

ABSTRACT

In tropical areas, *Aedes* mosquitos cause >100 million symptomatic cases/year of viral diseases, such as dengue, yellow fever, chikungunya and Zika, and thousands of deaths. With increasing trade and travel, several *Aedes* species have been introduced into Europe and are now spreading spectacularly rapidly becoming a widespread significant public health risk which needs to be effectively addressed, as testified by recent cases of autochthonous chikungunya and dengue transmission.

Transboundary risks require effective surveillance, risk assessment, and vector control, with efficient dissemination of information and guidance to stakeholders, requiring collaboration between the normative, research, public health, commercial and civil society sectors at international, national and local scales. This is not happening. Despite the range of institutional guidelines available, current mitigation activities are largely uncoordinated, and implemented piecemeal nationally or locally, reducing cost-effectiveness and impact.

AIM Cost Action will build a gender, age and geographically balanced network from critical stakeholder sectors. The Action will assess and review current surveillance, control and analysis practices, develop best practice guidelines and protocols ensuring consistency across Europe. It will facilitate development of new tools and identify priority research topics. Recommendations to standardise and streamline entomological and spatial analysis will promote enhanced risk assessments needed for reliable targeting and planning. Critical elements maximising impact will be involvement of civil society and citizen scientists, as well as collaborative dissemination ensuring that technical outputs and guidelines are customised at different geographical scales for each operational stakeholder group. Lessons learned will be transferrable to other emerging vector borne diseases worldwide.

RESEARCH COORDINATION OBJECTIVES (1-10)

The following coordination objectives will be implemented by two integrated Working Groups:

1. systematically review of current methodologies and practices to sample, monitor and identify *Aedes* invasive mosquitoes (AIMs), as well as for data analysis and for mathematical/statistical/computational modelling, and establishment of pros and cons and cost-effectiveness of alternative approaches (including citizen science community based ones) under different climatic/ecological and epidemiological scenarios (Working Group 1, Task 1);
2. transfer of knowledge on most cost-effective AIM monitoring/surveillance approaches to less experienced stakeholders to promote and harmonize monitoring/surveillance and data sharing approaches and assure comparable outputs needed to provide active monitoring surveillance beyond country/region barriers (WG1.2);
3. promotion of studies to identify research needs for the development of novel monitoring/surveillance approaches (with particular reference to citizen science community based ones) (WG1.3);
4. production of guidelines containing recommendations for best practice sampling, surveillance, spatial modelling and map output production, taking into account the needs of the stakeholders by assessing the outputs from the perspective of both producers and end-users (e.g. PH officers, the public) in order to ensure the maximum integration and impact at the EU level and beyond (WG1.4)

5. systematically review of AIM control methodologies implemented across CCs/NCCs and establishment of pros and cons and cost-effectiveness of alternative approaches (including citizen science community based ones) under different climatic/ecological/sociological and epidemiological scenarios (WG2.1);
6. transfer of knowledge on most cost-effective, locally tailored and sustainable AIM control methods to less experienced stakeholders, and promotion of data sharing (WG2.2);
7. identification and promotion of most relevant of studies to develop novel evidence-based AIM-control interventions (including citizen science community based ones) with the involvement of innovative Companies, in order to pave the way toward development of novel/improved control tools (WG2.3).

CAPACITY BUILDING OBJECTIVES (1-10)

- Creating a Pan-European multidisciplinary network of scientists with common background on AIM bionomics, surveillance and control in order to identify and develop innovative research concepts and ideas and to promote the implementation of optimised/innovative monitoring/control campaigns projects in synergy with international Organizations in the fields of surveillance and control of mosquito and mosquito-borne diseases.
- Nurturing a new generation of medical entomologists with inter-disciplinary expertise on AIM related activities and international collaborative perspectives, and able to maintain & improve expertise and capacity to prevent or control AIMS and related health risks in Europe and beyond.
- Creating a synergistic relationship between scientists private companies, citizen scientists and decision-makers across Europe and beyond for the implementation of best practices and innovative tools in local AIM and EAIMBV surveillance/monitoring and control campaigns in order to overcome present fragmentation in knowledge and interventions and eventually improve health and well-being in Europe and beyond. This will involve each sector learning new skills and perspectives.
- Raising public awareness of AIMS, related health risks and control options to obtain a more informed consensus on preventive Citizen Science community-based interventions, as well as on possible innovative control approaches to be implemented under different epidemiological scenarios.
- Jointly refining, optimizing, customising and delivering guidelines and protocols for AIM surveillance/monitoring/control in conjunction with international Organizations and Public Health end-users to promote their implementation at national and local scales.

