Global Health
Supply Chain Summit

Using Data Analytics to Drive Decision Making and Improve Resiliency in Last Mile Distribution

Track 16 / Abstract 136

November 15, 2023

2023

Nairobi, Kenya

Panel Agenda

Introductions – 5 minutes

Presentations – 10-12 minutes each

Q&A and Discussion – 15-20 minutes

Introduction

PANEL:
Using Data Analytics to Drive Decision Making and Improve Resiliency in Last Mile Distribution

Moderator: Kevin Pilz
Senior Supply Chain Advisor, USAID
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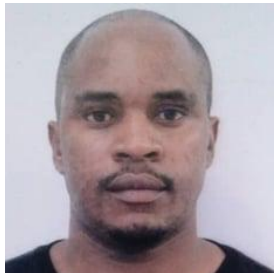
PANELISTS

Increasing the visibility on the value of using data analytics to support last mile approaches
James Flood, Frontline Research Group/ Project Last Mile, jamesfl@frontlineafrica.com



Using an open-source dynamic routing tool for sustainable, flexible, and cost-effective last mile distribution in Zambia
Bruce Kamuti, Zambia Medicines and Medical Supplies Agency (ZAMMSA), Bruce.Kamuti@zammsa.co.zm

Using data for last mile distribution for hard-to-reach communities in DRC
Mariam Zameer, VillageReach, Mariam.Zameer@villagereach.org

openrouteservice (ORS) – Open-Source routing & optimization
Julian Psotta, Heidelberg Institute for Geoinformation Technology (HeiGIT), julian.psotta@heigit.org

Project
Last Mile

Increasing the visibility on the value of using data analytics and insights to guide decision making for last mile distribution.

JAMES FLOOD, PROJECT LAST MILE

GLOBAL HEALTH SUPPLY CHAIN SUMMIT 2023

Global partners:

PEPFAR · USAID FROM THE AMERICAN PEOPLE · THE GLOBAL FUND · BILL & MELINDA GATES foundation · THE COCA-COLA FOUNDATION · THE COCA-COLA COMPANY

Project Last Mile works closely with ministries of health and partners to apply the Coca-Cola System's best practices in logistics, supply chain, and strategic marketing to improve access to, availability and uptake of life-saving medicines and health services down to the last mile in Africa.

Quick exercise: Think about THREE different outlets / shops where Coca-Cola is sold in your hometown.

One large sized, one medium sized, one small sized

Examples: supermarket, a convenience store, a bar or restaurant, an informal spaza shop or the local market

How do the following differ across these three outlets?

1st End user / shopper (Consumer)

- Firstly, who are the typical consumers shopping for Coke at these outlets?
- What typical consumer behaviour happens here? Month-end shopping? Convenience shopping? Refreshment while on-the-go? Or simply enjoying a leisurely beverage with friends?
- What are their favorite brands / pack sizes, how much do they typically spend, how often do they do this?

2nd Outlets / shop (Customer) and what they offer the end consumer.

- CC has many brands and pack sizes… Are all the brands and packs available at these 3 outlets?
- Is pricing the same across all these outlets?
- How about the quantities available?
- How about marketing materials / promotions and the targeted messaging?

3rd Service or delivery needs at these outlets (customers)

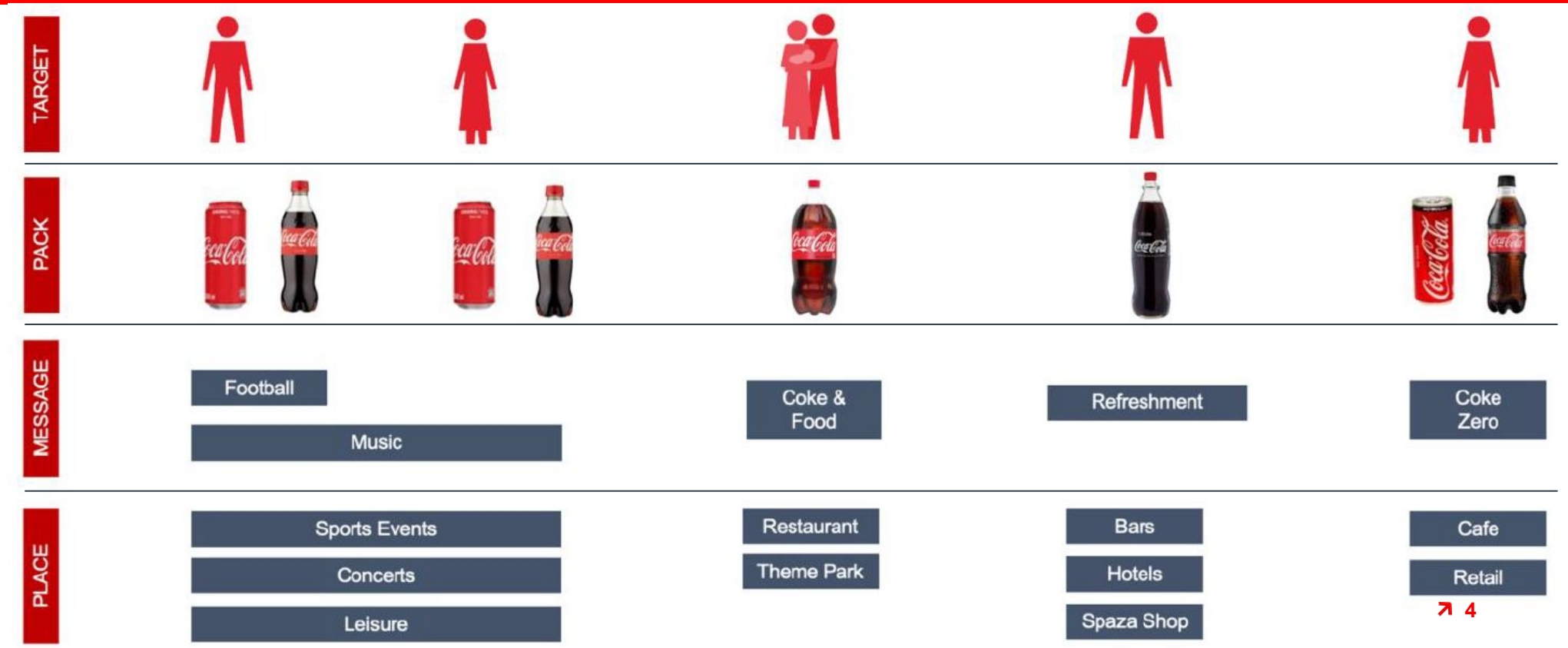
- How does distribution take place? How often? What day of the week? How accessible is it?
- Who services them? Where are they serviced from? What type of vehicles used?
- What storage capacity and cash flow constraints? Payment (cash / credit)?
- How do they order and receive deliveries?

THE ANSWER IT'S HIGHLY LIKELY THAT ALL 3 OUTLETS ARE DIFFERENT…. DO YOU AGREE????

↗ This is a differentiated service model/ approach, successfully used by the Coca-Cola Company right across the world.

This model/ approach is designed around:

- Putting the consumer at the center
- And then understanding what type of **product**, **messaging**, and **placement** is required to meet those consumer needs.
- All with the objective of making the right products, available to consumers at the right place, in the right quantities, at the right price, and with the right positioning and targeting messaging.



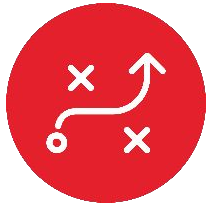
So, what does this mean?

In summary, there are **three elements** to this differentiated service model:

Understanding the consumer behaviour

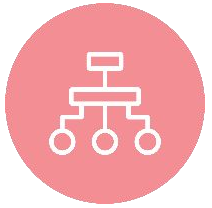
Understand where and when key consumer behaviour is taking place.

Understanding the consumer needs.



Strategic segmentation and channel design

Grouping all outlets into channels based on where / when these consumer behaviours take place, and how these outlets typically sell to the end consumer.



Route to market model design

Fit for purpose distribution & service model to meet the needs across these strategic channel or groups…

and ultimately the end consumer.

This a consumer centric, evidence-based approach, where **data analytics and insights** play a key role in guiding decision making across each of these key elements.

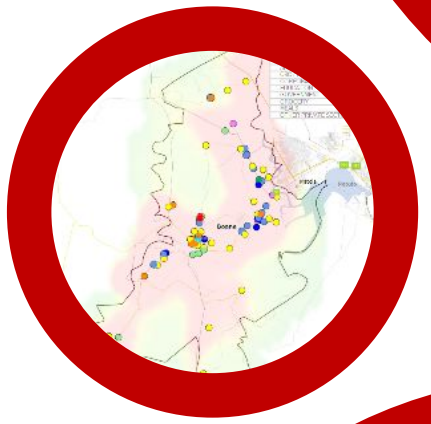
Last Mile Distribution?

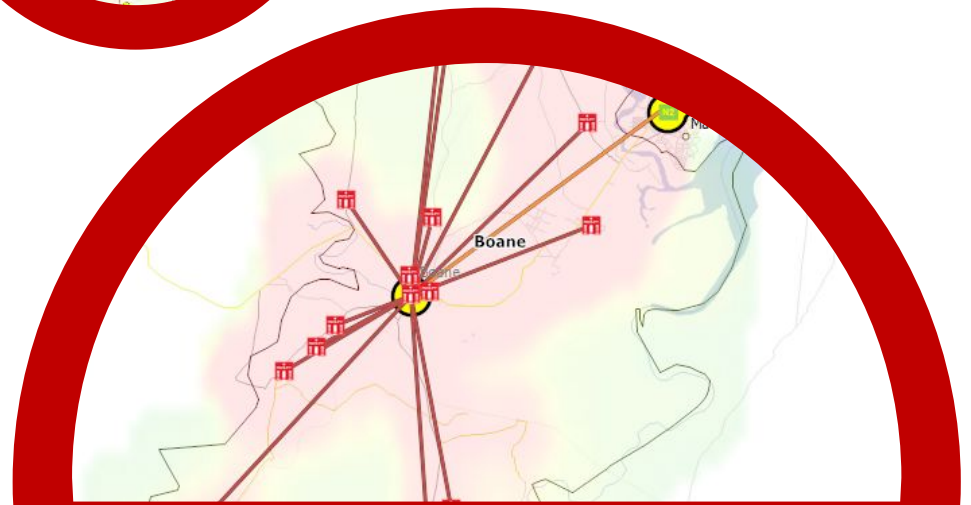
Once you understand the service needs for your different channel groupings, you are better positioned to match the right distribution model.

These service needs may include:

- The number of channel groups
- The number of outlets per channel group
- Coverage in proximity to target population
- Visit frequency requirements
- Ordering requirements
- Typical order sizes and product makeup
- Preferred delivery day / time
- Optimal vehicle size / carrying capacity, and accessibility
- The activities that need to take place during the visit - this may vary depending on the channel and size

This is where data analysis and insights come in. Tactical & operational guidance.





PRACTICAL EXAMPLE FROM A PILOT STUDY IN BOANE DISTRICT, MOZAMBIQUE , WORKING WITH THE NATIONAL AIDS COUNCIL (CNCS) IN 2022 - 2023

PLM implemented this consumer centric, evidence based approach in Boane to improve accessibility, availability and uptake of government condoms, in non-traditional access points, outside of the Public Health Services Supply Chain.

CREATING DEMAND
STRATEGIC MARKETING
National Condom Strategy Pillar 2

- Focus on consumer research
- A strong brand / call to action, with a compelling visual identity system,
- Developed segmented messaging approach for focus channel groups

FULFILLING DEMAND
ROUTE-TO-MARKET
Condom Strategy Pillar 3

- Landscape analysis study and data collection – where, when, who, and how…
- Designing a segmented, channel strategy with DC team
- Development of RTM strategy, including a delivery model and operations plan

EDUCATIONAL MESSAGING

Protect yourself

Use your head and avoid unplanned pregnancies

The Free condoms are great quality

AT WORK MESSAGING

Take it! There's always someone that needs them
Male focus

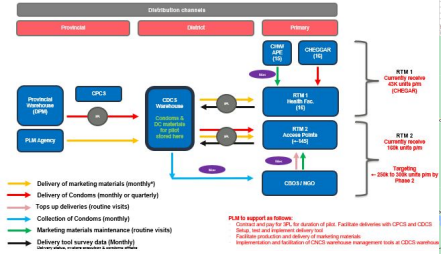
Take it! There's always someone that needs
Female focus

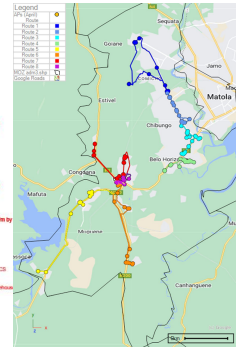
AT LEISURE MESSAGING

If you Shake more than 3 times...

