UNCTAD National Workshop Saint Lucia

24 – 26 May 2017, Rodney Bay, Saint Lucia

"Climate Change Impacts and Adaptation for Coastal Transport Infrastructure in Caribbean SIDS"

LISCoAsT – Large Scale Integrated Sea-level and Coastal Assessment Tool: Application for the SIDS (II)

By

Michalis Vousdoukas

European Commission, Joint European Research Centre, Ispra, Italy

LISCoAsT – Large scale Integrated Sea-level and Coastal Assessment Tool: Application for the SIDS

UNCTAD National Workshop Saint Lucia
"Climate change impacts and adaptation for coastal transport infrastructure in Caribbean SIDS"

Michalis Vousdoukas, Lorenzo Mentaschi, Evangelos Voukouvalas, Luc Feyen

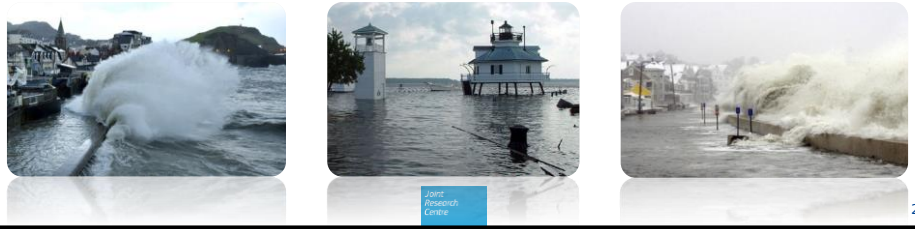
European Commission, Joint Research Centre, Ispra, Italy

Disaster Risk Management Unit

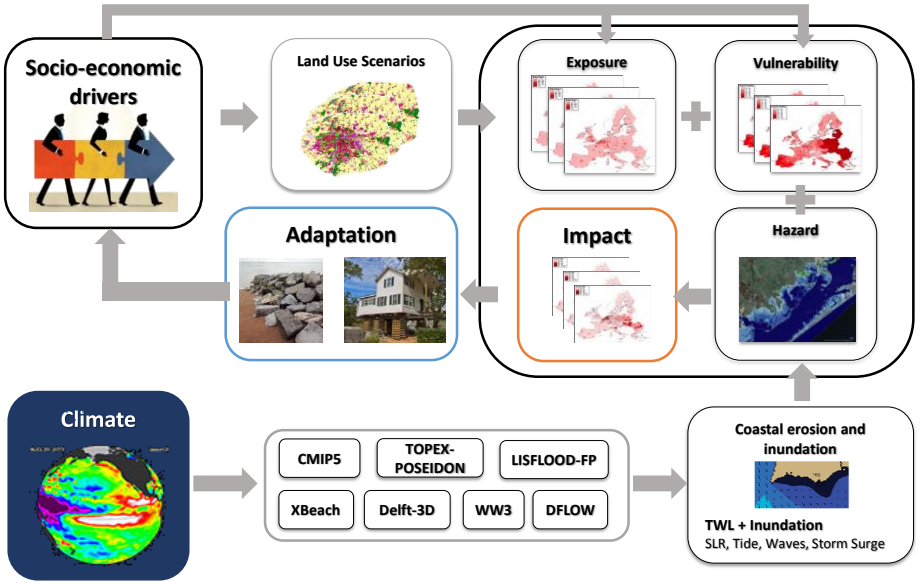
Directorate E, Joint Research Centre, EC

Activity on river floods:
European/Global Flood Awareness System (EFAS/GLOFAS)
Climate change projections (Alfieri L., Rojas R., Feyen L)

Coastal floods group:
Michalis Vousdoukas, Lorenzo Mentaschi, Evangelos Voukouvalas, Dimitrios Bouziotas, Tomas Montblanc, Georgia Kakoulaki, Francesco Dottori, Luc Feyen



The LISCoAsT approach

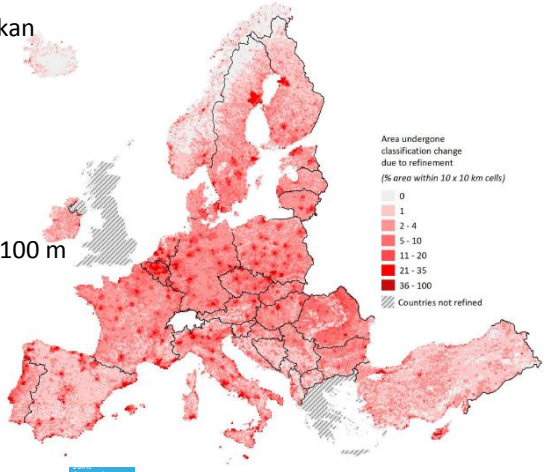


The LISCoAsT approach

EXPOSURE-VULNERABILITY

Exposure: current land use and population

- 2006 land use map, 100x100 m
- EU27 + EFTA + Turkey + Balkan
- 45 thematic classes
- Refined CORINE land use
  - Soil Sealing Layer
  - TeleAtlas®
  - Urban Atlas
- 2006 population map, 100x100 m
- EU27 + EFTA
- SSPs

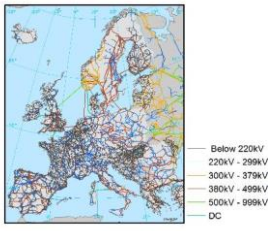


Batista e Silva, F., Lavalle, C., Koomen, E., 2013. A procedure to obtain a refined European land use/cover map. Journal of Land Use Science, 8 (3), pp. 255-283.
Batista e Silva, F., J. Gallego, C. Lavalle, 2013. A high-resolution population grid map for Europe. Journal of Maps, 9, 16-28.

