

Relev Project



Hurricanes and urban evolution in Saint-Martin between 1954 and 2017: How our societies change?

**Kelly PASQUON^{1,2}, Gwenaël JOUANNIC^{1,3}, Julien GARGANI^{2,4}, Chloé TRAN
DUC MINH¹, Denis CROZIER¹**

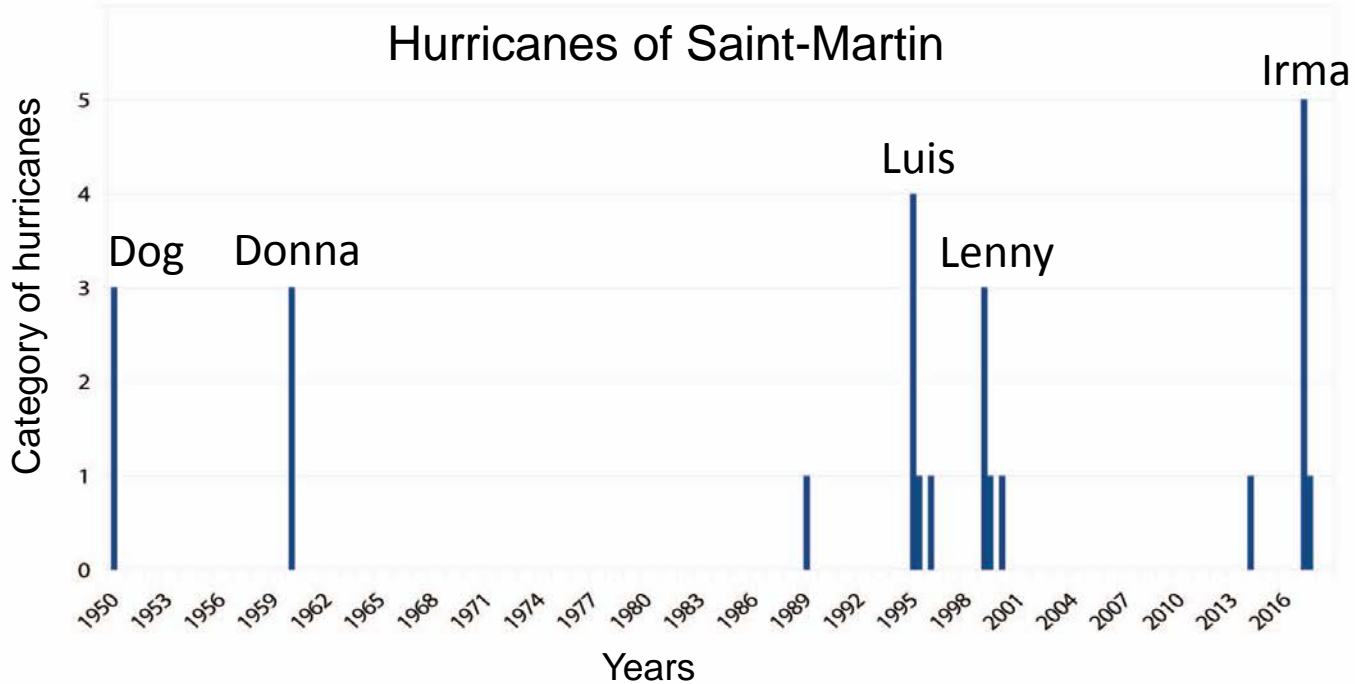
¹Cerema Ouest, 9 rue René Viviani, 44220 Nantes, France, ²Laboratoire GEOPS, Université Paris-Sud et CNRS, Université Paris-Saclay, bât. 509, 91405 Orsay, France, ³Cerema, Equipe-projet ESPRIM, France,

⁴Centre D'Alembert, Université Paris-Sud/Paris-Saclay, rue du Doyen Georges Poitou, bât. 407, 91405 Orsay, France

Hurricanes before Irma in Saint-Martin

According to the National Hurricane Center et Meteorological Service Netherlands Antilles and Aruba

13 hurricanes
have passed on
the island since
1950



➡ In this study, we wanted to focus on the adaptation of Saint-Martin to hurricanes from the 1950s to the present by looking at the urban planning of the island.

Cartography of construction and reconstruction

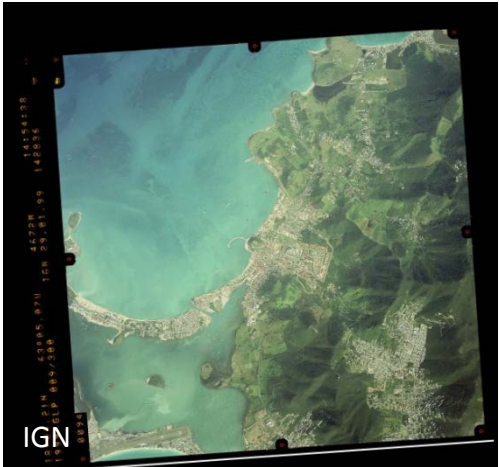
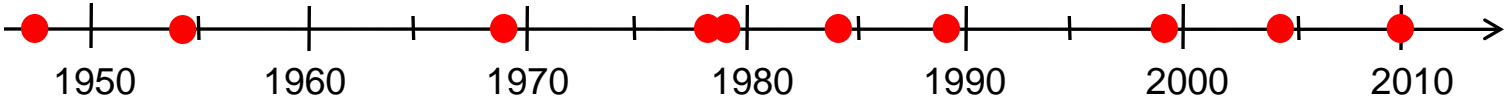
- Creation of maps of construction evolution (normal development of the island) including potential reconstructions (following hurricanes or other natural disasters) on Saint-Martin from 1954 to 2017.

 To understand how hurricanes influenced the “normal” development of the island.

Aerial photography

- Regular and highquality of **aerial shots** available on the IGN website

● Aerial shots



Marigot, large pond and surroundings

1999



Marigot, Nettle Bay, Sandy Ground

1954

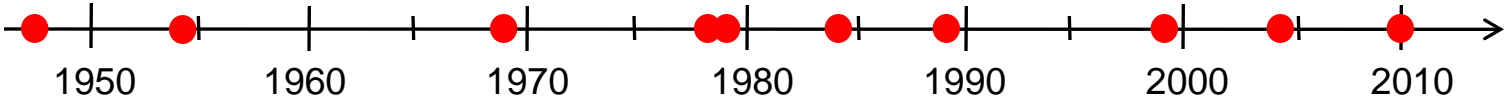


12 aerial shots since 1947

Aerial photography

- Regular and highquality of **aerial shots** available on the IGN website

● Aerial shots

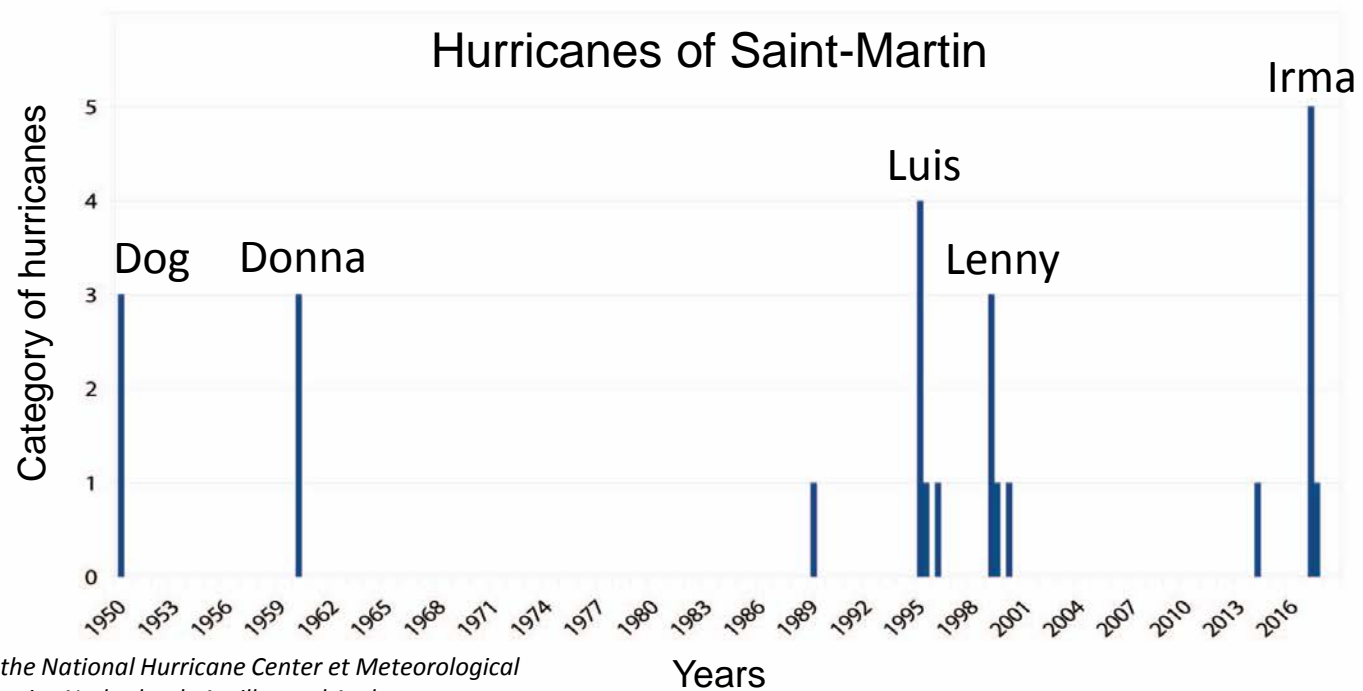


Years	1947	1954	1969	1978	1979	1984 (apr)	1984 (june)	1984 (oct)	1989	1999	2004	2010
Total coverage*	Yes	Nearly	Yes	No	No	Yes	Yes	Nearly	Yes	Yes	Yes	Yes
Colors (C) or black and white (BW)	BW	BW	BW	BW	BW	BW	BW	BW	BW	C	C	C
Number of images**	51	72	31	43	40	45	19	21	102	14	23	152
Zooms	-	-	103	-	-	-	30	30	-	-	-	-
Resolution	1/2500 0	1/10000	1/10000 and 1/19000 (zoom)	1/4300	1/9300 and 1/5000	1/20000	1/20000 and 1/2000 (zoom)	1/8500 and 1/2000 (zoom)	1/9000	1/30000	1/25000	1/ 10000

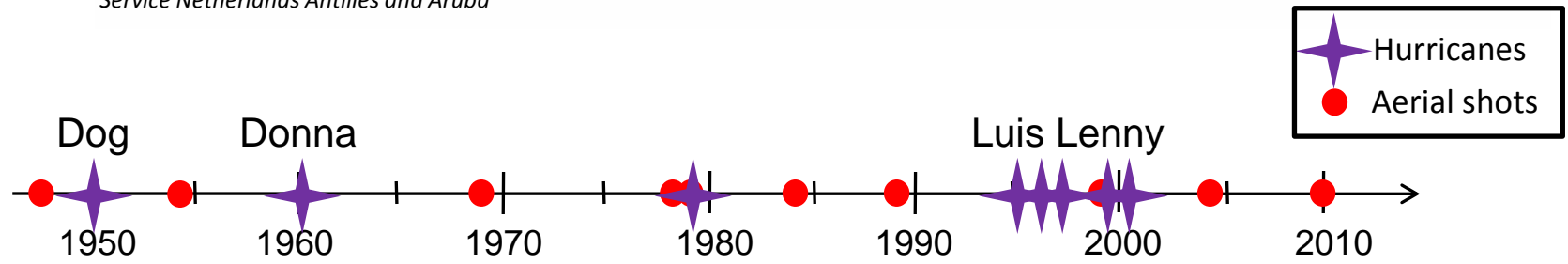
Total coverage and high quality

Aerial photography and hurricanes

- Regular hurricanes



According to the National Hurricane Center et Meteorological Service Netherlands Antilles and Aruba



Copernicus data

Copernicus project Risk & Recovery Mapping activated in february 2018



This map is used as a working basis

Cartography of construction and reconstruction











➡ What is the history of the buildings on Saint-Martin today?

- When were they built?
- Have they undergone any changes in their history? :
 - Following an enlargement?
 - Following hurricane damage?
 - As a result of abandonment?
- Have they been rebuilt? Removed?...

