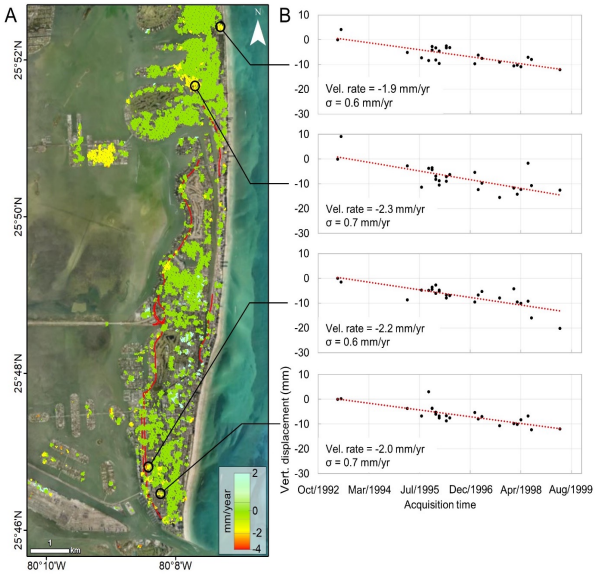
Localized coastal subsidence in Miami Beach and Surfside, Florida

Shimon Wdowinski [1] *and* Simone Fiaschi[2]

[1] ***Florida International University,*** [2] *TRE-Altamira*



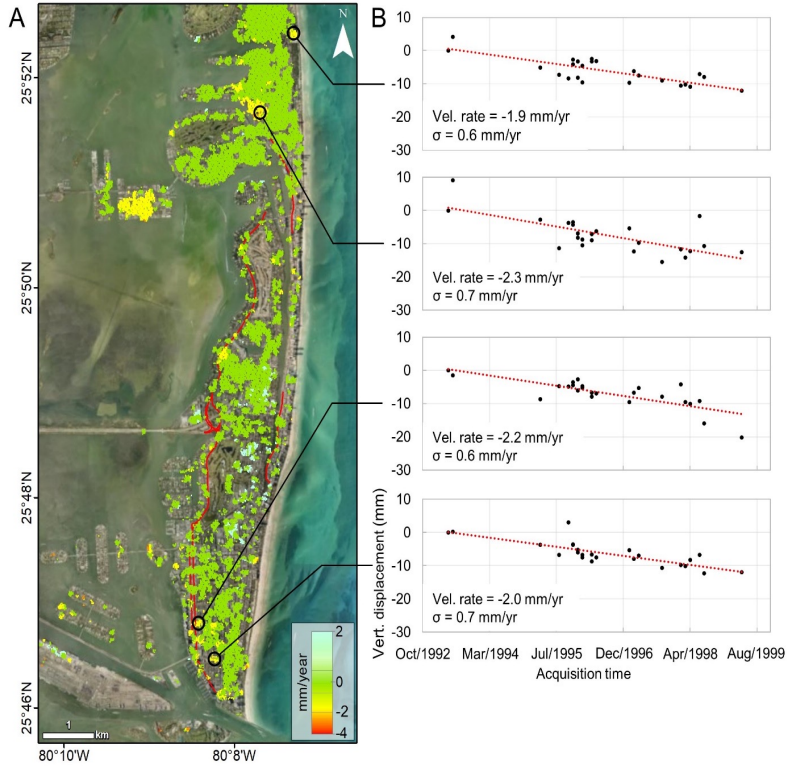
Fiaschi and Wdowinski (2020)