Mapping of large infrastructures and key economic assets

- Non renewable Power Plants (MW)
- Electricity distribution lines (km)
- Unesco cultural sites (number)
- Social infrastructure (number)
- Ports/Airports (No People Served)
- Transport networks (No People Served)
- Urban transport (No People Served)

Transmission lines



Ports

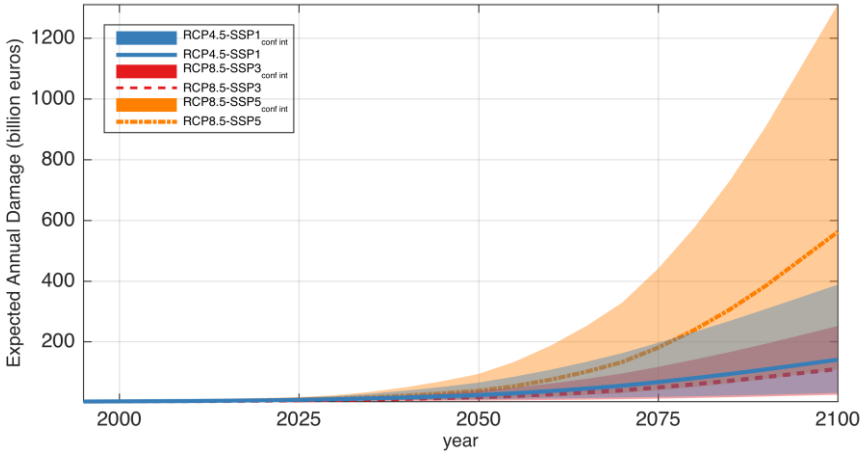
Railway network



Results

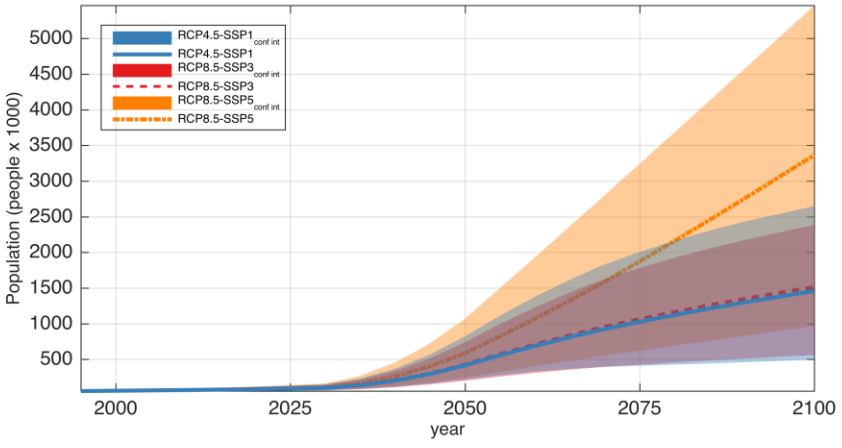
PROJECTIONS OF COASTAL IMPACTS FOR EUROPE

Projections of EAD for RCP4.5 and 8.5



Only direct impacts!

Projections of EA number of people affected

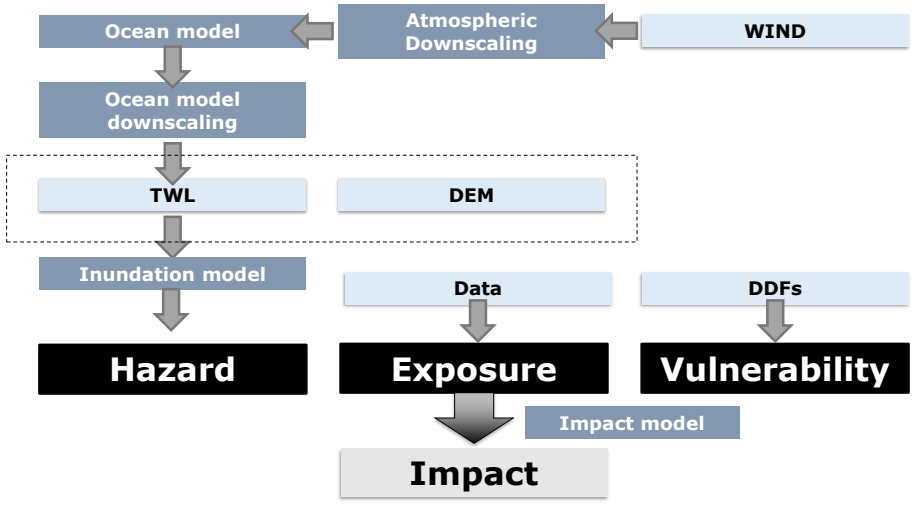


Only direct impacts!

