L
Benzo(b)fluoranthene		<0.010 (LQ)	µg/L
Benzo(g.h.i)perylene		<0.010 (LQ)	µg/L
Benzo(k)fluoranthene		<0.010 (LQ)	µg/L
Chrysene		<0.010 (LQ)	µg/L
Dibenz(a.h)anthracene		<0.010 (LQ)	µg/L
Fluoranthene		<0.030 (LQ)	µg/L
Fluorene		<0.020 (LQ)	µg/L
Indeno(1.2.3.cd)pyrene		<0.010 (LQ)	µg/L
Naphthalene		<0.100 (LQ)	µg/L
Phenanthrene		<0.030 (LQ)	µg/L
Pyrene		<0.060 (LQ)	µg/L
Sum of 16 PAH		<0.370 (LQ)	µg/L
Sum of 4 PAH		<0.040 (LQ)	µg/L

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Técnica Superior de Laboratório
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Analysis n.º:	QH / 15730 / 19
Collection Date:	-
Reception Date:	23-10-2019
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End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178540 / 19**

Product: Natural Water
Reference: Sample 13
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

In this report change the report of Organochlorine Pesticides. Motive: laboratory change.

Equivalent internal method is one that has the same area of application (parameters and matrices) and that meets the performance characteristics, obtaining results comparable to the standard method (s)

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15730 / 19
Collection Date:	-
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Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

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EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178540 / 19**

Product: Natural Water
Reference: Sample 13
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Notes

List of Abbreviations: EN-Estimated number; CFU-colony forming units; LQ - Limit of quantification; LD - limit of detection; LV - Limit Value; RV - Recommended Value, Pv - Parametric Value; C - According, A - Acceptable, NC - Nonconforming; Unit. - Unit, OD - Optical Density
The test marked with (s) was subcontracted and not accredited.
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ALS Controlvet

Correction of Previous Reports
Issue Date 29-11-2019

Analysis n.º:	QH / 15731 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178541 / 19**

Product: Natural Water
Reference: Sample 14
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Packaging: bottle
Work Order: 1806/2019

Test	Method	Result	Unit
(a) Organochlorine Pesticides (OCP) for GC-ECD	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1)		
Hexachlorobenzene		<0.0050	µg/L
2,4'-DDT		<0.010	µg/L
4,4'-DDT		<0.010	µg/L
Hexachloroethane		<0.010	µg/L
Hexachlorobutadiene		<0.010	µg/L
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene		<0.020	µg/L
1.2.3.4-Tetrachlorobenzene		<0.010	µg/L
Pentachlorobenzene		<0.010	µg/L
Trifluralin		<0.010	µg/L
Hexachlorocyclohexane Alpha		<0.010	µg/L
Hexachlorocyclohexane Beta		<0.010	µg/L
Hexachlorocyclohexane Gamma		<0.010	µg/L
Hexachlorocyclohexane Delta		<0.010	µg/L
Hexachlorocyclohexane Epsilon		<0.010	µg/L
Alachlor		<0.010	µg/L
Heptachlor		<0.010	µg/L
Aldrin		<0.0050	µg/L
Telodrin		<0.010	µg/L
Isodrin		<0.010	µg/L
Heptachloroepoxide-cis		<0.010	µg/L
Heptachloroepoxide-trans		<0.010	µg/L
2.4-DDE		<0.010	µg/L
alpha-Endosulfan		<0.010	µg/L
4.4`- DDE		<0.010	µg/L
Dieldrin		<0.010	µg/L
2.4-DDD		<0.010	µg/L
Endrin		<0.010	µg/L
beta-Endosulfan		<0.010	µg/L

Tondela
Zona Industrial Tondela - ZIM II Lote 2 e 6
3460-070 Tondela
Telef.: 232817817
Fax: 232817819

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15731 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178541 / 19**

Product: Natural Water
Reference: Sample 14
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
4.4`-DDD		<0.010	µg/L
Methoxychlor		<0.010	µg/L
Dichlobenil		<0.050	µg/L
Sum of 3 tetrachlorobenzenes		<0.030	µg/L
Sum of 4 hexachlorcyclohexanes		<0.040	µg/L
Sum of 4 isomers DDT		<0.040	µg/L
Sum of 6 isomers DDT		<0.060	µg/L
Sum of endosulfanes		<0.020	µg/L
Sum of 5 hexachlorocyclohexanes		<0.050	µg/L
Sum of 27 OCPs + 3 CBs		<0.290	µg/L
Sum of 29 OCPs + 3 CBs		<0.350	µg/L
(a) PAH for GCMS	CZ_SOP_D06_03_161 (US EPA 8270, CSN EN ISO 6468, US EPA 8000D, samples preparation according to CZ_SOP_D06_03_P01 chap. 9.1, 9.4.1)		
Acenaphthene		<0.010 (LQ)	µg/L
Acenaphthylene		<0.010 (LQ)	µg/L
Anthracene		<0.020 (LQ)	µg/L
Benz(a)anthracene		<0.010 (LQ)	µg/L
Benzo(a)pyrene		<0.020 (LQ)	µg/L
Benzo(b)fluoranthene		<0.010 (LQ)	µg/L
Benzo(g.h.i)perylene		<0.010 (LQ)	µg/L
Benzo(k)fluoranthene		<0.010 (LQ)	µg/L
Chrysene		<0.010 (LQ)	µg/L
Dibenz(a.h)anthracene		<0.010 (LQ)	µg/L
Fluoranthene		<0.030 (LQ)	µg/L
Fluorene		<0.020 (LQ)	µg/L
Indeno(1.2.3.cd)pyrene		<0.010 (LQ)	µg/L
Naphthalene		<0.100 (LQ)	µg/L
Phenanthrene		<0.030 (LQ)	µg/L
Pyrene		<0.060 (LQ)	µg/L
Sum of 16 PAH		<0.370 (LQ)	µg/L
Sum of 4 PAH		<0.040 (LQ)	µg/L

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15731 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178541 / 19**

Product: Natural Water
Reference: Sample 14
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

In this report change the report of Organochlorine Pesticides. Motive: laboratory change.

Equivalent internal method is one that has the same area of application (parameters and matrices) and that meets the performance characteristics, obtaining results comparable to the standard method (s)

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15731 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178541 / 19**

Product: Natural Water
Reference: Sample 14
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Notes

List of Abbreviations: EN-Estimated number; CFU-colony forming units; LQ - Limit of quantification; LD - limit of detection; LV - Limit Value; RV - Recommended Value, Pv - Parametric Value; C - According, A - Acceptable, NC - Nonconforming; Unit. - Unit, OD - Optical Density
The test marked with (s) was subcontracted and not accredited.
The test marked with (a) was subcontracted and is accredited.
In the results marked with (k) the microorganisms are present, but less than 3x dilution(if applicable).
In the results marked with (y) the microorganisms are present, but less than 4x dilution.
For the tests indicated by calculation techniques, the methodology followed can be made available on request.

This Test Report refers only to samples analyzed.
Prohibited the partial reproduction of this

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

ALS Controlvet

Correction of Previous Reports
Issue Date 29-11-2019

Analysis n.º:	QH / 15732 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178542 / 19**

Product: Natural Water
Reference: Sample 18
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
(a) Organochlorine Pesticides (OCP) for GC-ECD	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1)		
Hexachlorobenzene		<0.0050	µg/L
2,4'-DDT		<0.010	µg/L
4,4'-DDT		<0.010	µg/L
Hexachloroethane		<0.010	µg/L
Hexachlorobutadiene		<0.010	µg/L
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene		<0.020	µg/L
1.2.3.4-Tetrachlorobenzene		<0.010	µg/L
Pentachlorobenzene		<0.010	µg/L
Trifluralin		<0.010	µg/L
Hexachlorocyclohexane Alpha		<0.010	µg/L
Hexachlorocyclohexane Beta		<0.010	µg/L
Hexachlorocyclohexane Gamma		<0.010	µg/L
Hexachlorocyclohexane Delta		<0.010	µg/L
Hexachlorocyclohexane Epsilon		<0.010	µg/L
Alachlor		<0.010	µg/L
Heptachlor		<0.010	µg/L
Aldrin		<0.0050	µg/L
Telodrin		<0.010	µg/L
Isodrin		<0.010	µg/L
Heptachloroepoxide-cis		<0.010	µg/L
Heptachloroepoxide-trans		<0.010	µg/L
2.4-DDE		<0.010	µg/L
alpha-Endosulfan		<0.010	µg/L
4.4`- DDE		<0.010	µg/L
Dieldrin		<0.010	µg/L
2.4-DDD		<0.010	µg/L
Endrin		<0.010	µg/L
beta-Endosulfan		<0.010	µg/L

Tondela
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Telef.: 232817817
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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15732 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178542 / 19**

Product: Natural Water
Reference: Sample 18
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
4.4`-DDD		<0.010	µg/L
Methoxychlor		<0.010	µg/L
Dichlobenil		<0.050	µg/L
Sum of 3 tetrachlorobenzenes		<0.050	µg/L
Sum of 4 hexachlorcyclohexanes		<0.040	µg/L
Sum of 4 isomers DDT		<0.040	µg/L
Sum of 6 isomers DDT		<0.060	µg/L
Sum of endosulfanes		<0.020	µg/L
Sum of 5 hexachlorocyclohexanes		<0.050	µg/L
Sum of 27 OCPs + 3 CBs		<0.290	µg/L
Sum of 29 OCPs + 3 CBs		<0.350	µg/L
(a) PAH for GCMS	CZ_SOP_D06_03_161 (US EPA 8270, CSN EN ISO 6468, US EPA 8000D, samples preparation according to CZ_SOP_D06_03_P01 chap. 9.1, 9.4.1)		
Acenaphthene		<0.010 (LQ)	µg/L
Acenaphthylene		<0.010 (LQ)	µg/L
Anthracene		<0.020 (LQ)	µg/L
Benz(a)anthracene		<0.010 (LQ)	µg/L
Benzo(a)pyrene		<0.020 (LQ)	µg/L
Benzo(b)fluoranthene		<0.010 (LQ)	µg/L
Benzo(g.h.i)perylene		<0.010 (LQ)	µg/L
Benzo(k)fluoranthene		<0.010 (LQ)	µg/L
Chrysene		<0.010 (LQ)	µg/L
Dibenz(a.h)anthracene		<0.010 (LQ)	µg/L
Fluoranthene		<0.030 (LQ)	µg/L
Fluorene		<0.020 (LQ)	µg/L
Indeno(1.2.3.cd)pyrene		<0.010 (LQ)	µg/L
Naphthalene		<0.100 (LQ)	µg/L
Phenanthrene		<0.030 (LQ)	µg/L
Pyrene		<0.060 (LQ)	µg/L
Sum of 16 PAH		<0.370 (LQ)	µg/L
Sum of 4 PAH		<0.040 (LQ)	µg/L

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15732 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178542 / 19**

Product: Natural Water
Reference: Sample 18
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

In this report change the report of organochlorine pesticides. Motive: laboratory source.

Equivalent internal method is one that has the same area of application (parameters and matrices) and that meets the performance characteristics, obtaining results comparable to the standard method (s)

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15732 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178542 / 19**

Product: Natural Water
Reference: Sample 18
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Notes

List of Abbreviations: EN-Estimated number; CFU-colony forming units; LQ - Limit of quantification; LD - limit of detection; LV - Limit Value; RV - Recommended Value, Pv - Parametric Value; C - According, A - Acceptable, NC - Nonconforming; Unit. - Unit, OD - Optical Density
The test marked with (s) was subcontracted and not accredited.
The test marked with (a) was subcontracted and is accredited.
In the results marked with (k) the microorganisms are present, but less than 3x dilution(if applicable).
In the results marked with (y) the microorganisms are present, but less than 4x dilution.
For the tests indicated by calculation techniques, the methodology followed can be made available on request.

This Test Report refers only to samples analyzed.
Prohibited the partial reproduction of this

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Técnica Superior de Laboratório
Eugénia Silva

ALS Controlvet

Correction of Previous Reports
Issue Date 29-11-2019

Analysis n.º:	QH / 15733 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178543 / 19**

Product: Natural Water
Reference: Sample 22
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
(a) Organochlorine Pesticides (OCP) for GC-ECD	CZ_SOP_D06_03_169 (CSN EN ISO 6468, US EPA 8081, DIN 38407-3, samples prepared as per CZ_SOP_D06_03_P01 chap. 9.1, CZ_SOP_D06_03_P02 chap. 9.1)		
Hexachlorobenzene		<0.0050	µg/L
2,4'-DDT		<0.010	µg/L
4,4'-DDT		<0.010	µg/L
Hexachloroethane		<0.010	µg/L
Hexachlorobutadiene		<0.010	µg/L
1.2.3.5- & 1.2.4.5-Tetrachlorobenzene		<0.020	µg/L
1.2.3.4-Tetrachlorobenzene		<0.010	µg/L
Pentachlorobenzene		<0.010	µg/L
Trifluralin		<0.010	µg/L
Hexachlorocyclohexane Alpha		<0.010	µg/L
Hexachlorocyclohexane Beta		<0.010	µg/L
Hexachlorocyclohexane Gamma		<0.010	µg/L
Hexachlorocyclohexane Delta		<0.010	µg/L
Hexachlorocyclohexane Epsilon		<0.010	µg/L
Alachlor		<0.010	µg/L
Heptachlor		<0.010	µg/L
Aldrin		<0.0050	µg/L
Telodrin		<0.010	µg/L
Isodrin		<0.010	µg/L
Heptachloroepoxide-cis		<0.010	µg/L
Heptachloroepoxide-trans		<0.010	µg/L
2.4-DDE		<0.010	µg/L
alpha-Endosulfan		<0.010	µg/L
4.4`- DDE		<0.010	µg/L
Dieldrin		<0.010	µg/L
2.4-DDD		<0.010	µg/L
Endrin		<0.010	µg/L
beta-Endosulfan		<0.010	µg/L

Tondela
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Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15733 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178543 / 19**

Product: Natural Water
Reference: Sample 22
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Test	Method	Result	Unit
4.4`-DDD		<0.010	µg/L
Methoxychlor		<0.010	µg/L
Dichlobenil		<0.050	µg/L
Sum of 3 tetrachlorobenzenes		<0.030	µg/L
Sum of 4 hexachlorcyclohexanes		<0.040	µg/L
Sum of 4 isomers DDT		<0.040	µg/L
Sum of 6 isomers DDT		<0.060	µg/L
Sum of endosulfanes		<0.020	µg/L
Sum of 5 hexachlorocyclohexanes		<0.050	µg/L
Sum of 27 OCPs + 3 CBs		<0.290	µg/L
Sum of 29 OCPs + 3 CBs		<0.350	µg/L
(a) PAH for GCMS	CZ_SOP_D06_03_161 (US EPA 8270, CSN EN ISO 6468, US EPA 8000D, samples preparation according to CZ_SOP_D06_03_P01 chap. 9.1, 9.4.1)		
Acenaphthene		<0.010 (LQ)	µg/L
Acenaphthylene		<0.010 (LQ)	µg/L
Anthracene		<0.020 (LQ)	µg/L
Benz(a)anthracene		<0.010 (LQ)	µg/L
Benzo(a)pyrene		<0.020 (LQ)	µg/L
Benzo(b)fluoranthene		<0.010 (LQ)	µg/L
Benzo(g.h.i)perylene		<0.010 (LQ)	µg/L
Benzo(k)fluoranthene		<0.010 (LQ)	µg/L
Chrysene		<0.010 (LQ)	µg/L
Dibenz(a.h)anthracene		<0.010 (LQ)	µg/L
Fluoranthene		<0.030 (LQ)	µg/L
Fluorene		<0.020 (LQ)	µg/L
Indeno(1.2.3.cd)pyrene		<0.010 (LQ)	µg/L
Naphthalene		<0.100 (LQ)	µg/L
Phenanthrene		<0.030 (LQ)	µg/L
Pyrene		<0.060 (LQ)	µg/L
Sum of 16 PAH		<0.370 (LQ)	µg/L
Sum of 4 PAH		<0.040 (LQ)	µg/L

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15733 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178543 / 19**

Product: Natural Water
Reference: Sample 22
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

In this report change the organochlorine pesticides. Motive: laboratory source.

Equivalent internal method is one that has the same area of application (parameters and matrices) and that meets the performance characteristics, obtaining results comparable to the standard method (s)

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

Analysis n.º:	QH / 15733 / 19
Collection Date:	-
Reception Date:	23-10-2019
Start Date:	24-10-2019
End Date:	29-11-2019
Client nº:	7401

Dear Sir
Nemus – Gestão e Req.Ambiental, Lda.
EST. DO PAÇO DO LUMIAR CAMPUS DO LUMIAR ED. D
LISBOA
1649-038 LISBOA

Unit: Nemus – Gestão e Requalificação Ambiental, Lda.

Sample Identification **178543 / 19**

Product: Natural Water
Reference: Sample 22
Packaging: bottle
Work Order: 1806/2019
The sample collection was not performed by Controlvet.
The results of this test report apply to the sample as received.

Notes

List of Abbreviations: EN-Estimated number; CFU-colony forming units; LQ - Limit of quantification; LD - limit of detection; LV - Limit Value; RV - Recommended Value, Pv - Parametric Value; C - According, A - Acceptable, NC - Nonconforming; Unit. - Unit, OD - Optical Density
The test marked with (s) was subcontracted and not accredited.
The test marked with (a) was subcontracted and is accredited.
In the results marked with (k) the microorganisms are present, but less than 3x dilution(if applicable).
In the results marked with (y) the microorganisms are present, but less than 4x dilution.
For the tests indicated by calculation techniques, the methodology followed can be made available on request.

This Test Report refers only to samples analyzed.
Prohibited the partial reproduction of this

Eugénia Silva

Técnica Superior de Laboratório
Eugénia Silva

SYNLAB Analytics & Services B.V.
Correspondentieadres
Steenhouwerstraat 15 · 3194 AG Rotterdam
Tel.: +34 93 363 6000
www.synlab.nl

Analytical report

NEMUS - Gestão e Requalificação Ambiental Lda
César Jesus
Estrada do Paço do Lumiar
Campus do Lumiar,Edifício D, R/Chão
PT-1649-038 LISBOA

Your Project name	: Conservation_Plan_Lukanga_Swamp
Your Project number	: t19024
SYNLAB report number	: 13113941, version: 1
Certificate code	: PIVUHPHL

Rotterdam, 14.11.2019

Dear Mr./Mrs,

Attached you find the results of the laboratory tests carried out for your project t19024. The tests were carried out according to your order. The reported results refer only to the tested samples. The sample description, sample date (if provided) and project description were adopted from your order.

All tests were carried out by SYNLAB Analytics & Services B.V., Steenhouwerstraat 15, Rotterdam, Netherlands. Tests outsourced or carried out by the SYNLAB laboratory in France (99-101 Avenue Louis Roche, Gennevilliers) are marked in the report.

This certificate contains inclusive attachments 14 pages. In case of a version number of '2' or higher all former versions of the certificate are invalid. All attachments are inextricably part of this certificate. Only reproduction of the whole report is allowed.

In case of questions and/or remarks related to this certificate, for example in case of information required about measurement uncertainty of the analytical methods, please contact our Customer Support department.

Yours faithfully,



Jaap-Willem Hutter
Technical Director

TESTEN
RvA L 028

SYNLAB Analytics & Services B.V. is accredited under nr. L028 by the Raad voor Accreditatie, according to the criteria for testing laboratories ISO/IEC 17025:2005.

All our work is carried out under the General Conditions, kept at the Kamer van Koophandel (Chamber of Commerce) in Rotterdam, Netherlands:Trade record: KVK Rotterdam 24265286.

Analytical report

Project name	Conservation_Plan_Lukanga_Swamp	Order date	27.09.2019
Project number	t19024	Starting date	27.09.2019
Report number	13113941 - 1	Report date	09.10.2019

Code	Sample type	Sample description
001	Sediment	1
002	Sediment	2
003	Sediment	3
004	Sediment	4
005	Sediment	5

Analysis	Unit	Q	001	002	003	004	005
dry weight	wght.-%	Q	51.4	70.8	59.2	85.3	73.0
sample pretreatment (sieving <2mm)			yes	yes	yes	yes	yes
TOC	mg/kgdm	Q	33000	7800	30000	<2000	<2000
PARTICAL SIZE							
min. parts <2um	% of DM	Q	43	5.8	<1	<1	2.8
min. parts <20um	% of DM		56	8.6	2.1	1.6	22
min. parts <63um	% of DM	Q	70	21	16	4.8	62
min. parts <2 mm	% of DM	Q	96	97	89	98	87
min. parts >2 mm	% of DM	Q	<1	<1	<1	<1	<1
METALS							
aluminium	mg/kgdm	Q	27000	4600	1500	9600	29000
arsenic	mg/kgdm	Q	<4	<4	<4	57	8.8
cadmium	mg/kgdm	Q	<0.2	<0.2	<0.2	<0.2	<0.2
chromium	mg/kgdm	Q	29	23	<10	170	140
cobalt	mg/kgdm	Q	19	4.7	<1.5	20	570
copper	mg/kgdm	Q	190	6.8	<5	49	2600
mercury	mg/kgdm	Q	<0.05	<0.05	<0.05	<0.05	<0.05
lead	mg/kgdm	Q	<10	<10	<10	<10	<10
nickel	mg/kgdm	Q	18	4.5	<3	31	24
iron	mg/kgdm	Q	14000	19000	1700	85000	64000
zinc	mg/kgdm	Q	<20	<20	27	26	51
POLYCYCLIC AROMATIC HYDROCARBONS							
phenanthrene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	0.02
anthracene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	<0.02
fluoranthene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	0.06
pyrene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	0.05
benzo(a)anthracene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	0.03
chrysene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	0.02
benzo(a)pyrene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	0.03
benzo(ghi)perylene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	0.02
indeno(1,2,3-cd)pyrene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	<0.02
sum PAHs (9 OSPAR)	mg/kgdm		<0.18	<0.18	<0.18	<0.18	0.23
CHLOROBENZENES							
hexachlorobenzene	µg/kgdm		<0.5	<0.5	<0.5	<0.5	<0.5
POLYCHLORINATED BIPHENYLS							

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Analytical report

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Project number	t19024	Starting date	27.09.2019
Report number	13113941 - 1	Report date	09.10.2019

Code	Sample type	Sample description
001	Sediment	1
002	Sediment	2
003	Sediment	3
004	Sediment	4
005	Sediment	5

Analysis	Unit	Q	001	002	003	004	005
PCB 28	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 52	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 101	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 118	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 138	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 153	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 180	µg/kgdm	Q	<1	<1	<1	<1	<1
total (7) PCB	µg/kgdm		4.9	4.9	4.9	4.9	4.9
SEVERAL CHEMICAL ANALYSIS							
specific weight	g/l		2179	2565	2190	2556	2716

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Analytical report

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Project number	t19024	Starting date	27.09.2019
Report number	13113941 - 1	Report date	09.10.2019

Code	Sample type	Sample description
006	Sediment	6
007	Sediment	7
008	Sediment	8
009	Sediment	9
010	Sediment	10

Analysis	Unit	Q	006	007	008	009	010
dry weight	wght.-%	Q	55.4	76.6	58.0	74.4	51.4
sample pretreatment (sieving <2mm)			yes		yes	yes	yes
TOC	mg/kgdm	Q	35000	12000	<2000	<2000	50000
PARTICAL SIZE							
min. parts <2um	% of DM	Q	50	29	8.0	<1	49
min. parts <20um	% of DM		58	33	47	<1	62
min. parts <63um	% of DM	Q	65	36	63	13	68
min. parts <2 mm	% of DM	Q	89	81	74	93	89
min. parts >2 mm	% of DM	Q	<1	<1	<1	<1	<1
METALS							
aluminium	mg/kgdm	Q	28000	43000	13000	12000	45000
arsenic	mg/kgdm	Q	<4	<4	5.5	4.0	<4
cadmium	mg/kgdm	Q	<0.2	<0.2	<0.2	<0.2	<0.2
chromium	mg/kgdm	Q	29	55	19	14	20
cobalt	mg/kgdm	Q	6.0	30	180	140	10
copper	mg/kgdm	Q	39	180	3700	5000	55
mercury	mg/kgdm	Q	<0.05	<0.05	<0.05	<0.05	<0.05
lead	mg/kgdm	Q	<10	10	10	<10	14
nickel	mg/kgdm	Q	19	32	17	13	14
iron	mg/kgdm	Q	8300	14000	21000	14000	9300
zinc	mg/kgdm	Q	<20	45	40	38	<20
POLYCYCLIC AROMATIC HYDROCARBONS							
phenanthrene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	<0.03 [1)]
anthracene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	<0.03 [1)]
fluoranthene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	<0.03 [1)]
pyrene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	<0.03 [1)]
benzo(a)anthracene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	<0.03 [1)]
chrysene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	<0.03 [1)]
benzo(a)pyrene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	<0.03 [1)]
benzo(ghi)perylene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	<0.03 [1)]
indeno(1,2,3-cd)pyrene	mg/kgdm	Q	<0.02	<0.02	<0.02	<0.02	<0.03 [1)]
sum PAHs (9 OSPAR)	mg/kgdm		<0.18	<0.18	<0.18	<0.18	<0.27
CHLOROBENZENES							
hexachlorobenzene	µg/kgdm		<0.5	<0.5	<0.5	<0.5	<0.54 [1)]
POLYCHLORINATED BIPHENYLS							

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Analytical report

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Project number	t19024	Starting date	27.09.2019
Report number	13113941 - 1	Report date	09.10.2019

Code	Sample type	Sample description
006	Sediment	6
007	Sediment	7
008	Sediment	8
009	Sediment	9
010	Sediment	10

Analysis	Unit	Q	006	007	008	009	010
PCB 28	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 52	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 101	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 118	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 138	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 153	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 180	µg/kgdm	Q	<1	<1	<1	<1	<1
total (7) PCB	µg/kgdm		4.9	4.9	4.9	4.9	4.9
SEVERAL CHEMICAL ANALYSIS							
specific weight	g/l		2147	2338	2419	2570	2141

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Analytical report

Project name	Conservation_Plan_Lukanga_Swamp	Order date	27.09.2019
Project number	t19024	Starting date	27.09.2019
Report number	13113941 - 1	Report date	09.10.2019

Remarks

1	Increased detectionlimit due to a high moisture content.

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Analytical report

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Project number	t19024	Starting date	27.09.2019
Report number	13113941 - 1	Report date	09.10.2019

Code	Sample type	Sample description
011	Sediment	11
012	Sediment	12
013	Sediment	13
014	Sediment	14
015	Sediment	15

Analysis	Unit	Q	011	012	013	014	015
dry weight	wght.-%	Q	84.2	26.2	74.2	77.4	77.1
sample pretreatment (sieving <2mm)			yes	yes	yes	yes	yes
TOC	mg/kgdm	Q	<2000	57000	11000	<2000	3100
PARTICAL SIZE							
min. parts <2um	% of DM	Q	<1	14	15	1.9	<1
min. parts <20um	% of DM		<1	30	26	2.4	3.9
min. parts <63um	% of DM	Q	6.5	40	36	5.7	5.2
min. parts <2 mm	% of DM	Q	97	56	100	98	99
min. parts >2 mm	% of DM	Q	<1	<1	<1	<1	<1
METALS							
aluminium	mg/kgdm	Q	1700	35000	16000	2200	2800
arsenic	mg/kgdm	Q	<4	<4	<4	<4	<4
cadmium	mg/kgdm	Q	<0.2	<0.2	<0.2	<0.2	<0.2
chromium	mg/kgdm	Q	12	30	24	<10	18
cobalt	mg/kgdm	Q	4.1	13	86	7.7	160
copper	mg/kgdm	Q	8.7	42	1300	92	800
mercury	mg/kgdm	Q	<0.05	<0.05	<0.05	<0.05	<0.05
lead	mg/kgdm	Q	13	<10	10	<10	<10
nickel	mg/kgdm	Q	<3	28	15	<3	6.0
iron	mg/kgdm	Q	6500	5900	16000	2800	7200
zinc	mg/kgdm	Q	<20	<20	24	<20	<20
POLYCYCLIC AROMATIC HYDROCARBONS							
phenanthrene	mg/kgdm	Q	<0.02	<0.05 [1)]	0.05	<0.02	<0.02
anthracene	mg/kgdm	Q	<0.02	<0.05 [1)]	<0.02	<0.02	<0.02
fluoranthene	mg/kgdm	Q	<0.02	<0.05 [1)]	0.10	<0.02	0.05
pyrene	mg/kgdm	Q	<0.02	<0.05 [1)]	0.08	<0.02	0.04
benzo(a)anthracene	mg/kgdm	Q	<0.02	<0.05 [1)]	0.05	<0.02	<0.02
chrysene	mg/kgdm	Q	<0.02	<0.05 [1)]	0.04	<0.02	<0.02
benzo(a)pyrene	mg/kgdm	Q	<0.02	<0.05 [1)]	0.04	<0.02	<0.02
benzo(ghi)perylene	mg/kgdm	Q	<0.02	<0.05 [1)]	0.03	<0.02	<0.02
indeno(1,2,3-cd)pyrene	mg/kgdm	Q	<0.02	<0.05 [1)]	0.03	<0.02	<0.02
sum PAHs (9 OSPAR)	mg/kgdm		<0.18	<0.45	0.42	<0.18	<0.18
CHLOROBENZENES							
hexachlorobenzene	µg/kgdm		<0.5	<1.0 [1)]	<0.5	<0.5	<0.5
POLYCHLORINATED BIPHENYLS							

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Analytical report

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Project number	t19024	Starting date	27.09.2019
Report number	13113941 - 1	Report date	09.10.2019

Code	Sample type	Sample description
011	Sediment	11
012	Sediment	12
013	Sediment	13
014	Sediment	14
015	Sediment	15

Analysis	Unit	Q	011	012	013	014	015
PCB 28	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 52	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 101	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 118	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 138	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 153	µg/kgdm	Q	<1	<1	<1	<1	<1
PCB 180	µg/kgdm	Q	<1	<1	<1	<1	<1
total (7) PCB	µg/kgdm		4.9	4.9	4.9	4.9	4.9
SEVERAL CHEMICAL ANALYSIS							
specific weight	g/l		2546	2071	2487	2514	2514

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Report number	13113941 - 1	Report date	09.10.2019

Remarks

1	Increased detectionlimit due to a high moisture content.

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Analytical report

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Project number	t19024	Starting date	27.09.2019
Report number	13113941 - 1	Report date	09.10.2019

Code	Sample type	Sample description
016	Sediment	16
017	Sediment	17
018	Sediment	18
019	Sediment	8a

Analysis	Unit	Q	016	017	018	019
dry weight	wght.-%	Q	68.8	79.9	68.8	61.3
sample pretreatment (sieving <2mm)				yes	yes	yes
TOC	mg/kgdm	Q	33000	4600	14000	21000
PARTICAL SIZE						
min. parts <2um	% of DM	Q	34	8.5	24	30
min. parts <20um	% of DM		51	24	33	37
min. parts <63um	% of DM	Q	76	28	46	51
min. parts <2 mm	% of DM	Q	90	95	92	89
min. parts >2 mm	% of DM	Q	<1	<1	<1	1.1
METALS						
aluminium	mg/kgdm	Q	31000	8900	13000	24000
arsenic	mg/kgdm	Q	7.6	6.1	5.5	7.5
cadmium	mg/kgdm	Q	0.53	<0.2	<0.2	<0.2
chromium	mg/kgdm	Q	43	63	24	50
cobalt	mg/kgdm	Q	450	160	8.4	16
copper	mg/kgdm	Q	3300	1100	13	28
mercury	mg/kgdm	Q	0.24	<0.05	<0.05	<0.05
lead	mg/kgdm	Q	60	<10	<10	<10
nickel	mg/kgdm	Q	34	8.8	9.9	19
iron	mg/kgdm	Q	32000	32000	14000	25000
zinc	mg/kgdm	Q	250	<20	<20	<20
POLYCYCLIC AROMATIC HYDROCARBONS						
phenanthrene	mg/kgdm	Q	0.06 [2)]	<0.02	<0.02	<0.02
anthracene	mg/kgdm	Q	0.02	<0.02	<0.02	<0.02
fluoranthene	mg/kgdm	Q	0.12	<0.02	<0.02	<0.02
pyrene	mg/kgdm	Q	0.10	<0.02	<0.02	<0.02
benzo(a)anthracene	mg/kgdm	Q	0.05	<0.02	<0.02	<0.02
chrysene	mg/kgdm	Q	0.04	<0.02	<0.02	<0.02
benzo(a)pyrene	mg/kgdm	Q	0.05	<0.02	<0.02	<0.02
benzo(ghi)perylene	mg/kgdm	Q	0.08	<0.02	<0.02	<0.02
indeno(1,2,3-cd)pyrene	mg/kgdm	Q	0.06	<0.02	<0.02	<0.02
sum PAHs (9 OSPAR)	mg/kgdm		0.58	<0.18	<0.18	<0.18
CHLOROBENZENES						
hexachlorobenzene	µg/kgdm		<0.5	<0.5	<0.5	<0.5
POLYCHLORINATED BIPHENYLS						
PCB 28	µg/kgdm	Q	1.7 [3)]	<1	<1	<1

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Analytical report

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Report number	13113941 - 1	Report date	09.10.2019

Code	Sample type	Sample description
016	Sediment	16
017	Sediment	17
018	Sediment	18
019	Sediment	8a

Analysis	Unit	Q	016	017	018	019
PCB 52	µg/kgdm	Q	<1	<1	<1	<1
PCB 101	µg/kgdm	Q	1.3	<1	<1	<1
PCB 118	µg/kgdm	Q	1.2 [2)]	<1	<1	<1
PCB 138	µg/kgdm	Q	2.1	<1	<1	<1
PCB 153	µg/kgdm	Q	1.7 [2)]	<1	<1	<1
PCB 180	µg/kgdm	Q	<1	<1	<1	<1
total (7) PCB	µg/kgdm		9.4	4.9	4.9	4.9
SEVERAL CHEMICAL ANALYSIS						
specific weight	g/l		2246	2505	2432	2300

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Project number	t19024	Starting date	27.09.2019
Report number	13113941 - 1	Report date	09.10.2019

Remarks

2	The result is idicative due to the presence of interfering compounds
3	The result for PCB 28 is possibly overestimated because of the presence of PCB 31.

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Report number	13113941 - 1	Report date	09.10.2019

Analyses	Sample type	Relation to standard
dry weight	Sediment	Sediment: In house method (analysis equivalent to ISO 11465 and equivalent to NEN-EN 15934). Sediment (AS3000): in accordance with AS3210-1 and in accordance with NEN-EN 15934
sample pretreatment (sieving <2mm)	Sediment	In house method (seaving method)
TOC	Sediment	In accordance with NEN-EN 13137
min. parts <2um	Sediment	Gathered from NEN 5753
min. parts <20um	Sediment	Ditto
min. parts <63um	Sediment	In house method (seaving method)
min. parts <2 mm	Sediment	Ditto
min. parts >2 mm	Sediment	Ditto
aluminium	Sediment	digestion in accordance with NEN 6961, measurement in accordance with NEN-EN-ISO 17294-2
arsenic	Sediment	Ditto
cadmium	Sediment	Ditto
chromium	Sediment	Ditto
cobalt	Sediment	Ditto
copper	Sediment	Ditto
mercury	Sediment	Ditto
lead	Sediment	Ditto
nickel	Sediment	Ditto
iron	Sediment	Ditto
zinc	Sediment	Ditto
phenanthrene	Sediment	Own method, extraction with acetone-hexane, analysis with GC-MS
anthracene	Sediment	Ditto
fluoranthene	Sediment	Ditto
pyrene	Sediment	Ditto
benzo(a)anthracene	Sediment	Ditto
chrysene	Sediment	Ditto
benzo(a)pyrene	Sediment	Ditto
benzo(ghi)perylene	Sediment	Ditto
indeno(1,2,3-cd)pyrene	Sediment	Ditto
hexachlorobenzene	Sediment	Own method, analysis with GC-MS
PCB 28	Sediment	In-house method, acetone/hexane-extraction, analysis with GC-MS.
PCB 52	Sediment	Ditto
PCB 101	Sediment	Ditto
PCB 118	Sediment	Ditto
PCB 138	Sediment	Ditto
PCB 153	Sediment	Ditto
PCB 180	Sediment	Ditto
total (7) PCB	Sediment	Ditto
specific weight	Sediment	In house method

Sample	Barcode	Reception date	Sampling date	Container
001	Y5756355	25.09.2019	14.09.2019	ALC201
001	Y5756298	25.09.2019	14.09.2019	ALC201

Initials :

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Analytical report

Project name	Conservation_Plan_Lukanga_Swamp	Order date	27.09.2019
Project number	t19024	Starting date	27.09.2019
Report number	13113941 - 1	Report date	09.10.2019

Sample	Barcode	Reception date	Sampling date	Container
001	Y5756381	25.09.2019	14.09.2019	ALC201
002	Y5756392	25.09.2019	14.09.2019	ALC201
002	Y5756386	25.09.2019	14.09.2019	ALC201
003	Y5756394	25.09.2019	14.09.2019	ALC201
003	Y5756390	25.09.2019	14.09.2019	ALC201
003	Y5756387	25.09.2019	14.09.2019	ALC201
004	Y5756382	25.09.2019	14.09.2019	ALC201
004	Y5756393	25.09.2019	14.09.2019	ALC201
005	Y5755340	25.09.2019	14.09.2019	ALC201
005	Y5755360	25.09.2019	14.09.2019	ALC201
006	Y5756397	25.09.2019	14.09.2019	ALC201
006	Y5756396	25.09.2019	14.09.2019	ALC201
007	Y5755346	25.09.2019	14.09.2019	ALC201
007	Y5755349	25.09.2019	14.09.2019	ALC201
008	Y5755352	25.09.2019	14.09.2019	ALC201
008	Y5755241	25.09.2019	14.09.2019	ALC201
009	Y5755247	25.09.2019	14.09.2019	ALC201
009	Y5755290	25.09.2019	14.09.2019	ALC201
010	V6957993	25.09.2019	14.09.2019	ALC201
010	V6958001	25.09.2019	14.09.2019	ALC201
011	V6958023	25.09.2019	14.09.2019	ALC201
011	V6958005	25.09.2019	14.09.2019	ALC201
012	V6958004	25.09.2019	14.09.2019	ALC201
012	V6958015	25.09.2019	14.09.2019	ALC201
012	V6957999	25.09.2019	14.09.2019	ALC201
013	Y5755339	25.09.2019	14.09.2019	ALC201
013	Y5755341	25.09.2019	14.09.2019	ALC201
014	V6957988	25.09.2019	14.09.2019	ALC201
014	V6957998	25.09.2019	14.09.2019	ALC201
015	Y5755336	25.09.2019	14.09.2019	ALC201
015	Y5756311	25.09.2019	14.09.2019	ALC201
016	Y5756391	25.09.2019	14.09.2019	ALC201
016	Y5756384	25.09.2019	14.09.2019	ALC201
017	Y5756360	25.09.2019	14.09.2019	ALC201
017	Y5756388	25.09.2019	14.09.2019	ALC201
018	V6957987	25.09.2019	14.09.2019	ALC201
018	V6958003	25.09.2019	14.09.2019	ALC201
018	V6958000	25.09.2019	14.09.2019	ALC201
019	Y5756389	25.09.2019	14.09.2019	ALC201
019	Y5756385	25.09.2019	14.09.2019	ALC201
019	Y5756383	25.09.2019	14.09.2019	ALC201

Initials :

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SYNLAB Analytics & Services B.V.
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Steenhouwerstraat 15 · 3194 AG Rotterdam
Tel.: +34 93 363 6000
www.synlab.nl

Analytical report

NEMUS - Gestão e Requalificação Ambiental Lda
César Jesus
Estrada do Paço do Lumiar
Campus do Lumiar,Edifício D, R/Chão
PT-1649-038 LISBOA

Your Project name	: Conservation_Plan_Lukanga_Swamp - 2
Your Project number	: t19024
SYNLAB report number	: 13137776, version: 2
Certificate code	: VTQP3E4D

Rotterdam, 15.11.2019

Dear Mr./Mrs,

Attached you find the results of the laboratory tests carried out for your project t19024. The tests were carried out according to your order. The reported results refer only to the tested samples. The sample description, sample date (if provided) and project description were adopted from your order.

All tests were carried out by SYNLAB Analytics & Services B.V., Steenhouwerstraat 15, Rotterdam, Netherlands. Tests outsourced or carried out by the SYNLAB laboratory in France (99-101 Avenue Louis Roche, Gennevilliers) are marked in the report.

This certificate contains inclusive attachments 12 pages. In case of a version number of '2' or higher all former versions of the certificate are invalid. All attachments are inextricably part of this certificate. Only reproduction of the whole report is allowed.

In case of questions and/or remarks related to this certificate, for example in case of information required about measurement uncertainty of the analytical methods, please contact our Customer Support department.

Yours faithfully,

Jaap-Willem Hutter
Technical Director

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Analytical report

Project name	Conservation_Plan_Lukanga_Swamp - 2	Order date	31.10.2019
Project number	t19024	Starting date	05.11.2019
Report number	13137776 - 2	Report date	15.11.2019

Code	Sample type	Sample description
001	div. (solid)	sample nº 28 - Leaves
002	div. (solid)	sample nº 29 - Leaves
003	div. (solid)	sample nº 27 - Leaves
004	div. (solid)	sample nº 25 - Leaves
005	div. (solid)	sample nº 16 - Leaves

Analysis	Unit	Q	001	002	003	004	005
ANALYSES OUTSOURCED							
9 metals in vegetal leaves			see appendix	see appendix	see appendix	see appendix	see appendix

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Analytical report

Project name	Conservation_Plan_Lukanga_Swamp - 2	Order date	31.10.2019
Project number	t19024	Starting date	05.11.2019
Report number	13137776 - 2	Report date	15.11.2019

Code	Sample type	Sample description
006	div. (solid)	sample nº 2 - Leaves
007	div. (solid)	sample nº 26 - Leaves
008	div. (solid)	sample nº 11 - Leaves
009	div. (solid)	sample nº 15 - Leaves
010	div. (solid)	sample nº 17 - Leaves

Analysis	Unit	Q	006	007	008	009	010
ANALYSES OUTSOURCED							
9 metals in vegetal leaves			see appendix	see appendix	see appendix	see appendix	see appendix

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Analytical report

Project name	Conservation_Plan_Lukanga_Swamp - 2	Order date	31.10.2019
Project number	t19024	Starting date	05.11.2019
Report number	13137776 - 2	Report date	15.11.2019

Code	Sample type	Sample description
011	Sediment	sample nº 26 - Sediment
012	Sediment	sample nº 27 - Sediment

Analysis	Unit	Q	011	012
dry weight	wght.-%	Q	34.4	45.5
sample pretreatment (sieving <2mm)			yes	yes
TOC	mg/kgdm	Q	91000	38000
PARTICAL SIZE				
min. parts <2um	% of DM	Q	26	11
min. parts <20um	% of DM		34	21
min. parts <63um	% of DM	Q	36	25
min. parts <2 mm	% of DM	Q	53	64
min. parts >2 mm	% of DM	Q	1.2	<1
METALS				
aluminium	mg/kgdm	Q	23000	14000
arsenic	mg/kgdm	Q	<4	<4
cadmium	mg/kgdm	Q	<0.2	<0.2
chromium	mg/kgdm	Q	34	15
cobalt	mg/kgdm	Q	11	4.9
copper	mg/kgdm	Q	30	15
mercury	mg/kgdm	Q	<0.05	<0.05
lead	mg/kgdm	Q	15	<10
nickel	mg/kgdm	Q	19	11
iron	mg/kgdm	Q	11000	6200
zinc	mg/kgdm	Q	<20	<20
POLYCYCLIC AROMATIC HYDROCARBONS				
phenanthrene	mg/kgdm	Q	<0.04 [1)]	<0.03 [1)]
anthracene	mg/kgdm	Q	<0.04 [1)]	<0.03 [1)]
fluoranthene	mg/kgdm	Q	<0.04 [1)]	<0.03 [1)]
pyrene	mg/kgdm	Q	<0.04 [1)]	<0.03 [1)]
benzo(a)anthracene	mg/kgdm	Q	<0.04 [1)]	<0.03 [1)]
chrysene	mg/kgdm	Q	<0.04 [1)]	<0.03 [1)]
benzo(a)pyrene	mg/kgdm	Q	<0.04 [1)]	<0.03 [1)]
benzo(ghi)perylene	mg/kgdm	Q	<0.04 [1)]	<0.03 [1)]
indeno(1,2,3-cd)pyrene	mg/kgdm	Q	<0.04 [1)]	<0.03 [1)]
sum PAHs (9 OSPAR)	mg/kgdm		<0.36	<0.27
CHLOROBENZENES				
hexachlorobenzene	µg/kgdm		<0.74 [1)]	<0.51 [1)]
POLYCHLORINATED BIPHENYLS				
PCB 28	µg/kgdm	Q	<1	<1
PCB 52	µg/kgdm	Q	<1	<1
PCB 101	µg/kgdm	Q	<1	<1

Analysis marked with Q are accredited by the RvA

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Analytical report

Project name	Conservation_Plan_Lukanga_Swamp - 2	Order date	31.10.2019
Project number	t19024	Starting date	05.11.2019
Report number	13137776 - 2	Report date	15.11.2019

Code	Sample type	Sample description
011	Sediment	sample nº 26 - Sediment
012	Sediment	sample nº 27 - Sediment

Analysis	Unit	Q	011	012
PCB 118	µg/kgdm	Q	<1	<1
PCB 138	µg/kgdm	Q	<1	<1
PCB 153	µg/kgdm	Q	<1	<1
PCB 180	µg/kgdm	Q	<1	<1
total (7) PCB	µg/kgdm		4.9	4.9
SEVERAL CHEMICAL ANALYSIS				
specific weight	g/l		1821	2114

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Analytical report

Project name	Conservation_Plan_Lukanga_Swamp - 2	Order date	31.10.2019
Project number	t19024	Starting date	05.11.2019
Report number	13137776 - 2	Report date	15.11.2019

Remarks

1	Increased detectionlimit due to a high moisture content.

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Analytical report

Project name	Conservation_Plan_Lukanga_Swamp - 2	Order date	31.10.2019
Project number	t19024	Starting date	05.11.2019
Report number	13137776 - 2	Report date	15.11.2019

Analyses	Sample type	Relation to standard
dry weight	Sediment	Sediment: In house method (analysis equivalent to ISO 11465 and equivalent to NEN-EN 15934). Sediment (AS3000): in accordance with AS3210-1 and in accordance with NEN-EN 15934
sample pretreatment (sieving <2mm)	Sediment	In house method (seaving method)
TOC	Sediment	In accordance with NEN-EN 13137
min. parts <2um	Sediment	Gathered from NEN 5753
min. parts <20um	Sediment	Ditto
min. parts <63um	Sediment	In house method (seaving method)
min. parts <2 mm	Sediment	Ditto
min. parts >2 mm	Sediment	Ditto
aluminium	Sediment	digestion in accordance with NEN 6961, measurement in accordance with NEN-EN-ISO 17294-2
arsenic	Sediment	Ditto
cadmium	Sediment	Ditto
chromium	Sediment	Ditto
cobalt	Sediment	Ditto
copper	Sediment	Ditto
mercury	Sediment	Ditto
lead	Sediment	Ditto
nickel	Sediment	Ditto
iron	Sediment	Ditto
zinc	Sediment	Ditto
phenanthrene	Sediment	Own method, extraction with acetone-hexane, analysis with GC-MS
anthracene	Sediment	Ditto
fluoranthene	Sediment	Ditto
pyrene	Sediment	Ditto
benzo(a)anthracene	Sediment	Ditto
chrysene	Sediment	Ditto
benzo(a)pyrene	Sediment	Ditto
benzo(ghi)perylene	Sediment	Ditto
indeno(1,2,3-cd)pyrene	Sediment	Ditto
hexachlorobenzene	Sediment	Own method, analysis with GC-MS
PCB 28	Sediment	In-house method, acetone/hexane-extraction, analysis with GC-MS.
PCB 52	Sediment	Ditto
PCB 101	Sediment	Ditto
PCB 118	Sediment	Ditto
PCB 138	Sediment	Ditto
PCB 153	Sediment	Ditto
PCB 180	Sediment	Ditto
total (7) PCB	Sediment	Ditto
specific weight	Sediment	In house method
9 metals in vegetal leaves	div. (solid)	Subcontracted analysis

Sample	Barcode	Reception date	Sampling date	Container
001	X1295191	05.11.2019	10.10.2019	ALC201

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Analytical report

Project name	Conservation_Plan_Lukanga_Swamp - 2	Order date	31.10.2019
Project number	t19024	Starting date	05.11.2019
Report number	13137776 - 2	Report date	15.11.2019

Sample	Barcode	Reception date	Sampling date	Container
002	X1295198	05.11.2019	10.10.2019	ALC201
003	X1295193	05.11.2019	10.10.2019	ALC201
004	X1295197	05.11.2019	10.10.2019	ALC201
005	X1295194	05.11.2019	10.10.2019	ALC201
006	X1295195	05.11.2019	10.10.2019	ALC201
007	X1295196	05.11.2019	10.10.2019	ALC201
008	X1295192	05.11.2019	10.10.2019	ALC201
009	X1295199	05.11.2019	10.10.2019	ALC201
010	X1295190	05.11.2019	10.10.2019	ALC201
011	V6957994	05.11.2019	21.10.2019	ALC201
011	V6957991	05.11.2019	21.10.2019	ALC201
011	V6957995	05.11.2019	21.10.2019	ALC201
012	V6957992	05.11.2019	21.10.2019	ALC201
012	V6957989	05.11.2019	21.10.2019	ALC201
012	V6957986	05.11.2019	21.10.2019	ALC201

Initials :

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Standort Jena
Orlaweg 2
07743 Jena
Deutschland

SYNLAB Analytics & Services Germany GmbH . Orlaweg 2 . 07743 Jena

SYNLAB Analytics & Services B.V.
C/ Verge de Guadalupe, 18
08950 Esplugues, Barcelona
Spanien

Your contact:
Waldemar Demidow
Scientific Staff
Division Residues and Contaminants
Phone +49(0)3641 / 3096 - 345
waldemar.demidow@synlab.com
www.synlab.de

Test report for order no. F 23709 - 19

document no. F2019-023709-0

customer:	SYNLAB Analytics & Services B.V. C/ Verge de Guadalupe, 18, 08950 Esplugues, Barcelona
no. of samples:	10 samples
sample type:	plant material (10x)
sampling:	customer, 05-11-2019
date of sample receipt:	08-11-2019
test period:	08-11-2019 to 11-11-2019

remark: The test results relate only to the items tested. This report shall not be reproduced, except in full, without written consent of SYNLAB Analytics & Services Germany GmbH. This test report has been validated and cleared by the person mentioned below. All tests were conducted at the SYNLAB site in Jena unless stated otherwise.

Samples marked with "Sampling: Client" have been taken within the responsibility of the customer. The details of the sampling and all associated data (information on the sample, on-site values, volume information, etc.) were provided by the customer. They were taken over as transmitted. All results apply to the sample as received.

abbreviations, symbols: --: not determined, not applicable, (S) subcontraction to an accredited laboratory, (SY) conducted at different SYNLAB site; (N) non-accredited test method, loq: limit of quantification, n.determ.: not determined, n.a.: not applicable, n.d.: not detected, n.av.: not available, DM: dry mass, DS: dry substance, FS: fresh substance, OS: original substance, SF: surface, ‡: information provided by the customer

Jena, 11-11-2019

Waldemar Demidow
Scientific Staff
Division Residues and Contaminants

SYNLAB Analytics & Services Germany GmbH
Standort Jena
Orlaweg 2
07743 Jena
Deutschland

Test report for order no. F 23709 - 19
document no. F2019-023709-0

product::	plant material
sampling:	customer, 05-11-2019‡
sample transport:	courier
sample container:	plastic container
sample state:	flawless
date of sample receipt:	08-11-2019
sample temperature on arrival:	unchilled
purchase order no.:	P92108‡

lab no.			L1	L2	L3	L4	L5
labelling of sample(s):			Sample 28 - Leaves†	Sample 29 - Leaves†	Sample 27 - Leaves†	Sample 25 - Leaves†	Sample 16 - Leaves†
sample No.:			13137776-001‡	13137776-002‡	13137776-003‡	13137776-004‡	13137776-005‡
parameter	**analytical method**	**unit**					
sample preparation HNO3-pressure digestion	ASU § 64 LFGB L00.00-19/1 and DIN EN 13805:2014-12		--	--	--	--	--
As	DIN EN ISO 17294: 2017-01	mg/kg	0,0089	0,036	0,12	0,11	0,33
Pb	DIN EN ISO 17294: 2017-01	mg/kg	0,17	0,098	0,29	0,049	0,16
Cd	DIN EN ISO 17294: 2017-01	mg/kg	0,0034	0,0010	0,0017	0,0013	0,0036
Cr	DIN EN ISO 17294: 2017-01	mg/kg	0,40	1,1	0,40	0,13	1,1

SYNLAB Analytics & Services Germany GmbH
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Deutschland

Test report for order no. F 23709 - 19
document no. F2019-023709-0

	lab no.		L1	L2	L3	L4	L5
	labelling of sample(s):		Sample 28 - Leaves‡	Sample 29 - Leaves‡	Sample 27 - Leaves‡	Sample 25 - Leaves‡	Sample 16 - Leaves‡
	sample No.:		13137776-001‡	13137776-002‡	13137776-003‡	13137776-004‡	13137776-005‡
parameter	**analytical method**	**unit**					
Co	DIN EN ISO 17294: 2017-01	mg/kg	0,024	0,18	0,023	0,013	0,46
Cu	DIN EN ISO 17294: 2017-01	mg/kg	1,5	6,6	3,9	1,0	12
Ni	DIN EN ISO 17294: 2017-01	mg/kg	0,23	0,65	0,36	0,10	0,47
Zn	DIN EN ISO 17294: 2017-01	mg/kg	30	26	16	21	7,9
Hg	DIN EN 15763:2010-04	mg/kg	0,0032	0,0045	0,0035	0,0040	0,0036

	lab no.		L6	L7	L8	L9	L10
	labelling of sample(s):		Sample 2 - Leaves‡	Sample 26 - Leaves‡	Sample 11 - Leaves‡	Sample 15 - Leaves‡	Sample 17 - Leaves‡
	sample No.:		13137776-006‡	13137776-007‡	13137776-008‡	13137776-009‡	13137776-010‡
parameter	**analytical method**	**unit**					
sample preparation HNO3-pressure digestion	ASU § 64 LFGB L00.00-19/1 and DIN EN 13805:2014-12		--	--	--	--	--
As	DIN EN ISO 17294: 2017-01	mg/kg	0,011	0,031	0,14	0,084	0,048

SYNLAB Analytics & Services
Germany GmbH
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Orlaweg 2
07743 Jena
Deutschland

Test report for order no. F 23709 - 19
document no. F2019-023709-0

lab no.			L6	L7	L8	L9	L10
labelling of sample(s):			Sample 2 - Leaves‡	Sample 26 - Leaves‡	Sample 11 - Leaves‡	Sample 15 - Leaves‡	Sample 17 - Leaves‡
sample No.:			13137776-006‡	13137776-007‡	13137776-008‡	13137776-009‡	13137776-010‡
parameter	**analytical method**	**unit**					
Pb	DIN EN ISO 17294: 2017-01	mg/kg	0,028	0,30	0,063	0,10	0,072
Cd	DIN EN ISO 17294: 2017-01	mg/kg	0,00090	0,0020	0,0022	0,0030	0,0021
Cr	DIN EN ISO 17294: 2017-01	mg/kg	1,1	0,24	1,1	0,75	0,58
Co	DIN EN ISO 17294: 2017-01	mg/kg	0,049	0,022	1,1	0,41	0,99
Cu	DIN EN ISO 17294: 2017-01	mg/kg	5,4	3,6	19	12	11
Ni	DIN EN ISO 17294: 2017-01	mg/kg	1,0	0,18	0,87	0,44	0,34
Zn	DIN EN ISO 17294: 2017-01	mg/kg	11	15	7,5	11	14
Hg	DIN EN 15763:2010-04	mg/kg	0,0026	0,0028	0,0030	0,0049	0,0043

Appendix 2.4 – Spatial distribution of the parameters determined in the sampled media

A) Distribution of parameters determined in surface water samples

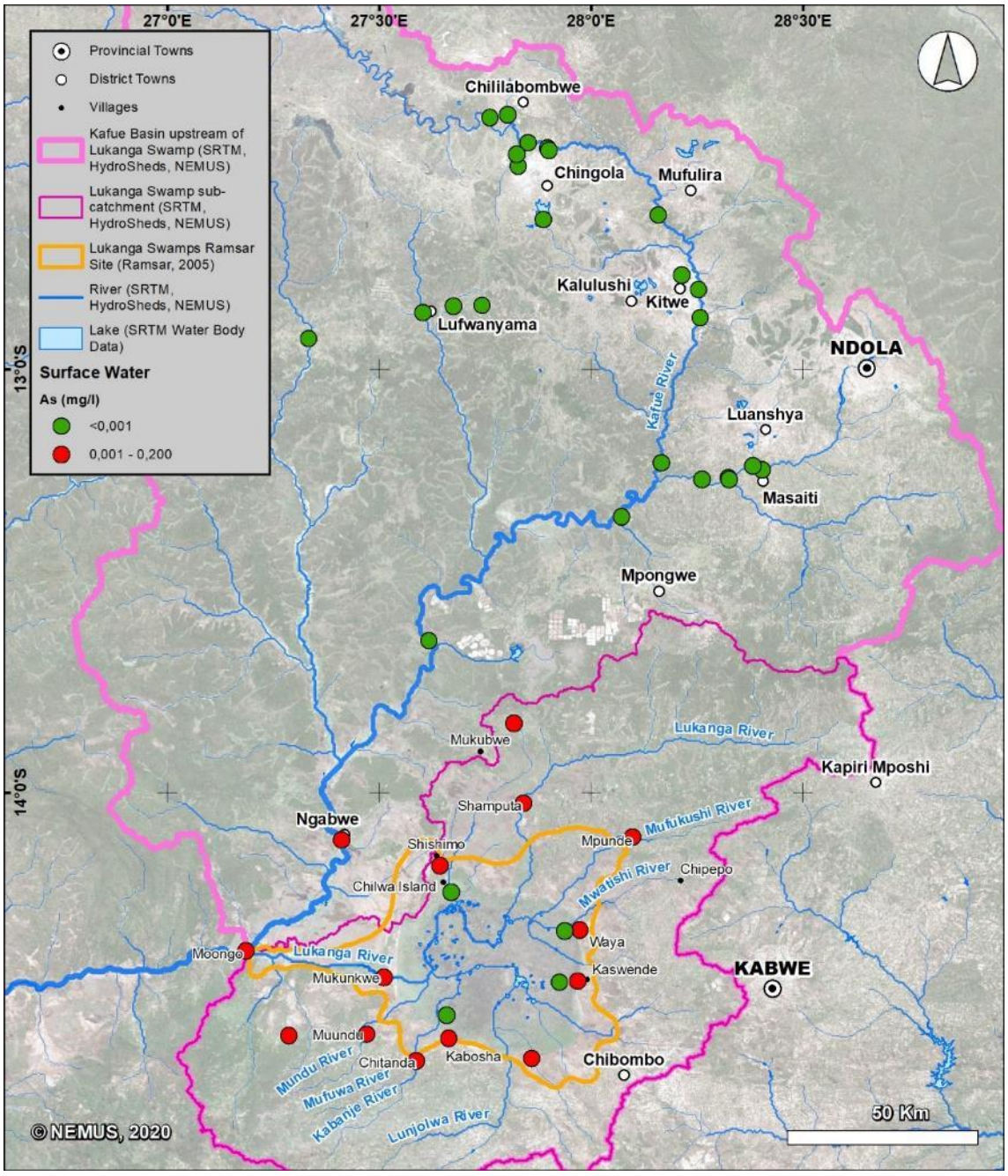


Figure 42 – Distribution of As in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

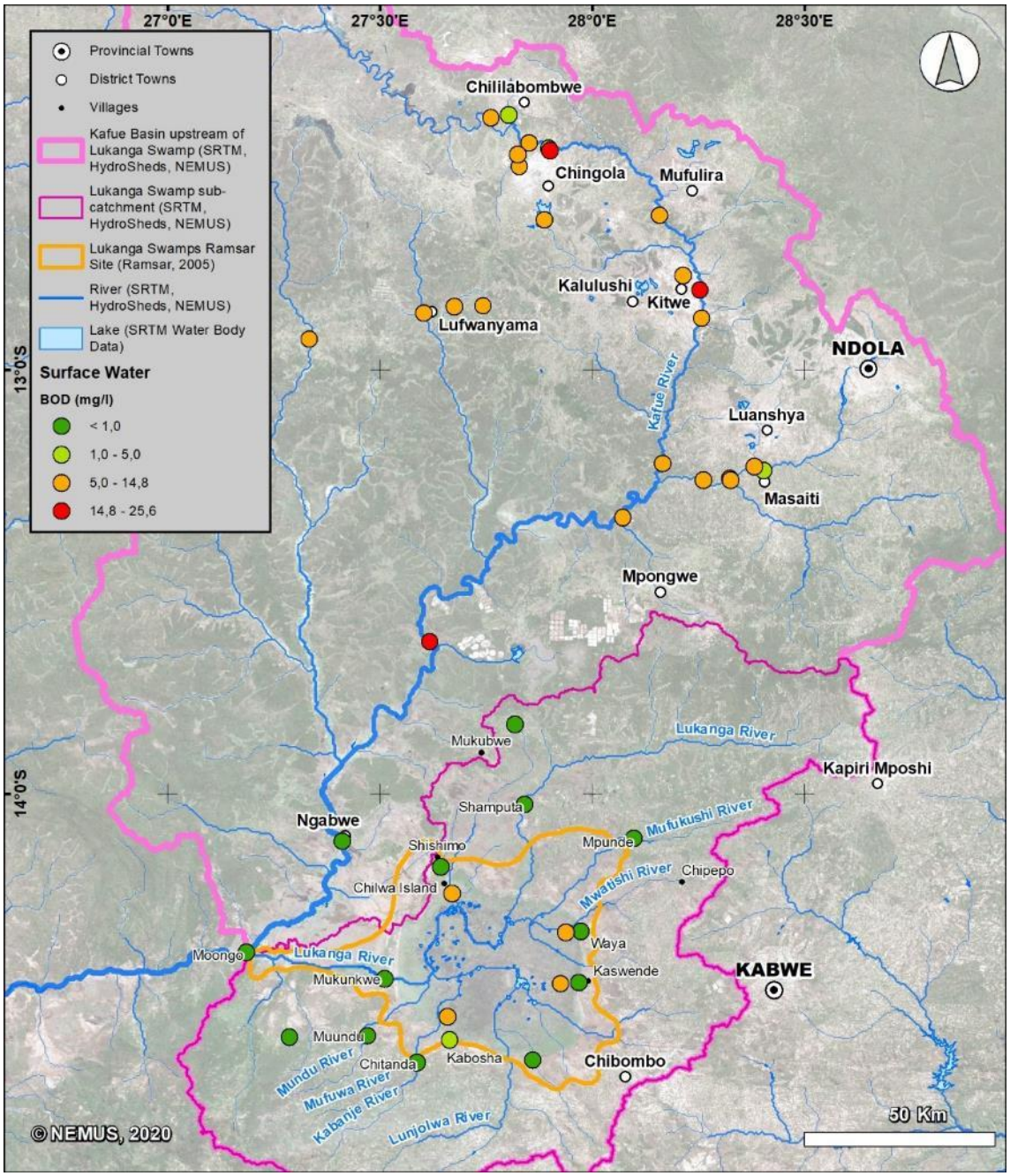


Figure 43 – Distribution of BOD in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

