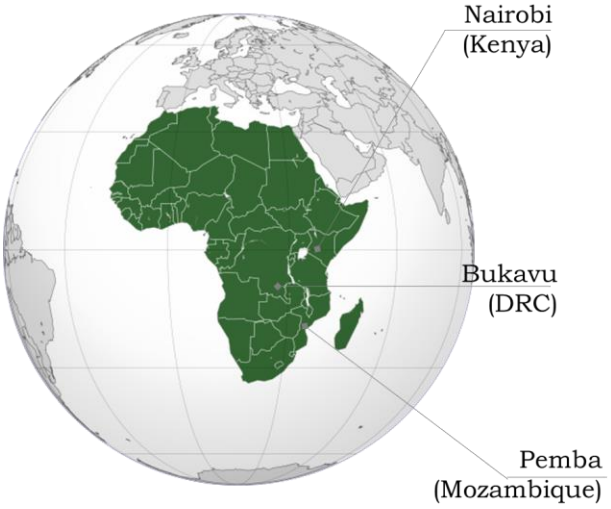
C2M2 Project- Africa Hub



Impact on Business

Impact on Healthcare

Impact on Education

Water Access

Final Report, November 2021

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1. Executive Summary

The COVID-19 impact on the African continent has followed a rather gradual infection rate as opposed to the rapid surges occurring in many other countries. As a result, Africa is a very interesting study case to observe to understand how countries have prepared themselves to handle the pandemic, manage their infection peaks, define, and implement measures to understand the impact on key sectors like education, healthcare, and the economy.

The goal of the Cities' COVID Mitigation Mapping (C2M2) was to provide detailed and useful insight regarding the secondary impacts of COVID-19 in the health-care systems, economy, and social sector in three major African cities: Bukavu in the Democratic Republic of Congo (DRC), Nairobi in Kenya, and Pemba in Mozambique. It was key for the country selection to be able to account for the cultural diversity reflected in the national languages, as well as the countries' experience dealing with major pandemics and their current case ranking in Africa.

The selected cities provided a blend of resources that include established universities, Secondary Cities (2C) project graduates, humanitarian OpenStreetMap teams, youth mappers, Open Cities teams, and government agencies and representatives of the civil society. Working with these teams facilitated access to existing data and local best practices while ensuring the inclusion of all stakeholders to support project objectives including:

- Universities
  They were strategic partners with a large resource pool and the potential to ensure project sustainability.
- Secondary Cities (2C) project graduates
  Cities that were part of the 2C project have a good set of geospatial data that was used to fast track the project execution. In addition, they are either part of/or already working with local universities on GIS projects.
- Humanitarian OpenStreetMap
  HOT is an international team dedicated to humanitarian action and community development through open mapping. They have mapped most target countries and cities. Their data is critical to reducing the information gap.
- Youth mappers
  They are university chapters' driven groups that work on addressing the need for geospatial data beyond the urgency of disaster response and planning. They also contribute time and talents to creating data in places of extreme poverty, where USAID works, to help create fundamental data for programming that addresses chronic development problems.
- Open Cities teams
  They have a large set of data on the Open Street Map (OSM) platform. Their work has been around building data foundational for disaster reduction and recovery by creating open data ecosystems that facilitate innovative, data-driven urban planning and disaster risk management.
- Government Agencies
  Government agencies provide practical insights and real data in the focus areas i.e., healthcare, economy, social.
- Civil Society
  They ensure the project benefits the local population.

2. Driving project success through the hub

The role of the hub is to provide project oversight and facilitate access to resources and best practices to ensure project success. That was achieved through a set of project facilitation, project oversight, and management tasks including:

A. Project Facilitation
   - Facilitate the selection of the sectors to focus on in each country
   - Assist countries in defining metrics that provide a good view of the secondary impacts for the selected sectors
   - Facilitate access to best practices and tools for analytics and decision support to better understand and mitigate the second order impacts
   - Assist cities in compiling recommendations to improve the cities' resiliency
   - Ensure focus remains on agreed upon projects, goals, and priorities
   - Facilitate access to data surrogates
   - Work with local embassies to facilitate access to decision makers and institutions that could benefit from the project outcome.

B. Project Oversight
   - Ensure the project deliverables are met within the defined time and budget
   - Make sure milestones are completed on time and meet expectations
   - Provide hub and project reporting to stakeholders.

C. Project Management
   - Provide project management support to all city projects and use email, video conferencing, and other modern means of communication to support the different projects.

Reporting Framework

The ability to measure the secondary impact of COVID-19 is critical to establish future best practices in the event of public health emergencies and reinforce urban resiliency, especially in emerging countries at city and local levels. One of the challenges while working towards that goal is identifying appropriate social metrics that can be used to track progress, identify gaps, and provide a benchmark to compare statuses across regions and nations.

To make decisions that effectively mitigate the social impact of COVID-19, reliable, up-to-date data is required i.e., availability of health services, their capacity, and preparedness to deliver services. For example, during the height of the pandemic, settlements in Kenya were in such high demand for water that scarcity became a genuine issue for many inhabitants of those areas. With the proper social metrics put in place, this water shortage can be assessed with previous population and demographic data. For example, interactive dashboards and maps that identify service and resource gaps can be used to inform policymakers on how/whether to best address the issue.

To achieve these benchmarks, however, ensuring the proper and appropriate collection of data is most important, and it can be whittled down to metric definition, collection methodology, and practical use. For instance, Bukavu has become a hub of not only COVID-19 cases but a hub of information throughout

this pandemic. Since it is important that the data collected now would establish a baseline for service availability, capacity, and readiness for comparison in the future, it's important to create a framework that addresses the specific needs of the information being collected and the individuals it is being collected from. Since each country had a different focus for the C2M2 project, the hub defined the following framework for data collection. Using measurement objectives that are relevant to the specific country project, the teams were able to define standardized metrics that enabled them to quantify second order impacts of COVID-19 and make recommendations.

Perspective	Strategic Objectives	Measurement objectives	In scope City
Pandemic	Understand the current state of the pandemic	COVID-19 stats	Bukavu, Nairobi, Pemba
Health	Impact of waterborne diseases	Access to drinking water	Nairobi
	Mitigate the impact on care and access to care	Access to care	Bukavu
		Reduce the impact of pandemics	Bukavu, Nairobi, Pemba
		Improve preventive care	
Education	Mitigate the impact on education	Access to education	Bukavu, Nairobi, Pemba
		Quality of education	
Economy	Mitigate the economic impact	Impact on local economy	Bukavu, Pemba
		Mobility	
		Economic health	Pemba
		Personal finances	Pemba
		Access to food	Bukavu, Pemba

Table 1: The metrics framework for all cities projects

Standardized metrics provided a common denominator for benchmarking and comparisons. The team blended C2M2-defined metrics and some metrics from the United Nation's Sustainability Development Goals 3,6 and 11. Once the metrics were finalized, the hub provided a data model defining the structure of data and best practices on how data should be collected, stored, and exchanged. The data collected was to be grouped into 3 categories: base, static and dynamic. The type of data determined how it was collected and at what frequency.

- Base Data Attributes– These are data attributes that are common to all points of interest. These typically include identity and location information like name, address, zip code, and latitude/longitude of school, hospital or water point so it could be mapped correctly. This is a fixed set.
- Static Data Attributes – Static attributes are data that are mostly common to all points of interest with values that change very infrequently. These include, facility's operating hours, primary water and power source, etc. The

information collected about the primary water and power sources can be used to track second order impacts like (#clean water points, sanitation).

- Dynamic Data Attributes – Dynamic attributes are associated with a specific category and facility type that change over time. This may include current inventory of goods (used to track economic impact and availability of basics goods) and available capacity of services (i.e., number of students per classroom, number of doctors in a hospital, bed availability in a hospital).

Accurate data collection is key to maintaining the integrity of the metrics and the dashboards. A formal data collection process ensures that the data collected is consistent and accurate. This process also requires tools to collect the different of data attributes and to present that information in a way that could be used by residents, public service institutions, and officials both at the local and national levels for decision support.

Technology Framework

The figure below reflects the end-to-end framework used for data collection, visualization, and analysis.

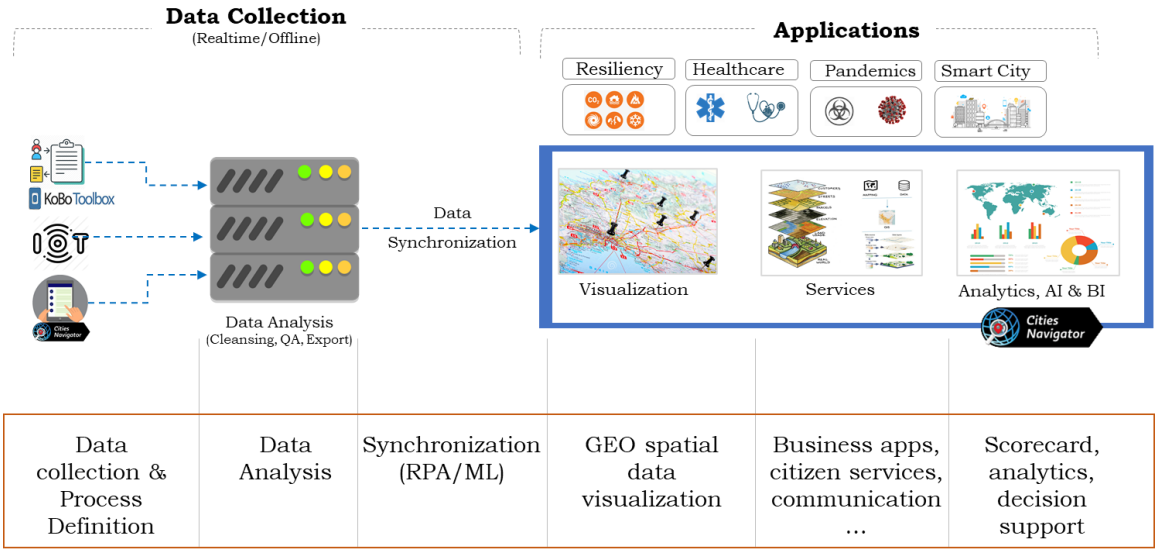

Figure 1: The technology framework

Data collection

The data collection was done using the Kobo Toolbox. This tool enables online and offline data collection hence making it possible to collect data were there is limited to no internet access. Using Kobo Toolbox, the hub created forms to collect data i.e., hospitals, schools, water points, business, …. The collected data was then uploaded to the Kobo Toolbox servers. The platform provides features for checking the consistency and completeness of collected data so it could be ingested in visualization and dashboarding platforms. Each team sent data collectors to each of the points to collect dynamic data monthly. This was done in collaboration with either an employee of the facility or someone with the agency and authority to record the dynamic data about a facility on a periodic basis.

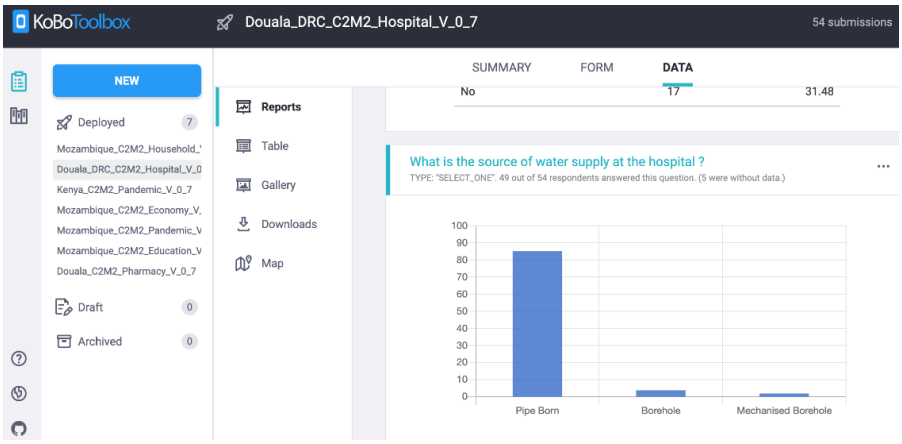

Figure 2: The Kobo Toolbox interface

Analytics and Dashboards

The hub suggested different platforms for data visualization and dashboarding i.e., QGIS, ArcGIS, Cities Navigator, an application that was created during the Secondary Cities project. It is a mobile application that allows governments and cities to improve their resilience and preparedness for emergencies. It includes a mass communication application, navigation capabilities and online citizen services. It is being adopted in Bukavu and Pemba. It provides live dashboards with actionable insights i.e.,

- Trend charts for availability of hospital beds, doctors, patients, and medicines over time by region
- General health indexes – patients by population and chronic medications by population; these indexes can be used to track progress of UN SDG 3 and to check secondary effects of COVID-19
- Epidemic preparedness – availability of vaccines

The figure below shows the summary data for the health category for Bukavu.

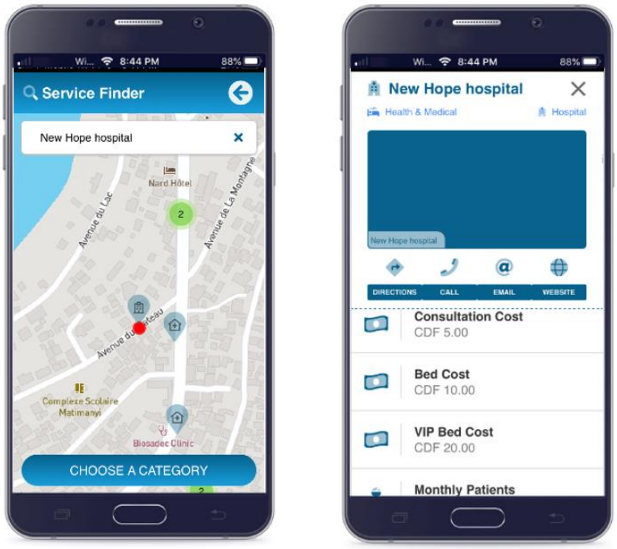

Figure 3: Cities Navigator mobile app

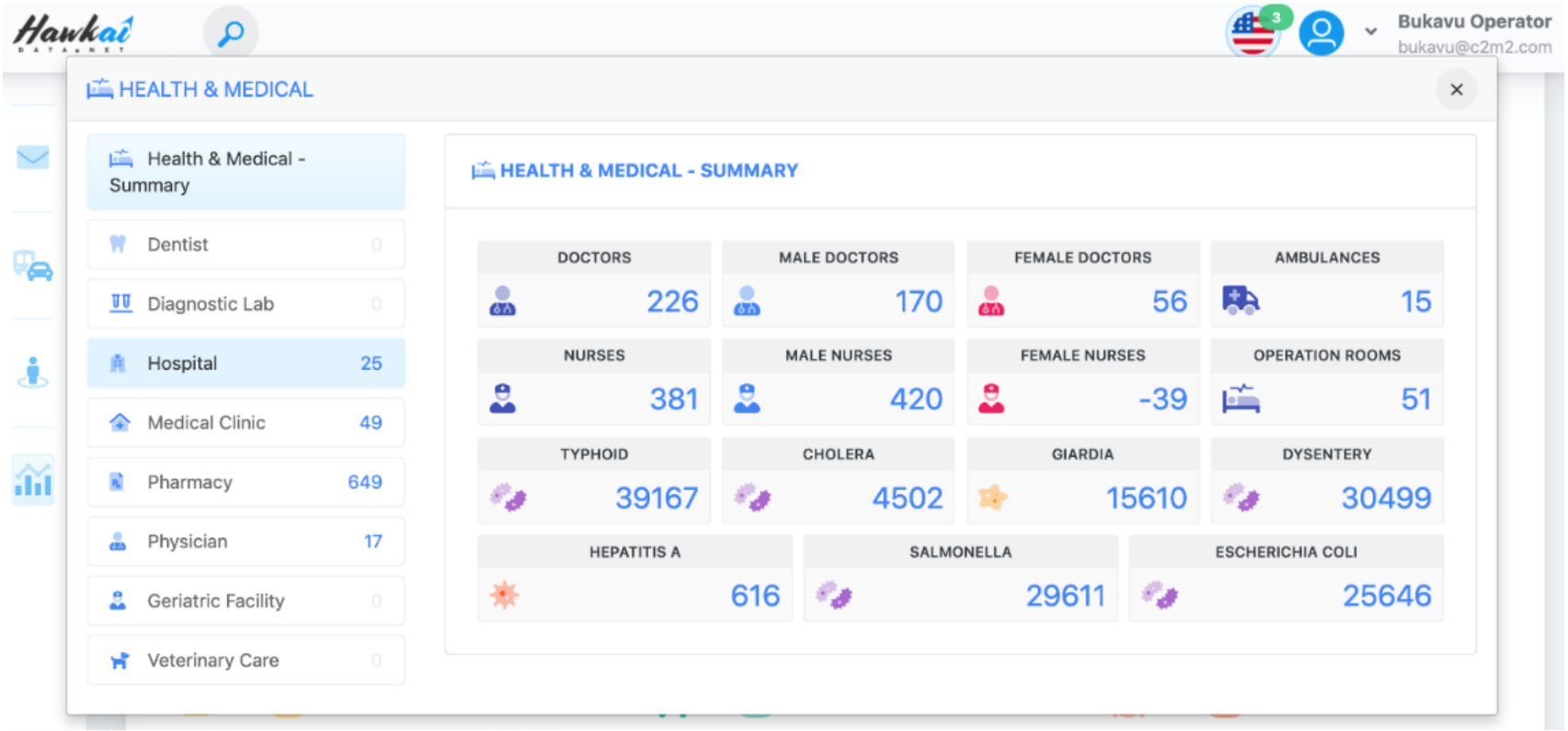

Figure 4: Dashboard for cities official to manage access to care
(Facility level drilldowns can be used for visually identifying resource availability.)

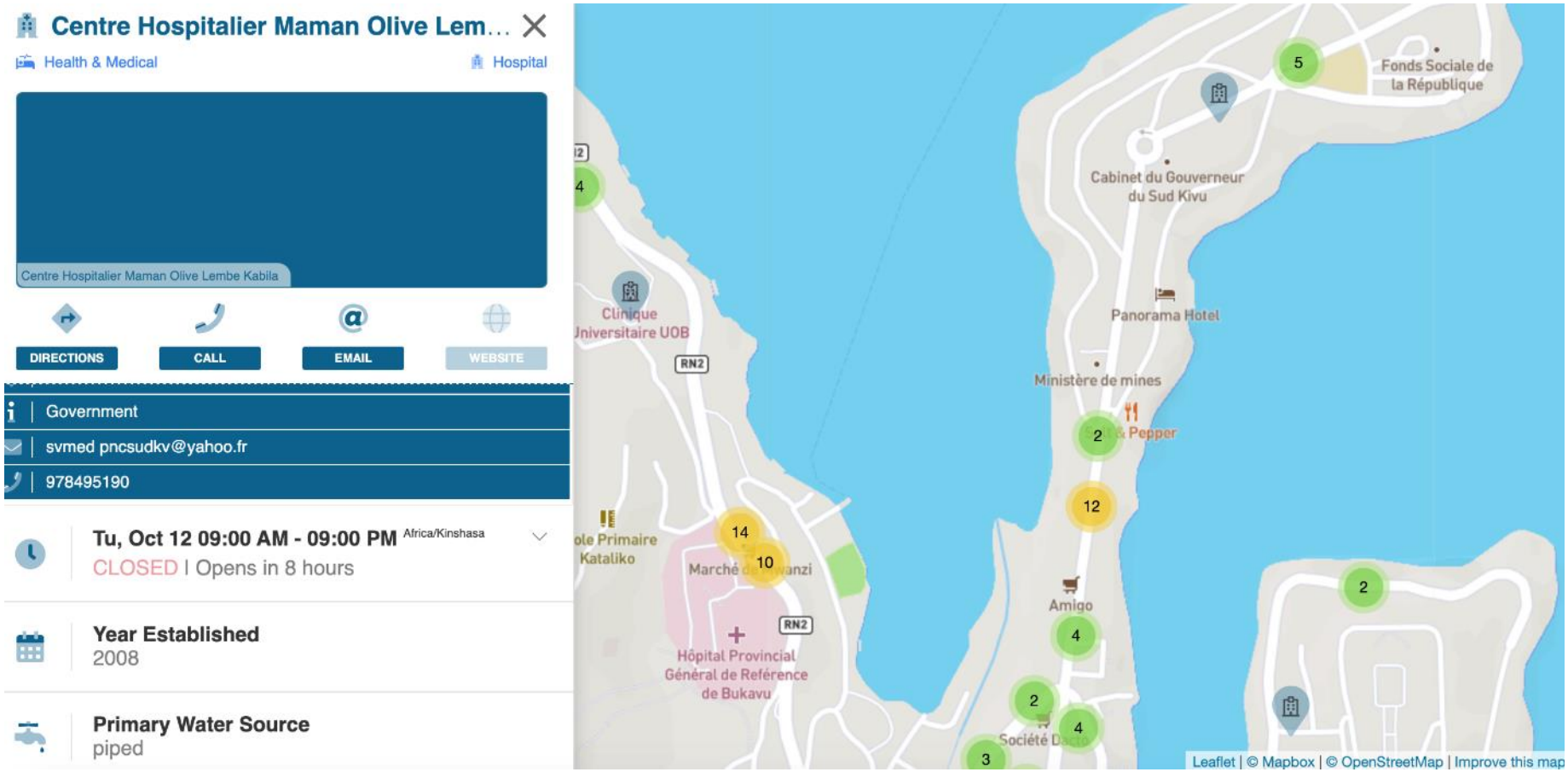

Figure 5. Drill-down into a facility to see different attributes
(Similarly, epidemics and pandemics can be monitored using heat maps to track live data.)

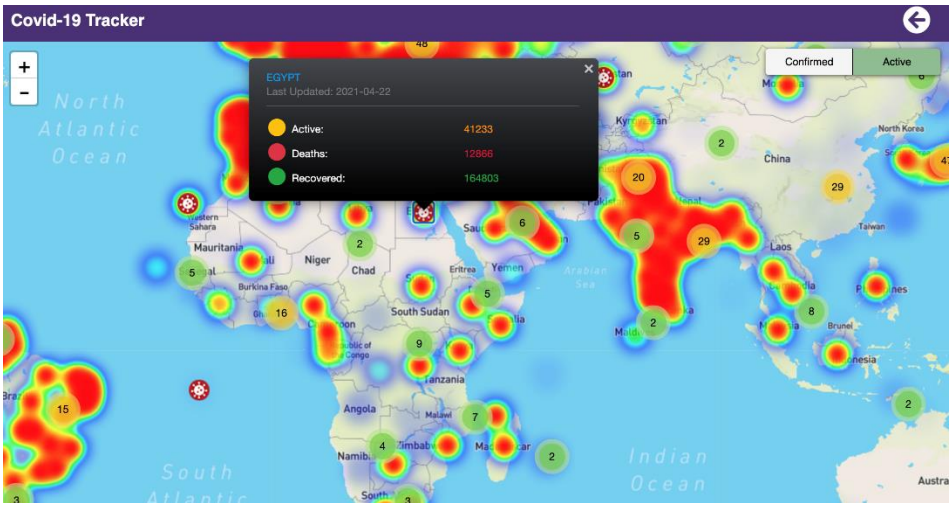

Figure 6: Heatmaps for tracking COVID-19 cases

Using the dashboards, local officials can keep the population and different stakeholders better informed. In addition, they can be used to drive effective responses during pandemics and increase resilience and social capital. Over time, these trends and indexes will provide a quantifiable way for a city to measure and justify the impact of its spending on resiliency efforts i.e., health initiatives while also providing a way for regions to measure the long-term effects of major emergencies. For example, a health facility registry for a city provides local officials with data and insights alongside the tools needed to measure, manage, and respond to the health needs of the local populations. This same data can be used to create services for city residents to locate the health services that they need and are close to where they are.

Hub Level Recommendations

The C2M2 project made it possible to strengthen and expand the work that was initiated during the Secondary Cities project to build local capacities and partnerships for emergency management and resiliency using geospatial data. Below is a summary of key achievements and perspectives:

Key achievements

- Great collaboration between the different city projects. It was very critical to ensure the same metrics were used across the hubs. Furthermore, it facilitated the exchange of best practices.
- Blending C2M2 and SDG metrics 3,11 enabled the team to expand the project beyond a single pandemic.
- Fostering a good collaboration between the different hubs (Africa, Asia, and Latin America) enabled the teams to exchange information and lessons learned throughout the project execution
- The support from the project leadership (State Department, CSU, and AAG) was critical for the successful project execution including:
    - Defining the project framework and objectives
    - Ensuring a successful project execution
    - Facilitating collaboration across hubs

    - Providing exposure beyond the hub through participation in multiple workshops hosted by Harvard University, Colorado State University, and George Mason University. That exposure enabled the teams to understand how critical their work is, their impact at the local level, and the need to strengthen local capacities to sustain the work that has been done through the Secondary Cities and the C2M2 projects.
    - Introduction to local support organizations that helped local partners integrate a larger regional network that provided additional resources i.e., local US embassies, regional offices of the Centers for Disease Control and Prevention (CDC), and the Regional Centre for Mapping of Resources for Development (RCMRD).
- Establishing best practices and a framework for data collection and reporting that could be adapted to different types of emergencies to help local officials understand and monitor their impact for better mitigation
- Leveraging geospatial applications like QGIS, OSM, and Cities Navigator to demonstrate the value of the work achieved to local officials and the civil society.