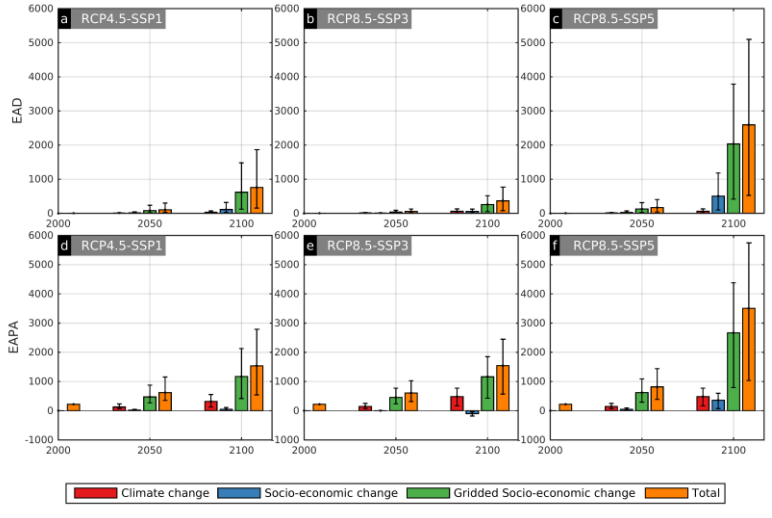
Critical aspects

- Temporal and spatial scales
- Consider all processes (tides, waves, storm surge, erosion, protection failure, etc), or exclude the right ones ☺
- Data quality
- Find the right inundation model for the scale and data quality
- Exposure maps, stationary or dynamic
- Find the right impact assessment methodology
- Adaptation pathways

Critical aspects



Coastal impacts- Socio-economic vs Physical



LISCOAST

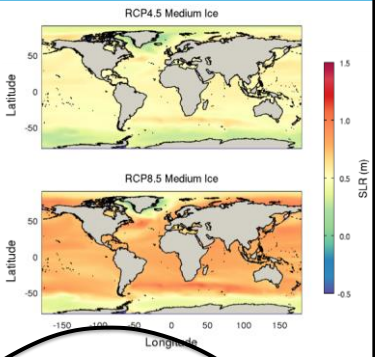
- A flexible coastal impact assessment tool
- Process-based, large scale, but not oversimplified
- Developed, validated and applied first for Europe and then implemented on global scale
- Building upon the group's expertise on inland flooding forecasting and impact assessment
- Collaborations with leading institutes of the field, smaller scale assessments for validation, incentive for improvement

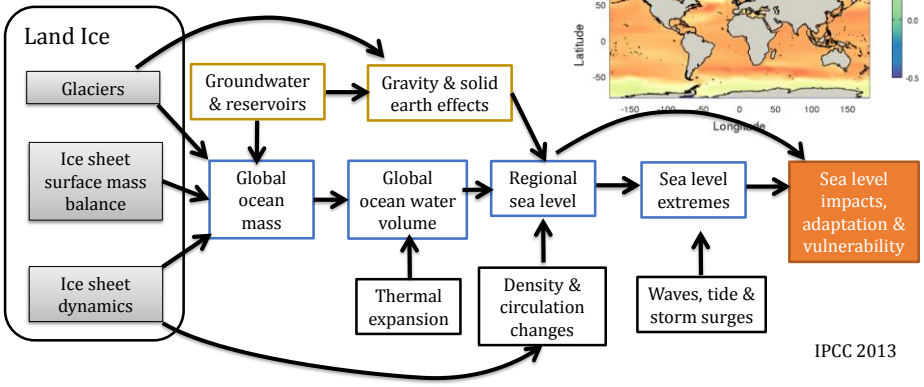


The LISCoAsT approach

HAZARD PROJECTIONS

Sea Level Rise and beyond



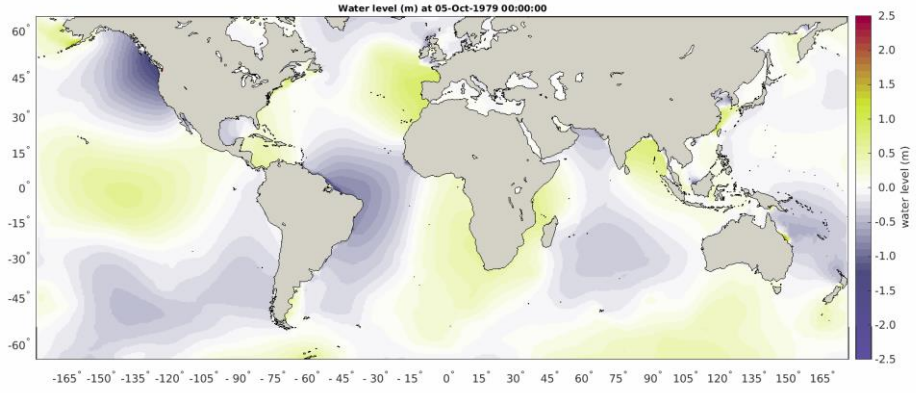


IPCC 2013

Sea level extremes: Global Storm Surge Model

Model used: DFLOW
Simulated tidal, wind and pressure driven ocean circulation

Flexible mesh
Nearshore resolution 0.11° x 0.05°
Offshore resolution 0.94° x 0.42°



