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International Conference on Marine Data and Information Systems

# Broad ranges for quality control of coastal data related to marine eutrophication: the Mediterranean Sea case study

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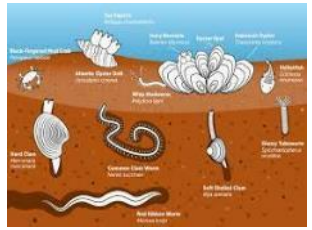
OGS National Institute of Oceanography and Applied Geophysics
NATIONAL BIODIVERSITY FUTURE CENTER
EMODnet European Marine Observation and Data Network

# General background: Marine eutrophication

***Eutrophication**: "a process driven by **enrichment of water by nutrients (…**especially nitrogen and/or phosphorus), leading to: … **water quality degradation**.*

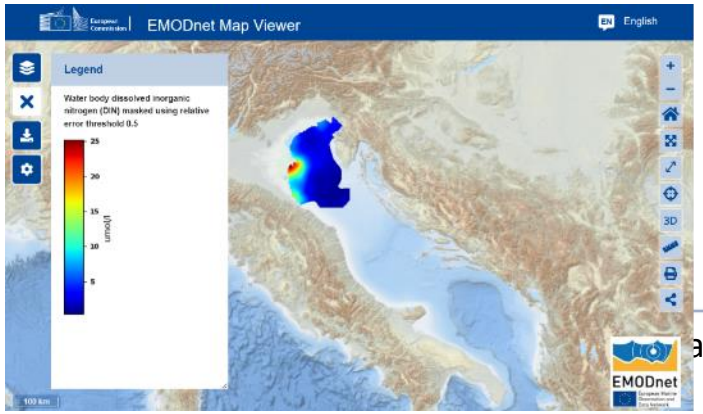
*Is one of the 11 descriptors of environmental status according to **EU MSFD**, and one of the ecological indicators assessed by Regional Sea Conventions*

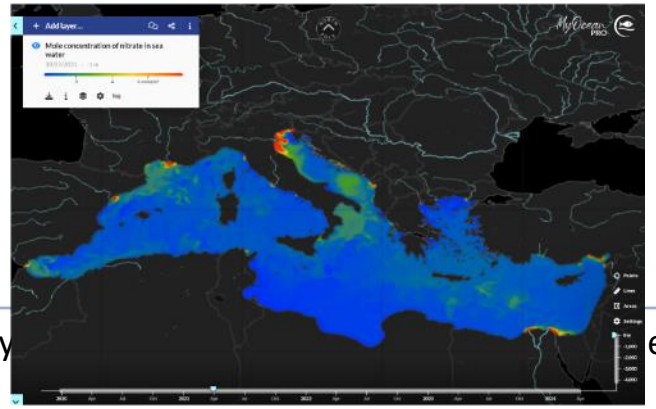
*May cause **biodiversity alterations** and adversely affect food-web integrity*



# The Mediterranean Sea

- *Is regarded as an "**oligotrophic** (low nutrients & chlorophyll)" basin*
- *However, it is characterized by several well documented **eutrophic** areas (e.g. North Adriatic Sea)*
- *Eutrophic areas are close to the **coast** (due to continental inputs, land-sea interactions, human activities)*
- *In eutrophic areas nutrient concentrations can reach very **high levels** in comparison with open waters*



# Quality control:

- ❑ *The assessment of spatial and temporal trends of marine eutrophication requires **validated** data collected over years by multiple, sometimes heterogeneous, sources*
- ❑ *Data **Quality Control**: a fundamental step of data management*

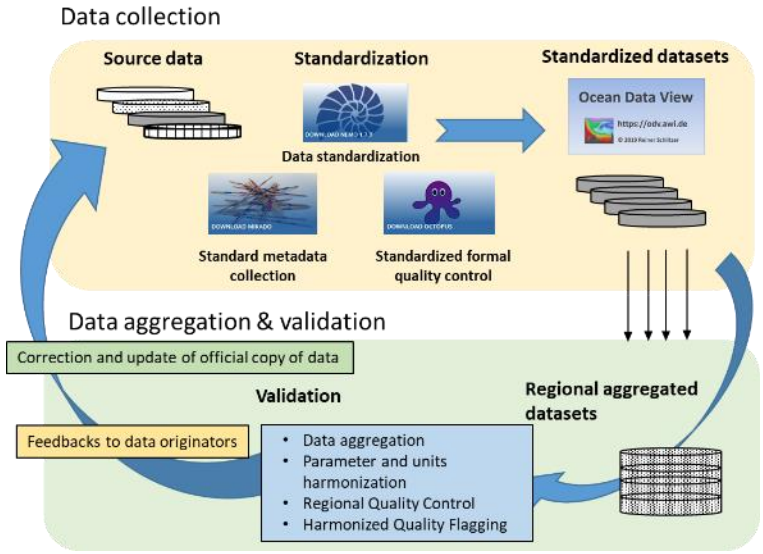
*Standard steps of data Quality Control:*

