



MISSION REPORT

Dengue outbreak in Madeira, Portugal

October – November 2012

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This report of the European Centre for Disease Prevention and Control (ECDC) was coordinated by Bertrand Sudre.

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Abbreviations

CEVDI	Centro de Estudos de Vectores e Doenças Infecciosas
DENV-1	Dengue virus serotype 1
DGS	Directorate-General for Health, Lisbon
DNA	Deoxyribonucleic acid
DDT	Dichlorodiphenyltrichloroethane
GIS	Geographic information system
IASAÚDE, IP-RAM	Instituto de Administração da Saúde e Assuntos Sociais, IP-Região Autónoma da Madeira (Institute of Health Administration and Social Affairs, Autonomous Region of Madeira)
ICPC-2	International Classification of Primary Care, Second edition
ICT	Information and communications technology
IHMT	Instituto de Higiene e Medicina Tropical, Lisbon (Institute of Hygiene and Tropical Medicine)
INSA	Instituto Nacional de Saúde Doutor Ricardo Jorge
MDSS	Madeira Dengue Surveillance System
RAM	Região Autónoma da Madeira (Autonomous Region of Madeira)
RT-PCR	Real-time polymerase chain reaction
SESARAM, E.P.E.	Serviço de Saúde da Região Autónoma da Madeira, E.P.E. (Health Service, Autonomous Region of Madeira)
SOP	Standard operating procedure
SRPCBM	Serviço Regional de Protecção Civil e Bombeiros da Madeira (Civil Protection and Fire Rescue, Madeira)

1 Introduction

On 3 October 2012, Portugal reported two cases of autochthonous dengue virus infection in the Autonomous Region of Madeira (Portugal). By 10 October, when the Institute of Health and Social Affairs (Instituto de Administração da Saúde e Assuntos Sociais, IASAUDE) reported 18 confirmed and 191 probable cases, it had become clear that this constituted a noteworthy outbreak of dengue in Madeira. Confirmatory tests by the National Institute of Health in Lisbon identified dengue virus serotype 1 (DENV-1).

An ECDC Rapid Risk Assessment published on 10 Octoberⁱ concluded that this was the first documented outbreak of dengue in Madeira. The *Aedes aegypti* mosquito, the most effective vector for dengue virus, has been present on Madeira since at least 2005. Although the introduction of the virus to the island is not an unexpected event given the dramatic expansion of endemic dengue transmission globally over the last 20–30 years, the outbreak is large and constitutes a significant public health event with regards to the local population and the large number of visitors to the archipelago of Madeira.

Dengue is an outbreak-prone mosquito-borne viral disease with manifestations ranging from asymptomatic infections, non-specific febrile illness, classic dengue fever (with sudden onset of high fever, severe headache and retro-orbital pain, myalgia, arthralgia, a maculo-papular rash and minor haemorrhage), to the less frequent severe presentations of dengue which are characterised by an increase of vascular permeability that can lead to life-threatening hypovolemic shock. The severe forms of dengue normally present after the first two days of fever. Early recognition of the clinical and laboratory warning signs of severe dengue is an essential part of case management. There are no antiviral or other specific treatments for dengue; however, supportive care with timely management of haemodynamic disturbances dramatically reduces case fatality. Note that there are four distinct dengue viruses without cross-immunity. People can develop four dengue infections in their lifetime.

Humans are the host reservoir of dengue virus and vertical transmission is uncommon in the mosquito life cycle. For the chain of transmission to remain unbroken, a competent mosquito vector must take a blood meal from a viraemic human case and later inject the virus into a susceptible human while taking another blood meal. This interval corresponds to the extrinsic incubation period of about 10 days, which is the time taken by dengue virus to complete its development in the mosquitoes (intermediate host). *Aedes aegypti* is adapted to breed in proximity to humans and in urban environments, and it is the most effective of the dengue virus vectors. In general, the increase in global transportation of goods and passengers has facilitated the rapid expansion of both *Aedes aegypti* mosquitoes and dengue virus transmission to new areas.

The *Aedes aegypti* mosquito is not present in continental European Union countries but the climatic conditions in southern Europe are assumed to be favourable for imported female mosquitoes or larvae to establish breeding. The less effective *Aedes albopictus* vector is established in southern Europe and there is documentation of rare occasions of autochthonous transmission of dengue virus following importation of viraemic dengue cases. *Aedes aegypti* surveillance has been strengthened in the EU to prevent the establishment of a new mosquito population.

Portugal requested ECDC's assistance with an assessment of the situation and guidance for outbreak control. This report covers the activities and findings of the ECDC mission to Madeira from 22 October to 7 November 2012.

ⁱ European Centre for Disease Prevention and Control. Autochthonous dengue cases in Madeira, Portugal. 10 October 2012. Stockholm: ECDC; 2012. Available from: http://www.ecdc.europa.eu/en/publications/Publications/Forms/ECDC_DispForm.aspx?ID=975

2 Objectives

2.1 Overall objective

The overall objective of the mission was to support the regional authorities in Madeira with the assessment and control of the dengue outbreak. ECDC was specifically asked to:

- set up an electronic surveillance system for timely monitoring of the outbreak;
- conduct an epidemiological analysis of the outbreak;
- provide guidance on vector control;
- set up a surveillance system for vector-borne diseases.

2.2 Specific terms of reference

Epidemiology and surveillance:

- Review and analyse available and new epidemiological information.
- Describe the outbreak in terms of time and place of cases, case characteristics and disease outcomes.
- Strengthen the data collection system in order to improve the quality and timeliness of surveillance data of the on-going outbreak.

Vector control:

- Together with regional and national Portuguese entomologists, review the current vector situation and developments since *Aedes aegypti* was first found in Madeira.
- Support local entomologists with expertise on the different products and appropriate approaches for the control of *Aedes aegypti* in the context of the current dengue outbreak.
- Monitor the impact of vector control interventions on the vector population, human health and environmental impact.
- Support the preparation of a medium-term strategy for vector control.

Surveillance of vector-borne diseases:

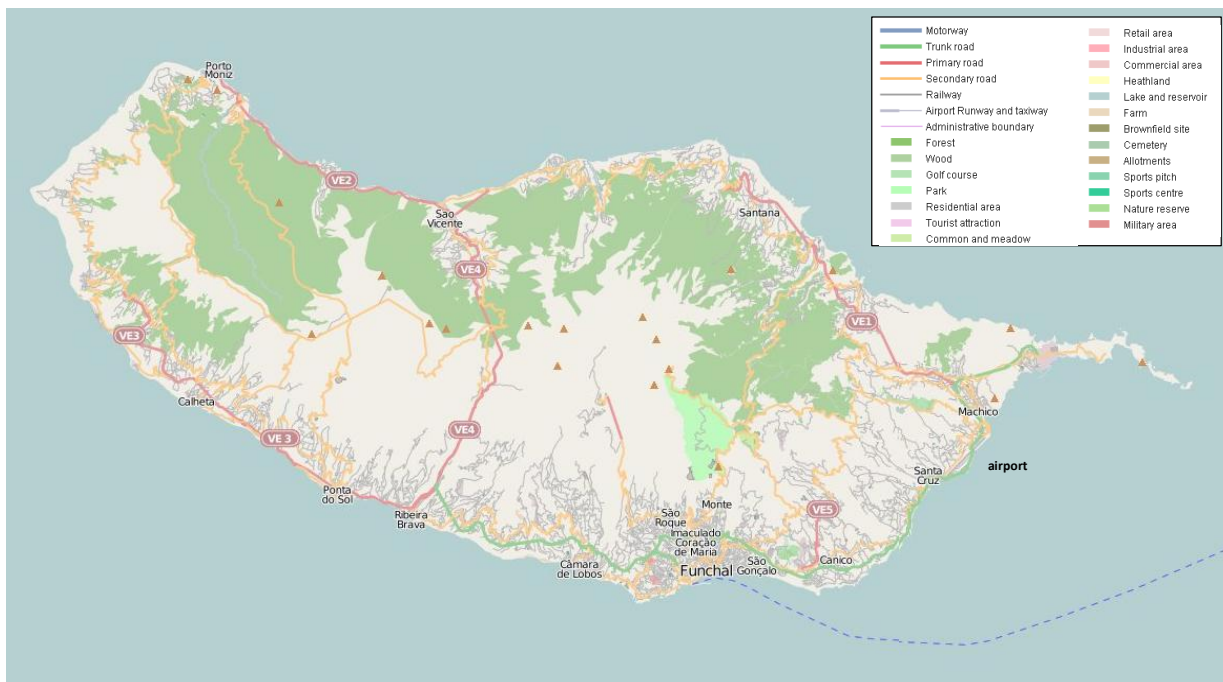
- Facilitate the development of a plan to strengthen the surveillance of and response to vector-borne diseases in Madeira.

3 Activities and findings

3.1 Context

Madeira is an autonomous region of Portugal and includes the islands of Madeira, Porto Santo, and the Desertas and is an outermost region of the European Union. The archipelago is located in the Atlantic Ocean at the same latitude as the middle part of Morocco, 400 km north of Tenerife, Canary Islands. The main island (Madeira Island, see Figure 1, below) constitutes 93% of the archipelago's area and 90% of the island's landmass is above 500 m in altitude. It measures 57 km from west to east and 22 km from north to south and has an area of 750 km². The island is mountainous (highest point Pico Ruivo 1 862 m) and the population is concentrated along the coast (highest population density along southern coast). The population is around 260 000 inhabitants, of which 110 000 live in the capital Funchalⁱ.

Figure 1. General map of Madeira



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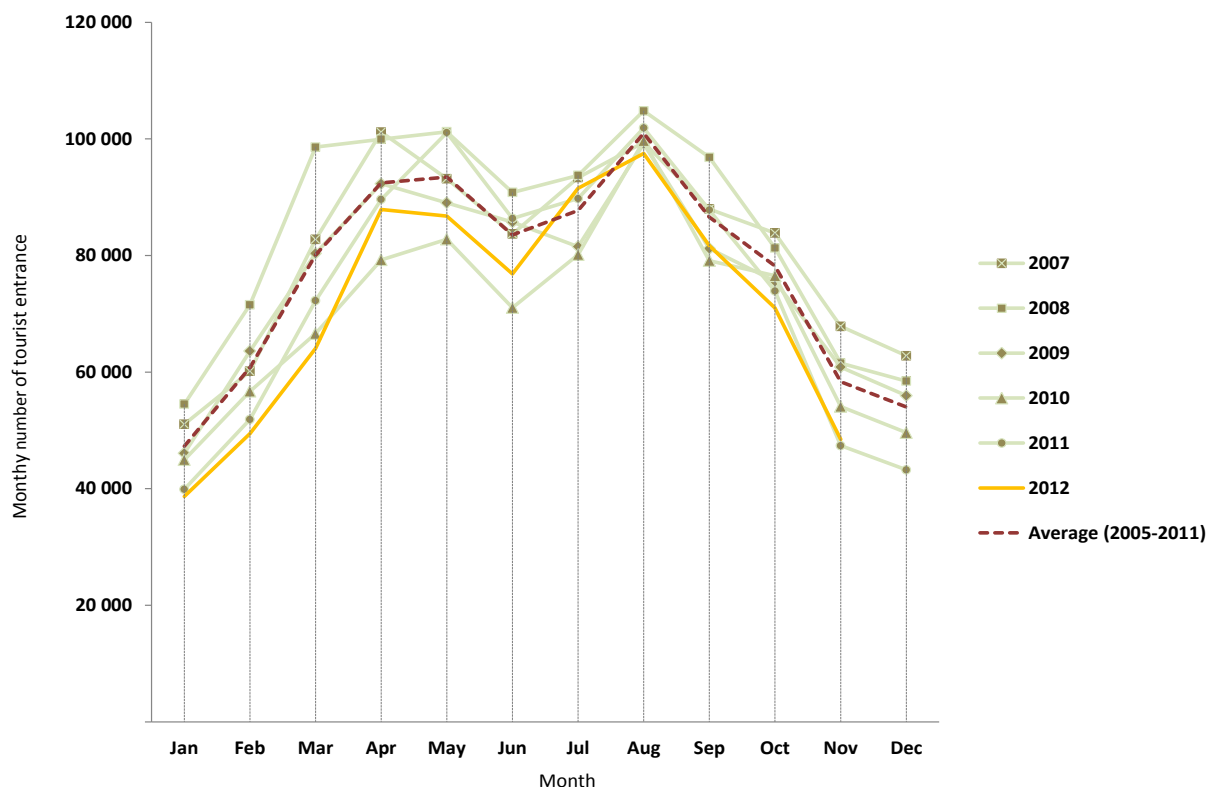
The climate is strongly influenced by the Gulf Stream and Canary Current. The monthly average temperature ranges from 18 degrees Celsius in January to 23 degrees Celsius in Augustⁱⁱ. The rainy season is from November to February and the dry season from April to September. The annual average rainfall is close to 700 mm. The tropical vegetation is luxuriant and Madeira is well-known for its many endemic species and floral diversity. The climate is favourable for vineyards, banana and vegetable cultivation. There are large differences in sun exposure, humidity and temperature between the north and the south of the island, producing contrasting local microclimates.

