

# The Spread of Asian Tiger Mosquitoes and Related Health Risks Along the French Riviera: *An Analysis of Reactions and Concerns Amongst the Local Population*

Cécilia CLAEYS\*

*Population Environment & Development Laboratory,  
Aix-Marseille University, Marseille*

Elise MIEULET

*Population Environment & Development Laboratory,  
Aix-Marseille University, Marseille*

**Abstract:** Since the early 2000s, the accidental introduction of the tiger mosquito has exposed Europe to new diseases previously observed in Southern countries, leading to the onset of new nuisances and health risks. In France, the area first affected was the French Riviera. Based on the results of a qualitative and quantitative survey, this article analyses the reactions and concerns amongst the local population regarding the spread of Asian tiger mosquitoes and the related health risks. While residents are well aware of the mosquitoes' presence and perceive a related increase in nuisances at different levels, they tend to play down the related health risks, notably due to the high degree of trust placed in the French healthcare system. It is the wealthiest inhabitants that are most affected by the problem, which primarily affects villa districts. Finally, cultural resistance has hindered the success of awareness-raising campaigns due to the stigma associated with mosquitoes.

**Keywords:** *asian tiger mosquito; population reactions; population concerns; qualitative and quantitative sociological survey.*

## Introduction

### *Mosquito control in the south of France: between comfort and public health*

Human disease caused by local mosquito species disappeared from mainland France in the 1940s mainly

due to the draining of wetlands and general improvements in public hygiene, public health and living conditions (Derex, 2008). The unwitting introduction of an exotic mosquito to Europe, through international trade, first observed in 1999, brought the south of France to a pre-epidemic stage. Indeed,

\*e-mail: cecilia.claeys@univ-amu.fr. Cécilia Claeys is Lecturer in Sociology, Population Environment & Development Laboratory, Aix-Marseille University, Marseille, France. Elise Mieulet is PhD Student in sociology, Population Environment & Development Laboratory, Aix-Marseille University, Marseille, France. The English language reviewing of this article was done by Jocelyne A.L. Serveau.

this mosquito, called the Asian tiger mosquito (*Aedes albopictus*) is the vector of two diseases which, thus far, have been limited to tropical areas: chikungunya and dengue fever<sup>1</sup>. Chikungunya, also known as CHIKV, is a virus transmitted to humans via the bite of an infected mosquito. The symptoms of the disease involve a two-to five-day febrile phase, followed by a longer phase of arthralgia lasting several weeks or months, even years in some cases, which affects the joints of the extremities (Sourisseau et al., 2007). Dengue fever, also known as breakbone fever, is an infectious disease transmitted by several mosquito species. Four different types exist and exposure to one usually leads to immunity against that particular variant, but infection with a different type increases the risk of severe complications. Most infected individuals are asymptomatic or only have a fever; the disease may also be characterized by headache, muscle and joint pain, and a specific skin rash. In a small number of cases the disease develops into a haemorrhagic fever or into dengue shock syndrome and can be life threatening (Reiter, 2010). The risk of Chikungunya and dengue fever spreading is dependent on two factors: the first is the introduction of the virus by viremic individuals and the second is the transmission of the virus by mosquitoes (INVS 2006).

First observed in the south of France in 2004 near the Italian border in the town of Menton, the Asian tiger mosquito has not stopped expanding its range along the French Mediterranean coast. Both urban and suburban (Silver, 2008), *Aedes albopictus* have been under surveillance in France since 1998

by a monitoring committee established by the Adège<sup>2</sup> agency. This surveillance was ordered by the Ministry of Health and was further reinforced in 2006. Monitoring confirmed the presence of Asian tiger mosquitoes in areas such as the Alpes Maritimes in 2004, Haute-Corse, Corse-du-Sud, Var and most recently in the Bouches-du-Rhone (INVS/National Institute for Public Health Surveillance, 2006). Asian tiger mosquito management along the French Riviera has facets which are technical (health monitoring and vector control), and others which are based on public information campaigns and public awareness programmes about the individual measures that can be taken to limit the spread of mosquitoes. Such campaigns are led by the EID-Mediterranean<sup>3</sup>, under the auspices of the General Council of the Alpes Maritimes department, and have been widespread in some municipalities. Mosquito control operations are carried out each time a suspicious fever is detected in an individual returning from a tropical region. Several indigenous cases have been identified, but so far they have been controlled and have not led to outbreaks. Furthermore, the spread of Asian tiger mosquitoes and related diseases such as Chikungunya and dengue fever may worsen with impending global warming (Epstein, 2007).

### ***Health, risk and culture: a case study showcasing the complementarity of theories in the social sciences***

The connection between risk society theory (Beck, 1992), cultural theory (Douglas, 1992), the impact of trust (Giddens, 1990) and affective

rationality theory (Slovic et al., 2004) pointed up in this article will highlight the diversity and complexity of the social processes observed. Indeed, instead of focusing on the opposition between these theoretical frameworks, we have chosen to stress their complementarity. Such theoretical frameworks allow us to understand risks as 'both real and socially constructed' (Beck, 1999), escaping within risk analysis from 'the orthodox dichotomy of objective versus subjective or rational versus non-rational' (Zinn, 2009, p. 523).

Concretely, this article will analyse how social actors react to the emergence and proliferation of mosquitoes as a nuisance on the one hand, and their concerns about the health risks related to the spread of this vector of Chikungunya and dengue fever on the other hand. The results of our research underscore the commonly observed social inequalities which exist between lay and scientific health knowledge (Bartley et al., 1998), risk perception (Douglas and Calvez, 1990) and preventive behaviour (Douglas, 1992; Petrie, 1997), but they also point up new findings in terms of exposure to risk and nuisance which defy traditional social structures, comforting Beck's thesis (1992).

The first section of this article will analyse public awareness and trust regarding the risk of a Chikungunya and Dengue fever epidemic. The second section will focus on people's exposure to and acceptance of tiger mosquito bites. Finally, the last section will describe the mental and cultural barriers to awareness campaigns in an area of acute economic importance: the famous French Riviera resort area.

## Methods and materials

This article will present the results of a qualitative and quantitative sociological survey conducted from 2009 to 2010 in the first French region affected by the spread of Asian tiger mosquitoes: the coastal part of the Alpes Maritimes, better known as the French Riviera (Côte d'Azur). This research was conducted as part of the European research programme Life + (Life08/ENV/F/000488), coordinated by EID-Méditerranée<sup>4</sup>. The qualitative corpus includes thirty-five interviews conducted with key institutional stakeholders and inhabitants. Six interviews were conducted with key institutional stakeholders directly involved in managing the *Aedes albopictus* situation in the Alpes Maritimes. Twenty-nine interviews were conducted with residents of the department: 18 were randomly approached on the street and five were chosen because they had to deal with the arrival of *Aedes albopictus* in their professional life (e.g. pharmacists, tourism professionals, etc.). Finally, six interviews were conducted after a field visit and a presentation by EID technicians. Depending on the interviewee, the interviews lasted between twenty minutes and one hour and thirty five minutes.