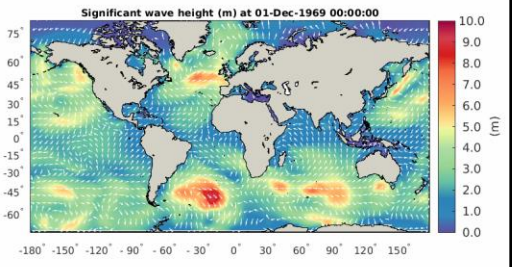
Sea level extremes: Global wave model

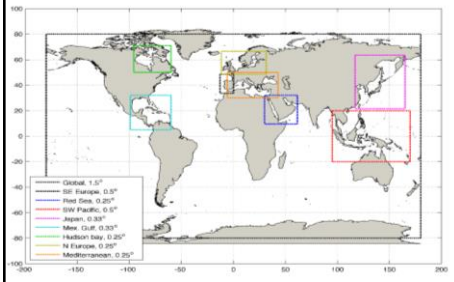
Model used: WaveWatch3 v4.18

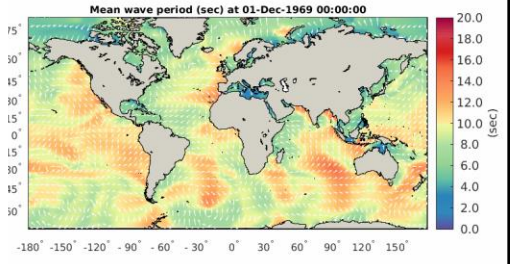
Generates waves from wind fields

Resolves all wave directions and frequencies

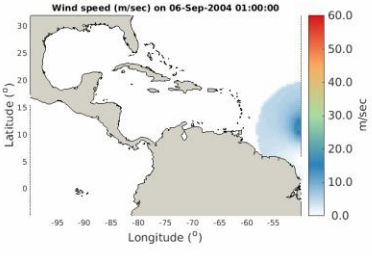
Considers several parameters including temperature, ice concentration

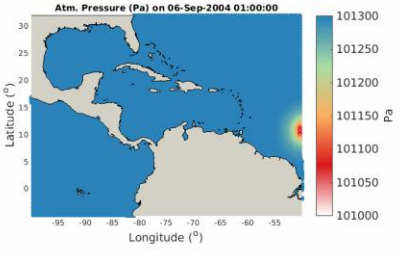


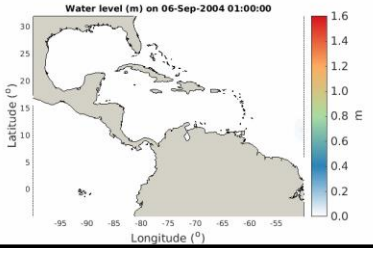




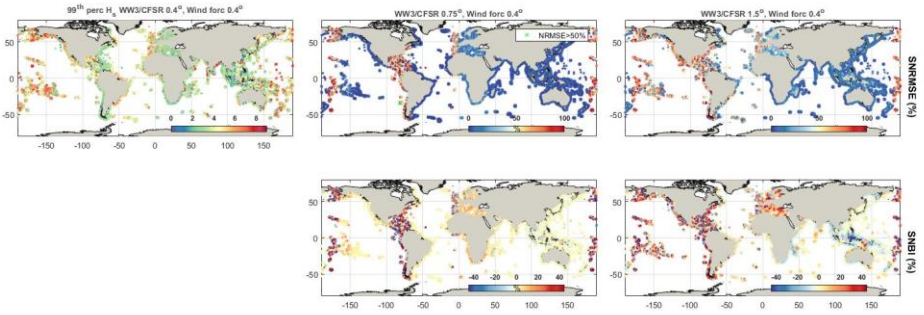
Sea level extremes: Tropical cyclones



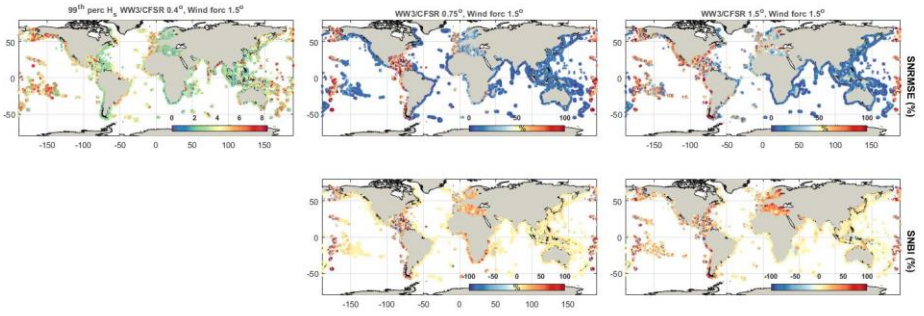




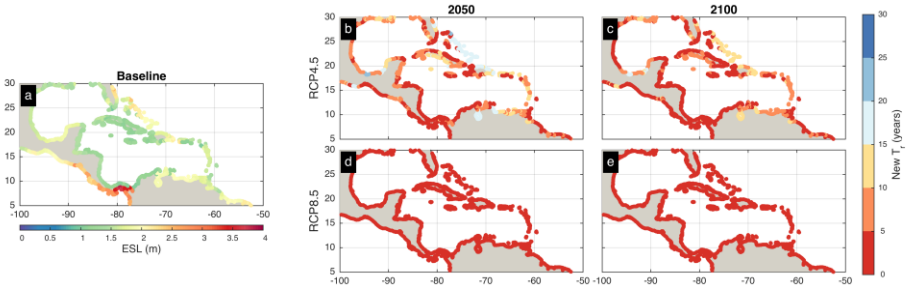
Sea level extremes: Grid resolution effects