Cartography of construction and reconstruction

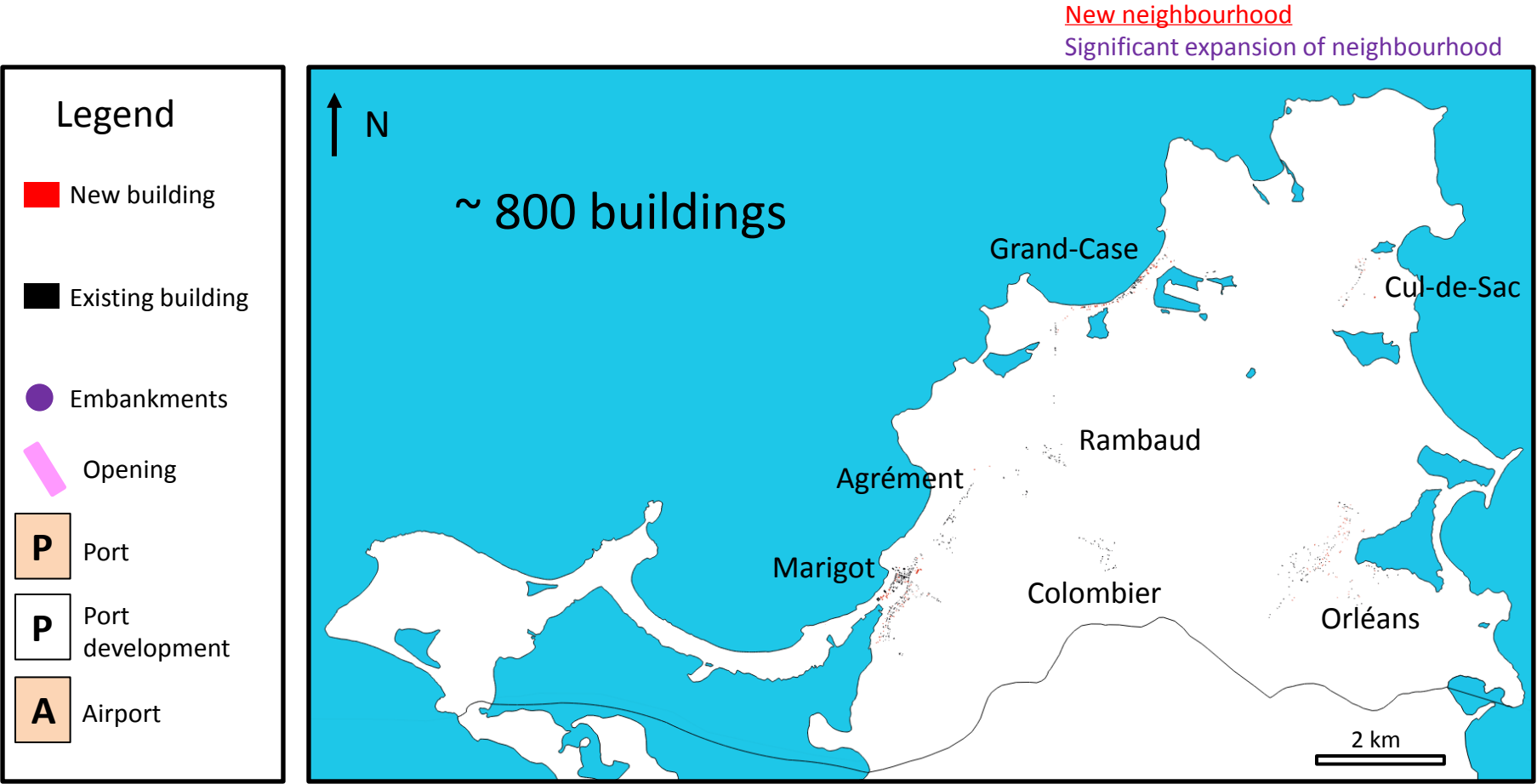
➡ Creation of detailed classes for each building

legend: condition of building

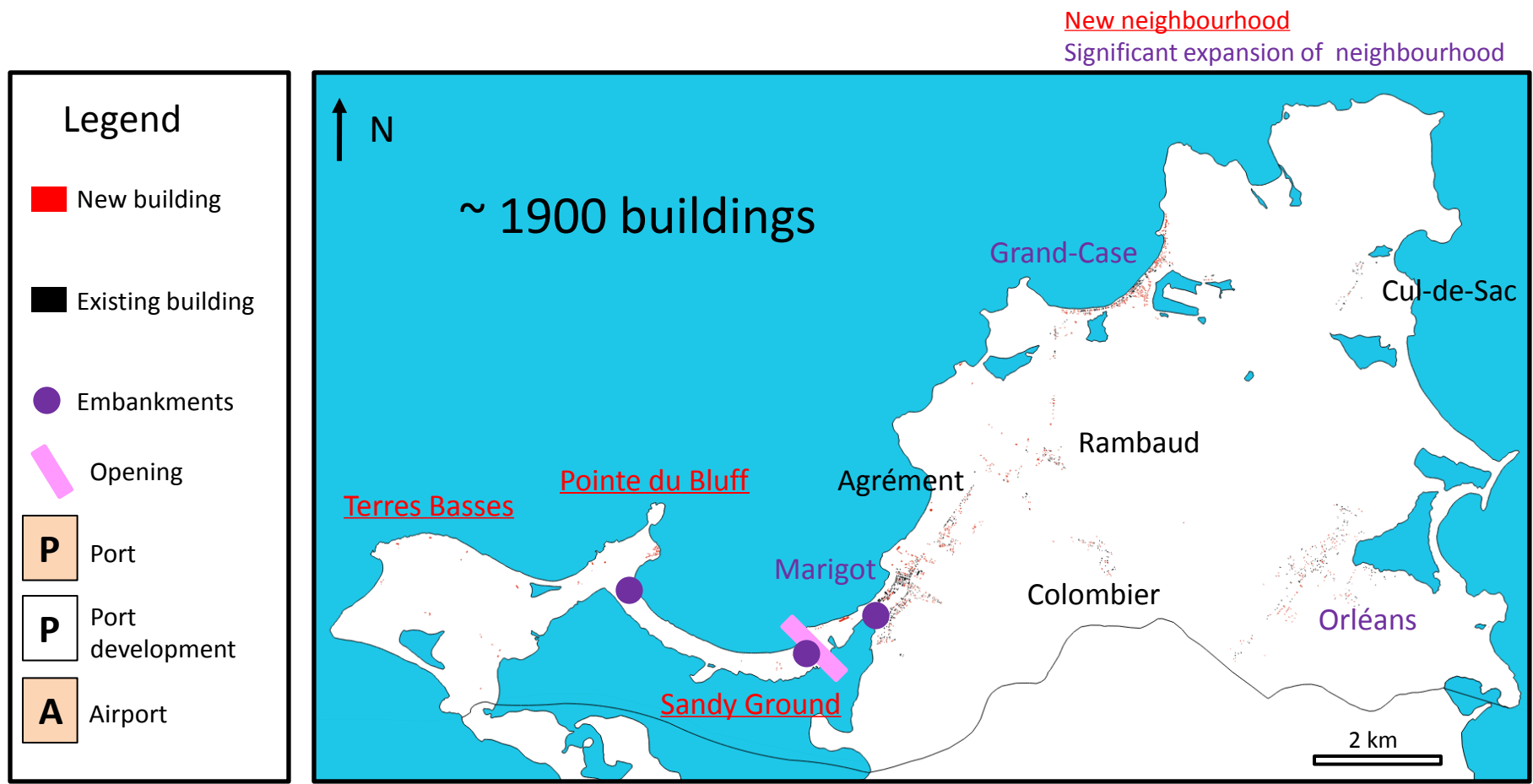
 Building in construction	 Existing building	 Modified building
 New building	 In work building	 Removed building
 Damaged or abandoned building		 Destroyed building
 Permanently damaged or abandoned building		 Reconstructed building

➡ Depending on its state at a given time, a building will have a particular color