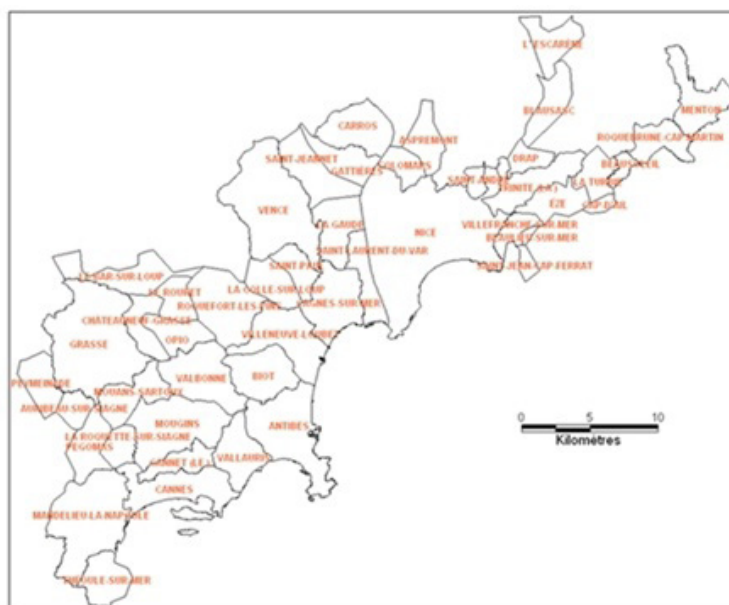
We began by doing a thematic analysis of the corpus of interviews using NVivo qualitative research software. This allowed us to compare the differing discourse of interviewees on the same topic. Next, we focused on the interviewees' arguments. According to Jean-Blaise Grize (2004; 1996) and the theory of natural logic, people's discourse provides access to

their mental models. Grize has argued that since mental models cannot be directly observed, discourse can be used as a means to ascertain them. The challenge, therefore, was to search for traces of thoughts in the discourse collected, and to analyse, cut and reorganise them according to the main themes highlighted.

Our quantitative corpus was based on a sample of 281 inhabitants representative of the population along the French Riviera exposed to the spread of tiger mosquitoes. The quantitative survey provided complementary information to the qualitative corpus. It allowed us to quantify the different arguments and attitudes observed within the qualitative survey. Despite its relatively small size, the sample has a margin of error (amount of error that can be tolerated) of 4.91%, with a confidence level (amount of uncertainty that can be tolerated) of 90%.

Since we were interested in the interaction between people and tiger mosquitoes, it was necessary to examine the areas where these

two types of populations interact in significant proportions. This was achieved using a GIS, including MapInfo© software, to run spatial sampling with interdisciplinary, linking, socioeconomic, topographic and entomological data. To do so, we cross-referenced a detailed spatial mapping of the different environments (CRIGE, Regional Centre for Geographic Information), a spatial distribution of the human population (INSEE, the National Institute of Statistics and Economic Studies), an estimate of the range of *Aedes albopictus* (EID-Mediterranean), and a spatial mapping of complaints made to the special toll-free number (EID-Mediterranean and General Council of the Alpes Maritimes). These different levels of information helped connect the objective aspects (presence or absence of mosquitoes) and subjective aspects (personal feelings of discomfort). Ultimately this led us to choose the following area, made up of 48 municipalities in the department:



**Figure 1.** Area selected for the survey questionnaire

The questionnaire was administered by telephone; it was a quota-based survey by sex, age and profession. In addition, two control variables were taken into account: the type of habitat and place of residence, once again using a GIS.

The questionnaire thus allowed us to touch on the following topics with 63 questions (filter questions, open and multiple choices questions, open and single answer questions, closed and multiple choice questions, and closed and one-choice questions).

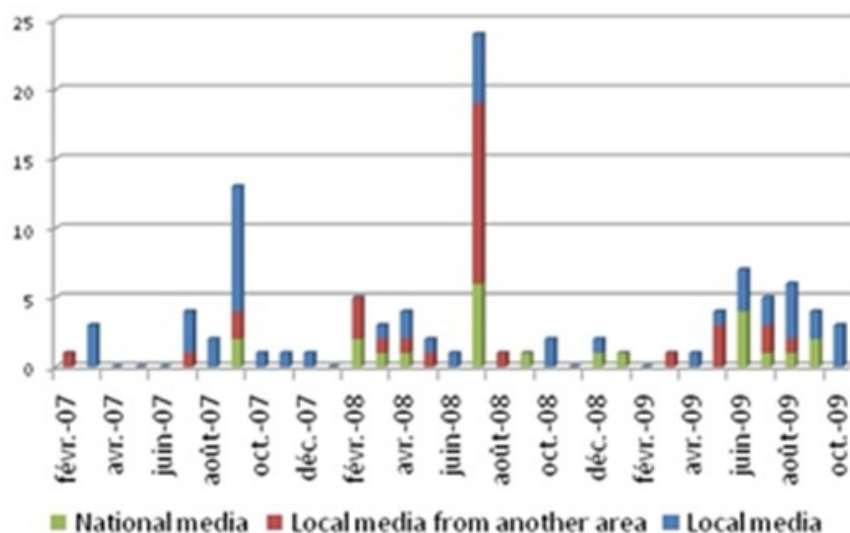
The data were analysed using a descriptive statistics approach based on three main actions: frequency distribution, cross-tabulations and multiple correspondence analysis (MCA). On cross-tabulations, chi-square statistics were used to test for independence and to focus only on significant results according to the chi square statistical test threshold  $\alpha = 0.1$ . This threshold was chosen based on the size of the sample. Indeed, for a higher level of confidence (0.05 or 0.01) a larger sample size would be necessary.

## Results

### *Public awareness and trust with regard to a new epidemic risk*

Until 2007, the tiger mosquito issue was largely absent from the public sphere, understood here in the Habermasian sense (1962), since it was almost entirely confined to the institutional sphere and had not yet gained the interest of the media and general public. Then, between 2005 and 2007, the issue entered the French public sphere with the Réunion crisis. At the time, the French islands of Réunion and Mayotte (Indian Ocean) were facing a major epidemic which entered an inter-epidemic period in April 2007. The graph below (Fig.2) illustrates this point by showing the weak and mainly seasonal nature of the Asian tiger mosquito as seen in French media coverage, except during the Italian health crisis (summer 2007) and the Minister of Health's visit to the Alps Maritimes region in July 2008.

