SHORT TERM SCIENTIFIC MISSION (STSM)
SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA17108
STSM title: Population Dynamics Modelling of *Aedes albopictus* in Northern Italy
STSM start and end date: 23/09/2019 to 27/09/2019
Grantee name: Kamil Erguler

PURPOSE OF THE STSM:

(max.200 words)
The main purpose of this STSM is to initiate a long-term collaboration between the vector-borne disease modelling groups of Fondazione Edmund Mach and The Cyprus Institute. Specifically, the project aims to facilitate a joint project on mathematical modelling of *Aedes albopictus* population dynamics using a set of environmental drivers and longitudinal surveillance data collected from Fondazione Museo Civico Rovereto (FMCR) and Museo delle Scienze di Trento (MUSE) in the Province of Trento, Northern Italy. The region offers a unique variety of habitat conditions for the vector populations to survive. Focusing modelling efforts over this region could help to develop better models and improve predictive capacity and range of applicability. The three broad objectives of this mission are

1. to assess, revise, and, if possible, improve the existing approaches for the mathematical modelling of *Ae. albopictus* population dynamics,

2. to put together a database of environment/climate variables and longitudinal surveillance data to be used specifically for the modelling of population dynamics in Northern Italy, and

3. to facilitate the collaboration of the host and the home institutions on modelling *Ae. albopictus* population dynamics for the region.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

(max.500 words)
Both Dr Erguler and Dr Manica presented their work at the departmental seminar organised at the host institute to facilitate the engagement of the visiting scientist and the local team of expert modellers and environmental scientists. The team interacted frequently and conversed for long hours sharing ideas about the most appropriate environmental datasets to utilise and the key features to be included in a model to best describe the vector dynamics in the region.
Two population dynamics models of *Ae. albopictus* were selected as the most suitable approaches taking into account the level of detail included in the models and the range of their calibration. Following population dynamics modelling, the need for incorporating disease transmission dynamics was established.

1. The population dynamics model described in Guzzetta *et al.* 2016 is based on ordinary differential equations and was developed for Northern Italy with data from the provinces of Belluno and Trento. The

accompanying disease transmission model is described in Manica *et al.* 2017 as an SEIR model for chikungunya. Collectively, this model will be referred to as the Manica model.

2. The second model to be employed is described in Erguler *et al.* 2016. The model is based on the age- and stage-structured difference equations model (the sPop model later described in Erguler 2019), and was calibrated with the data from the Emilia-Romagna region of Italy. The accompanying disease transmission model is based on the sPop implementation of the SEIRC model developed for the chikungunya virus. Collectively, this model will be referred to as the sPop model.

The team exchanged code (in Python and C programming languages) and instructions on how to run both models in a shared repository. In addiition, topics ranging from the mechanism of diapause to the breeding site availability and carrying capacity were discussed, which will help improve the structure and assumptions for each model.
The team discussed the limitations of resolution in environmental models, and, following a revision of a range of available datasets, selected the followings as the main source of environmental data:

- MODIS LST reconstructed from 2002 to 2018 at 250 m spatial resolution over Europe.

- COSMO REA6 [0] from 1995 to 2015 (may be possible to extend up to 2017) at 6 km spatial resolution.

- ECAD from 1950 to 2018 at 12 km spatial resolution over Europe.

With the help of Mr Luca Delucchi GIS technician at FEM), daily mean temperature and daily precipitation were obtained corresponding to the trap locations in the region of surveillance.
A total of 20 municipalities of the Province of Trento offered to share longitudinal mosquito surveillance data for this project from 2009 to 2015. The surveillance data will be made available in November 2019 and will be composed of the following information:

- ID_MUNI: Unique identifier of the municipality
- CODE_MUNI: Municipality code
- MONTH: Month of each observation
- WEEK: Week of each observation
- DATE: Date of each observation
- NTrap: Number of traps
- notactive: Number of inactive traps for the corresponding time
- Total_Eggs: Total number of eggs
- Mean_Eggs: Mean number of eggs
- SD_Eggs: Standard deviation

DESCRIPTION OF THE MAIN RESULTS OBTAINED

The CyI-FEM modelling team has successfully initiated the colaborative project on *Aedes albopictus* population dynamics modelling in Northern Italy. The team established a shared repository for code, analyses, models, environmental variables, and any results which will arise from this project. The repository is shared only between the two institutes, however, the results will be published as a collaborative project under the umbrella of AIM-COST CA17108.
Figure 1 displays the study region and the municipalities of the Province of Trento, which offered to contribute to the project with surveillance data. Figure 2 demonstrates the execution of each model (sPop and Manica) at 11.125 - 46.125 longitude - latitude using environmental data from the E-OBS dataset (25 km spatial resolution). The models require improvement and re-calibration for the Province of Trento, and this STSM project provided a solid ground for collaborative work on this subject.

