The Director General

Maisons-Alfort, 7 May 2020

OPINION
of the French Agency for Food, Environmental and Occupational Health & Safety

on the "benefit-risk assessment of the vector control practices usually implemented to combat dengue fever, in the current global lockdown context"

On 14 April 2020, as part of the management of the COVID-19 crisis in France, ANSES received an urgent request from the Directorate General for Health to undertake the following expert appraisal: "Benefit-risk assessment of the vector control practices usually implemented to combat dengue fever, in the current global lockdown context".

1. BACKGROUND AND PURPOSE OF THE REQUEST

1.1. Background

In January 2020, a new emerging virus was identified in China, after a cluster of cases of lung disease had been reported in December 2019 in the city of Wuhan (Hubei province). The World Health Organization (WHO) officially named this new coronavirus SARS-CoV-2, or severe acute respiratory syndrome coronavirus 2, responsible for the new infectious respiratory disease called coronavirus disease 2019[1] (COVID-19).

On 30 January 2020, in light of the scope of the COVID-19 epidemic, the WHO declared it a Public Health Emergency of International Concern (PHEIC); on 11 March 2020, it was characterised as a

[1] 19 for 2019.

pandemic[2]. After the first cases were reported in France on 24 January 2020, the Orsan REB[3] section of the French Orsan plan (Organisation of the health system response in exceptional health situations) was rolled out on 23 February by the Minister for Solidarity and Health. On 1 March, when stage 2 had just been declared (on 29 February), the first cases were diagnosed in the French overseas territories[4].

Since 14 March 2020, France has been in stage 3 of the COVID-19 epidemic. On 16 March 2020, Emmanuel Macron, President of the French Republic, decreed a nationwide lockdown (a health measure consisting of restrictions on human contact and movements) in France, effective as of 12:00 pm on Tuesday 17 March, for a minimum period of 15 days. On 27 March, the Prime Minister extended the national lockdown until 15 April. On 13 April, the President of the Republic extended it again until 11 May, with possible gradual easing of the lockdown as from that date.

At the same time, since the beginning of 2020, all of France's overseas territories have been in the epidemic or pre-epidemic stage of dengue[5], leading the authorities to consider as essential the continuation of the vector control (VC) activities usually implemented to combat dengue in these territories and malaria[6] in Mayotte and French Guiana, during this period.

1.2. Purpose of the request

In the context of the COVID-19 pandemic and the ongoing dengue epidemics in France's overseas territories, the Directorate General for Health (DGS) submitted a formal request to ANSES on 14 April 2020 to assess the benefit-risk ratio, for the general population and for workers, of the VC practices usually implemented to combat dengue during the COVID-19 epidemic.

The aims were to identify the actions taken by VC operators that pose a risk of contamination by the SARS-CoV-2 virus for themselves and for the population, weigh them against the risks run in terms of the transmission of dengue (or malaria), and determine whether these actions could be maintained as is or whether they should be suspended (during either the lockdown or its gradual easing).

The recommendations in the report were supposed to focus on the adaptations required to implement or suspend certain VC activities to protect the health of workers and the population from the risk of COVID-19 while maintaining, as well as possible, the control of dengue and malaria vectors.

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[2] A pandemic is an epidemic that spreads to almost all of the population on a continent or on several continents or even worldwide.

[3] Section of the Orsan plan dedicated to epidemiological and biological risks.

[4] This Opinion only deals with French overseas *départements* and regions (Guadeloupe, French Guiana, Martinique, Reunion Island and Mayotte, as well as the territorial collectivities of Saint-Barthélemy and Saint-Martin). The overseas collectivities of French Polynesia, Saint Pierre and Miquelon, and Wallis and Futuna were not considered, because they have special statuses and their own institutions.

[5] Dengue virus is the most common human arbovirus (see Annex 4 on dengue virus). The incidence of dengue has increased 30-fold over the past 50 years, due in particular to globalisation and urbanisation. This viral disease, which is transmitted by mosquitoes of the genus *Aedes*, regularly occurs in French overseas territories. The vectors are *Ae. aegypti* in Mayotte, French Guiana and the Caribbean, and *Ae. albopictus* on Reunion Island and in Mayotte.

[6] Malaria is the leading endemic tropical parasitic disease worldwide, affecting almost 40% of the world's population. In 2019, there were an estimated 228 million malaria cases, including 405,000 deaths, most of which occurred in Sub-Saharan Africa (https://www.who.int/publications-detail/world-malaria-report-2019). In French Guiana and Mayotte, this vector-borne disease, transmitted by mosquitoes of the genus *Anopheles*, takes the form of highly localised outbreaks.

1.3. Scope of the expert appraisal

Potential means of contamination by SARS-CoV-2 were identified for VC operators who go into the field to combat outbreaks of dengue (or malaria cases) in French overseas territories. The means of contamination may be the same for operators in mainland France involved in controlling imported and secondary cases of arboviruses (dengue, chikungunya, Zika) during the period of activity of the *Ae. albopictus* vector. Therefore, it has been considered that the results of the risk analysis in French overseas territories can be extrapolated to mainland France and Corsica.

The risk assessment only covered the field activities of VC operators (door-to-door campaigns, treatments, etc.); office and teleworking activities (preparation of operations, mapping, data analysis, etc.) were not taken into account.

The assessments, discussions and recommendations presented in this report were carried out/prepared in the current state of scientific knowledge on SARS-CoV-2 and are subject to revision as this knowledge evolves.

2. ORGANISATION OF THE EXPERT APPRAISAL

To examine this expert appraisal, ANSES set up an Emergency Collective Expert Appraisal Group (GECU). This "Dengue & lockdown" GECU was made up of nine experts. They were recruited for their scientific and technical skills in the areas of medical entomology, public health, epidemiology, infectious diseases, vector control, biocides, and human and social sciences. This work was therefore conducted by a group of experts with complementary skills.

To conduct this expert appraisal, the experts met for four conference calls on 15, 23 and 28 April and on 6 May 2020.

The experts also held eight hearings with people involved in the management or surveillance of arbovirus epidemics in French overseas territories, as well as an infectious disease physician and an occupational physician (see list of people interviewed in Table 4, in Annex 2 of this Opinion).

Annex 1 lists the literature references consulted as of 28 April 2020. ANSES did not conduct a systematic review of the scientific literature on the topic. In the absence of quantified data (prevalence of COVID-19 in the population, infectious dose by inhalation and contact with contaminated surfaces, exposure scenarios, etc.) for assessing risks to workers and the population, the benefit-risk analysis was based on expert opinions.

The methodological and scientific aspects of the work were presented to the "Vectors" Working Group (WG), a permanent group of ANSES experts dealing with issues relating to vectors, on 6 May 2020. The GECU's analyses and conclusions were then validated on the same day.

The expert appraisal was carried out in compliance with French standard NF X 50-110 "Quality in Expert Appraisal Activities – General Requirements of Competence for Expert Appraisals" (May 2003), with the aim of respecting the following points: competence, independence, transparency and traceability.

ANSES analyses interests declared by experts before they are appointed and throughout their work in order to prevent risks of conflicts of interest in relation to the points addressed in expert appraisals. The experts' declarations of interests are made public via the ANSES website (www.anses.fr).

3. Analysis and conclusions of the *GECU*

After reviewing the epidemiological situation with regard to dengue, malaria and COVID-19 in the affected French Overseas *Départements* and Regions (DROMs), the GECU's experts first considered the practices implemented to prevent and control dengue and malaria. They then sought to characterise the risk of contamination by the SARS-CoV-2 virus when these practices are carried out, both for workers and for the population. Lastly, they assessed the benefit-risk ratio for workers and the general population, in the event that the VC practices usually implemented should be maintained, adapted or suspended, with regard to the risk of transmission of COVID-19 and dengue (and possibly malaria).

3.1. Epidemiological situation with regard to dengue, malaria and COVID-19 in the French territories in question

Of the arboviruses transmitted by Aedes *mosquito vectors (dengue, chikungunya, Zika and yellow fever), which are all covered by epidemiological surveillance, only dengue has been identified to date as being transmitted in French overseas territories. In mainland France and Corsica, imported cases of all these arboviruses are also covered by vector control measures to prevent any local transmission.*
Moreover, a decrease in the number of people seeking healthcare and biological diagnostic testing was observed when the generalised locked was put into place, which may have affected the surveillance data (underestimation) and comparisons between these surveillance data and those from earlier periods.

3.1.1. Circulation of dengue, malaria and COVID-19 in the Indian Ocean

In the Indian Ocean, two historical dengue epidemics, which are poorly documented but affected around one-third of the population, occurred on Reunion Island in 1977-78 and in Mayotte in 1993, with *Aedes albopictus* as the primary vector.

Since 2010, there have been repeated periods of autochthonous dengue moderately circulating in Mayotte (a few hundred cases in 2010, 2012 and 2014) and on Reunion Island (a few dozen cases in 2014, 231 in 2015-2016 and 97 in 2017), with hotspots for transmission frequently identified in the western and southern parts of the island. Since 2017, the virus has continuously spread on Reunion Island, with the occurrence of a moderate epidemic in 2018 (6,770 confirmed cases) followed by a major epidemic in 2019 (between 1 January 2018 and 1 January 2020, 24,951 confirmed cases were recorded, including 733 hospitalisations and 20 deaths, 12 of which were directly related to dengue). Thus, since 10 July 2018, Reunion Island has been experiencing a "medium-intensity epidemic" (level 4 of the Orsec[7] plan).

3.1.1.1. On Reunion Island

Since the beginning of 2020, there has been a third epidemic wave of dengue, with 5,410 confirmed cases recorded on the island between 1 January and 19 April 2020 (for a population of 860,000 inhabitants). Unlike in 2019 when the main serotype was DENV-2, DENV-1 has been dominant in 2020, followed by DENV-2 and DENV-3, which was introduced in the island in 2019 (SpF 2020) and of which cases have been reported primarily in the eastern part of the island (see Annex 4 concerning DENV-1, 2, 3 and 4 viruses). The co-existence of several serotypes is a sign of dengue becoming endemic on the island. In 2020, numerous secondary cases of dengue (reinfection with DENV-1 after primary infection with DENV-2 with increased risk of clinical severity) have been recorded on

[7] The ORSEC plan (*Organisation de la Réponse de Sécurité Civile /* Civil protection Response Organization) is the French programme for organising relief at the departmental level in the event of a disaster.

the island, especially in the southern parts (St. Pierre, St. Louis). Four deaths have been reported in 2020: three were classified as directly related to dengue and one as indirectly related.

On Reunion Island, autochthonous malaria was eliminated in 1979. However, the *Anopheles arabiensis* vector persists to a limited extent in some communities and a few imported cases are identified under the mandatory notification scheme every year. Preventing the reintroduction of malaria on the island relies on the passive detection and early treatment of imported cases, combined with larval control targeting cases based on the entomological situation.

On Reunion Island, the first imported cases of COVID-19 were detected on 11 March. The special 'COVID-19' epidemiological review published by *Santé publique France* (SpF) on 29 April 2020 described 420 confirmed cases of COVID-19, including 66 cases with secondary transmission due to an imported case and 58 cases with autochthonous transmission. Since 11 March, 12 cases of patients hospitalised in intensive care units have been reported, including one patient who was still hospitalised on 29 April 2020. As of the same date, no deaths caused by SARS-CoV-2 had been reported on the island.

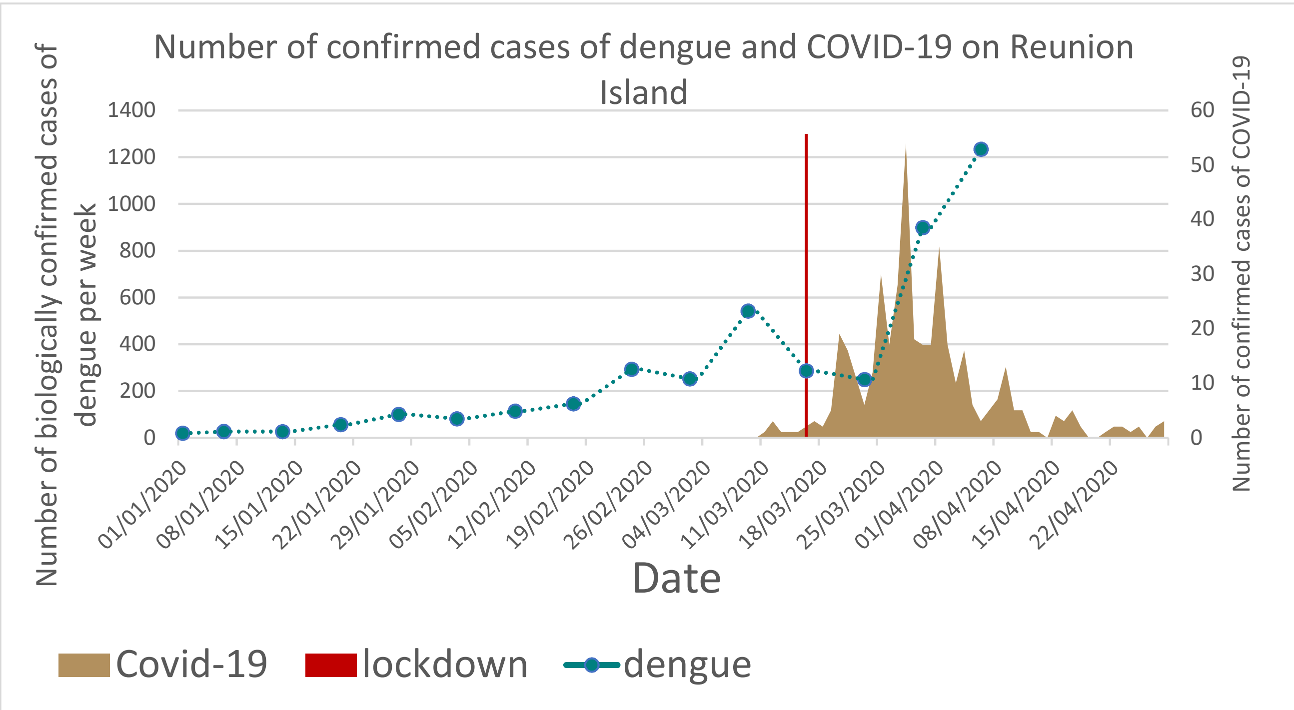

Figure 1: Number of confirmed cases of dengue and COVID-19 on Reunion Island since 1 January 2020 (according to the information from the SpF epidemiological reviews), *with different scales for the number of cases* (differing by a factor of 20)

3.1.1.2. In Mayotte

A dengue epidemic was reported in Mayotte on 6 March 2019, triggering level 4 (medium-intensity epidemic) of the Orsec plan. Moreover, the circulation of dengue has been increasing sharply since the beginning of 2020, with a total of 3,163 confirmed cases[8] as of 20 April (for a population of 256,500 inhabitants[9]). All of the island's communes have been affected. The only circulating

[8] Reference: Regional Health Agency (ARS) press release of 20 April 2020.

[9] Reference: INSEE, 2017. https://www.insee.fr/en/statistiques/4227071

serotype in Mayotte is DENV-1. This is the largest dengue epidemic ever recorded in Mayotte. It has been particularly severe, with 12 deaths reported between 1 January and 20 April 2020[8].

Mayotte and French Guiana are the only French *départements* affected by malaria. It is transmitted by two major vectors: *Anopheles gambiae s.s.* and *Anopheles funestus*. According to the WHO, Mayotte officially entered the malaria elimination phase in 2014. Nevertheless, an alarming surge in the number of autochthonous malaria cases was observed in 2016 (18 cases) and continued in 2017 (nine cases), 2018 (two cases) and 2019 (54 cases, including four autochthonous cases).
Since the beginning of 2020, and as of 15 April, around 20 imported cases and only one autochthonous case had been reported [Mayotte Regional Health Agency (ARS) hearing, P. Rabarison].

The first case of COVID-19 was reported in Mayotte on 13 March 2020. As of 22 April 2020, 344 COVID-19 cases had been biologically confirmed by the analytical laboratory of the Mayotte Hospital Centre (CHM). Since 13 March, 81 cases had been hospitalised, including four who were still in intensive care units on 22 April. Four deaths had been reported by the same date.

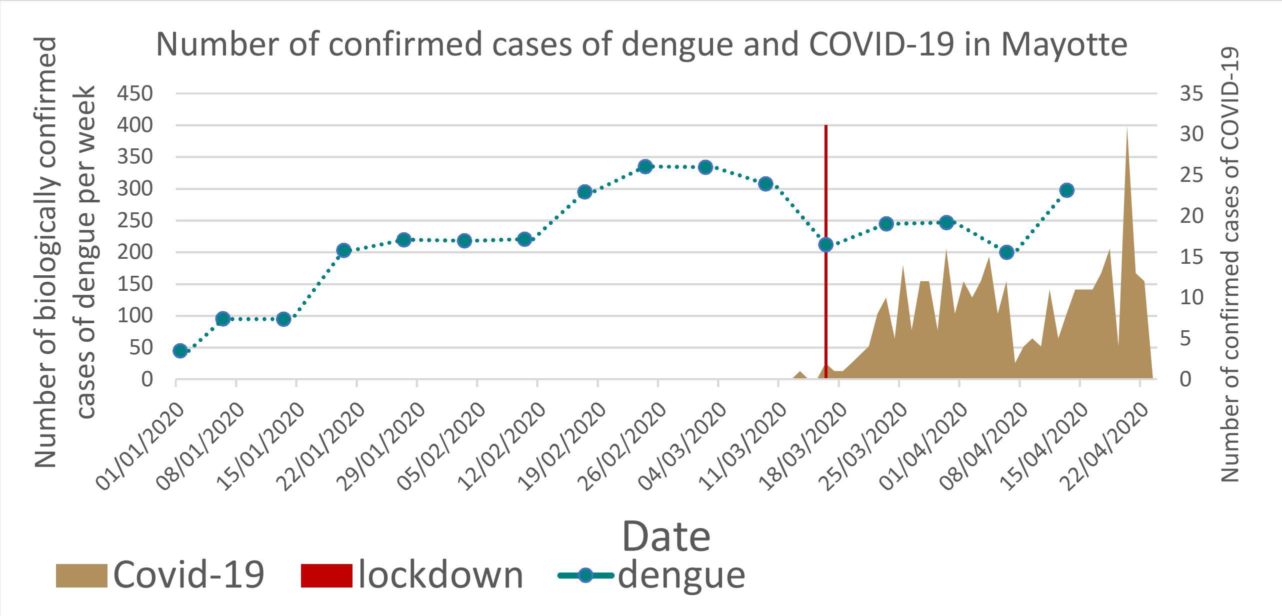

Figure 2: Number of confirmed cases of dengue and COVID-19 in Mayotte since 1 January 2020 (according to the information from the SpF epidemiological reviews), *with different scales for the number of cases* (differing by a factor of 10)

3.1.2. Circulation of dengue, malaria and COVID-19 in French Guiana

Since the beginning of 2020 and as of 16 April 2020, more than 700 confirmed cases of dengue had been reported in French Guiana (for a population of 281,600 inhabitants[10]) (

[10] Source: INSEE, 1 January 2018. https://www.insee.fr/fr/statistiques/3695893

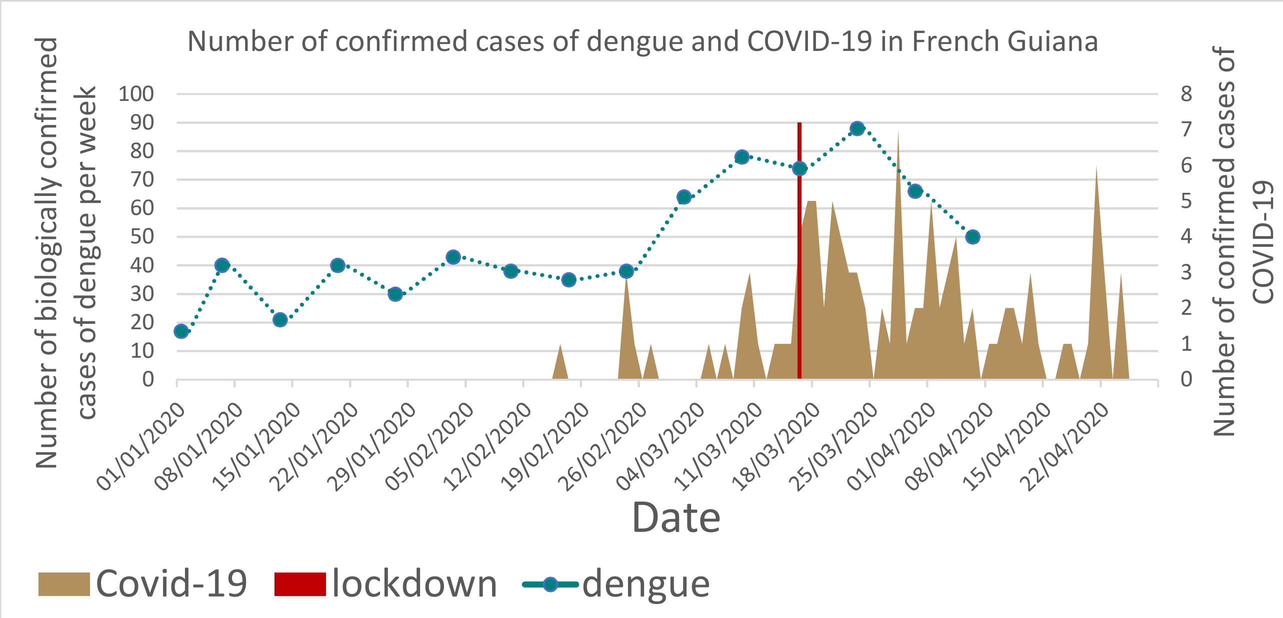

Figure 3). There are two main circulating serotypes: DENV-2 (50%) and DENV-1 (50%). DENV-3 only circulates at a very low level (<1%). The circulation of dengue virus differs widely depending on the commune, with high circulation in communes located in the western part of the *département* and on Cayenne Island. The situation is epidemic in the Maroni River and Kourou sectors and pre-epidemic in the Cayenne and Saint-Laurent du Maroni sectors.