The economy is based on tourism, the free commercial zone of Madeira, construction (with companies working abroad in Portuguese-speaking countries, mainly South America and Africa) and agriculture.

ⁱ See <http://en.wikipedia.org/wiki/Madeira>

ⁱⁱ See Instituto Português do Mar e da Atmosfera, Lisbon, at <http://www.ipma.pt>

Figure 2. Number of nights spent in the Autonomous Region of Madeira by tourists, by month, 2007 to 2012



Source: Adapted from the Regional Statistical Office, http://estatistica.gov-madeira.pt/index.php?option=com_turismo_ie&Itemid=221

In addition, many tourists reach Madeira by cruise ship. Many are transatlantic cruises and the tourists often spend only one day on the island, mostly visiting Funchal and its surroundings. The high tourist season is between April and September (Figure 2). The high season for cruise ships is from September to January, with a peak over the New Year, but large cruise ships anchor in Funchal all year round.

3.2 Health information system

The health sector is managed by the Regional Secretariat of Health and Social Affairs (Secretaria Regional dos Assuntos Sociais) and activities are divided between two departments:

- IASAÚDE, IP-RAM (Instituto de Administração da Saúde e Assuntos Sociais, IP-Região Autónoma da Madeira);
- SESARAM, E.P.E. (Serviço de Saúde da Região Autónoma da Madeira, E.P.E.).

The Regional Secretariat of Health and Social Affairs also operates the civil security services (SRPCBM, Serviço Regional de Protecção Civil e Bombeiros da Madeira) which deals with health emergencies and natural disasters.

The health information system captures information in two main ways:

- The public sector, which includes the main Dr Nelió Mendonça Hospital in Funchal and Hospital dos Marmeleiros, and 14 primary healthcare centres, one in each municipality and four in Funchal, report outpatient and discharge diagnosis to a central database operated by SESARAM.
- The private sector is under the responsibility of IASAÚDE and there are eight registered private clinics and 412 registered medical doctors, 11 of which are general physicians.

The HIS operates with unique identifiers which are used by both public and private providers as well as the diagnostic services. The healthcare system is well-structured and the majority of the symptomatic dengue cases are expected to be referred to the public sector. Surveillance for the purpose of monitoring the outbreak focuses on data from the public sector in accordance with the Normative Document 5/2012 from 26 October 2012 'Monitoring of the outbreak and management of cases of dengue in Região Autónoma da Madeira (RAM)'.

3.3 Epidemiological analysis of the main characteristics of the outbreak

Materials and methods

After the arrival of the ECDC team, two separate systems were put up:

- One for the analysis of the retrospective data (up to 28 October, end of week 43)
- One for the systematic collection of new data: the Madeira Dengue Surveillance System (MDSS) starting from 29 October.

Data sources

- Retrospective data: all data available were collected from (i) voluntary-based reports to the healthcare system of RAM (Serviço de Saúde da Região Autónoma da Madeira, SESARAM) and (ii) the regional laboratory, where all confirmations for suspect diagnoses have been sought.
- Prospective data: a new ad hoc surveillance system, the Madeira Dengue Surveillance System (MDSS), was set up, based on data from the SESARAM only. Reports to the SESARAM have been made mandatory, based on the Normative Document 5/2012 of 26 October 2012 'Monitoring of the outbreak and management of cases of dengue in RAM' (Circular Normativa n.º 5/2012 – Monitorização do surto e gestão de casos de dengue na RAM, in Portuguese) updated on 12 November by the regional Instituto de Administração e Assuntos Sociaisⁱ.

The SESARAM uses an integrated information system for day-to-day activities for both hospital units and every primary healthcare centre. The MDSS was developed by the ICT unit of SESARAM with the support of ECDC.

The MDSS receives data daily from two sources:

- Hospital diagnoses according to ICD9-CMⁱⁱ. In the new system, when a clinician selects diagnosis code '061: Dengue', the system by default requests that the user completes a case information sheet that is fed to the MDSS (Annex 5).
- Primary healthcare centres use International Classification of Primary Care (ICPC-2) codes. The list of ICPC-2 codes did not include dengue in Madeira and a new code had to be generated and added to the list of diagnoses. When physicians report a case, the system works in a similar way as for hospital diagnosis reporting.

Epidemiological case definition

The case definition for surveillance of dengue was communicated in document 014/2012 published on 3 October 2012 and updated on 30 October 2012 by the Health Directorate of Lisbon (Abordagem de casos de dengue, Orientação nº 014/2012 de 03/10/2012, updated on 30/10/2012, in Portuguese) and in document 06/2012 published on 26 October 2012 and updated on 12 November by the regional Instituto de Administração e Assuntos Sociaisⁱ.

Probable case must meet both the clinical and epidemiological criteria.

- Clinical criteria: acute onset of fever and at least two of the following symptoms or signs: headache, retro-orbital pain, myalgia, arthralgia, exanthema, haemorrhagic manifestations or leucopenia.
- Epidemiological criteria: resident in or visit to a dengue-affected area during the 21 days prior to onset of symptomsⁱⁱⁱ.

Confirmed case is defined as a probable case with at least one of the following laboratory results:

- Presence of dengue virus specific IgM antibodies in blood or cerebrospinal fluid (CSF).
- Significant increase in the concentration of dengue virus specific IgG antibodies (seroconversion).
- Detection of dengue virus nucleic acid in blood or CSF with RT-PCR.

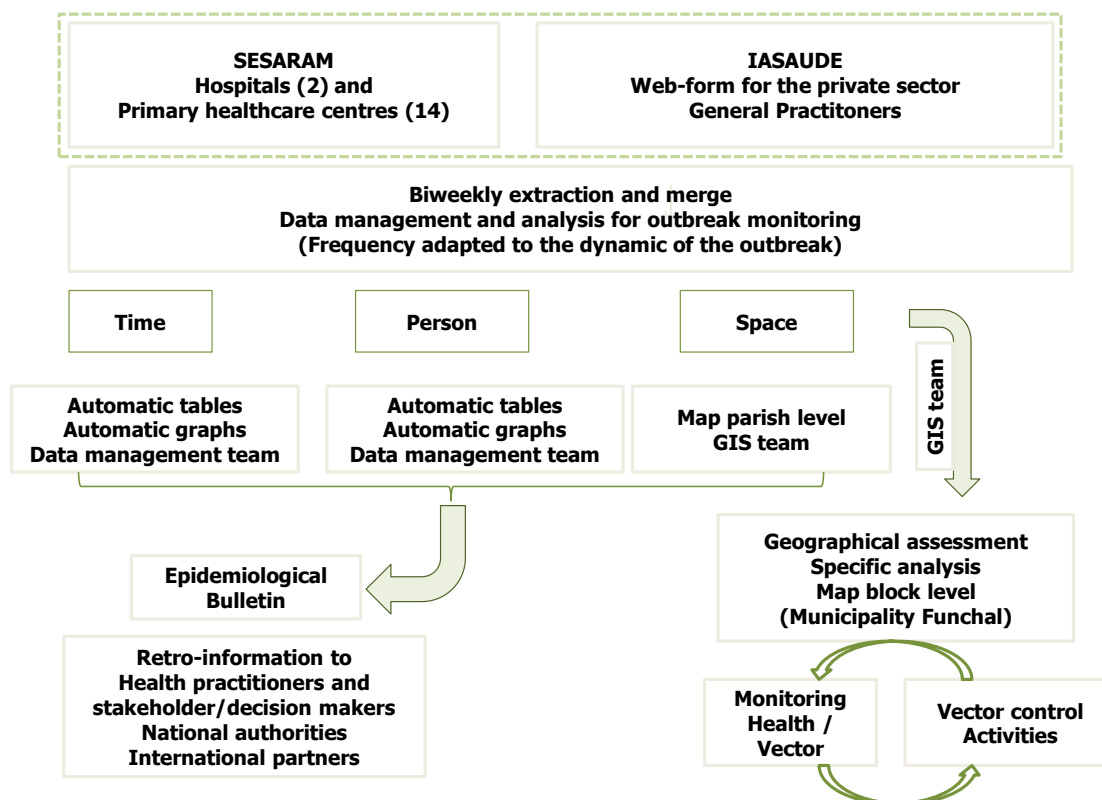
Data retrieval and analysis

Data retrieved by the Madeira Dengue Surveillance System is sent by email from the Statistics Service of SESARAM to the Institute for Health and Social Affairs of RAM (IASAUDE) and to the Clinical Direction Board (Direção Clínica). Data retrieval is done twice a week, on Mondays and Thursdays, but this frequency can be tailored according to the dynamics of the outbreak. Figure 3 shows the MDSS workflow.

ⁱ <http://iasaude.sras.gov-madeira.pt>

ⁱⁱ International Classification of Diseases, Ninth revision, Clinical Modification.

ⁱⁱⁱ Since the entire RAM is considered an affected area, the epidemiological criterion is met for all cases.

Figure 3. Data workflow of the dengue surveillance system in Madeira

The retrieved data are analysed by the biostatistics team and geographic information system (GIS) team of IASAUDE (detailed workflow in Annex 5). The GIS team produces weekly maps showing the distribution of new cases by parish ('freguesia'). The biostatistics team produces a weekly epidemiological bulletin which is published by IASAUDE to relevant stakeholders.

The biostatistics team and GIS teams have been provided with MDSS toolkits containing the following standard operating procedures and workflow charts:

- an automated Microsoft Excel 2010 file for data monitoring and production of graphs and tables;
- step-by-step instructions;
- template maps from Quantum GIS (Version 1.8.0 'Lisboa'ⁱ);
- a template for the weekly epidemiological bulletin.

Different automatic procedures for the geolocation of cases were tested and discussed with the GIS team. The geographical information for Madeira has a high resolution, particularly for Funchal and other urban areas, and a set of base ground layers available to allow vector control measures to be directed at specific buildings, hotels, restaurants, hospitals, clinics, schools, streets, sewage systems and irrigation networks.

ECDC conducted training sessions to support the use of spatial analysis (such as buffering tool, spatial extraction, density maps). The objectives were to overlay case occurrence with vector surveillance data and to extract general information for vector control management around the location of probable cases (number of schools, healthcare centres, etc.).