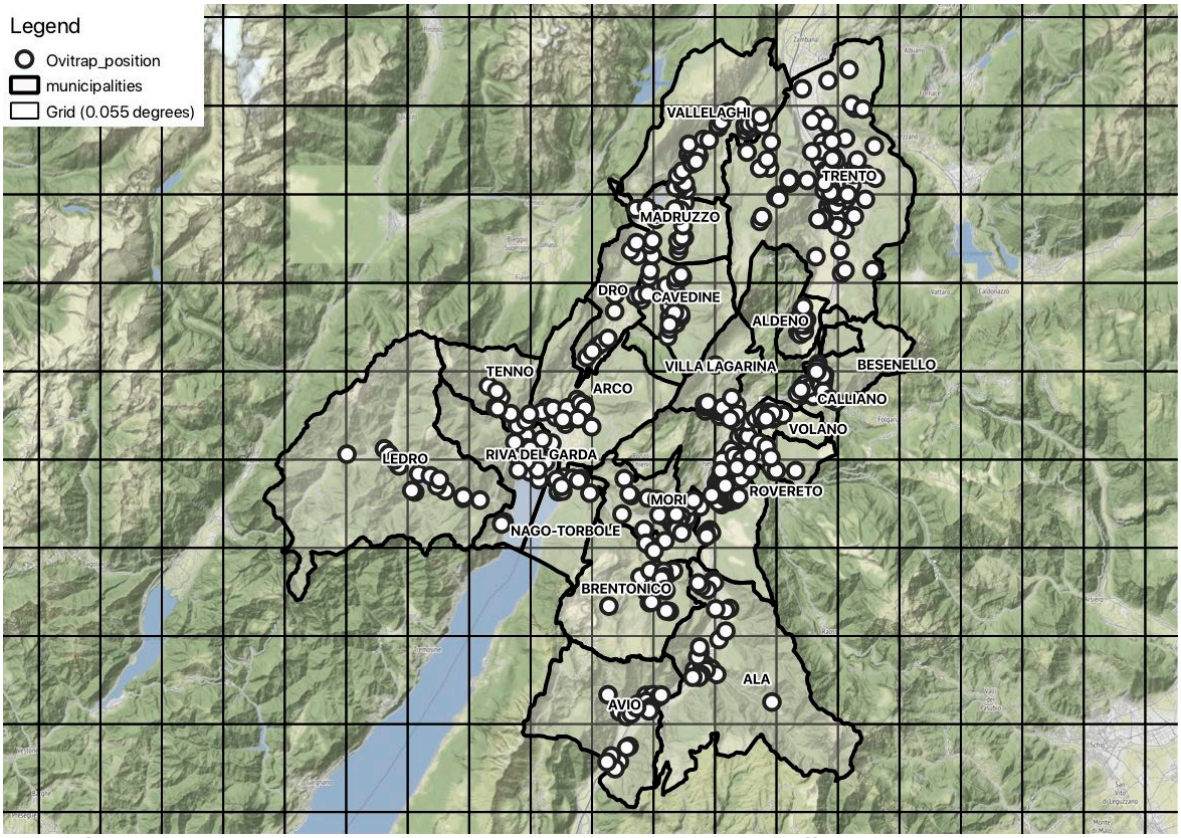
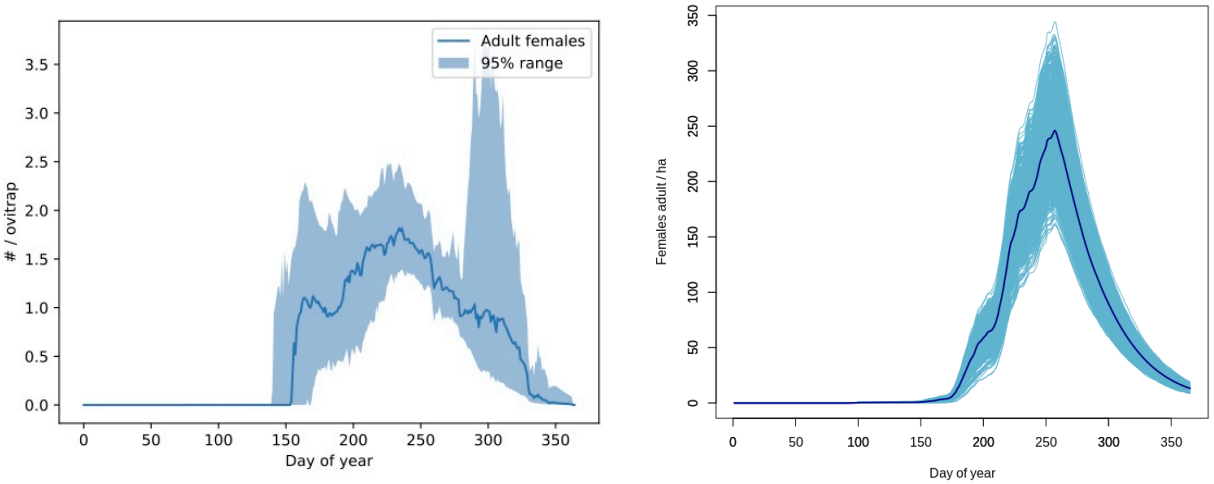


Figure 1: Study region and the trap locations within the municipalities offering to contribute to the project.



a) The sPop model **b)** The Manica model

Figure 2: Simulation runs prior to calibration.

FUTURE COLLABORATIONS (if applicable)

Through the established routes, under the umbrella of AIM-COST CA17108, the Cyl-FEM modelling team will continue communicating and meeting occasionally to discuss about the progress and any issue related to the project.