Saint-Martin 1954

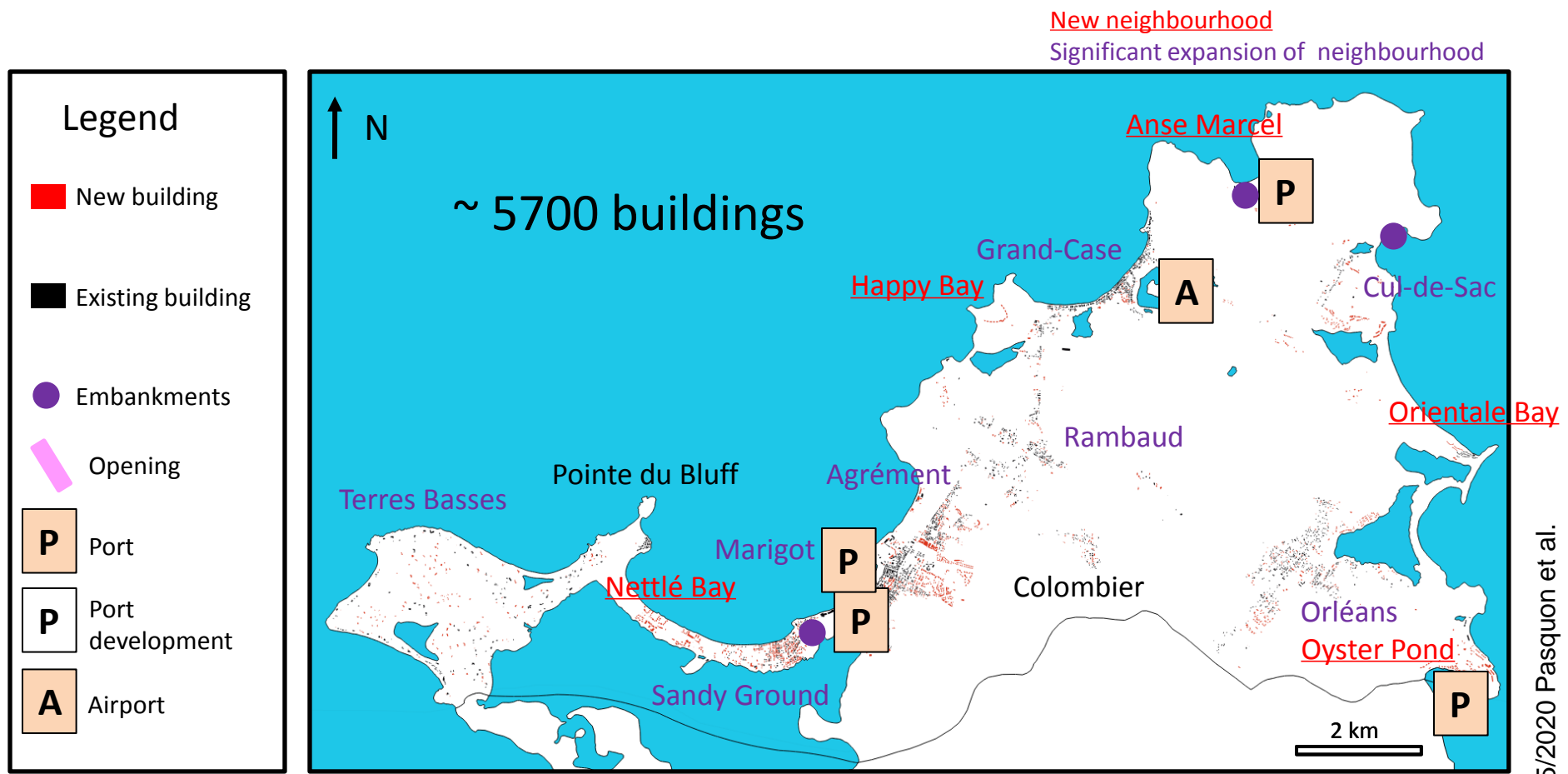


Saint-Martin 1969



➡ Modified environment: embankments, channel creation at Sandy Ground

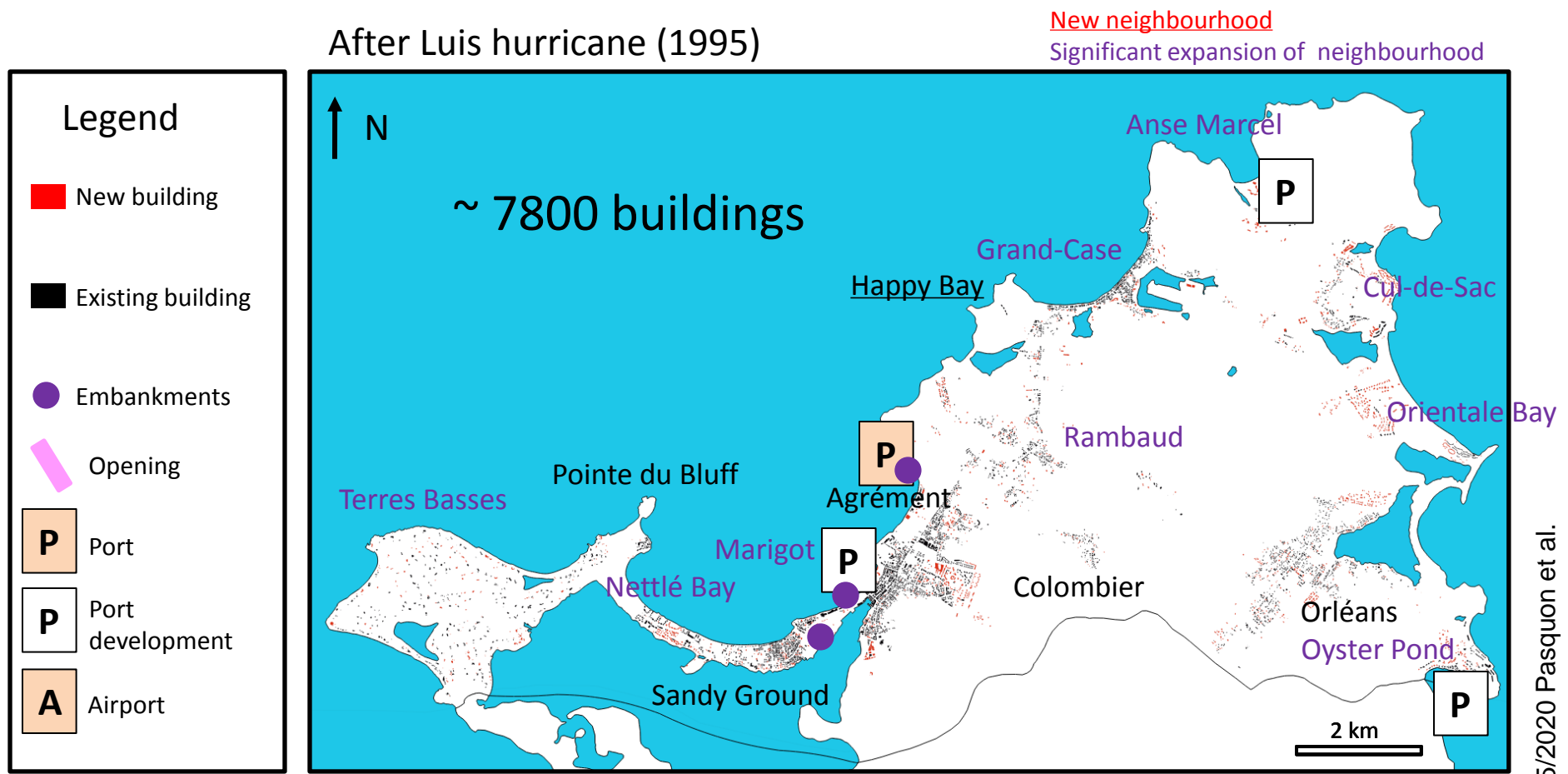
Saint-Martin 1989



➡ Constructions increase, transports increase (ports, airport), major development of Terres Basses

Saint-Martin 1999

Before Lenny



➡ Transports development, first trading port

Saint-Martin 2010

After Lenny hurricane (1999)