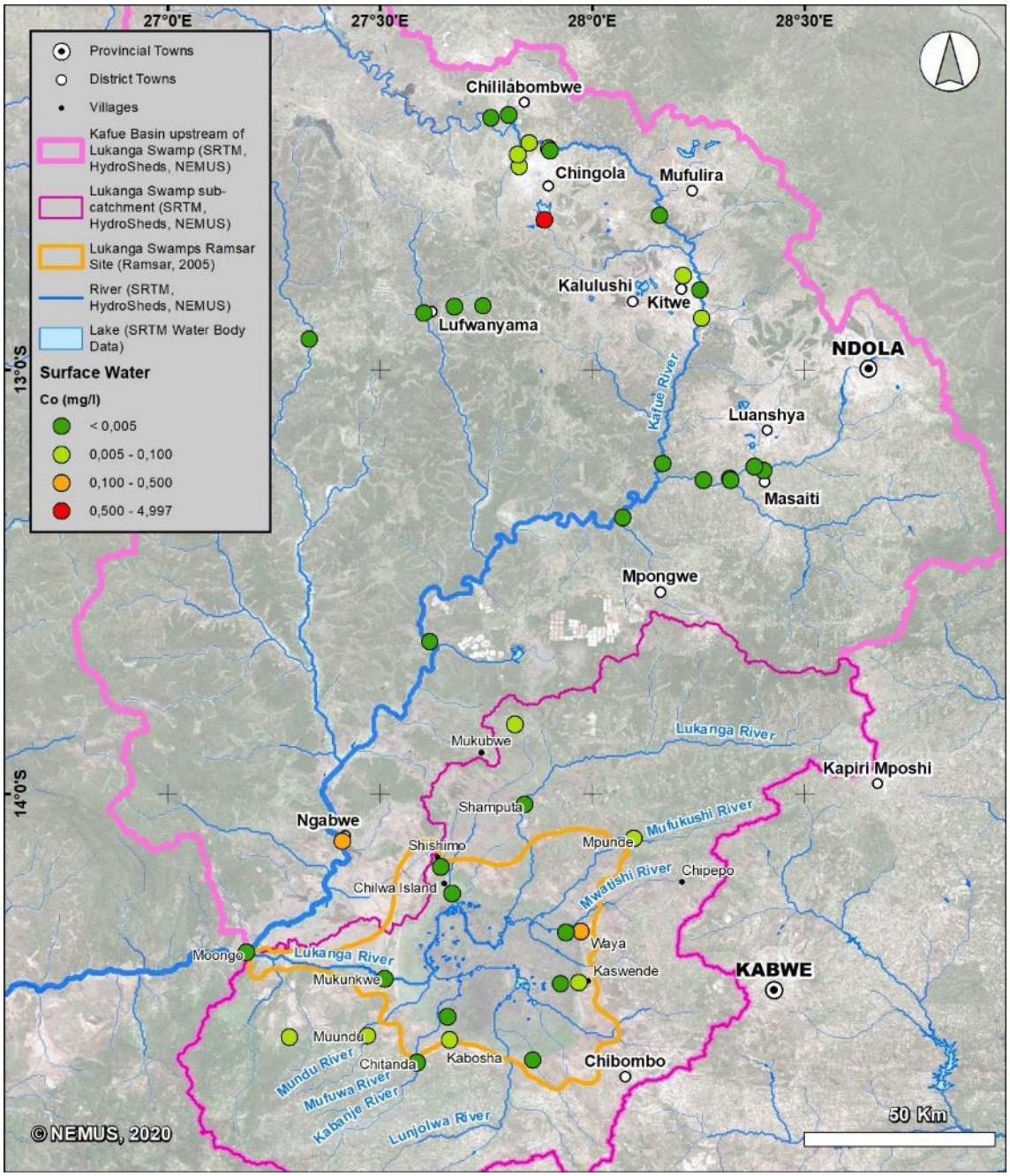


Figure 44 – Distribution of Co in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

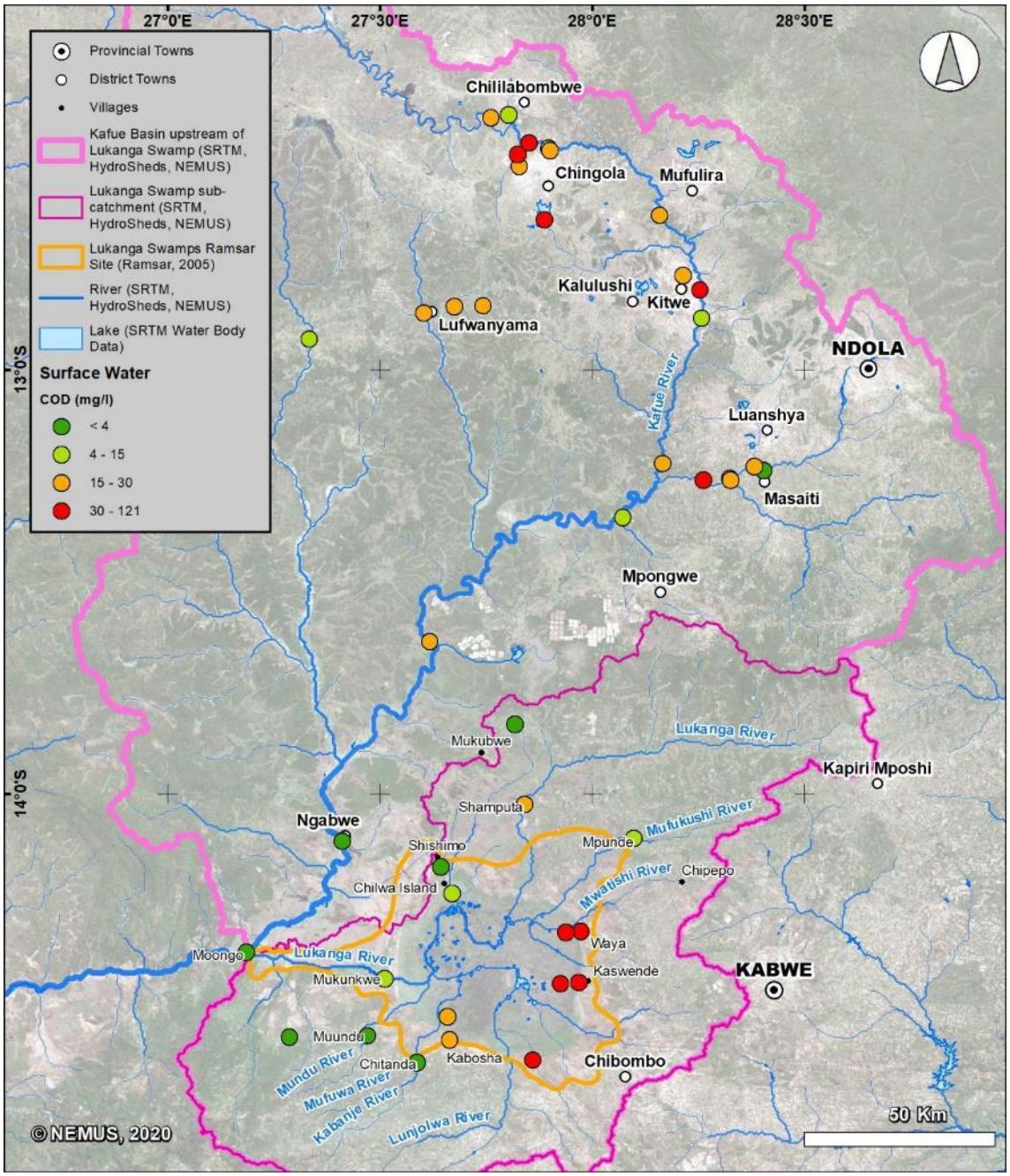


Figure 45 – Distribution of COD in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

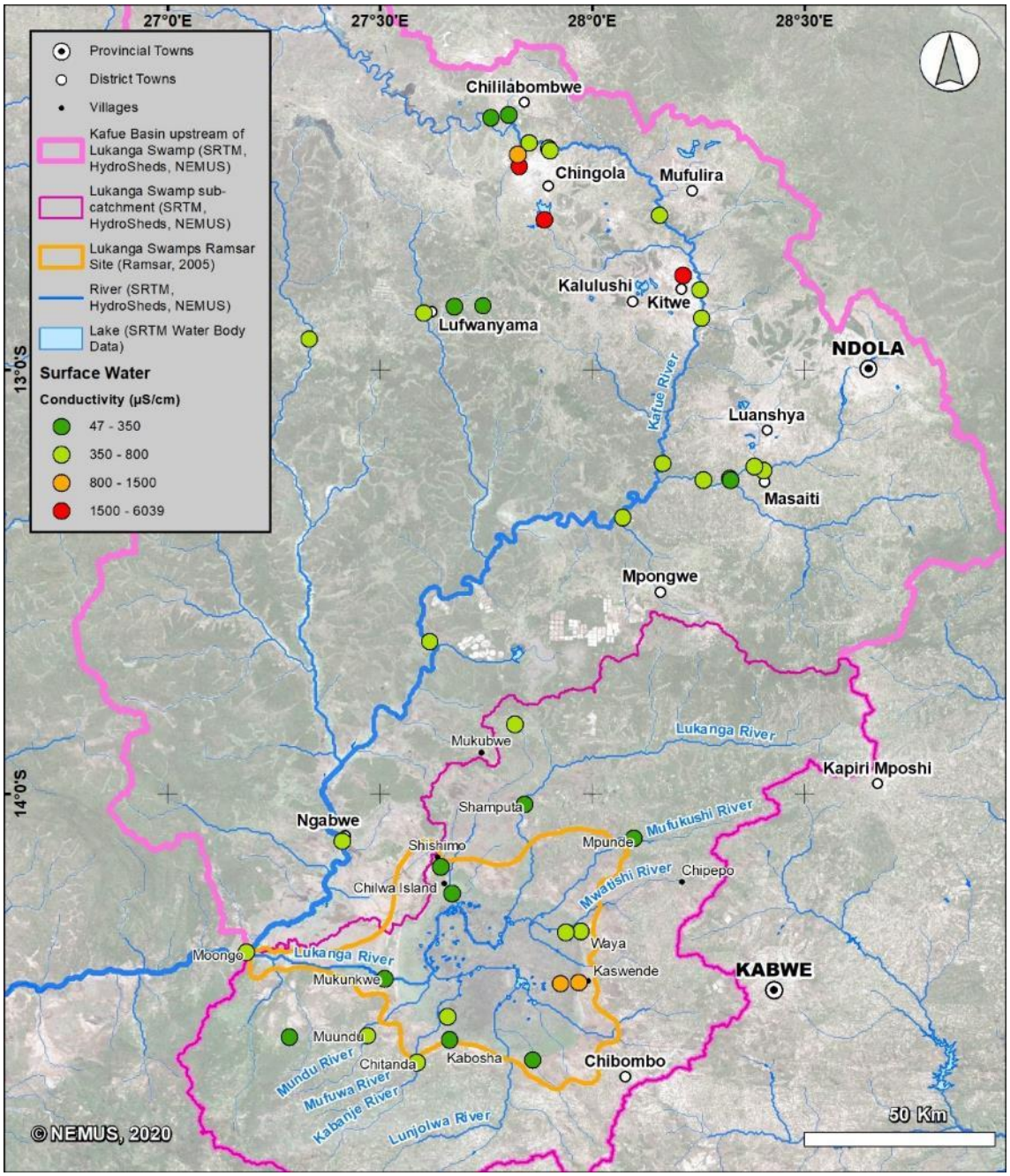


Figure 46 – Distribution of conductivity in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

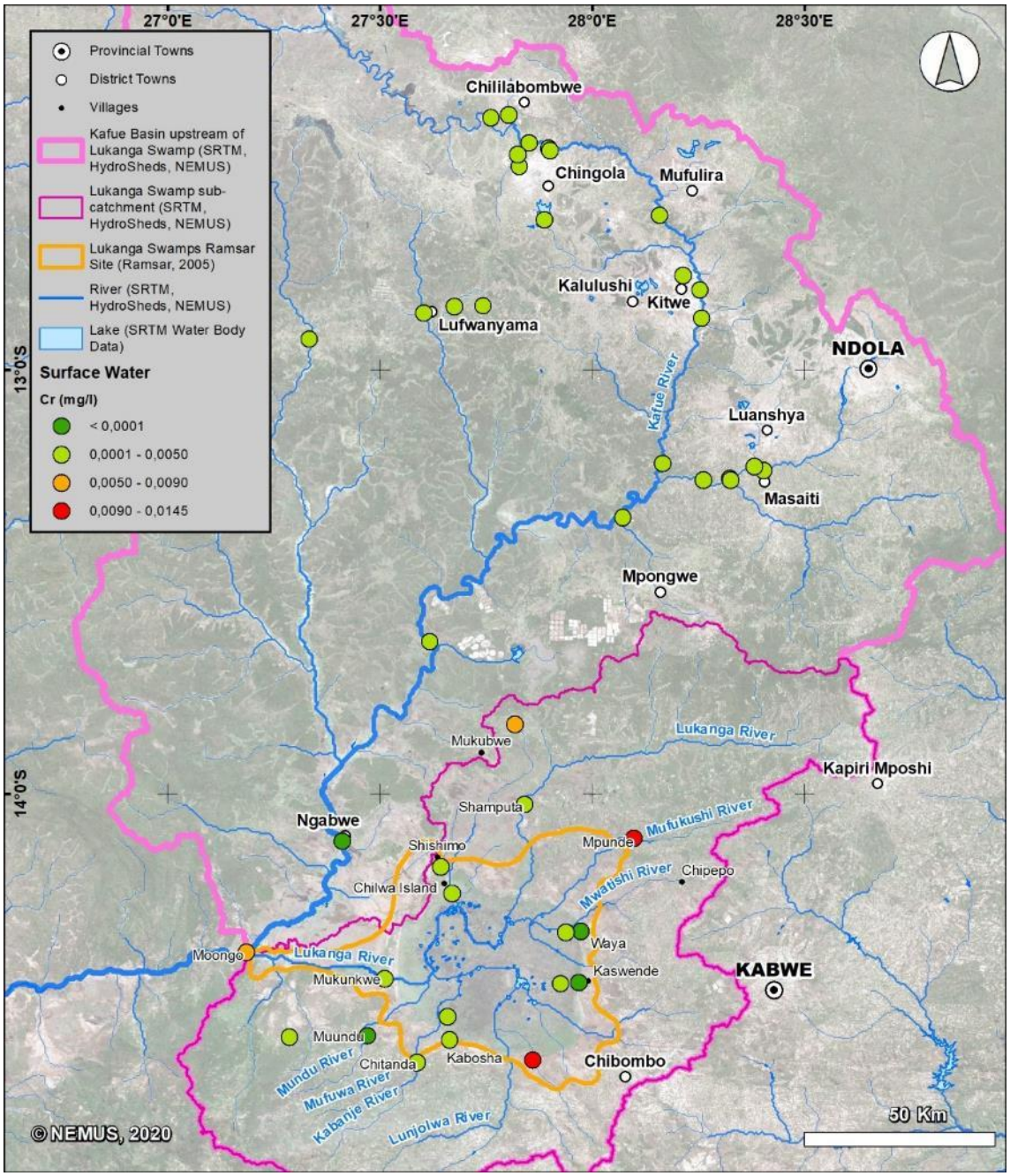


Figure 47 – Distribution of Cr in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

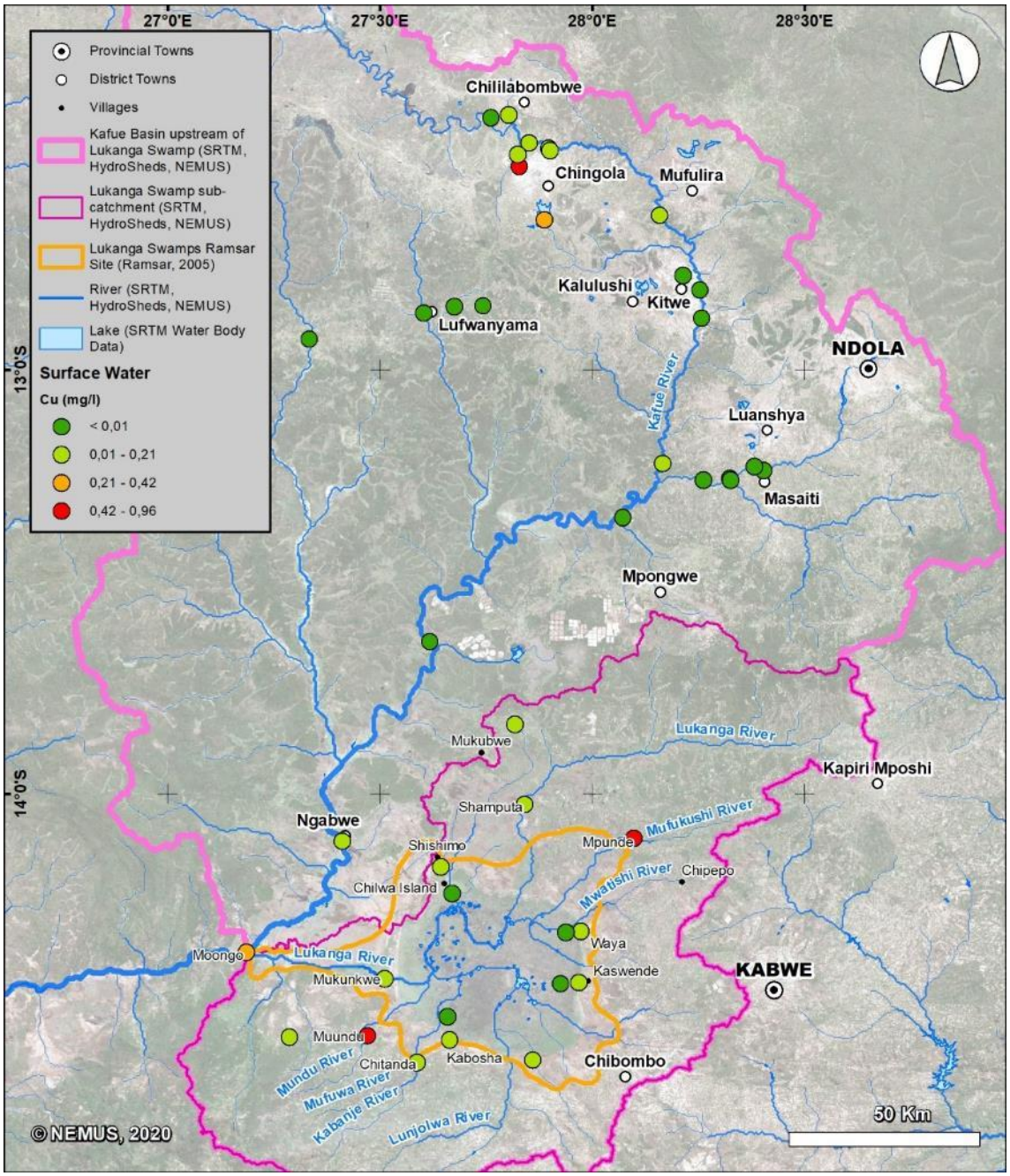


Figure 48 – Distribution of Cu in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

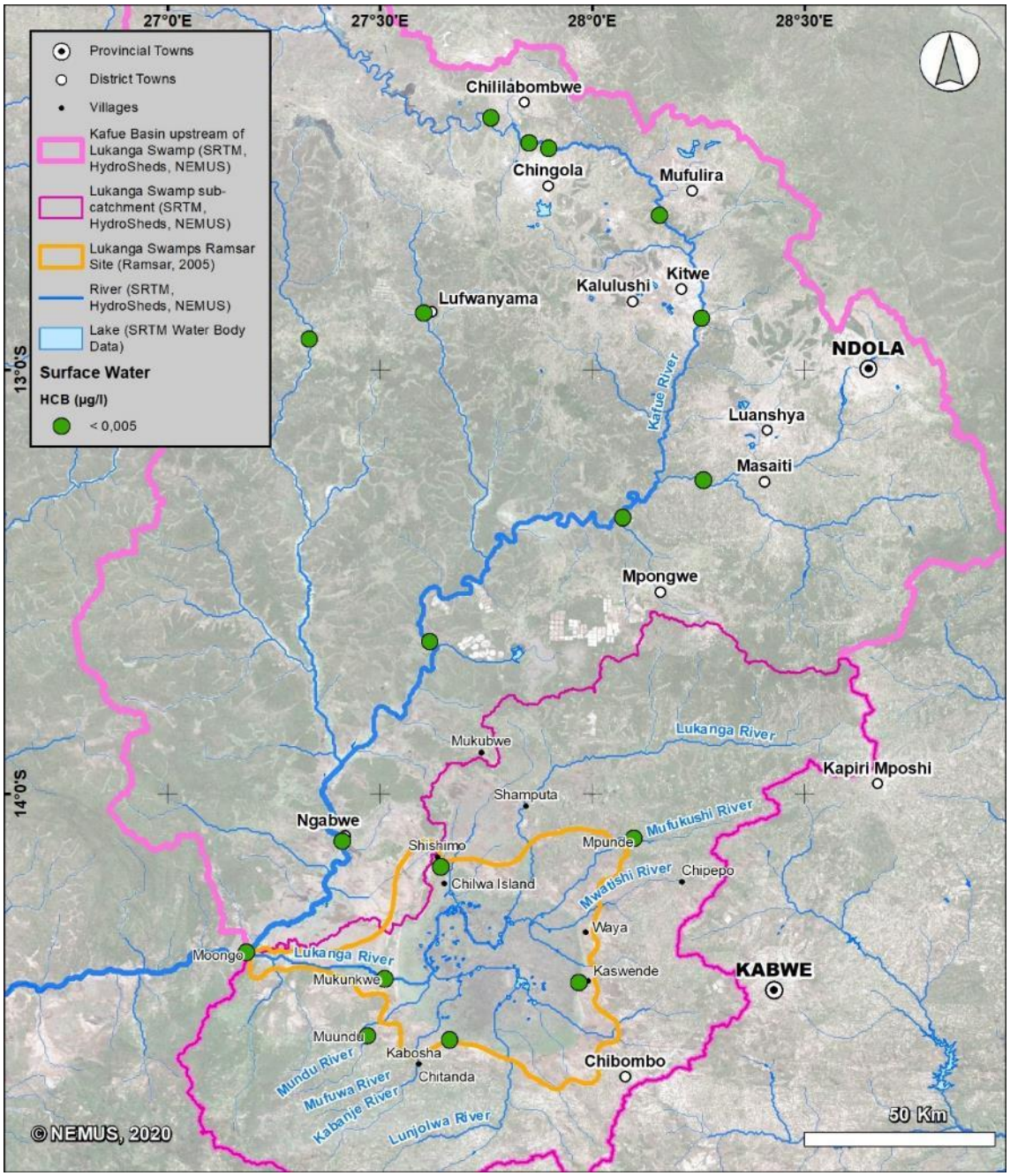


Figure 49 – Distribution of HCB in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

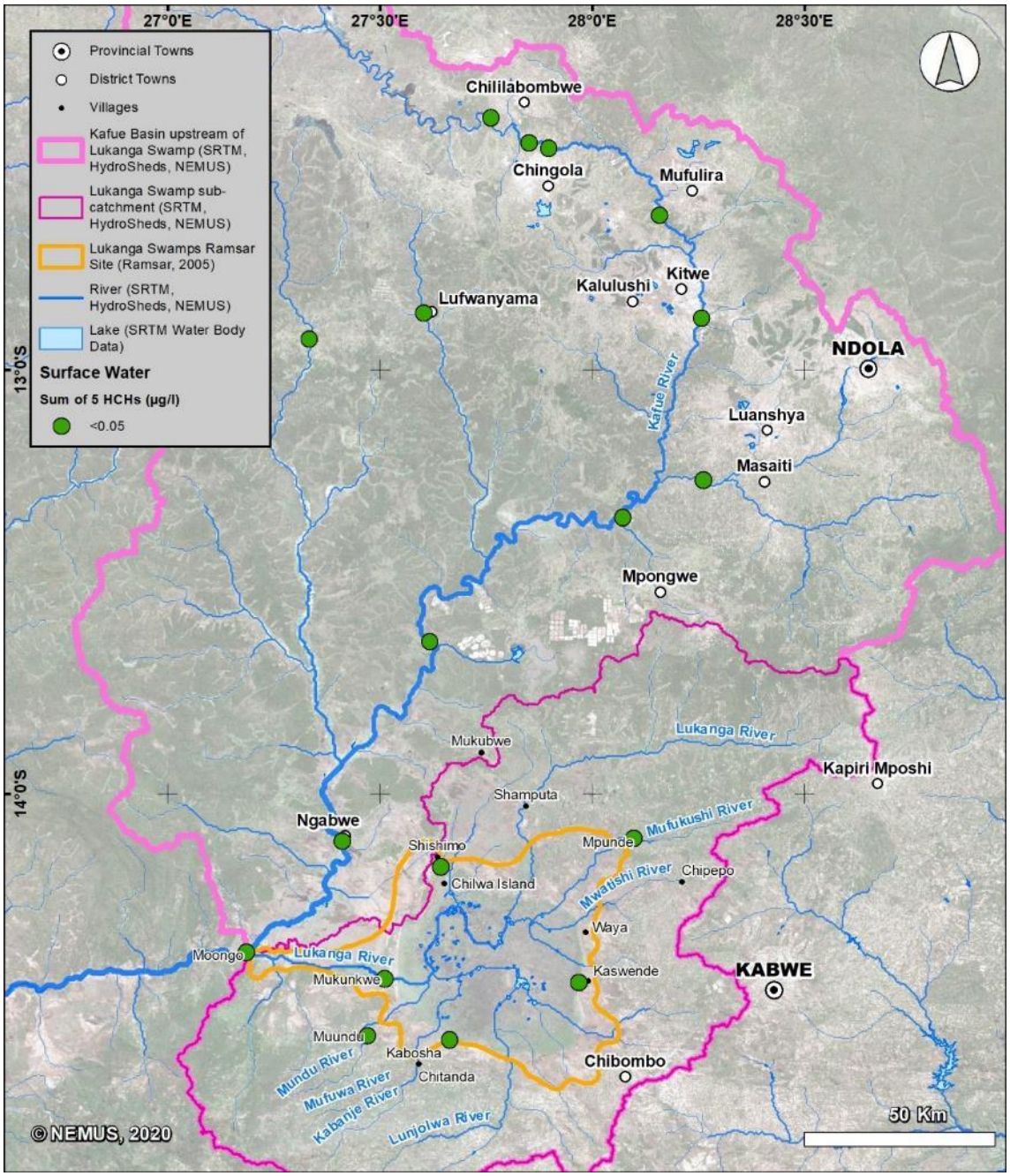


Figure 50 – Distribution of HCH in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

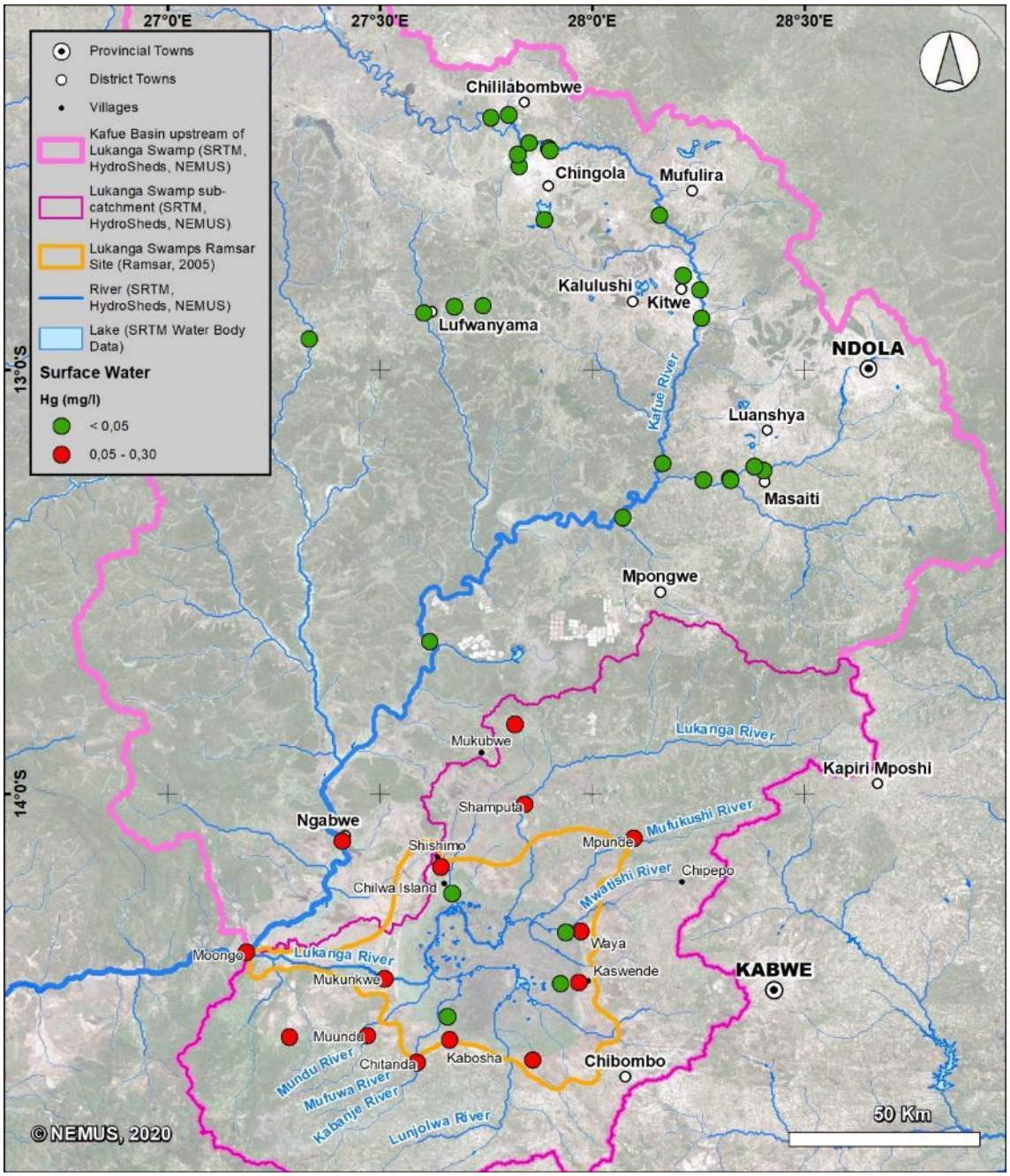


Figure 51 – Distribution of Hg in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

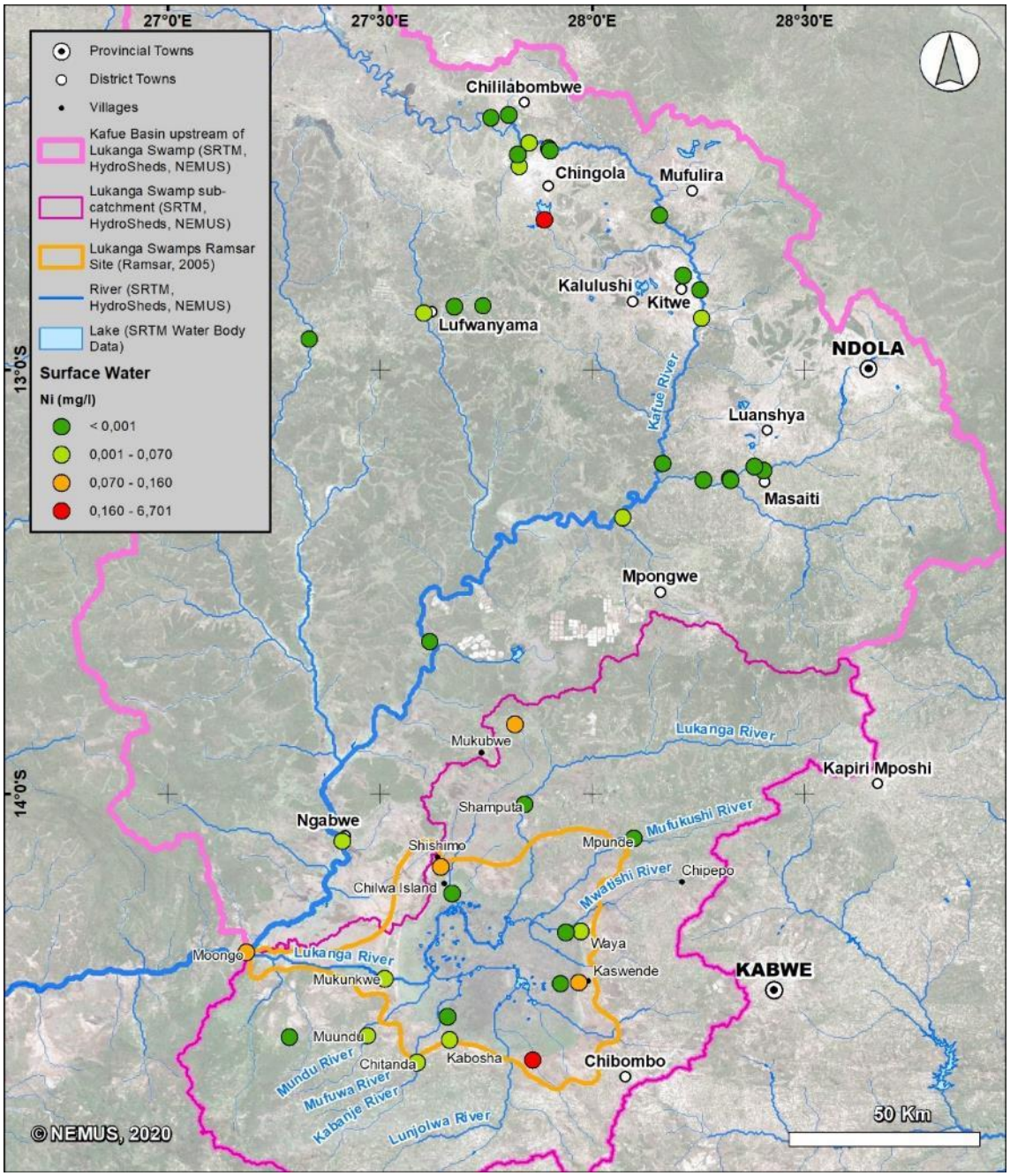


Figure 52 – Distribution of Ni in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

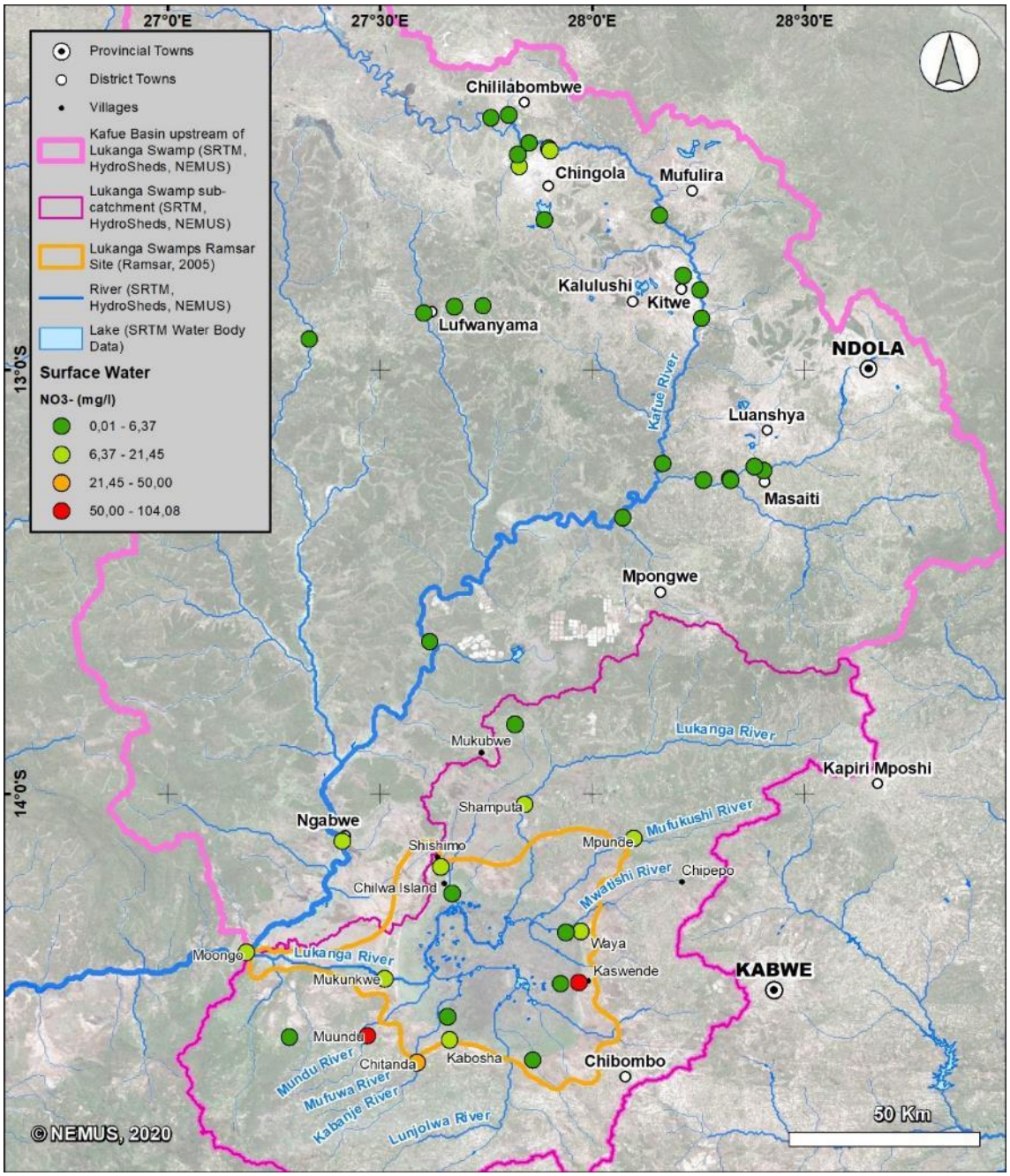


Figure 53 – Distribution of nitrates in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

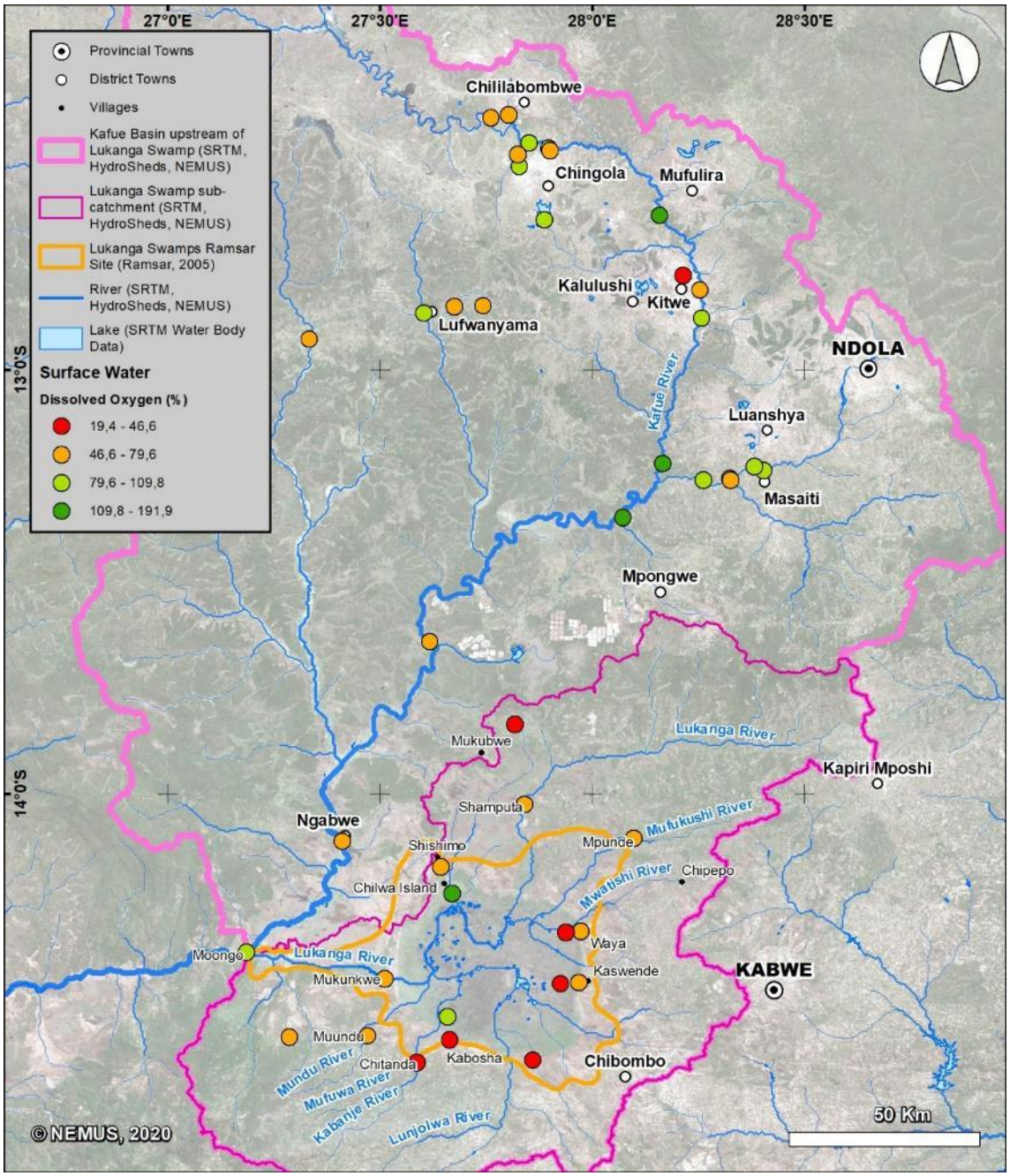


Figure 54 – Distribution of dissolved oxygen in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

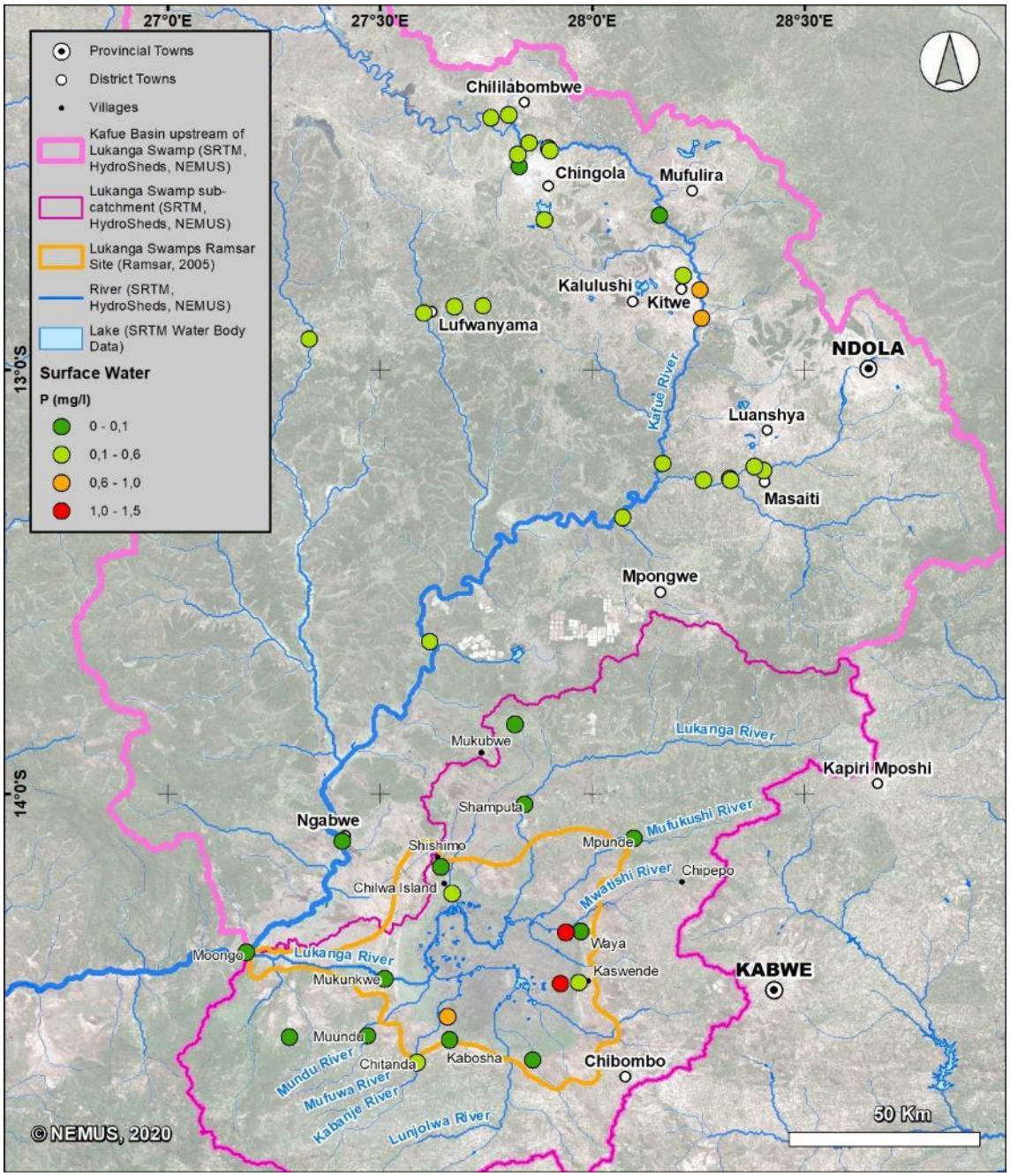


Figure 55 – Distribution of phosphorus in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

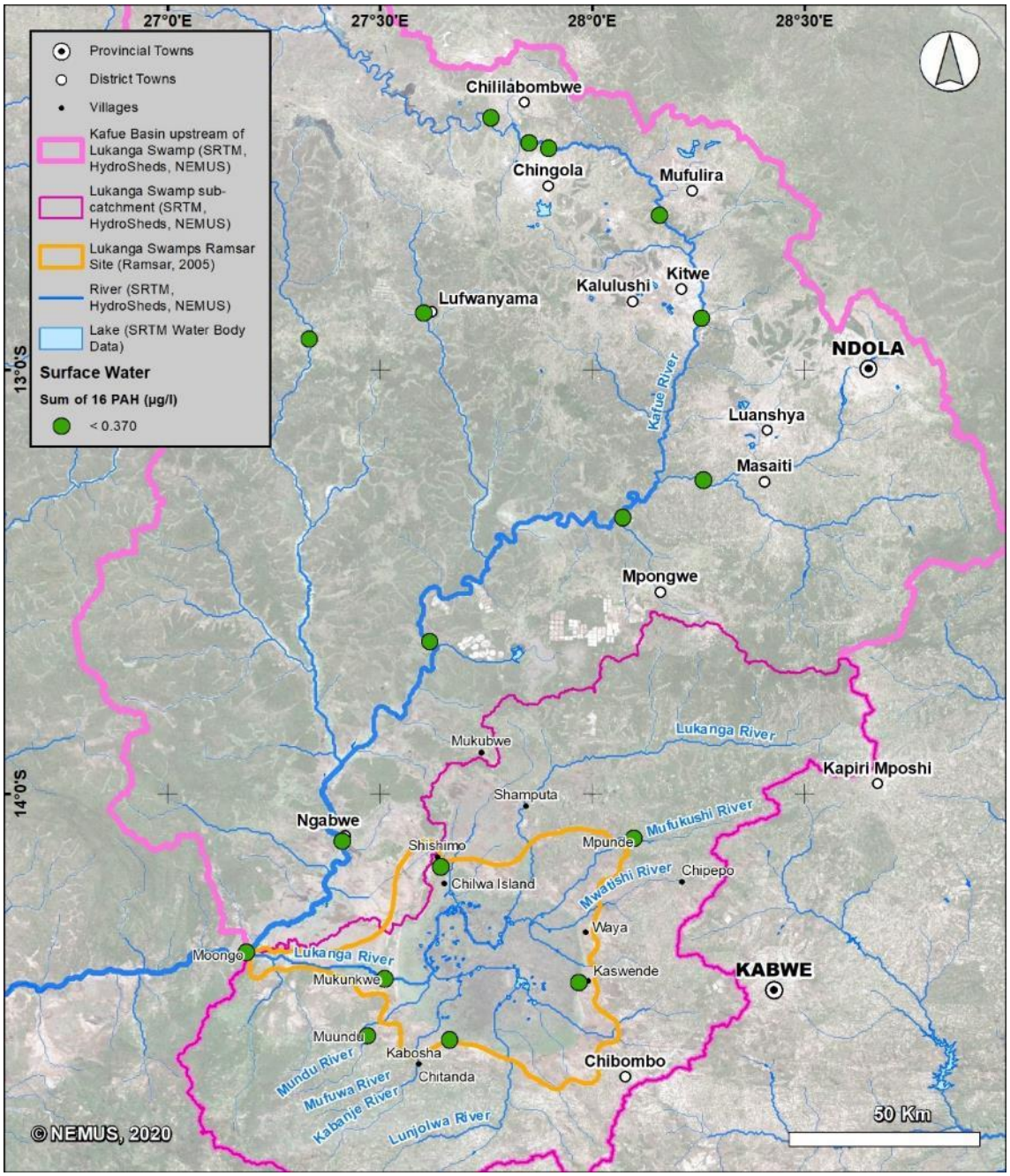


Figure 56 – Distribution of PAH in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

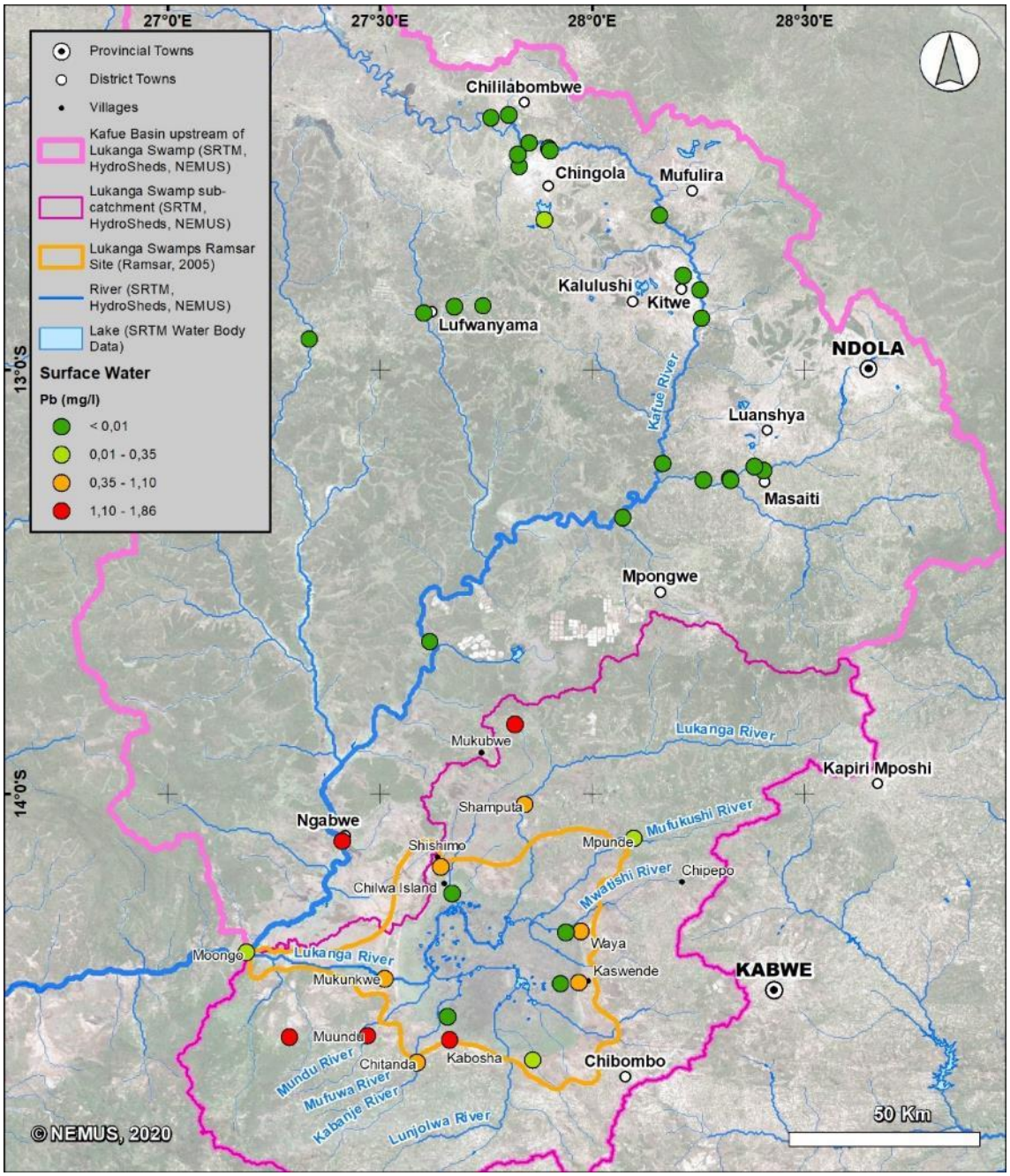


Figure 57 – Distribution of Pb in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

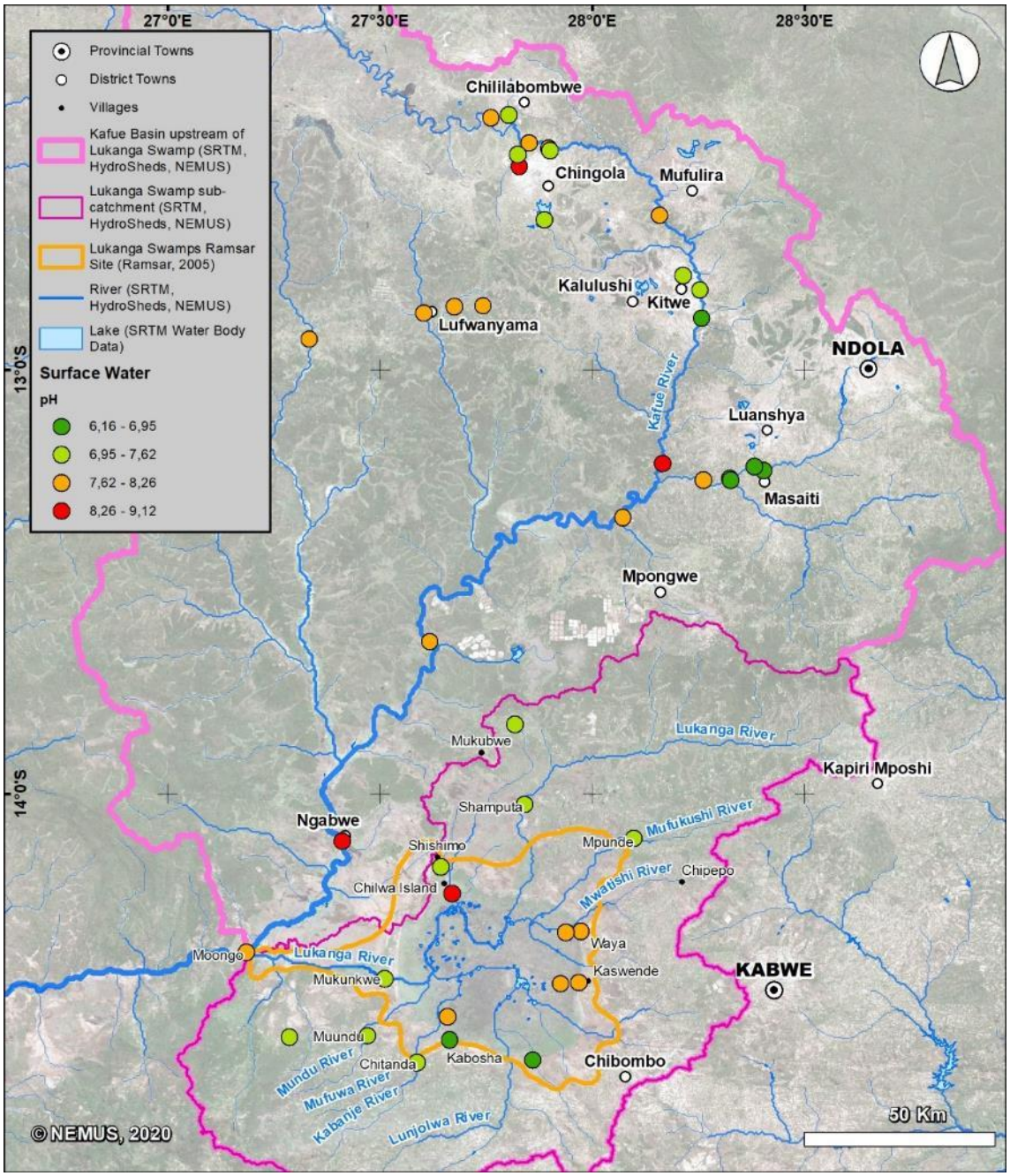


Figure 58 – Distribution of pH in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

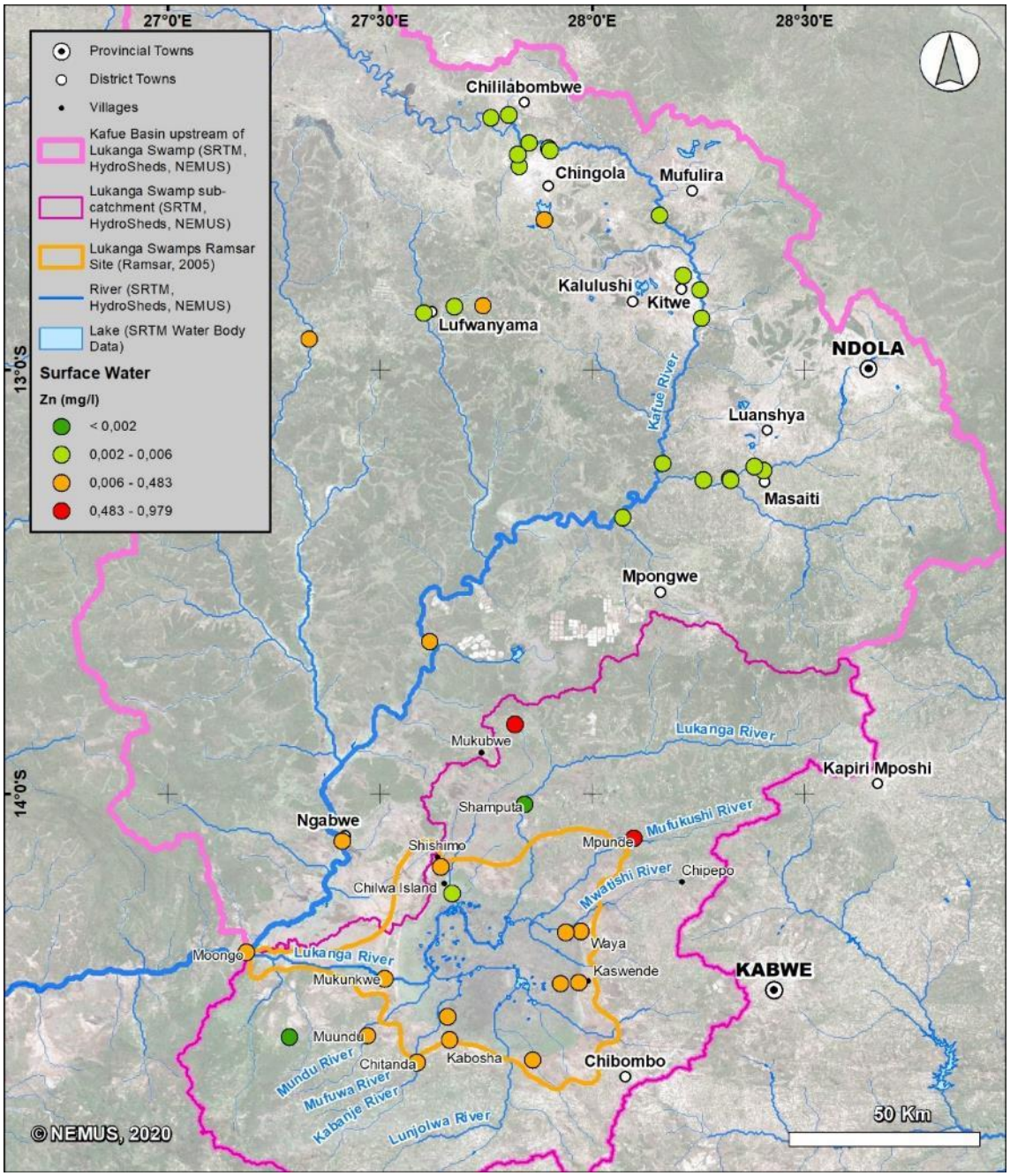


Figure 59 – Distribution of Zn in surface water samples in the Lukanga Swamp and Upper Kafue River Basin

