The Bioko Island Campaign Information Management System (CIMS):

A spatial decision support system for strengthening intervention implementation and coverage estimation

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Overview

I. CIMS background

II. Historical evaluation of IRS performance

III. IRS case study

IV. Facilitating operational research

I. CIMS Background

CIMS Motivation:
Accurate denominators

- IRS on Bioko Island largely in densely populated urban areas
  - Unclear and possibly changing deployment zones
  - No unique household identifiers makes counting denominators difficult
  - Availability of homeowners limiting factor for productivity
- Coverage estimates unreliable without accurate denominators
- Planning deployment of household-level interventions difficult without unique identifiers and reliable denominators

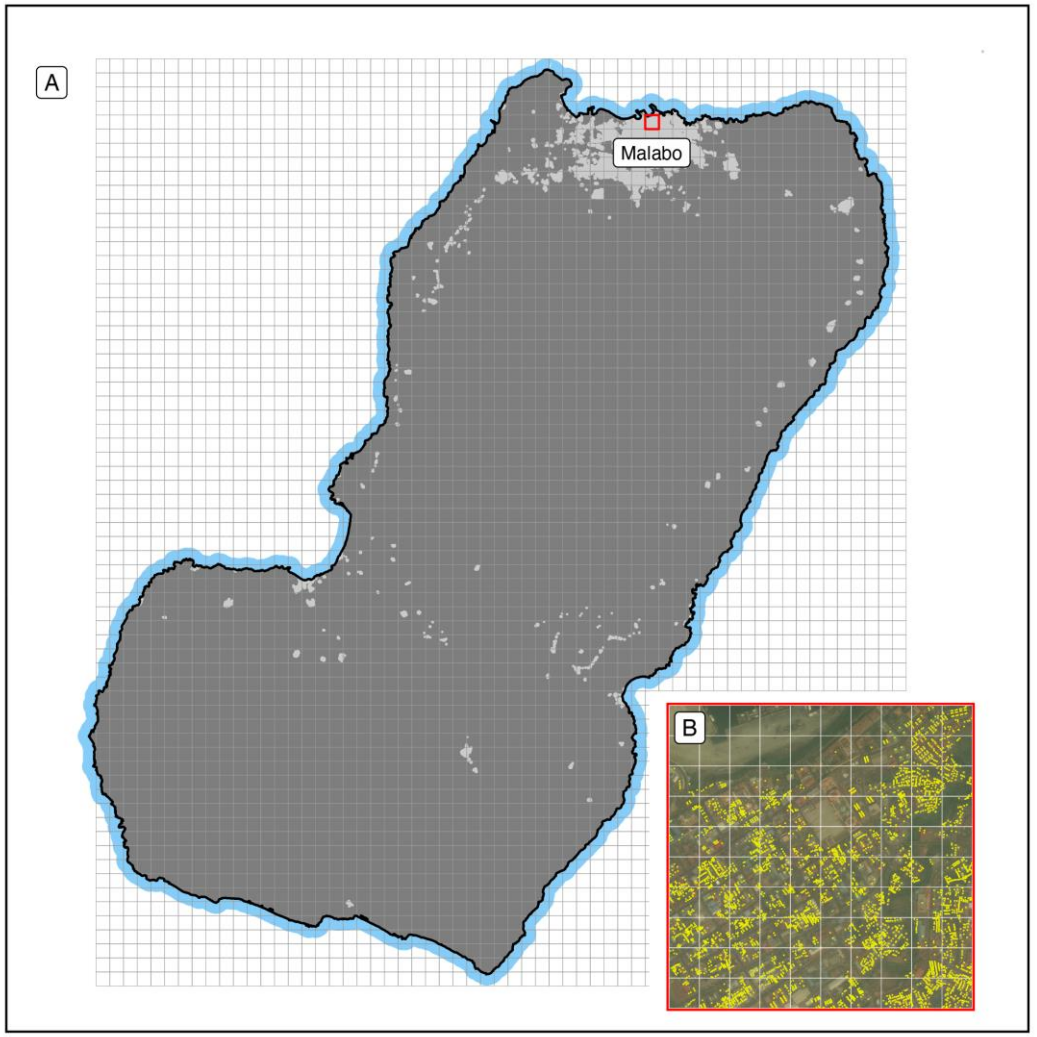
CIMS Motivation:
Digitizing data collection and standardizing data systems

- Previously, data entered only in paper forms
  - Data quality concerns
  - Delay in analysis-ready data limiting responsiveness
- Different data systems for different activities presents difficulties:
  - Multiple systems for field teams to learn
  - Difficult or impossible to link data from other activities

Centralized, standardized data collection, management and analysis system can streamline planning, implementation and analysis

CIMS outline:
A grid-based system

- A grid-based mapping system underpins the CIMS
- The grid-based system splits the island into 2091 1x1km map-areas (241 inhabited), and 197086 100x100m map-sectors (4108 inhabited)
- These discrete units are used for coding all houses within
- Uses in planning and implementation:
  - Estimating accurate and up-to-date denominators
  - Defining precise targets of houses to intervene
  - Calculating IRS coverage and guiding teams during deployment



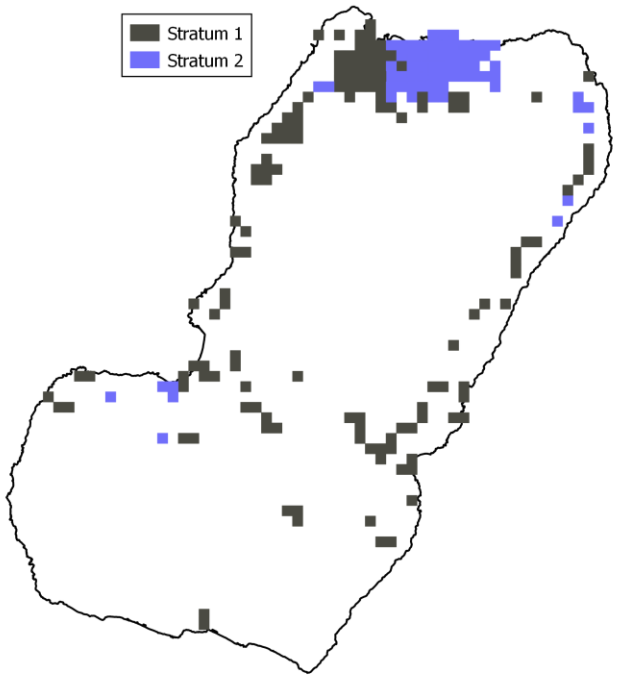
García GA, Hergott DEB, Phiri WP, Perry M, Smith J, Osa Nfumu JO, et al. Mapping and enumerating houses and households to support malaria control interventions on Bioko Island. Malaria Journal. 2019;18(1):283.