On metadata:

- ❖ Date and time
- ❖ Latitude and longitude (position not on land)

On data:

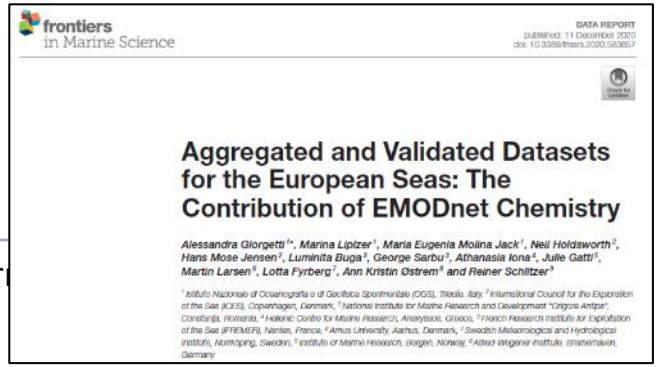
- ❖ Null/missing values
- ❖ Range check:
  - global
  - **regional**
- ❖ Spikes
- ❖ Vertical stability and bottom depth
- ❖ Comparison with climatology




https://doi.org/10.3389/fmars.2020.583657

**However**:
Regional ranges may not be suitable for coastal data, due to their natural high variability

*… to verify if data lie within expected extremes encountered in the oceans, in a particular region or period (SDN, 2010; U.S. Integrated Ocean Observing System V2.1, 2018; Garcia et al., 2024 – World Ocean Atlas)*

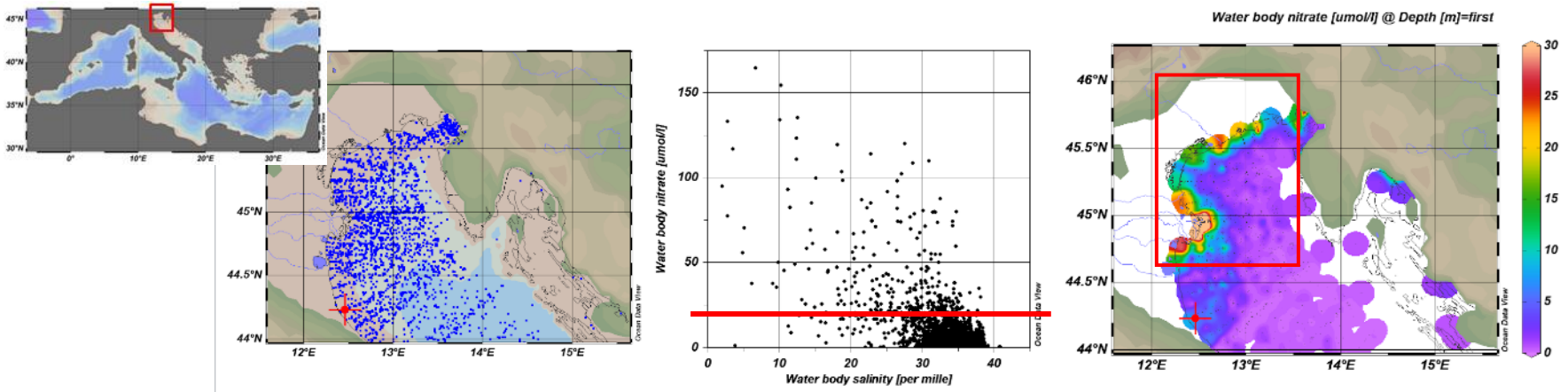

frontiers in Marine Science

DATA REPORT

Aggregated and Validated Datasets for the European Seas: The Contribution of EMODnet Chemistry