A look at the future

- Expand the current university network throughout the continent to be able to provide continuous support at the local level
- Help universities strengthen their geospatial capabilities by helping them establish local youth mappers chapters
- Adopt and make use of technologies that enable the universities to show the practical use of collected geospatial data i.e., by focusing on water access in Kenya, showcasing how to improve access to care in Bukavu, or helping local officials in Pemba prepare for the next emergency by addressing identified gaps in remote education
- Integrate local NGOs and other non-for-profit organizations into the partner networks to fast-track project execution by focusing on expanding existing data vs. starting data collection anew
- Identify advocates at the local levels to be ambassadors for the use of geospatial data for government decision making to help manage emergencies
- Collaborate on regional publications with a focus on how geospatial data is being used to help address local challenges
- Strengthen relationships between the local US embassies in the different countries with active partners to enable collaboration with local governments and help showcase the value of the different projects
- Continue to expand the use of geospatial data to build applications that are adapted to local needs i.e., for vaccine tracking

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Bukavu

Understanding the Second Order Impacts of COVID-19 in Bukavu, Democratic Republic of Congo

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2. Introduction

2.1. Background

After experiencing the second-deadliest outbreak in West Africa, the Democratic Republic of Congo (DRC) has been able to efficiently assess and prevent outbreaks through the implementation of contact tracing, isolation guidelines, etc. The country's ability to keep COVID-19 cases and deaths relatively low for a nation of its size can be greatly attributed to its history with Ebola and the etiquette that developed from that experience. That crisis was used as a blueprint to understand how to create and follow protocols that are specific to a nation's resources and environment to best handle extreme public health situations. Despite this, the health needs of the average citizens are not being met as the number of testing facilities in the nation's capital are limited and fear of infection from going to consultations or to the hospital have increased. Although the capital of the DRC, Kinshasa, has the most accessible healthcare services in the nation, they still accounted for roughly 90% of all COVID-19 cases. This highlights the need to look at how cities like Bukavu, which are on the outskirts of the country, are going to be able to receive adequate attention and care as the pandemic progresses.

2.2. Project implementation area description

The city of Bukavu was selected for this project given its strategic position and role in the DRC. Bukavu is in the eastern region of the Democratic Republic of the Congo at the extreme south-western edge of Lake Kivu. It is west of Cyan Gugu in Rwanda and separated from it by the outlet of the Ruzizi River. It is the capital of the South Kivu province and as of 2012, it had an estimated population of 806,940. In the '90s, the city received thousands of refugees fleeing ethnic violence in neighboring countries, Burundi and Rwanda, and is now a cultural melting pot.

Bukavu is a commercial and industrial hub as well as a tourist destination. It is one of the most densely populated cities in the DRC and home to a major university with the resources required to successfully execute the C2M2 project.

Since the beginning of the COVID-19 pandemic in 2020, business activities have suffered a sharp decline for most of the population. To reduce and hopefully contain the spread of the coronavirus disease, authorities in the Democratic Republic of Congo established a quarantine in Bukavu starting May 27, 2020. While these measures significantly impacted both the citizen's social life and the city's economy, they did help reduce the spread of the disease. By August 2020, Bukavu was no longer the epicenter of the disease, and this project became a well-timed opportunity to assess the second order impacts of COVID-19 and provide recommendations on how to mitigate them going further.

2.3. Project Goals, Objectives, and Outcomes

The project focused on the second order impacts of COVID-19 from a healthcare and education perspective in Bukavu. The goal was to use geospatial data to:

- Provide best practices and tools to government agencies and healthcare services officials that enable them to better understand the second order impacts of COVID-19
- Provide metrics to support decision making and inform strategic actions to mitigate the second order impacts of COVID and similar pandemics in the future

- Provide applications that will help local officials easily communicate with the population while providing reliable information on how to quickly access critical services

Building upon these goals, this report provides:

- A comparative analysis of COVID-19 January 2021 – August 2021
- A project assessment including:
  - Results of the data analysis and visualized results
  - Challenges related to prevention management
  - Lessons learned.
- Recommendations including how to propose solutions
- Tools and technology used for data collection and analysis.

To support the comparative analysis and project assessment, the team defined a set of strategic objectives and geospatial metrics to help quantify second order impacts. The table below provides an overview of the metrics that were collected in Bukavu with a focus on healthcare and education.

Perspective	Strategic Objectives	Measurement objectives (metrics)	In scope
Pandemic	Understand the current state of the pandemic	# New cases, #Recovered, #Death	√
Health	Conclude impact of water-borne diseases	Access to drinking water	√
	Mitigate the impact on care and access to care	Access to care	√
		Reduce the impact of pandemics	√
		Improve preventive care	√
		Mental health	√
Education	Mitigate the impact on education	Access to education	√
		Quality of education	√
Economy	Mitigate the economic impact	Impact on local economy	√

Table 2: Geospatial metrics used in Bukavu

3. Comparative Analysis

3.1. Healthcare

The city of Bukavu has three (3) health zones corresponding to three (3) urban municipalities. These include: Ibanda, Kadutu, and Bagira. In each health zone, many levels of health facilities coexist, including:

1. Health posts: Health facility level I
   Smallest health facility that can be led by a nurse
2. Health centers: Health facility level II & III
   Hospitals
3. Health formation
   An area within which the above-mentioned health facilities are located.

The table below provides a breakdown of health facilities by location and category as well as an estimation of the population in each health zone (municipality).

Health Zone	# of Health Centers	# of Hospitals	# of Health Posts	# Health Formations (FOSA*)	Village/ Avenue	Population
Bagira	8	2	20	30	74	148,135
Ibanda	17	24	7	48	207	481,107
Kadutu	13	10	10	33	79	392,298
Total	**38**	**36**	**37**	**111**	**360**	**1,021,540**

Table 3: Healthcare facilities in Bukavu

The most vulnerable population groups in the city include:

- Patients with chronic and metabolic diseases
- Elderly people
- Medical and paramedical staff including nurses and doctors
- Pharmacists and laboratory technicians
- Travelers and people working in highly frequented public places
- Rural communities in areas surrounding the city.

The city of Bukavu registered a total of 3,544 positive COVID-19 cases during the last 10 months with an average of 354 cases per month. The epicenter was in the municipality of Ibanda, which reported 77% of the cases with an average of 272 cases per month. Out of the 3,544 cases recorded in the city of Bukavu; 82 deaths were recorded. Co-morbidities such as diabetes and hypertension, age (>60 years), and access to care were factors favouring this lethality.

Health Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	TOTAL
Ibanda	87	112	69	18	19	30	641	551	1192	2719
Kadutu	6	24	5	8	2	3	184	139	323	694
Bagira	5	4	0	4	0	0	29	30	59	131
TOTAL	**98**	**140**	**74**	**30**	**21**	**33**	**854**	**720**	**1574**	**3544**
Overall deaths	3	0	1	0	0	0	4	35	39	82

Figure 7: COVID-19 cases in 2021 by health zone (Bukavu)

Given the limited resources at both the national and local levels, the DRC did not have the necessary screening capacity to effectively identify and report COVID-19 cases, and the rise in cases only exacerbated the issue. However, to fight the pandemic, both the national and local governments in the DRC set policies relating to preventive measures to reduce the spread early into the pandemic. The table below reflects the changes in restrictive measures throughout the duration of the project.

ID	Measure	Q1 2021	Q2 2021	Q3 2021
1	Curfew	x		x
2	Barrier measures (social distancing, masks, hand washing…)	x	x	x
3	No public gathering	x	x	
4	Limit on number of people at festive ceremonies	x		x
5	No sport events	x	x	
6	Burial without ceremony	x	x	x
7	Church activities must uphold barrier gestures	x	x	
8	School closures	x	x	
9	Travel restrictions	x	x	
10	Avoid close contact with people experiencing a fever or cough or that are sick		x	x
11	In the case of fever, cough, or difficulty breathing, consult the Health Center		x	x
12	Avoid direct unprotected contact with live animals and with surfaces in contact with animals		x	x
13	No consumption of raw or undercooked animal		x	x
14	Get vaccinated if eligible		x	x
15	Expand rapid testing to the entire province			x

Table 4: Restrictive measures over time (Bukavu)

In Q2 2021, a countrywide vaccination campaign was launched. Unfortunately, this launch was soiled with controversy due to rumours spread by social networks and media networks regarding the nature and effectiveness of the vaccine. Those controversies plunged the population into a dilemma leading to two contradicting psychological feelings: fear of the disease and realization of the danger posed by the COVID-19 pandemic.

The second and third waves of COVID-19 peaked in Q3 2021 with a worrying number of deaths, and the messages from social networks pertaining to the dangers of getting vaccinated only traumatized the population more. As the pandemic was at its peak, the population engaged in self-medication at the slightest symptoms related to COVID-19.

3.2. Education/Social

There are three (3) urban municipalities in Bukavu: Ibanda, Kadutu, and Bagira. The table below provides an overview on the number of schools in the city by municipality.

Health zone	Nursery	Primary	Secondary	ITM/IEM*	HEIs	TOTAL
Bagira	16	108	72	0	2	198
Ibanda	110	270	194	4	11	589
Kadutu	28	62	52	2	8	152
Total	**154**	**440**	**316**	**6**	**21**	**939**

ITM*: Institute of Medical Techniques | IEM*: Institute of Medical Education

Table 5: Schools in Bukavu

COVID-19 and the implemented prevention measures led to schools' closures in early 2021 and this impacted all key players within the school value chain including students, parents, and teachers. Below are illustrative examples:

- **Before the COVID-19 Pandemic**
  Teaching programs in Bukavu were well respected and parents were able to send their children to school without fear. Additionally, there were no hand washing requirements, hydro-alcoholic solutions, masks, or social distancing required.
- **Since the COVID-19 Pandemic**
  The lockdown that resulted in over 5-months of school closures negatively impacted the education system including:
  - No pay for teachers in most private and public schools
  - Demotivated teachers and learners
  - Schools having to invest in unplanned infrastructure i.e., building handwashing points, providing hydro-alcoholic solutions, etc.
  - Parents having to play teachers at home and make sure their children participate in the remote learning classes.

Although most institutions tried to find methods and means to deliver remote education, many challenges made it almost impossible i.e.:

- Many households' inability to acquire TV sets due to their limited income
- Many households' inability to afford monthly TV subscription fees to access TV based educational programs
- Scarcity of energy; In fact, most households do not have continued/have limited access to electricity.

3.3. Collateral impact on the economy

The COVID-19 pandemic in the South Kivu province and the subsequent restrictive mobility measures impacted the economic development and social relations between the urban population and residents of the surrounding counties. The limitation of population movement from surrounding counties to the cities where many earn their income through petty trade deeply impacted the food supply and led to a spike in the cost of commodities. In addition, the closure of the DRC's borders to neighboring countries (Burundi, Uganda, Tanzania, and Rwanda) increased the unemployment rate for women and young adults. As a result of these shortfalls, the psychological stress due to COVID-19 preventive measures is believed to be among other factors that

triggered the increment of registered deaths during the lockdown period. Below are illustrative facts:

Before the COVID-19 Pandemic

- Free movement of the population and goods
- NGOS and other not for profit organizations were able to operate freely and bring resources into the region
- The majority of the Bukavu population had a purchasing power that enabled them to eat at least twice a day.

Since the COVID-19 Pandemic

- Implemented measures and limitations to reduce the spread of COVID-19 halted the flow of goods and resources from rural areas to the city and within the region
- Borders' closures between the DRC and many of its neighboring countries (Burundi, Uganda, Tanzania, and Rwanda) led to a spike in food prices up to 3x; many carriers and border operators had to close their businesses or reduce staff, thus increasing the local unemployment rate
- Since inter-provincial and inter-border trade facilitated the circulation of currency and other goods, implemented restrictions i.e., on inter-provincial water transportation during lockdown on Lake Kivu and Lake Tanganyika resulted in unemployment
- Social distancing chips away at African solidarity
- Youth income-generating activities like taxi operators, carriers, dockers, baggage handlers, etc. that ran 24/7 prior to the pandemic were shut down; many young adults became unemployed, and their motorcycles/car and taxis had to go out of business due to the prolonged periods of inactivity.

In a nutshell, the pandemic created a psychosis that reduced the productive capacity of the urban population and their purchasing power.

4. Project Assessment

4.1. Understanding the pandemic and its second order impacts

To understand the second order impacts of COVID-19, the team implemented a monthly data collection process in schools, hospitals, and pharmacies. Given the repetitive lockdowns and limited cooperation from some institutions, the team sampled data that was representative for the selected sectors.

a. Data Sampling

	Hospitals	Pharmacies	Schools
Available data sets	92	380	414
Sampled	67	52	44
Observations	Data sampling to monitor the second order impacts in hospitals focused on established institutions	Several small pharmacies did not meet the standards defined by the Ministry of Health and were therefore excluded from the sampling	School surveys were challenging given the repetitive lockdowns and the vaccination campaigns; the team sampled institutions in each municipality to ensure the project had enough data to drive recommendations

Table 6: Data sampling to understand the second order impacts (Bukavu)

b. Causal Loop Diagram: Second order impacts on the economy in Bukavu

Borders' closure led to a spike in food prices and consequently food insecurity in the city. The borders' closure also increased the unemployment rate for border operators (mainly women and young adults), lowering their standard of living.

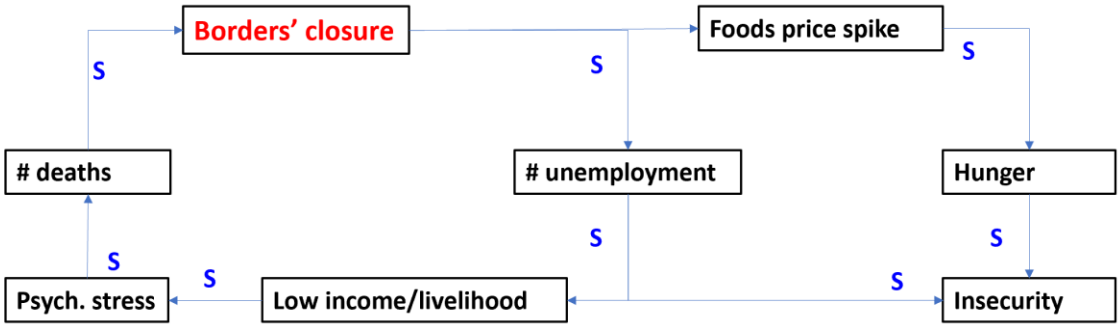


Figure 8: Causal loop data – impact on the economy (Bukavu)

c. Causal Loop Diagram: Second order Impacts on healthcare in Bukavu

Limited access to healthcare facilities encouraged self-medication, which caused many unregistered deaths. The death toll created a psychosis that in turn prevented the population from going to hospitals whenever ill due to the fear of being tested or contaminated. The immediate consequence for hospitals included few patients, low revenue for the healthcare facilities, and less pay for the staff.

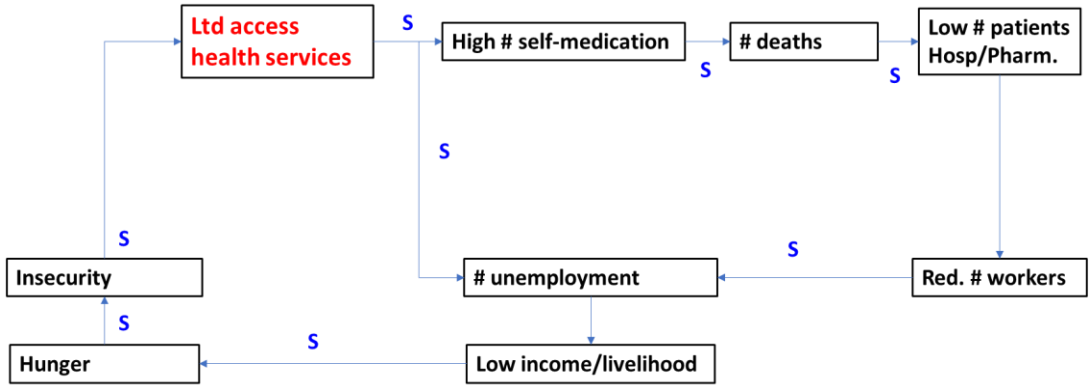


Figure 9: Causal loop data – impact on healthcare (Bukavu)

d. Causal Loop Diagram: Second order impacts of on education in Bukavu

Schools' closure had a negative impact on students, parents, teachers, and school owners in the city of Bukavu.

- Youths (young girls and boys) lacked the opportunity to go to school and instead spent their time idling in the city with the subsequent risks of unwanted pregnancies for young girls and hooliganism for the young boys. The situation created a breeding ground for child labor as those young people were looking for ways to support their families and make ends meet.
- During lockdowns, teachers and school owners in many private and public schools were not paid, and this resulted in mass unemployment and lower incomes, making them unable to satisfy the basic needs of their families.

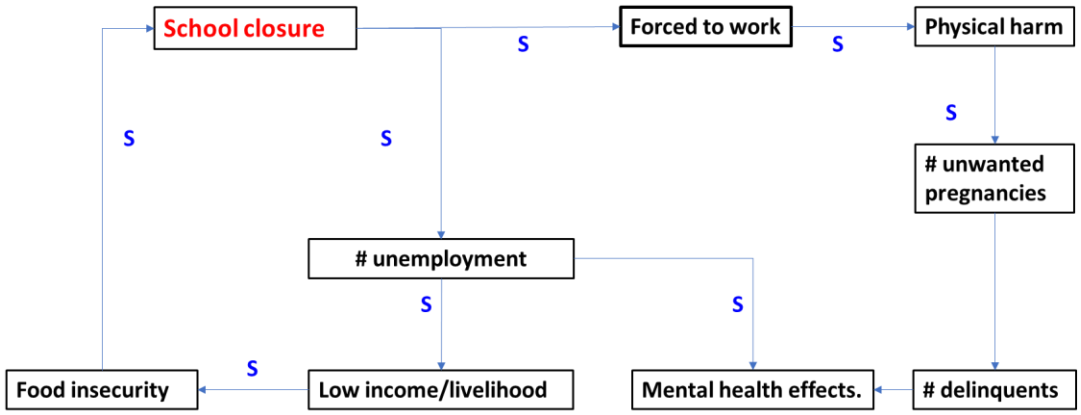


Figure 10: Causal loop Data – Impact on education (Bukavu)

e. Heatmap

Based on the heat map **Figure *11***, the healthcare facilities in Bukavu are unevenly distributed. Below are illustrative examples:

- The Ibanda and Kadutu health zones have the most healthcare facilities while Bagira, the largest health zone, only has a few
- Within the Ibanda zone, the Ndendere and Nyalukemba districts have more health facilities than Panzi, the largest and most populated district in the Ibanda zone

It should be noted that the Panzi district has one of the largest hospitals in the city, the Panzi General Referral Hospital.

4.2. Geospatial data analysis based on 2nd order impact on healthcare

The section below provides illustrative examples on how collected geospatial data enabled the project to better understand the second order impacts of COVID-19 on healthcare.

Access to care

The city of Bukavu has three (3) health zones (
Figure 12) that correspond to the three (3) urban municipalities (Ibanda, Kadutu, and Bagira) that provide health services to 1,617,650 people. Each health zone provides many categories of health facilities which are grouped together based on the level of service provided. Based on our analysis, the largest zone (Bagira) has the least number of health care facilities.

Care capacity

The following are highlights based on interviews with officials at the different medical facilities:

- There was an increase in the number of positive cases in Q3 2021 due to the 3rd wave
- Many institutions did not receive government subsidies to support the influx of patients
- Most hospitals were limited in terms of the care they could provide given their already strained bed capacity.

In fact, a good understanding of the city's bed capacity was critical for planning purposes, and that information was not readily available to local officials prior to the project (**Figure *13***).

Access to physicians

There are not enough doctors to meet the needs of the population in each zone (**Figure *14***).

Additionally, the majority of healthcare facilities do not have the required equipment to perform COVID-19 tests and therefore are not authorized to receive COVID-19 cases. As a result, the population is not suffienctly tested and many resort to self-medication.

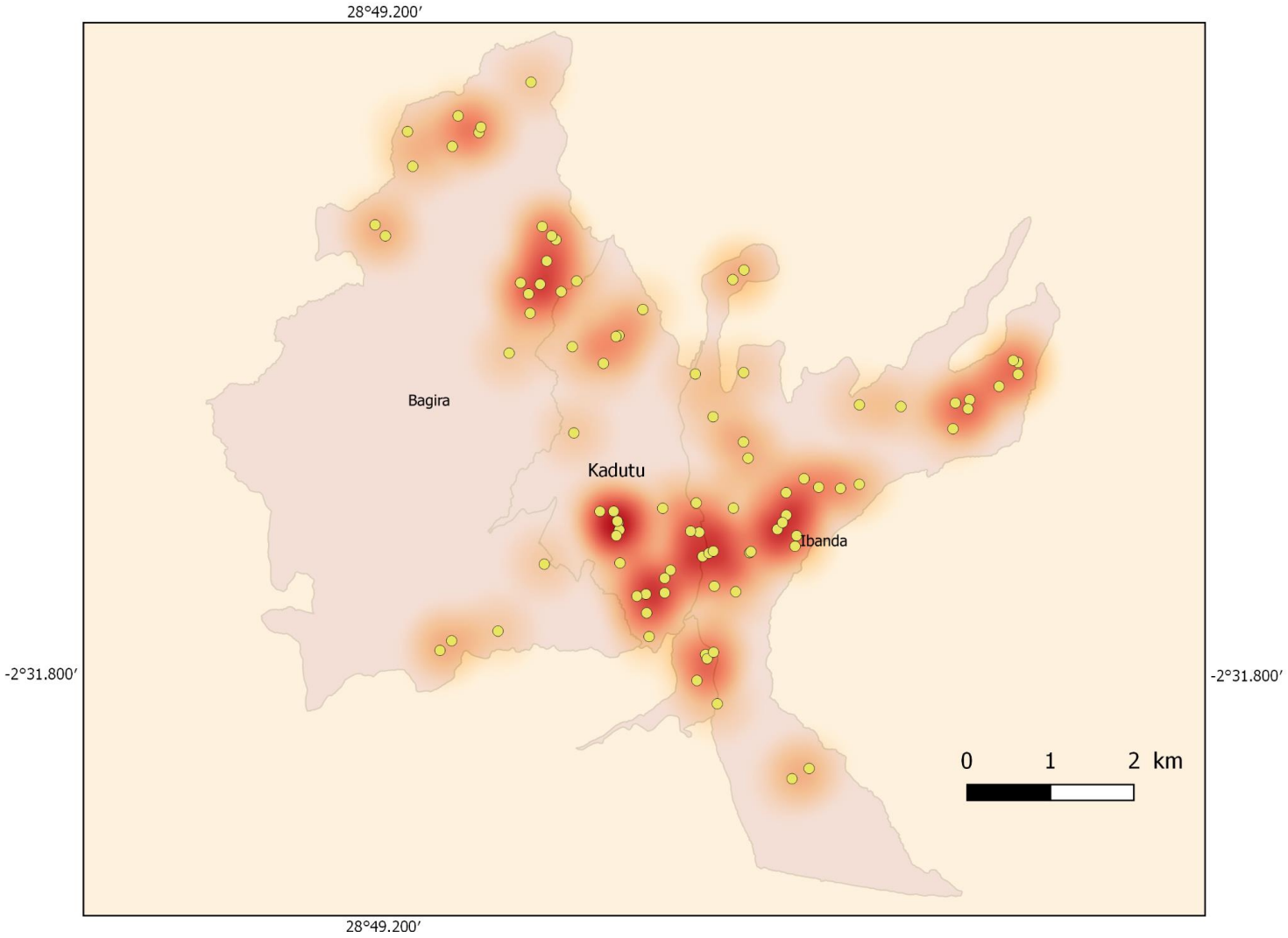
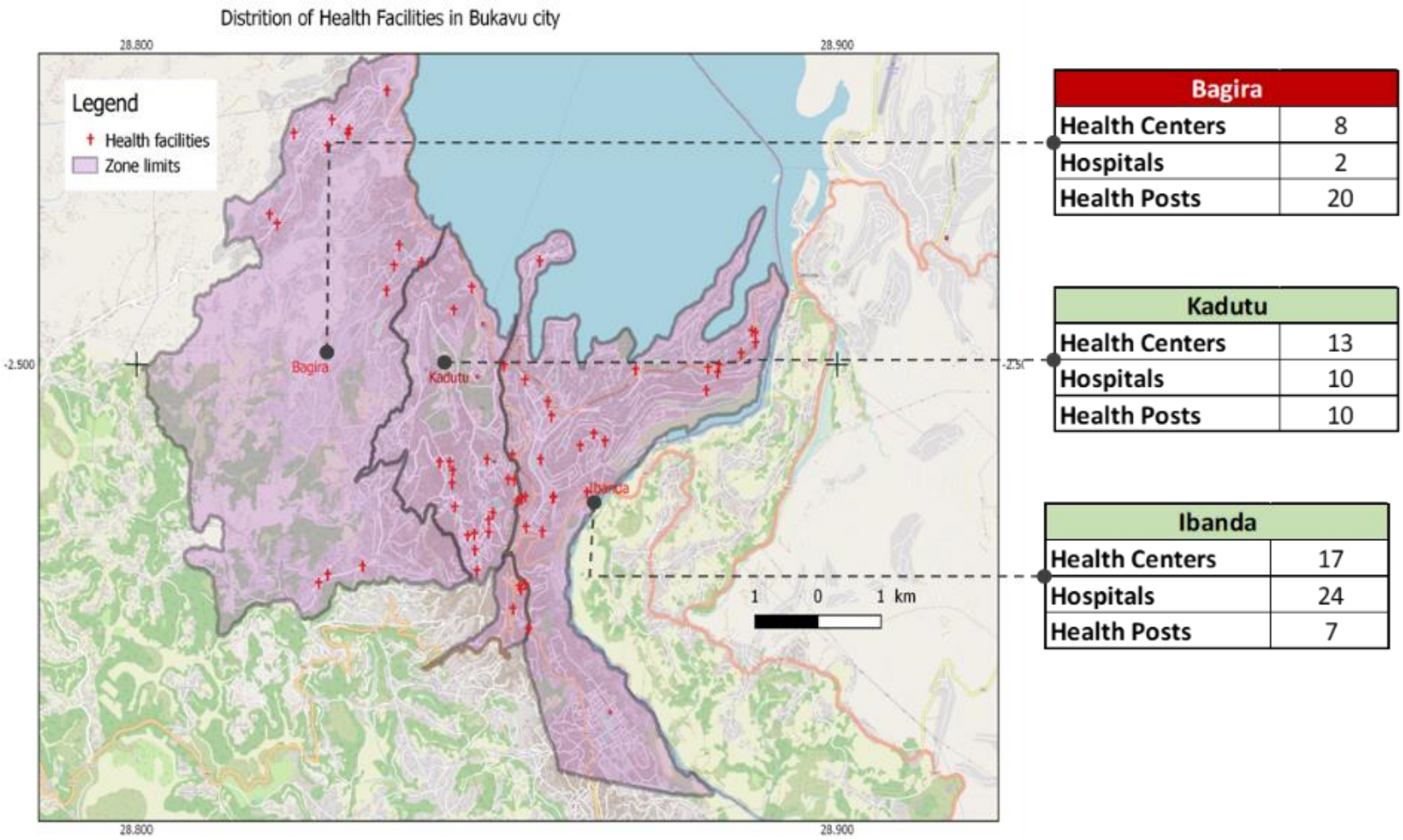