CIMS outline:
Maintaining the household database

- Monitoring coverage of interventions requires an accurate denominator (inhabited houses)
- Island-wide health census in 2014 created initial database of households
- Household database is updated by fieldworkers who:
  - Evaluate houses as inhabited or uninhabited
  - Identify houses that have been destroyed
  - Identify new houses
- Denominators dynamically updated during field activities

Grid-based survey stratification

- Survey sampling previously done by community
- To standardize sampling and improve representativeness, implemented grid-based stratified sampling system based on:
  - Population density
  - Local residual transmission

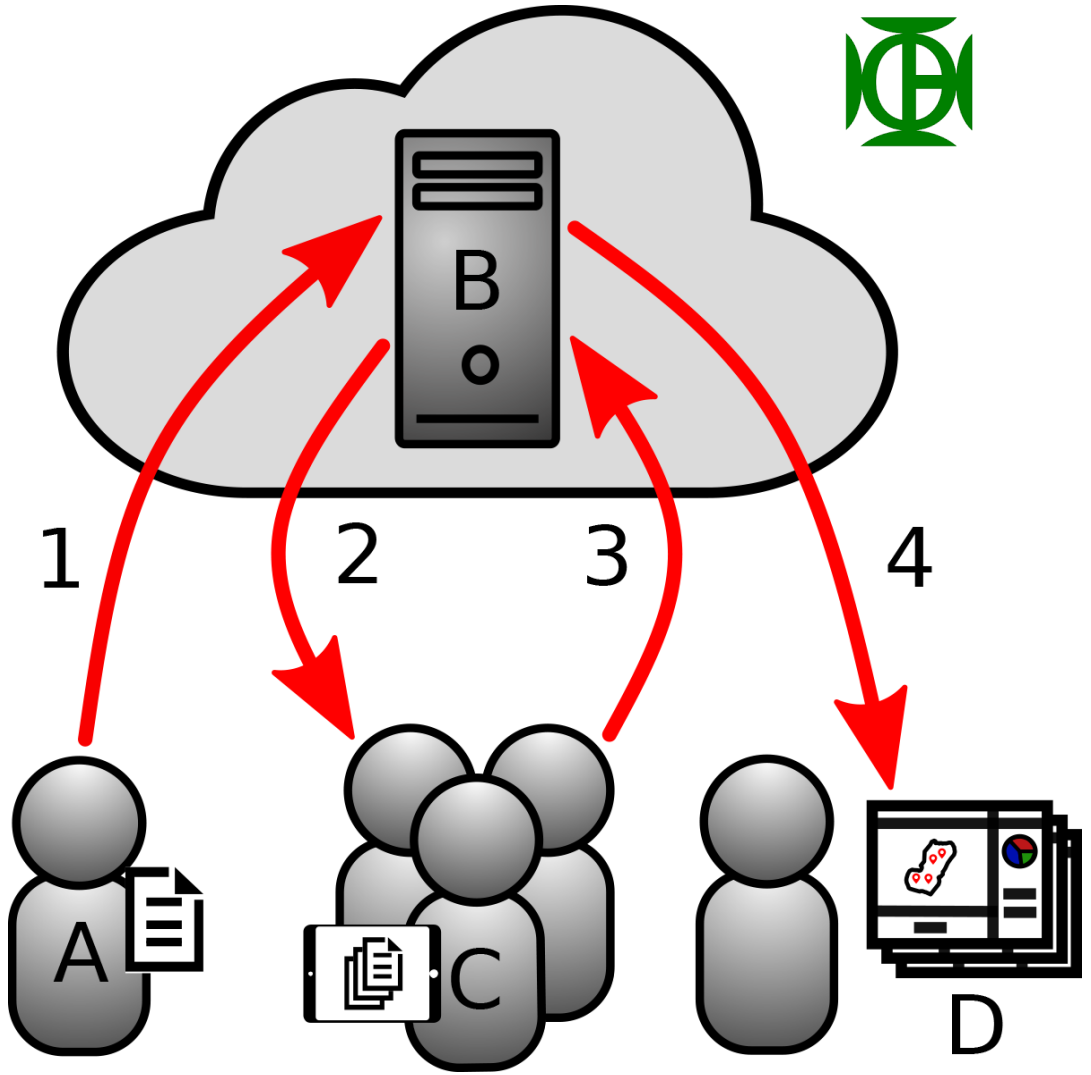


CIMS outline:

Data collection, management and analysis

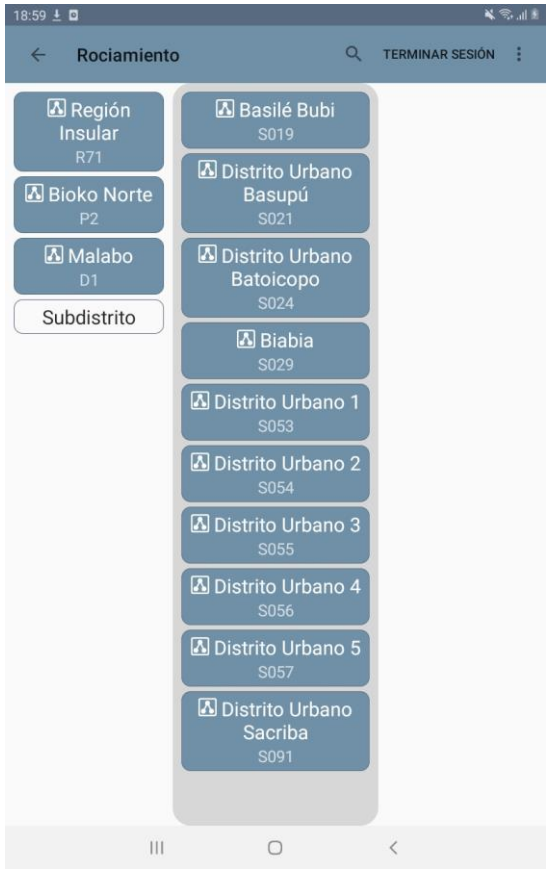
System for offline tablet-based data collection over pre-defined location hierarchies:

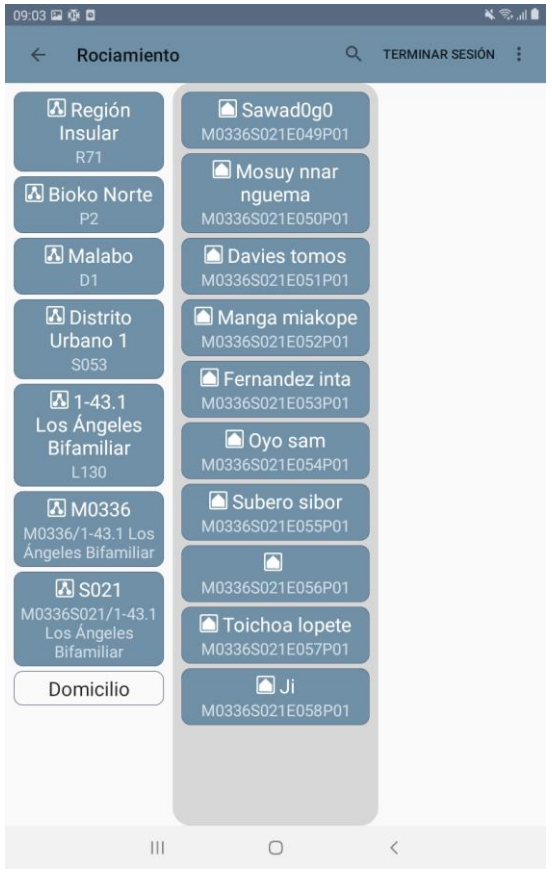
1. Forms for data collection created
2. Forms and relevant data downloaded to tablets and used to collect data offline
3. Completed forms sent to server
4. Data pulled from server and analyzed in real time, e.g. using dashboards