A woman with a condom
is always in good company

When things get popping



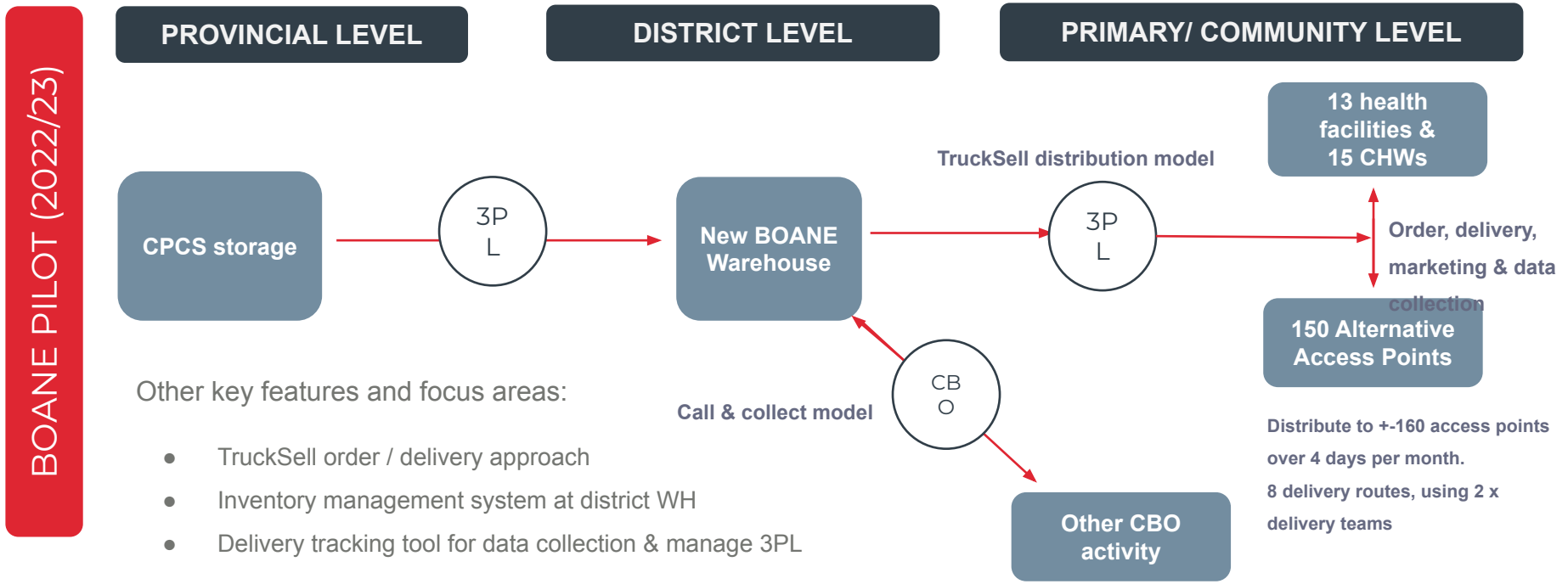


Example of a important insights on leisure channel, how shaped our model

The team then designed and implemented a fit-for-purpose RTM model to execute PLM's consumer centric, evidence based, segmented channel strategy.

Working closely with provincial and district level representatives from the CNCS, PLM implemented a **hybrid model** with x 2 distribution models for LMD:

- **TruckSell model (3PL)**
- **Call & collect (COBs)**



CBO – Community based organisation. 3PL – third party logistics provider

Phase 1 results – Improved access, availability and uptake in non-traditional access points, outside of the public health supply chain

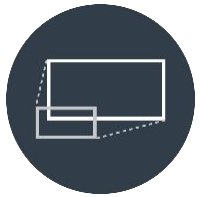
Over a period of **6 months**, the project distributed **1,200,000 condoms**

977,000 condoms were distributed by a third-party logistics (3PL) partner. **223,000 condoms** were distributed by CDCS/CBOs

2-3 condoms per person, per for the target population of 90,000 individuals month, aged 15-40 years (previously <1).

43% increase in the number of active access points

243% increase in the number of condoms made available to the population in Boane.



Demand was increased, ensuring the population absorbed the additional condoms supplied.

Despite this large increase in the availability of condoms, offtake was high at 75% averaged across access points.

Ultimately, making the right products, available to consumers, at the right place, in the right quantities, with the right positioning and targeting messaging.

CLOSING THOUGHTS

Like the private sector, **data analytics and insights key** for LMD planning and operations in public health supply chain.

There is a lot of value in a **consumer centric, evidence-based decision making** in last mile distribution. Bottom up approach. Start with the consumer / patient.

Implementing the **right distribution model** can improve efficiency, effectiveness, and ultimately impact, if executed correctly.

Question: In your supply chain, how do the patients' needs, and service needs vary across the different facility classifications?

In hospitals, health facilities, pharmacies, rural health posts or other alternative access points. Are the patient and service needs all the same?

What data analysis can be done to better understand these when designing your LMD strategy / model?

To learn more about some of the distribution models applied by The Coca-Cola Company across Africa, and how these can be adapted, please reach out to the Project Last Mile team.

COMPLEXITY

	MOTOR-BIKE/MANUAL DISTRIBUTION CENTRE	TRUCKSELL	PRESELL
			
Model	• Inventory held locally in **small to medium storage area** (shipping containers, informal market outlets) • **Manual pushcarts** used for delivery • **High delivery frequency** (2.00-6.00x weekly) • **High daily route visits** (30-60 outlets per day) • Product **sold and delivered at the same time** during the outlet visit	• Inventory held locally in **small to medium storage area** (shipping containers, informal market outlets) • **Small trucks** (<2.5T) used for delivery • **High delivery frequency** (1.00-3.00x weekly) • **Medium daily route visits** (15-30 outlets per day) • Product **sold and delivered at the same time** during the outlet visit	• Inventory held remotely in **medium to large storage area** (warehouse, central distribution centre) • **Large trucks** (>2.5T) used for delivery • **Low delivery frequency** (0.25-1.00x weekly) • **Low daily route visits** (10-20 outlets per day) • Product **sold and delivered at the same time** during the outlet visit • Product **sold by salesman** then **delivered next day**
Environment	• **High density outlet areas** (informal outdoor markets, taxi ranks, city centre) • **Small outlets** with limited range of items sold and limited storage • Outlets **inaccessible** for truck delivery • **Short travel distances between** outlets (<25m) • **Short stem distance** from storage	• **Small to medium VPO** (General Trade and On-Premise outlets) • **Limited range** of items sold • Outlets **accessible** for truck delivery • **Short stem distance** from storage (<5km) • **Limited range** of SKUs delivered (<10)	• **High VPO** (supermarkets, wholesale) • **Large outlets** with wide range of items sold and sufficient storage • Outlets **accessible** for truck delivery • **Long stem distance** from storage (>5km) • **Wide range** of SKUs delivered (>10)

Project
Last Mile

Find out more at

projectlastmile.com

Global partners:

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THE Coca-Cola FOUNDATION

THE Coca-Cola COMPANY

VILLAGE REACH

Using data for last mile distribution for hard-to-reach communities in DRC

Mariam Zameer

What does the last “mile” look like in DRC?

Often, the last mile looks like this:

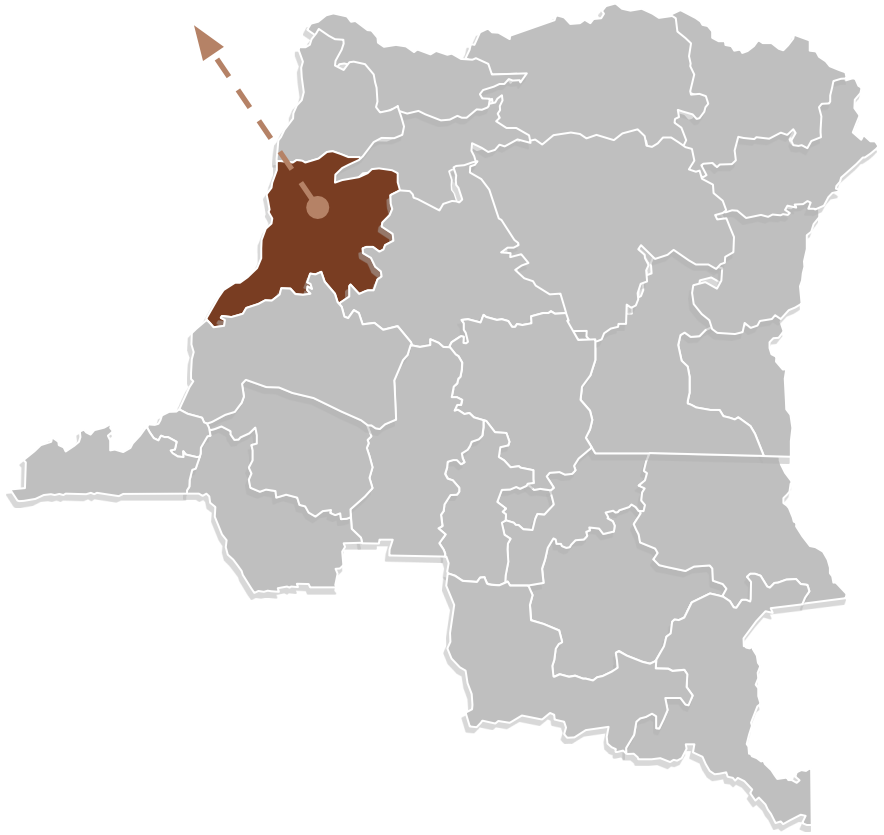
The Last Mile Delivery Challenge in DRC

Challenge: Recurrent stock out of vaccines and other health products at facilities

1. **Inefficient supply chain** design
2. **Limited leadership & management** capacity among supply chain actors
3. **Limited data & supply chain management** capacity among health workers
4. **Poor data visibility and product traceability**
5. **Limited and inefficient transport**
6. **No inventory management** to monitor stock regularly

Results from implementing NGCA in Equateur Province

Equateur

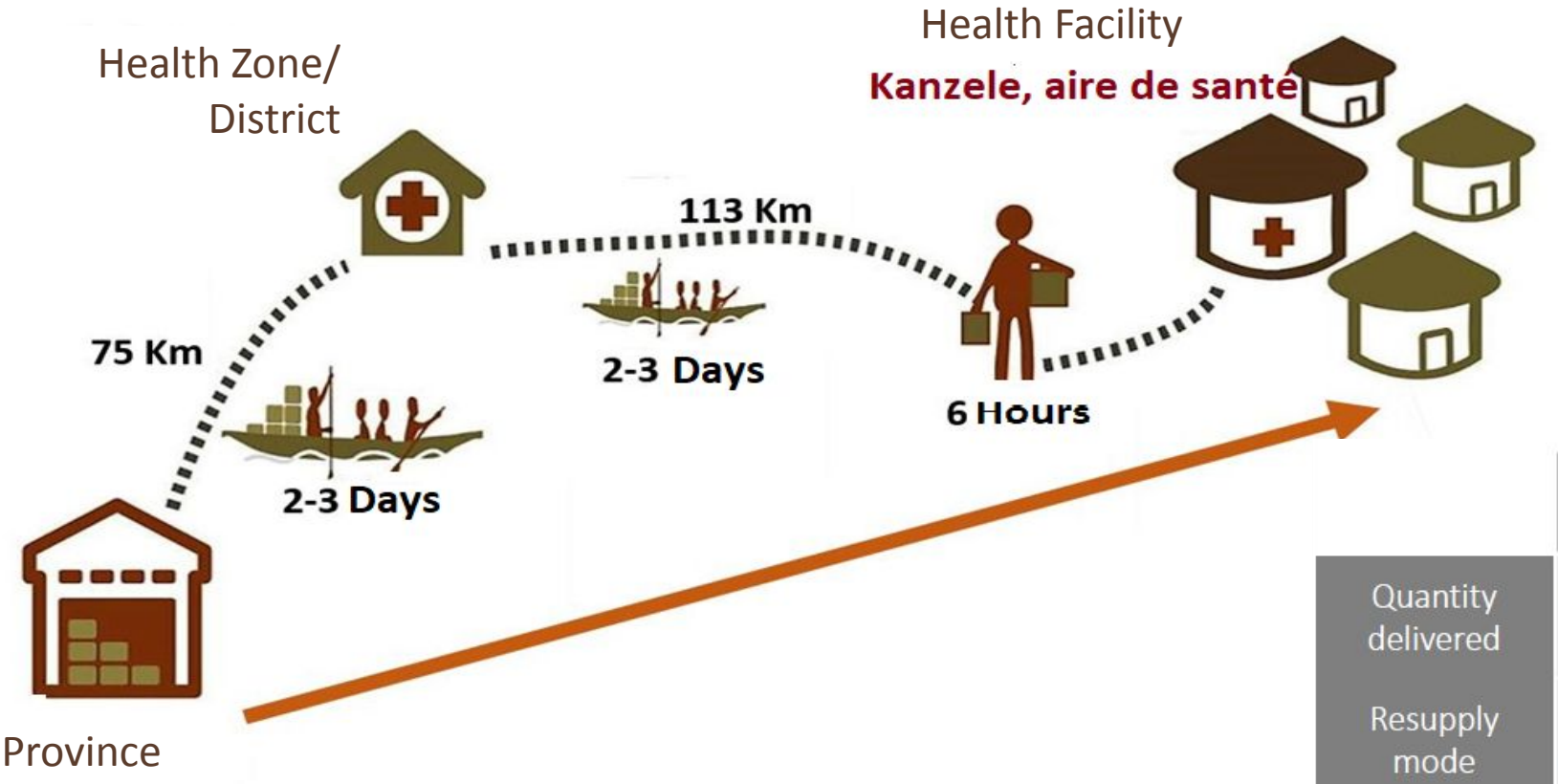


✔ **Improved product availability**: Health facilities with full vaccine availability **increased** from 17 percent to **85 percent**

✔ **Overall cost reduction:** Total supply chain costs **decreased by 34 percent**

✔ **Increased immunization coverage:** Average monthly consumption of vaccine doses **increased 22 percent**

Designing Next Generation of Supply Chain: **Overview**



	Traditional multi-level supply chain	Optimized supply chain
Quantity delivered	**Population-based** allocation system	**Consumption-based** Inventory Control System
Resupply mode	SDPs **fetch** from zone, zones **fetch** from province	**Delivery** from province to SDPs
Resupply frequency	**Monthly** to zones	**Every 2 months** to SDPs
Segmentation	**Siloed** supply chains for vertical programs	**Resource sharing** for distribution

Designing Next Generation of Supply Chain: **Components**

PRODUCTS TO PEOPLE

1 Rapid assessment

Use **data triangulation** to create a vulnerability and prioritization score, using data from coverage, surveillance, vaccine supply and logistics, cold chain equipment functionality, provider capabilities etc. across different health zones to prioritize zones for targeting.