Figure 11: Heat map on access to care (Bukavu)



Bagira	
Health Centers	8
Hospitals	2
Health Posts	20

Kadutu	
Health Centers	13
Hospitals	10
Health Posts	10

Ibanda	
Health Centers	17
Hospitals	24
Health Posts	7

Figure 12: Access to care in Bukavu

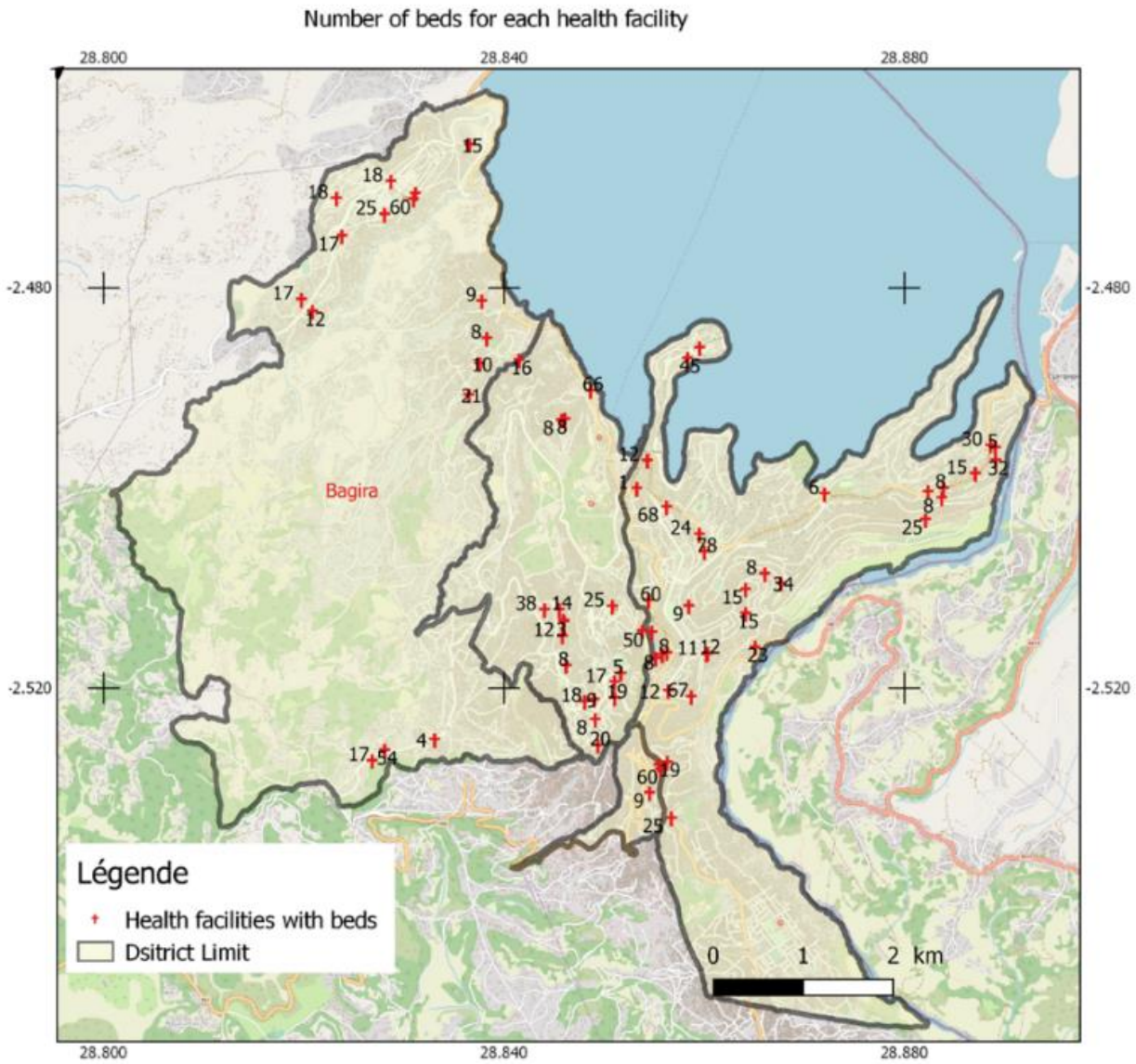
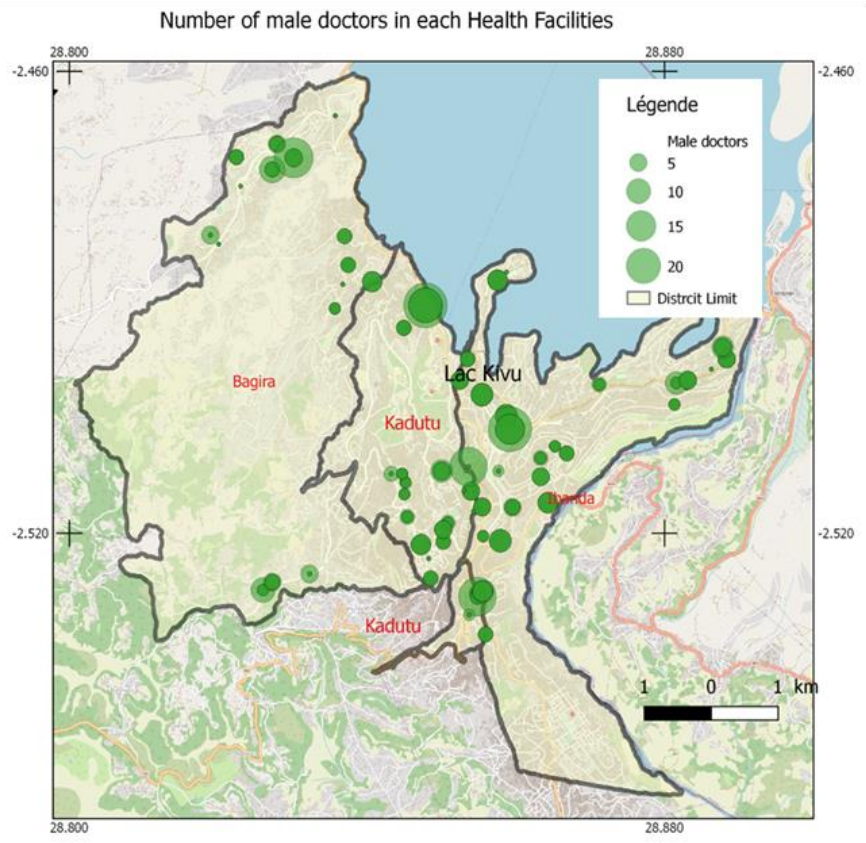


Figure 13: Bed capacity (Bukavu)



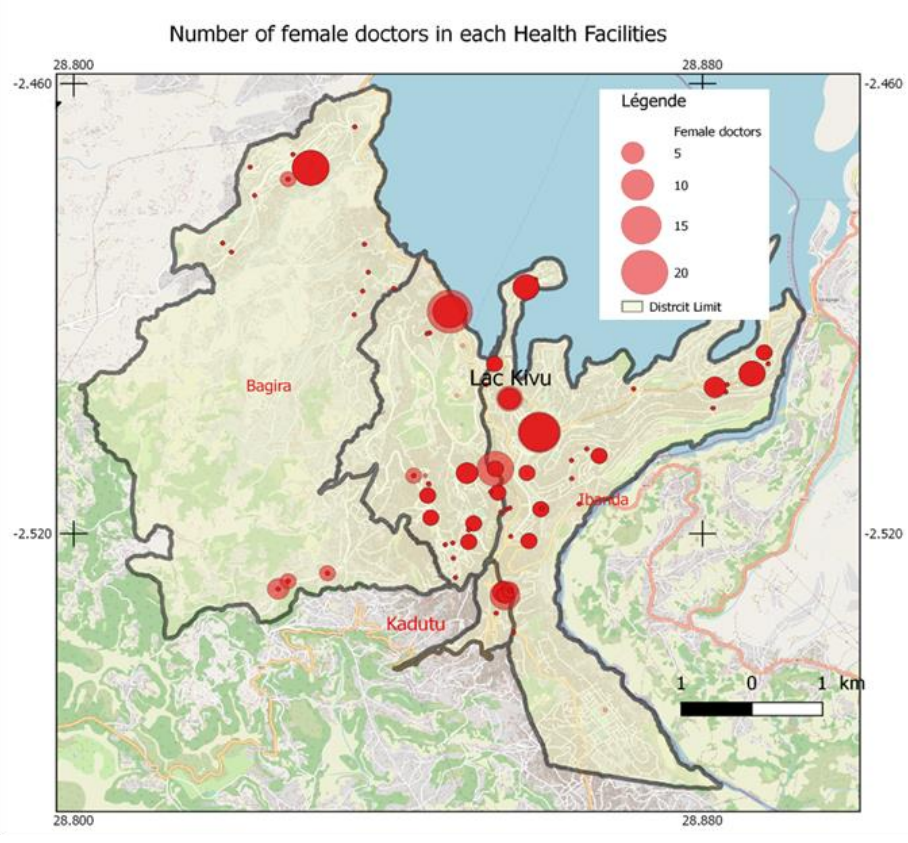


Figure 14: Healthcare professionals by health zone (Bukavu)

4.3. Challenges managing prevention

From the beginning of the pandemic in March 2020, surveillance and response teams worked to stop the spread of the disease. Preventive measures were defined at the national (President's regulations) and the provincial (Governor Decree) levels to reduce the spread of the disease. As the focus shifted toward prevention and use of vaccines in Q2/Q3 2021, rumors in the media and social networks about vaccination led to rejection by the community, forcing the government and local officials to invest more in communication. It is important to mention that numerous technical, ecological, economic, and political constraints disrupted the enforcement of preventive measures to fight COVID-19. In addition, social promiscuity in popular suburbs and customs such as hand shakings, hugs, hospital visits to patients without standard precautions, and taking public transportation without respecting preventive measures contributed to the increase in the number of COVID-19 cases. Furthermore, the Infection Prevention and Control (IPC) center of South Kivu revealed other challenges related to the response against COVID-19 that made it more difficult to manage. These challenges included:

- Low screening capacity due to inadequate equipment to cover the entire region in areas with high risk
- Insufficiency of rapid test kits (RDT)
- Poor control capacity at borders to detect and manage cases in a timely manner
- Stigmatization of positive cases by family members and the community, which increased psychological disturbances and prevented and discouraged people from getting tested
- Social networks created confusion in the minds of the population about the dangers of vaccines which decreased adherence to the vaccination campaign
- Self-medication following the high cost of COVID-19 related drugs
- Relaxation of barrier measures.

4.4. Stakeholder engagement

The C2M2 Bukavu Project benefited from the full engagement and involvement of key partners and stakeholders including:

- The Faculty of Sciences of the Official University of Bukavu (UOB)
- The Provincial Health Division of South Kivu (DPS)
- The City Council and Stephanie Clinics
- The Ministries of Health and Education.

Encountered challenges were mostly during data collection as many schools were closed during the early phases of the project. In addition, the data collectors had to deal with:

- Changes of names (ownerships) of healthcare facilities
- Relocations of healthcare facilities due to rental issues
- Newly created healthcare facilities that were not surveyed in earlier data collection rounds
- Some healthcare and school facilities' managers found it cumbersome to provide quarterly updates
- The collapse or closure of some previously surveyed facilities and their transformation into other types of businesses (shops, hair salons, bars, and night clubs).

Despite the above-mentioned challenges, the teams were able to collect enough data to provide a foundation for decision support.

4.5. Lessons learned

The C2M2 project will benefit the city of Bukavu beyond this initial project. Below are lessons learned and illustrative facts:

1. The project enabled the city to create the first ever geo-localized database of education and healthcare facilities
2. The ability to feed collected data into the "Cities Navigator" platform and use it for decision support and communication is of paramount importance and was appreciated by all authorities and stakeholders who attended the final project workshop
3. Acquired materials and tools during the project are incredibly important as they will be used by the faculty and University to upgrade their lecturing methods as well as establish new and innovative virtual & remote learning systems.
4. Remote working methods (Webinar, Zoom, and WhatsApp meetings) have been a great experience. They made it easy to host meetings with various partners including the U.S. State Department, the Africa Hub, the American Association of Geographers (AAG), and other cities' projects
5. Collecting dynamic data in an unusual context of repetitive lockdowns and movement restrictions was a big challenge for team. This project allowed the team to develop adaptive strategies to approach and communicate with the respondents to complete data collection
6. Working with education and healthcare facilities to gather geospatial data was a challenging undertaking. In this context, the collaboration with the state services in charge of education and health was very beneficial for smooth project execution
7. Teamwork involving several researchers, other hub countries, and stakeholders has been an exciting experience that greatly increased the exposure of UOB. It also positioned the faculty of science as go to institution for to use of geospatial data to manage emergencies
8. The school is launching a youth mapper chapter to further strengthen its ability to continue the work that was started with the C2M2 project and be able to support future projects.

5. Recommendations

Based on the collected data, the team identified the following opportunities to improve the city's ability to mitigate the second order impacts of COVID-19 and other pandemics:

Healthcare

- Increase the number of healthcare facilities, especially in the Bagira district
- Train more professionals in the monitoring, response, and management of the COVID-19 pandemic
- Provide necessary equipment for testing
- Launch an information campaign that uses neighborhood ambassadors to increase vaccination adoption
- Conduct follow up surveys using the infrastructure that was created through the C2M2 project to track progress.

Education

- Leverage geospatial tools to regularly survey schools on the use and adoption of remote learning methods
- Establish and share best practices with other regions

- Monitor the implementation of preventive measures in schools and universities
- Improve access to drinking water and handwashing points in schools
- Create a framework to continuously review the adoption of remote learning and define best practices that will ensure the city is better prepared for the next pandemic or emergency.

Economy

- Make it easy for small businesses to access grants or bridge loans that will help them go through economic downturns due to emergencies or pandemics
- Strengthen the small business cooperatives' network to ensure they have the capacity to close supply chain gaps during borders' closures or lockdowns
- Encourage internal food production to reduce the dependency on food imports from neighbouring countries especially during lockdowns and border closures
- Create policies that set aside funding (i.e., from collected local taxes) to stimulate the creation of local start-ups and strengthen the local economy.

Building upon these recommendations and based on discussions with the city's officials and other key stakeholders, additional suggestions were made to facilitate the execution of the above-mentioned recommendations and sustain the project:

- Create a geospatial information center at the Official University of Bukavu that will help sustain the work that was initiated by the C2M2 project including:
  - Engaging municipalities to establish a partnership for the collection, processing, and visualization of geographic data for sectors that fall within their management and identify revenue-generating opportunities that could help sustain ongoing activities
  - Engaging the provincial education and health ministries for a partnership to expand the collection, processing, and visualization of geographic data for schools and healthcare services
  - Strengthening the partnership and collaboration between the Association of American Geographers and the Official University of Bukavu by exchanging best practices.
- Create a youth mapper chapter at the university to provide best practices and continue project support while building a strong resource base for geospatial projects
- Adopt and expand the use of the "Cities Navigator" platform beyond Bukavu; the team would like to use it at the university to help the government manage and organize its different sectors (health, education, taxes, and crime) in the South Kivu province and across the country if possible. This would be a great achievement of the C2M2 project in the DRC
- Secure ongoing support and guidance from the C2M2 project leadership for best practices on the use of technology and geospatial data to improve the resiliency of the city and the province.

6. Tools and Technology Used for Data Collection and Analysis.

The team used mobile phones and tablets for data collection. The team used ArcGIS version 10.2 and QGIS version 3.1 for additional data analysis and the creation of story maps. This made it possible to easily and accurately present and visualize the results. Once the data processing and analysis was completed, the information was then uploaded into the "Cities Navigator" application which allowed the information to be managed and displayed in real time.

Nairobi

Understanding the Second Order Impacts of COVID-19 in Nairobi, Kenya

By

Erica Hagen,
GroundTruth Initiative, Map Kibera, Open Schools Kenya

7. Introduction

7.1. Background

Nairobi has been the epicenter for Kenya's COVID-19 outbreak during the global pandemic. The Kenyan government imposed a lockdown in March 2020, which included the prohibition of in-country travel. This resulted in massive economic damage. Some trade was allowed to continue, but most individuals were negatively impacted. Schools were also ordered shut. While the country removed most of this lockdown during the latter half of 2020, on March 26, 2021, a new lockdown was imposed in response to the spike in COVID-19 cases throughout the country, with emphasis on the five counties with the highest caseloads including Nairobi. Those hit hardest by the economic toll of these lockdowns were people living in the informal settlements of Nairobi, such as Kibera and Mathare. These two settlements hold approximately 400 thousand inhabitants together[1] and are the focus of this project.

7.2. Project implementation area description

The project will focus on Kibera and Matera since they will enable us to get firsthand data on the second order impacts on some of the most vulnerable populations in Nairobi. The informal settlements of Nairobi are key vulnerable parts of the city. An estimated 2.5 million people live in Nairobi's slums, which is more than half the city population.

Kibera is the largest slum in Nairobi and the largest urban slum in Africa. Mathare is a collection of slums in Nairobi.

7.3. Project goals, objectives and outcomes

In order to geographically track the second order impacts of the pandemic on these residents, the project focus was set on two key sectors: education and access to water and sanitation. School closures had a large impact on the non-governmental small private school sector which serves most residents, and the families who attend the schools. Water shortages were widespread and heavily impacted the slum areas. Toilets

1 This project mapped a portion of Mathare which is considered home to the slum area and most vulnerable. The exercise did not cover the entirety of the administrative boundary of Mathare.

were off limits during curfews and high-quality facilities were scarce. The table below provides an overview of the metrics that were collected in Bukavu with a focus on healthcare and education.

Perspective	Strategic Objectives	Measurement objectives	In scope City
Pandemic	Understand the current state of the pandemic	#New cases, #Recovered, #Deaths	√
Health	Impact of water borne diseases	Access to drinking water	√
	Sanitation	Access to clean, operational toilets, Access to handwashing facility	√
	Mitigate the impact on education	Access to education	√
Education		Quality of education	√

Table 7: Geospatial metrics used in Nairobi

8. Comparative Analysis

8.1. Water and toilet mapping in Kibera and Mathare

A. Results of Surveys:
The team collected 662 individual survey responses in Kibera and Mathare regarding COVID-19's impacts on water and sanitation. The surveys had 337 respondents in Kibera and 309 in Mathare. The respondents were selected randomly and contacted with an even distribution throughout the areas. The survey respondents were located near their homes or workplaces and they were residents of the two informal settlements. Below is a summary of survey results:

Water Perspective

a. Shortage of water supply in the slums was a major problem, especially during mid-2020 when messaging about water and washing to prevent disease was particularly strong.

b. Some sample responses in Kibera vs Mathare
Where is the water point you access located?
- Right outside the home (under 50 meters): 17% in Kibera and 35% in Mathare.
- A bit far (walking distance 50-100m): 27% in Kibera, 9% in Mathare.
- Very far (over 100m): 5% in Kibera, 1% in Mathare.

Residents in both Mathare and Kibera required more water during the pandemic than usual, most likely an increase in their standards of hygiene which included increased washing, bathing, handwashing, etc (**Figure *15***). The difficulty in access was primarily a result of not finding enough supply, but also due to difficulty

paying for water. Residents indicated they had to walk further than usual to find enough water or buy water from water vendors who travel around the slums (as opposed to buying from a tap or fixed location). Forty-two percent of respondents could only access water on a weekly basis with 77% saying their water supply was either not reliable or only slightly reliable (in terms of actual availability). Although there was a free water program introduced by the city, most residents,83%, were not benefitting from it.

Toilets

Toilet access during COVID-19 was also a challenge. We found that toilet access for those without an in-compound toilet was challenging due to curfews, which sometimes ran from 7 pm through early morning hours. Fifty-four percent of respondents had an in-compound toilets that they used (compounds usually consist of several small homes with a gated wall around them and large open space in the middle – all made of non-formalized structures and materials), but 42% did not use public toilets when outside the compound. That proved very difficult especially as curfews were enforced by police, sometimes violently. Furthermore, in Mathare in particular, many respondents complained about hygienic conditions at the public facilities by mentioning how they were not clean or well maintained. Below are some quotes from the survey in response to "Please describe the challenge(s) you faced":

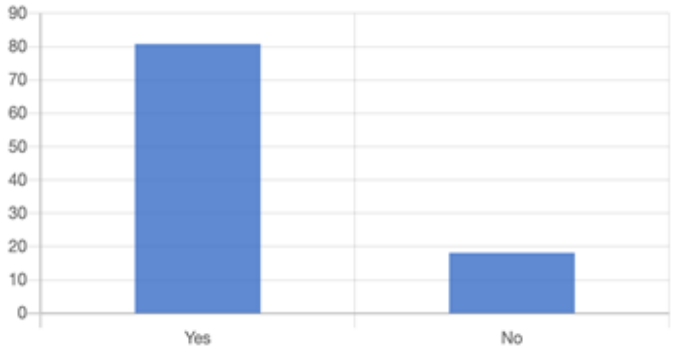
- "When you go to the water point sometimes you find long lines of water jerry cans so you have to wait for hours or even go home without water"
- "We needed a lot of water but the government neglected us very much up to date"
- "Water was costly, there was rationing of water"
- "The fact that we needed more water during the corona pandemic was very demanding physically and financially"
- "We had to go fetch water from far places since there is no water in our area, sometimes you find long queues of people waiting to fetch water"
- "I bought from vendors who sell expensively"
- "Hand washing points have no soap"
- "Lack of enough toilets in the area"
- "Since the toilet uses water, it was difficult to maintain the toilet hygiene"
- "When there is no water within our area, vendors hike the price of water."

B. Water Mapping

The team mapped both public and private (in compound) water points throughout Kibera and Mathare (**Figure *16***, **Figure *17***), gathering information on several aspects such as their frequency of supply, whether they are operational, their operator, and their prices.

During the Covid-19 pandemic did you require more water than usual?

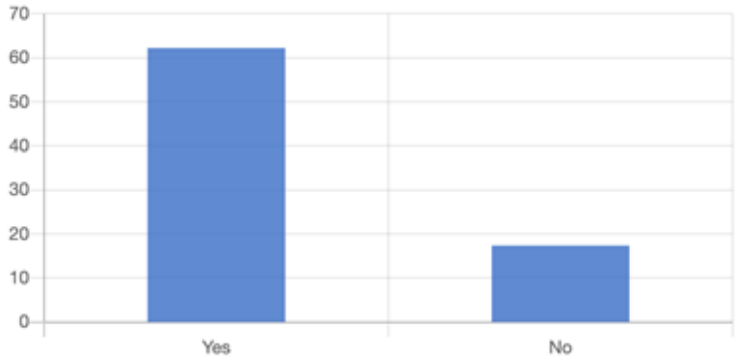
TYPE: "SELECT_ONE". 655 out of 662 respondents answered this question. (7 were without data.)



Value	Frequency	Percentage
Yes	535	80.82
No	120	18.13

Did you face any difficulty in accessing enough water?

TYPE: "SELECT_ONE". 527 out of 662 respondents answered this question. (135 were without data.)