Indeed, there was a Chikungunya outbreak in Italy during the summer

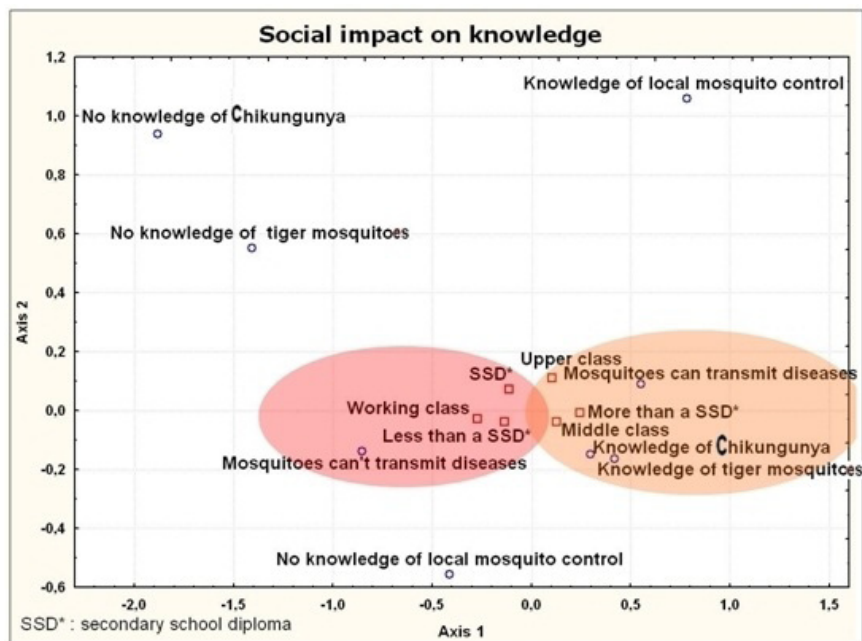


**Figure 2.** Media coverage based on time and location

of 2007. This event was a turning point and proved that southern Europe could be affected by an epidemic. Despite public information campaign efforts, a large majority of the inhabitants interviewed during the quantitative survey (85 percent) claimed never to have heard (or not to remember hearing) about such campaigns. This is a fairly standard result in the sociology of risk (Douglas and Wildavsky, 1982)

and the sociology of health (Marmot and Wilkinson, 1999; Boltanski, 1971) and, more specifically with regard to Chikungunya, in the recent work of Raude and Setbon (2008, 2009). It is widely accepted that apprehension about a potential hazard differs based on a person's social group and obligation network.

For this MCA, education level (more or less than a secondary



**Figure 3.** Multiple correspondence analysis of the social impact on knowledge

school diploma) and socio-economic status (recoded with the concept of social class) were used as additional variables. Our analysis focused on the following questions: Have you heard of Chikungunya? Have you heard of the tiger mosquito? To your knowledge, are mosquito control methods used in the Alpes Maritimes? Do you think that mosquitoes can transmit diseases to humans in mainland France?

The proximity between phrases such as 'knowing about Chikungunya',

'knowing about tiger mosquitoes' and whether 'mosquitoes can transmit diseases' is proof of the strong cyclical dimension that exists between such information. In the diagram, the off-set position of the 'knowledge about local mosquito control' category is proof that inhabitants are poorly informed about local mosquito control initiatives. The MCA also revealed that people of lower socio-economic status and those with a secondary school diploma or less education tend to be less informed



about tiger mosquitoes, related diseases and their public management. Conversely, people from the middle and upper classes and/or people with a higher level of education are most knowledgeable about the issue.

The doctors and key institutional stakeholders interviewed for this research were unanimous in forecasting that a local epidemic is inevitable. As one entomologist said,

‘Oh ... I am 100% sure ... With oh ... We don’t know whether it will occur in one or fifteen years, but I’m 100% sure.’

Such discourse differs from other studies, such as Vazeille et al. (2008) who have argued that while there is a possibility of a Chikungunya outbreak in this area, it is not certain that one will occur. Their results are based on the fact that even if mosquitoes found in the area have the potential to serve as a vector for infection during laboratory experiments, the situation in a natural environment depends on parameters other than just vector competence; parameters such as density, longevity, host preference and duration of the gonotrophic cycle need to be taken into account as well.

It is also worth noting that there was no consensus amongst the general population regarding the likelihood of an epidemic. When asked, ‘*Do you think that a Chikungunya or dengue fever outbreak could occur in the Alpes Maritimes?*’ forty-three per cent (43 percent) of the quantitative sample responded affirmatively, forty-two per cent (42 percent) responded negatively and twelve per cent (12 percent) were undecided.

Psychologist Paul Slovic (2004)

has shown that a pattern exists in which response to risk is dependent on ‘affective rationality’. As such, ‘exogenous’ knowledge primarily based on science is overshadowed by ‘endogenous’ knowledge based primarily on personal experience and thought. Sociology, for its part, points to social inequalities as a source for varying perceptions of risk and exposure. While classic research has underscored a linear correlation between social inequality and exposure to risk (Zimmerman, 1993), Ulrich Beck (2007) has argued that exposure to risk and risk management have become a new form of social inequality in the globalised world which at times reinforce social inequalities and at times de/restructure them. Statistical analysis of the questionnaire used in this research revealed no socioeconomic variables which could significantly explain people’s opinions about an epidemic outbreak. This corroborates the results observed by Slovic and Beck.

Regarding the argumentative logic apparent in the qualitative corpus, the existence of different registers is revealed, of which two could be clearly identified: a fatalistic attitude and a jaded perspective, with some people shifting between different registers during a single interview.

When presented with the potential of an epidemic, inhabitants tended to first react with fatalism. As such, the initial reaction was often to mention the inevitability of an epidemic and the fact that since biological processes were involved, humans were helpless. For example, a waitress in Cannes said,

‘We are not immune to anything, eh (...). So it’s best not to think

about such things’.

In responding to a question about the likelihood of a Chikungunya epidemic, a real estate agent added,

‘How can I answer that? The only thing that still surprises me in this world are my children; nothing else surprises me anymore...’.

Whilst maintaining a fatalistic attitude, a few others tended to put things into perspective by referring to other common epidemics over the past decade. For example, a pharmacist said,

‘Anything is possible... We heard about bird flu for two years. Then there was swine flu... so, sure Chikungunya is possible. It happened in Réunion, so it depends... All it takes is one day... A number of mosquitoes arrive and breed here... and then... And beyond the mosquitoes themselves, will the environment and climate be favourable or not? We actually do not have much control.’

Although the people we interviewed also placed increased emphasis on present-day risk and uncertainty, the mention of other epidemics was not sufficient to reach a consensus amongst inhabitants about the risk of an epidemic in the area. This process further tended to inspire another reaction with regard to a Chikungunya epidemic: a jaded reaction. Such responses are quite common, as shown by Sandman et al. (1998) when they argue that the assessment of risk occurs through two processes: an overestimation but also an underestimation. The minimisation effect results in a large majority of

cases from the recent multiplication of health alerts. As one shopkeeper said,

‘Anything is possible, but we must be ready to be vaccinated... The question is: are the vaccines ready and is there enough for everyone? ... Nothing is certain! It’s like that other case, swine flu. It’s the same.’