B) Distribution of parameters determined in groundwater samples

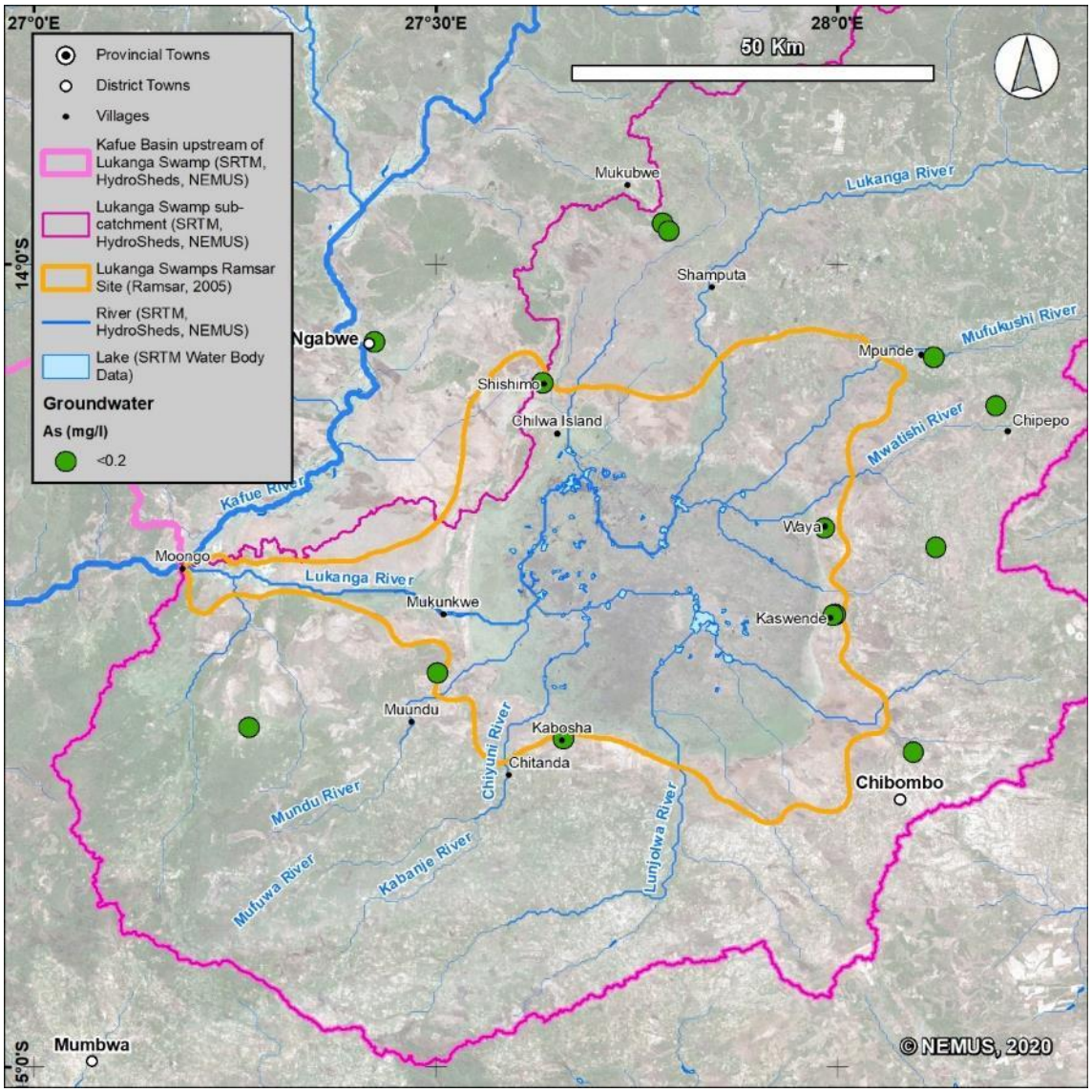


Figure 60 – Distribution of As in groundwater samples in the Lukanga Swamp area

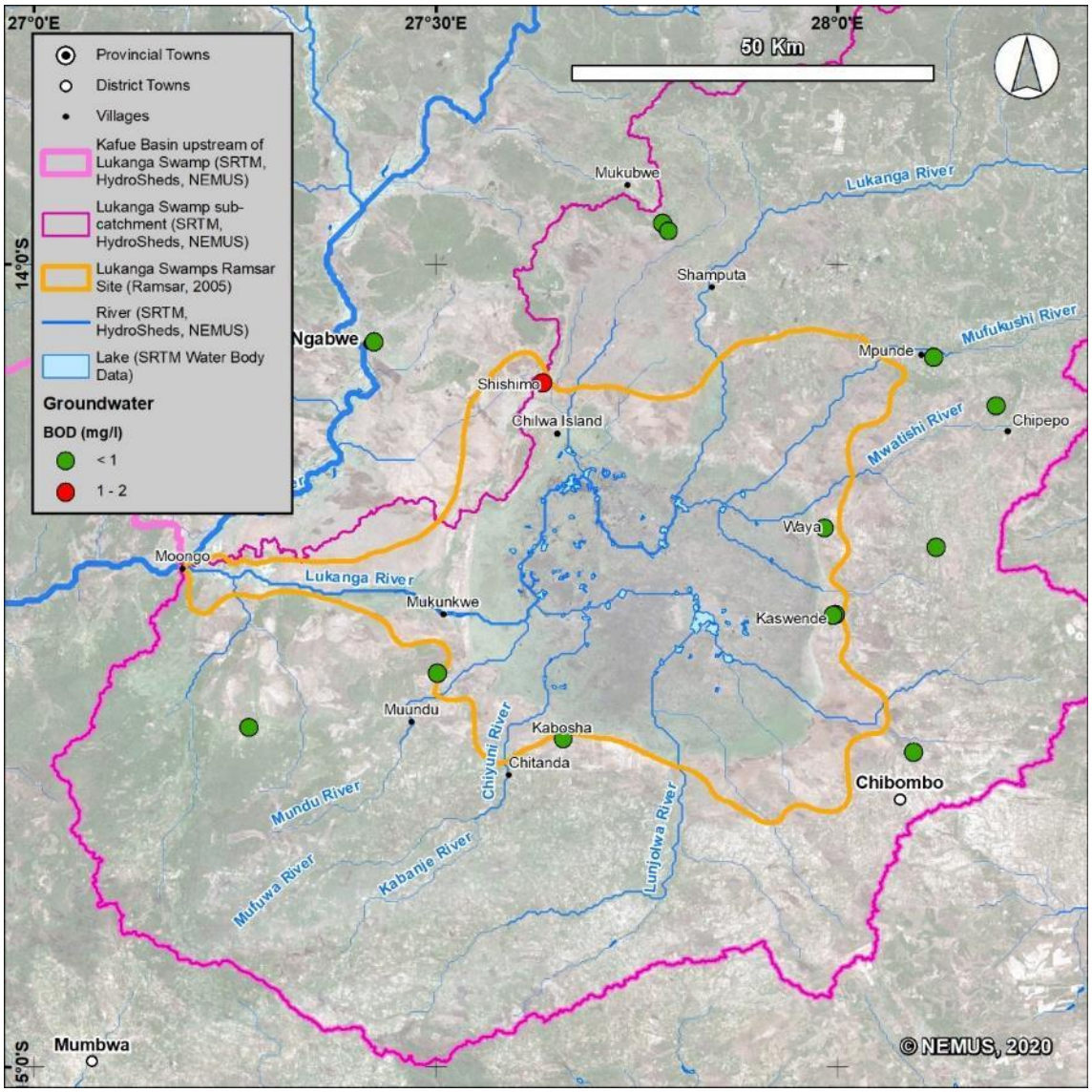


Figure 61 – Distribution of BOD in groundwater samples in the Lukanga Swamp area

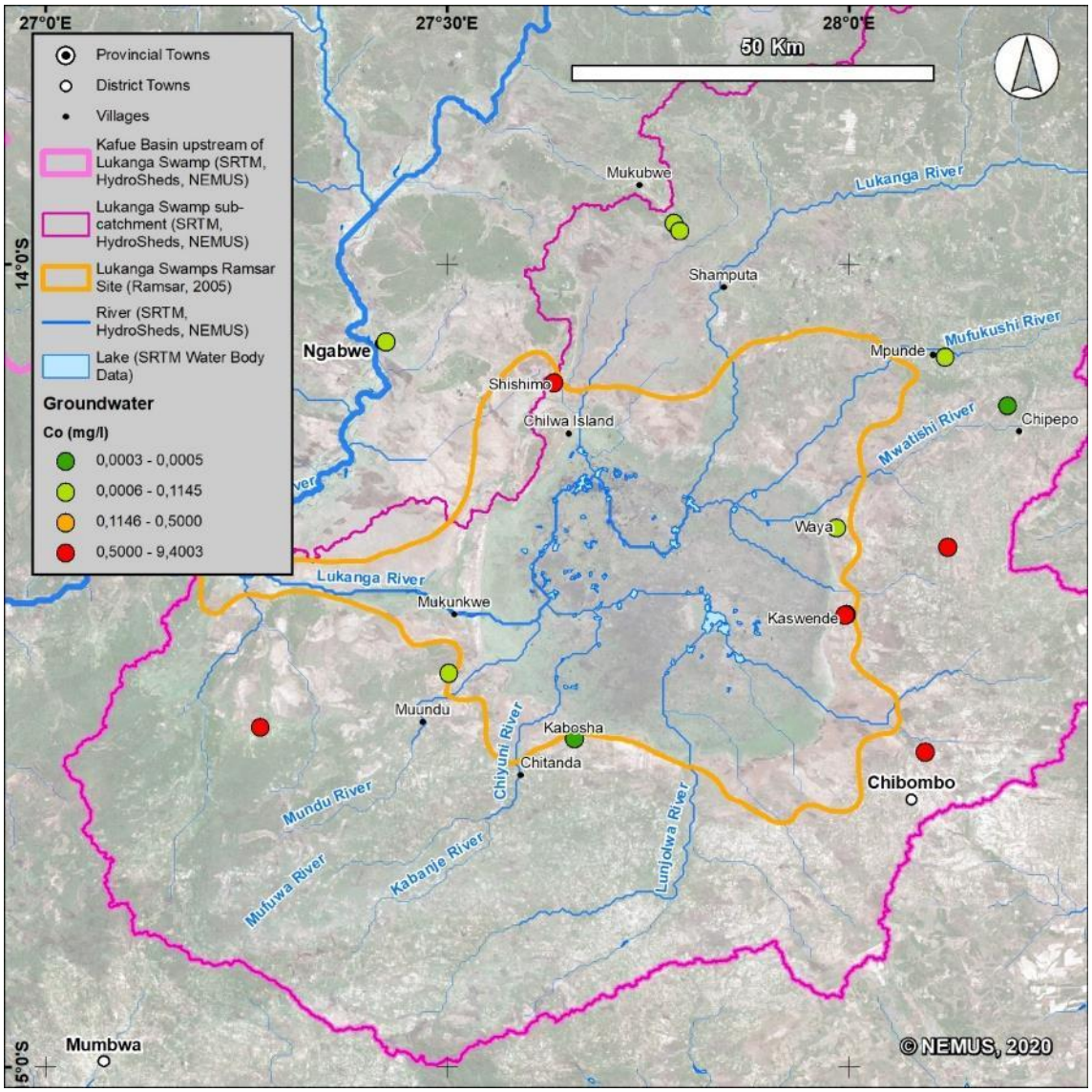


Figure 62 – Distribution of Co in groundwater samples in the Lukanga Swamp area

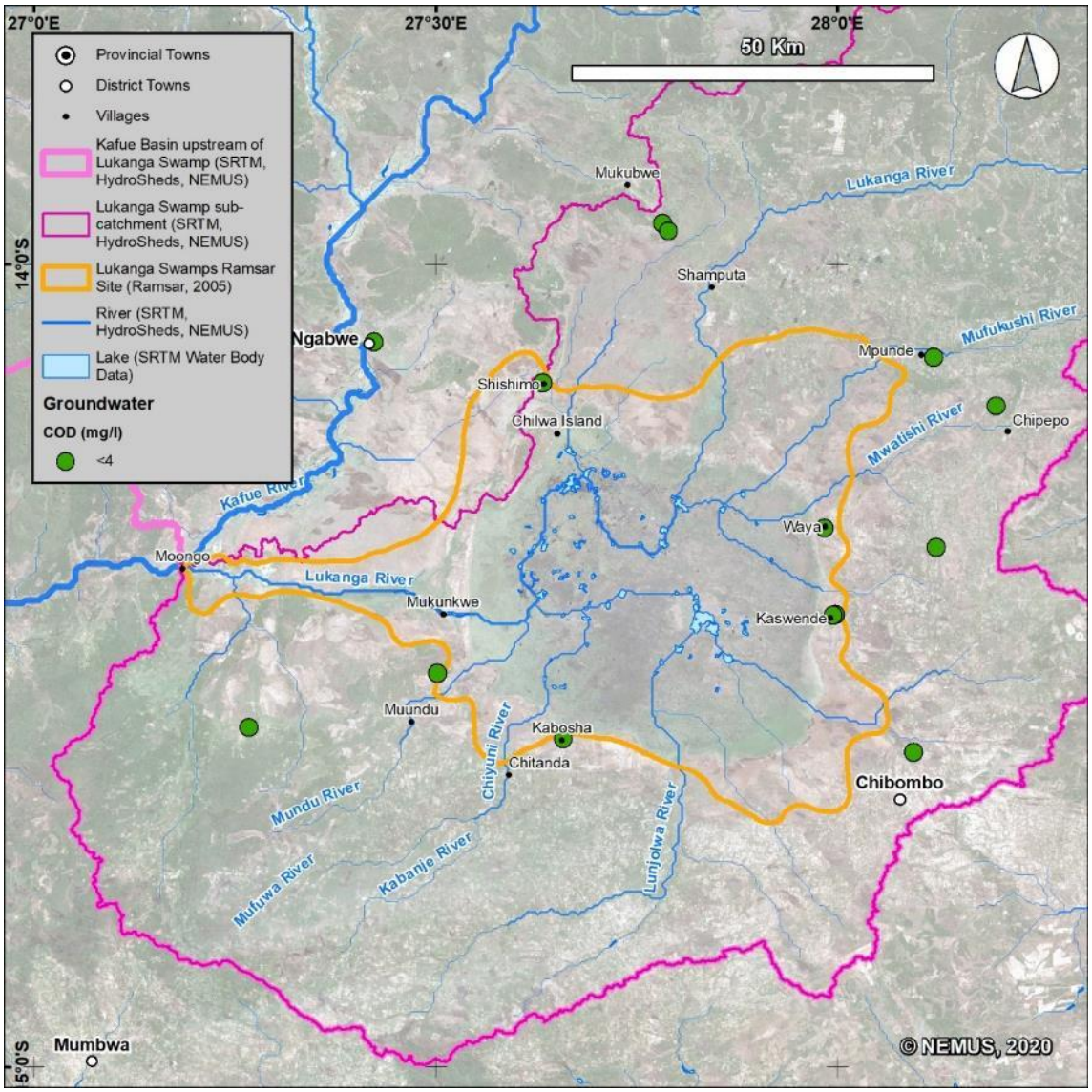


Figure 63 – Distribution of COD in groundwater samples in the Lukanga Swamp area

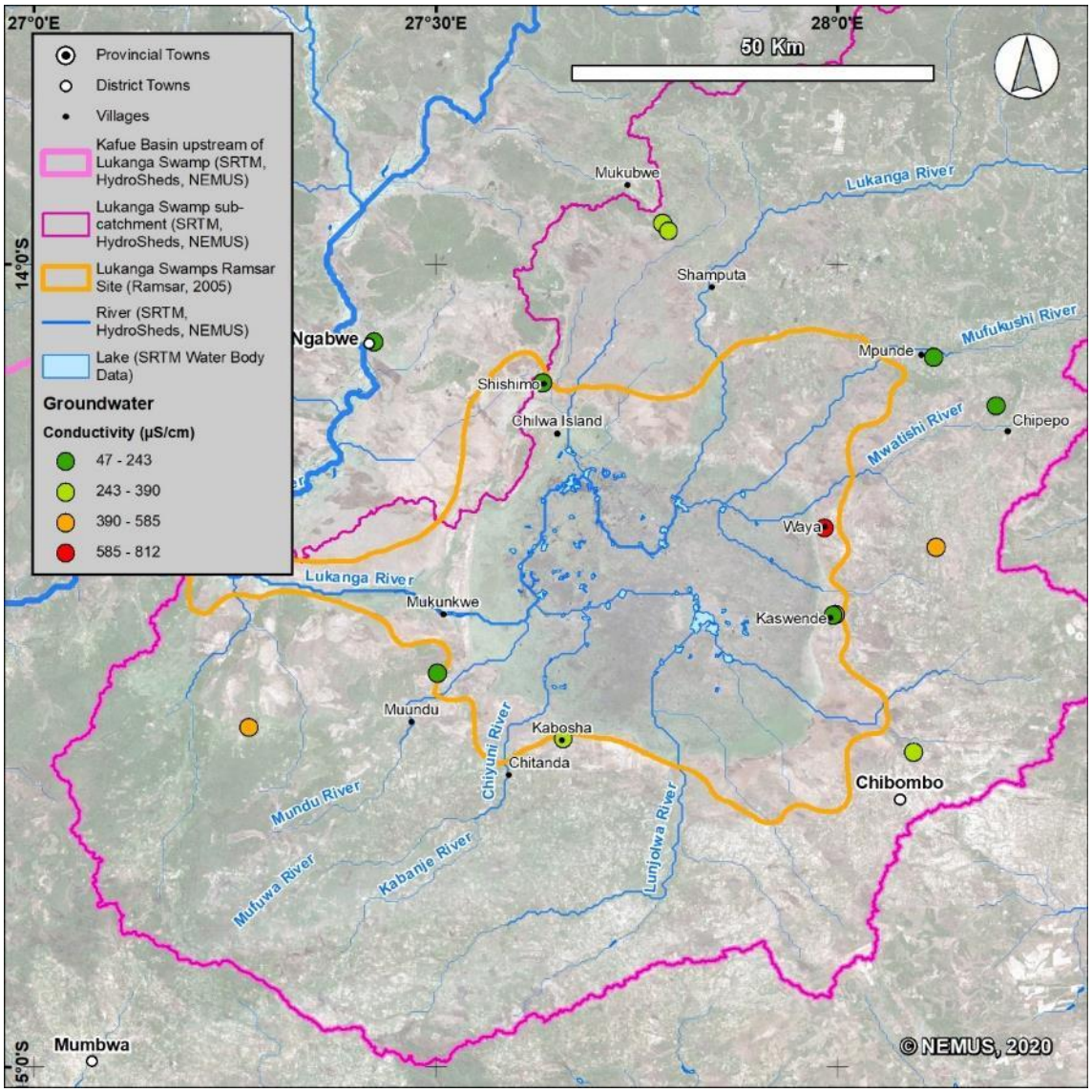


Figure 64 – Distribution of conductivity in groundwater samples in the Lukanga Swamp area

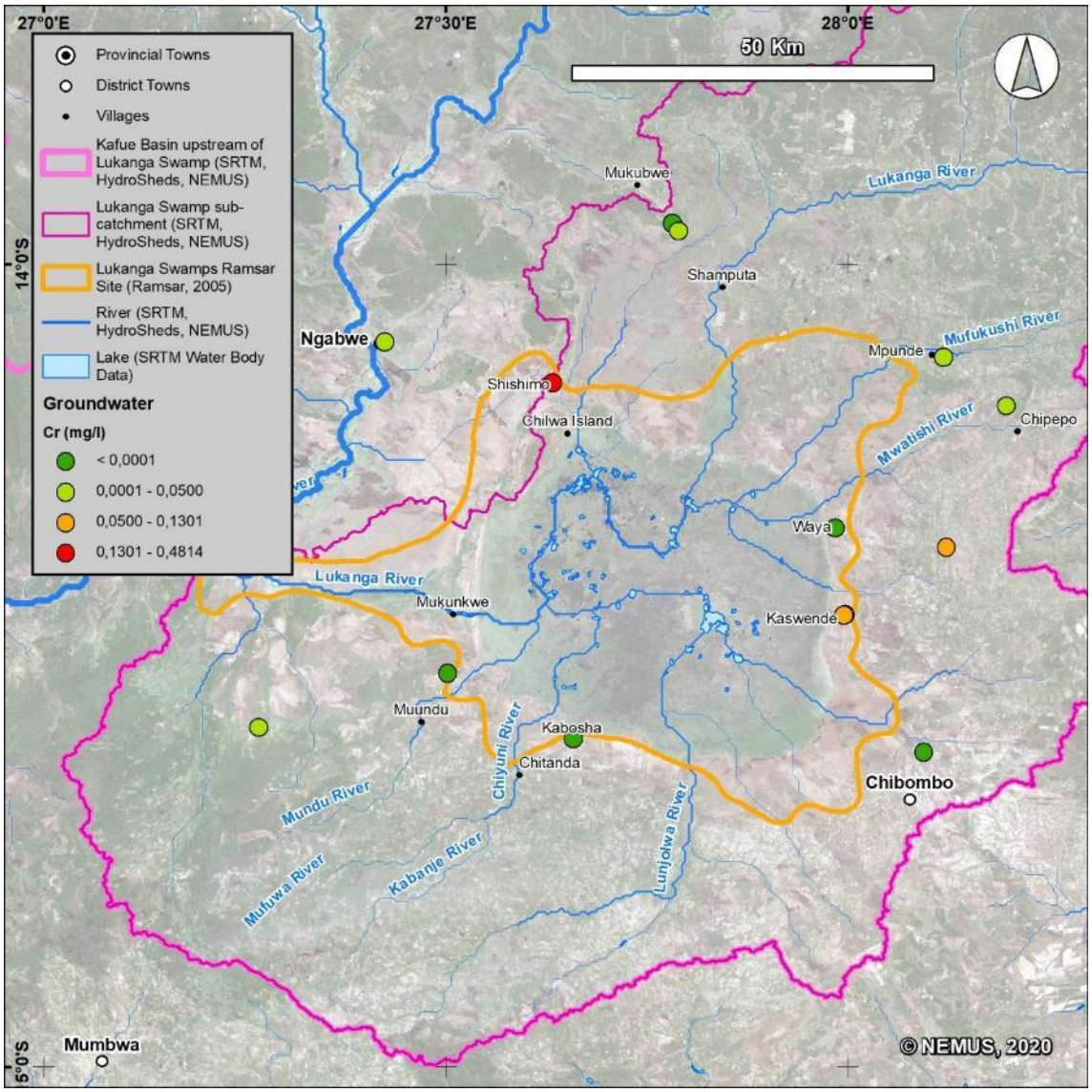


Figure 65 – Distribution of Cr in groundwater samples in the Lukanga Swamp area

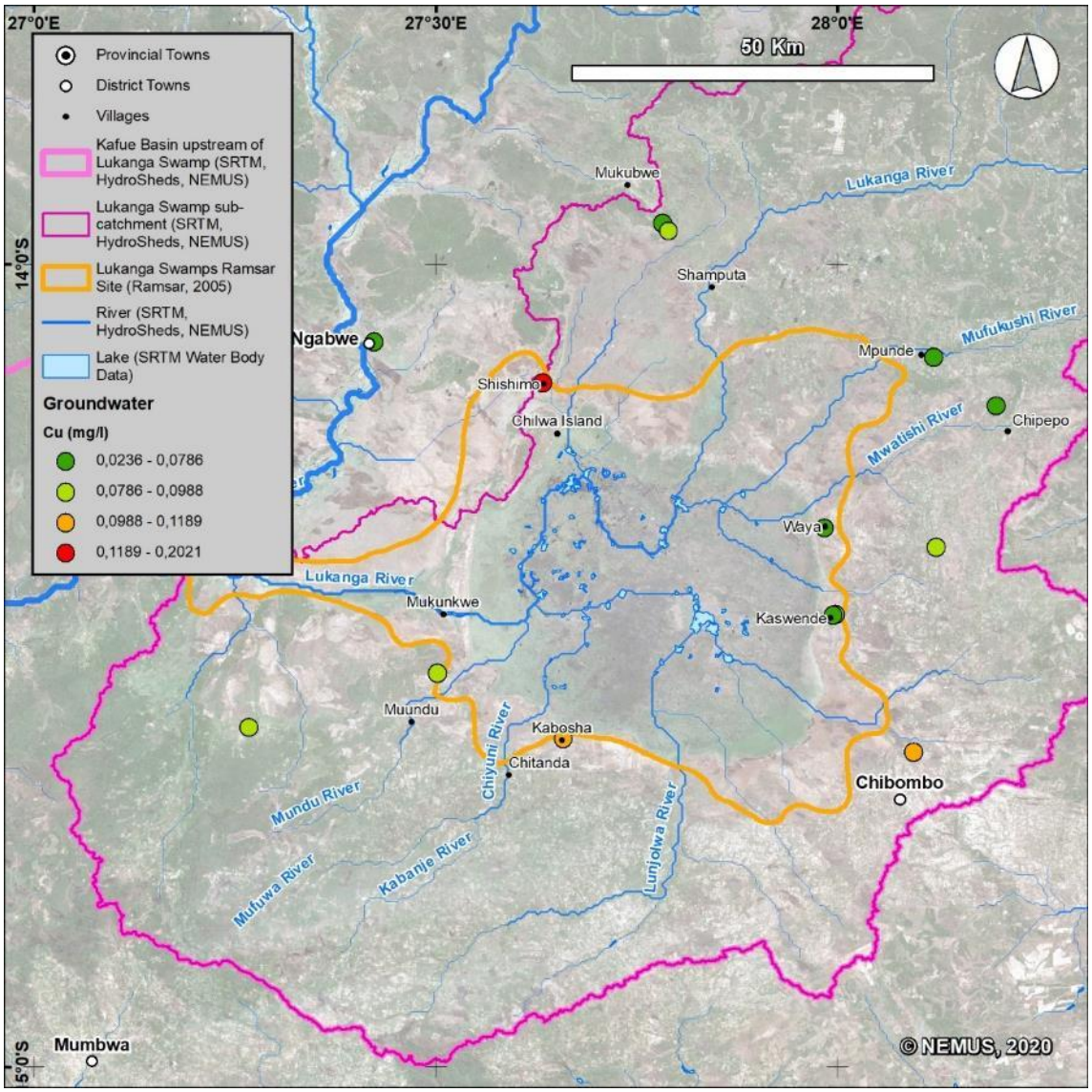


Figure 66 – Distribution of Cu in groundwater samples in the Lukanga Swamp area

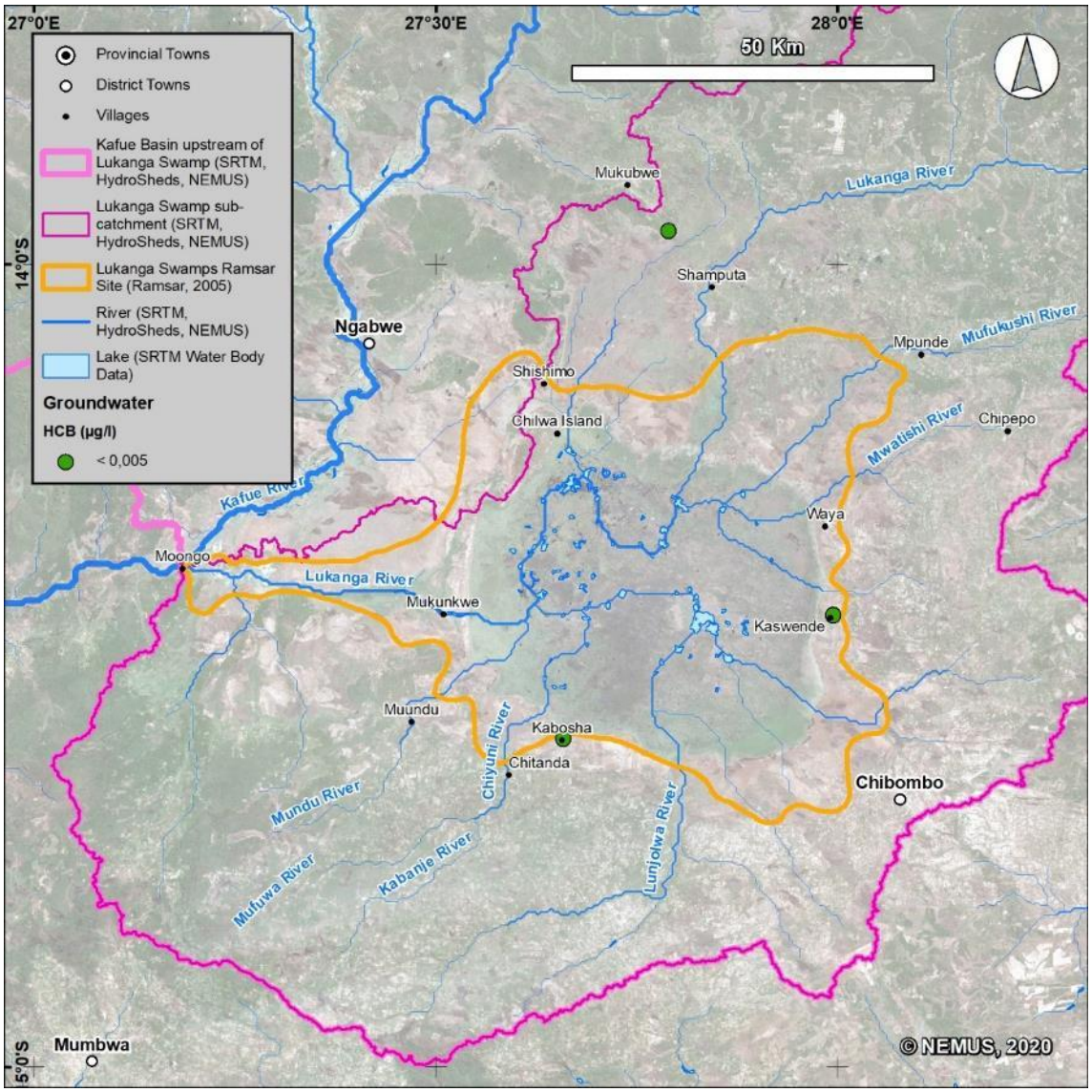


Figure 67 – Distribution of HCB in groundwater samples in the Lukanga Swamp area

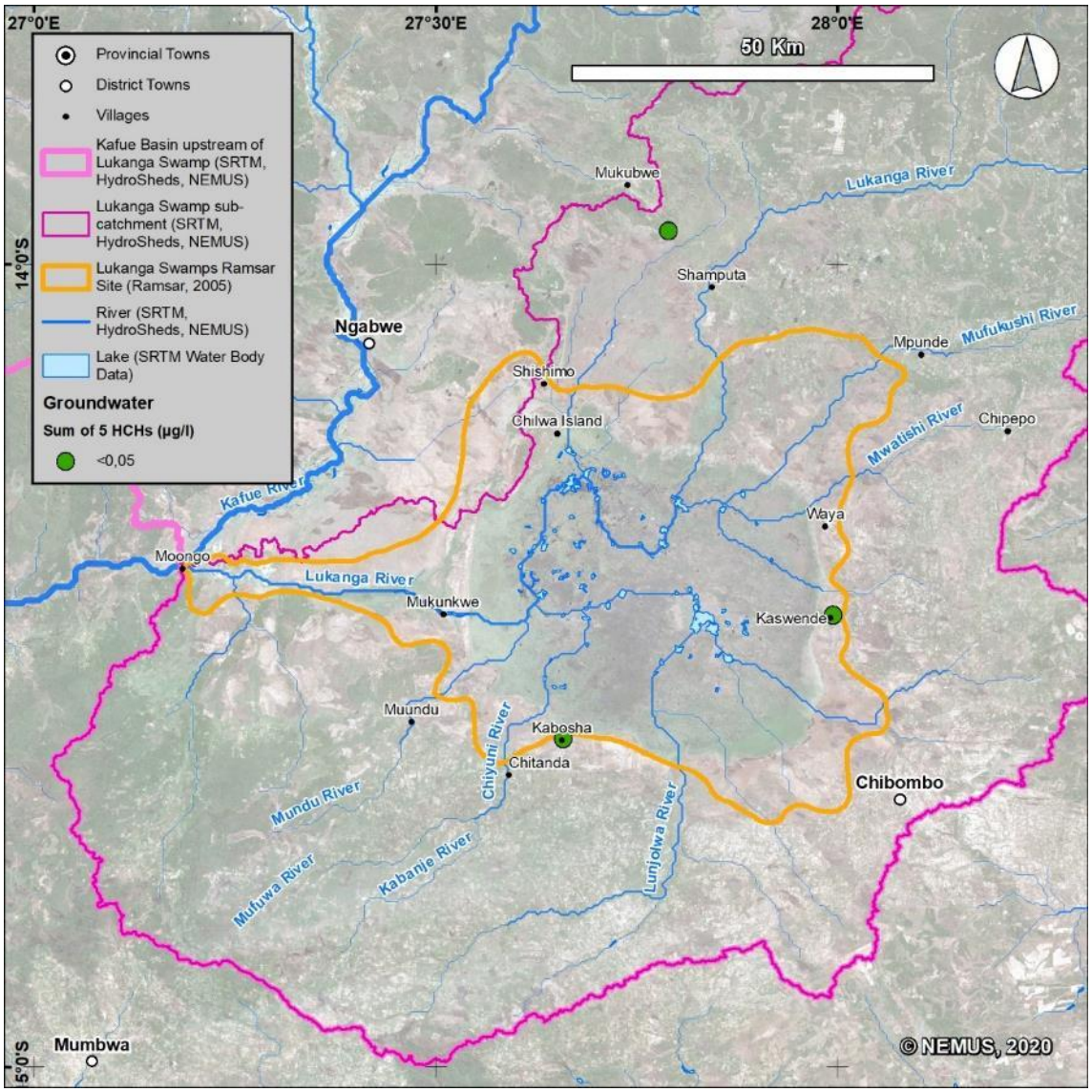


Figure 68 – Distribution of HCH in groundwater samples in the Lukanga Swamp area

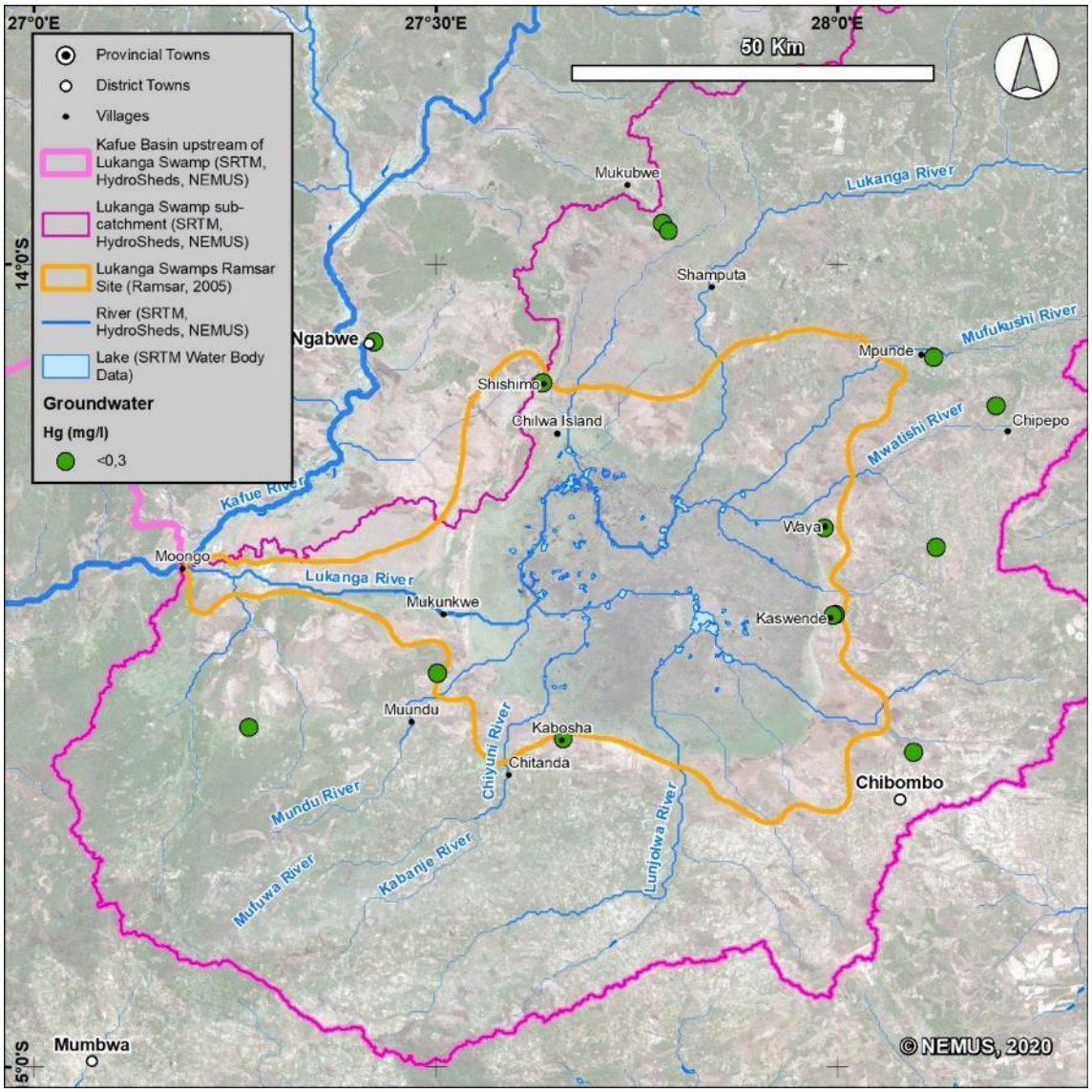


Figure 69 – Distribution of Hg in groundwater samples in the Lukanga Swamp area

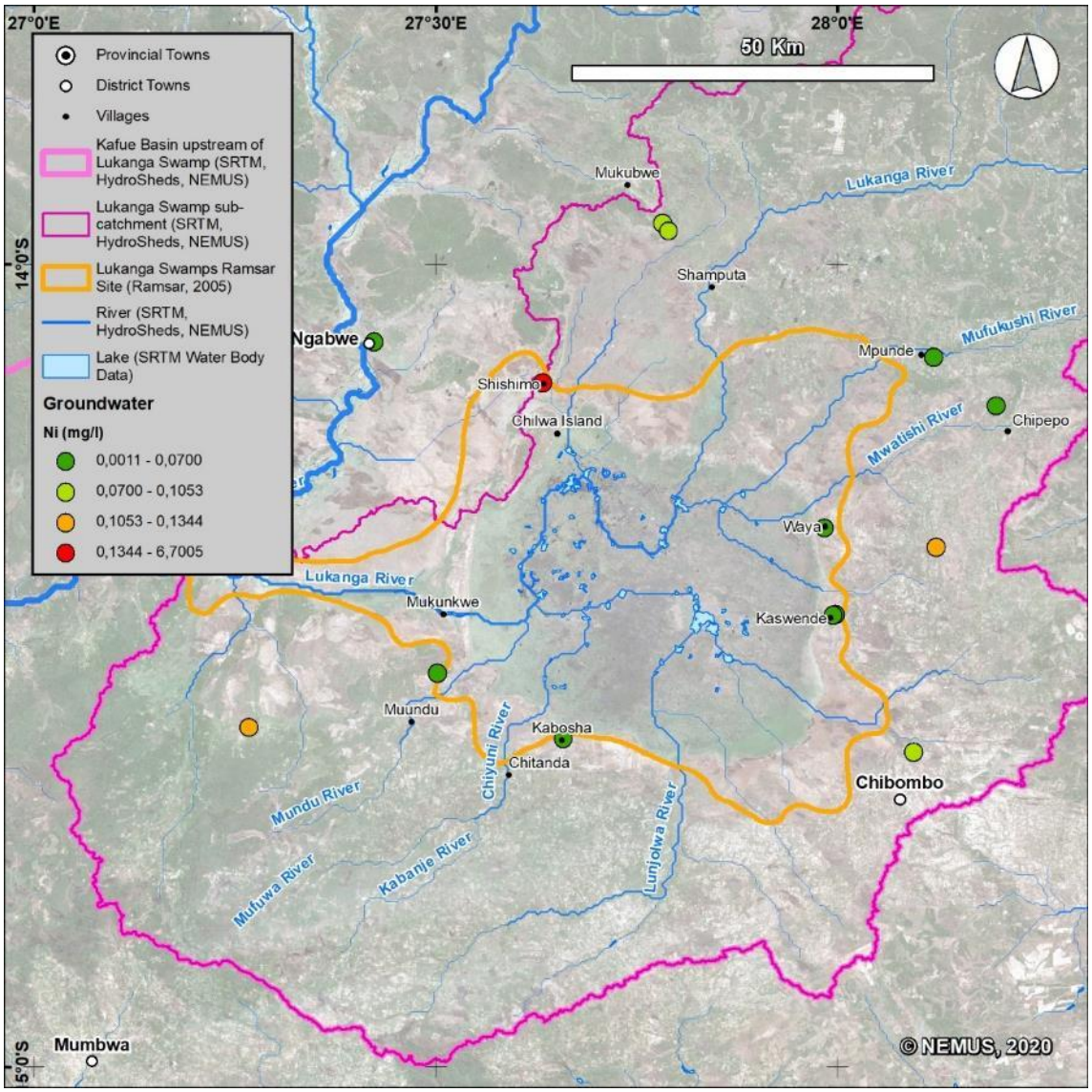


Figure 70 – Distribution of Ni in groundwater samples in the Lukanga Swamp area

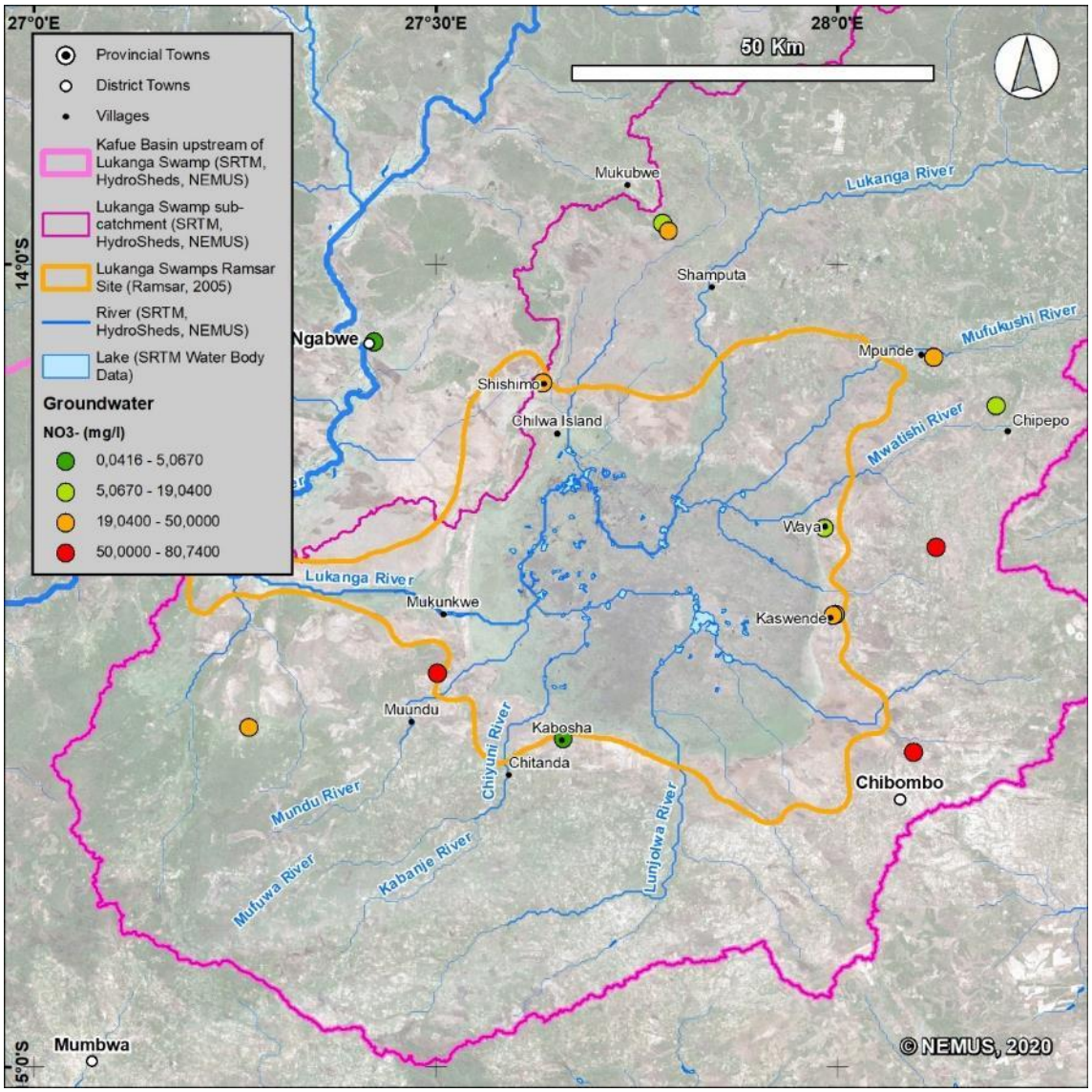


Figure 71 – Distribution of nitrates in groundwater samples in the Lukanga Swamp area

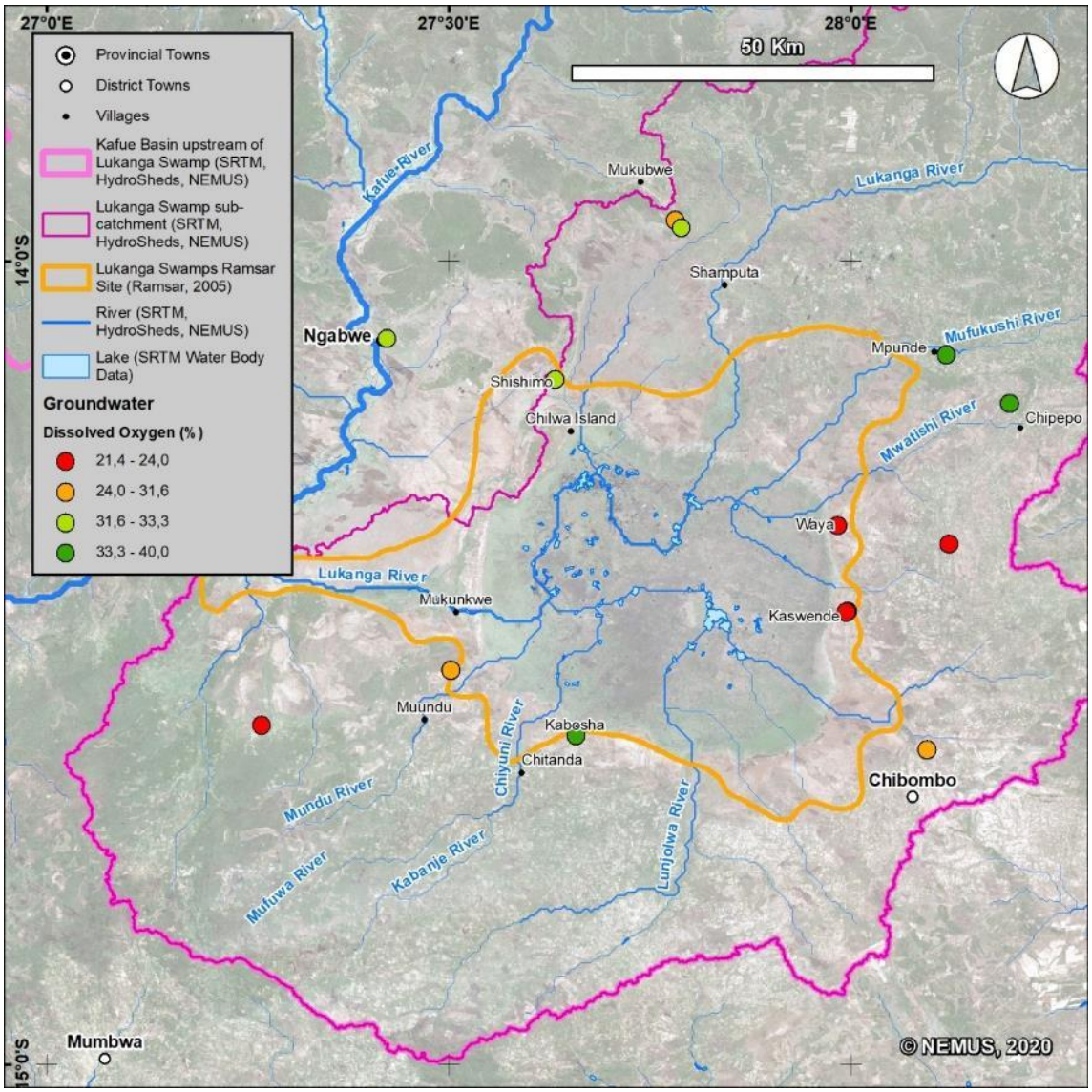


Figure 72 – Distribution of dissolved oxygen in groundwater samples in the Lukanga Swamp area

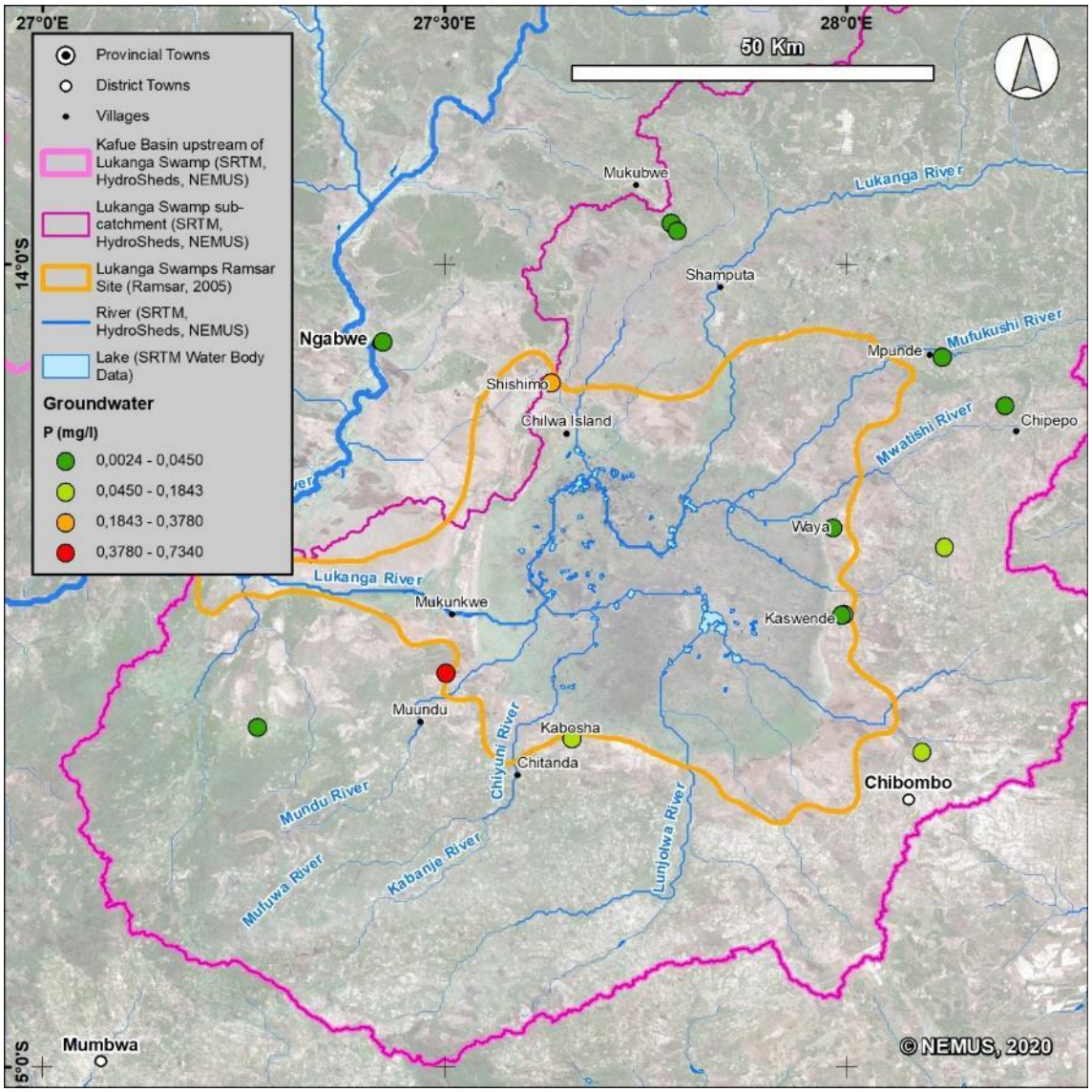


Figure 73 – Distribution of P in groundwater samples in the Lukanga Swamp area

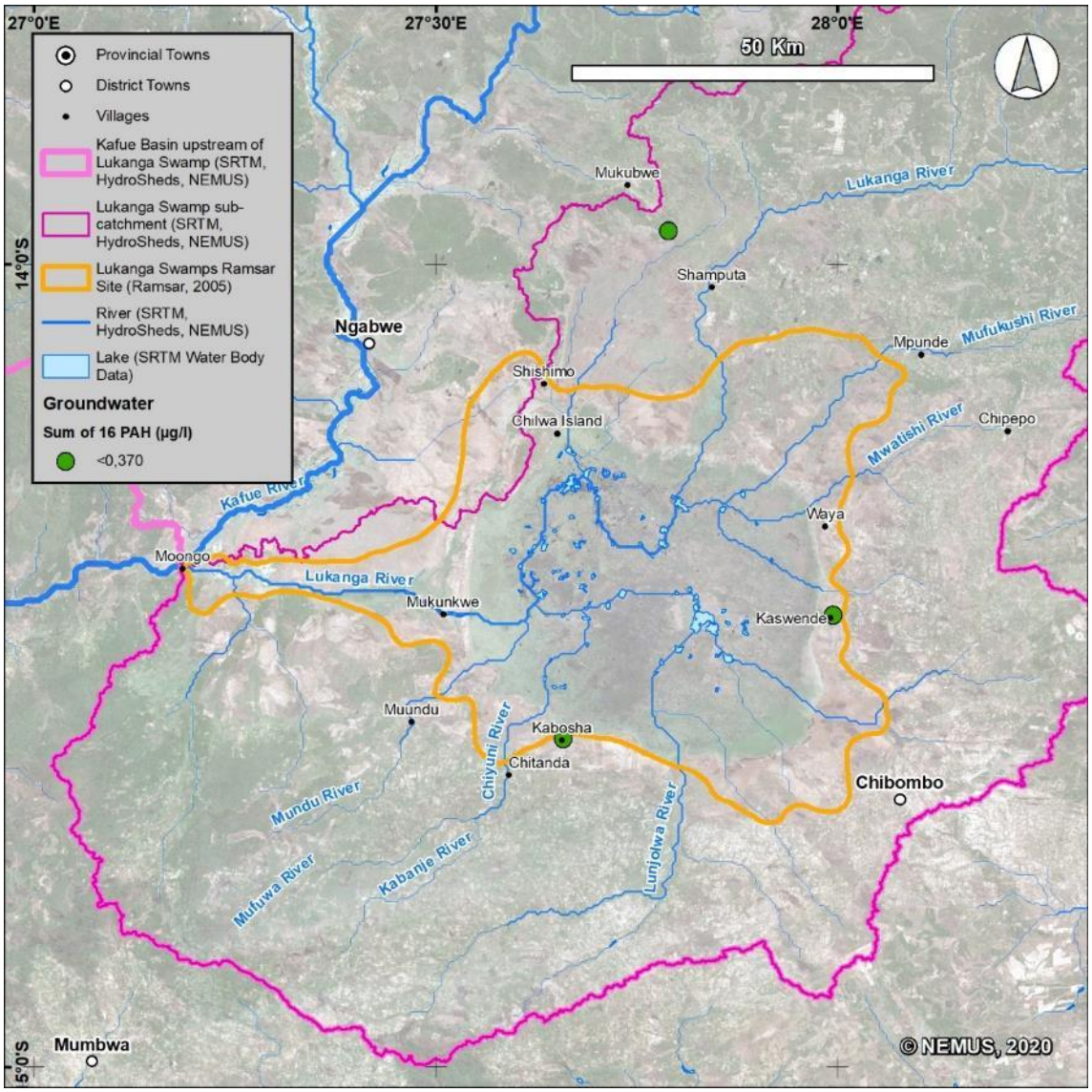


Figure 74 – Distribution of PAH in groundwater samples in the Lukanga Swamp area

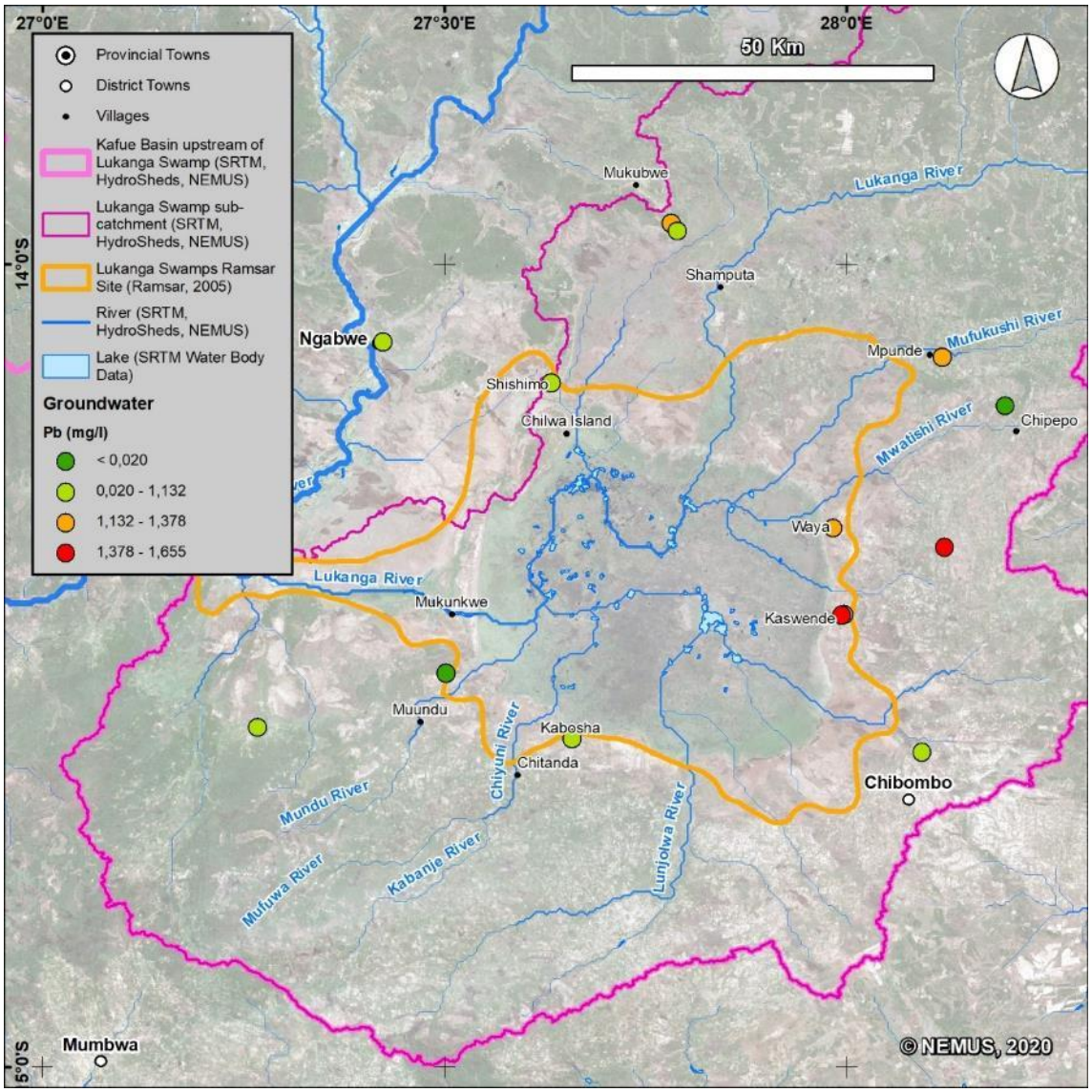


Figure 75 – Distribution of Pb in groundwater samples in the Lukanga Swamp area

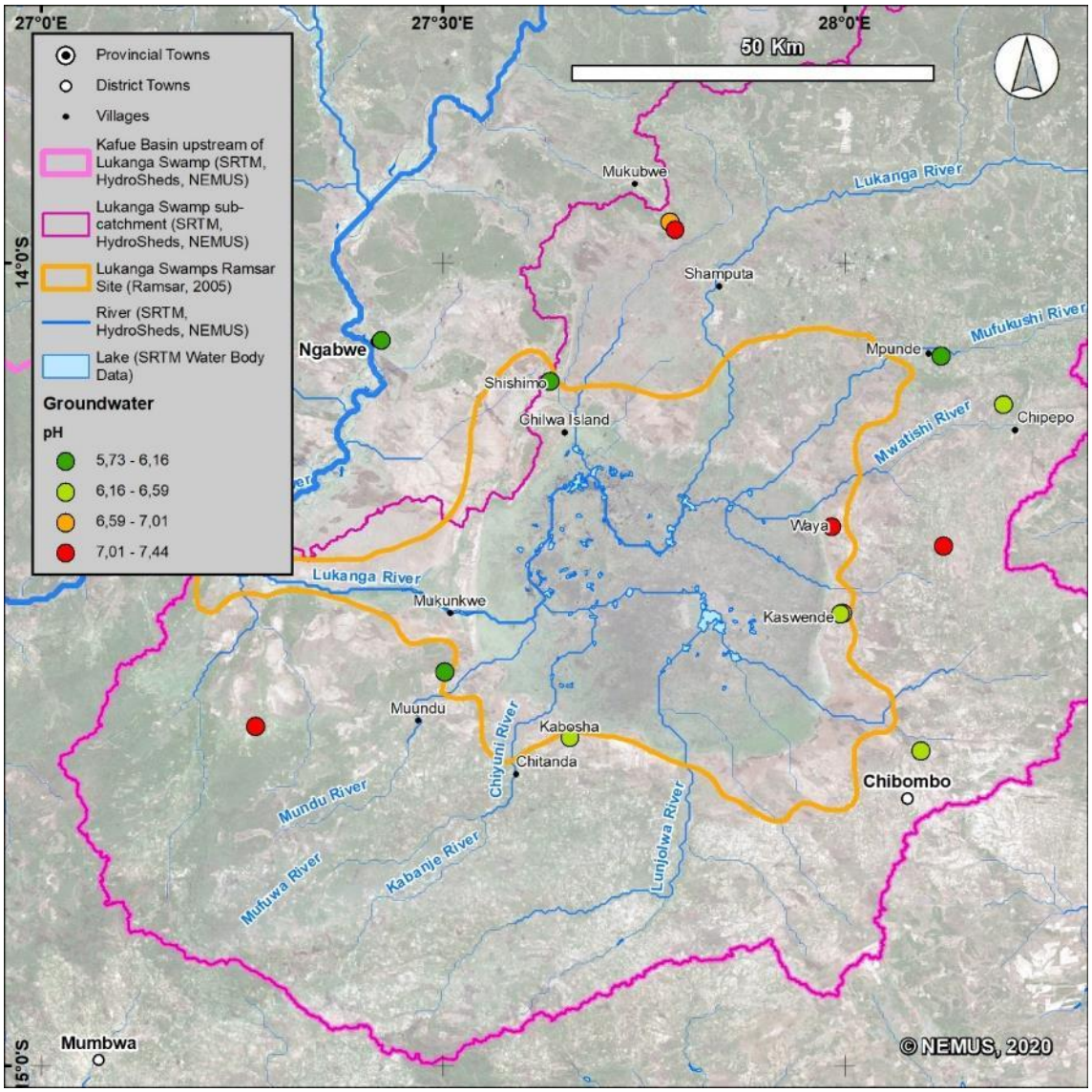


Figure 76 – Distribution of pH in groundwater samples in the Lukanga Swamp area

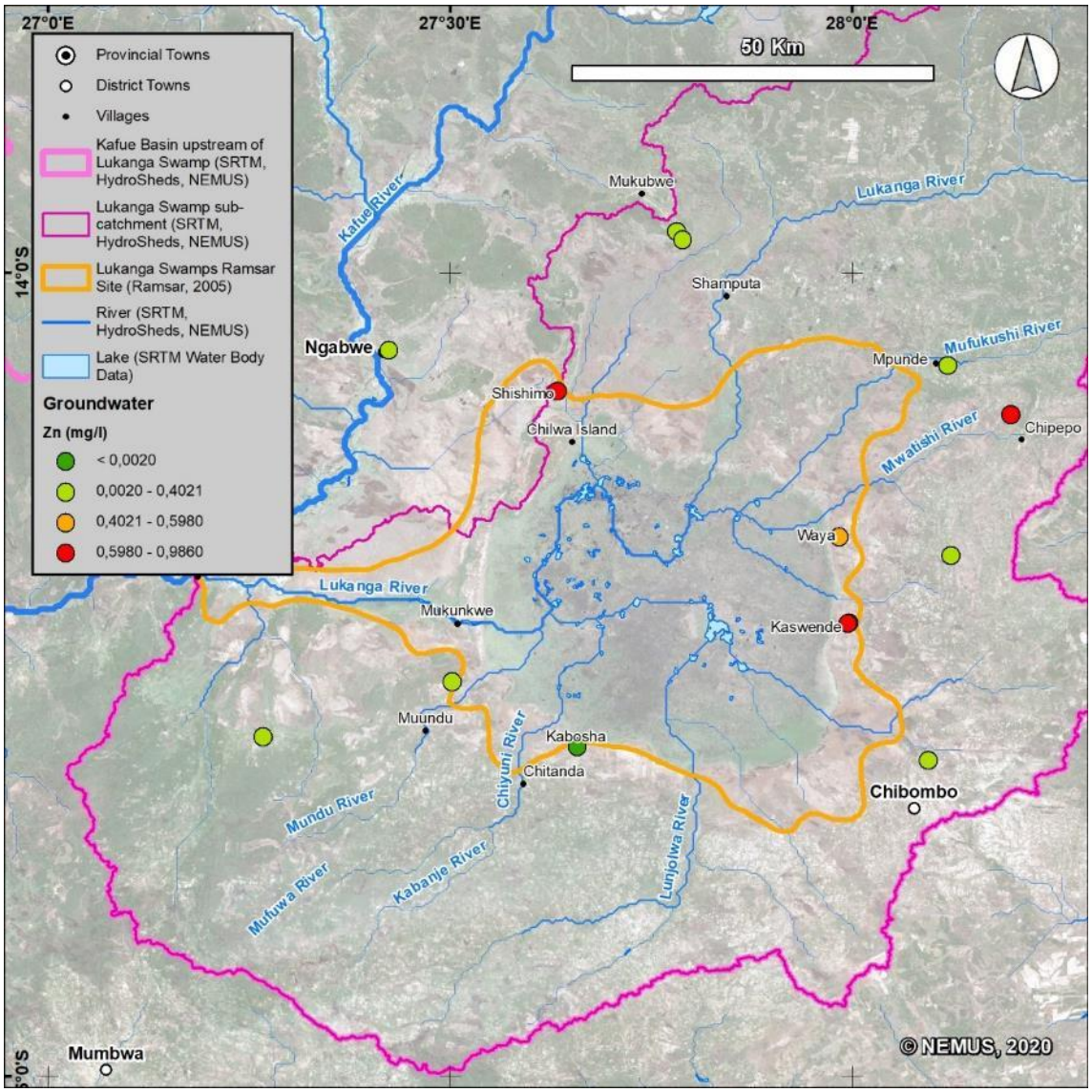


Figure 77 – Distribution of Zn in groundwater samples in the Lukanga Swamp area

C) Distribution of parameters determined in sediment samples and in composite leaf samples, if that is the case