Time characteristics

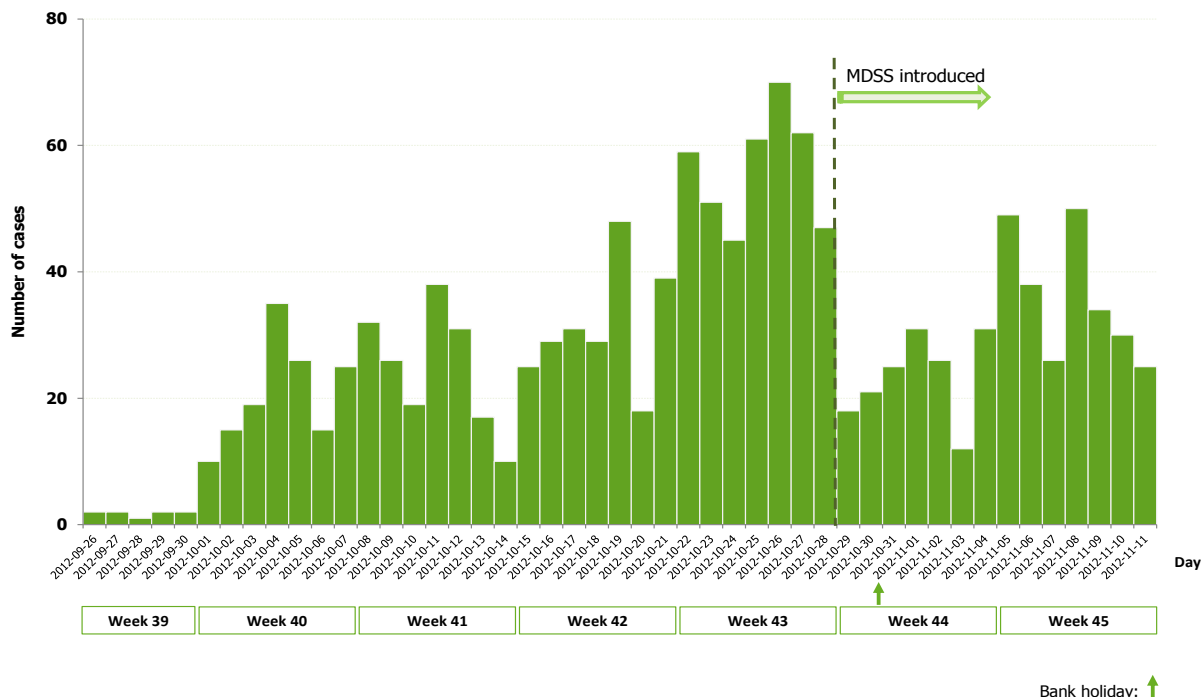
The first two cases with dengue had onset of symptoms on 26 September (week 39). The epidemic curve shows a progressive increase in the number of cases until week 43 (Figure 4). The number of notifications drops over the weekends. The most noticeable increases in trend of notification take place over week 40 and week 43. The marked increase in cases in week 39 could result from delayed notifications during the first days of the outbreak. There is a decrease of reported cases in week 44, the first week after introduction of the MDSS, without any clear explanation for this change of pattern. Note that 1 November is a bank holiday in Portugal. Up to 11 November,

ⁱ <http://www.qgis.org/>

1 357 dengue cases (probable and confirmed) were notified, of which 669 cases were laboratory-confirmed. Overall, 89 patients were hospitalised and no severe forms or deaths were registered.

The data relative to week 44 – the first week after introduction of MDSS – were reported by the SESARAM team in the form of an epidemiological bulletin (Annex 6), using the ICT support tool kit developed by the ECDC team.

Figure 4. Dengue cases (probable and confirmed) by date of diagnosis, 26 September to 11 November 2012, Madeira



Place characteristics

The cumulative attack rate was 50.7 per 10 000 population for the period 26 September to 11 November 2012. The outbreak is concentrated in some municipalities and 82% of all cases have been reported from Funchal municipality, with the highest incidence reported from Santa Luzia and Nazare parishes. Santa Cruz and Câmara de Lobos municipalities also have high case numbers (Table 1).

Table 1 shows absolute case numbers and cumulative attack rates for probable and confirmed cases by municipality. The higher attack rates in southern municipalities are likely to result from the higher population density in these areas and the uneven distribution of the *Aedes aegypti* vector present along the southern coastline. However, it should be noted that cases are recorded according to residence and since *Aedes aegypti* mosquitoes are active during the day, many of the cases may have been infected when working away from their residence.

Table 1. Dengue cases and attack rates by municipality, 26 September to 11 November 2012, Madeira

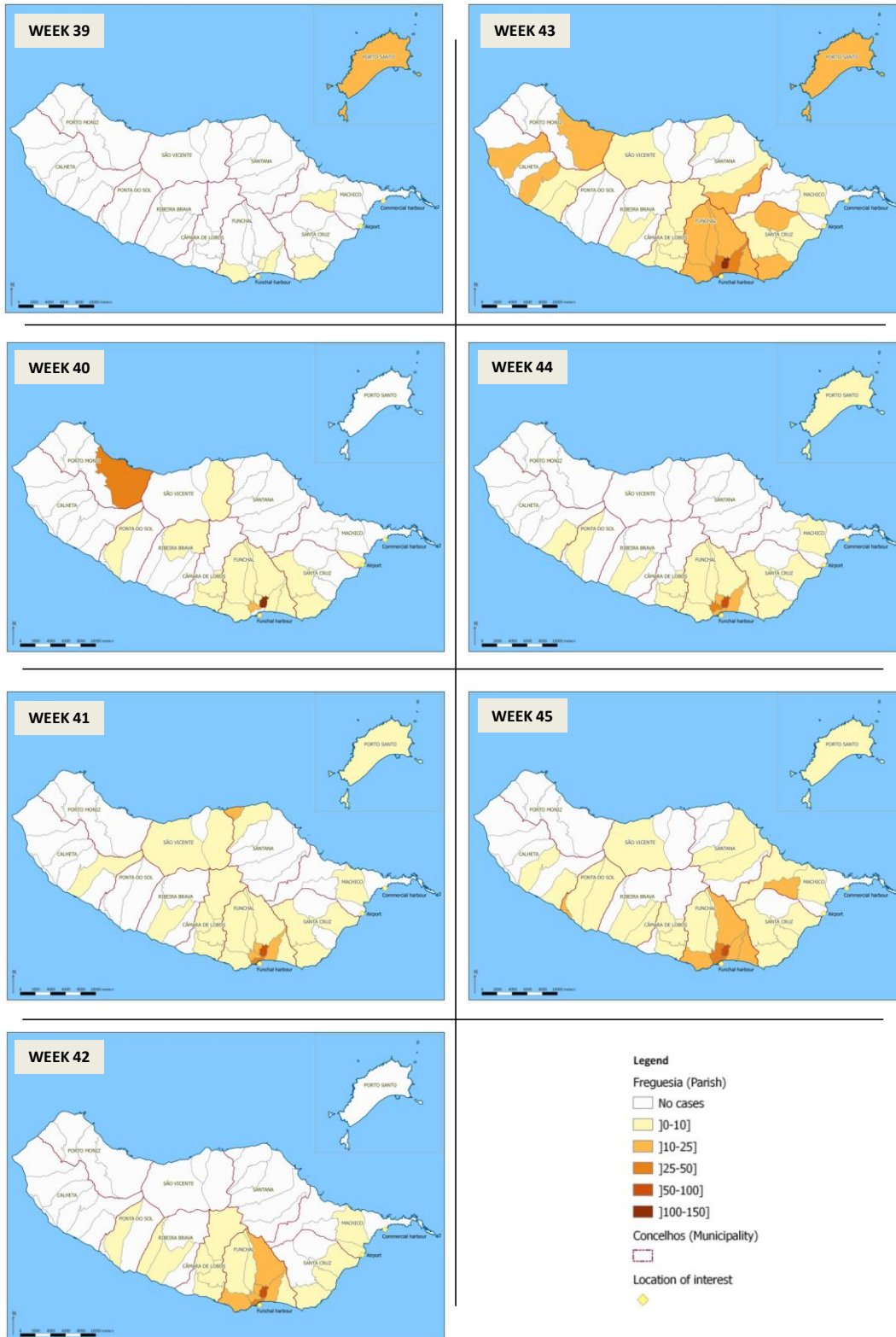
Municipality of residence	Total number of cases	Attack rate (cases per 10 000 inhabitants)	Week of occurrence of first case	Number of weeks with cases
Funchal	1031	92.1	39	7
Santa Cruz	114	26.5	41	3
Porto Santo	13	23.7	40	6
Câmara de Lobos	65	18.2	40	6
Porto Moniz	3	11.1	40	2
São Vicente	6	10.5	41	4
Santana	7	9.1	40	4
Ribeira Brava	12	9.0	39	7
Calheta	10	8.7	41	4
Machico	18	8.2	39	7
Ponta do Sol	7	7.9	40	4
Others	71	-	41	4
Total (Madeira)	1357	50.7	39	7

Figures 5 and 6 show the incidence at the level of parish, based on residence. The first confirmed case was reported from Santa Luzia parish in Funchal municipality on 3 October 2012. Cases have clustered in and around Santa Luzia and Nazare parishes since the onset of the outbreak. By week 40, cases were reported from the entire Funchal municipality with the highest incidence still in Santa Luzia and Nazaré parishes. Cases were also reported from the two neighbouring municipalities of Camara de Lobos and Santa Cruz. The outbreak spread geographically in weeks 41 and 42 but the highest incidence continued to be recorded in central Funchal. It is important to take note of the small populations in some parishes which sometimes result in single cases translating into an incidence of above 10 per 10 000 population.

Figure 5. Cumulative incidence (cases per 10 000 inhabitants) of dengue cases (probable and confirmed), by parish of residence, week 39 to week 44, 2012, Madeira



Figure 6. Weekly incidence (cases per 10 000 inhabitants) of dengue cases (probable and confirmed), by parish of residence, by week, week 39 to week 44, 2012, Madeira

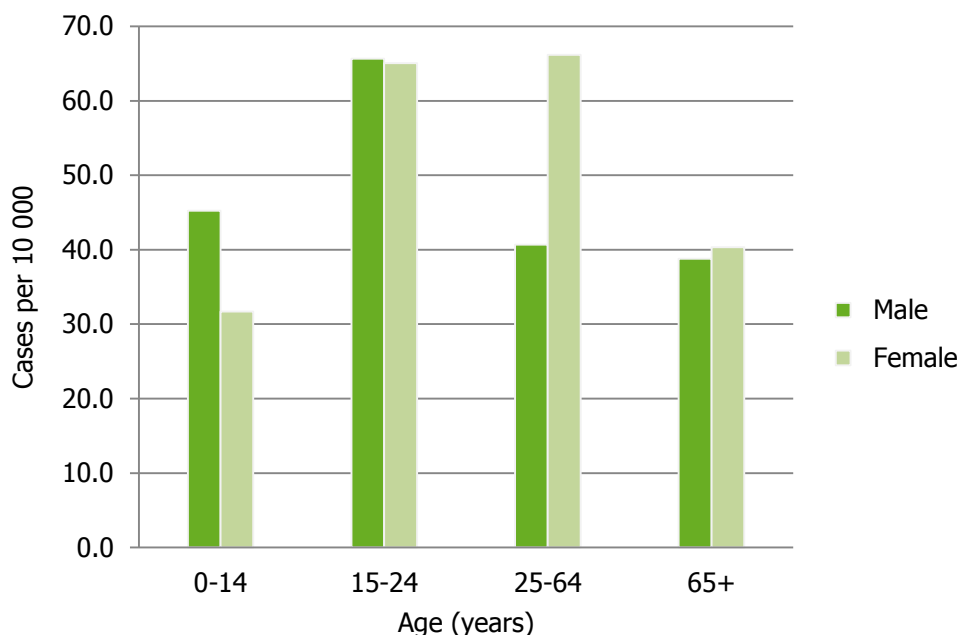


Gender and age distribution

As of 4 November, 1 357 cases meeting the case definition for probable or confirmed cases had been reported. Among those 1 357 reported cases, the attack rate was higher for women than men; the female-to-male ratio was 1.41.

The sex ratio suggests a markedly increased risk of infection among women aged 25 to 64 years. The gender distribution is reversed for children, with a considerably higher rate of infection among boys aged 0–14 years than girls, while the gender ratio is roughly balanced in the other age intervals (Figure 7). Why the incidence among women of working age is roughly 25% higher than for men of the same age has not been established but it is likely to reflect higher exposure to infected mosquitoes. Indeed, *Aedes aegypti* breed and rest in human dwellings and surroundings and women in Madeira are more likely than men to remain in and around the home, carrying out domestic activities during the day when the mosquitoes are most active.

Figure 7. Probable and confirmed cases of dengue attack rates (cases per 10 000) by age group and gender, 26 September to 11 November 2012, Madeira



4 Entomological situation

Key features of *Aedes aegypti* in Madeira

Aedes aegypti is currently the only mosquito capable of transmitting dengue virus in Madeira. The exact year of introduction is not known but it is likely that *Aedes aegypti* was established in Madeira not long before the first documentation of its presence in 2005 (within Santa Luzia parish). Entomological investigations indicate that the mosquito was likely first imported to Funchal and that it has since spread eastwards and westwards in the urban areas along the southern coastline of the island.