CIMS outline:
Location hierarchies

- Data entered at the household level
- Households geolocated and situated within administrative location hierarchy
- Allows calculation of indicators for various (possibly changing) administrative divisions





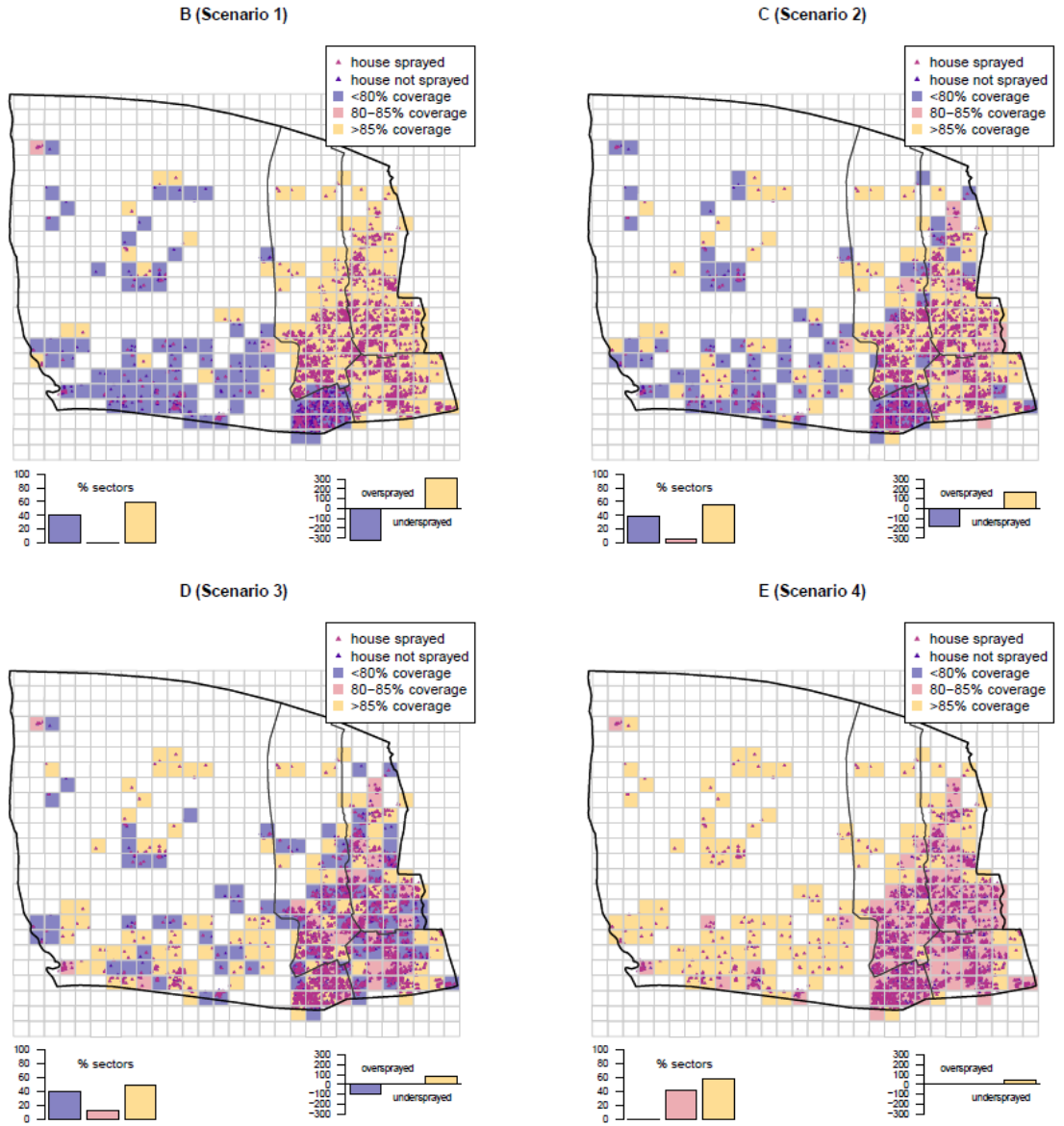
II. Historical evaluation of IRS performance

Assessing IRS operational performance over time

- We used IRS data collected through the CIMS in the last five rounds on Bioko (2017-2021) to evaluate both **coverage** and **productivity** over time
- For **coverage**, we
  - Measured coverage at map-sector-level and assessed *operational efficiency*: the proportion of sprayed map-sectors that were sprayed at *optimal* coverage (80-85%)
  - Compared *over* (> 85% of houses sprayed) and *underspraying* (< 80% of houses sprayed) at map-sectors, by round.
- For **productivity**, we
  - Obtained the number of houses sprayed per sprayer per day (h/s/d), compared to assumption of 4 h/s/d in budgeting and deployment planning

Targeting IRS coverage based on map-sectors

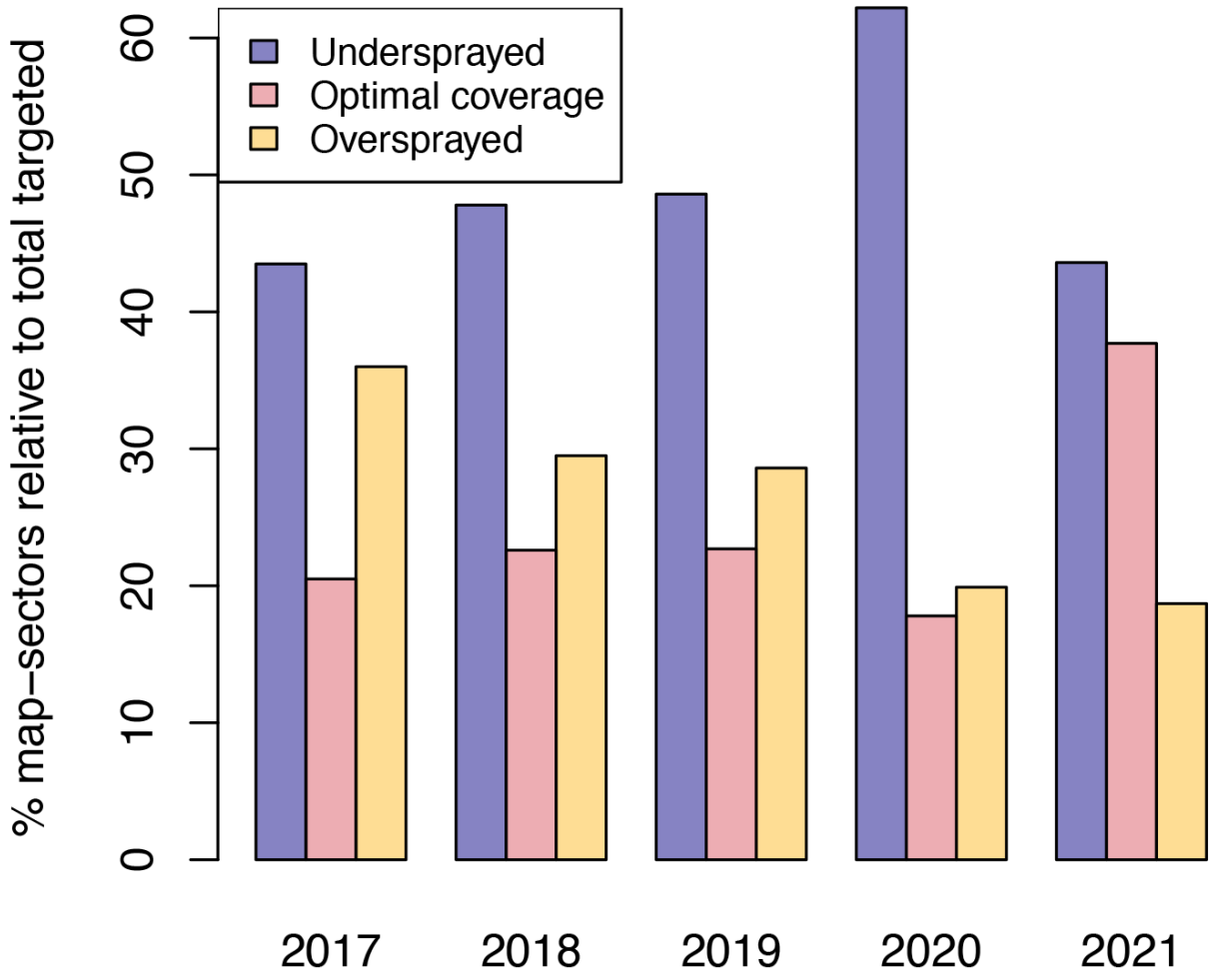
- Finer granularity allows for more equitable distribution of coverage
- This maximizes community protection while optimizing productivity
- It also allows for more flexibility of targeting IRS, both spatially and temporally