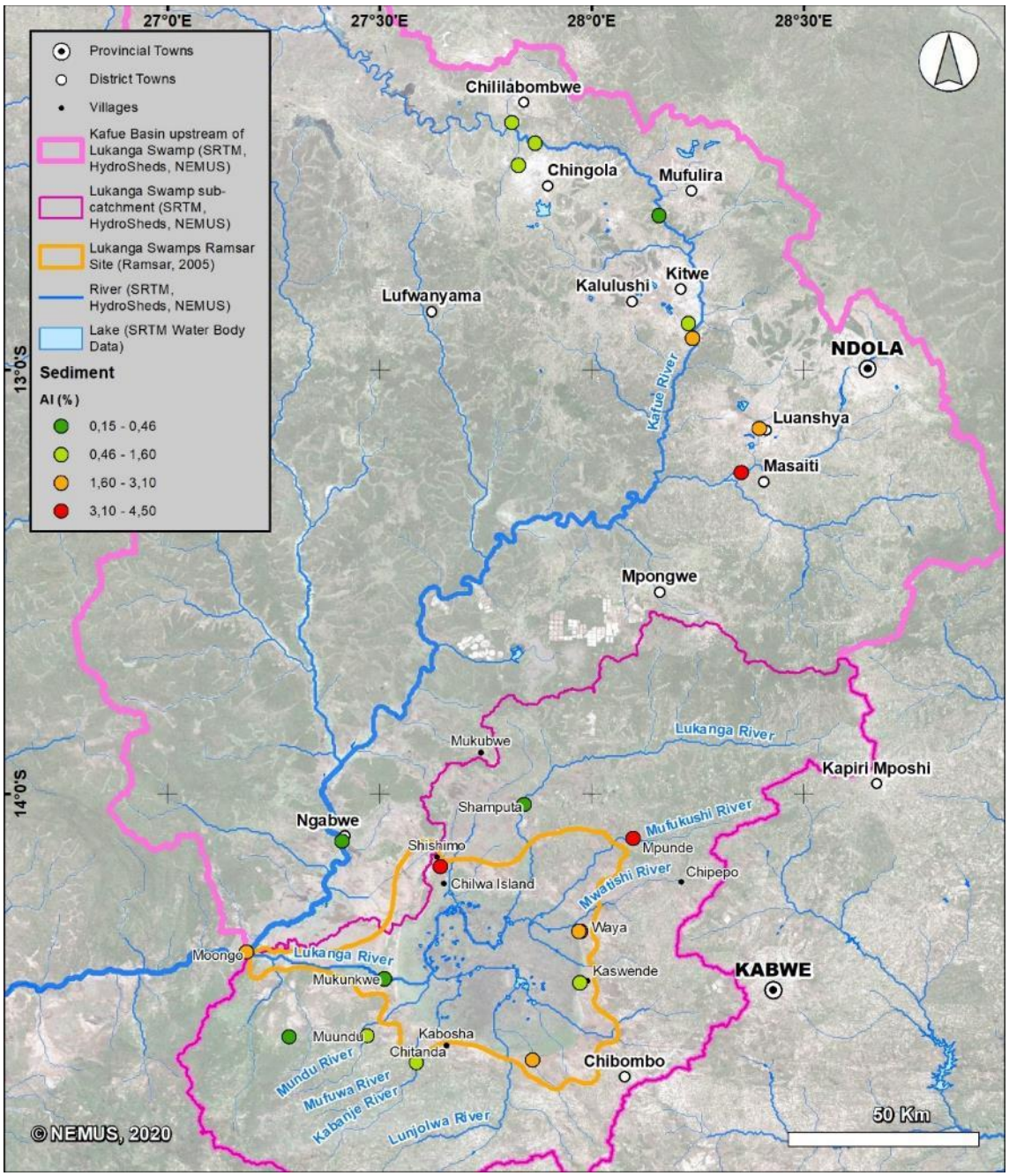


Figure 78 – Distribution of Al in sediment samples in the Lukanga Swamp and Upper Kafue River Basin

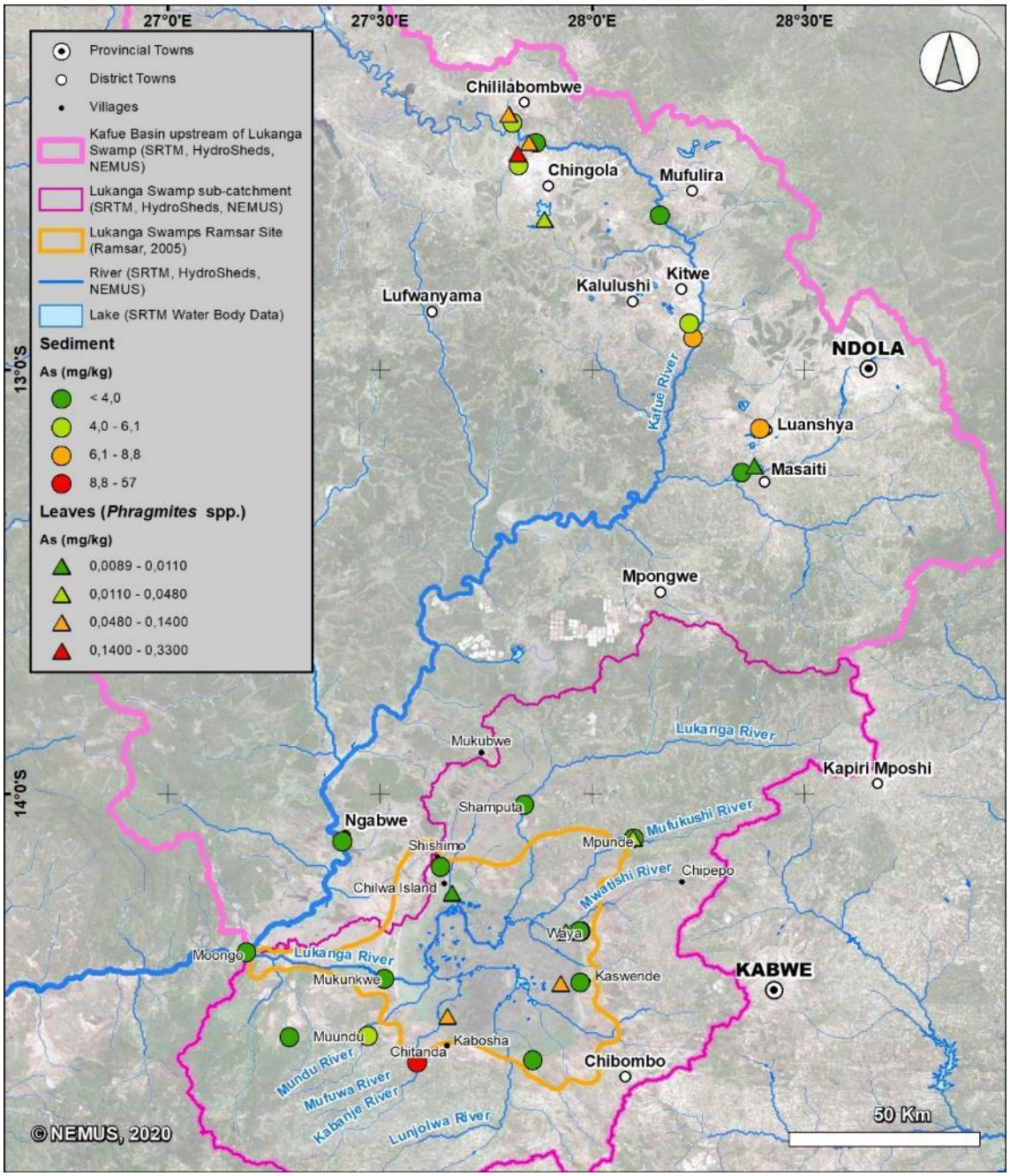


Figure 79 – Distribution of As in sediment samples and composite leaf samples in the Lukanga Swamp and Upper Kafue River Basin

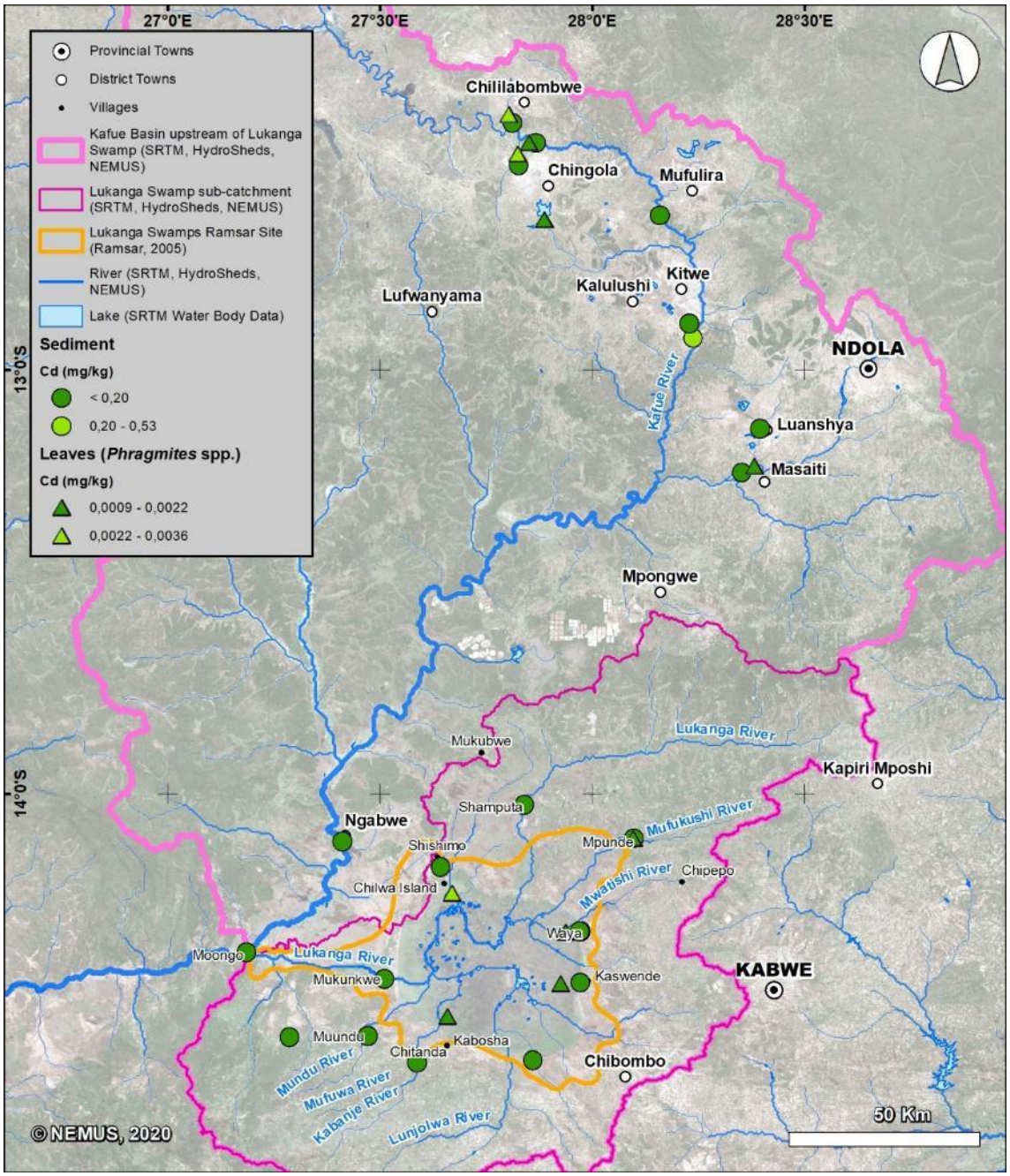


Figure 80 – Distribution of Cd in sediment samples and composite leaf samples in the Lukanga Swamp and Upper Kafue River Basin

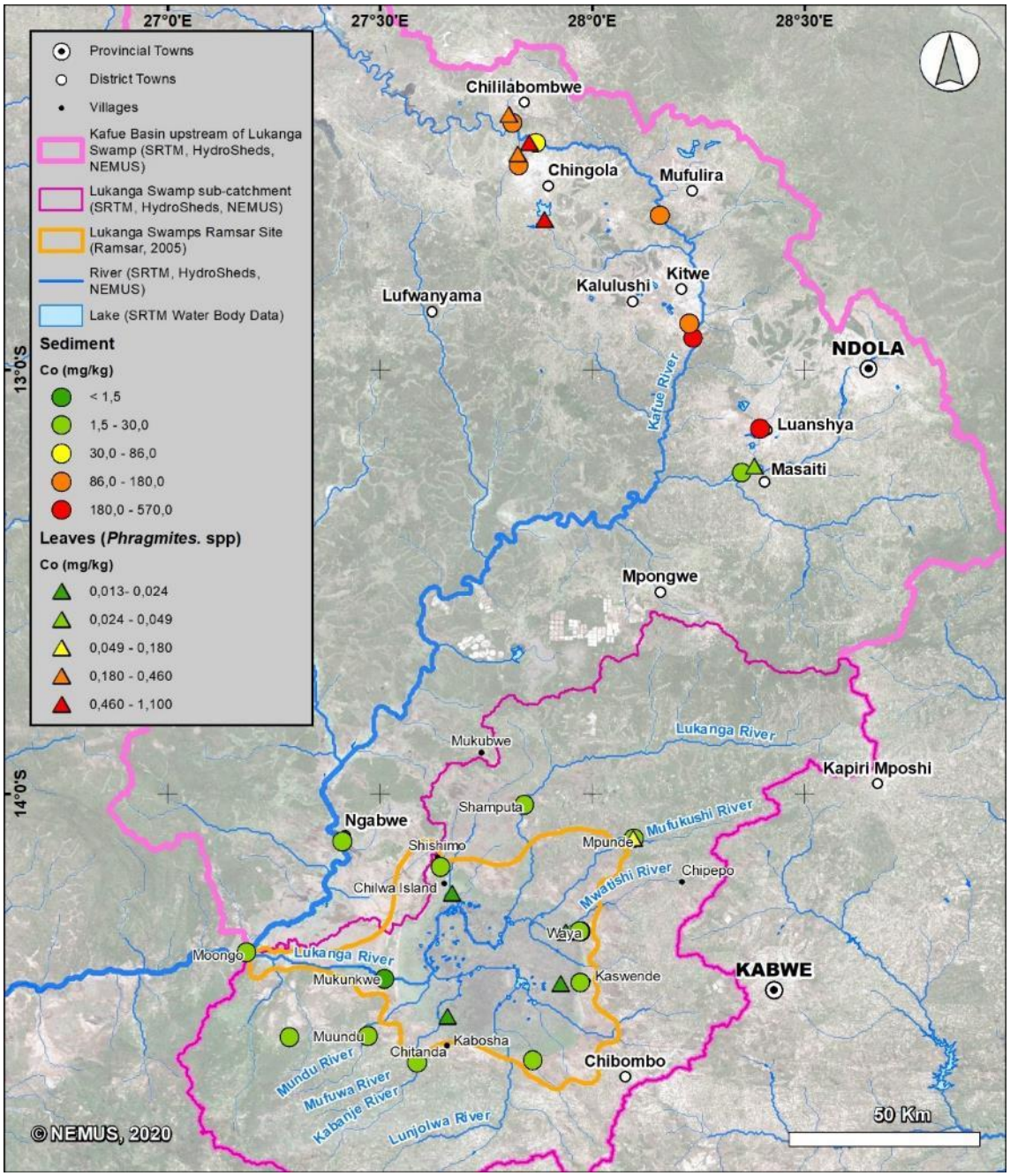


Figure 81 – Distribution of Co in sediment samples and composite leaf samples in the Lukanga Swamp and Upper Kafue River Basin

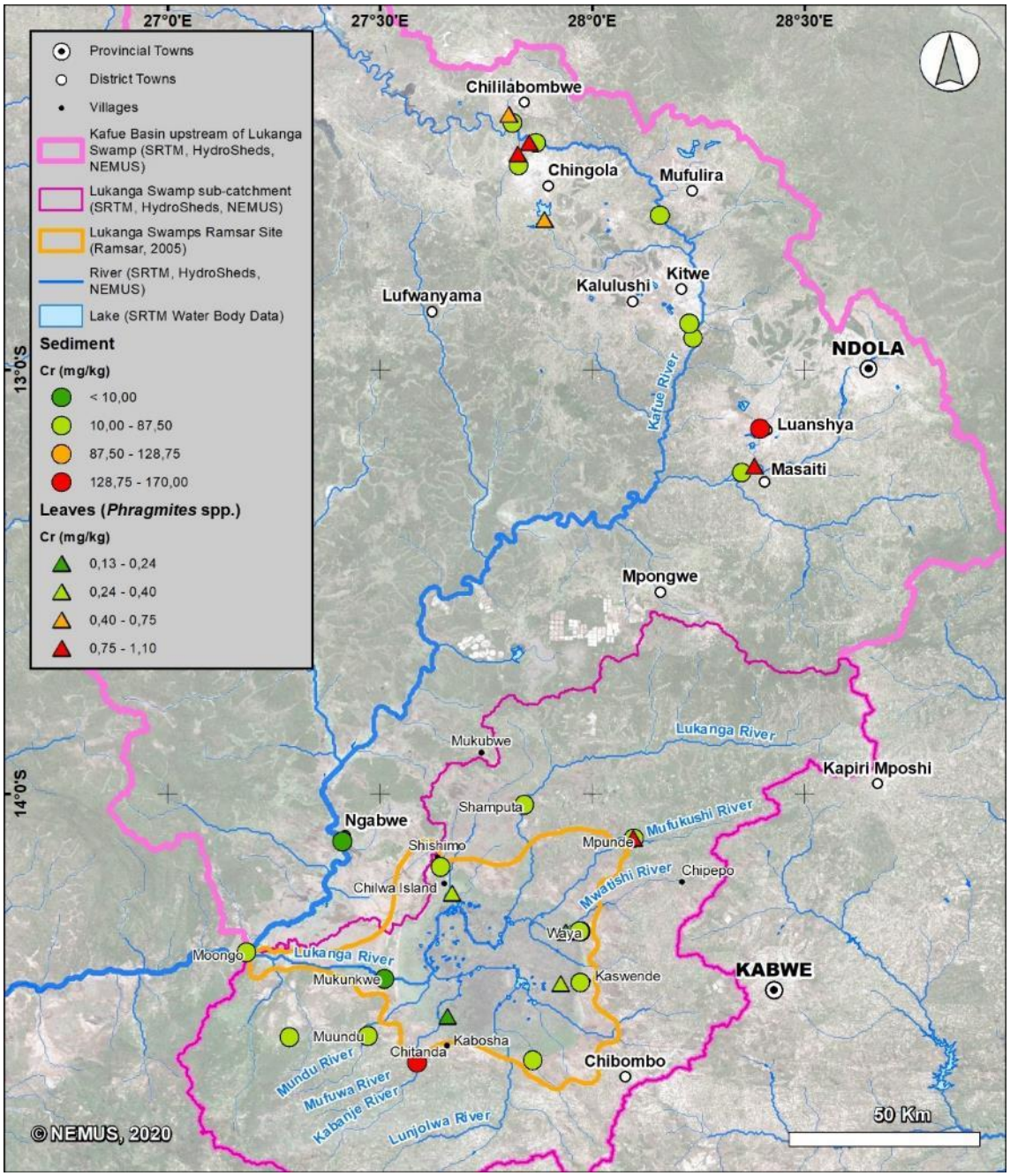


Figure 82 – Distribution of Cr in sediment samples and composite leaf samples in the Lukanga Swamp and Upper Kafue River Basin

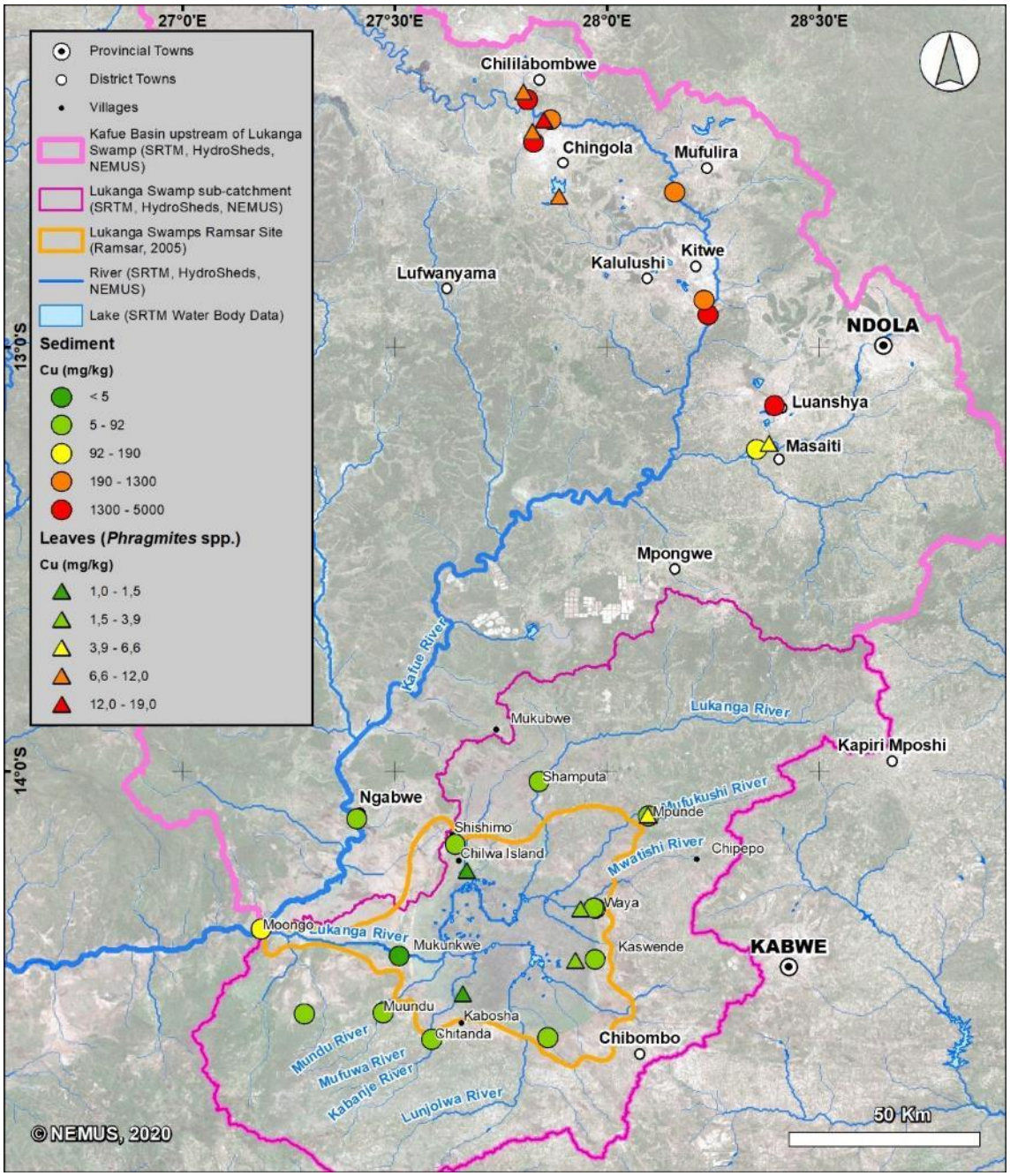


Figure 83 – Distribution of Cu in sediment samples and composite leaf samples in the Lukanga Swamp and Upper Kafue River Basin

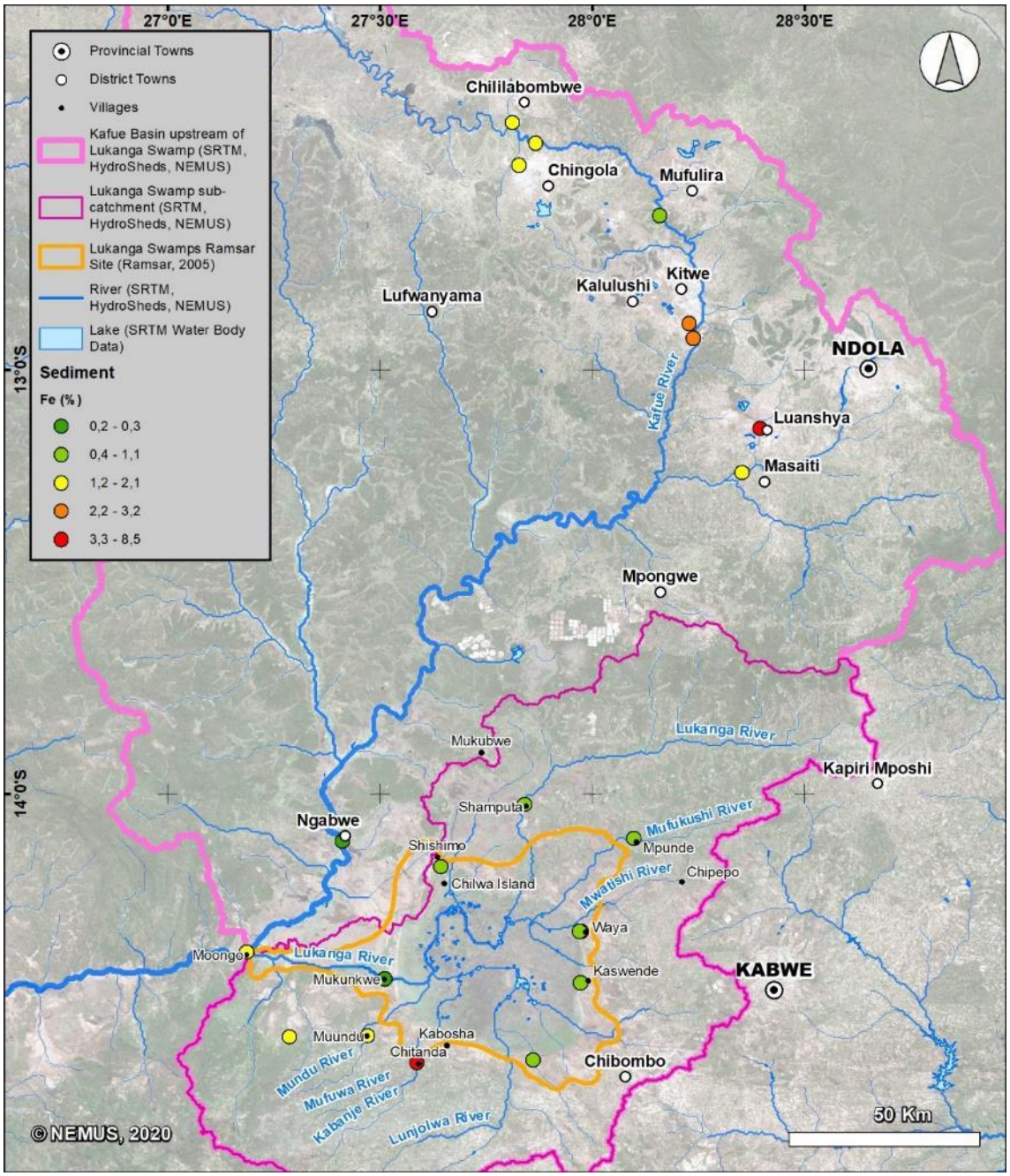


Figure 84 – Distribution of Fe in sediment samples in the Lukanga Swamp and Upper Kafue River Basin

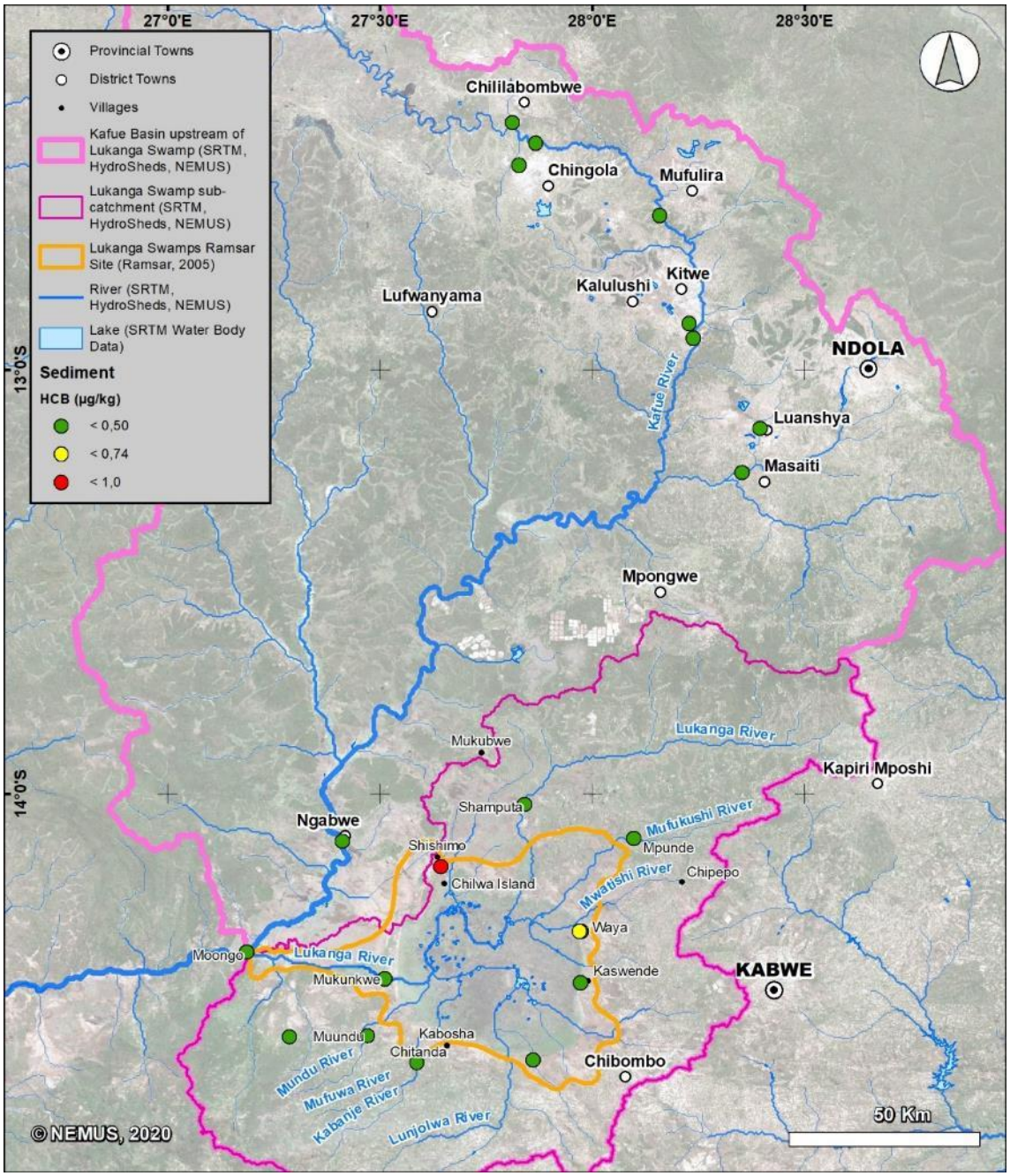


Figure 85 – Distribution of HCB in sediment samples in the Lukanga Swamp and Upper Kafue River Basin

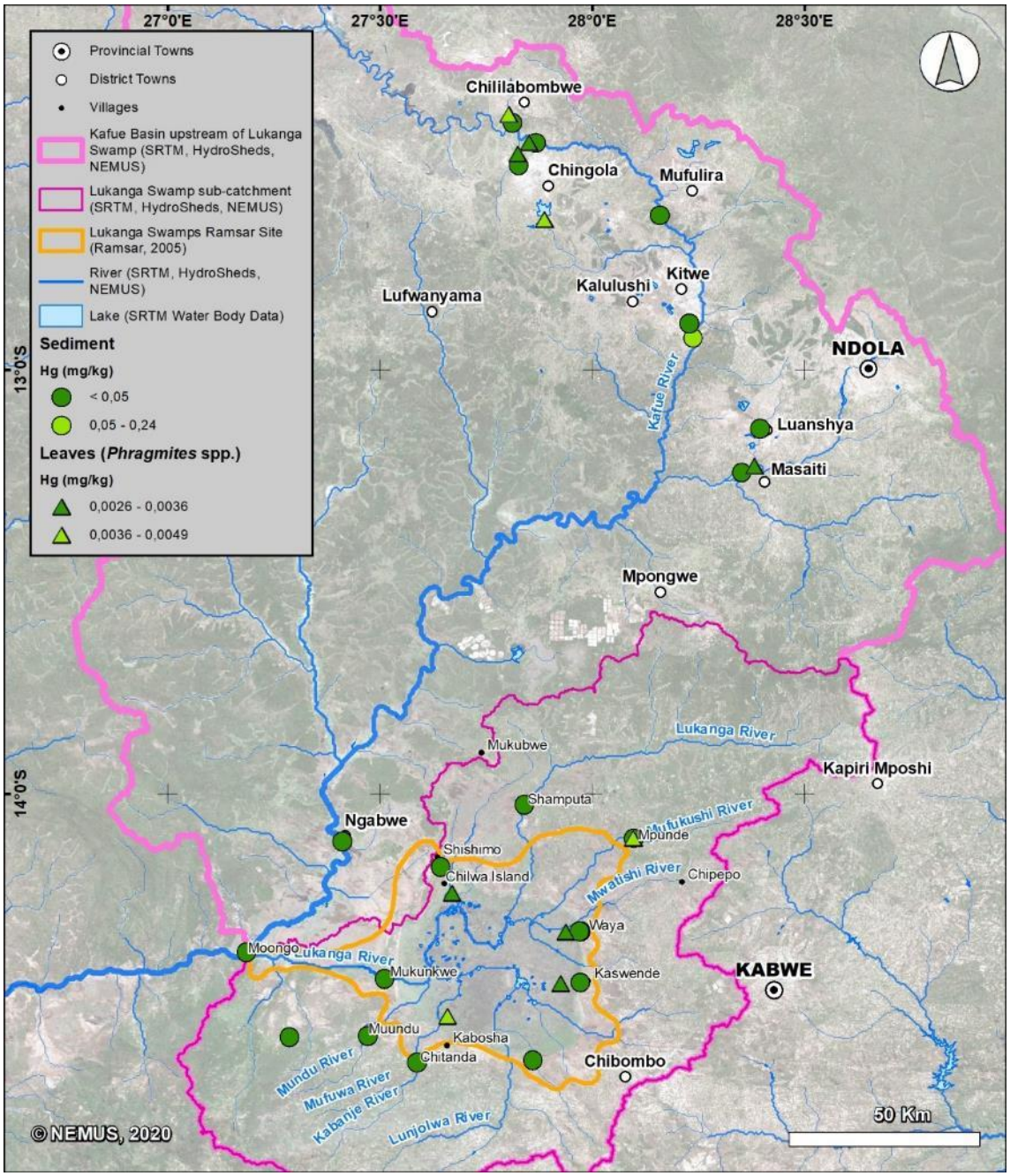


Figure 86 – Distribution of Hg in sediment samples and composite leaf samples in the Lukanga Swamp and Upper Kafue River Basin

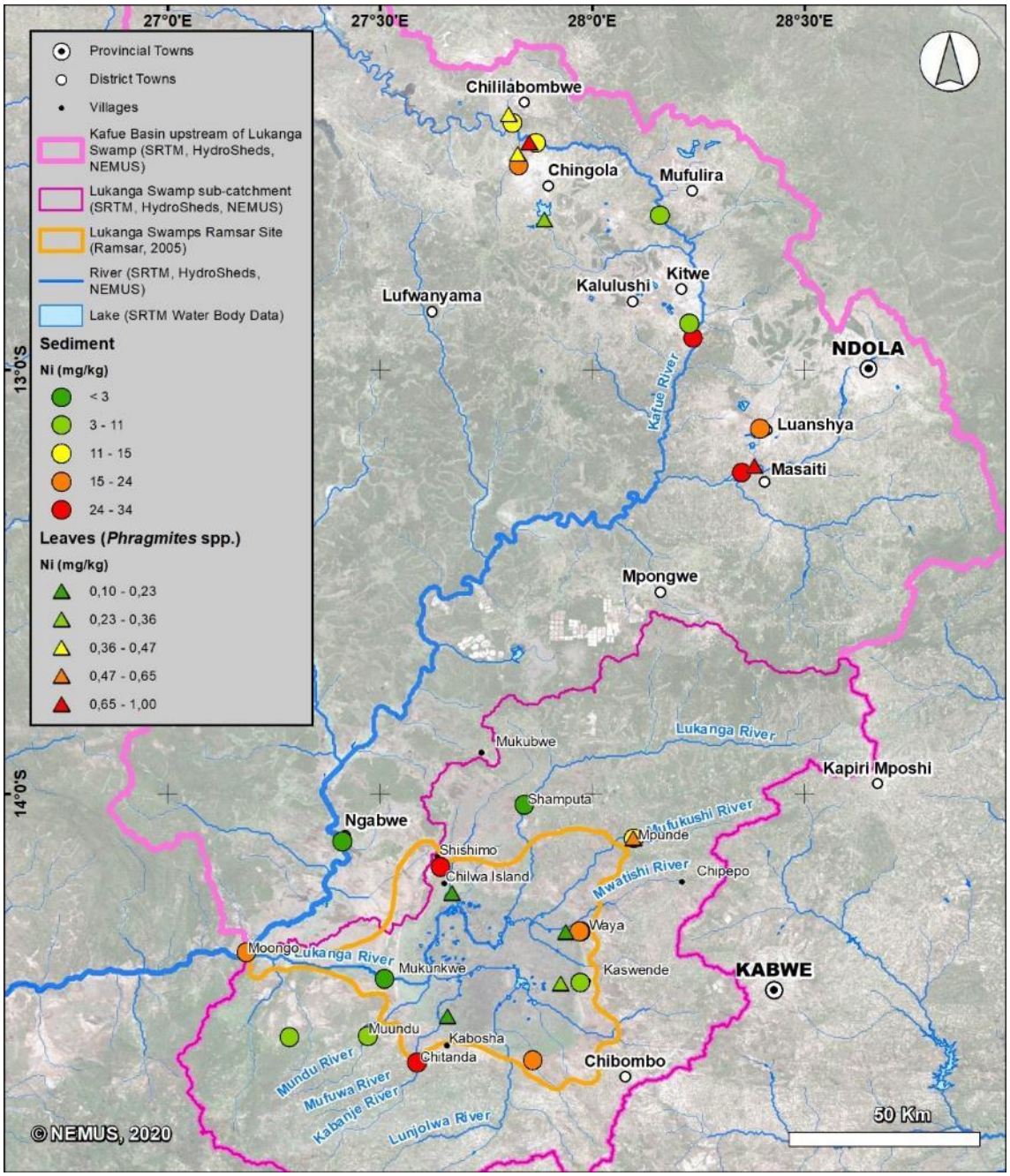


Figure 87 – Distribution of Ni in sediment samples and composite leaf samples in the Lukanga Swamp and Upper Kafue River Basin

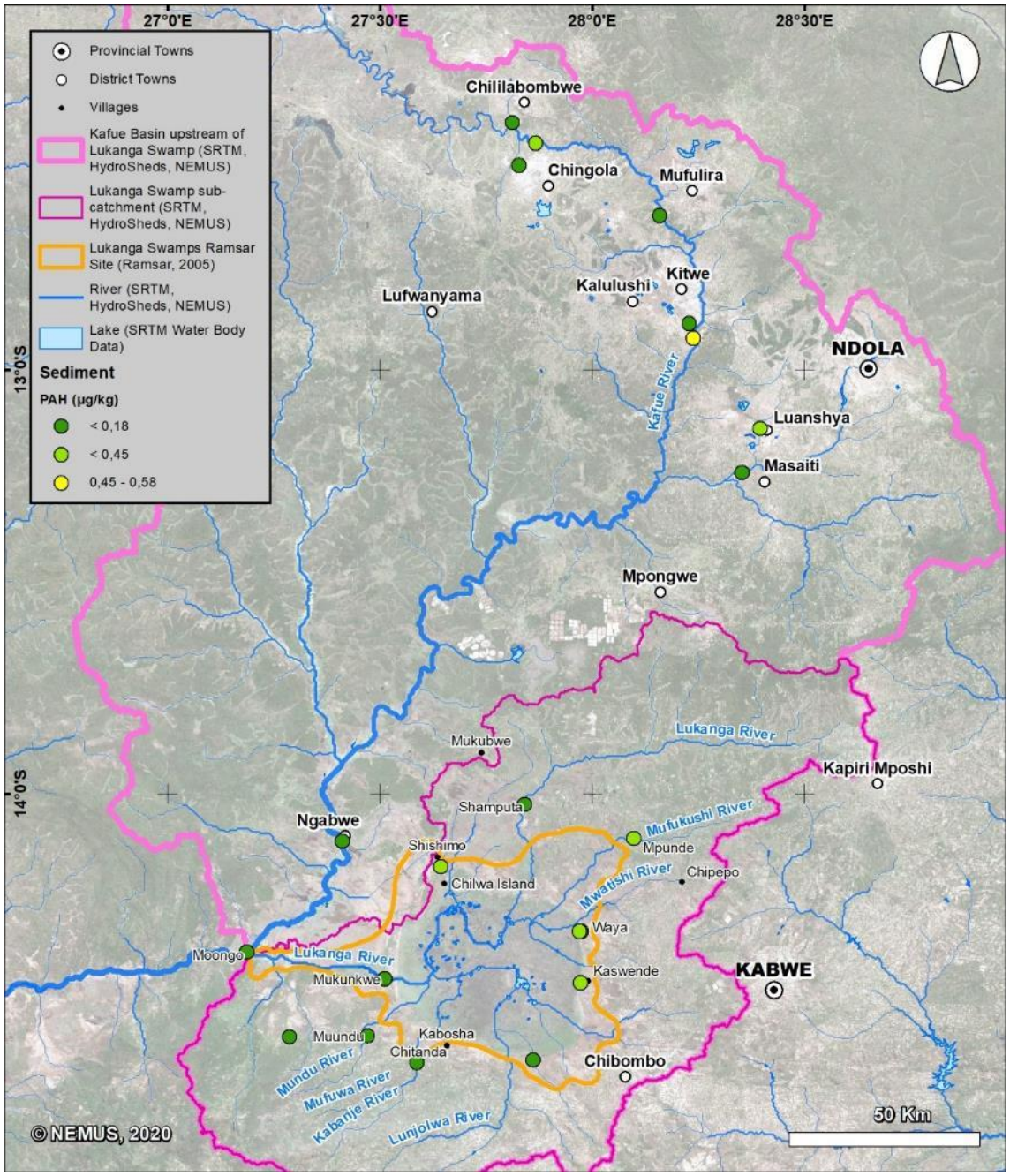


Figure 88 – Distribution of PAH in sediment samples in the Lukanga Swamp and Upper Kafue River Basin

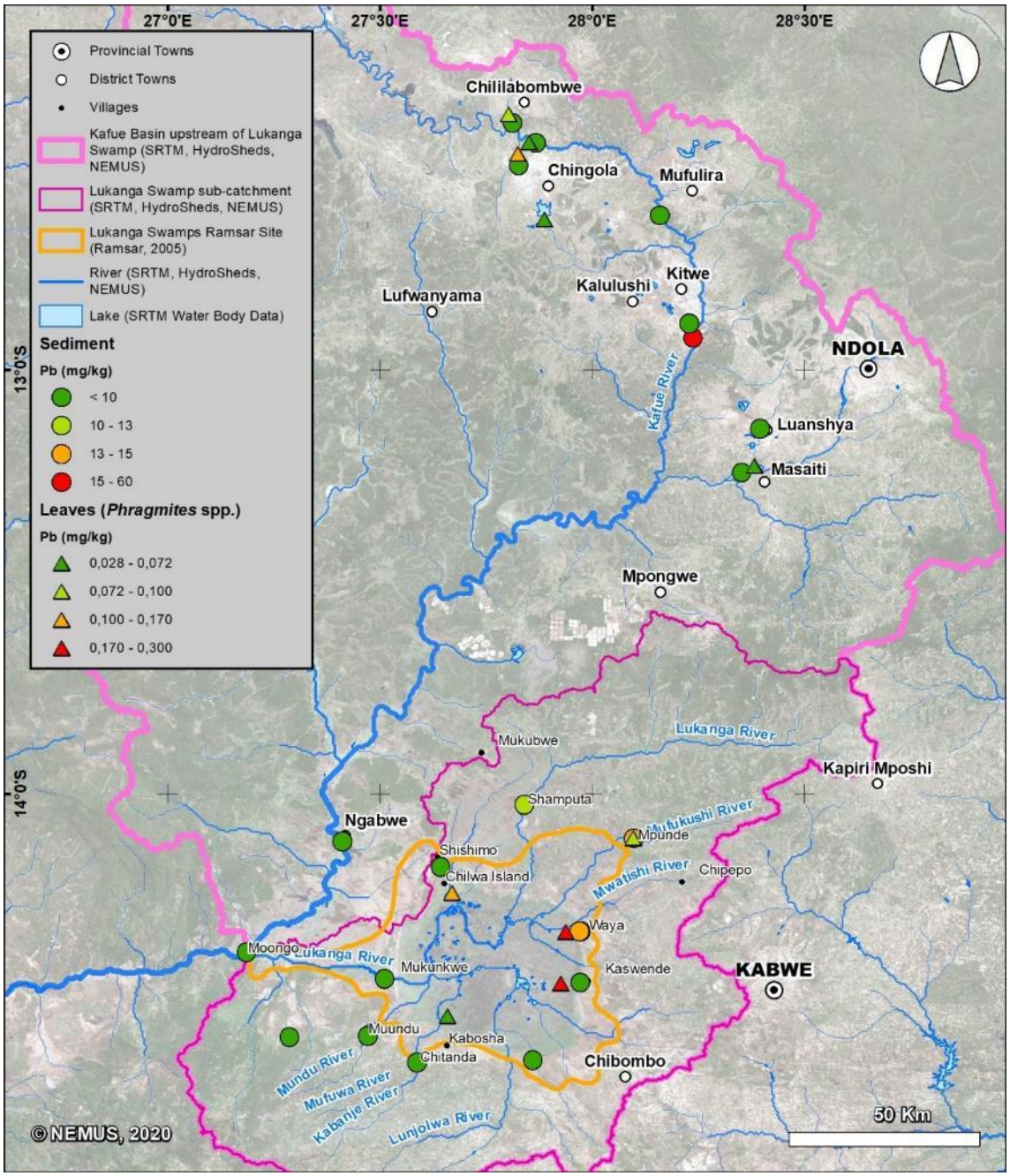


Figure 89 – Distribution of Pb in sediment samples and composite leaf samples in the Lukanga Swamp and Upper Kafue River Basin

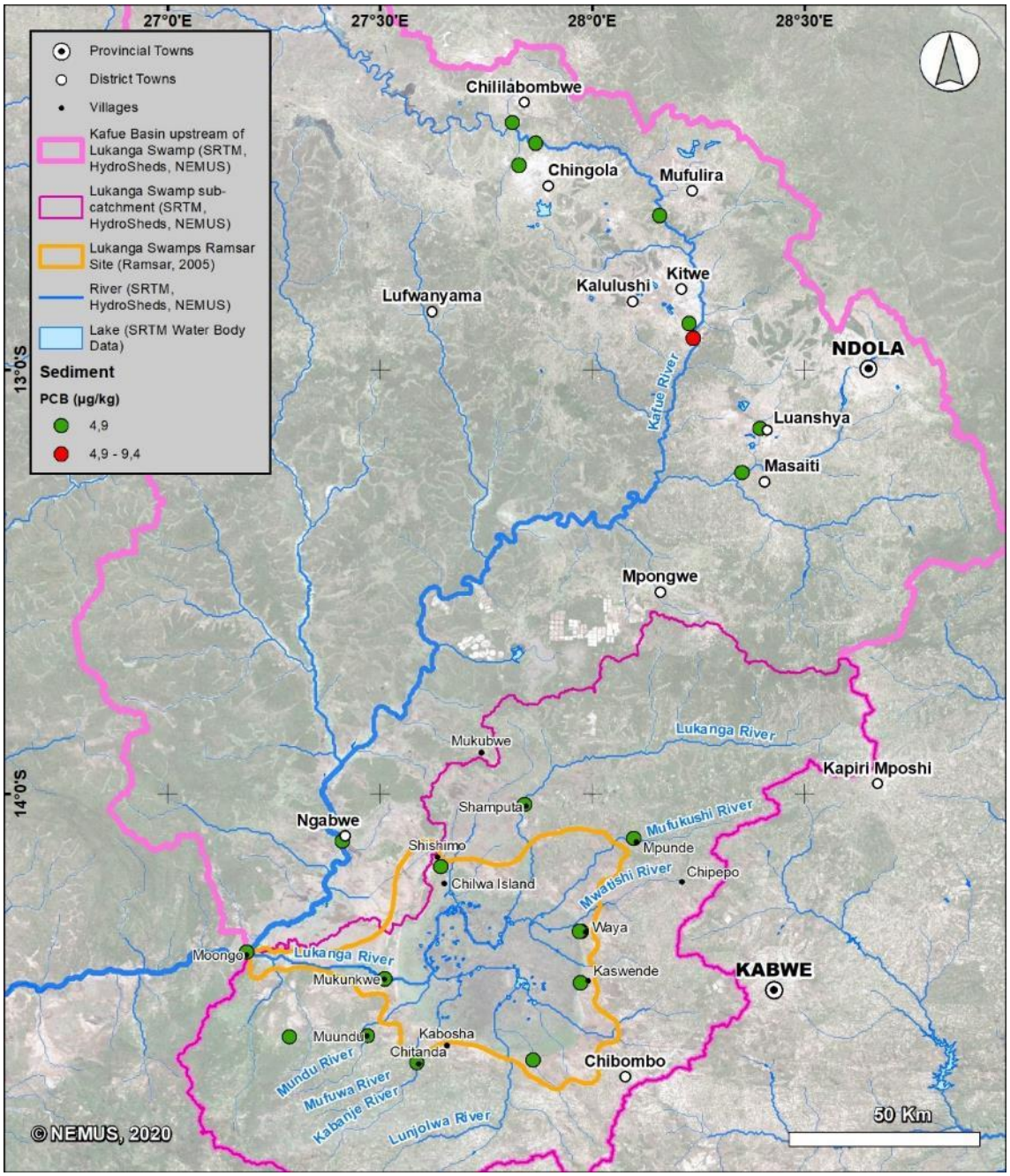


Figure 90 – Distribution of PCB in sediment samples in the Lukanga Swamp and Upper Kafue River Basin

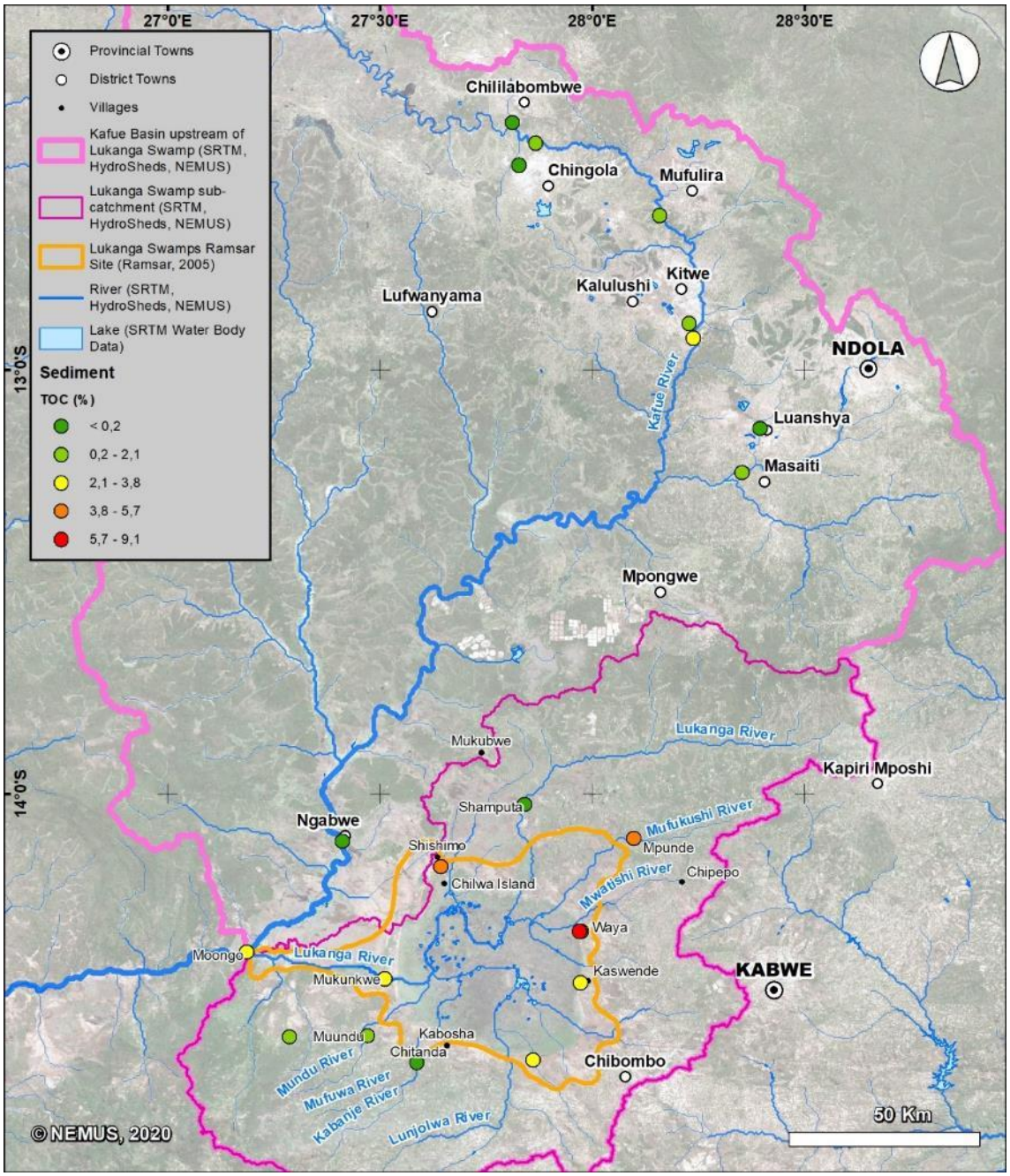


Figure 91 – Distribution of TOC in sediment samples in the Lukanga Swamp and Upper Kafue River Basin

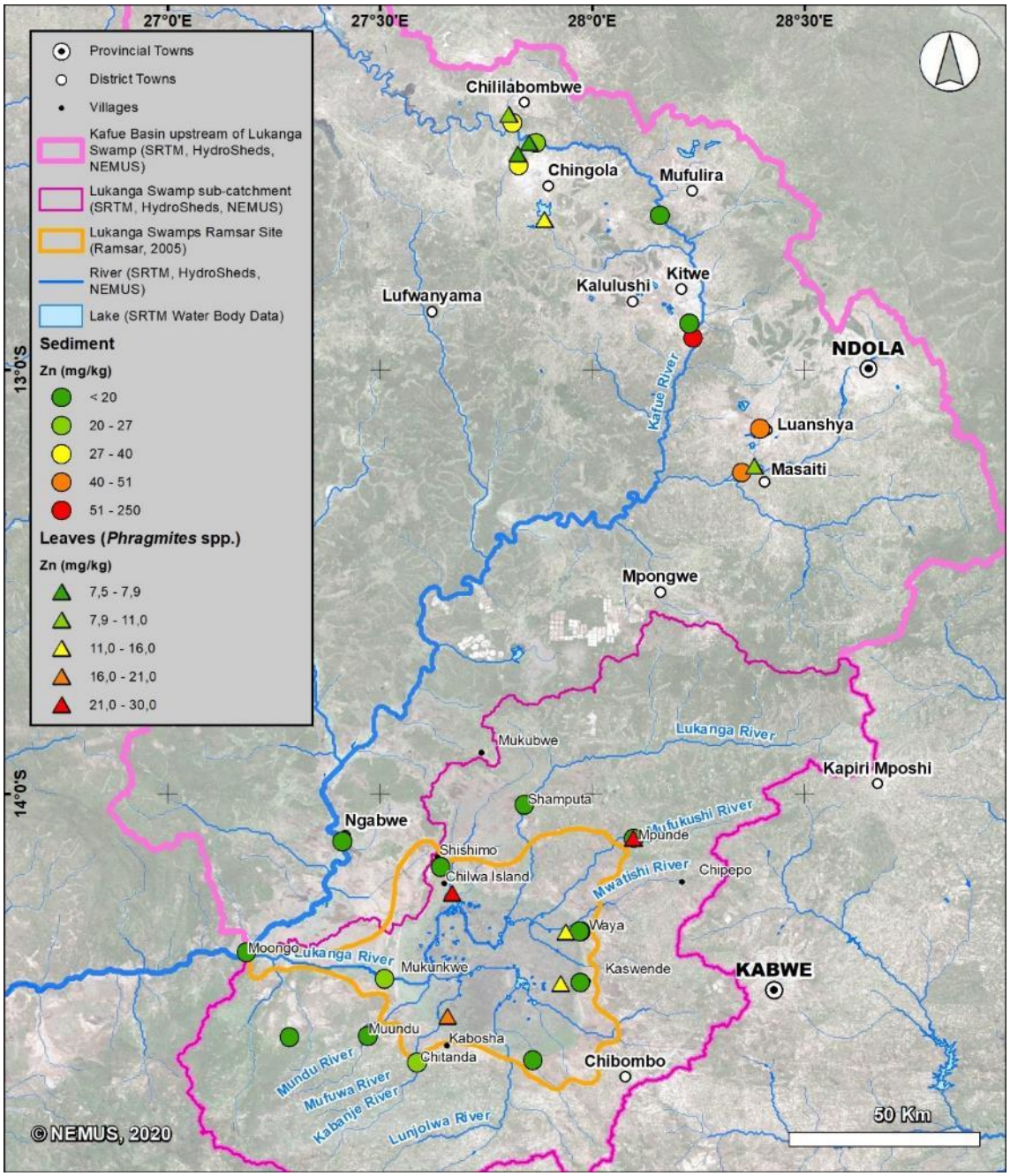


Figure 92 – Distribution of Zn in sediment samples and composite leaf samples in the Lukanga Swamp and Upper Kafue River Basin

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Appendix 3 – Stakeholder consultation

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The stakeholder engagement actions **conducted to date** include:

- Interviews with key stakeholders
    1. ZEMA, Copperbelt Office – Principal Inspector in charge of Water, Mr. Cliff Ngwata (Ndola, 11th October 2019);
    2. Zambia National Farmers Union, Copperbelt Office – Credit and marketing facilitator, Mr. Kaluba (Kalulushi, 11th October 2019);
    3. Chamber of Commerce, Copperbelt Office – Past President of Chamber of Commerce Kitwe, Mr. Sharad Nayee (Kitwe, 11th October 2019);
    4. Copperbelt University, School of Mines and Mineral Sciences – Dr. Jhonnah Mundike (Kitwe, 15th October 2019);
    5. Water Resources Management Authority (WARMA) – Acting Director General, Eng. Ken Nyundu (Lusaka, 30th October 2019);
    6. BirdWatch Zambia – Wetlands Project Officer, Ms. Clara Nanja (Lusaka, 30th October 2019);
    7. Misenge Environmental and Technical Services Limited – Environment and Radiation Specialist, Mr. Cyril Lukeke (Kalulushi, 31st October 2019);
- Community interviews
    1. Headman Kennedy Muweshi, Headman John Chitunami, Davy Kaboko – Chiyokoma and Muweshi / Moongo area, 17th October 2019;
    2. Davy Malichi, Wallace Musonda, Bana Mumba, Erasmus Muyinda, Phergason Musonda – Kabosha Village, 18th October 2019;
    3. Laban Mofya – Waya Village, 19th October 2019;
    4. Shadrick Mwelwa, Martine Musonda, Silvester Zulu – Kaswende Village, 20th October 2019;
    5. Albina Kunda, Evaristo Mpundu – Chishimu Village, on the upland of Chilwa Island, 21st October 2019;
- Stakeholder consultation workshops
    - W1 – Lusaka, 29th October 2019;
    - W2 – Kitwe, 1st November 2019;
- Formal requests for specific information, by letter/email, to most of the stakeholders present at the workshops, among other key stakeholders (who were also informed about the plan by this means)
    1. Agricultural Consultative Forum;
    2. BirdWatch Zambia;

3. Chambishi Copper Smelter;
4. Chibombo Town Council;
5. Chingola Municipal Council;
6. Copperbelt University – School of Mines and Mineral Sciences;
7. Kabwe Municipal Council;
8. Kapiri Mposhi Town Council;
9. Kitwe City Council;
10. Konkola Copper Mines;
11. Lukanga Water Supply & Sanitation Company Limited;
12. Ministry of Agriculture;
13. MCDSS – Social Welfare Department;
14. MFL – Fisheries office for Central Province; Department of Fisheries
15. MLNR – Department of Climate Change and Natural Resources;
16. MLNR – Environment and Natural Resources Management Department;
17. MLNR – Forestry Department;
18. MMMD – Mines Safety Department;
19. MWDSEP – Department of Water Resources Development;
20. Misenge Environmental and Technical Services Limited;
21. Mopani Copper Mines;
22. Mufulira Municipal Council;
23. Mulonga Water and Sewerage Company;
24. NFC Africa Mining;
25. Ngabwe Town Council;
26. Nkana Water and Sewerage Company;
27. Provincial Chiefs and Traditional Affairs office for Central province;
28. University of Zambia – Institute of Economic and Social Research;
29. Water Resources Management Authority;
30. WWF-Zambia;
31. Zambia Climate Change Network;
32. Zambia Land Alliance.

