MapAction data readiness for Covid vaccine delivery: South Sudan pilot project

14 July 2021

Narrative for the Integrated Humanitarian Data Package

Contents

Project Background

As COVID-19 vaccines start arriving in low and middle-income COVAX initiative participant countries, successful vaccination programmes in those countries will depend on geographic data to help identify priority population groups and to plan efficient "last mile" vaccine delivery.

Aware of likely data gaps in many countries, and anticipating specific data needs, with support from the Calleva Foundation, MapAction ran a pilot project, focussing on South Sudan, a country with imminent COVAX deliveries and known data gaps.

The aims of the pilot project were:
- To build a portfolio of immediately useful country data
- To produce a documented readiness package and make it publicly available.
- To build learning and community practice around the process to inform future work so as to assist further work in other COVAX eligible countries (see Feedback section at end of document).
- To be in a better position to respond extremely quickly to COVAX's needs.

South Sudan was chosen because of:
- COVAX allocation due in the first half of 2021 (732,000 doses).
- A context of acute humanitarian needs (see Humanitarian Response Plan 2021).
- Known challenges in demographic, health infrastructure, and logistics data.

Project Partners and Contributors

In order to progress the pilot project, applications for assistance were invited from partner organisations, with small grants (£5,000-£10,000) made available. Other organisations (Esri and Mapbox) contributed free of charge and in kind.

| MapAction | Overall project management IHDP concept development Metadata creation File GeoDatabase creation GIS desktop projects creation Basic useful python/R scripts Survey tools Narrative authoring Portal publication Outreach and evaluation | |

CartONG	• Data sourcing and exploration • Data mining and ETL • Data quality assurance • Data model and user stories • Population calculations • Data enrichment and creation • GeoPackage creation	
OpenMap Development Tanzania Humanitarian OpenStreetMap Team	• OpenStreetMap tasking and mapathons • Data validation • South Sudan OpenStreetMap improvement	
afrimapr	• Health facility location data visualisation and comparison • Creation of open-source R code and applications to view health facilities & other data.	
Esri	• Africa Geoportal support • Esri technology and application support	
Mapbox	• Accessibility surface creation • Accessibility surface and zonal statistics python scripts	

Country Background

Independence

On the 9th July 2011, after an independence referendum held the previous January, the three southern historic provinces of Sudan seceded to form the Republic of South Sudan and the Draft Transitional Constitution of the Republic of South Sudan 2011 came into force.

Later that July, The Republic of South Sudan became the 193rd and latest member of the United Nations and the 54th country to join the African Union.

Territory

The 2011 constitution states that both the three former southern historic provinces of Sudan and the Abyei area make up the territory of South Sudan.
- The boundaries of the three former southern historic provinces of Bahr el Ghazal, Equatoria and Greater Upper Nile are those as they stood on 1st January 1956.
- The Abyei Area, the territory of the nine Ngok Dinka chiefdoms transferred from Bahr el Ghazal Province to Kordofan Province in 1905 as defined by the Abyei Arbitration Tribunal Award of July 2009.

Government

There are three levels of government in South Sudan:
1. **National** - Admin level 0 (consisting of legislature, executive and judiciary)
2. **State** - Admin level 1
3. **Local** - Admin level 2, explained below

Local government tiers consist of:
- **Rural**: County (admin2), Payam (admin3) and Boma (admin4)
- **Urban**: City (admin2), Municipal (admin3) and Town Councils (admin4)

Legislation of the states also provides for the role of **Traditional Authority** as an institution at local government level on matters affecting local communities.

Administrative Geography

Since independence the number of states has varied.

Years	Number of states	Useful links
2011–2015	10	https://www.usip.org/publications/2021/03/south-sudan-10-states-32-states-and-back-again
2015–2017	28	https://web.archive.org/web/20151208183221/https://

		radiotamazuj.org/en/article/kiir-and-makuei-want-28-states-s-sudan
2017–2020	32	https://www.sudantribune.com/spip.php?article61403
2020–present day	10	https://www.usip.org/publications/2021/03/south-sudan-10-states-32-states-and-back-again

Special Administrative Areas

At the end of the South Sudanese Civil War on 22 February 2020, three Special Administrative Areas (SAA) were created:

Name	SAA type	Useful links
Greater Pibor	Administrative Area	https://en.wikipedia.org/wiki/Pibor_Administrative_Area
Ruweng	Administrative Area	https://en.wikipedia.org/wiki/Ruweng_Administrative_Area
Abyei	Special Administrative Status Area	https://en.wikipedia.org/wiki/Abyei

The Abyei Area is considered to be simultaneously part of the Republic of Sudan and the Republic of South Sudan, effectively a condominium. Under the terms of the Abyei Protocol, the residents of the Abyei Area have been declared, on an interim basis, to be simultaneously citizens of the states of West Kurdufan (Republic of Sudan) and Northern Bahr el Ghazal (Republic of South Sudan).

The Protocol on the resolution of the Abyei conflict put Abyei into a special administrative status government directly by the presidency. The precise borders of the Abyei Area were to be determined by an Abyei Borders Commission (ABC). By this protocol, the Abyei Area is "the area of the nine Ngok Dinka chiefdoms transferred to Kordofan in 1905".

In 2005, a multinational border commission established this to be those portions of Kordofan south of 10°22′30″ N. An international arbitration process redrew Abyei's boundaries in 2009 to make it significantly smaller, extending no further north than 10°10′00″ N.

## Disputed Areas

There are two disputed areas in South Sudan:
- The Kafia Kingi area is disputed between South Sudan and Sudan
- The Ilemi Triangle is disputed between South Sudan and Kenya.

The Integrated Humanitarian Data Package

An Integrated Humanitarian Data Package (IHDP) is a package of cleaned, checked and enriched data accompanied by ready to use desktop GIS projects, survey tools and useful scripts.

The purpose of an IHDP is to remove potentially slow and error prone data management steps between sourcing data and making it ready for instant use in a humanitarian context i.e. the COVAX initiative.