Source: USA Today

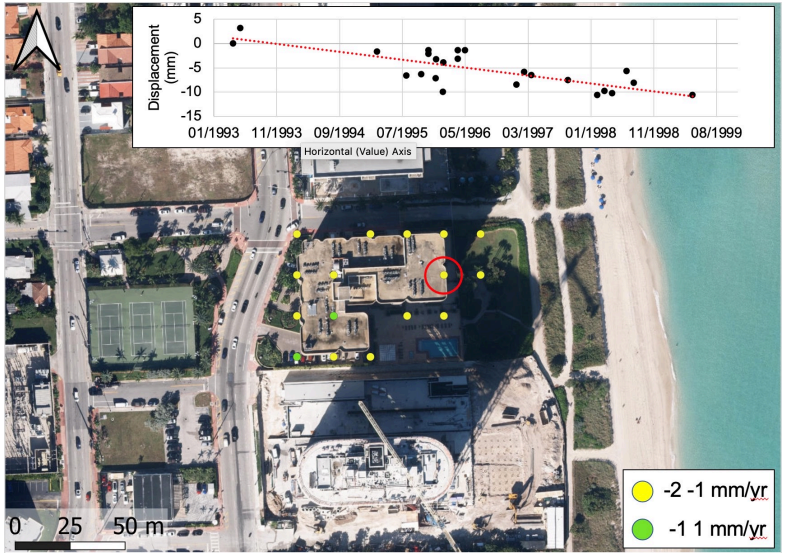
Local land subsidence in Miami Beach

Fiaschi and Wdowinski (2020) studied land subsidence in Miami Beach to evaluate its contribution to coastal flooding hazard. They used ERS-1/2 data acquired during 1993-1999 and detected:

- Subsidence rate 2-3 mm/yr mainly in the western side of the city.
- A localized subsidence pattern (~2 mm/yr) in the eastern side of the city at the location of the collapsed Surfside building.



Surfside building collapse (June 24, 2021)



Source: USA Today

- A localized subsidence pattern (~2 mm/yr) in the eastern side of the city at the location of the collapsed Surfside building.

Questions following the Surfside building collapse

1) Did the detected subsidence in the 1990s have a differential component?
2) Did the building continue subsiding after 1999?
3) Did other subsiding areas in Miami Beach continue subsiding after 1999?
4) Did other areas in Miami Beach start subsiding after 1999?

Answers

Q1: Post-processing of the ERS-1/2 velocity map.

Q2-Q4: Processing Sentinel-1 data for the period 2016-2021

Q5: Analysis of precise-leveling data of the past 100 years

InSAR data & Processing

Dataset	ERS-1/2	Sentinel-1
Acquisition span	03/05/1993 - 06/05/1999 (6 years)	27/09/2016 – 03/07/2021 (5 years)
Number of acquisitions	24	132
Spatial resolution	20 x 20 m	5 x 15 m
Processing software	SARscape®	SqueeSAR®

Questions 1: Did the detected subsidence in the 1990s had a differential component?