Sea level extremes: Forcing resolution effects



Caribbean TWL projections: Changes in frequency



Data to be available

Joint Research Centre

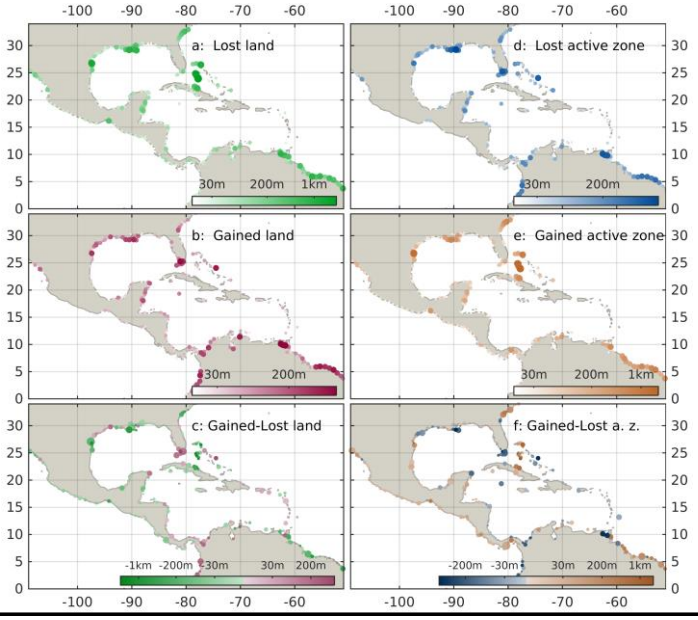
https://global-surface-water.appspot.com

Current Global Erosion Trends

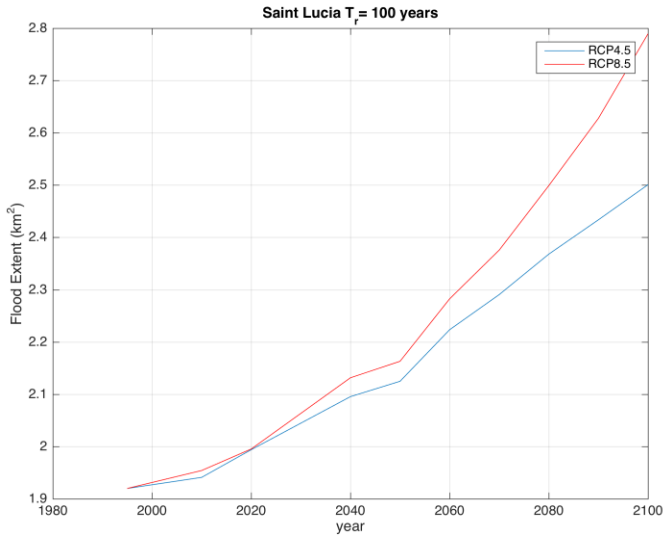
Joint Research Centre

Long-term shoreline dynamics

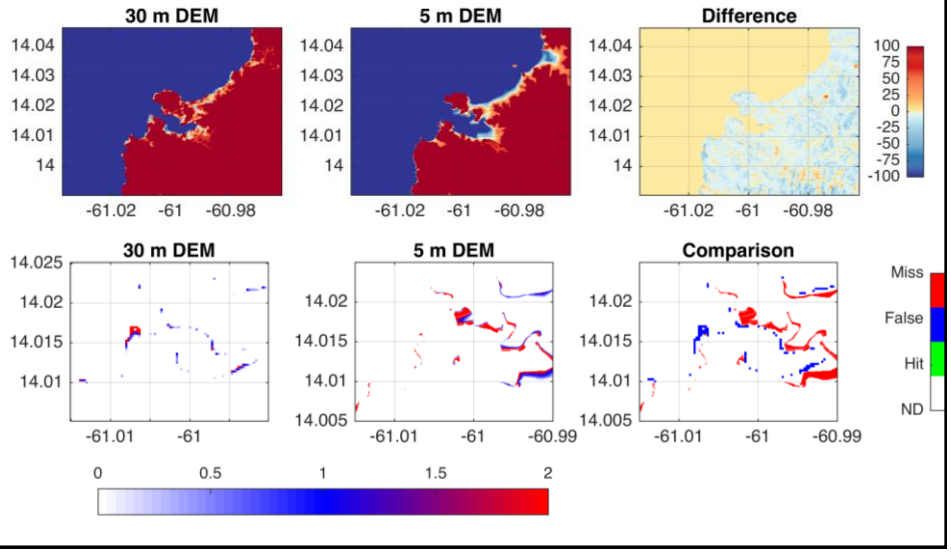
Based on Pekel et al 2016, Nature
3000000 Landsat satellite images
Past 32 years
30 m resolutionc



