Leptospirosis in French Polynesia: 11 years of surveillance data, 2007–2017

N. Bouscaren, C. Benoit de Coignac, S. Lastère, D. Musso, Y. Teissier, J. Formont, F. Chaix, M. Giard

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Article type: original article

Authors and affiliations: Bouscaren N[1], Benoit de Coignac C[2], Lastère S[3], Musso D[4-5], Teissier Y[6], Formont J[6], Chaix F[7], Giard M[6]

1- Inserm CIC1410, CHU Réunion, Saint Pierre, France.
2- Private praticioner, Réunion, France
3- Laboratoire de biologie médicale et d'anatomie pathologique, Centre hospitalier de la Polynésie française, Pirae, Tahiti, Polynésie française
4- Unit of Emerging Infectious Diseases, Institut Louis Malardé, Papeete, Tahiti, Polynésie française
5- Aix Marseille Univ, IRD, AP-HM, SSA, VITROME, IHU-Méditerranée infection, Marseille, France
6- Bureau de veille sanitaire, Direction de la santé, Papeete, Tahiti, Polynésie française
7- Service de médecine interne, Centre hospitalier de la Polynésie française, Pirae, Tahiti, Polynésie française

Corresponding author:

Dr Nicolas Bouscaren

Inserm CIC 1410, CHU Sud Réunion, BP 350, 97448 Saint Pierre Cedex, Réunion, France
Tel : +262 (0)262 71 98 30
Email : nicolas.bouscaren@chu-reunion.fr / n.bouscaren@gmail.com

Word count: Abstract 192, text 2164

Tables and Figures: Table: 2, Figure: 2

Reference: 35 (max 50)

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Abstract

Leptospirosis is a worldwide zoonosis with higher incidence in tropical areas and is a neglected disease in the Pacific region. French Polynesia is a French overseas Territory located in the South Pacific. Data on the epidemiology in French Polynesia are scarce. In this study, we described our understanding of leptospirosis epidemiology in French Polynesia and discussed the prospects concerning this disease and its surveillance to better address preventive actions. We reported 11 years of surveillance data between January 1st 2007 and December 31st 2017. Over the study period 1,356 confirmed and probable leptospirosis cases were reported, the mean annual incidence rate was 46.0 (95%CI 43.6-48.5) cases per 100,000 inhabitants, we registered 864 (63.7%) hospitalisations, among them, at least 270 (19.9%) were in intensive care unit and 24 (1.8%) patients died. Even if incidence of leptospirosis is lower in French Polynesia compared to most of other Pacific countries and Territories, our data confirms that the disease is highly endemic in our country. Despite all preventive measures, leptospirosis remains a major public health concern in French Polynesia, highlighting the need to maintain intensive leptospirosis surveillance, medical staff training and information of the general population.

Introduction

Leptospirosis is a worldwide bacterial zoonosis, with a significant health burden on economically vulnerable population [1–3]. It is a neglected tropical disease, especially in the Pacific Region [4–6].

Leptospirosis is caused by spirochetes of the genus *Leptospira,* bacteria belonging to the *Leptospiraceae* family [7,8]. Many mammals' species, wild or domestic, can carry the pathogen. Rodents are the main reservoir of *Leptospira* [1]. Epidemiology of leptospirosis is characterized in the Pacific islands by a potentially important role of livestock farming animals [4].

Human contamination results from contact of abraded skin or mucous membranes with urine or tissues of infected animals, directly or indirectly via contaminated water or wet soil [1,9,10]. Spectrum of the disease range from subclinical infection as flu-like symptoms to severe disease with multi-visceral complications like acute renal failure, pulmonary haemorrhage (Weil's disease), and death [1,9,11]. Treatment is based on early antibiotic therapy. The vaccine only protects against the serovar Icterohaemorrhagiae, the most frequently responsible for severe human infections, and it must be renewed every two years.

