GWF 2023
GEOSPATIAL WORLD FORUM

AN OPEN-SOURCE GEOSPATIAL APPROACH TO MAKING SENSE OF THE COMPLEX SPATIO-TEMPORAL DYNAMICS DRIVING HUMAN ACTIVITIES ACROSS THE QUINQUEPARTITE PORT-SEA CONTINUUM

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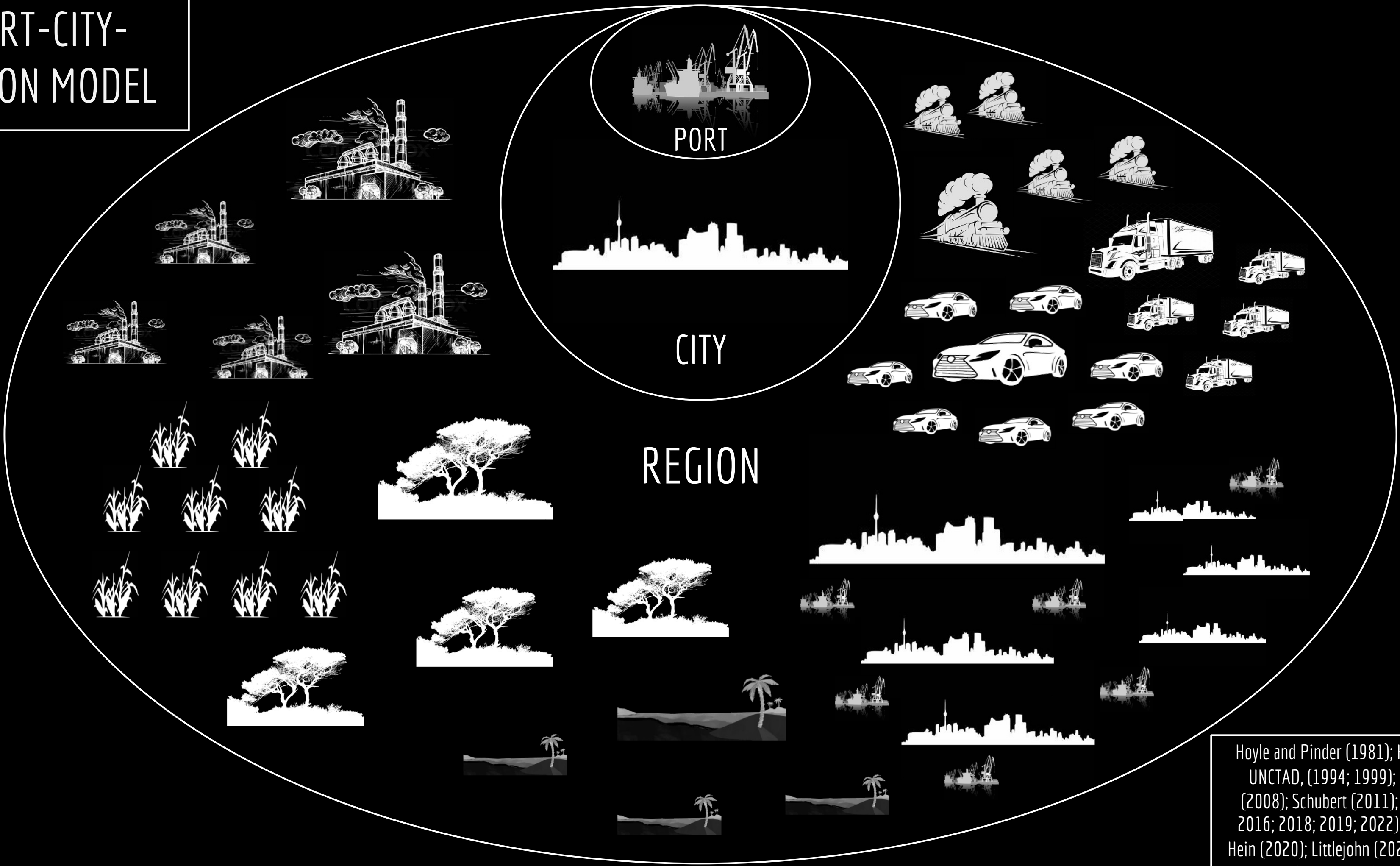
UNIVERSITY OF HULL | DEPARTMENT OF GEOGRAPHY, GEOLOGY AND ENVIRONMENT

White Rose Social Sciences DTP
E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

"The Natural and Cultural Ocean have spatially [and temporally] intertwined in extreme and unprecedented ways via processes of extended urbanisation."

(Couling, 2018; Couling and Hein, 2020)

PORT-CITY-REGION MODEL



Hoyle and Pinder (1981); Hoyle (1989); UNCTAD, (1994; 1999); Kokot et al. (2008); Schubert (2011); Hein (2014; 2016; 2018; 2019; 2022); Couling and Hein (2020); Littlejohn (2020); Russo and Musolino (2020; 2023), amongst others.

THE FIVE GENERATIONS OF PORT-CITY MODELS

GENERATION I
THE CITY PORT

The first ports were built near settlement centres (extending into ancient human history, at least as far back as the Bronze Age)

Key Characteristics:
I. Close Proximity to Human Settlement
II. Economic flows exchanged for intermediate and final demand

GENERATION II
THE INDUSTRIAL PORT

The second generation of ports were constructed near industrial complexes.

Key Characteristics:
I. Added value and influx of employees to industrial plants and the port complex
II. Supporting the supply of raw materials and finished products from industrial plants

GENERATION III
THE CONTAINER PORT

During the 1980's Ports became integrated transport centres/logistics platforms, thanks largely to the emergence of containerisation and the requirements for international trade to meet the demands of a globalising population.

Key Characteristics:
I. Emergence of containerisation
II. Exports/Imports from the wider local region (regional port) and further afield (Gateways)

GENERATION IV
THE COOPERATIVE PORT

Since the end of the 20th century, ports have become increasingly cooperative with a greater push toward both horizontal and vertical governance integration.

Key Characteristics:
I. Push towards multi-level governance integration (Port-City-Region Model)
II. Shared maritime services and interconnected terrestrial infrastructures

GENERATION V
THE DIGITAL PORT

Today, ports are undergoing further rapid changes as a consequence of the emergence of AI/ML capabilities which are facilitating the process of digitisation.