Flood extent projections for St Lucia

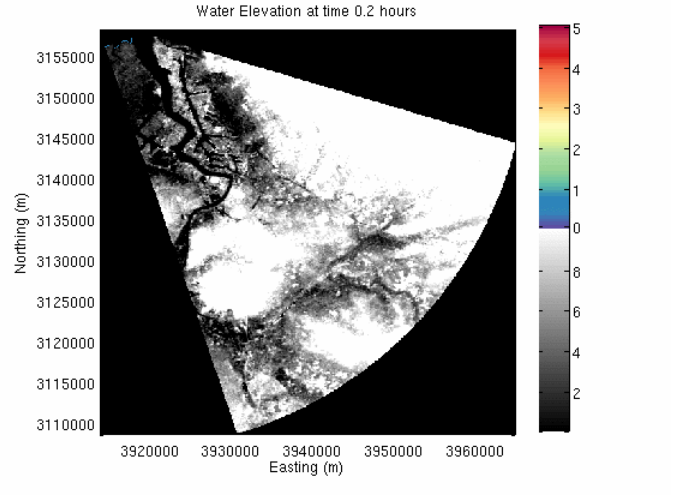


Digital Elevation data



2D vs 3D inundation simulations

Coastal Inundation: type of model



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Research article

11 Apr 2016

Developments in large-scale coastal flood hazard mapping

Michalis I. Vousdoukas[1,2], Evangelos Voukouvalas[1], Lorenzo Mentaschi[1], Francesco Dottori[1], Alessio Giardino[3], Dimitrios Bouziotas[1,3], Alessandra Bianchi[1], Peter Salamon[1], and Luc Feyen[1]
[1]European Commission, Joint European Research Centre (JRC), Institute of Environment and Sustainability (IES), Climate Risk Management Unit, Via Enrico Fermi 2749, I-21027-Ispra, Italy
[2]Department of Marine Sciences, University of the Aegean, University hill, 41100, Mitilene, Lesbos, Greece
[3]Deltares, P.O. Box 177, 2600 MH Delft, The Netherlands.

Review status
This discussion paper is under review for the journal Natural Hazards and Earth System Sciences (NHESS).

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Abstract. Coastal flooding related to marine extreme events has severe socio-economic impacts, and even though the latter are projected to increase under the changing climate, there is a clear deficit of information and predictive capacity related to coastal flood mapping. The present contribution reports on efforts towards a new methodology for mapping coastal flood hazard at European scale, combining (i) the contribution of waves to the total water level; (ii) improved inundation modelling; and (iii) an open, physics-based framework which can be constantly upgraded, whenever new and more accurate data become available. Four inundation approaches of gradually increasing complexity and computational costs were evaluated in terms of their applicability for large-scale coastal flooding mapping: static inundation (SM); a semi-dynamic method, considering the water volume discharge over the dykes (VD); the Flood Intensity Index approach (Iw); and the model LISFLOOD-FP (LFP). A validation test performed against observed flood extents during the Xynthia

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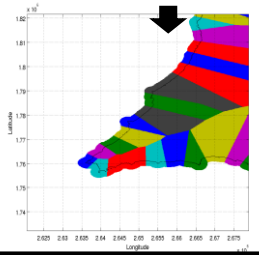
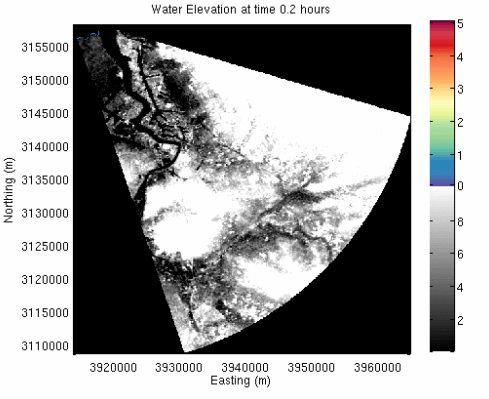
Coastal Inundation on EU scale

- TWL components estimated every 25 km of coast
- SRTM DEM
- Similarly coastline and all data divided in 25 km long segments, extending 50 km inland

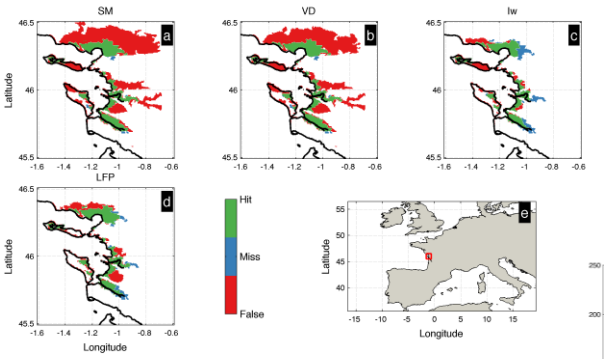




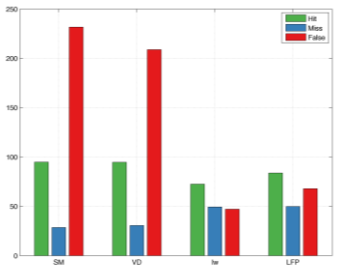
$$\eta_{TWL} = \eta_{MSL} + RSLR + \eta_{tide} + \eta_{stormsurge} + \eta_{wave}$$

Joint Research Centre

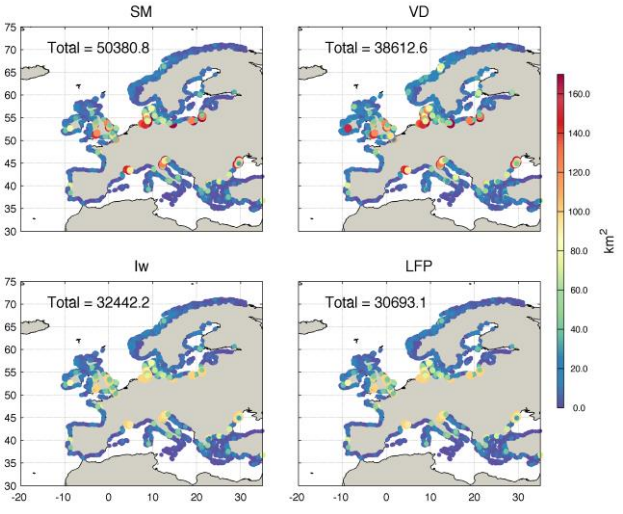
Validation for the Xynthia storm



Hit	$H = \frac{Fm \cap Fo}{Fo} \times 100$
Miss	$F = \frac{Fm / Fo}{Fo} \times 100$
False alarm	$C = \frac{Fm \cap Fo}{Fm \cup Fo} \times 100$