Aedes aegypti breeding follows a seasonal pattern with the highest mosquito density from July to December. The seasonal variation in breeding has implications for mosquito control and for any attempt to eradicate *Aedes aegypti* from the island. The characteristics of the Madeira *Aedes aegypti* population are those classically described for the species:

Behaviour. The species is mainly active in daylight and it feeds both indoors and outdoors. The mosquitoes bite at any time of day or night if in close proximity to a person but the peaks in blood-seeking activity are in the morning and mid- to late afternoon. Only female mosquitoes bite humans.

Natural habitat. The natural larval habitats for *Aedes aegypti* are fruit husks, tree holes, leaf axes, and small water-holding containers. The importance of the natural habitat should not be under-estimated in Madeira. Indeed, Funchal has abundant tropical vegetation, parks and botanic gardens, and terraced banana cultivations are part of the urban landscape.

Urban habitat. *Aedes aegypti* is a 'peridomestic' species and rarely found more than 100 m from human habitation. In and around Funchal, the myriad of flowerpots on saucers are perfect breeding sites in the urban ecosystem. Other urban breeding sites such as discarded tyres, buckets and other containers are also plentiful. Field investigations and expert interviews identified potential 'super-breeding' sites in the urban habitat, such as unoccupied and abandoned houses in a high-occupation household density setting. Vector control measures, both larvae reduction and adult insecticide spraying, would require reviewing the present regulations and the administrative procedures to gain access to these premises.

Life cycle. The life cycle can be completed in 10–21 days depending on temperature and environmental conditions. The meteorological conditions in Madeira are favourable for a short life cycle and the high humidity favours the survival of adult mosquitoes. The female mosquitoes spread their eggs over several breeding sites. The eggs are resistant to desiccation and can survive several months of dry weather.

Aedes aegypti's ecological success in Madeira is attributed to the combination of favourable natural and human conditions. Densely populated residential areas are mixed with green areas containing abundant sub-tropical vegetation including mature trees along the southern coastline. There are numerous artificial domestic breeding sites and the meteorological profile is favourable, with a long rainy season, high humidity and optimal ambient temperature with limited diurnal variation. Funchal city is likely to be the place of introduction but some characteristics of the city affecting the vector should be highlighted. Unlike many dengue-prone cities around the world, Funchal is well-maintained and mosquito breeding is not attributed to poor sanitation and inadequate waste disposal. What is particular for Funchal are the many unoccupied houses likely harbouring numerous breeding sites. Moreover, flower cultivation is cherished in Madeira culture and people take pride in growing large numbers of plants both indoors and outdoors on balconies and terraces. In domestic premises, saucers under potted plants have the potential to be highly productive breeding sites too. In addition to these, many other breeding sites should be considered, such as:

- old buildings and flat canopied roofs (that undoubtedly harbour accumulations of water such as disused wells, cellars and blocked gutters);
- natural breeding sites in mature trees and tropical vegetation; storm sewers, catch basins, sewage and drainage systems, notably in the city centre (flat area). For the latter, the productivity of such sites is unclear; they are probably flushed during heavy rainfall but the drainage system has been found positive for *Aedes aegypti* during the outbreak (data not published; Professor C. Sousa and collaborators).

Entomological surveillance has been in place since the introduction of *Aedes aegypti*. Surveillance is supported by networks of institutions including the Natural History Museum of Portugal, New University of Lisboa and Mosquimac project). Figure 8 shows the locations of the ovitraps found positive for *Aedes aegypti* (data not published; Professor C. Sousa and collaborators). The Autonomous Region of Madeira, since 2010, is part of the REVIVE programme coordinated by the Centro de Estudos de Vectores e Doenças Infecciosas (CEVDI)ⁱ.

ⁱ <http://www.insa.pt/sites/INSA/Portugues/AreasCientificas/DoencasInfecciosas/AreasTrabalho/EstVectDoencasInfecciosas/Paginas/Inicial.aspx>

Since the start of the outbreak, the number of ovitraps and BG-Sentinel mosquito traps (BioGents, Regensburg, Germany) has been increased in order to monitor the vector population more closely and assess the impact of vector control activities. The harbours and airport are included in the vector surveillance network. The quality of the entomological data is very high and allows local public health authorities to closely monitor the vector population. A survey by Instituto de Higiene e Medicina Tropical (Universidade Nova de Lisboa) and ISAUDE of breeding sites in the affected areas found that 40% of houses Santa Luzia (n=171) had breeding sites with a container index of 14%, and in Nazare (n=43) 14% of houses had breeding sites and a container index of 7%.

Figure 8. Location of positive ovitraps in 2011, from entomological surveillance network



Aedes aegypti insecticide resistance

In 2009, WHO diagnostic tests for insecticide resistance were carried out for one-hour exposure to DDT (dichlorodiphenyltrichloroethane) 4.0%, malathion 5.0%, permethrin 0.75%, and deltamethrin 0.05%. The tests showed that the *Aedes aegypti* strain in Madeira is highly susceptible to malathion, with mortality rates of 99.0%. There was high resistance to DDT (33.3% mortality rate) and permethrin (29.4% mortality rate), and marked resistance to deltamethrin, (65.2% mortality rate). This profile is characteristic of *Aedes aegypti* populations in the Caribbean (Seixas, 2012)ⁱ.

To survey possible knockdown resistance (kdr) mutations, DNA was extracted from 35 mosquitoes previously characterised as resistant to DDT, permethrin and deltamethrin. The intron spanning exons 20 and 21 was amplified and directly sequenced to detect four possible mutations (I1011M, I1011V, V1016I, V1016G) of the DDT/pyrethroid insecticide target site of the voltage-gated sodium channel of *Aedes aegypti*. A single amino acid substitution, V1016I, conferring knockdown resistance to DDT/pyrethroid insecticides was detected. This kdr mutation was found in only one DDT-resistant homozygote and in two permethrin-resistant heterozygotes, corresponding to 6% of the analysed mosquitoes (Seixas, 2012)ⁱ.

Testing of mosquitoes collected in 2012 is ongoing at the New University of Lisbon for new resistance profiles. The same resistance probably applies to temephos, an organophosphate that has been widely used for control of larvae. Thus, the arsenal of insecticides and larvicides appears, to date, to be limited. The compounds most likely to be effective in Madeira are:

- carbamate formulations (e.g. bendiocarb) that can be used as a residual adulticide (insecticide applied to solid surfaces where adult mosquitoes are likely to rest); treatments can last for several months, particularly if shaded;
- *Bacillus thuringiensis israelensis* (bti) a bacteria-derived toxin that is lethal when ingested by larvae.

There are three private companies in Madeira ('desbaratização, desratização, desinsectização', DDD companies) performing nuisance vector control (Exterminio, Rentokil-Portugal and Truly Nolen).

ⁱ Seixas G. *Aedes* (*Stegomyia*) *aegypti* (Diptera, Culicidae) from Madeira Island: geographical origin and insecticide resistance. Master thesis. Lisbon: Instituto de Higiene e Medicina Tropical, Universidade Nova de Lisboa; 2012.

Summary

Activities to control mosquito larvae have been implemented on the island for the last five years (see Annex 7). Field activities, including breeding site reduction, awareness campaigns and door-to-door home visits by field teams were ongoing during the ECDC field investigations.

Information on the probable geographic site of transmission are important for outbreak control. The excellent integration of temporal and spatial distribution of cases (place of work and place of residence) will allow field activities to be directed to 'hot spots'. The absence of a long-term adult mosquito control strategy headed by a dedicated vector control unit was unfortunately an obvious weakness in the response.

In summary, the following priority areas were identified:

- The need to maximise efforts to reduce those mosquito populations that are in contact with the largest numbers of humans.
- The need for coordination and oversight of the vector control campaign.
- Triage of the areas which should be treated first in view of limited resources.
- Acquiring permits to access abandoned and unoccupied houses.
- Leadership and commitment for inter-sectorial approaches to outbreak control including all stakeholder groups such as environment, the school system, tourism authorities, hotel/restaurant professional associations, etc.

5 Outbreak response activities

This section summarises the measures taken as of 3 November 2012. The ECDC team contributed to the discussion of these measures with the local and national authorities for the definition of the response activities.

Epidemiological surveillance and sharing of information

The normative document 06/2012 published on 26 October 2012 and updated on 12 November by the regional Instituto de Administração e Assuntos Sociais¹ mandates notification of dengue cases through the computerised health information system. Information is retrieved and analysed regularly. An epidemiological summary is automatically produced for monitoring and decision making purposes. Routine laboratory confirmation of cases is not recommended during a large outbreak, but is to be maintained for cases coming from newly affected areas, for severe cases in order to identify the circulating serotype(s) and for a subset of patients for the sole purpose of following the global evolution of the outbreak.

The entomological surveillance and control is reinforced in the areas with a large number of cases. Background information is integrated with the geographical information system (information layers such as hotel, restaurant, water resources from Funchal municipality's database, etc.) to optimise vector control activities.

Prevention, treatment and control

Public health measures

A series of measures were implemented around clusters of cases:

- Door-to-door campaigns and residence visits.
- Awareness-raising activities aimed at the local population, combined with information on best strategies for the elimination of mosquito breeding sites (household, garden/courtyard).
- Promotion of personal use of insect repellents and domestic insecticides.

Further measures were implemented in healthcare centres:

- A new flowchart for dengue was implemented at national level after the notification of the first two cases.
- Ambulatory monitoring of the activities; appointment of a local focal point for dengue.
- Introduction of specific dengue patient care management for severe and non-severe cases.
- Follow-up consultation.

Blood safety

At the date of the alert, on 6 October, blood donations were put under embargo. During the period 6 October to 4 November, 397 blood donations were collected and tested by RT-PCR in Lisbon: six DEN1-positive blood donors were detected. Since 5 November, the RT-PCR assay has been introduced in Nelio Mendonça Hospital laboratory.

Vector control

The activities of vector control are coordinated by local health authorities with the collaboration of all public sectors involved in it. Entomological surveillance is enhanced in the affected areas to ensure the vector control activities have an impact.

The use of usual industrial products to tackle the adult mosquito populations focuses on primary healthcare centres, schools, public places with a high density population and potential mosquito breeding sites. The use of domestic insecticides is recommended in restaurants, schools and hotels (both reception area and rooms).

Intra/intersectoral collaboration

Internal partners

Internal partners: the collaboration of all sectors (health, transport and tourism, urban development, education) involved in the vector control and management of the outbreak is encouraged at the level of RAM and at municipality level.

¹ <http://iasaude.sras.gov-madeira.pt/>

National Level: collaboration is promoted with the national institutions (DGS, IHMT, INSA) and research groups with field entomology expertise (monitoring of vector population, scientific advice for the development of vector control strategies).

External partners

ECDC: support to the monitoring of the outbreak, epidemiological analyses for the epidemiological bulletin, capacity building of the biostatistics and geographical information system teams, and advice to support integrated vector control activities (gathering evidence through EU scientific network).

Communication plan

A communication plan, regularly updated, covered different media (TV spots, SMS, IASAUDE webpage, specific communications to healthcare workers, etc.). The purpose was to promote public education, with an emphasis on individual measures to avoid mosquito bites (for example, insect repellents). Personal protection measures also include actions to reduce the number of breeding sites in and around private residences.

Furthermore, a communication campaign was implemented, using leaflets and posters, to inform the general public on dengue fever (transmission, symptoms, medical care). This general campaign was conducted in public administration and buildings, tourist areas and in main places of transit (namely, the airport and the harbours).

Internal and external evaluation

A permanent internal evaluation was conducted. An external evaluation will be conducted at the end of the outbreak to gain knowledge and delineate the lessons learned for potential new outbreaks of vector-borne diseases in RAM.

6 Conclusions

Madeira was affected by a rapidly evolving dengue outbreak of moderate severity. At the time of writing (mid-November 2012), the number of cases was expected to rise in the following weeks and the highest priority in the short-term should continue to be controlling the outbreak. There is a possibility of sustainability of the virus during the winter season and subsequent re-emergence when climatic conditions again favour *Aedes aegypti* mosquito activity.

