



PASSport – Operational Platform managing a fleet of semi-autonomous drones exploiting GNSS high Accuracy and Authentication to improve Security & Safety in port areas,



Maritime University of Szczecin (MUS) together with Sistematica S.p.A. and PASSport partners

INVITE

to the seminar dedicated to output and conclusions about
PASSport validation campaign n#1 held in Kołobrzeg on 29.09.2022

Motivation: to present and discuss results achieved during validation campaign in Kołobrzeg Port where two subsystems of PASSport were validated

1. air and water pollution monitoring by multicopper drones
2. Mixed Reality decision making platform

Time: 10:00 at 14.12.2022

Venue: online

Agenda:

Time	Subject	Speaker
10:00 – 10:10	Welcome	Lucjan Gucma (Maritime University of Szczecin)
10.10 – 10.20	Keynote speech	Manuel Lopez Martinez (EUSPA)
10:20 – 10:35	PASSport project	Marco Nisi (Sistematica S.p.A.)
10:35 – 10.50	Kołobrzeg Port presentation	Artur Lijewski (CEO of Kołobrzeg Port Authority)
10:50 – 11:10	Presentation of the Mixed Reality system	Bartosz Muczyński (MUS)
11.10 – 11:30	Results of verification and validation	Lucjan Gucma (MUS)
11:30 – 12.00	Round table, next steps and Conclusion	Marco Nisi (Sistematica S.p.A.) & All

Organization details: seminar will be online. The Link will be sent after registration.

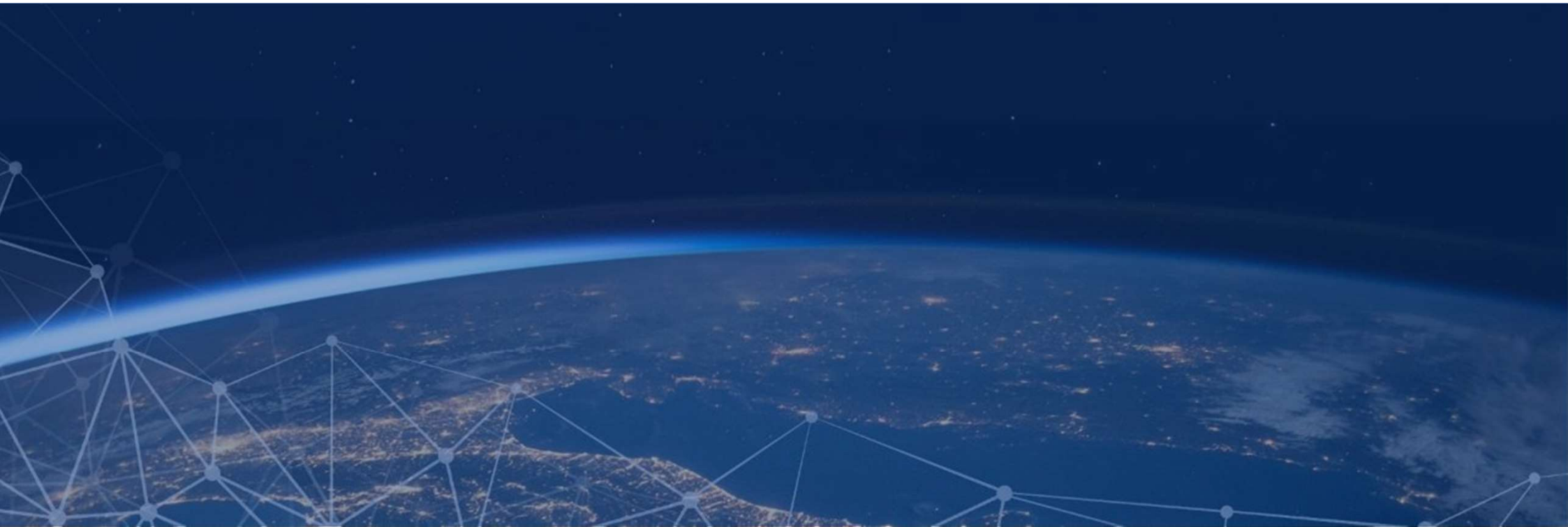
Registration: To register please send your details to: [Passport webinar](#)

PASSport project: PASSport (<https://h2020-passport.eu/>) is a solution based on a fleet of drones in various sea port case studies like monitoring, diagnostics, air and water pollution, anomalies detection, traffic monitoring



The team involved in Kolobrzeg campaign session in September 2022

PASSport project has received funding from the European Union Agency for the Space Programme (EUSPA), under the European Union's Horizon 2020 research and innovation programme (grant agreement No 101004234)



Open Service Navigation Message Authentication for drones

H2020 Passport Project Seminar

14th December 2022



A new EU Space Programme

EU space activities **under one umbrella**



Galileo

Global satellite navigation and positioning system (GNSS)

More than **2 billion Galileo receivers** worldwide



EGNOS

EGNOS "Makes navigation signals more accurate and trustable for Safety-critical applications"

Operational in **400+** airports & helipads in 23 countries



Copernicus

Earth Observation (EO), monitoring based on satellite & non-space data

Nr.1 world provider of space data and information (>20TB/day)



GOVSATCOM

Secure satellite communications for EU governmental actors

Rapid support over crisis areas



Others

Space Situational Awareness (SSA/SST)

Access to Space

Galileo Open Service Navigation Message Authentication (OSNMA)

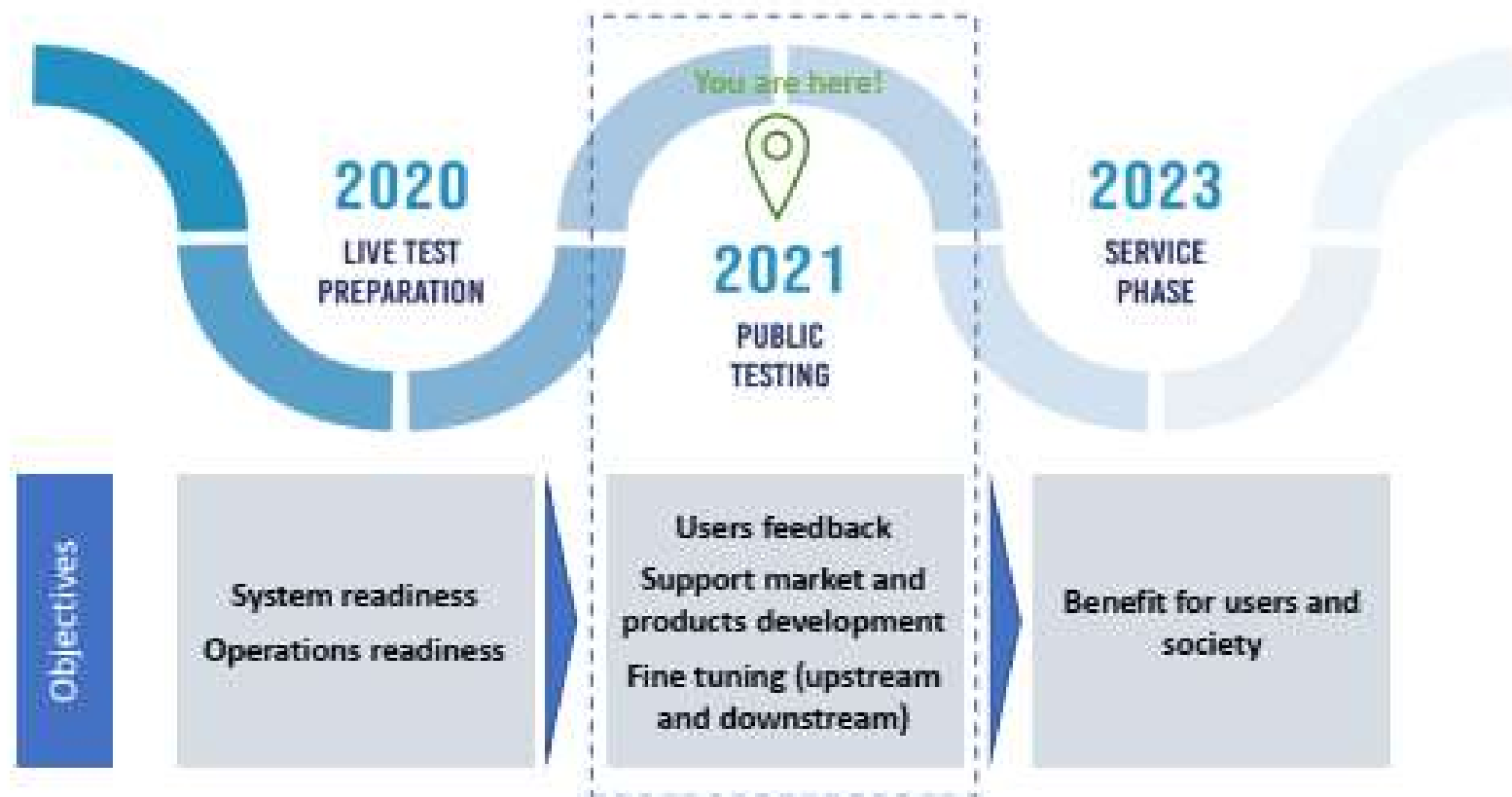


Overview of the **main characteristics of the service**, along with information on features such as **service levels, target performance, an implementation roadmap**, and an **overview of the target markets for the service**



https://www.gsc-europa.eu/sites/default/files/sites/all/files/Galileo_OSNMA_Info_Note.pdf

Galileo OSNMA roadmap



OSNMA provides an authenticated solution for U-space PVT



- Within the U-space regulation, **geo-awareness and geo-identification are mandatory so that:**
 - to avoid flight into areas in which the drone should not operate
 - to inform other drones where the drone is and how it intends to operate
- The regulation **requires sharing the PVT** from the drone (and manned aviation operating in U-space) **in real time** using an open and documented transmission protocol



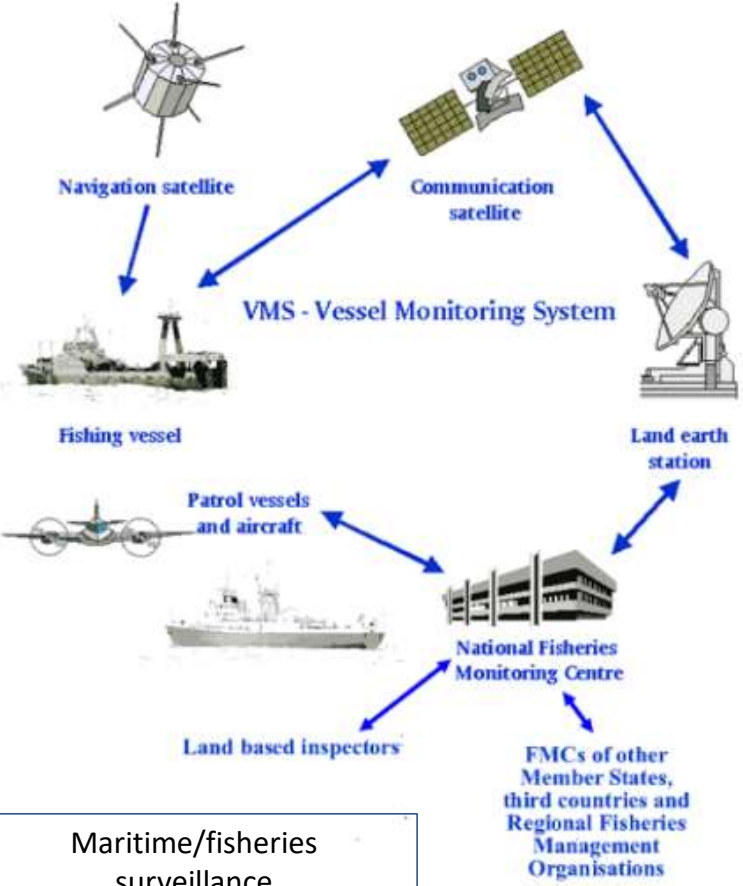
Calls for a trusted PVT

- Unlike manned aviation, drones **depend entirely on GNSS for PVT**
- A solution is needed to **secure end to end position reporting and mitigate risks from operations in the wrong place** (close to people / restricted areas).

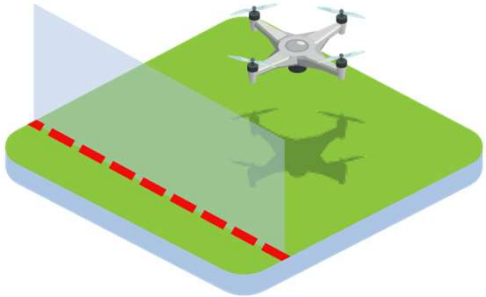


Regulations do not specify how PVT sharing should happen, what technology or what protocol should be used, opening an opportunity to integrate OSNMA

Galileo OS-NMA provides additional trust in drone position reporting: use cases



Port Surveillance



Airspace Infringement / E-Conspicuity

4D authentication of images -> Support to maritime, ports and fisheries surveillance

Authentication of the path for BVLOS operations

Next Steps

1. Proof of concept in real operational scenario for **authentication of the position for georeferenced images** used for surveillance, in cooperation with manufacturers and potential interested bodies
2. Demonstration of **authentication of the flight path for BVLOS**
3. Complete integration of **Galileo OS-NMA in commercial receivers and autopilot**
4. Definition of **contingency procedures in case of GNSS disruption.**
5. Development of **suitable open standards** to support exchange of positioning information in U-Space and interoperability with manned aviation



Thanks !

You can contact me at

Manuel.Lopezmartinez@euspa.europa.eu



The European Union Agency for the Space Programme is hiring!

Apply today and help shape the future of #EUSpace!

Ongoing prototyping of Galileo OS-NMA drone receivers and integration in autopilot



Two projects DEGEE and GEODESY targeting for commercial solution in a box.

Objectives

- Integrate OS-NMA in a receiver suitable for drone operation.
- Define contingency operational procedures in case of authentication failure.
- Contribute to standardization.



CERTIFLIGHT project: end to end integration of OS-NMA in flight tracking and georeferenced images



PASSport

Kolobrzeg campaign, September 29th 2022





Agenda

- The rationale for PASSport initiative
- The concept
- Drones, EGNSS, EO and MR as enabling technologies
- Use cases and Validation campaigns



PASSport

Operational Platform managing a fleet of semi-autonomous drones exploiting GNSS high Accuracy and Authentication to improve Security & Safety in port areas

• 2005/65/CE directive asking to complement surveillance systems for the whole port area. Around one thousand European ports fall within the scope of the directive.

To complement already operational platforms to support the recognition, management and analysis of safety and security aspects of daily operations

- Pollution monitoring (safety)
- Support to e-navigation (safety)
- Critical buildings/ Infrastructures protection (security)
- Protection against non-cooperative small craft approaching the port areas (security)
- Underwater threats monitoring (security)

Novelty: usage of a **fleet of semi-automated drones** integrating space based services (and other sensors) for a safe and efficient guidance, navigation and control (GNC) even in a challenging environment in presence of obstacles - including buildings and other ground assets - and potentially unfavorable weather conditions.



The concept

Copernicus



EGNOS



EGNSS (Galileo/ EGNOS)



Passport Aerial Segment (PAS)

External Operational interfaces

- Dintel
- Operator EMP
- Operator shiplocus

Passport Ground Segment (PGS)

- Passport Mission Element (PME)
- Passport Control Element (PCE)

Passport Underwater Segment (PUS)

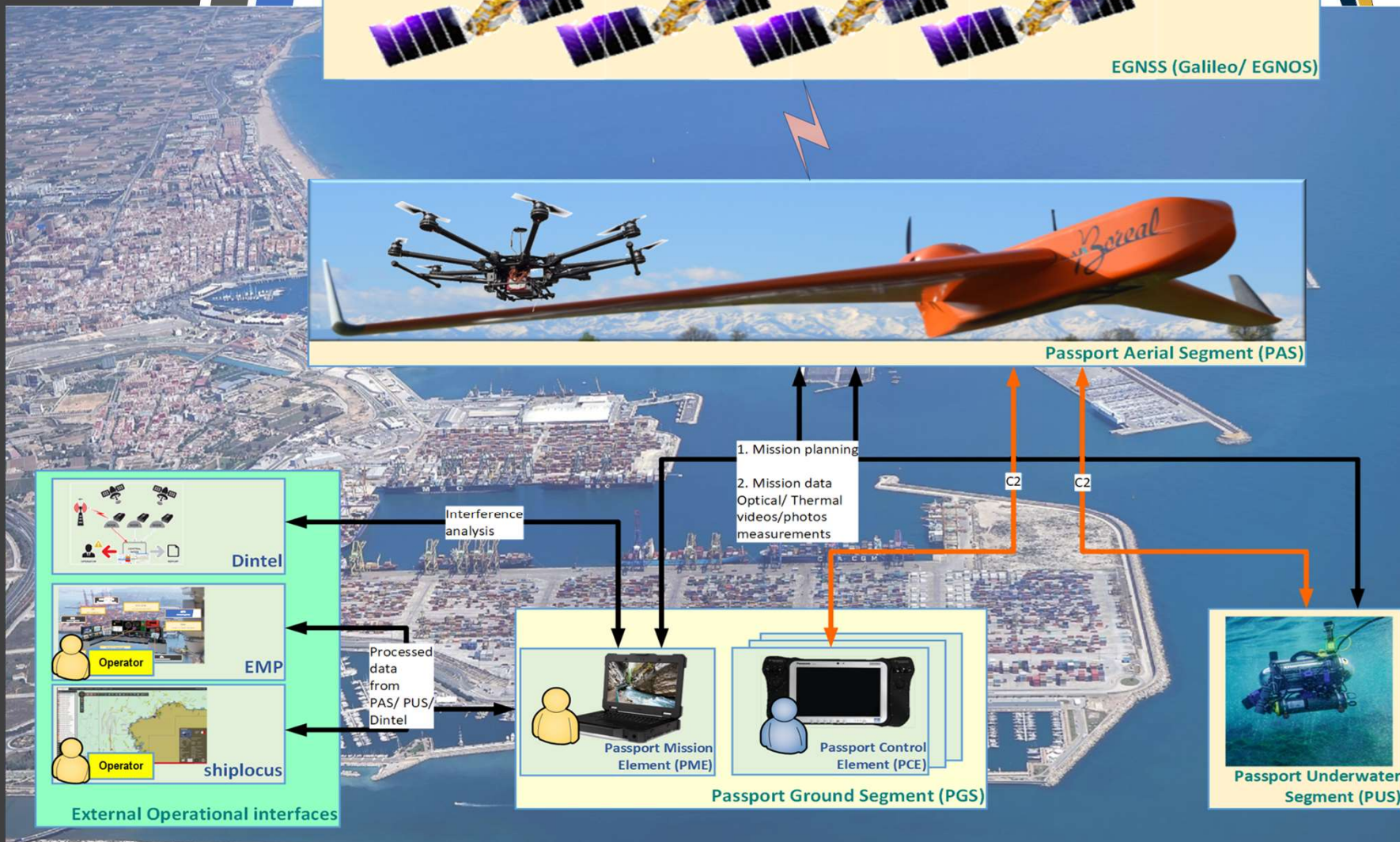
- 1. Mission planning
- 2. Mission data
Optical/ Thermal
videos/photos
measurements

Interference analysis

Processed data from PAS/ PUS/ Dintel

C2

C2



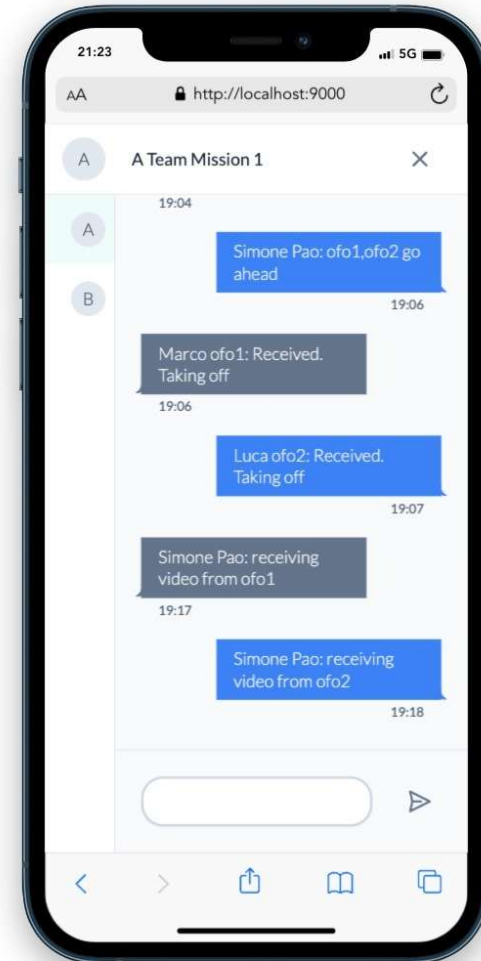
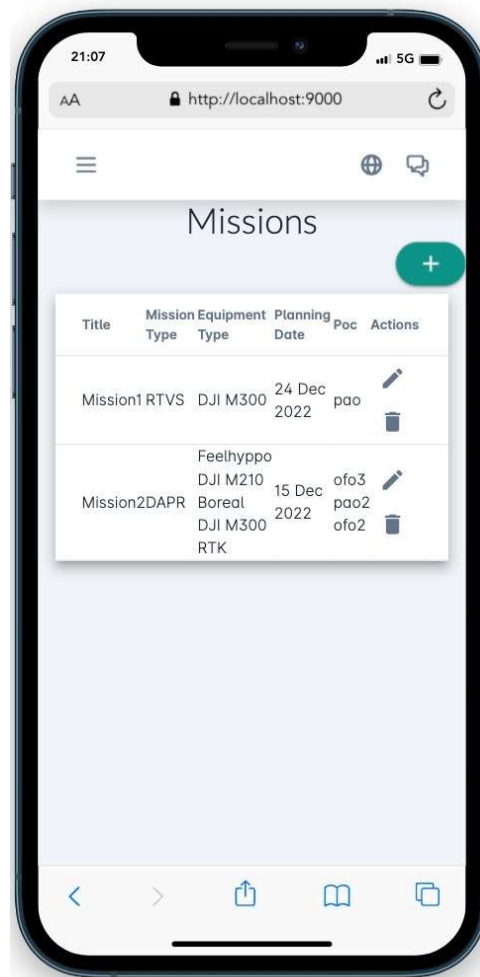
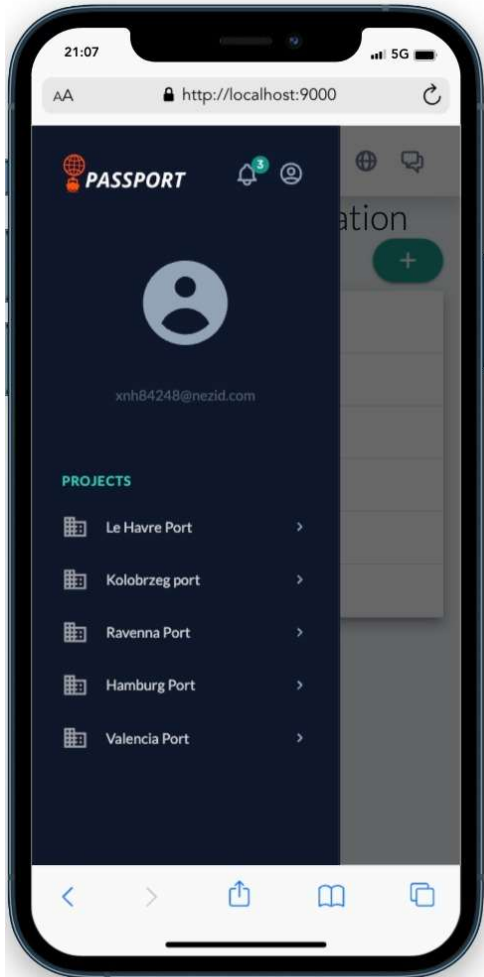
The PASSport platform: Platform Admin Operator (PAO)

The screenshot displays the PASSport Platform Admin Operator (PAO) interface. On the left is a dark sidebar menu with the following categories and items:

- CoC (Chain of Command)
 - Mission Planning
 - SecOps (Security Operations)
 - Config
 - Threats
 - Status
- DAPR (Data acquisition Processing and Reporting)
 - Data Acquisition
 - Data Processing
- RTVS (Real time Video Streaming)
 - Nodes Configuration
 - Video Streaming and Processing
- Home
- Archive
- View

The main dashboard area features a top navigation bar with the PASSPORT logo, a user profile for 'admin@localhost', and system management options like 'System Configuration' and 'User management'. Below this is a 'PROJECTS' section with a dropdown for 'Le Havre Port'. The central part of the dashboard contains two video feeds. The left feed shows a coastal scene with a 'boot 0.70' label, and the right feed shows a group of people with a 'boot 0.69' label. Below the video feeds is a gallery of 'Image/ Video' thumbnails. On the far right, there are communication icons and a 'PASSPORT' logo with a globe icon.