# The Mediterranean – North Adriatic case study

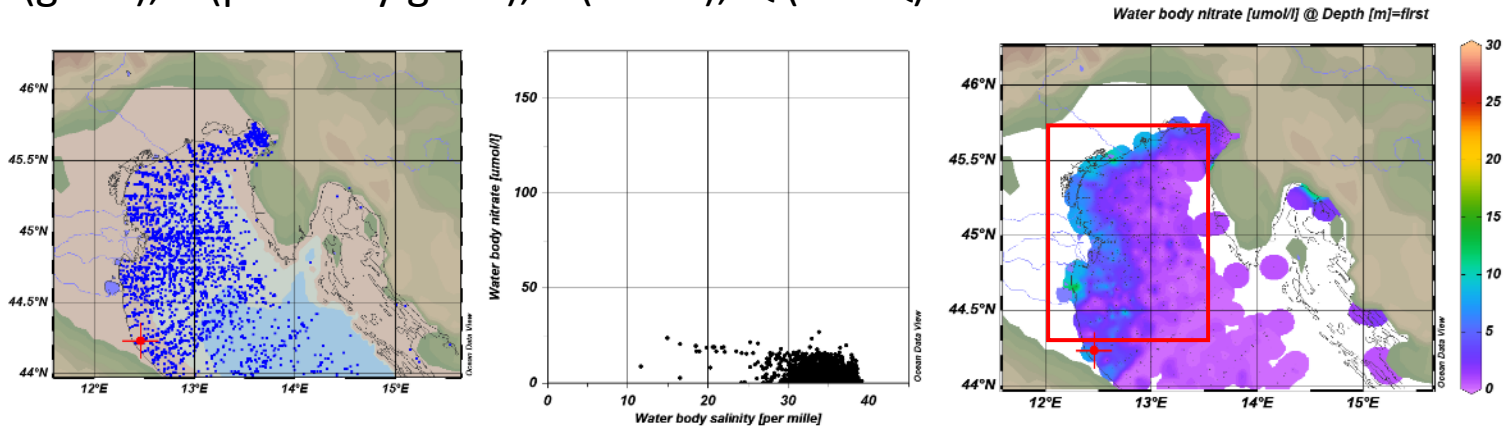
Profile-type - all data – before «regional range» check*:




*Regional range for Nitrate in DJ1 - North Adriatic, 0-200m depth: 0 – 16.0 µmol/l

Coastal eutrophication no longer visible

Only QF 1 (good), 2 (probably good), 6 (< LoD), Q (< LoQ):




| | |
|---|---|
| 0 | no quality control |
| 1 | good data |
| 2 | probably good |
| 3 | probably bad |
| 4 | bad data |
| 6 | Below limit of detection or 0 |
| Q | Below limit of quantification |

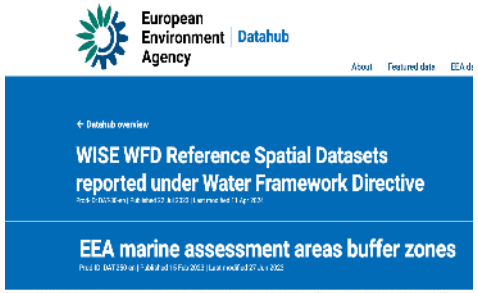
## Purpose of this work:

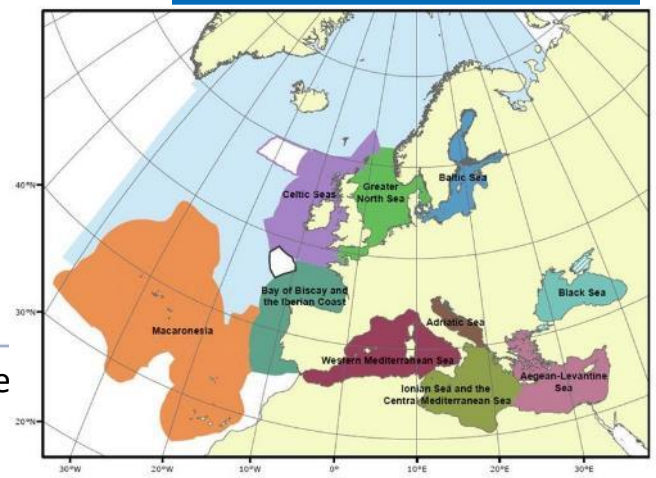
evaluate ranges of biogeochemical parameters in **coastal** waters to help data validation using data accessible through EMODnet Chemistry.

❖ Need of area-specific ranges.