DELIVERABLES

DL3.1 Web platform and science blog platform (month 6);

DL3.2 Report on results from Delphi and specialised questionnaires (month 18);

DL2.1 Report/publication on conventional and novel AIM control practices in Europe (month 24);

DL1.1 Report/publication on sampling design for monitoring and surveillance of AIMS and EAIMBV in Europe (month 30);

DL1.2 - Publication of best practices and white papers for AIM monitoring and surveillance, including modern citizen science approaches and Road Map for AIM mapping from data to models derived from STSMs (month 42)

DL3.3 Synthesised feedback with recommendation for customising surveillance, control and modelling guidelines (month 42);

DL2.2 Report on feasibility of scaling-up, cost-benefits and community acceptance of conventional and innovative AIM control approaches (month 48).

DL3.4 Guidelines for customisation of mapped outputs (month 48).

WORKING GROUPS

WG1 – MONITORING & SURVEILLANCE of AIMs and EAIMBVs

Task WG1.1 – Review, optimisation and ToK of AIM monitoring and surveillance. The practicality and efficiency of current sampling protocols for collecting different mosquito stages (i.e. eggs, larvae, resting/ovipositing/host-seeking adult females, resting males), AIM identification based on morphology using identification keys or molecular approaches (PCR; molecular genotyping; MALDI-TOF), National EAIMBV surveillance programs will be systematically reviewed, based on country level case specific data. Information and knowledge exchange will be facilitated and promoted at country level to maximise stakeholder involvement, to identify needs and gaps of different approaches, with the final aim of refining the interventions from inception to assessment to consolidate and harmonise recommendations for each species/pathogen and level of expertise. The contribution of citizen science to monitoring and surveillance by innovative smart phone mosquito monitoring applications already available in some European countries will be exploited and supported by interactive communication tools and platforms to facilitate inputs and information exchange.

Task WG1.2 - Integrating surveillance data analysis, spatial modelling & mapping to ensure the quality and applicability of future technical outputs at the European level. Surveillance data provide the opportunity to produce spatial model of predicted vector distributions of areas that have not been adequately sampled in the field. The surveillance data must however be standardised and representative. In addition, the modelling methods and the covariates data also need to be reliable and harmonized to ensure comparable outputs for different areas and from different practitioners. Finally, the outputs themselves need to be tailored for a range of potential users in the academic, PH administration and public arenas. Task 1.2 will assess the major potential ‘roadblocks’ in the work chain from sampling to dissemination, and provide a set of guidelines containing recommendations for best practice sampling, modelling and output production to ensure the maximum integration and impact at the EU level of the three sets of activities. Such a Road map will not only be valuable within the context of AIM/EAIMBV assessments, but will be widely applicable to other vectors, their hosts and the diseases they carry.

WG2 – CONVENTIONAL and INNOVATIVE CONTROL TOOLS

Task WG2.1 – Review, optimisation of current control options. The control of AIMs where there is a risk of EAIMBV autochthonous transmission (e.g. when, for an infected human imported case is reported to health authorities) consists of focal spraying of adulticide insecticides. Preventive larval control based on habitat management campaigns to reduce availability of potential larval habitats and/or treatment of non-removable breeding sites (e.g. rain catch basins) are strongly recommended to reduce abundance of AIMs and related nuisance, but are rarely effectively implemented by public administrations. Private citizens are also investing considerable resources to reduce the nuisance using focal insecticide treatments and/or spatial/personal repellents and

trapping devices whose effectiveness is rarely assessed. The main focuses of this task are exchanges of information and knowledge and provision of recommendations for optimising at the Pan-European level methodologies to control AIM, for each species/geographical context. The practicality and efficiency of current control methods and the trends will be systematically reviewed, based on country level case specific examples. A critical prospective analysis for the use of public health pesticides in future decades taking into account the risk of insurgence and spread of insecticide resistance will be discussed in the frame of current Biocide European directive.