An IHDP is provided as a ZIP file and structured as follows:
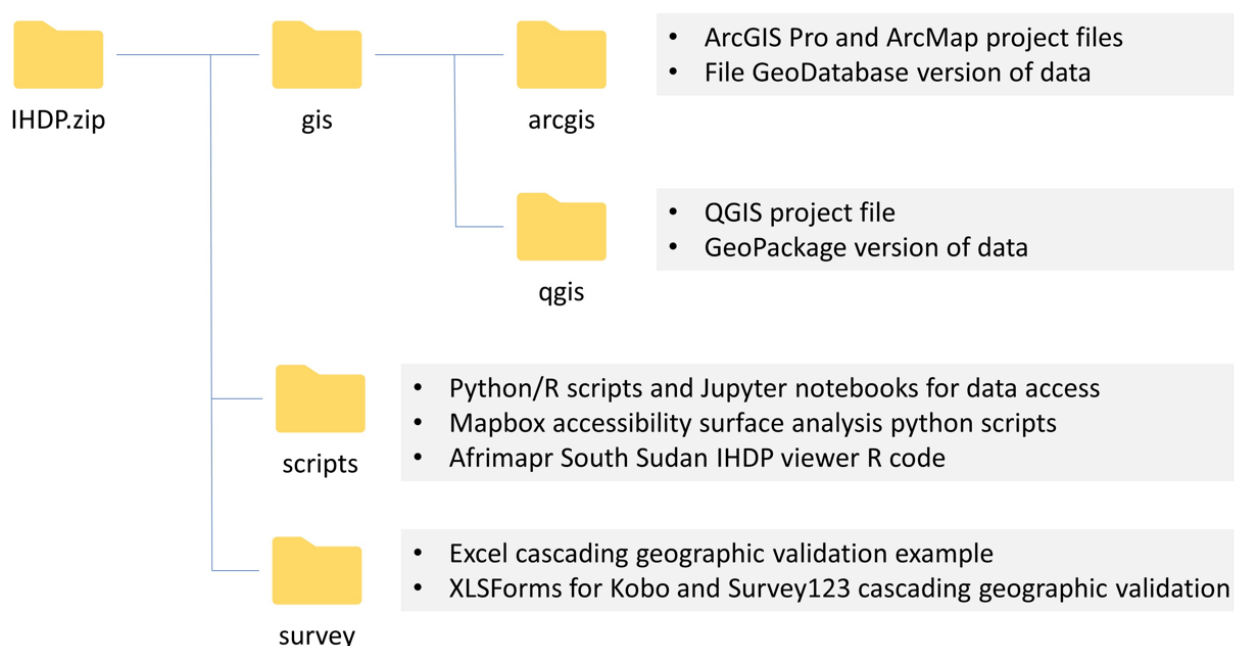
The resultant IDHP for South Sudan was made available on:
- https://www.africageoportal.com/
- https://maps.mapaction.org/

Data

Naming Conventions

All data has been named in accordance with the MapAction data naming convention which has the following structure:

```
<geo_extent>_<category>_<theme>_<geometry>_<scale>_<source>_<permissions>
```

Note: The IHDP itself, desktop GIS projects, File Geodatabase/GeoPackage, scripts and survey files have also adopted some elements of this convention.

Formats

IHDP data is provided in two formats:

Esri File GeoDatabase (see IHDP gis/arcgis folder)	`ssd_ihdp_c19_s0_pp.gdb`	Contains feature classes for use with ArcGIS Pro and ArcMap.
OGC GeoPackage (see IHDP gis/qgis folder)	`ssd_ihdp_c19_s0_pp.gpkg`	Contains SQLite tables for use with QGIS.

The data contained within each format is exactly the same. These formats were chosen explicitly to differentiate dta provision from the source data files.

The reason for providing two different formats is to accommodate the preferences and use cases of different desktop GIS users. In addition, although Esri states support for GeoPackages in ArcGIS Pro, difficulties were encountered with GeoPackages and ArcMap, and ESRI does not support use of any of their geoprocessing tools with GeoPackages that requires geodatabase output.

As a GeoPackage is at its heart an SQLite Database, its contents can also be examined by tools such as SQLite Studio and DB Browser.

Metadata and Licensing

Metadata is held in a table called **ihdp_metadata** within both the File GeoDatabase and the GeoPackage. Although Esri ArcGIS Pro and GeoPackages both support the iso19115 standard for geographic metadata, the simpler OCHA level 2 metadata standard was used in this case.

Data licensing information is held within the metadata. For the purposes of this pilot project all IHDP content has been assigned a Creative Commons CC BY-NC-ND 4.0 license.

The metadata table and contents are replicated in Appendix A.

Data Mining

Prior to data mining activities, an exploration of a range of diverse data sources in a variety of data formats was carried out including non-governmental and governmental sources, and mainly focused on population, health sites, health catchment areas, admin boundaries, points of interest (POI) and transportation network data.

The main open data sources were:
- Humanitarian Data Exchange (HDX)
- World Food Programme (WFP) Geonode Portal
- Médecins Sans Frontières (MSF)

- Open Street Map (OSM)
- WorldPop

OpenStreetMap Improvements

From 26 April 2021 to 18 May 2021, 16 members of the Humanitarian OpenStreetMap Team (HOT) in Tanzania set up five HOT projects via their HOT Tasking Manager and OSM Changeset Analyzer (OSMCha) to improve South Sudan OSM data.