New neighbourhood
Significant expansion of neighbourhood

Legend

New building

Existing building

Embankments

Opening

P

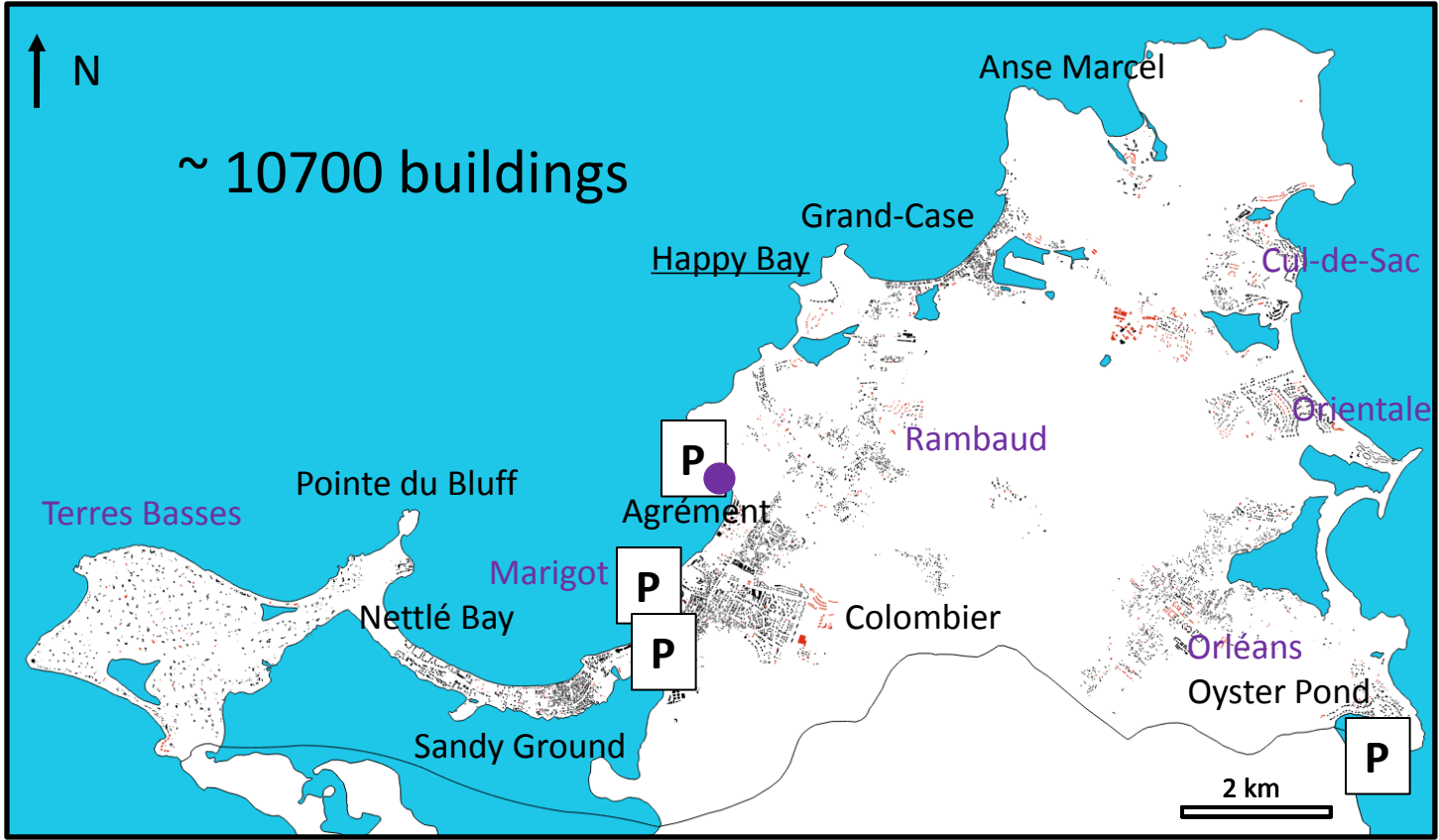
Port

P

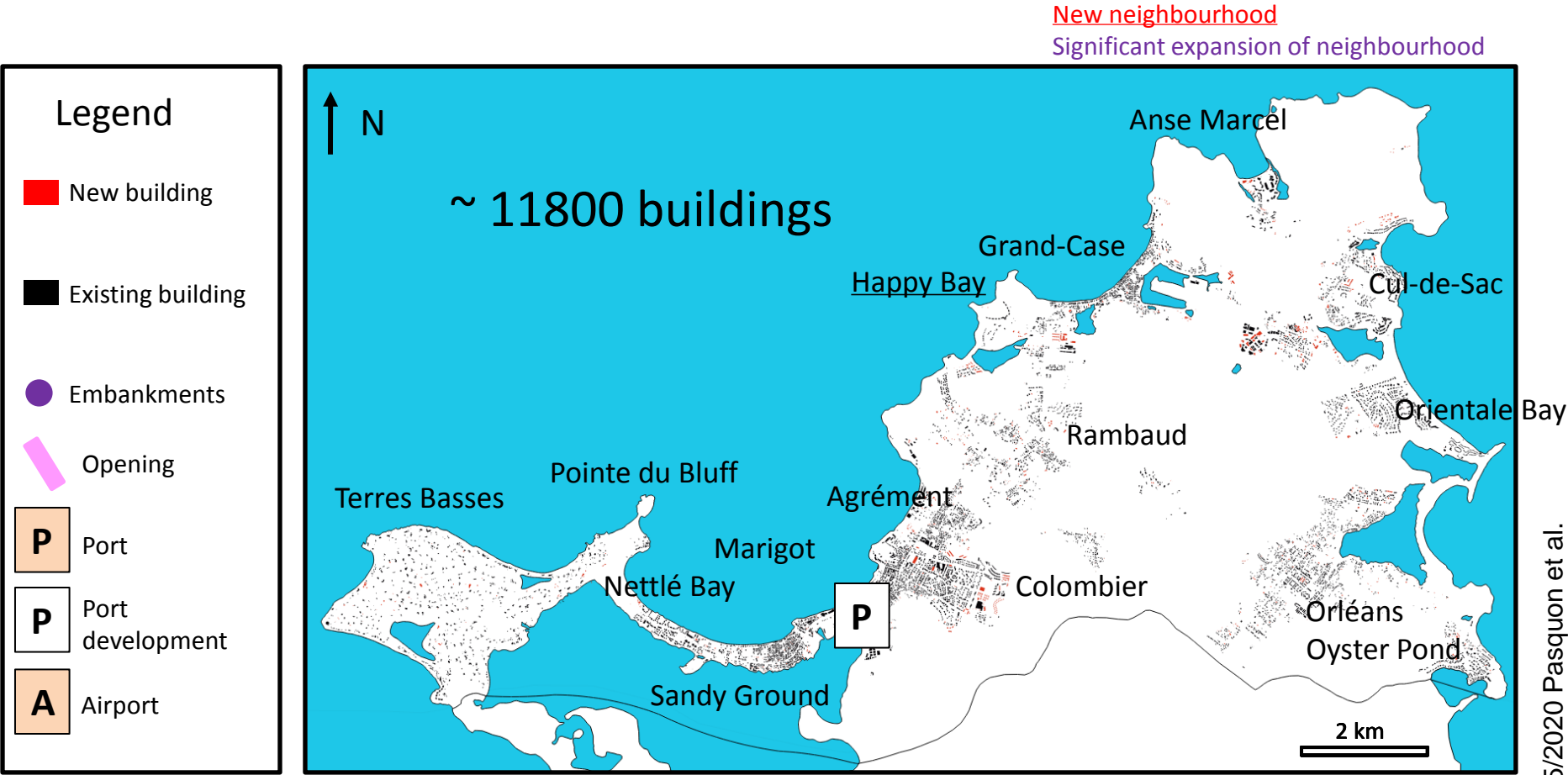
Port development

A

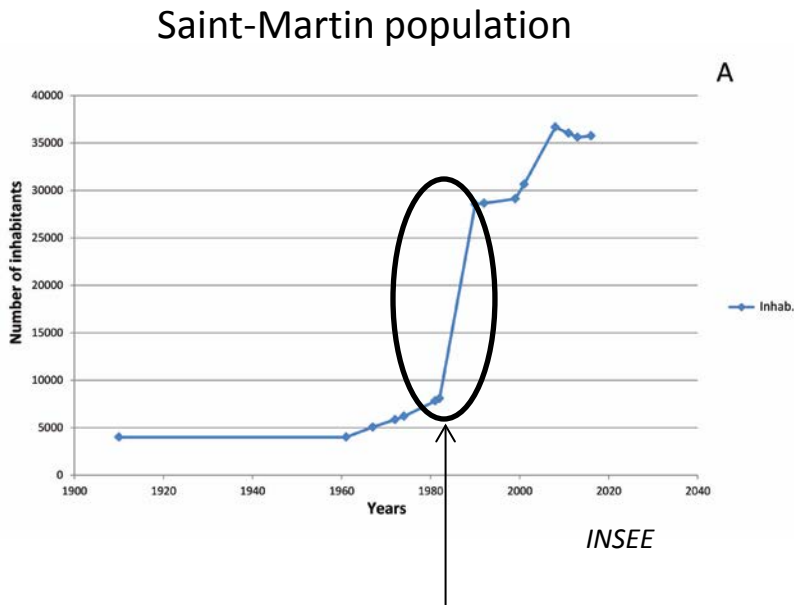
Airport



Saint-Martin 2017 Before Irma

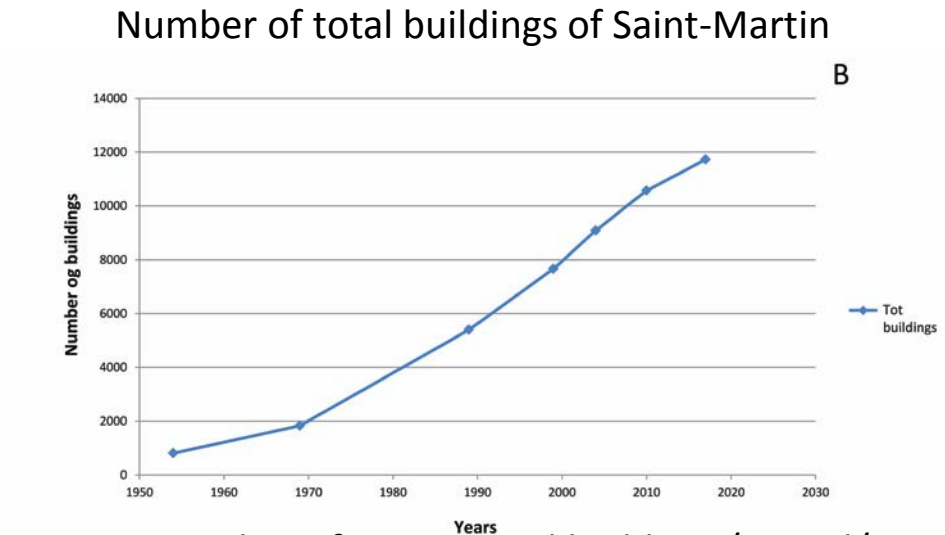


Population and number of buildings

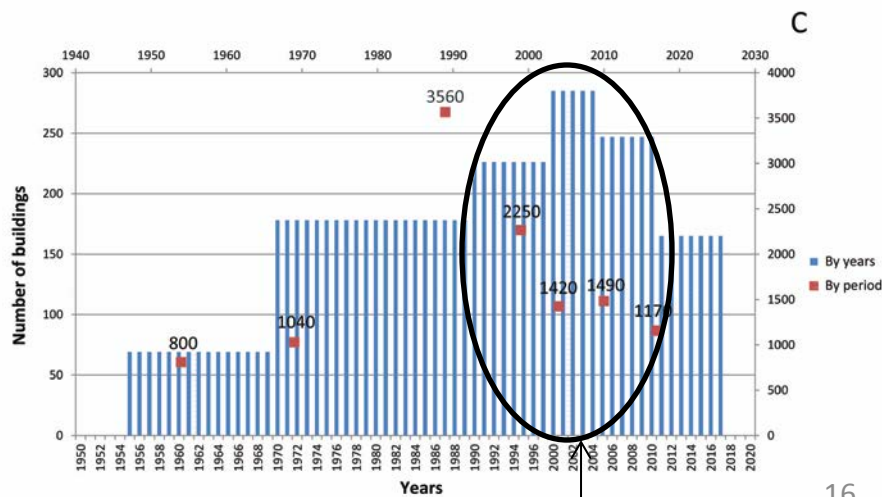


Important increase in population

More important constructions/year

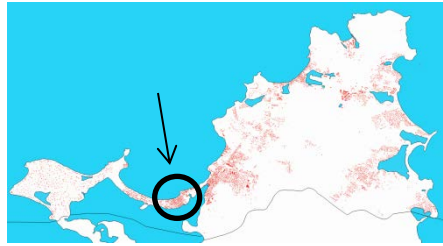


Average number of constructed buildings/period/year



Assessment global maps

- Over 11 000 buildings were built between 1954 and 2017
- Start over significant changes in environment from 1954 to 1969
- Early development of transport (ports/airport) between 1969 and 1989
- Increase in population in the 1980s and increase of constructions in the 1990s and 2000s



Sandy Ground 1969



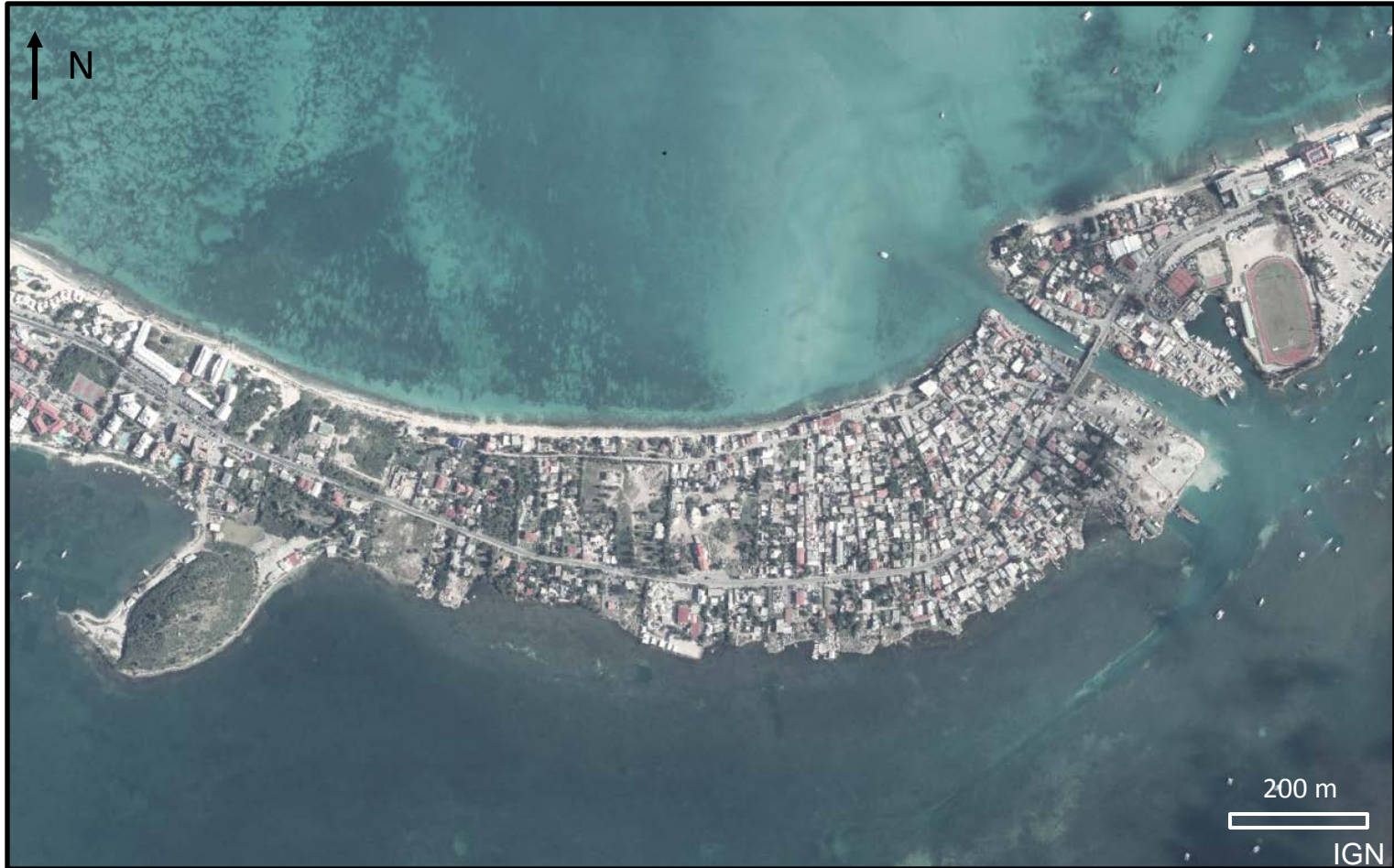
Sandy Ground 1984



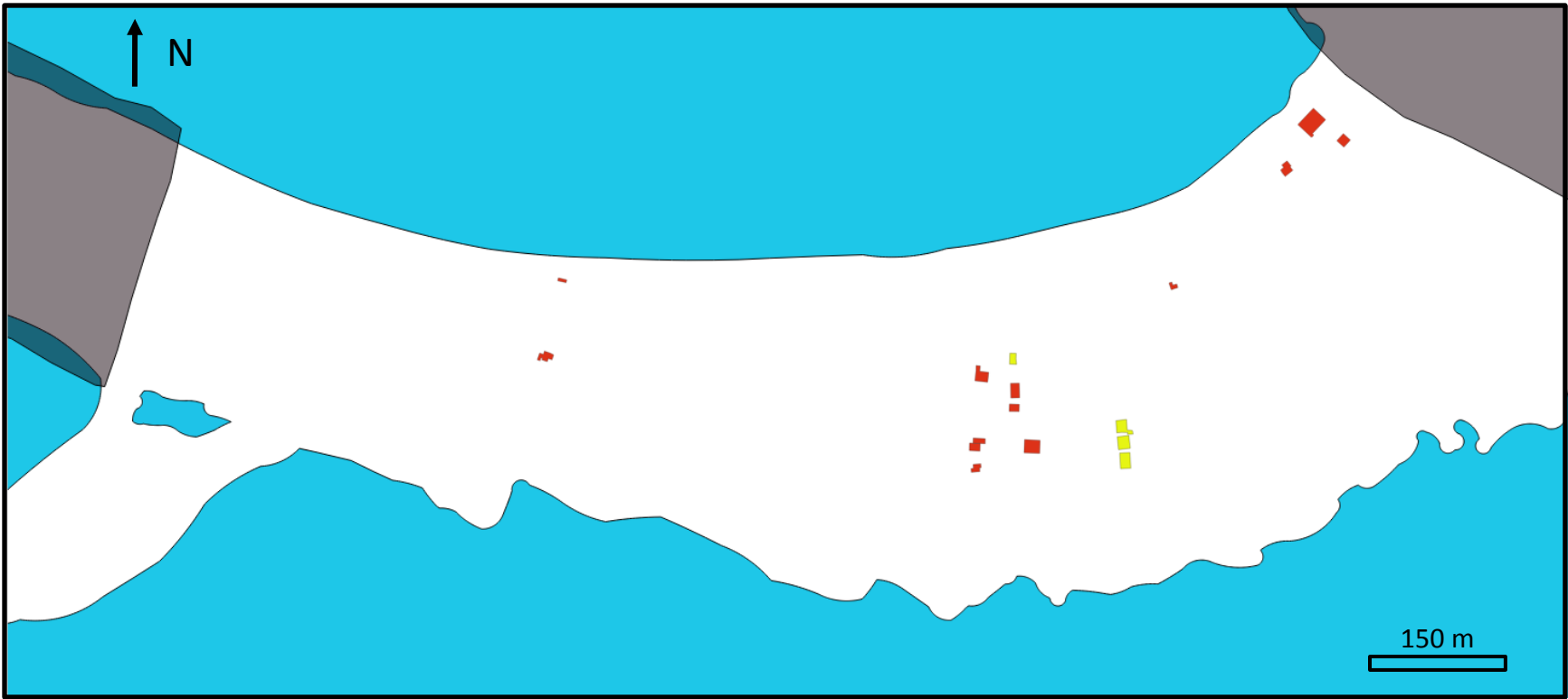
Sandy Ground 1989



Sandy Ground 2004



Sandy Ground 1969



Legend

Building in construction	In work building	Damaged or abandoned building	Destroyed building
New building	Modified building	Permanently damaged or abandoned building	Reconstructed building
Existing building	Removed building		

22

Sandy Ground 1978

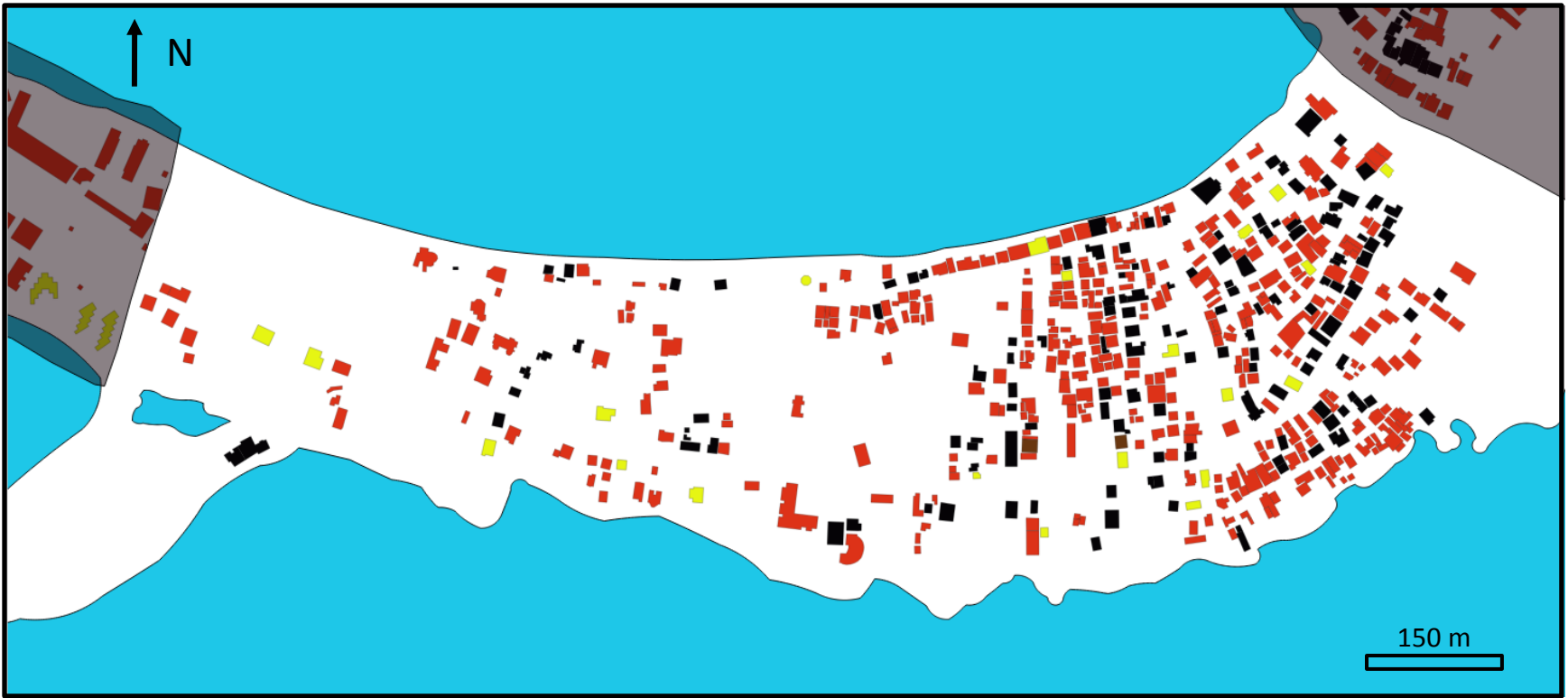


Legend

Building in construction	In work building	Damaged or abandoned building	Destroyed building
New building	Modified building	Permanently damaged or abandoned building	Reconstructed building
Existing building	Removed building		