Task WG2.2 - Quality evaluation of AIM control operations. Mosquito control operations are conducted by public or private agencies, depending on the specific country regulation and local situations. As these operations are usually publicly funded, they should be conducted with maximum transparency and quality control and external independent evaluation. Quality evaluation in mosquito control is largely unattended in Europe and thus strongly required in parallel with mosquito control operations. Preliminary experience developed in some countries will be gathered and analysed to assess cost-benefit, and protocols for quality evaluation in different settings will be developed alongside provision of training.

Task WG2.3 - Innovative vector control tools/New Paradigms. A limited number of mosquito larvicides (e.g. bacterial toxins and insect growth regulators, IGRs) and adulticides (e.g. pyrethroids) are presently available to control AIM and alternative efficient control solutions with low environmental impact are still lacking. Alternative innovative methods for the control of mosquito vectors of arboviruses - such as Wolbachia infections, paratransgenesis, Attractive Toxic Sugar Baits, mass-trapping, auto-dissemination, innovative sterile male releases and transgenic approaches - are under development aiming in most cases at a niche role rather than becoming the default intervention across a wide range of settings. Successful demonstration of cost-effectiveness of novel interventions in certain settings in CCs/NCCs is required to facilitate registration processes, policy endorsement, and expansion-scale up strategies in other places. Knowledge base acceptance of novel approaches to the target populations is particularly relevant in case of possible implementation of biotechnology-based approaches and transgenic technologies. Novel control approaches will be compared with current methods and gaps in deployment of alternative AIM control tools will be identified. Strengths and weaknesses of each method, for a range of settings and geographical contexts, will be assessed in terms of efficiency, environmental, operational and ethical constraints, by assessing specific use cases, and by literature reviews. Conditions/sites where such alternative methods could be deployed will be identified and recommended. Network members will also provide guidance to the implementation and cost-effectiveness analysis of possible local pilot trials of novel control interventions supported by external funds and to the approaches to be implemented to raise of public awareness on vector control options in order to stimulate evidence-based decisions and informed consensus.

WG3- DISSEMINATION, CUSTOMISATION AND COMMUNICATION

Task WG3.1 - Dissemination within the COST-Action network & to scientific external audience. Traditional methods will be used to disseminate AIM-COST ACTION activities and outputs - primarily a dedicated Website. This will contain a wide range of content including but not limited to formal Action documents (objectives, meeting presentations, minutes), details of participants, outputs and publications, downloads, links to other relevant networks and projects, factsheets, news and events and a science blog.

Task WG3.2 – Customisation: guidelines for surveillance/control and for modelling outputs. This overarching task consists of 2 subtasks, as follows: T3.2a Surveillance and control guidelines:

as set out above, existing guidelines for surveillance and control are not widely or consistently used at the national level and require customisation to local conditions. This task will disseminate guidelines developed by WG1 and 2 to a range of stakeholders to solicit feedback and enable appropriate revision.

T3.2.b Mapping and Modelling Outputs. Maps are powerful dissemination and advocacy tools – “a picture is worth a thousand words”. They can also be, if inadvertently, misleading. They may not map the right parameter (e.g. presence or absence rather than abundance); they may provide the wrong level of detail (e.g. km vs. administrative unit level); they may use inappropriate designs or simply be too complicated. The specific question to be addressed in this task is how to optimise existing mapped outputs for end users. The WG activities will therefore focus on the detailed customisation and translation of technical products for each defined user group, through: i) a WS to consult representative producers and users to identify dissemination needs (e.g. what information should be disseminated and to whom, what methods to use, who is responsible for the dissemination, and feedback loops should validate usability); ii) an STSM for preparation of dissemination guidelines; iii) presentation of the draft guidelines to Users at dedicated session during AC, for feedback; iv) Incorporation of feedback / guideline finalisation. Full use will be made of the links to the GMAC and to UNEP Environment Live so that all Citizen Science involved in innovative community led monitoring can input their views on the type of up-to-date and accurate information they wish to use. GMAC will feed into this process experience from using already available Citizen Science data on mosquito nuisance (risk of bites).