These projects were:
- 10684 - Nzara-Ringasi Roads
- 10699 - Yambio Urban Area
- 10748 - Yambio Roads
- 10749 - Makpandu-Madebe Roads
- 10750 - Maridi-Mambe Roads

The locations of these areas is shown below:
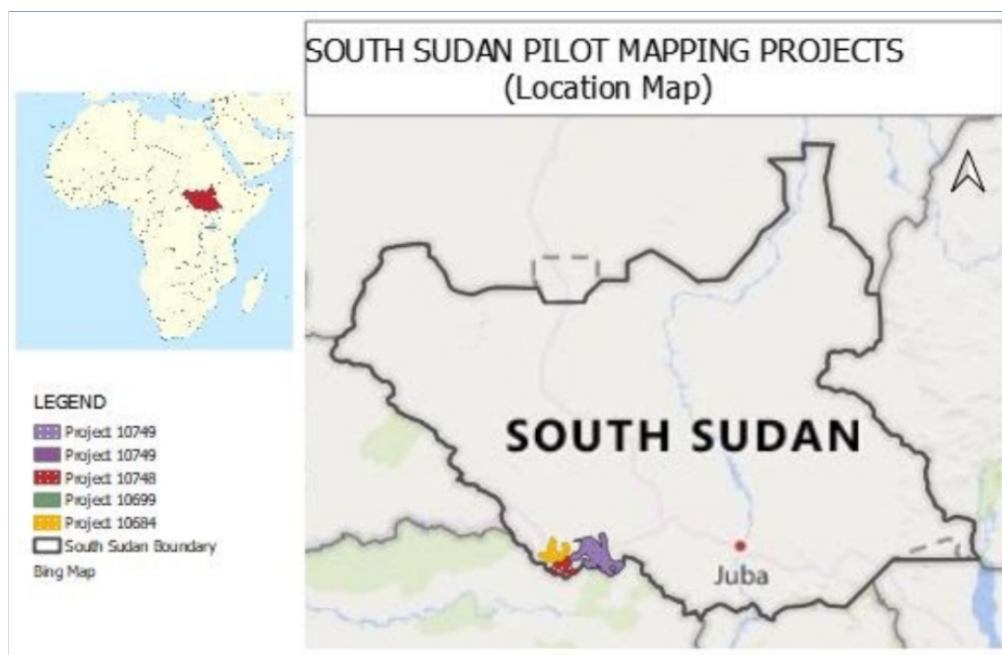
OpenMap Development Tanzania undertook validation of the tasks.

Total tasks mapped and validated	3376 tasks 90% mapped by advanced mappers 7% mapped by intermediate mappers 3% by beginner mappers
Total working hours	952 hours
Roads validated	5676 km

Data Quality

With exploration and OSM improvement complete, an assessment of the data quality was performed taking into account accuracy, precision, error studies and uncertainty. This quality assessment process went through both automatic and sampling processes. The assessment verified three elements:

- The dataset must have been updated within the last 2 years
- The dataset must cover most of the area of interest (AOI)
- The fields must contain information for most of the features

Some interesting datasets did not respect all those requirements and therefore were excluded from the dataset.

Data Model

With the appropriate datasets identified, a replicable, simple and efficient data model was created for each dataset. This work was based on an evaluation of existing data models and validation by the pilot project partners.

Data model definition was also based upon the creation of user stories (see Appendix B). These user stories were then used to define which type of products are needed to answer those needs. From these products, the data needed to produce those products was derived.

See Appendix C for the details of the data model.

Data Creation

For the vast majority of datasets included with the IHDP, an Extract, Transform and Load (ETL) process was developed in FME to create the final dataset. The process consisted of the following steps.

| various file formats (shp, xlsx, csv, gpkg) | conversion where needed to WGS 84 | filtering based on various fields | clipping with country boundary | Reorganisation of data structure to match data model | Export of data to OGC GeoPackage |
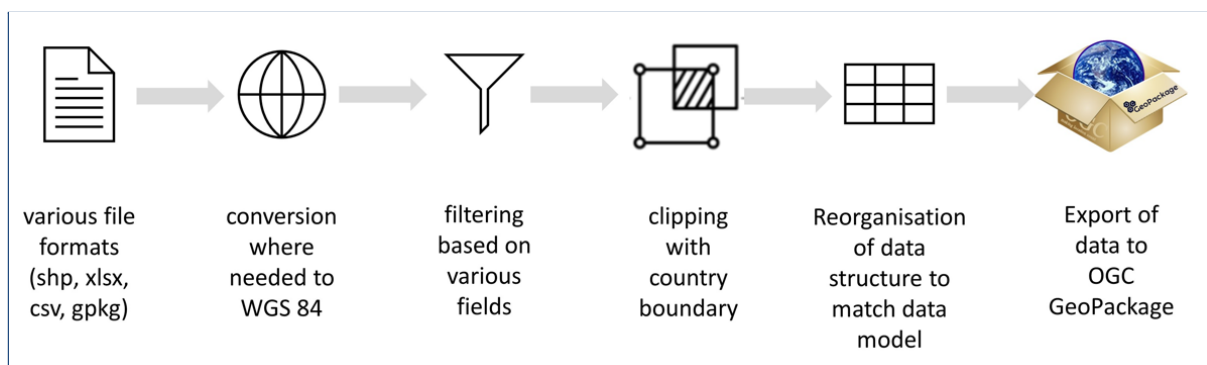
Population Information