Annual worldwide incidence of leptospirosis is estimated at 1 million cases, with 5-15% of severe diseases [12] and about 60,000 deaths [13]. Leptospirosis is responsible for 2.9 million Disability Adjusted Life Years (DALYs) per annum with a preponderant occurrence among low and middle-income tropical countries and males [2]. The burden of leptospirosis is underestimated because of high proportion of sub-clinical and asymptomatic infections, lack of notification systems, and poor access to accurate laboratory diagnosis in low and middle-income countries [1,14–16]. World Health Organisation (WHO) created in 2009 the Leptospirosis Burden Epidemiology Reference Group (LERG), with the goal to conduct research and develop policy targeted towards decreasing the burden of leptospirosis [17].

Pacific Islands have highly favourable environmental conditions for transmission of leptospirosis: hot and humid tropical and subtropical climate with high rainfall, recurrent flooding, poverty, urbanization, local life style (barefoot walking, swimming), and occupational activities [15]. Knowledge of the global burden of leptospirosis in the Pacific region remains incomplete, principally due to the lack of laboratory capacities to confirm cases.

French Polynesia (FP) is a French overseas Territory located in the South Pacific, constituted of five archipelagos: Society, Marquesas, Tuamotu-Gambier and Austral Islands. The population is about 280 000 inhabitants (2017 census), spread in 72 inhibited islands with 70% of the population leaving on Tahiti Island [18]. Few data on the epidemiology of leptospirosis in FP exist [4,19] with the first human infections reported only in 1959 [20]. Number of reported cases per year between 2006 and 2012 ranged between 79 and 127 and the annual incidence between 30 and 49 cases per 100,000 inhabitants [21–23].

In this study, we described our understanding of leptospirosis epidemiology in FP and discussed the prospects concerning this disease and its surveillance to better address preventive actions.

Methods

We reported 11 years of surveillance data between January 1st 2007 and December 31st 2017. In FP, all probable and confirmed leptospirosis cases are collected by the local health authority (*Bureau de veille sanitaire*), based on notification forms filled in by general practitioners, and laboratory results provided by laboratories of the "*Institut Louis Malardé*" and of the "*Centre Hospitalier de la Polynésie française*".

Case definition

Confirmed case: leptospirosis symptoms with either isolation of bacteria by culture or of its DNA by polymerase chain reaction (PCR) or seroconversion of specific immunoglobin class M (IgM).

Probable case: leptospirosis symptoms and IgM detection ELISA on a single serum collected more than 1 week post symptoms onset.

Excluded case: leptospirosis symptoms with PCR negative on sera collected within the first week post symptoms onset or ELISA IgM negative on sera collected more than 1 week post symptoms onset.

Demographic data were provided by the FP statistic institute [24]. Population estimation along the duration of the study was calculated using an exponential increase during two consecutive censuses.

All confirmed and probable cases were included in statistical analysis. Qualitative variables were described using frequency and percentages. Quantitative variables were described using mean ± standard deviation [minimum-maximum]. Annual Incidence rates (AIRs), meaning number of cases per 100,000 persons year (PY), were presented with 95% confidence intervals (95%CI), based on the Poisson model. We used a Z test for comparing AIRs between genders and between archipelagos. Relative Risks (RR) with corresponding 95% CI were computed. A p level of <0.05 was considered statistically significant. All statistical analyses were performed using STATA® V13.1 software (StataCorp LP, Lakeway Drive, College Station, Texas 77845 USA) for Windows. Mapping was done using the QGis® v2.18.1 software and Google Earth Pro®.

Results

Between 1 January 2007 and 31 December 2017, 1,356 leptospirosis cases were reported: 851 (62.8%) confirmed and 505 (37.2%) probable. Over the study period the AIR was 46.0 (95%CI 43.6-48.5) cases per 100,000 PY (Figure 1a). Median number of cases on decade was 109 with a peak in 2017 with 199 cases corresponding to an AIR of 72.1 (95%CI 62.5-82.9) cases per 100,000 PY.