2 Supply Chain Redesign

Using historical data to **co-design the supply chain** with provincial stakeholders. The model implements direct delivery, skipping health zones, informed allocations, and delivery every 2 months.

Districts sign a commitment in presence of provincial governor

3 Route Design

Design for shortest route and lowest cost, for direct delivery to health facilities.

Routes defined based on distance, functional cold chain capacity, road network, road conditions, transport available, and safety.

Data collected during delivery is analyzed to inform future deliveries.

4 Supply chain capacity

Build supply chain leadership at central, provincial and zonal levels defining **roles and responsibilities**, and **communication** processes.

Supply chain management capacity on supportive supervision and focusing on ways to improve the use of **data for decision-making**.

5 Inventory management

Leverage distributions to provide supportive supervision and to **collect regular stock data** from health facilities. Data is analyzed to inform future deliveries.

6 Responsive Supply Chain

Using **data triangulation** and other methods, to ensure that supplies are adequate and reaching the most under-reached communities.

Next Generation of Supply Chain: **Component Deep Dive**

PRODUCTS TO PEOPLE

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Building leadership and management capacity in supply chains:

- **Leadership: strategies and mobilizing resources to succeed in constantly changing system**
- **Management: managing day-to-day tasks necessary for supply chain to run effectively**

HOW?

- Position public health supply chain as a core component of a ministry's business model.
- Build knowledge of different supply chain approaches and models
- Enable leaders to create, convene, and broaden the capacity of stakeholder groups to positively impact supply chain operations.
- Supportive supervision
- 5-day training, accompanied by solving a challenge for capstone and WhatsApp group to problem solve together

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PRODUCTS TO PEOPLE

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WHY?

- The current logistics management information system (SIGL) does not have data on consumption, and number of days of stockouts. DVD-MT and SMT do not have updated data.
- Paper tools are almost non-existent, and stock is almost never monitored or managed on a daily basis, leading to frequent stock-outs.
- Some health facilities are overstocked and some understocked

HOW?

- Analysis of monthly inventories before each distribution at province and health zone.
  - Compare the inventory data for vaccines and other health products to calculate stock needed
- At each delivery, collect as average monthly consumption, vaccine wastage rates, expiry, number of days of stockouts and months of stock available after the delivery
- Create a stock information circuit on a regular basis: Zonal office analyses consumption data weekly and highlights fluctuations
- Supervision at health facilities, builds supply chain management and inventory management capacity
- Triangulate the number of kids vaccinated, and number of vaccine doses used per month or weekly.

Designing Next Generation of Supply Chain: **Components**

PRODUCTS TO PEOPLE

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Next Generation of Supply Chain: **Component Deep Dive**

PRODUCTS TO PEOPLE

6

Responsive Supply Chain

Using **data triangulation** and other methods, to ensure that supplies are adequate and reaching the most under-reached communities.

WHY?

Delivery to the last mile is only effective if it is meeting the needs of people – both the "visible" demand (what we can see in the data) and the "invisible" demand, i.e. children who do not interact with the health system and we need to uncover with more complex data triangulation.

Responsive supply chain is a "learning supply chain" –constantly validating the needs of the population and is getting products to ALL people. This creates an efficient and agile supply chain, allowing for adjustment to serve more people.

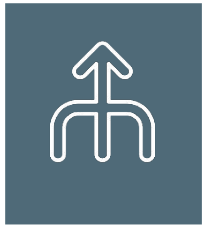
HOW?

During health facility visits, triangulate data from health facility register and vaccination cards.

- Assess whether the expected children have been vaccinated by triangulating the target, children who have been vaccinated and then calculated then % of coverage for each antigen
- For those not vaccinated, create a map and plan with health facility nurse and CHWs. Plan includes strategies for vaccinating the child and target date for vaccinating.

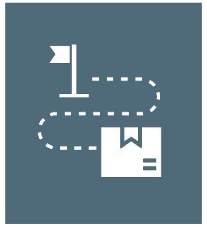
Nouvelle Génération des Chaînes d'Approvisionnement (NGCA): **Success Factors for a Holistic Approach**

Pooling Resources



Integrated Distribution, At Any Opportunity

Triangulation of Data Early & Often



Going the Extra Mile


Thank you!
VillageReach
Starting at the Last Mile

Using an open-source dynamic routing tool for sustainable, flexible, and cost-effective last mile distribution in Zambia

ZAMMSA

Bruce Kamuti, Assistant Manager Outbound Logistics,
Zambia Medicines and Medical Supplies Agency (ZAMMSA))

Background: Why is a Dynamic Routing Tool Needed?

As the number of destination facilities grows, the number of possible facility sequences grows exponentially.

If 4 health facilities are scheduled for deliveries, they can be sequenced 24 different ways for a delivery route. But if 22 facilities are scheduled for deliveries, the number of possible sequences grows to 1,124,000,727,777,607,680,000 — that's over 1.1 sextillion!

A dynamic routing tool, such as the **Dispatch Optimizer Tool**, can quickly conduct these complex mathematical calculations that are beyond human capability. This can allow transportation planners the flexibility to reconstruct routes weekly as volumes and conditions change.

What Problems Does the Dispatch Optimizer Solve?

Reduce cost and time of deliveries while maintaining service standards by dynamically optimizing delivery routes.

HOW TO GROUP FACILITIES INTO ROUTES?

IN WHAT SEQUENCE TO VISIT FACILITIES?

WHAT TYPE OF VEHICLE TO USE FOR EACH ROUTE?

HOW TO RAPIDLY REFRESH THESE DECISIONS FOR EACH UNIQUE ORDER?

Why Dynamic Route Optimization?

Static Route Planning vs. Dynamic Route Optimization

- Using set routes planned with or without the use of route optimization software
- Even if routes are mathematically optimized, they are done so for one static scenario and reused under changing circumstances
- This makes it difficult to manage changing volumes, late orders, changing circumstances

This is what most countries do today, but there is now the ability to do better.

- Software like the Dispatch Optimizer can allow rapid dynamic adjustments based on changing circumstances and uncertainty
- Can adjust to variability in orders (e.g., different commodity types, quantities, seasonal patterns)
- Can adjust to changes in vehicle and driver availability
- Can optimize late orders separately to find the most efficient dispatch plans while not delaying the on-time orders
- Can adjust as a rainy season impacts accessibility (e.g., split truck routes onto smaller 4x4 SUVs, remove inaccessible facilities)

Open-source software and improving data and IT landscapes have opened options that used to be accessible primarily to corporations able to purchase costly software licenses.

Experience Using DOT in Zambia and Beyond

A Successful Roll-out in Zambia

- **Engagement with local stakeholders**
  ZAMMSA collaborated with USAID's GHSC-PSM project and their 3PLs in Lusaka to coordinate efforts for the application and business processes
- **User-focused design tailored to public health supply chains**
  App developers spent time embedded in ZAMMSA central medical warehouse and 2 hubs, observing operations and collecting requirements for an operational route optimization application
- **Ongoing and expanding operational use**
  ZAMMSA staff use the tool weekly, with all regional hubs and about 1,955 last-mile health facilities in Zambia currently receiving deliveries planned using this tool; working on expansion to every hub in-country

DOT being run in ZAMMSA Lusaka warehouse on October 1, 2021


First optimized dispatch leaving Mansa hub on June 3, 2022

Transforming Transportation and Warehouse Planning

BEFORE

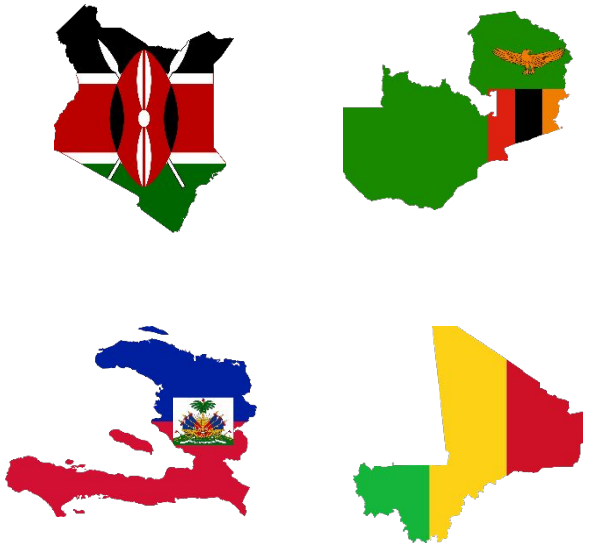
- Transportation planning was done manually, using guess work based on prior experience
- Sometimes delivered to the same facility on multiple routes for different commodities
- Warehouse sometimes staged orders and the truck was too small or unnecessarily large
- Consistently increasing commodity categories and volumes in Zambia was making reliance on prior experience risky

AFTER

- Data-driven decision making that is flexible to changing circumstances
- Reduced instances of multiple dispatches to the same facility
- Volumetrics and optimized vehicles ensure the best vehicles are planned for each load
- Transportation planners are well prepared to respond to changing or increasing order volumes, even during health crises

Other benefits: Reduced costs and carbon emissions; increased customer satisfaction and employee/3PL

The footprint and features continue to grow, as other countries actively seek to learn from Zambia's example and adopt the tool.



Early 2020

A proof of concept was developed by USAID GHSC-PSM in Excel and tested in Haiti.

October 2021

The Dispatch Optimizer was launched in Zambia's central medical warehouse in Lusaka.

June 2022

Based on the initial success, the tool was adapted and rolled out in Luanshya and Mansa, Zambia.

July 2022

The app was tested in Kenya, including developing new features to address country-specific needs.

2023 and Beyond

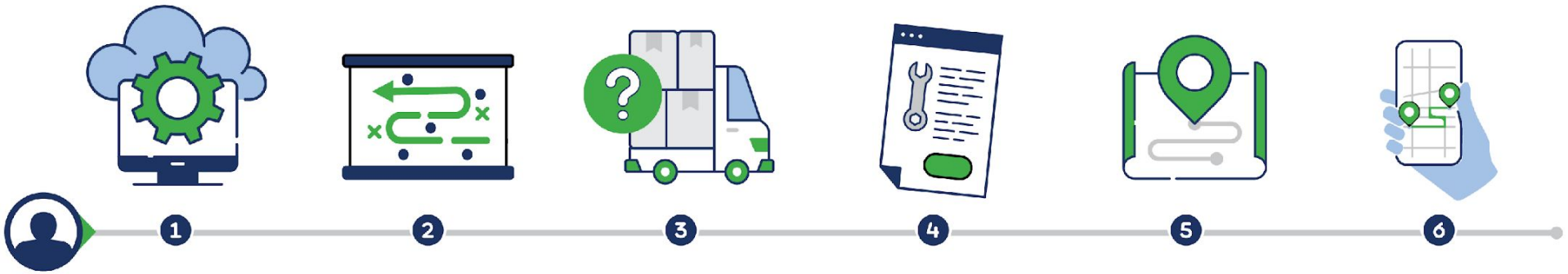
Zambia is expanding to 2 new hubs this year and 3 by end of 2024. New features are improving use.

Mali is also testing use of the app

Technical Solution Details

How to Use the Dispatch Optimizer Tool

The process to generate optimized routes with the Dispatch Optimization Tool



1. User uploads order template; facility details are pre-loaded in the application.
2. User reviews the customers for the order on a map and excludes any as needed
3. User reviews the available fleet and customer vehicle restrictions and modifies, as needed.
4. User selects parameters for the model and clicks a button to run the optimization.
5. Optimization outputs the ideal routes and vehicle assignments and displays them on the website as maps and KPIs.
6. User downloads an Excel file, which includes stop-by-stop route plans for drivers and loading plans for warehouse managers.