In French Guiana, malaria is transmitted by *Anopheles darlingi* mosquitoes. Efforts made to control malaria have led to a considerable reduction in the number of cases recorded every year, which dropped from over 4,500 in 2005 to around 600 in 2017. In 2019, the total number of malaria attacks was down sharply, reaching the lowest number ever recorded for more than 10 years with 212 attacks reported in patients managed by the local healthcare system. In the first quarter of 2020, 36 malaria attacks were recorded. As of 17 April, six new cases had been reported since the start of the lockdown [hearing with the Territorial Collectivity of French Guiana, S. Chantilly].

The first case of COVID-19 was confirmed on 4 March 2020. As of 29 April 2020, there had been 125 confirmed cases of COVID-19 in French Guiana, including 40% involving autochthonous transmission (

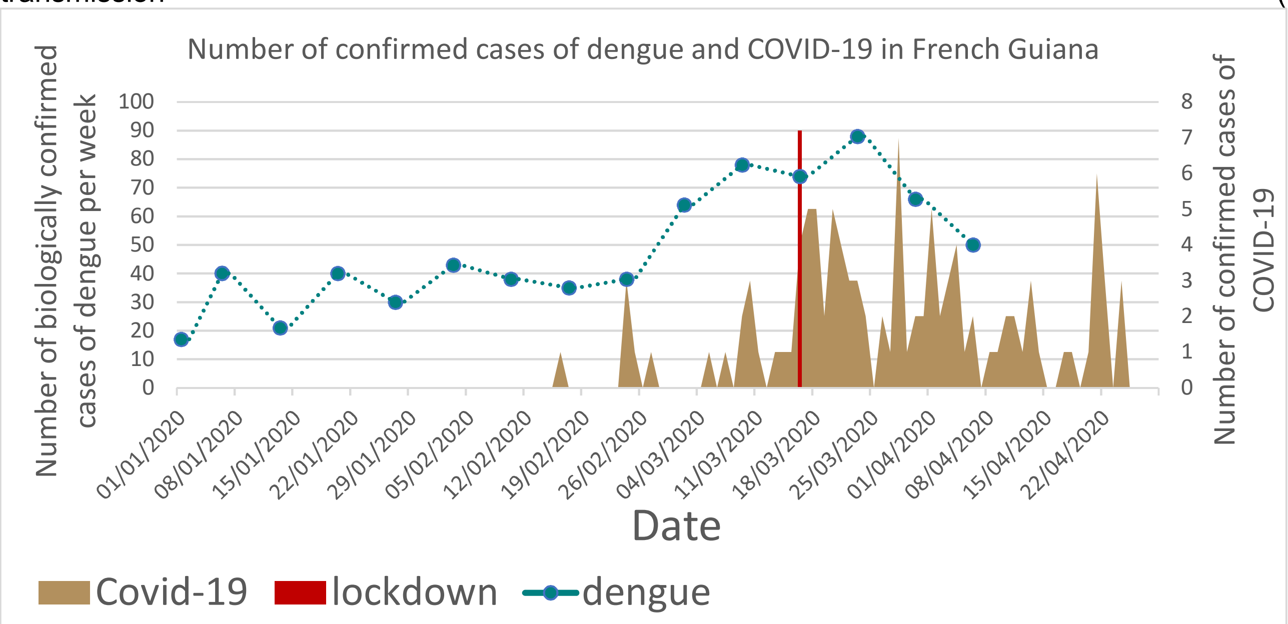

Figure 3). Since week 9 of 2020, 36 people had been hospitalised for COVID-19, including three in intensive care units. On 29 April, three people were still hospitalised, there were no patients in intensive care, and one person had died from COVID-19.

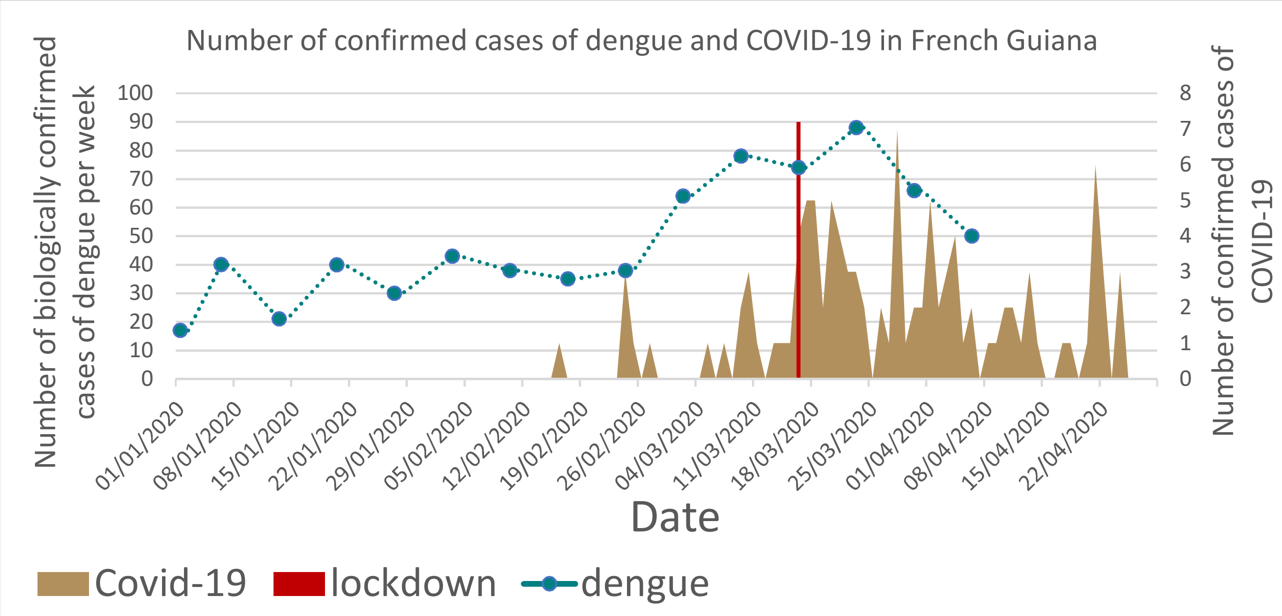

Figure 3: Number of confirmed cases of dengue and COVID-19 in French Guiana since 1 January 2020 (according to the information from the SpF epidemiological reviews), *with different scales for the number of cases* (differing by a factor of 10)

3.1.3. Circulation of dengue, malaria and COVID-19 in the French *départements* in the Caribbean

In the French Caribbean, the epidemiology of dengue has evolved over the last 30 years towards a hyper-endemic situation, where several viral serotypes are currently co-circulating and where the virus does not completely cease to circulate between epidemics. In 2010, the largest dengue epidemics in these *départements* resulted in 86,000 cases in Martinique and Guadeloupe. In 2011 and 2012, there were no epidemics in the French Caribbean; the last major epidemic occurred in 2013-2014. Since the end of 2018, after an interruption in transmission following the Zika epidemic (2016), cases of the virus being transmitted have once again been observed. Therefore, in January 2020, the health authorities in the region declared a dengue epidemic in Guadeloupe and Saint-Martin and indicated that Martinique was also at risk of an epidemic.

Considered as eradicated since the 1970s in Martinique and Guadeloupe, malaria had occurred in these *départements* until the 1950s, and the last autochthonous cases were probably observed in 1965 (Fontenille 2009). Nonetheless, there are competent vectors[11] on these islands and the risk of re-emergence from imported cases, although considered as limited, has caused surveillance to be maintained in the form of mandatory notification with the early treatment of imported cases and VC operations targeting these imported cases if necessary.

[11] *Anopheles albimanus* has been identified in Saint-Martin and *An. albimanus* and *An. aquasalis* are regularly found in Guadeloupe and Martinique.

3.1.3.1. In Guadeloupe

Between the start of the dengue epidemic, in week 42 of 2019, and week 13 of 2020, the number of cases was estimated[12] at nearly 7,680 in Guadeloupe (for a population of around 390,700[13]) (

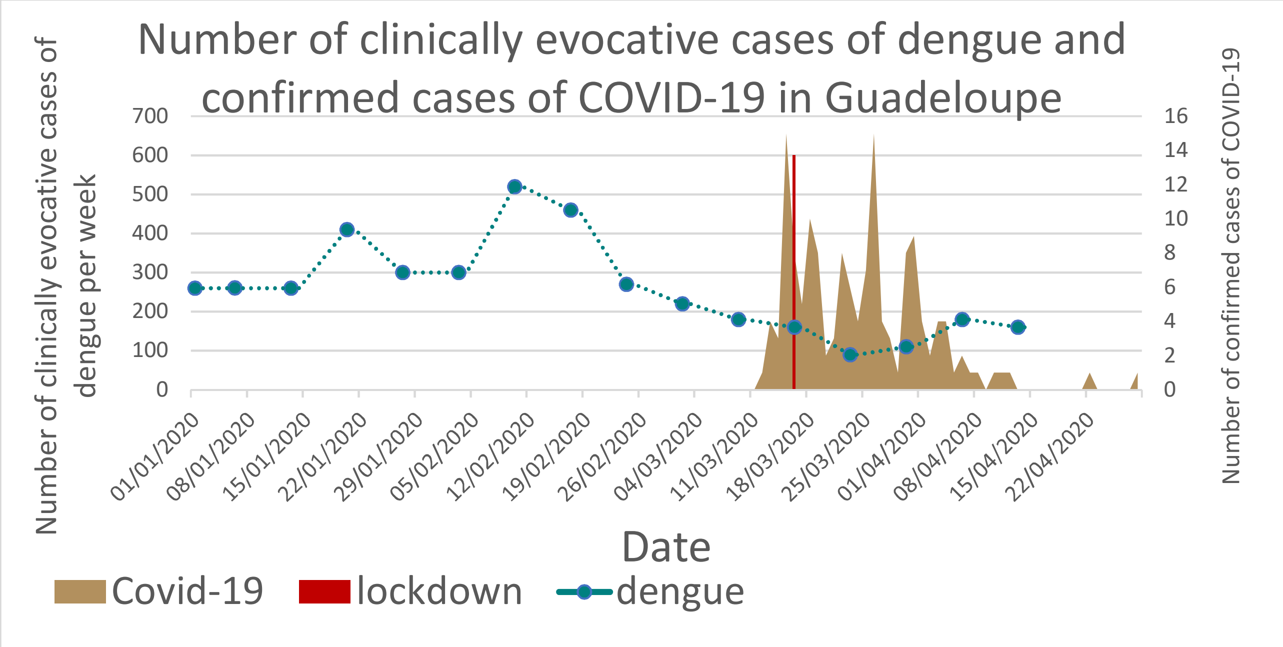

Figure 4). There were no deaths related to dengue. The main circulating serotype is DENV-2.

In Guadeloupe, the first case of COVID-19 was reported on 12 March 2020 (

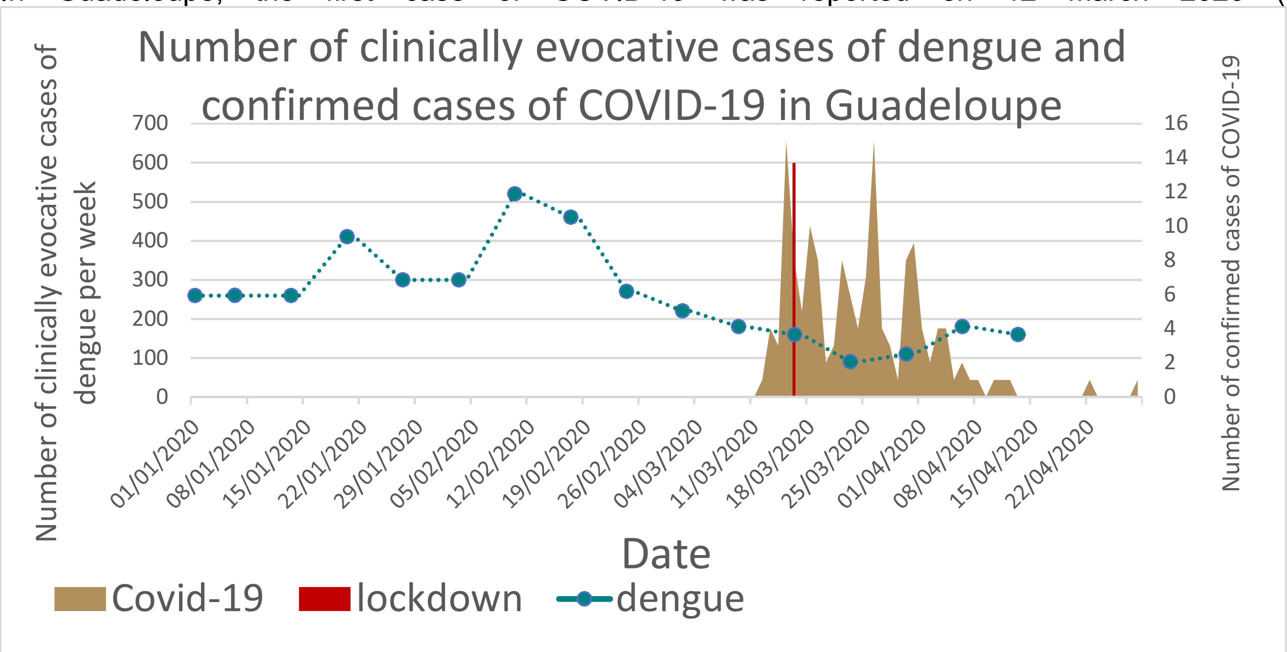

Figure 4). As of 29 April 2020, 151 cases had been confirmed. Of these confirmed cases, 40% had been exposed outside of Guadeloupe. Eleven COVID-19 deaths had been recorded.

[12] Estimation from the network of sentinel physicians.

[13] Source: INSEE, 1 January 2018. https://www.insee.fr/fr/statistiques/3695574

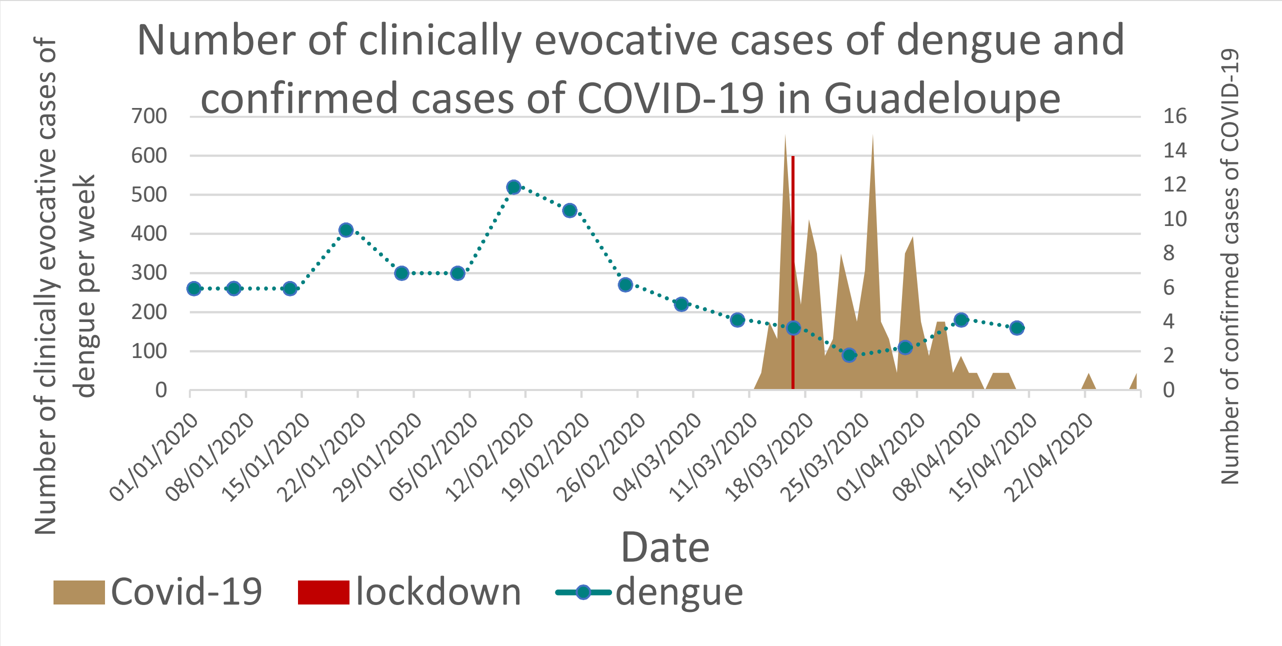

Figure 4: Number of confirmed cases of dengue and COVID-19 in Guadeloupe since 1 January 2020 (according to the information from the SpF epidemiological reviews), *with different scales for the number of cases* (differing by a factor of 50)

3.1.3.2. In Saint-Martin

Since the start of the dengue epidemic in Saint-Martin in week 3 of 2020, the number of cases has been estimated at nearly 1,045 on the island (for a population of around 35,334[14]) (Figure 5). The main circulating serotype is DENV-1. There has been one death caused by dengue virus.

In Saint-Martin, the first case of COVID-19 was reported on 29 February 2020 and 34 cases had been confirmed as of 28 April 2020 (Figure 5). No new cases have been confirmed since 16 April 2020. Three deaths have been recorded in intensive care units.

[14] INSEE, 2019 data. https://www.insee.fr/fr/statistiques/4265419?sommaire=4265511

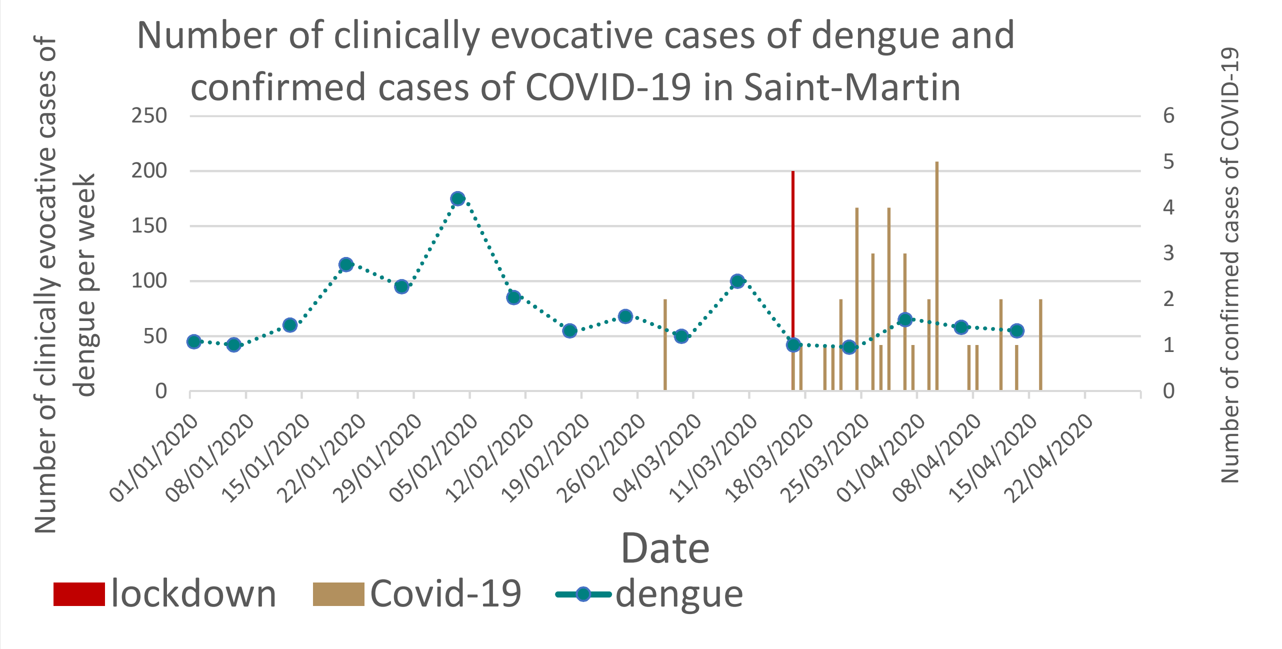

Figure 5: Number of confirmed cases of dengue and COVID-19 in Saint-Martin since 1 January 2020 (according to the information from the SpF epidemiological reviews), *with different scales for the number of cases* (differing by a factor of 50)

3.1.3.3. In Saint-Barthélemy

Since December 2019, 209 clinically evocative cases and 65 biologically confirmed cases of dengue have been detected in Saint-Barthélemy (for a population of around 9,961[15]) (Figure 6). DENV-2 is the main serotype.