A total of 1,032 (76.1%) cases were reported in men cases and 324 (23.9%) in women (sex ratio 3.2) with an overall average age of 33.7±16.2 [2-80] on men and 35.2±17.8 [1-88] on women. Comparison of AIRs showed a significant excess risk of contamination in men [68.5 (95%CI 64.4-72.8) cases per 100,000 PY] vs women [22.4 (95%CI 20.1-25) cases per 100,000 PY], RR=3.1 (IC 95% 2.7-3.5), $p<0.001$. The age group repartition showed the largest number of cases was [20-29] years with 332 (24.5%) cases representing a peak AIR of 66.8 (95%CI 59.8-74.4) cases per 100,000 PY. During the whole period, cases were reported throughout the year, but mostly between January and May with a noticeable decrease from August to December (Figure 1b).

Geographical distribution

Island of residence was available for 1,282 (94.5%) cases. The Society archipelago accounted for 95.5% of cases with an annual average of 114.7±35.1 [74-192] cases. The AIRs per archipelago were 48.8 (95%CI 46.1-51.6) cases per 100,000 PY for the Society, 53 (95%CI 39.8-69.2) for the Marquesas, 1.3 (95%CI 0.0-7.4) for the Austral, and 2.2 (95%CI 0.6-5.5) for the Tuamotu Gambier. Map, number of cases, AIRs and RR by island in Society archipelago are presented in Table 1 and Figure2.

Over the study period we recorded 864 (63.7%) hospitalisations; among them, at least 270 (19.9%) were in intensive care unit and 24 (1.8%) died.

Information on risk factors for leptospirosis was obtained from 920 (67.8%) cases for occupational risk, 885 (65.3%) cases for leisure activity, 835 (61.6%) cases for contact with animals, and 324 (23.9%) cases for high risk facilities (Table 2).

Discussion

The worldwide AIR of leptospirosis is about 15 cases per 100,000 PY; the highest incidence is reported in the Oceania region with 150 cases per 100,000 PY and a mortality rate of 9.6 per 100,000 PY. In this region AIR of up to 844 cases per 100,000 PY over an 11-year period from 2004 to 2014 has been reported in Futuna [25], with a pic of 1,945 cases per 100,000 PY in 2008 [4]. The AIR of leptospirosis in FP between 2007 and 2017 was 46.0 (95%CI 43.6-48.5) cases per 100,000 PY, in the lower range of AIR reported in the region (40-270) [13]. This incidence is low compared with other Pacific Islands, probably because, at the difference of FP, most of them are low and middle income countries. However, AIR of leptospirosis in FP is most probably underestimated, especially in the most remote islands (Marquesas, Tuamotu Gambier and Austral). Main factors responsible for underestimation of leptospirosis in FP are misdiagnosis with other diseases, especially dengue, a high number of cases with few symptoms , and geographic constraint (isolation, multiplicity of islands, lack of medical personnel to carry out sampling, difficulties in accessing health care facilities, lack of transport or communication within and between islands) [26]. Similar clinical symptoms between leptospirosis and arboviral infection is a main issue during arboviral outbreaks, leading to undetection of leptospirosis cases and delayed treatment, potentially responsible for fatal cases [27].

Over the period 2007-2012 we noticed low variation of AIR. A peak of incidence was recorded in 2010. At the end of January 2010, cyclonic depressions (OLI hurricane) caused heavy rainfall and mudslides in many FP islands, especially in Tahiti [22]. These exceptional climatic conditions led to an increase in the number of cases in the first quarter of 2010. The population was quickly made aware by the local health authority of the probable increase in the risk of leptospirosis. Health professionals were encouraged to collect blood sample of patients with acute fever and diffuse pain syndrome. From 2013, the AIR increased due to an increase in screening linked to an arbovirus's epidemic context. Dengue and Zika epidemics occurred simultaneously between September 2013 and March 2014, followed by a major Chikungunya epidemic between October 2014 and March 2015 [28,29]. These 3 arboviruses are the main differential diagnoses of leptospirosis in endemic areas [11,27]. Concomitantly, the development of affordable molecular diagnosis in FP increased the number of tests and then the number of diagnosed cases. The significant increase of AIR in 2017 is mainly related to the heavy rains and floods at the beginning of the year [30].