Value	Frequency	Percentage
Yes	412	62.24
No	115	17.37

Figure 15: Access to water during COVID (Nairobi)

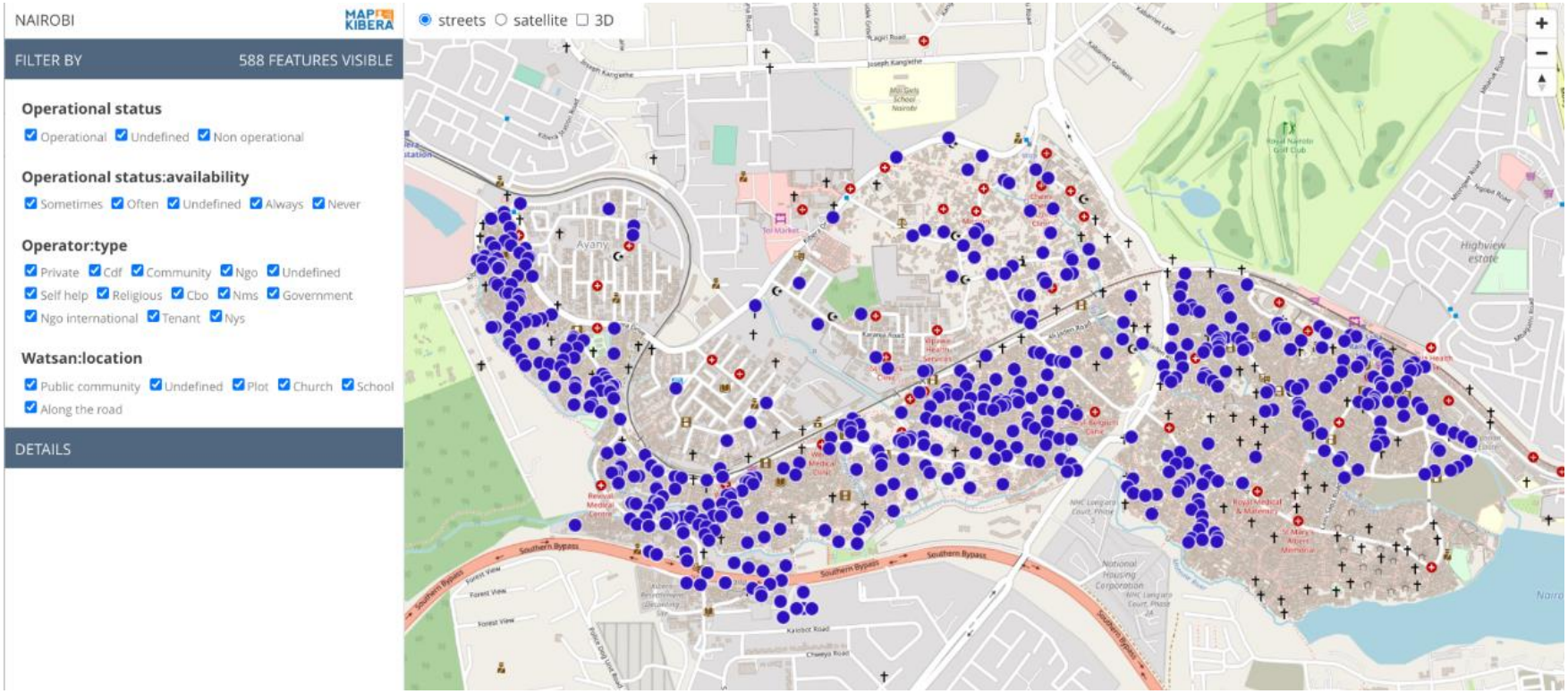


Figure 16: Map of water points in Kibera

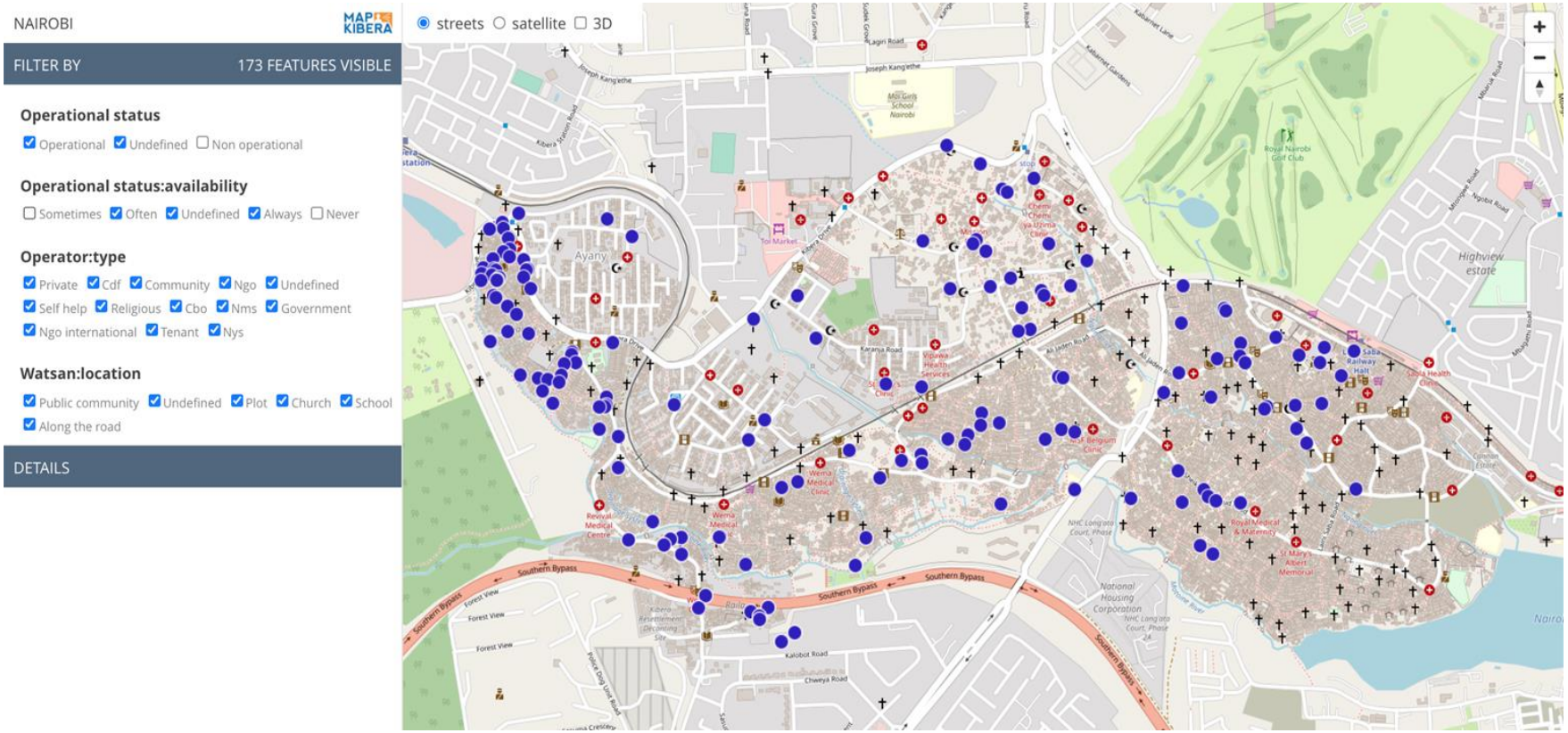


Figure 17: Water points based on availability (Kibera).

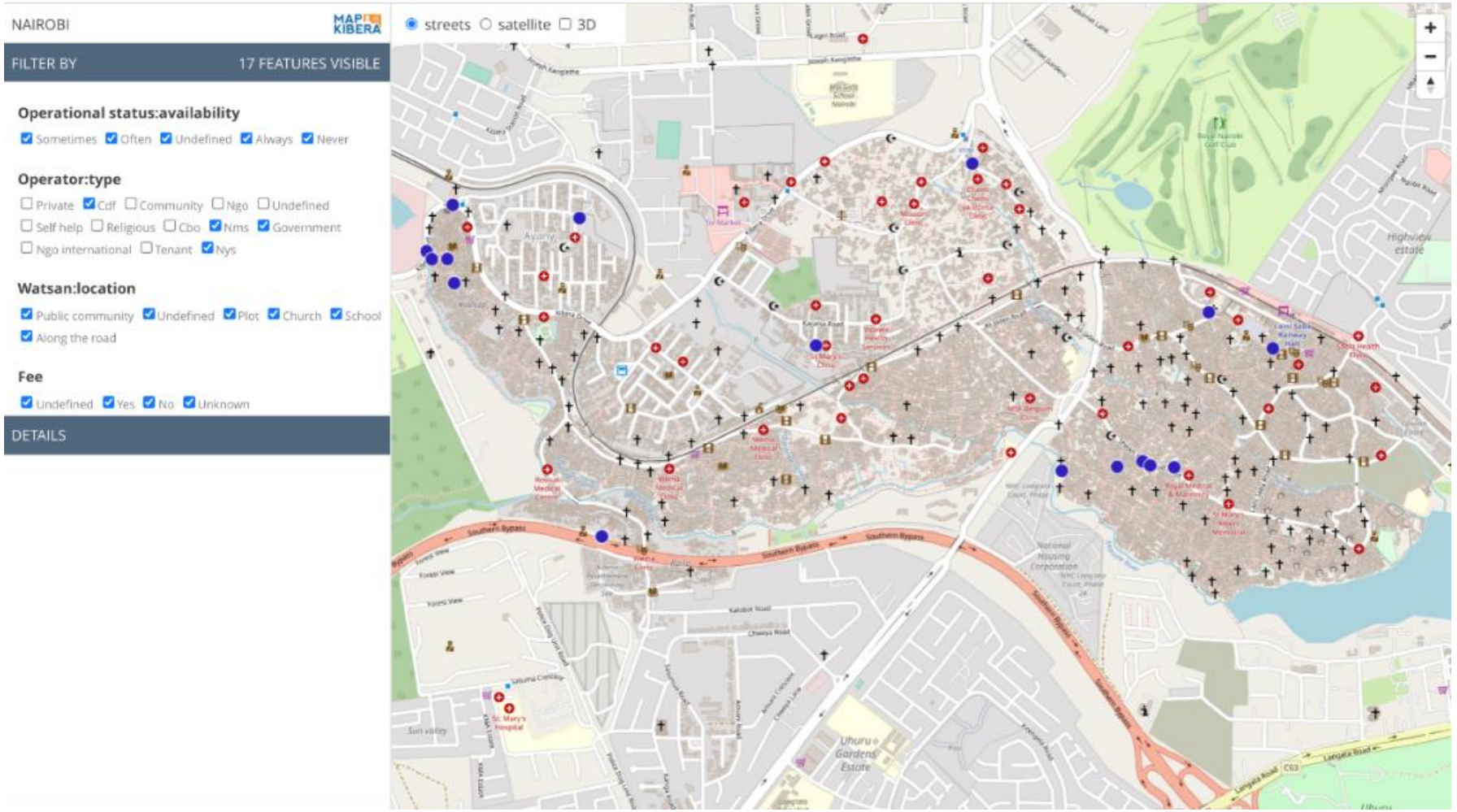


Figure 18: Availability of government-provided water facilities in the slums (NYS = National Youth Service; NMS = National MF; CDF = Community Development Fund).

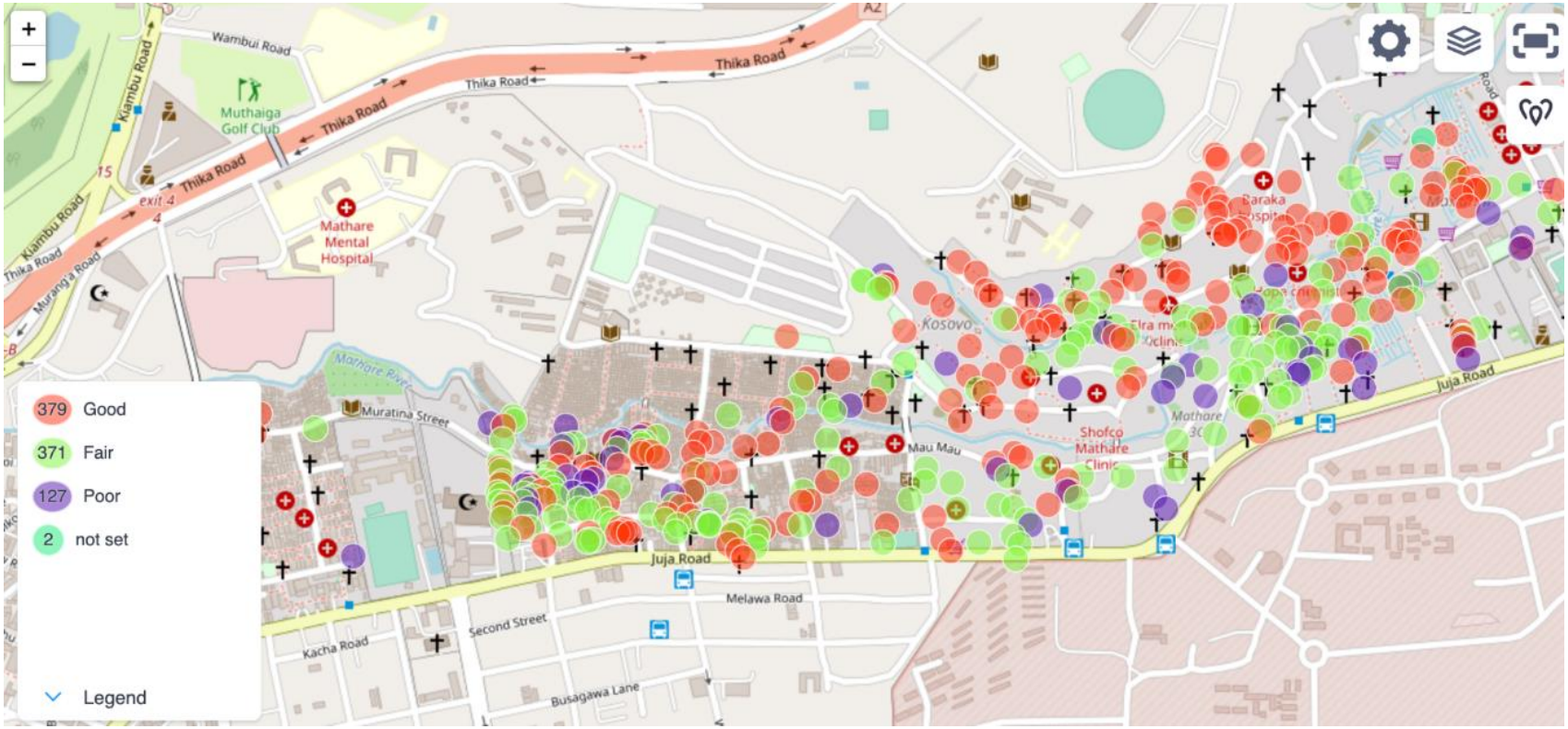


Figure 19: Toilet mapping in Kibera

As illustrated in **Figure 18**, the water access problems described in the surveys were more acute than the coverage of points would indicate, and certain areas are more vulnerable than others. Given that COVID-19 caused a much higher demand on water, due to the need for better hygiene, water rationing was adopted by the Nairobi City government and consequently, slumdwellers were at a greater level of vulnerability. Additionally, it is important to note that the total number of water points was not sufficient for the number of residents. An estimated total of 250,000 residents had to share just 173 highly reliable water points, which amounts to nearly 1443 residents per point. The sheer impossibility of this highlights the lack of reliance residents had on having access to water as their main sources were only occasionally available. As a result, many had to purchase water from water trucks and carts to meet their water needs during the height of the pandemic. This data also showed that the generally insufficient water supply is available mainly via private operators in the slum areas. Below is an illustration of the scarcity of government-provided water points.

C. Toilet Mapping

Toilet mapping had 901 facilities mapped in both Kibera and Mathare. Kibera had 471 mapped and Mathare had 430 mapped (**Figure *19***). The survey also included coverage of each toilet's operator, whether it was operational, and apparent condition (good, fair, poor). It also recorded cost if any, availability of handwash facilities, and the number of stalls. Photographs were also collected for each facility.

Figure 20: Sample toilets in Kibera

D. Impact on education in Kibera and Mathare

The team surveyed 1271 parents in both Mathare and Kibera pertaining to the issues they faced with school closures during the lockdowns and the pandemic in general. Schools were closed from March through September 2020.

- Each respondent had an average of 2 children and most had students in primary school
- 10% of students had to switch schools due to the pandemic for a variety of reasons such as inability to pay school fees or the closing down of private schools

- In Kibera, 165 of the 703 respondents had their children in public or government-run schools, while the rest attended private schools (mainly low-cost small schools)
- Only 80 of the respondents had children in public schools in Mathare. However, 25 respondents from Kibera and 8 from Mathare had to move their children from private to public schools because of the pandemic disruptions
- Public schools were generally better resourced during the pandemic to weather the economic challenges, while private schools were often forced to permanently close, curtail services, or remove those who could not pay
- During schools' closure, mothers were primarily responsible for the children's care throughout the day, whether they were employed or not.

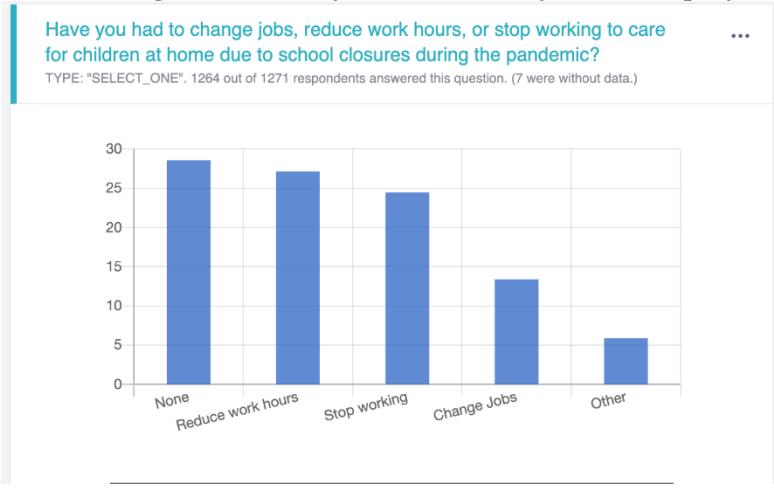


Figure 21: How did parents adjust to ensure care for their children.

Based on the surveys on how parents adjusted to care for their children, the project observed a difference in responses across genders: around 30% of male parents that participated in the survey had no change to their work status. Twenty-six percent had to reduce work hours and 18% had to stop working. Of female respondents, 28% had no change, 28% reduced work hours, and 28% had to stop working.

Quotes from survey replies:

If you had to switch schools, what was the reason?

- "The school she was before required every parent to have a smart phone for their kids to study online but in her current school I had to pick the handouts myself and once she is done, I just return them for grading."
- "The school was closed because the owner could not afford to pay rent."
- "I did not have money and for that reason I had to transfer him to a public school because it's cheaper."
- "I had to relocate to my ancestral home because my job was terminated due to the pandemic."
- "The school he was before was congested and not safe with the COVID protocols"
- "Since I lost my job, I was unable to pay school fees."

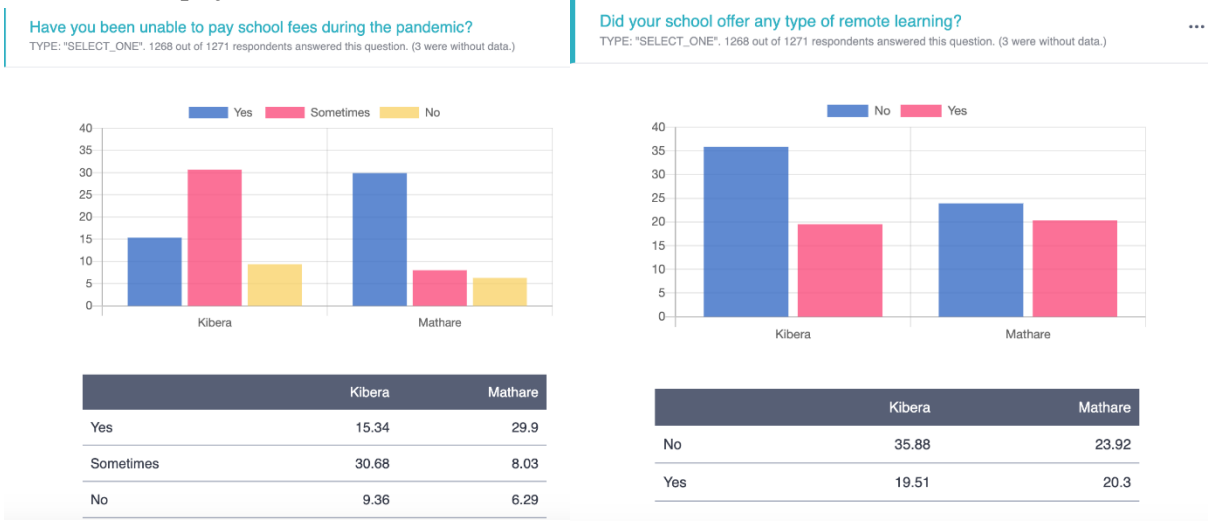
What has been the economic impact of school closures for your family?

- "Expenses have doubled and I had to spend more on basics like food."
- "Had to hire a private teacher to help my children's studies"
- "I was not able to pay the school fees for one of my children hence he didn't get his degree"
- "Family expenditure increased since I had to cater for their lunch unlike during school period where lunch is provided by the school"
- "The second born started to engage himself into drug abuse and used to steal some cash for that. The cost of living also increased and my husband time at work was reduced and hence we had less income"
- "Being with my children at home for a long period of time led to increase in expenditures while having no income"
- "My children's performance decreased since they were not able to learn."

What has been the overall economic impact of the pandemic on your family?

- "Am afraid that my landlord might force me to move out since my business is not doing well and much of the responsibility is on me"
- "Because of the reduction of business hours, I'm making less and for that reason can't pay my rent and school fees on time"
- "Skipped meals to sustain the family with the little we come up with doing casual work"
- "Because of the curfew, we have to close at least 2 to 3 hours before the prime time yet late hours are the most favorable for my clothing business."

The figures below show responses to the survey questions for parents regarding school fee payments and remote learning provision.



	Kibera	Mathare
Yes	15.34	29.9
Sometimes	30.68	8.03
No	9.36	6.29

	Kibera	Mathare
No	35.88	23.92
Yes	19.51	20.3

Figure 22: Survey on school fees and remote learning

The figures show what types of remote learning were provided and whether the children were able to take part, based on the parent survey outcomes.

	Kibera	Mathare
Mobile phone	11.34	22.8
Printed Packets	20.78	11.59
Online	9.45	11.08

	Kibera	Mathare
no	25.14	21.66
yes	13.83	14.86
sometimes	16.28	7.83

Figure 23: Remote learning offers and participation (Nairobi)

Most schools did not offer remote learning options. If they did, many children could not access them, especially if they were provided on a phone or online. Seventy percent of parents said their students fell behind in their schooling and were no longer at the level they should have been.

E. **School Mapping in Kibera and Mathare**

The team mapped every school in Kibera and Mathare. Before the pandemic, Map Kibera Trust had mapped schools in three informal settlements in Nairobi using OpenStreetMap and created the site Open Schools Kenya. Based on this initial mapping there were 365 schools in or primarily serving Kibera, and 233 serving the informal central area of Mathare. The team sought to update this data to reflect the changes the pandemic might have brought to the education sector.

The team tracked schools which were forced to close during the pandemic in Kibera, which included those that closed for a variety of reasons beyond the pandemic, such as the building of a new road and railway widening. At least 19 schools had closed directly because of the pandemic and related economic challenges.