In Saint-Barthélemy, the first case of COVID-19 was reported on 29 February 2020; six cases had been confirmed as of 28 April 2020 and no other cases have been recorded since 26 March (Figure 6).

[15] Source: INSEE 2019. https://www.insee.fr/fr/statistiques/4265419?sommaire=4265511

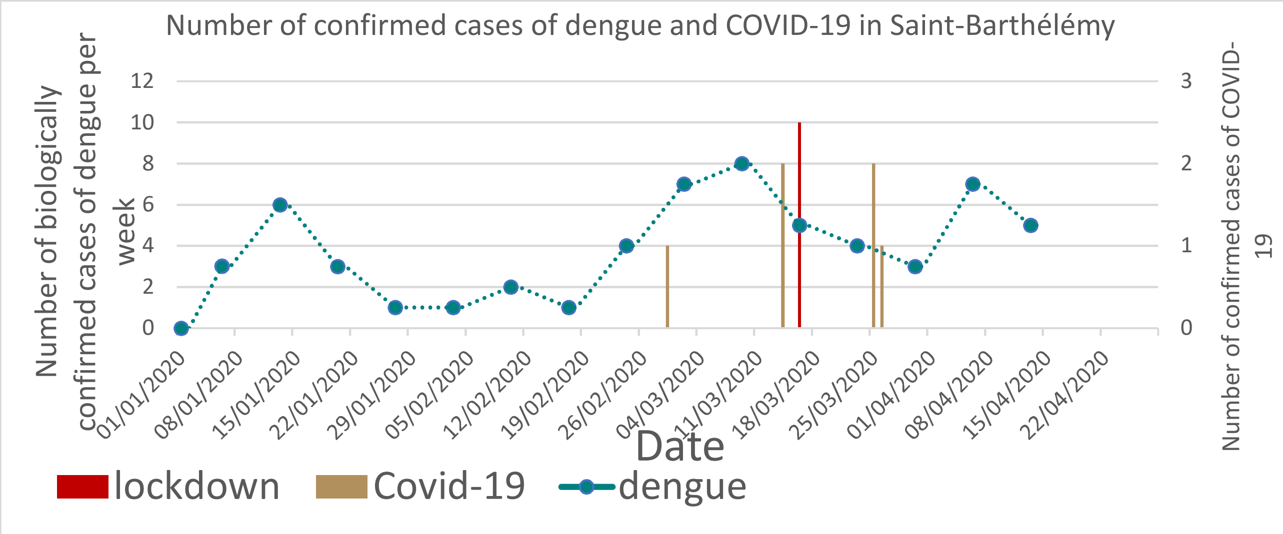

Figure 6: Number of confirmed cases of dengue and COVID-19 in Saint-Barthélemy since 1 January 2020 (data source: SpF epidemiological reviews) *with different scales for the number of cases* (differing by a factor of 4)

3.1.3.4. In Martinique

Since July 2019, the number of clinically evocative cases of dengue has been estimated at nearly 3,940 in Martinique with 1,080 biologically confirmed cases (for a population of around 376,480[16]) (Figure 7). Of the 186 dengue cases serotyped since July 2019, 80% have been DENV-3 viruses; DENV-2 is the second most widely circulating serotype. There has been one death caused by dengue.

The first case of COVID-19 was reported on 5 March 2020. As of 28 April 2020, 178 biologically confirmed cases had been reported (Figure 7). As of the same date, there had been a total of 37 severe cases hospitalised in intensive care units and seven deaths had been reported.

[16] Source: INSEE 2019. https://www.insee.fr/fr/statistiques/1405599?geo=DEP-972

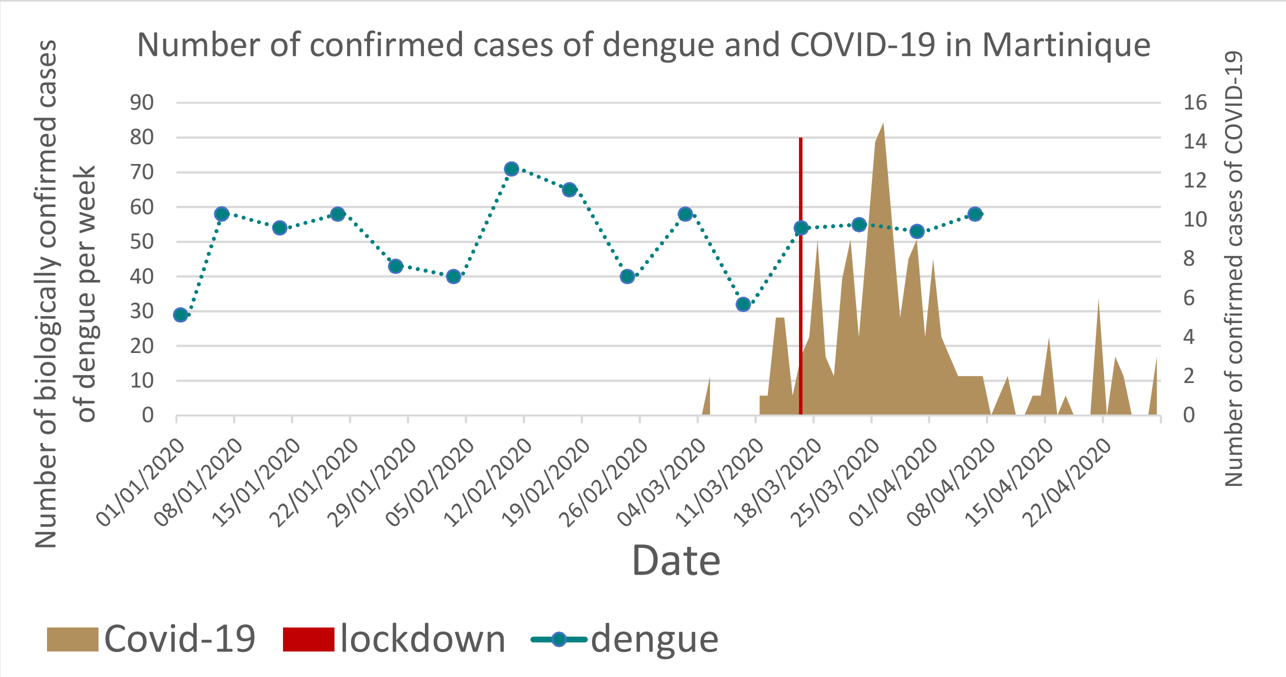

Figure 7: Number of confirmed cases of dengue and COVID-19 in Martinique since 1 January 2020 (according to the information from the SpF epidemiological reviews), *with different scales for the number of cases* (differing by a factor of 5)

3.1.4. Epidemiological situation of mosquito-borne diseases and COVID-19 in mainland France and Corsica

In mainland France, in 2020, the *Ae. albopictus* mosquito is present in 58 *départements*. It first arrived in 2004, in Alpes-Maritimes. Since 2006, a control scheme for arboviruses caused by this mosquito (dengue, chikungunya, Zika) has combined entomological surveillance, human epidemiological surveillance, and VC and preventive actions. It includes, among other things, plans to conduct appropriate VC actions targeting imported cases of these arboviruses during the vector's period of activity (from 1 May to 30 November[17]). This is because these cases pose a risk of autochthonous transmission in areas colonised by *Ae. albopictus,* as has already been observed in the past.

Imported cases of dengue, chikungunya and Zika are regularly identified in mainland France in travellers returning from tropical regions affected by these arboviruses. Their number is highly dependent on the epidemics occurring in the DROMs, due to the intensity of traveller flows. In 2019, a year marked by dengue epidemics on Reunion Island as well as in Martinique and Guadeloupe, 657 imported cases of dengue were confirmed during the period of heightened surveillance (versus 189 cases in 2018).

Imported cases can be responsible for episodes of autochthonous transmission, of which 15 occurred between 2010 and 2019: 11 for dengue, one for Zika and three for chikungunya. Each episode involved one to 17 autochthonous cases. The vector had been present for at least three years in the affected territories before the first episode of autochthonous transmission (Franke F 2019).

[17] Period of heightened surveillance during the activity period of *A. albopictus* in mainland France and Corsica.

In 2020, with the population under lockdown since mid-March and with major restrictions on air travel since that date, which are expected to be extended until July[18], the number of imported cases will likely decrease sharply, along with the risk of autochthonous transmission of these arboviruses. However, some imported cases may occur due to continuing air traffic (three flights per week maintained between Paris and Reunion Island, two flights per week maintained between Paris and the Caribbean, plus a limited number of special flights dedicated to repatriating French citizens from foreign countries, some of which are affected by dengue, chikungunya or Zika). As of 22 April 2020, 12 imported cases of dengue had been reported via mandatory notification, with travellers returning after 17 March, almost exclusively from the Caribbean (11) and with one traveller returning from Mayotte via Reunion Island.

In mainland France, imported cases of malaria are observed every year in people returning from endemic tropical countries where malaria transmission is active.

In mainland France, the first cases of COVID-19 were officially reported starting on 24 January 2020. As of 5 May 2020, more than 94,000 hospitalisations due to SARS-CoV-2 infection had been recorded, around 24,000 of which were still ongoing[19]. More than 25,000 deaths have been recorded in hospitals and in social and medical-social establishments[20].

3.1.5. Possible health consequences of the co-circulation of the pathogens that cause dengue, malaria and COVID-19

Initially, a decrease in the number of people seeking healthcare and biological diagnostic testing was observed for dengue when the generalised lockdown was introduced (due to reduced access to healthcare and fears of either saturating healthcare facilities or being infected in them, by SARS-CoV-2 in particular), which affected the representativeness of the surveillance data (which can therefore be considered as underestimated). In Mayotte for example, the lockdown caused the closure of clinics and a decrease in consultations with general practitioners [P. Rabarison hearing], incidentally causing the number of reported patients to decrease. All of the people interviewed thus expressed concerns about a post-lockdown surge in dengue cases. Moreover, the decrease in notifications may lead to a decline in the number of VC operations targeting dengue cases and accelerate the spread of the virus.

Furthermore, intensive communication around COVID-19 has left little room for prevention messages on arboviruses. The media seems to have placed its full attention on the lockdown, minimising communication on dengue. On Reunion Island, communication on dengue, already perceived as a “familiar” disease (Metzger 2009, Idelson and Ledegen 2011, Thiann-Bo 2019, Watin 2009), is suffering from this dire situation. There is a risk of attention being deflected and collective mobilisation against its spread being reduced.

Moreover, while the likelihood of co-infection or successive infections with the pathogens causing dengue, malaria and COVID-19 is still poorly described at this time, infection with dengue virus is a cause of immunosuppression, which is a potential aggravating factor for COVID-19 infection and for an increase in severe forms due to co-infections [A. Cabié hearing]. Diagnostic difficulties and even

[18] Date highly subject to change based on governmental decisions and the measures taken by air transport operators.

[19] https://www.santepubliquefrance.fr/maladies-et-traumatismes/maladies-et-infections-respiratoires/infection-a-coronavirus/articles/infection-au-nouveau-coronavirus-sars-cov-2-covid-19-france-et-monde

[20] https://www.santepubliquefrance.fr/maladies-et-traumatismes/maladies-et-infections-respiratoires/infection-a-coronavirus/articles/infection-au-nouveau-coronavirus-sars-cov-2-covid-19-france-et-monde

errors (increased if access to laboratory tests is difficult) may also emerge, due to clinical similarities between infected cases (see Annex 5).

In the end, with the decrease in the number of VC operations on the one hand and in community mobilisation on the other, the co-circulation of the pathogens causing dengue, malaria and COVID-19 is generating concerns about an increase in the number of arbovirus cases and the risk of hospital services becoming saturated (these are sometimes already fragile in certain territories, especially in Mayotte).

3.2. Management measures taken to control vector-borne diseases and COVID-19

3.2.1. Vector control (VC) practices usually implemented

In general, the VC operations implemented in all of the affected territories to control *Aedes* or *Anopheles* mosquitoes are based on an integrated control strategy including community mobilisation, mechanical control, chemical control and integrated (vector and epidemiological) surveillance. This section only gives an overview of the strategies put into place in the territories in question.

- **Community mobilisation**

Community mobilisation is part of an overall approach relying on individuals, social groups and institutions (WHO 1986). It targets and is based on a set of actors and stakeholders, ranging from healthcare professionals to construction professionals by way of garage owners (tyre storage), tourists and residents in a territory at risk of vector-borne diseases. For each type of actor, communication strategies are developed to inform them of their role in managing epidemic risk and to take their own constraints into account to find appropriate solutions. These operations can differ in nature depending on the territory and the degree of viral or parasitic circulation: they may take the form of awareness-raising measures in private homes (door-to-door campaigns) in areas experiencing dengue outbreaks, press releases, press conferences in the field (in sub-prefectures), posters, flyers in affected areas and airports, radio or TV advertising campaigns, other awareness-raising initiatives (participation in neighbourhood meetings, activities at markets and events, awareness-raising in schools and universities) or a dedicated hotline (free-phone number, etc.). Actions such as door-to-door campaigns by VC operators help empower local residents by building their knowledge and making them aware of their ability to act within their private space. The ultimate and essential objective of community mobilisation is to engage citizens and raise their awareness to bring about lasting behavioural change in the target population for maintaining preventive measures (such as mechanical control) in order to reduce and control vector risks.

- **Mechanical control**

"Mechanical" control, also called "physical" control, essentially consists in eliminating the breeding sites of mosquito vectors. This mechanical control encompasses all of the techniques that use physical action to remove mosquitoes from breeding sites. It can be carried out:

- in the private sphere (by residents in particular), in the water collection or supply systems found in and around homes. In this case, vector control consists in regularly monitoring and destroying potential breeding sites for these vectors, whether they are objects present intentionally (flower pots, rainwater collection vessels: tanks, barrels, etc.) or unintentionally (waste, clogged gutters, etc.).
- in the public sphere, where mechanical control primarily targets systems causing water to stagnate as well as the management of waste and dumping, which can contribute to the development of breeding sites and mosquitoes.

Mechanical control can partly be carried out by VC operators, especially during epidemics; however, it should also rely on the participation of the population, hence the need to implement frequent public awareness-raising actions (see above paragraph on community mobilisation). Mechanical control is essentially aimed at *Aedes* mosquitoes, the females of which select artificial or natural breeding sites in suburban or urban areas, whereas *Anopheles* mosquitoes prefer natural breeding sites (such as puddles, small ponds, footprints, ruts, streams, etc.) for which mechanical control is more complex.

Broadly speaking, mechanical control also aims to reduce the density of adult vectors via trapping methods and to reduce human/vector contact (through the use of mosquito nets and the wearing of long clothes).

Note that to control *Anopheles* mosquitoes, which are endophilic and nocturnal, reducing human-vector contact can also rely on the distribution and use of long-lasting insecticidal nets (LLINs) (on the borderline between mechanical and chemical control, presented below), as can be observed in certain areas of French Guiana [see S. Chantilly hearing].

- **Control using biocidal products**

In its broadest sense, control via biocidal products refers to the use of insecticides and repellents. The former are used to kill mosquito vectors, while the latter aim to repel them and reduce human-vector contact. Of the biocides used to kill mosquitoes, larvicides target the juvenile aquatic stages of development (larvae, pupae); adulticides (or imagocides) target the adult flying stage.

Larvicides

The most widely used larvicide in France is *Bacillus thuringiensis var. israelensis* (Bti) of biological origin. Other formulations rely on *Bacillus sphaericus* (Bs). These bacteria naturally found in soil have demonstrated an entomopathogenic role that has been exploited for several decades. Several formulations of this bacillus are available on the market (pellets, water-dispersible powder, concentrated suspension, dispersible tablets).

These formulations are not harmful to the environment (the impact on non-target fauna is very limited, especially if the prescribed doses are used) and are used on all types of breeding sites (natural and artificial) when these cannot be eliminated. These biolarvicides are mainly used to control *Aedes* mosquitoes; in a very few specific contexts, they may be used to control *Anopheles* mosquitoes.

Adulticides

Only one class of insecticides is currently authorised: pyrethroids (deltamethrin). Beyond the fact that pyrethroids are not selective, the massive, continuous use of the same active substance poses a high risk of selecting resistance to this substance, thus compromising the effectiveness of sanitary actions. This control is reserved for treatments targeting arbovirus cases, so as to limit the transmission of vector-borne pathogens (viruses, parasites).

<u>Actions taken to control *Aedes* and *Anopheles* mosquitoes (through the use of deltamethrin):</u>

- systematic daytime application of adulticide treatments near homes, targeting isolated cases and emerging hotspots;
- in-home spraying targeting isolated cases and emerging hotspots for dengue, when the vector is *Ae. aegypti*, and in malaria-prone areas due to the endophagic and endophilic behaviour of the *Anopheles* mosquito vectors;
- spatial spraying (unlike the previous two types of treatments, this is primarily reserved for established transmission hotspots). Three types of spatial spraying can be used depending on the accessibility of the space (operators choose the device in the field):

- ultra-low-volume (ULV) spatial sprayers with devices mounted on pick-up trucks (usually at night);
- portable sprayers using thermal fogging;
- portable sprayers using cold treatment.

3.2.2. Measures taken to control the COVID-19 epidemic

No medications or vaccines are currently available to control the transmission of the SARS-CoV-2 virus (see Annex 3 on transmission). The global situation as well as the control measures taken in countries are rapidly changing.

In mainland France, when the country entered stage 2 of the COVID-19 epidemic, the French health authorities recommended and stressed the importance of the following, to prevent transmission and slow the spread of the virus:

- **"barrier gestures":** avoid shaking hands and hugging/kissing, frequently wash hands with soap or hand sanitiser gel, cough or sneeze into an elbow or disposable tissue, wear a mask if sick, etc.
- **physical distancing:** avoid all non-essential gatherings and public places, keep a distance of at least one metre from others, limit any contact with people at risk of severe forms of COVID-19 (people over the age of 65 and/or with certain chronic diseases[21]).

Since the move to stage 3 of the COVID-19 epidemic on 14 March and the declaration of a health emergency, provisions have been introduced into French law by the French "Emergency Act No. 2020-290 of 23 March 2020[22] to deal with the COVID-19 epidemic" and its implementing texts. Additional measures have been taken to reduce the extent of the epidemic and its consequences in terms of the health system's ability to care for patients. These have included the lockdown on the population, effective as of 17 March 2020 at 12 noon. The lockdown is aimed at keeping contacts to an absolute minimum by limiting movement to what is strictly required (grocery shopping, healthcare and work when teleworking is not possible), limiting outings near homes (individual physical activity, dog-walking, etc.), closing borders, etc.

3.2.3. Lockdown implementation and consequences in French overseas territories

3.2.3.1. Compliance with lockdown rules

A general lockdown was imposed all across France as of noon on 17 March. However, the epidemiological situation differed from one territory to another. Mainland France was in stage 3 of the COVID-19 epidemic, whereas French Guiana and Reunion Island for example were in stage 1. On Reunion Island, as of 20 April, there had been no circulation of the virus [hearing with the Reunion Island ARS, Dr F. Chieze] or any local chain of contamination.

Overseas, the same management measures were applied as those in force in mainland France (see 3.2.2). Moreover, certain territories, such as French Guiana, Martinique and Guadeloupe on Easter weekend and certain communes on Reunion Island[23], imposed a curfew from 8 pm to 5 am as well as temporary denials of access to natural spaces (Ministerial Order Nos 508/2020 of 27 March 2020 and 583/CAB/BPA of 11 April 2020).

[21] For more details about at-risk individuals, see https://www.hcsp.fr/explore.cgi/avisrapportsdomaine?clefr=807

[22] which codifies these provisions in Articles L. 3131-12 to L. 3131-20 of the French Public Health Code.

[23] Due to non-compliance with the lockdown rules, one commune (La Possession) ordered a curfew from 8 pm to 5 am starting on 29 March.