Leptospirosis is known to be seasonal, and strongly associated with rainfall in tropical settings [9]. The number of cases increases during the hot and rainy season and decreases during the cold and dry season [31,32]. Heavy rains and floods are associated with a six-fold increased risk of developing leptospirosis and are a direct cause of epidemics as for the year 2017 in our cohort [31]. In FP, rainfall usually increases from December with a peak in January and then decreases until April. In our cohort 60% of cases occurred during the first 5 months of the year, cases increased from January with a peak in March and remains high until June. Thus, the recrudescence of reported cases of leptospirosis seems to be delayed by 2 months compared with the peak rainfall. This phenomenon had already been observed in Futuna and Reunion Island [25,33]. In two studies in Mayotte, cases followed the evolution of rainfall with a three-month delay. According to the authors, the importance of seasonal peaks is more related to the number of consecutive months with heavy rains than to the total rainfall [34,35]. The discrepancy observed between the incidence of leptospirosis and peak rainfall is explained by the soaking of the soil after the peak rainfall, which favour leptospires survival in the environment [33,35].

We have found a geographical disparity in the incidence of leptospirosis in FP. AIR were higher in high islands: Leeward Islands, Windward Islands and Marquesas. In contrast, lower islands (atolls) of the Tuamotu-Gambier were almost free of cases due to their geomorphology: coral atolls without relief and very little fresh water standing on the surface, no river or sludge because of the very porous soils, and low rainfall. In the high islands, the development of agricultural and industrial operation, and higher population density create waste and activities that may attract rodents and thus increase the risk of contamination [31,32]. In the Society archipelago, AIRs are higher in some Windward Islands and in the south-east part of Tahiti which are agricultural regions and where the main pig, cattle, horse and poultry farms are located.

Most cases occurred in males, in accordance with what is described elsewhere. It probably only reflects higher exposure of the male population through agricultural, farming and outdoor leisure activities. The highest AIR was in the [20-29] year's old class. Like sex ratio, a high number of cases in young age's classes possibly reflects a frequent exposure of young active men involved in agriculture and farming activities. However, the hypothesis that older classes are relatively protected by the immunity resulting from previous exposures also deserves consideration.

The main risk factor for leptospirosis in FP is professional or private agricultural activity: prevention measures should target this population. Secondary risk factors are mostly recreational with fresh water contact during leisure time (barefoot walking in mud, river bathing, hiking, gardening or fishing). Other factors such as contact with rats, pigs as well as dogs (large population of stray dogs), leaving in poor sanitary condition or in family farms in semi-urban areas near watercourses, can contribute to the transmission of the disease [4,19].

Conclusion

Leptospirosis is a major public health concern in FP where it will become soon a reportable disease. All laboratories and medical facilities, including intensive care unit, are available to diagnose and care cases. Prevention includes guidelines for healthcare workers, prevention measures for the general population broadcasted by a bi-monthly bulletin, and a reminder of the risk sent to the media after each heavy rainfall or flooding. In addition, following the WHO One Health approach, collaboration between animal and human health has been initiated to struggle against zoonosis as leptospirosis. Enhancement of rodents control by the improvement of waste management is needed. Despite all preventive measures, leptospirosis remains highly endemic in our country, highlighting the need to maintain leptospirosis surveillance, medical staff training and information of the general population.