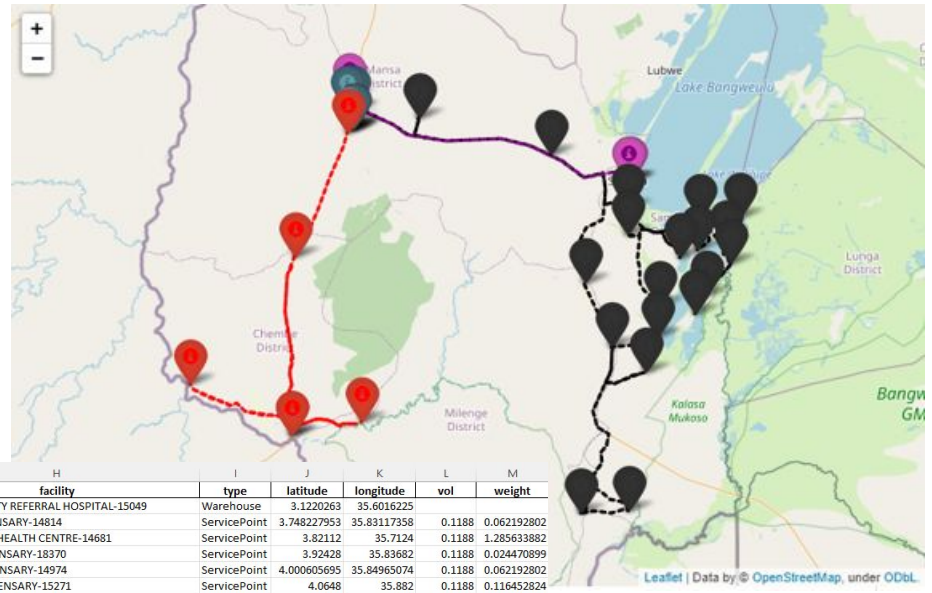
The Dispatch Optimizer Application

Route maps, details and KPIs can be viewed on the interactive website

Summary Statistics

Dispatches	Volume (m³)	Utilization
4	46	71.1%

Stops	Distance (KM)	Fuel (L)	Cost (ZK)
32	1,017	249	20,652



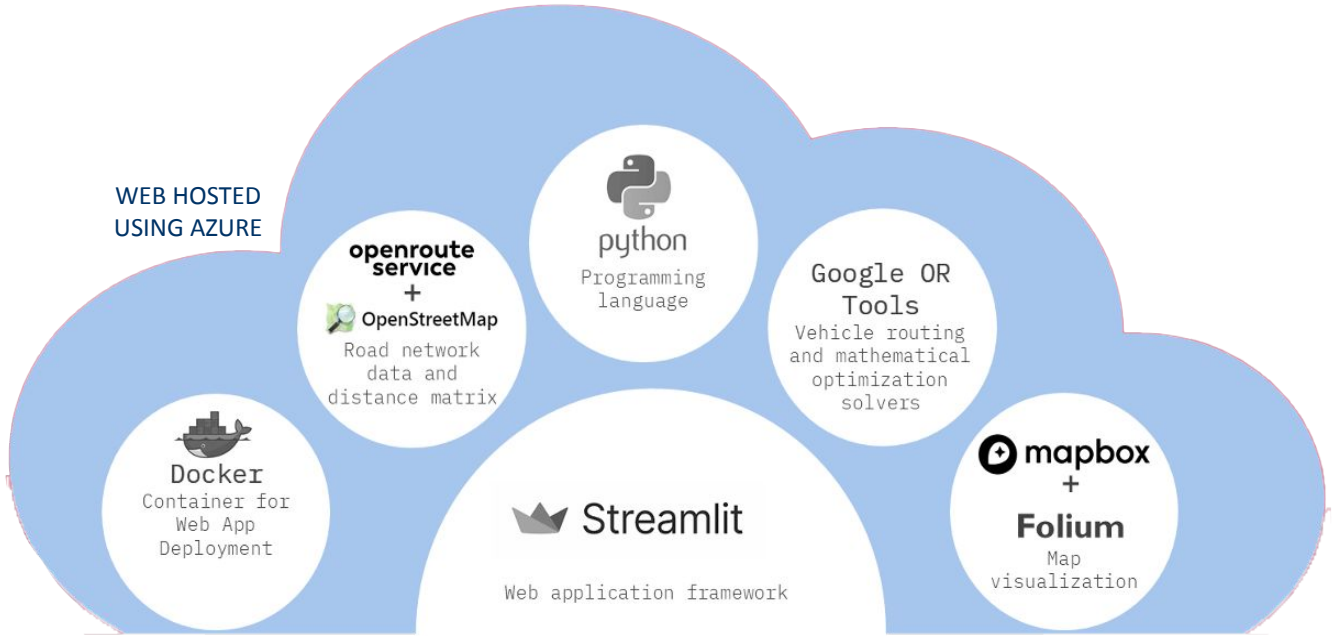
Or downloaded in Excel for manual modifications, additional analysis, or sharing plans with warehouse staff and suppliers.

route	stop_no	facility_id	distance	time	fuel_usage	cost	facility	type	latitude	longitude	vol	weight
Dispatch 001	0	915049	0	0	0	21001	LODWAR COUNTY REFERRAL HOSPITAL-15049	Warehouse	3.1220263	35.6016225		
Dispatch 001	1	14814	85.4	1.9	11.1	26123.86	KATABOI DISPENSARY-14814	ServicePoint	3.748227953	35.83117358	0.1188	0.062192802
Dispatch 001	2	14681	19.1	0.6	2.5	5842.69	KANAKURUDIO HEALTH CENTRE-14681	ServicePoint	3.82112	35.7124	0.1188	1.285633882
Dispatch 001	3	18370	33.8	0.9	4.4	10339.42	LOMEKWI DISPENSARY-18370	ServicePoint	3.92428	35.83682	0.1188	0.024470899
Dispatch 001	4	14974	9	0.4	1.2	2753.1	KOKISELEI DISPENSARY-14974	ServicePoint	4.000605695	35.84965074	0.1188	0.062192802
Dispatch 001	5	15271	8.2	0.4	1.1	2508.38	NACHUKUI DISPENSARY-15271	ServicePoint	4.0648	35.882	0.1188	0.116452824
Dispatch 001	6	15310	12.9	0.5	1.7	3946.11	NARIOKOTOME DISPENSARY-15310	ServicePoint	4.1442	35.91058	0.1188	0.005827873
Dispatch 001	7	15096	20.4	0.7	2.7	6240.36	LOWARENGAK HEALTH CENTRE-15096	ServicePoint	4.282512268	35.89751138	0.1188	0.097883598
Dispatch 001	8	15062	23.8	0.7	3.1	7280.42	LOKITAUNG SUB COUNTY HOSPITAL-15062	ServicePoint	4.26233	35.75434	0.2148225	0.72899468
Dispatch 001	9	14636	11.9	0.5	1.5	3640.21	KACHODA DISPENSARY-14636	ServicePoint	4.30986	35.68339	0.1188	0.005827873
Dispatch 001	10	20184	0.7	0.2	0.1	214.13	KAALEM DISPENSARY-20184	ServicePoint	4.32244	35.67673	0.1188	0.321408471
Dispatch 001	11	14637	61.6	1.5	8	18843.44	KAERIS DISPENSARY-14637	ServicePoint	3.983218482	35.47965856	0.1188	0.232905649
Dispatch 001	12	15186	0	0.2	0	0	MILIMA TATU DISPENSARY-15186	ServicePoint	3.983090047	35.47960491	0.1188	0.014596812
Dispatch 001	13	18099	61.2	1.5	8	18721.08	NADUNGA DISPENSARY-18099	ServicePoint	4.265958	35.236588	0.1188	0.067346081
Dispatch 001	14	14604	57.2	1.4	7.4	17497.48	KAALENG HEALTH CENTRE-14604	ServicePoint	4.503042	35.403972	0.1188	0.014596812
Dispatch 001	15	20660	29.9	0.8	3.9	9146.41	NARENGEWOI DISPENSARY-20660	ServicePoint	4.684603382	35.574369	0.1188	0.116452824
Dispatch 001	16	14975	25	0.8	3.2	7647.5	KOKURO HEALTH CENTRE-14975	ServicePoint	4.670741	35.712821	0.1188	0.023214167
Dispatch 001	17	14854	89.4	2	11.6	27347.46	KIBISH GK DISPENSARY-14854	ServicePoint	5.2901962	35.8215793	0.1188	0.023214167
Dispatch 001	18	14540	1.8	0.3	0.2	550.62	GSU DISPENSARY (KIBISH)-14540	ServicePoint	5.2813671	35.8245604	0.1188	0.062192802
Dispatch 001	19	15054	42.8	1.1	5.6	13092.52	LOKAMARINYANG DISPENSARY-15054	ServicePoint	5.01779	35.59455	0.1188	0.058226412
Dispatch 001	20	14996	9.8	0.4	1.3	2997.82	KOYASA DISPENSARY-14996	ServicePoint	4.9912	35.5112	0.1188	0.067346081
Dispatch 001	21	14643	27.8	0.8	3.6	8504.02	KAIKOR HEALTH CENTRE-14643	ServicePoint	4.92123332	35.34123	0.151443	0.052928301
Dispatch 001	22	15092	32.5	0.9	4.2	9941.75	LORUTH DISPENSARY-15092	ServicePoint	4.84831	35.1641	0.1188	0.011607084
Dispatch 001	23	15059	175.9	3.8	22.9	53807.81	LOKICHOGIO (AIC) HEALTH CENTRE-15059	ServicePoint	4.205532917	34.34719425	0.261185	0.386451765
Dispatch 001	24	15081	2	0.3	0.3	611.8	LOPIDING SUB COUNTY HOSPITAL-15081	ServicePoint	4.20529	34.35938	0.2376	0.37315681
Dispatch 001	25	22215	69.8	1.6	9.1	21351.82	NATUKOBENYO HEALTH CENTRE-22215	ServicePoint	3.818459358	34.63018959	0.1188	0.124385603
Dispatch 001	26	25417	22.4	0.7	2.9	6852.16	NAREGAE DISPENSARY-25417	ServicePoint	3.75483	34.750505	0.1188	0.232905649
Dispatch 001	27	25411	12.9	0.5	1.7	3946.11	NALEMSEKON DISPENSARY-25411	ServicePoint	3.726557	34.8116917	0.1188	0.232905649
Dispatch 001	28	14579	8.8	0.4	1.1	2691.92	KAAPOKA HEALTH CENTRE-14579	ServicePoint	3.7301981	34.843963	0.4802495	1.581429354
Dispatch 001	29	915049	118	2.9	15.3	36096.2	LODWAR COUNTY REFERRAL HOSPITAL-15049	Warehouse	3.1220263	35.6016225		

Collaborating with and Contributing to Open-Source Technology

- Tool built on top of open-source tools, as shown in the graphic – including OpenRouteService from co-panelist organization HeiGIT
- Deployed on Azure cloud and users access it like any website
- Source code is available for download on GitHub (link below)
- Tool can be adapted for other types of health commodity distribution or service delivery, such as for community health workers conducting home visits

The system architecture emphasizes intuitive user experience and analytical rigor



https://github.com/ghsc-psm/Dynamic-Optimization-Routing

Want to Learn More?

Visit the QR Code on the Screen to…

READ more about the Dispatch Optimizer Tool

WATCH a video about the Dispatch Optimizer Tool

EXPLORE the Dispatch Optimizer Tool's source code

EMAIL for more details

Thank You!

Introduction

openrouteservice (ORS) – Open-Source routing & optimization

Julian Psotta
Heidelberg Institute for Geoinformation Technology (HeiGIT) at the University of Heidelberg (Germany)

What is openrouteservice?

openrouteservice is...