People appear to make lists of dangerous new viruses and animals, as if nothing could take them by surprise, or as though they were tired of the relentless litany of risks. One health professional said,

‘Yes, jellyfish ... So, for me, *Aedes albopictus*, or wait, *Culex*, or ... *mariae*... It’s just another annoying animal ... some are fatal, others are annoying and that’s life ... I mean, we cannot sterilise the atmosphere because there is a crowd of frightened people ... what if tomorrow there is, um ... We must adapt.’

Such attitudes are understandable given the increasing importance attributed to the notion of risk. Thus, in *The consequences of Modernity*, Giddens (1990) argues that modernity has been accompanied by a globalization of risk especially in terms of its intensity and the expanding number of contingent events. A similar idea has been put forward by Crawshaw and Bunton (2009) regarding the ‘growth of uncertainty in contemporary society’ especially threatening individual wellbeing.

In our study, we observed that while opinions diverged over the likelihood of an epidemic outbreak, the high level of trust expressed by the population tended to be more



unanimous. Thus, when asked directly whether they trusted the French health system to handle a Chikungunya outbreak, seventy-one per cent (71 percent) of the quantitative sample answered affirmatively. When the same question was asked about the French government, the percentage of affirmative answers declined, although the majority of respondents remained confident (54 percent). There was only one variable which really affected

it: the degree of discomfort that inhabitants blamed on mosquitoes<sup>(4)</sup>. As such, those most annoyed (Level 4) were less likely to have confidence in the French health system (59.18 percent compared to 73.91 percent (Level 1), 74.13 percent (Level 2) and 76 percent (Level 3) in the quantitative sample<sup>5</sup>). Such confidence stems from trust in the health system but also from confidence in the public ability to manage a potential crisis.

**Table 1:** *Knowledge about mosquitoes and associated issues, likelihood of an epidemic, trust in the government and health system key frequency distributions observed in the quantitative survey*

Questions asked in the quantitative survey	Responses	Enrolment	Distribution(%)
Have you ever heard of the information campaign 'Be dry with mosquitoes?'	Yes	41	14.591
	No	239	85.053
	I don't know	1	0.356
Have you heard of the Asian tiger mosquito?	Yes	210	76.923
	No	63	23.077
	I don't know	0	0
Have you heard of Chikungunya?	Yes	241	86.071
	No	38	13.571
	I don't know	1	0.357
To your knowledge, are mosquito control methods used in the Alpes Maritimes?	Yes	94	33.452
	No	119	42.349
	I don't know	68	24.199
Do you think that mosquitoes can transmit diseases to humans in mainland France?	Yes	169	59.643
	No	89	31.786
	I don't know	24	8.571
Do you trust the French health system to deal with a Chikungunya outbreak?	Yes	178	70.635
	No	50	19.841
	I don't know	24	9.524
Do you trust the French government to deal with a Chikungunya outbreak?	Yes	134	53.600
	No	87	34.800
	I don't know	29	11.600
Do you think that an outbreak of Chikungunya or dengue fever might occur in the Alpes Maritimes?	Yes	107	42.629
	No	106	42.231
	I don't know	38	15.139

Discourse analysis revealed that such confidence is rooted in the fact that mainland France is perceived to be a Western country with a highly

structured healthcare system that is clearly prepared to handle such an epidemic. Comparison with the Réunion pandemic was occasionally

made, but such comparison focused on the fact that mainland France does not face the same economic insecurity and health problems. One teacher noted,

‘Regarding hospitals... I think we still have a valid structure. I think that we should be able to cope. Um...on Réunion island they were inundated...’

This is an example of how the relationship between vernacular and social inequalities in health can play out. In the qualitative study, both inhabitants and experts shared the same sense of pride, almost jingoism, about the French healthcare system; then, through their discourse they transcended reality with regard to the relative disadvantage of some Southern countries, including those which are French territories. Such a perspective tends to combine awareness about social inequality in terms of healthcare across the world and ethnocentric prejudice. The high level of confidence placed in the national healthcare system is also a by-product of the French culture of public policy support for the national health system and is part of the French welfare state tradition (Castel, 1995; Merrien, 1997; Merrien et al., 2005; Rosenvall, 1981).

Given this context of confidence, what makes people believe that an epidemic will occur locally? The MCA (Fig. 4) shows that trust in the health system and the degree of discomfort caused by mosquitoes has an impact on belief in a local Chikungunya outbreak. It reveals that those who do not trust the health system often believe in the likelihood of an epidemic, whilst those who are confident in the health system are not convinced of the

inevitability of an outbreak. Such results echo earlier research into the influence of trust on the perception of risk (see for example, Frewer et al., 2003; Slovic, 2000; Siegrist, 2000; Siegrist and Cvetkovich, 2000). Trust is an instrument of risk management, especially if the risk is ‘generated by ignorance and uncertainty’ (Giddens, 1991, p. 244). This observation seems even more accurate in health care considering that such contexts involve major consequences which can be life threatening (Alaszewski, 2003). Further, in our context we must also keep in mind that the Asian tiger mosquito issue is still relatively new to respondents. Their associated knowledge level is still relatively low, thus making it even easier to defer to experts’ experience and knowledge.

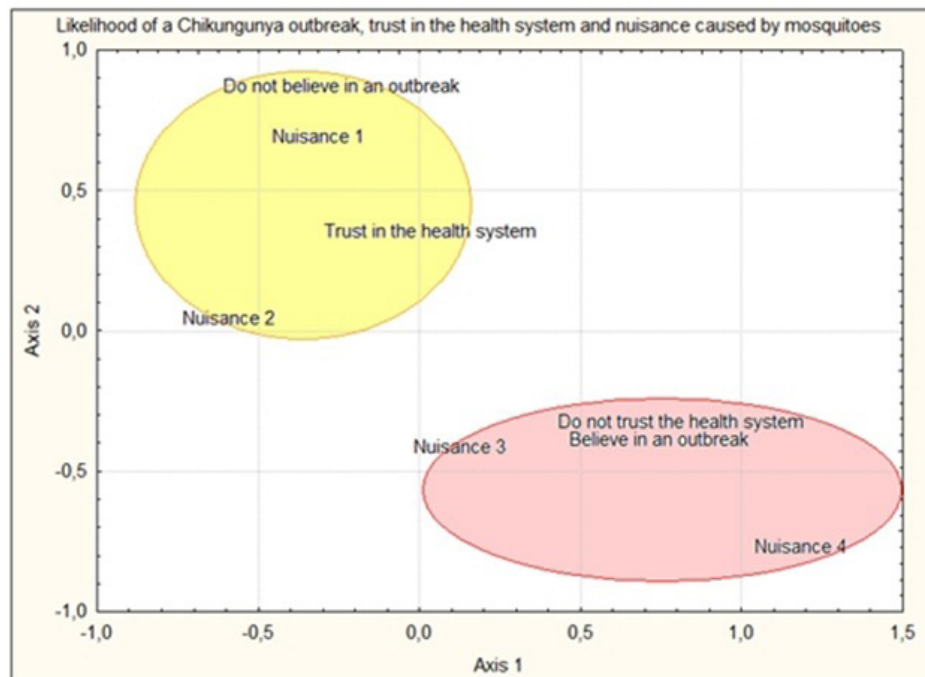
Another factor at play here, however, is the discomfort expressed with regard to mosquitoes. Thus, people with a greater degree of discomfort often expressed belief in an epidemic whilst those with lower discomfort levels were not convinced of the inevitability of an outbreak. Such results beg a better look at perceived discomfort levels.