Figures and tables

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Figure 2: Map of Society archipelago with a focus on Tahiti island, annual incidence rate of leptospirosis by island and municipality, 2007-2017

Table 2: Potential risk factors of leptospirosis, French Polynesia, 2007-2017

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Figure 1a: Leptospirosis cases and annual incidence rates in French Polynesia, 2007-2017

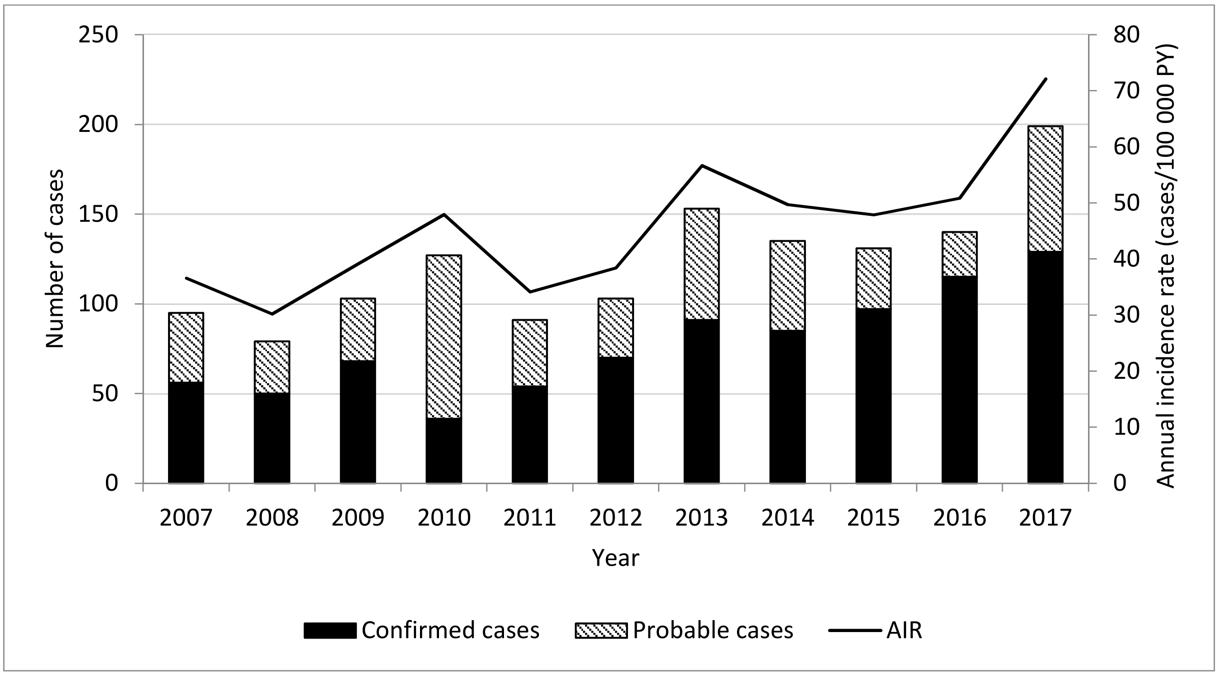
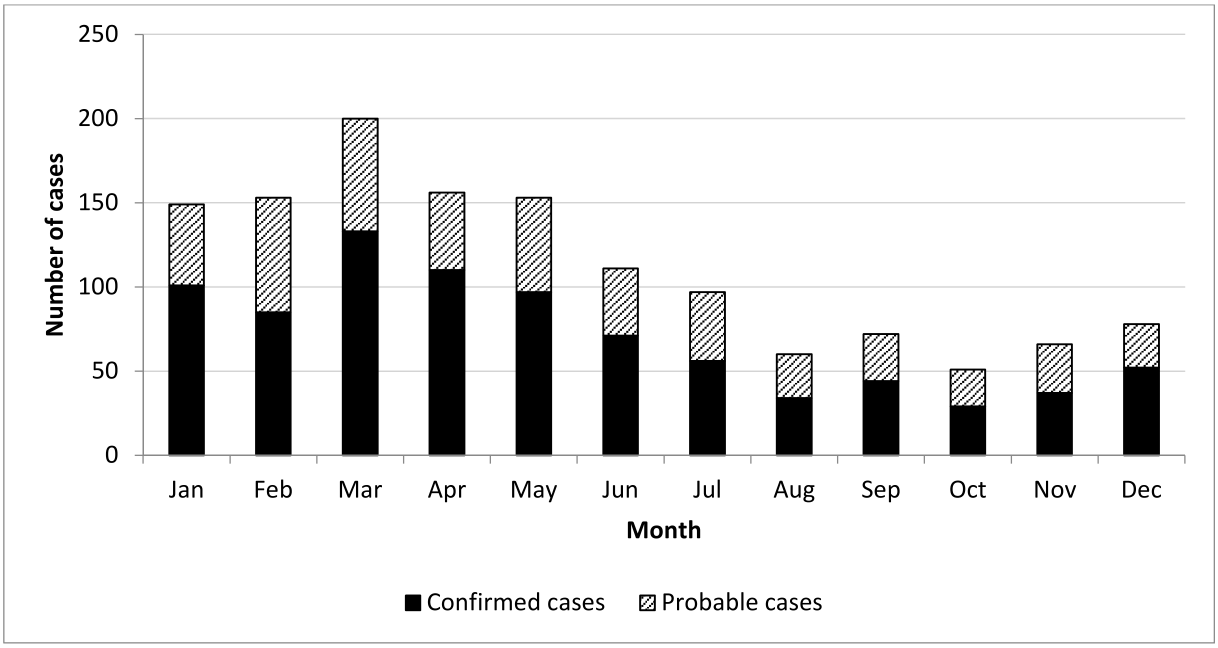