23

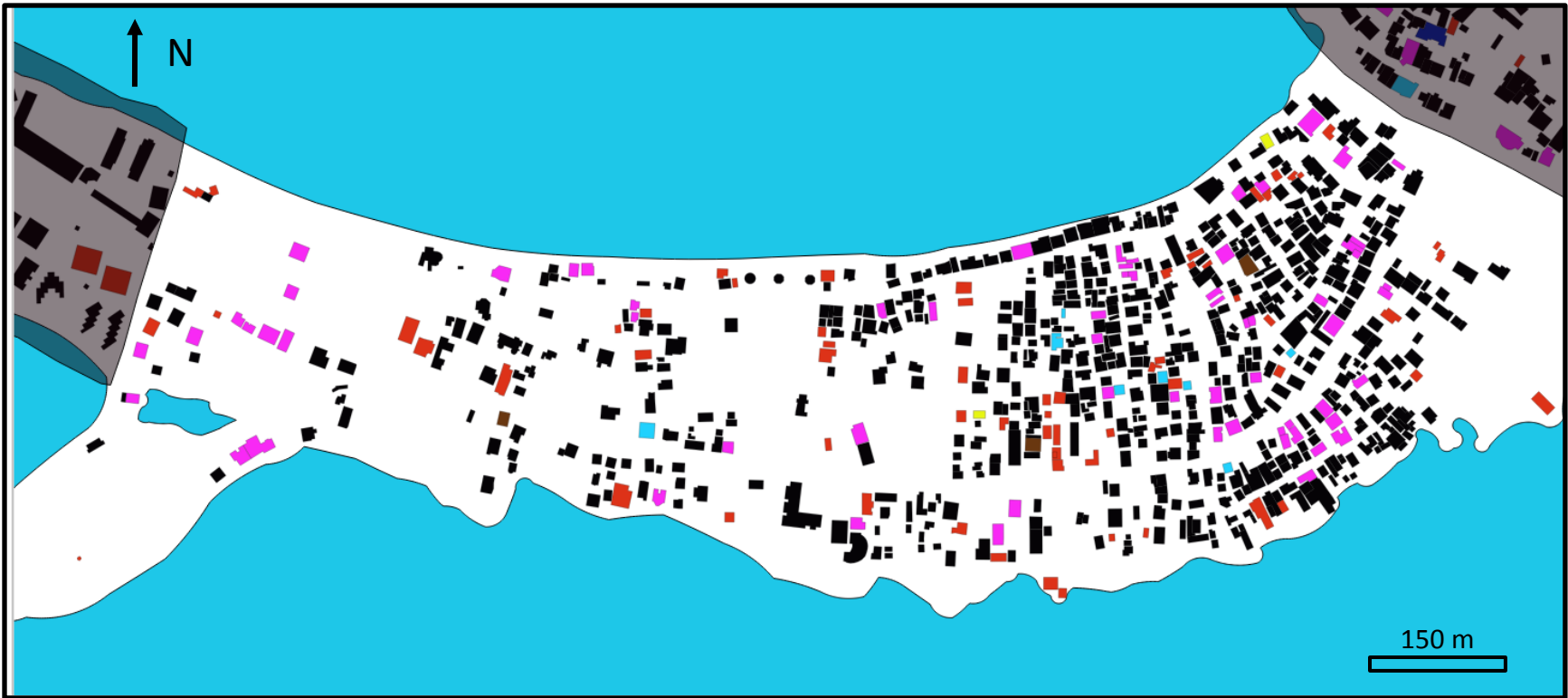
Sandy Ground 1989



Legend

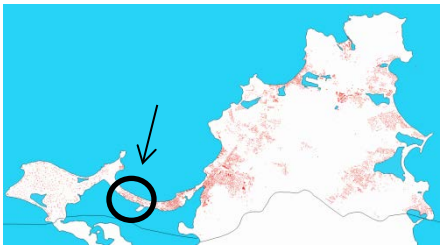
- | | | | |
|--------------------------|-------------------|---|------------------------|
| Building in construction | In work building | Damaged or abandoned building | Destroyed building |
| New building | Modified building | Permanently damaged or abandoned building | Reconstructed building |
| Existing building | Removed building | | |

Sandy Ground 2004

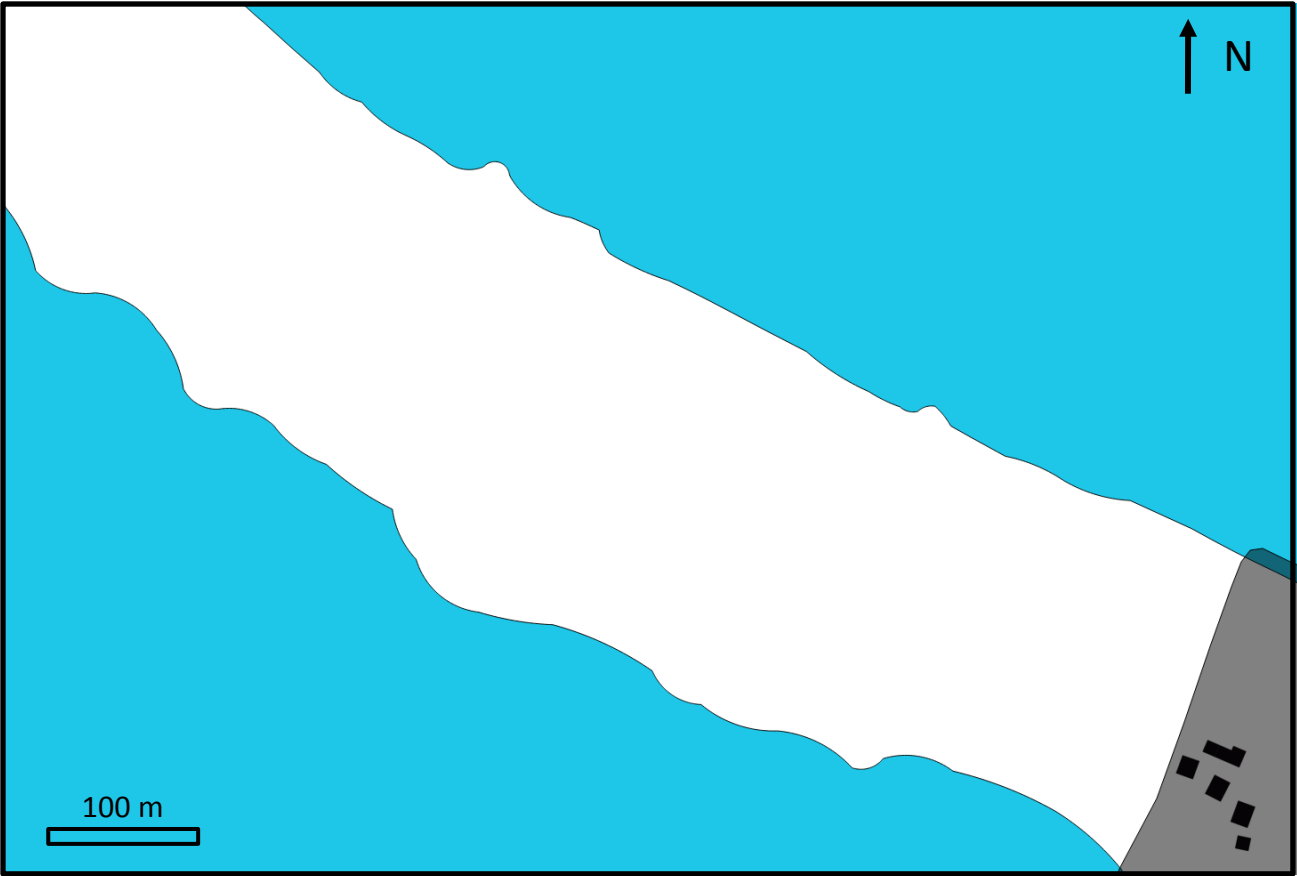


Legend

- | | | | |
|--------------------------|-------------------|---|------------------------|
| Building in construction | In work building | Damaged or abandoned building | Destroyed building |
| New building | Modified building | Permanently damaged or abandoned building | Reconstructed building |
| Existing building | Removed building | | |

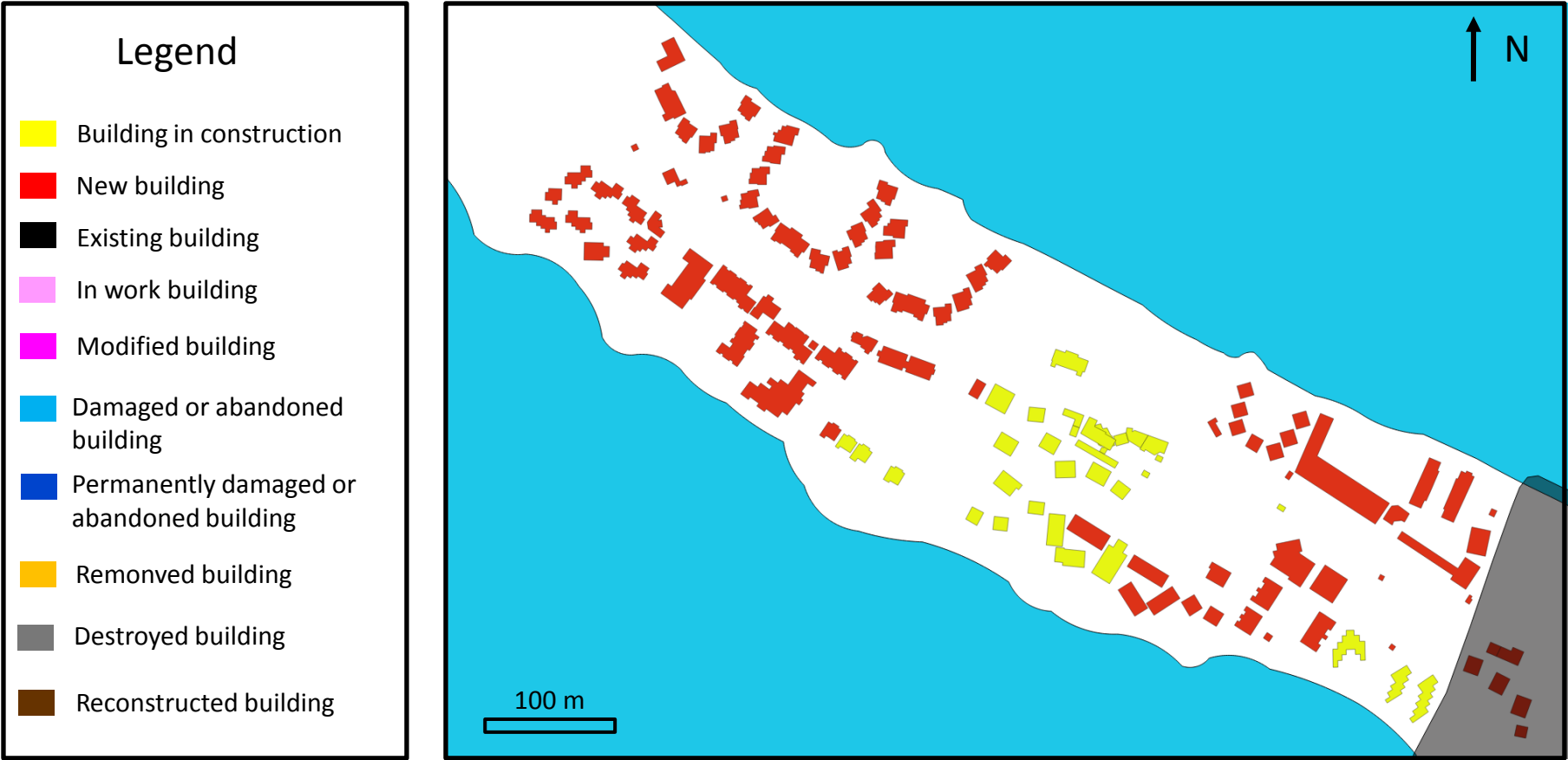


Nettlé Bay 1984



EGU– 07/05/2020 Pasquon et al.