## Approach:

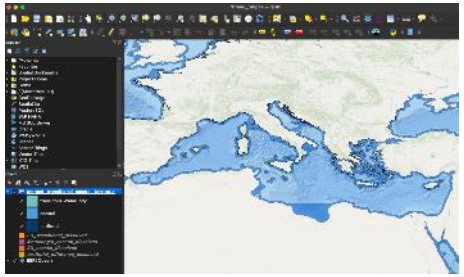
- ❑ Need of definition of transitional, **coastal**, territorial and open waters using a common and standard approach at Mediterranean scale (EU WFD, 2000 & MSFD, 2008):
- ❑ Due to unavailability of official “coastal waters” and “transitional waters” for the whole basin, analysis limited to the MSFD region. All available data have been used for open waters
- ❑ To support the EU directives: analysis at MSFD sub-basin scale (Western Med, Adriatic Sea, Ionian Sea and Central Med, Aegean and Levantine Sea)



# Filtering different waters from the EMODnet Chemistry Mediterranean Sea aggregated collection:

- EEA marine assessment areas buffer zones (2022)
- WISE WFD Reference Spatial Datasets reported under Water Framework Directive 2022 (2023)



- Maritime Boundaries Geodatabase: Territorial Seas (12NM) (2023)

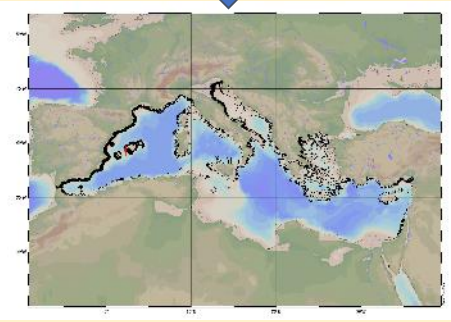
Merged shapefile (with new attribute: transitional-coastal-territorial waters)

- Mediterranean Eutrophication Aggregated datasets 1911/2022 v2023 Resource identifier: 74158cb0-a21f-42ea-8a29-72a96b2a0da2

4 datasets corresponding to MSFD subregions:

- ❑ Adriatic;
- ❑ Aegean-Levantine;
- ❑ Central and Ionian;
- ❑ Western Med

4 datasets with an **additional metavariable:** water type (transitional, coastal, territorial, other)

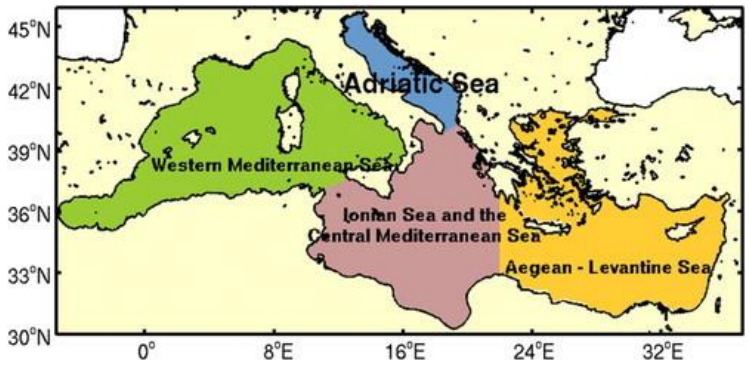


Aggregated ODV collections with the additional metavariable for the surface water type that allows filtering stations.
In addition: the datasets have been analysed by depth range (0-74.99; 75-199.99; +200)

## Analysis on following datasets:

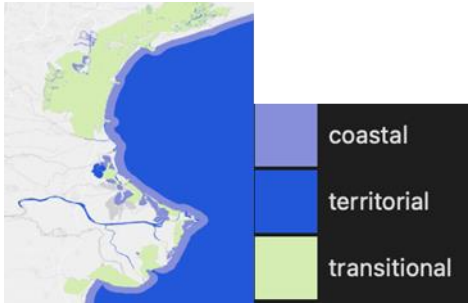
**4 MSFD subregions:**

- ❑ **Adriatic;**
- ❑ **Aegean-Levantine;**
- ❑ **Central and Ionian;**
- ❑ **Western Med**




**4 water types:**

- ❑ transitional
- ❑ **coastal**
- ❑ territorial
- ❑ open




**3 depth ranges:**

- ❑ **0-74.99 m;**
- ❑ **75-199.99 m;**
- ❑ > 200 m

**Selected variables:**

- ❑ **nitrate**
- ❑ nitrite
- ❑ ammonium
- ❑ **phosphate**
- ❑ **silicate**
- ❑ …