Except in Mayotte, lockdown compliance is perceived as being high in overseas France. On Reunion Island, the culture of cyclone risk (leading the population to prepare for short lockdowns every year when a tropical storm is announced) seems to have benefited the establishment of rapid and sustained lockdown measures (Thiann-Bo Morel[24], 2020), and this lockdown seems to have been perceived as "salutary" by part of the population on Reunion Island (see media, press forums, doctor associations, etc.). The situation in French Guiana fits with this analysis [hearing with the Territorial Collectivity of French Guiana, S. Chantilly].

The lockdown seems to be a time for developing home and garden maintenance activities. The authorisation to open garden centres was a governmental response with regard to these leisure activities considered as physically and mentally beneficial for citizens on lockdown. However, the pre-existing literature showed that gardens are conducive to the proliferation of *Aedes albopictus* and *Aedes aegypti*, exposing amateur gardeners in particular to bites from these mosquito vectors for dengue (Soulancé *et al.*, 2011). It has also been shown that different types of gardens and their management methods can either increase or reduce these risks of exposure (Claeys *et al.*, 2016).

For these regions, while there was fairly good lockdown compliance initially, the media indicated that this compliance seemed to drop as of week 4. Easter weekend probably encouraged the resumption of visits for families that had not been able to get together due to the lockdown ("customary" gatherings during cyclone lockdowns). More and more people were observed on the street and in open shopping centres and shops [hearings with the ARSs of Reunion Island (H. Thébault), Guadeloupe (Y. Thôle) and Mayotte (P. Rabarison)]. The media published pictures of heavy traffic.

Since week 5, certain economic activities seem to have resumed[25], especially in the building sector, causing a surge in population movements; figures from police roadside checks appear to confirm this upturn in activity[26]. The "optimistic" figures on the COVID-19 epidemic reported by the media seemed to spur certain individuals to "relax" their compliance with the lockdown rules.

In Mayotte, on the other hand, the people interviewed [P. Rabarison hearing and personal communication of J. Devillers] had the impression that it took some time for the lockdown to be put into place, since the precarious conditions of part of the population in this territory require that they leave their homes to "survive" (hawking of fruits and vegetables, undeclared work in the building sector, etc.). They also had the sense that economic activity picked up as from week 5. These individuals expressed significant concerns regarding cultural activities during the Ramadan period[27] and the social gatherings that accompany it. Most of the population is Muslim, and the preparation of Ramadan, which started on 25 April in Mayotte, risks accentuating breaches of lockdown measures. It is not certain that the recommendations of religious leaders[28] will be sufficient to reduce these likely breaches, especially for food supplies.

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24 https://theconversation.com/a-la-reunion-la-pandemie-aggrave-les-inegalites-sociales-133809

25 website: https://la1ere.francetvinfo.fr/reunion/coronavirus-relachement-du-confinement-les-controles-renforces-ce-week-end-encore-823986.html

26 https://la1ere.francetvinfo.fr/reunion/confinement-plus-de-400-reunionnais-verbalises-ce-week-end-826854.html

27 The month of Muslim fasting, from 23 April to 23 May 2020.

28 "Regarding the month of Ramadan, the Cadi Council recommends keeping mosques closed and prohibiting group prayers" (Mayotte la 1ere • Published on 24 April 2020 at 6:36 pm).

3.2.3.2. Restrictions on sea and air passenger travel

While it is true that cross-border travel did accelerate the spread of the COVID-19 epidemic across borders, it was rapidly called into question in certain overseas territories. Protests and refusals to welcome people from the outside were reported by the press.

There had already been tensions[29] on Reunion Island before the lockdown, related in particular to the arrival of cruise ships docking in the city of Le Port, whereas micro-outbreaks of COVID-19 affecting numerous cruise ships had started around the world and were widely covered by the media.

Given the acceleration of the COVID-19 epidemic worldwide, especially in Europe and mainland France, and daily counts in the press distinguishing between autochthonous cases and imported cases, air travel was also quickly identified as contributing to the epidemic and as needing to be reduced. Although airports were not closed, air travel was impacted during the lockdown period. Flights were limited to three commercial (and one cargo) flights per week between Reunion Island and Paris and two flights per week between French Guiana and the Caribbean and Paris. There have been no flights to or from Mayotte since the start of the lockdown. Air Austral will partially resume flights in mid-May.

Since the beginning of April, in most French overseas territories, people landing in the territory have been quarantined in hotels requisitioned for the situation and subject to strict to strict lockdown rules. Overall, there has been good compliance with these quarantines (the press has only reported nine cases of non-compliance with quarantines[30] on Reunion Island for which fines were issued).

3.2.3.3. Waste collection and the proliferation of breeding sites

In certain overseas territories, such as on Reunion Island, the issue of waste had already been pointed out in the past as contributing to the proliferation of mosquitoes (Taglioni *et al.*, 2009; Elpeboin *et al.*, 2015; Thiann-Bo, 2019). It appears that the lockdown has disrupted waste collection in different ways depending on the territory. In parallel, households on lockdown have sometimes engaged in indoor and outdoor cleaning operations, which has generated an increase in the amount of waste to be collected. The calendar indicating that waste should be put out the evening before collection day has not always been followed [H. Thébault hearing]. Combined with the closure of collection centres in the first weeks of the lockdown, which made it impossible to drop off waste in dedicated facilities, this phenomenon has potentially generated an increase in "dumping" responsible for the proliferation of breeding sites in the southern part of the island, an epidemic hotspot. The rounds usually made to identify illegal dumping are sometimes no longer conducted due to reduced staffing during the lockdown [H. Thébault hearing].

In Mayotte, waste collection is a recurring problem that has been accentuated by the lockdown. Waste accumulates in public spaces, thus increasing, in response to recurring rains, potential breeding sites for mosquitoes. In certain parts of the island, lockdown compliance is difficult for some of the population due to various factors such as living in "bangas"[31], a lack of water, etc. Food, water and oil distribution operations have been organised, leading people to gather without any protection and with no possible application of "barrier gestures".

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29 https://www.la-croix.com/France/Covid-19-manifestants-reclament-controle-touristes-Martinique-Reunion-2020-03-01-1201081372; https://la1ere.francetvinfo.fr/guadeloupe/Covid-19-plusieurs-iles-caraibes-refusent-accueillir-bateaux-croisiere-804571.html

30 Press source: https://la1ere.francetvinfo.fr/reunion/9-personnes-ont-quitte-leur-quatorzaine-la-prefecture-tape-du-poing-sur-la-table-820244.html

31 In Mayotte, "bangas" are makeshift dwellings made out of corrugated iron.

3.3. "COVID-19" risk assessment for VC operators

In France, in labour law, biological agents are classified into four groups depending on the level of infection risk they pose (Box 1). SARS-CoV-2, responsible for the current pandemic, is not yet classified. However, in light of current knowledge and by analogy with the SARS-CoV that occurred in 2003, this coronavirus may be considered as a group 3 pathogen or higher (ANSES 2020).

Box 1: Classification of pathogenic biological agents

- Group 1 includes biological agents unlikely to cause human disease;

- Group 2 includes biological agents that can cause human disease and might be a hazard to workers. They are unlikely to spread to the community and there is usually effective prophylaxis or treatment available;

- Group 3 includes biological agents that can cause severe human disease and present a serious hazard to workers. They may present a risk of spreading to the community, but there is usually effective prophylaxis and/or treatment available;

- Group 4 includes biological agents that can cause severe human disease and are serious hazards to workers. They may present a high risk of spreading to the community. There is usually no effective prophylaxis or treatment available.

Two coronaviruses are currently classified in group 3:
- Middle East respiratory syndrome coronavirus (MERS-CoV);
- Severe acute respiratory syndrome coronavirus (SARS-CoV).

The other coronaviruses are currently classified in group 2 (Ministerial Order of 18 July 1994 as amended).

To protect VC operators from "COVID-19" risk, the various possible sources of contamination were identified (§ 3.3.1), as were means of prevention (preventive measures and personal protection) (§ 3.3.2).

3.3.1. **Identification of possible sources of contamination for VC operators**

The WG's experts focused on the level of risk of contracting COVID-19 for VC operators associated with specific VC actions carried out in the field (door-to-door campaigns, treatments, etc.), to the exclusion of all those that can be performed in an office or via teleworking (preparation of operations, mapping, reports, communication, community mobilisation via the media or social networks, etc.) and that are already covered by recommendations with regard to the risks related to the COVID-19 virus (ANSES 2020).

Based on currently available knowledge, COVID-19 is a respiratory disease that can be transmitted directly, by an infected individual, or indirectly, by contact with respiratory secretions produced by an infected individual (see Annex 3 on the means of transmission of the SARS-CoV-2 virus for more details).

Concerning direct transmission, given the contagiousness of the virus, in the absence of barrier gestures and physical distancing, the risk of contamination by an infected individual is considered to be very high. According to a recent study conducted by *Institut Pasteur*, the basic reproduction number (R0), which indicates the number of people infected by each patient, has decreased from 3.3 at the start of the lockdown to 0.5 (Salje *et al.* 2020).

Concerning the possibility of the virus being indirectly transmitted, i.e. via contact with contaminated services, this cannot be ruled out in the current state of knowledge given the virus's persistence in the environment[32] (see Box 2).

Box 2: Persistence of SARS-CoV-2 in the environment

The virus's persistence can vary depending on multiple parameters such as temperature, humidity, the type of surface, etc.

On inert surfaces, without any cleaning measures, viruses in the family *Coronaviridae* can persist for up to nine days (Kampf *et al.* 2020), especially when the temperature and relative air humidity are low (Casanova *et al.* 2010). Various authors showed that SARS-CoV-2 could still be detected (although at much lower levels) on polypropylene plastic for up to 72 hours, on stainless steel for up to 48 hours, on cardboard for 24 hours, and on copper for four hours (van Doremalen *et al.* 2020).

Chin *et al.* (2020) reported similar results, noting that at a temperature of 22°C, the virus remained viable and detectable on plastic and steel for four days, on glass for two days and on wood for one day (Chin *et al.* 2020). The authors also reported that the virus persisted for much longer on smooth, non-porous surfaces than on porous surfaces such as wood, paper and fabric. However, these maximum periods are merely theoretical, as they were recorded in experimental conditions. Although not formally demonstrated to date, contamination via surfaces is definitely possible, by analogy with the flu and SARS-CoV[33]. However, it is not currently possible to state under what conditions the virus is contaminating when found on surfaces. The same authors also measured the virus's stability at various temperatures (suspended in culture medium); it remained detectable for twice as long at 4°C than at 22°C. These results, although they are preliminary and need to be replicated, suggest that the virus is sensitive to heat and raise questions regarding the possible environmental persistence of the virus in cool weather.

To identify the VC actions posing the highest risk of contamination for operators, based on the presentation of VC operators' tasks given during the hearings, the experts sought to determine the most frequent sources of potential contamination via contact with: 1) people and/or 2) potentially contaminated surfaces. Each action was considered as part of a common scenario (unusual and accidental situations were not taken into account).

In Table 1, for each VC action, the number of potential means of contamination (via contact with people or surfaces) has been assessed, to associate them with an average level of exposure to the virus.

In light of the wide variety of possible scenarios depending on the local context and given the absence of quantified contamination levels, the experts chose to use a qualitative, graduated increasing risk scale from + to +++. These are exposure levels that have been compared with one another; they are not absolute values (meaning that they cannot be used to predetermine the individual exposure levels of operators).

[32] "Environment" here refers to the broad sense of the word, encompassing all of the natural as well as artificial surroundings of humans.

[33] AP-HP note by Lucet of 14 April 2020:
http://www.cpias-ile-de-france.fr/docprocom/doc/lucet-and-co-masques-140420.pdf

Table 1: Identification of the various possible sources of contamination for VC operators with regard to the COVID-19 virus

Vector control (VC) actions	Possible sources of contamination by the COVID-19 virus **in the absence of specific precautions** (normal operations)	
	Contact people	Potentially contaminated surfaces[34]
Preparation of operations		
Going to a locker/access room/changing room to retrieve equipment, change clothes	One or more teams of operators, as well as planning colleagues providing instructions (+++)	Multiple objects frequently handled by several people (doorknobs, wash basins, furniture, preparatory documents – instructions and maps, etc.) (+++)
Preparation of biocide mixtures by the operator(s) (adulticides, Bti, etc.), filling of tanks	One (at least two people to fill tanks) or possibly a few colleagues wearing personal protective equipment (++)	Handling of professional equipment (cans, tanks, sprayers, etc.) with appropriate protection with regard to the chemical risk (biocide) (coveralls, gloves, mask) (+)
Travel to carry out operations	Close and prolonged (several hours) contact in a vehicle and in open air with a partner, less often with other people (if traffic is congested or in the event of a protest or *gendarmerie* checks, etc.) (+)	Car surfaces (door, steering wheel, gearshift lever, etc.) (+)
Operations in public spaces[35]		
Spatial spraying (at night) with a vehicle-mounted device[36]	Close and prolonged (several hours) contact in a vehicle with a partner only (+)	Car surfaces (door, steering wheel, gearshift lever, etc.) (+)
Anti-larval treatments (with Bti)	Possible contact with the public (++)	Multiple objects (urban furniture, tyres, electric cabinets, etc.) for which it cannot be known if they have been touched/handled within a period compatible with the virus's survival time (+)
Adulticide application with a standalone device	Possible contact with the public (++)	Multiple objects (urban furniture, waste, etc.) for which it cannot be known if they have been touched and/or handled within a period compatible with the virus's survival time (+)
Mechanical removal of mosquito-breeding sites	Possible contact with the public (++)	Moving/handling of multiple objects (pots, waste bins, tyres, etc.) for

[34] Taking into account the virus's persistence in the environment, contact surfaces are deemed potentially contaminated if they have been touched in the previous 24 hours. Objects not commonly used or usually used with protective equipment, or whose use is reserved for only one person, are considered as lesser sources of contamination.

[35] Verification and treatment if necessary of areas with numerous breeding sites known to be productive: distilleries, mangroves, crawl spaces, flood zones, pools of stagnant water in dry rivers, sewage treatment plants (STPs), etc.

[36] Spraying of insecticide on the streets of a neighbourhood with numerous cases of dengue, using a vehicle-mounted fogger.

Vector control (VC) actions	Possible sources of contamination by the COVID-19 virus **in the absence of specific precautions** (normal operations)	
	Contact people	Potentially contaminated surfaces[34]
		which it cannot be known if they have been touched/handled within a period compatible with the virus's survival time (++)
Residential door-to-door campaigns		
Verbal communication	Close and prolonged (~ 15mn) contact with the residents in the visited households (+++)	Intercom systems, handles, doors (++)
Distribution of informational brochures	Contact with the residents in the visited households (+++)	Hand-delivery of documents by operator to citizen[37] (++)
Mechanical removal of breeding sites	Contact with the residents in the visited households (+++)	Moving/handling of multiple objects (pots, waste bins, vases, etc.) for which it cannot be known if they have been touched/handled within a period compatible with the virus's survival time (+++)
Treatments around homes (adulticide application with a standalone device)	Possible contacts with the partner and the residents in the visited households (+++)	Possible handling of multiple objects outside of homes for which it cannot be known if they have been touched/handled within a period compatible with the virus's survival time (++)
Treatments within homes (adulticide application with a standalone device)	Possible contacts with the partner and the residents in the visited households (+++)	Multiple surfaces inside the visited households (doors, walls, furniture to be moved, etc.) (+++)
Distribution of repellents/bed nets	Close and prolonged (~ 15mn) contact with the residents in the visited households (+++)	Repellents/bed nets to be handled that may be hand-delivered, doorknobs, etc. (++)
Community mobilisation (excluding door-to-door campaigns and "remote" activities[38])		
School operations	Closed and prolonged contact with a large number of people (students, teachers) (+++)	Multiple surfaces (doors, furniture, informational brochures, etc.) (+++) indoors or (++) outdoors
Public meetings	Closed and prolonged contact with a large number of people (general public) (+++)	Multiple surfaces (doors, furniture, informational brochures, etc.) (+++) indoors or (++) outdoors
Participation in events, workshops, etc.	Closed and prolonged contact with a large number of people (general public) (+++)	Multiple surfaces (doors, furniture, informational brochures, etc.) (+++) indoors or (++) outdoors

[37] When no special precautions are taken, the risk of contamination is higher for the citizen (receiver) than for the operator (sender).
[38] i.e. media, social networks, etc.

Vector control (VC) actions	Possible sources of contamination by the COVID-19 virus **in the absence of specific precautions** (normal operations)	
	Contact people	Potentially contaminated surfaces[34]
Other actions		
Training	Closed and prolonged contact with a large number of people to be trained (+++)	Multiple surfaces (doors, furniture, informational brochures, etc.) (+++)
Commuting	Commuting alone (+) or carpooling (++)	Personal vehicle (+)
Breaks (lunch, etc.)	Possible close and prolonged contact with a colleague or other people, without wearing masks (+++)	Multiple surfaces, for which it cannot be known if they have been touched within a period compatible with the virus's survival time, without wearing gloves (+++)

For the same viral load, the risk of contamination by the COVID-19 virus increases with the number of close contacts with potentially contaminated individuals, as well as, to a lesser extent, with the number of contacts with contaminated surfaces. Thus, the VC actions posing the highest risk of contamination are those undertaken door to door and some specific community mobilisation actions (public meetings, events, etc.).

3.3.2. **Identification of means of prevention to reduce occupational risks**

3.3.2.1. Basic principles for the prevention of occupational risks

According to the French Labour Code (Article R4421-1 *et seq.*), if there is a risk to the health or safety of workers, any exposure to the biological agent in question must be avoided. When exposure cannot be avoided, it should be reduced by taking a series of incremental measures.

When it is not possible to eliminate the hazard, as is the case with a number of work situations in the current epidemic context, measures to limit risks of exposure to the SARS-CoV-2 virus, recommended by ANSES in its Opinion of 26 March 2020 (ANSES, 2020), must take into account the main means of transmission identified, which are direct transmission via expelled droplets and indirect transmission via hand-to-mouth or hand-to-face contact after touching contaminated surfaces or individuals.

As stated in the ANSES Opinion of 26 April 2020, before implementing any specific technical or organisational preventive measures, the employer must ensure strict application of the basic principles of preventing infection with the SARS-CoV-2 virus, namely physical distancing measures and the "barrier gestures" recommended by the health authorities (see § 3.2.2).

In general, there are four types of measures for preventing or reducing specific risks that the employer can put into place:

- *technical measures,* which aim to reduce the risks associated with the employees' work situation. These include limiting the quantity of droplets in a given space by implementing dilution measures such as ventilation, or installing physical barriers such as "sneeze guards" for activities in contact with the public;
- *organisational measures,* which generally involve adapting work policy or procedures to reduce or minimise exposure to a hazard;
- *practices that promote safety at the work station,* in order to reduce the duration, frequency or intensity of exposure to a hazard, and including the "barrier gestures" that constitute the essential basis for the prevention of transmission risks;

- *personal protective equipment (PPE) or adapted work equipment*: in the current epidemic context, this may include gloves, goggles, face shields or masks.

Independently of the SARS-CoV-2 epidemic and once all collective (physical, organisational, safety/general hygiene) measures have been implemented, measures to ensure safety at work can require the wearing of personal protective equipment to address risks inherent in a given work situation. Regardless of the reasons, this equipment should be part of an overall system intended to provide an acceptable level of protection. It is important to stress that the current epidemic situation in no way calls into question the PPE requirements determined following the assessment of activity-related risks as identified by the company in the single document on occupational risk assessment.

Regarding the limitation of exposure to SARS-CoV-2 and the use of PPE, ANSES stresses that although this equipment can help prevent certain types of exposure if used correctly, it should not replace the other measures defined in the prevention strategy.

Examples of PPE that can be used in the current epidemic context include gloves, goggles, face shields, and respiratory face masks. All types of PPE should be:

- selected based on the hazard to the worker;
- tightly fitted and properly worn;
- inspected, cared for and replaced on a regular basis, in accordance with the manufacturer's instructions for use;
- correctly removed, cleaned and stored or disposed of, as the case may be, to avoid contaminating oneself, others or the environment.

The various types of masks:

- <u>FFP1, 2 or 3 respiratory face mask</u>: This type of mask complies with the European health and safety requirements as well as the NF EN 149 standard. The mask's wearer is protected against inhaling suspended particles in the air that could contain infectious agents (and *a fortiori* against inhaling larger droplets). There are several types: FFP1 (filters 80% of aerosols), FFP2 (filters 94% of aerosols) and FFP3 (filters 99% of aerosols).