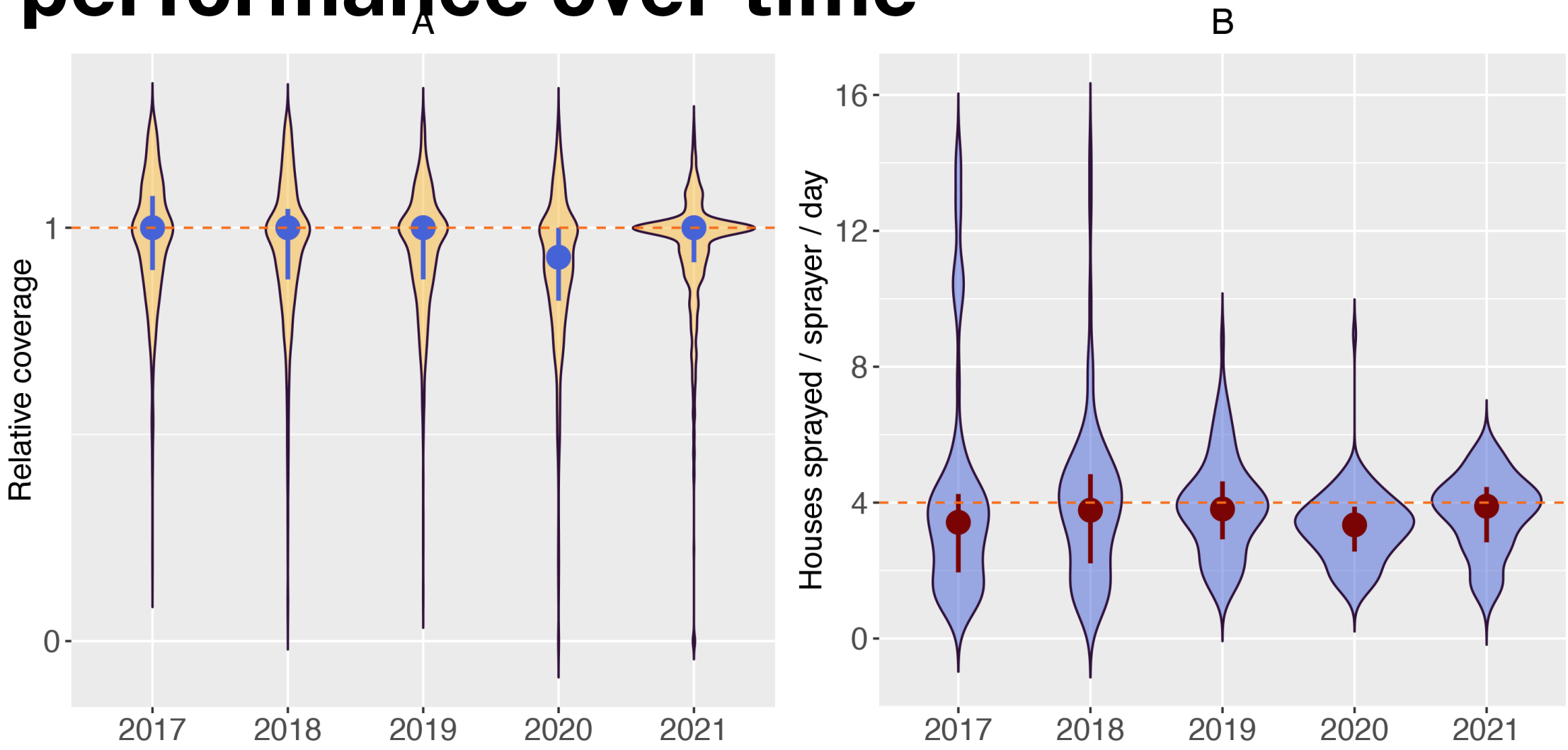
García GA, Atkinson B, Donfack OT, Hilton ER, Smith JM, et al. (2022) Real-time, spatial decision support to optimize malaria vector control: The case of indoor residual spraying on Bioko Island, Equatorial Guinea. PLOS Digital Health 1(5): e0000025.

Assessing IRS operational performance over time

- Overall coverage was highest in 2017 (80.2%) but that year also showed the lowest operational efficiency (20.5%, aside from 2020) and highest overspraying (36%).
- Despite lower overall coverage in 2021 (77.5%), optimal coverage was the highest (37.7%) and overspraying the lowest (18.7%).
- Marginal improvement in median productivity in 2021 compared to previous years