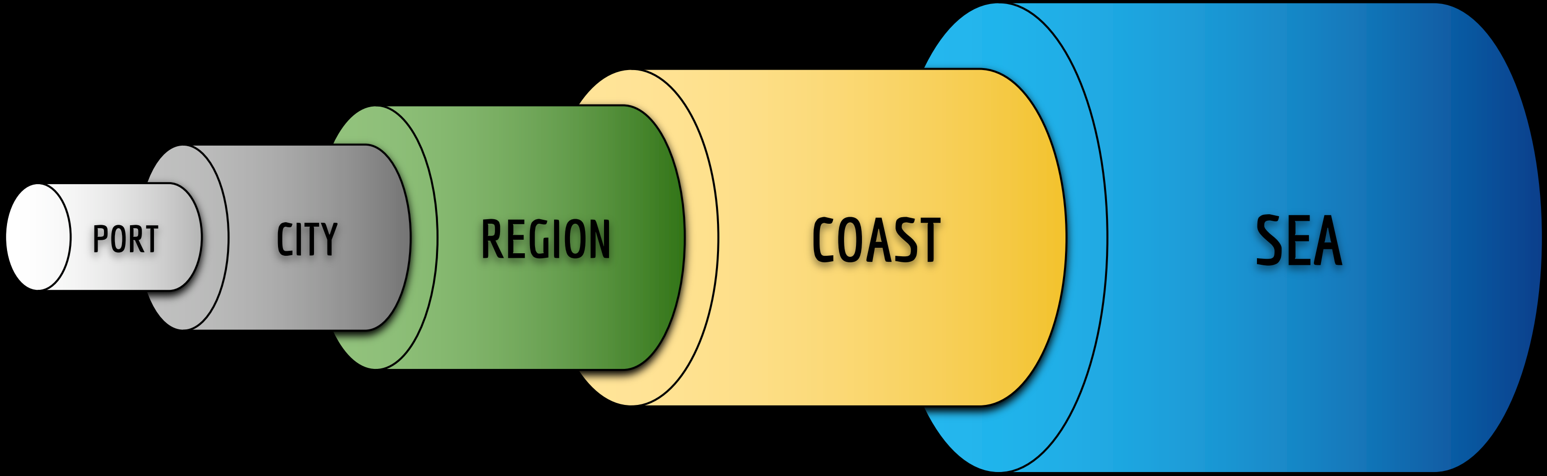
Key Characteristics:
I. The increasing use of AI/ML (Digital Twins) to optimise operations and decision-making among stakeholders
II. The development of Port Community Systems

With the emergence of “Blue Economy” thinking and an increasing interest in and need for e.g. marine resource extraction, maritime decarbonisation/technological solutions, ocean-based climate solutions etc…

These processes have increasingly tethered: (1) Port Complexes to Port Cities; (2) Port Cities to Regions; (3) Port-City-Regions to Regional Sea Coastlines; and (4) Regional Sea Coastlines to Regional Sea Areas.

I have proposed the extension of the holarchic Port-City-Region model to incorporate (1) the larger units of the regional sea coastline and subsequently (2) nearshore and offshore areas under national jurisdiction...

(...and ostensibly beyond once the BBNJ is enacted and a Deep-Sea Mining Code is concomitantly agreed and subsequently implemented.)



PORT-SEA CONTINUUM
(SOFT SYSTEMS MODEL)

THE BLUE ECONOMY: WHAT ARE THE CONSTITUENT COMPONENTS?

World Bank definition of the "Blue Economy":

"[It is the] *sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem.*"

What are the components of that vision?

The Blue Economy comprises the established ocean uses (e.g. aggregates, fisheries, oil and gas extraction, shipping, tourism etc) and emerging/new uses (e.g. aquaculture, marine biotechnology, offshore renewable energy, seasteading, seabed mining etc).

WHERE DO GEOSPATIAL METHODS AND TOOLS FIT IN?

In Short?...

EVERYWHERE

SAR-DERIVED LANDWARD ANALYSES OF COASTAL LAND USE AND THE EVOLUTION OF PORT CITIES USING PUBLICLY-AVAILABLE DATA

GLOBAL HUMAN SETTLEMENT LAYER DATA PACKAGE:

BUILT-UP SURFACE GRID, POPULATION GRID AND SETTLEMENT MODEL CHANGE DETECTION
(GHSL-BUS: 1975-2020 + 2025 and 2030 Linear Projections; GHSL-POP: 1975-2020 + 2025 and 2030 Linear Projections; GHSL-SMOD II: 1975-2020 + 2025 and 2030 Linear Projections)

COPERNICUS LAND MONITORING SERVICE:

CORINE LAND COVER CHANGE DETECTION:
(CLC2000-CLC2006-CLC2012-CLC2018)

COASTAL AND RIPARIAN ZONE CHANGE:
(CZ2012-CZ2018 and RZ2012-2018)

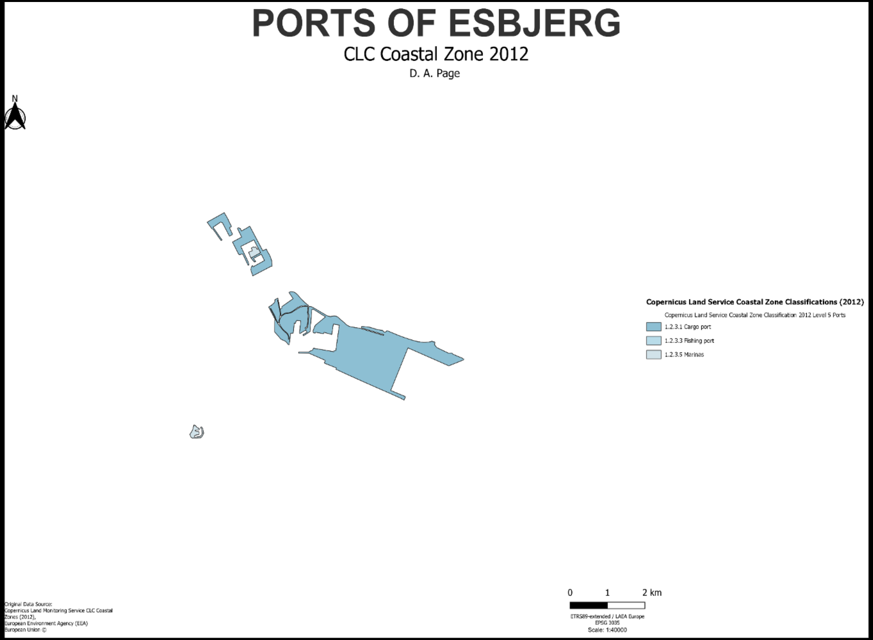
IMPERVIOUSNESS DEGREE CHANGE:
(IMD2006-IMD2009-IMD2012-IMD2015-IMD2018)

