Supporting Polio eradication through the use of geographic information systems

Based on experience from the Polio program in Nigeria

Annual Disease Modeling Symposium

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Seattle

Under Dr. Vincent SEAMAN’s leadership
Poliomyelitis

- Highly infectious disease caused by a virus
- Spreads through person-to-person contact usually via the fecal-oral route
- Can cause irreversible paralysis
- Mainly affects children under five years old

Source: www.polioeradication.org
Poliomyelitis eradication

• Poliovirus detection
  – Acute Flaccid Paralysis (AFP) Surveillance
  – Environmental surveillance

-> identify where and how poliovirus is circulating

• Poliovirus interruption
  – Routine Immunization (RI)
  – Supplementary Immunization Activity (SIA)
  – Rapid outbreak response

-> increase population immunity and stop the transmission cycle
SIA and microplanning
High resolution satellite imagery, machine learning and settlements extraction
Building the basemap

Spectral signatures and neighborhood types
Building the basemap

- Field data collection using GPS-enabled mobile devices to collect
  - Settlement names
  - Settlement’s Admin-3 attribution (to generate vaccination boundaries using voronoi polygons)
  - Points Of Interests (health facilities, markets, schools, etc.)
  - Microcensus data for each neighborhood type to generate a 90-meter GIS-based population model
The resulting basemap
Leveraging the basemap

Ensure every settlement is visited

So that every child is vaccinated
The Vaccination Tracking System (VTS)

An information system which monitors vaccination teams going house to house during SIAs
Assessing the quality of SIAs

• Compute “geographic coverage” at settlement, Ward, LGA and State levels and combining multiple interventions

• Identify in near real-time missed or partially covered settlements

• Identify chronically missed or partially covered settlements

• Estimate target population of non-visited settlements
Calculation of geographic coverage

**Built up areas (11’000+)**
- Large settlements
- Cities with more than 100 residences

**Small Settlement Areas (24’000+)**
- Rural villages
  - with 20-100 residences

**Hamlet Areas (60’000+)**
- Clusters of hamlets within 200m from one another
- Each hamlet containing less than 20 residences

BUA polygons divided into 50 meter grid squares

75 meter Buffer around SS Point Feature

50 meter buffer around each hamlet
Solution components

Geodatabase

Local Laptops

National EOC Dashboard

GPS-enabled phones

Tablets / Hamlet Buster
Geodatabase

- Repository of inhabited settlements and other geo-data
- Architected to support multiple concurrent editors regularly enhancing the geo-data
GPS-enabled Phones

- GPS-enabled android phones
- Rely on GPS network only
- Operate completely offline
- Capture GPS position every 2 mins
- Distributed to 12’000+ vaccination teams
- No interaction required - vaccination teams simply need to carry it
Local Laptops

• Extract GPS positions from the phones via USB

• Operate completely offline

• Centralize all GPS position per day / LGA / campaign

• Compute daily analytics, display dashboard and maps including offline satellite imagery

• Inform the decisions and planning for the next days

• Transfer GPS positions to EOC via MiFi / WiFi
Emergency Operation Center (EOC)

- Web-based dashboard
- Consolidated view at the National EOC
- Fully automated data reception and processing
- Updated near real-time (< 30 mins to compute daily analytics)
- Cross-campaign analyses
Tablets (aka Hamlet Buster)

- Ruggedized and field-ready
- Rely on GPS network only
- Operate completely offline
- Contains settlement locations and offline satellite imagery
- Help locate and reach chronically missed settlements during microplanning or in-between round activities
- Can collect geo-referenced data such as place names and other information
Tablets (aka Hamlet Buster)
Tablets (aka Hamlet Buster)

Zero-dose child #1.....

Zero-dose child #2.....
Campaign Workflow

- GPS-enabled phones collect time-stamped GPS coordinates every 2 minutes.
- Vaccinators return phones to WFP at the end of their day.
- Missed Settlement Report generated at end of days 4 & 5.
- Feedback for daily coverage provided to WFPs and LGA team at daily meeting.
- Tracks uploaded to EOC/Dashboard via MiFi.
- GPS returns to LGA HQ where GPS tracks are downloaded to Laptop and geo-coverage computed.
- Given to Ward Focal Person (WFP) at LGA HQ each morning.
- WFP returns to Ward take-off point and gives phones to vaccinators.
- WFP returns to LGA HQ where GPS tracks are downloaded to Laptop and geo-coverage computed.
- Feedback for daily coverage provided to WFPs and LGA team at daily meeting.
- Tracks uploaded to EOC/Dashboard via MiFi.
Data flow

Field level
-RES tracks

Data/WiFi

MiFi/WiFi

H2H tracks/data

National level
-National EOC
-Analytics automatically updated every half hour

Web server

Internet
Analytics

Geographic coverage at National, State, LGA, Ward and settlement levels
Analytics

Missed Settlement List (MSL)

Missed or Partially Covered Settlements Report: Nigeria / Borno (STATE)

SHOWING 1 TO 50 OF 2858 MISSED SETTLEMENTS

<table>
<thead>
<tr>
<th>STATE</th>
<th>LGA</th>
<th>WARD</th>
<th>SETTLEMENT NAME</th>
<th>CUMULATIVE % VISITED</th>
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Analytics

Chronically Missed Settlement List (CMSL)

Chronically Missed or Partially Covered Settlements over Campaigns: Nigeria / Borno (STATE)

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### Geographic coverage time trend at State, LGA and Ward levels

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Analytics

Vaccination Reach

Integrates H2H tracks as well as other special interventions (e.g. RES, RIC, hit and run, ODK lat-lon, etc.) to have a comprehensive view of vaccination reach.
Analytics - eTally

Tally sheet at State, LGA, Ward and team levels and map depicting location of vaccination activities, revisits and non-compliances.
The VTS – at scale

- 58 campaigns monitored since Jan 2013
- Up to 80 LGAs monitored per campaign
- Up to 12’000+ teams in the field visiting 20’000+ settlements per campaign
- Generating 4’000’000+ GPS positions in a single day
- Processed in < 30 mins
- 19’000’000+ GPS positions collected in a single campaign
- 450’000’000+ GPS tracks in the VTS
- hundreds of zero dose child vaccinated thanks to the “Hamlet Buster”
The VTS – Impact

Chronically Missed Settlements trend
State of Kano

Introduction of “Hamlet Buster”
The VTS – Impact

Wild polio virus (WPV) cases trend
Nigeria

Introduction of VTS