This leads us to question the existing debate and controversy over the management of risk and uncertainty, which mainly opposes objective knowledge and beliefs and ideologies (Wynne, 1982, 1989; Pidgeon et al., 1992).

In our research, many interviewees did not seem to have the information and knowledge necessary to adequately form an opinion about the potential risk of an epidemic. Nevertheless, in the range of responses obtained, people did not rely on faith

or belief either. Coupled with the high degree of trust expressed by those we interviewed, such findings point to an ‘in between strategy’ as expressed by Zinn (2008). Their perception cannot be considered completely rational or completely irrational, but is rather at the crossroads of the two. The position adopted by individuals with regard

to the occurrence of an epidemic is part of an ‘in between strategy’ to the extent that opinions were based on people’s limited knowledge about the mosquitoes and previous epidemics, their confidence in the health system, jingoism and personal experience with regard to mosquitoes.



**Figure 4.** Multiple correspondence analysis of the likelihood of a chikungunya outbreak, trust in the health system and nuisance level caused by mosquitoes

***People’s exposure and acceptance of tiger mosquito bites: the standard of living effect***

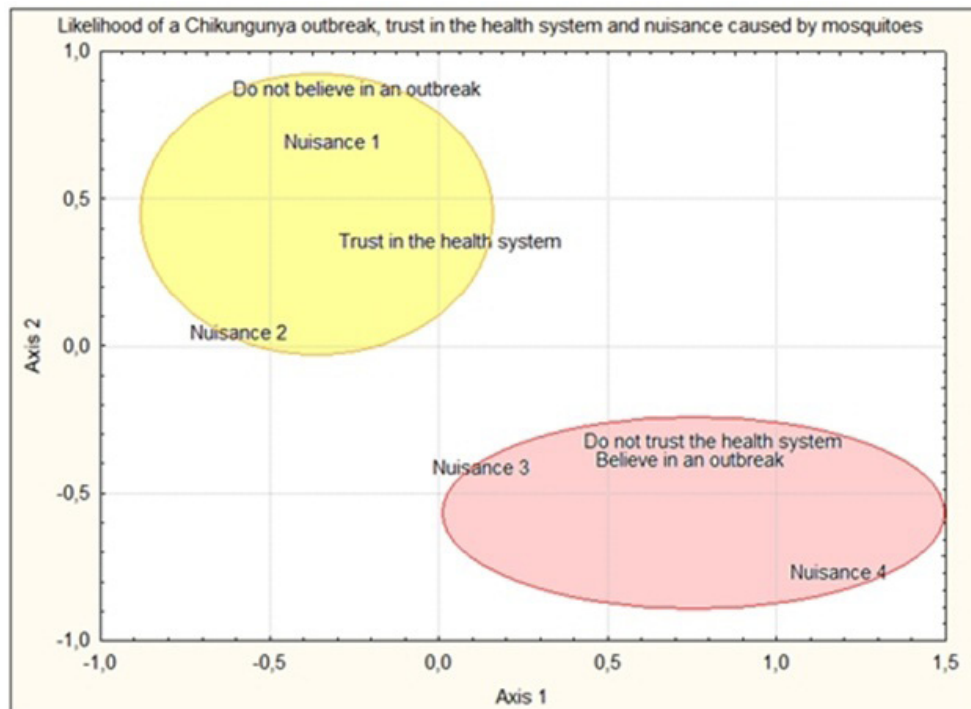
Although the first indigenous cases of dengue fever have been observed in the South of France, no epidemic outbreak has as yet occurred. This fact is comforting for expert and public confidence in the French health system. Conversely, both in interviews and in the questionnaires, what matters more for the public is the heightened discomfort

level connected with the increasing number of mosquitoes: it has gone from a minor nuisance to a painful, infected wound. Such discomfort levels, which result in an increase in complaints from inhabitants, are both objective and subjective, and they depend on biological, social and cultural factors. Here we shall examine the notion of discomfort through a theoretical risk framework defined as the interaction between hazard and vulnerability (Oliver-Smith and Hoffman, 2002).

Hazard is the presence of mosquitoes and vulnerability is the set of social activities which expose individuals in varying degrees to mosquito bites, a potential vector for disease. To fully grasp the multi-faceted nature of discomfort, we must consider its physical and symbolic aspects. As such, in addition to the physical dimension of vulnerability we must also examine the symbolic aspects which are socially

and culturally constructed and which lead to a different discourse about discomfort and different degrees of acceptance or complaint.

To begin, a connection is clearly visible in time and space between the expanded distributional range of Asian tiger mosquitoes and the emergence and increase in public complaints about discomfort, as shown on the map (Fig.5).



**Figure 5.** *Calls to the special toll-free number and Asian tiger mosquito presence along the French Riviera*

The quantitative survey (conducted in areas estimated by entomologists as affected by the spread of Asian tiger mosquitoes) shows that inhabitants indicate different discomfort levels. As such, 40 percent of our sample claimed not to have been bothered by mosquitoes over the past twelve months, 60 percent indicated varying degrees of discomfort, from limited to

average to high (respectively 18, 20 and 22 percent of all responses).