EUROPEAN ENVIRONMENT AGENCY:

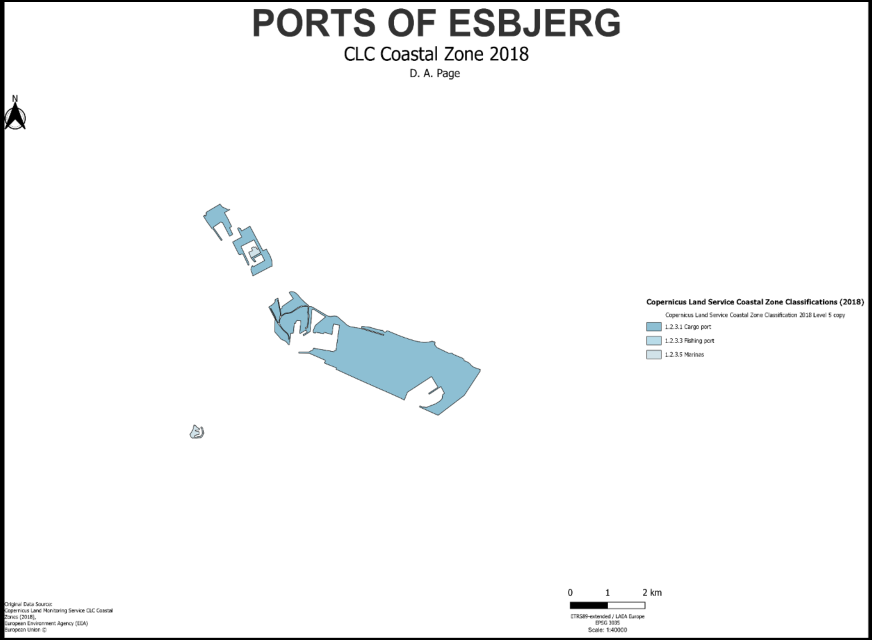
CLC ACCOUNTING LAYERS (2000-2018)