Written **records from the stakeholder and community interviews** are presented in **Appendix 3.1**.

A **report of the first stakeholder consultation workshops** is presented in **Appendix 3.2**, including:

- Workshop programme;
- Supporting PowerPoint presentations;
- Participation and discussion notes;
- Attendance lists.

To date, only the Social Welfare Department (of the Ministry of Community Development and Social Services), Lukanga Water Supply & Sanitation Company Limited, Mulonga Water and Sewerage Company and NFC Africa Mining provided information in **response to the formal requests**.

Of the stakeholder engagement actions comprised in the assignment, only the **focus group discussions** with local communities didn´t start in the first quarter of the work schedule. But they got their kick-off in December 2019, while this report was first closed and submitted:

- Two communities are scheduled to be engaged, on the 20th and 21st December 2019 – Kabosha and Muchoko villages, respectively;
- There are three groups to be met in each community, so six focus group discussions will be conducted at this stage;
- The field form / checklist for these focus group discussions is presented in **Appendix 3.3** and it is composed of five main questions / question groups:
  - 1. Community/group characterization; governance;
  - 2. Main economic activities undertaken by the community/group;
  - 3. Ecosystem services dependence;
  - 4. Conflicts / malfunctions regarding ecosystem services;
  - 5. Community / group acceptance of future conservation efforts.

Afterwards, up to 12 focus group discussions (two or three groups in six or four villages/communities) will be scheduled to April-May (towards the end of the hunger and rainy seasons and in time to be considered in Phase 3 – Characterization and assessment).

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Appendix 3.1 – Stakeholder and community interviews' records

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CONSERVATION PLAN FOR LUKANGA SWAMP AND UPPER KAFUE RIVER BASIN

Questions for stakeholder interview

Date: 11th October 2019

Place: Chamber of commerce offices, Kitwe, Copperbelt Zambia

Institution: Chamber of Commerce, Copperbelt Office

Context
Zambia Environmental Management Agency (ZEMA) awarded NEMUS the development of the Conservation Plan for Lukanga Swamp and Upper Kafue River Basin, under Contract nr. ZM-ZEMA-52311-CS-CQBS. The development of a Conservation Plan for Lukanga Swamp aims primarily at generating both qualitative and quantitative data and tools required to support informed cross sectoral decision making and the participatory management of the area. In this context, the assignment includes field work and the conduction of interviews and focus group discussions in Lukanga Swamp, its catchment and Upper Kafue River Basin, i.e., in Central and Copperbelt Provinces. On behalf of NEMUS, we thank you for any cooperation in providing available information that might be relevant for the assignment.

Consultant: nemus empowering sustainability

Financing: THE WORLD BANK IBRD • IDA | WORLD BANK GROUP

1. What are the biggest and/or more impacting developments in the Copperbelt Province, capable of influencing the ecosystems downstream?

i. The uncoordinated construction of infrastructure

The allocation of building plots is done outside the town planning plans. Many buildings are being constructed right on the Kitwe greenbelt zone. The construction developments are political influenced. There is land grabbing rather than land allocation by the local authority. There is total break own in land allocation and usage in Kitwe. Building developments are being done in the dambos that have since dried up (e.g. near Kitwe Central Hospital).

ii. Disused mine slimes dams

The local authority was using the closed down mine slimes dams for domestic solid waste damps. There are health hazard ricks in these solid waste damp areas. During rainy season, there is runoff of waste into streams affecting the river ecosystem. Some of these slimes dams were now being opened up for infrastructure development with the apparent consent of the environmental institutions such as ZEMA.

iii. Illegal small-scale sand miners

There is high demand of sand in Kitwe for infrastructure construction. Sand mining activities were mushrooming at a fast rate to complement the need in infrastructure development. Sand mining has been done in the banks of the streams. As a result, some water streams were diverted leading to dry up streams.

iv. Car wash activities

The car wash business is increasing. There are now many cars on the road. Entrepreneurs have invested in car wash businesses to cope with the need. The car wash stations are set near the Kitwe stream where water is drawn to wash the cars and poured back into the stream. The stream's ecosystem is affected.

v. Solid waste management effects

The collection of solid waste in Kitwe from residential and commercial places by the local authority and the solid waste contracted companies is insufficient. At Chisokone market, there are hills of uncollected garbage. And right next to the garbage hills are makeshift merchandise selling points. This poses a health hazard situation to the vendors. There is foul stench emitted from this uncollected garbage.

2. What are the main environmental and social impacts from those developments?

- Three watercourses have dried up in the Kitwe area due to infrastructure construction.
- Health problems due to solid waste dump areas poor management.
- Runoff from waste dump areas and car washing stations decreasing water quality of streams.

3. Do you know about and/or have access to any studies on those impacts and their consequences in the Kafue basin downstream?

At times there are environmental reports on national and social media. When the Mines were being privatised, there were media sensitization on how the mining was impacting on environment and effecting the community livelihoods.

4. Can you identify other drivers of ecosystem change in the Lukanga Swamp, operating both in the swamp and Upper Kafue Basin?

i. Growth in infrastructure development
There is uncoordinated construction of residential and commercial buildings along the riverbanks against the environmental regulations. Land allocation was being allocated on the reserved Kitwe greenbelt by the local authority. The dambos in Kitwe greenbelt are drying up as a result of being clogged with debris from road constructions to create foundation slabs. Other tributaries to Kafue River in Kitwe were also drying up attributed to human encroachments. There is low inflow of water into Kafue river.

ii. Sand mining
As a result of high development in construction of residential and shopping malls in Kitwe, sand is on high demand. Mining of sand was being done along the banks of the tributaries to the Kafue River. The flow and water level in these tributaries were affected leading to the river ecosystem degradation.

iii. Pollution from Industries
There were few industries polluting the rivers in Kitwe as compared to the 1980s situation. Many industries were now putting up efficient controls in effluent discharged in rivers waters. Though, however, there are some beef industries that were not complying with environmental laws. There are indiscriminately discharging their effluent in streams such as Mindola and Kitwe streams.

iv. Indiscriminate solid waste disposal
The local authorities have designated sites for solid waste disposal. These sites have become full of waste. During rainy season, the rivers such as streams to Kitwe Rivers, experience runoff waste that eventually affect the river ecosystem. Much evidence is observed at Chisokone market, the biggest market in Kitwe. It sits on a dambo. There is more waste generated than collected by the local authority. This waste poses healthy hazards to human beings. This waste eventually finds its way into the streams. Downstream are car washing entrepreneurs that use this water to wash cars.

5. How do you think the identified impacts and changes can be mitigated, and the Swamp managed in a sustainable manner?

i. There were a lot of backfilling of the Kitwe River nearer Copperbelt University and on wetlands near the Kitwe Central hospital and where ECL mall has been built over. These wetlands and dambos help feed the Kitwe streams which were now being destroyed by constructing houses and other buildings on them. Minor tributaries are being completely buried and some were drying up.

   The Uchi stream between Ndeke and Nkana East area is another stream that is at the verge of drying up as a result of reckless construction of residential houses near the stream. If this stream dries up, it means less water in the Kafue River and consequently the Zambezi River.

   Mitigation: **capacity building to the local authority planning department** who were allocating such lands outside the approved town planning schedule.

ii. ZEMA should step up on following up on agreed developments in environmental impact assessments with respective contractors through the local authority

iii. Implementation of the environmental laws and policies already stablished in Zambia

iv. Sensitise the local authority on the effects of external political influence in town planning

i. Who are the key stakeholders in the region to engage in the Conservation Plan for Lukanga Swamp and Upper Kafue Basin

i. NWASCO. Revive the citizen groups that check on quality of water supply to the community. Mining companies including small scale mines

ii. Small scale sand miners

iii. Enterprenuers such as car wash groups

ii. Other comments/observations

WARMA to harmonise the land allocation issues and change of land use. ZEMA and WARMA roles are missing out on housing developments in the local authority. Public disclosure on approved district development infrastructure projects must be enhanced to harness full community participation in environmental issues.

The conservation plan should be simple enough so all authorities can understand and implement it.

CONSERVATION PLAN FOR LUKANGA SWAMP AND UPPER KAFUE RIVER BASIN

Questions for stakeholder interview

Date: 11th October 2019

Place: ZEMA offices, Ndola, Copperbelt Zambia

Institution: ZEMA, Copperbelt Office

Context
Zambia Environmental Management Agency (ZEMA) awarded NEMUS the development of the Conservation Plan for Lukanga Swamp and Upper Kafue River Basin, under Contract nr. ZM-ZEMA-52311-CS-CQBS. The development of a Conservation Plan for Lukanga Swamp aims primarily at generating both qualitative and quantitative data and tools required to support informed cross sectoral decision making and the participatory management of the area. In this context, the assignment includes field work and the conduction of interviews and focus group discussions in Lukanga Swamp, its catchment and Upper Kafue River Basin, i.e., in Central and Copperbelt Provinces. On behalf of NEMUS, we thank you for any cooperation in providing available information that might be relevant for the assignment.

Consultant: nemus empowering sustainability

Financing: THE WORLD BANK IBRD • IDA | WORLD BANK GROUP

1. What are the biggest and/or more impacting developments in the Copperbelt Province, capable of influencing the ecosystems downstream?

i. Farming along the upper Kafue River

Commercial and small-scale farming

ii. Minerals Mining activities

Mineral mining activities affect the middle part of the upper Kafue River. Effluents are discharged in the tributaries of the Kafue River by Konkola Copper Mines in Chillilabombwe and Chingola, and Mopani copper mines in Kitwe and Mufulira towns.

iii. Urban industrial development

Many of the manufacturing industries on the Copperbelt discharge their effluent in tributaries to the Kafue River. In Ndola, many industries discharge their effluent in the Kafubu River, a tributary to the Kafulafuta river that eventually joins the Kafue River.

iv. Untreated waste

The treatment of domestic water in many treatment plants is not efficient and fall below the stablished environmental standards such as in Nkana, Mulonga and Kafubu water treatment plants set on many streams to Kafue River.

Many of these water treatment plants have broken down water pipes and the machines are obsolete with age.

v. Charcoal burning

There is increase in demand for charcoal for household use on the Copperbelt which causes forest destruction.

2. What are the main environmental and social impacts from those developments?

i. Problems of water quality in the Kafue River

The problems are related to microbiology and metal content in the water. ZEMA issues operating licences to industrial companies with set standards to discharge effluent in the river waters. ZEMA in past 10 years was physically monitoring the industries on the effluent discharge in the river water, but this was not the case at the present time. The respective industries submit data reports to ZEMA every six months on their effluent discharge. And ZEMA do not follow up on companies discharging above the set standards unless there are public outcries.

There was a public outcry on the quality of water in Chingola where livestock died after drinking from the heavy metal polluted river by Konkola Mines. ZEMA took the river water samples and found that the river was heavily polluted.

Many of the water treatment plants such plants belonging to Nkana, Mulonga and Kafubu water sewerage companies fall below the set water treatment standards because their plants water uptake points are within the streams heavily polluted by the mines. There were community reports of poor water quality, for example in Mufulira, but there were no clinical reports to substantiate the community outcries.

There were reports on industrial effluent discharge in river water at WARMA dating 10 years ago that can be accessed.

3. Do you know about and/or have access to any studies on those impacts and their consequences in the Kafue basin downstream?

University of Zambia studies on fish surrogate of water quality in upper Kafue river by Dr Mwase Maxwell and Michael Kambole.

ZEMA commissioned study to consolidate studies on quality of water monitoring in the Kafue River. Consultant was Professor Thompson Sinkala.

Dr Chabwera had done numerous studies on the Lukanga Swamps.

4. Can you identify other drivers of ecosystem change in the Lukanga Swamp, operating both in the swamp and Upper Kafue Basin?

i. Overfishing

ii. Mineral mining

There is evidence that water quality in many tributaries to the Kafue River in the upper basin is heavily polluted with metals and the level of heavy pollution reduces in tributaries to Kafue River located near the Lukanga Swamps.

iii. Charcoal burning

5. How do you think the identified impacts and changes can be mitigated, and the Swamp managed in a sustainable manner?

i. Ensure that water treatment plants treat water to acceptable standards.

ii. Revisit the ZEMA set effluent discharge standards. They were not generated to local conditions but were borrowed from other countries.

iii. Reinforce ZEMA water quality monitoring. ZEMA receives reports from companies but financial support (equipment and transport) hampers ZEMA to physically counter check and verify the reports on the ground.

iv. ZEMA strengthen working relationship with local authority on monitoring development projects. About 10 years ago ZEMA advised the local authority against allocation land within 50 meters for residual plots. Recently, the local authority went against the advice, and the developed residential structured had to be demolished.

v. Who are the key stakeholders in the region to engage in the Conservation Plan for Lukanga Swamp and Upper Kafue Basin

i. WARMA

ii. Mining companies including small scale mines

iii. Local authorities

iv. Manufacuring industries

v. Commeciarl and farmers

vi. Ministry of Agricuture

vii. Water utility companies

vi. Other comments/observations

CONSERVATION PLAN FOR LUKANGA SWAMP AND UPPER KAFUE RIVER BASIN

Questions for stakeholder interview

Date: 11th October 2019

Place: ZNFU offices, Kalulushi, Copperbelt Zambia

Institution: Zambia National Farmers Union, Copperbelt Office

Context
Zambia Environmental Management Agency (ZEMA) awarded NEMUS the development of the Conservation Plan for Lukanga Swamp and Upper Kafue River Basin, under Contract nr. ZM-ZEMA-52311-CS-CQBS. The development of a Conservation Plan for Lukanga Swamp aims primarily at generating both qualitative and quantitative data and tools required to support informed cross sectoral decision making and the participatory management of the area. In this context, the assignment includes field work and the conduction of interviews and focus group discussions in Lukanga Swamp, its catchment and Upper Kafue River Basin, i.e., in Central and Copperbelt Provinces. On behalf of NEMUS, we thank you for any cooperation in providing available information that might be relevant for the assignment.

Consultant: nemus empowering sustainability

Financing: THE WORLD BANK IBRD • IDA | WORLD BANK GROUP

1. What are the biggest and/or more impacting developments in the Copperbelt Province, capable of influencing the ecosystems downstream?

i. Mineral mining

Mining activities releases effluent in tributary streams to the Kafue River. Water is contaminated. There have been reports of farmers' complaints on quality of river water affecting their crops. Crops are stunted. There have been health complaints from people living along the Luswishi River of stomach pains whenever they drink river water. Small mines mining precious stones are operating in this area and releasing effluents in the river.

ii. Farming

There is small scale and commercial farming along the rivers. They use river water to irrigate their crops. The pesticides and fertiliser they use drain in the river. The livestock drink water from these rivers. There have been reports of livestock dying along the Lufwanyama River. The farmers are not aware that they contribute to contamination of river water. Because of the size of the mines, the farmer's complaints are towards the mining activities.

2. What are the main environmental and social impacts from those developments?

i. Health effects

The stomach complaints from people farming along the rivers are attributed to the quality of water. The labour input is reduced on crop production and hence the crop yield is reduced. This eventually affects the low food livelihood intake at household level. Poverty rises. The children are the most affected.

ii. The effects of farming on the banks of the Lufwanyama River. This river starts from Chingola town and joins the Kafue River in Central province and if water fetching for human activities is neglected along the river and at the source, this river may have low water flow and eventually dry up.

iii. There have been reports of cattle dying in Chilengwa area of Lufwanyama district.

3. Do you know about and/or have access to any studies on those impacts and their consequences in the Kafue basin downstream?

Neither aware of any studies nor visits made to the Kalulushi ZNFU office. Nemus was the first to visit the offices and discuss the effects of developmental activities on the Kafue River and its tributaries.

4. Can you identify other drivers of ecosystem change in the Lukanga Swamp, operating both in the swamp and Upper Kafue Basin?

i. Population growth

The population and demand for building houses to live in is growing. The houses are now being built along the riverbanks against the environmental regulations. Some were being built on the river watersheds. Many tributaries to the Kafue River are drying up resulting in the reduction of the inflow of water in many rivers.

ii. Small scale mining

There are small mines of precious stones in the Lufwanyama district. They use open mining methods and they shift the mining from place to place. They leave unburied deep mining ditches. This affects the water level of the area. The mining effluents are discharged in the streams affecting the river ecosystem.

iii. Farming

There are many farmers doing crop production and keeping livestock. The main farming group are Tonga tribes of southern province who in the last 5 years have been migrating to the Lufwanyama district. The pesticides and fertiliser used in farming runoff into the river streams. The grazing of cattle depends on the wetlands. There have been reports of cattle dying in Chilengwa area of Lufwanyama district.

5. How do you think the identified impacts and changes can be mitigated, and the Swamp managed in a sustainable manner?

i. Sensitise the farmers on how to use the pesticides, fertilisers and river water for irrigation in their farming activities

ii. Train the community farmers on how to preserve food harvested to safe guide the household food security

iii. Teach the farmers on conservation farming to address the late delivery of farming inputs such as seeds and fertilisers. Use of organic fertilisers include compost manure and animal manure. The farming community is willing to use the organic fertilisers for the soil, particularly in many parts of the Lufwanyama district where it still is fertile.

iv. Encourage and teach farmers on crop diversification farming to include cultivation of sorghum, soya beans, groundnuts, cassava etc. This would encourage farmers to depend less on fertiliser that is every farming season delivered late.

v. Who are the key stakeholders in the region to engage in the Conservation Plan for Lukanga Swamp and Upper Kafue Basin?
i. Mining companies including small scale mines ii. Small scale and commercial farmers iii. Ministry of agriculture
vi. Other comments/observations
Nil

CONSERVATION PLAN FOR LUKANGA SWAMP AND UPPER KAFUE RIVER BASIN

Questions for stakeholder interview

Date: 15/10/2019

Place: KITWE

Institution: CBU

Context
Zambia Environmental Management Agency (ZEMA) awarded NEMUS the development of the Conservation Plan for Lukanga Swamp and Upper Kafue River Basin, under Contract nr. ZM-ZEMA-52311-CS-CQBS. The development of a Conservation Plan for Lukanga Swamp aims primarily at generating both qualitative and quantitative data and tools required to support informed cross sectoral decision making and the participatory management of the area. In this context, the assignment includes field work and the conduction of interviews and focus group discussions in Lukanga Swamp, its catchment and Upper Kafue River Basin, i.e., in Central and Copperbelt Provinces. On behalf of NEMUS, we thank you for any cooperation in providing available information that might be relevant for the assignment.

Consultant: nemus – empowering sustainability

Financing: THE WORLD BANK – IBRD • IDA | WORLD BANK GROUP

1. **What are the biggest and/or more impacting developments in the Copperbelt Province, capable of influencing the ecosystems downstream?**

- SOLID WASTE MANAGEMENT
- WASTEWATER TREATMENT
- MINING ACTIVITIES
- UNPLANNED SETTLEMENTS WITHIN 50M ALONG RIVERS & STREAMS

2. **What are the main environmental and social impacts from those developments?**

- SEDIMENTATION
- EUTROPHICATION
- HEAVY METAL CONTAMINATION (WATER & SEDIMENTS)
- DESTRUCTION OF AQUATIC ECOTONES

3. **Do you know about and/or have access to any studies on those impacts and their consequences in the Kafue basin downstream?**

- YES

4. Can you identify other drivers of ecosystem change in the Lukanga Swamp, operating both in the swamp and Upper Kafue Basin?
- CHARCOAL BURNING - FARMING & GARDENING WITHIN 50M OF RIVERIN SYSTEMS
5. How do you think the identified impacts and changes can be mitigated, and the Swamp managed in a sustainable manner?
SUSTAINABLE MANAGEMENT, TREATMENT & PLANNING OF ITEMS LISTED IN Q1 & Q4

6. Who are the key stakeholders in the region to engage in the Conservation Plan for Lukanga Swamp and Upper Kafue Basin?
- All Municipalities on the Copperbelt - The Copperbelt University - Zccm-ih - All Mining Companies

7. Other comments/observations
N/A

CONSERVATION PLAN FOR LUKANGA SWAMP AND UPPER KAFUE RIVER BASIN

Stakeholder interview

Date: 30th October 2019

Place: WARMA offices, Lusaka Zambia

Institution: Water Resources Management Authority

Context
Zambia Environmental Management Agency (ZEMA) awarded NEMUS the development of the Conservation Plan for Lukanga Swamp and Upper Kafue River Basin, under Contract nr. ZM-ZEMA-52311-CS-CQBS. The development of a Conservation Plan for Lukanga Swamp aims primarily at generating both qualitative and quantitative data and tools required to support informed cross sectoral decision making and the participatory management of the area. In this context, the assignment includes field work and the conduction of interviews and focus group discussions in Lukanga Swamp, its catchment and Upper Kafue River Basin, i.e., in Central and Copperbelt Provinces. Being one of the key stakeholders of the assignment, NEMUS took the opportunity of the first Stakeholder Consultation Workshop to ask WARMA for a specific interview, thanking in advance for any cooperation in providing available information that might be relevant for the assignment.

Consultant:
nemus
empowering sustainability

Financing:
THE WORLD BANK
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Main issues discussed
1. Consultancy for the Development of a Conservation Plan for Lukanga Swamp and Upper Kafue Basin – WARMA asked ZEMA about the consultancy and what is expected from NEMUS; WARMA also wondered how it could benefit from the Plan 2. River basin planning – WARMA has studies on this and it can collaborate as long as the information is formally asked (ZEMA) 3. Monitoring Plan for the Kafue (Upper and Lower) and other information from WARMA potentially relevant for the assignment

CONSERVATION PLAN FOR LUKANGA SWAMP AND UPPER KAFUE RIVER BASIN

Stakeholder interview

Date: 30th October 2019

Place: BirdWatch Zambia offices, Lusaka Zambia

Institution: BirdWatch Zambia, BirdLife International

Context
Zambia Environmental Management Agency (ZEMA) awarded NEMUS the development of the Conservation Plan for Lukanga Swamp and Upper Kafue River Basin, under Contract nr. ZM-ZEMA-52311-CS-CQBS. The development of a Conservation Plan for Lukanga Swamp aims primarily at generating both qualitative and quantitative data and tools required to support informed cross sectoral decision making and the participatory management of the area. In this context, the assignment includes field work and the conduction of interviews and focus group discussions in Lukanga Swamp, its catchment and Upper Kafue River Basin, i.e., in Central and Copperbelt Provinces. Being one of the key stakeholders present at the first Stakeholder Consultation Workshop, NEMUS asked BirdWatch for a specific interview, thanking in advance for any cooperation in providing available information that might be relevant for the assignment.

Consultant: nemus empowering sustainability

Financing: THE WORLD BANK IBRD • IDA | WORLD BANK GROUP

Main issues discussed
1. Cartography of weed in the Lukanga Swamp since 2007. Satellite imagery: MEDEEM Zambia; MODOO 2011-2016/17 2. Project 20117-March 2021 -> funded by Darwin Initiative – UK Government, through Birdlife International; monitoring reports: biodiversity; monitoring of beetle for weeds 3. Three entry points in the Swamp: Waya (4 officers), Chiuni (1 officer), Chilwa (2 officers -> Department of Fisheries) 4. Lukanga represents 10% of the fish production of Zambia 5. Fisheries Officer for Central Province -> facilitator for the experiments and research on Lukanga 6. Water quality analyses were performed in the beginning of the project – baseline 7. Fish inventory – the Fisheries Department should have one, even if not up to date 8. Invasive weed ~50% of all the Swamp 9. Margin conservation is the main problem – mammals have nearly disappeared 10. Field information and contacts (from local officers, accommodation, boats) were also shared

CONSERVATION PLAN FOR LUKANGA SWAMP AND UPPER KAFUE RIVER BASIN

Stakeholder interview

Date: 31st October 2019

Place: Misenge Environmental and Technical Services Limited, Kalulushi, Copperbelt Zambia

Institution: Misenge Environmental and Technical Services Limited

Context
NEMUS met with Misenge Environmental and Technical Services Limited to discuss their experiences and view of a potential link between the environmental pollution existing on the Copperbelt and the pollution in Lukanga Swamps. It was further discussed how the pollution on the Copperbelt was fairing if there were any environmental-related conflicts and what were the main environmental concerns

Consultant:
empowering sustainability
nemus

Financing:
THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

Main issues discussed
1. Background of Misenge Environmental and Technical Services Limited. It was explained and how it turned out into a consultancy firm. Before the privatization of the mines, Misenge Environmental and Technical Services Limited was a Unit responsible for environment management with mining industries. After the privatization, the Unit was part of a new company providing environmental services to ZCCM IH on mining liabilities. After the mining liabilities were addressed, a consultancy firm was established to provide further services to parent companies or any other would-be clients. The Misenge Environmental and Technical Services Limited now offers services that include analytical services, engineering services, radiation services, and environmental projects' management. 2. Privatization of the mines. It started in 1998 and the last mine to be privatized was Mopani mines in Kitwe in 2002. Privatization took 4 years that all mines under ZCCM were privatized. Historical trends of pollution on the Copperbelt relating to the mining activities. People speculate over the mining activities imparting on the Lukanga swamps ecosystem, and effectively there are mining effluents discharged in Kafue River above the statutory admissive levels. 3. Public control of mining activities. ZEMA receives return reports from the mining companies, conducts audits of reports but is not enforcing the law to the culprits. ZEMA has the capacity to enforce the law on culprits but the political influence is high. ZEMA's enforcement of environmental laws was also discussed in the light of the case in court where residents in Chingola had taken KCM to court for polluting their drinking water. The case revealed that ZEMA was operating under political influence.

4. Link evidence between pollution existing on the Copperbelt and the Lukanga Swamps.
    a. The weed hyacinth first observed in Lubengele sewerage ponds was not clearly established if it was the same weed found in Lukanga Swamps. The weed is more related to flourish in a high nutrient charged environment such as sewerage ponds.
    b. There were studies conducted by the Swedish Geological Thornlock consultants and the University of Zambia in 2005 on Kafue River upstream and ecosystem highlighting on the impact of sewerage, and it was agreed that an electronic copy of the study report would be shared.
    c. The case of Mwambashi River, polluted by Chambeshi metals mines was also discussed, and how the effluents are discharged into the river and it goes through the dambo that acts as a purifier. The water sampled and tested after the dambo was clean with low metal contents. This study was done in the 1980s.
5. Effects of agriculture cultivation on the river banks as a driver to ecosystem change in the river. Land along the river banks is allocated to the farmers by the local authorities and regulatory bodies such as WARMA are not collaborating with local authorities to regulate the farmers polluting the rivers. A case was cited in Kabwe Lead project where ZEMA marked out areas in Kabwe highly lead-contaminated and there should be no settlements plots allocated. The local authorities were now locating settlement plots in the same highly lead-contaminated areas. A clear case of uncoordinated efforts to address environmental issues.
6. Effects of infrastructure development on the Copperbelt hydrological system. Reference was made to how Mindolo stream in Kitwe was encroached by the shopping malls structures and how the debris from roads building was been dumped near the streams affecting the water flow and the eventual river ecosystem being affected.
7. Other drivers of ecosystem change in Lukanga swamps – deforestation and cattle rearing, influencing river pollution.

FIELD FORM – *Key informant interviews*

Date: 17.10.2019

Village name: Chiyokoma and Muweshi / Moongo area

Interview ID: Christopher Sinyinza

What are the main economic activities/ resource uses undertaken by people on your village? Which ones relate to the wetland?

A: The main economic activities are:

- Fishing;
- Livestock rearing such as free-range chickens and cattle;
- Subsistence agriculture.

Other activities include wood harvesting (for building materials, for instance), wild fruit harvesting and wild plant harvesting for medicinal purposes. Not every household owns land to practice agriculture in.

What were the main threats/ drivers of change of wetland ecosystems and resource availability observed in the past 10 years?

A: The three main threats are:

- The use of wrong fishing nets, which catch even the small fish;
- The overharvesting of trees for firewood at household level, and to sell to fishermen for drying fish;
- The Population increase putting pressure on the natural resources

What invasive weeds do you know about? *When did they first appear?*

A: Invasive weeds:

- Currently dominant reeds are invasive - the ones that were used for making mats in the past have disappeared and been replaced with current softer ones;
- Javan weed;
- Chikwema weed - water lilies.

How do these impact local economic activities? *Do they hinder movement and fishing activities within the swamp?*

A: The weeds growing on the swamp's channels slow down the movement of canoes. Fish breeding areas have also been affected.

Where do the invasions extend to? (*attempt to collect additional information for mapping*)

A: Weed invasions have almost covered the whole swamp area.

Do you know of any control programme for these species? *Any programme involving local communities? If so, are the results positive?*

A: Bird watchers have introduced insects to feed on weeds, as a biological weed control measure.

FISHING

What proportion of village residents engage with fishing? *What about migrants? Is this number increasing?*

A: Almost 90% of the village's residents are engaged in fishing.
The number of migrants to Moongo area is decreasing as compared to other villages due to the reduction of fish catches.

What are the species that are caught? *(common and Latin names if possible) Are different species' catches seasonal?*

A: Main catches are:
- Milonge, or Tigerfish;
- Lemba
- Mpinde
- Amatuku

What proportion of the catch is consumed locally, by the household and other villagers, and what proportion is taken to outside markets? *What outside markets/urban centres, is the fish sold at?*

A: About 80% of the catch is consumed locally and about 10% is sold to traders that buy and take fish to urban areas such as in Luanshya, Kasumbalesa, Lusaka and other Copperbelt towns

What is the average price of each of the main species? *If the price fluctuates, how variable is it, and why does it fluctuate?*

A: The price of fish fluctuates depending on actual selling points, season and the trader's negotiating skills. There are many fish selling points, including: fishing camps, harbours, village markets.

AmaTulu is the most common fish caught. These are small fish, and are sold in heaps:
- 30 small fish are sold at K10.00 in the fishing area;
- 20 small fish are sold at K10.00 in the harbour;
- 15 small fish are sold at K10.00 in the village.

The fish price is high during the dry season as compared to rain season when water levels are higher.

Where are the main fishing areas within the Lukanga Swamp?

A: Locals are very secretive about fishing areas. This is because they fear that the Lukanga Swamp is up for sale, which they claim to have heard about. They mentioned places such as Kaboshe, Chilwa and Mukunkwa as profitable fishing areas, which are relatively far.

Past trends in resource availability – *have fish yields been declining, maintaining, or improving? Is there an overall trend or do these fluctuate cyclically? Why do you think this is?*

A: Fish yields have been declining, which is also indicated by lowered turnouts of incoming traders to the Muweshi village. Other locals who participated in the discussion were able to say that there is plenty of fish in Lukanga Swamps, but that fishing ponds are far within the swamp, and are difficult to access.

Fishing gear – *what kinds of fishing methods and nets are used?*

A: Fishing nets are used to catch fish.

How is the fish stored/preserved for transportation to markets, or within households?

A: The fish is smoked in drums using firewood. This is the preferred method, for it is fast and easy. During the dry season sun drying is also employed, parallel to the smoking method.

Is the annual fishing ban followed? If not, why?

A: Annual fishing ban is enforced by the Fisheries Department staff, who patrol the swamps.

WILD PLANT HARVESTING

What plant species are harvested for fibre *(grass, leaves, vines, reeds, for construction, for mats, baskets and poles for punting canoes)?*

A: Reeds are harvested to make mats; bamboos (although now rare) are cut to make chicken coops. Tall grass is harvested, soon before bushes are set on fire, to thatch houses and sometimes knit together to sun dry fish on.

What species are harvested for "Wild food" *(fungi, leaves, nuts, roots, seeds)?*

A: Wild fruits from *Parinari curatellifolia* Planch (Mupundu in Bemba) and *Uapaca Kirkiana* Muell arg (Musuku in Bemba) are commonly harvested, as well as several mushroom species.

What species are harvested for medicinal purposes?

A: The roots, bark and leaves from *Pterrocarpus angolensis* (Mulombwa in Bemba), and leaves and bark from *Combretum imberbe* (Mubimba in Tonga) are used in the preparation of traditional medicine.

Where are the main harvest areas?

A: Within the forest in the uplands of the Lukanga swamps.

Who harvests wild plants mainly, permanent residents or migrants?

A: There is minimal harvest done by the permanent residents.

Are these harvested mainly for personal or commercial use? *What proportion is sold outside? Where are the main markets/urban centres?*

A: Permanent residents harvest for local use to address any emergency ailment before visiting the clinic. There are no medicines in the village.

What is the average price for each of these products/materials? *Do these prices fluctuate? If so, why?*

A: None of these products are sold.

Have you noticed of any trends in wild plant availability in the past 5 to 10 years? *Have they been decreasing, maintaining or augmenting, and why?*

A: Due to population increases and diminishing fish yields, there is an increasing pressure on the land, which is deforested for agriculture, and eventually loses soil fertility. Many viable medicinal species have been overexploited and people currently have to move a considerable distance to locate these.

TREE HARVESTING

What tree species are cut, and for what?

A: The following trees are cut:

- *Piliostima thonningi* Milne-Redh (Musekese in tonga): for house building materials;
- *Burkea Africana* Hook (Kapanga in bemba): to produce charcoal (which is used in household fires) and to produce a local brewing;
- *Afezelia quanzensis* welw (Mupapa in bemba): for timber and to build the structures on which to dry fish.

Where are the main harvest areas? *Are these managed regularly? How?*

A: The cutting of trees is done in the agriculture fields, when clearing the land for farming. Trees are cut, heaped and once they are dry, they are taken home for household use and to sell to migrant fishermen.

What proportion of village residents engage in this activity? *What about migrants?*

A: The village residents own very small farming lands and they are not so much involved in tree harvesting, only a small proportion of residents who own large tracks of traditional lands are.

What proportion is used by the household and what proportion is sold? *Where are these sold?*

A: The main suppliers of firewood are the Tongas, who own big tracks of lands and use the ox drawn carts to transport firewood to the harbours.

What is the average price of the different wood products? *Do these prices fluctuate? Why?*

A: Prices of wood fires vary according to sizes, ranging from K20 to K5.

How has wood resources' availability evolved in the past 5 to 10 years? *Has it been decreasing, maintaining or increasing? And why?*

A: Availability and supply of wood resources have remained constant, however, with a transect walk there is proof that the resources are being cut at a fast pace.

AGRICULTURE
What proportion of village residents own land and cultivate it? *How much land per household?* A: Ownership of land is vested in the headman. He allocates land and arbitrates on land disputes. About 70% of residents own land and almost 30% live on rented land to practice agriculture.
What are the main crops cultivated in this village/region? *Maize; cotton; groundnuts; pumpkins; sweet potatoes; cassava; sunflowers; soya; vegetables: tomatoes; cabbage; others.* A: They grow maize, cassava, soya beans and others, pumpkin and cotton.
Is agriculture mainly for personal consumption/subsistence or also for commercial purposes? *Typically, what proportion of crop products is consumed by the household?* A: Many residents grow maize, cassava, pumpkins, and yams for home consumption. Cotton and Soya beans are grown for sale to the outsiders.
Where are crop products sold? *Which main markets/urban centres?* A: Cotton is grown under an out-grower scheme. It is sold to a cotton ginnery industry in Mumbwa town. Soya is grown for sale to the outsiders.
What is the commercial value/average price, of the main crop products? *If the price fluctuates, how variable is it, and why does it fluctuate?* A: The returns in the cotton out-grower scheme is far above the inputs of the farmer such as time and labour on planting, weeding, harvesting and packaging. Its labour intensive and outweighs the profits
Are there any products added to the crop? A: Pesticides are applied in the cotton fields. Fertilizers such as top dressing and urea are applied in the maize fields.
Are crops normally irrigated? A: No
What about the burning practice, is it undertaken? *If so, how frequently and for what purposes?* A: Early burning is practiced to allow new vegetation to sprout for cows to feed on, and to prepare the land for cultivation.
Are subsidized agricultural products (seeds, fertilizers, pesticides) important for the productivity/maintenance of small-scale agricultural activity in the area? *Which kind? Has land productivity changed since the introduction of these programmes?* A: The government fertilizer scheme does not benefit many residents of Moongo. Many residents are not able to pay upfront sum of money as contribution to access the full support package in the scheme.
Any past trends or events relating to the agricultural activity around the Lukanga Swamps that is noteworthy? (*concerns, conflicts, changes in management, changes in traditional practices, trends in disease, etc*.) A: The cotton out-grower scheme extension officers are offering agriculture related cotton expertise on how they can integrate crop rotation with other agriculture products on the small pieces of land they own. This is to the advantage of the locals. The designated agriculture extension officers rarely visit this area.

LIVESTOCK
What proportion of village residents have livestock? *How many animals per household?* A: There are no residents that own animals but the residents of the upland own cattle. They own an average of 50 animals per household.
What kind of livestock? *Cattle; goat; chicken; sheep; pigs; other.* A: Cattle.
Is livestock raised for household consumption or for commercial purposes? *What proportion each?* A: Cattle are raised for family investments. When household needs arise, a cow is slaughtered or sold as a whole to raise funds to meet the needs of school children, marriage ceremonies, land preparations, etc.
Where are the livestock-related products sold? *What markets/urban centres?* A: When a cow is slaughtered in the village, beef is sold locally, but most times the animal is transported to the town abattoir, slaughtered and the beef sold to urban butcheries.
What is the average price of livestock products, and how variable are these prices? A: The prices of beef in the village are way below the urban butcherly price of K34 per kg.
How are wetland ecosystems important to livestock? *Is dry season grazing and watering important?* A: The livestock depend 100% on wetlands. Livestock grazing is throughout the year.
HUNTING
What animal species are hunted? (*common and Latin names if possible*) A: In the Swamps, small animals such as impalas, birds and rodents are hunted.
What proportion of resident villagers engage in hunting? *What about migrants? Are hunter numbers increasing?* A: Nearly every man head of household is involved in hunting small animals. In the swamps, migrant fishermen secretly hunt these small animals to sustain their appetite.
Are hunting products mainly for personal consumption or are these also sold elsewhere? *What proportion of each? Where are the main markets?* A: Resident villagers do not hunt to sell but put up animal traps to catch small animals for home consumption.
What is the average price of the different species? *Do these prices fluctuate? If so, why do you think this is?* Not applicable
How has hunting resource availability evolved? *Are wild animal numbers decreasing, maintaining or increasing? And why?* A: The wildlife number is decreasing due to population increase. Wildlife has moved to far places.

Other comments/issues raised by the interviewee

A: They raised fears that the Lukanga Wetlands might be up for sale, and hence the visits. They fear that the visits were mere preparation visits to hoodwink the locals to give as much information about Lukanga Swamps. The World Wide Fund visits to the area are still fresh, they visited them asking them to move away from the shores of the wetlands and settle 15Km away.

They made an appeal to the visitors to visit Chief Chitanda to array any suspicions on the “sale” of the Lukanga Swamps.

FIELD FORM – *Key informant interviews*
Date: 18.10.2019
Village name: Kabosha
Interview ID: Christopher Sinyinza
What are the main economic activities / resource uses undertaken by people on your village? Which ones relate to the wetland? A: Main activities are: fishing; livestock keeping such as chickens and cattle; and subsistence agriculture.
What were the main threats/ drivers of change of wetland ecosystems and resource availability observed in the past 10 years? A: Human population increase is putting pressure on natural resources. There is high an unemployment, the wrong types of fishing nets are being used, and there is continued deforestation.
What invasive weeds do you know about? *When did they first appear?* A: The reeds that were used for making reed mats have disappeared and have been replaced with current softer ones; there is the Amayeya (water hyacinth), and the Chikwema (water lily).
How do these impact local economic activities? *Do they hinder movement and fishing activities within the swamp?* A: The weeds in the channels slow down boat movements; fish breeding areas have also been affected.
Where do the invasions extend to? (*attempt to collect additional information for mapping*) A: The invasion of the weeds has almost covered the whole Lukanga swamp.
Do you know of any control programme for these species? *Any programme involving local communities? If so, are the results positive?* A: Bird watchers have introduced the insects to feed on weeds as ecological weed control measure.

FISHING
What proportion of village residents engage with fishing? *What about migrants? Is this number increasing?* A: Almost 100% of residents are engaged in farming. Kabosha village is a fish camping village. While some are going back to their original towns, the number of migrants to Kabosha is on the rise.
What are the species that are caught? *(common and Latin names if possible)* Are different species' catches seasonal? A: Catches are mainly composed of Amatulu, Mpende (Red breams), white wash fish, and Munyima.
What proportion of the catch is consumed locally, by the household and other villagers, and what proportion is taken to outside markets? *What outside markets/urban centres, is the fish sold at?* A: The most widely caught fish is the Amatulu, and is consumed locally and sold to traders that buy and take it to urban areas such as Kabwe, Lusaka and Copperbelt towns.
What is the average price of each of the main species? *If the price fluctuates, how variable is it, and why does it fluctuate?* A: The price of fish fluctuates depending on the selling point, from the fishing camps, to the harbour and the village.
Where are the main fishing areas within the Lukanga Swamp? A: Kamatipa, Chibuta, Waya, Kakuyu, Chimbala, Chinenga, Chinyanja, Nsokolo, Mumi, Kamatipa.
Past trends in resource availability – *have fish yields been declining, maintaining, or improving? Is there an overall trend or do these fluctuate cyclically? Why do you think this is?* A: Fish yields have been declining. This was attributed to high unemployment among the youths, who are now turning to fishing as a means to raise funds. Many fishermen from as far as Chilubi Island on Lake Mweru, where fishing yields have declined, have migrated to Kabosha. There are other types of migrants in kabosha, such as pensioners. Their work benefits have been delayed by the government of Zambia. These are mainly men and they buy fish from the fishing camps and take it to the urban areas to sell it. Finally, the net that are being used have a very small mesh size, which catches even the smaller fish.
Fishing gear – *what kinds of fishing methods and nets are used?* A: Fishing nets are used to catch fish.
How is the fish stored/preserved for transportation to markets, or within households? A: The most popular method of fish preservation is by smoking it in drums or mud made kilns. Sun drying is also done.
Is the annual fishing ban followed? *If not, why?* A: The annual fishing ban is enforced by the Fisheries Department, and is adhered to by fishermen.

WILD PLANT HARVESTING
What plant species are harvested for fibre *(grass, leaves, vines, reeds, for construction, for mats, baskets and poles for punting canoes)? (common and Latin names if possible)* A: Around the swamps, wood canoes are made out of hardwood, such as Musase (*Albizia antunesiana* harms) and Mululu (*Khaya nyasica* stapf). Reeds mats are made out of reeds.
What species are harvested for "Wild food" *(fungi, leaves, nuts, roots, seeds)? (common and Latin names if possible)* A: Mushrooms and other wild fruits are commonly harvested, mainly in the rain season.
What species are harvested for medicinal purposes? *(common and Latin names if possible)* A: The roots of *Brachystegia boehmii* (Musamba in Kaonde) are used in an infusion to treat diarrhoea. The bark and roots of *Brachystegia spiciformis* (Muputu in bemba Berth) are used for medicinal purposes as well.
Where are the main harvest areas? A: The residents of Kabosha own farms on traditional lands where wood and other wild plants are harvested.
Who harvests wild plants mainly, permanent residents or migrants? A: The harvesting is done by the permanent residents on the farms on traditional land.
Are these harvested mainly for personal or commercial use? *What proportion is sold outside? Where are the main markets/urban centres?* A: 90% of the migrants visit the traditional lands to harvest wildlife plants for medicinal use.
What is the average price for each of these products/materials? *Do these prices fluctuate? If so, why?* A: Nothing is sold out
Have you noticed of any trends in wild plant availability in the past 5 to 10 years? *Have they been decreasing, maintaining or augmenting, and why?* A: The population of the village has increased in the last 5 years that have put pressure on natural resources such as fish and vegetation resulting in deforestation and soil fertility loss. Through deforestation, many viable medicinal species have been cut down with minimal replacements

TREE HARVESTING
What tree species are cut, and for what? *(common names and Latin names if possible)* A: The following species are commonly cut: - Umulama for smoking the fish; - Ichibobo for smoking the fish; - Musamba (Kaonde for *Brachystegia boehmii* taub) for fire wood and for smoking the fish; - Muputu (Bemba for Brachystegia spiciformis Berth).
Where are the main harvest areas? *Are these managed regularly? How?* A: Cutting of trees for smoking fish is done in the traditional land by the local lenje tribe, who transport it on ox drawn carts to the harbour.
What proportion of village residents engage in this activity? *What about migrants?* A: The village residents do not own any farming lands and they are not so much involved in tree harvesting. Only those who own large tracks of traditional land.
What proportion is used by the household and what proportion is sold? *Where are these sold?* A: Most of the firewood used by migrants is bought in by Lenjes for household use. The firewood is sold at a central place in the village.
What is the average price of the different wood products? *Do these prices fluctuate? Why?* A: Prices of wood fires vary according to sizes. The price ranges from K20 to K5 the smallest log.
How has wood resources' availability evolved in the past 5 to 10 years? *Has it been decreasing, maintaining or increasing? And why?* A: The availability and supply of wood resources is declining with the increase in demand for smoking fish and household use.

AGRICULTURE
What proportion of village residents own land and cultivate it? *How much land per household?* A: Almost all migrants depending on fishing as a livelihood. The residents own big tracks of land where they practice agriculture.
What are the main crops cultivated in this village/region? *Maize; cotton; groundnuts; pumpkins; sweet potatoes; cassava; sunflowers; soya; vegetables: tomatoes; cabbage; others.* A: They grow groundnuts, maize and Soya beans
Is agriculture mainly for personal consumption/subsistence or also for commercial purposes? *Typically, what proportion of crop products is consumed by the household?* A: Household consumption.
Where are crop products sold? *Which main markets/urban centres?* A: Maize is sold at the residents' farms on big lands when the yield is favourable. Much of their maize surplus output is sold to the migrants at the main village market.
What is the commercial value/average price, of the main crop products? *If the price fluctuates, how variable is it, and why does it fluctuate?* A: Not applicable.
Are there any products added to the crop? A: Only fertilizers, in the maize fields.
Are crops normally irrigated? A: No.
What about the burning practice, is it undertaken? *If so, how frequently and for what purposes?* A: -
Are subsidized agricultural products (seeds, fertilizers, pesticides) important for the productivity/maintenance of small-scale agricultural activity in the area? *Which kind? Has land productivity changed since the introduction of these programmes?* A: Many migrants are not benefiting from the government fertilizer scheme.
Any past trends or events relating to the agricultural activity around the Lukanga Swamps that is noteworthy? (*concerns, conflicts, changes in management, changes in traditional practices, trends in disease, e* A: Many of the residents are fishermen. Agriculture is practiced at a small scale to supplement the household livelihood.

LIVESTOCK

What proportion of village residents have livestock? *How many animals per household?*

A: Many migrants have settled in Kabosha. Many do not own any land but rent accommodation to live in. Few migrants own animals on average of 4 animals. The upland residents own an average of 50 animals per household

What kind of livestock? *Cattle; goat; chicken; sheep; pigs; other.*

A: Cattle and chickens.

Is livestock raised for household consumption or for commercial purposes? *What proportion each?*

A: The cattle are raised for family investments.

Where are the livestock-related products sold? *What markets/urban centres?*

A: When cattle are slaughtered in the village, beef is sold locally. Most times cattle is transported to the town abattoir, slaughtered and beef sold to urban butcheries

What is the average price of livestock products, and how variable are these prices?

A: Locally, beef is sold at K40 per kg. The price in the urban butcheries is determined the prevailing town beef price per kg.

How are wetland ecosystems important to livestock? *Is dry season grazing and watering important?*

Livestock grazing is 100% dependent on wetlands

HUNTING

What animal species are hunted? (*common and Latin names if possible*)

A: Fishermen have reported hunting small animals in the swamps such as impalas and wild big birds that stroll near the fishing camps.

What proportion of resident villagers engage in hunting? *What about migrants? Are hunter numbers increasing?*

A: Coupled with population increase and the drought, the small animals have migrated to the interior of the swamps to seek refuge.

Are hunting products mainly for personal consumption or are these also sold elsewhere? *What proportion of each? Where are the main markets?*

A: Migrants hunt for their own consumption in camps.

What is the average price of the different species? *Do these prices fluctuate? If so, why do you think this is?*

A: Not applicable.

How has hunting resource availability evolved? *Are wild animal numbers decreasing, maintaining or increasing? And why?*

A: The wildlife has tremendously decreased due to human population increase and the drought has accelerated the reduction of animal populations.

Other comments/issues raised by the interviewee

A: There were questions and concerns raised that the Lukanga Wetlands was sold to the white men to start up a mining company.

FIELD FORM – *Key informant interviews*
Date: 19.10.2019
Village name: Waya Village
Interview ID: Christopher Sinyinza
What are the main economic activities / resource uses undertaken by people on your village? Which ones relate to the wetland? A: Main activities: fishing in the swamp; livestock rearing such as free-range chickens and cattle; and subsistence agriculture.
What were the main threats/ drivers of change of wetland ecosystems and resource availability observed in the past 10 years? A: Main threats and drivers of change include: - Cutting down trees; - Population increase putting pressure on the natural resources; - Use of wrong fishing nets.
What invasive weeds do you know about? *When did they first appear?* A: The reeds that were used for making reed mats in the past have disappeared and been replaced with softer ones. There is the Javan weed.
How do these impact local economic activities? *Do they hinder movement and fishing activities within the swamp?* A: the Javan affects the fish breeding areas, and slows down the movement of boats in the water channels, together with the reeds.
Where do the invasions extend to? (*attempt to collect additional information for mapping*) A: The Javan have almost covered the whole Lukanga swamp area.
Do you know of any control programme for these species? *Any programme involving local communities? If so, are the results positive?* A: Bird watchers have introduced the insects to feed on weeds as an ecological weed control measure

FISHING
What proportion of village residents engage with fishing? *What about migrants? Is this number increasing?* A: Almost 100% of residents are engaged in farming. Waya was once a fishing camp, with people migrating to the village from as far as Copperbelt, Luapula and Lusaka provinces.
What are the species that are caught? *(common and Latin names if possible) Are different species' catches seasonal?* A: The main fish species are: the Makobo, Amatulu, Imbiya, Bangola (tiger fish), and Mpende (red breams).
What proportion of the catch is consumed locally, by the household and other villagers, and what proportion is taken to outside markets? *What outside markets/urban centres, is the fish sold at?* A: Around 80% of the catches is transported and sold in urban centres and about 20% is consumed locally at the household level.
What is the average price of each of the main species? *If the price fluctuates, how variable is it, and why does it fluctuate?* A: The price of fish fluctuates depending on the actual selling point. Fish is sold at the fishing camps at the price of K10.00 for 30 small fish; and at the harbour at the price of K8.00 for 20 small fish.
Where are the main fishing areas within the Lukanga Swamp? A: There are over 100 fishing ponds in the Lukanga swamps. Some ponds are Nsokolo.
Past trends in resource availability – *have fish yields been declining, maintaining, or improving? Is there an overall trend or do these fluctuate cyclically? Why do you think this is?* A: Fish yields have been declining. The increase on the demand has put a pressure on the fish populations.
Fishing gear – *what kinds of fishing methods and nets are used?* A: Fishing nets are used to catch the fish.
How is the fish stored/preserved for transportation to markets, or within households? A: The most popular method of preservation is by smoking it in drums or mud kilns. Sun drying of fish is also done.
Is the annual fishing ban followed? *If not, why?* A: The annual fishing ban is enforced by the fisheries department.

WILD PLANT HARVESTING
What plant species are harvested for fibre *(grass, leaves, vines, reeds, for construction, for mats, baskets and poles for punting canoes)? (common and Latin names if possible)* A: Many migrants in Waya use wood materials to make canoes. These are made out of hardwood, such as musase (*Albizia antunesiana* harms) and mululu (*Khaya nyasica* stapf). The tall grass harvested for roofing houses and reeds are used in the fishing camps to harden the working space for drying fish on.
What species are harvested for "Wild food" *(fungi, leaves, nuts, roots, seeds)? (common and Latin names if possible)* A: The quantity of wild food collected is declining such as mushroom, wild fruits and these are commonly collected in rain season
What species are harvested for medicinal purposes? *(common and Latin names if possible)* A: The following are harvested: - *Pterrocarpus angolensis* (Mulombwa in bemba), for the roots, bark and leaves which are used in the preparation of traditional medicines; - *Combretum imberbe* (Mubimba in Tonga), for the leaves and bark, which are used for traditional medicines as well.
Where are the main harvest areas? A: Harvesting of medicinal plants is in the traditional farm lands around the village.
Who harvests wild plants mainly, permanent residents or migrants? A: The harvest is done by the migrants in the farms on traditional land.
Are these harvested mainly for personal or commercial use? *What proportion is sold outside? Where are the main markets/urban centres?* A: 90% of the migrants visit the traditional lands to harvest wildlife plants for personal medicinal use.
What is the average price for each of these products/materials? *Do these prices fluctuate? If so, why?* A: Nothing is sold out
Have you noticed of any trends in wild plant availability in the past 5 to 10 years? *Have they been decreasing, maintaining or augmenting, and why?* A: The population of Waya fluctuates seasonally. At the start of the rain season, many migrants return to Waya to prepare their agriculture fields and catch fish to sell before the fish ban. There is high deforestation in the village, and most of the land has lost its fertility. Through deforestation, many viable medicinal species have been cut down, with minimal regrowth.

TREE HARVESTING
What tree species are cut, and for what? *(common names and Latin names if possible)* A: The following tree species are cut: - *Albizia antunesiana* Harms (Musase in Bemba), for making canoes and to dry fish on; - *Albizia versicolor* (Mububu in Tonga), big trees are used for canoe making and to smoke fish on; - *Brachystegia boehmii* taub (Musamba in Kaonde) for fire wood and to smoke fish on; - *Khaya nyasica* Stapf (Mululu in Bemba), the bark and roots are used in the preparation of traditional medicine and the dry wood is used as firewood.
Where are the main harvest areas? *Are these managed regularly? How?* A: Cutting of trees for smoking fish is done in the traditional land by the local Lenje tribe, that transports it on ox drawn carts to the harbour to sell to migrant fishermen.
What proportion of village residents engage in this activity? *What about migrants?* A: The village residents do not own any farming lands and they are not so much involved in tree harvesting, only the few who own large tracks of traditional land.
What proportion is used by the household and what proportion is sold? *Where are these sold?* A: 20% of firewood bought off from the Lenje residents who own big tracks of lands is used at household level while 80% is sold to migrant fishermen to dry the fish.
What is the average price of the different wood products? *Do these prices fluctuate? Why?* A: Prices of wood fires vary according to sizes. The price ranges from K20 to K5 for the smallest log.
How has wood resources' availability evolved in the past 5 to 10 years? *Has it been decreasing, maintaining or increasing? And why?* A: The availability and supply of wood resources is declining with the increase in demand for smoking fish and household use.

AGRICULTURE
What proportion of village residents own land and cultivate it? *How much land per household?* A: Almost 100% of migrants in Waya are involved in agriculture, which they practice on small pieces of land. The headman allocates the land. Some who do not own any land rent it from other residents.
What are the main crops cultivated in this village/region? *Maize; cotton; groundnuts; pumpkins; sweet potatoes; cassava; sunflowers; soya; vegetables: tomatoes; cabbage; others.* A: They grow groundnuts, maize, pumpkins, yams, beans and soya.
Is agriculture mainly for personal consumption/subsistence or also for commercial purposes? *Typically, what proportion of crop products is consumed by the household?* A: Almost all the crops grown are consumed at household level. The surplus, such as of soya and maize, are sold in the village's open market.
Where are crop products sold? *Which main markets/urban centres?* A: The farmers around Waya sell their soya and maize surplus to the migrants at the main village market.
What is the commercial value/average price, of the main crop products? *If the price fluctuates, how variable is it, and why does it fluctuate?* A: The price fluctuates according to seasons. Crops are sold soon after harvest, at low prices.
Are there any products added to the crop? A: No pesticides. Fertilizers such as D compound and top dressing are applied in the maize fields.
Are crops normally irrigated? No
What about the burning practice, is it undertaken? *If so, how frequently and for what purposes?* A: Early burning is practiced in the farms around Waya to clear the land for farming preparations. The forest is burnt to allow new vegetation to sprout for cows to feed on.
Are subsidized agricultural products (seeds, fertilizers, pesticides) important for the productivity/maintenance of small-scale agricultural activity in the area? *Which kind? Has land productivity changed since the introduction of these programmes?* A: Just like in other fish camp villages, the government fertilizer scheme does not benefit many migrants in Waya. Many migrants depend and spend most of their time in the year on fishing. Mostly, the crop productivity has remained constant with an average of 5 x 50kg bags harvest of maize per household
Any past trends or events relating to the agricultural activity around the Lukanga Swamps that is noteworthy? (*concerns, conflicts, changes in management, changes in traditional practices, trends in disease, etc.*) -

LIVESTOCK
What proportion of village residents have livestock? *How many animals per household?* -
What kind of livestock? *Cattle; goat; chicken; sheep; pigs; other.* A: Cattle and chickens.
Is livestock raised for household consumption or for commercial purposes? *What proportion each?* A: Cattle are raised as household investments. Most times middle men buy off the animals and either slaughter them or drive them to urban butcheries.
Where are the livestock-related products sold? *What markets/urban centres?* A: When a cow is slaughtered in the village, beef is sold locally, but most times cattle are transported to the town abattoir, slaughtered, and the beef is sold to urban butcheries.
What is the average price of livestock products, and how variable are these prices? A: Local prices of beef are at K40 per kg. The price in the urban butcheries is determined by the prevailing town beef price per kg.
How are wetland ecosystems important to livestock? *Is dry season grazing and watering important?* A: Livestock grazing is 100% dependent on wetlands
HUNTING
What animal species are hunted? (*common and Latin names if possible*) A: Fishermen have reported to hunt small animals in the swamps such as impalas and wild big birds that stroll near the fishing camps.
What proportion of resident villagers engage in hunting? *What about migrants? Are hunter numbers increasing?* A: Coupled with population increase and drought, small animals appear to have migrated in the interior of the swamps to seek refuge. In the swamps, there are reports of the migrants secretly hunting these small animals and big birds.
Are hunting products mainly for personal consumption or are these also sold elsewhere? *What proportion of each? Where are the main markets?* A: Migrants hunt for their own consumption in the camps.
What is the average price of the different species? *Do these prices fluctuate? If so, why do you think this is?* A: Not applicable
How has hunting resource availability evolved? *Are wild animal numbers decreasing, maintaining or increasing? And why?* A: Wildlife has tremendously decreased due to population increase, and droughts may have accelerated the reduction of animal populations.

