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## Spatial investigation of congenital malformations in Reunion Island (2008-2012)

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## Introduction

Reunion Island is a French territory located in the south-western Indian Ocean (Figure 1). The Reunion Registry of congenital malformations (RMCR) is in charge of monitoring cases. Overall prevalence (289 cases per 10,000 births) is close to the average reported by mainland French registries (315 cases). However the **prevalence of spina bifida and anencephalies is almost twice** (19 cases per 10,000 births) **the one reported in mainland France** (10 cases). This study aims at describing the heterogeneous spatial distribution of different birth defects and identifying clusters.

The exposure to environmental pollutants (such as proximity to farmlands or pollution sites) could explain the occurrence of spina bifida and anencephalies (Rull RP *et al.*, 2006 ; Lacasana M *et al.*, 2006). Therefore this study focuses on comparing the spatial distribution of spina bifida and anencephalies with two other groups of malformations (cleft lip and palate and congenital heart defects) for which the average prevalences in Reunion Island are close to those measured in mainland France. These two are also related to environmental factors (Wang W, 2009 ; Greer W *et al.*, 2005).

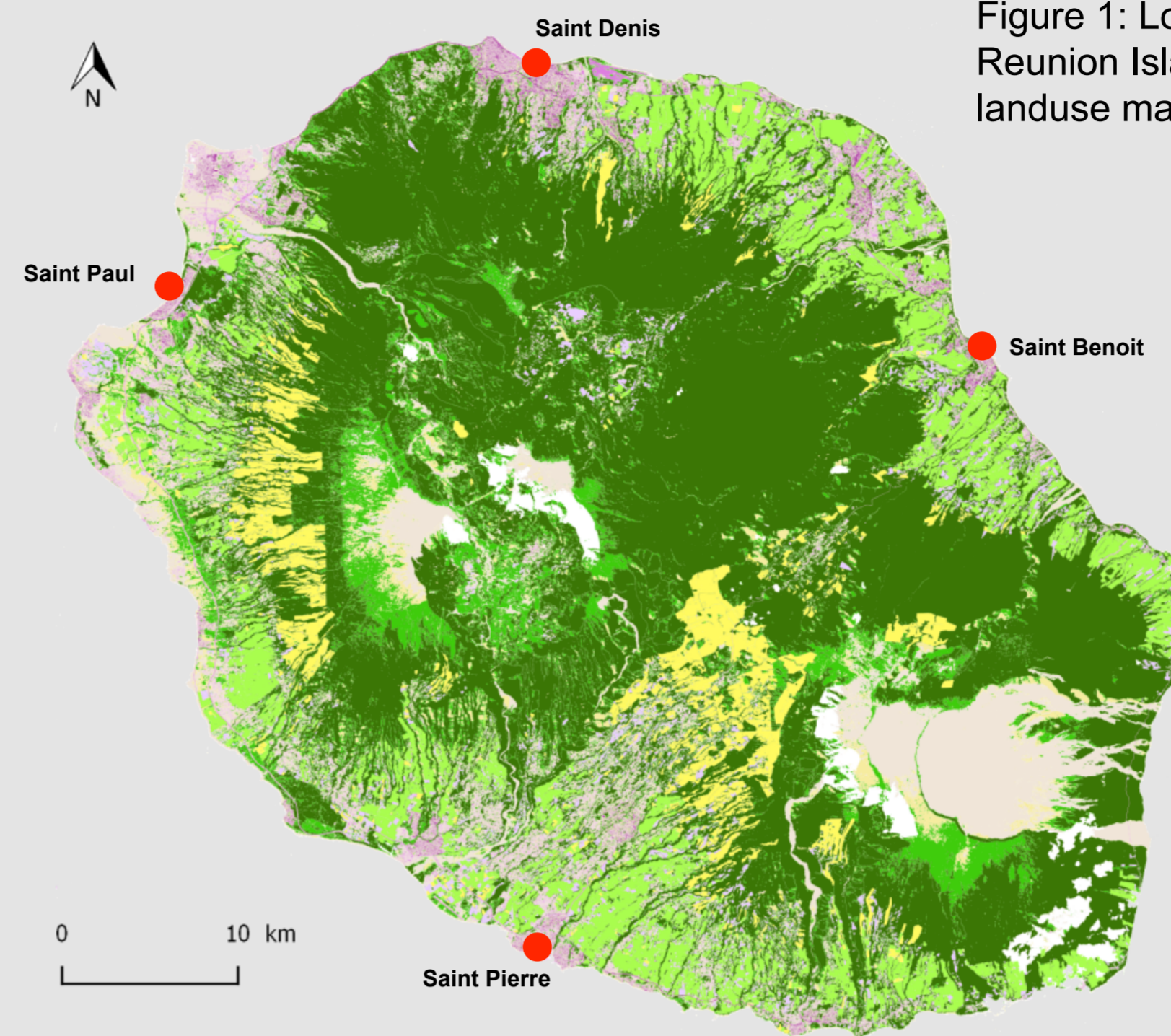
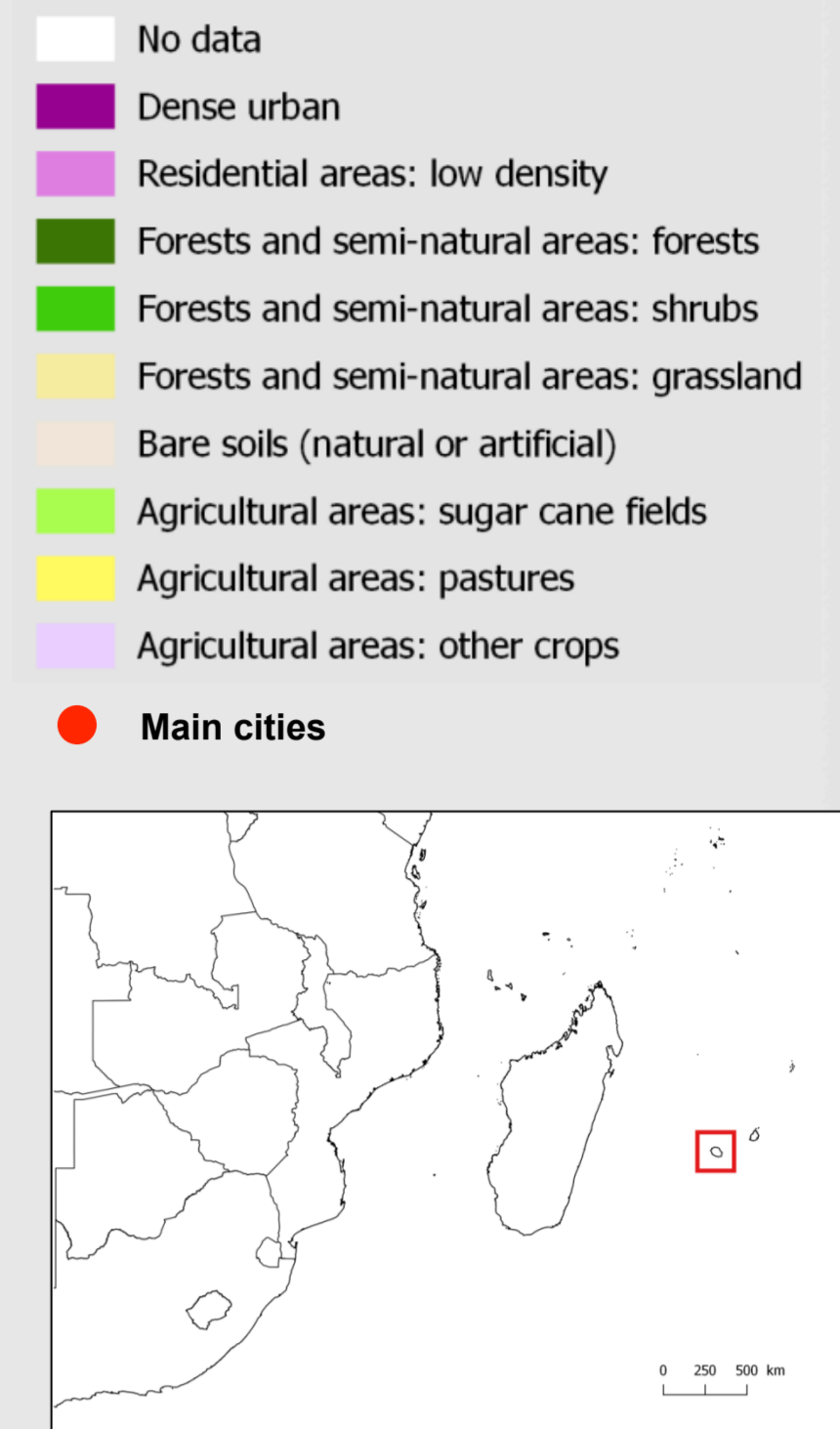