European scale application for the present-day 100-year event



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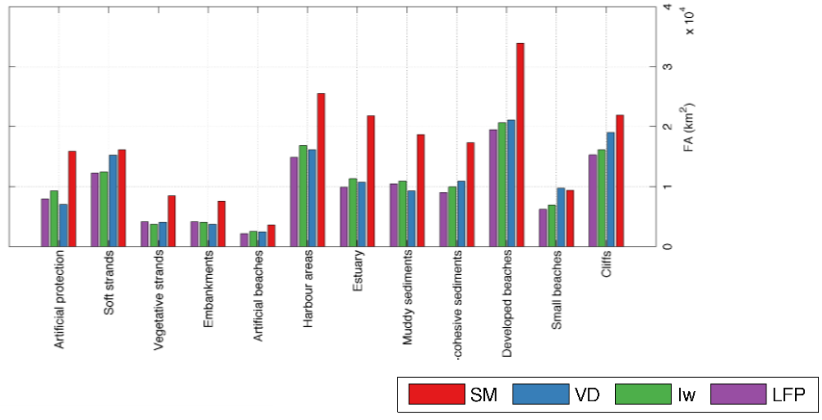

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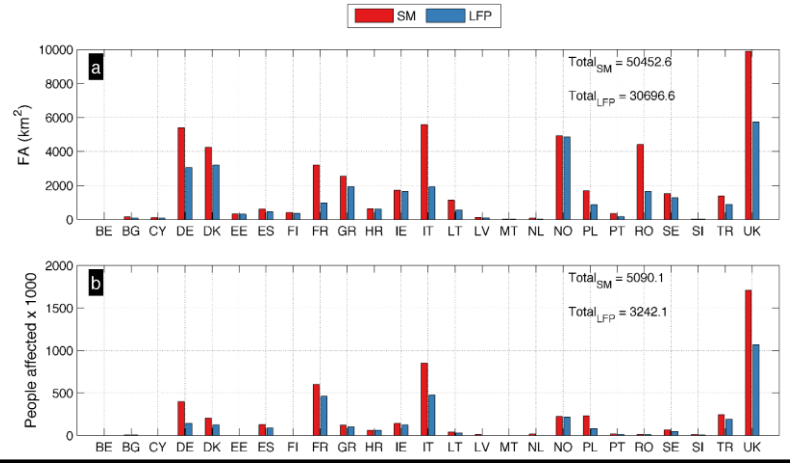
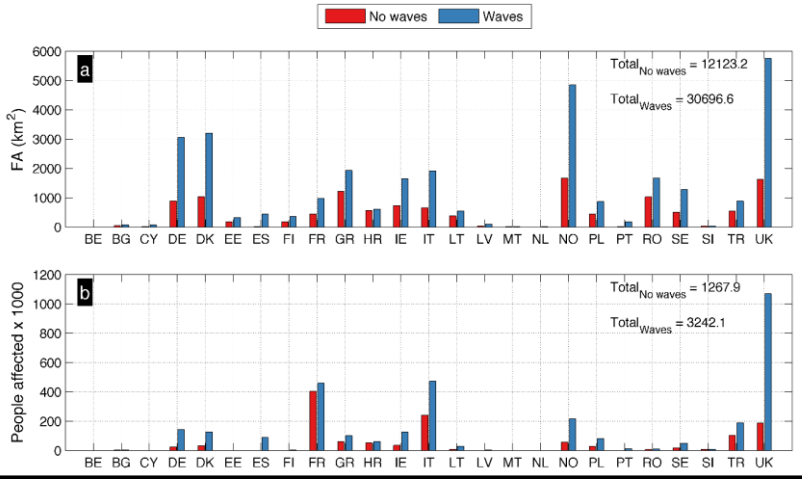
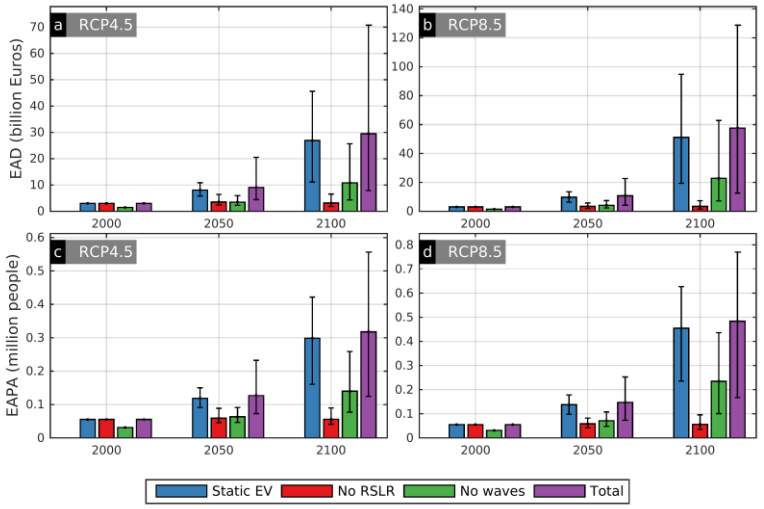