Creation of population information required a different approach to processing.
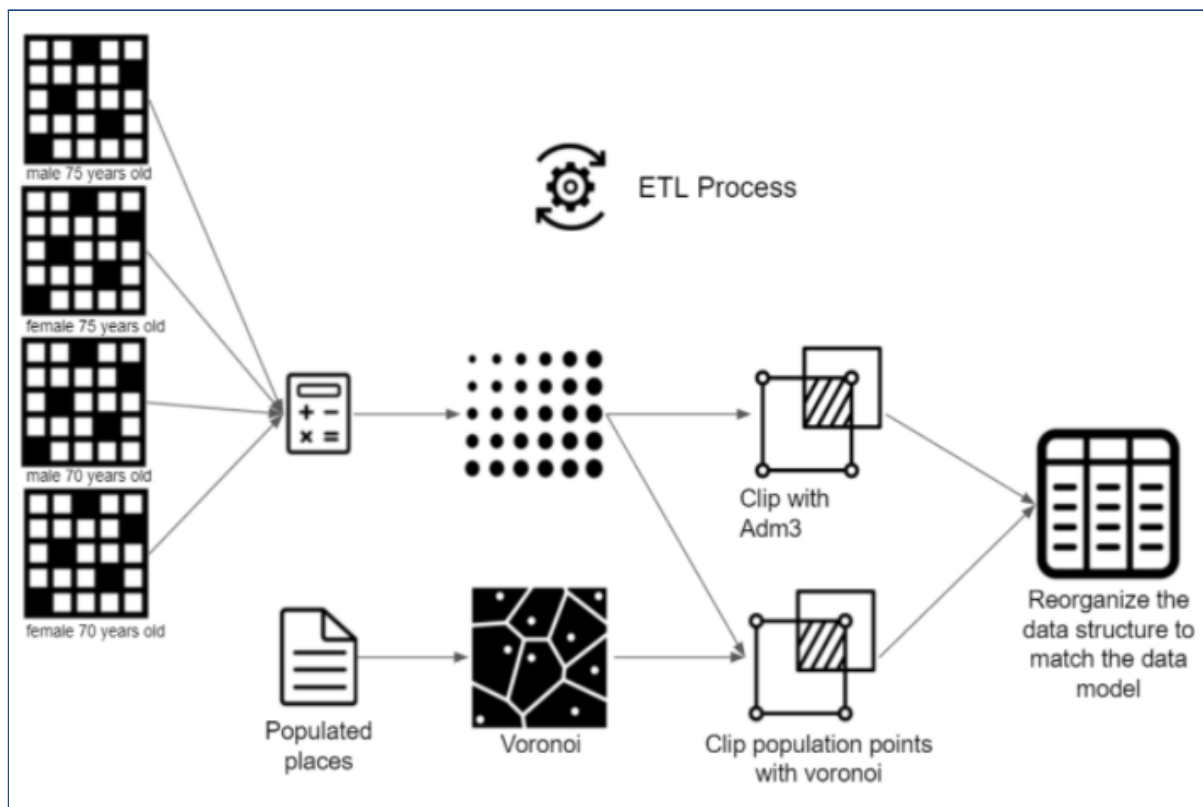
The constrained data per age from WorldPop was used as the basis for the above processing. This dataset is divided into different rasters by sex and age. The first step was to compiled the rasters into age categories only (removing the distinction between sex). The age categories were then chosen to reflect those used by COVAX initiative. This process resulted in four rasters of the following age categories:

- 0-24
- 25-40
- 41-65
- 65 and over

These rasters were then transformed into point layers and then summed and clipped to the lowest administration level. The same process was then repeated for populated places using a voronoi diagram approach around the populated places points.

Population information is therefore included in both administrative datasets and settlement datasets:

- **Country boundary** (`ssd_admn_ad0_py_s0_c19ihdp_pp`)
- **State boundary** (`ssd_admn_ad1_py_s0_c19ihdp_pp`)
- **County boundary** (`ssd_admn_ad2_py_s0_c19ihdp_pp`)
- **Settlements** (`ssd_stle_stl_pt_s0_c19ihdp_pp`)
- **Settlements including the distance of the settlement's population to the nearest road, hospital, airport and river** (`ssd_stle_stl_pt_s0_c19ihdp_pp_dist`)

Settlements Distance Dataset (`ssd_stle_stl_pt_s0_c19ihdp_pp_dist`)

An additional version of the settlements dataset is included within the IHDP. This dataset includes the distance of the settlement's population to the nearest road, hospital, airport and river. This distance information can be used to visualise the level of isolation of the different places across South Sudan.

Health Facilities Dataset (`ssd_heal_med_pt_s0_c19ihdp_pp`)

The primary source for the health facility dataset was the South Sudanese Ministry of Health (MoH). An additional health facilities dataset is available on request from Médecins Sans Frontières (MSF) by contacting GISCentre.GVA@geneva.msf.org.

Afrimapr has also provided some additional research on South Sudan health facility datasets in general along with three useful tools:
- Can open South Sudan Health facility location data help inform covid vaccine distribution?
- South Sudan Health Service Functionality Dashboard
- South Sudan IHDP mapviewer
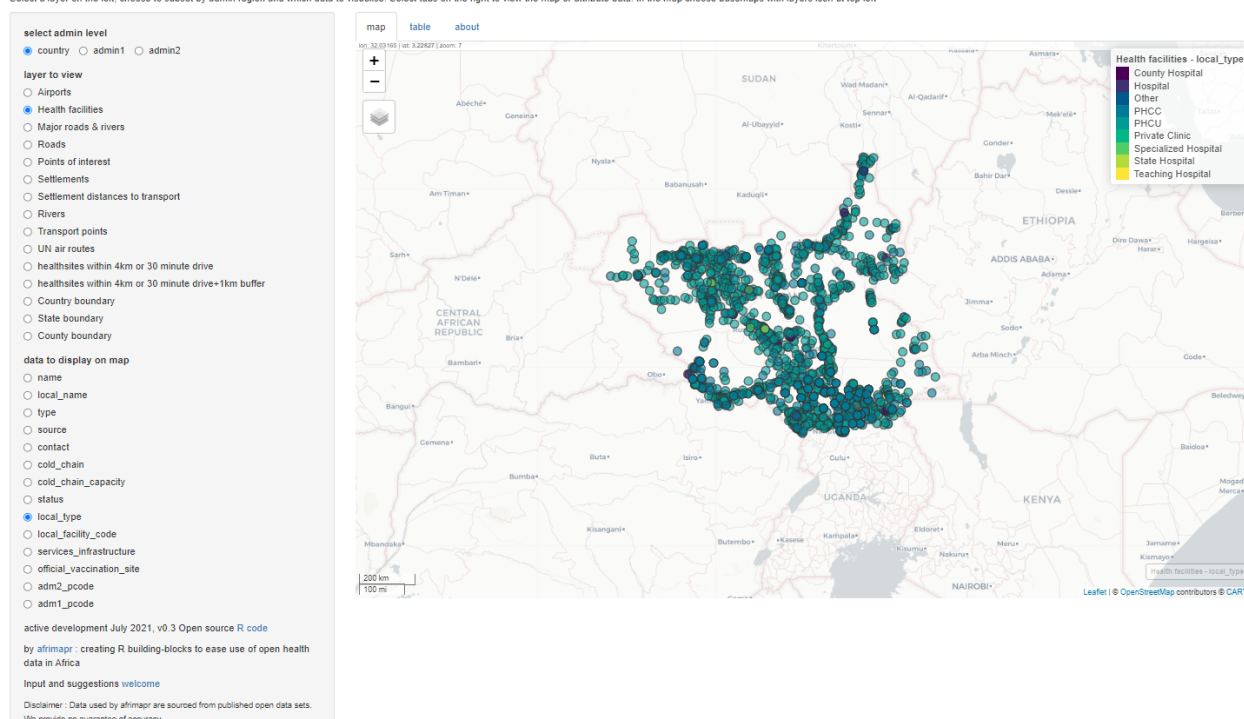
Accessibility Surfaces