Other comments/issues raised by the interviewee

A: There were questions and concerns raised that the Lukanga Wetlands might have been sold to the white men to start up a mining company.

Not only for wetland habitats/species, but also for surrounding ecosystems, such as woodlands.

FIELD FORM – *Key informant interviews*
Date: 19.10.2019
Village name: Chishimu Village, on the upland of Chilwa Island
Interview ID: Christopher Sinyinza
What are the main economic activities / resource uses undertaken by people on your village? Which ones relate to the wetland? A: Main activities are: fishing; livestock rearing; subsistence agriculture and gardening.
What were the main threats/ drivers of change of wetland ecosystems and resource availability observed in the past 10 years? A: The main threats are: - Deforestation; - Population increase (there are more people on Kilwa Island than on the uplands); - Use of wrong fishing nets.
What invasive weeds do you know about? *When did they first appear?* A: They mentioned the javan weed and the reeds.
How do these impact local economic activities? *Do they hinder movement and fishing activities within the swamp?* A: Javan affects the fish breeding areas; and both Javan and reeds slow down the movement of boats along the water channels.
Where do the invasions extend to? (*attempt to collect additional information for mapping*) A: Javan have almost covered the whole Lukanga swamp area.
Do you know of any control programme for these species? *Any programme involving local communities? If so, are the results positive?* A: Bird watchers have introduced the insects to feed on Javan weeds as an ecological weed control measure.

FISHING
What proportion of village residents engage with fishing? *What about migrants? Is this number increasing?* A: Almost 100% of the residents are engaged in fishing, and the number is increasing.
What are the species that are caught? *(common and Latin names if possible) Are different species' catches seasonal?* A: Bangola (tiger fish), Mpende (Red breams), Amatulu, Minsenga, and Imilonge.
What proportion of the catch is consumed locally, by the household and other villagers, and what proportion is taken to outside markets? *What outside markets/urban centres, is the fish sold at?* A: About 80% of fish catches is taken to urban markets such as Luanshya town and about 20% is consumed locally at household level.
What is the average price of each of the main species? *If the price fluctuates, how variable is it, and why does it fluctuate?* A: The price of fish fluctuates depending on the quantity caught. The fish is sold at good price when the catch yield is high. And the selling point matters. Fish is sold at fishing camps at the price of 30 small fish for K10.00, while in the harbour the price for 20 small fish it K8.00.
Where are the main fishing areas within the Lukanga Swamp? A: Nsuye, Namabala, Chibuta, Mutwe wa nsofu, Mufuta, Zilon, Chimbozya.
Past trends in resource availability – *have fish yields been declining, maintaining, or improving? Is there an overall trend or do these fluctuate cyclically? Why do you think this is?* A: The population on the Island is increasing. Nearly every household is involved in fishing, hence the increasing pressure on fish populations and declining fish yields.
Fishing gear – *what kinds of fishing methods and nets are used?* A: Fishing nets are used to catch fish.
How is the fish stored/preserved for transportation to markets, or within households? A: The most popular method is to smoke the fish in drums. Sun drying is also undertaken.
Is the annual fishing ban followed? *If not, why?* A: The annual fishing ban is enforced by the Fisheries department.

WILD PLANT HARVESTING
What plant species are harvested for fibre *(grass, leaves, vines, reeds, for construction, for mats, baskets and poles for punting canoes)? (common and Latin names if possible)* A: Fibre and wood from *Albizia antunesiana* (Musase) and *Khaya nyasica* (Mululu) are commonly harvested to make canoes. The tall grasses are harvested in the dry season for roofing houses and reeds are used to make house mats.
What species are harvested for "Wild food" *(fungi, leaves, nuts, roots, seeds)? (common and Latin names if possible)* A: Wild fruits and mushrooms are commonly collected in the rain season for consumption.
What species are harvested for medicinal purposes? *(common and Latin names if possible)* A: The following species are targeted for medicinal purposes: - *Albizia versicolor* (Mububu in tonga) for the roots; - *Swartzia madagascariensis* (Mulundu in Tonga) for the leaves, pods and barks.
Where are the main harvest areas? A: Harvesting of medicinal plants is in the traditional forest around Chishimu village and Chilwa.
Who harvests wild plants mainly, permanent residents or migrants? A: Wild plants are mainly harvested by permanent residents.
Are these harvested mainly for personal or commercial use? *What proportion is sold outside? Where are the main markets/urban centres?* A: These are harvested for consumption at the household level, and are not commercialized.
What is the average price for each of these products/materials? *Do these prices fluctuate? If so, why?* A: Not applicable.
Have you noticed of any trends in wild plant availability in the past 5 to 10 years? *Have they been decreasing, maintaining or augmenting, and why?* A: The quantity of wild food collected is declining. The population on the island is more than the population on the upland. However, the setting of a clinic on the Island has relieved some of the pressure on wild plants that are harvested for medicinal use. There is high deforestation on the Island due to agriculture and the soil is losing its fertility.

TREE HARVESTING
What tree species are cut, and for what? *(common names and Latin names if possible)* A: The following tree species are commonly cut: - *Albizia antunesiana* (Musase in Bemba), for making canoes and drying fish; - *Albizia versicolor* (Mububu in Tonga), the big trees are used for canoe making and for smoking fish; - *Brachystegia boehmii* (Musamba in Kaonde), for fire wood smoking fish; - *Khaya nyasica* (Mululu in Bemba), the bark and roots are used in the preparation of traditional medicine and the dry wood is used as firewood.
Where are the main harvest areas? *Are these managed regularly? How?* A: Cutting of trees for smoking fish is done in the island's forest.
What proportion of village residents engage in this activity? *What about migrants?* A: The migrants on the island do not own any lands. Only the permanent residents harvest trees.
What proportion is used by the household and what proportion is sold? *Where are these sold?* A: All the permanent residents depend on firewood for their household chores. 80% of firewood harvested is used at household level and 20% sold to migrant fishermen, who use it to dry the fish.
What is the average price of the different wood products? *Do these prices fluctuate? Why?* A: The price of firewood varies according to sizes. The price ranges from K20 to K5 for the smallest log.
How has wood resources' availability evolved in the past 5 to 10 years? *Has it been decreasing, maintaining or increasing? And why?* A: The availability and supply of wood resources is declining with the increase in population on the island and the demand for smoking fish.

AGRICULTURE
What proportion of village residents own land and cultivate it? *How much land per household?* A: Almost 100% of permanent residents at the Island are involved in agriculture, which they practice on small pieces of land. The headman allocated the land. Some who do not own land rent it from the residents.
What are the main crops cultivated in this village/region? *Maize; cotton; groundnuts; pumpkins; sweet potatoes; cassava; sunflowers; soya; vegetables: tomatoes; cabbage; others.* A: They grow beans, maize, groundnuts, pumpkins, yams, vegetables, tomatoes, cabbage and soya
Is agriculture mainly for personal consumption/subsistence or also for commercial purposes? *Typically, what proportion of crop products is consumed by the household?* A: Almost all the crops grown are consumed at household level. The surplus, such as soya and maize, is sold in the open village market or in barter trade of fish.
Where are crop products sold? *Which main markets/urban centres?* A: Maize surplus is sold to the migrants at the main village market.
What is the commercial value/average price, of the main crop products? *If the price fluctuates, how variable is it, and why does it fluctuate?* A: The price fluctuates according to seasons. Crops sold soon after harvest fetch low prices
Are there any products added to the crop? A: Chemical pesticides are applied in the garden crops. Fertilizers such as D compound and urea are applied in the maize fields.
Are crops normally irrigated? A: Garden crops are irrigated from the shallow ponds dug near the dambos.
What about the burning practice, is it undertaken? *If so, how frequently and for what purposes?* A: Early burning is practiced in the forest on the island to clear the land for farming preparations and to allow new vegetation to sprout for cows to feed on.
Are subsidized agricultural products (seeds, fertilizers, pesticides) important for the productivity/maintenance of small-scale agricultural activity in the area? *Which kind? Has land productivity changed since the introduction of these programmes?* A: Most people on the island receive the government fertilizer support after the crops have reached the growth peak. At times, the permanent residents buy their own fertilizer and do not wait for the government's late supply. The Maize production on the Island is low. The price of maize on the open market at the Island is more expensive than the maize price on the upland open market.
Any past trends or events relating to the agricultural activity around the Lukanga Swamps that is noteworthy? (*concerns, conflicts, changes in management, changes in traditional practices, trends in disease, etc*.) A: Deforestation is high on the Island due to agriculture, and the soil is losing its fertility, which is evidenced by the high use of fertilizer in agriculture. The late distribution of the government fertilizer support on the Island is a major concern. It compromises the production of maize and its price on the open market. Hunger loams at household level in the dry season.

LIVESTOCK

What proportion of village residents have livestock? *How many animals per household?*

A: About 10% of permanent residents on the Island own cattle.They own on average 4 animals per household. About 20% of migrants on the upland in Chishimu village own an average of 10 animals per household.

What kind of livestock? *Cattle; goat; chicken; sheep; pigs; other.*

A: Cattle and chickens are reared.

Is livestock raised for household consumption or for commercial purposes? *What proportion each?*

A: Cattle are raised as family investments. On the Island, cows are slaughtered and sold on an open market. On the upland, middle men buy and then drive them to urban butcheries.

Where are the livestock-related products sold? *What markets/urban centres?*

A: When cattle are slaughtered on the island, beef is sold locally. Those from the upland are transported to the town abattoir, slaughtered and the beef is sold to urban butcheries.

What is the average price of livestock products, and how variable are these prices?

A: On the Island, the price of beef is higher that of the upland.

How are wetland ecosystems important to livestock? *Is dry season grazing and watering important?*

A: Livestock grazing is 100% dependent on wetlands.

HUNTING

What animal species are hunted? (*common and Latin names if possible*)

A: Water bucks, wild birds and small rodents are hunted on the Island.

What proportion of resident villagers engage in hunting? *What about migrants? Are hunter numbers increasing?*

A: The rodents and Water bucks are found in the wetlands, on the Islands near fishing camps. Snares are used to trap them. The migrants secretly hunt and consume the meat at fishing camps.

Are hunting products mainly for personal consumption or are these also sold elsewhere? *What proportion of each? Where are the main markets?*

A: Hunting is for personal consumption.

What is the average price of the different species? *Do these prices fluctuate? If so, why do you think this is?*

A: Not applicable.

How has hunting resource availability evolved? *Are wild animal numbers decreasing, maintaining or increasing? And why?*

A: Wildlife has tremendously decreased due to human population increase and the drought seems to have accelerated the reduction of animal populations, who move to far wetland places.

Other comments/issues raised by the interviewee

Concerns were relayed about the late delivery of government fertilizer support to agriculture.

Not only for wetland habitats/species, but also for surrounding ecosystems, such as woodlands.

FIELD FORM – *Key informant interviews*
Date: 20.10.2019
Village name: Kaswende
Interview ID: Christopher Sinyinza
What are the main economic activities / resource uses undertaken by people on your village? Which ones relate to the wetland? A: The main activities are: livestock rearing (such as free-range chickens and cattle), subsistence agriculture and fishing.
What were the main threats/ drivers of change of wetland ecosystems and resource availability observed in the past 10 years? A: The main threats are: - Deforestation mainly to burn charcoal; - Overfishing intensified by migrants; - Overfishing intensified by the use of the wrong nets, which trap smaller fish.
What invasive weeds do you know about? *When did they first appear?* A: The Javan weed and reeds.
How do these impact local economic activities? *Do they hinder movement and fishing activities within the swamp?* A: Javans weeds have overgrown in the fish breeding areas. Both the reeds and the javan weeds have overgrown fishing camps and water channels, affecting boat movements.
Where do the invasions extend to? (*attempt to collect additional information for mapping*) A: They extend to almost all of the fishing camps in the Lukanga.
Do you know of any control programme for these species? *Any programme involving local communities? If so, are the results positive?* A: The whites that come to watch birds in the Lukanga have brought in Javans, the insects, to feed on the weeds as an ecological weed control measure.

FISHING
What proportion of village residents engage with fishing? *What about migrants? Is this number increasing?* A: Almost everyone living in Kaswende is engaged in fishing. The number of migrants is reducing because the catches in many fishing camps have reduced.
What are the species that are caught? *(common and Latin names if possible) Are different species' catches seasonal?* A: Red breams (Mpende) and small finger fish (Amatulu) are caught.
What proportion of the catch is consumed locally, by the household and other villagers, and what proportion is taken to outside markets? *What outside markets/urban centres, is the fish sold at?* A: The Amatulu are the most commonly caught fish in the swamps and are consumed locally. Almost all fish is sold out to traders that come from as far as Kabwe and Copperbelt to buy fish to resell.
What is the average price of each of the main species? *If the price fluctuates, how variable is it, and why does it fluctuate?* A: The price of fish fluctuates depending on the selling point and negotiating skills. Fish is sold at fishing camps at the price of K5.00 for 25; at the harbour at K5.00 for 18 small fish; and at the village K5.00 for 12 small fish.
Where are the main fishing areas within the Lukanga Swamp? A: Muchoko, Chibwendo, Mabange, Kabanakashi, Chibolele, Mulilachembe, Kankonde.
Past trends in resource availability – have fish yields been declining, maintaining, or improving? Is there an overall trend or do these fluctuate cyclically? Why do you think this is? A: Fish catches are declining in many fishing camps. This was attributed to the wrong use of fishing nets, mainly by the migrants.
Fishing gear – *what kinds of fishing methods and nets are used?* A: Fishing nets are used to catch fish.
How is the fish stored/preserved for transportation to markets, or within households? A: Sun drying and smoking of fish using drums or mud made kilns are used to preserve / store fish.
Is the annual fishing ban followed? *If not, why?* A: The Fisheries Department enforces the annual fishing ban and the fishermen are aware of it.

WILD PLANT HARVESTING
What plant species are harvested for fibre *(grass, leaves, vines, reeds, for construction, for mats, baskets and poles for punting canoes)? (common and Latin names if possible)* A: Many migrants in Kaswende use fibre and wood from local woodlands to build canoes. These canoes are made out of hardwood, such as Musase (*Albizia antunesiana* harms) and Mululu (*Khaya nyasica* stapf). Tall grass and reeds are harvested for roofing houses and making mats to sleep on.
What species are harvested for "Wild food" *(fungi, leaves, nuts, roots, seeds)? (common and Latin names if possible)* A: In the rain season, wild fruits flourish and the residents harvest them. Mushrooms are also harvested in the wild.
What species are harvested for medicinal purposes? *(common and Latin names if possible)* A: The leaves, bark and roots of *Piliostigma thonningi* Milne – Redh (Mufumbe in Bemba) and the roots of *Albizia versicolor* Welw (Musasengoma in Bemba) are used in the preparations of traditional medicine.
Where are the main harvest areas? A: Trees are harvested in the farms on tradition lands, where wood and other wild plants persist.
Who harvests wild plants mainly, permanent residents or migrants? A: The harvest is done by the permanent residents on the farms on traditional land.
Are these harvested mainly for personal or commercial use? *What proportion is sold outside? Where are the main markets/urban centres?* A: 90% of the migrants visit the traditional lands to harvest wildlife plants for medicinal use.
What is the average price for each of these products/materials? *Do these prices fluctuate? If so, why?* A: Nothing is sold.
Have you noticed of any trends in wild plant availability in the past 5 to 10 years? *Have they been decreasing, maintaining or augmenting, and why?* A: The population of Kaswende has decreased in the last 5 years. Migrants have opted to migrate to other villages where fish catches remain stable and the soil fertility is still intact.

TREE HARVESTING
What tree species are cut, and for what? *(common names and Latin names if possible)* A: Mutondo is cut to smoke fish; the Muputu (Bemba vernacular name for *Brachystegia spiciformis* Berth) is also cut.
Where are the main harvest areas? *Are these managed regularly? How?* A: Trees are mainly cut by Lenje residents in the traditional land. They transport the firewood on ox drawn carts.
What proportion of village residents engage in this activity? *What about migrants?* A: Kaswende comprises mainly migrants that do not own large pieces of land. The residents are Lenje, and are mainly engaged in firewood supply.
What proportion is used by the household and what proportion is sold? *Where are these sold?* A: 80% of the firewood used by migrants in Kaswende is bought for household use from the lenje residents who own big tracks of lands. These are delivered and sold at the harbour.
What is the average price of the different wood products? *Do these prices fluctuate? Why?* A: The price of firewood ranges according to sizes, from k20 to K5 for the smallest log.
How has wood resources' availability evolved in the past 5 to 10 years? *Has it been decreasing, maintaining or increasing? And why?* A: The availability and supply of wood resources is not declining. There are big tracks of land where trees are cut for fire wood.

AGRICULTURE
What proportion of village residents own land and cultivate it? *How much land per household?* A: Kaswende is a fishing camp that accommodates 80% of migrants who depend on fishing as a livelihood. The tracks of land that they own to practice agriculture are rented from the locals.
What are the main crops cultivated in this village/region? *Maize; cotton; groundnuts; pumpkins; sweet potatoes; cassava; sunflowers; soya; vegetables: tomatoes; cabbage; others.* A: They grow mainly maize.
Is agriculture mainly for personal consumption/subsistence or also for commercial purposes? *Typically, what proportion of crop products is consumed by the household?* A: Many residents grow maize for home consumption, from which they make mealie meal.
Where are crop products sold? *Which main markets/urban centres?* A: The farmers around Kaswende sell their maize surplus to the migrants at the main village market.
What is the commercial value/average price, of the main crop products? *If the price fluctuates, how variable is it, and why does it fluctuate?* Not applicable.
Are there any products added to the crop? A: Urea and top dressing are added as fertilizer to the maize fields.
Are crops normally irrigated? A: No.
What about the burning practice, is it undertaken? *If so, how frequently and for what purposes?* A: Early burning is practiced in the farms around Kaswende to clear the land for farming preparations and to allow new vegetation to sprout for cows to feed on.
Are subsidized agricultural products (seeds, fertilizers, pesticides) important for the productivity/maintenance of small-scale agricultural activity in the area? *Which kind? Has land productivity changed since the introduction of these programmes?* A: The government fertilizer scheme does not benefit many residents of Kaswende. Migrants depend on fishing and spend most of their time on it. The spouses, who usually remain at home, do not attend the government called meetings on fertilizer schemes, and so do not clearly understand the benefits.
Any past trends or events relating to the agricultural activity around the Lukanga Swamps that is noteworthy? (*concerns, conflicts, changes in management, changes in traditional practices, trends in disease, etc.*) A: Kaswende residents have been predominantly fishermen. Even though the allocation of agriculture land is vested in the headman, he has no land to allocate to his subjects for farming.

LIVESTOCK
What proportion of village residents have livestock? *How many animals per household?* A: Many migrants have settled in Kaswende, and do not own any land but rent accommodation to live in. Few migrants own an average of 4 animals. The upland residents own an average of 50 animals per household.
What kind of livestock? *Cattle; goat; chicken; sheep; pigs; other.* A: Mainly cattle and chickens.
Is livestock raised for household consumption or for commercial purposes? *What proportion each?* A: Most times, middle men buy off the beef and later sell in urban butcheries.
Where are the livestock-related products sold? *What markets/urban centres?* A: When cattle is slaughtered in the village, occasionally, the beef is sold locally, but most times cattle is transported to the town abattoir, slaughtered and the beef is sold to urban butcheries.
What is the average price of livestock products, and how variable are these prices? A: Th prices of beef fluctuate locally.
How are wetland ecosystems important to livestock? *Is dry season grazing and watering important?* A: Livestock grazing is 100% dependent on the wetlands.
HUNTING
What animal species are hunted? (*common and Latin names if possible*) A: There are no animals species around for hunting
What proportion of resident villagers engage in hunting? *What about migrants? Are hunter numbers increasing?* A: There are no reports about residents engaging in hunting activities.
Are hunting products mainly for personal consumption or are these also sold elsewhere? *What proportion of each? Where are the main markets?* A: There is secrecy in hunting. No one will reveal any information.
What is the average price of the different species? *Do these prices fluctuate? If so, why do you think this is?* A: Not applicable
How has hunting resource availability evolved? *Are wild animal numbers decreasing, maintaining or increasing? And why?* A: There used to be numerous types of wildlife, however, animals are rarely seen in the wetlands nowadays.

Other comments/issues raised by the interviewee

Not only for wetland habitats/species, but also for surrounding ecosystems, such as woodlands.

Appendix 3.2 – First stakeholder consultation workshops' report

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STAKEHOLDER CONSULTATION WORKSHOP REPORT

DATE(S): 29/10/2019 (Lusaka); 1/11/2019 (Kitwe)

VENUE(S): Cresta Golfview Kotel (Lusaka); Sherbourne Lodge (Kitwe)

SESSION(S) CHAIR(S) (speakers, chairperson/facilitator/moderator and support staff): Annel M. Phiri, Mwiche Kabwe, Taona Kabinga (Lusaka and Kitwe), Maxwell Mwewa, Viriginia S. Mazile, Mushota Zyambo, Keyvan Izadi, Edah Mwale (Lusaka), Josphat Sichula (Kitwe) (ZEMA); Pedro Bettencourt (Lusaka and Kitwe), Emma Sitambuli (Lusaka), Christopher Sinyinza (Kitwe) (NEMUS)

A) Workshop(s) programme

8:30 – 9:00 – Participants' register

9:00 – 9:15 – Official opening remarks

9:15 – 10:15 – Project presentation: Lukanga Swamps Conservation Plan

10:15 – 11:30 – Open debate

11:30 – 11:45 – Workshop synthesis, conclusions and recommendations

11:45 – 12:00 – Final remarks and closure

B) Attendance

No. of participants: 34 (Lusaka) + 20 (Kitwe)

Participating organisations:

- Agricultural Consultative Forum
- BirdWatch Zambia
- Chambishi Copper Smelter
- Chibombo Town Council
- Chingola Municipal Council
- Copperbelt University – School of Mines and Mineral Sciences
- Kabwe Municipal Council
- Kapiri Mposhi Town Council
- Kitwe City Council

- Konkola Copper Mines
- Lukanga Water Supply & Sanitation Company Limited
- Ministry of Mines and Minerals Development; Mines Safety Department
- Ministry of Agriculture
- Ministry of Lands and Natural Resources; Environment and Natural Resources Management Department; Forestry Department; Department of Climate Change and Natural Resources
- Misenge Environmental and Technical Services Limited
- Mopani Copper Mines
- Mufulira Municipal Council
- Mulonga Water and Sewerage Company
- Ministry of Water Development, Sanitation and Environmental Protection; Department of Water Resources Development
- NFC Africa Mining
- Ngabwe Town Council
- Nkana Water and Sewerage Company
- Ministry of Community Development and Social Services; Social Welfare Department
- University of Zambia; Institute of Economic and Social Research
- Water Resources Management Authority
- World Wildlife Fund – Zambia
- Zambia Land Alliance (ZLA)
- Zambia Climate Change Network (ZCCN)
- Zambia Mining and Environmental Remediation and Improvement Programme; Project Implementation Unit, Kabwe; Project Coordination Unit

C) Participation and discussion notes

Main issues discussed (including environmental and socioeconomic impacts in Lukanga swamps and upper Kafue Basin and drivers of change)
• Water balance – subsurface flow is very important • Deforestation; it is a huge problem, there is need for a plan to plant trees • Effects of nutrient loading in the Upper Kafue Basin and how it influences the river species in the Lukanga swamps ecosystem

Main issues discussed (including environmental and socioeconomic impacts in Lukanga swamps and upper Kafue Basin and drivers of change)

- Effects of the accelerating infrastructure development, particularly along and close to the streams feeding in Kafue River; the transition terrestrial vegetation system life towards the streams is affected and many perennial streams feeding in Kafue River are at the danger of drying up
- Lack of proper monitoring of developmental activities along the river basins
- Effects of solid waste management under the water utility companies; nutrient loading is discharged in small rivers tributary to the Kafue River and not directly into Kafue River
- Effects of loading of nutrients in the streams – higher in the wet season, according to mining sector representatives
- Effects of roads construction on the Copperbelt and the disposal of waste; a situation in Mufulira was cited, where the waste is being used to reclaim land near the streams for infrastructure development
- Political influence is rife in the allocation of plots for development; it was discussed and agreed that the local authorities should review their Integrated Development Plans with regards to allocation of plots near the streams; the case of a community was cited, that settled near Mushishima river and depended on water to irrigate their agriculture crops; their crops were burnt after using water from the river to irrigate their crops and the case is still in the courts of law
- Stakeholder empowerment; too early in the assignment to highlight the actual empowerment attributes, though all empowerment programs will be subject to discussion and approval by ZEMA
- Environmental issues around Lukanga Swamps; localized and not linked to the upper Kafue basin
- Population around Lukanga swamps – projected to double by 2024
- Farming access to irrigation water; it was mentioned that commercial farmers have more access to the river waters than the small scale farmers; so, to capture the extent of the impact of agriculture on the upper Kafue basin, there is need to capture how much land is currently under commercial agriculture farming along the riverfronts as compared to the situation about 10 years ago
- Climate change as a driver of change in the study of Lukanga Swamps and upper Kafue basin
- Governance as a driver of change; it was discussed that governance is a difficult subject to achieve in natural resources management

Provided information/clarifications

- The Ministry of Lands and Natural Resources, responsible for Wetland Policy, informed that 100,000 USD were allocated to ecosystem-based adaptation, to restore the ecosystem integrity of two wetlands, including Lukanga – restoration of the forest and also livelihood; by 2023, and by the Wetlands Policy, eight Wetland Management Plans should have been implemented
- With regard to the lack of proper monitoring of developmental activities along the river basins, it was mentioned that there is a ministerial policy guideline to that effect and so WARMA should step up and work with local authorities to implement the policy guidelines
- Mulonga Water and Sewerage Company has 21 treatment plants out of which 3 are functional, located in Mufulira, Chililabombwe and Chingola, and 18 are not; sewerage from the non-functional treatment centres flows into primary and secondary ponds; the communities living near these treatment plants divert sewerage to irrigate gardens before reaching the tertiary ponds
- Nkana Water and Sewerage Company is extracting water for domestic use in Kalulushi from Mwambashi River and mentioned that the sulphate level in the water is very high; the company is considering closing its extracting point at Mwambashi river and it was agreed that Nkana water utility company should make a case with ZEMA to assist the situation
- About 650,000 cubic meters of wastewater are discharged daily by KCM; the amount of effluent loaded in the streams is constant throughout the year, though
- In Nchanga mine, the loading of nutrients is high in the rain dry season, so there are intermittent closures of the tailing dams to regulate the abnormal discharge of sulphate in the streams
- There is $55.5 allocation under ZMERIP, meant to support other environmental projects such as the ongoing Lead project in Kabwe, supporting the Mufulira, Kitwe and Chingola Council to address environmental liabilities of the Mines

Data and/or information agreed to be shared
• To capture how much land is currently under commercial agriculture farming along the riverfronts as compared to the situation about 10 years ago, the Ministry of agriculture representative is to avail such information to Nemus • The ministry of agriculture representative also agreed to provide stats on how many commercial farmers are dependent on river stream waters for agriculture activities • WARMA to provide data on how much water is extracted from underground by commercial farmers in the upper Kafue basin • It was also agreed that the water utility companies would share with Nemus: • the map coordinate points where the discharge is loaded in the streams • the results of the analysis of effluent discharge monitoring data in the past one year that is submitted to ZEMA on a six-month basis • data on how much effluent is discharged in the streams and how much water is extracted from the rivers • There was an appeal for all the stakeholders present to work with Nemus by sharing the information and research documents done on Lukanga Swamps and upper Kafue basin; and that Nemus should contact them for any consultation to avoid duplication of works
Other recommendations
• Commerce should be included in the stakeholders, because investment is critical in Lukanga • Other stakeholders do engage: International Crane Foundation (ICF); Wildlife and Environmental Conservation Society of Zambia (WECSZ) • Nemus was advised to work closely with the Ministry of Lands on the wetland management policy

D) Attendance lists

Lusaka, 29th October 2019

No.	Name	Organisation	Contact	Email
1	Dr Emma Sitambuli	NEMUS	0975803946	esitambuli@gmail.com
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13	Mwitwa Mambwe	ACF	0953087041	Mwitwa.mambwe@acfzambia.org
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19	Theresa M. Nabuyanda	ZMERIP Kabwe-PIU	0968867128	Thresa.musongo@gmail.com
20	Annie Mwambazi	ZMWERIP PCU	0977705174	Simukali.mulongwe@gmail.com
21	Simukali Mulongwe	ZMERIP PCU	0977705174	Simukali.mulongwe@gmail.com

No.	Name	Organisation	Contact	Email
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25	Cholwe H. Chanda	ZCCN	0955867753	cholwechanda@gmail.com
26	Adreen Nansungwe	MOA	0977361386	adreennanasungwe@yahoo.com
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32	Aurelius Nkonde	Climate Change Dept MLNR	0966300124	acnkonde@gmail.com
33	Mwiche Kabwe	ZEMA	0977418297	mkabwe@zema.org.zm
34	Viriginia S. Mazile	ZEMA	0977770788	vmazile@zema.org.zm

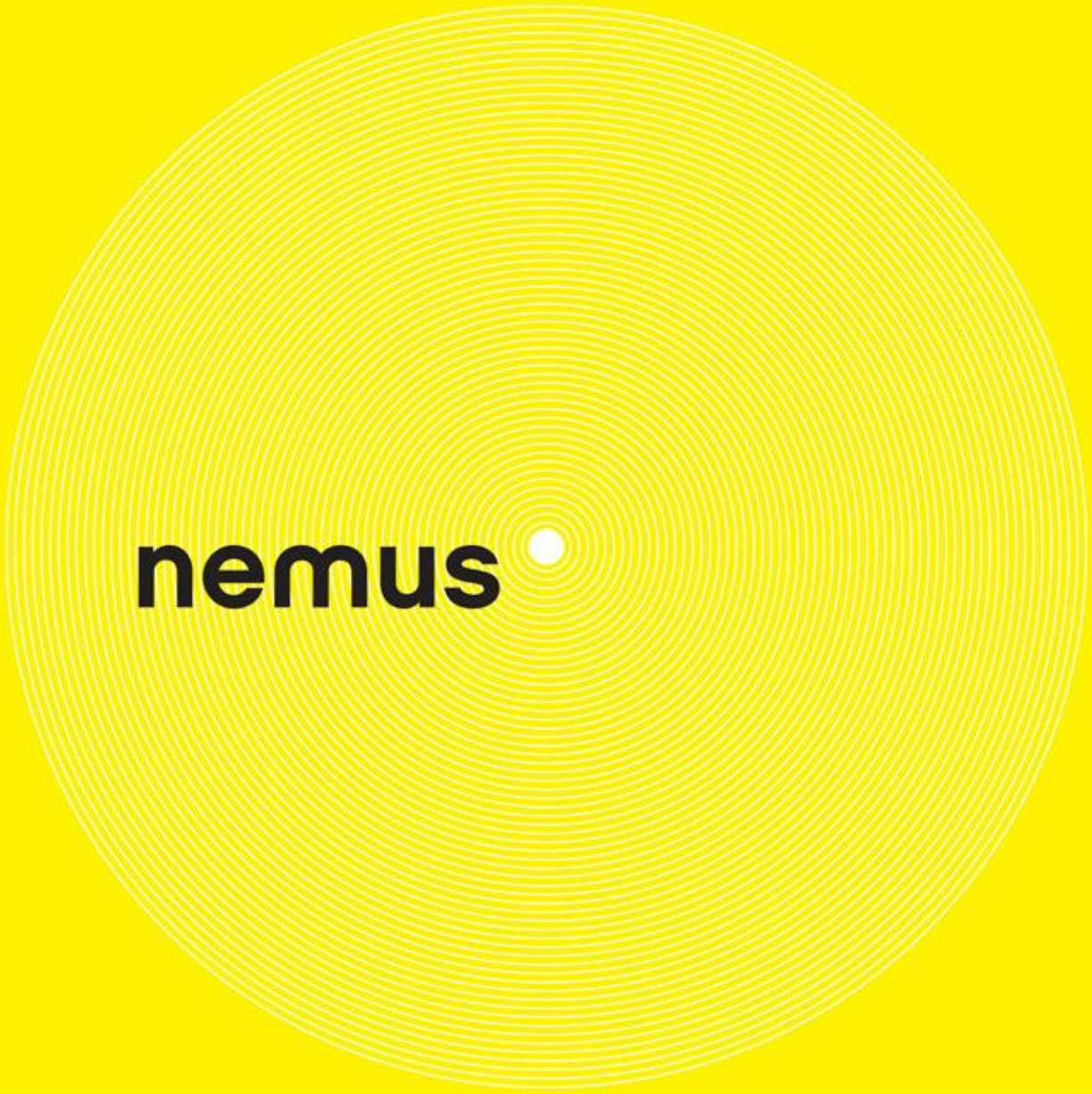
Kitwe, 1st November 2019

No.	Name	Organisation	Contact	Email
1.	Robinson Mubita	Chambeshi Copper Smelters	0966562975	rmubita@yahoo.com
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4	Sydney Supuni	Mulonga Water and Sewerage Company	0969259624	sydney.supuni@mwsc.com.zm
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8	Dr. Jhonnah Mundike	Copperbelt University	0975222297	jhomu@cbu.au.zm
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20	Christopher Sinyinza	Nemus Consultants	0964787080	csinyinza@yahoo.co.uk

E) Project presentation

The Powerpoint presentations used in the Workshops are presented in the following pages.

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nemus

Conservation Plan for Lukanga Swamp and Upper Kafue Basin

Stakeholder consultation workshop (W1 – Lusaka)



29th October 2019

nemus empowering sustainability

THE WORLD BANK IBRD • IDA | WORLD BANK GROUP

CONTENT

1. Introduction; objectives and scope
2. Assignment components and stakeholders
3. Background
4. Methodology
5. Work Plan

1 – Introduction; objectives and scope

INTRODUCTION

Assignment: development of a **Conservation Plan for Lukanga Swamp**, considering the impacts that may arise from its catchment and from the Upper Kafue Basin

It aims to answer the following questions:

What are the most significant ecosystem services provided by the Lukanga Swamp?	What are the potential drivers of ecosystem change?
How can the impacts be mitigated?	How can these areas be managed in a sustainable manner?

ASSIGNMENT FRAMEWORK

- With the support of the World Bank
- Under Component 2 of **Zambia Mining and Environmental Remediation and Improvement Programme** (**ZMERIP**)

ZMERIP's **overall objective**: *Reduce environmental health risks to the local population associated with the mining sector in critically polluted areas in Kabwe and Copperbelt provinces through improved capacity of key institutions*
Under the **Ministry of Mines and Minerals Development**
Launched on 13th January 2015
Duration: five (5) years
Budget: of USD 50 million

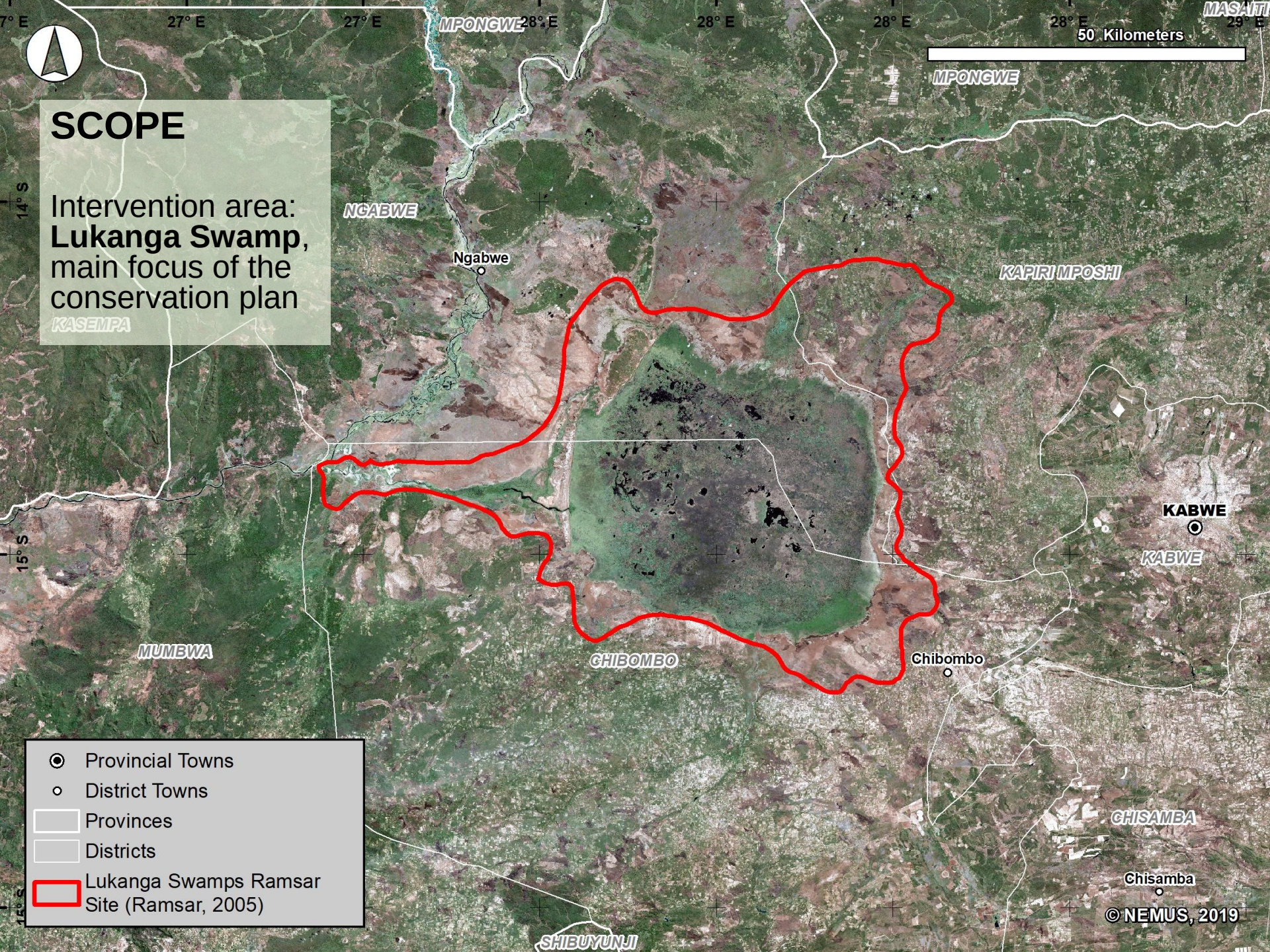
- ZMERIP's Component 2: *Enhancing Institutional Capacity for Environmental Governance and Compliance*

GENERAL OBJECTIVES

1	Generate qualitative and quantitative data and tools to support the participatory management of the area
2	Integrated approach to evaluate the upstream-downstream interactions and the impacts on Lukanga Swamp and its catchment
3	Assessment of the ecosystem services and livelihoods of the communities
4	Generate one ecosystems-based approach to conservation planning

SPECIFIC OBJECTIVES

1. Enhance sustainable, integrated planning of **water, energy, food security and ecosystems**
2. Provide data and tools to **support decision making**
3. Develop feasible incentives and enforcement mechanisms to **support sustainable ecosystem management**
4. Investigate projects for synergies, lessons and cost-efficiencies
5. **Raise stakeholder awareness** and empower them to design and implement ecosystem management solutions

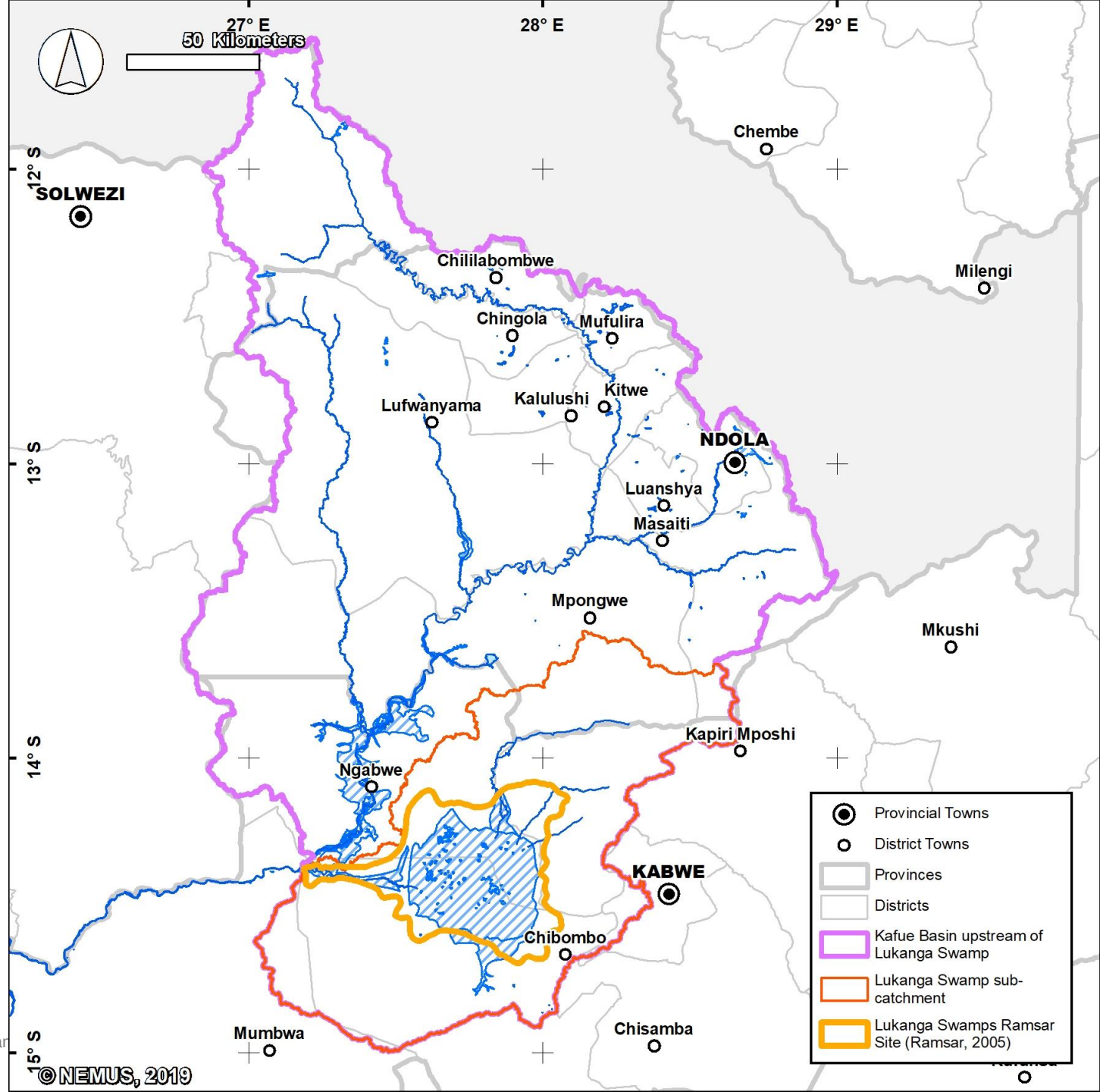

SCOPE
Intervention area: **Lukanga Swamp**, main focus of the conservation plan
KASEMPA
NGABWE
Ngabwe
MPONGWE
KAPIRI MPOSHI
KABWE
KABWE
MUMBWA
CHIBOMBO
Chibombo
CHISAMBA
Chisamba
SHIBUYUNJI
MASAITI
50 Kilometers
27° E
28° E
29° E
14° S
15° S
Provincial Towns
District Towns
Provinces
Districts
Lukanga Swamps Ramsar Site (Ramsar, 2005)
© NEMUS, 2019

STUDY AREAS

Lukanga Swamp
-> Represented by “Lukanga Swamps Ramsar Site”

Location of potential sources of impacts on Lukanga:

- **Lukanga Swamp sub-catchment**
- **Kafue River Basin upstream**



2 – Assignment components and stakeholders

LUKANGA SWAMP CONSERVATION PLAN

nemus

1 – Biophysical assessment; conservation status

2 – Evaluation of ecossystem services

3 – Development scenarios

4 – Cost-benefit analysis

5 – Integrated Management Plan for Lukanga Swamp Conservation

INDICATORS-BASED ECOSYSTEM SERVICES ASSESSMENT

1) Definition of ecosystem types and ecosystem assessment

2) Assessment of ecosystem services

3) Ecosystem service valuation

4) Analysis of future scenarios

KEY STAKEHOLDERS

Government institutions

Ministry of Mines and Minerals Development; Geological Survey Department; Mines Development Department; Mines Safety Department	Ministry of Water Development, Sanitation and Environmental Protection; Department of Water Resources Development	Ministry of Lands and Natural Resources; Department of Climate Change and Natural Resources; Forestry Department	Ministry of National Development and Planning
Ministry of Agriculture; Extension Services for Kafue; Office for Central Zambia	Ministry of Fisheries and Livestock	Ministry of Community Development and Social Welfare	Ministry of Chiefs and Traditional Affairs
Department of National Parks and Wildlife (DNPW) of the Ministry of Tourism and Arts	Ministry of Health; Radiation Protection Authority	Other national, provincial and district administrative authorities	

KEY STAKEHOLDERS

Regulators

- Zambia Environmental Management Agency (ZEMA)
- Water Resources Management Authority (WARMA)

Industry

- Mining operators
- Representatives from the agro-industry sector in UKRB
- Zambia National Farmers Union

Traditional authorities and/or community representatives

- Village Management Committees, traditional authorities and other community representatives
- Fishers and fisheries management committees
- Farmers and farmer associations' representatives
- Water users' associations, Joint Forest Management Committees and Community Resources Boards

KEY STAKEHOLDERS

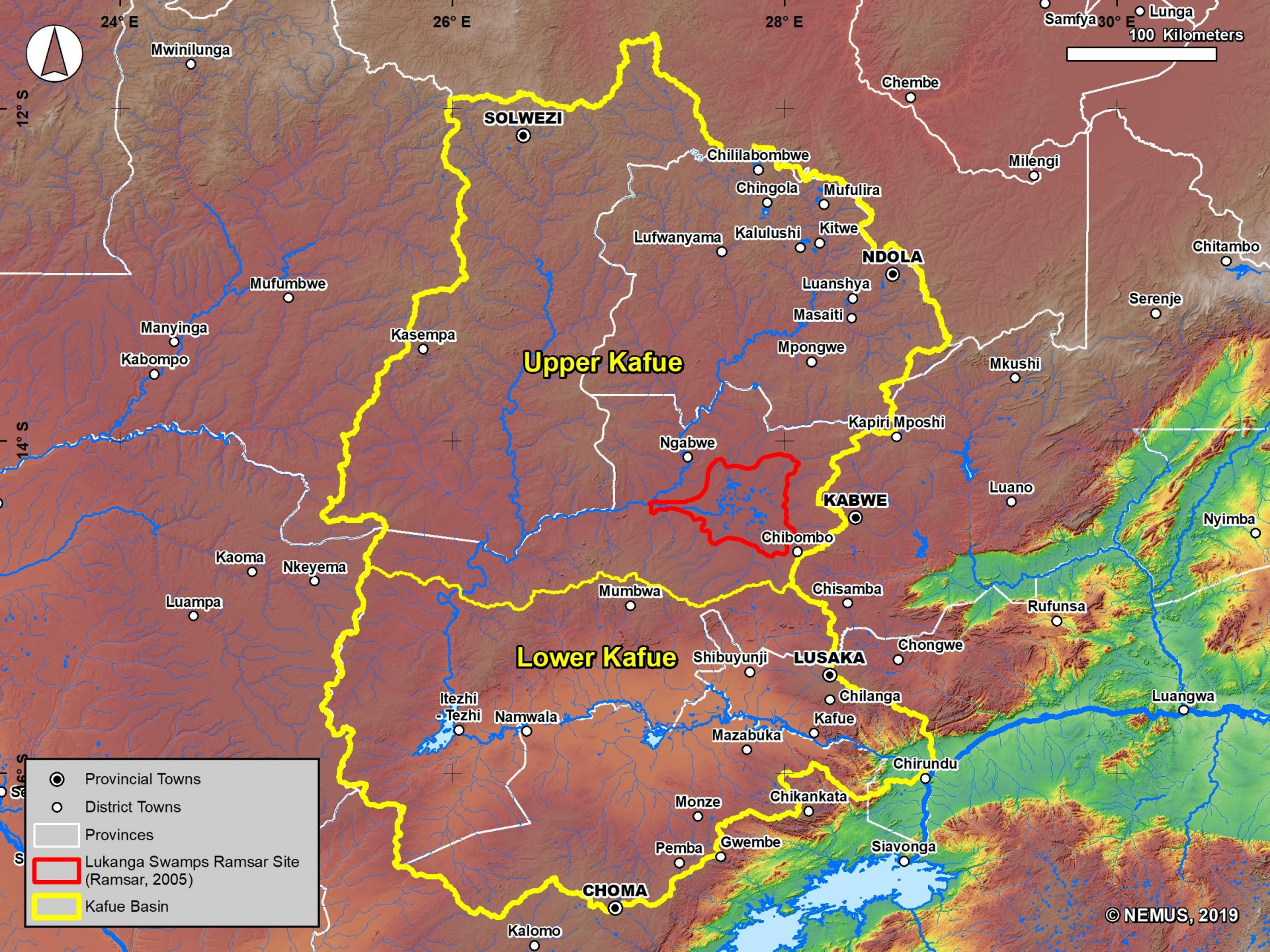
Civil society in general, NGOs, academic and research institutions

The Nature Conservancy (TNC)	WWF Zambia	Action Aid Zambia	Zambia Climate Change Network
Zambia Land Alliance	Agricultural Consultative Forum (ACF)	University of Zambia; Institute of Economic and Social Research; School of Mines	Zambia Institute for Policy Analysis and Research
Zambia Community Based Natural Resource Management (CBNRM) Forum	BirdWatch Zambia	Copperbelt university	Mulungushi University (Kabwe)

3 – Background

KAFUE RIVER BASIN

- Longest and largest river that flows entirely within Zambian territory
- One of Zambia's six major catchments
- 6,6 million people (~50% Zambia population)
- Plays a central role in Zambia's economy: most of the commercial and domestic water use activities
- Water uses: industrial, mining, hydropower, agriculture (irrigation and aquaculture), environmental and recreation
- Subdivided into 2 collective basins:
  - **Upper Kafue River Basin**
  - Lower Kafue River Basin


24° E
26° E
28° E
30° E
12° S
14° S
16° S
100 Kilometers
Mwinilunga
Samfya
Lunga
Chembe
SOLWEZI
Chililabombwe
Milengi
Chingola
Mufulira
Lufwanyama
Kalulushi
Kitwe
NDOLA
Chitambo
Mufumbwe
Luanshya
Serenje
Manyinga
Masaiti
Kasempa
Kabompo
Upper Kafue
Mpongwe
Mkushi
Kapiri Mposhi
Ngabwe
Luano
KABWE
Nyimba
Chibombo
Kaoma
Nkeyema
Chisamba
Mumbwa
Luampa
Rufunsa
Chongwe
Lower Kafue
Shibuyunji
LUSAKA
Itezhi - Tezhi
Chilanga
Luangwa
Namwala
Kafue
Mazabuka
Chirundu
Chikankata
Monze
Pemba
Gwembe
Siavonga
CHOMA
Kalomo
Provincial Towns
District Towns
Provinces
Lukanga Swamps Ramsar Site (Ramsar, 2005)
Kafue Basin
© NEMUS, 2019

LUKANGA SWAMP

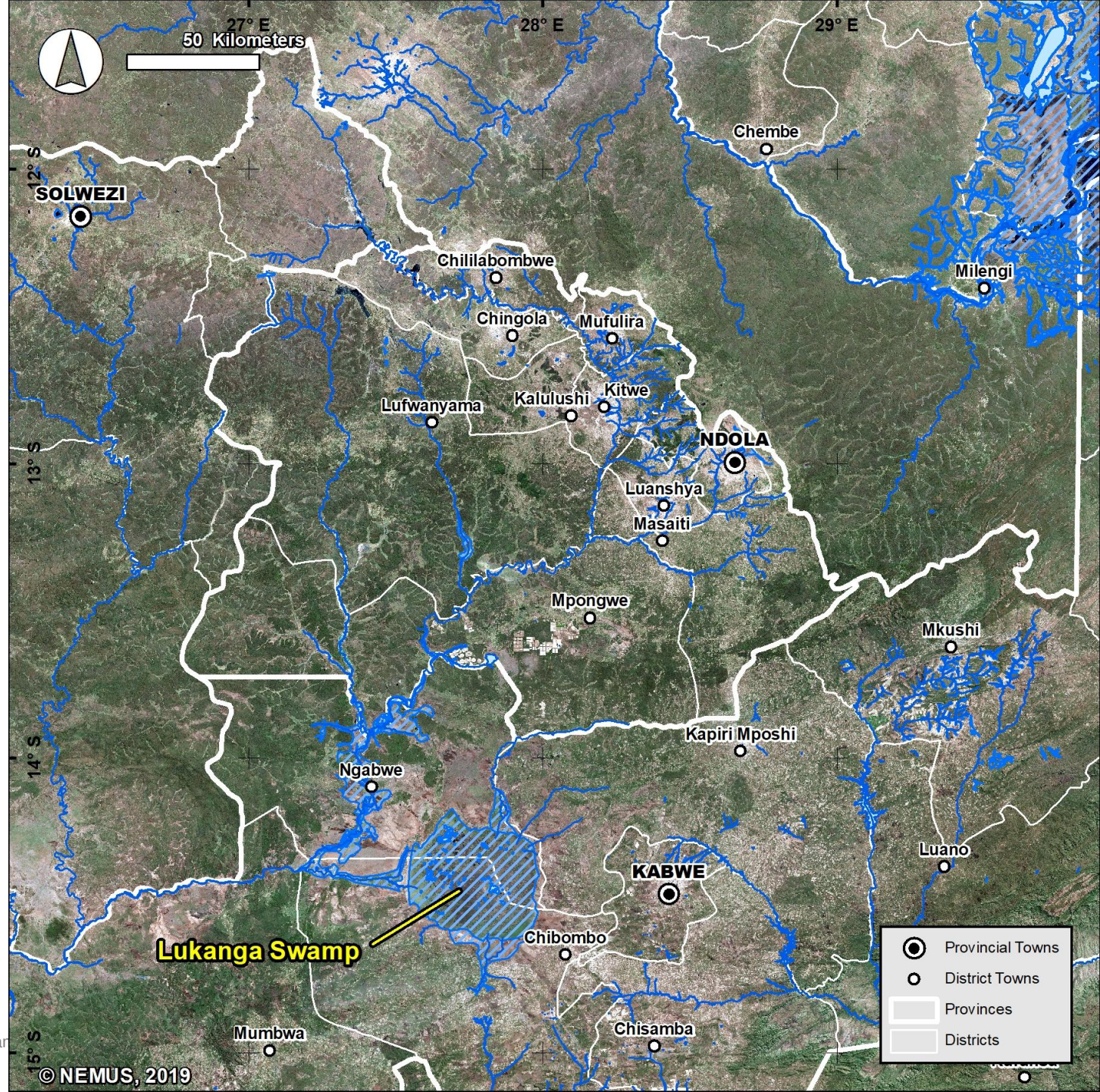
Lukanga Swamp develops in a shallow circular depression:

- 1.5 m average depth
- max. 6.1 m of water depth

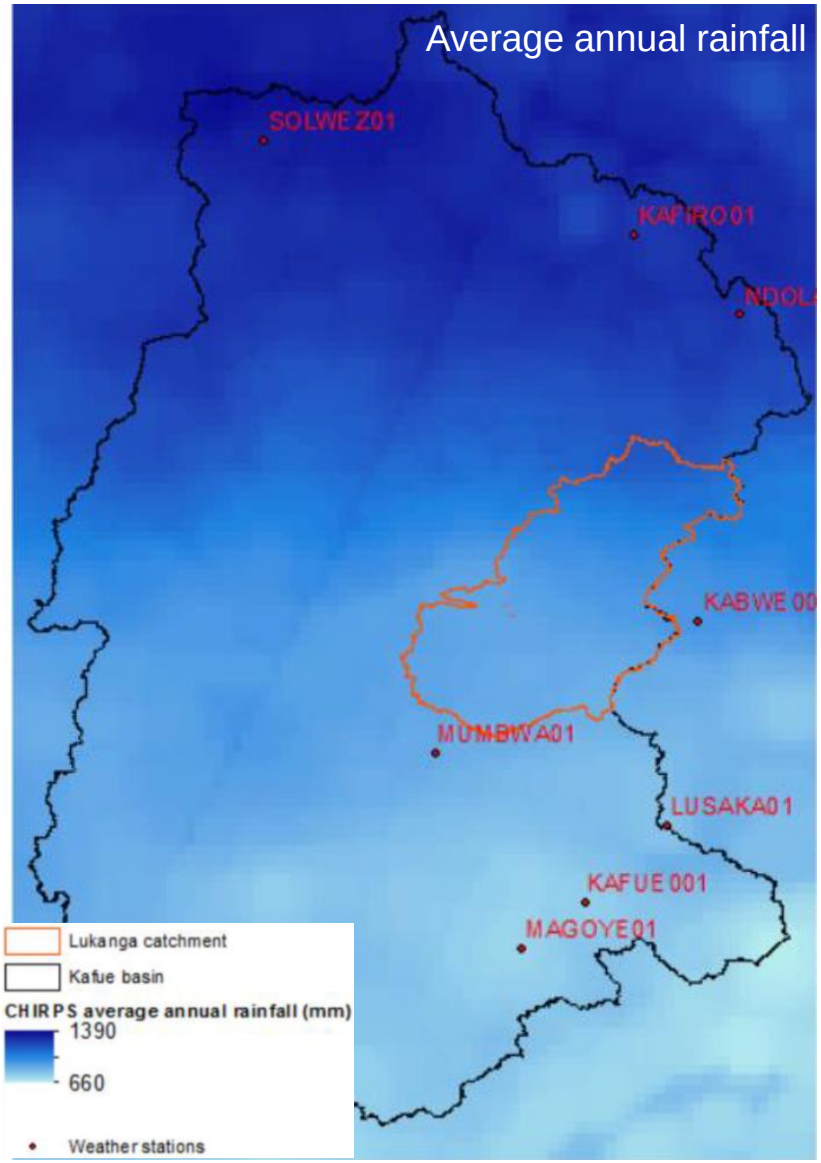
Largest permanent water body of the basin

Diameter: 40-50 m

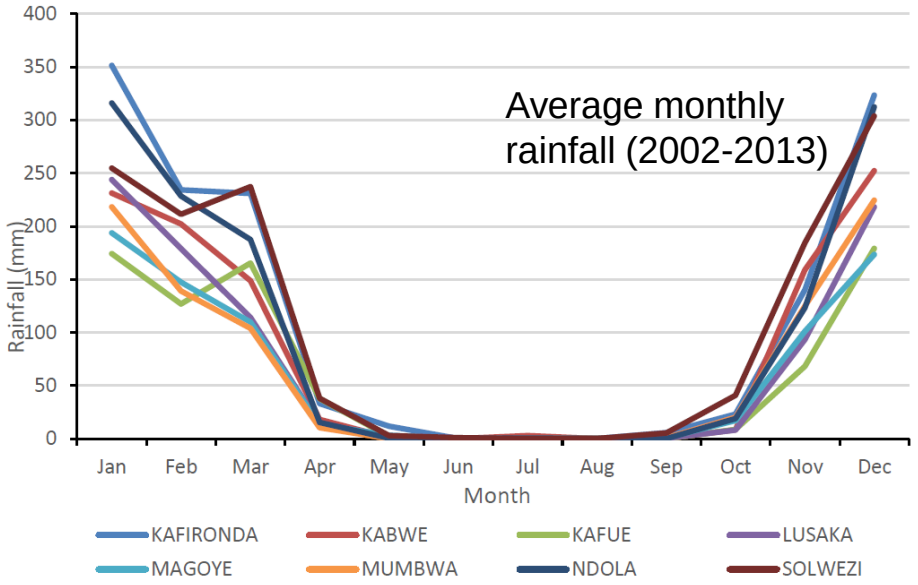
Area: 2,500 (low water) to 2,600km^2 (high flood level)



CLIMATE AND HYDROLOGY
Rainfall



Very pronounced dry and wet seasons



Source: *Hidrologycal evaluation and ecosystem valuation of the Lukanga Swamps; Final Report Jan.2017*