Entomologists have observed that the spread of tiger mosquitoes is primarily tied to anthropogenic causes, both at the local and international level (Erickson et al., 2010). Asian tiger mosquitoes do not fly very far alone (no more than a few hundred metres), but use means of transportation such



**Table 2:** *Discomfort caused by mosquitoes, evolution and time and period of this discomfort, and habitat type, key frequency distributions observed in the quantitative survey*

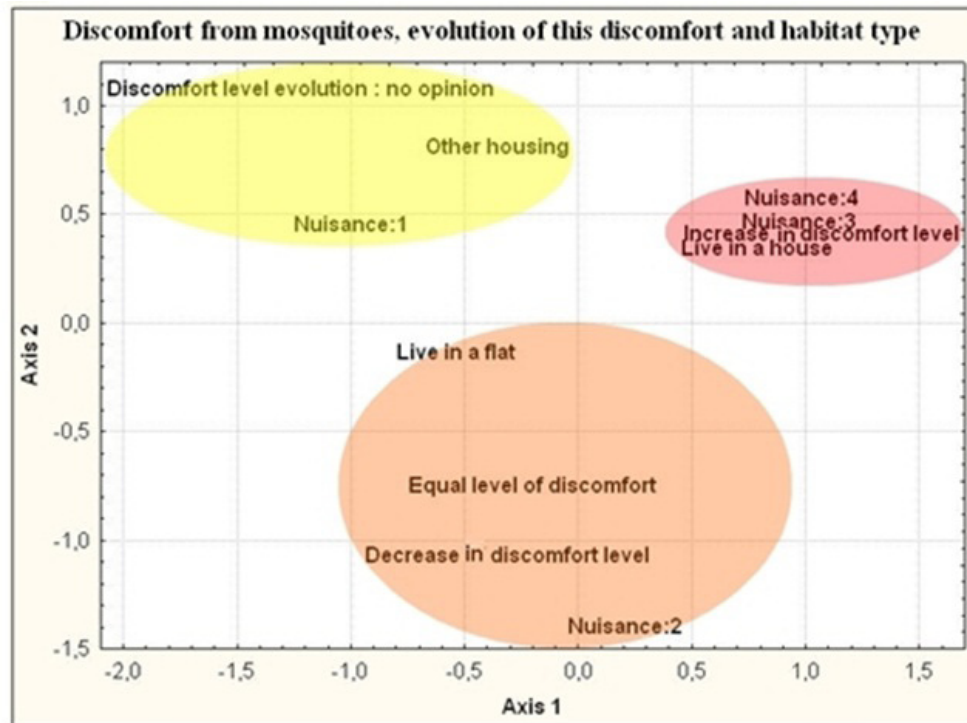
Questions asked in the quantitative survey	Responses	Enrolment	Distribution(%)
In the past 12 months, have you been bothered by the presence of mosquitoes? Choose on a scale of 1 to 4 where 1 is not at all bothered and 4 is extremely bothered.	1	111	40.072
	2	62	22.383
	3	54	19.495
	4	50	18.051
Compared to previous years, would you say that your discomfort level has increased, decreased or stayed the same?	Has not changed	100	35.587
	Increased	98	34.875
	I don't know	66	23.488
	Decreased	17	6.050
Where do you live?	An apartment	166	59.075
	A house	113	40.214
	Other	2	0.712
Over the past 12 months, at what time of day were you bothered by mosquitoes?	Evening	138	51.880
	Day	47	17.669
	Night	46	17.293
	Morning	34	12.782
	I don't know	1	0.3759
Over the past 12 months, during which activities were you bothered by mosquitoes?	A drink / meal outdoors	101	31.173
	Indoors	56	17.284
	Gardening	43	13.272
	Outings (market, outdoor café / restaurant, etc.)	25	7.716
	Walking	24	7.4074
	While sleeping	23	7.0988
	Other	20	6.1728
	Outdoors sports	14	4.321
	Activities in or around a pool	12	3.7037
	At work (Indoors)	3	0.9259
	At work (Outside)	1	0.3086
	I don't know	2	0.6173
During which months of the year have you been bothered by mosquitoes?	July	159	28.700
	August	128	23.105
	June	110	19.856
	September	67	12.094
	May	44	7.942
	October	11	1.986
	April	11	1.986
	March	6	1.083
	November	5	0.902
	December	5	0.902
	January	4	0.722
	February	4	0.722

as cars, trains, buses, boats and planes (by accident or whilst following human prey). As such, the trajectories of expanding ranges are not linear. This may offer a first explanation for the heterogeneous discomfort levels expressed by inhabitants. During the quantitative and qualitative surveys, inhabitants from different neighbourhoods in a single town or village recently affected by Asian tiger mosquitoes were exposed to varying degrees of discomfort: from a strong degree of discomfort to none at all.

The MCA above reveals that type of habitat is the most significant

variable explaining the discomfort expressed by respondents. It is as such that inhabitants in flats in collective housing units expressed none or low degrees of discomfort caused by mosquitoes whereas the highest degrees of discomfort were expressed by inhabitants living in villas or suburban housing. The discriminating effect between collective and individual habitat does not result in a clear-cut distinction between lack of discomfort on the one hand and varying degrees of discomfort on the other, but it does distinguish between a lack or limited degree of discomfort





**Figure 6.** Multiple correspondence analysis of the discomfort caused by mosquitoes, evolution of this discomfort and habitat type

and higher degrees. This difference actually distinguishes between areas which may still be free from Asian tiger mosquitoes, with only a few 'traditional' indigenous species, and areas affected by the spread of Asian tiger mosquitoes which have seen a recent and exponential rise in discomfort levels.

The first set of factors explaining the correlation between the degree of discomfort from Asian tiger mosquitoes and individual habitat can be understood based on the interaction between the mosquito's characteristics, as provided by entomologists, and anthropogenic factors. Thus, the rather anthropomorphic nature of the species, as noted above, can also be seen at the micro-scale of a neighbourhood or garden. As a mosquito control manager

noted,

'Albopictus are born in a plant pot saucer, slip into the hedge and feast on biting people whilst they eat their own breakfast, lunch and dinner'.

In gardens, plant pots and particularly their saucers, but also any container such as a basin or a pool, provide Asian tiger mosquitoes with convenient substitute breeding grounds to replace their natural grounds, originally located in the hollow of tropical tree trunks (Silver, 2008). This can explain why the closer an inhabitant is to the Asian tiger mosquito's artificial breeding grounds, the greater the degree of discomfort expressed.

Moreover, Asian tiger mosquitoes' anthropomorphic means of spreading

mean that their arrival in a new area is sudden and takes the local population from a high level of comfort to an unbearable degree of discomfort without any transition period. Our interviews revealed that this sudden shift is perceived as even more unbearable due to the fact that it interrupts or affects activities which revolve around comfort at home, free time and outdoor leisure activities in summer. It is exacerbated by the standard of living and quest for quality of life, as well as the social value placed on outdoor space and leisure which are particularly strong along the French Riviera, one of France's most famous historical resort areas. Further, as Inglehart (1977, 1999) has argued about the culture shift in advanced industrial societies, once people's material needs are largely satisfied, their focus shifts to non-material goods and particularly to quality of life. For example, one woman complained that,

'It's unpleasant and spoiling our summer. We can't have any guests over, mainly due to the nuisance caused by the mosquitoes. We cannot eat our meals outdoors.'

Inhabitants newly exposed to the spread of Asian tiger mosquitoes quickly realise their propensity to bite humans at any time of day or night and over a longer biting season. In Nice, a newsagent explained,

'Once you go out the door, day or night, they are there biting you.'

The MCA below was carried out to have a better understanding of the factors that may influence the level of discomfort expressed by respondents.