Aedes aegypti, the most effective of the vectors competent for transmitting dengue virus, was first documented on Madeira in 2005. The habitat in Madeira is very favourable and the *Aedes aegypti* population has expanded rapidly.

An attempt to eliminate *Aedes aegypti* from Madeira would require a massive and well-coordinated intervention, and the outcome would not be certain. However, this option should not be ruled out without first conducting feasibility and cost-benefit analyses. In addition, elimination of the vector would require long-term measures to prevent re-introduction of the mosquito.

Substantial reduction of transmission of dengue disease can be achieved by:

- reducing the *Aedes aegypti* population;
- reducing the number of mosquito bites through personal and domestic protection such as insect repellents, bed nets, window screens, and protective clothing.

The Madeira health information system is comprehensive enough to detect and monitor outbreaks of dengue and the new automated data retrieval system will ensure timely reports.

The large number of tourists visiting the island means that continued importation of dengue cases from Madeira to continental EU countries is expected until the mosquito population is decreased and transmission interrupted.

The risk of importation of the *Aedes aegypti* mosquito to continental Europe via air and sea travel, and via cargo ships is likely to have increased since the mosquito was established in Madeira although it is difficult to quantify that risk.

Madeira is vulnerable to re-introduction of viruses transmitted by *Aedes aegypti* (e.g. dengue or chikungunya viruses). The important increase of co-circulation of different dengue virus serotypes worldwide is a potential source of re-introduction to Madeira in the future.

7 Recommendations

The recommendations have been divided into public health measures and vector control, as well as short-term and medium-term actions that are essential for the effective control of the current outbreak. The time frame for the medium-term actions is to the next mosquito season which starts with the beginning of the next wet season 2013. There are also recommendations for longer term actions.

Recommendations for public health actions

Short term

Diagnostics

The 2012 outbreak was laboratory-confirmed, but since 31 October 2012 it has been no longer thought necessary to perform dengue tests on all patients. Laboratory confirmation still continues for 20% of all probable cases while 10% of the positive cases are studied at the national reference laboratory (INSA) with nucleic acid detection (RT-PCR). All severe cases are submitted to laboratory investigation and the positive samples are studied at INSA in Lisbon to identify the circulating serotype(s).

Due to the kinetics of immune response and according to orientation from DGS number 014/2012, the serodiagnosis recommendations are the following:

- Seroconversion from negative for dengue-specific serum IgM specific for the dengue virus, in the blood (or cerebrospinal fluid in case of neurological manifestations), OR
- seroconversion of IgG antibody titre for the dengue virus, OR
- isolation or detection of nucleic acids (RT-PCR) of dengue virus in the blood or cerebrospinal fluid.

The confirmation of a positive NS1 antigen assay should be performed to exclude possible false positive assays. Sequencing of some RT-PCR positive samples is required to identify the circulating viral strain(s) and further epidemiological links.

Surveillance

The following recommendations are reinforced:

- Apply the case definition for all reporting of cases.
- Maintain timely extraction of data in the MDSS twice weekly and adjust the frequency according to evolution of the outbreak.
- Maintain sufficient human resources for epidemiological surveillance and analyses until the current epidemic subsides. In particular, a field epidemiologist with experience with GIS and vector-borne diseases and a public health communication expert would be needed.
- Maintain systematic 'early morning reports' on the number of outpatient consultations until the epidemic subsides. The key numbers to follow are the number of consultations for probable dengue cases from the previous day. This will allow close follow-up of the front line evolution of the workload of the healthcare facilities.
- Implement web-based case reporting by the private health sector on the IASAUDE website.
- Report laboratory results on a weekly basis including serotype monitoring, percentage of positive results among all tested, and test results for severe cases.
- Monitor the utilisation of the dengue hotline Saú24: 808 24 24 24 (number of calls per day, geographical location of calls).
- Include epidemic data from tourist cases diagnosed after returning to their home countries for the purpose of outbreak management and vector control. This information will be regularly provided by ECDC to health authorities in Portugal.
- Integrate epidemiological and entomological information, to analyse the typology of the main area affected by the outbreak. This information will lead vector control activities and the entomological surveillance after the outbreak.

Blood safety

In the affected area:

- Defer donations from blood donors with fever or flu-like symptoms until 28 days after recovery.
- Screen blood donors for dengue using RT-PCR.
- Inform blood donors to report any symptoms in the 15 days following donation.
- Quarantine bloods products in stock for retrospective testing.
- Have platelets supplied by Portuguese Blood and Transplantation Institute.
- Conduct post-transfusion haemovigilance.

Blood collection in non-affected areas:

- Defer blood donors for a period of 28 days after leaving the affected area.
- Defer blood donors with fever or flu-like symptoms for 28 days after recovery.
- Defer confirmed cases of dengue infection for 120 days after diagnosis.

Communication

The following recommendations are made:

- Increase dissemination of outbreak information to local and national authorities, healthcare providers and partners and to the public in order to keep them proactively updated and supportive of the control efforts.
- Provide regular information to medical doctors, nurses and other public and private healthcare providers.
- Explore novel methods of communication such as SMS, Twitter and electronic newsletters.
- Inform travellers leaving Madeira about the early symptoms of dengue and the need to seek medical care.
- Provide information about dengue to medical officers on cruise ships.
- Develop an information leaflet or booklet for dengue patients that includes prevention of dengue transmission at home and other measures, mainly reduction of potential breeding sites.

Medium term

RAM health authorities and internal and external partners recognise the need to strengthen specific surveillance of dengue outbreaks in Madeira before the start of the next season with high mosquito density (June 2013).

Public health surveillance

- Include in the next evaluation and revision of contingency plan a review of the MDSS for its improvement.
- Ensure early recognition and diagnosis of dengue by local health practitioners and nurses through sessions of training and debriefing about the outbreak management.
- Develop standard operating procedures (SOPs) on the basis of lessons learned covering:
 - detection (clinical algorithm);
 - confirmation (algorithm for testing to reference regional and national reference laboratory).

Public health emergency management

- Develop a public health emergency plan and corresponding SOPs.
- Conduct a table-top exercise with all stakeholders to test the SOPs.
- Consider a command-post exercise to test operational aspects of the implementation of the plan and the SOPs.

Communication

- At the end of the outbreak, conduct a review of the communication activities before and during the outbreak with the help of an external audit.
- Develop a communication plan for future outbreaks based on the findings of the review.

Overall

- Conduct a cross-sectorial review and planning workshop ahead of the next mosquito season.

Risk assessment for introduction of other vector-borne diseases to Madeira

Due to the presence of the competent vector *Aedes aegypti* on Madeira Island, an evaluation of the possibility of setting up an early warning system to monitor the potential introduction of pathogen(s) (other dengue serotypes, chikungunya virus and to a lesser extent yellow fever virus) and subsequent potential emergence of human cases is of high interest.

- The importation through migrants and travellers from endemic areas is not negligible. A specific scheme of surveillance/screenings should be envisaged as a general recommendation. Targeted information and control to these specific groups at point of entry in Madeira (airport and the commercial and tourist harbours) might be included in a communication plan with regards to travellers and migrants coming from regions with ongoing dengue epidemics.
- Proof of yellow fever vaccination should be considered for travellers and migrants coming from endemic countries.

Case management

- Regular training for healthcare practitioners on the early recognition of diseases transmitted by *Aedes aegypti*, with priority on dengue.
- Prepare an algorithm of clinical care management of patients with medium-severe and severe cases.
- Prepare an algorithm of the laboratory tests to be conducted and ensure sufficient stock of laboratory reagents targeting dengue, as well as chikungunya and yellow fever.
- Protect patients (mosquito bednet).

Recommendations for vector monitoring and control

Despite the activities for vector monitoring and control that are already in place, two main sectors should be reinforced: first, the control and surveillance of the *Aedes aegypti* mosquito population during an outbreak with the overall goal of controlling dengue virus transmission in the medium term; secondly, the vector control and surveillance of the *Aedes aegypti* mosquito population at the time of the outbreak in order to reduce the probability of emergence of vector-borne diseases. General recommendations are presented below; specific activities are detailed in the corresponding annexes.

Short term (emergency response)

- Because of the various activities required, the response to the outbreak needs a central coordination supported by a well-defined management structure. The establishment of a formal working group with representatives of all stakeholders – health, environment, tourism, civil defence – is recommended.
- The vector measures should be implemented in a step-wise manner, targeting first the areas affected by dengue and all potential places of exposure due to high human density.
- The adult mosquito population should be urgently reduced in order to break the disease cycle.
- Metabolic and genetic insecticide resistance tests should be conducted for the local population of *Aedes aegypti* in order to identify effective insecticides.
- The larvae population should be reduced using larvicides and the number of breeding sites reduced to diminish the mosquito population, and subsequently the transmission of dengue. Nevertheless, these actions will not necessarily have an immediate impact due to the adult mosquito population.
- Elimination of vector habitats should be led by community and fieldworkers.
- Recruitment of additional fieldworkers should be considered to enlarge the geographical extent of the response, notably in the municipalities neighbouring Funchal.
- The use of geographical information should be reinforced to synthesise, analyse, and produce maps for field actions for current and future vector control.
- Inter-sectorial collaboration and vector control activities should be reinforced at institutional, community and individual levels (see Box 1 below).

Box 1: Proposed vector control activities at institutional, community and household level

The activities presented below are managed by a coordinating structure gathering the main stakeholders, notably sectors of health, environment, tourism, civil defence and structures representing the community.

Institutional level

(Public institutions, hospitals and healthcare centres, medical and environmental professional associations, schools, colleges, etc.)

- Information about the mosquito behaviour: where, when, how to reduce its population?
- Personal protection measures
- Screens on doors and windows
- A weekly check for mosquito larval habitats (drying plant pots, water containers, coolers, etc.)
- Systematic check of flat roofs and clogged gutters (often seen in Funchal in abandoned houses)
- Indoor spraying at the biting time of the *Aedes aegypti* mosquito (early morning or late afternoon)

Community level

(Local groups and residents' associations to engage the population with vector control)

- Dengue-awareness campaigns
- Cleaning days (to reduce available outdoor resting places for adult mosquitoes in domestic premises and other breeding sites)
- Use of mosquito nets to protect infants and small children from mosquito bites during the day
- Insecticide-treated nets, screen and curtains
- Weekly treatment of water containers in coordination with environmental technicians

Box 1: continued

Household level

(Residents in dengue-affected areas and more broadly residents in areas where *Aedes aegypti* have been recorded)

- Dwelling rooms should be sprayed (end of the day, doors closed, e.g. bathrooms, kitchens and toilets)
- Personal protection measures
- Insecticide-treated nets, screen and curtains
- Strengthen efforts towards the reduction/destruction of potential/present larval habitats in and around houses and other premises (inspection twice a week)
- Ensure functioning water drainage (flat roofs and terraces) and cover water containers

Medium term

- The creation of a Vector Surveillance and Control Unit in RAM is highly recommended. In an integrated approach, entomological surveillance and vector control activities should be led by this Unit.
- Enhancement of a co-lead between the health and environmental sectors together with collaboration with academic research might be an option to be considered.
- The effort and commitment of partners should be reinforced for a global, standardised and sustainable surveillance of mosquito distribution. A detailed spatial analysis (analysis on habitat suitability and seasonality drivers) should be performed as a means for long-term vector control.
- The network of entomological surveillance should be maintained for long-term surveillance during and after the outbreak to ensure a proper analysis and monitoring of mosquito distribution and assessment of the impact of vector control measures.
- Conduct a feasibility study and cost–benefit analysis of *Aedes aegypti* elimination programmes and review the findings in a workshop.
- Redefine the vector surveillance activities under Scenario 3 of the guidelines for the surveillance of invasive mosquitoes in Europeⁱ.
- *Aedes aegypti* is an 'endophilic' species, i.e. one that enters human dwellings. To reduce their numbers in a sustainable manner, long-lasting physical alterations (such as door and window screens) to vector habitats should be evaluated.
- Applied research projects should be envisaged to monitor the impact of vector control measures.
- Collaboration and capitalisation on lessons learned should be reinforced and experiences of other vector control initiatives shared during a workshop ahead of the next mosquito season to review vector control activities.