- ... built on OpenStreetMap data
- ... open source
- ... free for everyone to use (*)

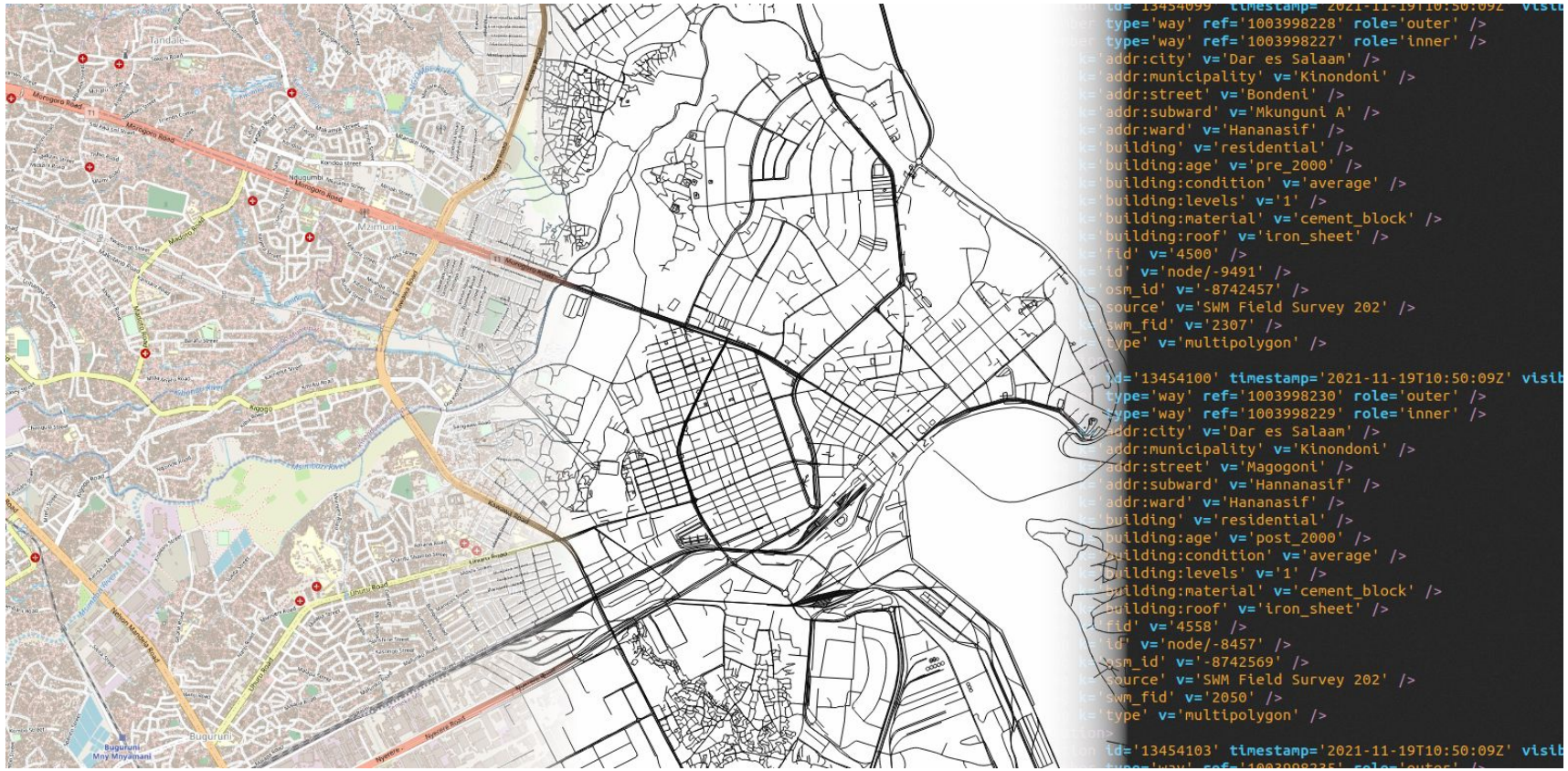
- (*) based on terms of service

OpenStreetMap

- Since 2004
- ~70 GB of data (2023)
- 9 billion nodes
- ~980 million ways

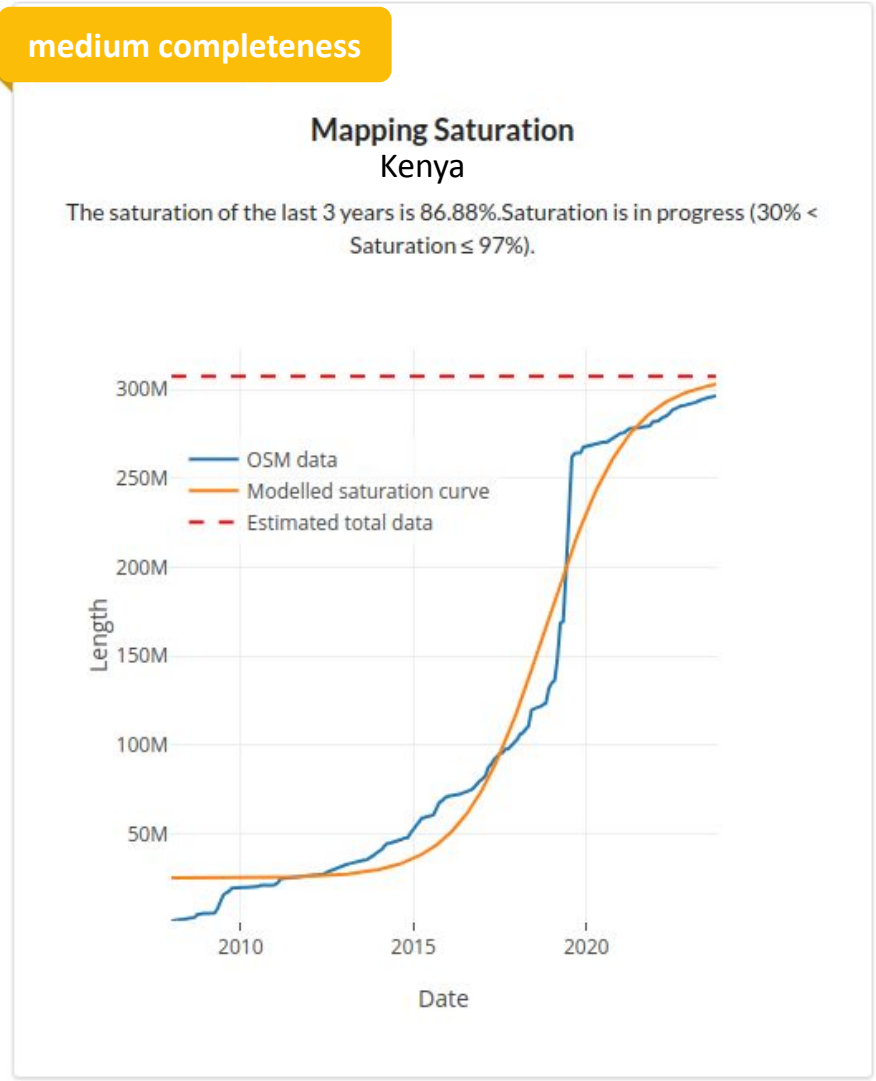
- Free open-data
- Customizable
- Regularly updated
- World-wide coverage

Often better quality and completeness compared to authoritative data!

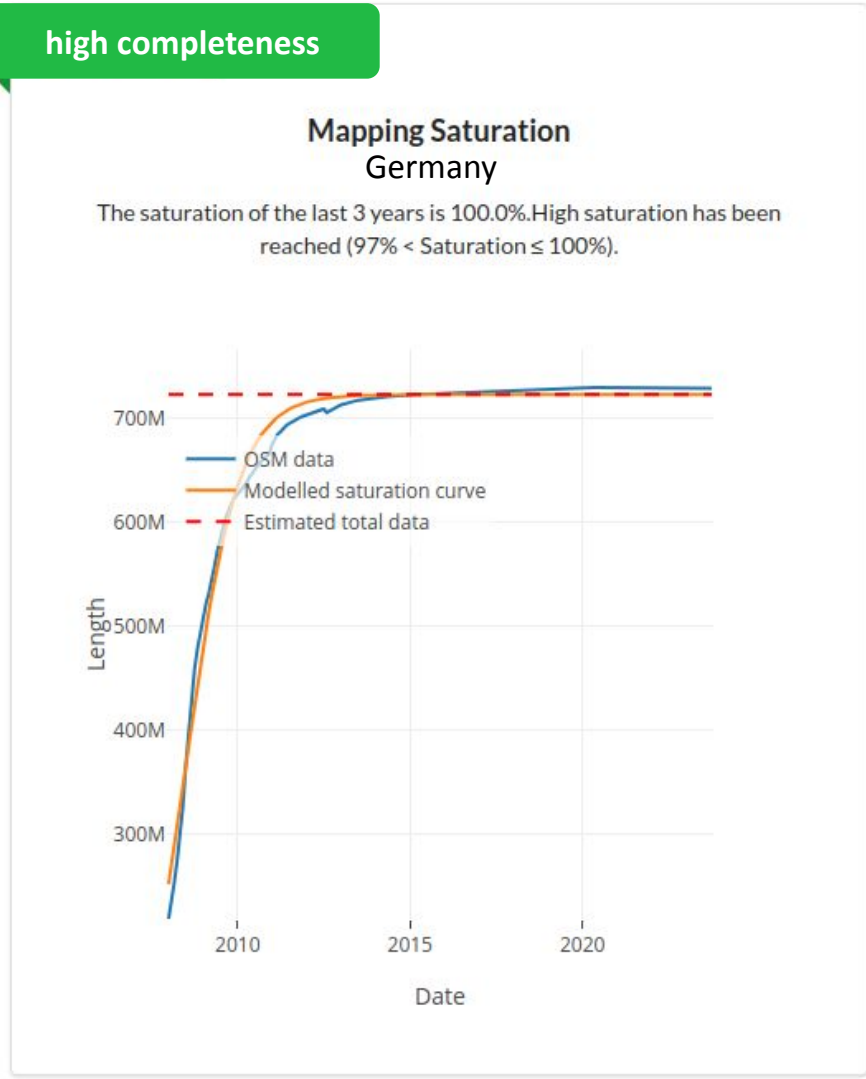


OSM Comparison - Kenya and Germany

medium completeness



high completeness

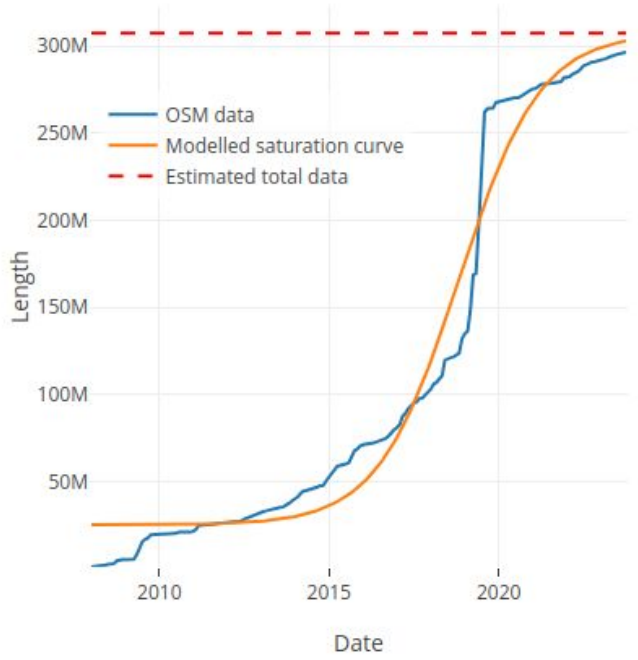


OSM - Road Quality in Kenya

medium completeness

Mapping Saturation
Kenya

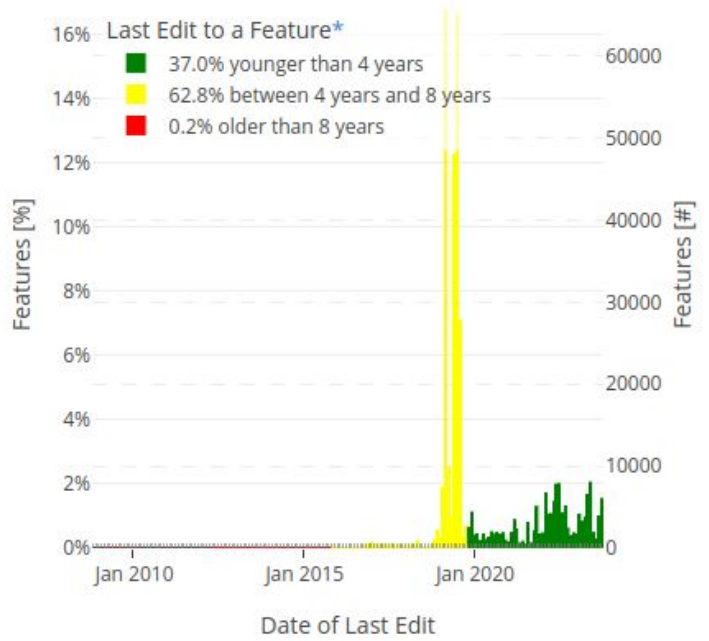
The saturation of the last 3 years is 86.88%.Saturation is in progress (30% < Saturation ≤ 97%).