Assessing IRS operational performance over time



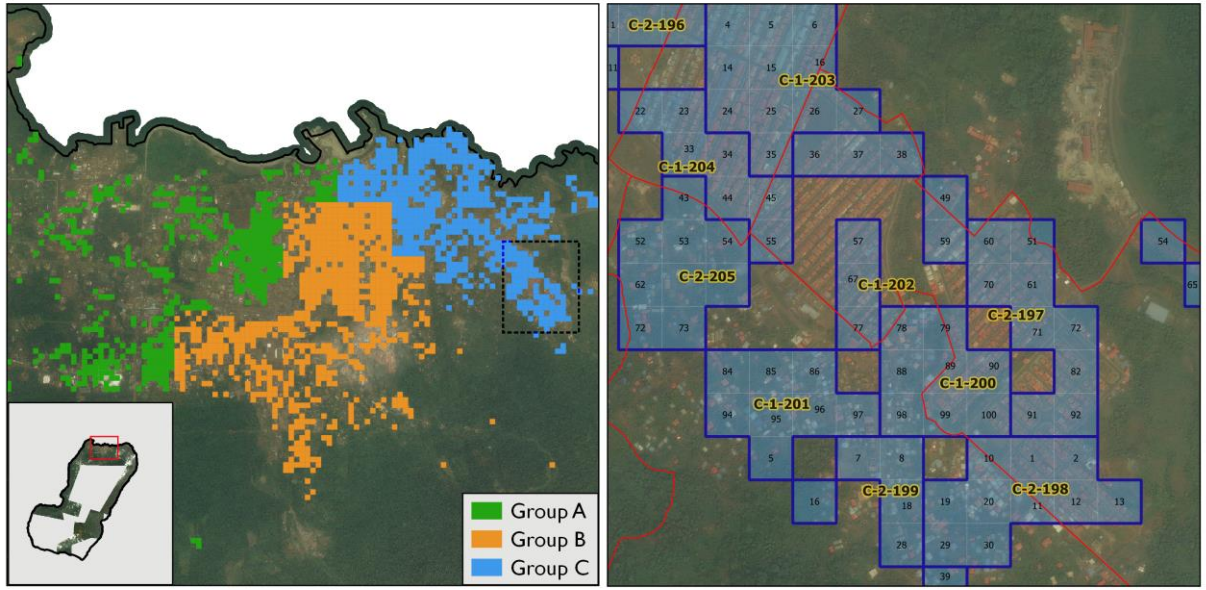
Assessing IRS operational performance over time

- Monitoring IRS in real-time has allowed significant improvement in operational efficiency while marginally improving productivity
- Grid-based planning has improved ability to follow up coverage targets more closely and a more granular level
- Current efforts are focused on determining optimal vector control coverage in order to deploy interventions more efficiently, saving scarce resources while optimizing community coverage
- This must allow for community plus spillover effect sizes of different interventions suites targeted using map-sectors

III. IRS Case Study

Using CIMS for IRS deployment planning

- Sectors are grouped into work zones and field offices
- Targeted coverage and previous year's estimate of inhabited houses informs work plan



IRS implementation

- IRS implementation consists of 2 main teams:
  - Community mobilizers who sensitize and evaluate households
  - Spray teams who conduct and supervise household spraying
- Denominators dynamically updated during the round, changing the number of houses targeted
- Challenge is managing teams to maintain productivity while avoiding underspraying, overspraying, and controlling the quality of spraying

Following IRS in real-time

- Tableau dashboards show updated coverage by sector
- Data used daily by field teams for work planning and prioritization
- Weekly data interpretation meeting for adjusting work plan as necessary

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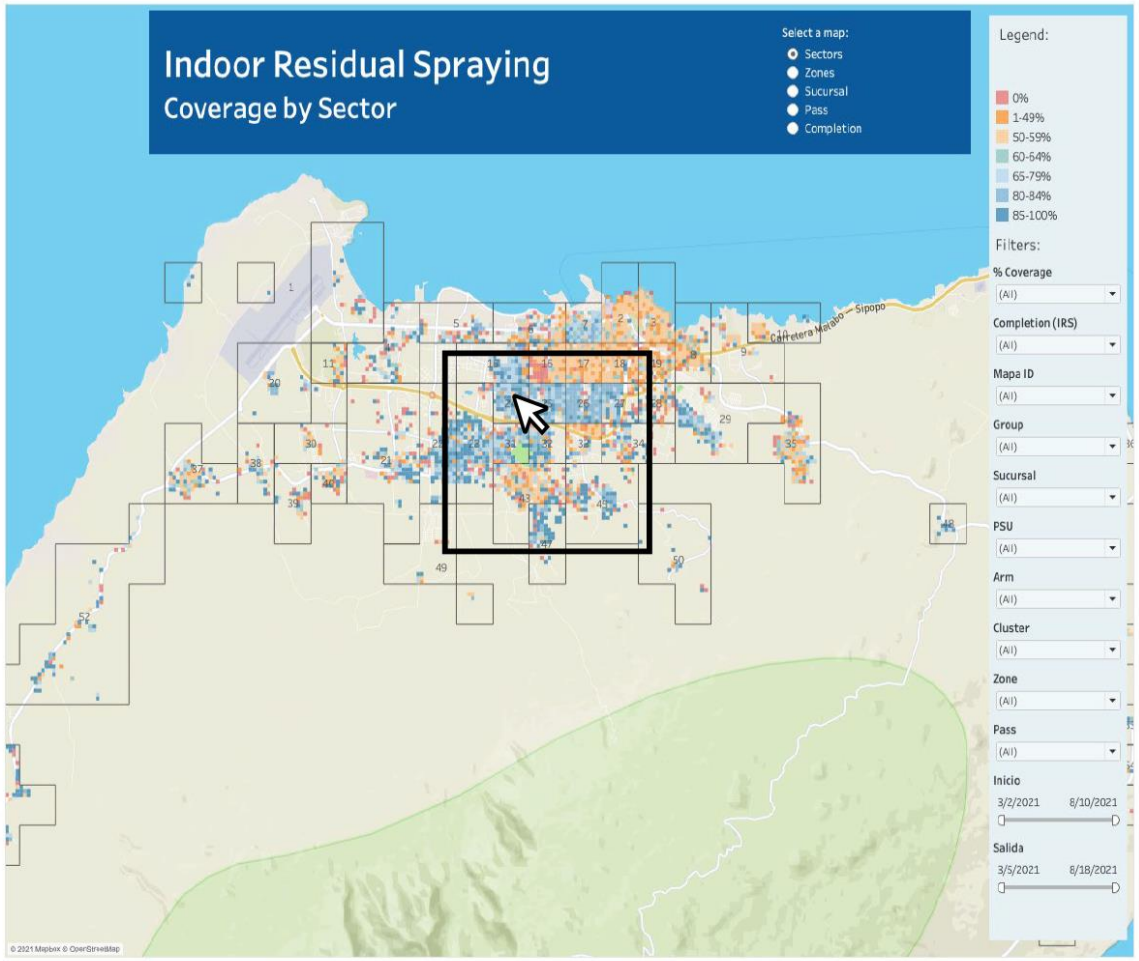

Following IRS in real-time

- Important datapoints for work planning:
  - Proportion houses evaluated
  - Coverage and houses remaining to spray
  - Productivity
  - Acceptance