ⁱ European Centre for Disease Prevention and Control. Guidelines for the surveillance of invasive mosquitoes in Europe. Stockholm: ECDC; 2012. Page 12. Available from: <http://www.ecdc.europa.eu/en/publications/Publications/TER-Mosquito-surveillance-guidelines.pdf>

Annex 1. Summary of ECDC team activities

At the request of the Portuguese health authorities and those of the Autonomous Region of Madeira, a team from ECDC arrived in Funchal on Monday 22 October 2012.

The ECDC mission team collaborated with the IASAUDE staff, the public health authority of RAM.

A data management and analysis team were set up.

Activities were focused in four different areas:

- Data management of the outbreak, including clinical, laboratory and geographical information systems, set up an automatic system for timely analysis of the epidemiological features of the outbreak and capacity building of the local team.
- Entomological situation and vector control activities: evaluation and support for the best evidence-based strategy for vector control activities and proposal for vector monitoring.
- Planning technical, logistic and normative aspects.
- Collaboration on the response plan and vector control activities.
- Cross-sectorial approach with other stakeholders in Madeira.
- Collaboration on the integrated response plan with expert consultations and ECDC senior experts.

ECDC staff		Presence in Madeira	
		Arrival	Departure
Josep Jansa	Head of Section: Response - Epidemic Intelligence and Emergency Operations	22/10/2012	28/10/2012
Joana Gomes Dias	Expert biostatistician	22/10/2012	
Bertrand Sudre	Scientific officer environmental determinants of infectious diseases	23/10/2012	07/11/2012
Hervé Zeller	Head of Emerging and Vector-borne disease programme	24/10/2012	
Experts (consultation)			
Paul Reiter		31/10/2012	04/11/2012
EPIET fellow			
Benedetto Simone		23/10/2012	11/11/2012

Annex 2. Daily schedule and main activities

Day	Activities undertaken
Monday 2012-10-22	Arrival of the ECDC team in the field
	First briefing meeting to meet the IASAUDE team
Tuesday 2012-10-23	Meeting with IASAUDE team to define the monitoring of the outbreak: case definition, coverage, haemorrhagic/severe events
	Meeting with IASAUDE biostatistics team to assess characteristics of current dataset
	Meeting with Professor Carla Sousa to present entomological information in Madeira
	Assessment of available geographic data
Wednesday 2012-10-24	Meeting with IASAUDE team to define details of outbreak monitoring, entomological issues, operational plan, necessity of inter-sectorial approach
	Meeting with geographical information team to assess skills and possible training needs
	Meeting with stakeholders from DGS, SESARAM and IASAUDE to discuss new variable to be introduced in the current information system and modalities to retrieve information
	ECDC internal meeting (current possible and confirmed cases, outbreak monitoring situation)
Thursday 2012-10-25	ECDC internal meeting (how to deal with duplicates, mapping, merging datasets)
	Meeting with GIS team to define software for mapping, information sources, meteorological variables, technical issues
	ECDC internal meeting to compare SESARAM and laboratory datasets
	Hospital Nelio Mendonça visit
Friday 2012-10-26	Meeting with João Abreu and SESARAM ICT team to discuss limits and solutions to incorporate new variables in the system, and how to link the SESARAM dataset
	Meeting with SESARAM ICT team to present new data collection forms and to discuss them
	Hospital dos Marmeleiros visit
	Teleconference with ECDC experts in Stockholm
Saturday 2012-10-27	Dataset management: laboratory and SESARAM
	Analysis of the data available up to 23 October 2012
	Josep Jansa's handover and planning of the Madeira team week
	Meeting and consultation with entomologists
	Discussion on possible measures for vector control
Sunday 2012-10-28	Dataset management: laboratory and SESARAM
	Analysis of the data available up to 23 October 2012
	Field visit in São Martinho and Câmara de Lobos
	Quality check of geolocation data
Monday 2012-10-29	Meeting the outbreak response team from IASAUDE
	Full working day with biostatistics team to manage and analyse the datasets, and to produce epidemiological bulletins
Tuesday 2012-10-30	Establishment of the information circuit from SESARAM to IASAUDE
	ECDC report drafting
	Meeting with the SESARAM ICT team
	Stakeholders meeting
	Visit of main tourist information centre
Wednesday 2012-10-31	Meeting with the SESARAM ICT team
	Analysis of the hospitalisations dataset and preparation of workflows
	Improvement of the outputs taking into account comments from ECDC team in Stockholm
	Description and systematisation of case definitions used so far
Thursday 2012-11-01	Standardisation of the datasets
	Standardisation of the outputs

	Development of a draft for the workflow for the epidemiological bulletin
	Development of a draft for the SOP for the epidemiological bulletin
	Development of a list of outputs for the epidemiological bulletin
Friday 2012-11-02	Meeting with the biostatistics team
	Assessment of the new dataset retrieved from the Madeira Dengue Surveillance System
	Geographic data management and analysis
Saturday 2012-11-03	ECDC report drafting
	Update and improvement on the databases using the new dataset
	Update and improvement on the laboratory dataset
	Draft of the weekly bulletin and mapping templates
Sunday 2012-11-04	Meeting with IASAUDE to draft and review the weekly bulletin
	Revision of workflow for the weekly bulletin
	ECDC report drafting
	Preparation of a list of outputs for the monitoring of symptoms
	Epidemiological data management and mapping
Monday 2012-11-05	Meeting with SESARAM ICT team to address issues with the data quality
	Briefing with the biostatistics team on retrospective report
	Draft of the retrospective report based on the ECDC report with biostatistics team
	Meeting with SESARAM ICT team to address issues with data
	Update and review with IASAUDE on weekly bulletin
Tuesday 2012-11-06	Meeting with the biostatistics team to discuss weekly bulletin and IASAUDE report
	Drafting of report
	Geographic data management
Wednesday 2012-11-07	Drafting of report
	Briefing with biostatistics team

Annex 3. Persons met

General Directorate for Health (Lisbon)

Director of the Department of Disease Prevention and Health Promotion: Ana Leça

Director of the Department of European Affairs and International Cooperation: Paula Vasconcelos

IASAUDE

President: Ana Nunes

Vice president: Ana Clara Silva

Coordinator of the Health Units: Maria Vacas

Technicians: Catarina Valente, Márcia Baptista, Marco Magalhães, Margarida Clairouin, Luís Antunes, Bruno Cunha, João César

Cabinet Counsellor: Marta Gouveia

Health delegate of the Funchal municipality: Maurício Melim

Health delegate of the Santa Cruz municipality: Alice Romão

SESARAM

Deputy Director of the Clinical Board: Pedro Ramos, João Araújo

Senior Assistant: Ana Paula Reis

Director of the Pathology unit: Graça Andrade

Director of blood safety: José Bruno Freitas Nurses: Maria Conceição Vieira, José Ferreira,

Head of the ICT service: João Abreu

Stakeholders and policy makers

Regional secretary for Social Affairs: Francisco Ramos

Regional secretary for Culture, Tourism and Transports: Conceição Estudante

Regional secretary for Environmental affairs and natural events: Manuel Correia

Regional director for Tourism: Bruno Freitas

Regional director of Agriculture and rural Development: Bernardo Araujo

Annex 4. Epidemiological enquiry form used by Madeira Dengue Surveillance System

DENGUE - Inquérito Clínico / Geográfico para os casos diagnosticados com DENGUE

Dados do Utente (dados carregados com base na ficha de identificação do utente):

Nome: [REDACTED] Idade: [REDACTED]

Morada: [REDACTED]

Freguesia de Residência: [REDACTED] Processo Clínico: [REDACTED]

Telefone: [REDACTED] Número do cartão de saúde: [REDACTED]

Data de Início dos sinais/sintomas*: 02-11-2012

Febre (quadro febril agudo, duração (dias)) Mialgia
 Cefaleia Artralgias
 Dor retro orbitária Outros : [REDACTED]
 Exantema

Manifestações Hemorrágicas*? Sim Não

Epistaxis Gengivorragia Metrorragia
 Hematuria Hemorragia g. intestinal Petéquias

Viajou nos últimos 14 dias*? Sim Não

indique o País: ROMENIA

Exerce atividade diária (laboral/escolar)*? Sim Não

indique a freguesia (onde exerce atividade diária): FAJÁ DA OVELHA

Informações Complementares:

[REDACTED]

*preenchimento obrigatório

Cancelar Guardar e Fechar

Variables:

- Name, age, address and parish of residence, clinical ID, telephone number, health number
- Date of onset of symptom(s): fever (duration in days), myalgia, cephalalgia, arthralgia, retro-orbital pain, exanthema, other; haemorrhagic manifestations: epistaxis, gingival bleeding, metrorrhagia, haematuria, gastrointestinal bleeding, petechiae
- Travel in the past 14 days, with country; daily activity (school/work); parish of daily activity; further information

Annex 5. Workflow of Madeira Dengue Surveillance System

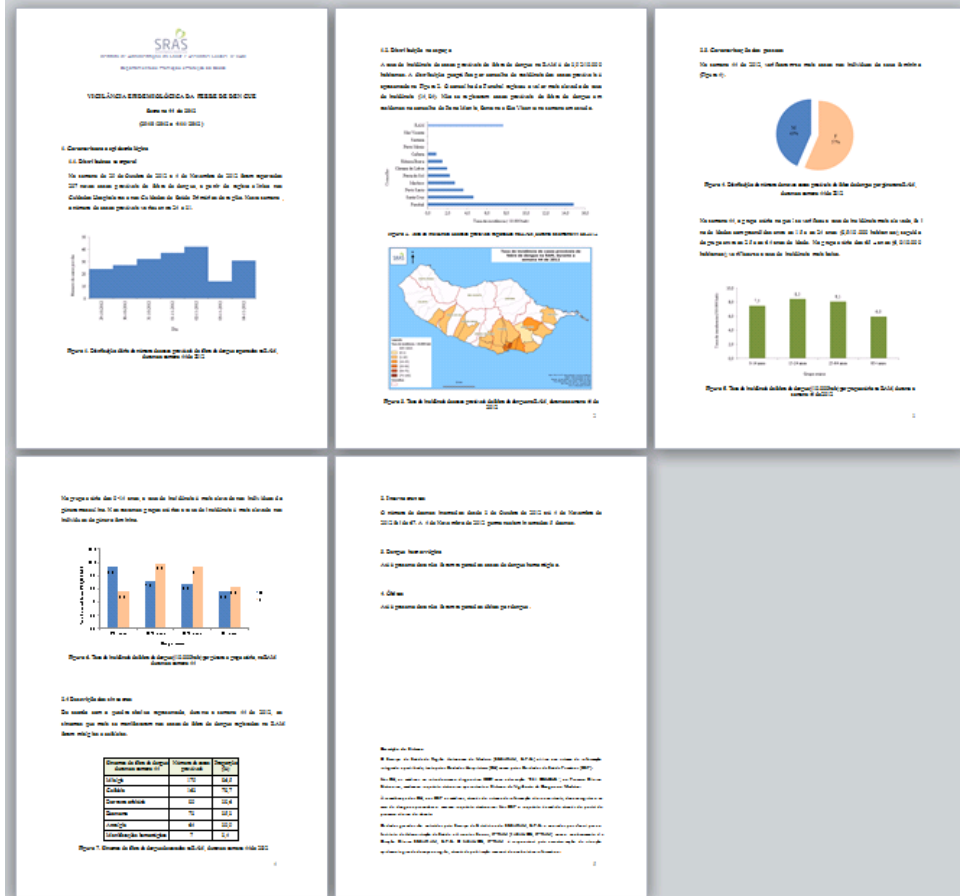
The statistical service of SESARAM retrieves data relative to clinical diagnoses of dengue, laboratory diagnoses and hospitalisations (cumulative and to date). These data are sent bi-weekly to a reference person in IASAUDE. The occurrence of dengue-related deaths and cases of haemorrhagic dengue are communicated immediately to IASAUDE.

From IASAUDE, the databases are sent to the biostatistics team. The team is in charge of preparing a database and analysing the data; sending data relative to number of cases by municipality and by parish to the GIS team.