Figure 1: Location of the Reunion Island and landuse map in 2014



## Material and methods

### Cases and birth data:

This study includes all cases (congenital heart defect, cleft lip and palate, spina bifida and anencephaly) recorded from 2008 to 2012 by RMCR. Birth data were provided by INSEE (French Statistical Institute) at the "IRIS" scale (the smallest unit). Prevalences per 10,000 births were calculated for each group of pathology.

### Cases georeferencing and aggregation:

Each case is geolocalized according to the mother's residential address, based on the database "BD Adresse" provided by IGN (National Geographical Institute). We aggregated cases data and calculated prevalences at 3 administrative scales:

- District (largest administrative unit): 24 units,
- Subdistrict: 130 units,
- IRIS (smallest administrative unit): 344 units.

### Cluster detection methods:

- Kulldorff: SaTScan software (Kulldorff M, 1997)
- Standardized Prevalence Ratio (SPR): Poisson distribution to compare the number of cases with a theoretical number of cases (number of births × average island prevalence). P-value < 0,05 means that the result is statistically significant.
- Hierarchical Clustering Analysis (HCA)

### Geographic epicenter method (Boumediene F, 2011):

This method allows to intersect the clustering results at different scales and assign an index to each IRIS (Figure 2). For instance, an index value of 3 stands for an IRIS identified as a cluster at each of the three scales (this IRIS is located in a subdistrict and a district which are both clusters). An index of 2 stands for an IRIS identified as a cluster at the IRIS scale and only one of the two other scales.