Copernicus
Europe's eyes on Earth

THE GROWTH OF THE PORTS OF ESBJERG: CLC 2012 vs 2018

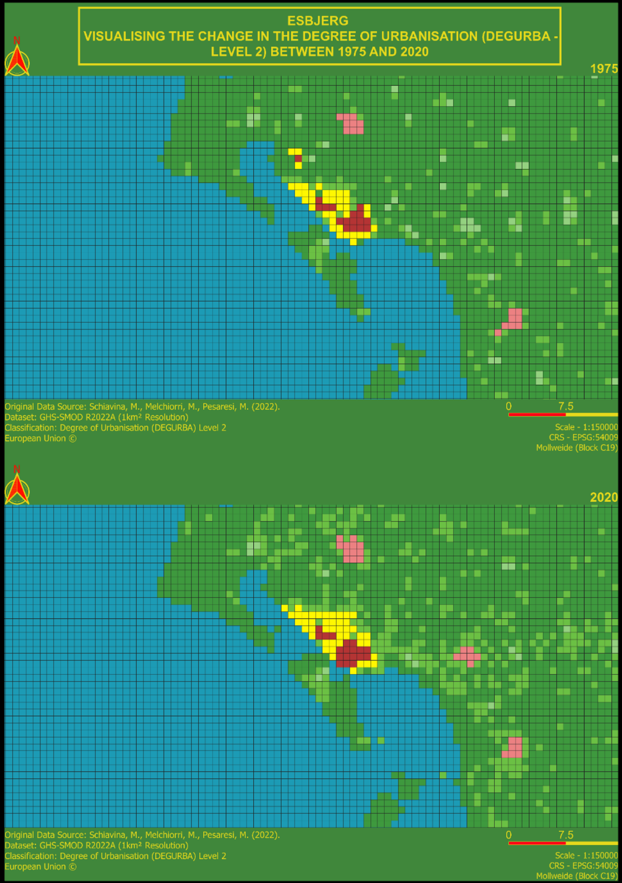


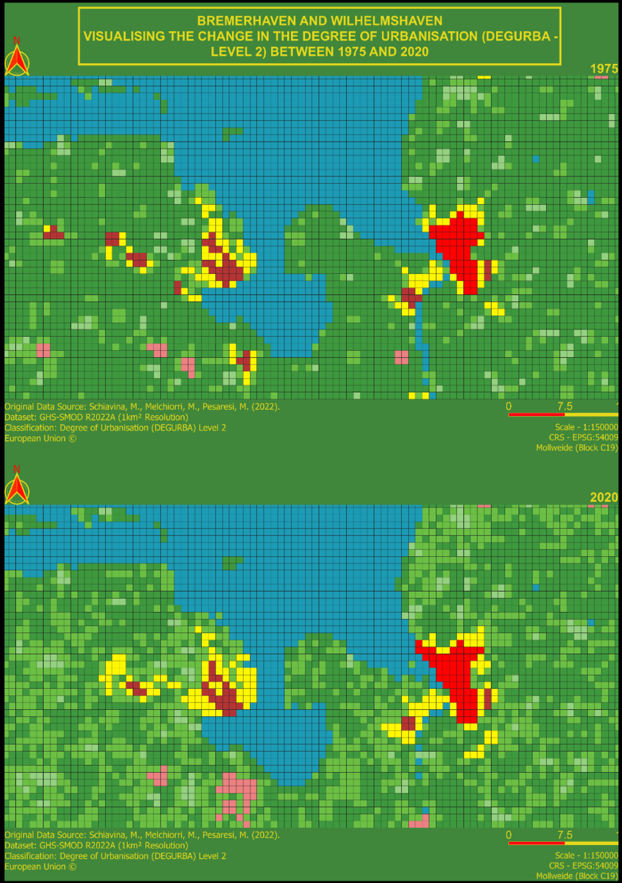
2012

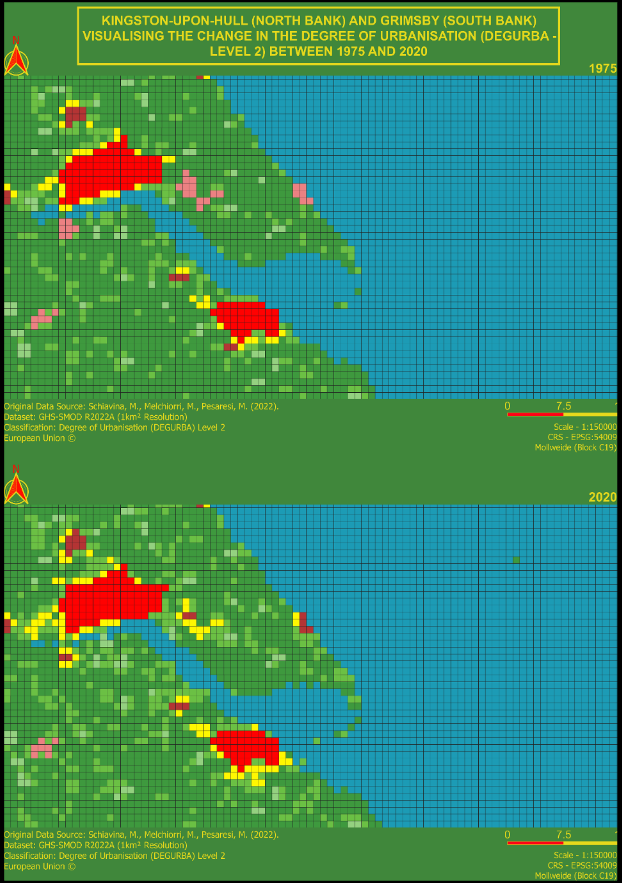


2018

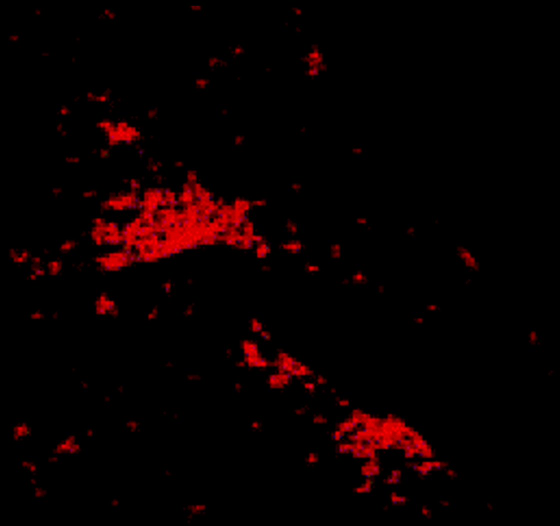
CELLULAR AUTOMATA VISUALISATION OF THE DEGREE OF URBAN CHANGE IN KINGSTON-UPON-HULL, BREMERHAVEN AND ESBJERG (1975-2020)