The GIS team produce the maps with incidence by municipality and by parish and sends them to the biostatistics team. The latter team produce the epidemiological bulletin (inclusive of maps) and send it to IASAUDE.

IASAUDE approve the bulletin and disseminate it.

Annex 6. SESARAM weekly bulletin; example of week 44/2012 from Madeira Dengue Surveillance System



The bulletin reports a summary of the information relative to the epidemiological week, following a similar scheme to that used in the current report. The epidemiological characterisation is structured in terms of time (daily incidence of cases), place (distribution and incidence by municipality and parish) and person (description by gender and age group). Information relative to occurrence of symptoms among cases, hospitalisations (cumulative and on day of data collection), and number of haemorrhagic cases and of deaths are also reported.

Annex 7. Previous and current activities for vector control

Health education activities developed in the context of the introduction of the mosquito *Aedes aegypti* and of the outbreak of dengue fever in RAM.

Before the outbreak

Posters, flyers and other materials

- Elaboration and distribution of the flyer: 'Measures of prevention for vector-borne diseases', 2005
- Elaboration and distribution of the poster: 'Measures of prevention for vector-borne diseases', 2005
- Elaboration and distribution of the flyer on dengue fever with recommendations for travellers, 2010
- Elaboration and distribution of posters in the airport: 'Health alert for travellers to and from Rio de Janeiro', 2008
- Elaboration and distribution of information for the airport: caution measures at home in case of dengue infection, 2010
- Elaboration and distribution of the airport enquiry about dengue (professionals), 2010
- Creation of the logo 'Mosquita', 2009
- Information (PowerPoint presentation) on 'Prevention and control of the mosquito *Aedes aegypti*', 2009 and 2010

Radio programmes broadcast in RAM

- 22 December 2005
- 22 November 2007
- 12 March 2009

TV and radio spots

- TV spot for the prevention of breeding of the mosquito *Aedes aegypti*, 2005

Articles published

- Article: Vector-borne diseases ('*Doenças transmitidas por mosquitos*') in the journal SAÚDE, n. 2 – Special Edition: Evidence in public health (*Evidências em Saúde Pública*), 2010
- Article: Prevention of vector-borne diseases ('*Prevenção de doenças transmitidas por mosquitos*') in the journal Vida Boa, n. 2, 2006
- Article: Prevention of vector-borne diseases ('*Prevenção de doenças transmitidas por mosquitos*') in the journal Saber, n. 103/IX, 2005

Press conference

- *Aedes aegypti*, 20 July 2009

Workshop

- *Aedes aegypti* – medical entomology and clinical dimension, 22 July 2009

Web

- Creation of the microsite *Aedes aegypti*, 2008
- Elaboration of a series of pop-ups, 2009
- Exhibition in the atrium of IASAÚDE, IP-RAM
- Distribution of the flyer 'Preventive measures to avoid vector-borne diseases', since 2005
- Community poster: 'Preventive measures to avoid vector-borne diseases', since 2005

During the outbreak

Posters, flyers and other materials

- Distribution of the flyer 'Preventive measures to avoid vector-borne diseases' produced in 2005
- Distribution of the poster 'Preventive measures to avoid vector-borne diseases' produced in 2005

- Elaboration and distribution of the flyer 'Recommendations to travellers' in English and Portuguese, October 2012
- Elaboration and distribution of a complete PowerPoint presentation on the vector *Aedes aegypti*, October 2012
- Elaboration and distribution of the flyer 'Preventive measures', October 2012
- New informative, 3-page flyer on dengue, October 2012
- Information (PowerPoint slides) on 'Prevention and control of the mosquito *Aedes aegypti*', updated October 2012
- Information (PowerPoint slides) on 'Clinical management of dengue cases', October 2012
- Update of the flyer for travellers in four more languages (Spanish, Italian, German and French), October 2012

Web

- Update of the microsite *Aedes aegypti*, October–November 2012 (<http://iasaude.sras.gov-madeira.pt/mosquitos/>)
- Elaboration of a series of pop-ups with alert messages and recommendations, October 2012
- Example of communication with pop-pup windows on IASAUDE website: <http://iasaude.sras.gov-madeira.pt/about> reduction breeding site for *Aedes aegypti*



TV programmes broadcast in RAM

- 10 October 2012

Radio programmes broadcast in RAM

- 25 October 2012

TV and radio spots

- TV spot for prevention of the breeding of the mosquito *Aedes aegypti*, October 2012
- Radio spots, October 2012

Health education in the community

- Santa Cruz Municipality – gardeners, those responsible for cemeteries, urban cleaners (12 October)
- Santa Cruz Municipality – policemen, firemen, municipality technicians (15 October)
- Primary school teachers, educational aids action, cooks, childhood educators and administrative staff (17 October)
- Caniço school (first and second cycle) – educational aids action, cooks, childhood educators and administrative staff (17 October)
- Nursing school, São José de Cluny: professors, student nurses, health professionals and general public (around 250 people attended), 17 October 2012
- Professional school Dr Francisco Fernandes, São Martinho: teachers from several schools in Funchal (around 120 people attended), 18 October 2012
- Professional school Dr Francisco Fernandes, São Martinho: teachers from several schools in Funchal (around 80 people attended), 18 October 2012.
- Assomada school – educational aids action, cooks, childhood educators and administrative staff (18 October)
- Escola Vargem – educational aids action, cooks, childhood educators and administrative staff (18 October)
- Santa Cruz, Gaula e Camacha schools – educational aids action, cooks, childhood educators and administrative staff (18 October)

- Professional school Dr Francisco Fernandes, São Martinho: teachers from several schools in Funchal (around 50 people attended), 25 October 2012.
- Professional school Dr Francisco Fernandes, São Martinho: teachers from several schools in Funchal (around 20 people attended), 25 October 2012.
- Secondary and tertiary school Dr Horácio Bento de Gouveia: education staff and teachers (around 70 people attended), 26 October 2012
- Community centre – Caniço for resident people in that area (2 November)
- Presentation at Mary College – dengue and vector control; attendance: 90 people; promotion: parents association

Health education in healthcare centres

- Health centre of Caniço: nurses (23 October)
- Health centre of Santa Cruz: all professionals (26 October)
- Healthcare centre Bom Jesus: nurses; around 30 people attended (29 October 2012)
- Healthcare centre Bom Jesus: technicians; around 35 people attended (30 October 2012)
- Healthcare centre Bom Jesus: nurses; around 35 people attended (31 October 2012)
- Healthcare centre Bom Jesus: more interventions were planned for November, involving different professionals (technicians, administrative staff, social workers, dieticians, psychologists and dentists).
- Healthcare centre Santo António, two meetings: nurses and staff; around 50 people attended (30 October 2012)
- Health centre of Santa Cruz: all professionals (12 November 2012)
- Healthcare centre Nazaré: event planned (as of November 2012)
- Healthcare centres Monte e São Roque: events planned (as of November 2012)

Application of epidemiological enquiries

- Epidemiological enquiries to the residents of the parishes of Funchal with a confirmed dengue diagnosis, 9 October 2012 until the start of the ECDC mission.

Meeting in the atrium of IASAÚDE, IP-RAM

- Distribution of flyers 'Measures of prevention of vector-borne diseases', 2012
- Poster 'Measures of prevention of vector-borne diseases', 2012
- Two TV spots (2005 and 2012) shown on LCD screens and information on 'Prevention and control of the mosquito *Aedes aegypti*' (PowerPoint presentation)

Annex 8. Detailed vector control activities

General consideration

A point worth stressing is that by the time mosquito control operations begin at a particular site, the infected mosquitoes may have moved some distance from where an infection occurred; experts suggests that, contrary to wide supposition that movement is never more than 50–100 metres, dispersal can be far greater, particularly where houses are close together. In conclusion, operations should cover at least 150–200 metres around target sites such as homes of dengue patients.

Due to the fine spatial granularity of field responses, the use the geographical information of place of residence and daily activities (work) together with global geographical information was implemented. Every week, the detailed geo-location orients fieldworkers toward affected locations. Various activities should continue to be conducted: door-to-door campaigns, monitoring of breeding sites and BG traps, and geo-location of abandoned houses. The ECDC mission supported this work to optimise the geo-location processes, spatial analysis, and thematic mapping.

As previously mentioned, the establishment of a dedicated Vector Surveillance and Control Unit in RAM is highly recommended to lead the entomological surveillance and vector control activities.

Mosquito source reduction (elimination of breeding sites and larvae)

Personal protection measures and behavioural changes

Target: Large population within and outside the area with dengue transmission (additional effort around geographic cluster of case).

- Promote the use of household insecticide products (domestic aerosols, spray cans, and mosquito coils).
- Promote the use of protective clothing and repellents (long-sleeved shirts, long trousers).
- Since the vector species usually bite during the daytime, insecticide-treated mosquito nets have limited utility except for bedridden dengue case, night workers, babies and infants in order to diminish the risk of intra-household transmission.

Community actions to spread knowledge of the mosquitoes and of dengue transmission

- Provide instructions to enable inspectors (employees, volunteers, school children, scouts, etc.) to search for infested sites stressing the possibility of finding uncommon or unique breeding sites harbouring large numbers of mosquitoes.
- Visit hospitals, geriatric homes, schools, etc. to recommend routines for vector control.
- The population interest should be addressed with an ad hoc communication strategy (SMS, TV spots, posters, 'dengue day', etc.). The media support should be simple, practical and original, prepared in collaboration with the required expertise in public health communication.

The field visits identified several abandoned/empty summer houses in close proximity to dengue cases and positive ovitraps in Santa Luzia and in the centre of Funchal. The systematic geo-localisation of such potentially highly productive breeding sites should be performed. The disinfection and breeding sites reduction should then be implemented by public operators in appropriate security conditions (access with civil security of fire department). Legal measures should be envisaged to gain access to those areas.

The activities are summarised in Table 2 below.

Table 2. Proposed list of sites for source reduction (elimination of breeding sites)

Site	Justification and action
Homes of suspected dengue cases	Clearly there are critical sites to be considered. Source reduction, bed nets and residual treatments should all be considered. Doctors should give instructions and a flyer to out-patients and to hospitalised patients on discharge.
Abandoned/empty summer houses	Potentially important breeding sites. Access restricted to public operators with correct security measures.
Public area	Clean catch basin and use of larvicide.

Site	Justification and action
Outdoor cafés/restaurants	Such sites also warrant particular attention. Again, eliminate or empty water-holding containers in as large a radius as possible. Remove water under wood terrace if stagnant water below.
Hotels and guest houses	The hotel association should be encouraged to employ personnel to inspect hotel premises, eliminate infested sites and monitor impact with ovitraps (remove rubbish and other unwanted items in backyard).
Bus stops, funicular stations, museum waiting queue	Any place where people are likely to linger should be considered a potential focus (especially in the afternoon).
Homes and public places	All likely containers should be emptied of water and inverted or discarded. Special attention to water in saucers under flower pots; these should be cleaned at least once a twice week or (preferably) discarded.
Schools	A prime site for exchange of virus and children bring virus to the home environment. Perhaps children can be instructed to do their own search for breeding sites in the school and as far as possible (at least 200 m) in the surrounding areas.
Prisons	Serious outbreaks can occur among prisoners.
Hospitals	As above. Special attention, of course, to dengue patient consultation.
Geriatric homes	Inmates may be particularly vulnerable to bites. Medical practitioner should be alerted and protection measure taken.

Biological vector control measures

Target: Large population within and outside the area with dengue transmission. Focus on reduction of breeding sites with difficult access by the community actions (sewage system, drainage system, catch basin, etc.).

- In **urban areas**, based on the consultation of experts conducted by ECDC, *Bacillus thuringiensis* has been considered an effective mosquito control agent. As mentioned, in the majority of cases, a strong source reduction by the population is the most effective approach for control.
- An exception is the catch basin: directly beneath every drainage grid in the street there is a small reservoir arranged to trap solid material. These can be prolific sites for mosquito production if stagnant water is still present. They are best treated with a larvicide, preferably *Bacillus thuringiensis* using, for instance, slow-release pellets of Vectobac that give effective control for several weeks.
- The sewage system of Funchal has been identified has potential source of *Aedes aegypti* during the entomological investigations. Due to the high frequency of tourists visiting the town, and given the high density of habitats, the management of this potential breeding site of *Aedes aegypti* is pressing.

