**Objectives Road Map for Alex Musiime**

Objective 1: Develop high-resolution, dynamic spatial models that describe the distribution of malaria vector species in Uganda.

Plan for objective 1

**Data sets**

1. Collate all vector datasets
2. NMCP datasets
3. year 2020-2026
4. Vector Atlas
5. GBIF

2. Quality check on vector locations

1. Make an intervention dataset space over time
2. ?shape file
3. Join the vector dataset?
4. Curate environmental and land cover covariate raster datasets
5. MAP standard layers
6. environmental
7. land cover/use (Agriculture)
8. Water Observation from Space (WOfS) long-term frequency on land;

-The frequency with each pixel is covered with water

1. Terrain wetness

5 MESS (Multivariate Environmental Similarity Surfaces) analysis of Uganda based on a curated set of covariates

1. Consider sampling bias for Uganda
2. accessibility (Weiss - major cities)
3. burden areas (to highlight in the methods)
4. intervention areas (to highlight in the methods)
5. Explore sources of each data sets

**Modelling Approaches**

* Write out a mental model of what distribution of malaria vector species in Uganda (intervention pressure, agriculture, environment, sampling bias)

Suggest different models including;

- Generalized Additive Models (GAMs)

-GLM, generalized linear model

-BRT, boosted regression trees

Discuss with supervisors the modelling approaches suggested

Select the best modelling approaches

Fit the model using the different variables

Do cross-validations

Evaluate Metrics

Generate species-specific mean probability or density

Variable importance tables and figures

Objective 2: Map the patterns of phenotypic insecticide resistance and identify the key ecological and intervention-related drivers in Uganda

**Data sets**

* Collate all insecticide resistance datasets

-NMCP bioassay data (WHO tube, CDC bottle assays) 2020–2026

-Vector Atlas resistance records

-IR Mapper (subset for Uganda)

-Published studies and reports (Not in Vector Atlas)

* Link resistance records to vector distribution data from Objective 1
* Intervention datasets

-IRS coverage and insecticide class over time

-ITN/LLIN distribution (net type, insecticide class, coverage by year/district)

* Environmental and land cover covariate raster datasets

-Climate (rainfall, temperature, humidity)

-Land cover/use (agriculture, urban, peri-urban)

-Land cover; Vegetation index

-Agricultural pesticide proxies (where available)

**Data preparation**

-Quality check on resistance records (species ID, location, date, insecticide, sample size, % mortality)

-Standardise insecticide classes (pyrethroids, carbamates, organophosphates, organochlorines, Neonicotinoids, pyrroles)

-Geocode records and join to intervention and environmental covariates

-Consider spatial and temporal bias in resistance testing

-Write out a mental model of what influences resistance (intervention pressure, agriculture, environment)

**Modelling Approaches**

* Write out a mental model of what influences resistance (intervention pressure, agriculture, environment, species distribution)
* Suggest different models, including:

-Generalized Linear Models (GLMs) / Generalized Additive Models (GAMs)

-Generalised Linear Mixed Models (GLMMs) with spatial–temporal random effects

-Regression Trees (BRTs)

-Bayesian hierarchical models for spatial correlation and uncertainty

-Response variable: mortality (%) or resistance category (susceptible/possible resistance / confirmed resistance)

-Select the best modelling approaches in consultation with Gerry/Nick and team

-Fit the models using covariates (intervention, environment, agriculture)

-Do cross-validations and model comparisons

-Predictive accuracy (cross-validation AUC, RMSE, coverage of predictive intervals)

-Variable importance (environmental vs. intervention-related drivers)

-Comparison of predicted resistance surfaces with independent datasets (e. g 2020 to predict 2021)

**Outputs**

-Resistance probability/density maps by insecticide class over space and time

-Resistance trends linked to interventions (IRS, ITNs)

-Variable importance tables and figures

-Maps of resistance “hotspots” and overlap with intervention areas

**Linkage between Objectives**



**To do**

-Get village names

-Coordinates for each village

-Data at village level