1 mm/yr interval

Vel (mm/yr)
- < -4
- -3 -4
- -2 -1
- -1 1
- 1 2

No noticeable differential component

0.5 mm/yr interval

Vel (mm/yr)
- -2 -1.5
- -1.5 -1
- -1 -0.5
- -0.5 0.5

Noticeable differential component of 0.5 mm/yr

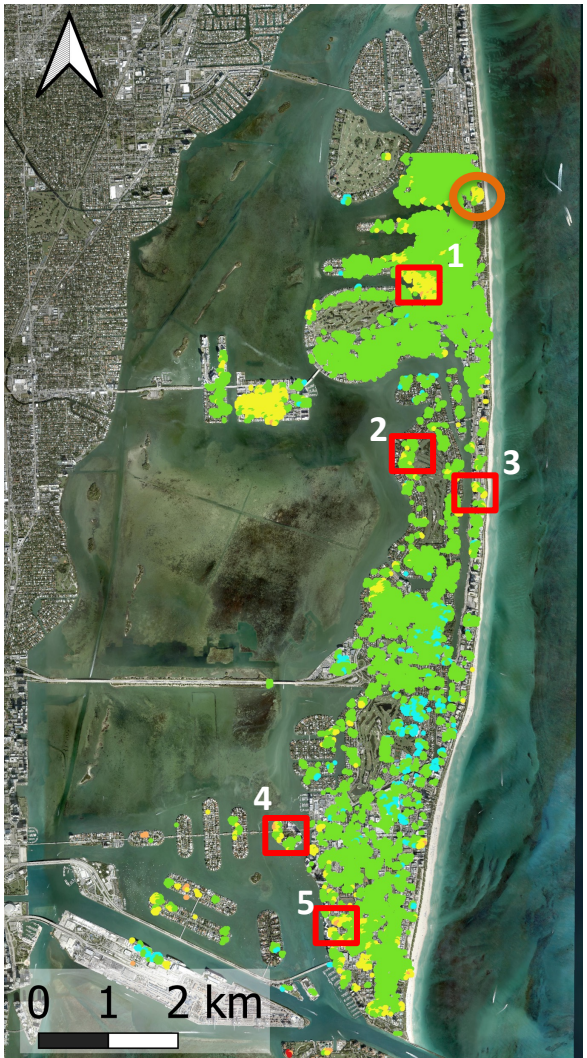
0.25 mm/yr interval

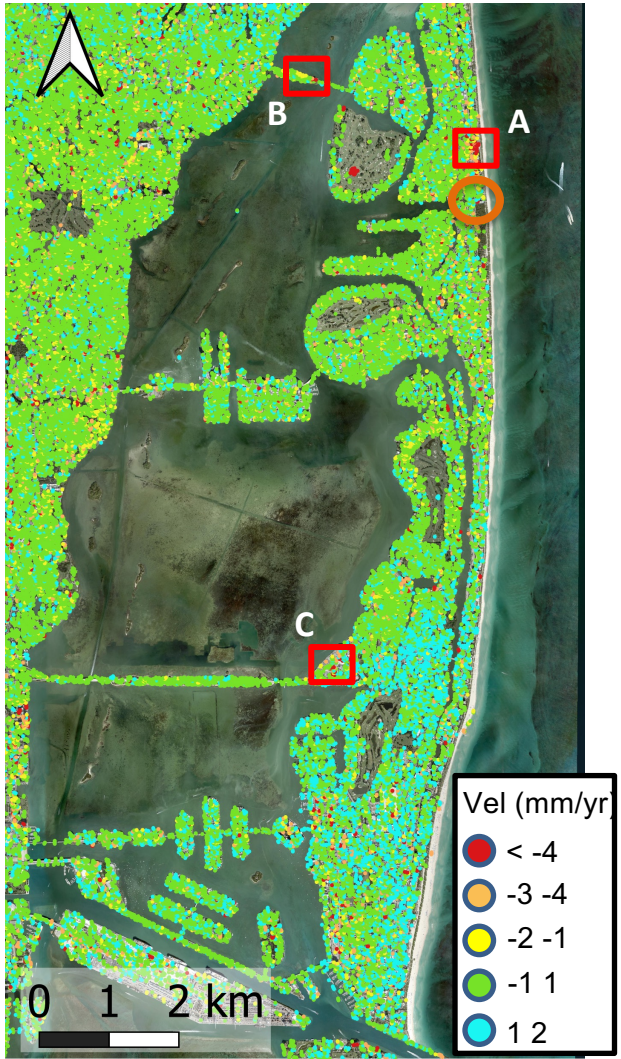
Vel (mm/yr)
- -2 -1.75
- -1.75 -1.5
- -1.5 -1.25
- -1.25 -1
- -1 -0.75
- -0.75 -0.5
- -0.5 -0.25

Noticeable differential component of 0.5 mm/yr

Differential subsidence: 0.5 mm/yr

ERS-1/2
(1993-1999)



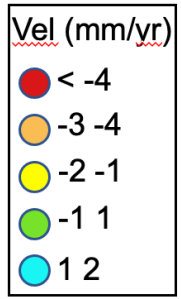


Sentinel-1
(2016-2021)

Questions 2: Did the building continue subsiding after 1999?