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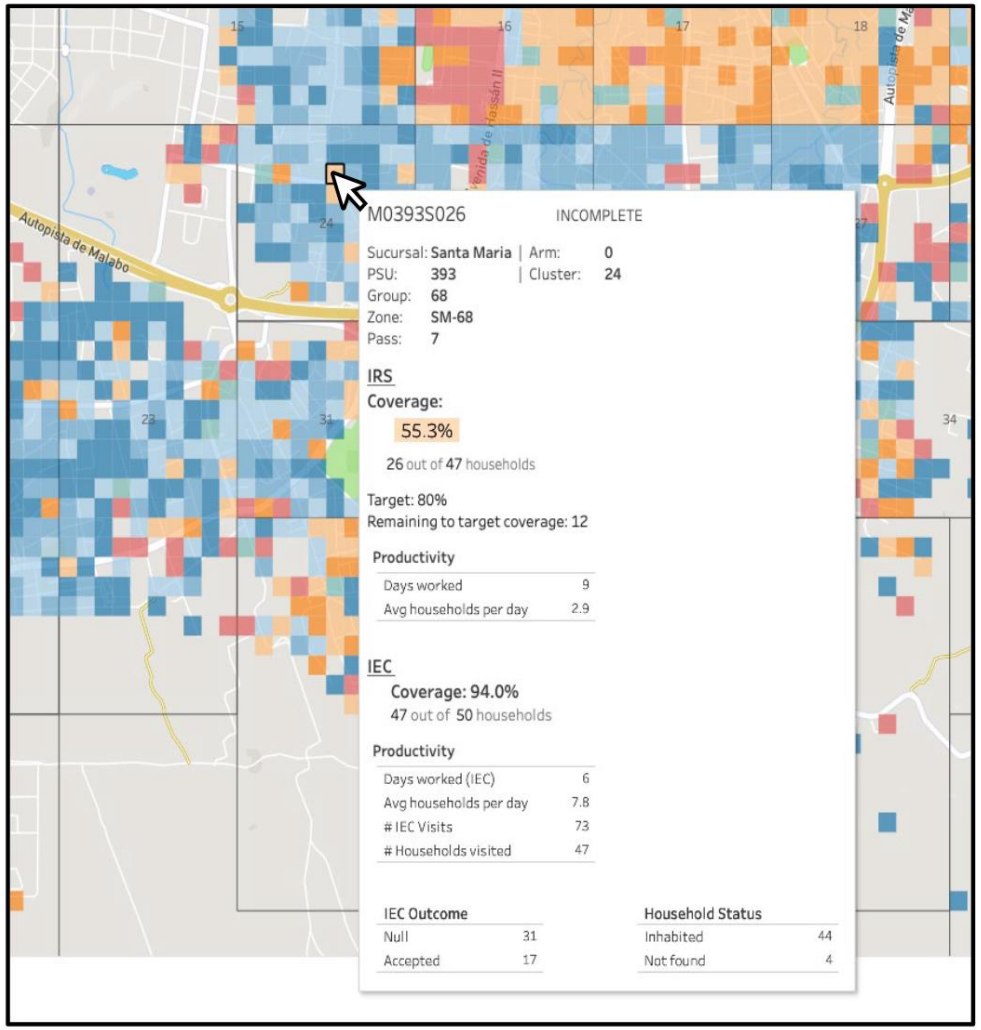
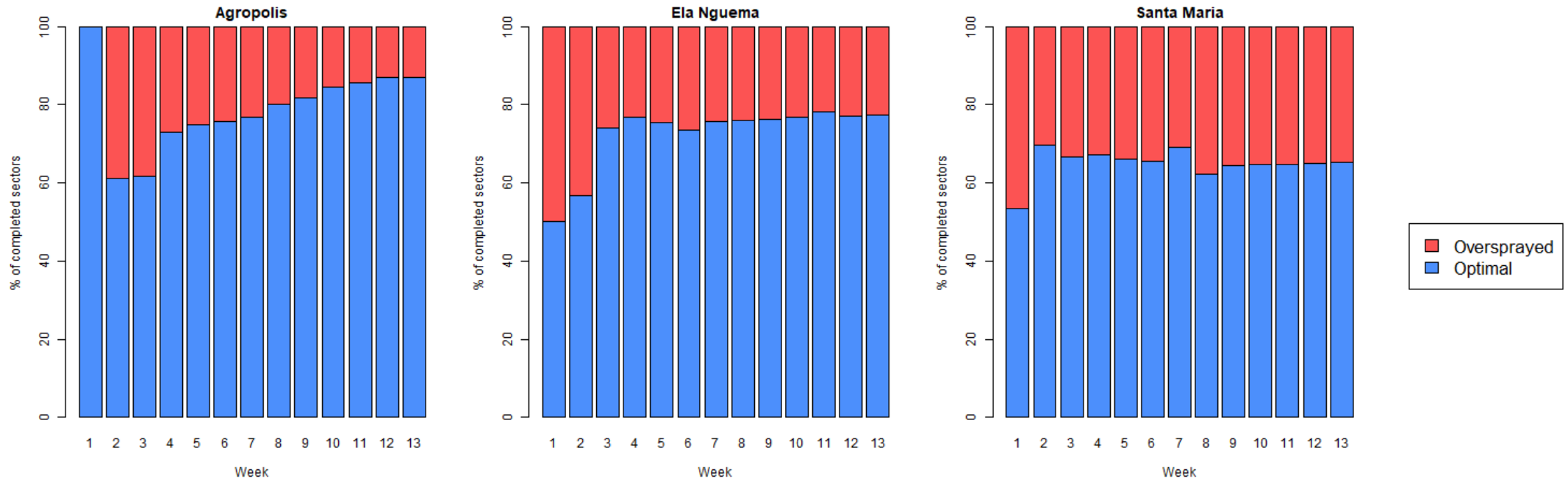