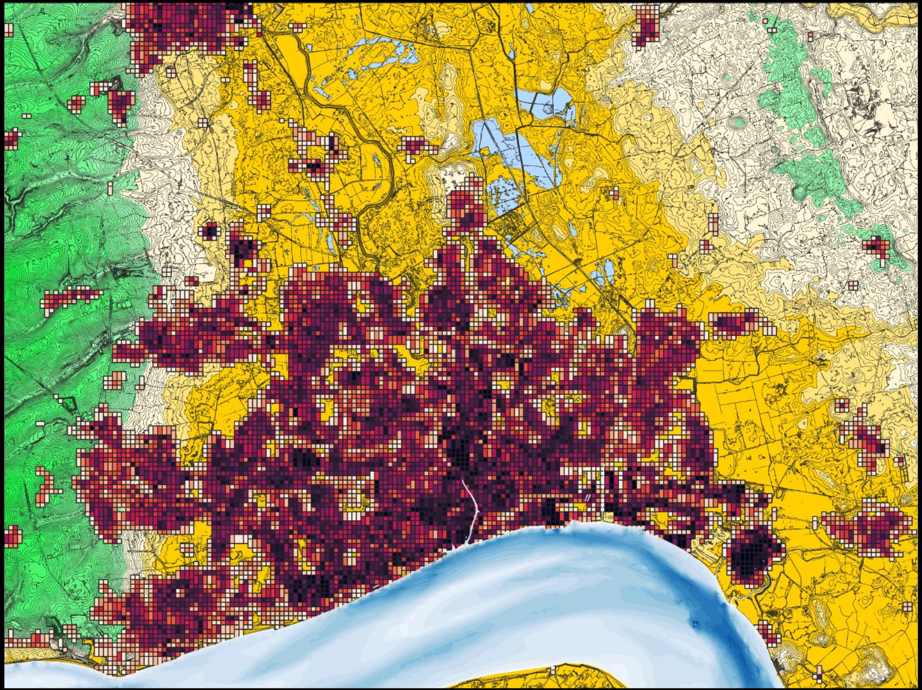


KINGSTON-UPON-HULL: BUILT-UP SURFACE CHANGE



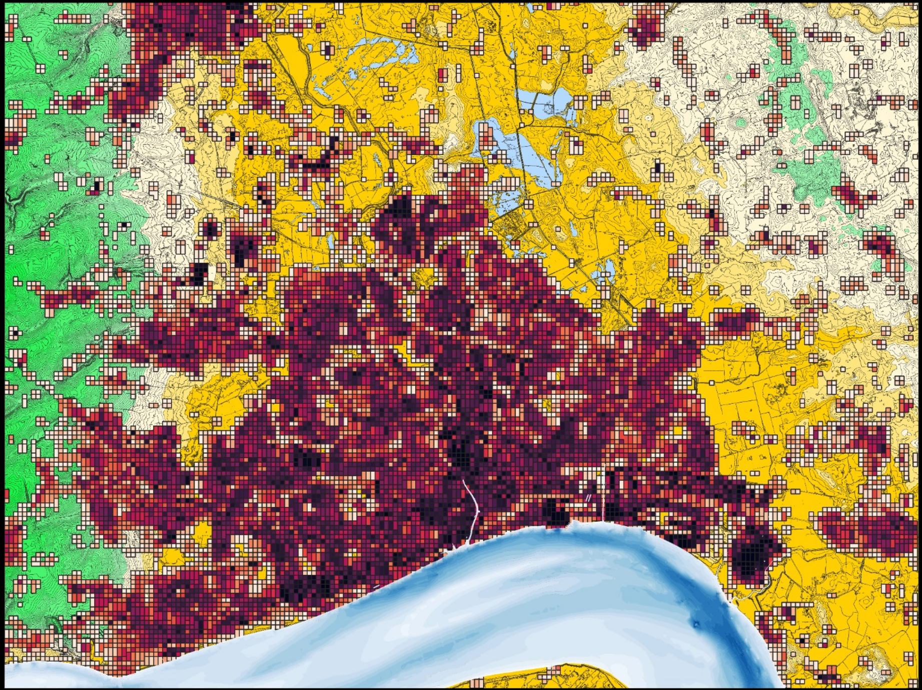
1975

KINGSTON-UPON-HULL: BUILT-UP SURFACE CHANGE



1975

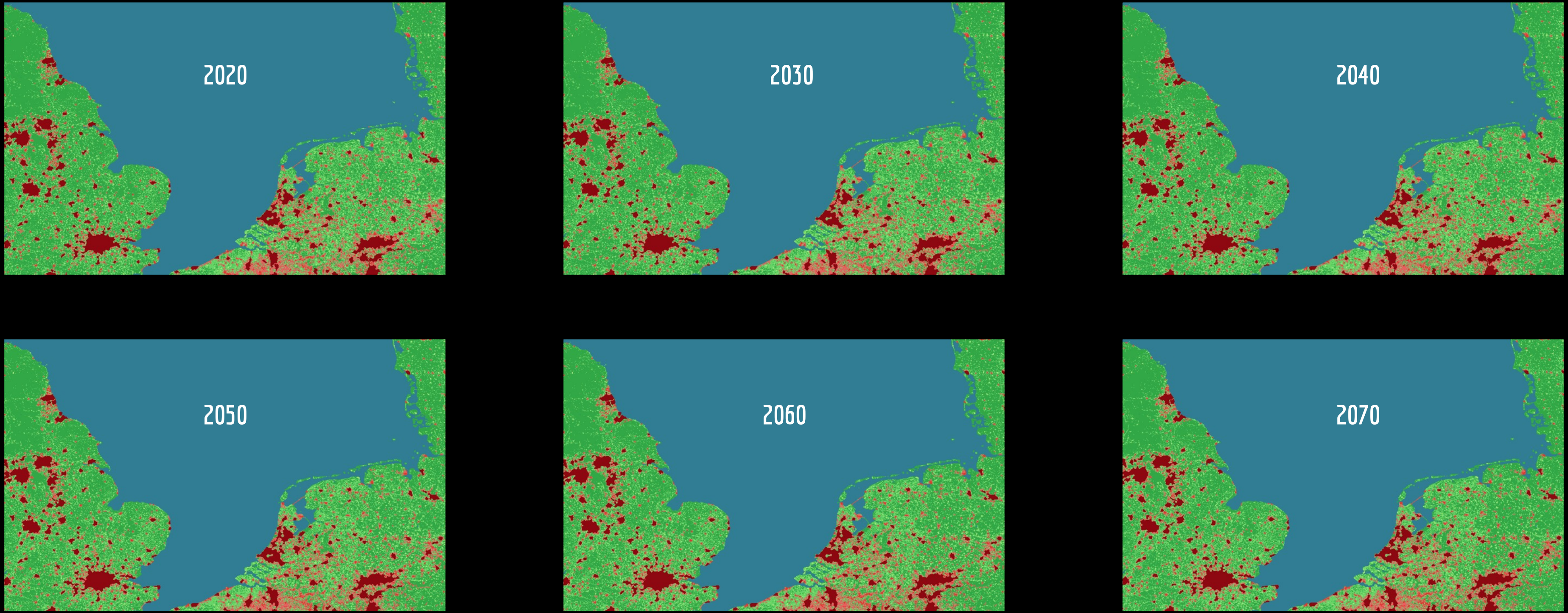
ORIGINAL B-US DATA COLLECTED BY LANDSAT-1 & LANDSAT-2



2020

ORIGINAL DATA BU-S DATA COLLECTED BY SENTINEL-2

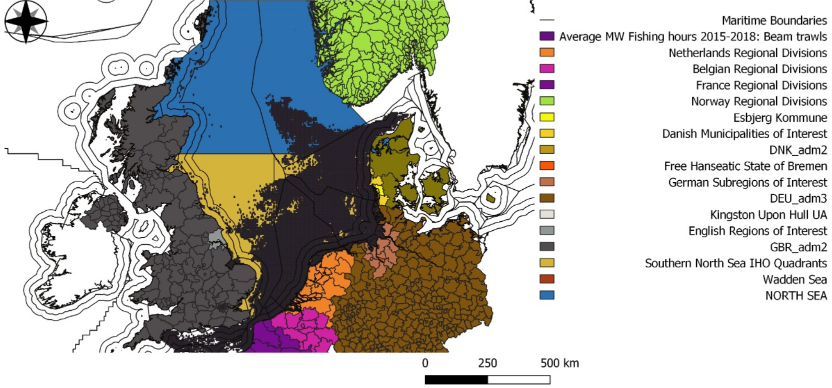
SOUTHERN NORTH SEA SETTLEMENT MODEL LINEAR DECADAL PROJECTIONS (2020-70)



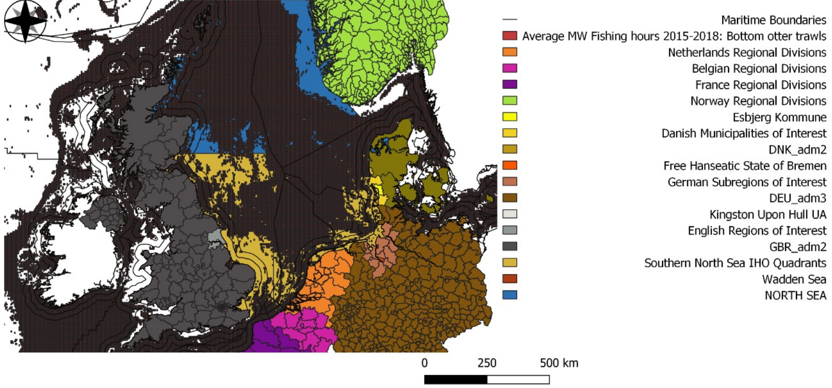
MULTIFACETED OFFSHORE SPATIO-TEMPORAL ANALYSES USING EMODNET, ICES AND OSPAR DATA

- EMSA Vessel Route Density (2019-2023 - Annual)
- EMODNet AIS-derived Vessel Density (2019-2023 - Annual)
- EMODNet Oil and Gas Wells (1963-2020 - Annual)
- EMODNet Offshore Installations (2001-2019 - Biannual)
- EMODNet Wind Farms (1995-2022 - Annual)
- OSPAR Monitoring of Radioactive Substances in Biota/Seawater (2000-2020 - Demidecadal)
- OSPAR Dumping at Sea Points (1995 vs 2020)
- OSPAR Encounters with Munitions (2010-2020)
- VMS-derived Bottom Fishing Intensity for vessels >12m (2009-2022) - OSPAR (2009-2017 - Annual) and ICES (2018-2021 - Annual)