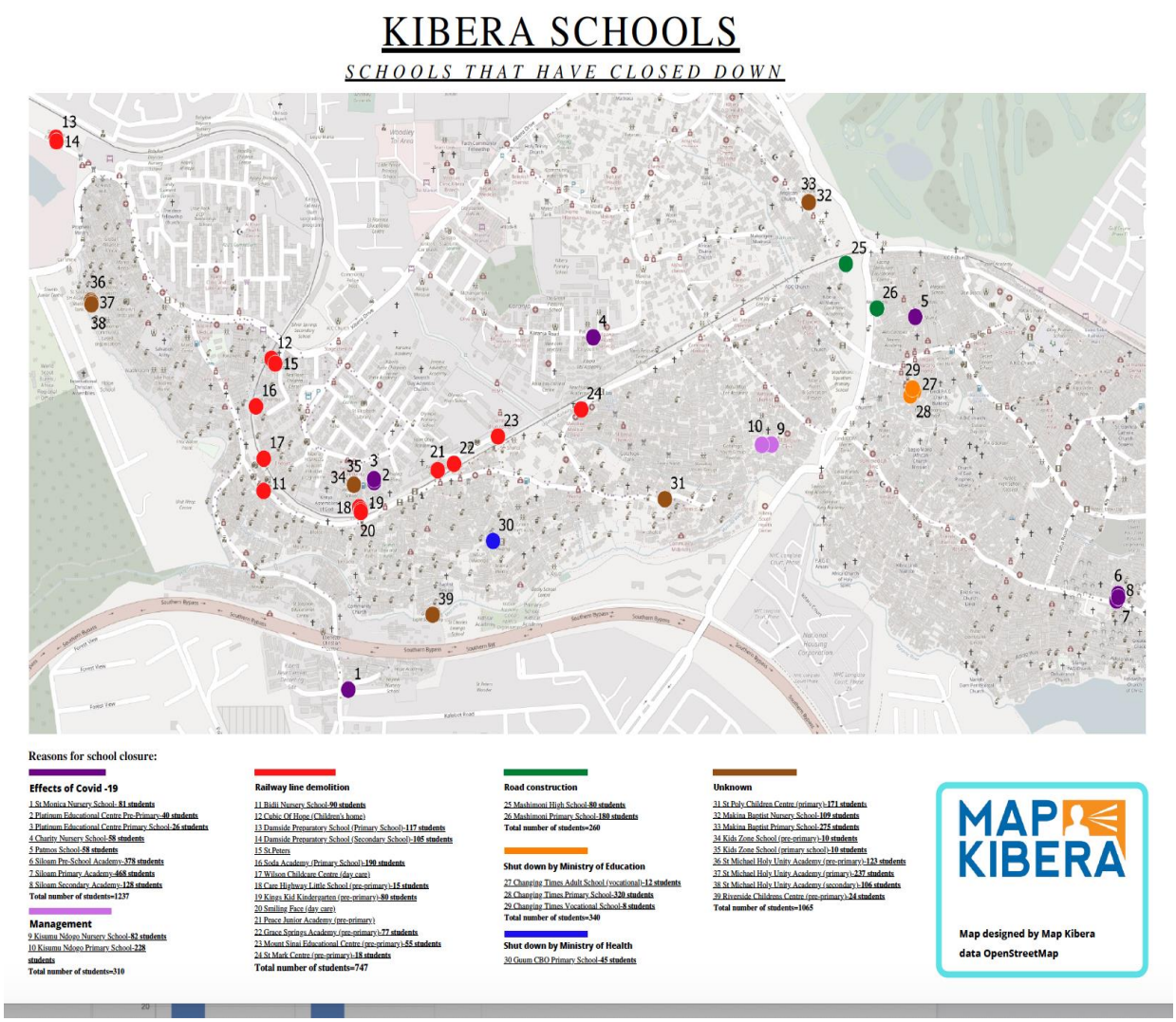


Figure 24: School mapping in Kibera

8.2. Collateral impact on the economy

The communities in Kibera and Mathare took a strong hit from the economic disruptions of the pandemic lockdown as well as from the virus itself. Not enough attention was paid to ensuring that substantial educational, water and sanitation access disruptions would be mitigated by government programs. The primary second order impacts of the COVID-19 pandemic on Kibera and Mathare residents seems to have been related to the economy even more so than health. Job and income loss was devastating to those living on the margins of subsistence. Some of the key challenges faced in this study, which focused on education and access to water and sanitation, included

- Extremely scarce and unreliable water supply
- Inability to pay for water
- Walking long distances for water
- Inability to access toilets after dark during curfews
- School closures (both short term and permanent) with great economic impacts for school owners

– Families unable to provide enough food for children home from school, children falling behind due to the lack of remote schooling, inability to pay school fees, and crowding in public schools.

9. Project Assessment

9.1. The pandemic and its second order impacts through a causal loop

Here is a causal loop diagram showing the relationships between COVID-19 cases, the economy, and the education sector:

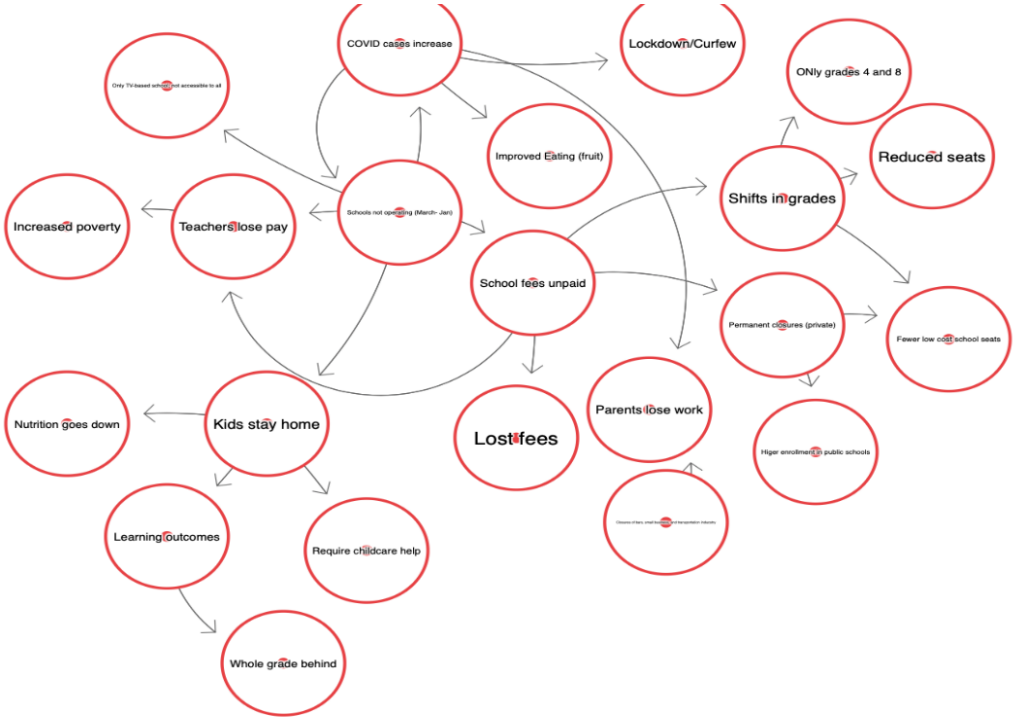


Figure 25: Causal loop to understand second order impacts in Kibera

9.2. Geospatial data analysis based on access to water

Here is an initial heatmap showing access to water in each slum:
There were some variations in vulnerability to water challenges. However, looking more closely at our water data site (https://mapkibera.github.io/watsan/nairobi/#14.59/-1.31422/36.78635/0/1) we can see the following:

The number of fully operational and reliable water point sources is not evenly distributed (**Figure 28**), nor sufficient for the population (i.e., we see only 173 points for at least 200,000 people in Kibera[2]). Similarly, in Mathare, water points are frequent but reduced substantially when selecting for operationality and reliability. With regard to toilets, it is important to note that access to toilets in good condition for the population was sparse (**Figure 29**, **Figure 30**, **Figure 31**, **Figure 32**, **Figure 33**).

2 Note: Some parts of Kibera which are more formally organized may have access to water internal to homes as well. However, this does not represent the majority of the population.


Mathare
Valley

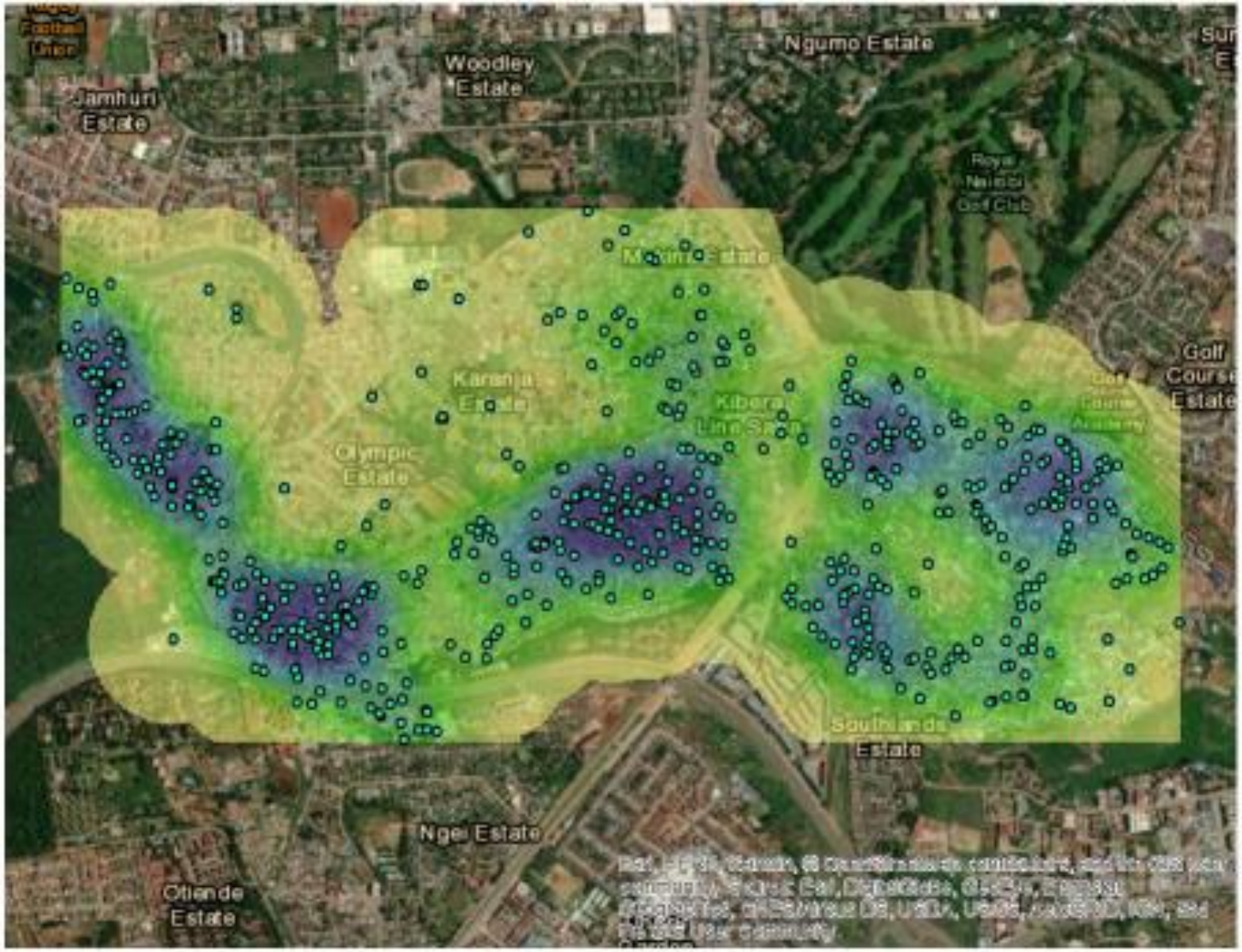


Figure 26: Heatmap of water access in Kibera and Mathare

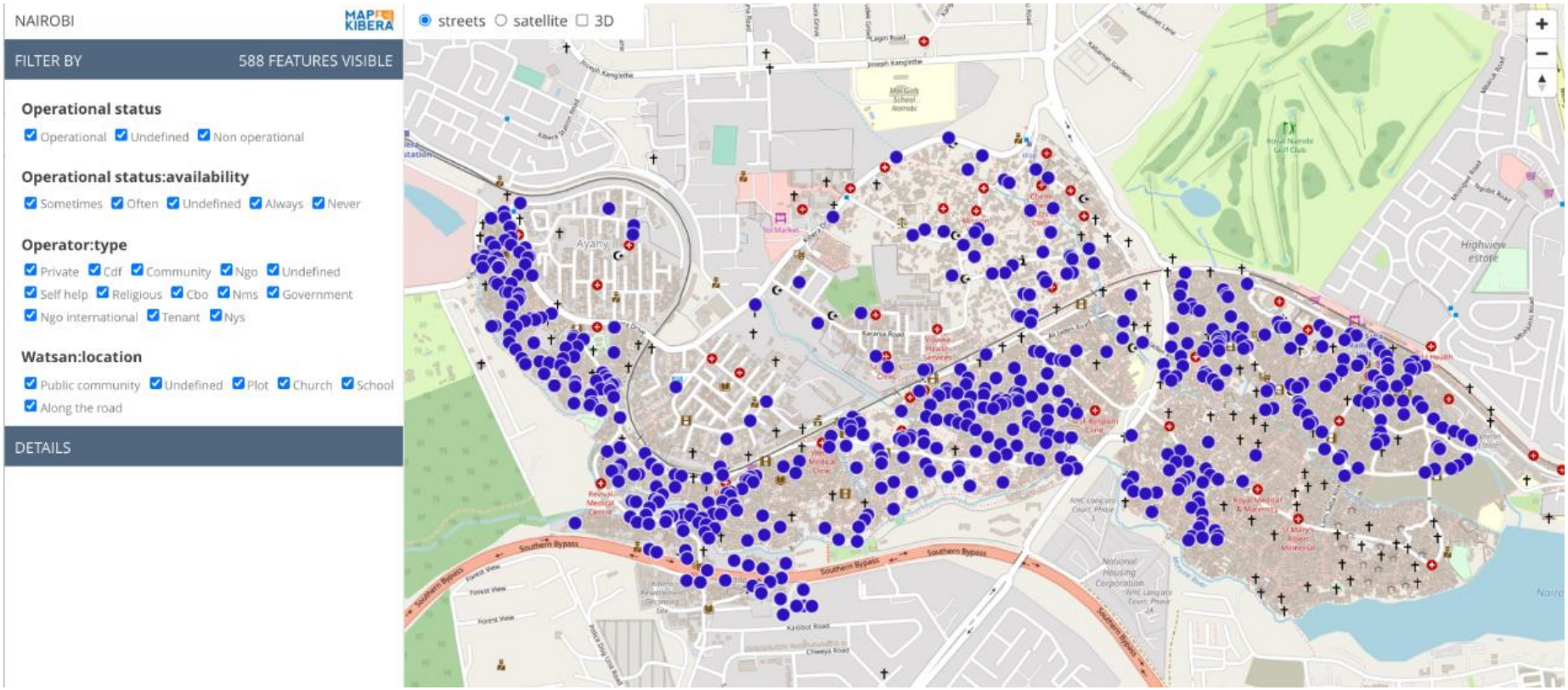


Figure 27: Water point distribution in Kibera

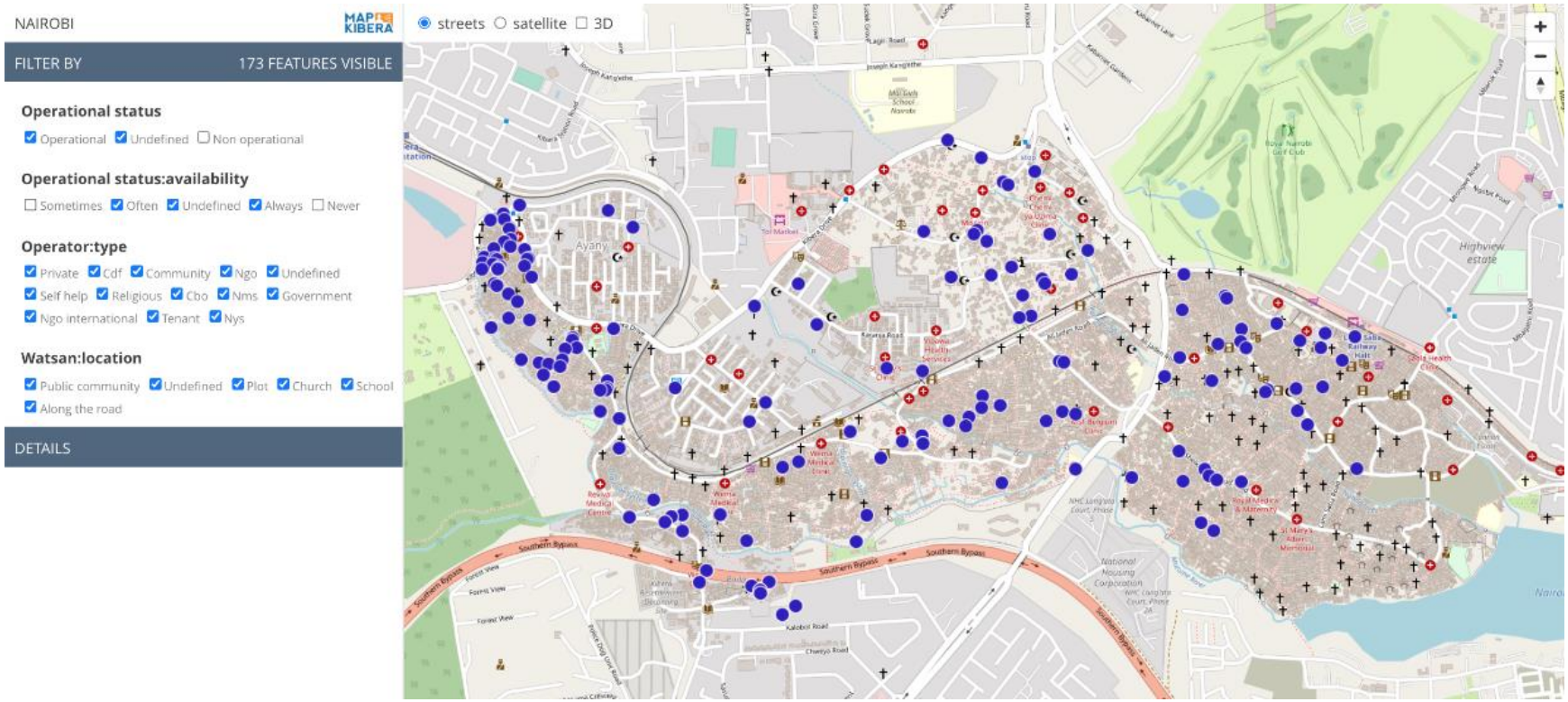


Figure 28: Water point distribution in Kibera based on availability

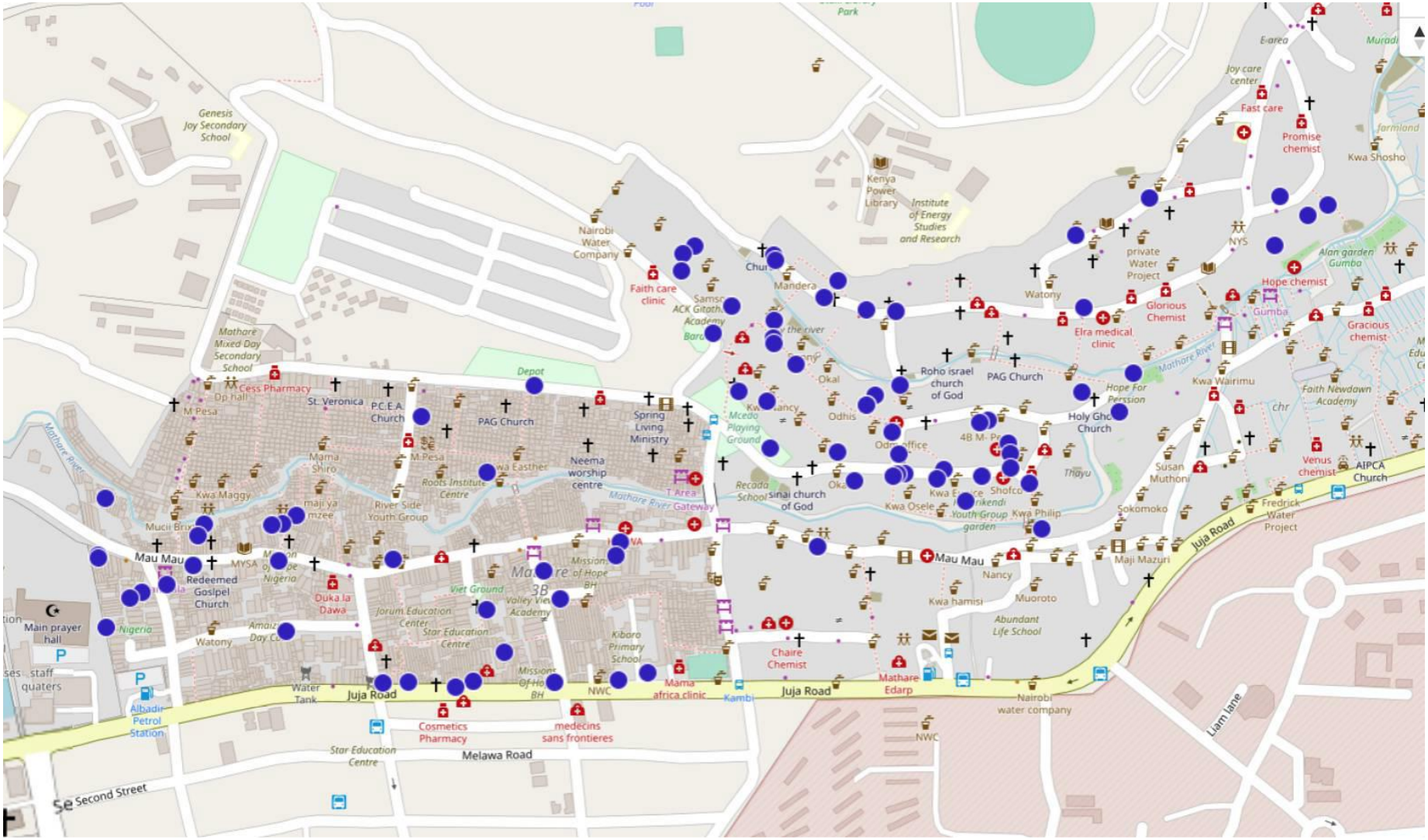


Figure 29: Distribution of toilets in Kibera.

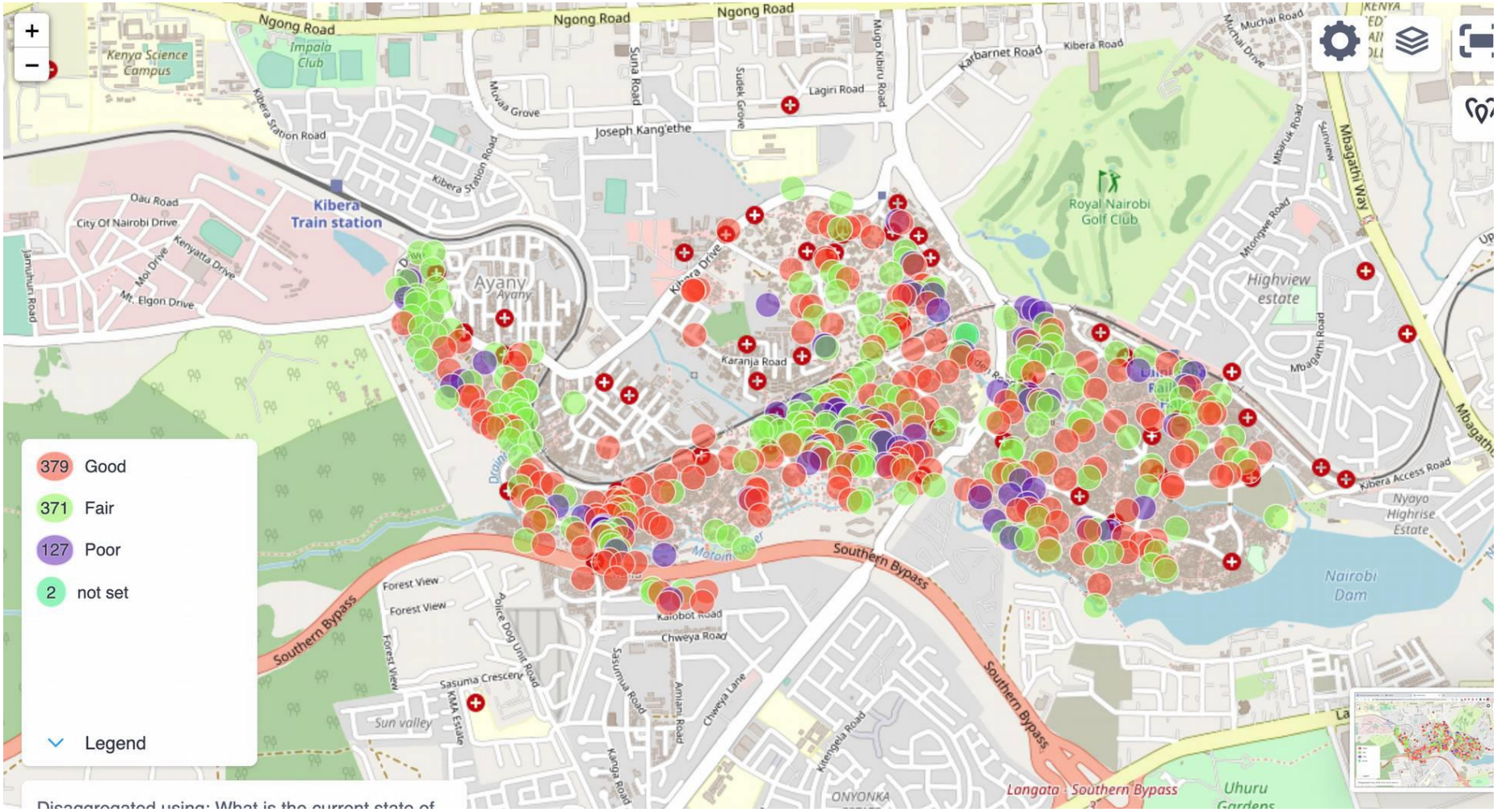


Figure 30: Distribution of toilets in Kibera.