The PASSport platform: On field operator (OFO)



GNSS usage as enabling technology

- **GOAL:**

To use E-GNSS capabilities to contribute to **safety** (automated drones flying in a challenging environment) and **security** (image geo-referencing for surveillance analysis or the need of a robust and protected GNSS signal as input for GNC of the drones) for operations in ports.

E-GNSS can provide:

- **High accuracy:** E-GNSS can provide drones position very accurately, even in the level of centimetres depending on the technology used.
- **Integrity and reliability** of the solution is required not only for the safety of the operations but also as means of measuring the confidence in the correctness of the positioning information provided by the navigation system. The reliability on the RPAS position provided by the GNSS user terminal will be also very useful to increase the reliability of the images taken from the RPA.
- **Robustness against interferences or spoofing attacks.** The concern on GNSS interferences, mainly the intentional ones, recommends the use of GNSS solutions that are robust against interferences.

User requirement	GNSS contribution
Safe trajectory for automated RPAS	High accuracy (e.g. Galileo HAS, PPP)
Geo-localisation of detected target	Integrity (e.g. SBAS, HA with integrity)
System resilience	Signal authentication (e.g. Galileo OS-NMA) Interference detection (e.g. DINTEL)

HOW?



GNSS user terminal
(e.g. magicUT)

Interference
monitoring system
(DINTEL)

PASSPORT



- **GOAL:**

To use dedicated algorithm based on Copernicus data: wind detection and measurement, ship detection, air pollution estimation, port facility stability assessment

Earth
Observation
(EO) usage to
support port
operations'
monitoring

- **Maritime applications**

Sentinel-1 data for the **detection of ships** within Le Havre and Valencia port areas.

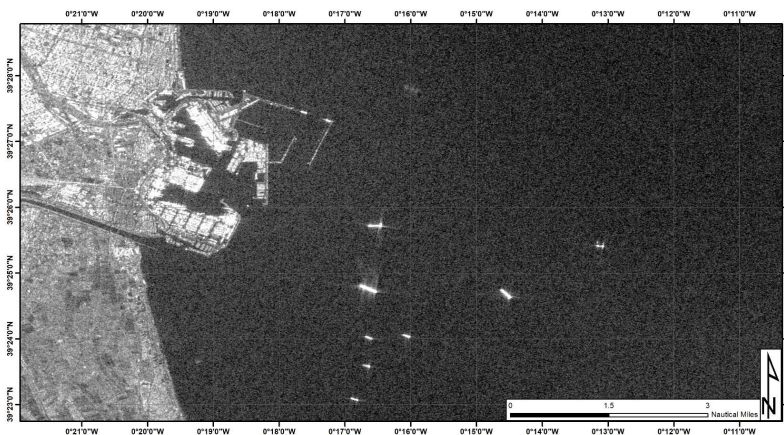
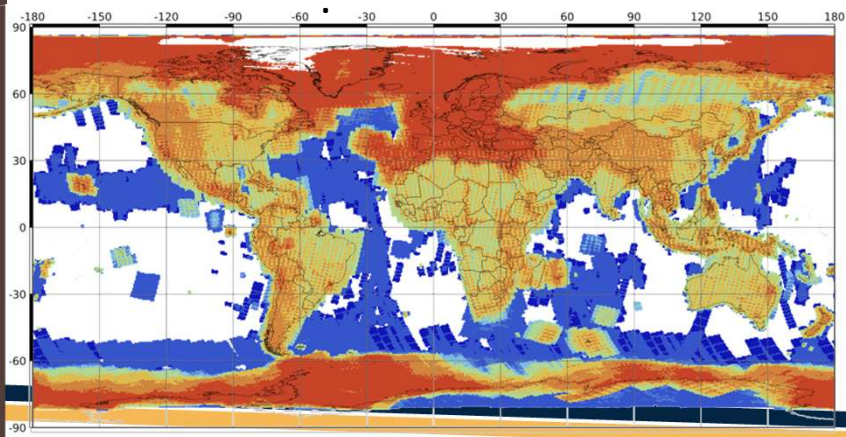
Sentinel-1 data for the assessment of the major **winds** within Ravenna and Le Havre port areas.

- **Terrestrial applications**

analysis of **EGMS interferometric data** for the assessment of the stability of Hamburg port facilities and infrastructures.

- **Athmosphere applications**

Sentinel-5p data for the Kołobrzeg **air/water quality** assessment



Mixed Reality device for drones' mission

- **GOAL:**

to increase **situational awareness and improve decision making** time by providing the user with real-time data from drones that are part of the system.

Use-cases:

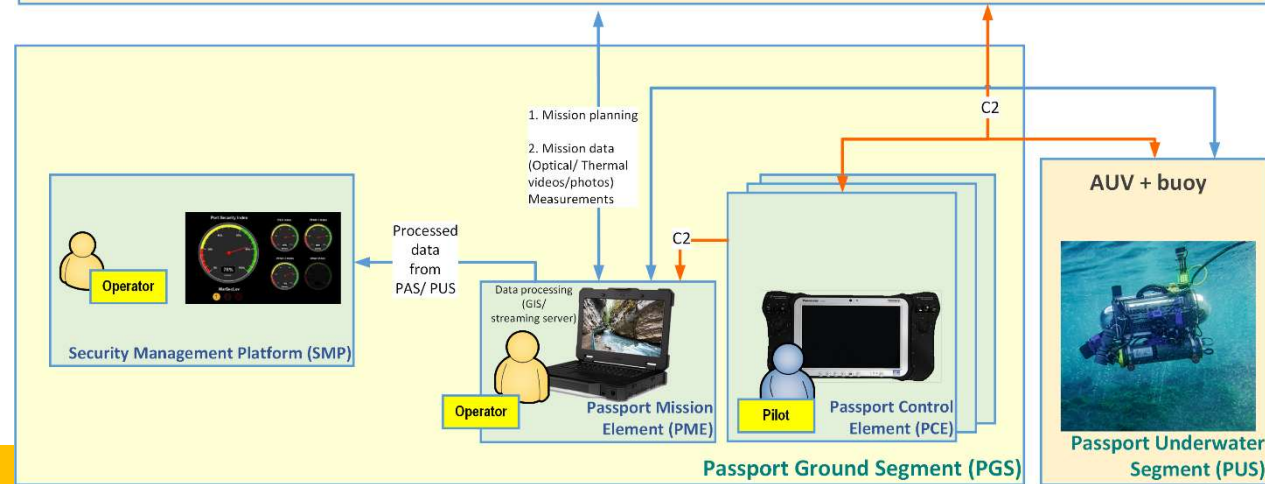
- Pollution detection where drone monitors discharged ballast waters or ships' emissions and measures level of SO₂. An immediate alert will be visible through the glasses with the identification of a polluter if a pollution is detected.
- Safety and security monitoring where immediate alert and video feed will be shown to the operator when a predefined criterium is met, e. g. movement detection (unauthorized entry to port facilities) or elevated building temperature (fire indication).



Ravenna campaign (2023/04)

Underwater threats monitoring (security)

- Underwater inspection and monitoring
- Bathymetry integrated with underwater inspection (ship/vessel and pier yard)
- Video for context awareness (semi-autonomous flight). Drone integrated with already existing CCTV
- Drone segment: self-charged drone + tethered (surveillance + communication relay)

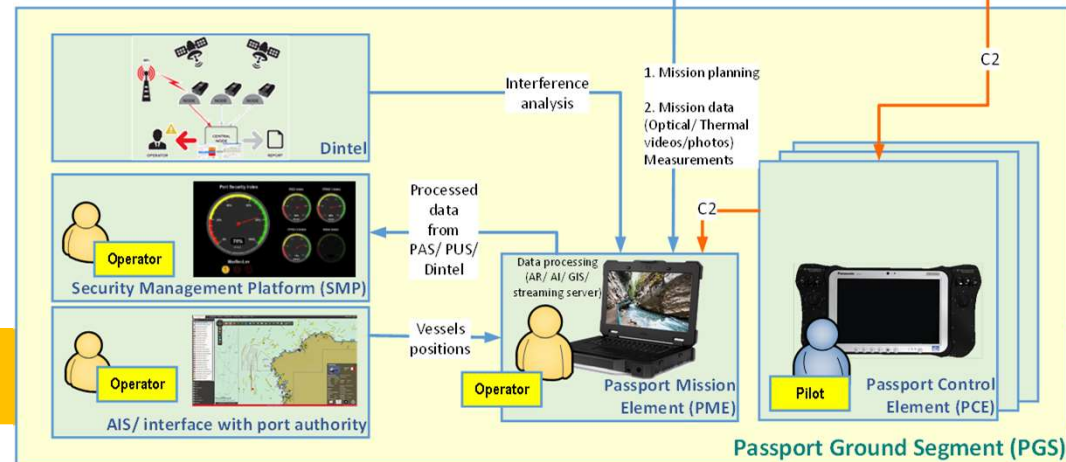
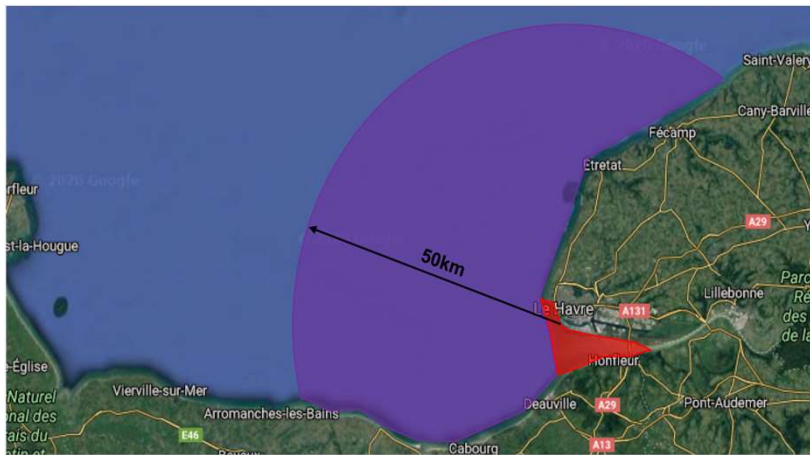




Le Havre (HAROPA) campaign (2023/05)

Protection against non-cooperative small craft approaching the port areas (security)

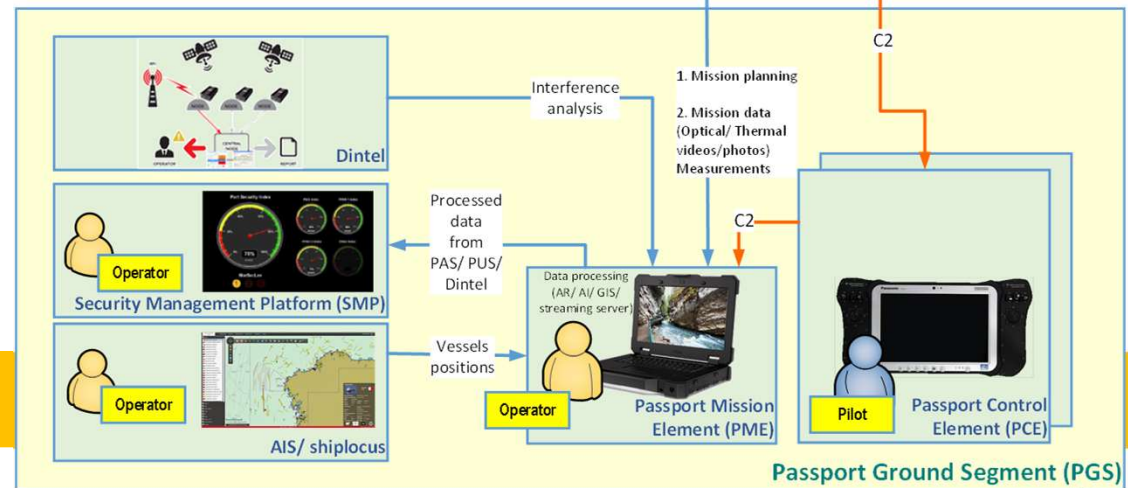
To assess operational contribution of RPAs in support to protection against non-cooperatives small crafts approaching the port areas. Migrant or activist semi-rigid inflatable boats, leisure boats with deliberate or undeliberate illicit behavior, should be consider as non-cooperative crafts.



Hamburg campaign (2023/07)

Critical Infrastructures protection (security)

- Sea side (vessel traffic monitoring) and ground side surveillance
- Non cooperative ships detection and location based on AI algos
- Ground side asset/ people detection and location based on AI algos
- GNSS interference detection
- Video for context awareness

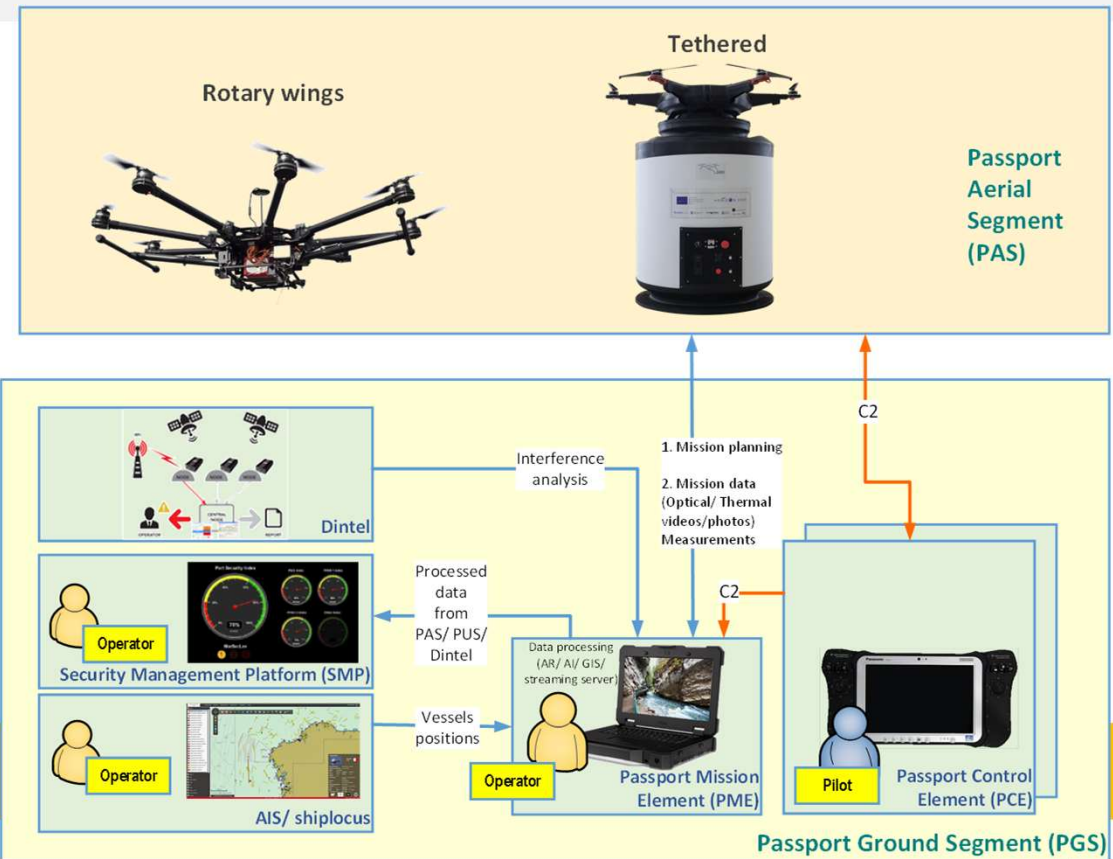




Valencia campaign (2023/09)

Support to e-navigation (safety)

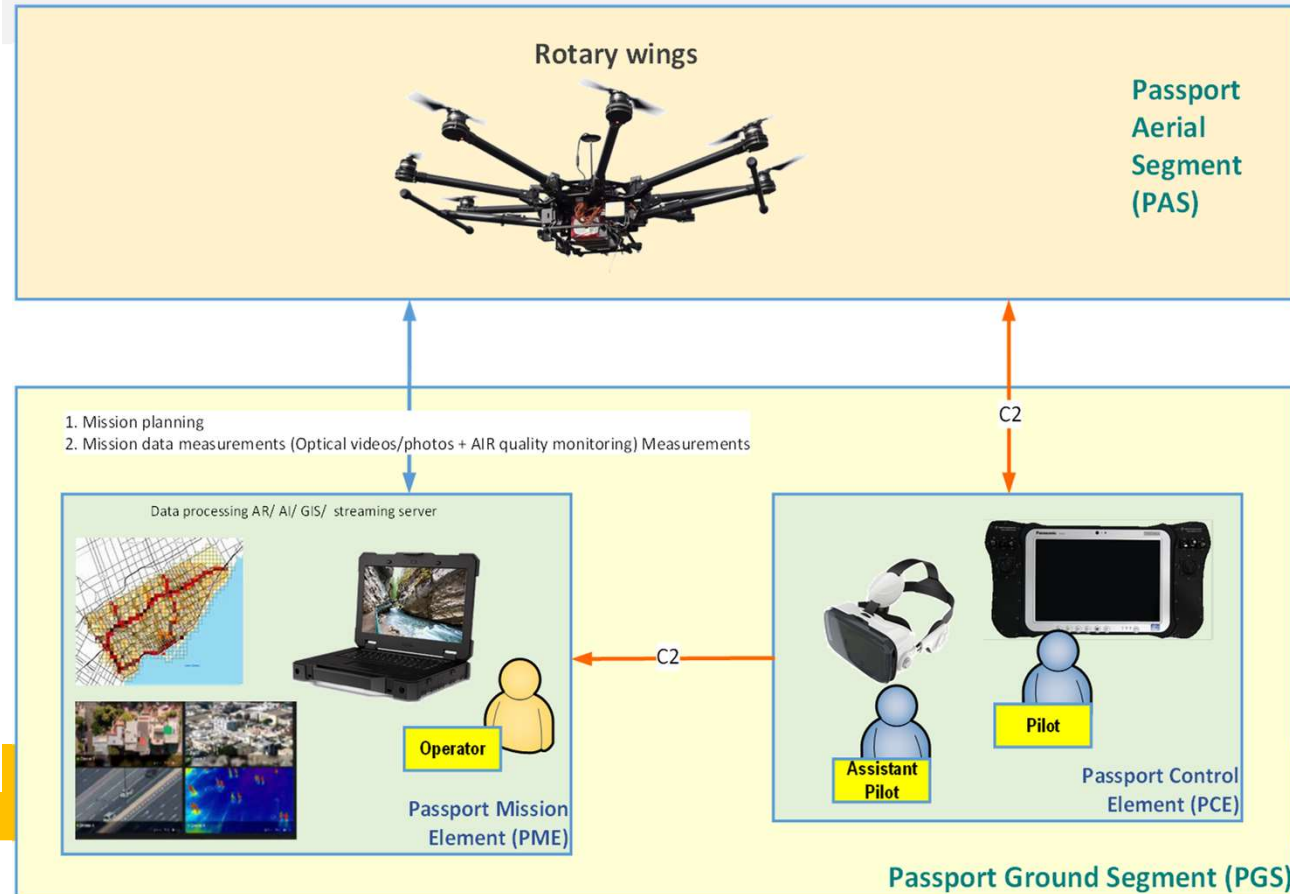
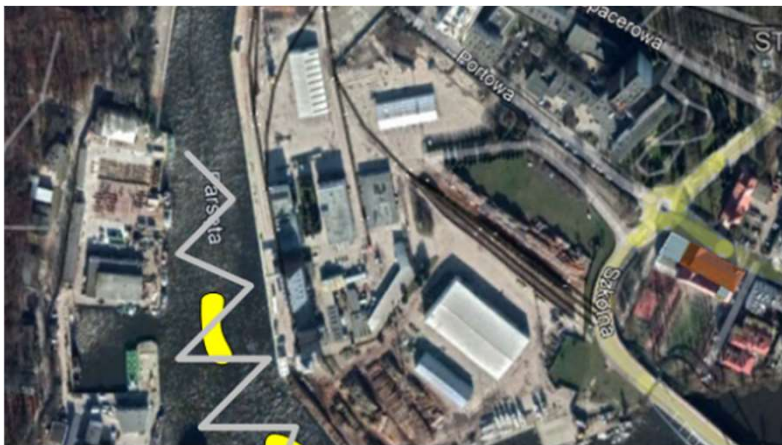
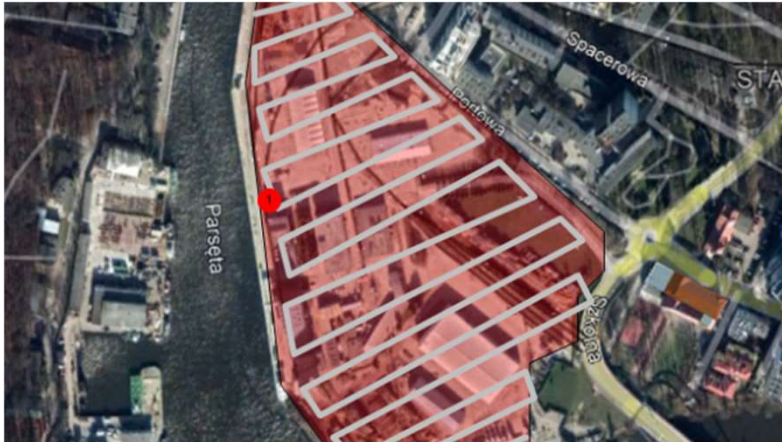
- Contribute to continuous real-time monitoring for ship arrival/departure to/from port.
- Detection of vessels with AIS disabled.
- Provide real-time information/data to support "Pilots" VTS.
- Ships monitoring in anchorage areas