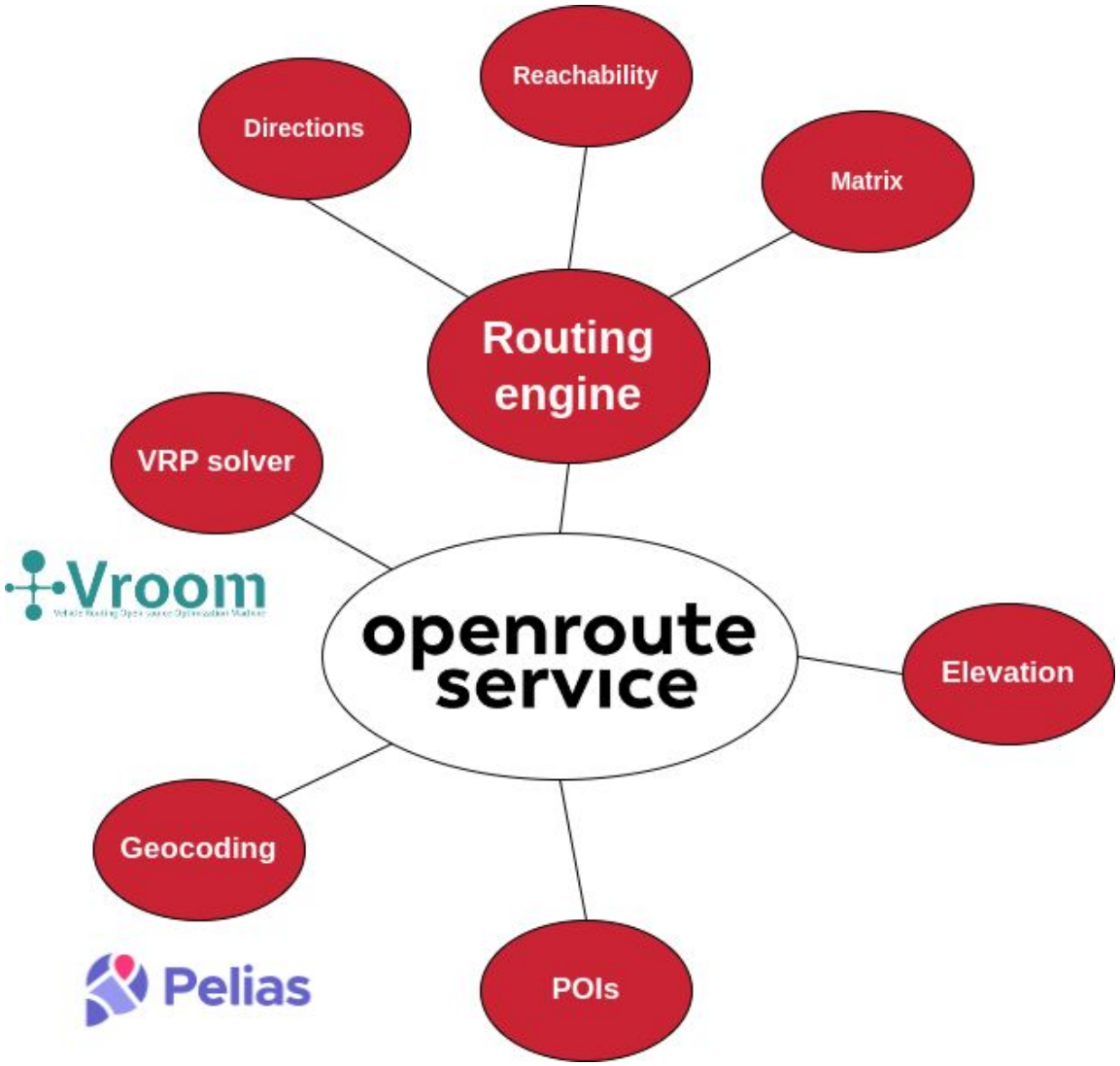
medium completeness

Currentness
Kenya

In the area of interest 37% of the 391405 features were edited (created or modified) for the last time in the period between 22 Oct 2019 and 22 Oct 2023. Some features are up-to-date and some features are out-of-date.



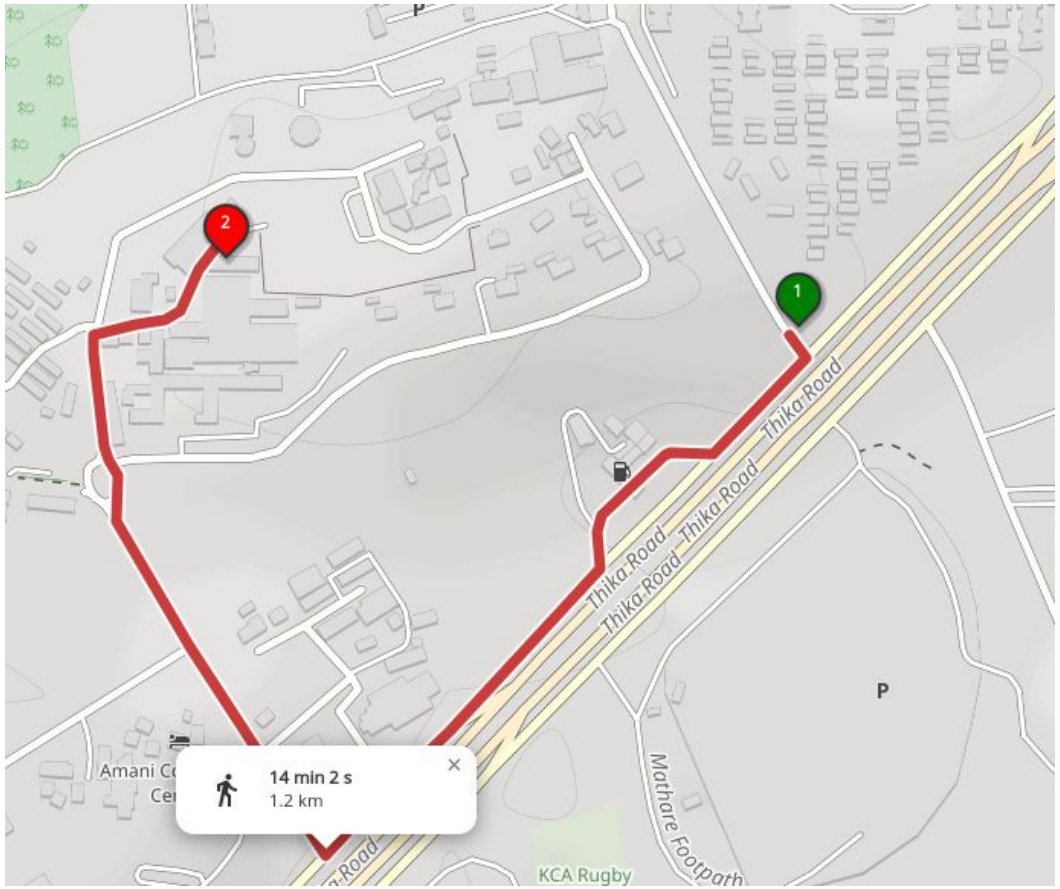
Services



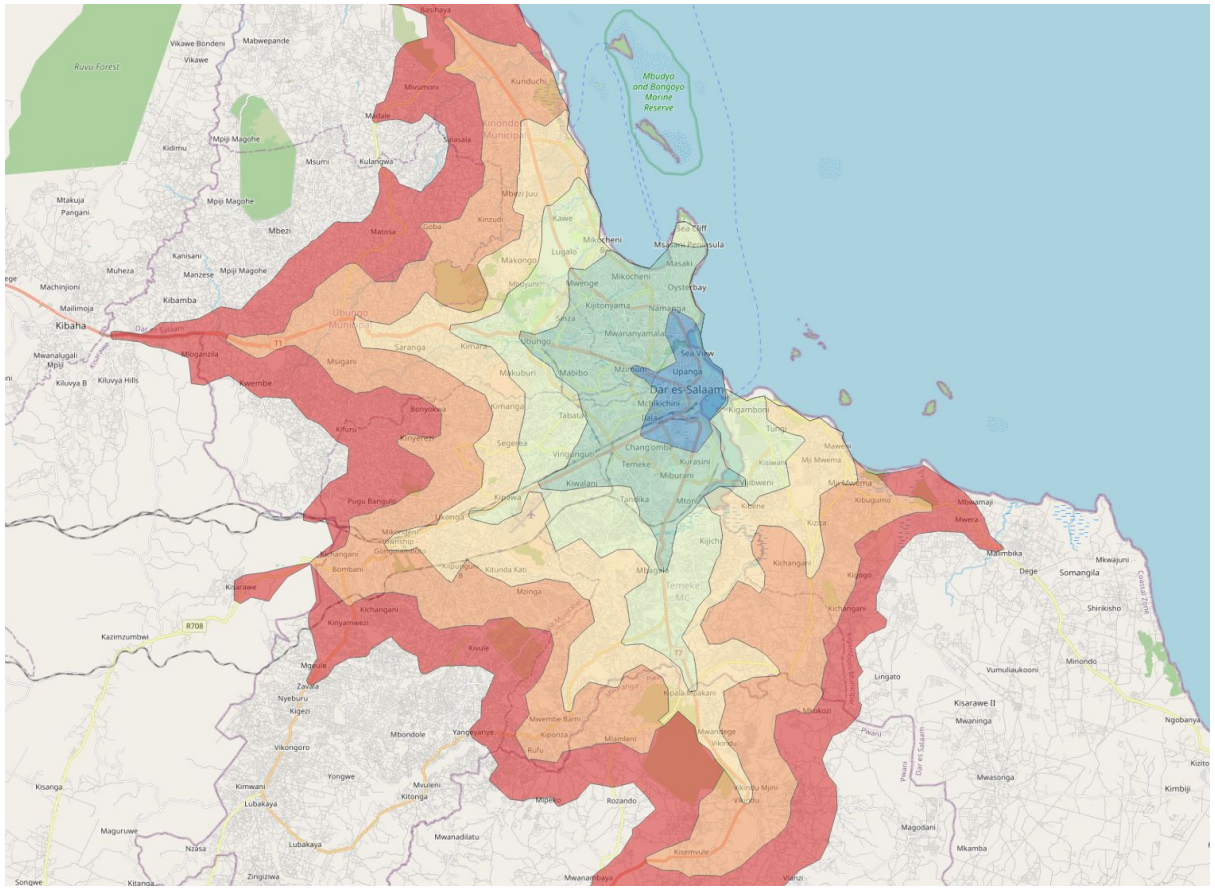
Openrouteservice is a stack of routing related services

Endpoint - Directions & Reachability

A-To-B Directions



Reachability



Endpoint - Matrix

- Simple **coordinate to coordinate** time/distance
- Up to **2,500 Combinations** in one GO
- Backbone of the VRP optimizer

API response: 200 210 ms

Response data in a table

Search

Durations	9.700817, 48.476406	9.207772, 49.153882	37.572963, 55.801279	115.665017, 38.100717
9.700817, 48.476406	0 sec	5778.21 sec	91517.44 sec	395689.16 sec
9.207772, 49.153882	5551.84 sec	0 sec	90217.7 sec	394389.41 sec
37.572963, 55.801279	91528.26 sec	89947.35 sec	0 sec	308088.88 sec
115.665017, 38.100717	396748 sec	395167.09 sec	307701.75 sec	0 sec

DOWNLOAD

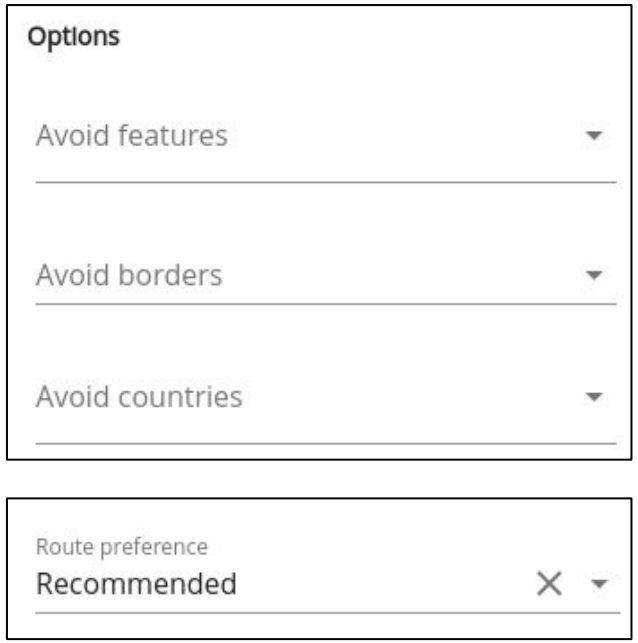
Optimization - Overview

Preference-based optimization:

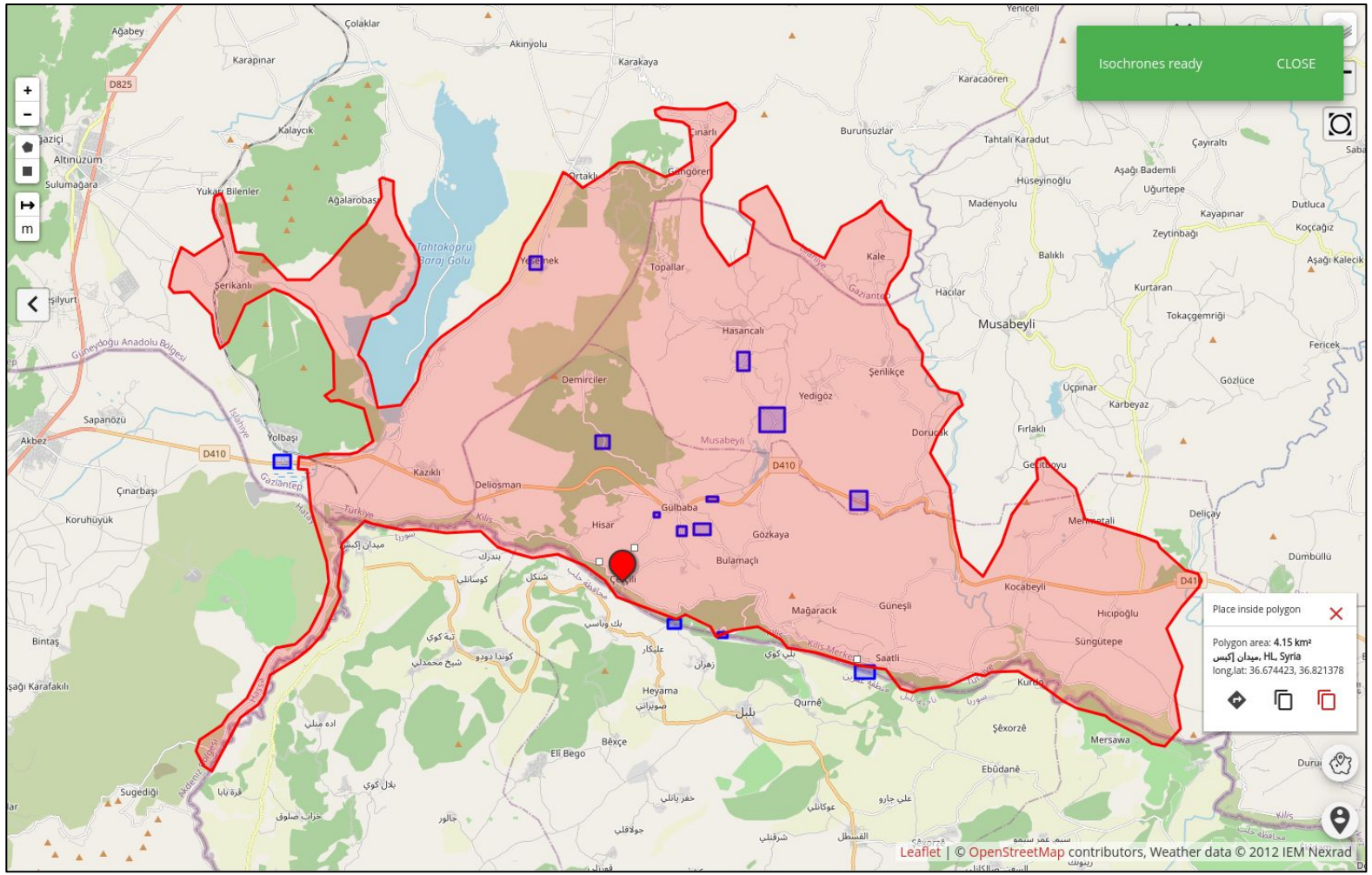
- Fastest vs Shortest vs Recommended routes
- Avoid Highways, toll ways and ferries
- Avoid borders
- Avoid specific countries
- For routing and reachability
- Dynamic avoidable storage

Algorithm-based optimization:

- Optimize time and distance
- Scenario oriented and software driven
- Uses the matrix endpoint



Optimization – Turkey Earthquake

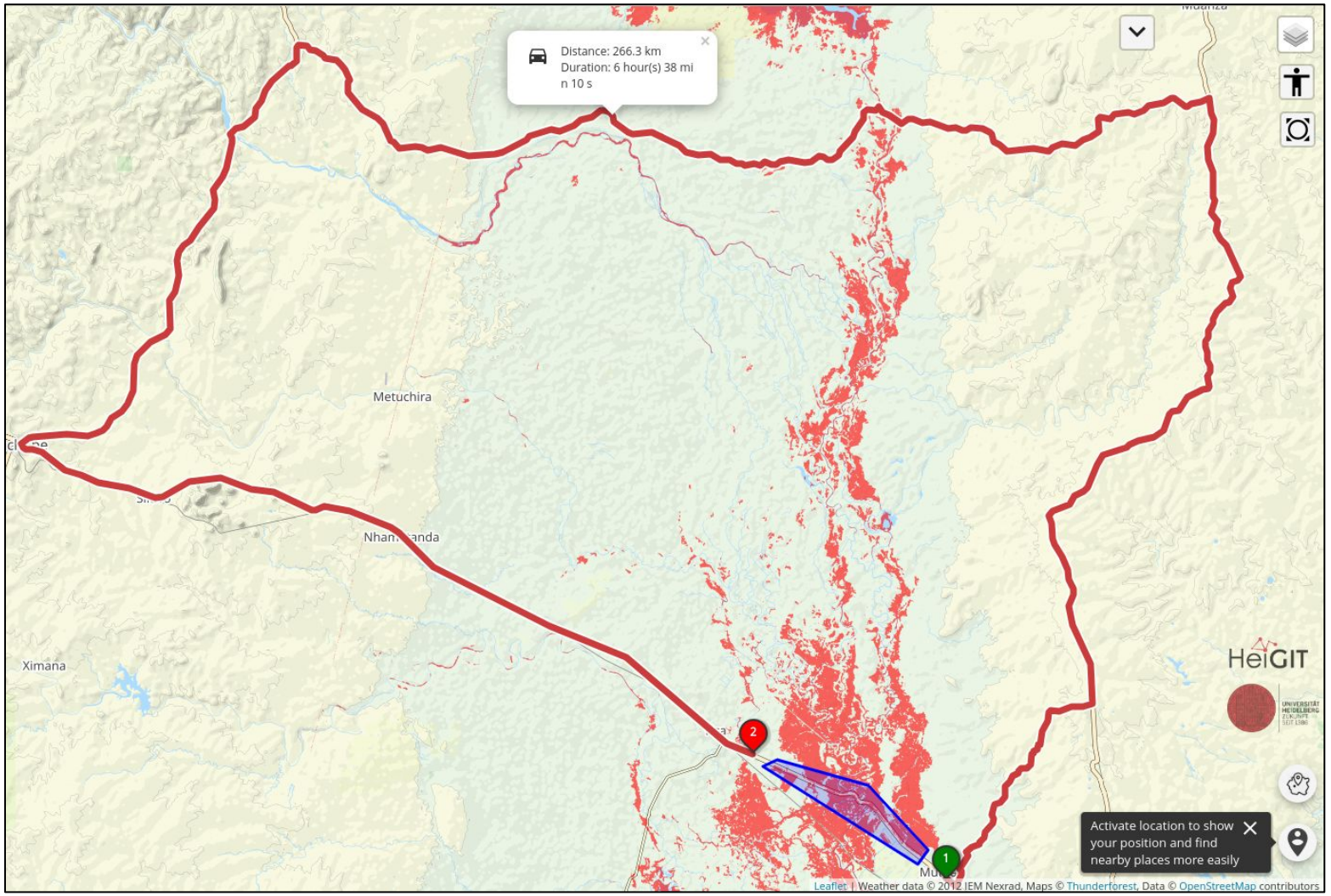


Preference-based optimization

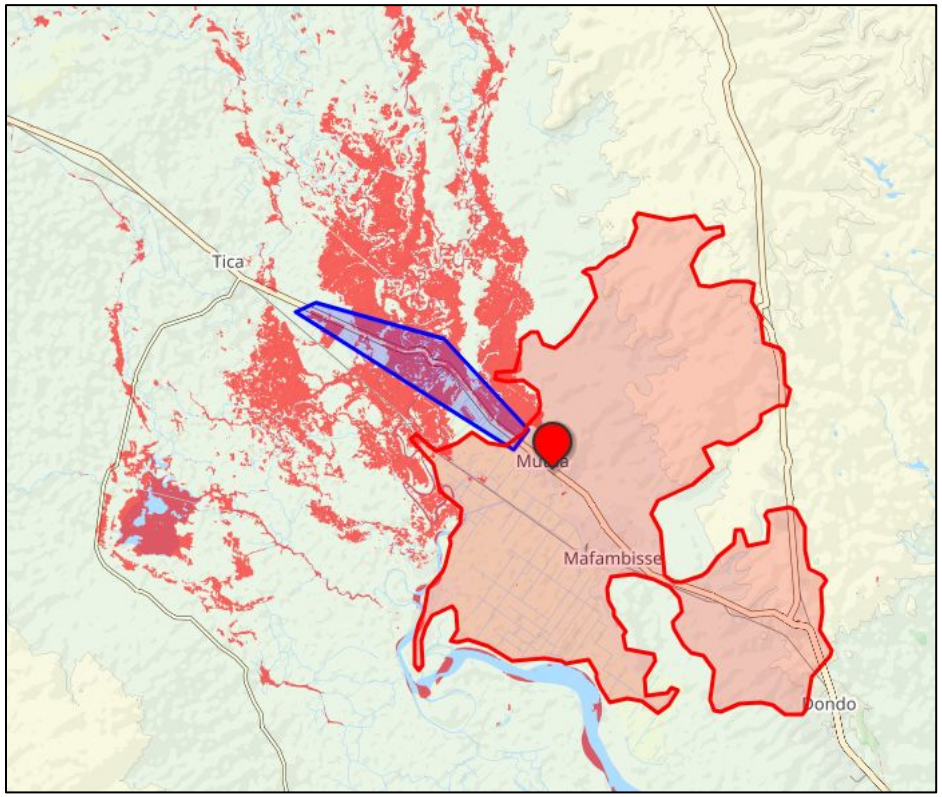
Select a disaster region

- ✓ Slovenia
  Last update: 2023-10-26 18:32:31 UTC
- ✓ Earthquake in Anatolia region
  Last update: 2023-11-10 15:47:29 UTC
- ✓ Africa
  Last update: 2023-11-10 15:14:20 UTC
- ✓ Central and South America
  Last update: 2023-11-10 15:10:19 UTC
- ✓ SE Asia and Oceania Islands
  Last update: 2023-11-10 15:07:16 UTC

Optimization - Mozambique Cyclone Idai

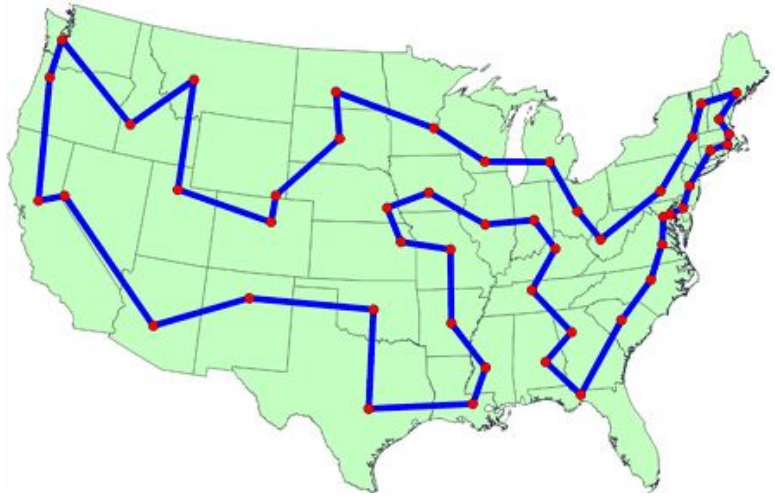


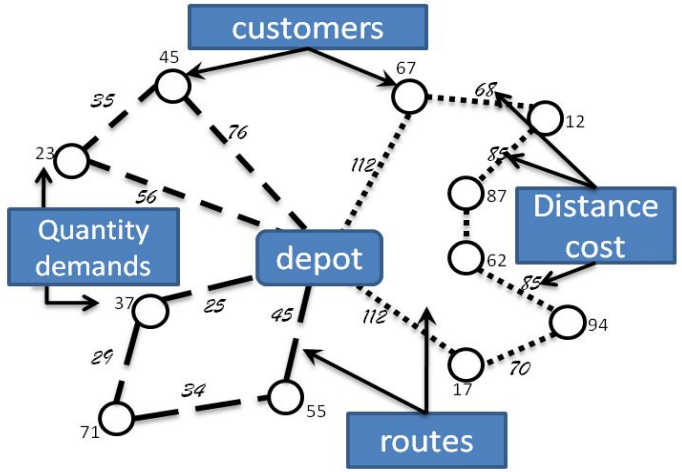
Preference-based optimization



Route Optimization with ORS – VRP

Travelling Salesman Problem (TSP)