Thus, one can observe again that collective housing is often associated

with low levels of expressed discomfort. In addition, while the sample represents a 24 hour period, the evening remains the most frequently mentioned time of day. This period is indeed characterised by an increase in social activities which increase the vulnerability of inhabitants. The evening is a time for outdoor social activities on terraces, in gardens, individual swimming pools and whilst having a drink or dinner with family or friends. The same trend is visible with regard to duration throughout the year. While inhabitants who expressed the highest degree of discomfort mentioned being bothered by mosquitoes throughout the year, respondents more frequently mentioned July and August, followed by May, June and September. Here again, the summer and holidays tend to involve more outdoor social activities which expose inhabitants to mosquitoes and therefore increase their vulnerability, as shown in the MCA.

For inhabitants, the discomfort caused by Asian tiger mosquitoes cannot be compared to the slight nuisance generated by the few local mosquito species. Residents and stakeholders met through the interviews were unanimous about the fact that tiger mosquitoes are more described the discomfort as follows: '

They have many nasty habits.  
That's why we call them Tigers...  
They will not surrender their goal:  
they want to bite, they need to'.

Key institutional stakeholders agree with this perspective, although they admit to a lack of scientific explanation to explain why tiger mosquito bites are more painful than those of other species. For instance, a doctor in

charge of the mosquito issue explained that,

‘The bite is not the same; the pain is not the same. The reaction is not the same’.

During the qualitative survey, the most affected inhabitants showed us the numerous bites on their legs and arms and underscored the pain involved. The irritating, itchy bites lead to abundant scratching, particularly at night, and then to infection. For instance, a resident in Mandelieu-la-Napoule complained as follows:

‘I’ve been eaten, look. On my legs, arms, fingers! It’s horrendous. It’s itchy and I know that I scratch myself at night. During the day, I avoid scratching. We use Apaisyl, etc., but at night I scratch without realising it.’

The aggressiveness of Asian tiger mosquitoes and the painfulness of the bites were emphasised by inhabitants, and key institutional stakeholders, including medical experts, but lack of scientific explanation for this phenomenon makes it particularly subjective and emotional. Some inhabitants distinguished between indigenous mosquitoes and Asian tiger mosquitoes, calling the former normal and the latter pathological, emphasising their exotic origins which make them more unbearable. The mosquitoes’ ability to reach the most sensitive areas of the body (e.g., legs, arms and finger joints) and their painful bites leading to infected wounds are perceived as an affront to the body’s intimacy and integrity. This feeling of having been violated also leads to a sense of shame and/or stigmatisation by others, as expressed by some of interviewees.

For example, one inhabitant said that she felt better when she saw that other people had been bitten too:

‘The other day, we went for a walk in Nice. Looking at other women on the street, I saw that they had huge bites too. I said to my friend, Look, they’ve been bitten too.’

The mosquitoes’ shameful and stigmatising effects also influence information and awareness-raising campaigns, which are confronted with mental and cultural barriers, as well as with economic and political constraints.

### ***The mental, cultural, political and economic barriers confronting awareness-raising campaigns***

Every person interviewed from a public body in charge of this issue (in the health and entomology fields) underscored a recurring dilemma: how to inform efficiently without generating panic amongst the population? This dilemma has tended to create mistrust between the media and key institutional stakeholders and has led to a continuous struggle between releasing enough information and the fear of releasing too much information (Wilkinson, 2009), especially given the significant impact the media can have on the risk level assigned by the population (Wilkinson, 2009; Nicol et al., 2008) and also on its acceptance of such risks (Bakir, 2010). Indeed, as Rohrmann (1992) and Wilkinson (2009) have shown, communicating on such issues is complex. This was particularly perceptible in the words of one mosquito control manager:

‘We never talk about disease to avoid spreading the wrong information. We do not talk about such risk. It happened once, at the beginning, in 2006, during the very first mosquito controls done in a neighbourhood with a suspected case of fever; the local television came, the newspaper wrote a dramatic article about the tiger attacks and Chikungunya outbreak. The same day, we received 170 telephone calls from residents, it was nuts. And it was not good.’

The results of our qualitative and quantitative surveys are fairly reassuring: they show that a large majority of residents are confident and, thus far, no signs of dramatization or large-scale panic have been observed. Yet, public attitudes are not always predictable and they can shift quickly from complete confidence to harsh criticism and alarmed discourse (Sandman, 1998). Further, authorities’ fear of potential public panic is testament to a related issue involving political and economic interests.

As such, the key institutional stakeholders interviewed, who are subject to the diktat and volatility of popularity ratings, are torn between taking an active approach by anticipating an epidemic, and falling into the trap of overdoing things. A few previous health scandals in France remain fresh in peoples’ minds: the two primary examples are the contaminated blood scandal in the 1990s and the recent H1N1 outbreak. In the former, political actors were accused of not intervening quickly enough despite expert reports, leading to the HIV infection of two thousand blood

transfusion patients (Fillion, 2009); in the latter, political actors in charge of the H1N1 epidemic were accused of overreacting, leading to large-scale vaccination campaigns criticised by some experts for their pertinence and cost (Gallopain, 2009). The first case would tend to lead decision-makers to compensate with ostentatious policies whereas the second would tend to lead them to cost-benefit calculations. Such dilemmas and their controversial background shed light on how difficult it can be for decision-makers ‘to transform an unmanageable contingent future into a manageable complexity’ (Zinn, 2009, p.512).

Finally, the strongest and most recurrent argument advanced by those interviewed to explain the ‘information *versus* creating panic’ dilemma was the local economy. The main source of economic income along the French Riviera is generated directly or indirectly from tourism<sup>5</sup>. That is why key institutional stakeholders fear that overly dramatic information campaigns and awareness-raising about the spread of tiger mosquitoes and the related epidemic risks could frighten off tourists and affect the prestige of France’s most famous resort area.

Such concerns promote an atmosphere of secrecy or at least of discretion. Thus, when a suspected case of Chikungunya or dengue fever is reported to authorities, the mosquito eradication protocol for vector control is carried out with utmost discretion, just before dawn. Neighbourhood residents are informed the day before by local authorities; however they are told that mosquito control is being carried out due to increased levels

**Table 3:** Prevention and protection measures taken by inhabitants, frequency distribution observed in the quantitative survey

Questions asked in the quantitative survey	Responses	Enrolment	Distribution(%)
Over the past 12 months, what measures have you taken against mosquitoes? Whether in the Alpes Maritimes or in another area ...	None	100	22,08
	Lotion / Body sprays	59	13,02
	Electric diffusers	52	11,48
	Plants	42	9,272
	Coils to burn	30	6,623
	Aerosols	30	6,623
	Emptying stagnant water	28	6,181
	Essential oils	21	4,636
	Other	21	4,636
	Screens on windows	16	3,532
	Insect / UV Lamp	14	3,091
	Bracelets against mosquitoes	10	2,208
	Air conditioning	8	1,766
	Spray clothing	8	1,766
	Non electric broadcaster	5	1.104
	Bed net	4	0.883
	Loose/long clothing	4	0.883
	I don't know	1	0.221

of discomfort. In this case, tiger mosquitoes and the related health risks are not explicitly mentioned.