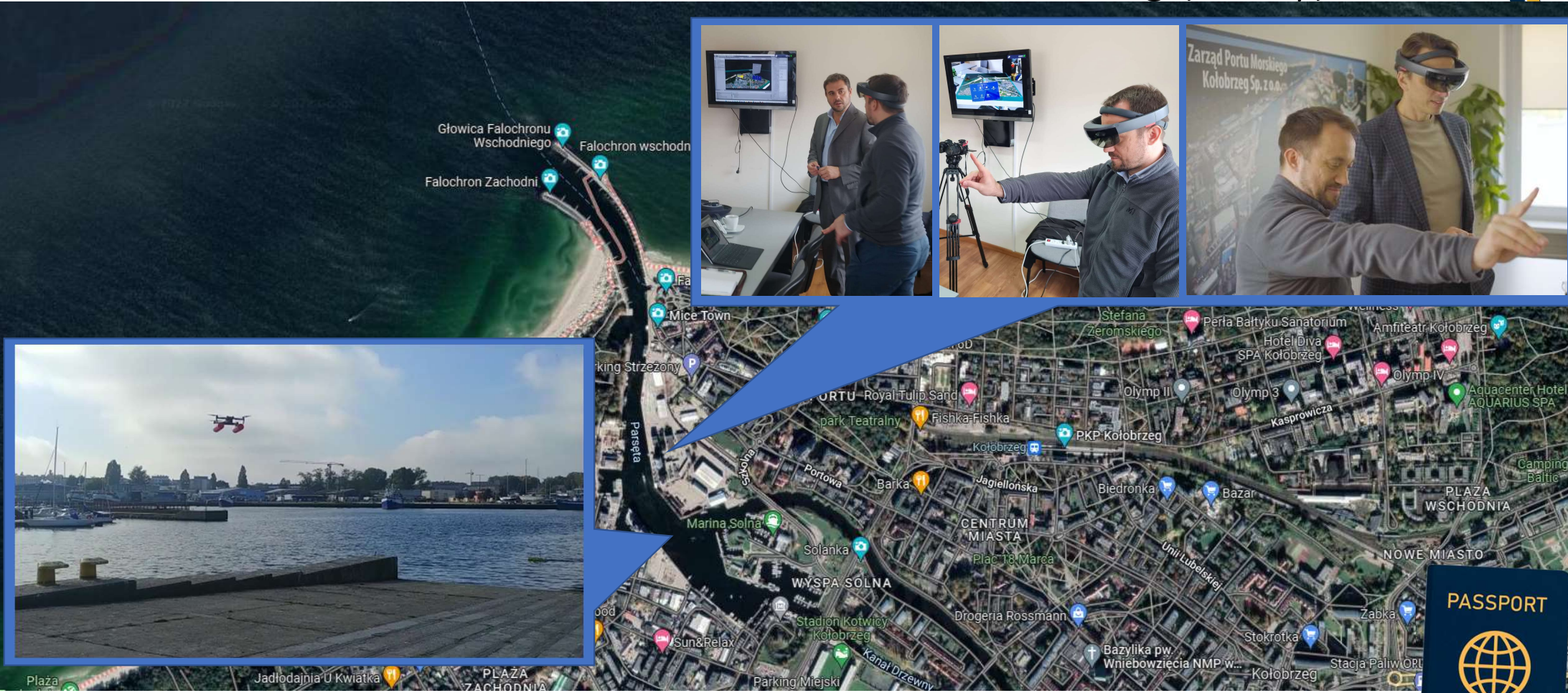
Kolozberg campaign (2022/09)

Air/water monitoring (safety)

- In situ (drone fleet) + global (Copernicus Sentinel 5P) quality parameters ingested on a GIS
- MR for real time mission control
- Video for context awareness



Kolozberg campaign (2022/09) Air/water monitoring (safety)



Promotion and Stakeholders perspectives gathering



H2020-PASSport
170 followers
10mo •

<https://lnkd.in/enKZr5pr>

Présentation du projet PASSport à la 11e édition des assises port Notamment, en présence des principaux ports français et du Min été présentée la campagne C4 qui se déroulera au port du Havre

Presentation of the PASSport project at the 11th edition of the as futur 2021. In particular, in the presence of the main French ports of the Sea, the C4 campaign was introduced which will be carried of Le Havre in May 2023

EUSPA - EU Agency for the Space Programme
#Galileo #Copernicus #drones #EGNSS

See translation



H2020-PASSport
170 followers
4mo • Edited •

Vancouver, May 17th 2022
International Association of Ports and Harbours (IAPH) conference for sustainability awards.
PASSport project has been awarded as winner in the category digitisation. What an achievement!
#port #GNSS #EO EUSPA - EU Agency for the Space Programme



BM Bergmann-Marine
4mo •

The H2020-PASSport Project has been presented th of Ports and Harbors (IAPH) Sustainability Award in BM Bergmann-Marine is one of the partner in the p



H2020-PASSport
170 followers
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PASSport consortium participated to the European Maritime Days in F #emd2022 arranging a conference panel to present current achievem future evolution for safety and security supporting port surveillance.

Look at the video here=> <https://lnkd.in/en4Kcj7z>

Special Thanks to all attendees => agenda in the first comment
EUSPA - EU Agency for the Space Programme



PASSport conference at European Maritime Days 2022
youtube.com

Kuala Lumpur, June 29th #IHMACONGRESS2022

What an inspiring technological panel today at the session chaired by capt. Jonathon Pearce and introduced by PIANC International president Francisco Esteban Lefler.

My speech about H2020-PASSport concluded the panel after the interesting presentations by capt. Ricky Rouse about automation subject and by Ingrid Römers introducing the drone's usage perspective and status of play in port of Rotterdam.

Thank again #IHMA for the given opportunity, EUSPA - EU Agency for the Space Programme cofunding the PASSport initiative and all PASSport partners providing as usual good quality contributions.



PASSPORT. 11me Assises port du futur. Novembre 2021
youtube.com





Thank you for your attention!

marco.nisi@grupposistemica.it



www.h2020-passport.eu

<https://www.linkedin.com/company/h2020-passport>

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<https://www.facebook.com/H2020-PASSport-100313468652600>

https://www.instagram.com/h2020_passport/

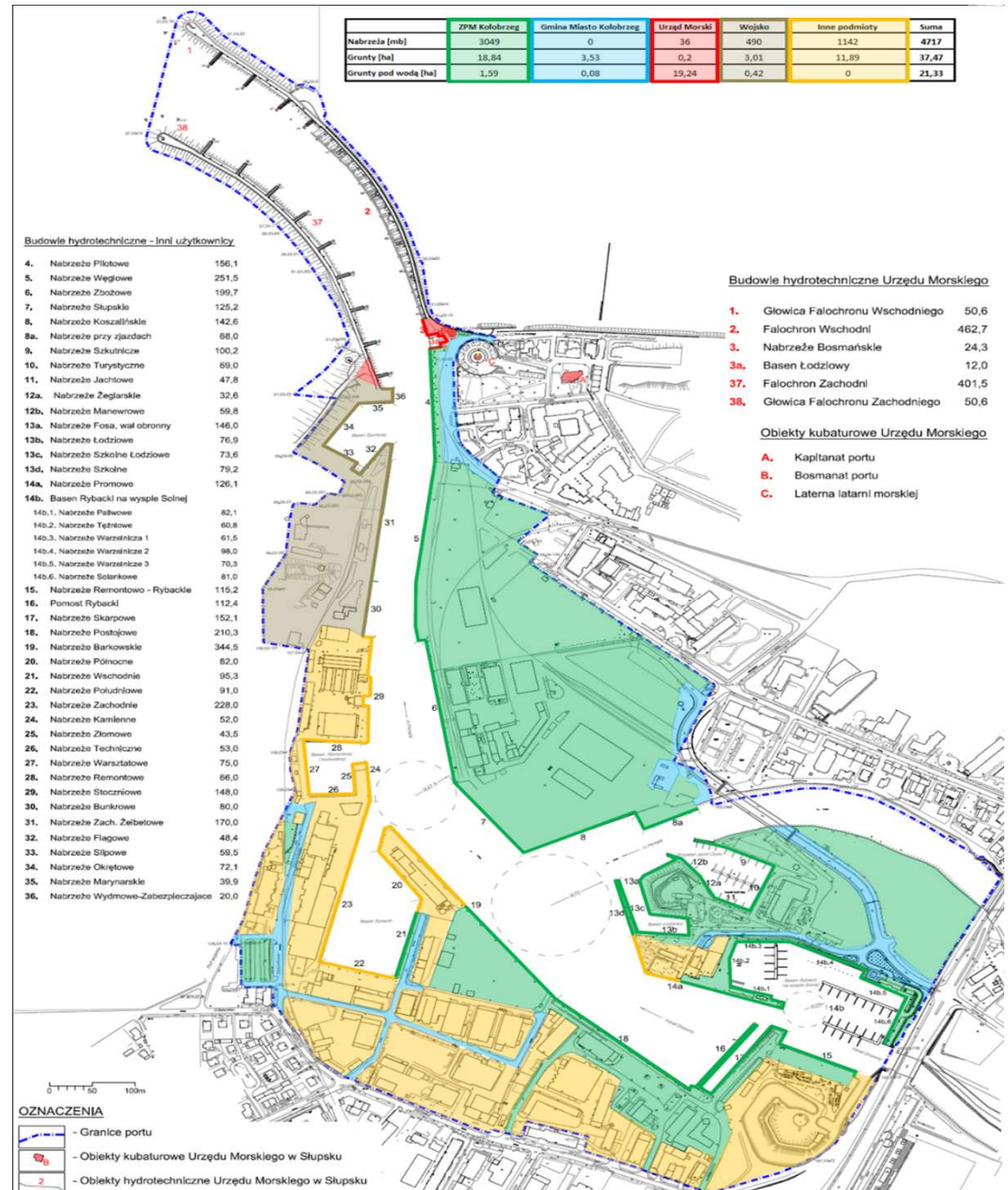


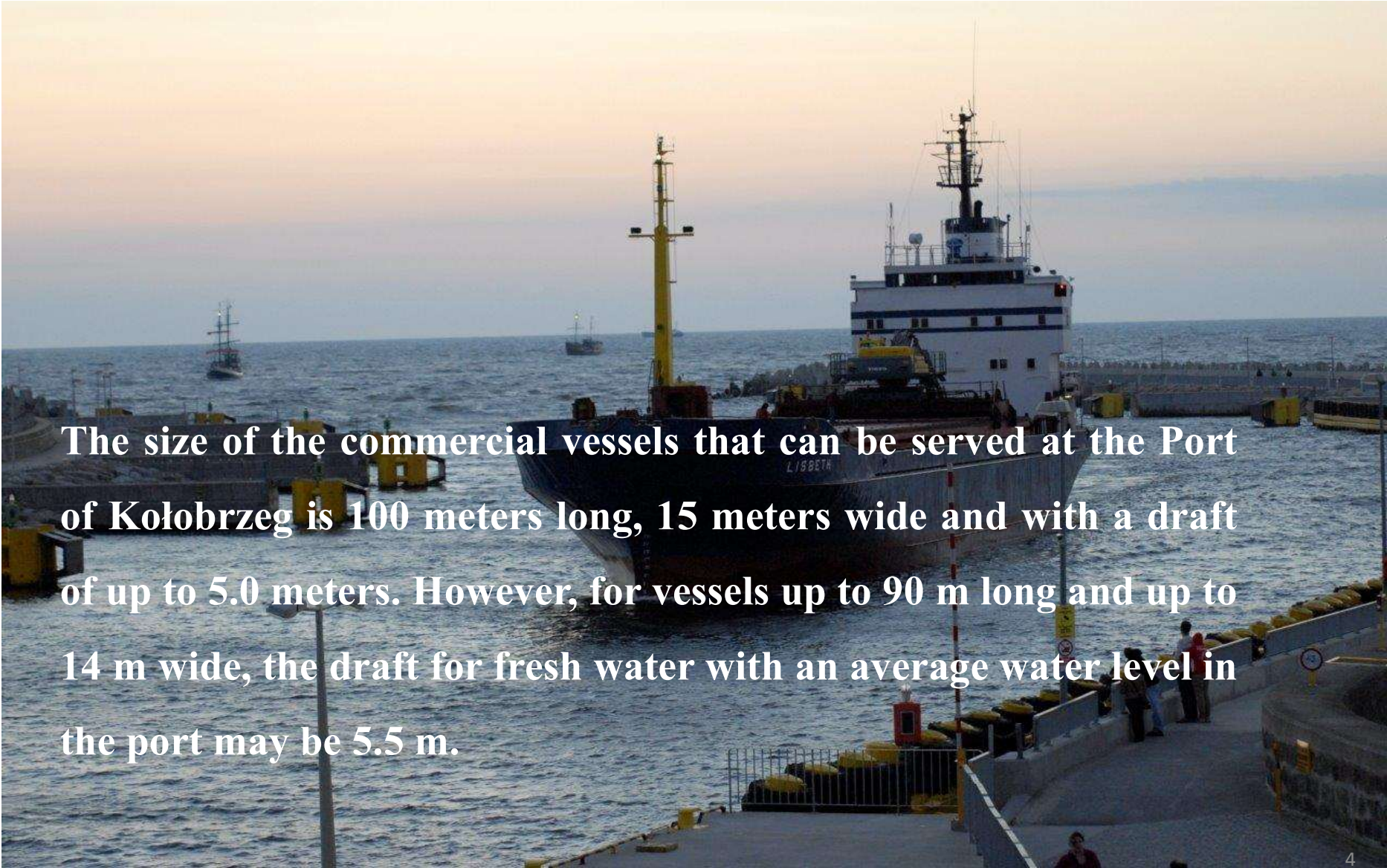
Kołobrzeg - december 2022

Who we are?

- after the transformation in our country, the government didn't have any specific plans concerning small ports;
- an act was introduced which enabled the local communities to manage their port independently;
- in that time we didn't have any good practices in the maintenance and management of port infrastructure;
- from 2017, according to the EU directive, financial support can only be provided by ports in the TEN-T network;
- we did not have enough physical resources for expansion and modernization of port infrastructure;
- as a result of our initiative, the act was amended and since 2019 we have been running a business in the field of cargo reloading;
- each year we reloaded over two hundred thousand various types of loads – we still develop this branch of business.

The administrative boundaries of the Port of Kołobrzeg cover 58.8 ha, of which: 21.3 ha are areas under water, and 37.5 ha are areas on land approximately 50% of the land area is under of Kołobrzeg Sea Port Authority. The total length of the quays at the Port of Kołobrzeg is: 4 717 metres. Kołobrzeg Sea Port Authority manages the quays with a total length of 3,049 m, which constitutes 65% of all quays in the port.

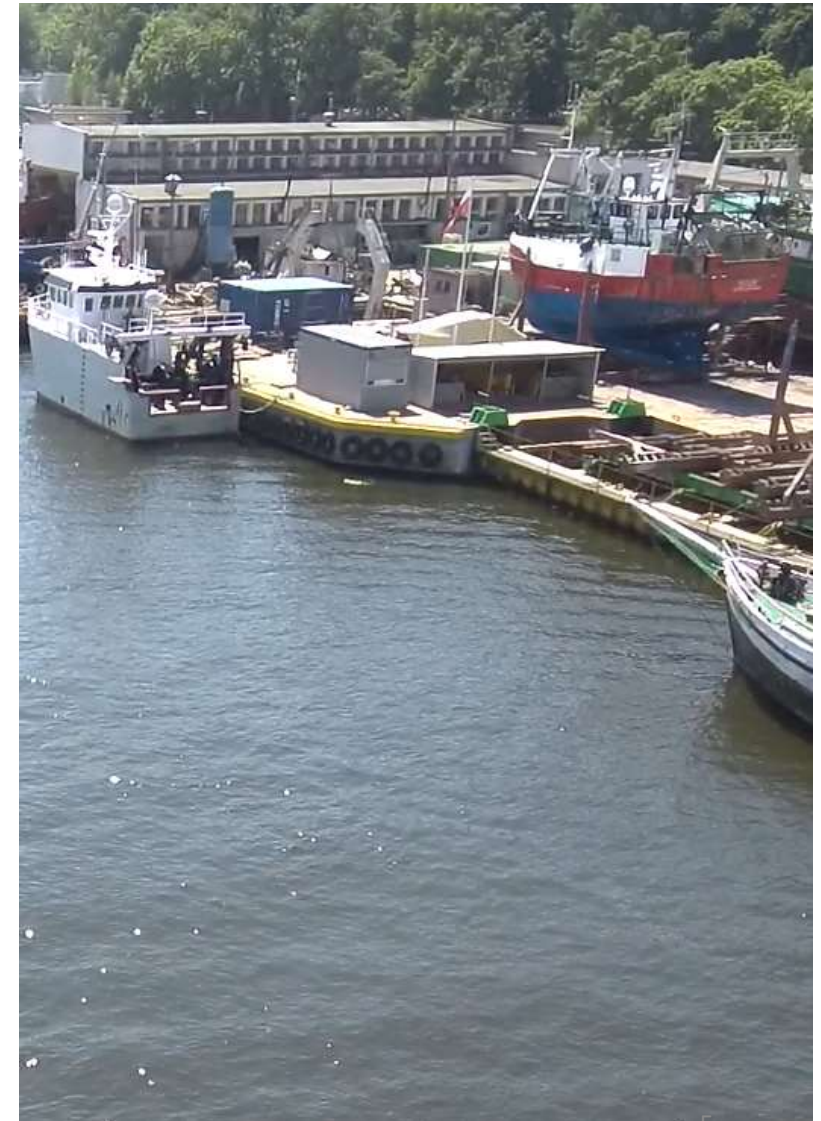


A large commercial vessel, likely a cargo ship, is docked at a port. The ship is white with a dark hull and has a yellow crane on its deck. The name 'L/B BETA' is visible on the side of the hull. The ship is docked at a pier with yellow fenders. In the background, other ships are visible on the water, and the sky is a mix of orange and blue, suggesting sunset or sunrise. The text is overlaid on the image in a white, bold font.

The size of the commercial vessels that can be served at the Port of Kołobrzeg is 100 meters long, 15 meters wide and with a draft of up to 5.0 meters. However, for vessels up to 90 m long and up to 14 m wide, the draft for fresh water with an average water level in the port may be 5.5 m.