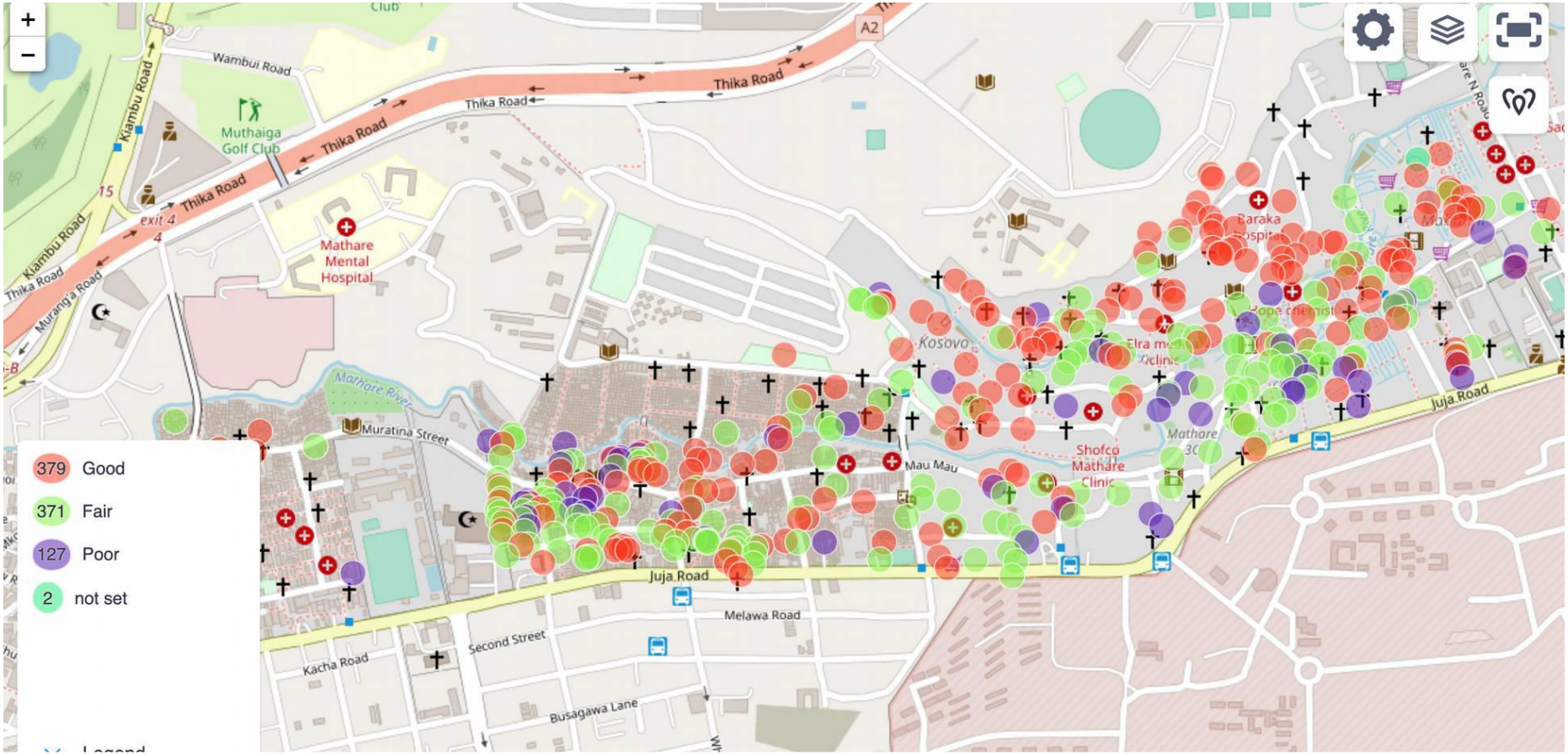


Figure 31: Distribution of toilets in Mathare.

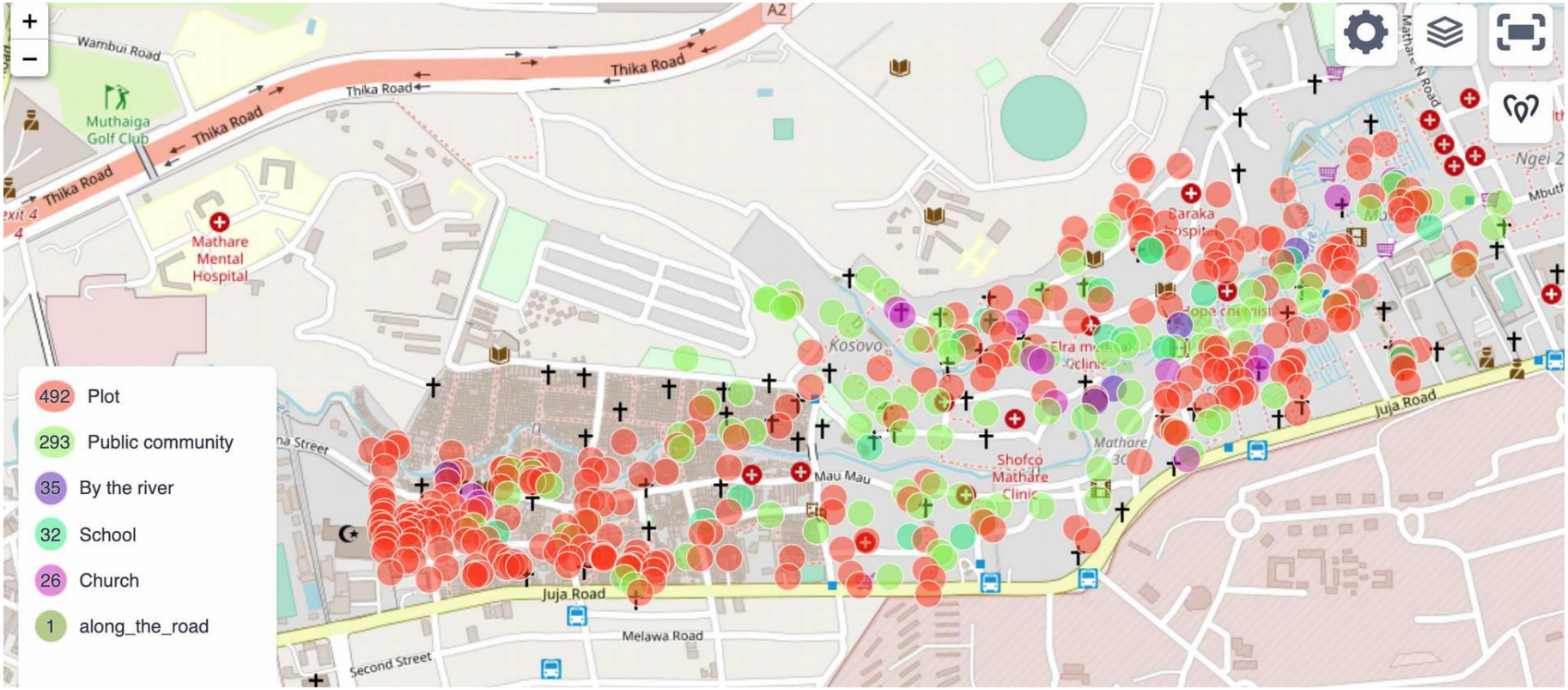


Figure 32: Distribution of in compound plot toilets in Mathare.

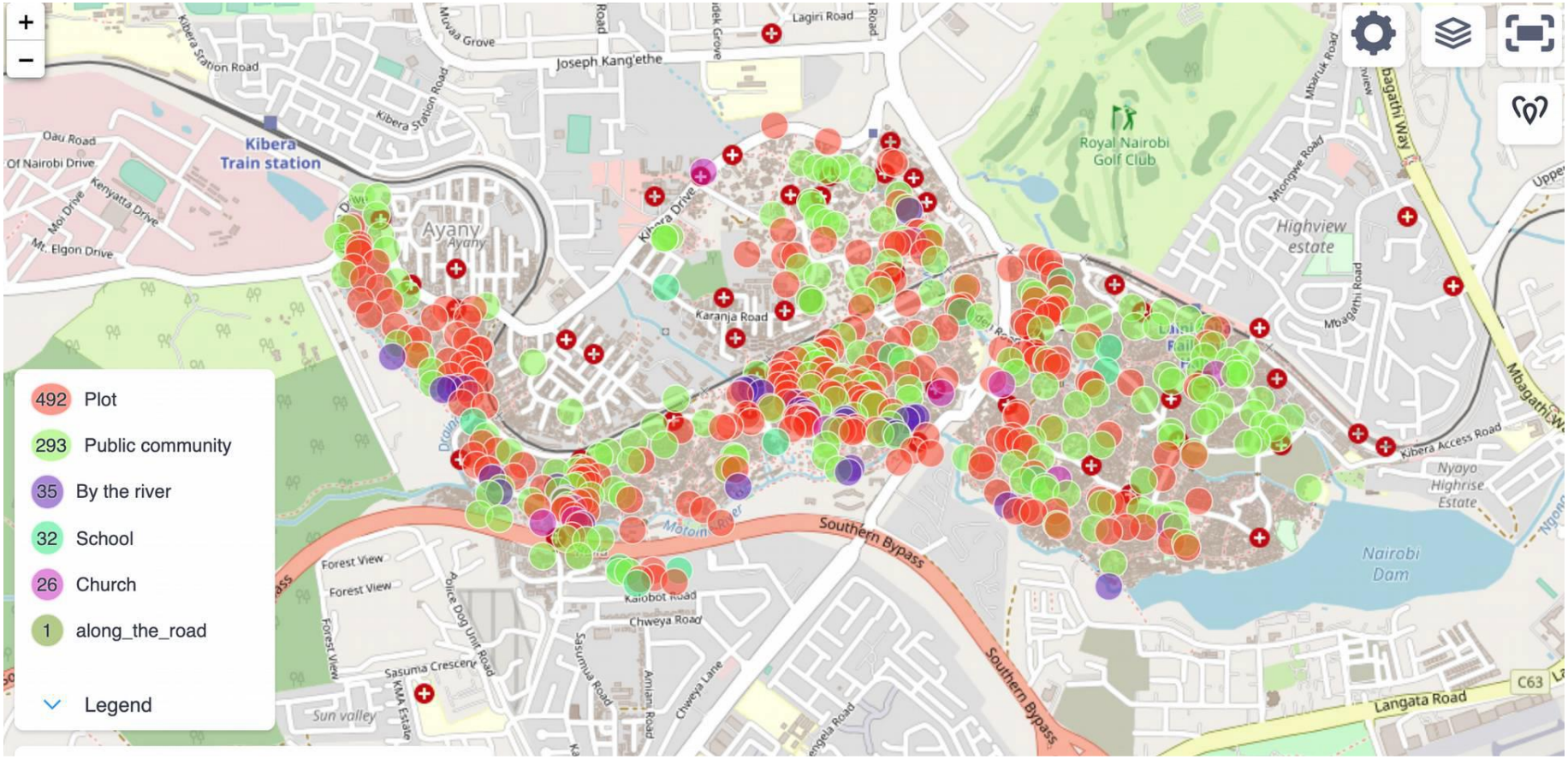


Figure 33: Distribution of in compound plot toilets in Kibera.

Considering that public toilets are also unavailable at night during times of curfew, this is another major problem that needs to be urgently addressed. Note that in the map below, we can see that in certain parts of Mathare, particularly in the western segment of the settlement, many residents have access to "plot" toilets, but the central and eastern residents have far fewer. Plot toilets are located within the housing compound; public toilets are outside and inaccessible during curfews.

9.3. Challenges managing prevention

Vaccine rollout was slow and mostly available to certain people. Only ~2% had been vaccinated by September 2021.

9.4. Stakeholder engagement

Due to the nature of Map Kibera's relationships within the target communities, there were no challenges engaging local stakeholders. Map Kibera was able to easily build relationships with key stakeholders in the communities like local education officials. Other local community-based organizations were also engaged throughout the project. Small meetings and workshops are still being held in November 2021 to let the stakeholders see the results of the project and to encourage action among relevant organizations and officials.

The universities that were identified as potential partners were engaged initially, but their scope of work was not finalized. There was not a programmatic need for them to host larger workshops and presentations as we expected due to the ongoing pandemic and restrictions on gathering.

9.5. Lessons learned and metrics based on the last 12 months

The main hindrance to our planning was an inability for GroundTruth to travel to Kenya, which required remote working with the local Map Kibera team. This also hindered relationship-building and workshops planned among intended project stakeholders. However, mapping and data gathering in-person continued as planned. Key lessons learned is the ability to help local partners with video conferencing technologies to support remote work especially where travel is limited.

10. Recommendations

It is key to track the impacts of policies and pandemic-related challenges in the informal settlements. To date, the government of Kenya has not closely tracked the informal school sector, known as APBET schools (Alternative Basic Provision of Education*), or the informal water and sanitation sector. It is key for the policymakers and government leaders to prioritize the most vulnerable residents during a pandemic. To do so, they need to be fully aware of the following:

- Locations of schools and how many children attend each school and the impacts of the various policy decisions including lockdowns on non-public schools and affiliated families, teachers, and staff. The closures of schools caused them to lose their financial support forcing them to close or turn away non-paying families
- Reliance on school-based nutrition and feeding
- Impacts of closing schools on children's nutrition and health
- Impacts of water shortages and rationing on informal settlements' residents; Locations of all water points and their functionality and reliability as well as understanding the water points ratio per population; While the water system

remains complex, during a pandemic emergency, water becomes essential and more should be done to distribute free water at times when residents may otherwise not have access, endangering hygiene and health

- Locations and status of toilets and sanitation facilities used by residents of the informal areas; During times of health emergencies, it is important to quickly be able to assess and improve sanitation options. It is also key to know how many compounds have internal toilets and how many people rely on public facilities which are inaccessible during curfew, and remedy that issue
- It is our strong recommendation for policymakers to partner with the civil society organizations such as Map Kibera Trust and others to create reliable and real time up-to-date maps and collect data around these key metrics, which are extremely hard to track given the informal status of the communities, and utilize data in OpenStreetMap for analysis including:
  - **Identify school closures and remote learning options**
    Policymakers should be aware that remote learning is not possible for most residents of the informal settlements and was not provided to them during the pandemic closures. It is also important to note the impact of private school closures on the public school system including crowding in the public system from the influx of students.
  - **Access to data for communities in informal settlements**
    Informal settlement communities need access to maps and data as well. Supporting the use of open data and open maps in conjunction with community organizations is key.

11. Tools and technology used for data collection and analysis.

For data collection, the team used smartphones and ODK Collect app, linked to surveys built in Kobo Toolbox. The team used OpenStreetMap, Kobo's cloud database, and local CSV exported files as primary data repositories. All public data has been put into OpenStreetMap. Survey data is held privately in the Kobo website. The team did not collect any PII to ensure the data is being protected, but locations were collected of survey respondents, some of which were in their homes.,. For analysis, the team used a website built to bring in data from OpenStreetMap and the Kobo data results. See: https://mapkibera.github.io/watsan/nairobi/#14.59/-1.31422/36.78635/0/1

Pemba

Understanding the Second Order Impacts of COVID-19 in Pemba, Mozambique

By

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Universidade Católica de Moçambique

12. Introduction

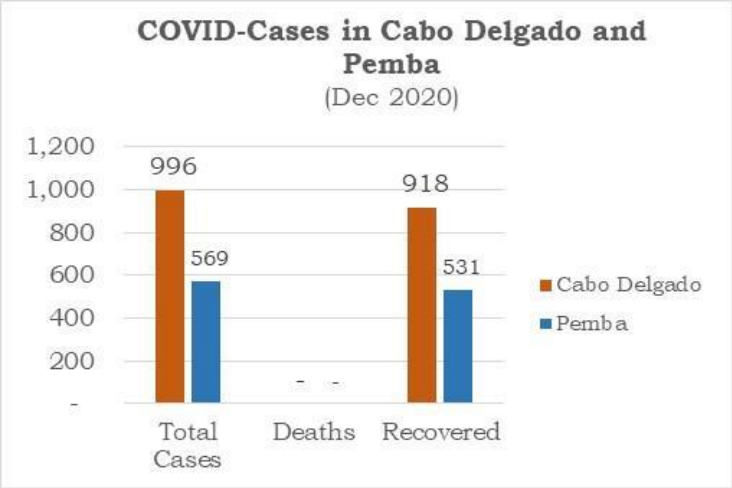
12.1. Background

Pemba is an emerging city due to the discovery of oil and gas deposits in the Province of Cabo Delgado, which has attracted individuals from many surrounding countries. As a result, the city is experiencing a demographic shift that has increased the mobility of people and goods, both of which have contributed to the spread of COVID-19 in the city. Consequently, Pemba was declared the city with the second highest "community transmission" of COVID-19. To mitigate this situation, the city of Pemba built the largest COVID-19 treatment center in the country with a capacity of 200 beds. As of early December 2020, the city has recorded 569 COVID-19 cases (38 active, 531 recovered and 0 deaths). For that reason, Mozambique declared a state of emergency (level 1-3). This state of emergency led to reduced mobility for people and goods, suspended the activity of 1175 companies, and affected the stability of more than 12,160 jobs.

As the thirteenth-most populated country in Africa, the study of the second order impacts of COVID-19 in Mozambique provides an opportunity to understand how such a large nation was able to keep its cases and deaths relatively low in comparison to smaller countries. Additionally, as Mozambique is still dealing with the aftermath of several recent natural disasters, the data collected could prove itself to be instrumental in helping the country assess how to best respond to natural disasters and pandemics in the future. As 75% of their workforce is in the informal economy (subsistence farming, fishing, and livestock), having the project focus on the port city of Pemba provides an incredible opportunity to evaluate the second order impacts of COVID-19 on Mozambique's economy, especially in relation to its growth as a tourist attraction.

12.2. Project implementation area description

Pemba is the capital of the Cabo Delgado Province and located in the northern region of Mozambique. The municipality of Pemba is composed of 2 administrative units and 10 residential neighborhoods. According to the National Statistics Institute, the general census of 2017 recorded the total city population at 200,529 (101,426 women and 99,103 men). Pemba Bay is the largest bay in Africa and third largest in the world. This places the city in a privileged position off the Indian Ocean with ample resources to develop its fishing industry. In fact, Pemba's main economic activities revolve around fishing and tourism. Due to these attributes and Pemba's previous participation in Secondary Cities (2C) projects, the city was a great choice to understand and analyze the second order impacts of COVID-19.



On March 22, 2020, Mozambique officially registered its first case of COVID-19 in Maputo City. The Cabo Delgado Province was the second region to register a case of COVID-19. It was a 61-year-old Mozambican citizen who tested positive through local

infection. This situation created some panic within the local communities given the lack of accurate and reliable information about the disease, despite efforts by the local government to keep the population informed. Therefore, launching the C2M2 project in Q4 2020 was truly a great opportunity to use geospatial data to better understand second order impacts of COVID-19.

12.3. Project Goals, Objectives, and Outcomes

The project focused on the second order impacts of COVID-19 from an education and economy (business and household) in Pemba. The goal was to use geospatial data to:

- Provide best practices and tools to government agencies, businesses, and schools that would enable them to better understand the second order impacts of COVID-19
- Provide metrics to support decision making and inform strategic actions to mitigate the second order impacts of COVID-19 and similar pandemics in the future
- Provide applications that will help local officials easily communicate with the population while providing citizens with information on how to quickly access critical services.

Building upon these goals, this report provides:

- A comparative analysis of COVID-19 from January 2021 – August 2021
- A project assessment including:
  - Results of the data analysis and visualized results
  - Challenges related to prevention management
  - Lessons learned.
- Recommendations including sustainability of proposed solutions
- Tools and technology used for data collection and analysis.

To support the comparative analysis and project assessment, the team defined a set of strategic objectives and geospatial metrics to help understand second order impacts. The table above provides an overview of the metrics that were collected in Pemba with a focus on healthcare and education.

Perspective	Strategic Objectives	Measurement objectives (metrics)	In scope
Pandemic	Understand the current state of the pandemic	#New cases, #Recovered, #Deaths	√
Education	Mitigate the impact on education	Access to education	√
		Quality of education	√
Economy	Mitigate the economic impact	Impact on local economy	√
		Mobility	√
		Economic health	√
		Personal finances	√
		Access to food	√

Table 8: Metrics used in Pemba.

13. Comparative Analysis

With the discovery of gas in the Rovuma Basin, people in search of employment opportunities and recent terrorist attacks have caused mass displacement of residents from other districts to the city of Pemba. As a result, the city became more vulnerable to the spread of COVID-19 and was later declared the city with the second highest "community transmission" of COVID-19 in Mozambique.

Given the high number of COVID-19 cases in Pemba by Q4 2020, the government (central and local) declared a state of emergency (level 1-3) and implemented a set of restrictive measures including:

- Banning all public and private events
- Suspension of religious services
- Visa suspension
- Closure of schools
- Closure of entertainment establishments
- Closure of borders
- Advice against crowding.

These measures had a direct impact on the local economy including the tourism sector (especially entertainment and lodging), retail, productivity, labor costs, unemployment rate, and personal finances. According to the Confederation of Economic Associations of Mozambique, at least 1175 companies suspended their activity by January 2021 and more than 12,160 jobs were affected.

According to the National Institute of Statistics in Mozambique (INE), restrictions on the movement of people and the sudden paralysis and severe reduction in economic activities during the same period impacted 90% of the informal sector and 10% of the formal sector. This situation resulted in job losses for many informal sector workers, increasing poverty and vulnerability.

To reduce the impact on the local economy, especially during the holiday season, the government lifted some restrictions on December 17, 2020. With the ease of some restrictive measures came a spike of new COVID-19 cases in January. In fact, the country recorded 48,935 new cases, 608 deaths, and 40,155 recovered individuals in Q1 2021. In the same period, Pemba registered 2,492 cases, 10 deaths, and 2,431 recovered.

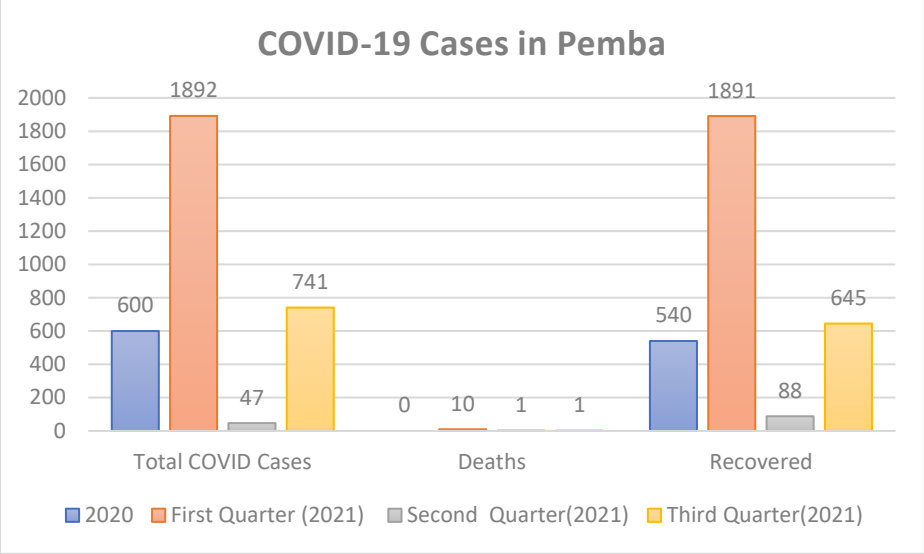


Figure 34: Covid Cases in Pemba, Q1-Q3 2021.

With the National Health System reaching its capacity limit, many health workers were infected, and some lost their lives, forcing the government to reinstate some restrictive containment policies by early 2021 including:

- Media/community radio being invited to reinforce education and communication in more creative and more efficient formats to spread the message aimed at changing the attitudes on preventing COVID-19
- COVID-19 testing for all travelers as a way of strengthening surveillance at the borders'; checkpoints were also established on highways for truck drivers
- Encouragement not to go to work, schools, training facilities, and other public places for people with proven respiratory symptoms or fever
- Call for greater individual and collective vigilance
- The restriction of business hours for restaurants: 6am to 8pm from Monday to Friday and 6am to 3pm on Saturday and Sunday; furthermore, the number of customers was limited to an approved capacity
- The assignment of open-door licenses, restoration licenses, and bottle store licenses were temporarily suspended
- Closing of the following establishments: disco/pubs, game rooms, casinos, bars, and stalls selling alcoholic beverages
- Temporary suspension of cultural activities such as cinemas, theaters, museums, galleries, cultural centers, and auditoriums, as well as activities in catering, tourism, and similar undertakings
- Suspension of all activities in gyms, public pools, and other public and private places for the development of physical exercise
- Holding national championships in all sports with public presence
- The continued authorization of training sessions for national and local teams
- The permission to continue tennis, swimming, motor racing, motorcycling, cycling, athletics, sailing, and canoeing competitions
- Limiting private events to a maximum of thirty participants (from 50) if held in closed or semi-open spaces (rooms, tents, or equivalent), or fifty people (from 150) if held outdoors, ensuring a distance of at least two meters between people and strict compliance with preventive measures
- Restricting private events including wedding ceremonies and birthdays to end before 8pm

- Making the failure to comply with the measures an act of transgression and disobedience, punishable under the terms of the law
- In cases of disobedience and recidivism, additional to the provisions of the preceding paragraph, a prosecution will be initiated with the judicial court.

The following measures were also announced:

- Services, conferences, meetings, and religious celebrations are authorized, provided they do not exceed fifty people
- Funeral ceremonies must not exceed the maximum number of twenty participants at the wake and only ten participants if it is related to a positive COVID-19 death
- Expired official documents are considered valid until May 31, 2021
- All stakeholders, from the public and private sectors were advised to:
  a. Resume teleworking, especially for individuals at risk of developing illnesses
  b. Continuously inspect all markets, commercial establishments, bus stops, public transport, and other places where there is agglomeration, to ensure compliance with the preventive measures already adopted
  c. Hold the heads of public and private institutions accountable where there are clusters of service users.

On February 4th,2021, the President announced a series of additional measures to be implemented within 30 days to ease restrictions:

- Resume face-to-face classes nationwide at institutions of primary and secondary education, professional, technical, and vocational training, and high schools
- Depending on the evolution of the epidemiological situation and the ability to comply with the preventive measures recommended by the authorities, some educational institutions or regions, may interrupt their classroom teaching activities or start them later on
- Educational institutions must observe measures defined in the national health protocol for the prevention of COVID-19 in the country
- Training for national professional soccer teams competing for the championship known as *Mocambola***,** is authorized, but the national championship is prohibited
- Resumption of training is subject to weekly tests of COVID-19, and athletes/players who test positive will be subjected to the regime provided for in the presidential decree
- The business hours for shopping centers are from 9am to 7pm, Monday to Saturday, and from 9am to 4pm on Sundays, with the other commercial establishments maintaining their normal business hours

In Q2 2021, the country saw an improvement in newly registered cases with a daily average of about 35 cases. After relative stability, Mozambique returned to the third wave in Q3 2021 with an average of about 406 cases daily due to the Delta variant. It mostly affected young people aged 35 to 45. This spike frightened local authorities as the incidence of the virus in youths was increasing daily.