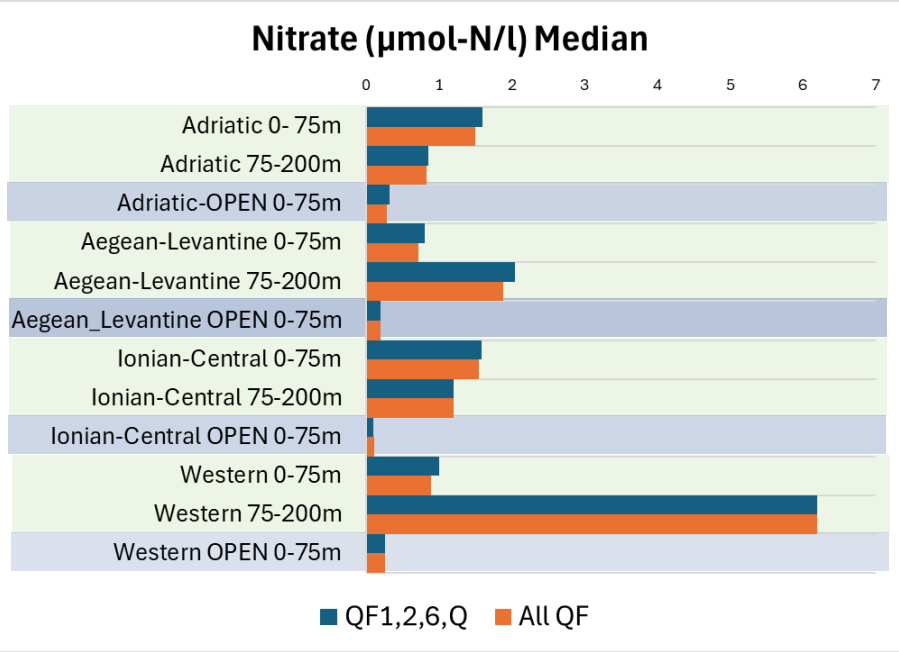
**For each dataset:**

- ❖ Considering all data (regardless of Quality Flag - QF)
- ❖ Considering QF 1, 2, 6, Q
  - ➢ min
  - ➢ **Max**
  - ➢ mean
  - ➢ standard deviation
  - ➢ **median**
  - ➢ 25 - 75 – **99$^{th}$ percentile**

**Comparison with existing "upper ranges" (maxima per sub-basin):**

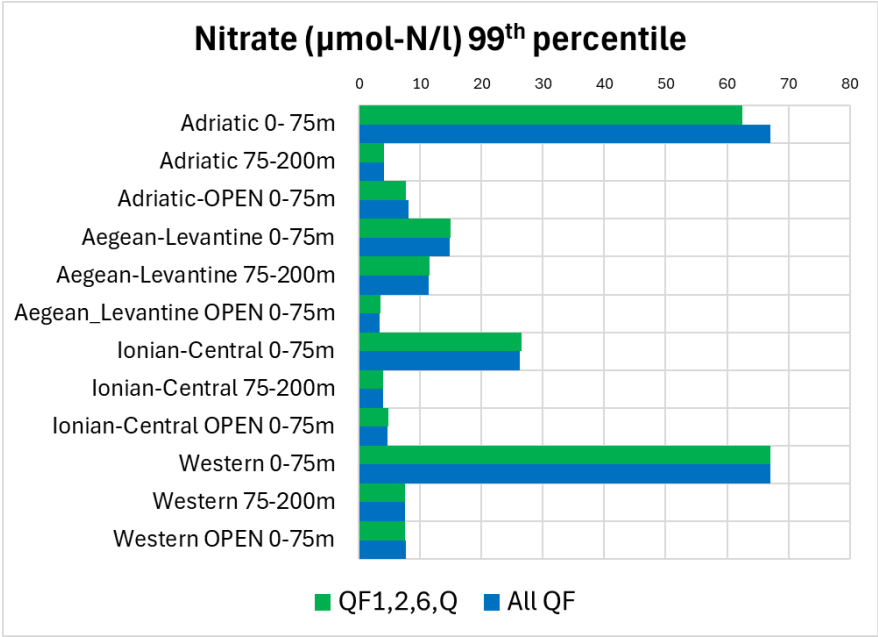
| | 0-200 m | 0-200 m | 0-200 m |
|---|---|---|---|
| | Nitrate (umol/L) | Phosphate (umol/L) | Silicate (umol/L) |
| Maximum Western Med | 50 | 2 | 40 |
| Maximum Central Med | 9 | 1 | 10 |
| Maximum Adriatic | 16 | 1,5 | 60 |
| Maximum Aegean | 7 | 7 | 20 |