Figure 1b: Cumulated monthly cases of 11 years of leptospirosis in French Polynesia, 2007-2017



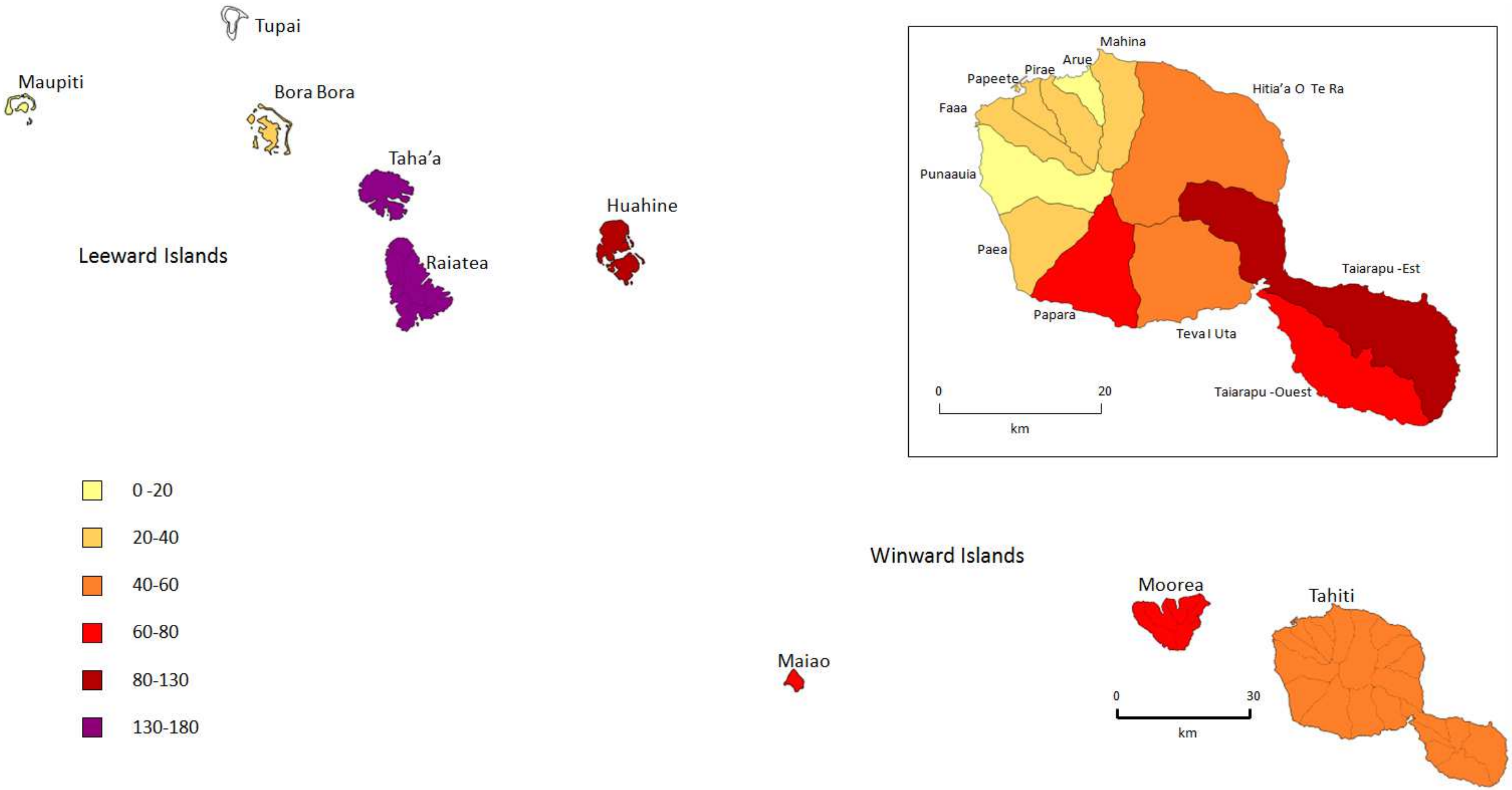


Figure 2: Map of Society archipelago with a focus on Tahiti island, annual incidence rate of leptospirosis by island and municipality, 2007-2017

Table 1: Leptospirosis cases, annual incidence rates (AIR) and relative risks (RR) by island of Society archipelago, 2007-2017

Islands	n (%)	AIR[a] (IC95%)	RR (IC95%)	p[b]
Tahiti	731 (57.9)	40.0 (37.1-43.0)	1.00 (reference group)	
Moorea - Maiao	121 (9.6)	63.8 (53.0-76.3)	1.6 (1.3-1.9)	<0.001
Raiatea	191 (15.1)	141.9 (132.3-163.5)	3.6 (3.0-4.2)	<0.001
Tahaa	94 (7.5)	163.7 (132.3-200.4)	4.1 (3.3-5.1)	<0.001
Huahine	87 (6.9)	125.5 (100.5-154.8)	3.1 (2.5-3.9)	<0.001
Bora-Bora	37 (2.9)	35.1 (24.7-48.3)	0.9 (0.6-1.2)	0.437
Maupiti	1 (0.1)	7.6 (0.2-42.4)	0.2 (0.03-1.4)	0.098

[a]AIR : Annual Incidence Rate in number of cases per 100,000 persons year

[b]Comparison of relative risk with the reference group.

Table 2: Potential risk factors of leptospirosis, French Polynesia, 2007-2017

Category		**Number of cases**	**Percentage over the total number of cases provided for this category**	**Missing values for this category**	
Occupational risk	Farmer	383	41.6%	436	32.2%
	Sanitation and waste treatment	60	6.5%		
	Animal husbandry	134	14.6%		
	Cattle breeding	23	2.5%		
	Horse breeding	17	1.8%		
	Pig farming	43	4.7%		
Leisure activity / fresh water contact	Fishing	131	14.8%	471	34.7%
	Hunting	40	4.5%		
	Gardening	319	36.0%		
	Hiking	101	11.4%		
	Walking barefoot	497	56.2%		
	Fresh water swimming	277	31.3%		
	River mouth surfing	67	7.6%		
Contact with animals	Cats	292	35.0%	521	38.4%
	Dogs	466	55.8%		
	Rats	545	65.3%		
High risk facilities	Dump in the vicinity	126	38.9%	1032	76.1%
	Water abstraction	48	14.8%		