In this third wave, the epicenters were in the provinces of Maputo and Tete. Surprisingly, the Province of Cabo Delgado, especially the city of Pemba, once the epicenter of community transmission for COVID-19, managed to control the evolution of the pandemic.

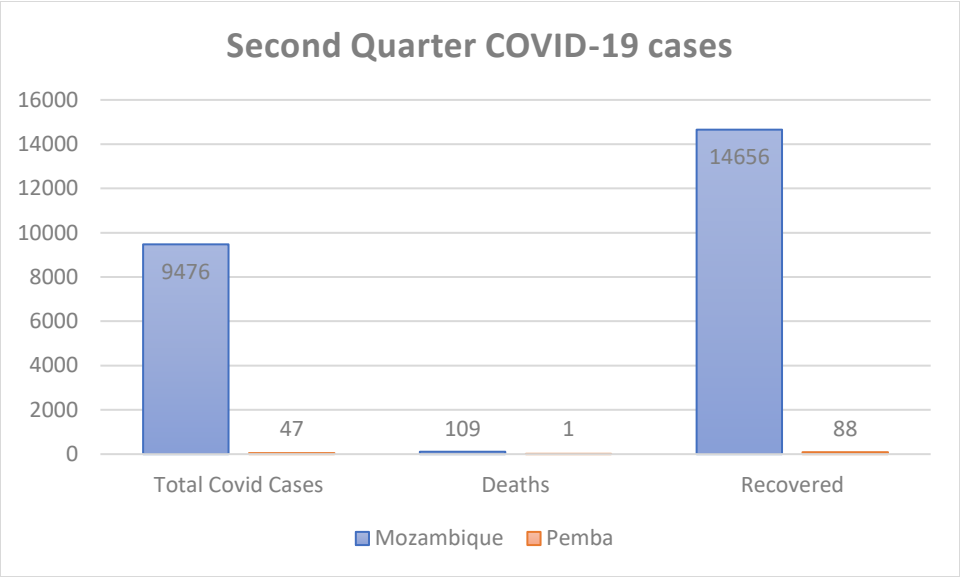


Figure 35: Second quarter COVID-19 cases (Pemba)

Due to the accelerated evolution of the pandemic, the government had to tighten some restrictive measures in June 2021 including beach closures, the introduction and enforcement of a curfew from 10:00 pm to 4:00 am, and the closure of theatres and museums.
The new measures also reduced the business hours for restaurants, take-away bottle stores, and home delivery services from 6 am to 8 pm. Religious services and celebrations, conferences, and meetings could not exceed forty percent of the maximum capacity of each venue, with a maximum of 40 people indoors and 80 people outdoors. In addition to using the restrictive measures as a way of fighting the COVID-19 spread, the Mozambican government also intensified its vaccination campaigns. The goal was to vaccinate a total of 16,825,333 people (15 years or older), representing 54.6% of the total population.

In a nutshell, the government was very responsive and appropriately adjusted to the different surge cycles to protect lives and mitigate the second order impacts on the local economy and the vulnerable population groups.

13.1. Impact on the economy

The Mozambican economy was directly affected by the COVID-19 pandemic. The border closures had a direct impact on the volume of imports and exports. The limitation of movements within the country during the state of emergency that spanned from Q2 to Q4 2020 greatly impacted the local economy and labor market. Some households saw their purchasing power and savings decline. Wages during the same period were influenced by restrictive measures that reduced working hours and the production capacity of many enterprises.

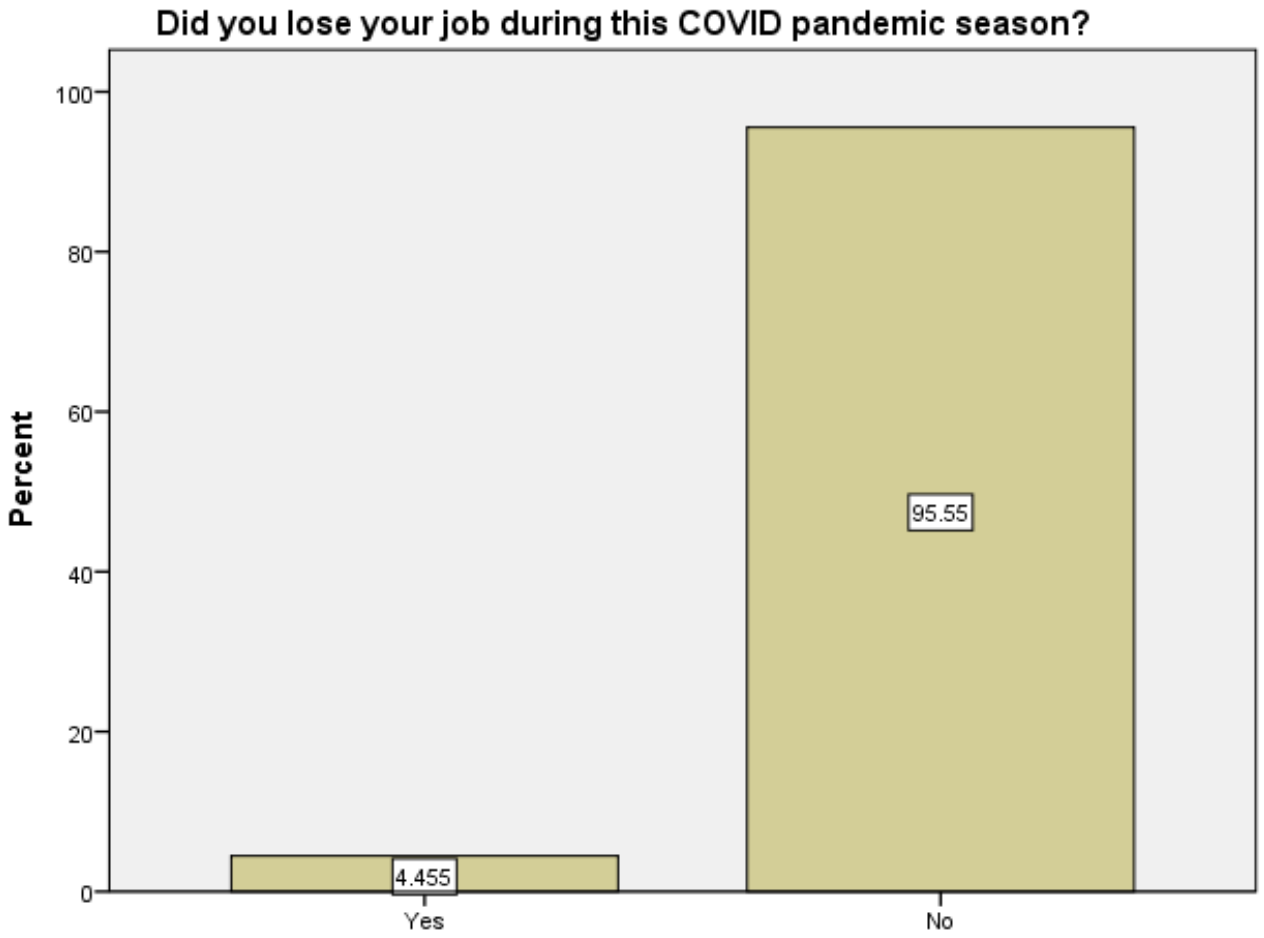


Figure 36: Impact on jobs in Pemba

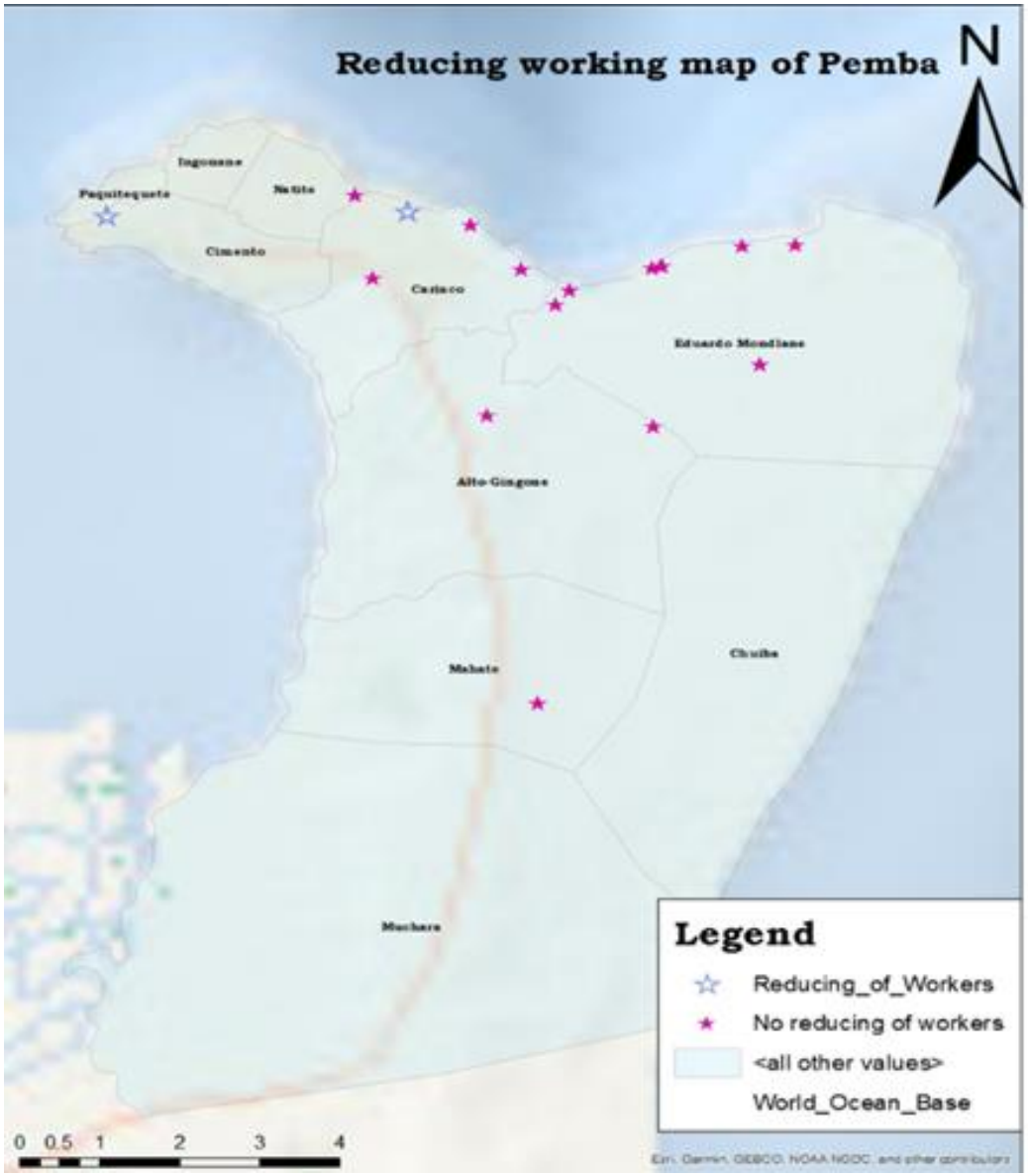


Figure 37: Workforce reduction in Pemba

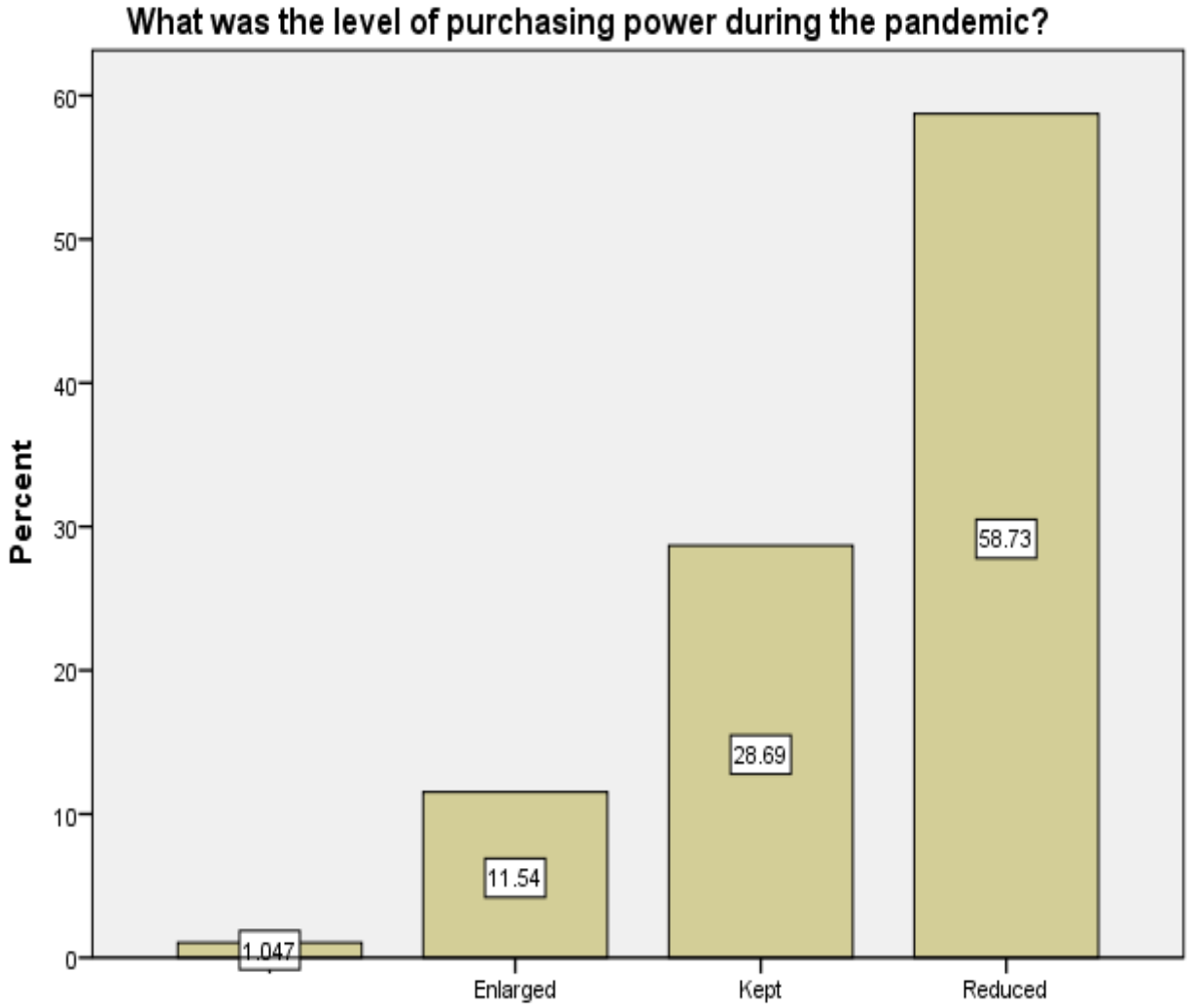


Figure 38: Impact on purchasing power in Pemba

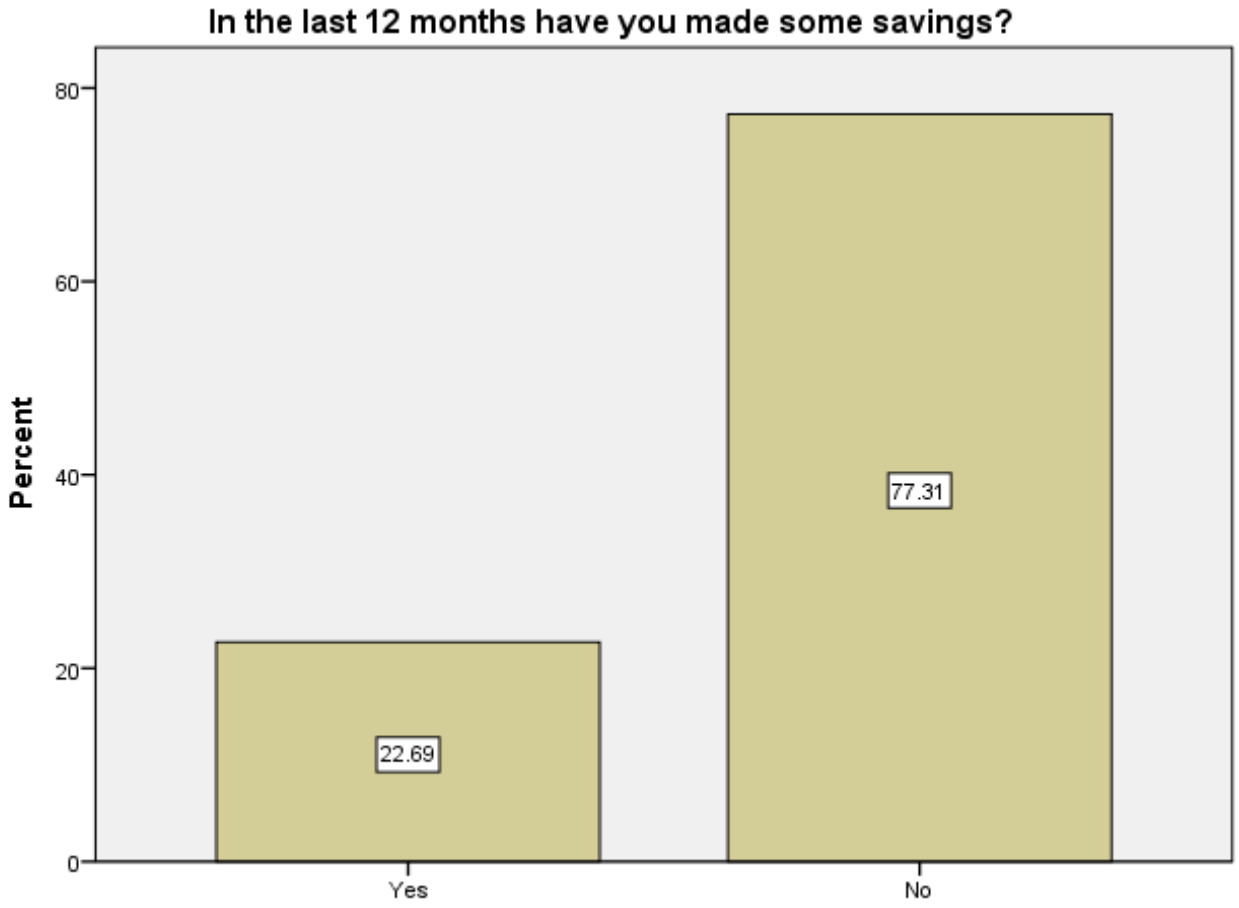


Figure 39: Impact on personal savings in Pemba

Workforce reduction & job loss (Figure 37)
Only a few businesses in Pemba had to reduce their workforce since Pemba did not implement a proper lockdown. The city opted for establishing restrictive measures that simply limited openings hours to enable businesses to remain open. In the subsequent period from January to August 2021 ("Public Calamity" period), Pemba's economy continued to feel the effects of COVID-19 given the prolonged restrictions on business hours that directly affected the output of Pemba's institutions.

Impact on purchasing power (

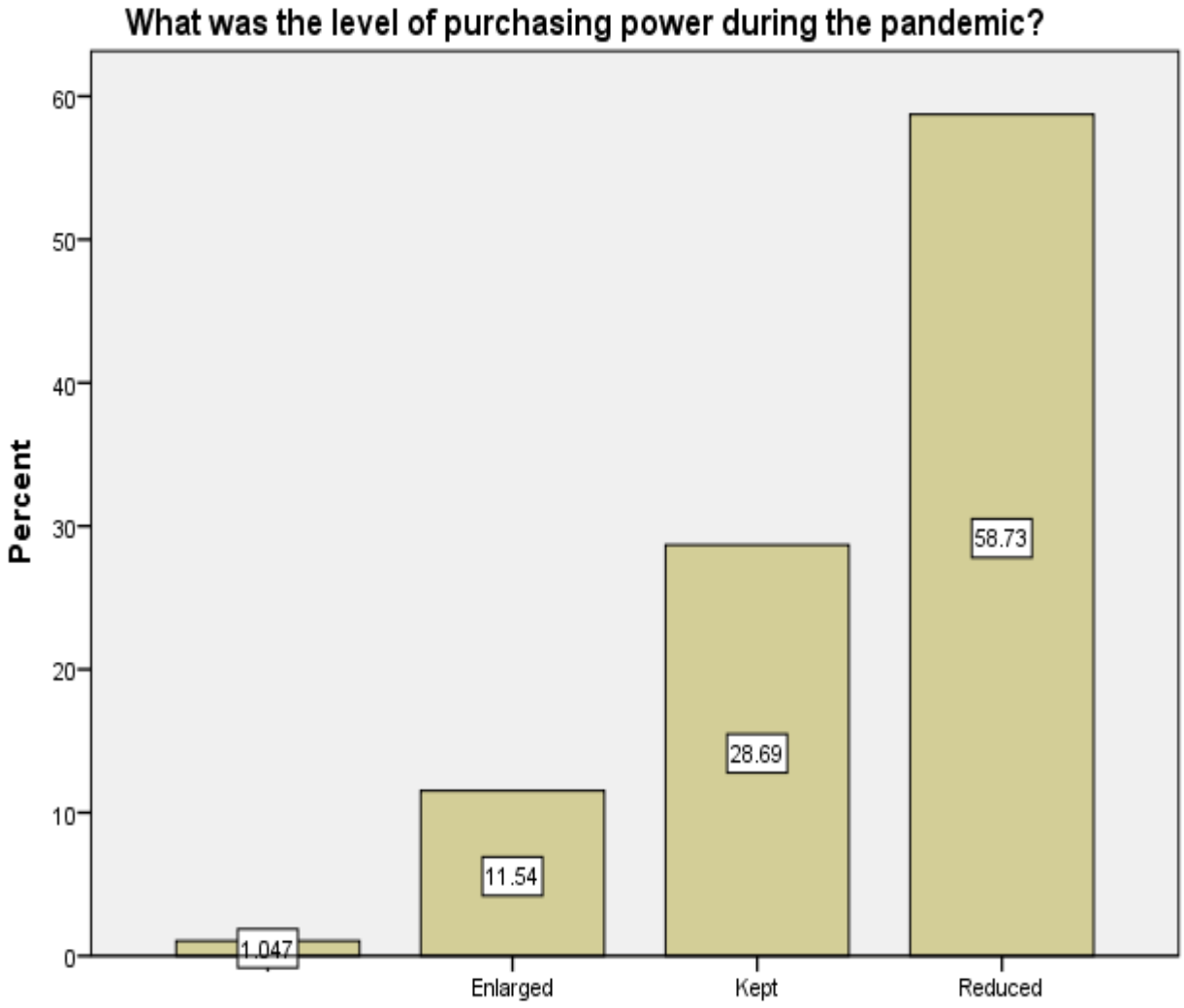


Figure 38)
Restrictive measures that limited the mobility across borders, between cities and rural areas (main suppliers of local goods to the urban population), and within cities affected the normal operations of the different institutions and business. This led to a significant decline in the purchasing power of Mozambican families.

Impact on personal savings

Because of the restrictive measures, declining wages, and declining purchasing power, many families had to tap into their savings. In a nutshell, most families were not able to save throughout the "Public Calamity period".

13.2. Impact on the education

To better portray the second order impacts of COVID-19 on the education sector in the city of Pemba, it is best to look at it under the lens of the two major periods that mark the pandemic in the city: the period of the state of emergency in which classroom lessons were completely suspended and the period of "Public Calamity" with the resumption of classroom lessons under restrictive measures.

Impact on education during the state of emergency

During the State of Emergency from April to September 2020, classroom teaching at all education levels was completely suspended. During that period, various scenarios were experienced to mitigate the second order impacts including:

a. Reducing the students' headcount

During this period, many schools attempted to move to an online or remote classroom model. This attempt was not successful for many reasons including:

- Local perception that remote teaching did not contribute to students' learning
- Acquisition costs of digital learning management platforms
- Lack of mastery of digital platforms by both lecturers and students.

As a result, many schools had to resort to reducing the students' headcount and increasing the number of sections per grade to meet imposed restrictions.

b. Reduction of tuition fees

Given the economic impact on personal finances, some private schools had to reduce tuition fees to keep school affordable for most families. This move however forced those institutions to reduce staff salaries to remain operational. However, it should be noted that one should not limit the analysis of the second order impacts on the education sector to the reduction of salaries. It is equally important to look at the indirect impacts that include the reduction in purchasing power and the psychological upheaval created by the inability to afford basic goods due to price hikes that stemmed from border closures.

c. Online education and remote learning

In higher education institutions and some secondary schools, digital platforms were introduced (i.e., Google Classroom, Google Meet, Skype, and Zoom). However, the poor quality of the internet signal and the lack of proficiency in the use of these platforms by teachers and students (unprepared institutions) meant that not all students attended classes. This scenario forced educational institutions to invest in training students and teachers.