Potential:

- transport accessibility (S6, S11, railway, close proximity to the airport)
- Rich scientific background in the Koszalin and Szczecin centers



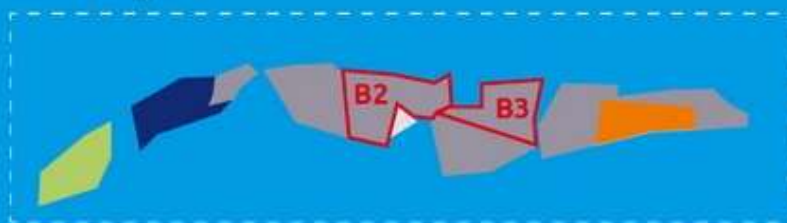
Farmy wiatrowe



Ławica Odrzana



Ławica Słupska



Ławica Środkowa



-  Wnioski złożone w listopadzie 2021 roku
-  Wnioski złożone 26 stycznia 2022 roku
-  Wniosek złożony 2 lutego 2022 roku
-  Wniosek złożony 9 lutego 2022 roku
-  B1 projekt Baltica 1 o mocy ok. 1 GW, realizowany przez PGE
-  B2 i B3 Projekt Morskiej Farmy Wiatrowej Baltica o mocy 2,5 GW, realizowany przez PGE

Kołobrzeg

Ustka

Łeba

Władysławowo

Gdynia

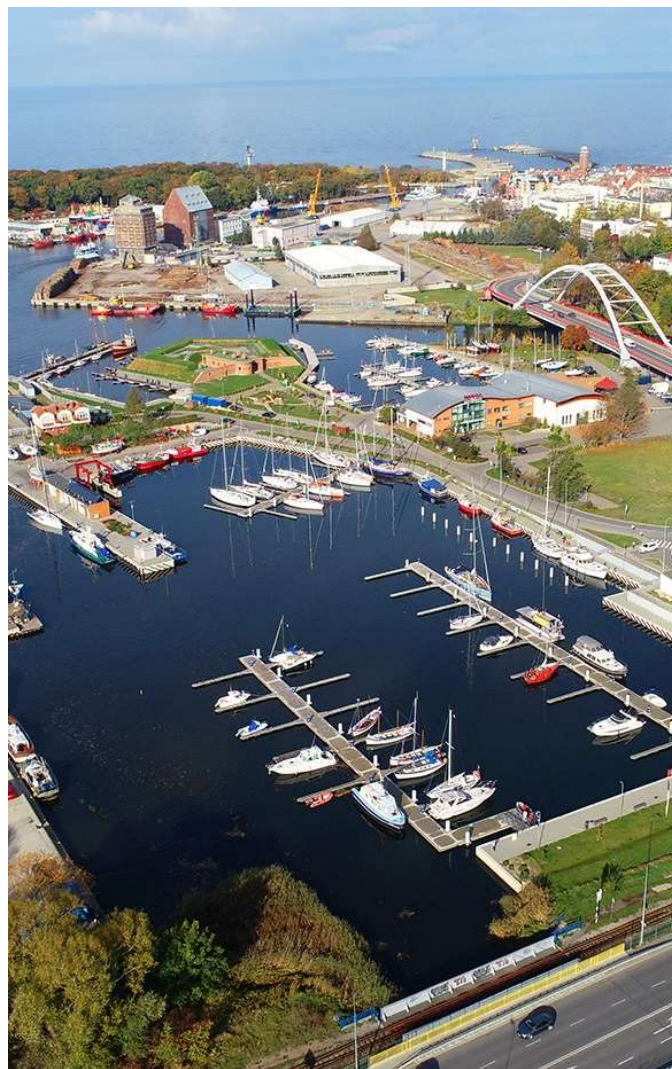
Gdańsk

Infrastructure on the day of establishing the Kołobrzeg Sea Port Administration in 2000

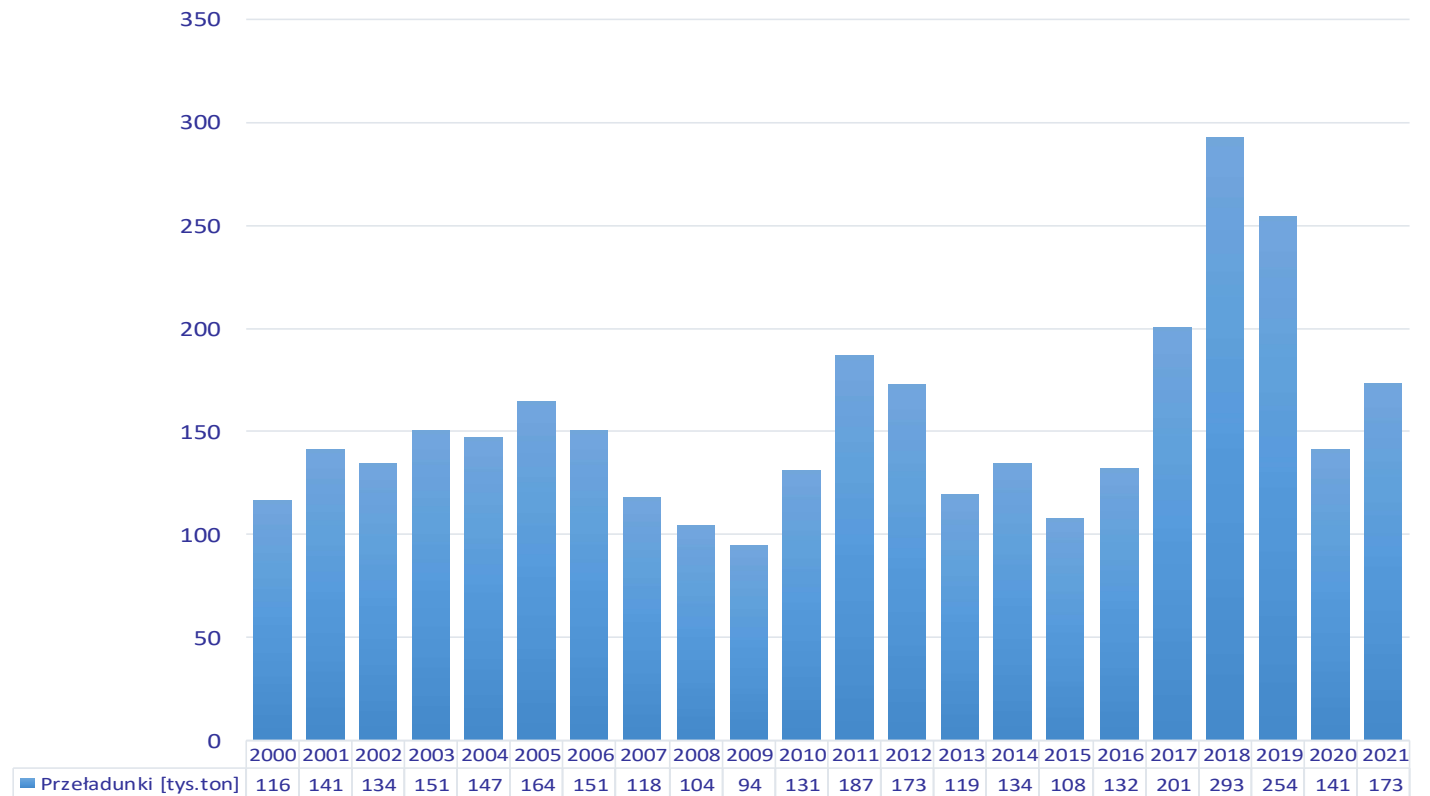


Investments in the Sea Port of Kołobrzeg

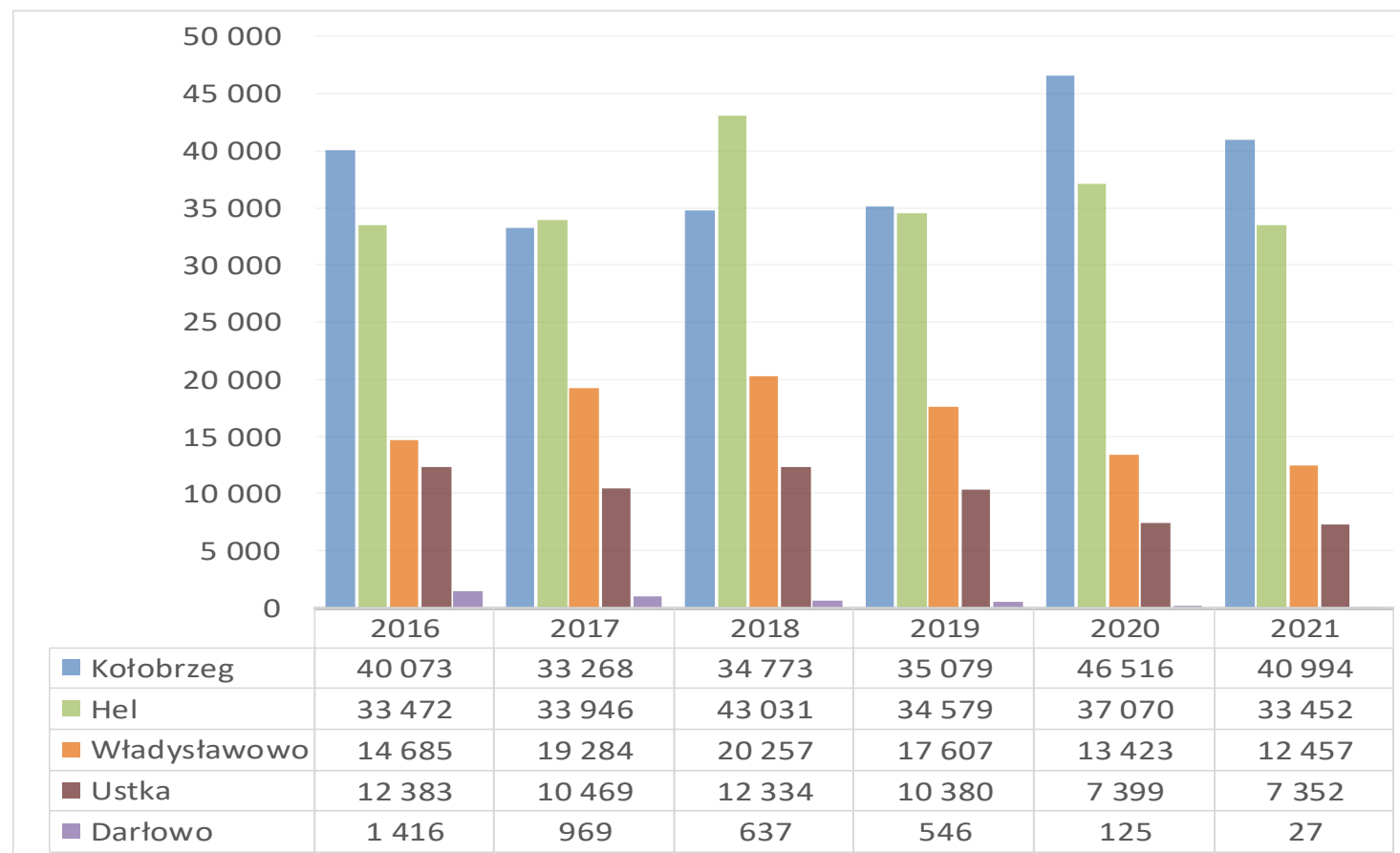
L.p.	Tytuł zadania	kwota zadania brutto	okres realizacji
1.	Modernizacja Portu Rybackiego w Kołobrzegu – Etap I	24 334 950,82 zł	2006 - 2007
2.	Modernizacja Portu Rybackiego w Kołobrzegu – Etap IV	5 381 129,64 zł	2007 - 2008
3.	Wyposażenie Portu Rybackiego w Kołobrzegu - Etap I	194 973,00 zł	2010
4.	System monitoringu w Porcie Rybackim Kołobrzeg	502 950,00 zł	2010
5.	Modernizacja instalacji elektrycznej na nabrzeżu Wschodnim w Porcie Rybackim w Kołobrzegu	87 762,00 zł	2010
6.	Modernizacja systemu odbojnic przy Nabrzeżu Wschodnim w Porcie Rybackim w Kołobrzegu	188 065,00 zł	2010
7.	Przeciwdziałanie zanieczyszczeniom w Porcie Rybackim w Kołobrzegu	113 126,00 zł	2010
8.	Przebudowa Pomostu Rybackiego w Porcie Rybackim w Kołobrzegu wraz z reorganizacją ruchu na terenie Portu Rybackiego Kołobrzeg	1 558 130,00 zł	2010 - 2011
9.	Innowacyjne rozwiązania w Porcie Rybackim Kołobrzeg	1 274 125,00 zł	2011
10.	Wymiana opraw elektrycznych w Porcie Rybackim Kołobrzeg	127 285,00 zł	2011
11.	Wyposażenie Nabrzeża Remontowego w Porcie Rybackim Kołobrzeg	802 607,00 zł	2011 - 2013
12.	Remont Basenu Łodziowego pod potrzeby jednostek rybackich w porcie Kołobrzeg	2 402 785,00 zł	2012 - 2013
13.	Modernizacja instalacji sanitarnej w boksach rybackich	185 696,00 zł	2011
14.	Udostępnienie falochronu wschodniego w Porcie Kołobrzeg	218 427,58 zł	2012
15.	Montaż odbojnic pochłaniających energię kinetyczną wraz z modernizacją nabrzeża	6 096 190,00 zł	2014 - 2015
16.	Modernizacja Portu Jachtowego w Kołobrzegu etap I	10 019 100,43 zł	2011
17.	Promocja Portu Jachtowego w Kołobrzegu	140 221,00 zł	2013
18.	Renowacja zabytkowych wrót Reduty Morast w Porcie Kołobrzeg	62 552,00 zł	2013
19.	Rzeźba Rybaka i Rybaczki w Porcie Rybackim Kołobrzeg	187 695,00 zł	2013
20.	Modernizacja systemu odbojnic przy Nabrzeżu Pilotowym w Porcie Kołobrzeg	374 084,77 zł	2014
21.	Budowa basenu rybackiego na Wyspie Solnej w Porcie Rybackim Kołobrzeg	17 061 488,00 zł	2014 - 2015
22.	Wzrost atrakcyjności zasobów kultury Pomorza Zachodniego poprzez przeprowadzenie prac konserwatorskich i restauratorskich przy Reducie Morast w Kołobrzegu – cennym zabytku na Zachodniopomorskim Szlaku Żeglarskim	5 773 964,04 zł	2018
23.	Ekspozycja historii dziejów Wyspy Solnej w Kołobrzegu	356 355,60 zł	2019-2020
24.	Poszerzenie oferty historycznej zabytkowej Reduty Morast w Kołobrzegu	17 100,00 zł	2019
25.	Działania na rzecz ochrony przed klusownikami w Porcie Kołobrzeg	63 222,00 zł	2019
RAZEM		77 523 984,88 zł	



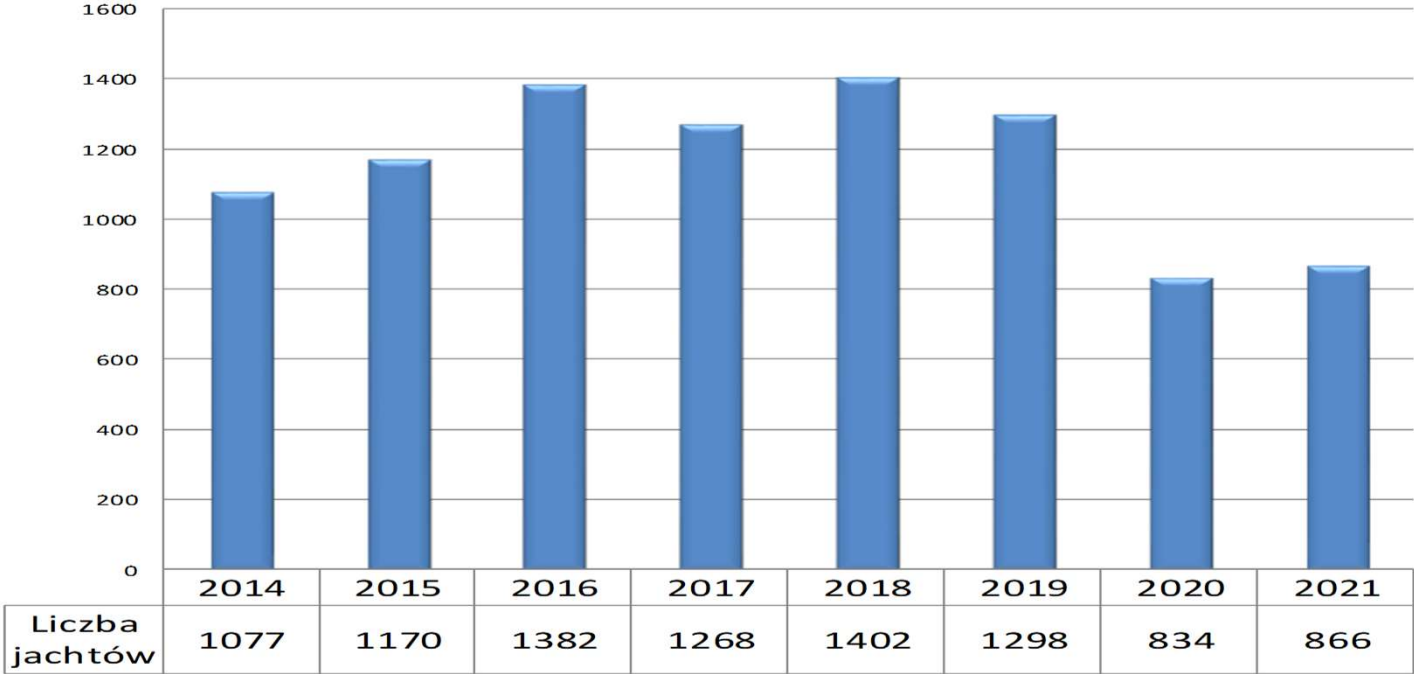
The volume of transshipments in the years 2000-2021



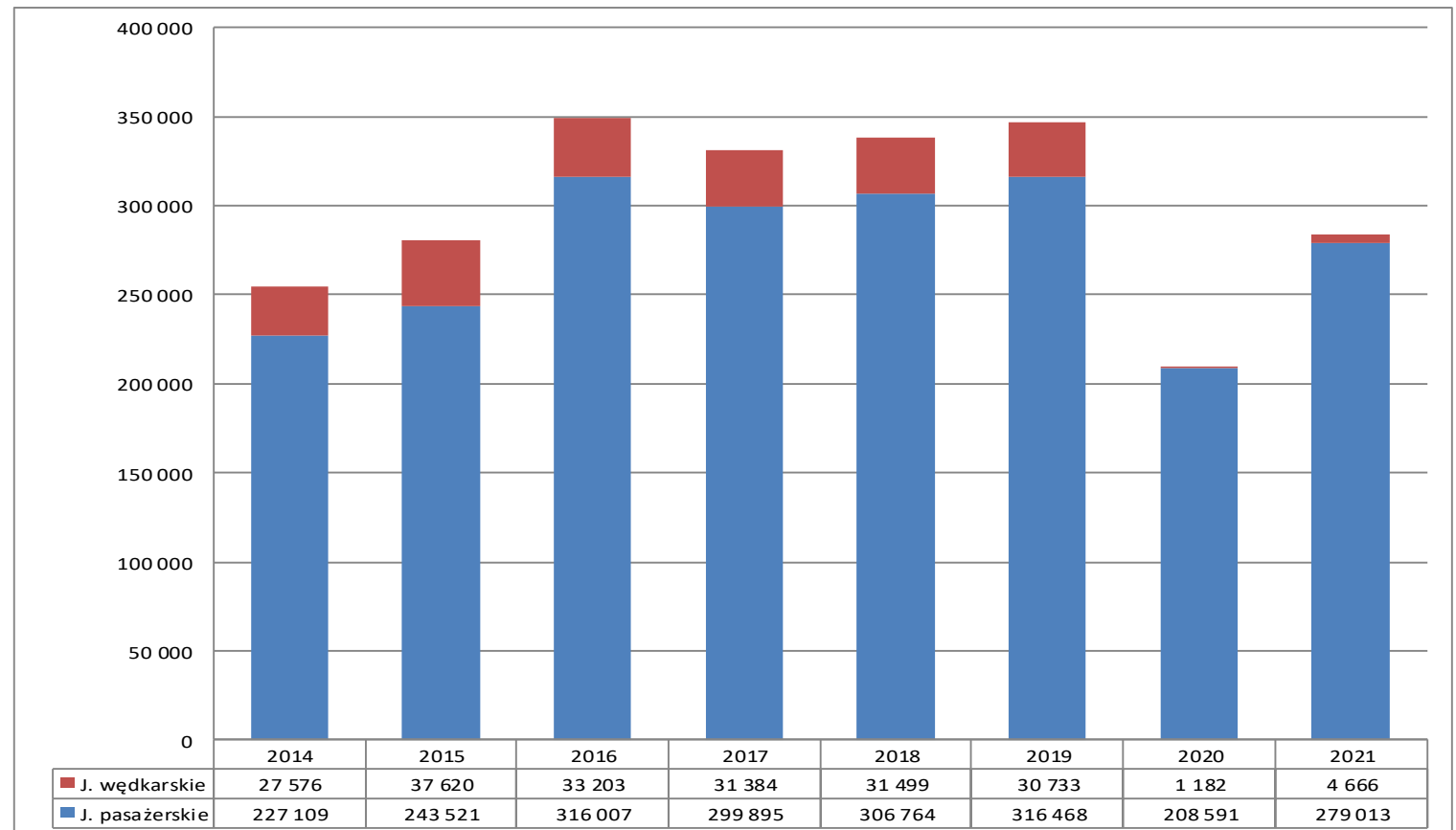
Transshipments of fish in Polish ports in 2016-2021



The number of yachts in the years 2014-2021



Number of passengers in 2014-2021



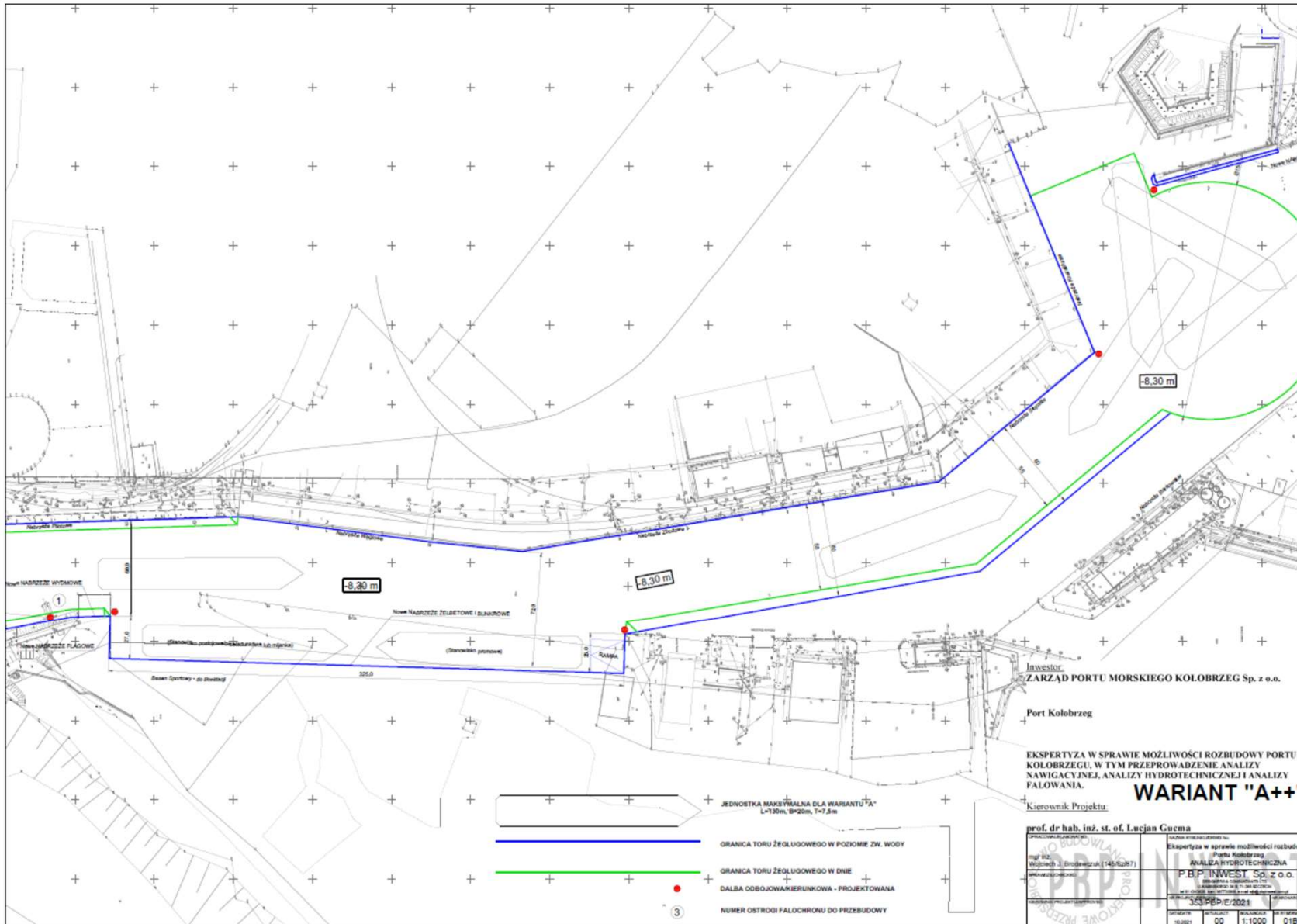
Needs:

- investment to become more than a fully operating
- construction of the quay on the side of the military port
- We are currently looking for sources of finance to modernize the quay
- The cost of modernization we calculate at approximately 11 mln euro



Additionally:

- the maintenance of the fairway is on the side of the Polish State
- we are in the process of modernizing the quay and the square to dedicated for wind farms functions



The widening of the fairway will allow the entry into the port of ships with the maximum parameters of:

Length: 130 meters

Width: 20 meters

Draft: 7.5 meters

The development of the wind farms is crucial for our region, because it brings an opportunity to change this mono-industry region, which now profits only from tourism.