Coastal Inundation: considering waves

European scale application for the present-day 100-year event



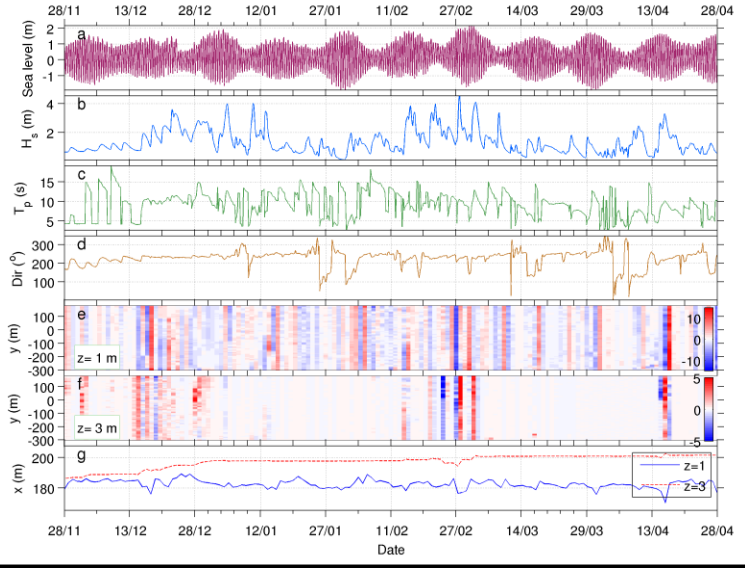
Coastal impacts- Physical contributions



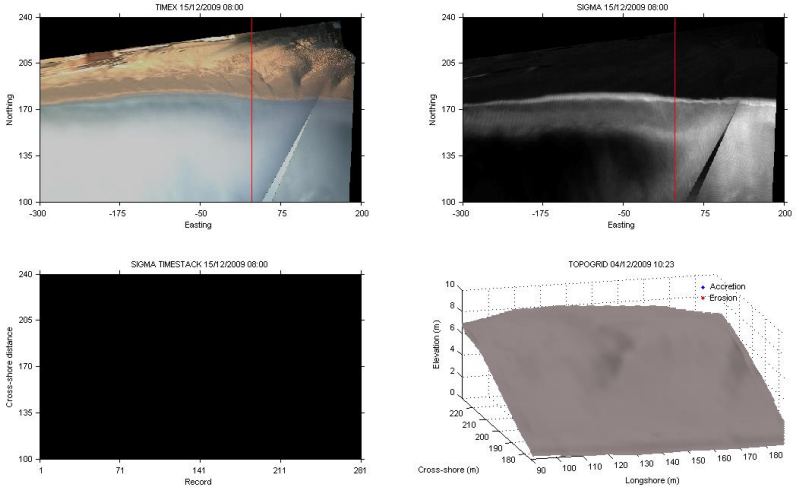
Coastal erosion and inundation

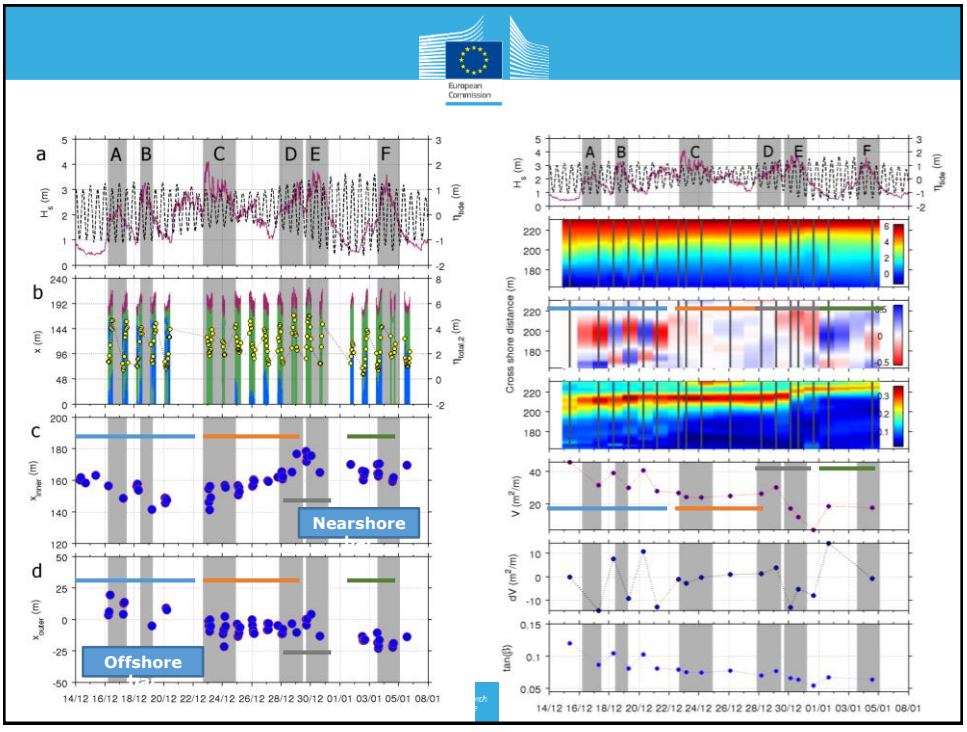
Hurricane Matthew, USGS

Intertidal topography



Storms and morphology





Monitoring and Modelling morphology

There are simple solutions

- **Design Disaster Risk Reduction procedures**
- **Schedule inspections/monitoring**
- **Identify available information sources**
- **Combine with local knowledge**
- **Understand the coastal systems and vulnerabilities**
- **Preparedness when there are anticipated impacts (protecting critical/sensitive points, issuing warnings, evacuating in extreme cases)**