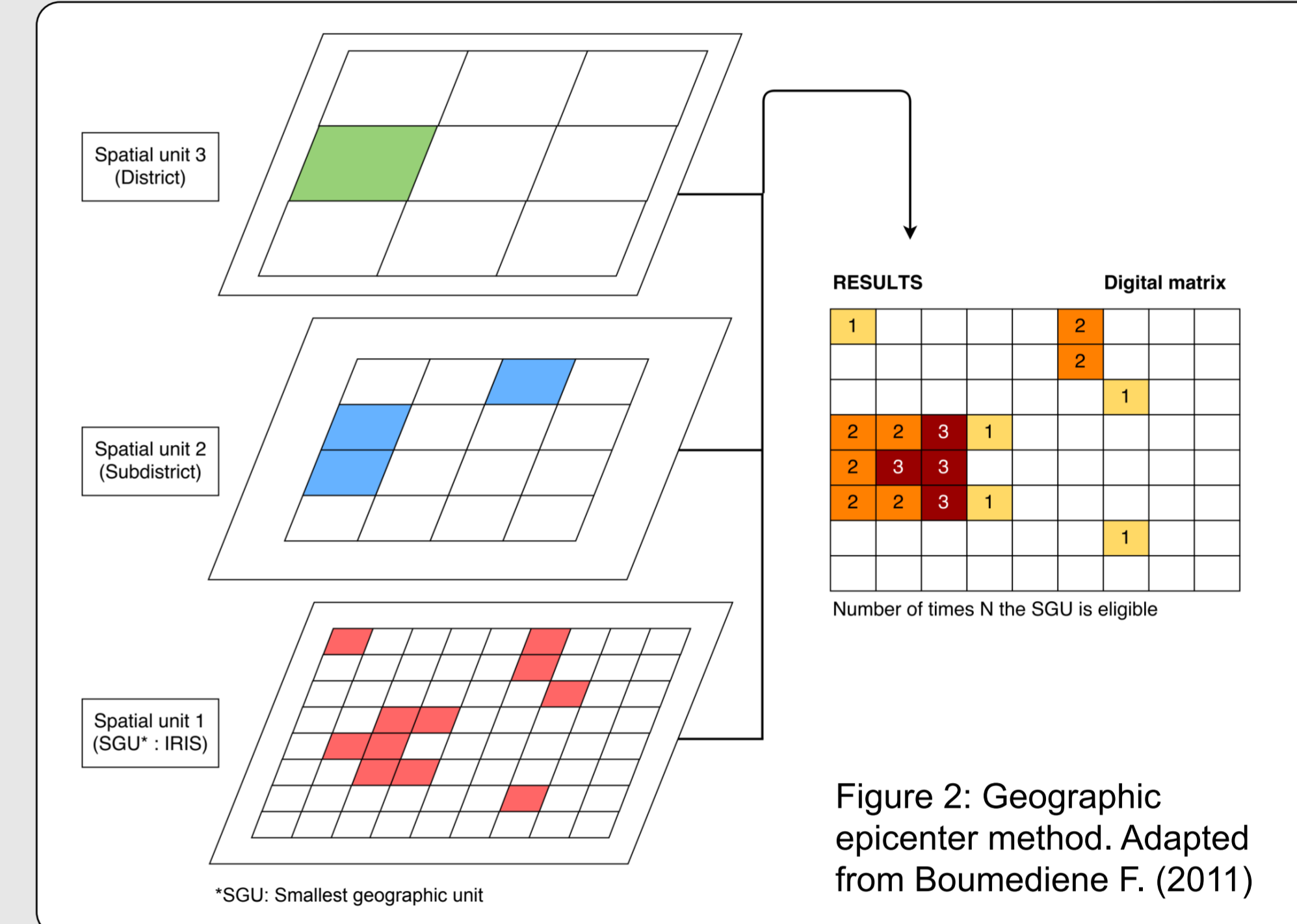
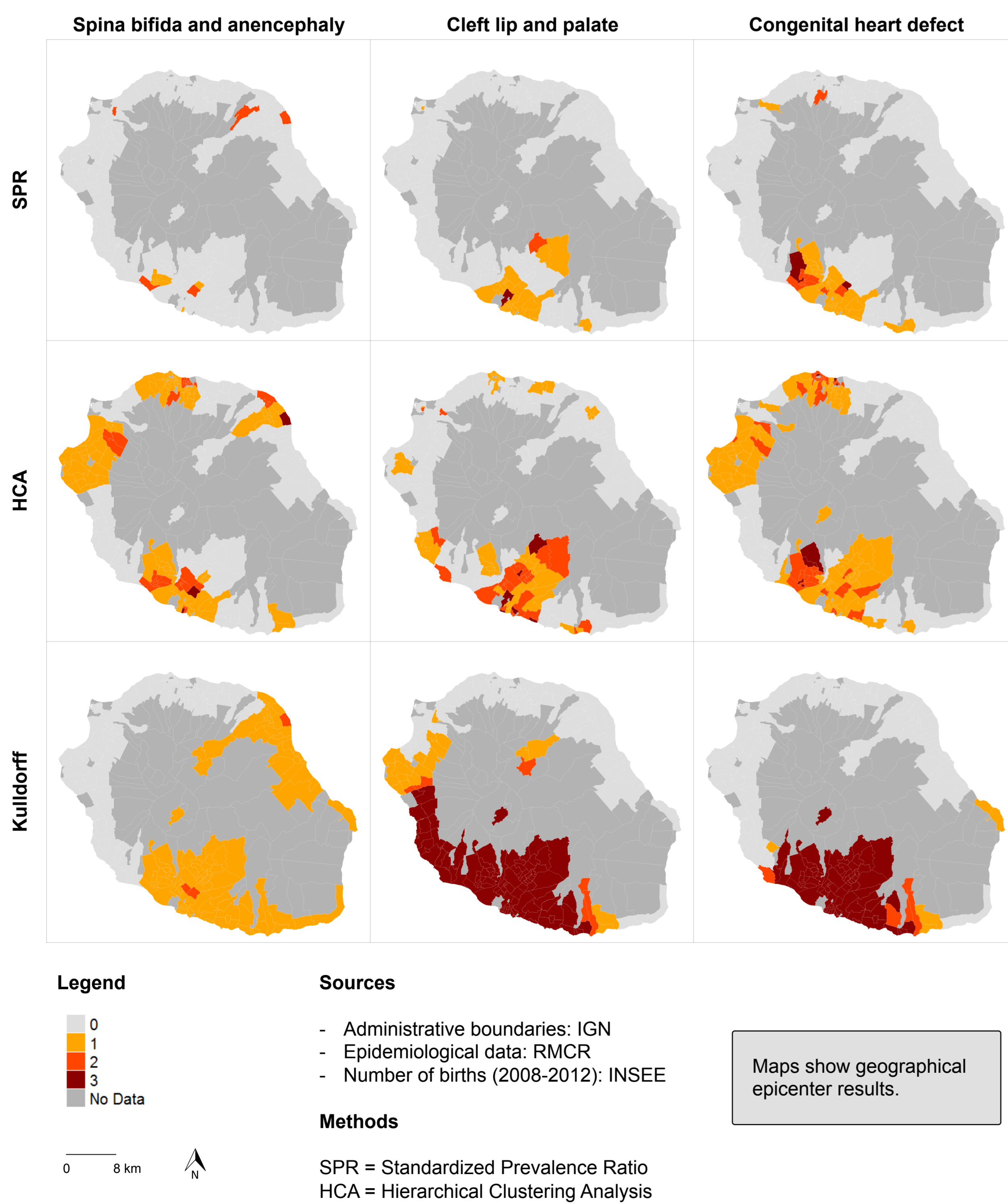