Nettlé Bay 1989



Nettlé Bay 1999

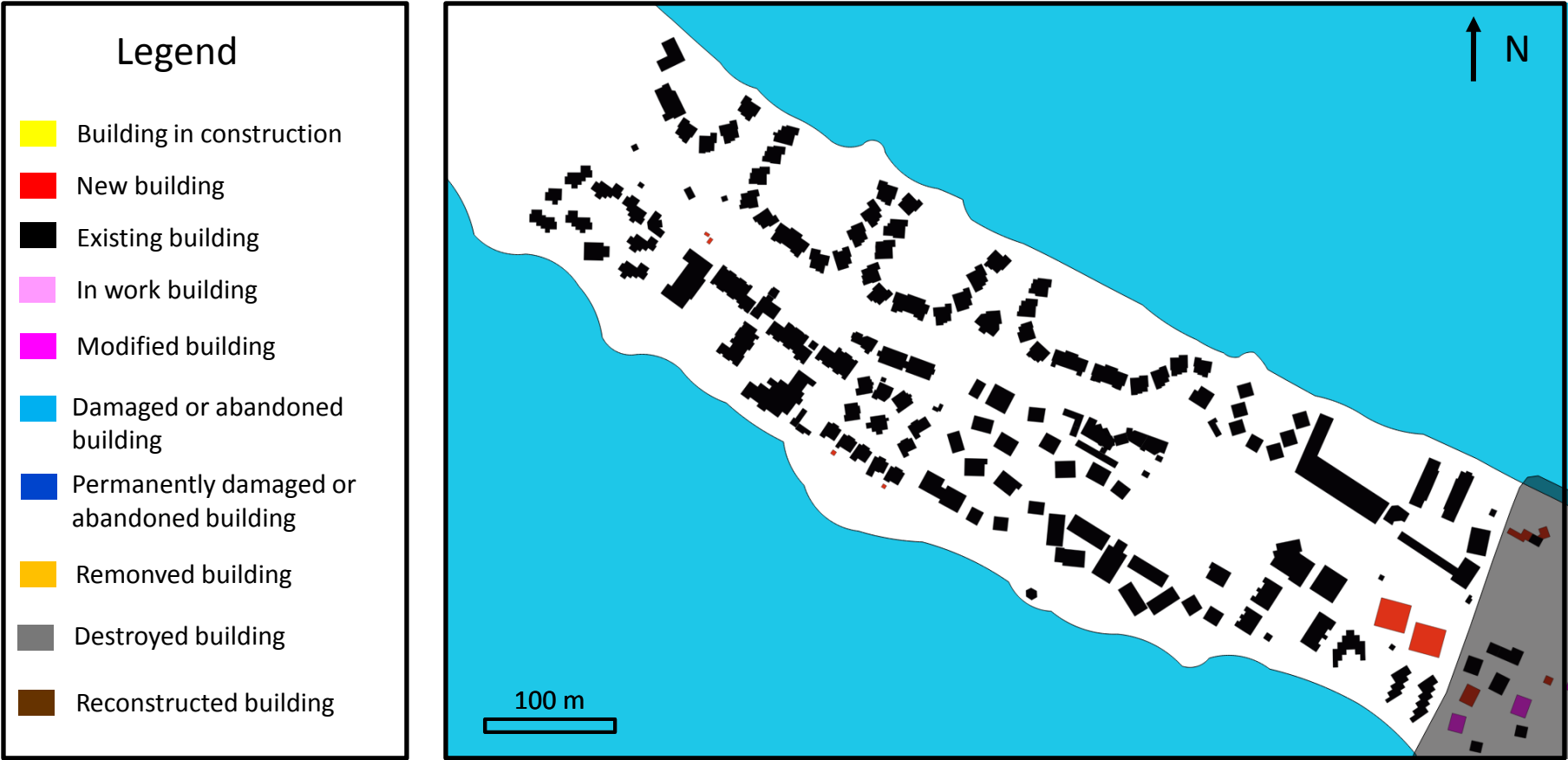
Before Lenny

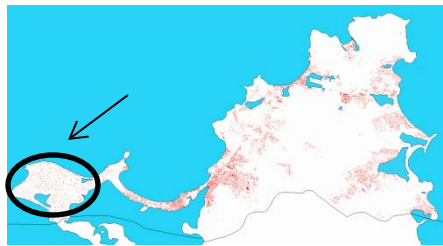
Legend

- Building in construction
- New building
- Existing building
- In work building
- Modified building
- Damaged or abandoned building
- Permanently damaged or abandoned building
- Remonved building
- Destroyed building
- Reconstructed building



Nettlé Bay 2004





Terres Basses 1969

Legend

Building in construction

New building

Existing building

In work building

Modified building

Damaged or abandoned building

Permanently damaged or abandoned building

Remonved building

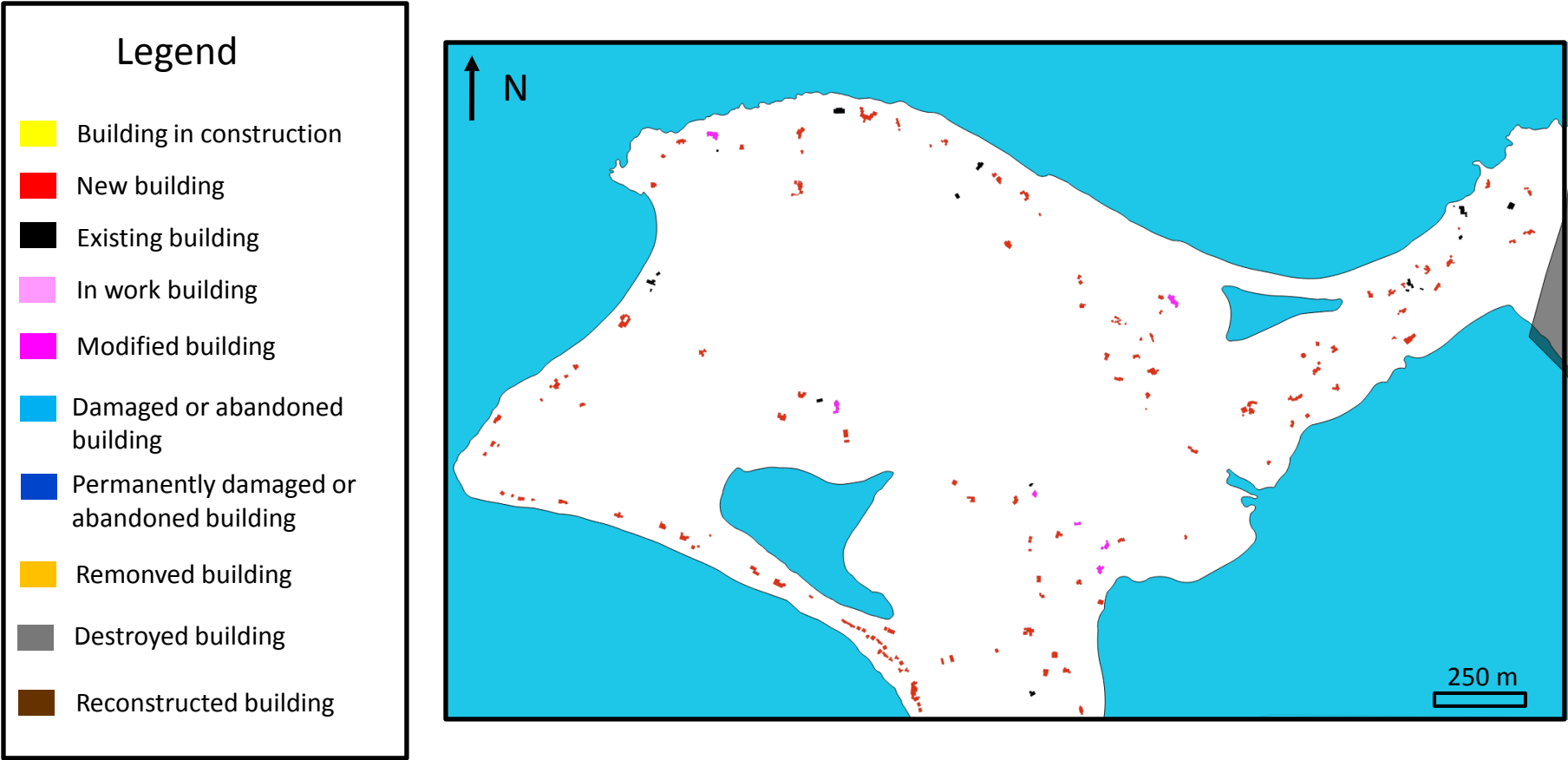
Destroyed building

Reconstructed building

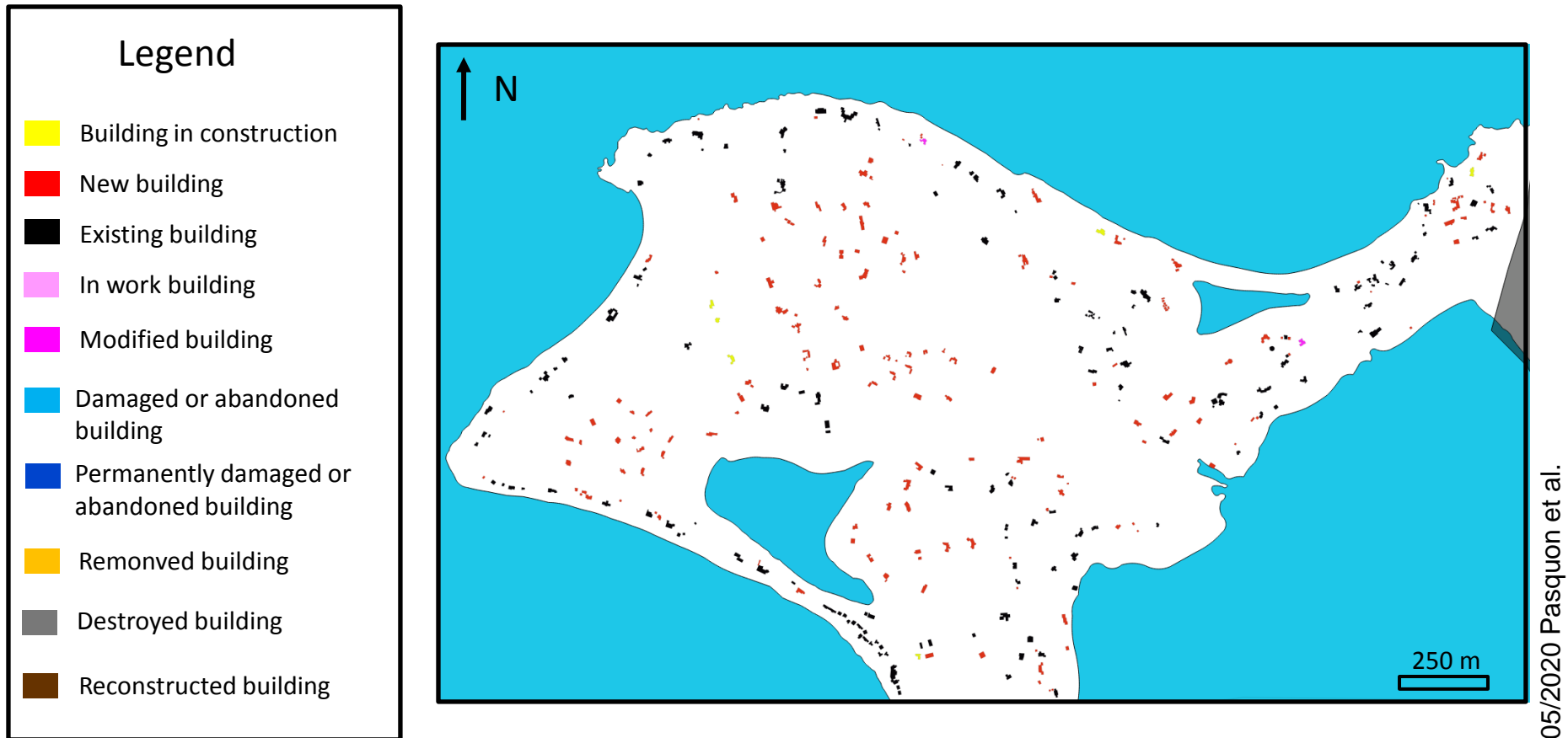


EGU– 07/05/2020 Pasquon et al.