The temptation to keep things secret is not always possible, however. Beyond the ethical issues raised, there are also technical constraints. Thus, the wide scale mosquito control generally implemented in other French regions (such as Camargue and Languedoc-Roussillon) for indigenous species which lay their eggs in rural wetlands and urban sewers does not apply to *Aedes albopictus*, which prefer to use thousands of small sources of water, such as their favourite, the saucers under plant pots in gardens. In order to be effective, mosquito control requires the involvement of inhabitants by encouraging them to drain every drop of water in every single potted plant. But, as previously mentioned and despite efforts aimed at communication

each year, most of the local population interviewed claimed never to have heard about such information campaigns. Moreover, very few people spontaneously mentioned draining their potted plants as behaviour adopted to reduce the discomfort caused by mosquitoes (6.18 percent of the quantitative sample).

Awareness campaigns face strongly embedded cultural and mental resistance. As such, even those who had heard of the campaign and were able to accurately describe its main content did not always apply the advice given. Our qualitative survey provided information about the processes behind such resistance. For instance, one inhabitant challenged the potted plant argument more than she accepted it:

‘Well, there may be a problem with the saucers under plant pots,



but here the bigger problem is the creek just behind us. We can even hear the toads’.

Another resident who, despite the presence of larvae in his pots, also remained sceptical:

‘At this time of year... uh... well, water no longer flows, there are only little pools of water, and no more than a trickle of water. There you get a load of them... That’s what should be handled first.’

Discourse analysis shows that such resistance comes from a deeply embedded cultural framework of classifying things, beings and places within nature/culture, wild/domestic and soiled/pure dichotomies (Douglas, 1990). As such, mosquitoes are traditionally associated with dirty places or wild wetlands perceived as soiled or wild places.

In the above example, the reference to toads is full of meaning, summoning an unfriendly or simply disgusting register to describe wildlife. For most of the inhabitants interviewed, it was completely unthinkable that their tiny garden, watered with drinkable tap water, next to their cosy villa in a well off neighbourhood could encourage the proliferation of dirty little creatures well known for their attraction to dirty places and dirty water. Taken as such, the mosquitoes’ intrusion is perceived as a scourge and leads to an attitude of denial on the one hand and to stigmatisation on the other. This process of denial-stigmatisation is used by people to absolve themselves and to place blame on ‘dirty places’ and/or ‘dirty people’, potentially leading to racist attitudes which stigmatise *‘foreigners as particularly dirty*

*people’*, as illustrated by the following excerpts. Asked about places where Chikungunya is present, one municipal employee and a retired woman in Cannes respectively responded:

‘... In African countries like Zaire, Somalia... I would rather say those places. Places where there is putrefaction...’

‘... In hot places... where it’s sunny, where there are destitute people, people who have poor hygiene.’

Such phenomena are exacerbated by the lack of any local ‘mosquito culture’, which is something that exists in other parts of the French Mediterranean coast rich in natural wetlands such as the Camargue region, where houses are traditionally built with screens on the windows and traditional folk costumes protect the legs (with thick trousers), arms (long sleeved shirts) and neck (bandana and hat) from insect bites (Claeys and Nicolas, 2009). Conversely, houses along the French Riviera are not equipped with screens on the windows and people are accustomed to wearing light and short summer clothes. Amongst our qualitative sample, only 3.53 percent of inhabitants had mosquito screens on their windows and only 0.88 percent mentioned wearing long and wide clothing as a means to protect themselves from mosquito bites. During the qualitative survey, one inhabitant commented that,

‘Having to wear long-sleeved clothes and trousers during the evening is fine, but it’s not possible during the day when it’s hot!’

## Conclusion

The qualitative and quantitative surveys conducted in the French Riviera revealed that inhabitants and key institutional stakeholders do not yet consider Chikungunya or dengue fever to be real health threats to the extent that they trust that the French health system is well equipped to handle them. Thus, the main issue related to the spread of tiger mosquitoes is the exponential increase in discomfort that accompanies it. The discomfort caused by mosquitoes is not a natural hazard; it must be understood as a socio-natural process since the insects' introduction, spread and reproduction are caused or encouraged by anthropogenic factors. Further, exposure to bites and the degree of discomfort involved are socially and culturally contextualised. The findings of this research confirm classic research into social inequality which shows that people with less education are disfavoured in terms of knowledge and awareness about risk and health. Yet these findings also underscore the opposite process, thus comforting Beck's thesis, with regard to vulnerability towards mosquito bites; as such, type of habitat (villas and suburban housing) and the related social activities of people of higher socio-economic status tend to increase their exposure to mosquito bites compared to people of lower socio-economic status living in flats without a garden. This is also why tiger mosquitoes and related diseases are perceived as a political and economic threat to the French Riviera given the importance of lifestyle and comfort for residents and tourists and the potential repercussions for the 'luxury' tourism industry. Such

economic and political factors tend to present public authorities with a dilemma, trapping them between the need to inform the population and a fear of overacting and causing panic amongst inhabitants and tourists. In this context, trust may be the key issue. Indeed, Giddens (1990) has argued that trust has become essential both for making contemporary risks and uncertainties bearable for lay people and in allowing abstract systems to operate. In the past, it was not necessary to have confidence in something that could be continuously monitored; at present, however, most operations occur remotely and without any visible landmarks in time and space, thus explaining why expert systems now depend on trust. Given this, trust in distant and abstract systems is both a condition and consequence of modernity.

## Notes

<sup>1</sup> These two diseases transmitted by *Aedes albopictus* should not be confused with malaria and West Nile virus, transmitted by other mosquitoes. In metropolitan France, malaria disappeared in the early twentieth century. In the 1990s a new health alert was raised in France's Camargue region with the introduction of the West Nile virus, transmitted from birds to mosquitoes, then to horses and, in some cases, even to humans.

<sup>2</sup> National Agency for Mosquito Control and Management of Natural Areas in which mosquitoes have already been eliminated

<sup>3</sup> Interdepartmental mosquito control agreement.

<sup>4</sup> Idem.

- <sup>5</sup> Pearson Chi<sup>2</sup>: 14,1688, dl=6, p-value=0,027814. presence of mosquitoes? Choose on a scale of 1 to 4 where 1 is not at all bothered and 4 is extremely bothered.'
- <sup>6</sup> The 'Nuisance' variable, with different levels from 1 to 4, refers to the following question in the questionnaire: 'In the past 12 months, have you been bothered by the
- <sup>7</sup> <http://www2.nice.fr/economie/11B-tourisme.pdf>.

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