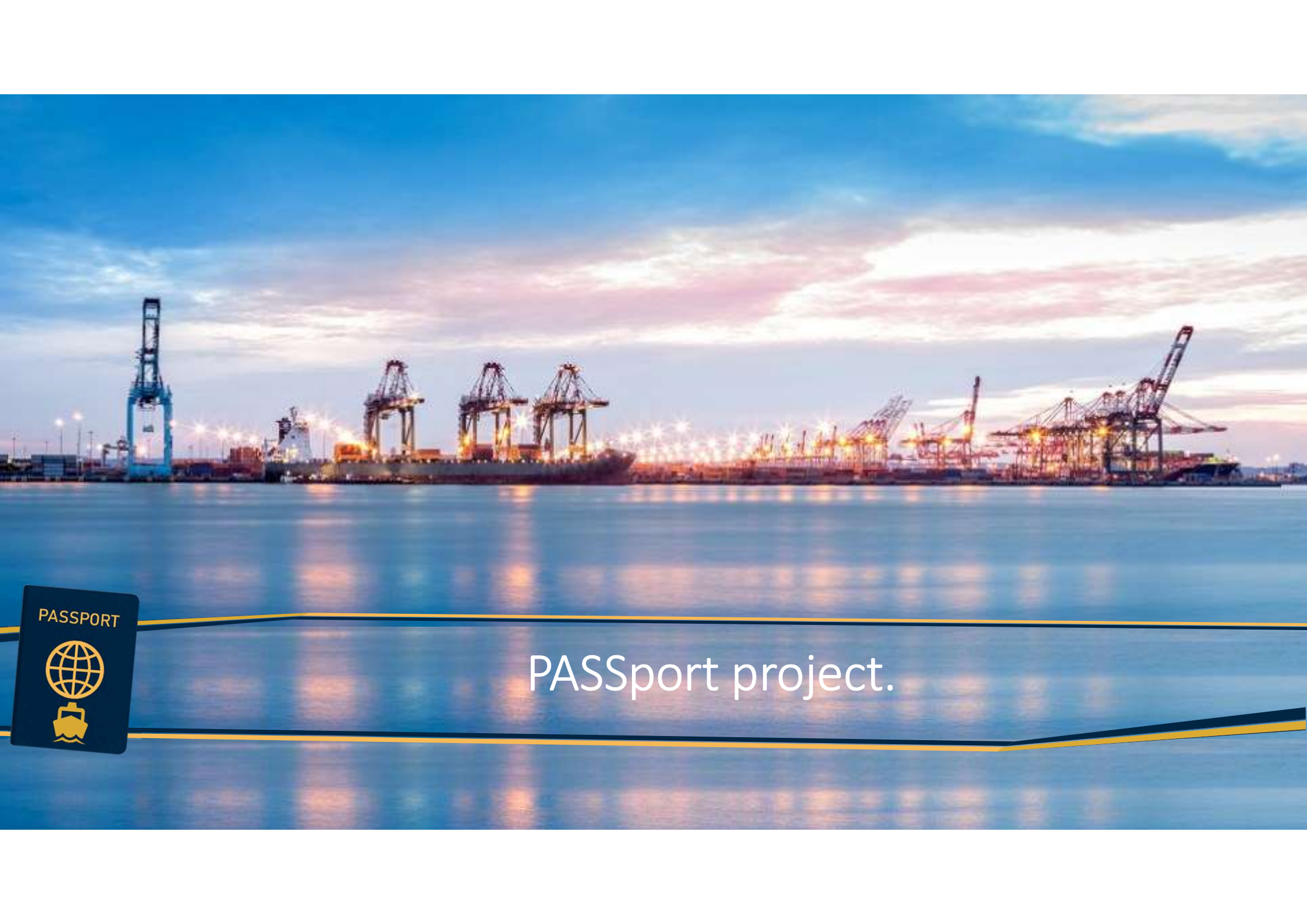
Kołobrzeg Sea Port Authority

ul. Portowa 41

78 – 100 Kołobrzeg

Artur Lijewski Chairman of the Board

tel. +48 605 353 802, e-mail: a.lijewski@zpmkolobrzeg.pl

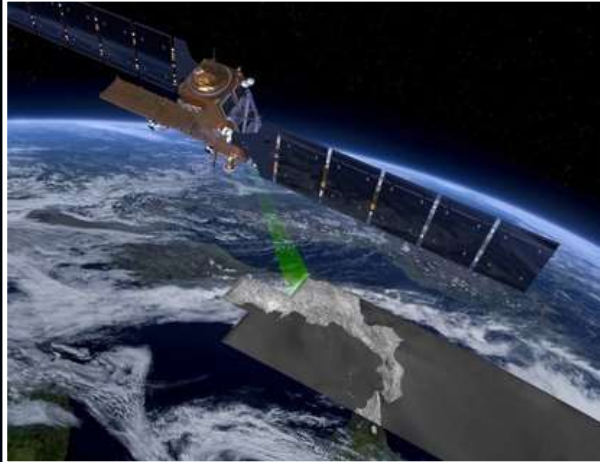


PASSPORT



PASSport project.

Earth Observation (EO) usage to support port operation monitoring



FULL, FREE AND OPEN ACCESS TO DATA



- ATMOSPHERE MONITORING
- MARINE ENVIRONMENT MONITORING
- LAND MONITORING
- CLIMATE CHANGE
- EMERGENCY MANAGEMENT
- SECURITY



opernicus
Europe's eyes on Earth

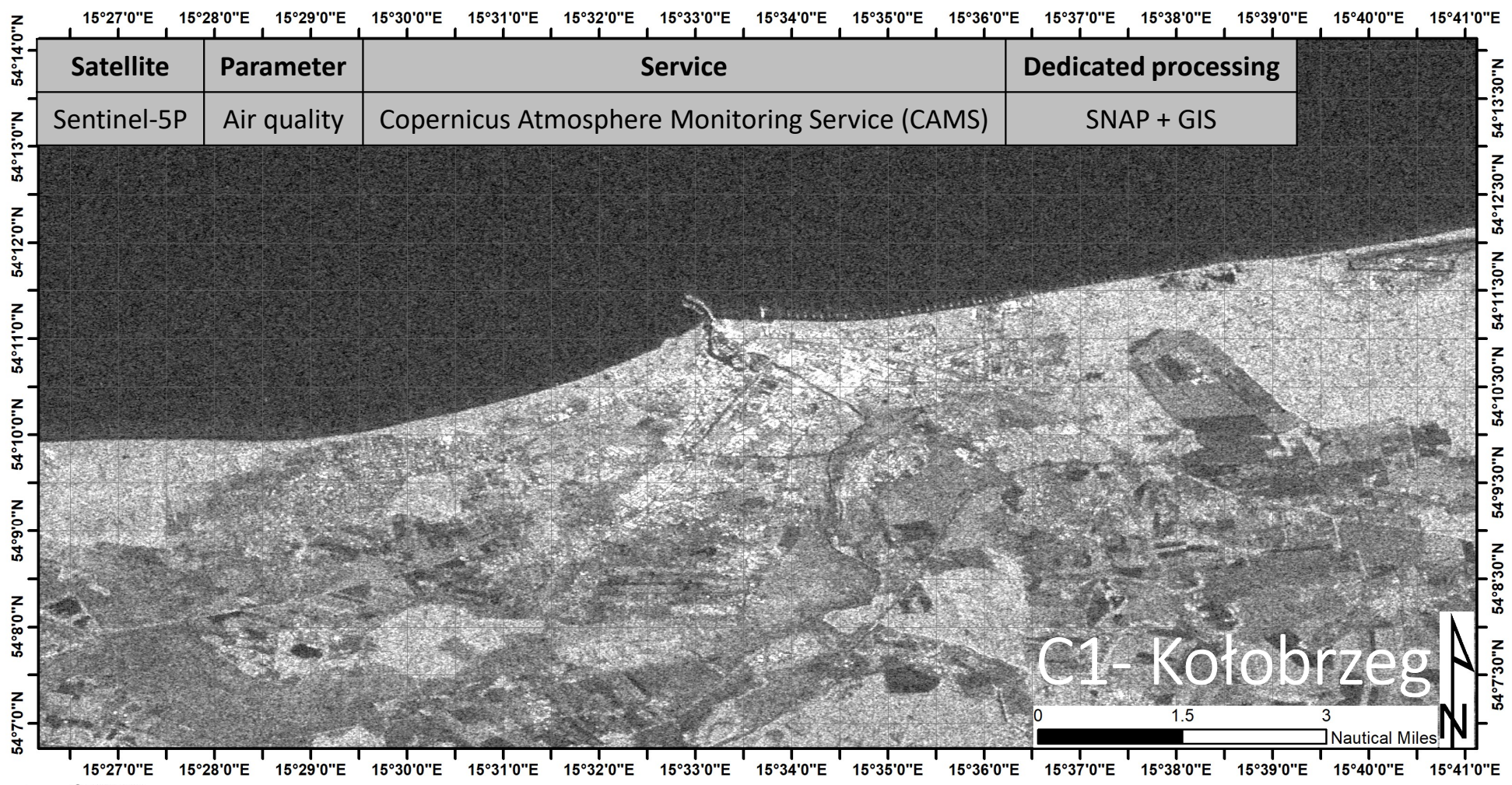


Sentinel-5P

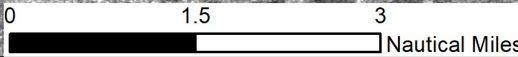
- The ESA **Sentinel-5 Precursor (S5P)** is the first Copernicus mission dedicated to monitoring our atmosphere. The satellite carries the state-of-the-art **Tropomi** instrument to map a multitude of trace gases such as nitrogen dioxide, ozone, formaldehyde, sulphur dioxide, methane, carbon monoxide and aerosols – all of which affect the air we breathe and therefore our health, and our climate.
- With a swath width of 2600 km, it maps the entire planet every day. Information from this new mission is used through the Copernicus Atmosphere Monitoring Service for air quality forecasts and for decision-making.
- **Tropomi** – a spectrometer – maps the global atmosphere every day with a resolution as high as 7 km × 3.5 km. At this resolution, air pollution over cities can be detected.



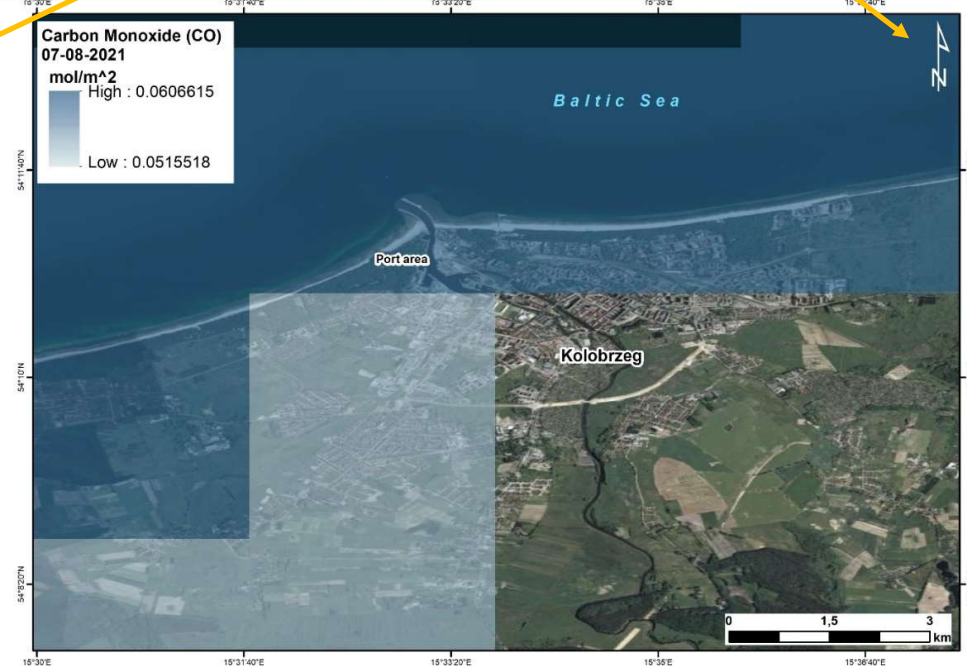
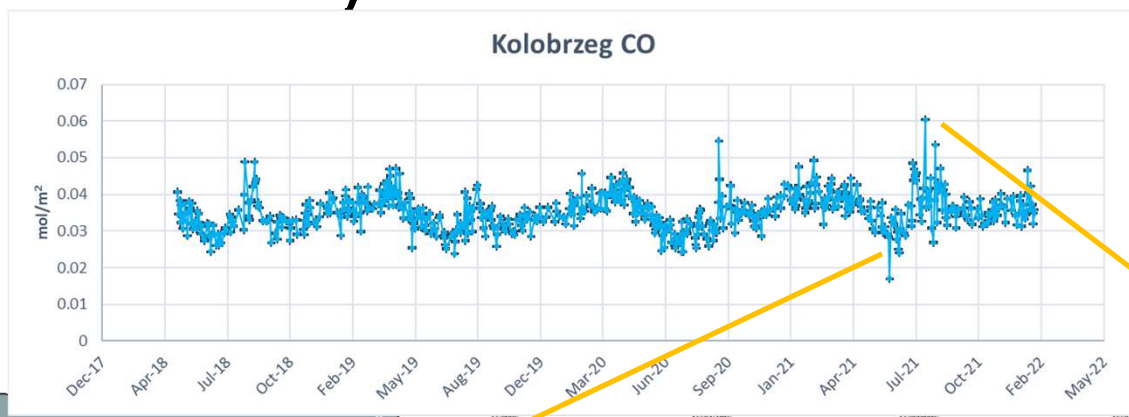
Earth Observation (EO) usage to support port operation monitoring



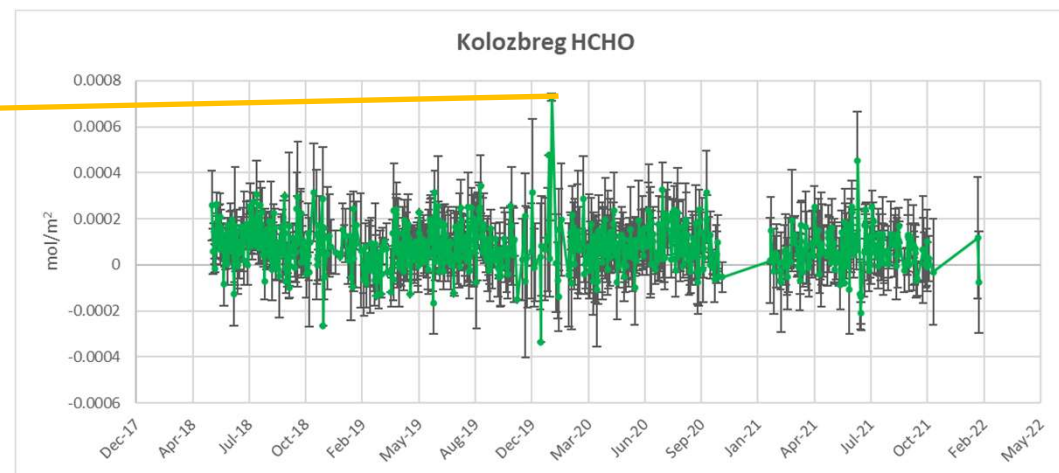
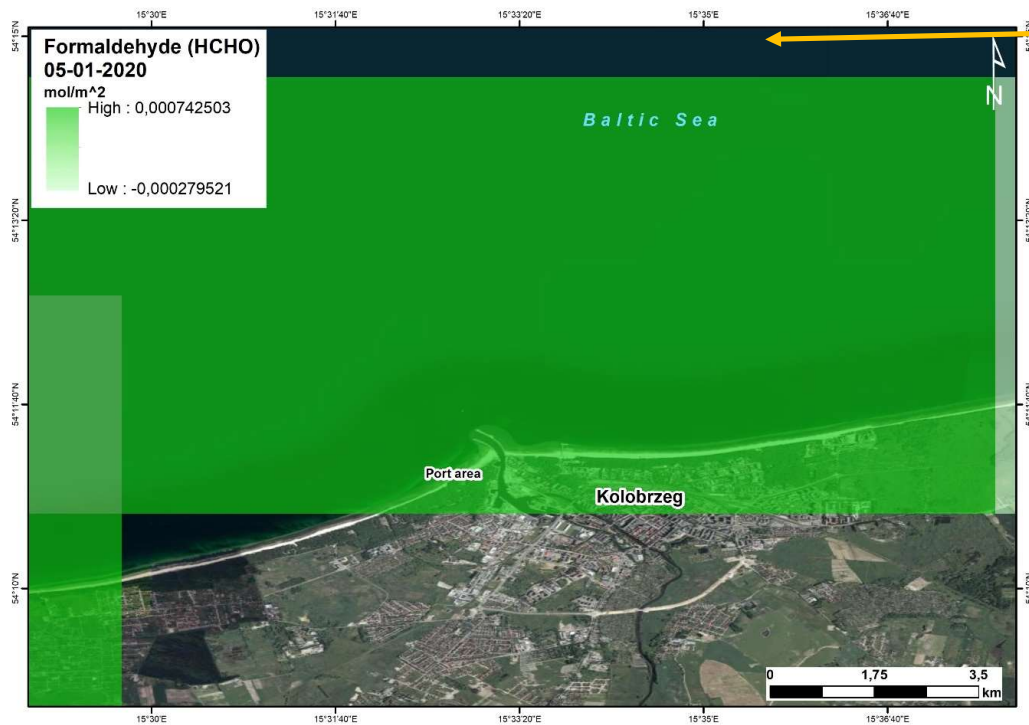
C1- Kołobrzeg



CO (Carbon Monoxide)



HCHO (Formaldehyde)

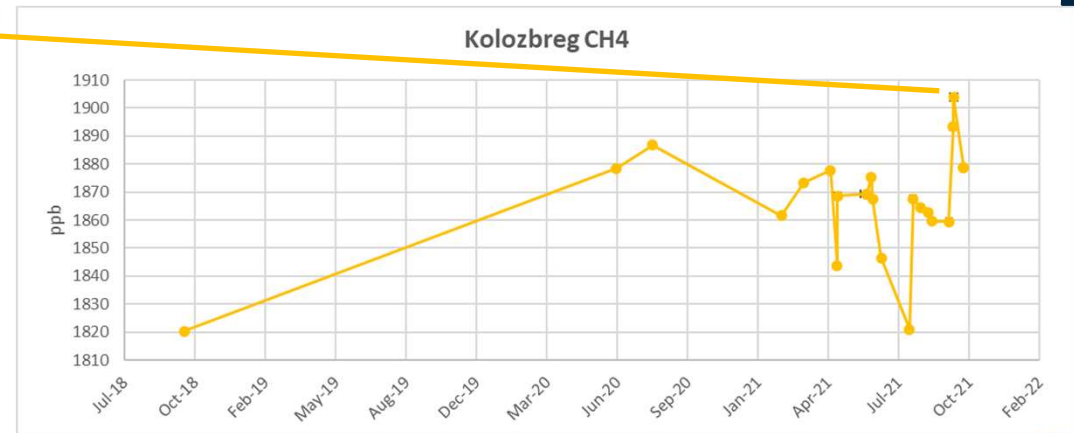
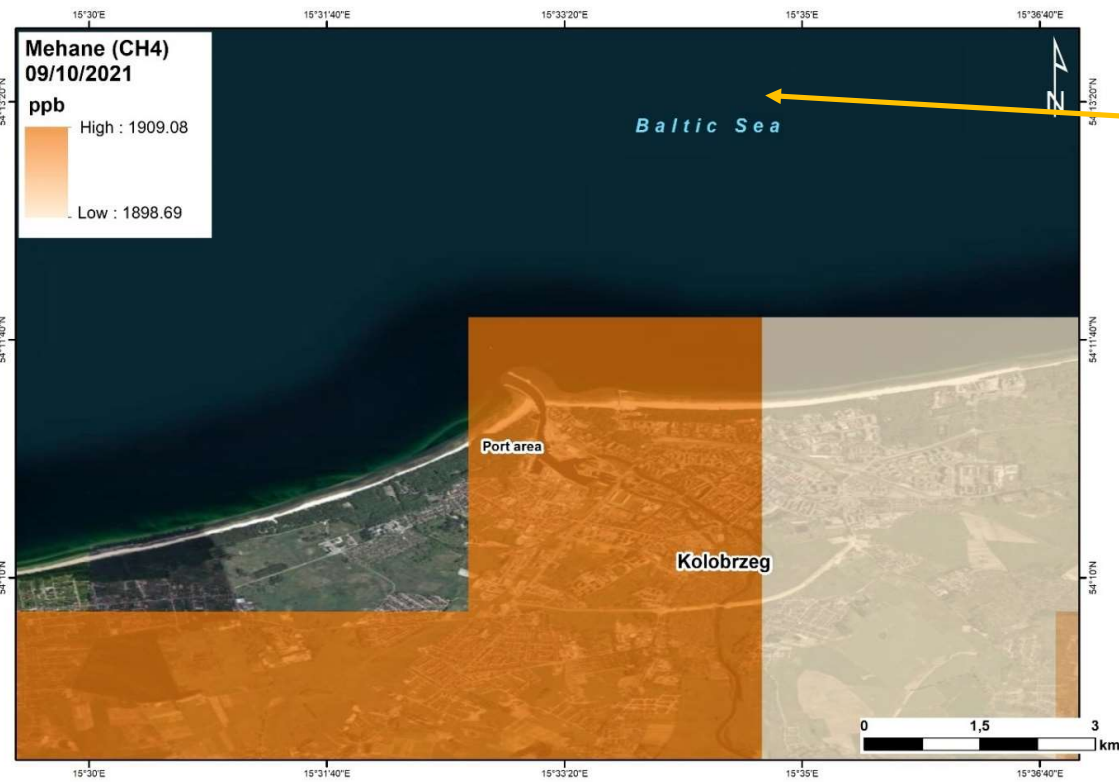