Once the training begun, another concern arose: limited features on free digital platforms. This led to schools needing to make additional investments i.e. the purchasing of software licenses. However, not all institutions could afford it. As an alternative, many schools began to use WhatsApp to record lessons and send them to students. In summary, educational institutions in the city of Pemba, as

well as the students had to make unforeseen investments in a context where many school administrators lost their jobs and the city was under constant threat of terrorism.

In primary schools, the use of brochures and television was the only choice. With that scenario:

a. Parents played a crucial role in the education of their children. This introduced a third fundamental figure in the learning process: the guardian
b. Not all children had access to electricity to follow the lessons on television
c. Ensuring that the subjects on TV were coordinated with what the student was supposed to learn during the same period caused another challenge.

Faced with these issues, several questions were raised, such as:

a. What about the children whose parents cannot read or write?
b. Did these children have the same level of learning as others?
c. What are the long-term repercussions of this teaching-period beyond the classroom and for the rest of their lives?

On the other hand, it was also reflected that children living in houses with only one room had difficulties concentrating as the same room where the other members of the family were doing different tasks was used as their classroom.

Impact on education during the period of "Public Calamity"

During the "State of Public Calamity," classroom lessons resumed however, the new restrictive measures required additional infrastructure investments and changes including:

a. Construction of toilets and installation of hand washing facilities
Building the mandated infrastructure entailed resources that were not budgeted for 2020. Many schools had to reallocate budgets to cover these costs while making cuts in other areas.

b. Introduction of the hybrid model (face-to-face/remote)
With the introduction of this model, private institutions were able to charge the regular tuition. This in turn enabled schools to adjust staff salaries to pre-COVID levels.

c. Increasing the number of class sections
With the resumption of face-to-face classes and the need for social distancing, many schools divided classes into sections vs. building new classrooms. This led to increased workload for teachers. The adoption of the hybrid model (face-to-face and online/brochures) enabled schools to create a class schedule that allowed for class rotation. In order to cope with the increase in class sizes created by social distancing, some private schools with a sound financial situation and some public institutions hired additional teachers.

d. A look at January to August 2021
This period saw the continuation of the restrictive measures that were implemented during the state of "Public Calamity" i.e., hybrid face-to-face classes. Since this had become the "new normal", there was no change in

tuition fees or salaries. However, there was a change in the number of students attending school due to new enrollments from February to April, the start of the new school year.

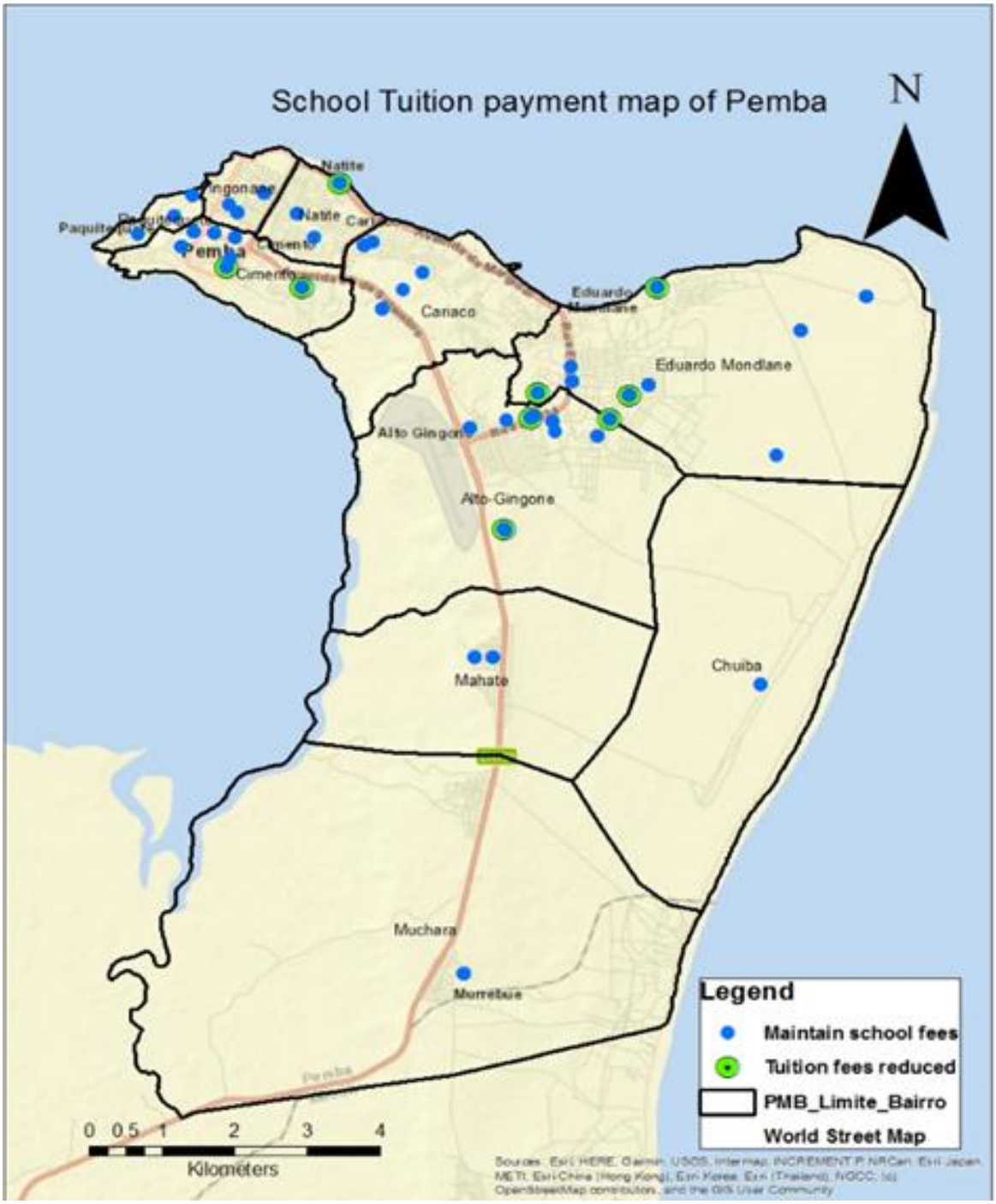


Figure 40: Impact of school fees in Pemba

Figure 41: Remote learning in Pemba

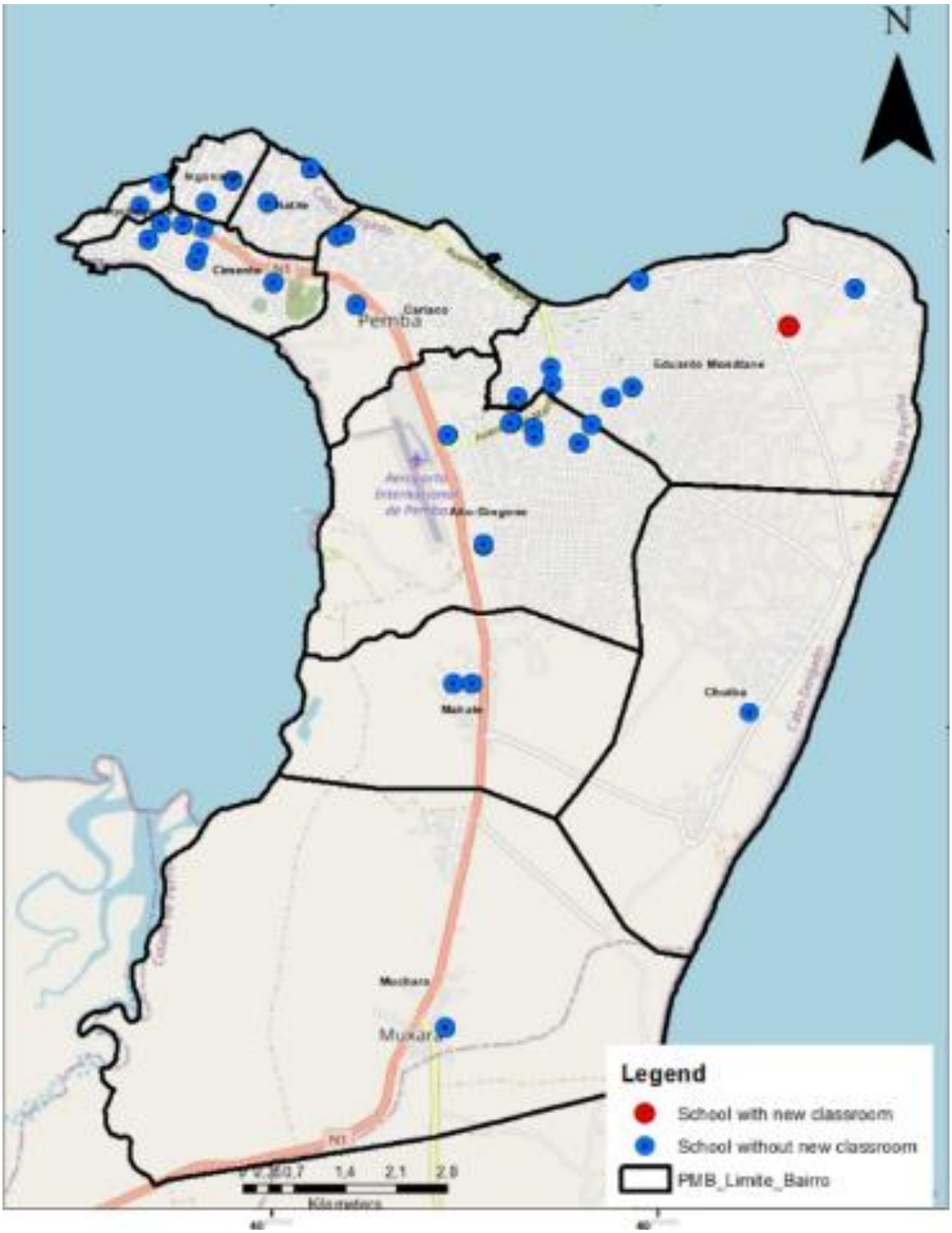


Figure 42: Schools with new classrooms in Pemba

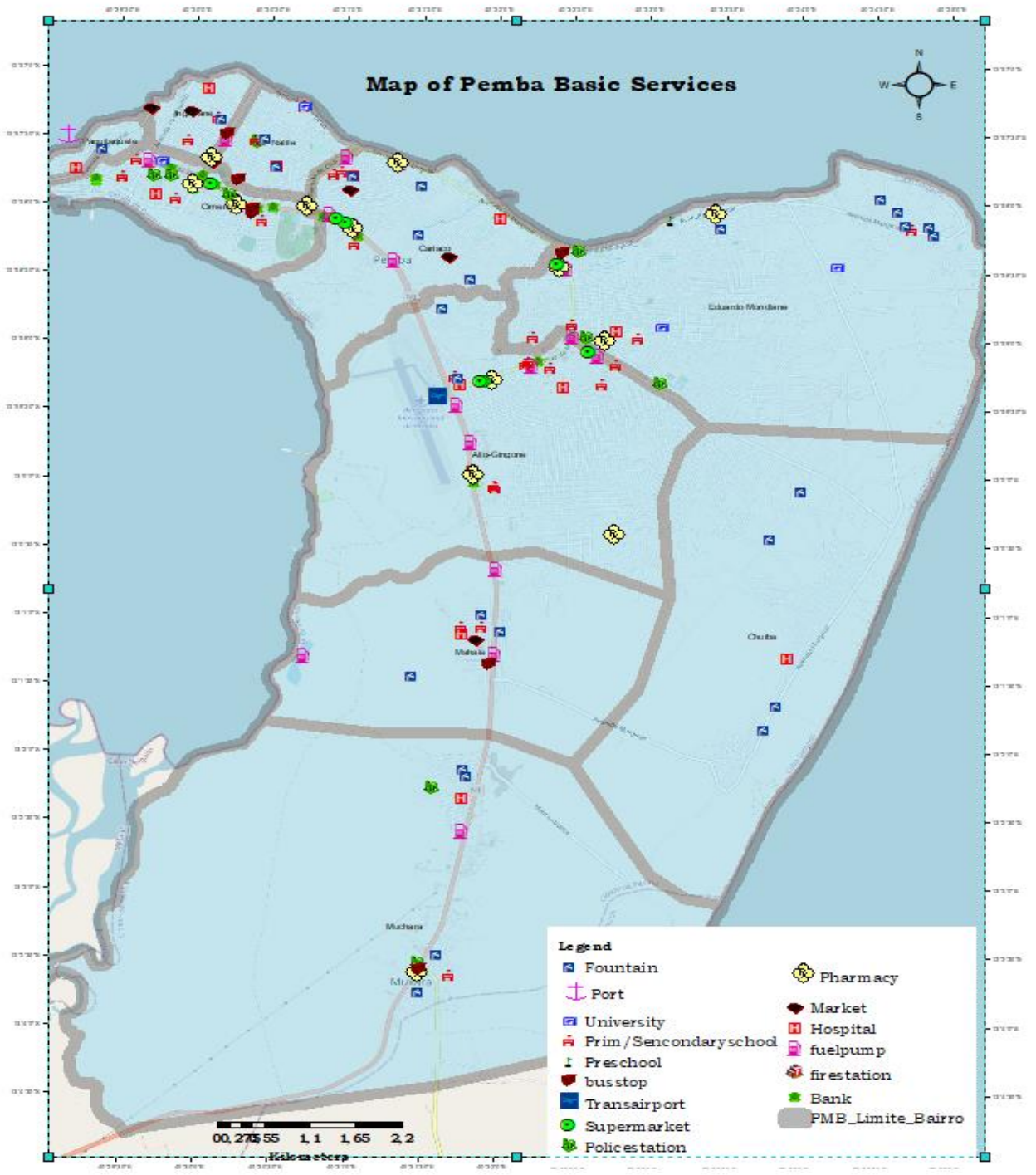


Figure 43: Map of basic services in Pemba

13.3. Geo-Referencing Basic Services

A key benefit of the project was the ability to geo-reference critical services to ensure the community knows how to access the basic services they would need during a pandemic (**Figure 43**). As reflected on the map, basic services are mostly concentrated in the city center, which highlights the need to expand them into other parts of the city including the suburbs.

13.4. Project Assessment

13.5. Understanding the pandemic and its second order impacts

Second order impacts of COVID-19 in Mozambique were tangible in many aspects of the society including healthcare, the economy, and the social foundation of the country. The causal loop diagram below reflects the interconnectivity of causes and effects across the different perspectives with an emphasis on vulnerable populations.

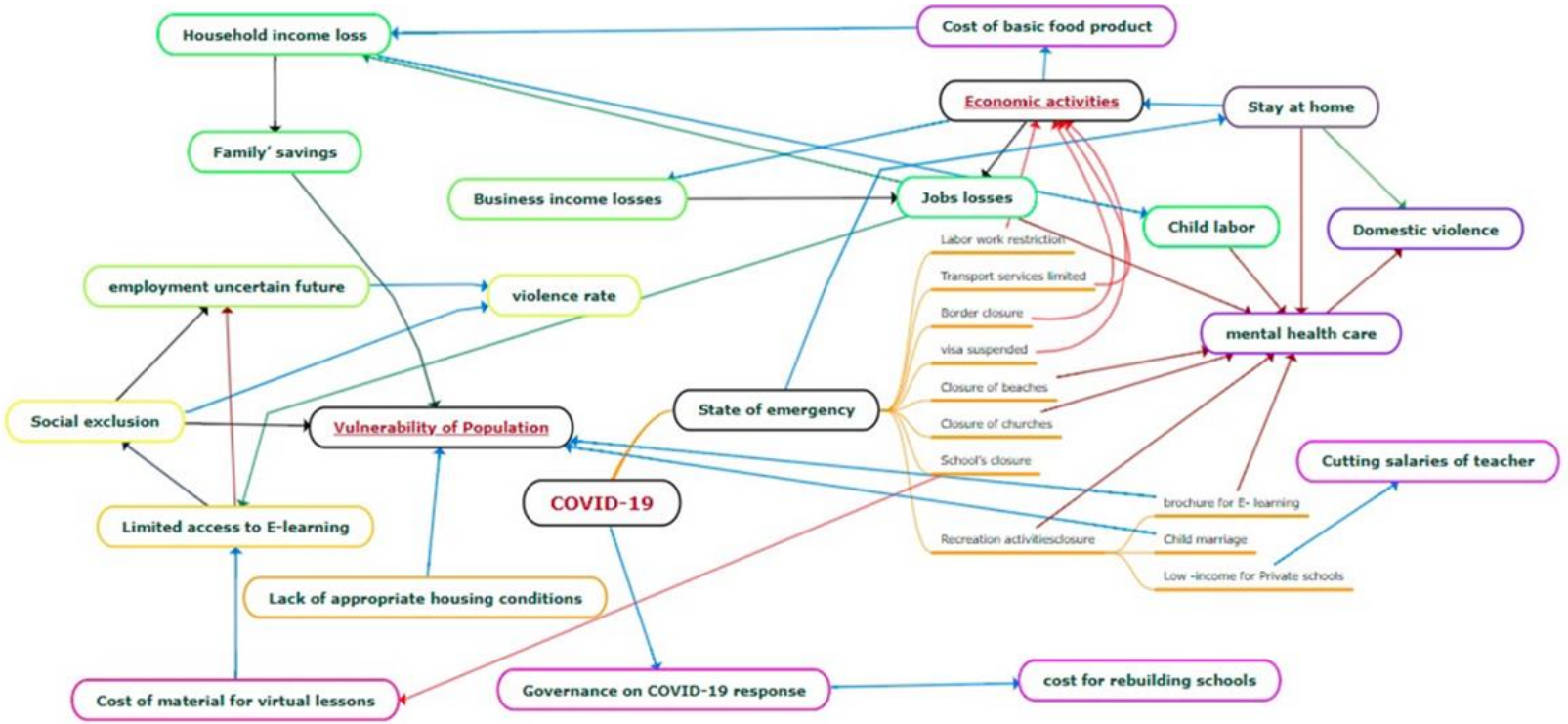


Figure 44: Causal loop diagram (Pemba)

13.6. Challenges managing prevention

On February 24, 2021, Mozambique received its first batch of vaccines. A total of 200,000 vaccines produced by the Chinese Pharmaceutical Company, Sinopharm (Beijing Institute of Biological Products, VeroCell Vaccine SARS-CoV-2), were primarily administered to at-risk professionals including the National Health Service and members of the Defense and Security Forces. Another batch of 484,000 doses was received, 384,000 of which under the COVAX initiative and 100,000 were donated by India.

Figure 45: First batch of the Sinopharm vaccine arriving in Mozambique (former Minister and the ambassador) *[http://www.xinhuanet.com/english/africa/2021-02/25/c_139766287_3.htm]*

Figure 46: US/Embassy in Mozambique delivering vaccines *[https://mz.usembassy.gov/mozambique-receives-384000-vaccines-under-the-covax-facility/]*

The vaccination in Pemba was administered in three phases:

a. **Phase 1:**
   This initial phase went from March 8th to 12th, 2021. The focus was on health professionals, elderly residents in nursing homes, workers in nursing homes, patients with diabetes mellitus, and those in the Defense and Security Forces.

b. **Phase 2:**
   The second phase of the vaccination campaign ran from April 19 to July, 2021 and covered final year students of health training courses, diabetic patients over the age of 18 that were not covered in the first phase, patients on immunosuppressive therapy, patients with chronic renal failure on hemodialysis or on a waiting list, patients with chronic respiratory insufficiency, patients with chronic heart failure, people residing in accommodation centers, prison inmates and employees, members of the Defense and Security Forces over the age of 18, primary school teachers, university students, and journalists.

Figure 47: Vaccination campaign in Mozambique

c. Phase 3:

The third phase of the vaccination campaign against COVID-19 took place in August 2021 and covered individuals 50 years and older, civil servants and state agents, veterans of the national liberation struggle, teachers not covered in the previous phases, drivers and public transport agents, motorcyclists, and taxi-bicycle drivers.

The resistance and non-compliance with restrictive measures to reduce the spread of COVID-19 in Pemba increased the necessity to get people vaccinated.

Although the Mozambican government implemented a massive vaccination campaign in the city of Pemba, adherence was low. Additionally, some people did not take both doses of the vaccine. Either due to misinformation or because the impact of the vaccination campaign was not publicly available hence many people did not see the need to get vaccinated.

13.7. Stakeholder engagement

The project team was able to get many stakeholders engaged in the project including:

- Municipal Council of Pemba
- Provincial Directorate of Education and Human Development
- District Services of Education, Youth, and Technology of Pemba
- Provincial Services of Economic Activities
- Provincial Directorate of Health
- Neighborhood Secretaries.

Despite the engagement of the different stakeholders and partners, the team still faced issues throughout the execution of the project including:

- No access to revenue data since many institutions considered it confidential information
- No access to stats and other info at the school level that was previously provided by the Provincial Directorate of Education
- Difficulty in the use of geospatial tools for data collection and data display since most tools and methodologies were new to some team members
- Co-locations of educational institutions in the facilities due to rental issues made it difficult to collect and ensure data separation
- The political and military situation in Cabo Delgado hindering activities including data capture.

However, mitigation strategies were identified to ensure successful project completion.

13.8. Lessons learned

Below are some of the lessons learned throughout the project:

- Use of geospatial platforms to monitor critical events and assist in decision making at the local level
- Experience in handling new digital platforms (ODK and Kobotool) that facilitated data collection especially in areas with limited to no internet connectivity
- Continued coordination and feedback from the various stakeholders and local and government entities was critical to ensure the project will benefit the city
- Creating geospatial maps to locate providers of critical services

- Improving the active participation of the community and local government ensured the data captured and analysis performed were relevant to them and the population
- Working with a global team and giving the university international exposure

14. Recommendations

4.1 Education

- Participatory inclusion of the Pemba community in the decision-making process
- Schools that have not yet made use of digital platforms for course delivery should embrace and train students and teachers in the use of such solutions
- Create awareness within the population of Pemba about the importance of GIS and its ability to help locate critical services in times of emergencies
- Capacity building in geographic information systems and use of geospatial data for decision support especially for city planners
- Creation of a GIS department at the university to drive the use of geospatial applications like Cities Navigator.

4.2 Economy

- Awareness of the Pemba community about the importance of GIS in order to make it easier to access mapped services
- Adoption of digital tourism
- Adoption of Cities Navigator applications to market touristic destinations to promote local tourism, ease of access, and basic services
- Adoption of economic policies that are appropriate to the reality experienced in the local communities vs. trying to emulate other countries' strategies
- Intensification of local commerce to reduce dependency on imports especially for commodities i.e., rice, flour.
- Invest in better monitoring solutions to improve mitigations strategies of second order impacts of infectious diseases and pandemics.

4.3 Sustainability of the project

- Improve collaboration with the public health department to help adopt the use of geospatial data and platforms to monitor the second order impacts of COVID-19 and other pandemics
- Involve undergraduate and graduate students in COVID-related research
- Launch a youth mapper chapter at the university (currently in progress)
- Look for funding sources to sustain the project
- Establish a community with the municipal council to sustain data collection
- Create awareness in other institutions to feed data into the Cities Navigator application.

15. Tools and technology used for data collection and analysis.

Below is the list of technologies used for the Geospatial data capture, visualization, and analysis:

Project phase	Tools	Used for
Data collect	Kobotool, ODK collect with tablets	Used for data collection (online and offline) including pictures
Data analysis	Excel	Used to perform data analysis and cleansing after download from Kobotool
	Spss and Stata	Tool for generating graphics to understand the behavior of impacted communities in Pemba
Data visualization	ArcGIS	Used to create maps for data analysis
	Cities Navigator	Data visualization platform used by city officials to communicate with the population, understand second order impacts and for decision support. In addition, it is used by citizens to quickly localize basic services, especially during emergencies.

Table 9: Geospatial tools used in Pemba

16. Appendix.

Websites

https://www.uasgadvisors.com/
https://www.univofbukavu.org/
http://www.ucm.ac.mz/
https://groundtruth.in/
https://www.mapkibera.org/
http://citiesnavigator.com/

Events and workshops

Meeting type	Event type	# Meetings
Meetings with stakeholders (State Department, AAG)	Meeting/Workshop	12
Meeting with Partners (RCMRD, Youth Mappers, SMEs)	Meeting/Workshop	30
Symposium participation (Harvard, CSU, George Mason)	Symposium	4
Bi-weekly Hub meeting	Meeting	20
Technology Review and Training (Technology, Cities Navigator)	Workshop	19
Bi-weekly data collection review meetings (Bukavu)	Workshop	10
Standups with Bukavu	Meeting	11
Quarterly stakeholder presentations (Bukavu)	Workshop	3
Bi-weekly data collection review meetings (Pemba)	Workshop	6
Standups with Pemba	Meeting	10
Quarterly stakeholder presentations (Pemba)	Workshop	3
Bi-Weekly project meetings (Nairobi)	Meeting	20

Survey instruments

- **Analytics framework**
  https://docs.google.com/spreadsheets/d/12Zg1kA_iY6CpFd_FTqBcnwznp0-m5CFD/edit?usp=sharing&ouid=108696609828990235258&rtpof=true&sd=true

- **Survey results (Kobo Collect Data Sets)**
  https://docs.google.com/spreadsheets/d/10p_h029dBZwtyYrBB3N9eefCyjlNluqx/edit?usp=sharing&ouid=108696609828990235258&rtpof=true&sd=true

Story Maps

- **Nairobi, Kibera**
  https://mapkibera.github.io/watsan/nairobi/#14.59/-1.31422/36.78635/0/1

- **Bukavu, DRC**
  https://storymaps.arcgis.com/stories/e1caa52477c94fcc9ca168a527030788