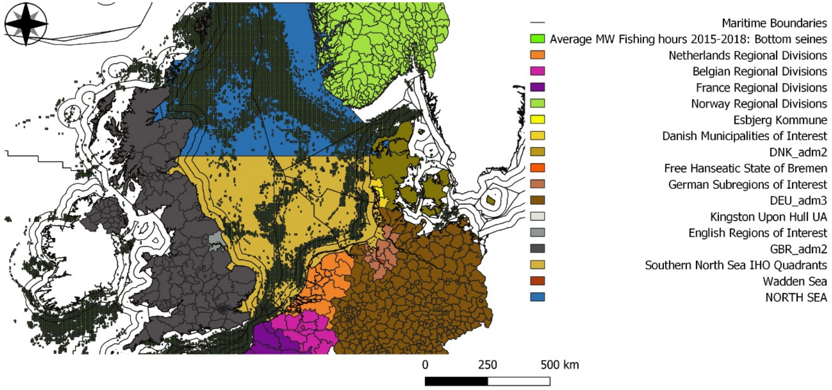
EMODnet ICES CIEM OSPAR



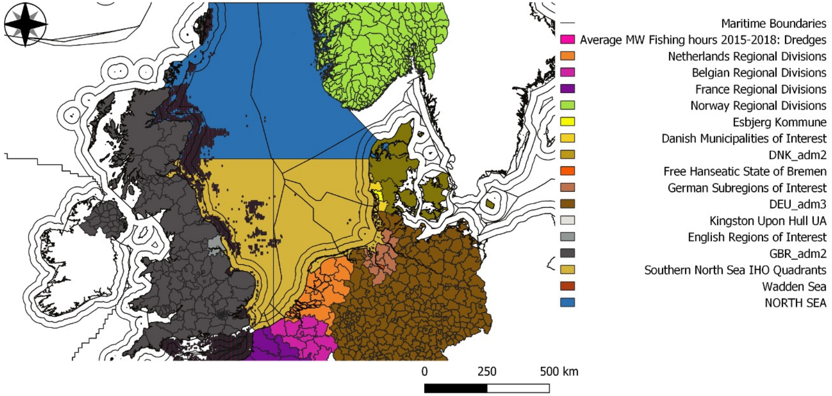
The Spatial Distribution of Average Annual Beam Trawling Fishing Effort (mW fishing hours) in the IHO North Sea Basin (2015-2018)



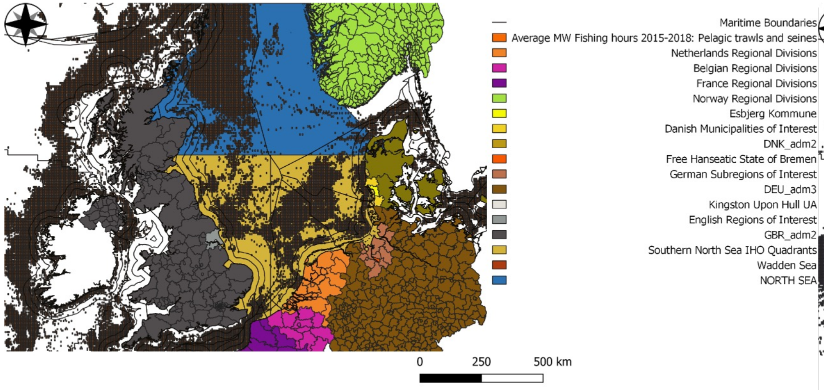
The Spatial Distribution of Average Annual Bottom Otter Trawling Fishing Effort (mW fishing hours) in the IHO North Sea Basin (2015-2018)



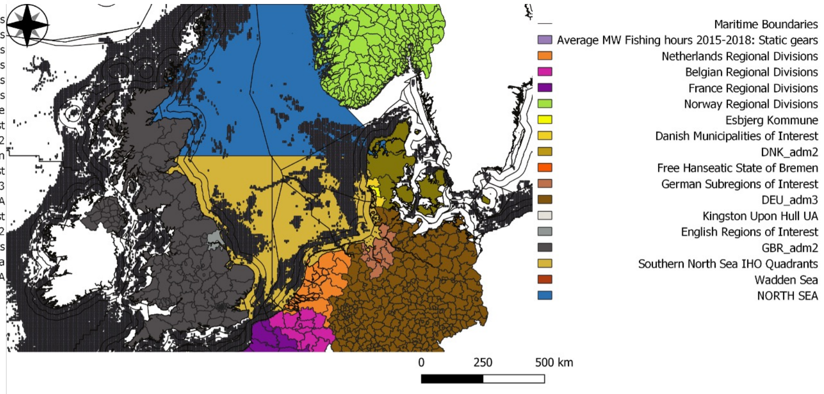
The Spatial Distribution of Average Annual Bottom Seine Fishing Effort (mW fishing hours) in the IHO North Sea Basin (2015-2018)



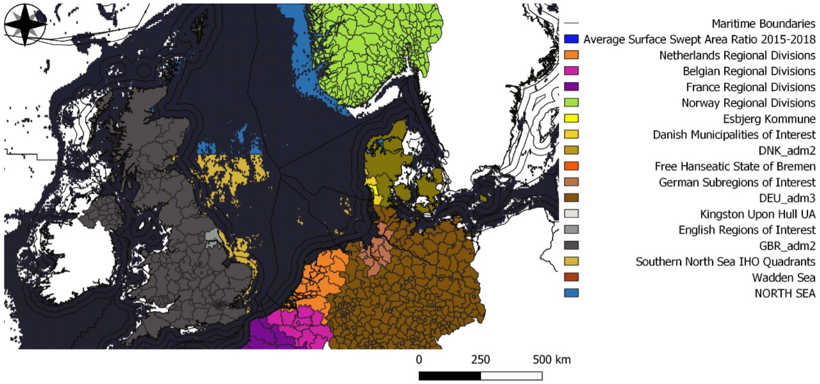
The Spatial Distribution of Average Annual Bottom Dredging Fishing Effort (mW fishing hours) in the IHO North Sea Basin (2015-2018)