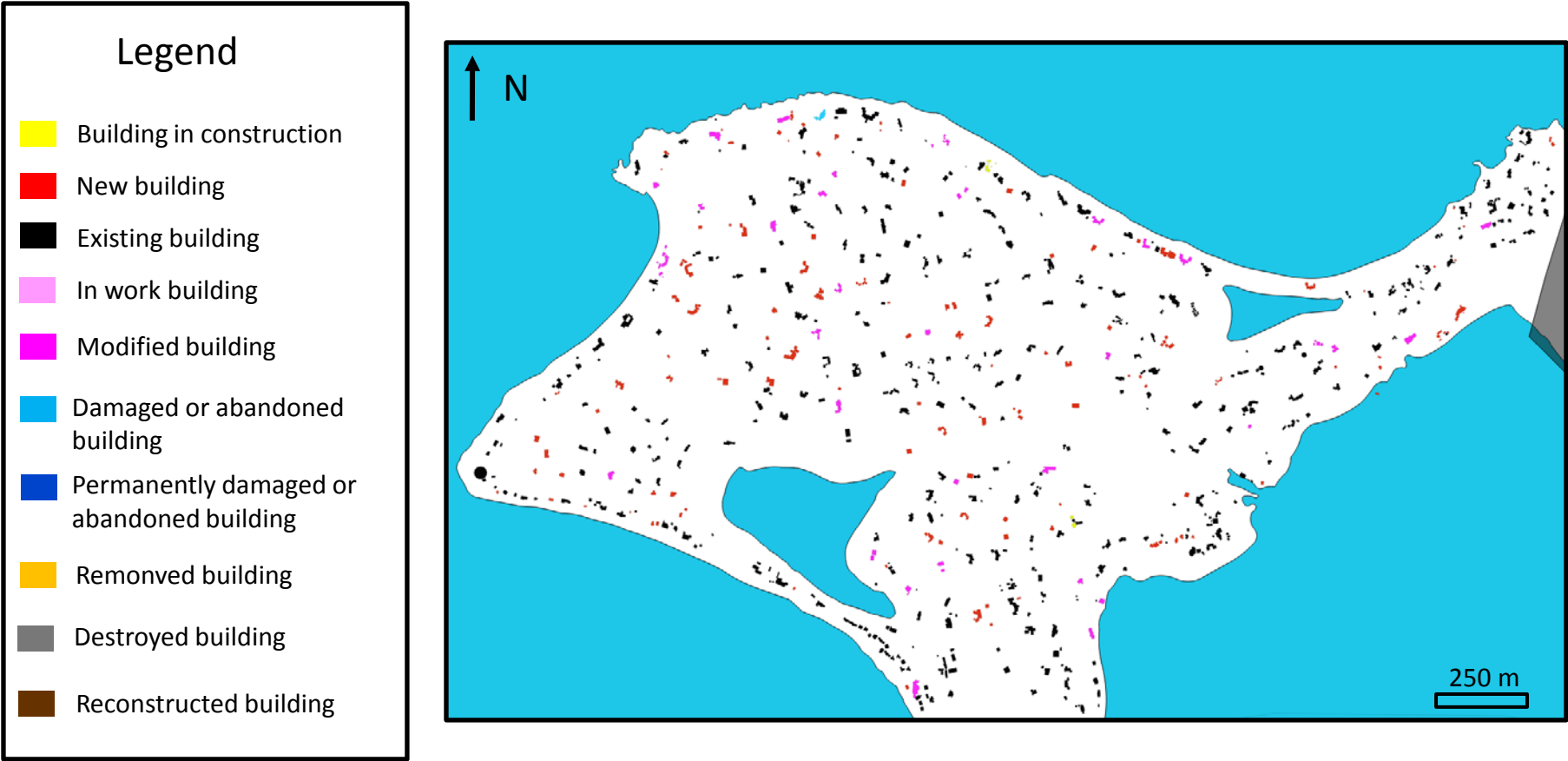
Terres Basses 1984



Terres Basses 1989

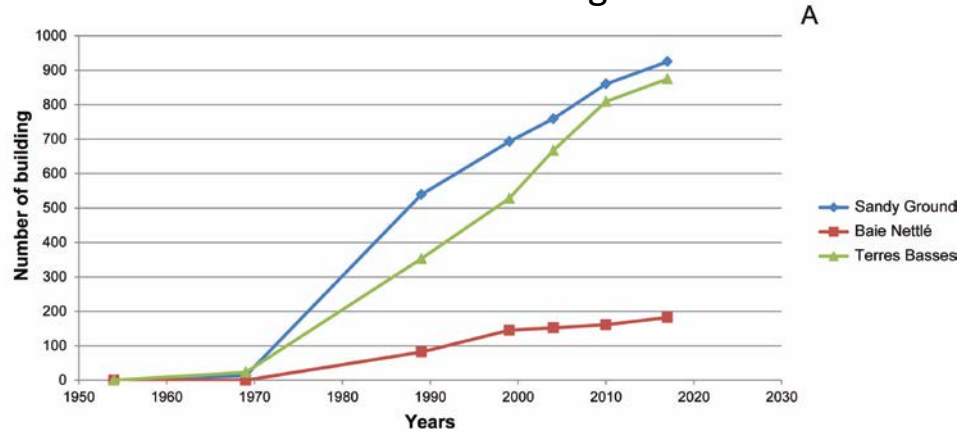


Terres Basses 2004

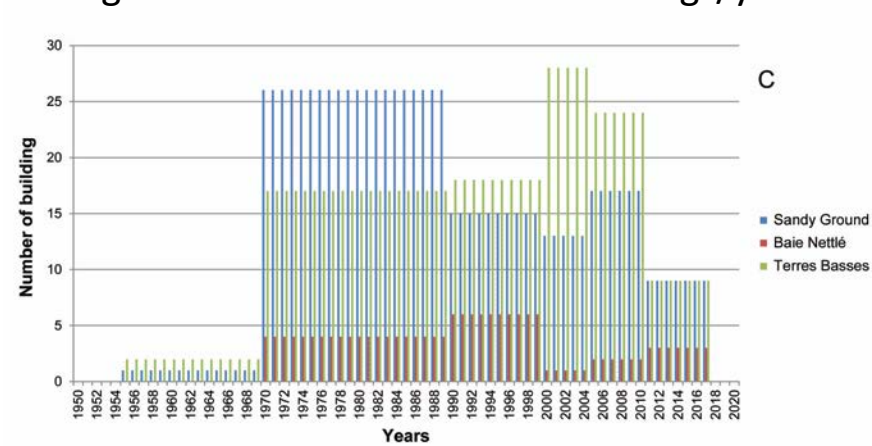


1) Evolution of the number of buildings by neighbourhood since 1954

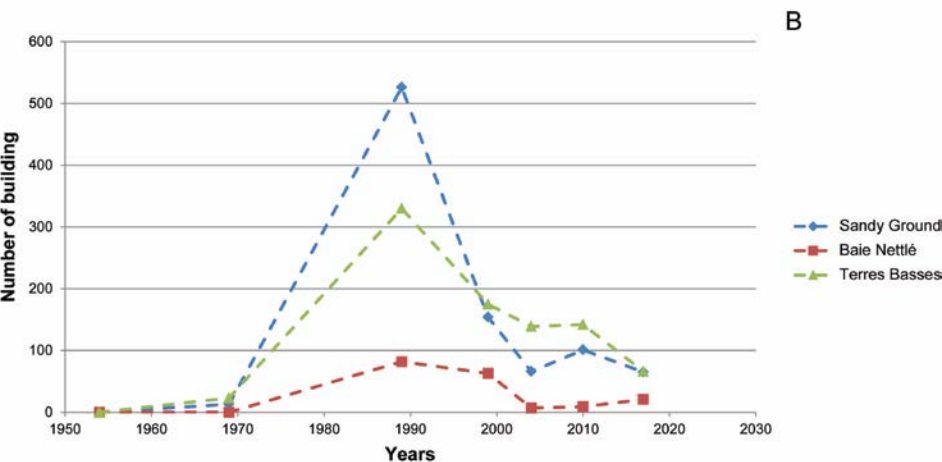
Number of total buildings



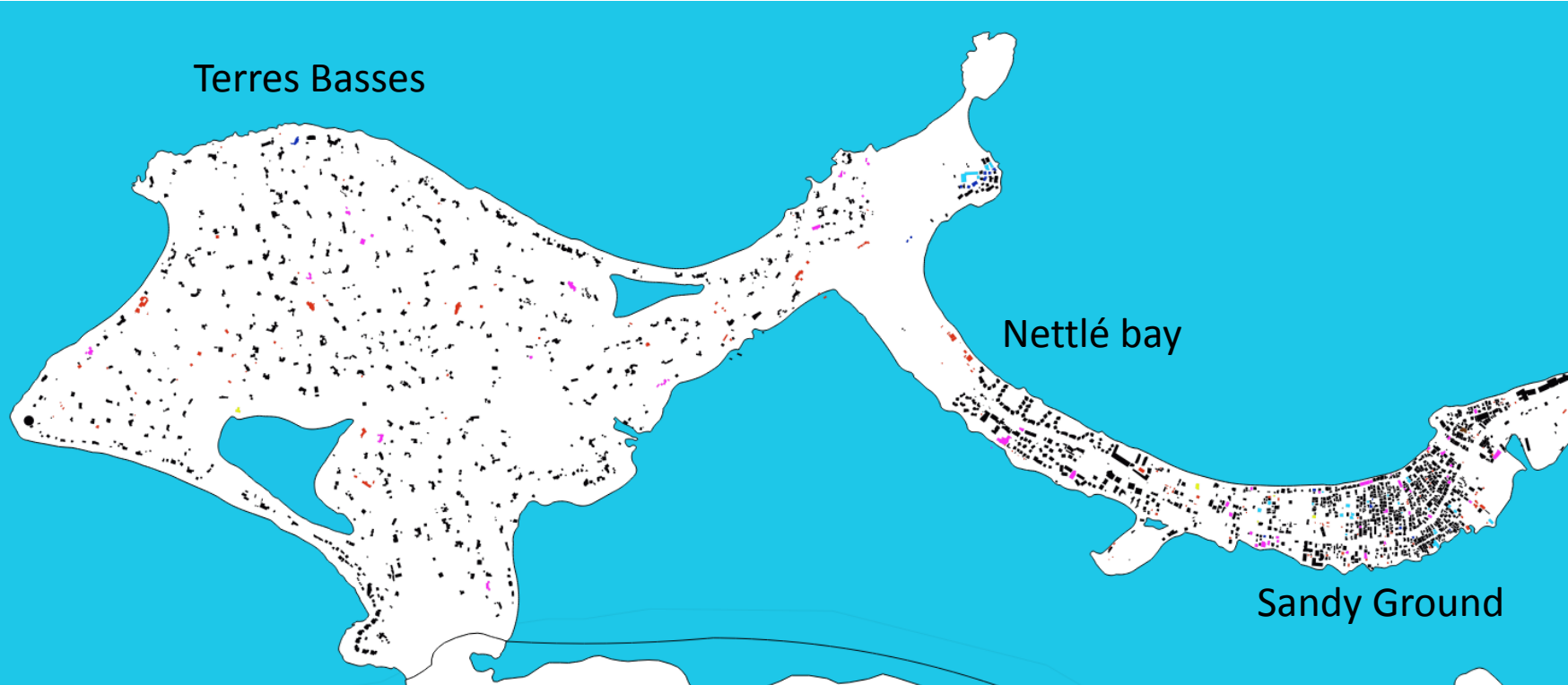
Average number of constructed buildings/year