Reduction of the adult mosquito population

Some of the following methods are recommended, based on the use of pyrethroid derivatives (pyrethroid is an organic compound similar to the natural pyrethrins) for the control of adult *Aedes aegypti* mosquitoes. However, use of pyrethroids should be re-evaluated when new resistance profiles of the mosquitoes become available. An analysis performed in 2009 revealed the presence of resistance, raising concern about the sustainable characteristics of such chemical strategies.

Other insecticide compounds that are available are malathion (organophosphate) and carbamates.

Aerosol dispersion (i.e. through painting walls with insecticides) can be conducted in a tailored, highly specific fashion, depending on the insecticide compound, the area to treat, and the overall objectives of vector control.

Note that several insecticide compounds are not authorised under EU legislation, such as malathion for fogging or ultra-low volume (ULV) spraying.

Fumigation with spray cans

- Domestic aerosols of insecticides using synthetic pyrethroid compounds are available in shops and supermarkets. There is already resistance in the local mosquito population but in sufficient dosage these aerosols will probably still be effective to kill adult mosquitoes in flight.
- House-holders, restaurant managers, hotel managers, libraries, etc. should be encouraged to use such sprays regularly, particularly if people are being bitten. In the home, *Aedes aegypti* are commonly found in cupboards (closets) where they shelter between the clothes, among shoes and in other dark places.

Residual insecticidal treatments

- Certain insecticides, sprayed onto solid surfaces, can kill mosquitoes that come into contact with those surfaces. Treatments should be made wherever it is likely that mosquitoes will rest.
- The insecticide of choice is bendiocarb (or other carbamate insecticides) because of the resistance to pyrethroids seen in 2009. The use in Madeira should be assessed with regards to EU Directives and regulation in Portugal.

The activities and sites are summarised in Table 3 below.

Table 3. Proposed list of sites for residual insecticide treatment

Site	Comments
Homes of suspected dengue cases	As above
Abandoned/empty summer houses	Potential important breeding sites. Access probably restricted to public operators with correct security measures.
Outdoor cafés/restaurants	Such sites also warrant particular attention. Again, underside of tables, chairs, reception desks and anywhere mosquitoes are likely to rest.
Hotels and guest houses	Shade under reception desks can be particularly attractive to adult mosquitoes.
Schools	Treat underside of desks with spray or paint. Aim to treat shaded sites where mosquitoes are likely to rest.
Prisons	As above.
Hospitals	As above. The undersides of reception desks are a classic favourite resting site for <i>Aedes aegypti</i> . Special attention, of course, to patient wards with dengue-suspected/confirmed patients.
Geriatric homes	Similarly, treat shaded sites such as underside of beds or wheelchairs.

Fumigation with hand foggers

A number of portable machines operated by trained personnel can be used to 'fog' outdoor and indoor areas with various formulations of insecticide. Synthetic pyrethroid compounds are used in Madeira by private companies (for instance alphacypermethrin or cyfluthrin). These products can be used as a first solution; refinement will be envisaged in accordance with laboratory testing and current regulations. Although some formulations (particularly 'thermal fogs') can give a limited residual effect, the impact of most treatments is ephemeral; only adult mosquitoes that are on the wing during the treatment are likely to be killed. The proposed list of sites is presented in Table 4.

Table 4. Proposed list of sites for fumigation with hand foggers

Site	Comments
Vegetation around buildings	Mosquitoes shelter among vegetation, particularly in bushes that provide heavy shade with high humidity. As far as practical, fog should be directed into the interior of such bushes.
Abandoned/empty summer houses	Potential important breeding sites. Access probably restricted to public operators with correct security measures.
Parks and other public 'green' areas, bus stops, museum queues	Particular attention to vegetation around benches, cafés and restaurants and other places where people sit or linger.
Hotels and guest houses	Designated staff (e.g. gardeners) should make a daily round of outdoor areas to give assurance to workers.

Fumigation with truck-mounted foggers

Aerosols dispensed from road vehicles are widely used for mosquito control, especially in the Americas. This method does not permit particles to enter sites where the insects are resting (natural shelter, indoor places, etc.). The impact is likely limited and a large aerial spraying campaign does not demonstrate a high cost–benefit. Locally, the hilly terrain and narrow streets of Funchal make this option most likely logistically unsuitable.

To date, the implementation of spraying is starting to target various indoor places (schools, hospitals and primary healthcare centres, tourist areas).

Annex 9. Detailed vector surveillance activities

An effective surveillance of vector distribution and dynamics, as well as a detailed description of the affected area, are necessary to enforce activities, monitor their impact and alert local residents about the risks related to the presence of mosquitoes. A large part of this information is integrated with the geographic information system but technical support is still needed to optimise the field resources available.

Recently, the guidelines for the surveillance of invasive mosquitoes in Europe evaluated different scenarios for entomological surveillanceⁱ. According to these guidelines, the situation in Madeira falls under Scenario 3. The practical choices for methods of collection are presented on pages 15 and 16 of the guidelines. Further development of surveillance activities tailored to the Madeira context will benefit from the guidelines and further expert advice.

Deploy field crews and workers to identify sites where the mosquito is present and transmission most likely occurs. The use of ovitraps to obtain 24/48-hour confirmation of presence/absence of *Aedes aegypti* should be implemented. Adding hay infusion in the ovitrap should be tested.

Adult mosquito surveys

Several options are available:

- Oviposition traps (or so-called ovitraps) are an inexpensive and simple means for monitoring the presence/absence of the mosquito of female *Aedes aegypti* through the detection of eggs. Standard ovitraps are a simple black jar or bucket filled with approximately one-third tap water. They are deployed in the field twice a week, preferably in shaded spots but as visible as possible. Mosquitoes lay their eggs on a wooden paddle or other rough surface standing in the water.
- Data from ovitraps can also be used to assess whether interventions have been successful. Another important feature of ovitraps is their capacity for detection of the presence of the vector when the breeding site surveys are unproductive. The noticeable advantage is the simplicity of the collection and its full integration in a geographical information system to map the presence of the vector.
- In urban areas, the ovitrap network integrated into the geographical information system is used for *Aedes aegypti* surveillance to evaluate the impact of adult control measures (i.e. space spraying) on the adult female population. Examples of mapping strategies are presented on page 32 of the guidelines for the surveillance of invasive mosquitoes.
- A potentially effective method is to use an infusion of hay in water in ovitraps (500 g of hay in 120 L of water, allowed to stand for one week) and to line the trap with water-resistant paper. The advantage is that the traps are far more attractive to mosquitoes and can therefore be collected after 24 hours, and the presence/absence before and after field interventions can be used to assess control efficacy.
- The BG traps network is already up and running and should be maintained to monitor the impact of the vector control activities on adult male mosquitoes (15 are currently in the field).
- Resting collection cannot be systematic due to the time dedicated to those activities. However, the house visits performed by a trained team should include an inspection of the most frequent resting indoor places and an explanation to the residents on domestic control measures to be implemented (dark places, bedrooms, closets and other protected shadowed sites).
- Landing/biting collection should be avoided in situations such as the current outbreak (considered as trustworthy proxy of proximity to out of sight larvae habitats).

Breeding sites surveys

During the field visit by the local team in RAM, several activities have already been conducted covering these aspects. The general recommendation is to maintain the level of human resources to continue the monitoring in the most affected areas.

The sampling unit is the premises or house in affected areas, which is systematically searched for breeding sites (water-holding containers). The collection of specimens for laboratory examination is needed to verify the species.

ⁱ European Centre for Disease Prevention and Control. Guidelines for the surveillance of invasive mosquitoes in Europe. Stockholm: ECDC; 2012. Page 12. Available from: <http://www.ecdc.europa.eu/en/publications/Publications/TER-Mosquito-surveillance-guidelines.pdf>

The classic indices to monitor *Aedes aegypti* intensity are:

- the house index (HI), corresponding to the percentage of houses infected with larvae and/or pupae (used as a proxy to quantify the spatial distribution);
- the container index (CI) or percentage of water containers infected with larvae or pupae (collect the type of breeding sites to assess the most frequent type to adapt the communication message);
- the Breteau index (BI) or number of positive containers per 100 houses inspected; and to a lesser extent
- the pupae index (PI), corresponding to the number of pupae per 100 houses. The first three criteria have been included in a global vector database to be overlaid with the vector control activities and the spatial distribution of cases.

This information (HI, CI and BI) has been collected by a well-trained team of technicians under the supervision of Professor C. Sousa, in a timely manner, in the entire Santa Luzia (Funchal) area and in some areas of Nazare. This provided outstanding knowledge of the vector in both these settings.

On one hand, field activities and data integration are onerous and time-consuming; but on the other hand they are key activities to maintain during a vector control campaign and a dengue outbreak. Now, the extension of surveillance is facing a challenge in the phase of extension of the outbreak: a triage and targeted surveys should only be implemented in the most affected areas due to the lack of resources. However, the network of entomological surveillance should be entirely maintained for long-term surveillance during and after the outbreak to ensure a proper analysis of mosquito distribution and vector control impact.

Annex 10. Web links of interest

Instituto de Administração da Saúde e Assuntos Sociais (IASAUDE): <http://iasaude.sras.gov-madeira.pt/>

Direção-Geral da Saúde (DGS): www.dgs.pt

World Health Organization: <http://www.who.int/topics/dengue/en/>

World Health Organization. Dengue haemorrhagic fever: diagnosis, treatment, prevention and control. 2nd edition. Geneva: World Health Organization; 1997.

<http://www.who.int/csr/resources/publications/dengue/Denguepublication/en/print.html>

Manual for Indoor Residual Spraying: Application of Residual Sprays for Vector Control:

<http://www.paho.org/English/AD/DPC/CD/mal-who-insecticide-manual.htm>

Guidelines for Integrated Vector Management: http://www.afro.who.int/vbc/framework-guidelines/guide_integrated_vector_management.pdf

Planning Social Mobilization and Communication for Dengue Fever Prevention and Control: A Step-by-Step Guide:

http://www.who.int/tdr/publications/publications/pdf/planning_dengue.pdf

Dengue Haemorrhagic Fever: early recognition, diagnosis and hospital management. An audiovisual guide for health care workers responding to outbreaks:

Video <http://terrance.who.int:85/streaming/dhf.wmv>

DHF video transcript http://www.who.int/csr/don/archive/disease/dengue_fever/dengue.pdf

Residual spraying on surfaces, many options possible according to WHO guidelines (p 30):

http://whqlibdoc.who.int/hq/2006/WHO_CDS_NTD_WHOPES_GCDPP_2006.1_eng.pdf

Aerial spraying: http://www.who.int/whopes/Insecticides_for_space_spraying_Jul_2012.pdf; see also

http://whqlibdoc.who.int/publications/2009/9789241547871_eng.pdf

ECDC: <http://ecdc.europa.eu/en/Pages/home.aspx>

Guidelines for the surveillance of invasive mosquitoes in Europe:

<http://www.ecdc.europa.eu/en/publications/Publications/TER-Mosquito-surveillance-guidelines.pdf>

Annex 11. Field visits pictures

Pictures 1 and 2. Santa Luzia, context



Picture 3. Santa Luzia, unoccupied house



Pictures 4–7. Santa Luzia, abandoned houses



Pictures 8–11. Santa Luzia breeding sites and monitoring system (ovitrap)



Example of small breeding sites on the ground in Santa Luzia (with presence of Aedes aegypti larvae) and right bottom a sentinel ovitrap

Pictures 12–14. Nazare context



Left to right: View of inner garden between buildings, inner garden close to dwellings and building hallway (stairs) with plants close to dwellings.

Picture 15. Santa Luzia, flowerpots after education campaign



We notice that residents take steps to reduce breeding sites.

Pictures 16–19. Nazare, examples of breeding sites



Garden in the courtyard, saucer with water, leaf axis with water and plants in building's hallway.

Picture 20. Large cruiser in Funchal harbour

There is a daily turn-over of around three large cruise ships in Funchal harbour.

Pictures 21 and 22. Breeding sites in the city centre (park)

*The tree hole on the right harboured plenty of larvae of *Aedes aegypti*. This is the typical natural habitat for this species.*