PASSPORT

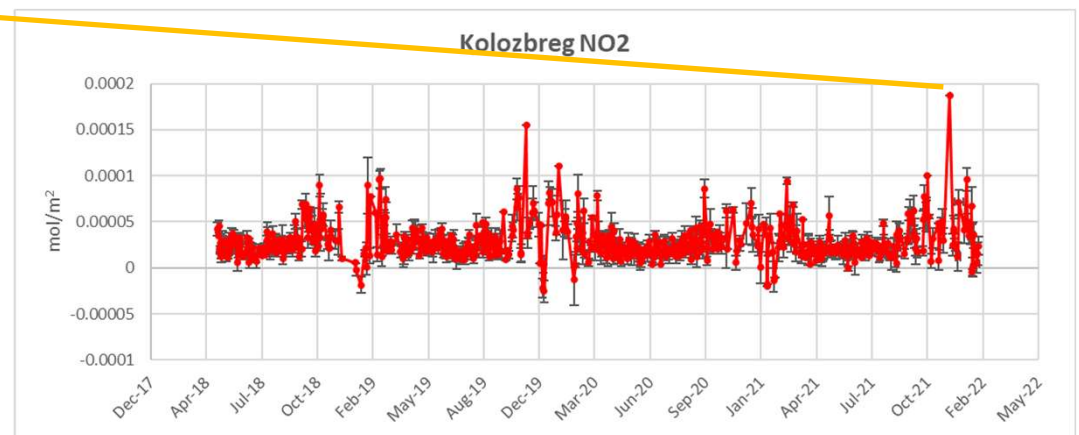
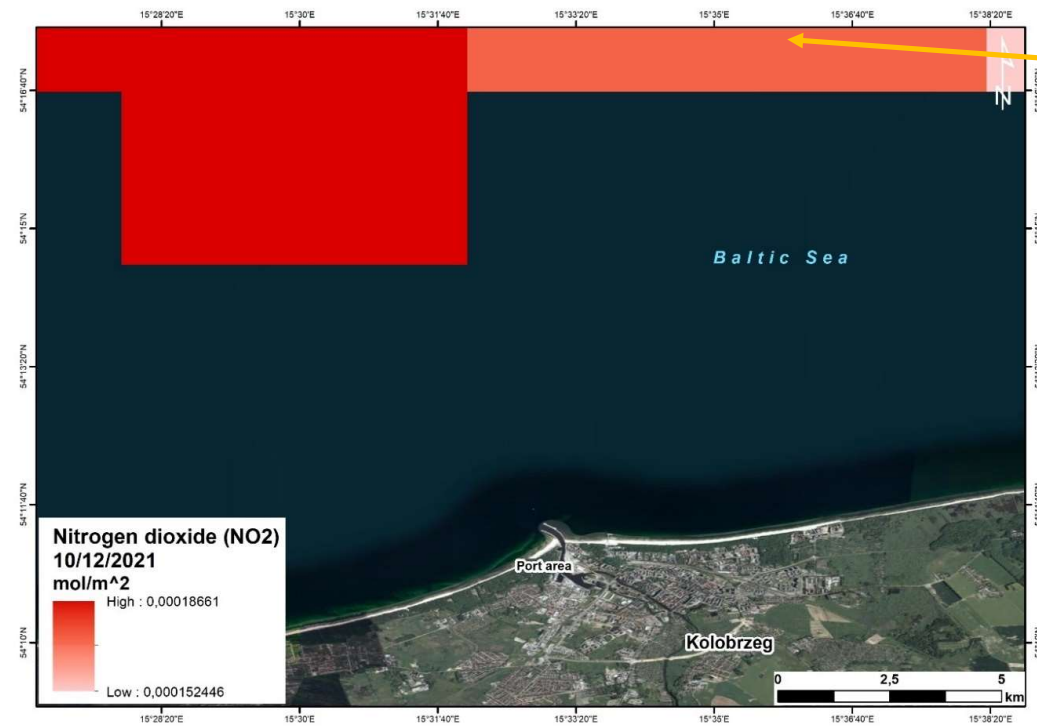


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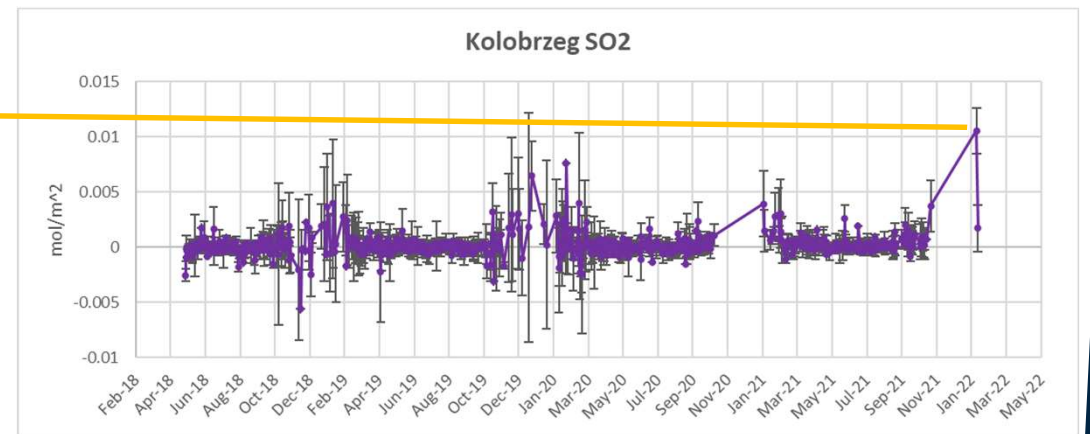
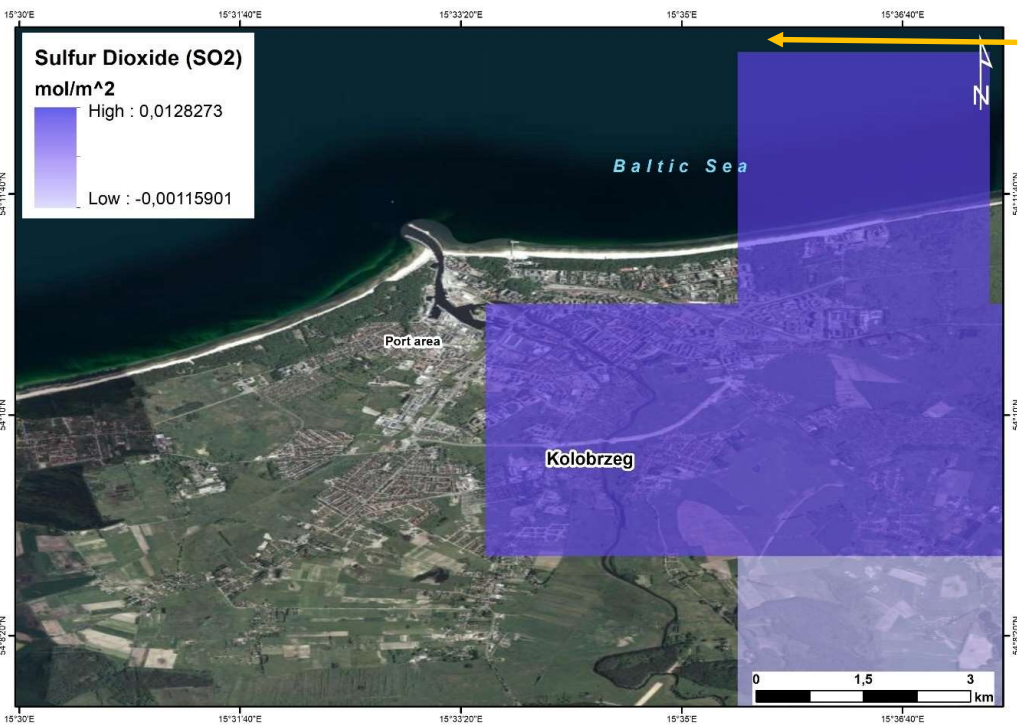
CH4 (Methane)



NO2 (Nitrogen dioxide)



SO2 (Sulfur Dioxide)

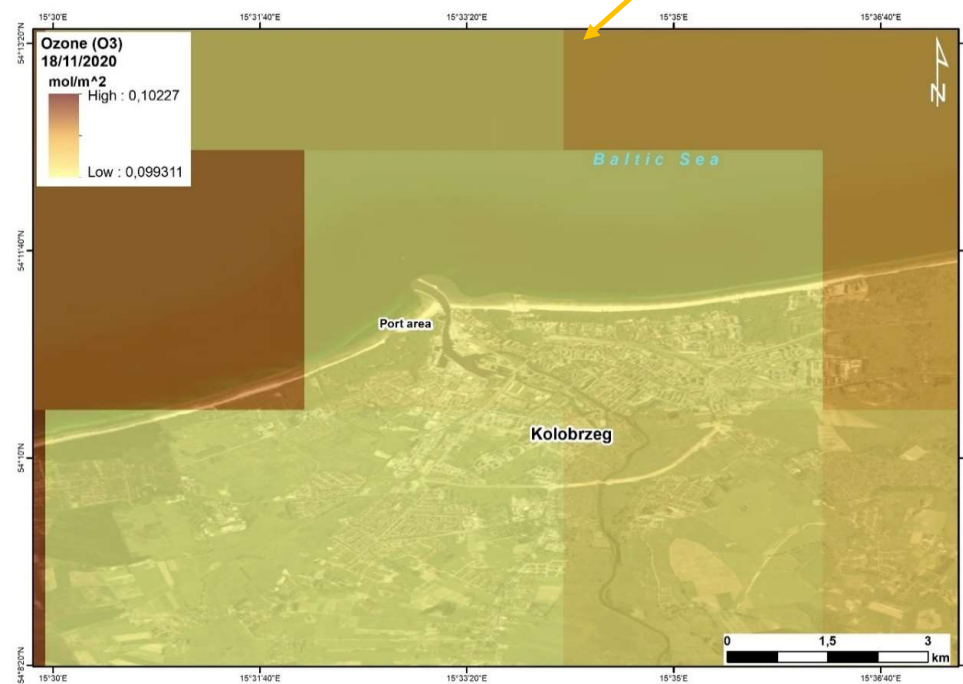
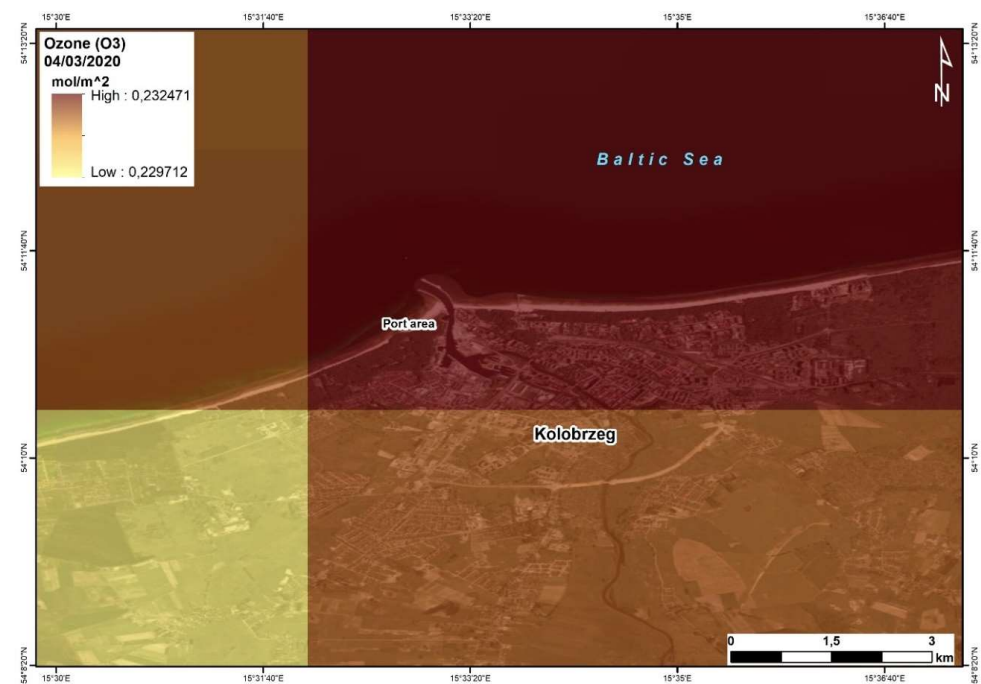
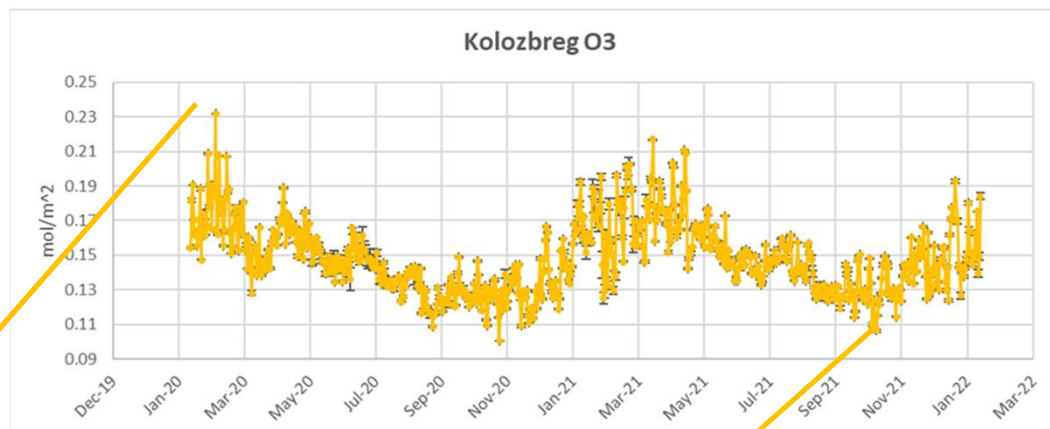


PASSPORT



9

O3 (Ozone)



Earth Observation (EO) usage to support port operation monitoring

- Sentinel-5P acquisitions provide useful information to monitor pollution and air quality in Kolobrzeg
- Sentinel-5P provides precious information allowing the retrieval of time series of pollutants, which may be useful to analyze the seasonal or anthropogenic variation of air quality in port areas.



PASSport validation campaign 1. Kołobrzeg

Presentation of system - a real case scenario

Kołobrzeg campaign



- IMO Regulation 2.9/MARPOL; **sulfur oxides** and **PM** emission controls apply to all fuels, on-board combustion systems, including main and auxiliary engines with boilers and inert gas generators.
- Emission Control Areas.
- Growing restrictions on SOx and NOx emissions.
- Several researches concluded that further international regulations are necessary to assess vessel-related air pollution due to ship traffic emissions*.
- EMSA five-year strategy (2020-2024).

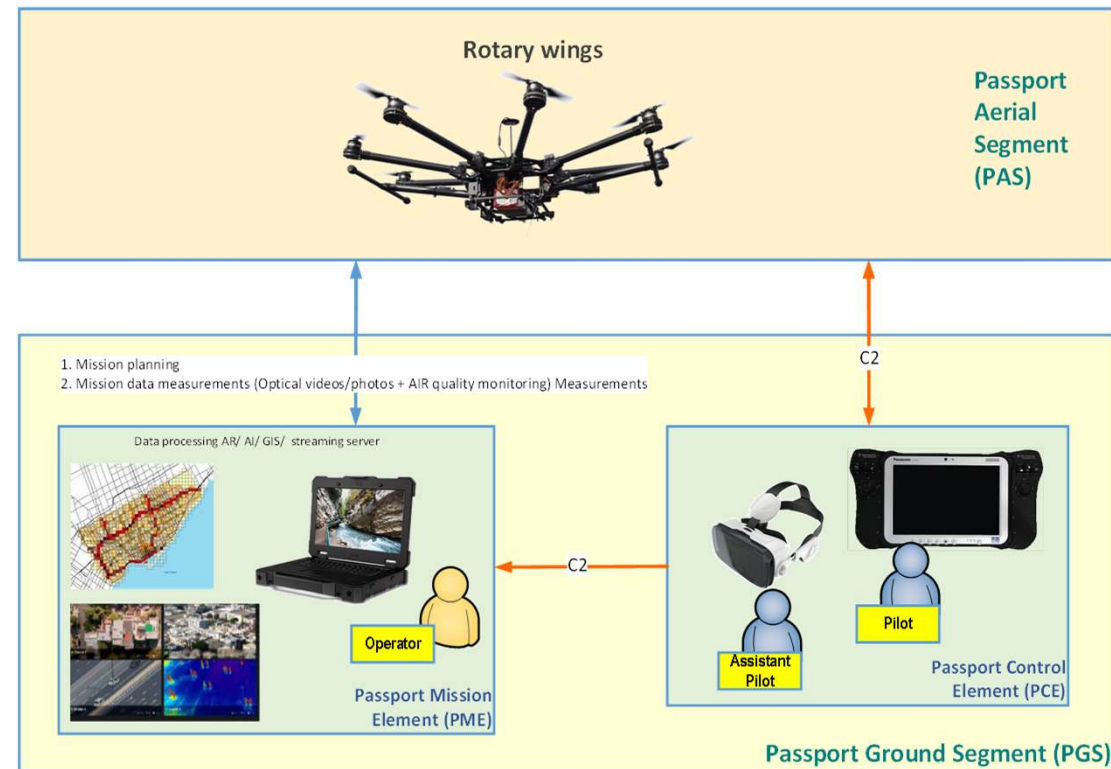


Samuel Lindgren, The coast is clear: Shipping emission standards, air quality and infant health, Transportation Research Part D: Transport and Environment, Volume 100, 2021, ISSN 1361-9209, <https://doi.org/10.1016/j.trd.2021.103067>

Kołobrzeg campaign (2022/09)

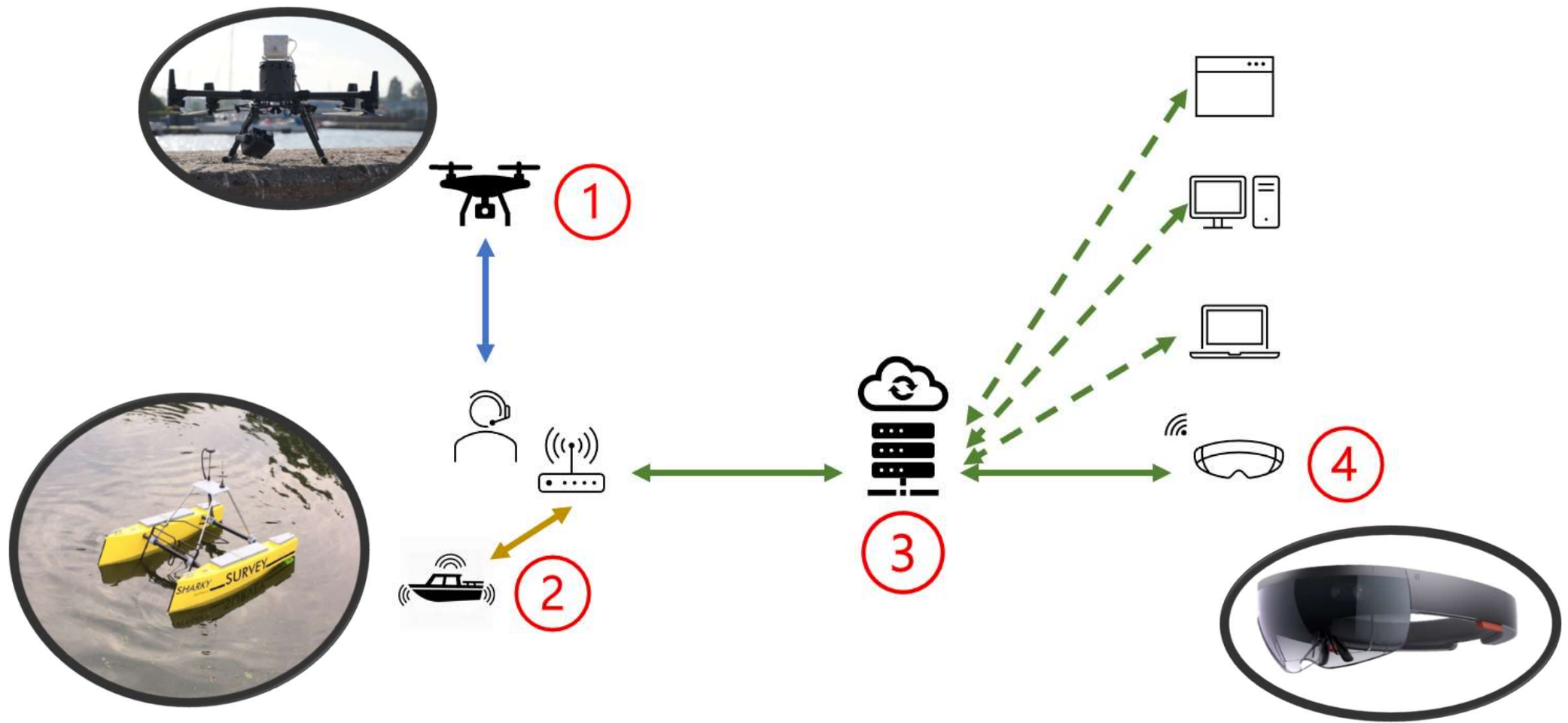
Air/water monitoring (safety)

- In situ (drone fleet) air quality parameters ingested on a GIS
- MR for real time mission control
- Video for context awareness





Kołobrzeg campaign – system architecture



Kołobrzeg campaign – drones

Double-hull USV “Sharky”

- Laminated hull structure that allows operations in water temperature in the range of 1-25°C.
- Dimensions (L x W): 1 x 0.85 m.
- Surface height: 0.6m.
- Draft: 0.3 m @ max. load.
- Displacement max: 25kg (10 kg with no additional load).
- Electric propulsion motor (BLDC) allowing infinitely variable speed control from 0 to 6 knots.
- Control modes available in the delivered solution:
 - manual (joystick mode),
 - autonomous - movement along pre-set waypoints (waypoint mode),
 - autonomous - return to destination point (return home),
 - ability to add your own within the software SDK.