This dataset contains two accessibility surfaces representing areas reachable within a ~30m drive of health facilities according to the Mapbox road network (derived from OSM), plus a 4km geodesic buffer around all health facility points to account for missing roads and walking time

for those without access to motor transport. Road network accessibility was computed using the Mapbox [Isochrone API](#).

`ssd_tran_iso_py_s0_c19ihdp_pp_30min1m4kmbuf`	• This shape represents a 30m drive time isochrone, minimally buffered (1m), plus a 4km geodesic buffer around all sites • Using [WorldPop population raster](#), this represents 6771809.5 or 60.76% of the total population
`ssd_tran_iso_py_s0_c19ihdp_pp_30min1km4kmbuf`	• This shape represents areas reachable within a 30m drive time isochrone buffered by 1km to compensate for smaller missing roads or rural settlements offset from a captured road, plus a buffer of 4km around each site. • Using [WorldPop population raster](#), this represents 7472244.5 or 67% of the total population.

Transportation Network

The logistics supply chain is a key concern in vaccine delivery, not least of all because transportation can be a challenge in South Sudan. However, development of an [integrated transport network](#) (ITN) to support routing and logistics is out of scope for the purposes of this pilot project.

Nonetheless an attempt has been made to provide initial line datasets to aid developing an ITN if required. The relevant line datasets are:
- **Roads** (`ssd_tran_rds_ln_s0_c19ihdp_pp`)
- **Major roads and rivers** (`ssd_tran_net_ln_s0_c19ihdp_pp`)
- **United Nations humanitarian air service routes** (`ssd_tran_air_ln_s0_c19ihdp_pp_unhas`)

Each of these datasets has additional fields to support potential ITN development, such as navigability, route distances, times and speeds.

To complete the ITN dataset prerequisites, point layers for vaccination centers (mobile or fixed) and location of vaccines storage (cold chain) would also need to be available.

With all the line and point prerequisite datasets in place, a [geospatial topology](#) check should be carried out and topological errors fixed, a desktop GIS can then be used to carry out [network analysis](#) to determine for example:

The shortest route between two points	
Route optimisation	
Service areas (distances via various modes of transport from vaccination centres)	
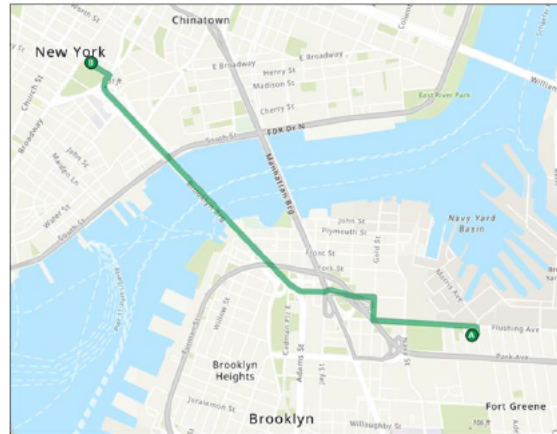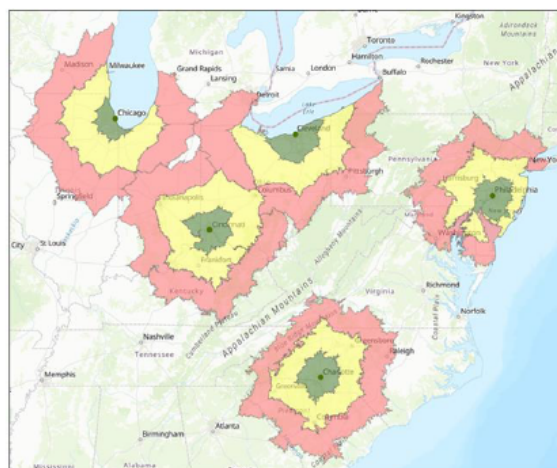
See:

- [QGIS network analysis training](#)
- [ArcGIS Pro network analysis tutorials](#)
- [ArcMap network analysis documentation](#)

Desktop GIS Projects

Three desktop GIS projects are provided as part of the IHDP:

QGIS 3.16.2 using GeoPackage version of data. (see IHDP qgis folder) `ssd_ihdp_c19_s0_pp.qgz`	
ArcGIS Pro 2.8.1 using File GeoDatabase version of data. (see IHDP arcgis folder) `ssd_ihdp_c19_s0_pp.mxd`	
ArcMap 10.6.1 using File GeoDatabase version of data. (see IHDP arcgis folder) `ssd_ihdp_c19_s0_pp.aprx`	
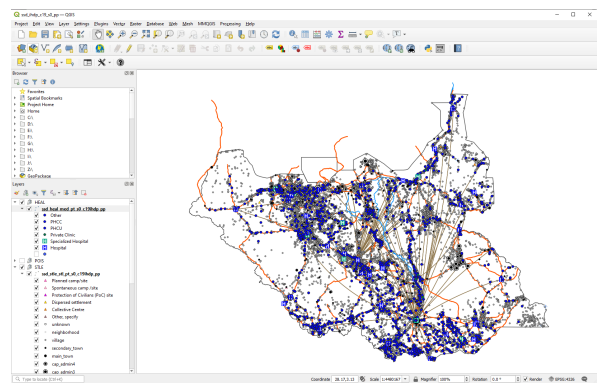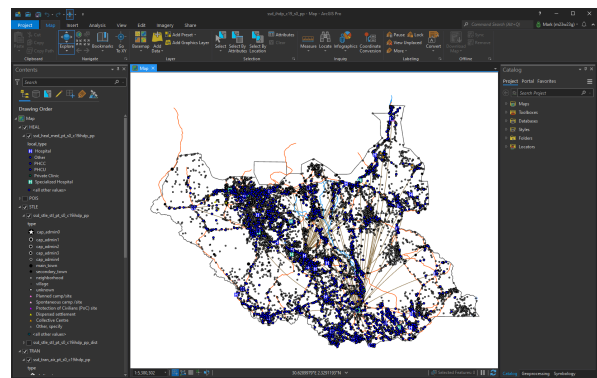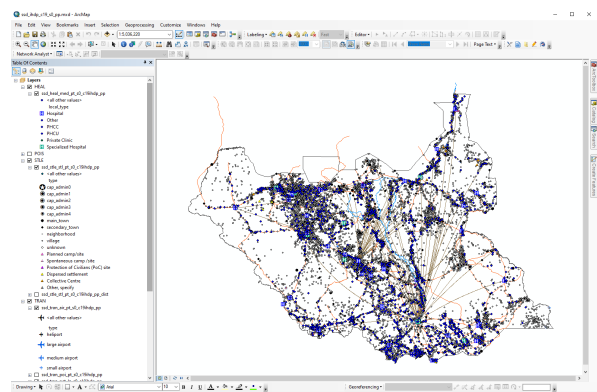
Structure and Styling