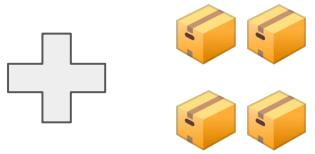




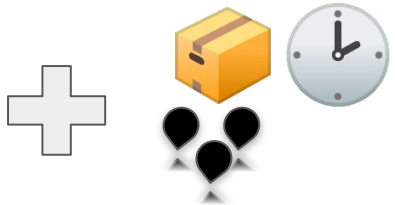
capacity = **C+VRP**

time window = **VRP+TW**

multiple depot = **MD+VRP**



pickup and delivery = **PD+VRP**

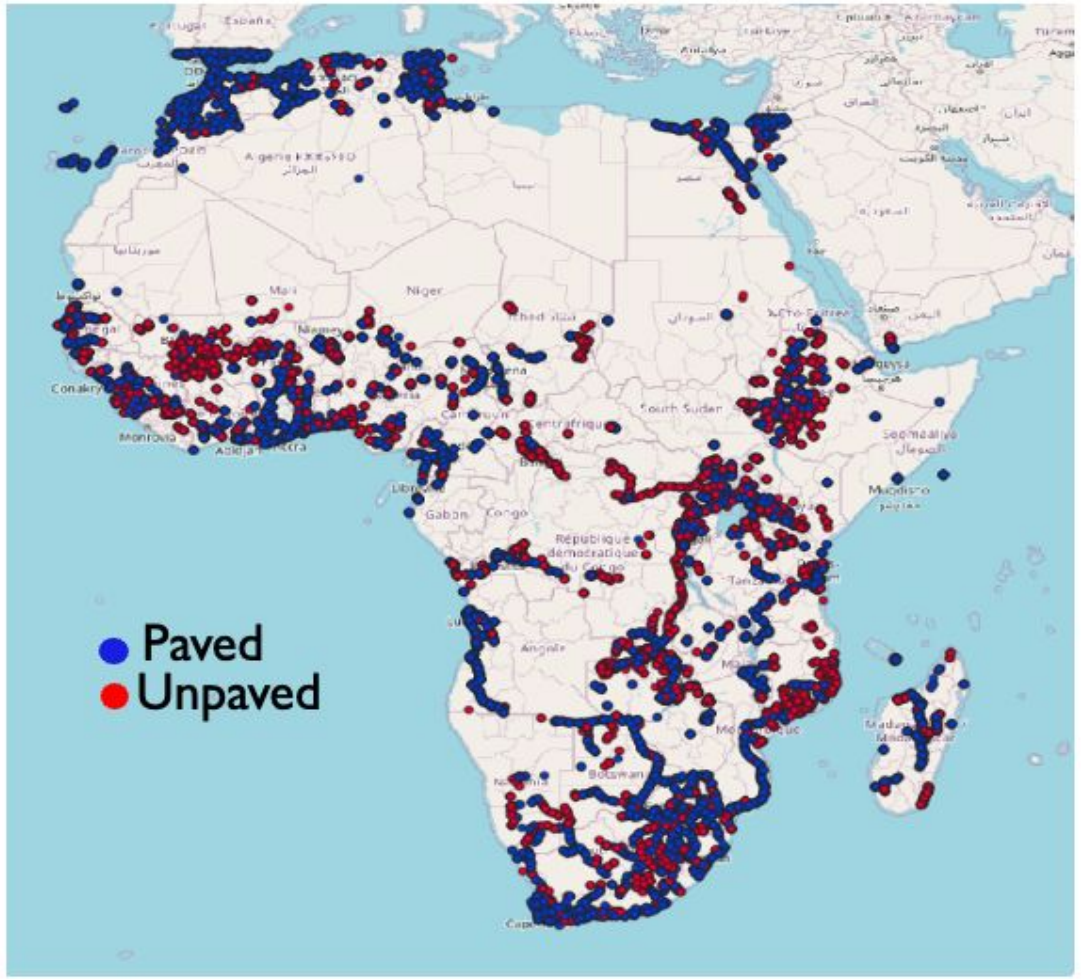


multiple depot heterogeneous = **MD+H+VRP+TW**

Upper Image: https://optimization.cbe.cornell.edu/index.php?title=Traveling_salesman_problem#
Lower Image: https://www.researchgate.net/figure/The-Capacitated-Vehicle-Routing-Problem-CVRP_fig1_319754352

Outlook - What's to come

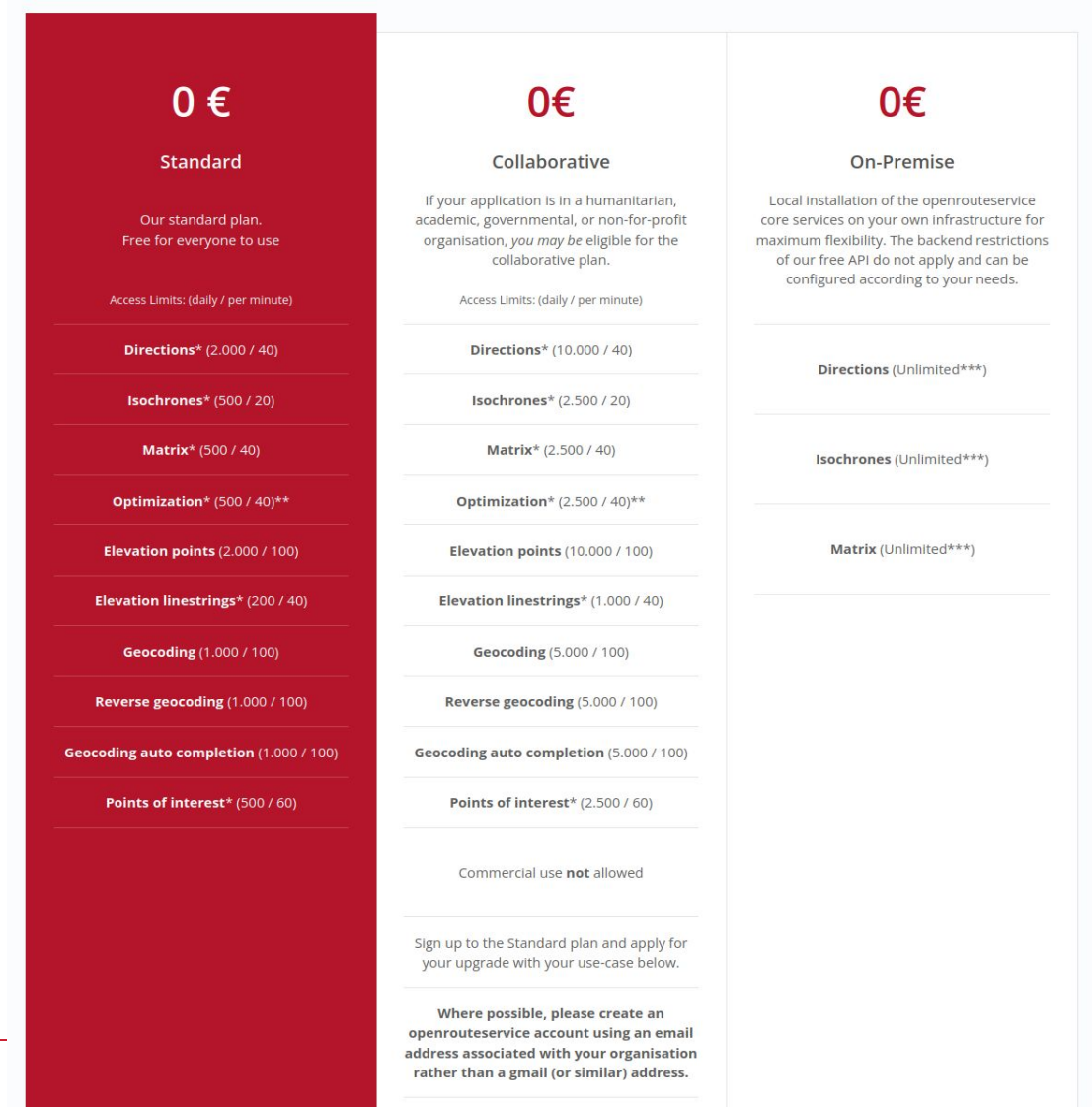
- AI detected road surface detection
  - 95,000 Mapillary images
  - Combined logic paved & unpaved
  - Matched to OSM
  - Global scale
- Enhanced travel time estimations
- Public transit optimization
- Vehicle optimization with avoid areas
- Increased free request quotas for our public API
  - +10,000 global routing requests
  - Higher requests per minute
  - More vehicles in optimization
- Public transit oriented multimodal routing
- ArcGIS Desktop and Cloud integrations



How to use openrouteservice - Plans

Plans

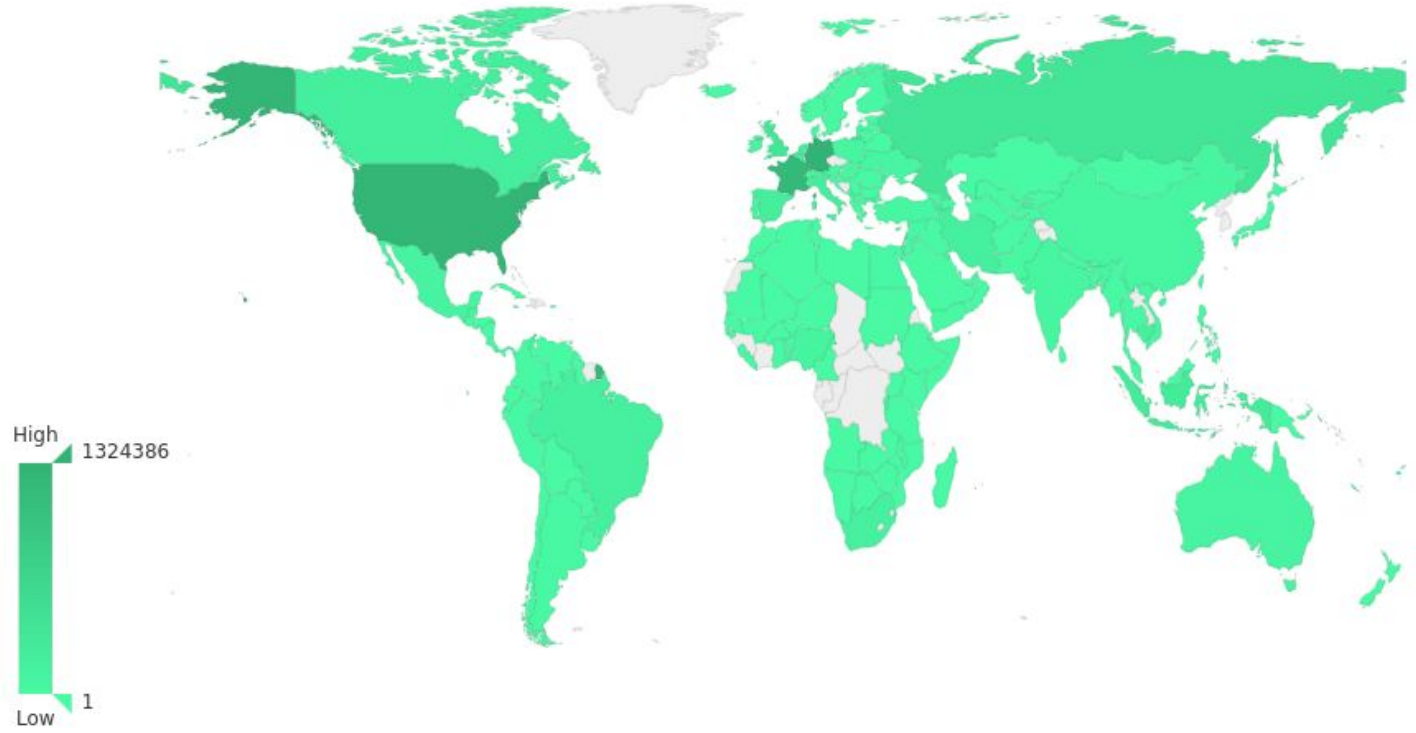
- **Standard** – for everyone
- **Collaborative** – academia, non-profit and humanitarian organisations
- openrouteservice.org/plans



0 €	0€	0€
Standard	Collaborative	On-Premise
Our standard plan. Free for everyone to use	If your application is in a humanitarian, academic, governmental, or non-for-profit organisation, *you may be* eligible for the collaborative plan.	Local installation of the openrouteservice core services on your own infrastructure for maximum flexibility. The backend restrictions of our free API do not apply and can be configured according to your needs.
Access Limits: (daily / per minute)	Access Limits: (daily / per minute)	
Directions* (2.000 / 40)	**Directions*** (10.000 / 40)	**Directions** (Unlimited***)
Isochrones* (500 / 20)	**Isochrones*** (2.500 / 20)	**Isochrones** (Unlimited***)
Matrix* (500 / 40)	**Matrix*** (2.500 / 40)	**Matrix** (Unlimited***)
Optimization* (500 / 40)**	**Optimization*** (2.500 / 40)**	
Elevation points (2.000 / 100)	**Elevation points** (10.000 / 100)	
Elevation linestrings* (200 / 40)	**Elevation linestrings*** (1.000 / 40)	
Geocoding (1.000 / 100)	**Geocoding** (5.000 / 100)	
Reverse geocoding (1.000 / 100)	**Reverse geocoding** (5.000 / 100)	
Geocoding auto completion (1.000 / 100)	**Geocoding auto completion** (5.000 / 100)	
Points of interest* (500 / 60)	**Points of interest*** (2.500 / 60)	
	Commercial use **not** allowed	
	Sign up to the Standard plan and apply for your upgrade with your use-case below.	
	Where possible, please create an openrouteservice account using an email address associated with your organisation rather than a gmail (or similar) address.	

In numbers:

- +80,000 registered users
- 10+ Years of experience
- ~1.2 million requests / day
- Requests from 192 countries



How to use openrouteservice?

Access through our…

- **Home: openrouteservice.org**
- **Maps: maps.openrouteservice.org**
- **API Documentation: openrouteservice.org/dev/#/api-docs**
- **Open-Source Code: github.com/GIScience/openrouteservice**
- **Disaster-Portal: disaster-portal.heigit.org**

OSM Quality Analyses:

- **Home: ohsome.org**
- **Quality Analyst: dashboard.ohsome.org**

Contact:

- **Smart Mobility Group @ HeiGIT: Julian.Psotta@heigit.org**

Q&A and Discussion