- <u>Mask for medical use ("surgical mask")</u>: this is a medical device (MD) that complies with the European health and safety requirements and with the NF EN 14683 standard. By preventing droplets expelled by the mask's wearer from being projected, this type of mask limits contamination of the external environment and other people. However, it does not protect against inhaling very small suspended particles in air. There are several types: type I, type II and IIR. Types II and IIR are intended for surgical use. Surgical masks are meant to be used only once. They should be changed as soon as they become wet and at least every four hours.

- <u>Alternative non-medical masks, called "barrier masks"</u>, developed in the context of the COVID-19 epidemic; these do not have PPE or MD status. The authorities are working with textile manufacturers to develop masks that, in combination with barrier gestures and physical distancing measures, may help certain non-medical professionals practise their activities. Two new categories of barrier masks have thus been defined based on Opinions of the French Health Products Safety Agency (ANSM) with adapted specifications:

    o *Category 1:* individual masks for use by professionals in contact with the public. These masks will be proposed to employees with positions or assignments involving regular contact with the public (cashiers, law enforcement officers, etc.). They filter 90% of the particles produced by the wearer;

o *Category 2:* collective masks to protect all the members of a group wearing these masks. These are intended for use by individuals having occasional contacts with other people in a professional setting. These masks may be worn by all of the individuals in a sub-group (company, department) when required by the workstation or working conditions. They filter 70% of the particles produced by the wearer.

Generally speaking, “home-made” or “do-it-yourself” masks are neither standardised nor tested and do not have the same performance.

In all cases:

- the wearing of a mask supplements barrier gestures but cannot replace them;
- the masks provided to combat COVID-19 should not provide less protection than those normally used by the same workers when they are exposed to other specific risks as part of their professional activity (chemical risk, etc.).;
- the wearing of PPE requires specific information and training to avoid contamination that could result from misuse (putting on, wearing conditions and duration, taking off, etc.).

Other PPE (gloves, goggles, etc.) should follow the same rules of use as masks: if it is not possible to adopt barrier gestures or use collective protective equipment, or when required by the activity (for example, if there is a risk of contaminating clothes in contact with infected surfaces).

Special attention should be paid to the use of gloves: used to keep hands from becoming contaminated when in contact with surfaces, they in turn may potentially be contaminated. The following precautions must be taken:

- do not touch your face when wearing gloves;
- when taking off your gloves, take care not to touch your skin with the outside part of the glove;
- put your gloves in a waste bin after each use;
- wash your hands or rub with hand sanitiser after removing your gloves.

For single-use PPE, its constant supply and disposal should be organised. For reusable PPE, its upkeep, in particular its cleaning, should also be organised.

3.3.2.2. Practical implementation of occupational risk prevention in the field

Since the start of the lockdown, all VC services have adopted measures intended to reduce risks of contamination by the SARS-CoV-2 virus that causes COVID-19 (including teleworking for certain activities) (see, for example, the Procedure on “Home visit following a report of an arbovirus case” of the Reunion Island ARS). In addition to the standard protective equipment used by operators who apply sprays (chemical masks, coveralls, gloves), which should be sufficient to limit any risk of contamination by SARS-CoV-2 during spraying (whether for the operators or for the residents in the treated areas), protective measures specific to VC actions have been established to reduce occupational risks. Although Guadeloupe has suspended all of its VC actions since 23 March, the hearings with the VC services of French Guiana, Martinique, Reunion Island and Mayotte enabled a number of good practices to be identified; these are measures implemented in workplaces, in the field or in vehicles (Table 2).

For example, for outdoor work, physical distancing measures (maintaining a distance of at least 1 m between people) and barrier gestures (washing hands and using hand sanitiser gel, etc.) help protect workers and the population from the risk of contamination between individuals.

Given their close proximity in service vehicles, operators are usually asked to wear a mask (generally a surgical mask) to protect themselves from one another when travelling. Sometimes, it seems that this practice is not well tolerated by operators, which is why some services go as far as asking operators to sit in staggered rows (with the passenger occupying the right rear seat) or use their personal vehicles for certain trips.

It was sometimes mentioned that workers can experience a sense of trust in their usual coworkers, reducing their compliance with barrier gestures and physical distancing measures [hearings with P. Rabarison, Mayotte ARS; M. Etienne, Territorial Collectivity of Martinique]. Moreover, in French overseas territories, except in Mayotte, since the COVID-19 epidemiological situation plateaued in mid-April in terms of the number of detected cases, the partial resumption of the activities and movements described above may contribute to reducing compliance with these barrier gestures for VC operators, just like for the rest of the population. It is therefore important to regularly communicate prevention messages.

Table 2: All of the preventive measures implemented by VC services to limit occupational exposure to SARS-CoV-2

To prevent person-to-person contamination	To prevent surface contamination
Within workplaces	
Physical distancing (>1 m) Staggered work hours Compartmentalisation of teams to prevent mixing Limit the size of teams Reserve time spent in workplaces for preparing and returning from assignments. Mask/shield	Hand-washing (soap, hand sanitiser) See that premises (handles, furniture, wash bins, etc.) are cleaned on a regular basis and at an increased frequency (adapt the cleaning protocol)
Within vehicles	
One person per vehicle OR seating of people in staggered rows OR wearing of masks Air out vehicles (between each use) Avoid changing drivers during a trip.	Hand-washing (soap, hand sanitiser) Regular cleaning of surfaces in contact with hands (i.e. doorknobs, steering wheel, gearshift lever, arm rests, etc.). Establish a protocol for cleaning vehicles (after every use) Use of a vehicle assigned to a given driver
Other places (public or private spaces)	
Physical distancing (>1 m) Masks/shields Reduce contact times where applicable (e.g. only interact with private individuals encountered when preparing and implementing mechanical control and larvicide) Breeding sites should be removed without any interaction with or proximity to the resident(s) in the visited home	Hand-washing (soap, hand sanitiser) Wearing of disposable gloves

Source: List of recommendations proposed based on the hearings

Some VC services have gone even further in the digitisation of interactions, to limit contact between colleagues or with citizens. For example, in Martinique, in terms of organisational measures, to limit the transmission of documents between colleagues, text messages/emails are sent at the beginning of the day or during the day to organise work [M. Etienne hearing].

In terms of community mobilisation, new technologies facilitate communication while limiting contacts. For example, the Territorial Collectivity of French Guiana broadcast a video clip[39] in several languages on social networks to raise the population's awareness of dengue control measures

[39] https://www.facebook.com/CTGuyane/videos/881157338998977/

during the lockdown [S. Chantilly hearing]. In Guadeloupe, communication on dengue is also continuing, combined with that on COVID-19 [Y. Thôle hearing], inviting citizens for example to take advantage of the cleaning operations carried out during the lockdown to remove breeding sites.

On Reunion Island, where door-to-door operations have been maintained, operators have been asked to put informational brochures in mailboxes instead of directly distributing them to residents. They have also been asked to maintain verbal communication while strictly complying with physical distancing measures [H. Thébault hearing].

As part of a Working Group led by the INTEFP[40], with the support of the Ministry of Agriculture, ANSES, the Health Insurance - Occupational Risks network, the INRS[41], the ANACT[42] and occupational physicians coordinated by Présance, the French Ministry of Labour prepared tip sheets for employers, which are responsible for the health and safety of their employees[43]. These sheets do not cover all of the trades authorised to work but are adaptable and are useful for all workers, to protect themselves from risks of COVID-19 contamination. As of 28 April 2020, there were no sheets specific to the activities of VC operators, but the recommendations from certain sheets could be transposed (see sheet entitled "Audit offices, verification offices, diagnosticians", for example).

3.3.3. Conclusion on occupational risk levels and how they are perceived

In the absence of exposure measurements and/or modelling for the COVID-19 virus, it is not possible to quantify contamination risk levels for VC operators themselves or for the population in contact with certain control activities. Nonetheless, by considering the various actions required for VC operations as a whole, the experts classified these operations into two categories based on the risk of SARS-CoV-2 contamination for workers:

- the most exposed activities are those requiring frequent and/or close contact with the public, especially if this contact occurs indoors (door-to-door public awareness-raising action, community mobilisation with people gathering in schools, public meetings, etc.);
- the least exposed activities are those not requiring any contact with the public, especially if they take place outdoors and with PPE (mechanical control, treatments around homes, spatial spraying, etc.).

This classification does not predetermine the final risk level for workers. This level depends in particular on the prevalence of COVID-19 in the population, the level and frequency of surface contamination, the effectiveness of the protective equipment used (masks, etc.), compliance with physical distancing measures and the application of barrier gestures.

In conclusion, given the exposure of VC operators to the COVID-19 virus (see § 3.3.1) and the existence of preventive and protective measures helping reducing this exposure for most of their activities (see § 3.3.2), the experts consider that VC professionals fall in the category of **low** exposure risk (when complying with distancing rules, applying barrier gestures, etc.) or **medium** exposure risk, for certain specific community mobilisation activities in direct contact with the population (public meetings inside a building, for example), according to the job category classification proposed by OSHA (OSHA 2020) (Box 3).

In the absence of precise measurements of exposure levels, this assessment was based on expert opinions (due to the current level of uncertainty, which is high, this Opinion will be updated if necessary based on changes in scientific knowledge).

[40] INTEFP: French National Institute of Labour, Employment and Vocational Training.
[41] INRS: French National Research and Safety Institute.
[42] ANACT: French National Agency for the Improvement of Working Conditions.
[43] https://travail-emploi.gouv.fr/le-ministere-en-action/coronavirus-Covid-19/proteger-les-travailleurs/article/fiches-conseils-metiers-et-guides-pour-les-salaries-et-les-employeurs

Box 3: Job category classification according to the level of risk of being infected with SARS-CoV-2

In its guide, OSHA (2020) proposed a classification of jobs based on whether the risk of exposure is low, medium, high or very high; at the same time, it provided recommendations specific to employers and workers for each risk category (Wong *et al.* 2020). In its Note of 26 March 2020, ANSES thus underlines that the risk level partly depends on the type of activity and the need for close contact (i.e. within 1 m) or repeated or prolonged contact with people known to be or suspected of being infected with SARS-CoV-2 (ANSES 2020).

Job classification:

Very high exposure risk: Very high exposure risk jobs are those with high potential for exposure to known or suspected sources of COVID-19 during specific medical, postmortem, or laboratory procedures.

High exposure risk: High exposure risk jobs are those with high potential for exposure to known or suspected sources of COVID-19.

Medium exposure risk: OSHA states that this category should include jobs that require frequent and/or close contact with (i.e. within 1 m of) people who may be infected with SARS-CoV-2, but who are not known or suspected COVID-19 patients. In workplaces where there is ongoing transmission, workers in this category may have contact with the general public (e.g. in high-population-density work environments and some high-volume retail settings).

Low exposure risk: Lower exposure risk jobs are those that do not require contact with people known to be, or suspected of being, infected with SARS-CoV-2 nor frequent close contact with (i.e. within 1 m of) the general public. Workers in this category have minimal occupational contact with the public and other coworkers.

3.3.4. Risk perceptions and acceptability of protective measures for workers

Risk perceptions play an essential role in motivating the adoption of preventive behaviours by professionals as well as non-professionals as part of their daily activities (Ferrer and Klein 2015). In the scientific literature, risk perceptions generally refer to the intuitive judgements voiced by people when asked about the nature, magnitude and consequences of the risks to which they are exposed. Risk perceptions are also considered to include a (probabilistic and consequentialist) cognitive dimension as well as an emotional dimension (fear of disease or accidents). In the area of chronic or endemic diseases, such as cardiovascular disease or AIDS[44], the emotional dimension of the perceived risk is often separated from its cognitive dimension. In other words, risks know as being serious and common (such as cancer induced by smoking or alcoholism) may not spark any particular concern in the population, especially when the risks have been chosen, or due to phenomena of psychological dependence on “familiar” risks (Slovic 2000). In the area of emerging infectious diseases on the other hand, it appears that the cognitive and emotional dimensions of perceived risk tend to converge. The difference also lies in the fact that in this case, individuals more readily agree to adopt preventive behaviours that protect not only themselves but also the community (wearing masks, for example).

In practice, perceptions of a low risk of contamination during social interactions can lower compliance with the instructions and recommendations that have been issued by the public authorities, whereas perceptions of a very high risk of infection can lead to avoidance behaviours or the taking of precautions that go beyond what is deemed necessary by public health experts. However, it should be noted that perceptions of a non-negligible health risk are an often necessary – but not always sufficient – condition to generate lasting behavioural changes in workers exposed to a hazard. The preventive measures recommended by the public authorities must be perceived as effective and acceptable (i.e. operationally tolerable) by the individuals concerned. The scientific literature reviews conducted over the last decade show that the combination of these two factors (perceptions of a risk to oneself and acceptability of preventive measures) is generally associated with high acceptance of

[44] Acquired immune deficiency syndrome.

individual or collective measures that can considerably reduce the risk of exposure to pathogens (Maloney, Lapinski, and Witte 2011).

Regarding COVID-19, unfortunately, no surveys on perceptions of risks and preventive measures have been undertaken in the DROMs, *a fortiori* in workers in contact with the public (even though research programmes are being prepared). However, the hearings tended to reflect the fear that some VC operators feel about being in contact with a potentially contagious population [hearings with P. Rabarison, Y. Thôle and H. Thébault]. Conversely, some residents also refuse to allow potentially contagious individuals to enter their homes [H. Thébault hearing].

The exceptional nature and duration of the lockdown has underlined the severity of the epidemic. Committees on health, safety and working conditions (CHSCTs) serve as sounding boards for these fears, which can cause suspensions of activity [Y. Thôle hearing] when the solutions found are not acceptable for workers. In Mayotte, there are notions of “fear of going into the field” and being contaminated [P. Rabarison hearing]. On Reunion Island, VC operators have expressed concerns about being chastised by residents angry with the institution they represent [H. Thébault hearing].

Furthermore, the numerous data collected from the population in metropolitan France have provided insight into how exposed workers perceive the risk of SARS-CoV-2 infection as well as the preventive measures recommended by the public authorities. As part of this expert appraisal, we analysed the data collected from 8 to 20 April 2020, from 4,005 individuals representative of the adult population in metropolitan France, by Arcane Research[45] in collaboration with the French School for Advanced Studies in Public Health (EHESP). Thanks to the size and nature of the sample, it was possible to precisely assess whether there were differences in perceptions between non-exposed workers (e.g. tele-workers) and workers exposed to social interactions as part of their professional activities. At the time of the expert appraisal (April 2020), due to the lockdown, it should be noted that almost one-third of the active population in metropolitan France is working away from home (companies, plants, offices, etc.) and that this percentage is likely to significantly increase in the coming weeks with the gradual easing of the lockdown measures.

[45] https://www.arcane-research.com/

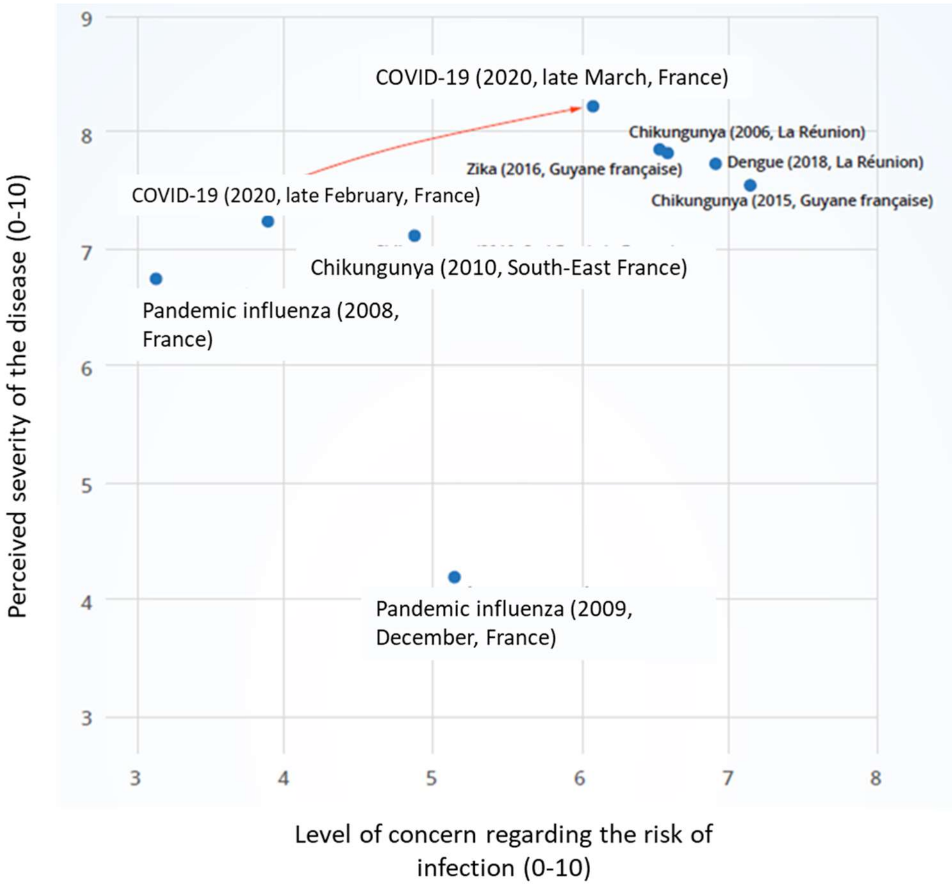

Figure 8: Perceived severity and concerns expressed during six outbreaks of emerging infectious diseases in France (source: COCONEL survey, 31 March-2 April 2020)

In general, as shown by the graph above (Figure 8), the comparison of the data on recent epidemics collected by various surveys as part of the COCONEL research programme[46] indicates that COVID-19 is not perceived in mainland France in a fundamentally different way than the other (re)emerging infectious diseases that have affected French overseas populations in the last decade. The data from the Arcane Research survey on the French population's response to COVID-19 also show that perceptions of risks and preventive measures related to COVID-19 are not necessarily associated with occupational exposure. In fact, as shown by the graph below (Figure 9), fears of contamination are not stronger in on-site workers than in tele-workers. However, they are higher in the jobless active population (average of 5.2 versus 5.6 out of 10 for this population, $p < 0.01$), which suggests the influence of a socio-economic rather than a health component in the understanding of risks associated with COVID-19. That said, it appears that workers in contact with the public are well aware of the fact that they are more at risk than others. "Exposed" workers assigned much higher scores than other active workers (4.8 versus 3.9 out of 10, $p < 0.001$) for the item regarding the probability/possibility of catching COVID-19 by the end of the epidemic. Lastly, no significant differences were found in mainland France regarding the perceived effectiveness and acceptability of the preventive measures recommended by the public authorities. The upcoming replication of these surveys in certain DROMs is expected to provide better knowledge of the overseas context.

[46] https://www.ehesp.fr/2020/04/08/etude-coconel-un-consortium-de-chercheurs-analyse-le-ressenti-et-le-comportement-des-francais-face-a-lepidemie-de-Covid-19-et-au-confinement/

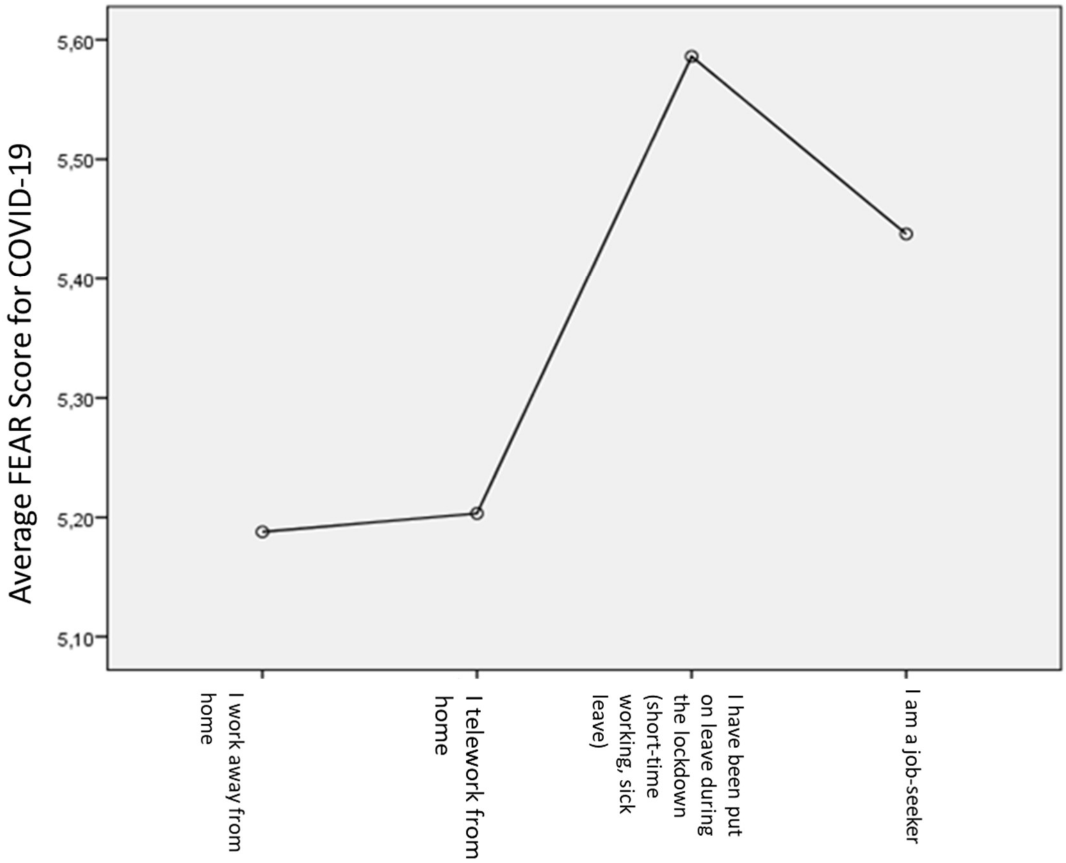

Figure 9: Fears expressed by active individuals in mainland France and Corsica depending on their professional situation (source: Arcane Research survey, 8-20 April 2020)

To conclude, it is important to stress, for precautionary purposes, the dynamic and changing nature of risk perceptions and of the social acceptability of preventive measures (Loewenstein and Mather 1990). Research work undertaken during the chikungunya epidemic in French Guiana showed, among other things, that perceptions of infectious risk decreased significantly as the spread of the virus slowed down in the population (Raude *et al.* 2019). It is thus likely that a drop in the incidence of COVID-19 will favour a reduction in the preventive efforts made by exposed as well as non-exposed workers and will ultimately cause the number of cases to increase again (especially if the virus turns out to be insensitive to seasonal weather fluctuations), which could favour the occurrence of a second epidemic wave.