The table of contents of each GIS project contains the same layers using the same categorisation. The layers are identically structured by data category.

All data is depicted using the same or similar styles, with QGIS styling held within the **layer_styles** table of the GeoPackage and ArcMap/ArcGIS Pro styles applied via their lyr/lyrx files held within the **layer_files** folder.

For the purpose of this pilot project, OCHA fonts were not used.

Useful Scripts

Very basic [python](#) and [R](#) scripts are provided to open, examine and plot the contents of File GeoDatabases and GeoPackages.The scripts are provided as files and [Jupyter Notebooks](#).

Python (see IHDP scripts folder)	`ssd_ihdp_c19_s0_pp.py` `ssd_ihdp_c19_s0_pp_py.ipynb`
R (see IHDP scripts folder)	`ssd_ihdp_c19_s0_pp.R` `ssd_ihdp_c19_s0_pp_R.ipynb`

For the purpose of this pilot project only the [Open Source Geospatial Foundation](#) Geospatial Data Abstraction Library ([GDAL](#)) libraries/packages were used.

Mapbox Accessibility Surface and Zonal Statistics

These two basic scripts create an accessibility surface using [isochrones](#) and [zonal statistics](#) via the [Mapbox Isochrone API](#) and a population raster image. An isochrone is a shape describing all areas reachable from a point along a road network. The Mapbox Isochrone API computes areas that are reachable within a specified amount of time from a location, and returns the reachable regions as contours of polygons or lines that you can display on a map.

These scripts take those isochrone shapes and combine them into one surface, overlays that surface with a geodesic buffer around the input points to account for walking accessibility, then computes a population count (sum) using a population layer raster.

Python (see 'mapbox accessibility surface analysis' folder in IHDP scripts folder)	`ssd_ihdp_c19_s0_pp_analysis.py` `ssd_ihdp_c19_s0_pp_isochrones.py`

- `ssd_ihdp_c19_s0_pp_isochrones.py` - This [CLI](#) script takes a set of input points as CSV and creates an isochrone for each, saving the result as GeoJSON.

  - Example usage: `python ssd_ihdp_c19_s0_pp_isochrones.py input.csv --token MAPBOX_TOKEN`
    - Output: `input_isochrone_driving_30.json`
  - For detailed usage instructions of all parameters: `python ssd_ihdp_c19_s0_pp_isochrones.py --help`

- `ssd_ihdp_c19_s0_pp_analysis.py` – This script takes a set of isochrones, points (as GeoJSON, not CSV), and population raster and determines the number of people living nearby. Parameters can be tuned as needed, and allow for buffering of both the isochrone input and input points to account for missing road segments and walking time.

Afrimapr South Sudan Mapviewer

See afrisouthsudan-main in the IHDP scripts folder for a version of the Afrimapr South Sudan IHDP viewer for running locally or deploying elsewhere. This is very useful if Internet access is slow or intermittent.

The code can also be found at https://github.com/afrimapr/afrisouthsudan

Survey Tools

Geographic cascading validation is a series of dependent selection lists in which the choices available in one list are dependent on the choice made in a parent list.

In support of survey activities, three methods of geographic cascading validation have been provided using the place codes (p-codes) of the same administrative area data provided in the IHDP.

Excel	`ssd_ihdp_c19_s0_pp_cascading-excel.xlsx`	'Where' worksheet example using named ranges/tables and associated formula
KoboToolBox (see IHDP survey folder)	`ssd_ihdp_c19_s0_pp_cascading-kobo.xlsx`	XLSForms
Survey123 (see IHDP survey folder)	`ssd_ihdp_c19_s0_pp_cascading-survey123.xlsx`	Esri XLSForms

Feedback

As mentioned in the project introduction section one of the aims of this pilot project is:

- To build learning and community practice around the process to inform future work so as to assist further work in other COVAX eligible countries

Therefore we would be very interested in any questions, feedback or comments you may have on this project or the Integrated Humanitarian Data Package (IHDP).