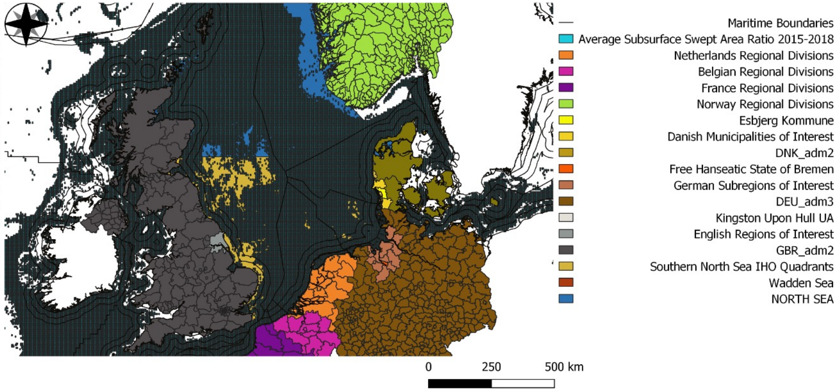
The Spatial Distribution of Average Annual Pelagic Trawls and Seines Fishing Effort (mW fishing hours) in the IHO North Sea Basin (2015-2018)



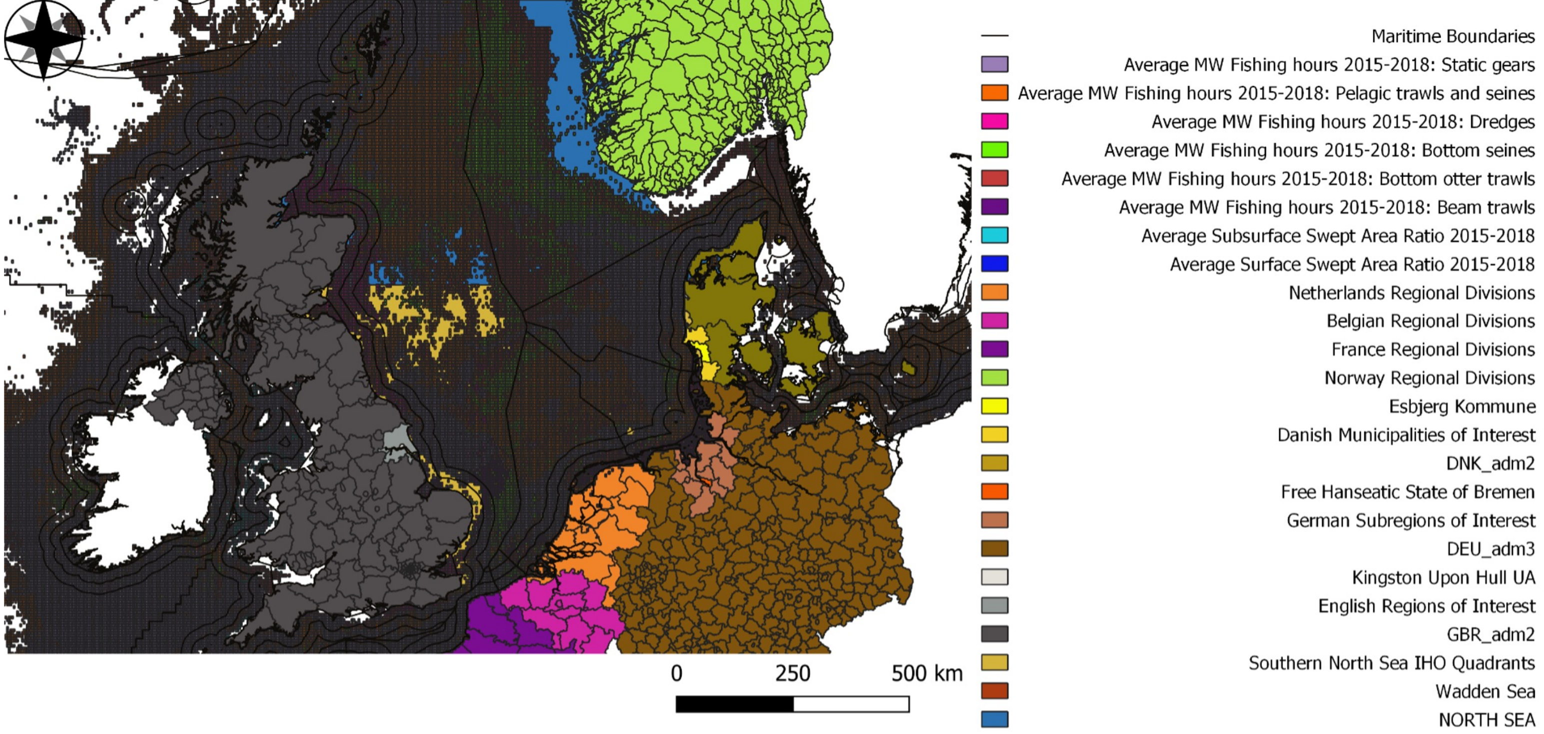
The Spatial Distribution of Average Annual Static Gears Fishing Effort (mW fishing hours) in the IHO North Sea Basin (2015-2018)



The Spatial Distribution of the Average Surface Swept Area Ratio in the IHO North Sea Basin (2015-2018)



The Spatial Distribution of the Average Subsurface Swept Area Ratio in the IHO North Sea Basin (2015-2018)

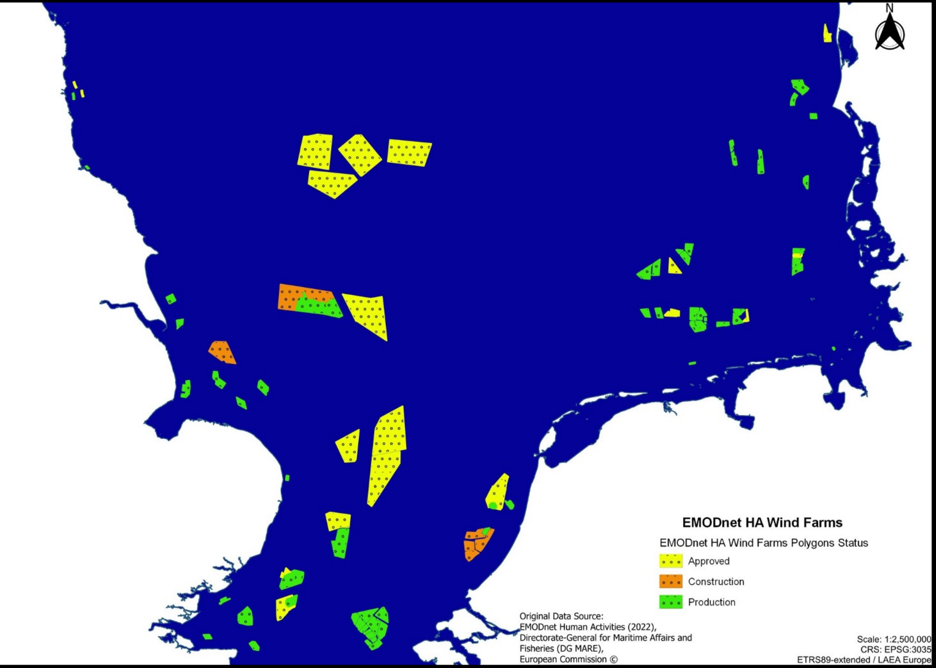


The Spatial Distribution of the Cumulative Surface-Swept Area Ratio, Subsurface-Swept Area Ratio and Average MW Fishing Hours across all Fishing Methods in the IHO North Sea Basin (2015-2018)