3.4. Risk-benefit analysis of maintaining or suspending VC for the general population

3.4.1. **"COVID-19" risk related to VC activities for the general population**

As is the case for VC operators, the risk of the SARS-CoV-2 virus being transmitted from a potentially contaminated operator or a neighbour to the population during the implementation of a VC action requiring contact with an operator (door-to-door campaign, destruction of breeding sites, etc.) is **low** (when complying with distancing rules and applying barrier gestures) or **medium** for certain specific community mobilisation activities where people gather together inside a building (public meetings).

3.4.2. Vector risk for the general population associated with the suspension of all or some VC actions

3.4.2.1. Discussion on the (entomological and/or epidemiological) effectiveness of "traditional" VC methods

VC strategies combine several types of actions within an integrated control approach. These involve various forms of biocide treatments targeting mosquitoes in adult stages (spatial spraying of deltamethrin inside and outside of homes) and in pre-fledging stages (application of Bti – or Bs – to breeding sites), as well as mechanical control measures (destruction of breeding sites) taken by operators in the public sphere or by populations in their private spaces; community mobilisation operations need to be carried out to raise awareness among these populations, primarily through door-to-door campaigns and public meetings, or by communicating via media and social networks (see description of these various approaches in § 3.2.1).

Table 3 shows a summary of the literature regarding relative estimates of the individual entomological and/or epidemiological effectiveness of each type of VC operation recommended to combat dengue and malaria in France (it is not an assessment of the absolute effectiveness of these operations). Each of the actions has its own specific effects: for example, the destruction of breeding sites has a major impact on densities of adult mosquitoes in comparison with adulticide treatments which have a low relative impact on these same densities but help significantly reduce the longevity of vector populations and at the same time eliminate older females most likely to transmit a pathogen (with an immediate effect on the transmission and spread of viruses).

Table 3: Estimation of the specific entomological and/or epidemiological effectiveness of the various VC actions conducted to combat dengue and malaria in France and risk of SARS-CoV-2 exposure of VC operators during their implementation

Operation	Entomological and/or epidemiological effectiveness	Level of evidence	Key studies
Operations in the public sphere			
Spatial spraying on the street with a vehicle-mounted device	Low	Low	(Stoddard *et al.* 2014, Esu *et al.* 2010, Samuel *et al.* 2017)
Spatial spraying in the public sphere with a standalone device	Moderate	Low	(Muzari *et al.* 2017, Samuel *et al.* 2017)
Mechanical removal of breeding sites	High	Moderate	(Alvarado-Castro *et al.* 2017)
Anti-larval treatments (Bti, Bs)	High	Moderate	(Boyce *et al.* 2013)
Door-to-door operations in the private sphere (residential)			
Awareness-raising, community mobilisation	High (reduction of dengue cases)	High	(Andersson *et al.* 2015, Alvarado-Castro *et al.* 2017)
Mechanical removal of breeding sites (by operators or residents)	Moderate	Low	(Alvarado-Castro *et al.* 2017)
Treatments within homes (adulticide application with a standalone device)	High (reduction of dengue cases)	High	(Vazquez-Prokopec *et al.* 2017, Samuel *et al.* 2017)
Standalone treatments of plants in home gardens	Moderate	Moderate	(Samuel *et al.* 2017, Boubidi *et al.* 2016)

Operation	Entomological and/or epidemiological effectiveness	Level of evidence	Key studies
Operations in the public sphere			
Other actions			
Community mobilisation with no door-to-door campaign (media, social networks, etc.)	Moderate	Low /moderate	(Heintze, Garrido, and Kroeger 2007, Al-Muhandis and Hunter 2011)

source: (Roiz et al. 2018) adapted

Note: Depending on the specific entomological (vector, vector density, resistance, etc.) and epidemiological context of each French overseas territory, the combination of the various actions included in the integrated VC strategy operationally implemented in the field is not necessarily the same.

3.4.2.2. Assessment of risks for the general population

Although very few data are available to estimate the effectiveness of VC actions, their complementarity and the resulting synergy mean they are more effective when undertaken simultaneously. The experts therefore consider that abandoning one or more specific actions would end up reducing the overall effectiveness of VC.

However, the hearings held with VC services revealed that, in the current health context and the anxiety-provoking climate generated by the COVID-19 pandemic, some of the actions considered the most effective (such as door-to-door campaigns and spraying in homes) had been neglected [hearings with M. Etienne, Martinique and P. Rabarison, Mayotte] and even that all VC actions had been suspended during the lockdown [Y. Tholle hearing, Guadeloupe]. The significant decrease in VC actions will likely negatively impact the dynamics of the current dengue epidemics in French overseas territories.

It is important to reiterate here that in late austral summer, Reunion Island and Mayotte are in the midst of an epidemic with the co-circulation of several DENV serotypes favouring an increased risk of secondary dengue cases and thus of the occurrence of severe forms in infected individuals. In the French *départements* in the Americas, the number of dengue cases was on the rise before the lockdown. Moreover, the historical analysis of the epidemics that have occurred in the Caribbean over the past few years suggests there will be strong momentum starting in June and continuing into July and August. These two points suggest a possible surge in the epidemic in the coming months. In French Guiana, due to its geography, seasonality cannot be considered at the departmental level. Nonetheless, past epidemics have mainly occurred in the first half of the year. With this in mind, notwithstanding the possible under-reporting of cases like in the Caribbean, the current epidemic along the Maroni River may be on the decline; on the coast, however, in particular in the west and on Cayenne Island, the epidemic that was declared more recently may be amplified in the coming weeks.

The experts consider that for the general population, the effects of a reduction in VC activities – and thus in the effectiveness of VC against dengue epidemics– and the health consequences this may generate (see § 3.1.5) would be greater than the potential health consequences (accidental transmission of SARS-CoV-2 to the population) of maintaining the activities of VC services in full compliance with physical distancing and preventive measures.

In conclusion, **it is essential to reinforce all of the actions included in VC strategies,** as usually practised to combat dengue and malaria in French overseas territories and more broadly in France, and to **establish optimum conditions that minimise the exposure of VC professionals to SARS-CoV-2** and the spread of this virus **in populations** during the implementation of these actions (see § 3.3.2 and recommendations in § 3.6.2).

3.5. Conclusions of the "Dengue and lockdown" GECU

All of France's overseas *départements* and regions are currently in the pre-epidemic or epidemic stage of dengue, with viral co-circulation. On 17 March, France went into a nationwide lockdown, due to the current COVID-19 epidemic.

In this dual context, it appears essential to continue implementing VC operations to reduce the number of dengue (and malaria) cases, in order to avoid saturating hospital services (which are sometimes already very fragile and/or are busy caring for COVID-19 patients and clinical forms of high-risk dengue) and prevent cases of dengue-COVID-19 co-infection that may end up being more severe. In this regard, the activities of VC operators should be considered as essential and their health and social utility should be publicly recognised and underlined.

As part of a risk-effectiveness analysis, the VC actions posing the greatest risk of SARS-CoV-2 contamination for operators were identified, and the effectiveness of VC operations, whether alone or combined (integrated control), was discussed. After examining the various actions normally conducted by VC operators during their work, the experts consider they belong to a low (spatial spraying, mechanical control, etc.) to medium risk (direct contact with the population, public meetings, etc.) occupational category of exposure to SARS-CoV-2 in the absence of specific precautions against the risks associated with SARS-CoV-2, according to the OSHA classification (see ANSES Opinion of 26 March 2020). Preventive measures are necessary (technical, organisational measures, personal protection, etc.) to protect workers as well as the population targeted by their operations.

Moreover, considering that to be optimally effective, VC actions should be implemented as part of an integrated control strategy, and given that exclusively chemical control is not desirable (due to environmental impacts, resistance and acceptability issues), the experts believe that, with the exception of actions requiring gatherings of people, all usual VC activities should be maintained, subject to modifications intended to protect workers (wearing masks and complying with minimum distances between people, etc.) (see recommendations below).

3.6. Recommendations

Reminder: The assessments, discussions and recommendations presented in this report were carried out/prepared in the current state of available scientific knowledge on SARS-CoV-2 and are subject to revision.

3.6.1. **Modifications to be made to vector control strategies**

Considering:

- the urgent need to combat arboviruses and malaria in general, and specifically in the current context of the dengue epidemics occurring in overseas France;
- that only an integrated control approach can be truly effective to combat these epidemics;
- that this control cannot be exclusively "chemical", as this would not significantly lower vector densities and would expose the environment to the potentially harmful consequences of biocides and generate problems related to insecticide resistance in vectors;
- that control techniques are all the more effective when they are complementary and combined as part of an integrated strategy;

- that epidemiological surveillance is an integral part of integrated control;
- that waste proliferation poses a major risk in terms of the expansion of breeding sites;

the GECU's experts recommend:

- maintaining the implementation of VC actions (door-to-door campaigns, mechanical control, treatments around and within homes, etc.) as part of an integrated control approach, while guaranteeing that operators are protected against the risk of SARS-CoV-2 transmission (see § 3.6.2) and while protecting the population;
- ensuring that VC services have the material and human resources needed for the ongoing fulfilment of their missions (implementation of business continuity and disaster recovery plans during and after the lockdown);
- directly involving operators from VC services in the construction of these business continuity and disaster recovery plans, especially with regard to personal protective measures;
- maintaining the surveillance of dengue (and other arbovirus) cases in French territories, as this surveillance will determine VC actions (targeting isolated cases, hotspots, etc.) during and after the easing of the lockdown;
- reinforcing communication with the public, with clear and specific messages that should be disseminated and covered by the media and shared on social networks so that the population i) in the event of any symptoms of dengue, consults the healthcare professionals who have organised themselves to protect their patients from COVID-19 risk by putting into place and complying with the recommended barrier measures, ii) facilitates the work of VC operators who strictly comply with barrier measures preventing the spread of COVID-19, and iii) adopts physical control measures in the context of community mobilisation (personal protection, body repellents, removal of breeding sites) (see § 3.6.3);
- reinforcing the collection of waste and bulky refuse, and ensuring its proper disposal.

3.6.2. **Protection of VC operators**

Before considering the implementation of technical or organisational preventive measures by employers, it is necessary to reiterate the importance of the basic principles for preventing infections that individuals should follow, to reduce their risk of contracting COVID-19. These include physical distancing measures and personal hygiene practices such as frequent hand-washing with soap or a hand sanitiser solution, as well as proper coughing and sneezing techniques, called "barrier gestures" by the health authorities in the current context of mobilisation.

Considering:

- that the necessary continuity of VC should not compromise the safety of VC operators;
- that in all sectors, barrier gestures, personal hygiene practices and distancing rules are the best forms of protection against the spread of COVID-19;
- that the Ministry of Labour has published several general and intersectoral practical sheets, by trade or area of activity[47], highlighting recommendations to protect workers;

[47] To support all companies and all employees in this period of unprecedented restrictions, the Ministry of Labour set up a team of experts dedicated to issuing specific recommendations to respond to the dual challenges of continuity and protection: https://travail-emploi.gouv.fr/le-ministere-en-action/coronavirus-Covid-19/proteger-les-travailleurs/article/fiches-conseils-metiers-et-guides-pour-les-salaries-et-les-employeurs

- that workers' concerns are legitimate with regard to risks of contamination as part of their activities;
- the current state of knowledge on SARS-CoV-2 transmission;
- the importance of taking into account operators' risk perceptions and the acceptability of the recommended protective measures, in order to regularly adapt practices to needs and operational constraints;

the GECU's experts recommend:

- regularly reminding VC operators of physical distancing rules and barrier gestures, including after the gradual easing of the lockdown;
- implementing the recommendations[48] of the Ministry of Labour for the maintenance of changing rooms, social areas and smoking areas (flow direction, pedal bins, etc.);
- adapting the workstations of the most vulnerable workers (co-morbidity factors, chronic disease, etc.);
- regularly reviewing and adapting prevention messages aimed at VC operators based on advances in scientific knowledge on how SARS-CoV-2 is transmitted;
- including CHSCTs in the drafting and revision of the operating protocols, business continuity plans (BCPs) and disaster recovery plans (DRPs) of VC services;
- proposing and disseminating a standard questionnaire for administrations, for the collection of data on perceptions of occupational risks and the acceptability of protective measures among VC operators.

The GECU's experts also reiterate that, to fulfil their obligations in terms of the health and safety of employees during the epidemic, employers must implement measures enabling compliance with the barrier and distancing gestures recommended by the Government and must supply the consumables and protective equipment required by employees (soaps, hand sanitiser gels, masks, gloves, etc.).

3.6.3. **Community mobilisation**

Considering:

- the need to continue conducting community mobilisation actions (see definition in § 3.2.1) to combat arboviruses, in a context where communication on COVID-19 has taken up the large majority of media space since the beginning of 2020 (during and possibly after the lockdown);
- the effectiveness of community mobilisation actions in the control of arboviruses, especially that of door-to-door campaigns;
- the risk of dengue epidemics becoming amplified if there is no community mobilisation to control breeding sites;
- the need for communes, communities of communes and associations to participate in community mobilisation;
- that the population is spending more time at home (including in gardens), where mosquito bites are more likely;

[48] https://travail-emploi.gouv.fr/IMG/pdf/covid19_vestiaires_v050520.pdf

the GECU's experts recommend:

- continuing the implementation of door-to-door campaigns, while complying with the recommendations to prevent "COVID-19" risk for VC operators (physical distancing, barrier gestures, personal protection, etc.);
- leaving sufficient room for communication in favour of community mobilisation against arboviruses during and after the lockdown, in combination with strong communication on COVID-19;
- taking advantage of the current exceptional situation to be flexible and innovative in terms of communication (digitised communication materials, active and powerful use of social networks, sand kits with explanations to reduce breeding sites in combination with saucers in garden centres, etc.);
- issuing messages suited to the lockdown situation of residents and to businesses that have stayed open (garden centres, sport and leisure (DIY in particular), food/drink, etc.), focusing on the mechanical destruction of structural breeding sites. The aims are to i) use the lockdown as a positive opportunity for residents to pay attention to their homes and gardens, with a view to the long-term reduction of breeding sites (e.g. verification and modification of the gutter slope, modification of plantations in gardens, etc.), and ii) raise awareness in the population (amateur gardeners, etc.) regarding the use of personal protective equipment (clothes that cover the body, repellents[49], etc.).
- suspending community mobilisation actions involving gatherings of numerous people (workshops, public meetings, etc.), in accordance with the prefectural and/or governmental recommendations;
- continuing to disseminate prevention messages after the easing of the lockdown and maintaining an appropriate frequency of messages based on the epidemic level;
- increasing the participation of communes and communities of communes in community mobilisation and the hygiene control of environments;
- continuing to inform the population and travellers of the need to consult a doctor if experiencing evocative signs of dengue (or malaria) and protect themselves from mosquito bites;
- developing a participatory science platform, along the same lines as covid.net and grippe.net[50] (created by INSERM), to supplement the surveillance scheme with an information system on how populations respond to dengue and to help the population acquire knowledge.

3.6.4. **Recommendations for funders and research teams**

Considering:

- the need to i) develop alternative vector control tools and methods to supplement the integrated control strategy, and ii) reduce contacts between individuals;
- the lack of data on the environmental persistence of SARS-CoV-2 (depending on the type of surface, etc.) and the infectious dose, which would be necessary to assess the occupational risks of VC operators;

[49] https://books.openedition.org/irdeditions/9385?lang=en
https://www.medecine-voyages.fr/publications/ppavtextecourt.pdf
[50] https://www.inserm.fr/actualites-et-evenements/actualites/covidnetfr-vous-pouvez-tous-aider-surveillance-epidemie

- the risks potentially associated with dengue-COVID-19 co-infections (severity of cases, number of people in intensive care, etc.);

the GECU's experts recommend:

- continuing the development of new VC techniques for the mosquito vectors of arboviruses and malaria, which would help improve the effectiveness of integrated control while limiting contacts with the population. These techniques may include the mass trapping of gravid females, pyriproxyfen auto-dissemination, the sterile insect technique (SIT), Wolbachia methods, or attractive toxic sugar baits. The use of these techniques in combination with other techniques within an integrated control programme could be very useful to reduce the use of insecticides, especially in the interval between epidemics;
- developing scenarios on co-exposure to infectious (for SARS-CoV-2 in particular) and chemical risks in VC operators, to better assess occupational risks.

4. AGENCY CONCLUSIONS AND RECOMMENDATIONS

The French Agency for Food, Environmental and Occupational Health & Safety endorses the conclusions and recommendations of the GECU mobilised for the emergency expert appraisal on the benefit-risk assessment of the vector control practices usually implemented to combat dengue, in the current context of the COVID-19 pandemic.

The guidelines proposed in this document provide a general framework for preventing risks of exposure to the SARS-CoV-2 virus for VC operators. The conclusions of the Opinion are based on expert opinions, since it was not possible, within the allotted time period, to base the expert appraisal on an in-depth review of the scientific literature.

ANSES underlines that despite the framework put into place to cope with the COVID-19 epidemic, it is essential to continue the integrated control of arboviruses and malaria which, as reiterated by the experts, can only be effective if it is the result of efforts made jointly by VC services and the population. On this topic, it stresses the importance of the experts' recommendations regarding the need for sustained intensive information on pre-existing epidemic risks (dengue, Zika, malaria, etc.), at a time when the media is tending to focus its attention on COVID-19. Regarding the protection of VC operators, the Agency reiterates that masks and other personal protective equipment are the last link in a chain of necessary measures and practices, including "barrier gestures", to protect VC professionals and the population from SARS-CoV-2.

Dr Roger Genet

ANNEX 1: KEYWORDS AND REFERENCES

KEYWORDS

Covid-19, SARS-CoV2, Coronavirus, dengue, paludisme, moustique, vecteur, épidémie, lutte anti-vectorielle, confinement, rapport bénéfices/risques.

COVID-19, SARS-CoV-2, Coronavirus, dengue, malaria, mosquito, vector, epidemic, vector control, lockdown, benefit/risk ratio.

REFERENCES

Al-Muhandis, Nada, and Paul R Hunter. 2011. "The value of educational messages embedded in a community-based approach to combat dengue fever: a systematic review and meta regression analysis." *PLoS neglected tropical diseases* 5 (8).

Alvarado-Castro, V., S. Paredes-Solis, E. Nava-Aguilera, A. Morales-Perez, L. Alarcon-Morales, N. A. Balderas-Vargas, and N. Andersson. 2017. "Assessing the effects of interventions for Aedes aegypti control: systematic review and meta-analysis of cluster randomised controlled trials." *BMC Public Health* 17 (Suppl 1):384. doi: 10.1186/s12889-017-4290-z.

Andersson, N., E. Nava-Aguilera, J. Arostegui, A. Morales-Perez, H. Suazo-Laguna, J. Legorreta-Soberanis, C. Hernandez-Alvarez, I. Fernandez-Salas, S. Paredes-Solis, A. Balmaseda, A. J. Cortes-Guzman, R. Serrano de Los Santos, J. Coloma, R. J. Ledogar, and E. Harris. 2015. "Evidence based community mobilization for dengue prevention in Nicaragua and Mexico (Camino Verde, the Green Way): cluster randomized controlled trial." *Bmj* 351:h3267. doi: 10.1136/bmj.h3267.