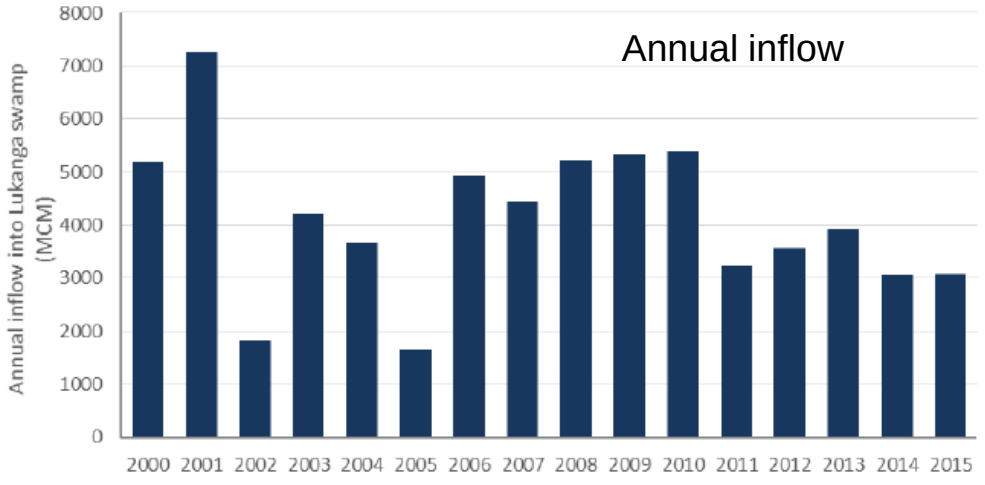
CLIMATE AND HYDROLOGY
Average inflow

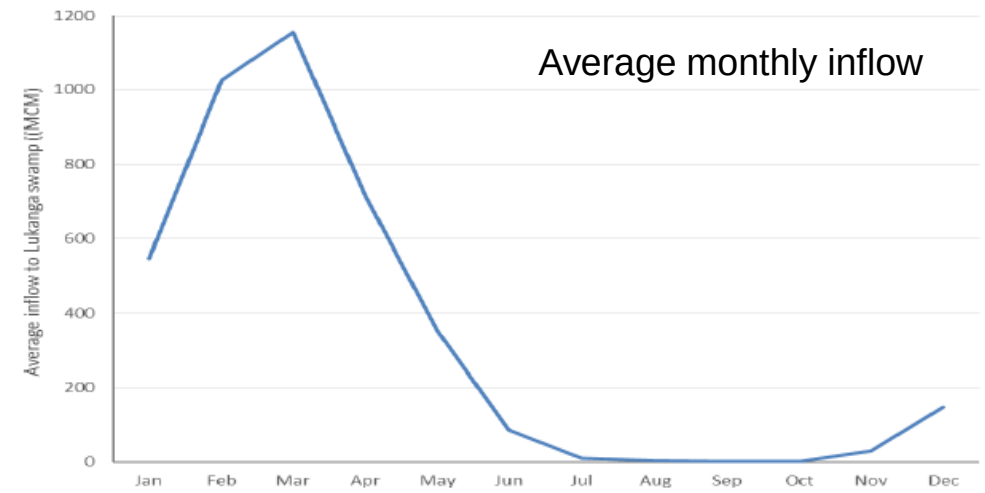
→ High annual inflow variability

The Lukanga Swamp acts as a nature-based reservoir in the Kafue river basin

- Retains water in wet periods
- Releases it slowly during the dry season and dry years

<u>Very important for downstream water users in the Kafue River Basin</u> (Lusaka water supply, hydropower, Kafue Flats)

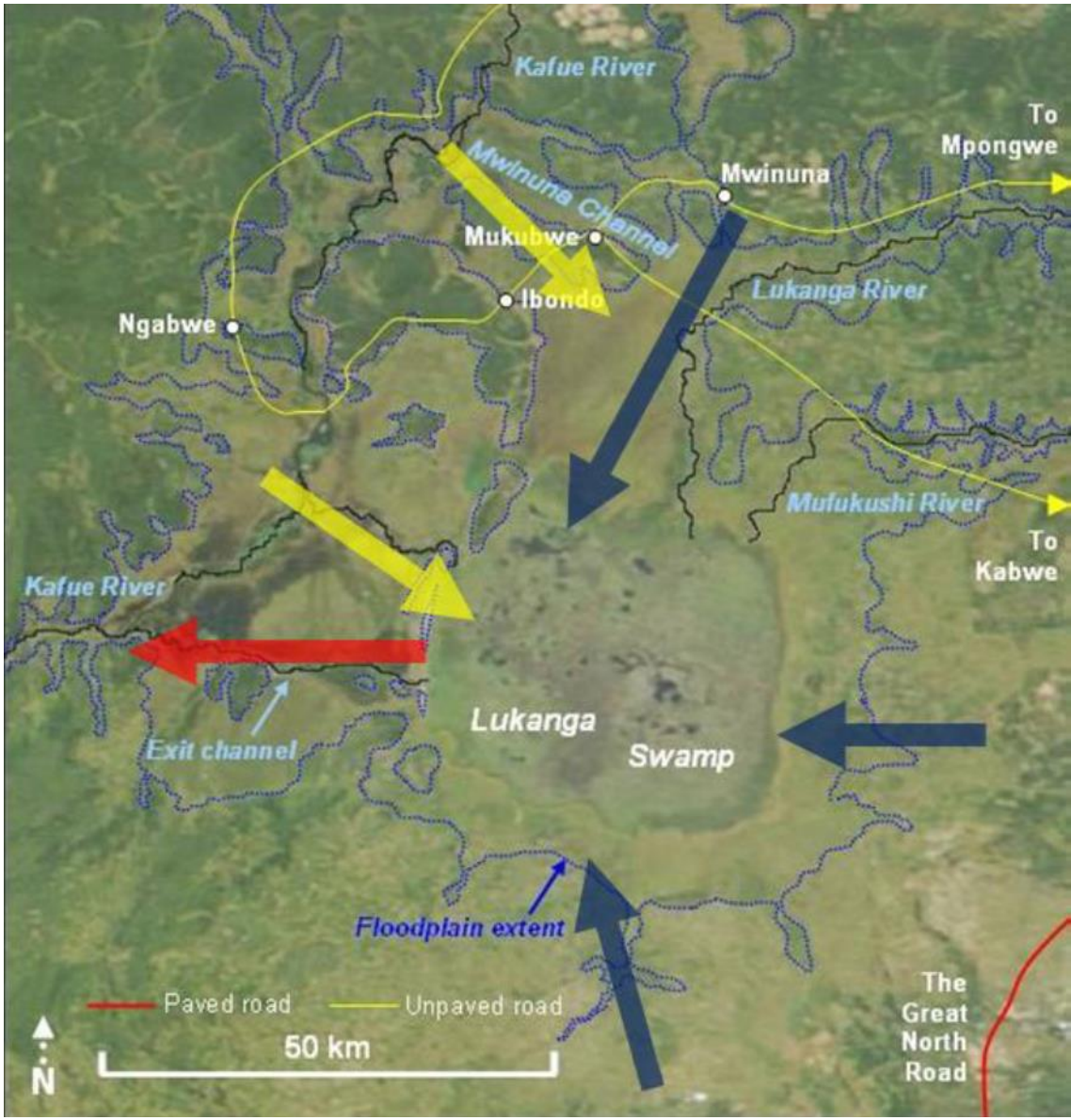




Source: *Hidrologycal evaluation and ecosystem valuation of the Lukanga Swamps; Final Report Jan.2017*

CLIMATE AND HYDROLOGY
Water Balance

←	Streamflow	Water inflow from the Lukanga watershed
←	Overflow	Occasional surface overflow from Kafue during flood events, and subsurface flow from the Kafue river floodplain to the Lukanga swamps
←	Outflow	Flow leaving swamp through exit channel to Kafue and subsurface flow between Kafue alluvial subsurface and swamp subsurface

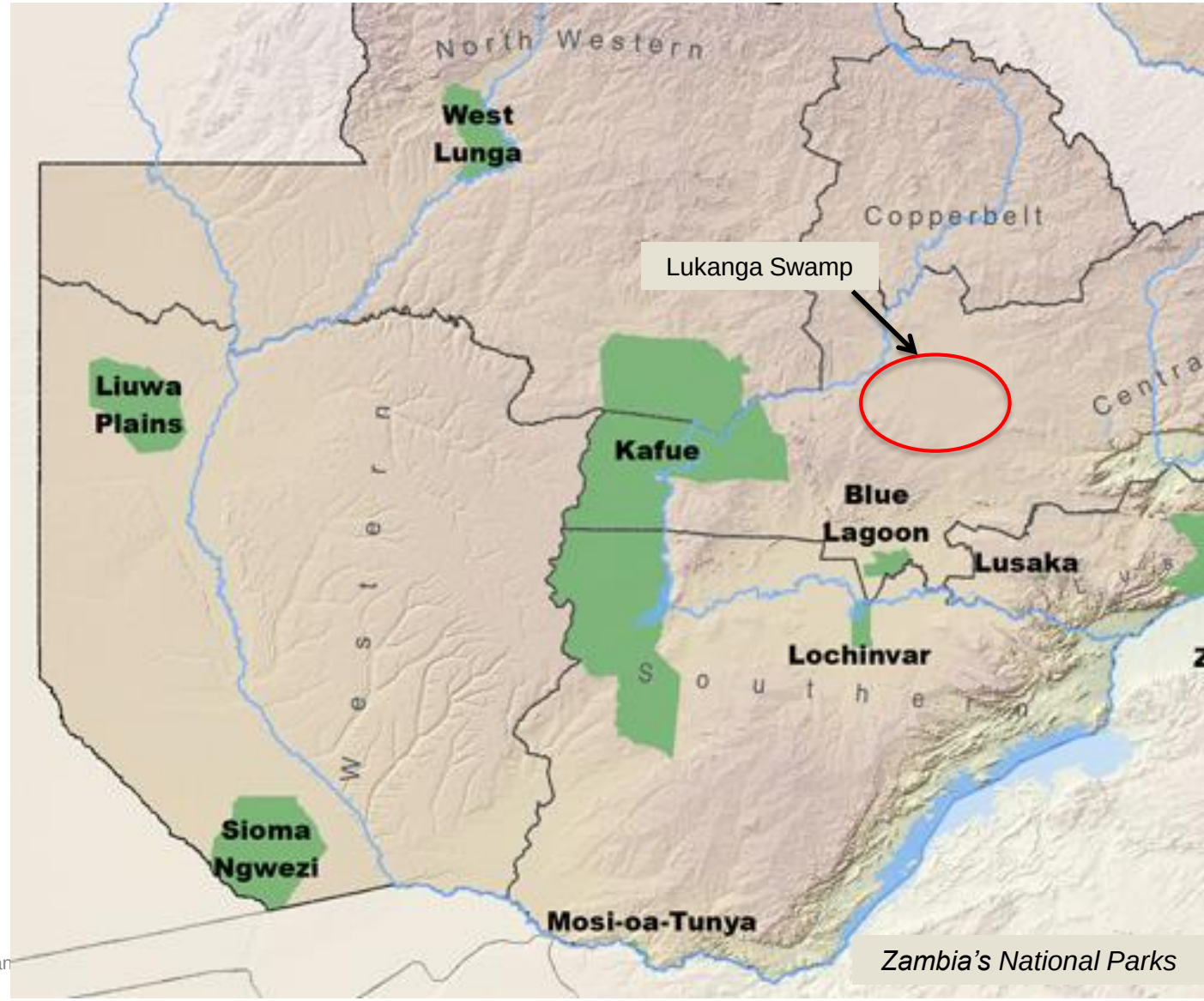


BIODIVERSITY
Ecological value

Ramsar site since 2005 (Ramsar Convention on Wetlands)

Important Bird Area (by BirdLife International)

100km East of <u>Kafue National Park</u>



Zambia's National Parks

BIODIVERSITY
Wetland ecosystems

Two major ecological types:

- **Palustrine (marsh): 95%**
  - permanent swamp, termitaria grasslands, and dambos
- **Lacustrine (open water): ~5%**
  - permanently inundated

Ecological status:
<u>potentially threatened</u>



Example of a palustrine wetland in Lukanga Swamp

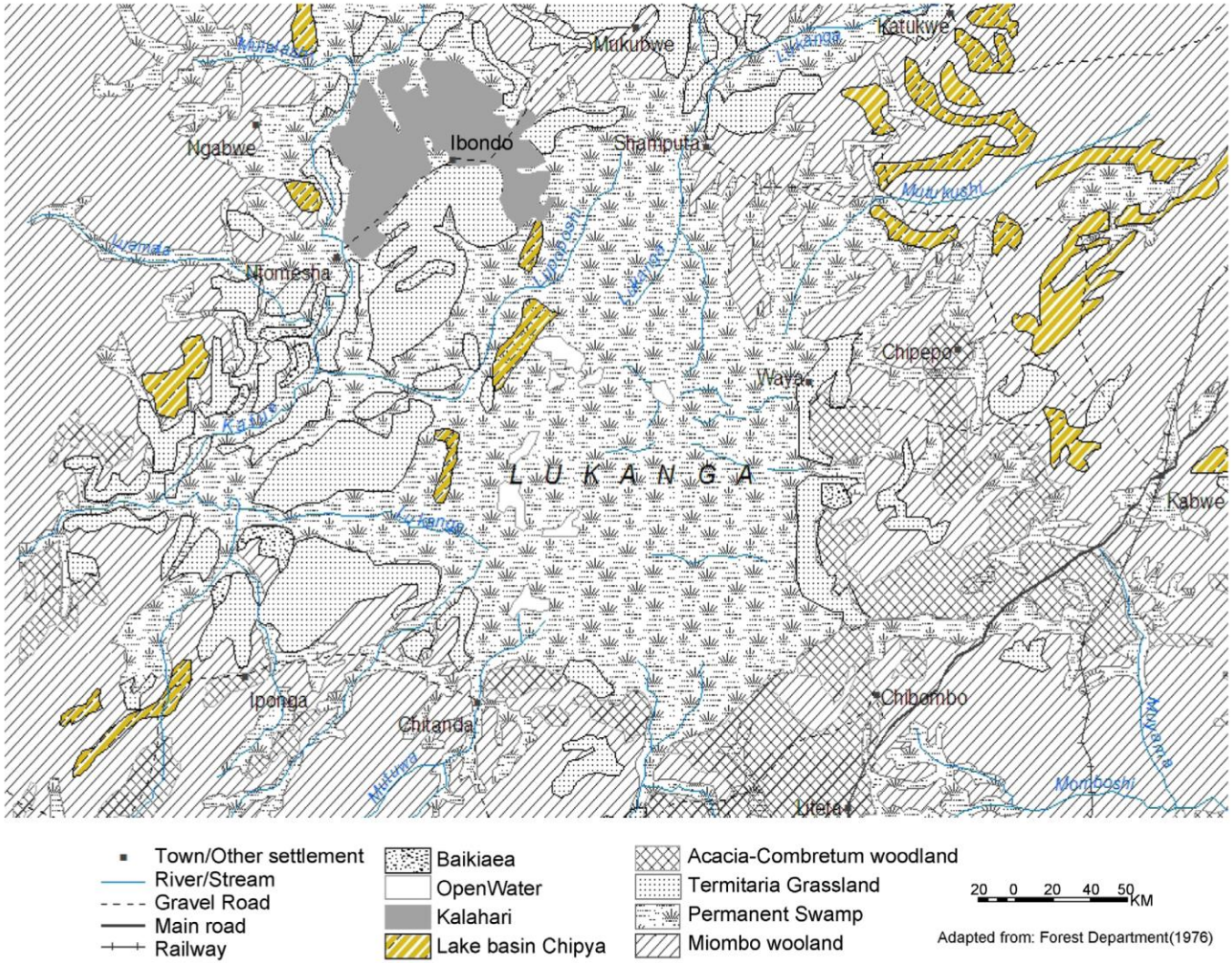


Arrival at a lacustrine environment of Lukanga Swamp

BIODIVERSITY
Habitat types

Eight habitat types:

1. Miombo woodland (main habitat)
2. *Acacia-Combretum* woodland
3. *Baikea* woodland
4. Kalahari
5. Lake basin Chipya
6. Termitaria grassland
7. Permanent swamp
8. Open water


Mukubwe
Katukwe
Ibondo
Ngabwe
Shamiputa
Mumbeshi
Mumbeshi
Mumbeshi

BIODIVERSITY
Fauna

Reptiles:
- *Crocodylus niloticus* (Nile crocodile)
- *Python sebae* (African python)

Amphibians:
- *Bufo lemairi* (yellow swamp frog)
- *Bufo regularis* (square marked toad)
- *Xenopus laevis* (clawed frog)
- *Pyxicephalus adspersus* (African bullfrog)

Birds (at least 316 species)*:*
- *Grus carunculatus* (Wattled crane)
- *Balearica regulorum (*Crowned/ Crested Crane)
- *Anastomus lamelligerus* (Openbilled stork)
- *Ephippiorhynchus senegalensis (*Saddle billed stork), etc.


Nile Crocodile


Crowned/ Crested Crane

Source: *Information Sheet on Ramsar Wetlands (RIS): Lukanga Swamps; 2005*

Note: red marks endangered species

BIODIVERSITY
Fauna

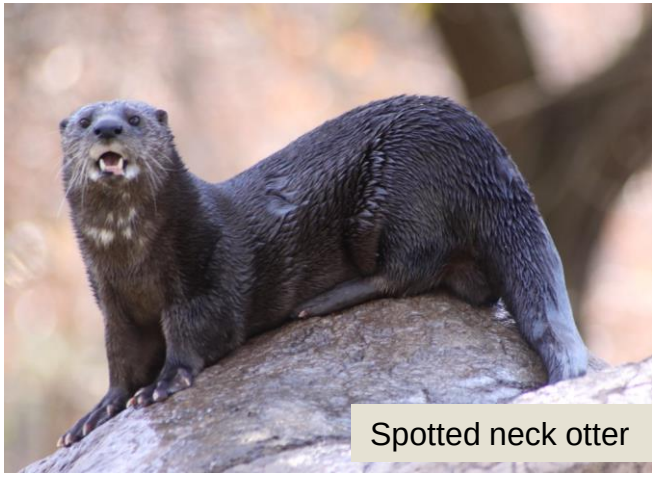
Mammals:

- *Tragelaphus spekei* (sitatunga)
- *Kobus leche* (Red Lechwe)
- *Redunca arundinum* (reedbuck)
- *Ourebia ourebi* (Oribi)
- *Felis caracal* (Caracal)
- *Felis serval* (Serval cat)
- *Lutra maculicollis* (spotted neck otter)
- *Aonyx congicus* (Clawless otter)
- *Atilax paludinosus* (Marsh mongoose)

Fish:

- *Tilapia*
- *Cichlids*
- *Serranochromis*
- *Characidae*
- *Claridae*


Red Lechwe


Spotted neck otter

Source: *Information Sheet on Ramsar Wetlands (RIS): Lukanga Swamps; 2005*

Note: red marks endangered species

BIODIVERSITY
Flora

- *Phragmites spp.*
- *Typha spp.*
- *Vossia cuspidata*
- *Nymphaea spp.*
- *Aeschynomene*
- *Cyperus papyrus*



Phragmites spp.



Nymphaea spp.



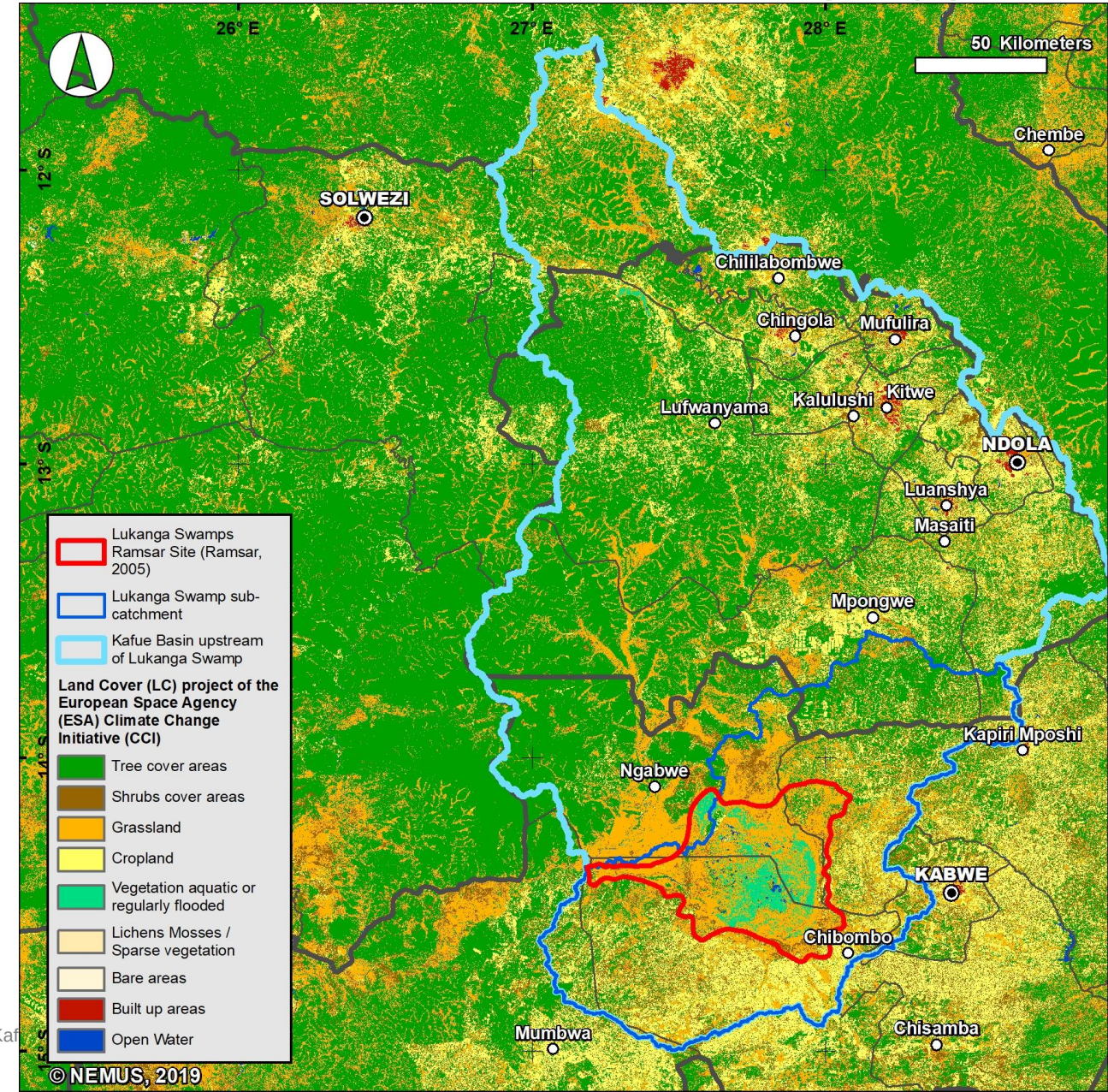
Typha spp.

Source: *Information Sheet on Ramsar Wetlands (RIS): Lukanga Swamps; 2005*

LAND USE AND SOCIOECONOMIC DINAMICS

60,000 people live in the wetland or nearby

Demographic projections show the growing trend will slow down for some districts (Chibombo, Kabwe, Kapiri Mposhi) from 2020 to 2035



LAND USE AND SOCIOECONOMIC DINAMICS

nemus

Population projections for Central Province districts crossed by Lukanga Swamp (2011-2035)

Province District	Population			Projected Annual Population Growth Rate	
	2011	2020	2035	2011-2020	2020-2035
Central Province	1,355,775	1,734,601	2,565,450	2.5%	2.5%
Chibombo District	156,708	194,778	271,991	2.2%	2.1%
Kabwe District	101,599	113,993	133,547	1.3%	1.0%
Kapiri Mposhi District	131,088	167,744	245,952	2.5%	2.4%
Mumbwa District	117,658	163,870	275,504	3.3%	3.3%
Ngabwe District	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Adapted from Zambia Population and Demographic Projections 2011-2035 (CSO, 2013).

Ecosystem services

Provisional services:

- Fisheries
- Water for consumption and irrigation
- Livestock grazing grounds
- Fuel wood
- Charcoal

Regulatory services:

- Climate regulation
- Carbon sequestration
- Water purification



Fishermen in the Lukanga Swamp



Livestock grazing grounds in the wetland area

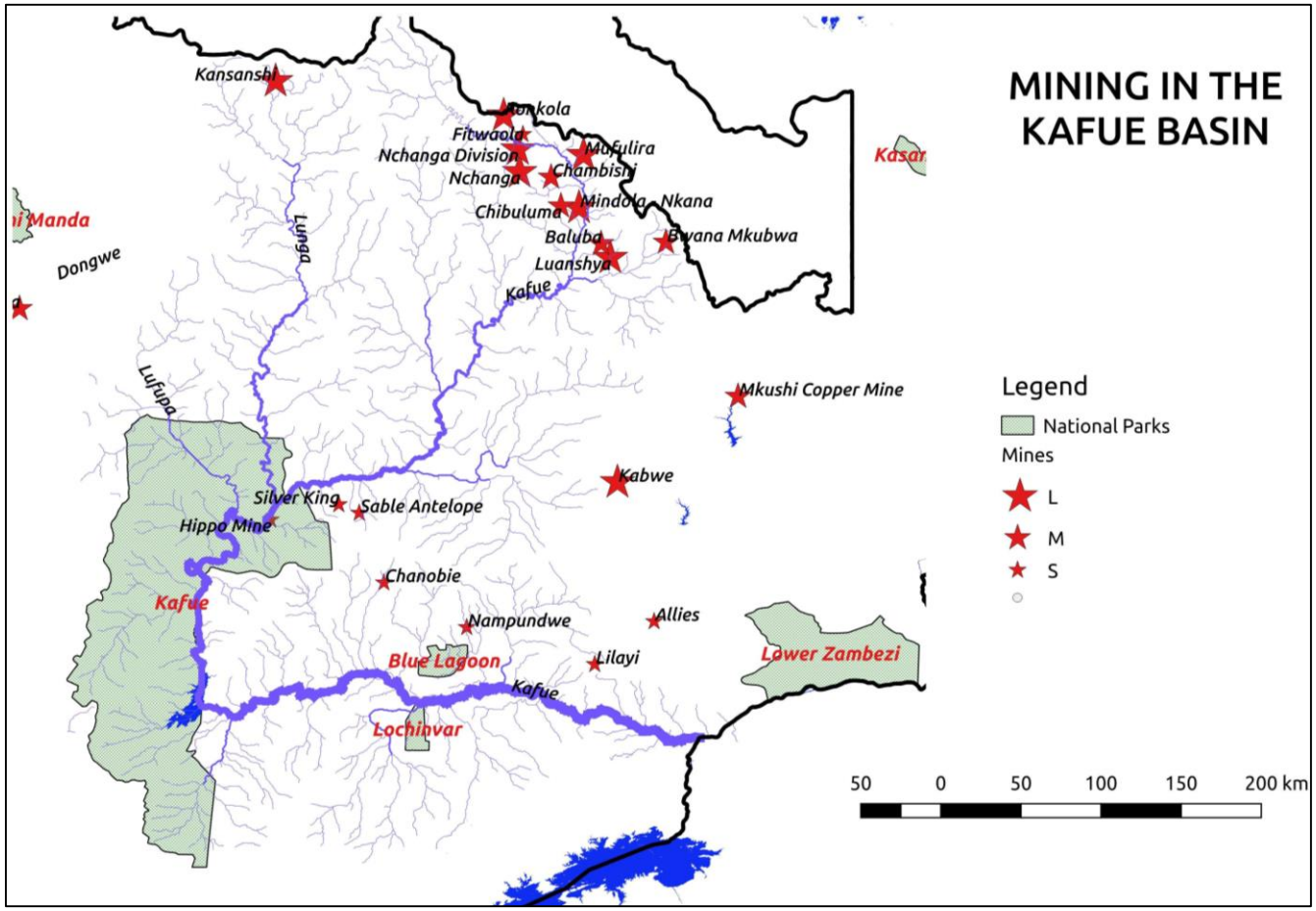


Gathering wood for a fish drying camp

ENVIRONMENTAL AND SOCIAL IMPACTS

The **Lukanga Swamp** functions as a major sediment, nutrient and pollutants trap, alleviating degradation of the downstream basin

Most of the mines of the Zambian Copperbelt lie within the headwaters of the Kafue River



Extractive industry in the Copperbelt Province



Mopani Copper Mine, Mufulira



Konkola Copper Mines, Chilabombwe
(1 of the 4 largest mining companies in Zambia)

Extractive industry in Zambia

Zambia is one of the largest producers and exporters of copper in Africa

The mining sector accounted for **73% of national exports** revenue in 2016 (**68%** from **copper mining**)

Production:

Commodity	Unit	2016 Production Quantity	2016 Value (US $ million)[1]
Copper	Mt	774,289.80	3,769.16
Gold	Kg	4,543.85	200.19
Zinc	Tonnes	585.00	1.22
Lead	Tonnes	365.00	0.68
Coal	Tonnes	57,293.00	n/a
Emerald and Berl	Kg	71,878.66	n/a
Limestone	Tonnes	3,319,600.00	n/a
Amythest	Kg	1,349,787.00	n/a
Dolomite	Tonnes	1,201,689.00	n/a
Total of the sector			**3,971.25**

n/a: not available

Exports:

	2016 (US $ million)	2016 % Contribution
Metal exports	**4,738.2**	**72.84%**
Copper	4,399.1	67.63%
Cobalt	112.9	1.74%
Gold	191.2	2.94%
Gemstones	28.4	0.44%
Manganese Ores/Concentrates	6.6	0.10%
Zambia Exports (f.o.b)	**6,504.7**	**100.00%**

Source: *9th Zambia EITI Report. December 2018*

ENVIRONMENTAL AND SOCIAL IMPACTS

Extractive industry's main environmental problems:

- **Air pollution** (>98% of the country's SO_2 emissions; PM_{10})
- **Soil contamination** (accumulation of metals – mainly copper & cobalt)
- **Water pollution and siltation** in the Upper Kafue River
- **Geotechnical issues**
- **Land degradation**

	Kitwe	Mufulira	Chingola	Kalulushi	Chililabombwe	Chambishi
Population *	522 000	161 000	210 000	96 000	90 000	11 000
Mining operations	Nkana & Mindolo	Mufulira	Nchanga & Chingola	Chibuluma	Konkola	Chambishi
As (mg/kg)	>5	>5	3	1	0.5	0.5
Co (mg/kg)	>60	>60	>60	35	9	19
Cr (mg/kg)	36	36	36	16	25	16
Cu (mg/kg)	>2200	>2200	>2200	1800	600	300
Hg(mg/kg)	>0.06	>0.06	0.035	0.02	0.02	0.02
Ni (mg/kg)	12	22	7	5	7	5
Pb (mg/kg)	>60	>60	>60	5	5	5
Zn (mg/kg)	>60	>60	>60	20	40	10

* Zambia Central Statistical Office 2010.

Average element concentrations
Green: higher than international guideline values for soil suitable for residential and agriculture;
Blue: likely to also be higher.

Source: Lindahl (2014). *Environmental impacts of mining in Zambia: Towards better environmental management and sustainable exploitation of mineral resources*

ENVIRONMENTAL AND SOCIAL IMPACTS
Kafue river

Between Chingola and Chilabombwe:





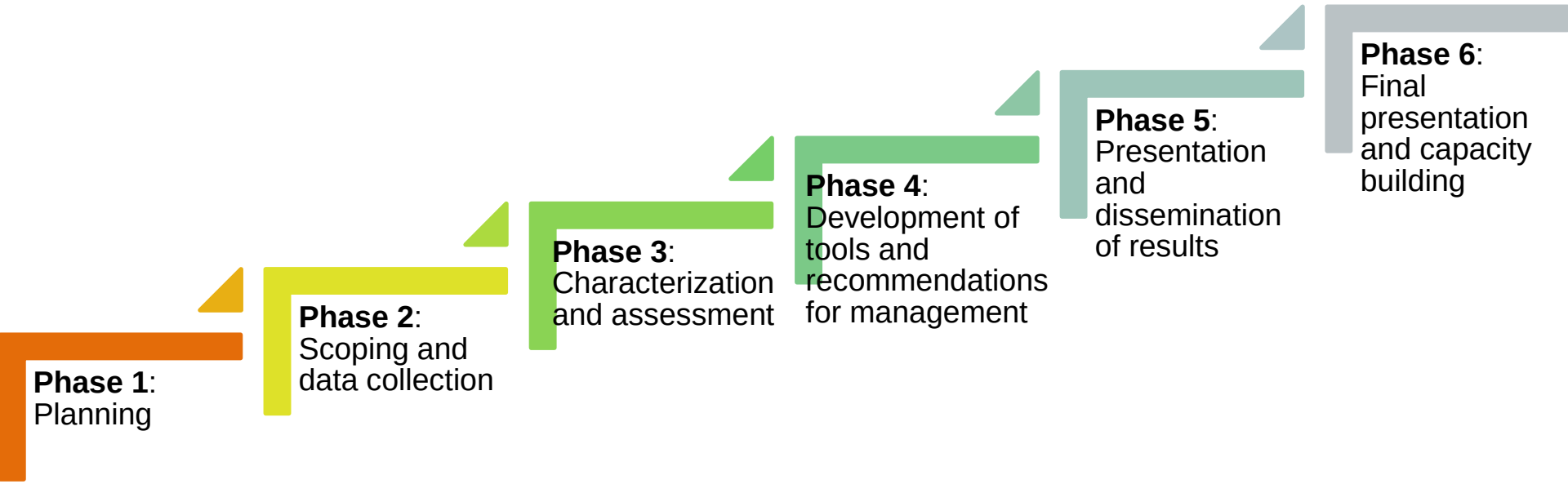


South of Mufulira:



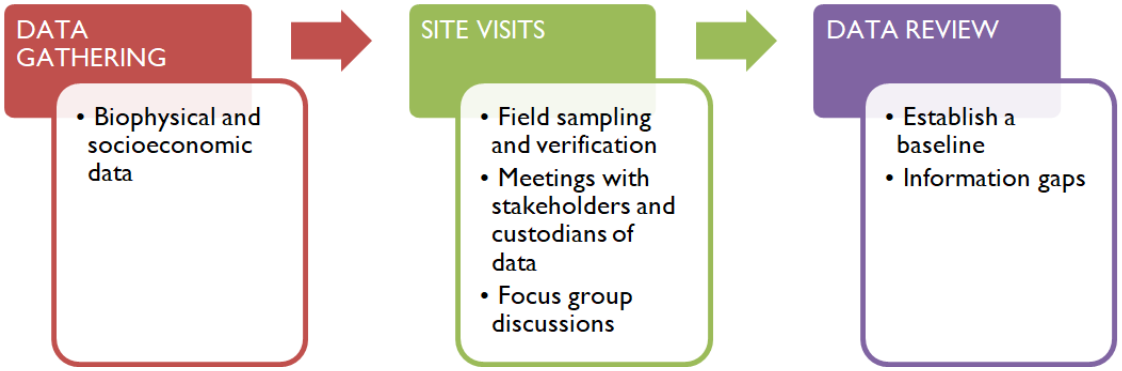
4 – Methodology

CONSERVATION PLAN DEVELOPMENT PHASES



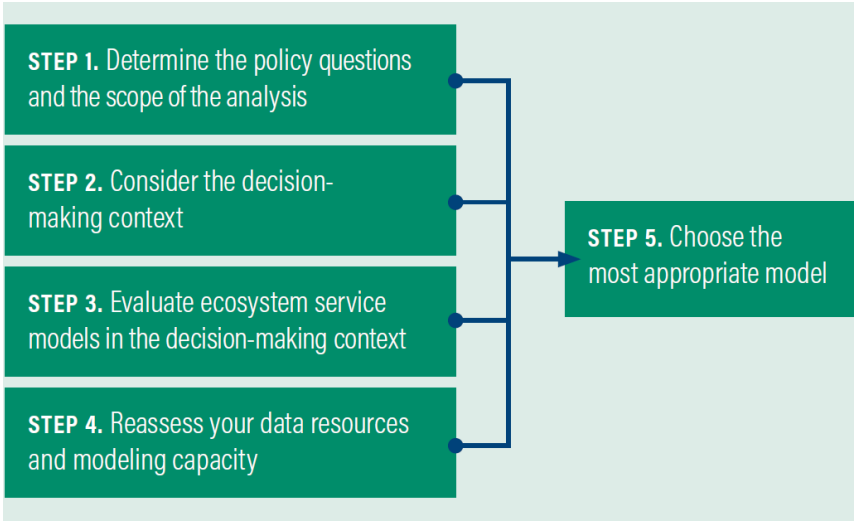
PHASE 2: SCOPING AND DATA COLLECTION

- In-desk data collection
- Assessment of data availability and identification of needs
- Field work
- Stakeholders Consultation Workshop (W1)
- Social surveys
- **Progress report #1 (D2)**
- Definition of ecosystem types and ecosystem assessment
- Selection of ecosystem services, indicators and assessment methods
- **Progress report #2 (D3)**



PHASE 3: CHARACTERIZATION AND ASSESSMENT

- Characterization of the study area's biophysical, socio-economic and governance systems
- Identification of drivers of ecosystem change and impacts
- Ecosystem services assessment (quantification/qualification and valuation), including assessment of future scenarios
- Assessment of the study's progress and further data needs
- **Progress Report #3 (D4)**



Model selection framework (assessment of future scenarios)

PHASE 4: DEVELOPMENT OF TOOLS AND RECOMMENDATIONS FOR MANAGEMENT

- Assessment of future scenarios
- Decision-making framework
- Revision of the Lukanga Swamp Catchment Management Plan
- Preliminary development of recommendations
- Water Monitoring Programme (WMP)
- Capacity Building Action Plan (CBAP)
- **Progress Report #4 (D5)**
- Stakeholders' consultation workshop (W2)
- **Progress Report #5 (D6)**
- **Draft report (D7)**

PHASE 5: PRESENTATION AND DISSEMINATION OF RESULTS

- Transfer of the data collected throughout the assessment
- Stakeholders consultation workshop (W3)
- Integration of commentaries and remarks
- **Final Report (D8)**

PHASE 6: FINAL PRESENTATION AND CAPACITY BUILDING

- (S1) Seminar
- (T1) Course on the application of the modelling tool
- (T2) Course on the implementation of the monitoring programme
- Distribution of awareness raising resources among key stakeholders and managers
- Distribution of capacity building resources among managers

5 – Work Plan

WORK PLAN

	Phase1	Phase 2	Phase 3
Objective	Planning	Scoping and data collection	Characterization and assessment
Duration	One and a half (1,5) months	Four and a half (4,5) months	Three (3) months
Deadline	One and a half (1,5) months	Six (6) months	Nine (9) months
Milestones	(M1) Meeting 1 – kick-off meeting	(W1) Stakeholders consultation workshop (M2) Meeting 2	Characterization of the study area Assessment
Deliverables (and delivery dates)	(**D1**) **Inception Report** (month 2)	(**D2**) **Progress report #1** (month 3) (**D3**) **Progress report #2** (month 6)	(**D4**) **Progress report #3** (month 9)

WORK PLAN

	Phase 4	Phase 5	Phase 6
Objective	Development of tools and recommendations for management (integration)	Presentation and dissemination of results	Final presentation and capacity building
Duration	Eight (8) months	One (1) month	One (1) month
Deadline	Sixteen (16) months	Seventeen (17) months	Eighteen (18) months
Milestones	(W2) Stakeholders consultation workshop (M3) Meeting 3	(W3) Stakeholders consultation workshop (M4) Meeting 4	Milestones: (M5) Meeting 5
Deliverables (and delivery dates)	(**D5**) **Progress Report #4** (month 12) (**D6**) **Progress Report #5** (month 15) (**D7**) **Draft Report** (month 16)	(**D8**) **Final Report** (month 17)	-

WORK SCHEDULE

PHASES	2019		2020		2021	
	OCT	FEB	MAY	DEC	JAN	FEB
Phase 1 – Planning	D1					
Phase 2 – Scoping and data collection		D2 D3				
Phase 3 – Characterization and assessment			D4			
Phase 4 – Integration				D5 D6 D7		
Phase 5 – Presentation					D8	
Phase 6 – Capacity building						

(D1) Inception Report
(D2 to D6) Progress Reports
(D7) Draft Report
(D8) Final Report

STAKEHOLDER ENGAGEMENT

Stakeholder Consultation Workshops	To discuss critical steps of the assignment among key stakeholders and obtain contributions
Interviews	To present the assignment and gather concerns regarding the sustainable development of Lukanga Swamp
Focus group discussions	To get a deeper understanding of the communities living within the catchment area
Seminar	To present the Final Report and inform a broader audience of the assignment's main results



Focus group discussion held by Nemus at Tanganyika's lakeshore community of Chisanza

STAKEHOLDER ENGAGEMENT

Workshop 1-2 Oct.-Nov. 2019	• Presentation of the scope of the assignment; stakeholder engagement for cooperation
Workshop 3 Aug. 2020	• Presentation and discussion of the management recommendations
Workshop 4 Dec. 2020	• Presentation and discussion of the Draft Report



Workshop held by LTDP and Nemus at Mpulungu

THANK YOU!

ZIKOMO!

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Conservation Plan for Lukanga Swamp and Upper Kafue Basin

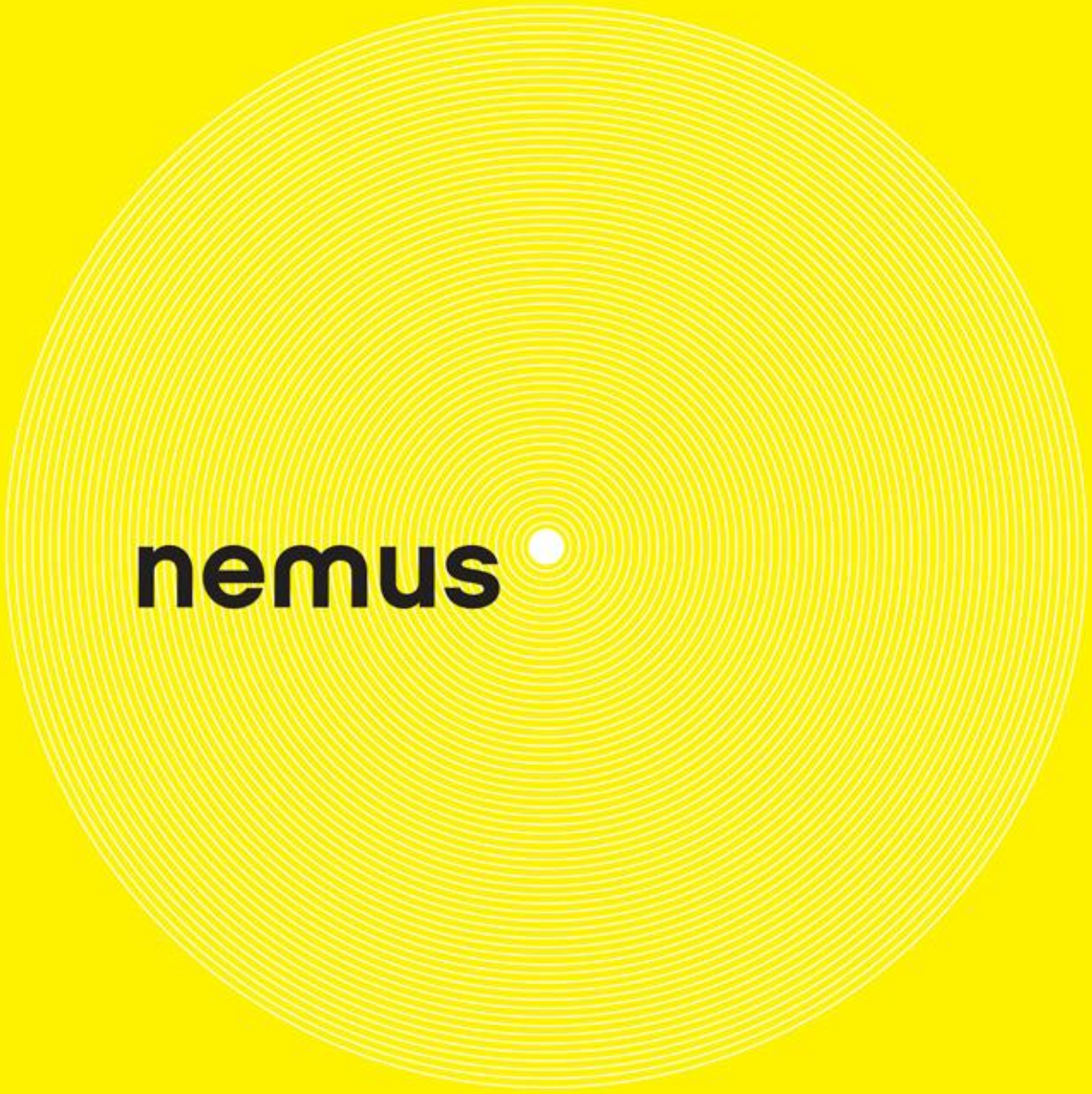
Workshop 1 – Lusaka, 29th October 2019

Topics for debate

1. Environmental impacts in Lukanga Swamp
2. Social and economic impacts in Lukanga Swamp
3. Main drivers for change in Lukanga Swamp

nemus empowering sustainability

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nemus

Conservation Plan for Lukanga Swamp and Upper Kafue Basin

Stakeholder consultation workshop (W2 – Kitwe)



1st November 2019

nemus empowering sustainability

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CONTENT

1. Introduction; objectives and scope
2. Assignment components and stakeholders
3. Background
4. Methodology
5. Work Plan

1 – Introduction; objectives and scope

INTRODUCTION

Assignment: development of a **Conservation Plan for Lukanga Swamp**, considering the impacts that may arise from its catchment and from the Upper Kafue Basin

It aims to answer the following questions:

What are the most significant ecosystem services provided by the Lukanga Swamp?	What are the potential drivers of ecosystem change?
How can the impacts be mitigated?	How can these areas be managed in a sustainable manner?

ASSIGNMENT FRAMEWORK

- With the support of the World Bank
- Under Component 2 of **Zambia Mining and Environmental Remediation and Improvement Programme** (**ZMERIP**)

ZMERIP's **overall objective**: *Reduce environmental health risks to the local population associated with the mining sector in critically polluted areas in Kabwe and Copperbelt provinces through improved capacity of key institutions*
Under the **Ministry of Mines and Minerals Development**
Launched on 13th January 2015
Duration: five (5) years
Budget: of USD 50 million

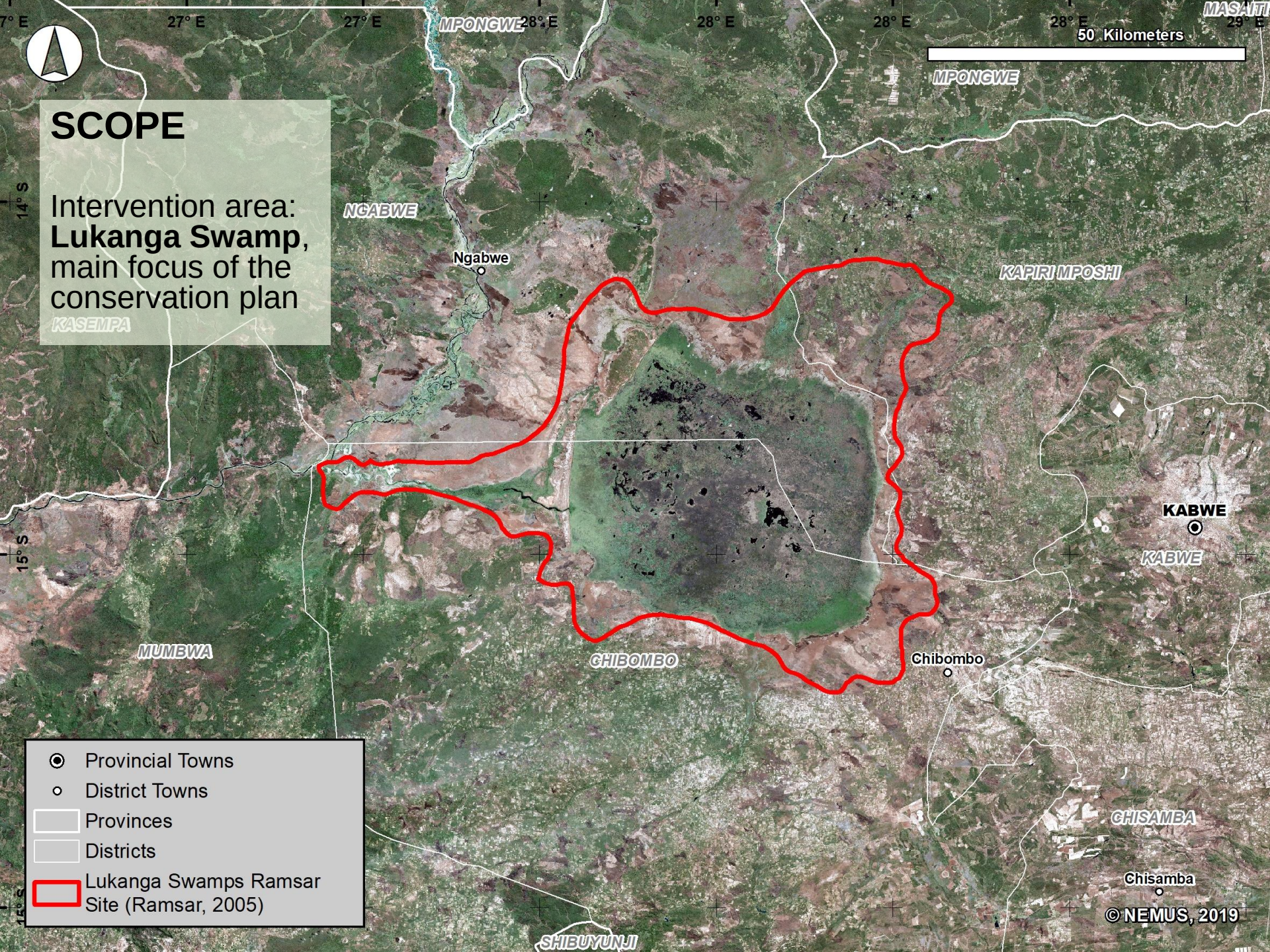
- ZMERIP's Component 2: *Enhancing Institutional Capacity for Environmental Governance and Compliance*

GENERAL OBJECTIVES

1	Generate qualitative and quantitative data and tools to support the participatory management of the area
2	Integrated approach to evaluate the upstream-downstream interactions and the impacts on Lukanga Swamp and its catchment
3	Assessment of the ecosystem services and livelihoods of the communities
4	Generate one ecosystems-based approach to conservation planning

SPECIFIC OBJECTIVES

1. Enhance sustainable, integrated planning of **water, energy, food security and ecosystems**
2. Provide data and tools to **support decision making**
3. Develop feasible incentives and enforcement mechanisms to **support sustainable ecosystem management**
4. Investigate projects for synergies, lessons and cost-efficiencies
5. **Raise stakeholder awareness** and empower them to design and implement ecosystem management solutions

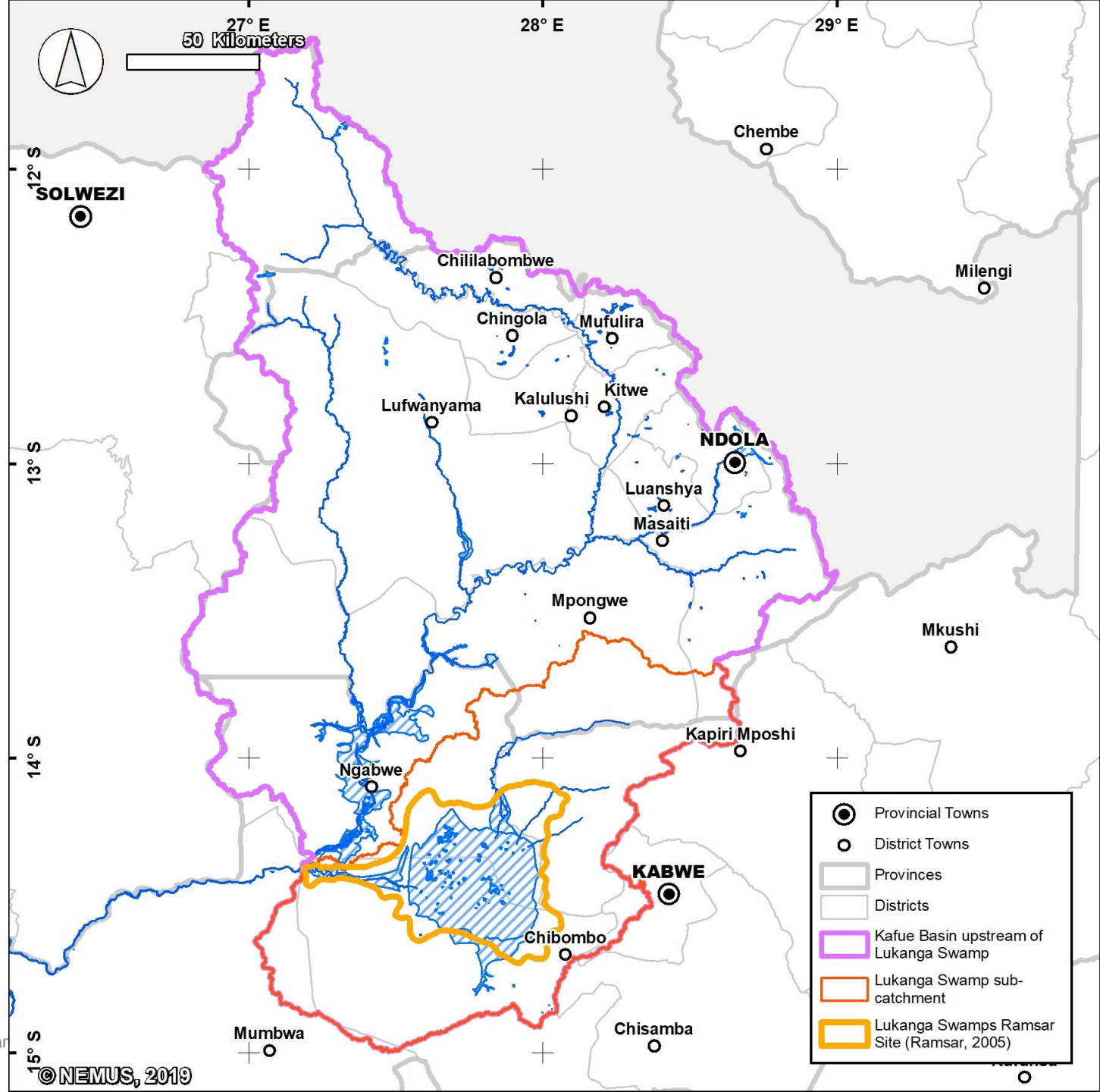

SCOPE
Intervention area: **Lukanga Swamp**, main focus of the conservation plan
KASEMPA
NGABWE
Ngabwe
MPONGWE
KAPIRI MPOSHI
KABWE
KABWE
MUMBWA
CHIBOMBO
Chibombo
CHISAMBA
Chisamba
SHIBUYUNJI
MASAITI
50 Kilometers
27° E
28° E
29° E
14° S
15° S
Provincial Towns
District Towns
Provinces
Districts
Lukanga Swamps Ramsar Site (Ramsar, 2005)
© NEMUS, 2019

STUDY AREAS

Lukanga Swamp
-> Represented by “Lukanga Swamps Ramsar Site”

Location of potential sources of impacts on Lukanga:

- **Lukanga Swamp sub-catchment**
- **Kafue River Basin upstream**



2 – Assignment components and stakeholders

LUKANGA SWAMP CONSERVATION PLAN

1 – Biophysical assessment; conservation status

2 – Evaluation of ecossystem services

3 – Development scenarios

4 – Cost-benefit analysis

5 – Integrated Management Plan for Lukanga Swamp Conservation

INDICATORS-BASED ECOSYSTEM SERVICES ASSESSMENT

1) Definition of ecosystem types and ecosystem assessment

2) Assessment of ecosystem services

3) Ecosystem service valuation

4) Analysis of future scenarios

KEY STAKEHOLDERS

Government institutions

Ministry of Mines and Minerals Development; Geological Survey Department; Mines Development Department; Mines Safety Department	Ministry of Water Development, Sanitation and Environmental Protection; Department of Water Resources Development	Ministry of Lands and Natural Resources; Department of Climate Change and Natural Resources; Forestry Department	Ministry of National Development and Planning
Ministry of Agriculture; Extension Services for Kafue; Office for Central Zambia	Ministry of Fisheries and Livestock	Ministry of Community Development and Social Welfare	Ministry of Chiefs and Traditional Affairs
Department of National Parks and Wildlife (DNPW) of the Ministry of Tourism and Arts	Ministry of Health; Radiation Protection Authority	Other national, provincial and district administrative authorities	

KEY STAKEHOLDERS

Regulators

- Zambia Environmental Management Agency (ZEMA)
- Water Resources Management Authority (WARMA)

Industry

- Mining operators
- Representatives from the agro-industry sector in UKRB
- Zambia National Farmers Union

Traditional authorities and/or community representatives

- Village Management Committees, traditional authorities and other community representatives
- Fishers and fisheries management committees
- Farmers and farmer associations' representatives
- Water users' associations, Joint Forest Management Committees and Community Resources Boards

KEY STAKEHOLDERS

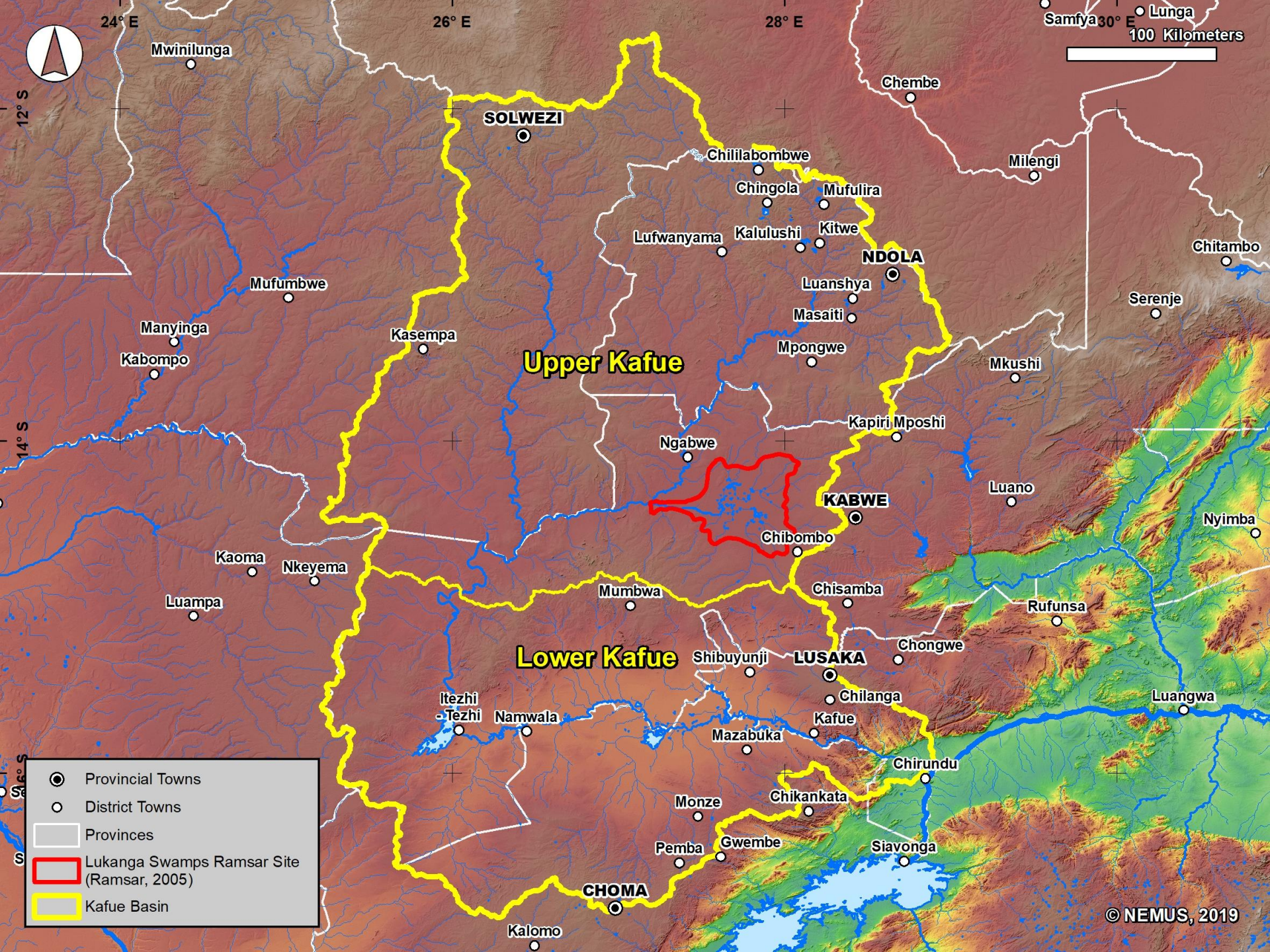
Civil society in general, NGOs, academic and research institutions

The Nature Conservancy (TNC)	WWF Zambia	Action Aid Zambia	Zambia Climate Change Network
Zambia Land Alliance	Agricultural Consultative Forum (ACF)	University of Zambia; Institute of Economic and Social Research; School of Mines	Zambia Institute for Policy Analysis and Research
Zambia Community Based Natural Resource Management (CBNRM) Forum	BirdWatch Zambia	Copperbelt university	Mulungushi University (Kabwe)

3 – Background

KAFUE RIVER BASIN

- Longest and largest river that flows entirely within Zambian territory
- One of Zambia's six major catchments
- 6,6 million people (~50% Zambia population)
- Plays a central role in Zambia's economy: most of the commercial and domestic water use activities
- Water uses: industrial, mining, hydropower, agriculture (irrigation and aquaculture), environmental and recreation
- Subdivided into 2 collective basins:
  - **Upper Kafue River Basin**
  - Lower Kafue River Basin