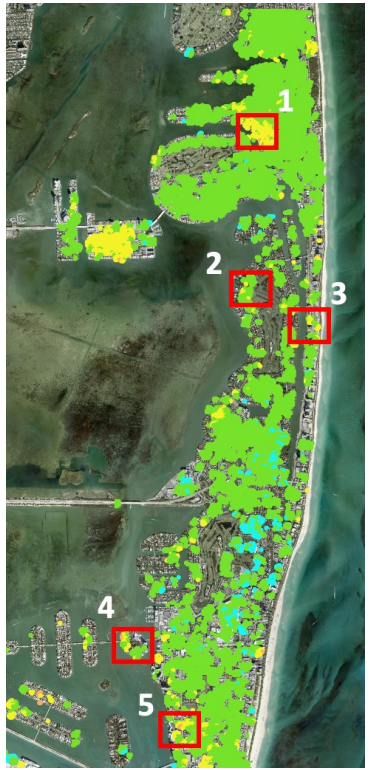
ERS-1/2 (1993-1999)

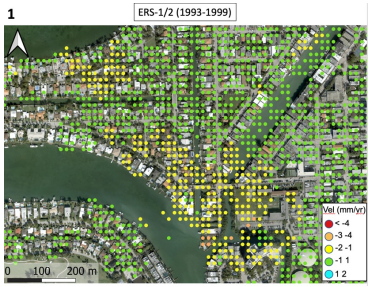
Sentinel-1 (2016-2021)



Answer: No noticeable movement in the Sentinel-1 dataset.

Questions 3: Did other subsiding areas in Miami Beach continue subsiding after 1999?





ERS-1/2

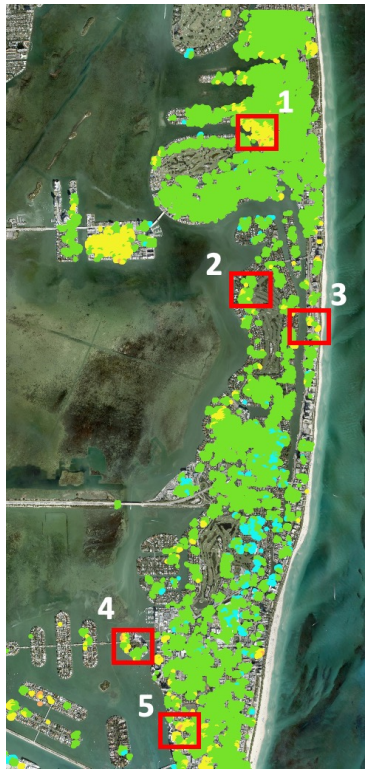
Sentinel-1

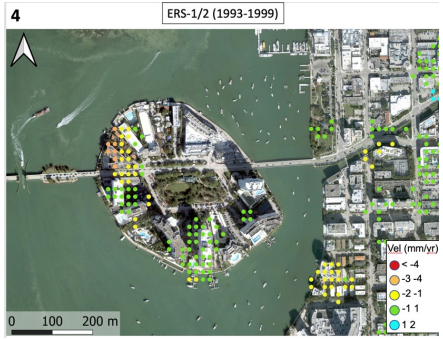
No

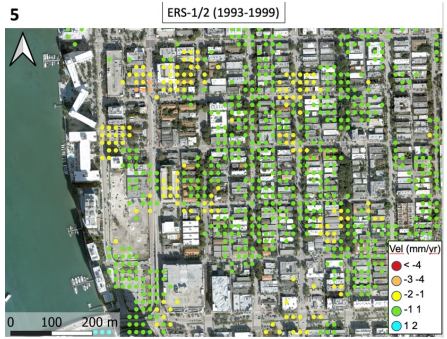
Yes

No

Questions 3: Did other subsiding areas in Miami Beach continue subsiding after 1999?