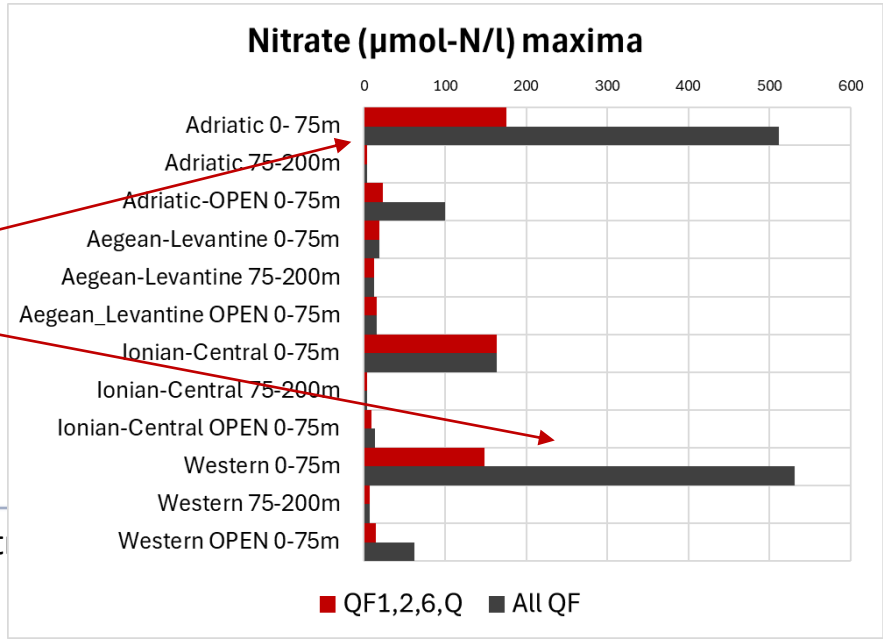
**Results:** Nitrate - comparison of statistics of all data (regardless of Quality Flag) and data with QF 1, 2, 6 and Q




coastal

open




- ➔ "Validated data" and «all data» do not show remarkable differences (median and 99° percentile)
- ➔ Remarkable differences only observed in maxima in the Adriatic and Western Med (0-75m)
- ➔ Highest concentrations (99th percentile & maxima) are always observed in the upper 0-75 m