Kołobrzeg campaign – drones

DJI Matrice 300 RTK

- Max. payload 3kg.
- Max. time flight 30 minutes.
- Max. number of sensors 3.
- Vertical Hovering Accuracy:
 - ± 0.1 m (Vision System enabled),
 - ± 0.5 m (GPS enabled),
 - ± 0.1 m (RTK enabled).
- Max Speed
 - S mode: 23 m/s,
 - P mode : 17 m/s.
- Max Wind Resistance 15 m/s.
- Operating Temperature: -20°C to 50°C .





Kołobrzeg campaign – air pollution

Sniffer 4D (Soarability Technology).

- Particulate matter:
 - PM1 (0.3 - 10 μm),
 - PM2.5 (0.3 - 10 μm),
 - PM10 (0.3 - 10 μm).
- O3 + NO2 (0-10 ppm).
- SO2 (0- 10 ppm).

- Georeferenced and timestamped data.
- Calibration procedures.
- Different configurations for additional gases.



KIM M-k, Jang Y, Heo J, Park D. A UAV-Based Air Quality Evaluation Method for Determining Fugitive Emissions from a Quarry during the Railroad Life Cycle. *Sensors*. 2021; 21(9):3206. <https://doi.org/10.3390/s21093206>




Kołobrzeg campaign – air pollution

- UV camera (PCO-UV 14 bit CCD camera - 1392x1040, 190nm – 1100nm)
- **Visible spectrum camera (Zemuse H20t, 1/1.7" CMOS, 20 MP, 20x zoom)**
- **IR (thermal) camera (640x512 @ 30 Hz)**
- Multi spectrum visible light camera (Mica sense RedEdge MX dual camera with spectrum:
 - coastal blue 444nm,
 - blue 475nm,
 - green 531nm, green 560nm,
 - red 650nm, red 668nm,
 - red edge 705nm, red edge 717nm, red edge 740nm,
 - NIR 842nm, 1280 x 960 – 1.2 MP per band))
- Laser range finder (1200m +/-0,2m)



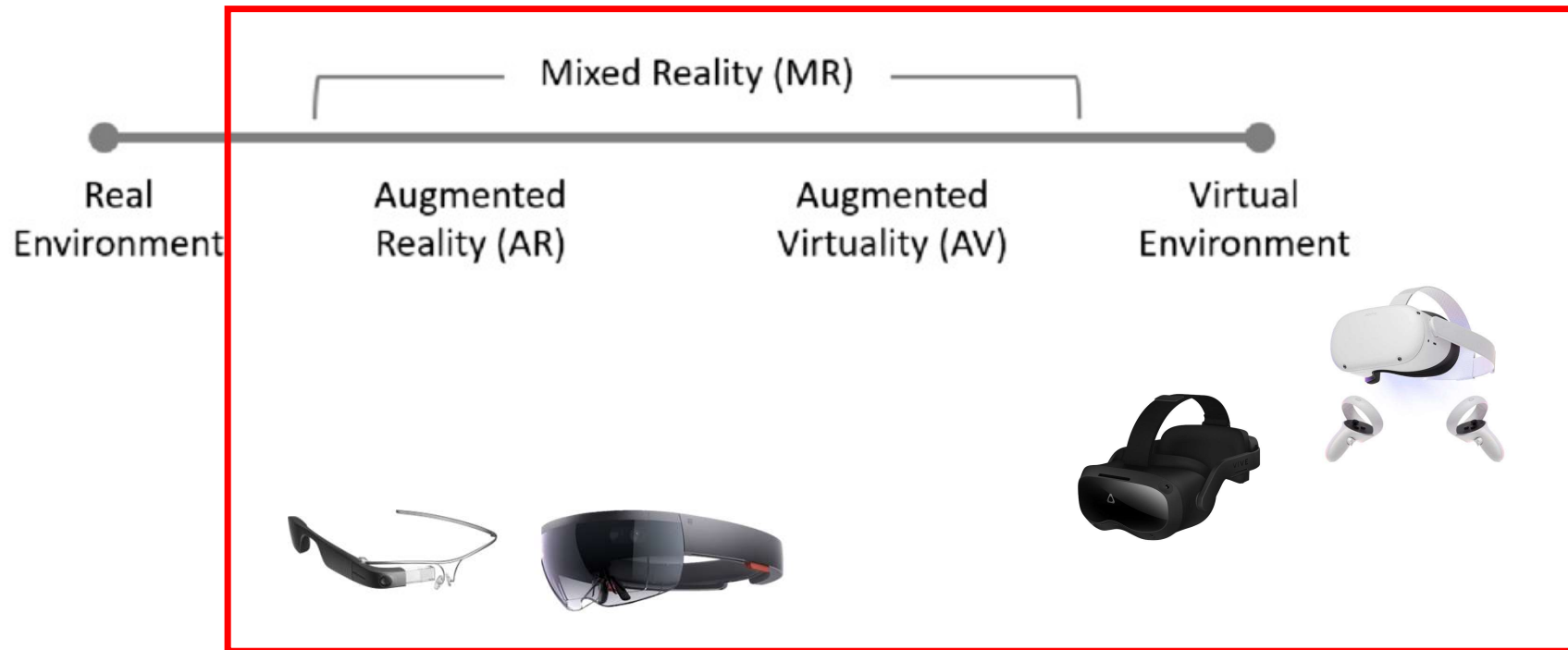


Kołobrzeg campaign – server

- Basic specification:
 - 12 x Intel Xenon X5660 @ 2.80 GHz
 - 12 GB RAM
 - Linux Ubuntu 20.04 OS
 - MQTT client/broker
 - DJI Cloud API
 - Data handling:
 - Synchronization
 - Preprocessing
 - Postprocessing
 - Storage
 - access to historical data
 - advanced analysis
 - reporting
 - AIS capabilities
 - interconnectivity
- 



Kołobrzeg campaign – extended reality



Extended reality - XR



Kołobrzeg campaign – extended reality

Microsoft HoloLens gen.1

- First 6DOF AR system.
- Stereoscopic holographic pass-through screens.
- Fully contained system.
- Already used in industrial and military applications.
- Hands gestures tracking.
- Voice recognition.
- Multi user environments .

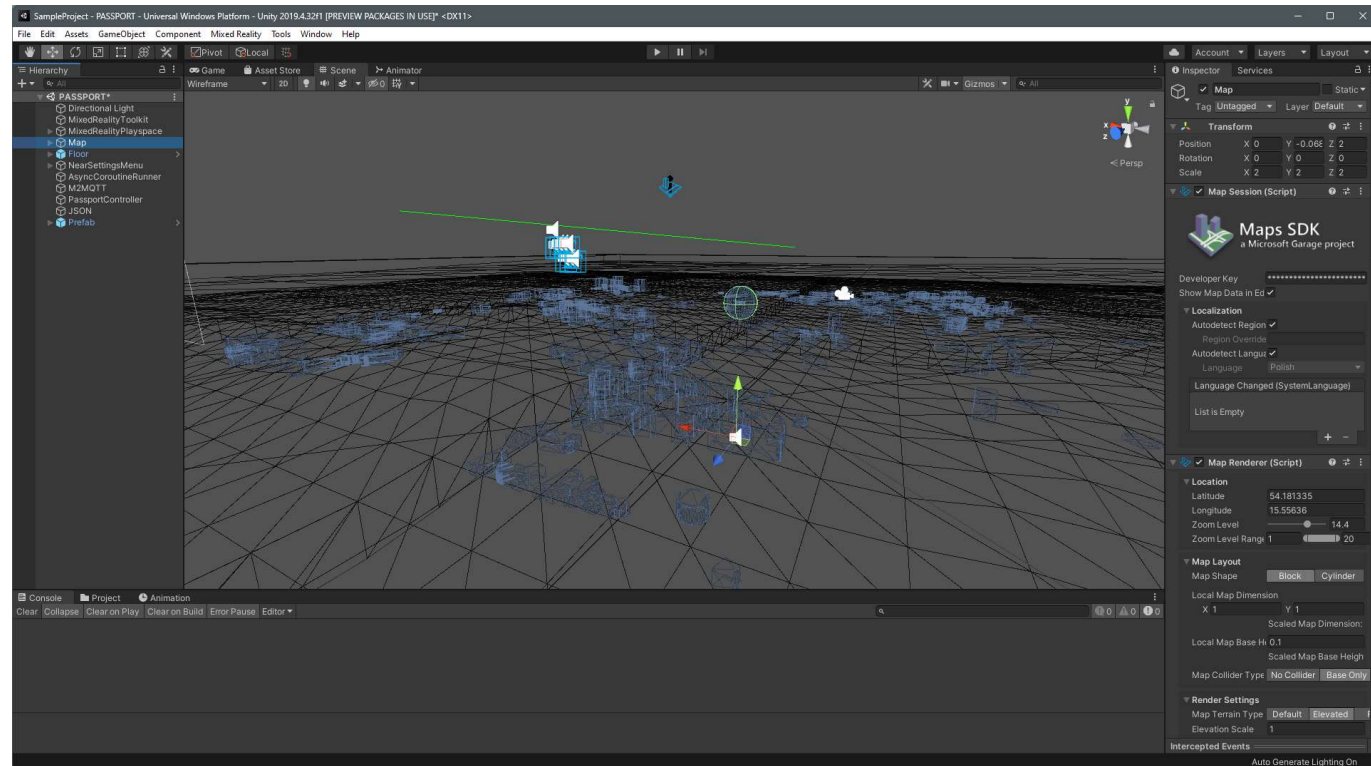


	Resolution per eye [px]	Refresh rate [Hz]	Horizontal FoV [°]	Weight [g]	Battery life [hrs]
MS HoloLens 1 gen.	1268x720	60	30	579	3
MS HoloLens 2 gen.	1440x936	60	43	556	3
Meta Quest 2	1832x1920	90	197	503	3
Meta Quest Pro	1800x1920	90	106	722	2



Kołobrzeg campaign – extended reality

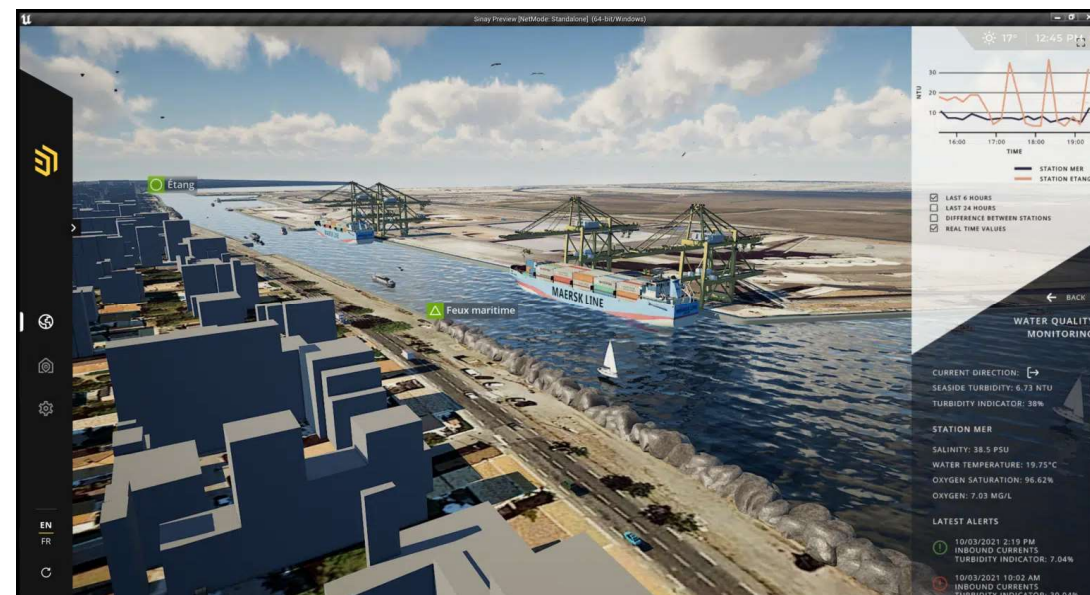
- Unity Engine version 2019.4.32f1,
 - Microsoft Mixed Reality Toolkit,
 - Microsoft Map SDK.
-
- Extensibility
 - Modification
 - Licensing

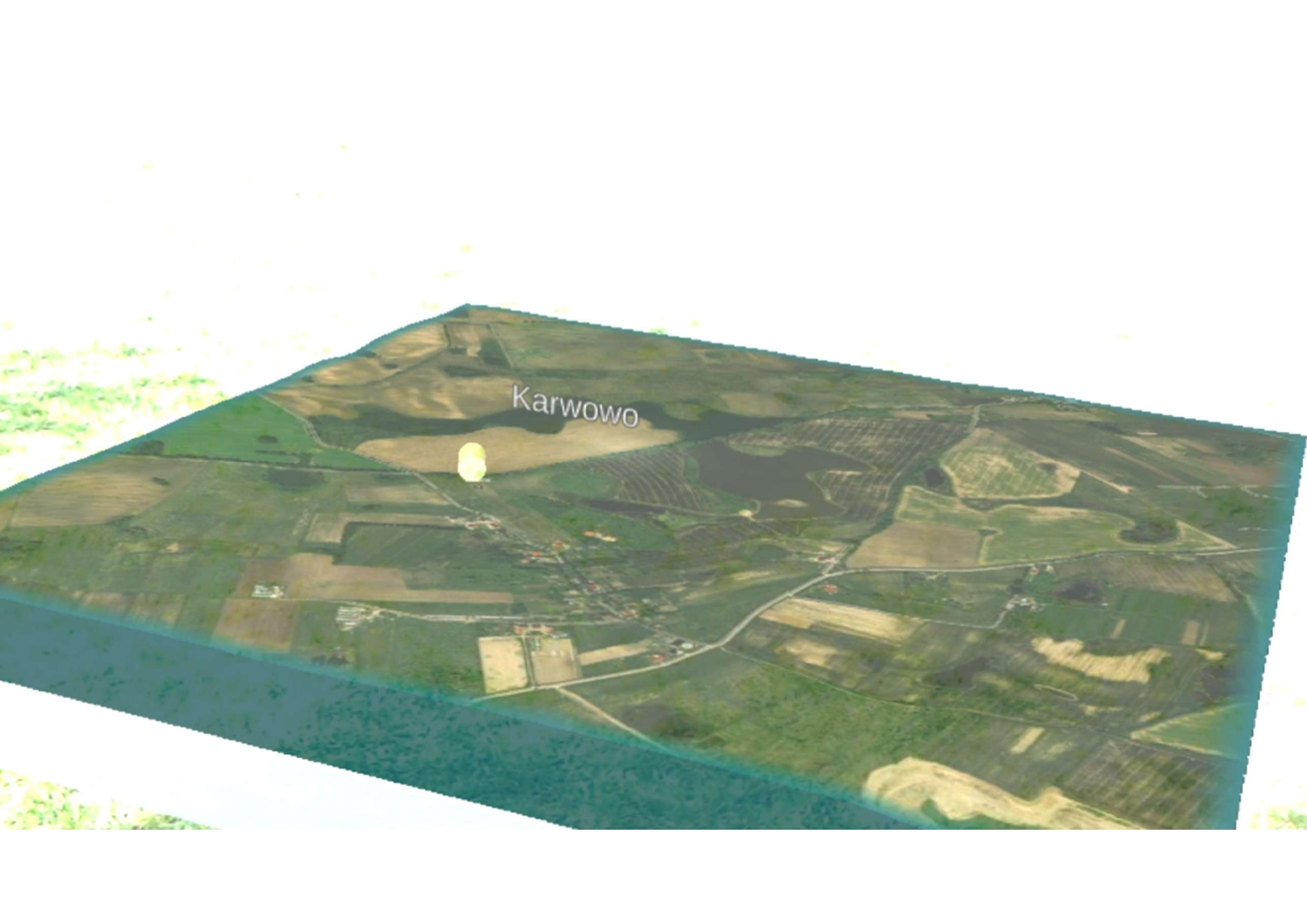


Kołobrzeg campaign – extended reality



- Disruptive technology.
- Rapid development since introduction in 2016.
- Widely used in industrial and enterprise sector.
- Unparalleled capabilities of 3D visualizations.
- Digital overlay on existing world.
- Digital twins, smart ports.
- New research area.
- Growing market.





Karwowo

Selectable menu - functionalities



Livestreaming into XR application



3D Datapoints



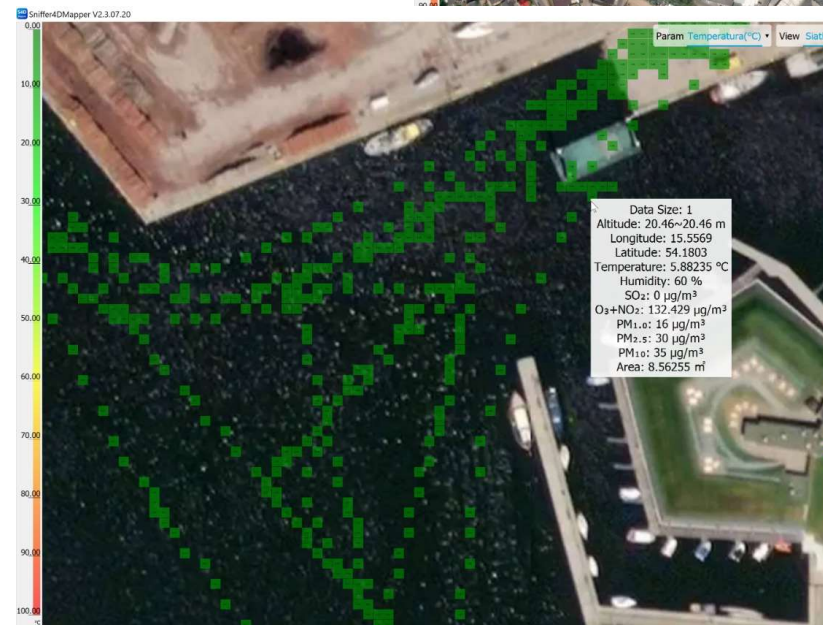
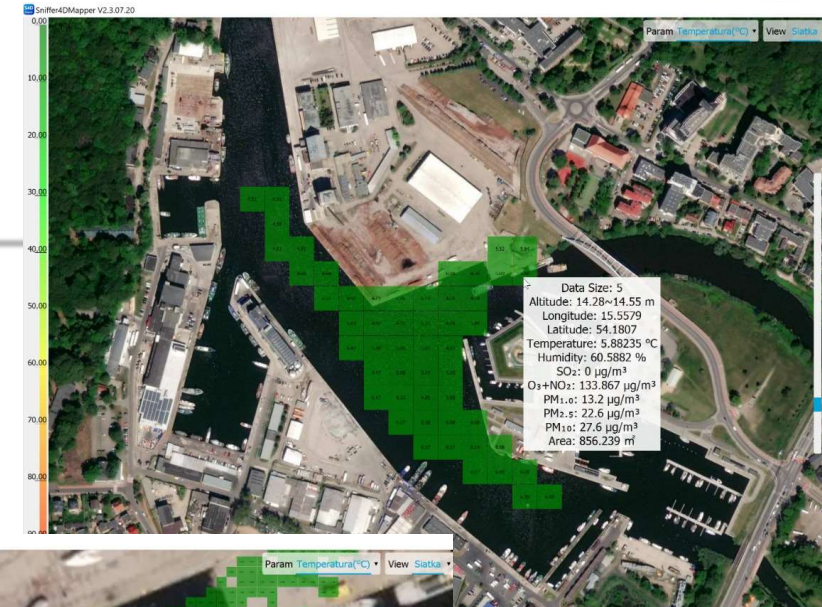
Kołobrzeg mission – recorded data



Data visualisation

Dedicated commercial software:

- 2d layer only.
- No external data sources (e.g. AIS, Sentinel).
- Restricted analysis options.
- Historical data analysis and aggregation.



Conclusions



- Drones are suitable for 3d mapping of air quality in the port.
- Digitalization of ports, especially digital twin solutions, require new approach to 3D data visualization.
- Presented solution is extendible and modular
 - alternative geodata sources,
 - overlaying additional data, e.g. satellite imagery,
 - implementation of high accuracy 3D models (utilizing photogrammetry),
 - support for wider ranges of devices (standardisation of XR frameworks).



Further directions

- Validating UV/IR/multispectral detection and monitoring of oil spills/water pollution.
- Increasing level of autonomy.
- Extending XR interface.
- Conducting usability and HCI studies for AR and VR interfaces.
- Integrating AIS services further expanding historical data recording.
- Building a database of emission control results.
- Testing the system for berthing manoeuvres monitoring.



Thank you for your attention

PASSport project validation and verification based on Kołobrzeg campaign



Validation & Verification

Verification (narrower)

If the system works according to specification, if the product is developed appropriate way. If the code is clean.

Problem in small development team is 1) what factors shall taken into consideration and 2) who is responsible fo testing (verification). This was done as cross checks between developers.

Validation (broader)

If the system works according to end user needs, if the product is appropriate.

If the user needs exist they could be applied for validation.