Real-time monitoring of overspraying



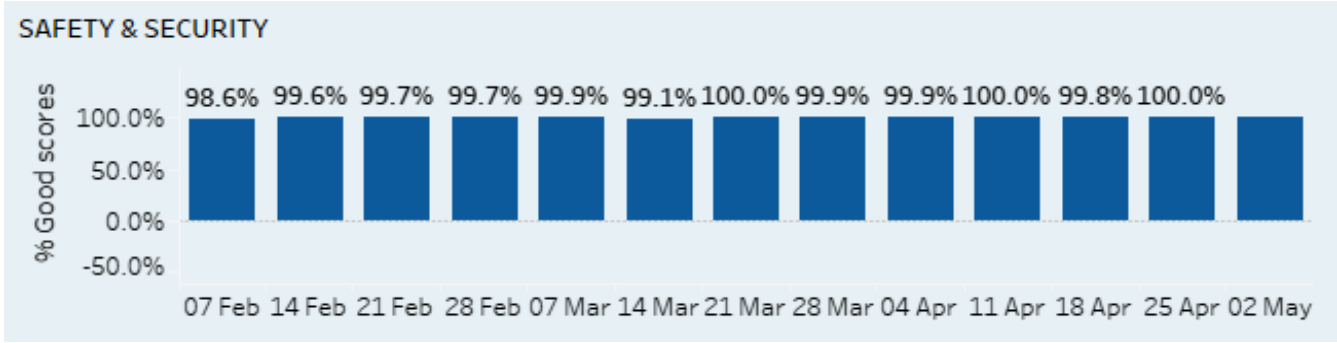
Monitoring quality of spraying

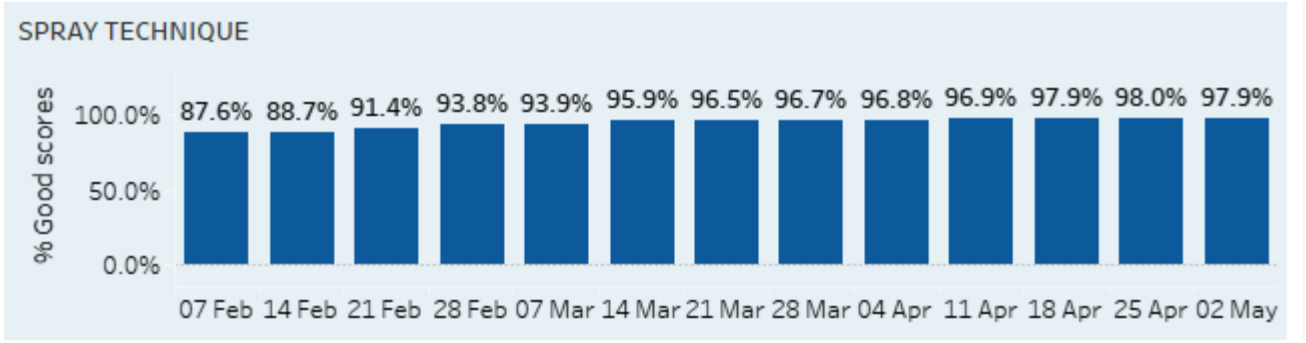
Safety & Security:

- Use of PPE
- Covering furniture
- Informed residents of safety measures

Spray technique:

- Correct use of equipment
- Sprayed all surfaces according to guidelines





Prioritizing mop-up

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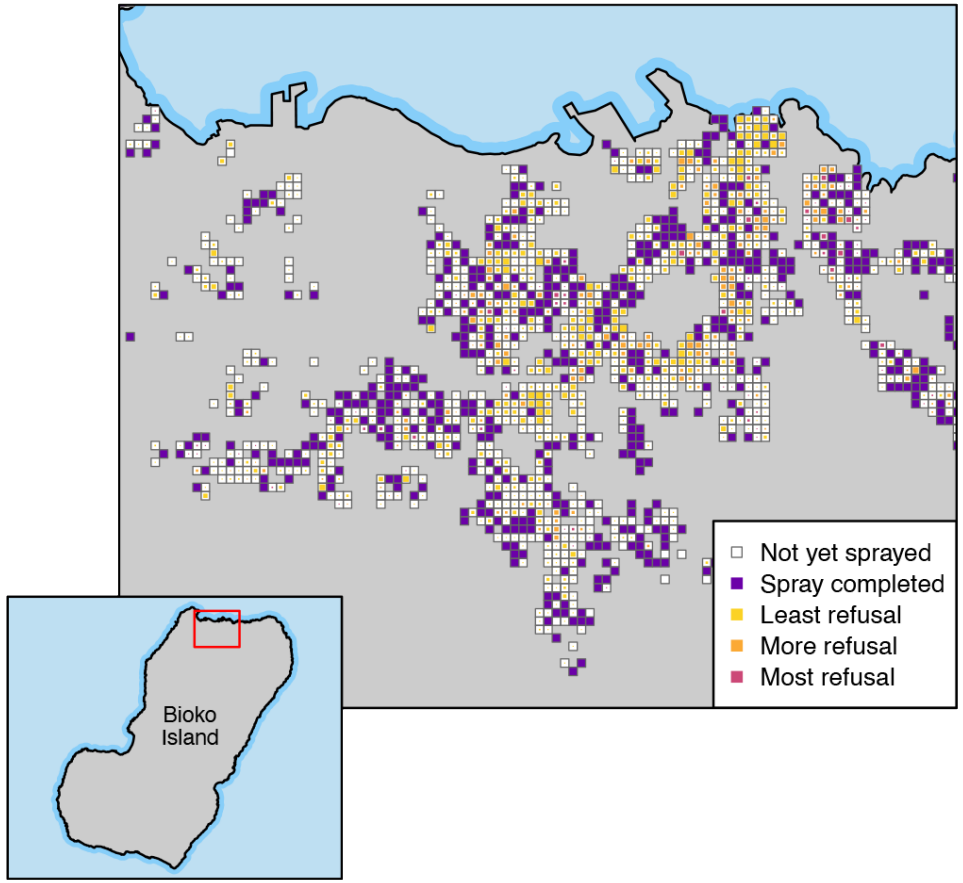

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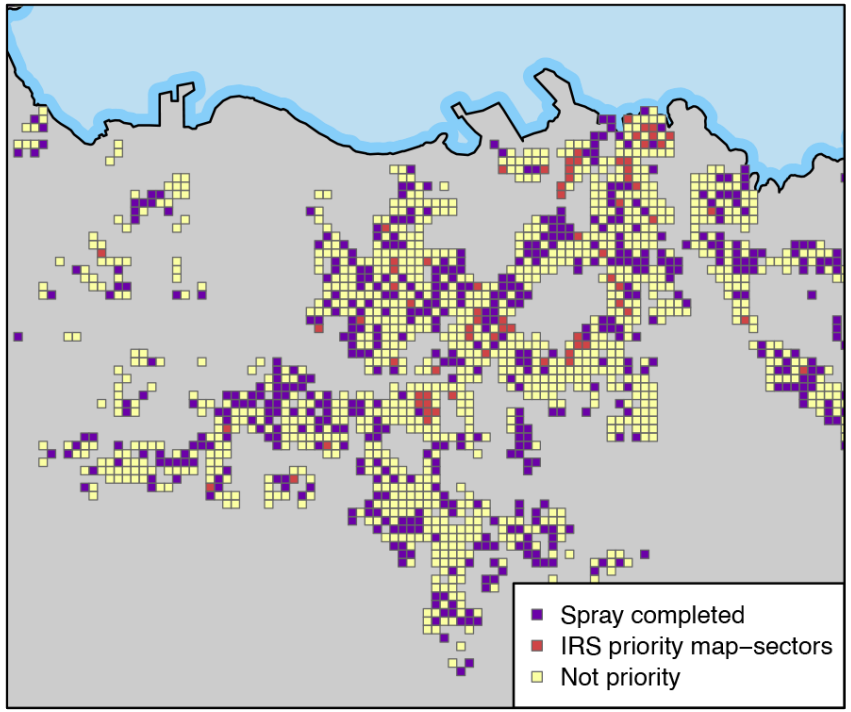
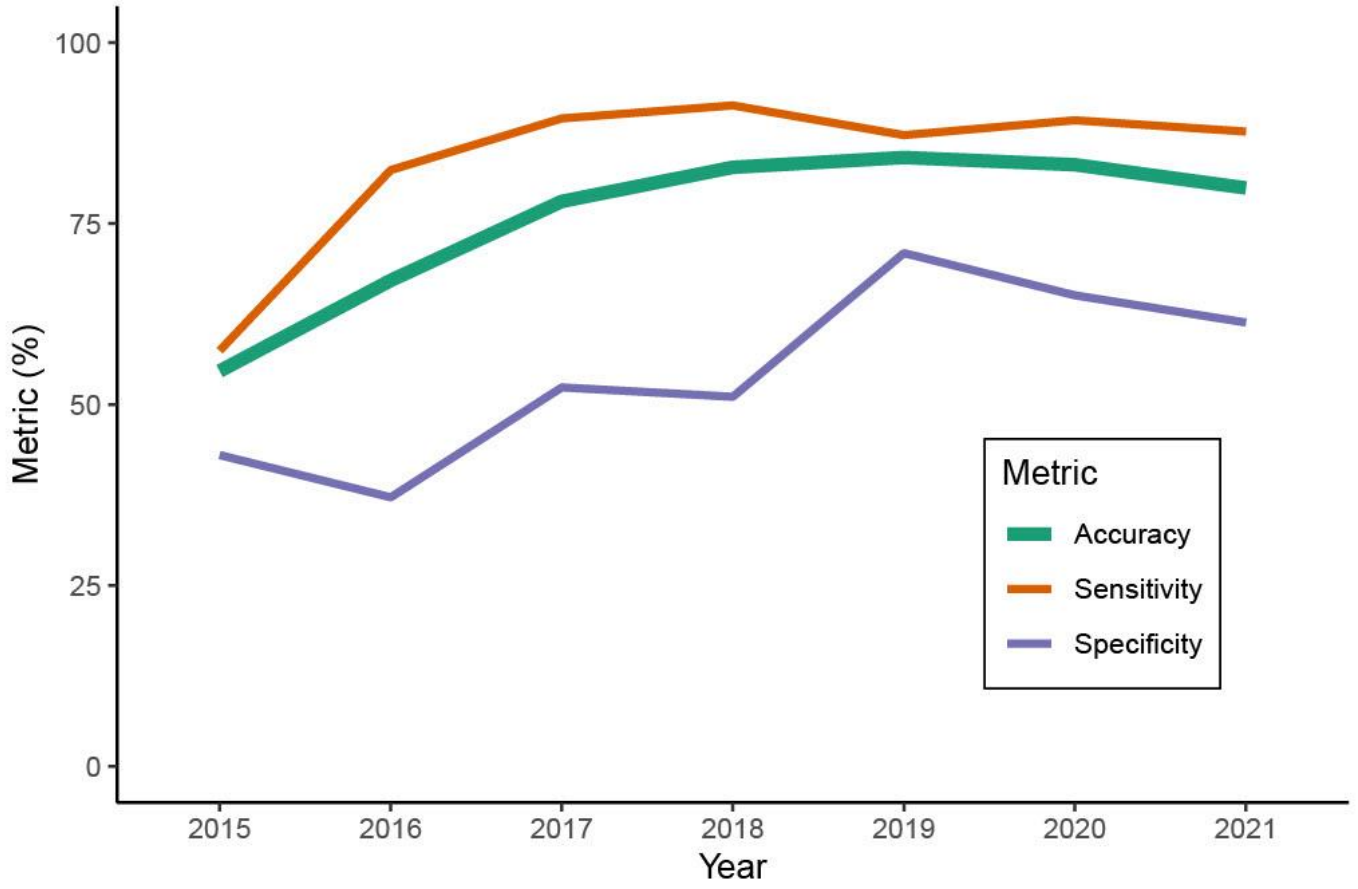