Figure 2: Geographic epicenter method. Adapted from Boumediene F. (2011)

## Results and discussion

### Cluster detection of the average prevalence of spina bifida and anencephaly, cleft lip and palate and congenital heart defect using 3 methods (2008-2012)



### Prevalence / group (per 10,000 births):

	Congenital heart defect	Cleft lip and palate	Spina bifida and anencephaly
Cases (EUROCAT)	500	108	141
Cases (geo-referenced)	473	104	127
Mean prev	75,4	15,1	18,7
Max prev	389,6	155	160
Std prev	63,8	27	29,6

### Results regarding groups of pathologies:

Overall, the southern region shows higher prevalences and a higher number of clusters.

### Similar patterns for cleft lip and palate and congenital heart defect (2 main clusters):

- South: high prevalence in 2 IRIS for cleft lip and palate and 5 IRIS for congenital heart defect.
- North or north west: high prevalence in 1 IRIS for cleft lip and palate and 1 IRIS for congenital heart defect.

### Spina bifida and anencephaly clusters:

- North east: high prevalence in 1 IRIS
- South: high prevalence in at least 3 IRIS

### Results regarding methods:

- SPR method is the most selective (small clusters with few IRIS).
- HCA results are quite similar to the SPR results with larger but isolated clusters.
- Kulldorff method generates large clusters (Gaudart J *et al.*, 2007).

## Conclusion

### A need to rely on different clustering methods:

The three clustering methods agree on identifying the South as a region of higher prevalence. Unlike congenital heart defects and cleft lip and palate, spina bifida and anencephalies seem to be more localized.

These clustering methods slightly differ on the size and number of clusters. Consequently, using several methods provides more certainty about the findings of the study.

### Perspectives:

This cluster investigation will help to focus on the most affected areas and investigate potential environmental factors that may contribute to congenital disorders.

The main hypothesis is based on the role of pesticides largely used on the island. Crops are mainly located in the south and the east of the island. Indeed recent work showed that the use of pesticides is responsible of some birth defects (INSERM, 2013). What about Reunion Island? Such investigation will require a case-control study with accurate information on living conditions and practices.

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