Please contact nmcwilliam@mapaction.org and/or mgillick@mapaction.org

References

Guidance on Developing a National Deployment and Vaccination Plan for COVID-19 Vaccines. WHO and UNICEF, November 2020.	https://apps.who.int/iris/handle/10665/336603
Using Geospatial Technologies to Improve Immunisation Coverage and Equity: A Landscape Analysis and Theory of Change. Gavi, UNICEF and HealthEnabled, September 2020.	https://www.gavi.org/our-impact/evaluation-studies/using-geospatial-technologies-improve-immunisation-coverage-equity
Guidance on the Use of Geospatial Data and Technologies in Immunization Programs. UNICEF, Gavi, ADB and Health GeoLab Collaborative, October 2018.	https://www.unicef.org/media/58181/file

Appendices

Appendix A - Metadata

FileIdentifier	PointOfContact	DateStamp	Title	ReferenceDate
ssd_ihdp_c19_s0_pp	CartONG	20210614	ssd_ihdp_c19_s0_pp	20210608
ssd_ihdp_c19_s0_pp	MapAction	20210704	ssd_ihdp_c19_s0_pp	20210608
ssd_admn_ad0_py_s0_c19ihdp_pp	CartONG	20210614	ssd_admn_ad0_py_s0_c19ihdp_pp	20210608
ssd_admn_ad1_py_s0_c19ihdp_pp	CartONG	20210614	ssd_admn_ad1_py_s0_c19ihdp_pp	20210608
ssd_admn_ad2_py_s0_c19ihdp_pp	CartONG	20210614	ssd_admn_ad2_py_s0_c19ihdp_pp	20210608
ssd_tran_air_pt_s0_c19ihdp_pp	CartONG	20210614	ssd_tran_air_pt_s0_c19ihdp_pp	20210608
ssd_heal_med_pt_s0_c19ihdp_pp	CartONG	20210614	ssd_heal_med_pt_s0_c19ihdp_pp	20210608
ssd_tran_net_ln_s0_c19ihdp_pp	CartONG	20210614	ssd_tran_net_ln_s0_c19ihdp_pp	20210608
ssd_tran_rds_ln_s0_c19ihdp_pp	CartONG	20210614	ssd_tran_rds_ln_s0_c19ihdp_pp	20210608
ssd_pois_poi_pt_s0_c19ihdp_pp	CartONG	20210614	ssd_pois_poi_pt_s0_c19ihdp_pp	20210608
ssd_stle_stl_pt_s0_c19ihdp_pp	CartONG	20210614	ssd_stle_stl_pt_s0_c19ihdp_pp	20210608
ssd_stle_stl_pt_s0_c19ihdp_pp_dist	CartONG	20210614	ssd_stle_stl_pt_s0_c19ihdp_pp_dist	20210608
ssd_phys_riv_ln_s0_c19ihdp_pp	CartONG	20210614	ssd_phys_riv_ln_s0_c19ihdp_pp	20210608
ssd_tran_poi_pt_s0_c19ihdp_pp	CartONG	20210614	ssd_tran_poi_pt_s0_c19ihdp_pp	20210608
ssd_tran_air_ln_s0_c19ihdp_pp_unhas	CartONG	20210614	ssd_tran_air_ln_s0_c19ihdp_pp_unhas	20210608
ssd_tran_iso_py_s0_c19ihdp_pp_30min1m4kmbuf	Mapbox	20210708	ssd_tran_iso_py_s0_c19ihdp_pp_30min1m4kmbuf	20210608
ssd_tran_iso_py_s0_c19ihdp_pp_30min1km4kmbuf	Mapbox	20210708	ssd_tran_iso_py_s0_c19ihdp_pp_30min1km4kmbuf	20210608

ReferenceDataType	Abstract	ResourceProvider
Creation	Geopackage containing various spatial layers and their metadata	CartONG
Creation	File GeoDatabase containing various spatial layers and their metadata	MapAction
Creation	Country boundary	HDX, WorldPop
Creation	State boundary	HDX, WorldPop
Creation	County boundary	HDX, WorldPop
Creation	Airports	HDX, WFP, OSM
Creation	Medical facilities	South Sudan MoH
Creation	Major roads and rivers	HDX, WFP, OSM
Creation	Roads	HDX, WFP, OSM
Creation	General points of interest	HDX, WFP, OSM
Creation	Settlements	HDX, WFP, OSM
Creation	Settlements including the distance of the settlement's population to the nearest road, hospital, airport and river.	HDX, WFP, OSM
Creation	Rivers	HDX, WFP, OSM
Creation	Transport points of interest	HDX, WFP, OSM
Creation	United Nations humanitarian air service routes	HDX, WFP, OSM
Creation	30m drive time isochrone, minimally buffered (1m), plus a 4km geodesic buffer	Mapbox
Creation	30m drive time isochrone buffered by 1km to compensate for smaller missing roads or rural settlements offset from a captured road, plus a buffer of 4km	Mapbox

PlaceKeyword	DataLanguage	CoordSys	DataDictionary	DistributionInfo
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND
South Sudan	English	WGS 1984	See narrative PDF	CC BY-NC-ND

Appendix B - Data Model User Stories

User Story	Product Needed	Data Needed	Fields Needed
AS National Coordination Comittee (NCC) or South Sudan National Immunization Technical Advisory Group (SSITAG), I want to have access to the most complete and up-to-date database on population per age group and per county in order to know the location and numbers of vaccine target populations I want to reach.	Database of population per age category and per state and per county Map of the populated places, with admin1, admin2 and admin3 boundaries	Population estimation per age category, per admin1, Admin2 and admin3 Populated places and total population per PPL	Admin1, Admin2, admin3, population estimation per age category Total pop, Admin1, Admin2, Admin3, name, type
As NCC, I want to have access to the most complete and up-to- date database on health sites, in order to set my vaccination strategy by coordinating and/or supporting the implementation of health services readiness and capacity assessments.	Database of health sites that have functioning cold chain equipment, per state and per county.	Health sites	Functioning cold chain equipment, storage capacity, contact person, GPS coordinates, Admin1, Admin 2, name, type.
As NCC, I want to have a mapping of health facilities with functioning cold chain equipment across the 10 states in order to plan the vaccination of health facility-based and community-based health care workers as well as elderly people from 65 years and above.	Database of health sites that have functioning cold chain equipments, per state and per county; Map of health sites with functioning cold chain equipments; Map of health catchment areas and population per age and per catchment area.	Health sites, health catchment areas, population estimation per age and per catchment area.	Health catchment areas, population, age.
As NCC, I want to have a mapping of refugee camps and IDPs settlements as well as an estimation of population per camp/settlement, in order to know the location and number of vaccine target populations I want to reach.	Map of refugee camps and IDPS settlements and population estimation per camp/settlement.	Refugee camps, IDP settlements, points and boundaries and population estimation of those camps/settlements.	Name, coordinates, population.
As NCC or NLWG, I want to have a clear picture of the country's transport network, in order to	Map of transport network with the different types of roads and their practicability	Transport network. Lnes: roads, water channels. Points: airports, ports, bridges,	Type, practicability, material, name