IV. Operational research

Evaluating accuracy of survey-based coverage estimates

- Compared to CIMS operational IRS data:
  - Recall of spraying is approximately 80% accurate
  - Sensitivity substantially higher than specificity
- Since 2018 MIS and operational coverage estimates align well



Implementing an operational trial of IRS coverage

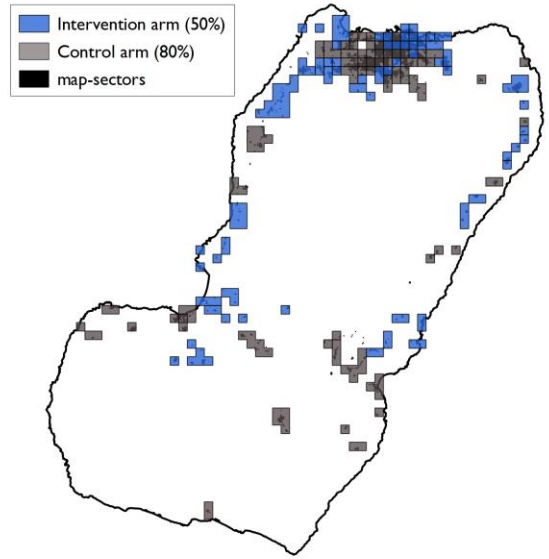
Non-inferiority trial to test effectiveness of 50% coverage compared to 80%

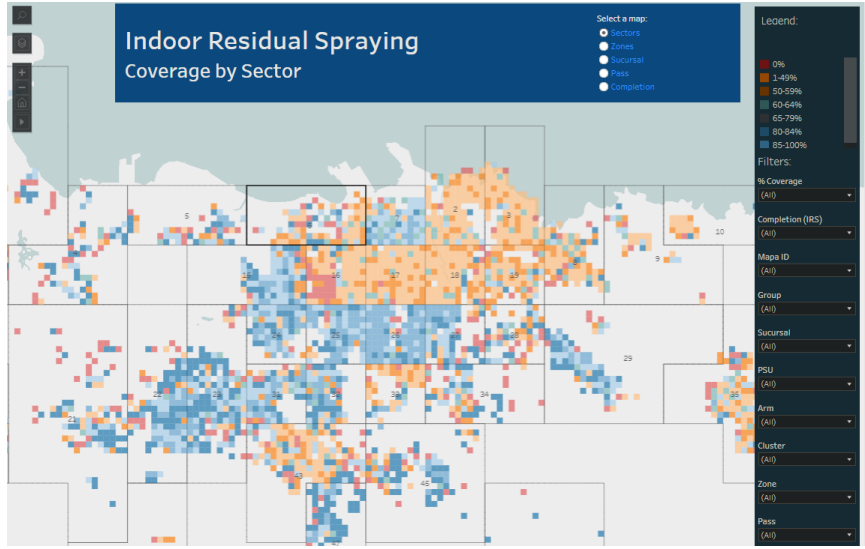
Motivation:

- Experience that sectors with 50% coverage see similar responses as 80%
- Little to no scientific evidence of 80% as an important threshold, despite guidance

Implementation:

- Grid-based system allows randomization
- Updated denominators ensure accurate measurement of coverage
- Monitoring coverage to maintain trail integrity
- Now in second year of trial, results forthcoming





Conclusions

- Implementing CIMS has transformed implementation of field activities
  - Supported better real-time monitoring
  - Enabled different methods of deployment planning and sampling
- Since implementing CIMS, much progress in productivity and operational efficiency of IRS
- Still lots of room to improve in IRS implementation
- CIMS has allowed new types of analysis and evaluation:
  - Accuracy of surveys for coverage estimation
  - Rethinking IRS coverage – or vector control more broadly?

Acknowledgements

BIMEP team

Creciendo Sin Paludismo en Guinea Ecuatorial

Donors

Ministerio de Minas Industria y Energía

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SANARIA Malaria Eradication Through Vaccination

IVCC Combating Insect Borne Disease

García GA, Atkinson B, Donfack OT, Hilton ER, Smith JM, Eyono JNM, et al. Real-time, spatial decision support to optimize malaria vector control: The case of indoor residual spraying on Bioko Island, Equatorial Guinea. PLOS Digital Health. 2022;1(5):e0000025.

Theoretical spillover effects