24° E
26° E
28° E
30° E
12° S
14° S
16° S
100 Kilometers
Mwinilunga
Samfya
Lunga
Chembe
SOLWEZI
Chililabombwe
Milengi
Chingola
Mufulira
Lufwanyama
Kalulushi
Kitwe
NDOLA
Chitambo
Mufumbwe
Luanshya
Serenje
Manyinga
Masaiti
Kasempa
Kabompo
Upper Kafue
Mpongwe
Mkushi
Kapiri Mposhi
Ngabwe
Luano
KABWE
Nyimba
Chibombo
Kaoma
Nkeyema
Chisamba
Mumbwa
Luampa
Rufunsa
Chongwe
Lower Kafue
Shibuyunji
LUSAKA
Itezhi - Tezhi
Chilanga
Luangwa
Namwala
Kafue
Mazabuka
Chirundu
Chikankata
Monze
Pemba
Gwembe
Siavonga
CHOMA
Kalomo
Provincial Towns
District Towns
Provinces
Lukanga Swamps Ramsar Site (Ramsar, 2005)
Kafue Basin
© NEMUS, 2019

LUKANGA SWAMP

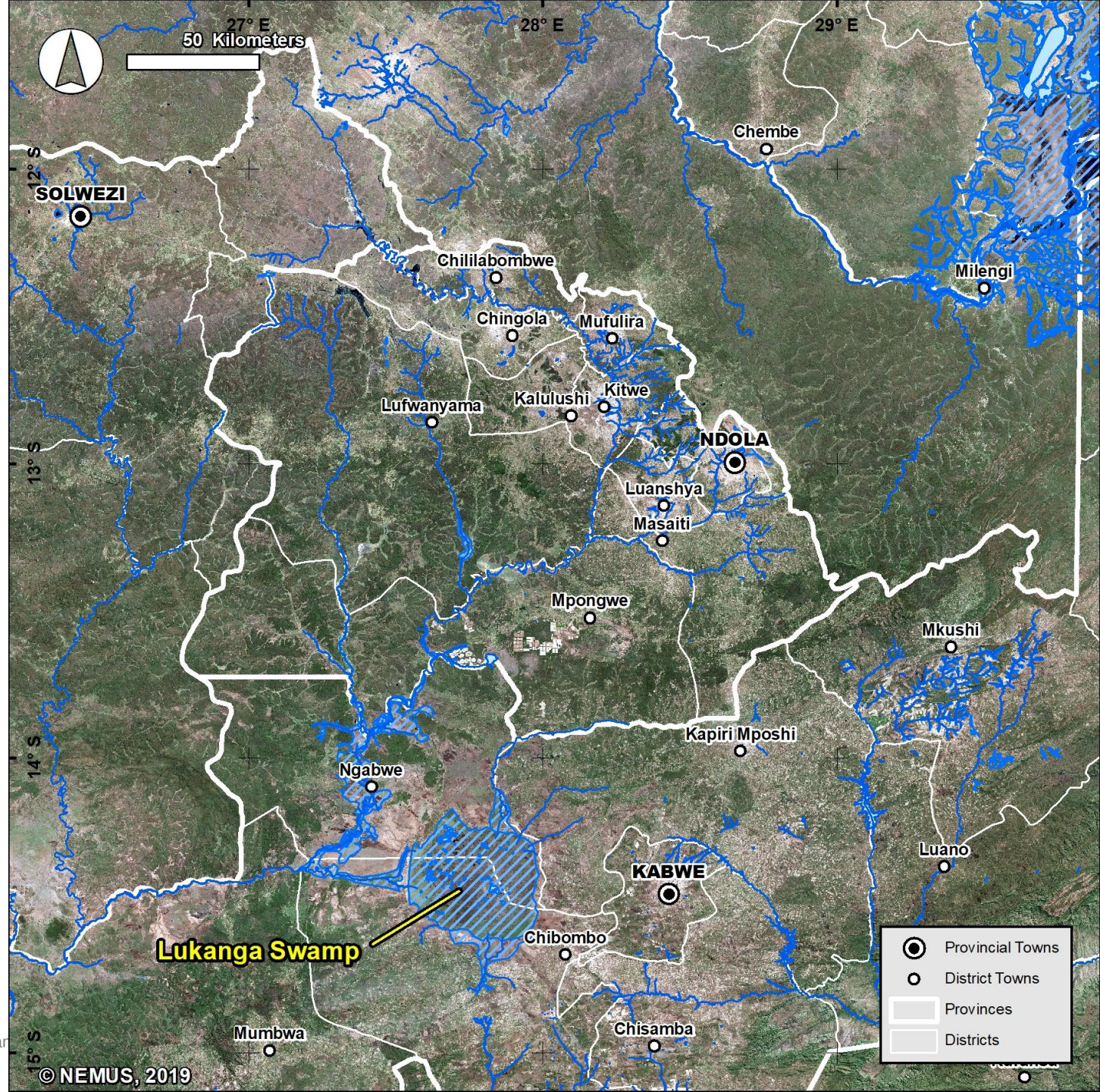
Lukanga Swamp develops in a shallow circular depression:

- 1.5 m average depth
- max. 6.1 m of water depth

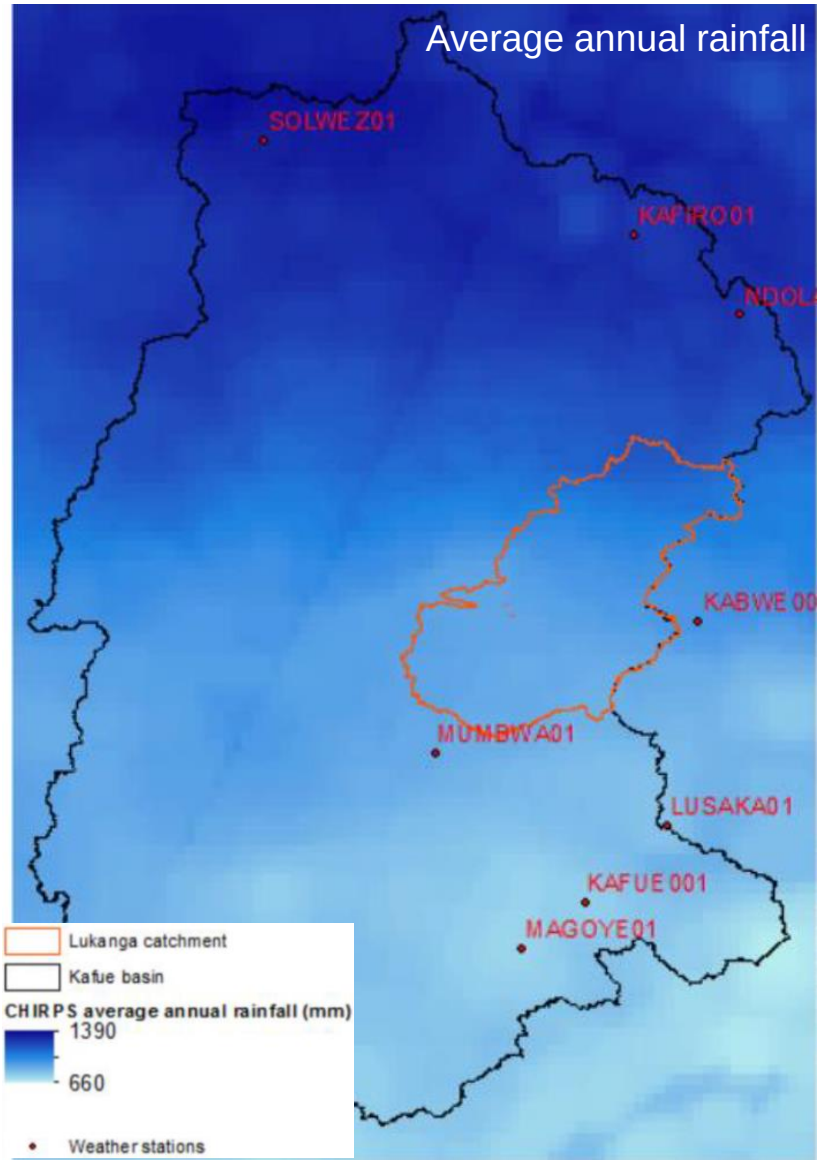
Largest permanent water body of the basin

Diameter: 40-50 m

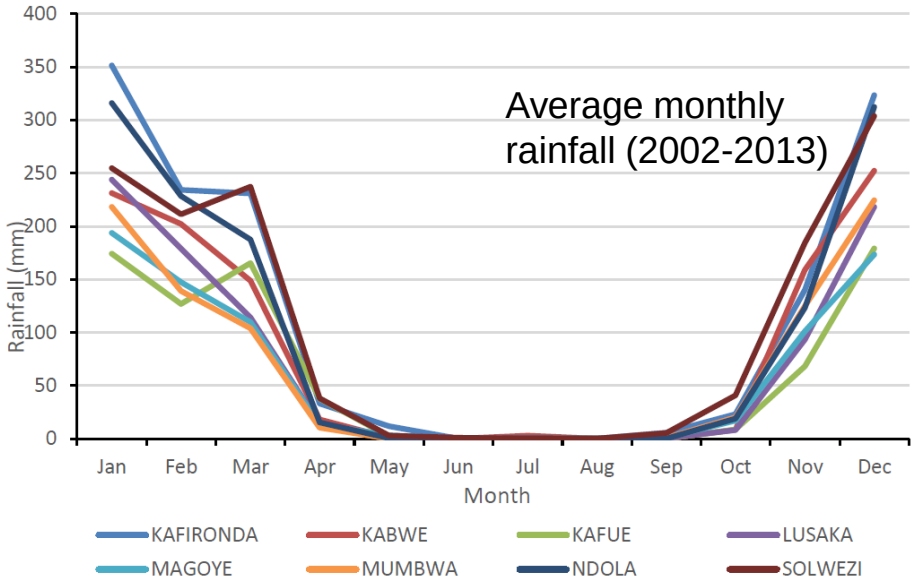
Area: 2,500 (low water) to 2,600km^2 (high flood level)



CLIMATE AND HYDROLOGY
Rainfall



Very pronounced dry and wet seasons



Source: *Hidrologycal evaluation and ecosystem valuation of the Lukanga Swamps; Final Report Jan.2017*

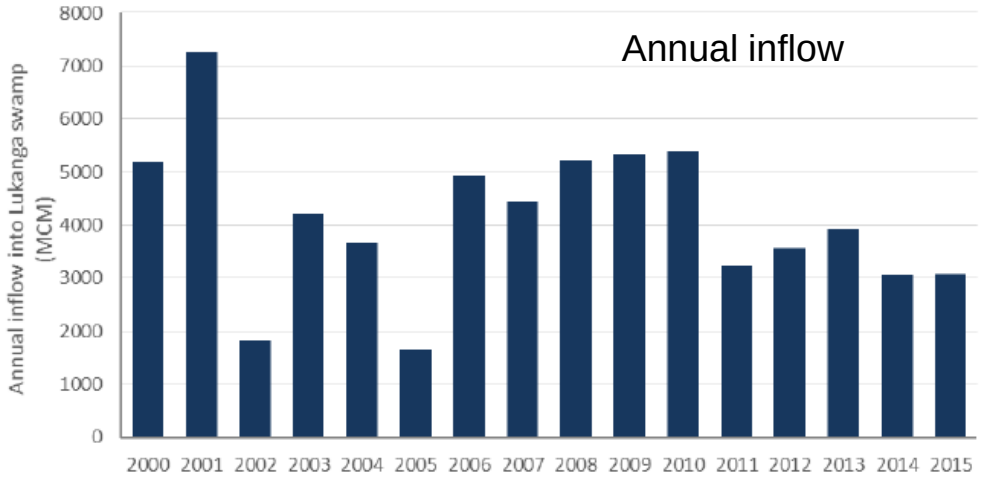
CLIMATE AND HYDROLOGY
Average inflow

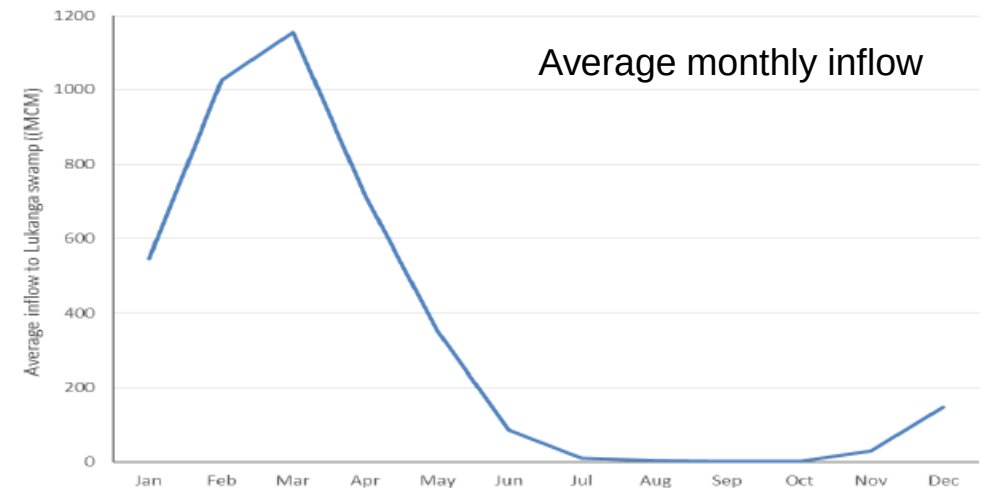
→ High annual inflow variability

The Lukanga Swamp acts as a nature-based reservoir in the Kafue river basin

- Retains water in wet periods
- Releases it slowly during the dry season and dry years

<u>Very important for downstream water users in the Kafue River Basin</u> (Lusaka water supply, hydropower, Kafue Flats)

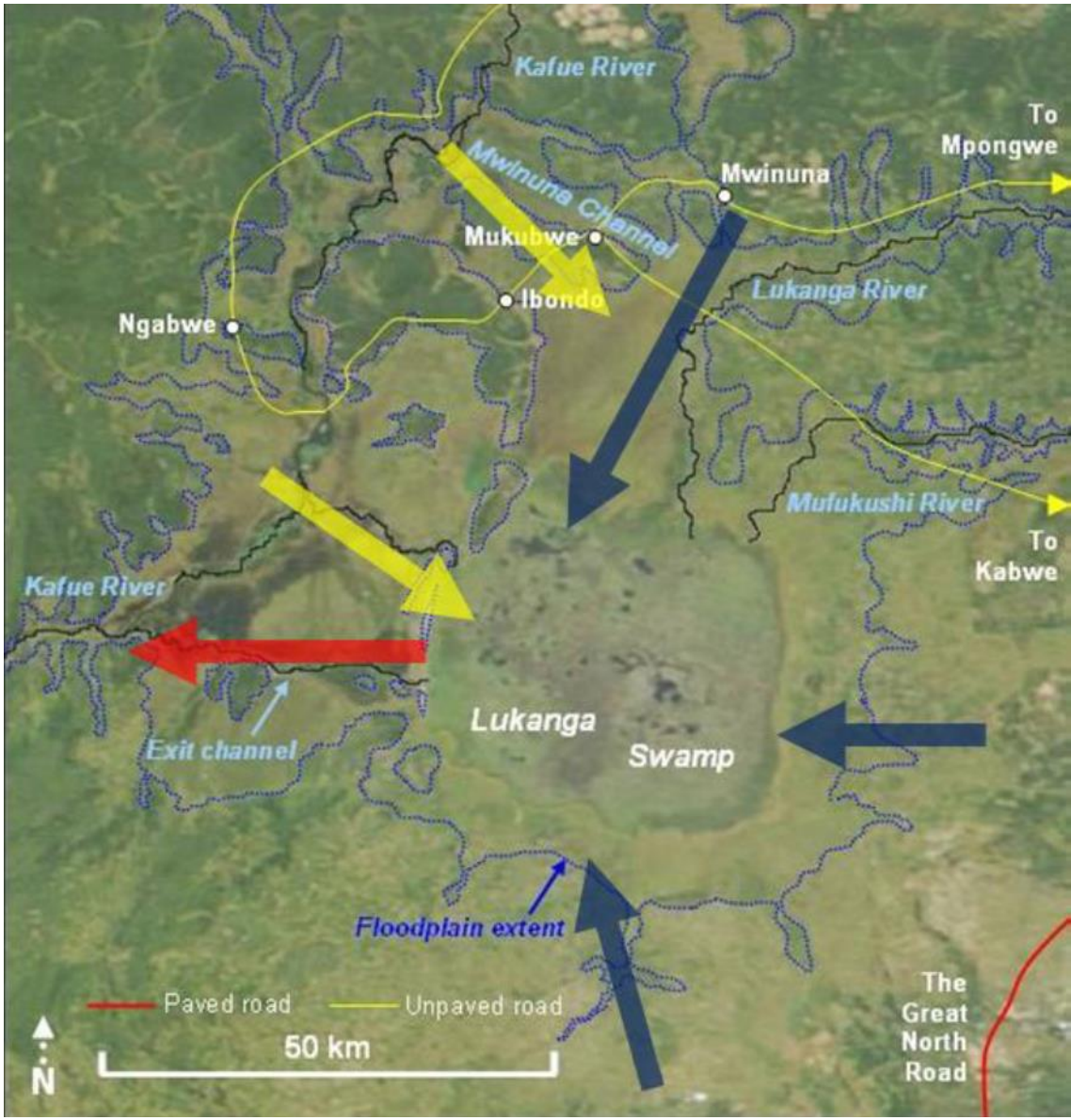




Source: *Hidrologycal evaluation and ecosystem valuation of the Lukanga Swamps; Final Report Jan.2017*

CLIMATE AND HYDROLOGY
Water Balance

←	Streamflow	Water inflow from the Lukanga watershed
←	Overflow	Occasional surface overflow from Kafue during flood events, and subsurface flow from the Kafue river floodplain to the Lukanga swamps
←	Outflow	Flow leaving swamp through exit channel to Kafue and subsurface flow between Kafue alluvial subsurface and swamp subsurface

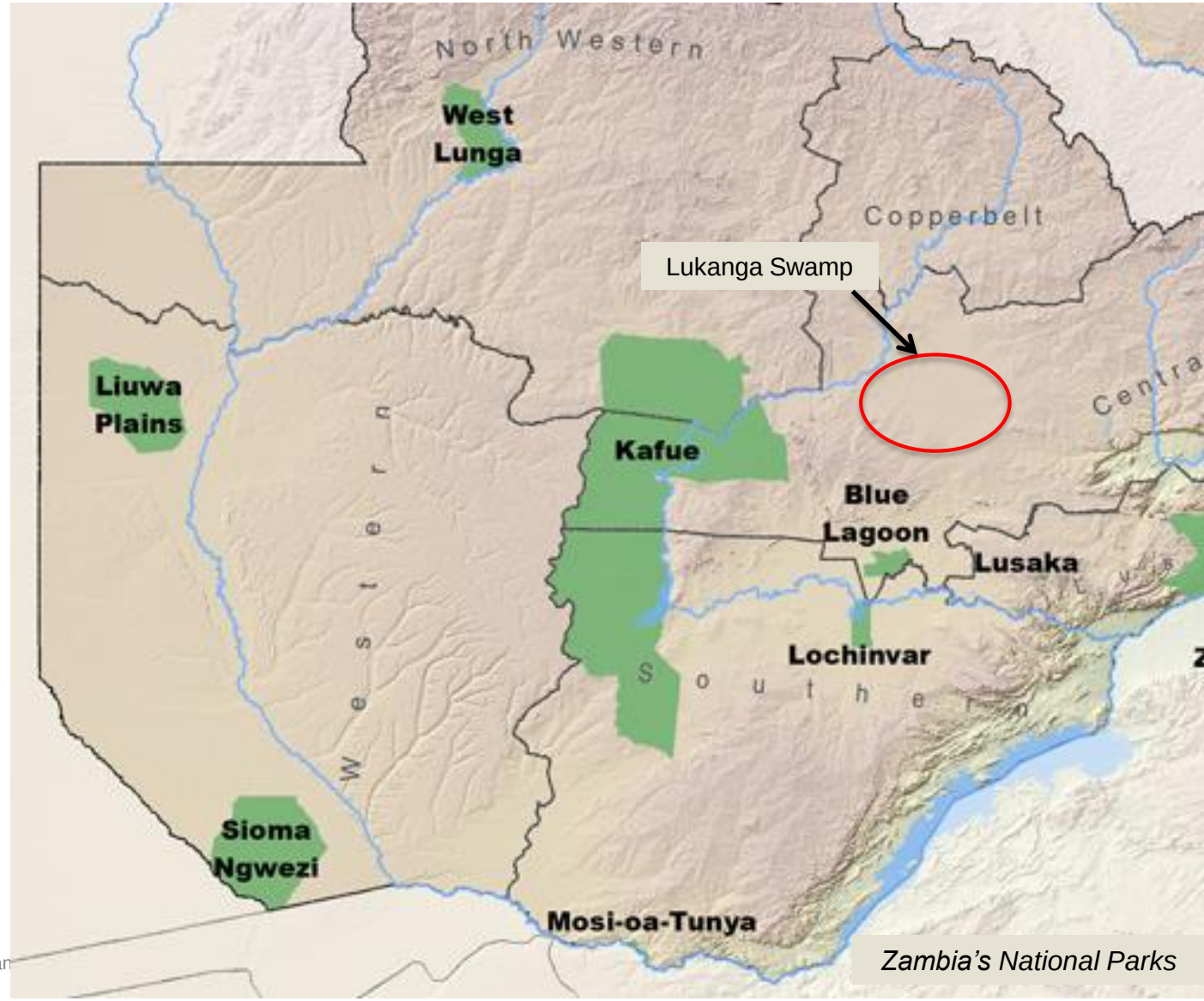


BIODIVERSITY
Ecological value

Ramsar site since 2005 (Ramsar Convention on Wetlands)

Important Bird Area (by BirdLife International)

100km East of <u>Kafue National Park</u>



Zambia's National Parks

BIODIVERSITY
Wetland ecosystems

Two major ecological types:

- **Palustrine (marsh): 95%**
  - permanent swamp, termitaria grasslands, and dambos
- **Lacustrine (open water): ~5%**
  - permanently inundated

Ecological status:
<u>potentially threatened</u>



Example of a palustrine wetland in Lukanga Swamp

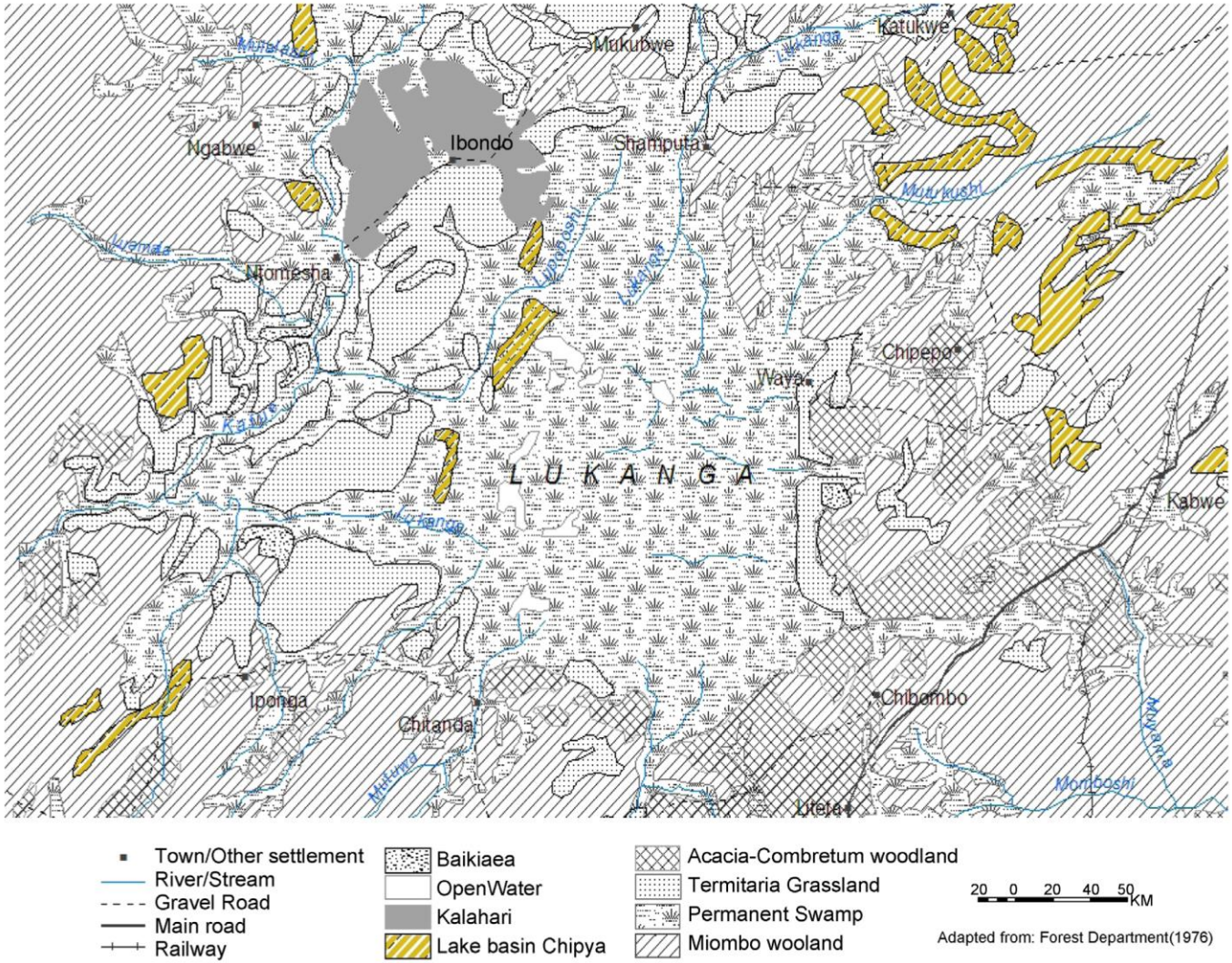


Arrival at a lacustrine environment of Lukanga Swamp

BIODIVERSITY
Habitat types

Eight habitat types:

1. Miombo woodland (main habitat)
2. *Acacia-Combretum* woodland
3. *Baikea* woodland
4. Kalahari
5. Lake basin Chipya
6. Termitaria grassland
7. Permanent swamp
8. Open water


Mukubwe
Katukwe
Ibondo
Ngabwe
Shamiputa
Mumbeshi
Mumbeshi
Mumbeshi

BIODIVERSITY
Fauna

Reptiles:
- *Crocodylus niloticus* (Nile crocodile)
- *Python sebae* (African python)

Amphibians:
- *Bufo lemairi* (yellow swamp frog)
- *Bufo regularis* (square marked toad)
- *Xenopus laevis* (clawed frog)
- *Pyxicephalus adspersus* (African bullfrog)

Birds (at least 316 species)*:*
- *Grus carunculatus* (Wattled crane)
- *Balearica regulorum (*Crowned/ Crested Crane)
- *Anastomus lamelligerus* (Openbilled stork)
- *Ephippiorhynchus senegalensis (*Saddle billed stork), etc.


Nile Crocodile


Crowned/ Crested Crane

Source: *Information Sheet on Ramsar Wetlands (RIS): Lukanga Swamps; 2005*

Note: red marks endangered species

BIODIVERSITY
Fauna

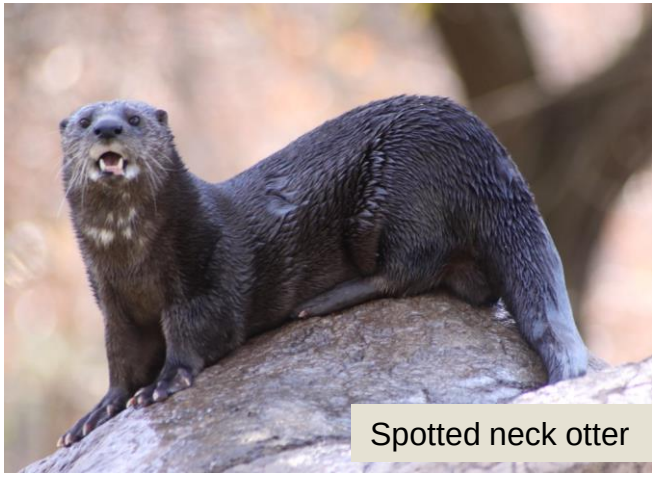
Mammals:

- *Tragelaphus spekei* (sitatunga)
- *Kobus leche* (Red Lechwe)
- *Redunca arundinum* (reedbuck)
- *Ourebia ourebi* (Oribi)
- *Felis caracal* (Caracal)
- *Felis serval* (Serval cat)
- *Lutra maculicollis* (spotted neck otter)
- *Aonyx congicus* (Clawless otter)
- *Atilax paludinosus* (Marsh mongoose)

Fish:

- *Tilapia*
- *Cichlids*
- *Serranochromis*
- *Characidae*
- *Claridae*


Red Lechwe


Spotted neck otter

Source: *Information Sheet on Ramsar Wetlands (RIS): Lukanga Swamps; 2005*

Note: red marks endangered species

BIODIVERSITY
Flora

- *Phragmites spp.*
- *Typha spp.*
- *Vossia cuspidata*
- *Nymphaea spp.*
- *Aeschynomene*
- *Cyperus papyrus*



Phragmites spp.



Nymphaea spp.



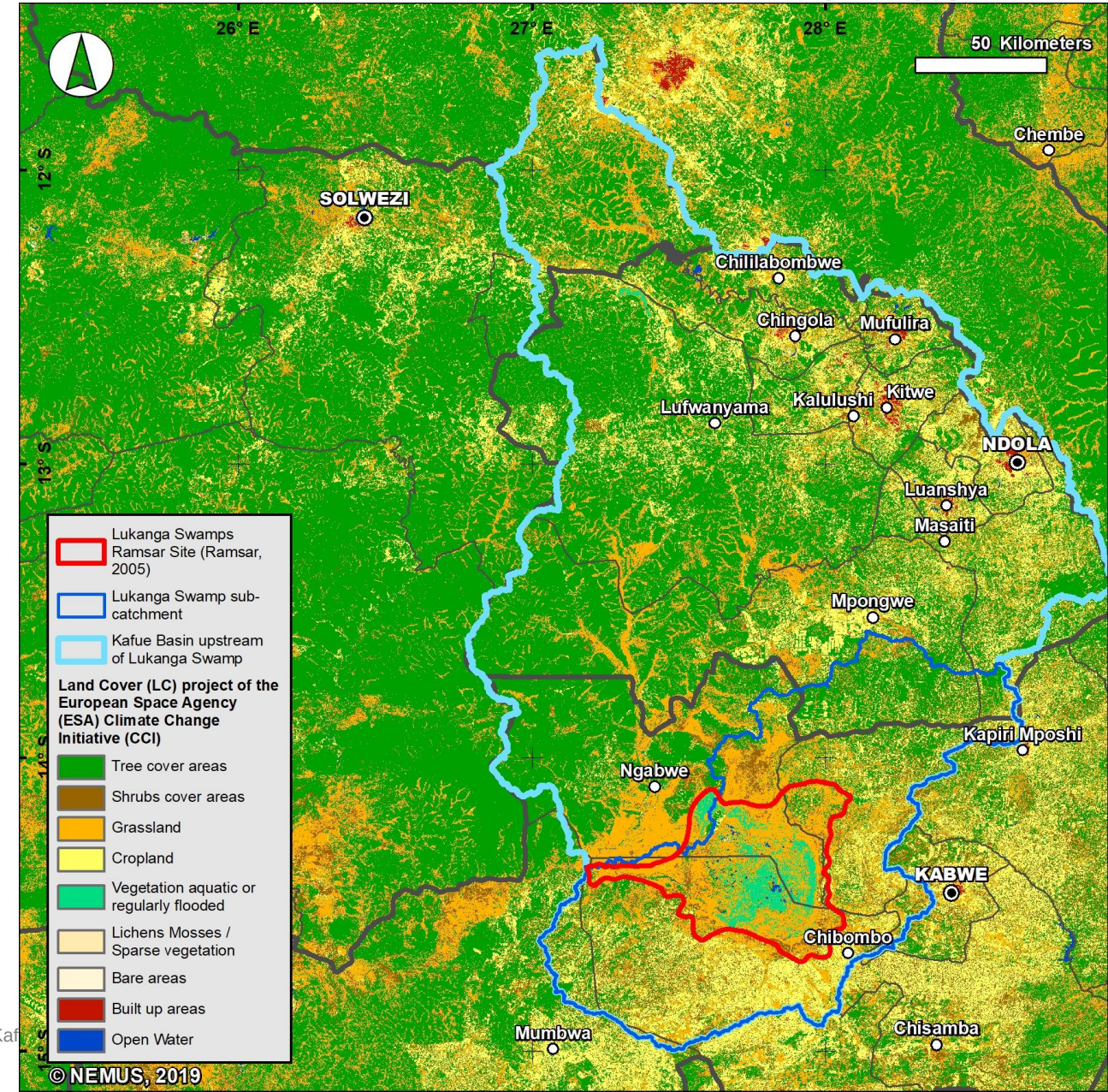
Typha spp.

Source: *Information Sheet on Ramsar Wetlands (RIS): Lukanga Swamps; 2005*

LAND USE AND SOCIOECONOMIC DINAMICS

60,000 people live in the wetland or nearby

Demographic projections show the growing trend will slow down for some districts (Chibombo, Kabwe, Kapiri Mposhi) from 2020 to 2035



LAND USE AND SOCIOECONOMIC DINAMICS

nemus

Population projections for Central Province districts crossed by Lukanga Swamp (2011-2035)

Province District	Population			Projected Annual Population Growth Rate	
	2011	2020	2035	2011-2020	2020-2035
Central Province	1,355,775	1,734,601	2,565,450	2.5%	2.5%
Chibombo District	156,708	194,778	271,991	2.2%	2.1%
Kabwe District	101,599	113,993	133,547	1.3%	1.0%
Kapiri Mposhi District	131,088	167,744	245,952	2.5%	2.4%
Mumbwa District	117,658	163,870	275,504	3.3%	3.3%
Ngabwe District	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Adapted from Zambia Population and Demographic Projections 2011-2035 (CSO, 2013).

Ecosystem services

Provisional services:

- Fisheries
- Water for consumption and irrigation
- Livestock grazing grounds
- Fuel wood
- Charcoal

Regulatory services:

- Climate regulation
- Carbon sequestration
- Water purification



Fishermen in the Lukanga Swamp



Livestock grazing grounds in the wetland area

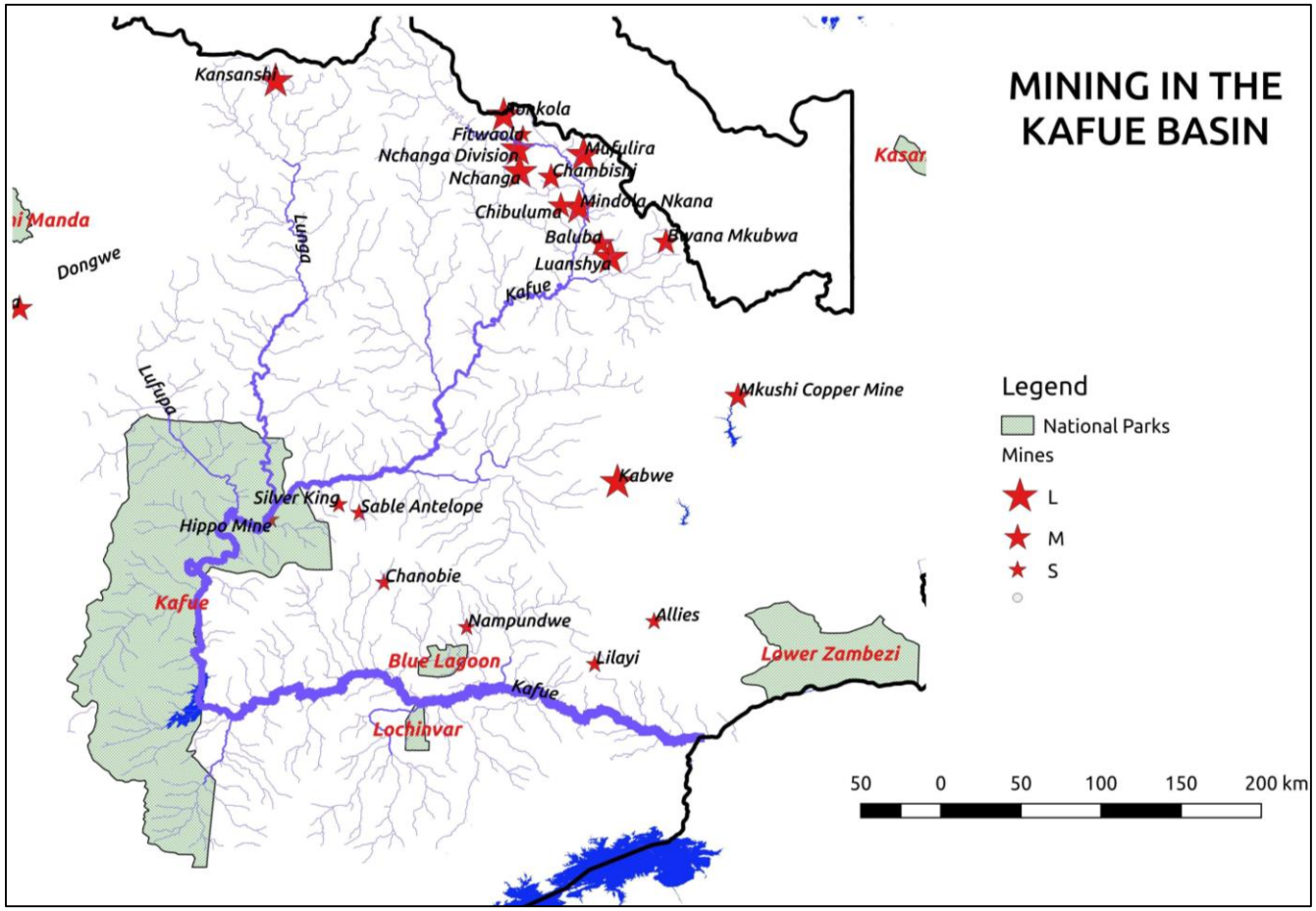


Gathering wood for a fish drying camp

ENVIRONMENTAL AND SOCIAL IMPACTS

The **Lukanga Swamp** functions as a major sediment, nutrient and pollutants trap, alleviating degradation of the downstream basin

Most of the mines of the Zambian Copperbelt lie within the headwaters of the Kafue River



Extractive industry in the Copperbelt Province



Mopani Copper Mine, Mufulira



Konkola Copper Mines, Chilabombwe
(1 of the 4 largest mining companies in Zambia)

Extractive industry in Zambia

Zambia is one of the largest producers and exporters of copper in Africa

The mining sector accounted for **73% of national exports** revenue in 2016 (**68%** from **copper mining**)

Production:

Commodity	Unit	2016 Production Quantity	2016 Value (US $ million)[1]
Copper	Mt	774,289.80	3,769.16
Gold	Kg	4,543.85	200.19
Zinc	Tonnes	585.00	1.22
Lead	Tonnes	365.00	0.68
Coal	Tonnes	57,293.00	n/a
Emerald and Berl	Kg	71,878.66	n/a
Limestone	Tonnes	3,319,600.00	n/a
Amythest	Kg	1,349,787.00	n/a
Dolomite	Tonnes	1,201,689.00	n/a
Total of the sector			**3,971.25**

n/a: not available

Exports:

	2016 (US $ million)	2016 % Contribution
Metal exports	**4,738.2**	**72.84%**
Copper	4,399.1	67.63%
Cobalt	112.9	1.74%
Gold	191.2	2.94%
Gemstones	28.4	0.44%
Manganese Ores/Concentrates	6.6	0.10%
Zambia Exports (f.o.b)	**6,504.7**	**100.00%**

Source: *9th Zambia EITI Report. December 2018*

ENVIRONMENTAL AND SOCIAL IMPACTS

Extractive industry's main environmental problems:

- **Air pollution** (>98% of the country's SO_2 emissions; PM_{10})
- **Soil contamination** (accumulation of metals – mainly copper & cobalt)
- **Water pollution and siltation** in the Upper Kafue River
- **Geotechnical issues**
- **Land degradation**

	Kitwe	Mufulira	Chingola	Kalulushi	Chililabombwe	Chambishi
Population *	522 000	161 000	210 000	96 000	90 000	11 000
Mining operations	Nkana & Mindolo	Mufulira	Nchanga & Chingola	Chibuluma	Konkola	Chambishi
As (mg/kg)	>5	>5	3	1	0.5	0.5
Co (mg/kg)	>60	>60	>60	35	9	19
Cr (mg/kg)	36	36	36	16	25	16
Cu (mg/kg)	>2200	>2200	>2200	1800	600	300
Hg(mg/kg)	>0.06	>0.06	0.035	0.02	0.02	0.02
Ni (mg/kg)	12	22	7	5	7	5
Pb (mg/kg)	>60	>60	>60	5	5	5
Zn (mg/kg)	>60	>60	>60	20	40	10

* Zambia Central Statistical Office 2010.

Average element concentrations
Green: higher than international guideline values for soil suitable for residential and agriculture;
Blue: likely to also be higher.

Source: Lindahl (2014). *Environmental impacts of mining in Zambia: Towards better environmental management and sustainable exploitation of mineral resources*

ENVIRONMENTAL AND SOCIAL IMPACTS
Kafue river

Between Chingola and Chilabombwe:





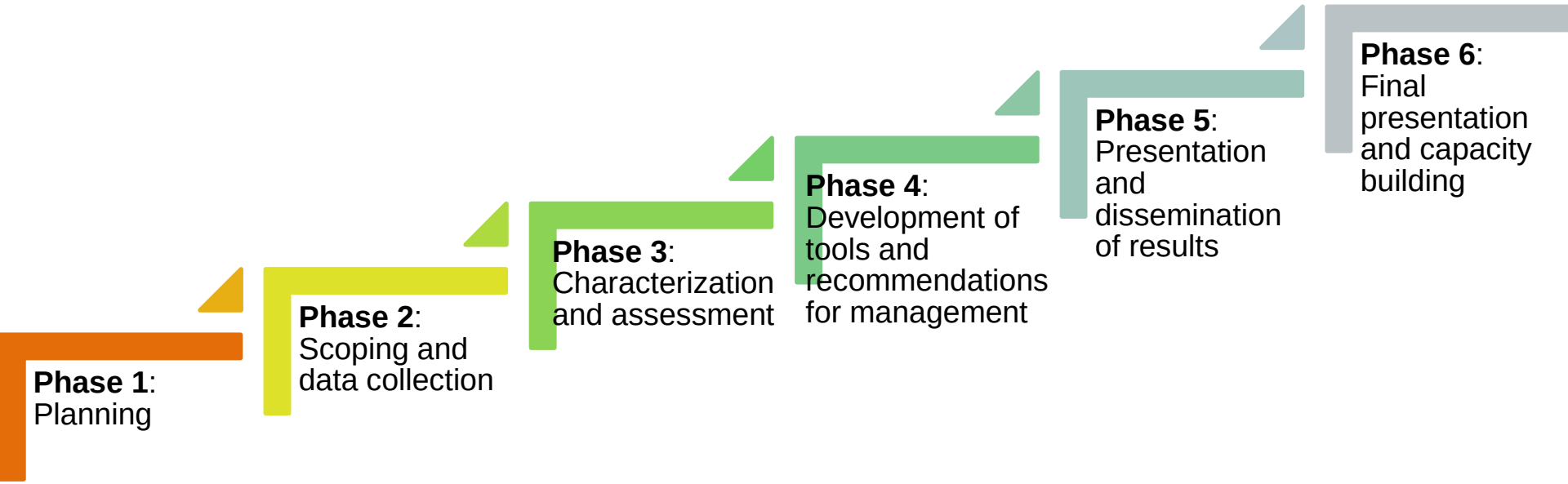


South of Mufulira:



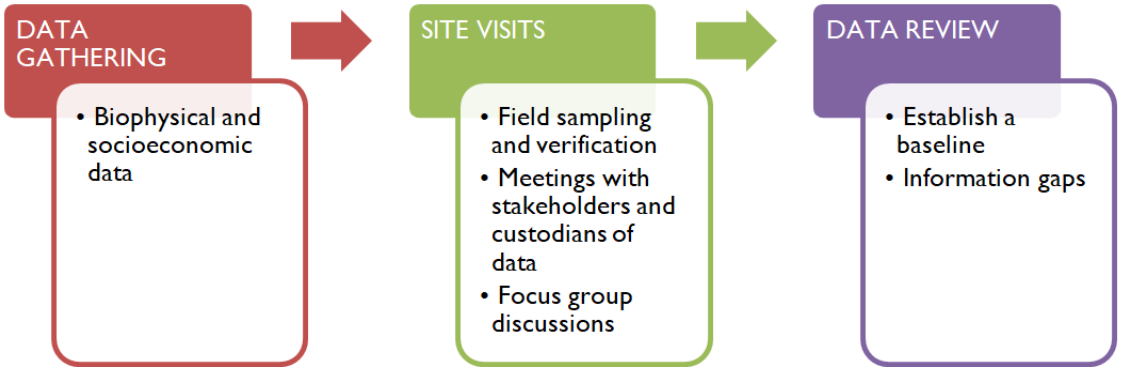
4 – Methodology

CONSERVATION PLAN DEVELOPMENT PHASES



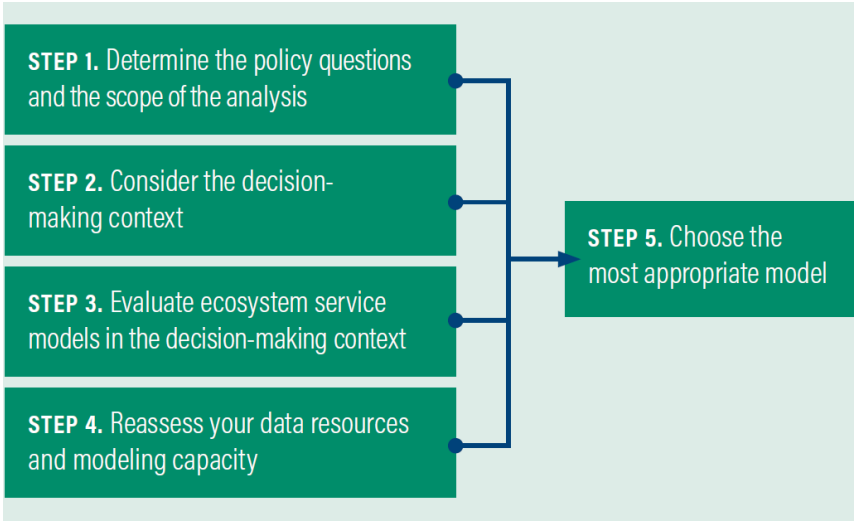
PHASE 2: SCOPING AND DATA COLLECTION

- In-desk data collection
- Assessment of data availability and identification of needs
- Field work
- Stakeholders Consultation Workshop (W1)
- Social surveys
- **Progress report #1 (D2)**
- Definition of ecosystem types and ecosystem assessment
- Selection of ecosystem services, indicators and assessment methods
- **Progress report #2 (D3)**



PHASE 3: CHARACTERIZATION AND ASSESSMENT

- Characterization of the study area's biophysical, socio-economic and governance systems
- Identification of drivers of ecosystem change and impacts
- Ecosystem services assessment (quantification/qualification and valuation), including assessment of future scenarios
- Assessment of the study's progress and further data needs
- **Progress Report #3 (D4)**



Model selection framework (assessment of future scenarios)

PHASE 4: DEVELOPMENT OF TOOLS AND RECOMMENDATIONS FOR MANAGEMENT

- Assessment of future scenarios
- Decision-making framework
- Revision of the Lukanga Swamp Catchment Management Plan
- Preliminary development of recommendations
- Water Monitoring Programme (WMP)
- Capacity Building Action Plan (CBAP)
- **Progress Report #4 (D5)**
- Stakeholders' consultation workshop (W2)
- **Progress Report #5 (D6)**
- **Draft report (D7)**

PHASE 5: PRESENTATION AND DISSEMINATION OF RESULTS

- Transfer of the data collected throughout the assessment
- Stakeholders consultation workshop (W3)
- Integration of commentaries and remarks
- **Final Report (D8)**

PHASE 6: FINAL PRESENTATION AND CAPACITY BUILDING

- (S1) Seminar
- (T1) Course on the application of the modelling tool
- (T2) Course on the implementation of the monitoring programme
- Distribution of awareness raising resources among key stakeholders and managers
- Distribution of capacity building resources among managers

5 – Work Plan

WORK PLAN

	Phase1	Phase 2	Phase 3
Objective	Planning	Scoping and data collection	Characterization and assessment
Duration	One and a half (1,5) months	Four and a half (4,5) months	Three (3) months
Deadline	One and a half (1,5) months	Six (6) months	Nine (9) months
Milestones	(M1) Meeting 1 – kick-off meeting	(W1) Stakeholders consultation workshop (M2) Meeting 2	Characterization of the study area Assessment
Deliverables (and delivery dates)	(**D1**) **Inception Report** (month 2)	(**D2**) **Progress report #1** (month 3) (**D3**) **Progress report #2** (month 6)	(**D4**) **Progress report #3** (month 9)

WORK PLAN

	Phase 4	Phase 5	Phase 6
Objective	Development of tools and recommendations for management (integration)	Presentation and dissemination of results	Final presentation and capacity building
Duration	Eight (8) months	One (1) month	One (1) month
Deadline	Sixteen (16) months	Seventeen (17) months	Eighteen (18) months
Milestones	(W2) Stakeholders consultation workshop (M3) Meeting 3	(W3) Stakeholders consultation workshop (M4) Meeting 4	Milestones: (M5) Meeting 5
Deliverables (and delivery dates)	(**D5**) **Progress Report #4** (month 12) (**D6**) **Progress Report #5** (month 15) (**D7**) **Draft Report** (month 16)	(**D8**) **Final Report** (month 17)	-

WORK SCHEDULE

PHASES	2019		2020		2021	
	OCT	FEB	MAY	DEC	JAN	FEB
Phase 1 – Planning	D1					
Phase 2 – Scoping and data collection		D2 D3				
Phase 3 – Characterization and assessment			D4			
Phase 4 – Integration				D5 D6 D7		
Phase 5 – Presentation					D8	
Phase 6 – Capacity building						

(D1) Inception Report
(D2 to D6) Progress Reports
(D7) Draft Report
(D8) Final Report

STAKEHOLDER ENGAGEMENT

Stakeholder Consultation Workshops	To discuss critical steps of the assignment among key stakeholders and obtain contributions
Interviews	To present the assignment and gather concerns regarding the sustainable development of Lukanga Swamp
Focus group discussions	To get a deeper understanding of the communities living within the catchment area
Seminar	To present the Final Report and inform a broader audience of the assignment's main results



Focus group discussion held by Nemus at Tanganyika's lakeshore community of Chisanza

STAKEHOLDER ENGAGEMENT

Workshop 1-2 Oct.-Nov. 2019	• Presentation of the scope of the assignment; stakeholder engagement for cooperation
Workshop 3 Aug. 2020	• Presentation and discussion of the management recommendations
Workshop 4 Dec. 2020	• Presentation and discussion of the Draft Report



Workshop held by LTDP and Nemus at Mpulungu

THANK YOU!

ZIKOMO!

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Conservation Plan for Lukanga Swamp and Upper Kafue Basin

Workshop 2 – Kitwe, 1st November 2019

Topics for debate

1. Environmental impacts in Lukanga Swamp and Upper Kafue Basin
2. Social and economic impacts in Lukanga Swamp and Upper Kafue Basin
3. Main drivers for change for Lukanga Swamp and Upper Kafue Basin

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Appendix 3.3 – Focus group discussions: field form and checklist

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CONSERVATION PLAN FOR LUKANGA SWAMP AND UPPER KAFUE RIVER BASIN

Focus group discussions – field form and checklist

Date: _____/_____/_____

Place / Community: _____

Community group(s) represented: _____

Other participants/represented institutions (ZEMA, etc.): _____

No. of participants: _____

Context

Zambia Environmental Management Agency (ZEMA) awarded NEMUS the development of the Conservation Plan for Lukanga Swamp and Upper Kafue River Basin.

The Conservation Plan for Lukanga Swamp aims to answer the following questions:

- *What are the most significant ecosystem services provided by Lukanga Swamp and how do the local communities depend on them?*
- *What are the drivers of ecosystem change in the Lukanga Swamp, operating both in the swamp and upstream?*
- *How can ecosystem degradation be alleviated and these areas be managed in a sustainable manner?*

In this context, the assignment includes field work and the conduction of interviews and focus group discussions, to involve the relevant stakeholders in the management of the swamp. On behalf of NEMUS, we thank you in advance for all your cooperation.

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1. **Community/group characterization; governance**
    a. How many people have permanent residence in this community?
    b. Are there people from other parts of the country who have come to settle here? Why did they move to this location?
    c. What is the community governance structure and composition?
    d. What infrastructure is in the community? What is functional and what is not?
    e. When/How were the VDCs formed? How many women/men?

2. **Main economic activities undertaken by the community/group**

Depending on the main economic activities undertaken by the community/group, related to the wetland, question groups 2a to 2f may be used.

<u>2a. FISHING</u>

a. What proportion of community members engage with fishing? What about migrants? Is this number increasing?
b. What are the species that are caught? (common and Latin names if possible) Are different species' catches seasonal?
c. What proportion of the catch is consumed locally and what proportion is taken to outside markets? What outside markets/urban centres, is the fish sold at? Do you market individually or as a group?
d. Where are the main fishing areas within the Lukanga Swamp?
e. Past trends in resource availability – have fish yields been declining, maintaining, or improving? Is there an overall trend or do these fluctuate cyclically? Why do you think this is?
f. Fishing gear – what kinds of fishing methods and nets are used?
g. How is the fish stored/preserved for transportation to markets, or within households?
h. Is the annual fishing ban followed? If not, why?
i. What are some of the common constraints affecting the fishing business? And how have you resolved these?

2b. WILD PLANT HARVESTING

a. What plant species are harvested for fibre (grass, leaves, vines, reeds, for construction, for mats, baskets and poles for punting canoes)?
b. What species are harvested for "wild food" (fungi, leaves, nuts, roots, seeds)?
c. What species are harvested for medicinal purposes?
d. Where are the main harvest areas?
e. Who harvests wild plants mainly, permanent residents or migrants?
f. Are these harvested mainly for personal or commercial use? What proportion is sold outside? Where are the main markets/urban centres?
g. Have you noticed of any trends in wild plant availability in the past 5 to 10 years? Have they been decreasing, maintaining or augmenting, and why?

2c. TREE HARVESTING

a. What tree species are cut, and for what?
b. Where are the main harvest areas? Are these managed regularly? How?
c. What proportion of community members engage in this activity? What about migrants?
d. What proportion is used by the household and what proportion is sold? Where are these sold?
e. How has wood resources' availability evolved in the past 5 to 10 years? Has it been decreasing, maintaining or increasing? And why?

2d. AGRICULTURE

a. What proportion of community members own land and cultivate it? How much land per household?
b. What are the main crops cultivated in this community/region? Maize; cotton; groundnuts; pumpkins; sweet potatoes; cassava; sunflowers; soya; vegetables: tomatoes; cabbage; others
c. Is agriculture mainly for personal consumption/subsistence or also for commercial purposes? Typically, what proportion of crop products is consumed locally?
d. Where are crop products sold – which main markets/urban centres?

e. Are there any products added to the crops? (e.g. fertilizers, pesticides)
f. Are crops normally irrigated?
g. What about the burning practice, is it undertaken? If so, how frequently and for what purposes?
h. Are subsidized agricultural products (seeds, fertilizers, pesticides) important for the productivity/maintenance of small-scale agricultural activity in the area? Has land productivity changed since the introduction of these programmes?
i. Any noteworthy past trends or events relating to the agricultural activity around the Lukanga Swamp? (concerns, conflicts, changes in management or in traditional practices, trends in disease, etc.)

2e. LIVESTOCK

a. What proportion of community members have livestock? How many animals per household?
b. What kind of livestock? Cattle; goat; chicken; sheep; pigs; other
c. Is livestock raised for household consumption or for commercial purposes? What proportion each?
d. Where are the livestock-related products sold? What markets/urban centres?
e. How are wetland ecosystems important to livestock? Is dry season grazing and watering important?

2f. HUNTING

a. What animal species are hunted?
b. What proportion of community members engage in hunting? What about migrants? Are hunter numbers increasing?
c. Are hunting products mainly for personal consumption or are these also sold elsewhere? What proportion of each? Where are the main markets?
d. How has hunting resource availability evolved? Are wild animal numbers decreasing, maintaining or increasing? And why?

3. Ecosystem services dependence

Which ecosystem services are used and why are they important? Examples:

Provisioning	**Food** – Production of fish, wild game, fruits and grains	
	Fresh water – Storage and retention of water for domestic, industrial and agricultural use; supply of drinking water	
	Fibers and Fuel – Production of logs, fuelwood, peat and fodder	
	Biochemicals – Extraction of medicines and other materials from flora and fauna	
	Genetic material – Genes for resistance to plant pathogens, ornamental species etc.	
Regulating	**Climate regulation** – Source and sink for greenhouse gases, including carbon; influence on local and regional temperature, precipitation and other climate processes	
	Water regulation (hydrological flows) – Groundwater recharge/discharge	
	Water purification and waste treatment – Retention, recovery and removal of excess nutrients and other pollutants	
	Erosion regulation – Retention of soils and sediments	
	Natural hazard regulation – Flood control and storm protection	
	Pollination – Habitat for pollinators	
Cultural	**Spiritual and inspirational ecosystems** – Source of inspiration; many religions attach spiritual and religious values to aspects of wetlands	
	Recreational – Opportunities for recreational activities such as wildlife tourism	
	Aesthetic – Many people find beauty or aesthetic value in aspects of wetland ecosystems	
	Educational – Opportunities for formal and informal education and training	
Supporting	**Soil formation** – Sediment retention and accumulation of organic matter	
	Nutrient cycling – Storage, recycling, processing and acquisition of nutrients	
	Biodiversity – Wetlands are highly productive and provide a wide range of ecological niches, supporting extensive biodiversity	

4. **Conflicts / malfunctions regarding ecosystem services**
   a. What were the main threats/ drivers of change of wetland ecosystems and resource availability observed in the past 10 years?
   b. What are some of the most common diseases affecting the community? Which of these diseases are seasonal, which months witness more disease outbreaks and why? Which diseases are new in the community?
   c. What are your sources of water for drinking? How has water availability and quality evolved in the past 10 years? Why?
   d. Are there any conflicts between the population and wild fauna? Or other kind?

5. **Community / group acceptance of future conservation efforts**
   a. How does the community/group feel about the possibility that actions to protect the fauna, flora and natural resources have to be enforced? Examples:
      - Fishing restrictions
      - Tree cutting control
      - Reduction of burnings
      - Removal of livestock from lakeside areas
      - Constraints on some crops
   b. Do you have other suggestions on how to alleviate the identified signs of degradation and conflicts/malfunctions?
   c. Other comments or suggestions for the team conducting the Conservation Plan for Lukanga Swamp?

ZAMBIA ENVIRONMENTAL MANAGEMENT AGENCY

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Conservation Plan for Lukanga Swamp and Upper Kafue Basin

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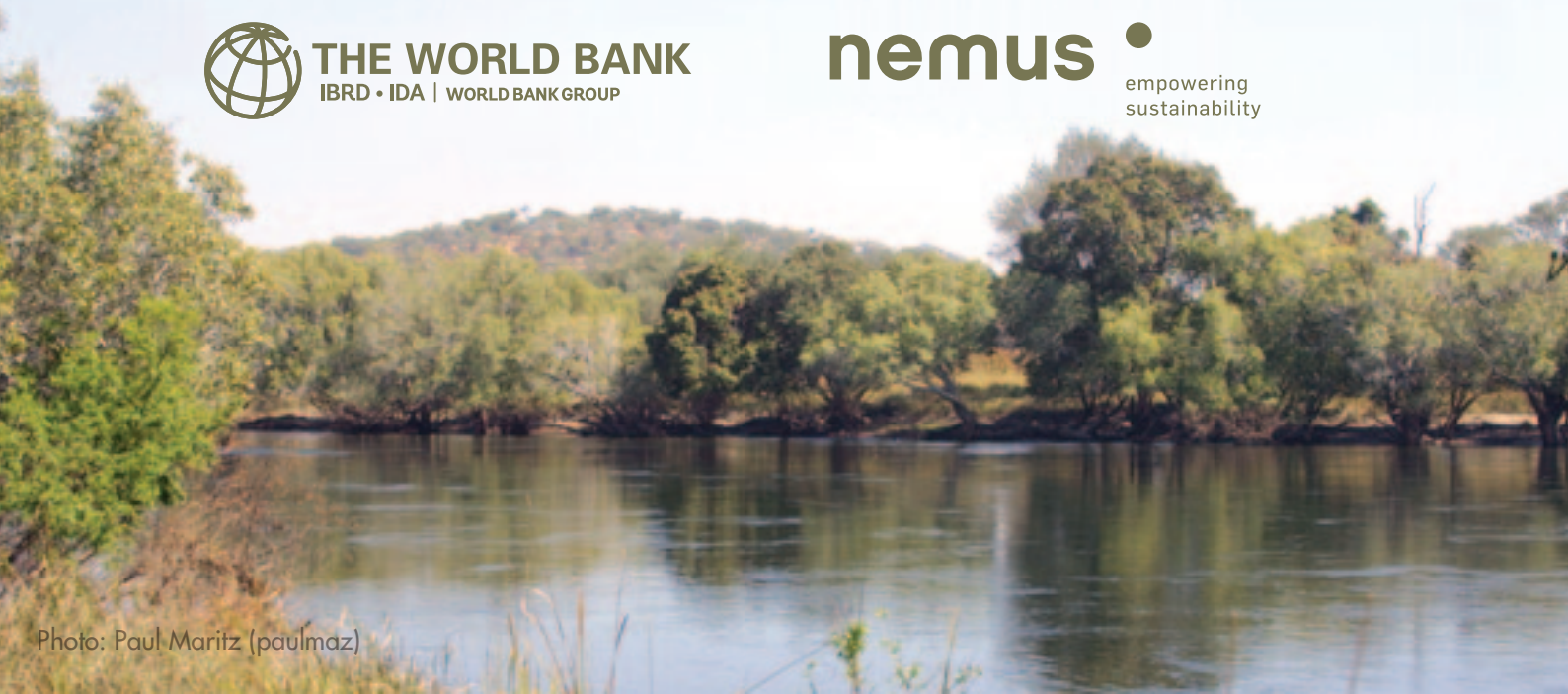


Photo: Paul Maritz (paulmaz)