Number of constructed buildings by period



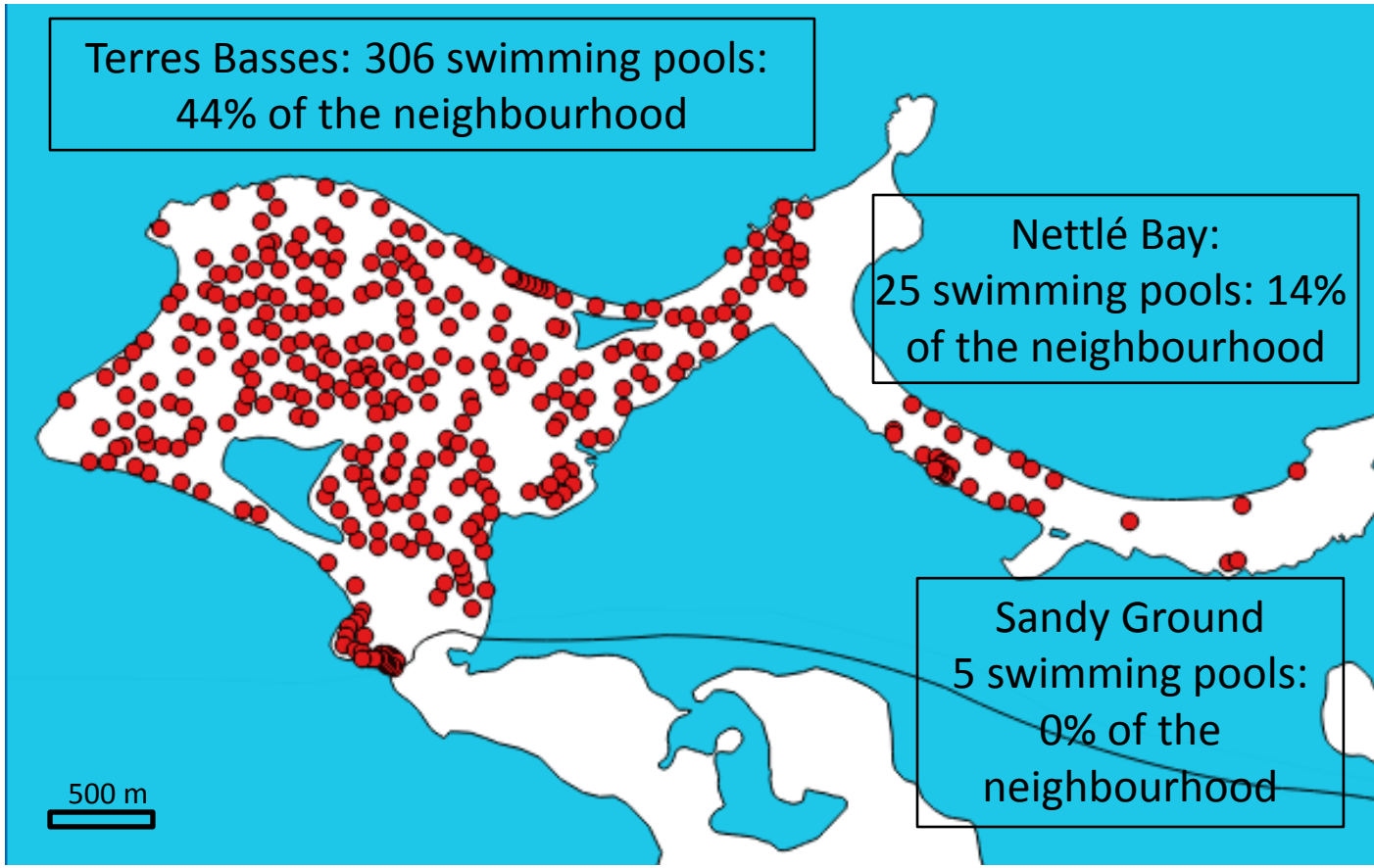
2) Buildings density by neighbourhood in 2017 (Before Irma)



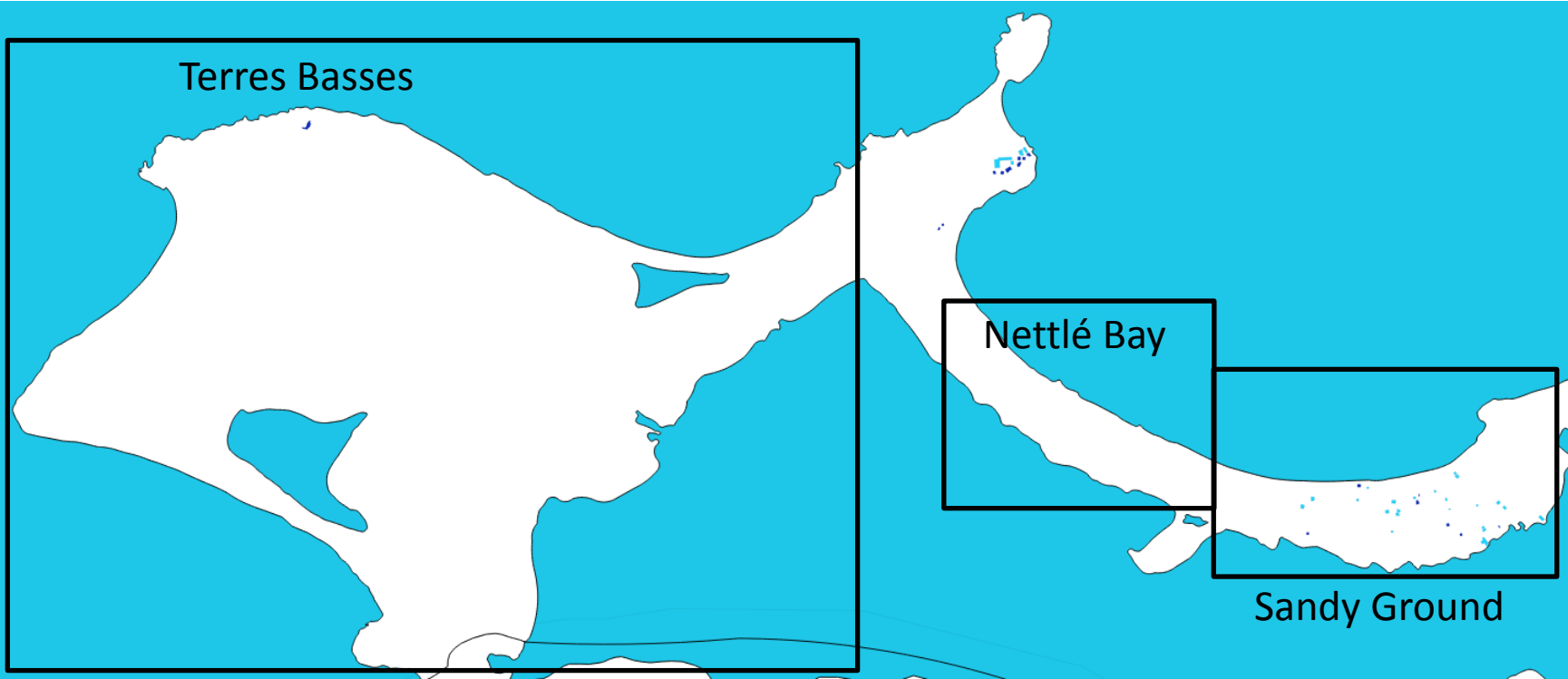
	Terres Basses	Nettlé Bay	Sandy Ground
Buildings number	880	186	929
Size of neighbourhoods (km²)	4	0.250	0.520
Buildings number/km²	220	745	1790

3) Percentage of swimming pools by neighbourhood in 2017 (before Irma)

● Swimming pools



4) Damaged or adandoned buildings in 2017 (before Irma)

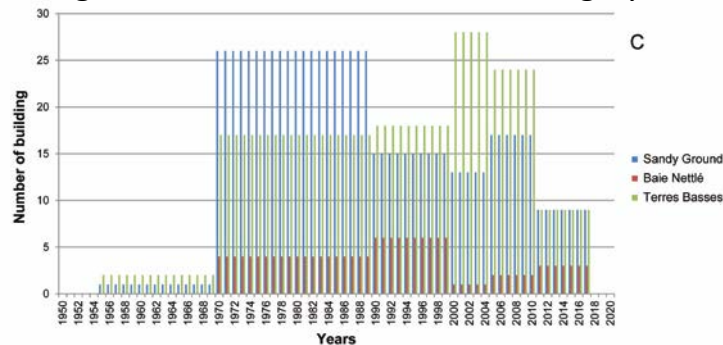


	Terres Basses	Nettlé Bay	Sandy Ground
Number of damaged or abandoned buildings	1	0	28
Total building number	880	199	929
% of damaged or abandoned buildings	0,1%	0%	3%

Assessment: comparison of 3 neighbourhoods

- Neighbourhoods constructed at different times

Average number of constructed buildings/year



- Differences in their present apparent wealth (2017 before Irma)

	Terres Basses	Nettlé Bay	Sandy Ground
Building density	220	745	1790
% of swimming pools	44%	14%	0%
% of damaged or abandoned buildings	0,1%	0%	3%

Impact of policy incentives and economic projects on urban planning

Urban development of Saint-Martin

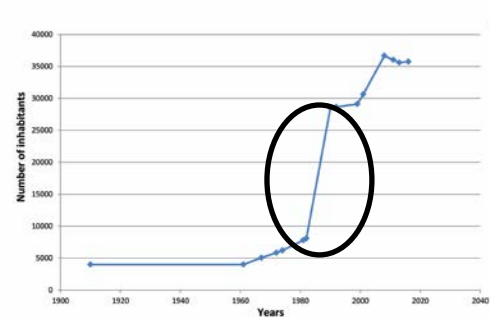
- Years 60-80 = beginning of urban development: European immigration mainly but also North American: beginning of real estate investment.
- 1986: Pons law: tax deduction of a large part of real estate investments (hotels, residences, transports, etc.) granted in France Overseas from 1986 for individuals and developers (duration 5 and 10 years).
- In 2001 and 2003, Paul law and Girardin law or «Programme pour l'outre-mer»: tax reduction on new investments (apartments or houses). (Follow the Scellier law in 2009, Duflot in 2014 and Pinel in 2015). In the same time, resale and transformation of hotel structures into private apartments.

The total number of dwellings continues to increase after 2009, but less than under the Pons law.

Impact of policy incentives and economic projects on urban planning

Urban development of Saint-Martin

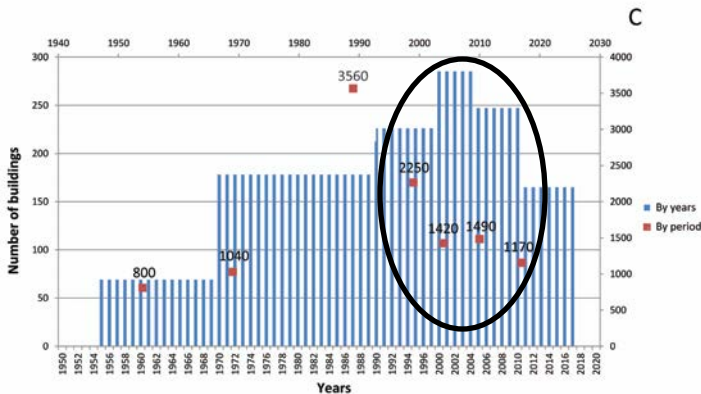
From the Pons Law (1986)



Massive influx of immigrant labour:
Haïti, Dominica...

↗ population

Construction of tourist
buildings, secondary
residences,...



Immigrant workers
dwellings
construction

Hurricane impact on urban planning

- **Luis** (1995) et **Lenny** (1999) hurricanes:

As a result of these hurricanes, some hotels have not been rebuilt or repaired. New construction is more cost-effective (Magnan 2008). Following Luis, 30% decrease in tourist between 1995 and 1996.

3 years after Luis, hotel occupancy had not yet returned to its value before Luis (Duvat, 2008).

Damaged and abandoned hotels visible in 2017 (before Irma) after Luis/Lenny



Adaptation of inhabitants of Saint-Martin ?

The population of Saint-Martin has adapted to:

- 1) the massive arrival of Europeans and North Americans on the island since the 1960s,
- (2) the arrival of construction workers (Haitians, Dominicans, etc.),
- (3) the important transformation of the environment through new construction,
- (4) tourists,
- (5) new shopkeepers,
- (6) the use of the French language more significantly (example: french used in school),
- (7) hurricanes and other natural disasters,

.....



The inhabitants of the island have constantly adapted since the 1950s

How are inequalities (particularly territorial) perpetuated?

Inequalities since the 1950s:

Native Saint-Martinoise

Europeans/Americans
arrived from the 60s

Immigrant workers from the
1960s (massively in the 1980s)

Today, **urban inequalities** are materializing in Saint-Martin: :

- 1) by differences in building density
- 2) by different housing sizes
- 3) by a larger number of swimming pools by building, built in more affluent areas
- 4) by more abandoned and “under construction” permanent buildings

Conclusion

The main factor that influenced urban planning in Saint Martin was not the repeated impact of hurricanes, but the **development of tourism and the construction industry** .