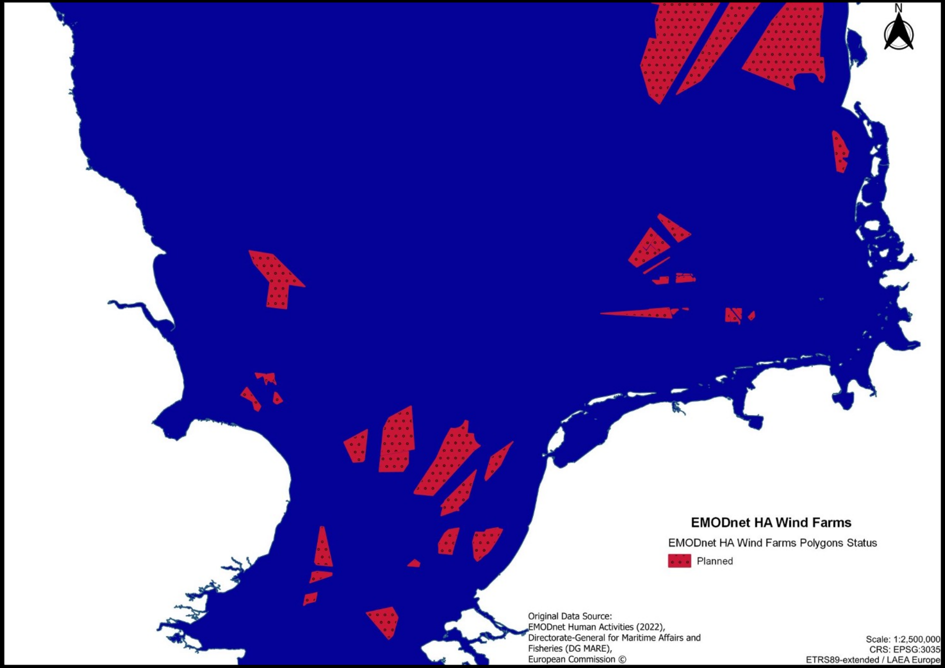
Dean Anthony Page
29/03/2022

SOUTHERN NORTH SEA OFFSHORE WIND FARMS

APPROVED, CONSTRUCTION AND PRODUCTION (2023)



PLANNED (2023)



SOUTHERN NORTH SEA OIL AND GAS WELLS (BOREHOLES) TIME-SERIES (1963-2020)

COMPARISON OF THE HIGHEST RESOLUTION OPEN ACCESS DTMS, DSMS AND POINT CLOUDS FOR THREE CASE STUDY SOUTHERN NORTH SEA PORT CITIES AND THE COPERNICUS SAR-DERIVED DEM: (1) KINGSTON-UPON-HULL; (2) BREMERHAVEN; (3) ESBJERG; (4) COPERNICUS EU DEM 1.1

	KINGSTON-UPON-HULL (ENGLAND) PROVIDER: ENVIRONMENT AGENCY TYPE: LiDAR	ESBJERG (DENMARK) PROVIDER: DATAFORSYNINGEN TYPE: LiDAR	BREMERHAVEN (GERMANY) PROVIDER: BUNDESAMT FÜR KARTOGRAPHIE UND GEODÄSIE TYPE: LiDAR	COPERNICUS DEM 1.1 (EUROPE) PROVIDER: EUROPEAN SPACE AGENCY/DEUTSCHES ZENTRUM FÜR LUFT- UND RAUMFAHRT
HIGHEST RESOLUTION FREELY-AVAILABLE LiDAR POINT CLOUD OR SYNTHETIC APERTURE RADAR-DERIVED DIGITAL TERRAIN/SURFACE MODELS AND BATHYMETRIC SURVEYS	**1m** (TERRESTRIAL POINT CLOUDS, FZ AND LZ DSM AND DTM) **2m** (SURFZONE DEM) **30m** (DEFRA MARINE DEM) **50cm** (MULTIBEAM ECHOSOUNDER	**0.05m** (POINT CLOUDS, FZ AND LZ DSM AND DTM) **50m** (DENMARK DEPTH MODEL)	**200m** (DTM ONLY) **50m** (GERMAN DEPTH MODEL) [RESTRICTED ACCESS: 1m DSM - ONLY FEDERAL AGENCIES 5m DTM - €279,000 10m DTM - €139,000 25m DTM - €54,000 50m DTM - €12,000]	**30m** (DSM ONLY) **1.25km-25km** (EMODNET BATHYMETRY)

ANALYSES OF NATIONAL AND SUBNATIONAL THEMATIC DATA USING LiDAR-DERIVED POINT CLOUDS/DSMs AS BASEMAPS FOR ENGLAND AND DENMARK

ENGLAND:

- HABITAT NETWORKS (2022)
- SALTMARSH CLASSIFICATION, EXTENT AND ZONATION (2022)
- RISK OF FLOODING FROM RIVERS AND SEAS (2022)
- WWNP FLOODPLAIN RECONNECTION POTENTIAL (2022)
- ORDNANCE SURVEY OPENMAP LOCAL (2022)
- MMO LICENSED AND UNLICENSED MARINE ACTIVITIES

DENMARK:

- HYDROLOGICAL ELEVATION MODEL (INCLUDING RUBBER BOOT INDEX FOR UP TO 7M RLSR)
- NATURE PROTECTION AREAS
- COASTAL PROXIMITY ZONES

5CM DANISH POINT CLOUD DATA COMBINED WITH AERIAL PHOTOGRAPHS INTO ORTHOMOSAICS

THE ROLE OF GEOSPATIAL TECHNOLOGIES AND TOOLS: AN EXEMPLAR OPEN-SOURCE FRAMEWORK

RDBMS

PROGRAMMING LANGUAGES

GIS/POINT CLOUD PROCESSING

2D/3D GRAPHICS MANIPULATION

THANK YOU!...

...AND HAPPY MAPPING!