Anses. 2020. Note d'appui scientifique et technique (AST) de l'Anses relative à la proposition d'orientations utiles pour la prévention de l'exposition au virus SRAS-CoV-2 en milieu professionnel, dans des contextes autres que ceux des soins et de la santé du 26 mars 2020.

Beeching, Nick. 2005. "Fever in the returning traveller." *Medicine* 33 (7):3-6.

Boubidi, Saïd C, David Roiz, Marie Rossignol, Fabrice Chandre, Romain Benoit, Marc Raselli, Charles Tizon, Bernard Cadiou, Reda Tounsi, and Christophe Lagneau. 2016. "Efficacy of ULV and thermal aerosols of deltamethrin for control of Aedes albopictus in Nice, France." *Parasites & vectors* 9 (1):597.

Boyce, R., A. Lenhart, A. Kroeger, R. Velayudhan, B. Roberts, and O. Horstick. 2013. "Bacillus thuringiensis israelensis (Bti) for the control of dengue vectors: systematic literature review." *Trop Med Int Health* 18 (5):564-77. doi: 10.1111/tmi.12087.

Casanova, Lisa M, Soyoung Jeon, William A Rutala, David J Weber, and Mark D Sobsey. 2010. "Effects of air temperature and relative humidity on coronavirus survival on surfaces." *Appl. Environ. Microbiol.* 76 (9):2712-2717.

Chin, Alex W. H., Julie T. S. Chu, Mahen R. A. Perera, Kenrie P. Y. Hui, Hui-Ling Yen, Michael C. W. Chan, Malik Peiris, and Leo L. M. Poon. 2020. "Stability of SARS-CoV-2 in different environmental conditions." *The Lancet Microbe*. doi: https://doi.org/10.1016/S2666-5247(20)30003-3.

Claeys C. (2019) (ed), *Mosquito management: environmental issues and health concerns*, Peter Lang, Bruxelles.

Claeys C., Robles C, Bertaudiere-Montes V, Deschamps-Cottin M, Megnifo HT, Pelagie-Moutenda R, Jeannin C, Sonor F, Dollin C, Sense M, Bravet P, Weill L, Demerrisse C, Mazurek H, Arrhegini L, Etienne M, Yebakima A, Gustave J, Fouque F. (2016) Socioecological factors contributing to the exposure of human populations to mosquito bites that transmit dengue fever, chikungunya and zika viruses: a comparison between mainland France and the French Antilles. *Environ Risque Sante*, 15.4:1-8.

Deslandes A, V Berti, Y Tandjaoui-Lambotte, Chakib Alloui, E Carbonnelle, JR Zahar, S Brichler, Yves Cohen, SARS-COV-2 was already spreading in France in late December 2019, International Journal of Antimicrobial Agents, 2020, 106006

Dupé, Sandrine. 2015. ""Séparer les moustiques des humains à La Réunion. Co-production d'un nouvel ordre socio-naturel en contexte post-colonial." La Réunion.".
ECDC, European Centre for Disease Prevention and Control. 2020. Cluster of pneumonia cases caused by a novel coronavirus, Wuhan, China. In *17 January 2020. ECDC: Stockholm*.
Esu, E., A. Lenhart, L. Smith, and O. Horstick. 2010. "Effectiveness of peridomestic space spraying with insecticide on dengue transmission; systematic review." *Trop Med Int Health* 15 (5):619-31. doi: 10.1111/j.1365-3156.2010.02489.x.
Ferrer, Rebecca, and William M. Klein. 2015. "Risk perceptions and health behavior." *Current opinion in psychology* 5:85-89. doi: 10.1016/j.copsyc.2015.03.012.
Fontenille, Didier (dir.) ; et al. . 2009. "La lutte antivectorielle en France. ." *Nouvelle édition [en ligne]. Marseille : IRD Éditions, 2009 (généré le 29 avril 2020).* .
Franke F, Giron S, Cochet A, Jeannin C, Leparc-Goffart I, de Valk H, et al. . 2019. "Émergences de dengue et de chikungunya en France métropolitaine, 2010-2018. B." *ull Epidémiol Hebd. 2019;(19-20):374-82*.
Heintze, Christoph, M Velasco Garrido, and Axel Kroeger. 2007. "What do community-based dengue control programmes achieve? A systematic review of published evaluations." *Transactions of the Royal Society of Tropical Medicine and Hygiene* 101 (4):317-325.
Hotta, S. 1952. "Experimental studies on dengue. I. Isolation, identification and modification of the virus." *J Infect Dis* 90 (1):1-9.
Huang, C., Y. Wang, X. Li, L. Ren, J. Zhao, Y. Hu, L. Zhang, G. Fan, J. Xu, X. Gu, Z. Cheng, T. Yu, J. Xia, Y. Wei, W. Wu, X. Xie, W. Yin, H. Li, M. Liu, Y. Xiao, H. Gao, L. Guo, J. Xie, G. Wang, R. Jiang, Z. Gao, Q. Jin, J. Wang, and B. Cao. 2020. "Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China." *Lancet* 395 (10223):497-506. doi: 10.1016/s0140-6736(20)30183-5.
Idelson, Bernard, and Gudrun Ledegen. 2011. *Chikungunya: la médiatisation d'une crise presse, humour, communication publique*.
Kampf, Günter, Daniel Todt, Stephanie Pfaender, and Eike Steinmann. 2020. "Persistence of coronaviruses on inanimate surfaces and its inactivation with biocidal agents." *Journal of Hospital Infection*.
Li, Xiaowei, Manman Geng, Yizhao Peng, Liesu Meng, and Shemin Lu. 2020. "Molecular immune pathogenesis and diagnosis of COVID-19." *Journal of Pharmaceutical Analysis*.
Loewenstein, George, and Jane Mather. 1990. "Dynamic Processes in Risk Perception." *Journal of Risk and Uncertainty* 3 (2):155-175.
Lovato, Andrea, and Cosimo de Filippis. 2020. "Clinical Presentation of COVID-19: A Systematic Review Focusing on Upper Airway Symptoms." *Ear, Nose & Throat Journal*:0145561320920762.
Maloney, Erin K., Maria K. Lapinski, and Kim Witte. 2011. "Fear Appeals and Persuasion: A Review and Update of the Extended Parallel Process Model." *Social and Personality Psychology Compass* 5 (4):206-219. doi: 10.1111/j.1751-9004.2011.00341.x.
Metzger, Pascale. 2009. "L'épidémie de chikungunya: un problème de moustiques." *Comment se construisent les problèmes de santé publique*:175-193.
Muzari, Mutizwa Odwell, Gregor Devine, Joseph Davis, Bruce Crunkhorn, Andrew Van Den Hurk, Peter Whelan, Richard Russell, James Walker, Peter Horne, and Gerhard Ehlers. 2017. "Holding back the tiger: successful control program protects Australia from Aedes albopictus expansion." *PLoS neglected tropical diseases* 11 (2).
OMS. 1986. "Charte d'Ottawa pour la promotion de la santé." Première conférence internationale pour la promotion de la santé, Ottawa (Ontario).
OSHA. 2020. Guidance on Preparing Workplaces for COVID-19. .
Raude, Jocelyn, Kathleen McColl, Claude Flamand, and Themis Apostolidis. 2019. "Understanding health behaviour changes in response to outbreaks: Findings from a longitudinal study of a large epidemic of mosquito-borne disease." *Social science & medicine (1982)* 230:184-193. doi: 10.1016/j.socscimed.2019.04.009.
Roiz, David, Anne L Wilson, Thomas W Scott, Dina M Fonseca, Frédéric Jourdain, Pie Müller, Raman Velayudhan, and Vincent Corbel. 2018. "Integrated Aedes management for the control of Aedes-borne diseases." *PLoS neglected tropical diseases* 12 (12).
Salje, Henrik, Cécile Tran Kiem, Noémie Lefrancq, Noémie Courtejoie, Paolo Bosetti, Juliette Paireau, Alessio Andronico, Nathanaël Hoze, Jehanne Richet, Claire-Lise Dubost, Yann Le Strat, Justin Lessler, Daniel Bruhl, Levy, Arnaud Fontanet, Lulla Opatowski, Pierre-Yves Boëlle, and Simon Cauchemez. 2020.
Samuel, M., D. Maoz, P. Manrique, T. Ward, S. Runge-Ranzinger, J. Toledo, R. Boyce, and O. Horstick. 2017. "Community effectiveness of indoor spraying as a dengue vector control method: A systematic review." *PLoS Negl Trop Dis* 11 (8):e0005837. doi: 10.1371/journal.pntd.0005837.
Slovic, Paul. 2000. *The perception of risk*, *The perception of risk.* London, England: Earthscan Publications.

Soulancé D., Gaimard M., Bley D. et Vernazza-Licht N. 2011. Lieux de vie et santé des populations : l'exemple du chikungunya à la Réunion, *Cahiers de géographie du Québec*, 55:156, 603-621.

SpF. 2020. "Point épidémiologique - Epidémie de Dengue à la Réunion - Augmentation du nombre de cas hebdomadaires- Point au 26 janvier ». Santé Publique France.".

Stoddard, S. T., H. J. Wearing, R. C. Reiner, Jr., A. C. Morrison, H. Astete, S. Vilcarromero, C. Alvarez, C. Ramal-Asayag, M. Sihuincha, C. Rocha, E. S. Halsey, T. W. Scott, T. J. Kochel, and B. M. Forshey. 2014. "Long-term and seasonal dynamics of dengue in Iquitos, Peru." *PLoS Negl Trop Dis* 8 (7):e3003. doi: 10.1371/journal.pntd.0003003.

Thiann-Bo, Marie. 2019. The chikungunya outbreak in Reunion: epidemic or environmental crisis?

van Doremalen, Neeltje, Trenton Bushmaker, Dylan H. Morris, Myndi G. Holbrook, Amandine Gamble, Brandi N. Williamson, Azaibi Tamin, Jennifer L. Harcourt, Natalie J. Thornburg, Susan I. Gerber, James O. Lloyd-Smith, Emmie de Wit, and Vincent J. Munster. 2020. "Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1." *New England Journal of Medicine* 382 (16):1564-1567. doi: 10.1056/NEJMc2004973.

Vazquez-Prokopec, Gonzalo M., Brian L. Montgomery, Peter Horne, Julie A. Clennon, and Scott A. Ritchie. 2017. "Combining contact tracing with targeted indoor residual spraying significantly reduces dengue transmission." *Science Advances* 3 (2):e1602024. doi: 10.1126/sciadv.1602024.

Wang, W., Y. Xu, R. Gao, R. Lu, K. Han, G. Wu, and W. Tan. 2020. "Detection of SARS-CoV-2 in Different Types of Clinical Specimens." *Jama*. doi: 10.1001/jama.2020.3786.

Watin, M., Metzger, P., Taglioni, F., & Idelson, B. . 2009. "Situation de crise, opinion publique et vulnérabilités: L'épidémie de chikungunya à La Réunion et à Mayotte." *Rapport final de l'IRD pour le Ministère de l'Outre-Mer.*

Wong, Jolin, Qing Yuan Goh, Zihui Tan, Sui An Lie, Yoong Chuan Tay, Shin Yi Ng, and Chai Rick Soh. 2020. "Preparing for a COVID-19 pandemic: a review of operating room outbreak response measures in a large tertiary hospital in Singapore." *Canadian Journal of Anesthesia/Journal canadien d'anesthésie*:1-14.

Xiang, Fei, Xiaorong Wang, Xinliang He, Zhenghong Peng, Bohan Yang, Jianchu Zhang, Qiong Zhou, Hong Ye, Yanling Ma, and Hui Li. 2020. "Antibody Detection and Dynamic Characteristics in Patients with COVID-19." *Clinical Infectious Diseases*.

Yan, G., C. K. Lee, L. T. M. Lam, B. Yan, Y. X. Chua, A. Y. N. Lim, K. F. Phang, G. S. Kew, H. Teng, C. H. Ngai, L. Lin, R. M. Foo, S. Pada, L. C. Ng, and P. A. Tambyah. 2020. "Covert COVID-19 and false-positive dengue serology in Singapore." *Lancet Infect Dis*. doi: 10.1016/s1473-3099(20)30158-4.

Young, B. E., S. W. X. Ong, S. Kalimuddin, J. G. Low, S. Y. Tan, J. Loh, O. T. Ng, K. Marimuthu, L. W. Ang, T. M. Mak, S. K. Lau, D. E. Anderson, K. S. Chan, T. Y. Tan, T. Y. Ng, L. Cui, Z. Said, L. Kurupatham, M. I. Chen, M. Chan, S. Vasoo, L. F. Wang, B. H. Tan, R. T. P. Lin, V. J. M. Lee, Y. S. Leo, and D. C. Lye. 2020. "Epidemiologic Features and Clinical Course of Patients Infected With SARS-CoV-2 in Singapore." *Jama*. doi: 10.1001/jama.2020.3204.

Points épidémiologiques de Santé Publique France

Santé Publique France. 2020a. « Point épidémiologique - Surveillance de la dengue - Guyane. Le point épidémiologique au 20 mars 2020 ». 03/2020. Santé Publique France.

———. 2020b. « Point épidémiologique -Dengue à Mayotte Surveillance dégradée dans le contexte de l'épidémie de Covid-19 - Point au 27 mars 2020 ». Santé Publique France.

———. 2020c. « Point épidémiologique - Surveillance de la dengue - Guadeloupe, Saint-Martin, Saint-Barthélemy ». 07/2020. Santé Publique France.

———. 2020d. « Point épidémiologique - Surveillance de la dengue - Martinique ». 07/2020. Santé Publique France.

———. 2020e. « Point épidémio régional - Guadeloupe, Saint-Martin, Saint-Barthélemy. Spécial COVID-19 ». 1. Santé Publique France.

———. 2020f. « Point épidémio régional - Guyane. Spécial COVID-19 ». 1. Santé Publique France.

———. 2020g. « Point épidémio régional - Martinique. Spécial COVID-19 ». 1. Santé Publique France.

———. 2020h. « Point épidémio régional - Réunion. Spécial COVID-19 ». 1. Santé Publique France.

———. 2020i. « Point épidémio régional - Mayotte. Spécial COVID-19 ». 1. Santé Publique France.

———. 2020j. « Point épidémiologique - Epidémie de Dengue à la Réunion - Forte augmentation du nombre de cas - Point au 5 avril ». Santé Publique France.

———. 2020k. « Point épidémio régional - Guadeloupe, Saint-Martin, Saint-Barthélemy. Spécial COVID-19 ». 2. Santé Publique France.

———. 2020l. « Point épidémio régional - Guyane. Spécial COVID-19 ». 2. Santé Publique France.

———. 2020m. « Point épidémio régional - Martinique. Spécial COVID-19 ». 2. Santé Publique France.
———. 2020n. « Point épidémio régional - Mayotte. Spécial COVID-19 ». 2. Santé Publique France.
———. 2020o. « Point épidémio régional - Réunion. Spécial COVID-19 ». 2. Santé Publique France.
———. 2020p. « Point épidémiologique - Surveillance de la dengue - Guadeloupe, Saint-Martin, Saint-Barthélemy ». 08/2020. Santé Publique France.
———. 2020q. « Point épidémiologique - Surveillance de la dengue - Martinique ». 08/2020. Santé Publique France.
———. 2020r. « Point épidémio régional - Guadeloupe, Saint-Martin, Saint-Barthélemy. Spécial COVID-19 ». 3. Santé Publique France.
———. 2020s. « Point épidémio régional - Guyane. Spécial COVID-19 ». 3. Santé Publique France.
———. 2020t. « Point épidémio régional - Martinique. Spécial COVID-19 ». 3. Santé Publique France.
———. 2020u. « Point épidémio régional - Mayotte. Spécial COVID-19 ». 3. Santé Publique France.
———. 2020v. « Point épidémio régional - Réunion. Spécial COVID-19 ». 3. Santé Publique France.
———. 2020w. « Point épidémiologique - Epidémie de Dengue à la Réunion - Forte augmentation du nombre de cas - Point au 19 avril ». Santé Publique France.

ANNEX 2: PRESENTATION OF THE PARTICIPANTS

PREAMBLE: The expert members of the Expert Committees and Working Groups or designated rapporteurs are all appointed in a personal capacity, *intuitu personae*, and do not represent their parent organisation.

EMERGENCY COLLECTIVE EXPERT APPRAISAL GROUP (GECU)

Chair

Mr Thierry BALDET, member of the "Vectors" WG – Researcher at CIRAD – Areas of expertise: Medical and veterinary entomology, vector control.

Members

Mr James DEVILLERS, member of the "Vectors" WG and the "Biocides" CES – Director of the French Centre for the Processing of Scientific Information (CTIS) – Areas of expertise: Biocides, vector control.

Ms Marie-Marie OLIVE, post-doctoral researcher at the IRD – Areas of expertise: Assessment of the effectiveness of VC strategies.

Ms Marie-Claire PATY, member of the "Vectors" WG – medical epidemiologist at *Santé publique France* – Areas of expertise: Epidemiology, human health, public health.

Mr Christophe PAUPY, member of the "Vectors" WG – Research Director at the IRD – Areas of expertise: Entomology, arboviruses, vector characterisation, vector control, knowledge of the situation in the Indian Ocean and on Reunion Island in particular.

Mr Jocelyn RAUDE, member of the "Vectors" WG – Lecturer at EHESP Rennes – Areas of expertise: Psychology of health, human and social sciences.

Mr David ROIZ PEREDA, member of the "Vectors" WG – Research officer at the IRD – Areas of expertise: Medical entomology, ecology of arboviruses, ecology and biology of mosquitoes, assessment of the effectiveness of VC strategies.

Mr Jean-Paul STAHL, member of the "Vectors" WG – medical infectious disease specialist at Grenoble University Hospital – Areas of expertise: Infectious diseases.

Ms Marie THIANN-BO-MOREL, Lecturer in Sociology, Faculty of Human and Environmental Sciences, University of Reunion Island – Areas of expertise: Sociology of health (mosquitoes, Reunion Island, vector-borne diseases, environment, biotechnologies). Sociology of the environment and risks (sharks, rats, biological animal and plant invasion, environmental justice).

Ms Cécilia CLAEYS, Lecturer in Sociology, Aix-Marseille University, Population - Environment - Development Laboratory – Areas of expertise: Sociology of the environment and of environmental and health risks.

Reviewer

Philippe QUENEL – Chairman of the "Vectors" WG, Professor, Director of the Laboratory for the Study and Research of the Environment and Health (LERES) at the School for Advanced Studies in Public Health (EHESP) – Areas of expertise: Public health (medicine), epidemiology (of vector-borne diseases in particular), biostatistics.

ANSES PARTICIPATION

Coordination and scientific contributions

Johanna FITE – Head of the “Vectors” Unit – ANSES

Elsa QUILLERY – Scientific Project Leader, “Vectors” Unit – ANSES

Scientific contribution

Henri BASTOS – Deputy Director of the Risk Assessment Department in charge of occupational health – ANSES

Administrative secretariat

Régis MOLINET – ANSES

HEARINGS WITH EXTERNAL EXPERTS

The people listed in the table below were interviewed by the Working Group.
The Working Group’s experts would like to thank all of the people interviewed for their time, in a particularly difficult context due to the management of the COVID-19 and dengue epidemics in particular, as well as for the quality of the exchanges. Information provided in this framework was taken into account during the preparation of the report.
Important: the inclusion of the people in the following table does not mean they endorse the conclusions of this report.