establish an efficient vaccine delivery strategy and identify bottlenecks.	and populated places.	checkpoints.	
As NCC, I want to know for each target area public places/buildings where we could do the outreach/mobile vaccination campaigns.	Map of public places/buildings (schools, churches, warehouses etc).	Points of interest.	Name, type, cold chain equipment (yes/no), storage capacity.
AS NLWG, I want to have a clear picture of the entire cold chain coverage and capacity from Juba to the different health sites with functioning cold chain equipment.	Map of the cold chain equipment, by type and storage capacity.	Cold chain equipment per type and per location (POI or Health Facilities).	Type, GPS location, storage capacity.
As NLWG, I want to have a mapping of the different admin boundaries of SSD, from State to the County level in order to help in the management of the cold chain and storage requirements.	Map of State and County boundaries.	Admin 1, Admin 2, Admin 3 and health boundaries.	

Appendix C - Data Model

PPL	Health facilities	POI	Airports	Transportation [points]	Transportation [lines]
pcode	Name	Name	Name	Name	Name
name_en	**Type [d]**	**Type [d]**	**Type [d]**	**Type [d]**	**Type [d]**
local_name	Source	Source	Source	Source	Source
type [d]	Contact	contact	Municipality	Time per segment	**Practicability [d]**
adm3_pcode	**Cold chain [d – yes/no]**	**Cold chain [d – yes/no]**	**Authority [d]**	adm3_pcode	**Material [d]**
adm2_pcode	Cold chain (Storage capacity)	Cold chain (Storage capacity)	**Class [d]**	adm2_pcode	**Condition [d]**
adm1_pcode	**Status [d]**	adm3_pcode	ICAO_code	adm1_pcode	
total_pop	Local type	adm2_pcode	IATA_code		
source	Local facility code	adm1_pcode	**Status [d]**		
	Services infrastructure		**Surface [d]**		
	Official Vaccination Site [d – yes/no]		adm3_pcode		
	adm3_pcode		adm2_pcode		
	adm2_pcode		adm1_pcode		
	adm1_pcode				

Administrative Boundaries 1	Administrative Boundaries 2	Administrative Boundaries 3
adm1_name	adm2_name	adm3_name
adm1_local_name	adm2_local_name	adm3_local_name
adm1_pcode	adm2_pcode	adm3_pcode
total_pop	adm1_pcode	adm2_pcode
Pop_00_24	total_pop	adm1_pcode
Pop_25_40	Pop_00_24	total_pop
Pop_41_64	Pop_25_40	Pop_00_24
pop_65plus	Pop_41_64	Pop_25_40
Source	pop_65plus	Pop_41_64
	Source	pop_65plus
		Source

Type [d]	Type [d]	Type [d]	Type [d]	Type [d]	Type [d]
Capital City	International Hospital	Extraction Site	International Airport	Checkpoint	Water channel
Administrative Centre	Hospital	Factory	Airport	Border crossing	Motorway
City	Main Hospital at Admin1 Level	Farming	Small Airport	Bridge	Trunk
Town	Main Hospital at Admin2 Level	Livestock	Aerodrome	Tunnel	Primary
Village Abandoned	Main Hospital at Admin3 Level	Mobile Phone	Airfield	Port	Secondary
Village	Hospital Admin 4	Oil Field	Airstrip	Ferry	Tertiary
Settlement	General Hospital	Power Station	Helispot	Ford	Unclassified
Dwelling or Farm	Reference Hospital	Power Tower	Helipad	Fuel	Residential
Neighborhood or Suburb	Hospital Private	Wasteland	Floatplane	Harbour	Service
Locality	Military Hospital	ATM		Jetty	Track
Unknown	Health Centre	Bank	**Authority [d]**	Mud Hole	Path
	Reference Health Centre	Bar	Civil	Parking	Unknown
	Specialist Hospital	Hotel	Military	Railway Station	Living Street
	Teaching Hospital	Market	Civil/Military	Roundabout	Railway
	Health Training Institutions	Night Club	Private	Damage	Runway
	Specialist Clinic	Restaurant	Unknown	Obstacle	
	Simple Health Centre II	Shop		Toll	**Practicability [d]**
	Simple Health Centre III	Stadium	**Class [d]**	Other	Non-Motorized
	Simple Health Centre IV	Supermarket	International	Unknown	Motorbike
	Communal Health Centre	Touristic	Domestic		4WD < 3.5MT
	Primary Health Care Centre	Tourist Info	Unknown		Light Truck < 10MT
	Primary Health Care Unit	Mosque	Private		Heavy Truck < 20MT
	Health Post	Synagogue			Truck and Trailer > 20MT
	Simple Health Post	Graveyard	**Status [d]**		Unknown
	Communal Health Post	Church	Open		
	Maternal and Child Health Post	Border Crossing	Closed		**Material [d]**
	Clinic	City Hall	Restricted		Paved
	Simple Clinic Farm	Community Centre	Unknown		Asphalt
	Simple Clinic Military	Consulate			Cobblestone
	Private Clinic	Courthouse	**Surface [d]**		Concrete
	Dispensary Uknown Type	Customs	Paved		Dirt
	Operational	Embassy	Unpaved		Ground
	Unknown	Fire Station	Ground		Sand
	Pharmacy	Military	Gravel		Gravel
	Laboratory	Ministry	Grass		Unknown
	Other	Party	Unknown		Not Applicable
	Unknown	Police			
		Post			
Status [d]		Prison			
Operational		Public Building			
Not operational		Town Hall			
Unknown		TV Radio			
		High School			
		Kindergarten			
		Nursery			
		Primary School			
		Private School			
		School			
		Secondary School			
		University			
		College			
		IDP			
		NGO			
		UN			
		Camp			
		Other			
		Unknown			