PASSPORT C1 campaign

- **C1 Validation Campaign**
- **LOCATION: Port of Kołobrzeg, Poland**
- **Time: 29.09.2022 1100**
- **SCOPE:**
 - **Air pollution monitoring,**
 - **Extended - augmented reality user interface.**

AGENDA (moderator Lucjan Gućma):

1100 – Welcome from Kołobrzeg (Artur Lijewski - Port CEO)

1110 – Presentation of PASSPORT (Marco Nisi - Passport leader)

1130 – Presentation of MUS Passport solution (Bartosz Muczyński – MUS team senior developer)

1200 – 1300 validation air pollution



CONDITIONS of Port Kołobrzeg

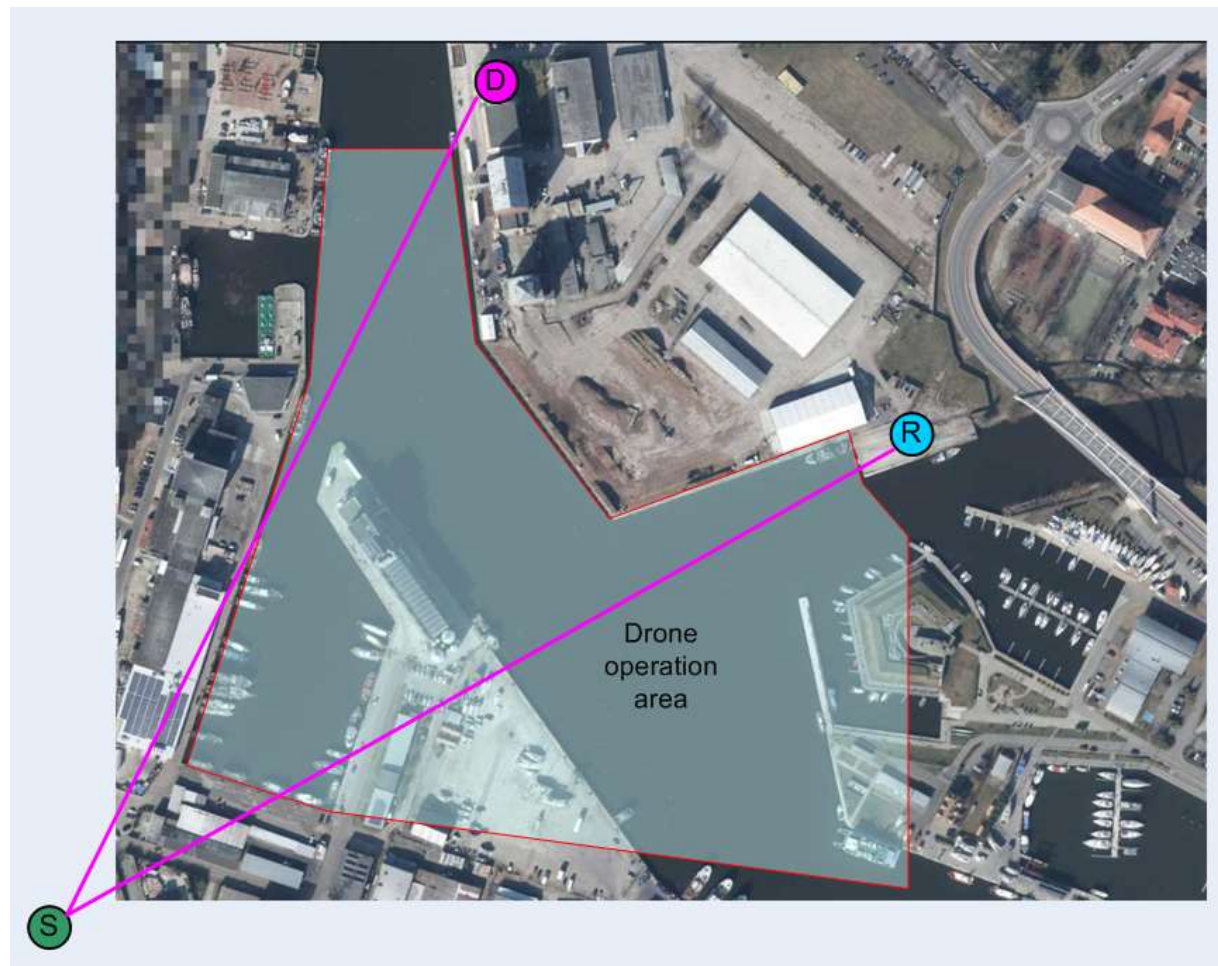


PASSPORT



4

PASSport validation setup



Validation setup – 1) Decision Module



Validation setup – 2) Real (operator) module



Validation setup – 3) Server Module



User requirements

User requirements are specified in Document D2.1 User Requirements.

List of mission and operational user requirements that have been addressed and tested as a result of augmented reality solution for pollution monitoring.

	Doc. No: _____ PASSPORT-D2.1
	Issue: _____ 1.0
	DATE: _____ 31.03.2021
	SHEET: _____ 1 of 18
	CLASSIFICATION: _____ Unclassified



Prepared by
Bartosz Muczyński (MUS), Lucjan Gućma (MUS), Robert Gaister (DLR), others
Verified by
Lucjan Gućma (MUS)
Approved by
Marco Nisi (SIST)



User requirements

UR_ID	Title	Architecture element	Qualitative validation description
UR-010	Scope	The mixed reality headset provides end users, port operators, with a full 3D visualization of drone position and pollution information, extending situational awareness about the state of the mission and possible sources and places of air and water pollution.	<p>Positively validated</p> <p>Pros – 3D visualisation helps to recognise the drone area and pollution monitoring is almost immediately visible.</p> <p>Cons – The controlling of AR handset is difficult to non-experienced user. The limited information is at this stage.</p>



User requirements

UR_ID	Title	Architecture element	Qualitative validation description
UR-040	Safety and security missions	Presented architecture complements already operational platforms to provide operational support daily operations related to air pollution monitoring (safety).	Limited validation – daily use was not the scope of activities Pros – not defined Cons – Limited number of sensors O3 and NO2 sensor works in one slot. Lack of storage and manipulation of data – comparison with .



User requirements

UR_ID	Title	Architecture element	Qualitative validation description
UR-050	Pollution monitoring	Selected range of cameras and sensors allows to visually identify water pollution and dedicated Sniffer 4D sensor allows to measure major air pollutants from ships, including SO2, NO2 and PM.	<p>Limited validation – water pollution not validated</p> <p>Pros – very effective online data for air pollution in scope of sensors for decision makers</p> <p>Cons – Limited number of sensors O3 and NO2 sensor works in one slot.</p>



User requirements

UR_ID	Title	Architecture element	Qualitative validation description
UR-100	Solution scalability	<p>Selected drone, DJI Matrice 300 RTK, meets the requirement, allowing for a:</p> <ol style="list-style-type: none"> usage of independent systems to help the drone constantly scan for obstacles and obtain the position information (when operating in normal weather conditions); easy mounting, dismounting and connecting payloads to the vehicle; sufficiently large payload to carry out tasks of monitoring and inspection; payloads to be connected in the configuration necessary to effectively perform the monitoring tasks; trouble-free interworking between different payloads; fulfilling its basic operational and telemetry functionalities with onboard built-in sensors; usage of additional GNSS independent systems to help the drone constantly scan for obstacles and obtain the drone position information (when operating in normal weather conditions); easy mounting, dismounting and connecting payloads to the drone; sufficiently large payloads to carry out tasks of pollution monitoring; connection of payloads in the configuration necessary to effectively perform the pollution monitoring task; trouble-free interworking between different payloads; 	<p>Positively validated</p> <ol style="list-style-type: none"> + + + + not checked + + + + +/- (air pollution payload connected permanently) not checked



User requirements

UR_ID	Title	Architecture element	Qualitative validation description
UR-105	Integrated centralised mission and control data	Centralized server that connects with every drone, operators and end-users. It also records and stores the data and allows for streaming it in real-time.	Positive validation Pros – Cons – The lagging of video stream significant >1s Data storage and manipulation not validated – limited availability



User requirements

UR_ID	Title	Architecture element	Qualitative validation description
UR-160	Duration of operations	A set of eight replaceable batteries allows for a several hours long mission.	Positive validation Pros – Hot swap verified Cons – limited time with two sensors to 20 mins of operation



User requirements

UR_ID	Title	Architecture element	Qualitative validation description
UR-220	Human Factors	Dedicated application designed for mixed reality headsets is based on a natural user interface allowing for a simple and intuitive interaction. It also supports voice recognition and voice commands. All controls are clearly described to the users. data layers can be switched on and off to avoid information overload.	<p>Positively validated</p> <p>Pros – 3D visualisation helps to recognise the drone area and pollution monitoring is almost immediately visible.</p> <p>Cons – The controlling of AR handset is difficult to non-experienced user. The limited information is at this stage.</p>

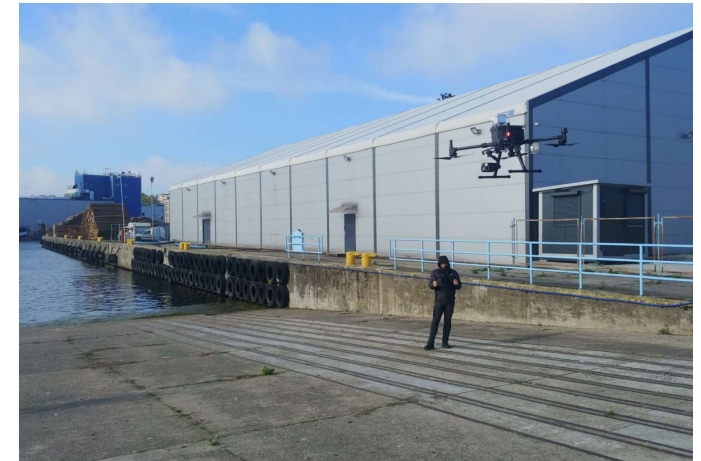
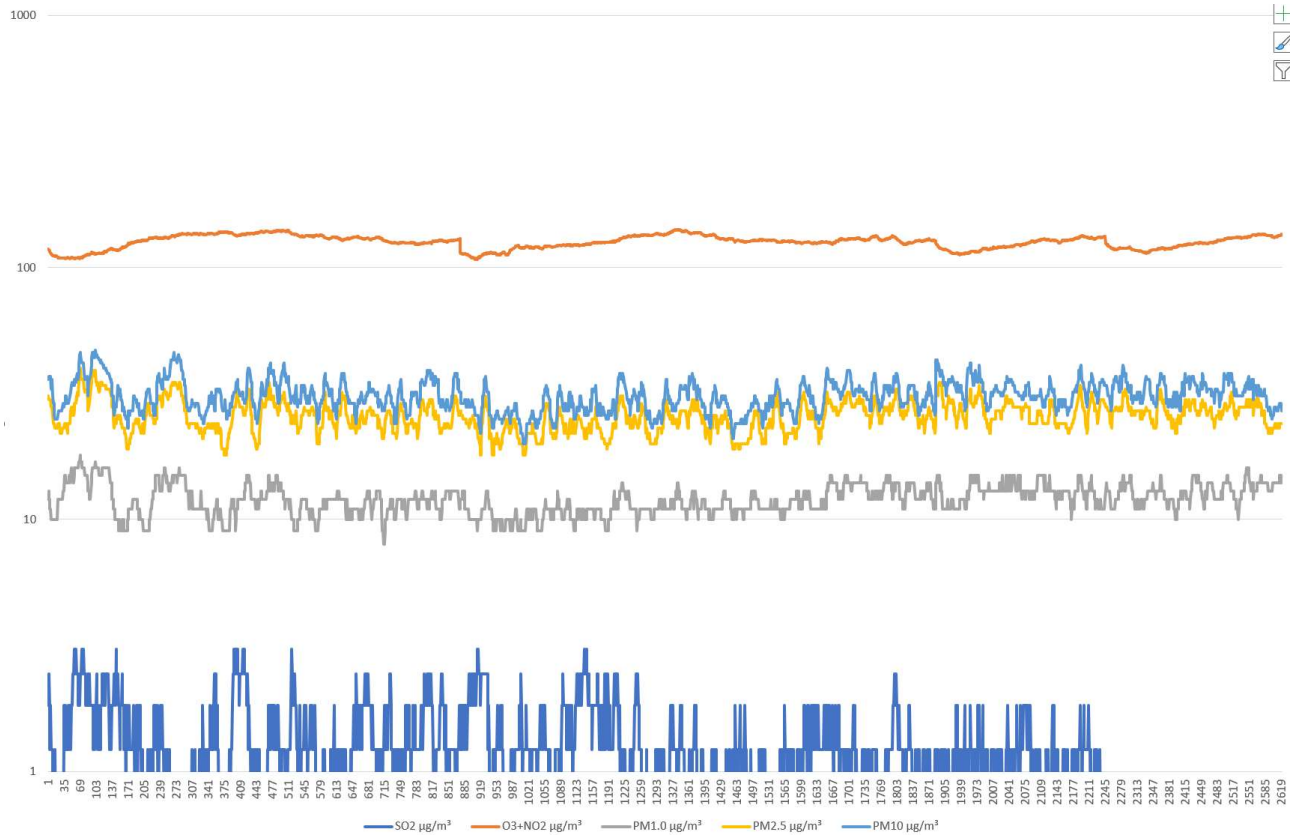


User requirements - other

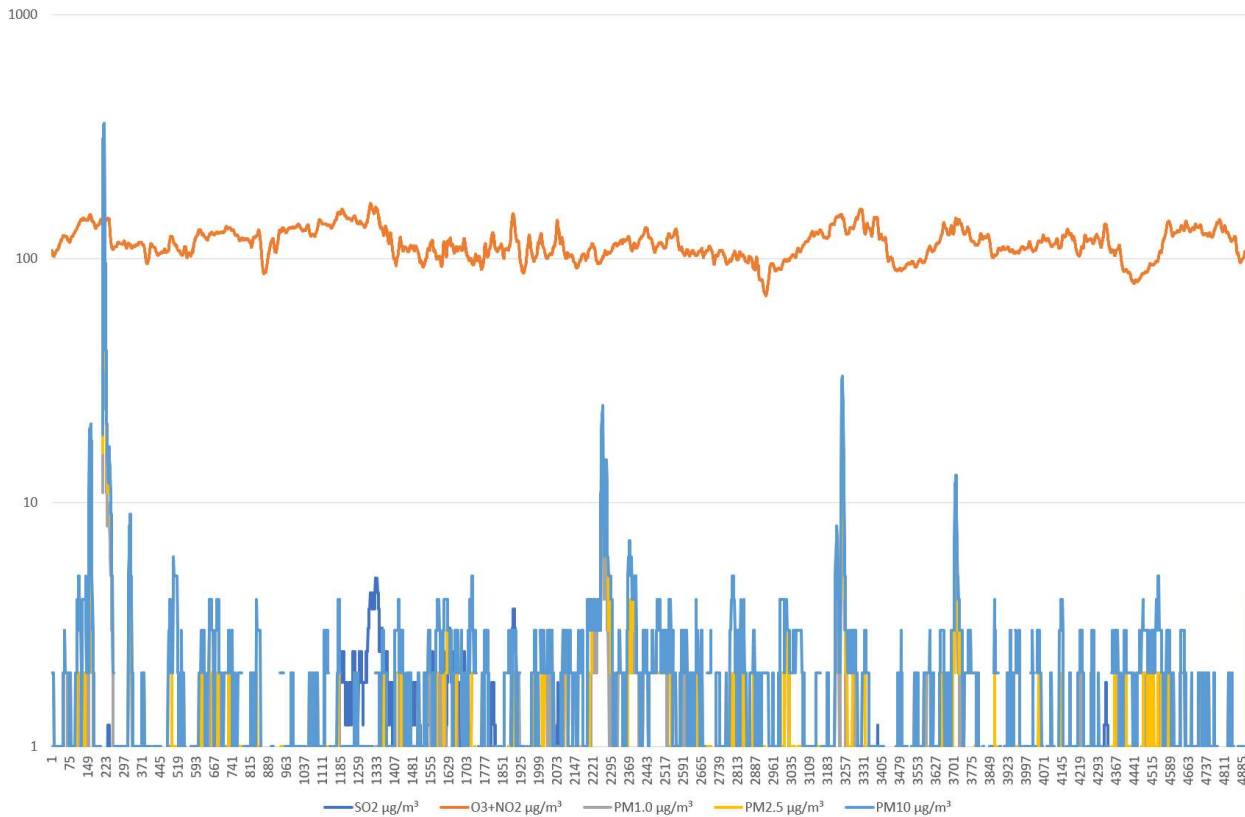
Other not specified in official document	Small port requirements / opportunity	24/7 working availability of drone makes opportunity for air and oil pollution detection in small port where staff is very limited after working hours
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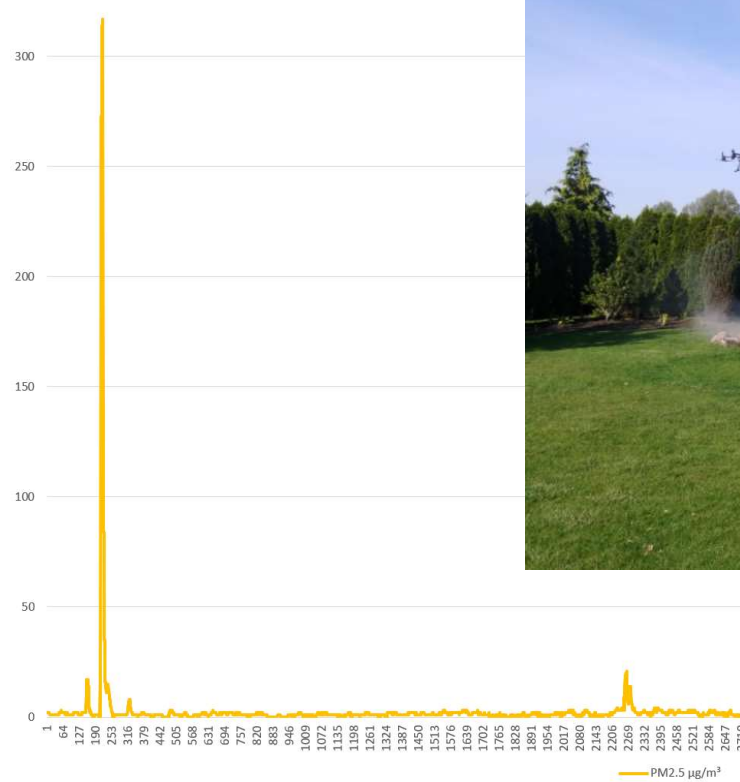
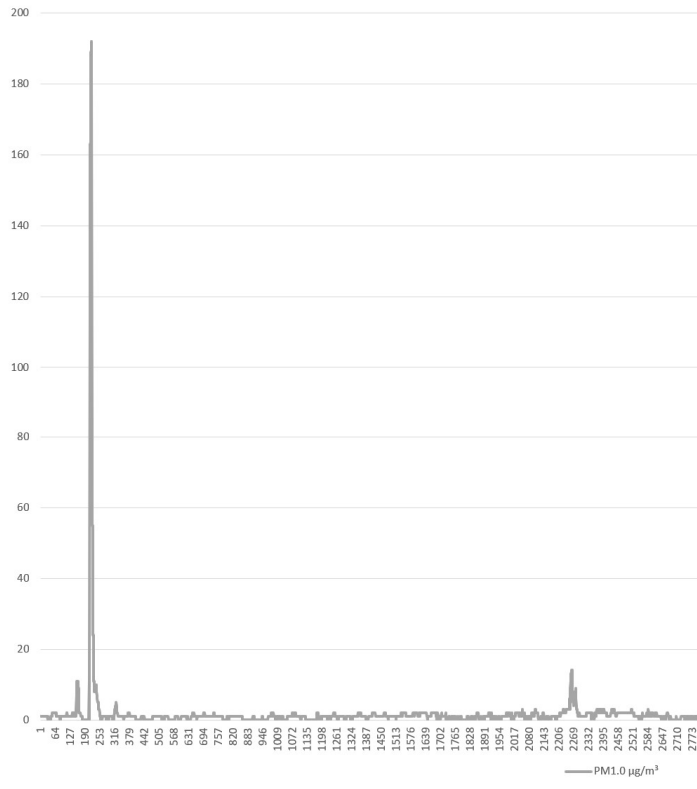
Validation of air pollution system Kołobrzeg

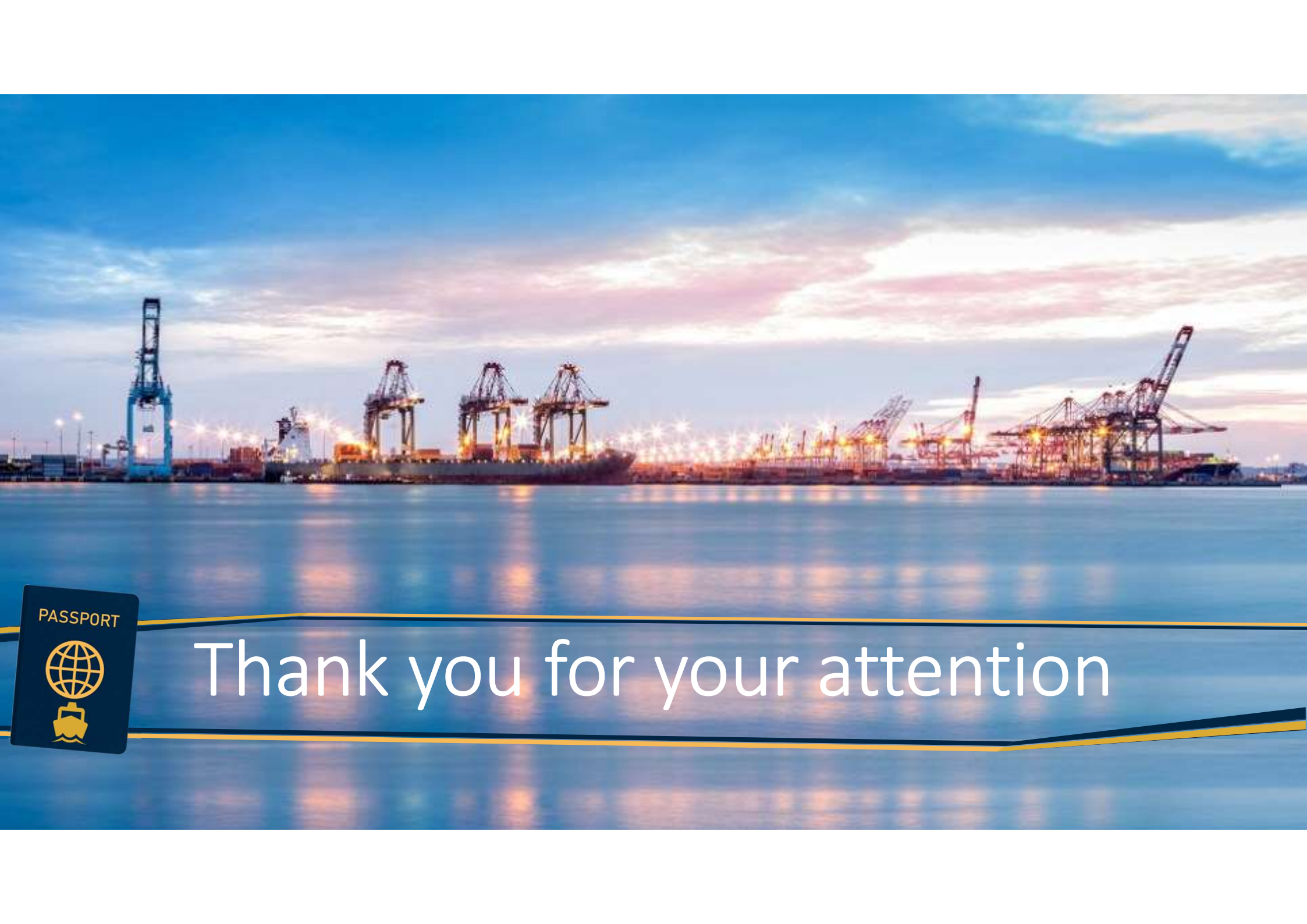


Validation of air pollution system - fireplace



Validation of air pollution system - fireplace





Thank you for your attention