Table 4: List of the people interviewed

Name	Function	Date
Patrick RABARISON	Head of the VC service of Mayotte	15 April 2020
Manuel ETIENNE	Medical entomologist, CEDRE-LAV Director, Territorial Collectivity of Martinique	16 April 2020
Grégory L’AMBERT	Medical entomologist, *EID Méditerranée*	17 April 2020
Sandrine CHANTILLY Johanna RESTREPO	Assistant to the Deputy Director General, *Pôle Prévention Solidarité Santé*, Territorial Collectivity of French Guiana Medical entomologist	17 April 2020
François CHIEZE Olivier REILHES Hélène THEBAULT	Health Monitoring and Safety Director, Indian Ocean Regional Health Agency Health Monitoring and Safety Deputy Director, Indian Ocean Regional Health Agency Head of the VC service of Reunion Island	20 April 2020

Dr Dominique BOISSERON-PAVILLA	Doctor, Preventive medicine of the Territorial Collectivity of Martinique	22 April 2020
André CABIE	Doctor and infectious disease specialist, Head of the Infectious Disease Department, Martinique University Hospital	27 April 2020
Yves THOLE	Head of the VC service of Guadeloupe	28 April 2020

ANNEX 3: TRANSMISSION OF DENGUE, MALARIA AND SARS-COV-2

Vector-borne transmission of dengue and malaria

Dengue virus is an arbovirus and therefore has biological characteristics enabling it to cross the species barrier. The virus is transmitted from vertebrate to vertebrate by mosquitoes of the genus *Aedes* (subgenus *Stegomyia*) which are its vector, as well as by blood transfusion and organ transplantation.
Ae. aegypti is considered the main vector of dengue, but *Ae. albopictus* can also act as a vector, as demonstrated by the outbreaks in China (2013), Japan (2014) and Hawaii (2015).
In the Caribbean and French Guiana, *Ae. aegypti* is primarily responsible for transmitting dengue as well as other arboviruses such as Zika and yellow fever. In the Indian Ocean, *Aedes albopictus* is largely dominant and has limited *Ae. aegypti* to very small refuge zones.
After biting someone contaminated by a virus, female mosquitoes can remain infectious throughout their lives and transmit the virus to other people via new bites. Mosquitoes tend to bite more often during the day, usually outdoors. The radius of action of mosquitoes of the genus *Aedes* generally ranges from 50 to 150 metres around the place where the female lays her eggs. However, some *Aedes* mosquitoes, despite active dispersal limited to a few tens or hundreds of metres around the breeding sites, are capable of rapidly dispersing over long distances by taking advantage of human activity (vehicles, transport of goods, etc.).

Plasmodium, the agent responsible for malaria, is primarily transmitted to humans by the bite of a mosquito of the genus *Anopheles*. Person-to-person contamination is possible, by blood transfusion or via the transplacental route (from mother to foetus).
In Mayotte, the main vectors of malaria are *Anopheles gambiae s.s.* and *Anopheles funestus*. On Reunion Island, although there is no transmission of malaria, a few small populations of *Anopheles arabiensis* persist on a very localised scale.
In French Guiana, as in a large part of South America, *Anopheles darlingi* is the main vector but its exclusive role in transmission is not as clear in the eastern part of French Guiana, where the assumption that other species contribute to maintaining the endemic is reinforced.
Female *Anopheles* mosquito vectors bite humans in their environment from dawn to dusk.

How SARS-CoV-2 virus is transmitted

The information provided below has been extracted from the Opinion of the French High Council for Public Health (HCSP) of 17 March 2020 (HCSP, 2020a):
"*Like most micro-organisms, SARS-CoV-2 does not have just one route of transmission.*
The main means of SARS-CoV-2 transmission are as follows:

- *direct transmission (by inhaling droplets when a patient coughs or sneezes) [from a distance of around one metre],*
- *transmission by contact (contact with the mouth, nose or ocular mucosa).*

However, some studies suggest that SARS-CoV-2 transmission is not limited to the airways. For example, for the eyes, a study detected viral RNA (and possibly culturable virus) by RT-PCR, although no direct transmission by this route has been described to date. The same is true for saliva. Another study suggested that SARS-CoV-2 may be transmitted by contact with asymptomatic patients.
Some publications have mentioned that, like all micro-organisms, SARS-CoV-2 may be spread by aerosols formed during medical procedures or by experimental aerosols. SARS-CoV-2 was detected by RT-PCR in various areas of a room accommodating an infected patient, suggesting it had been expelled into the air of the room. However, the presence of a virus in air does not mean that it is infectious or that there is 'airborne' respiratory transmission. There are no studies proving person-

to-person transmission of the virus via aerosols over long distances. However, if it exists, this is not the main mode of transmission.
The transmission of coronaviruses from contaminated surfaces to hands has not been proven. However, it cannot be ruled out, via surfaces newly contaminated by secretions. Furthermore, coronaviruses probably survive for up to three hours on dry inert surfaces and for up to six days in moist environments. Thus, handborne transmission from the environment is possible.
SARS-CoV-2 RNA has been detected in stools (on day 7 of the disease). However, the infectivity of the virus detected in stools was only mentioned on one occasion in a patient tested 15 days after the start of the symptoms, suggesting that transmission via stools is lower than transmission by respiratory droplets and handborne transmission. In particular, the risk of faecal transmission of SARS-CoV-2 virus has not been documented. Excretion of the virus has been detected in some patients after the disappearance of symptoms.
The main routes of transmission are via droplets and hands".

The ability of coronavirus to be transmitted via exhaled air (or aerosols) and not only by coughing or sneezing is not yet well known.

Box 4: Can the virus causing COVID-19 be transmitted by mosquitoes?

The virus that causes COVID-19 is a respiratory virus transmitted by droplets expelled when a sick person coughs or sneezes, or via contact with contaminated surfaces. The virus is deposited in the airways and is generally not found in blood or if it is, only in small quantities in certain symptomatic patients (Huang *et al.* 2020, Young *et al.* 2020, Wang *et al.* 2020).

In order for a mosquito to be able to biologically transmit a pathogen (virus, bacterium, parasite), this pathogen must cross various barriers once it has been collected during a blood meal from an infecting host: 1) it must resist the digestion process in the mosquito's stomach, 2) it must cross the intestinal epithelial barrier to the insect's circulatory system (haemocoel, haemolymph) and enter the salivary glands to be inoculated by the saliva into a new host during a new blood meal. Very few viruses are capable of completing such a development cycle in mosquitoes or other blood-sucking arthropods (midges, ticks, etc.); those that can are called arboviruses. These have selected blood-sucking arthropods (insects and ticks) for their transmission at the cost of long co-evolutionary processes. Arboviruses therefore have "keys" (for example, receptors enabling them to enter an arthropod's cells, as well as strategies for avoiding its immune system) enabling them to survive and replicate within their vector and be effectively transmitted. A very small percentage of viruses can be transmitted by mosquitoes. These include viruses of the genus *Flavivirus* (family *Flaviviridae*) as well as the dengue and Zika viruses (transmitted by mosquitoes of the genus *Aedes*) and the West Nile and Usutu viruses (transmitted by mosquitoes of the genus *Culex*). For these viruses, in general, there is high vector specificity (only a very small number of mosquito species are capable of transmitting a particular virus), attesting to co-evolutionary processes. The hundreds of arboviruses described to date belong to numerous well-known families and genera; none of them belong to the *Coronaviridae* family. This specificity means that other very widespread blood-borne human viruses (such as HIV and hepatitis C) and emerging viruses (such as Ebola) are not transmitted by mosquitoes. On this basis, it is highly unlikely that SARS-CoV-2, a virus with respiratory transmission, may be biologically or mechanically (via contamination of mouthparts and successive feeding attempts) transmitted by mosquitoes or any other blood-sucking arthropods.

ANNEX 4: THE PATHOGENS RESPONSIBLE FOR DENGUE, MALARIA AND COVID-19

DENV-1, 2, 3 and 4 viruses

Dengue virus was first isolated in 1943 by Hotta and Kimura Hotta (1952). The virus takes the form of spherical particles with a diameter of 40-50 nm; an envelope formed by a lipid bilayer surrounds a nucleocapsid made up of capsid proteins containing the genomic RNA. The genome is a 10.7 kb positive-sense single strand of RNA. It belongs to the genus *Flavivirus,* family *Flaviviridae*, and includes four serotypes (DENV-1, -2, -3, -4) that are antigenically different; immunity acquired against one of the serotypes only confers partial protection at most against infection with the other serotypes. It is thus possible to be infected with each of the four serotypes; these cross-infections increase the risk of developing severe dengue, also known as dengue haemorrhagic fever.

Parasites of the genus *Plasmodium*

Five species of parasites belonging to the genus *Plasmodium* are responsible for malaria in humans: *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, Plasmodium malariae* and *Plasmodium knowlesi*[51]. *Plasmodium* parasites are unicellular eukaryotes belonging to the phylum Apicomplexa[52].

P. falciparum, found in tropical and subtropical zones, is the most pathogenic species and is associated with the highest rate of mortality. *P. vivax* is the most geographically widespread species and coexists with *P. falciparum* in several parts of the world, although it particularly affects Asia and Latin America.

Although *Plasmodium* was discovered in 1880 by Charles Louis Alphonse Laveran, its biological cycle was not fully described until 1948. This complex evolutionary cycle involves two hosts: humans in which the parasite undergoes asexual multiplication, and *Anopheles* in which the sexual reproduction of *Plasmodium* occurs.

SARS-CoV-2 virus

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a new strain of the SARS-Cov coronavirus species. It was discovered in December 2019 in the city of Wuhan, Hubei province, China. This virus, of the subgenus *Sarbecovirus*, genus *Betacoronavirus* and family *Coronavirus*, has the typical morphology of coronaviruses, surrounded by a crown of proteins, hence their name. This 125-nm-diameter RNA virus has a relatively large 30 kb genome. Although the conditions in which this virus emerged are still being discussed, the virus likely has an animal origin and reservoir. Even though SARS-CoV-2 is very similar to a virus detected in a bat, the animal responsible for its transmission to humans has not yet been identified with certainty. Several publications suggest that the pangolin, a small mammal consumed in southern China, may be involved as the intermediate host between bats and humans. There are many coronaviruses that mainly infect animals. However, these viruses can sometimes cause infections in humans, which are usually associated with colds and benign flu-like syndromes, although they can also cause respiratory complications such as pneumonia. Coronavirus infections are generally not diagnosed due to their benign nature and spontaneous resolution. However, before SARS-CoV-2, two other coronaviruses had caused serious human epidemics: SARS-CoV, responsible for a global epidemic between November 2002 and July 2003, and Mers-CoV, which was first identified in 2012 in the Middle East.

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[51] *Plasmodium knowlesi* is usually found in monkeys and can be accidentally transmitted to humans.

[52] One characteristic of the Apicomplexa is the presence of an apical complex, which corresponds to a set of organelles at the apical end of the cell (microtubules, vacuoles, as well as specialist secretory organelles, rhoptries, micronemes and dense granules).

ANNEX 5: DIAGNOSING DENGUE, MALARIA AND COVID-19

The co-circulation of SARS-CoV-2 virus, responsible for COVID-19, with other transmissible infections poses a diagnostic problem in certain countries and territories where these infections with a similar clinical presentation are endemic (Beeching 2005, ECDC 2020). It is often difficult to distinguish them from one another exclusively via a clinical examination, and biological tests are necessary (Yan *et al.* 2020).

Dengue and malaria are two vector-borne diseases transmitted by mosquitoes, while COVID-19 is exclusively transmitted from person to person. Like many infections, these infectious diseases have fever in common; its grade (high or low) is not specific. All three can be accompanied by muscle pain, headaches and digestive signs. Lastly, all three can take a severe clinical form, namely shock, although the pathophysiologies may be different. However, severe COVID-19 has a clearer respiratory component than the two other diseases (ECDC 2020). There are two inconstant symptoms that can initially be considered signs of COVID-19: sudden loss of taste and smell (Lovato and de Filippis 2020).

Therefore, biological tests are often essential to distinguish between these diseases and above all propose public health behaviour as well as specific treatment in the event of malaria. This diagnosis of malaria should be deemed urgent due to the risk of rapid progression to life-threatening severity and the possibility of effective treatment.

Tests used to diagnose malaria

- Thick smear[53] and thin smear[54]: these are the tests most commonly used, enabling the parasite to be detected with a microscope. They have the disadvantage of depending on the biologist's experience in the area, like any direct examination.
- Rapid diagnostic test using strips detecting antigens (HRP-2 and pLDH proteins) in total blood. The sensitivity of this test ranges from 70% to 95% depending on the degree of parasitaemia. This test can remain positive for two to three weeks following a malaria attack and therefore cannot be used to monitor a case of treated malaria.
- Serum PCR[55] is available in specialist laboratories, for a backup diagnosis if difficulties are encountered with the other tests.

Tests used to diagnose dengue

The various dengue serotypes (see Annex 4) can be diagnosed by PCR or serology:

- Serum PCR, but viraemia is very brief and rapidly negative (within two or three days at most after the onset of symptoms).
- Serological tests with antibody detection, with the disadvantage of a usually retrospective diagnosis due to the time taken for these antibodies to appear. The main advantage of

[53] The "thick smear" test is more sensitive for the diagnosis of malaria than the thin smear, because a larger volume of blood is examined under a microscope.

[54] A thin smear is a drop of blood that is spread across a glass slide. It is then stained and examined with a microscope.

[55] Polymerase Chain Reaction (PCR) is an enzymatic amplification technique used to obtain a large number of identical copies of a DNA fragment.

serological testing is to establish the prevalence of infection in an endemic area; it also helps diagnosis the disease in correlation with the clinical presentation, in non-endemic areas.

SARS-CoV-2 (COVID-19)

For the moment, the ideal diagnostic panel is incomplete (Li *et al.* 2020).

- PCR with a nasopharyngeal sample. The sensitivity of this test varies depending on sampling quality and the viral inoculum. In general, diagnostic sensitivity is improved by combining PCR with a lung scan. In some patients, PCR is only positive in deep bronchial samples. Like any PCR, it is useful for diagnosing the disease in the acute phase but has little relevance for follow-up. In France, since April 2020, a negative PCR test has no longer been required to discharge patients from hospital.
- There are two types of serological tests[56]:
  - ✓ Traditional serological tests, which are mainly useful for evaluating the prevalence of infection in the population;
  - ✓ Rapid tests for the detection of serum antibodies, which are less specific but provide results within one hour and will be useful for the lockdown-exit strategy.

Both serological tests are currently being validated. At best, they can only be positive four to five days after the onset of clinical symptoms (Xiang *et al.* 2020). Thus, they will not be very useful for diagnosing the disease in the acute phase.

[56] https://www.has-sante.fr/jcms/p_3179992/fr/place-des-tests-serologiques-dans-la-strategie-de-prise-en-charge-de-la-maladie-covid-19

ANNEX 6: PRESENTATION OF TERRITORIES AND VC SERVICES

Guadeloupe

This territory is a group of islands located in the southern Caribbean Sea. Guadeloupe is both a French overseas *département* and region. The region is made up of several islands and islets, including Guadeloupe itself (Grande-Terre and Basse-Terre, also called "continental" Guadeloupe) as well as its dependencies: the island of Marie-Galante, the Les Saintes archipelago primarily consisting of Terre-de-Haut and Terre-de-Bas, La Désirade, and inhabited islets. Guadeloupe covers a land surface area of 1,628 km^2 and "continental" Guadeloupe has a surface area of 1,436 km^2, for a population of 390,704 habitants and a density of around 240 habitants per km^2 (INSEE 2018 data).

Organisation of VC in Guadeloupe

The Guadeloupe Regional Health Agency (ARS) organises VC in Guadeloupe as well as in Saint-Barthélemy and Saint-Martin[57]. A standard VC plan[58] presents the regulatory mosquito control framework as well as the main strategies for controlling these insects. The ARS's VC service includes 27 operators spread out across two sites.

French Guiana

French Guiana is a French region and *département* located in the north-eastern part of South America, bordering Brazil to the south-east and south and Suriname to the west. Since the territorial elections of 6 and 13 December 2015, the competences of both the region and *département* have been exercised within a single local authority called the Territorial Collectivity of French Guiana (CTG) whose deliberative body is the Assembly of French Guiana. With a surface area of 83,846 km^2 and a population of 281,612 inhabitants (INSEE 2018 data), French Guiana is the second largest region of France in terms of surface area and the second least populated (after Mayotte) with 3.2 inhabitants/km^2. It is also the *département* with the most forestland, as 97% of the territory is covered by the tropical forests of French Guiana. The *département* is divided into two *arrondissements* (Cayenne and Saint-Laurent du Maroni), which are subdivided into 19 cantons and 22 communes.

Organisation of VC in French Guiana

VC activities in French Guiana have been delegated by the French Guiana ARS to the VC service of the CTG, which carries out its functions. The VC service includes 138 operators spread out across 10 sites.

Martinique

Martinique is an island in the Caribbean Sea located in the Lesser Antilles. It is one of the Windward Islands. It has a total surface area of 1,128 km^2, stretching around 70 km in length and 30 km in width. According to INSEE, as of 1 January 2017, Martinique had 372,594 inhabitants. Martinique is made up of 34 communes spread out across three urban communities.
Like in French Guiana, following the territorial elections of 6 and 13 December 2015, this DROM became a *sui generis* territorial collectivity with the creation of the Territorial Collectivity of Martinique (CTM) under French Act No. 2001-884 of 27 July 2016.

[57] A delegation to the Overseas Collectivities of Saint-Martin and Saint-Barthélémy is attached to the General Directorate of the ARS, whose missions include hosting territorial conferences on its premises; carrying out health monitoring and managing alerts and crises; monitoring, inspecting and supporting health and medical-social establishments, services and associations; environmental health monitoring/VC; and monitoring health and transport professionals.

[58] https://www.guadeloupe.ars.sante.fr/system/files/2018-06/plan0118.pdf

Organisation of VC in Martinique

In Martinique, VC is organised by the ARC of Martinique in close collaboration with the CTM. A joint operational structure, the Mosquito Eradication and Entomological Research Centre-Vector Control (CEDRE-LAV), was created by the Martinique ARS and the CTM to respond to the main themes of their vector control strategy. CEDRE-LAV has 32 operators.

Mayotte

Mayotte is located in the Indian Ocean at the entrance to the Mozambique Channel, halfway between Madagascar and Africa and around 1,500 km from Reunion Island. Mayotte comprises two main islands – Grande-Terre and Petite-Terre – and several other smaller islands. It has a total surface area of 376 km^2. In 2017, Mayotte had 256,500 inhabitants, according to INSEE. As of 7 December 2010, under French Organic Act No. 2010-1486, Mayotte, which had until then been a departmental collectivity, became the 101st *département* of France and the 5th French Overseas *Département*-Region (DROM). It has 13 cantons and 17 communes.

Organisation of VC in Mayotte

In Mayotte, VC is the responsibility of a dedicated service of the Mayotte ARS. The VC service of the Mayotte ARS has around 50 operators.

Reunion Island

Located in the south-eastern Indian Ocean, Reunion Island is a French overseas *département* that is part of the Mascarene Islands. The island covers a surface area of 2,512 km² for a population of 866,506 inhabitants and a population density of around 342 inhabitants/km² (INSEE 2019 data). Reunion Island has five intercommunal bodies grouping together the island's 24 communes.

Organisation of VC on Reunion Island

Reunion Island has had a VC service since 1914. VC is carried out by the VC service of the Reunion Island ARS[59] which, in the absence of epidemics and when there are no new cases, aims to prevent or limit the proliferation of disease-causing mosquitoes throughout Reunion Island. Its daily field activities take the form of systematic operations for the prevention, removal and treatment of breeding sites. The VC service has 125 operators (including 20 supervisors) who carry out surveillance, prevention and control actions on a daily basis. This service is under the responsibility of a health engineer and his assistant. The service also has a medical entomologist.

The French overseas collectivities of Saint-Barthélemy and Saint-Martin

On 19 March 1946, Guadeloupe became a French overseas *département* and joined Saint-Barthélemy and Saint-Martin in a special *arrondissement*. In the referendum of 7 December 2003, whereas 73% of voters in Guadeloupe rejected the proposal to create a single collectivity replacing the *département* and region, voters in Saint-Barthélemy and Saint-Martin voted in favour of their communes becoming independent. Thus, under French Organic Act No. 2007-223 of 21 February 2007, these two territories became two Overseas Collectivities (COMs) separate from the other

[59] On 1 January 2020, the Indian Ocean ARS gave way to two new agencies: the Reunion Island ARS and the Mayotte ARS

dependencies and from Guadeloupe by replacing the *département* of Guadeloupe and the region of Guadeloupe.

Saint-Martin

Located in the northern part of the Caribbean, the island is 250 km from Guadeloupe and 25 km west of Saint-Barthélemy. As of 1 January 2019, it had 35,334 inhabitants with a density of 672 inhabitants per km^2. Saint-Martin is unique in that it is shared between France and the Netherlands. The French part of Saint-Martin covers 53 of the island's 93 km^2, while the southern part of the island, also called Saint-Martin (in Dutch: Sint Maarten), has been one of the four constituent countries of the Kingdom of the Netherlands since 10 October 2010.

Saint-Barthélemy

Like Saint-Martin, the island is located in the Caribbean Sea, 203 km south-east of Guadeloupe. It is a mountainous island of around 21 km^2 (24 km^2 with its islets[60]). As of 1 January 2019, it had a total population of 9,961 inhabitants.

<u>Organisation of VC</u>

In these two territories, VC is organised by the Guadeloupe ARS.

[60] The island is surrounded by numerous islets including Île Chevreau, Île Coco, Île Fourchue (a major anchorage), Île Frégate, La Tortue, Île le Boulanger, Les Grenadins, Pain de Sucre, Île Pelé, Île Petit Jean, Toc Vers, Les Gros Islets, Les Petits Saints, Roche Plate (Table à Diable), Mancel (La Poule et les Poussins), etc.