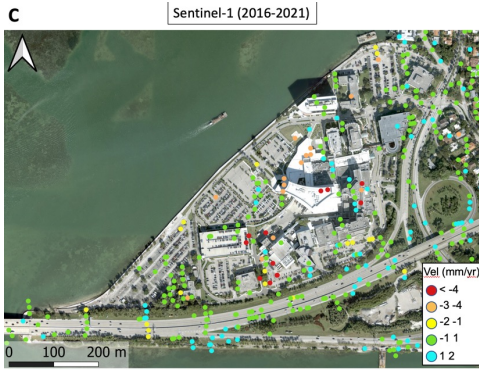
ERS-1/2

Sentinel-1

No

No

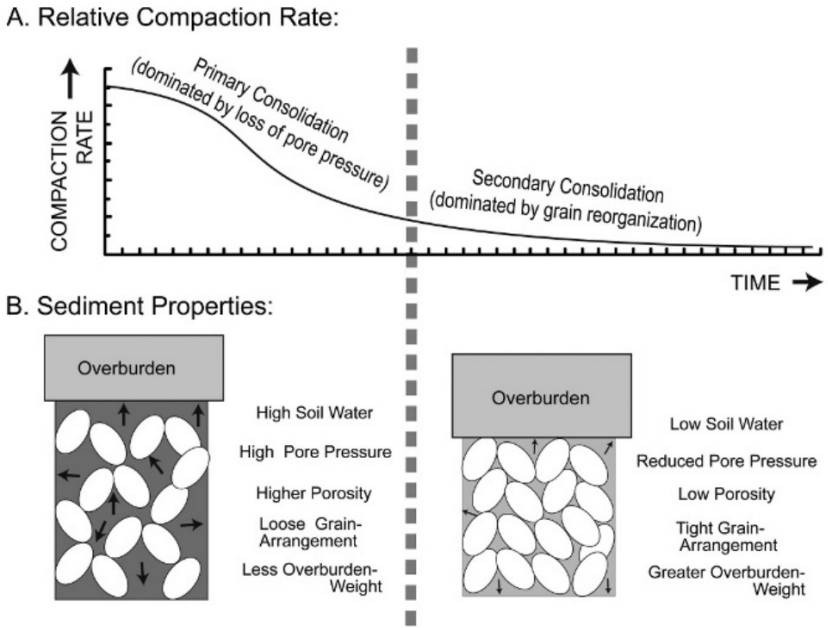
Questions 4: Did other areas in Miami Beach start subsiding after 1999?



Sentinel-1

Significance

Soil consolidation



Yuill et al. (2009)

- Slow subsidence in ERS-1/2 (2-3 mm/yr)
  - Secondary consolidation
  - Remanent from
    - Land reclamation ~100 years ago
    - Building construction (CTS) in 1980s.

*Accumulated subsidence (**lower bounds**):*
Western MB: 80 yr x 2-3 mm/yr = 20-30 cm
CTS: 20 yr x 2 mm/yr = 4 cm
CTS diff. comp. 20 yr x 0.5 mm/yr = 1 cm

- Rapid subsidence in Sentinel-1 (4-5 mm/yr)
  - Primary consolidation
  - Newly constructed buildings.

Accumulated subsidence:
5 yr x 4-5 mm/yr = 2-2.5 cm

Summary

1) Did the detected subsidence in the 1990s had a differential component?	Yes. ~0.5 mm/yr
2) Did the building continue subsiding after 1999?	Not during 2016-2021
3) Did other subsiding areas in Miami Beach continue subsiding after 1999?	Mostly not
4) Did other areas in Miami Beach start subsiding after 1999?	Yes. Mainly new constructions.

Acknowledgements

We thanks:

- ESA for providing InSAR data
  - ERS-1/2
  - Sentinel-1

- Florida Office of Insurance Regulations
  - Funding

Questions: via Email to

Shimon.Wdowinski@fiu.edu