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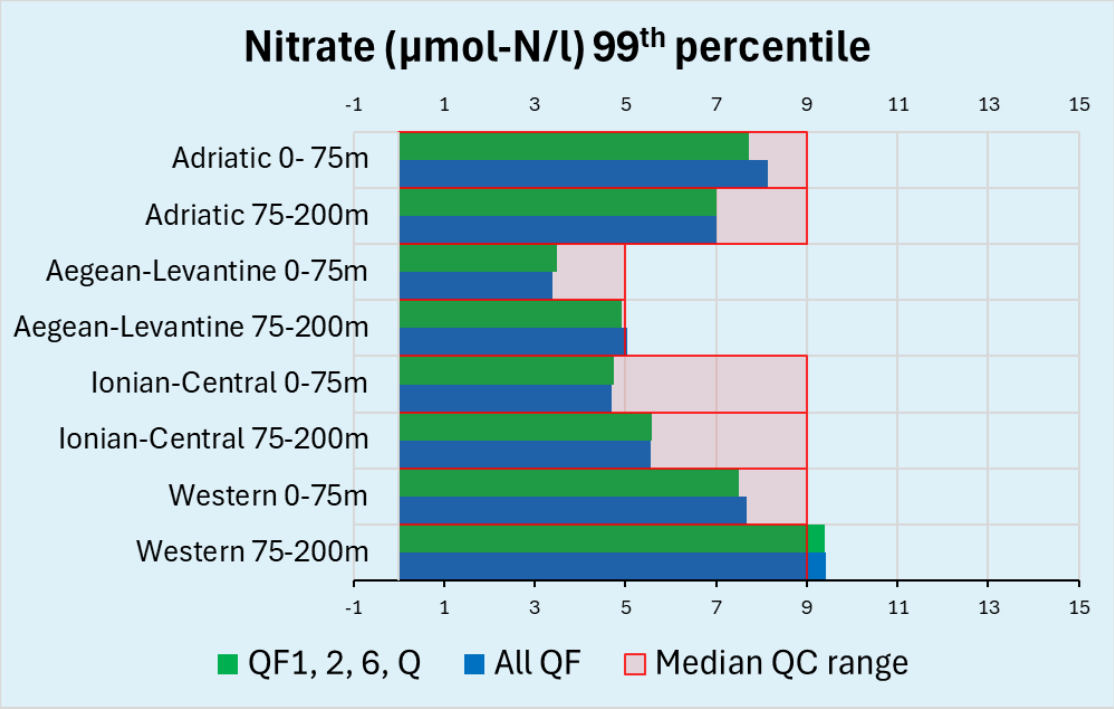
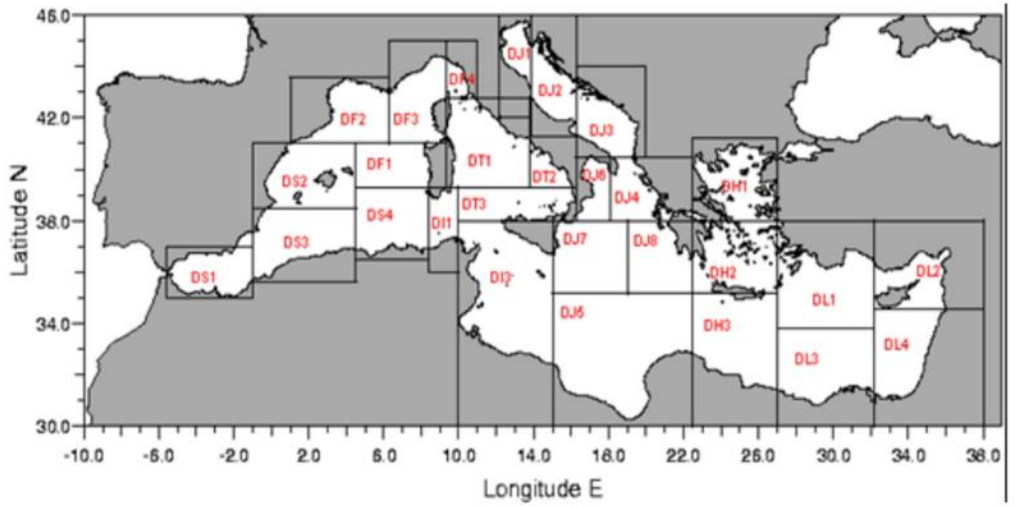
Broad ranges for quality control of coastal data related to marine eut

**Results:** Nitrate and current upper ranges for data quality control

Open waters:




Upper ranges:

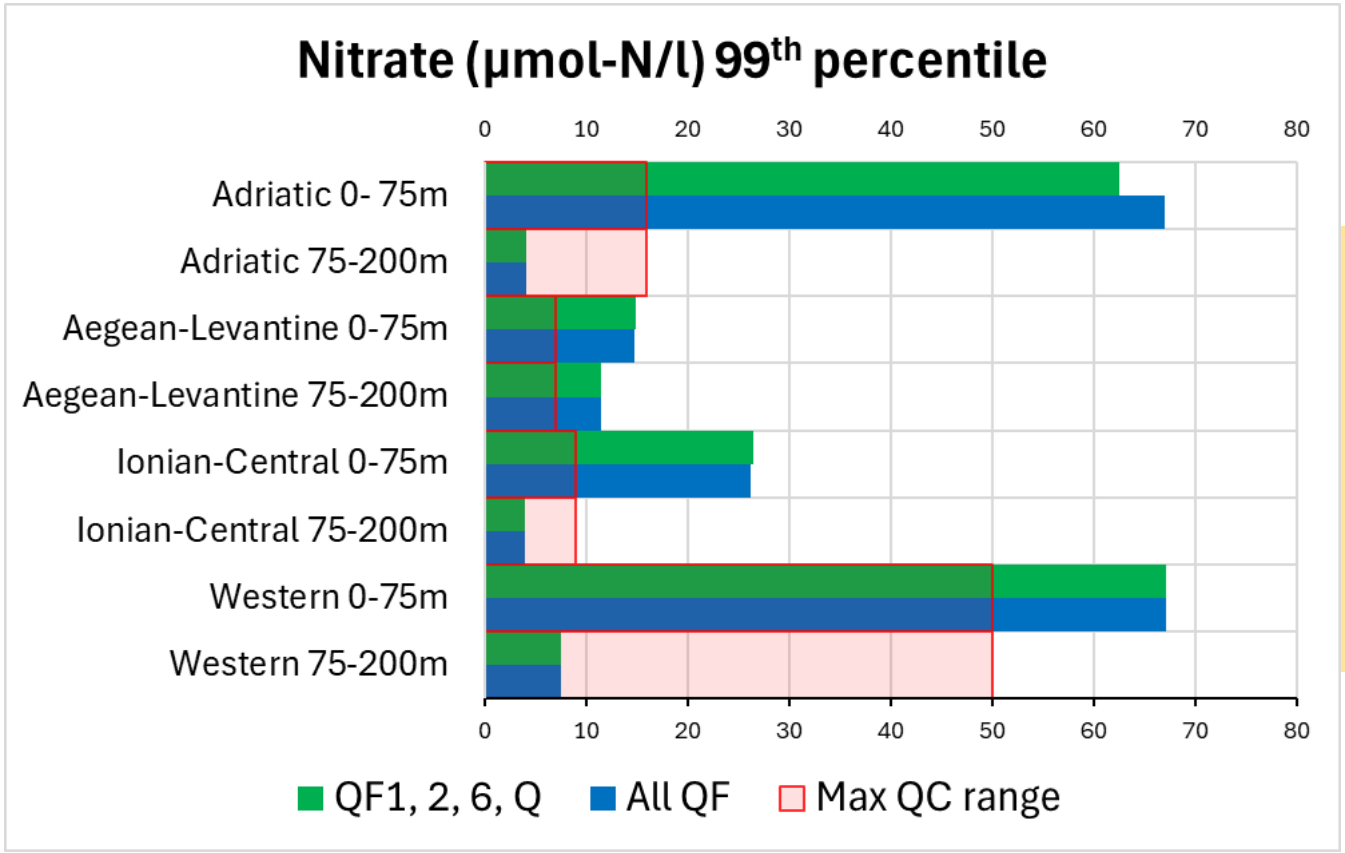


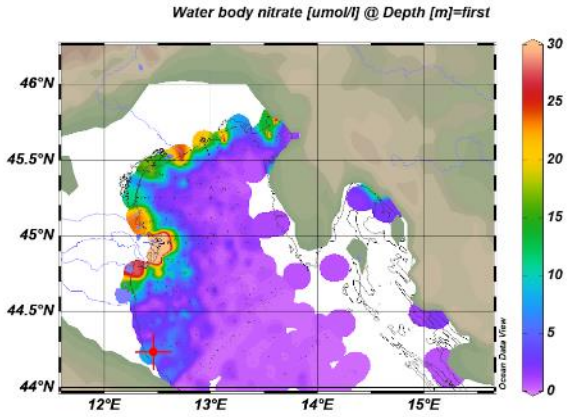

| Nitrate (umol/L) 0-200 m | Median | 99th percentile | Max |
|---|---|---|---|
| Western Med | 9 | 46 | 50 |
| Central Med | 9 | 9 | 9 |
| Adriatic | 9 | 16 | 16 |
| Aegean | 5 | 7 | 7 |

➔ Current regional ranges (median) capture 99% of data variability of open waters
➔ Current regional ranges are generally suitable for data QC for open water

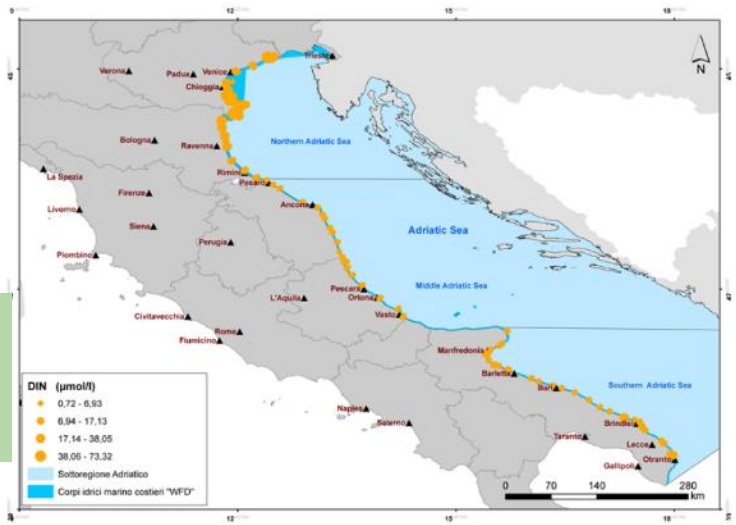
**Results:** Nitrate and current upper ranges for data quality control

Coastal waters:



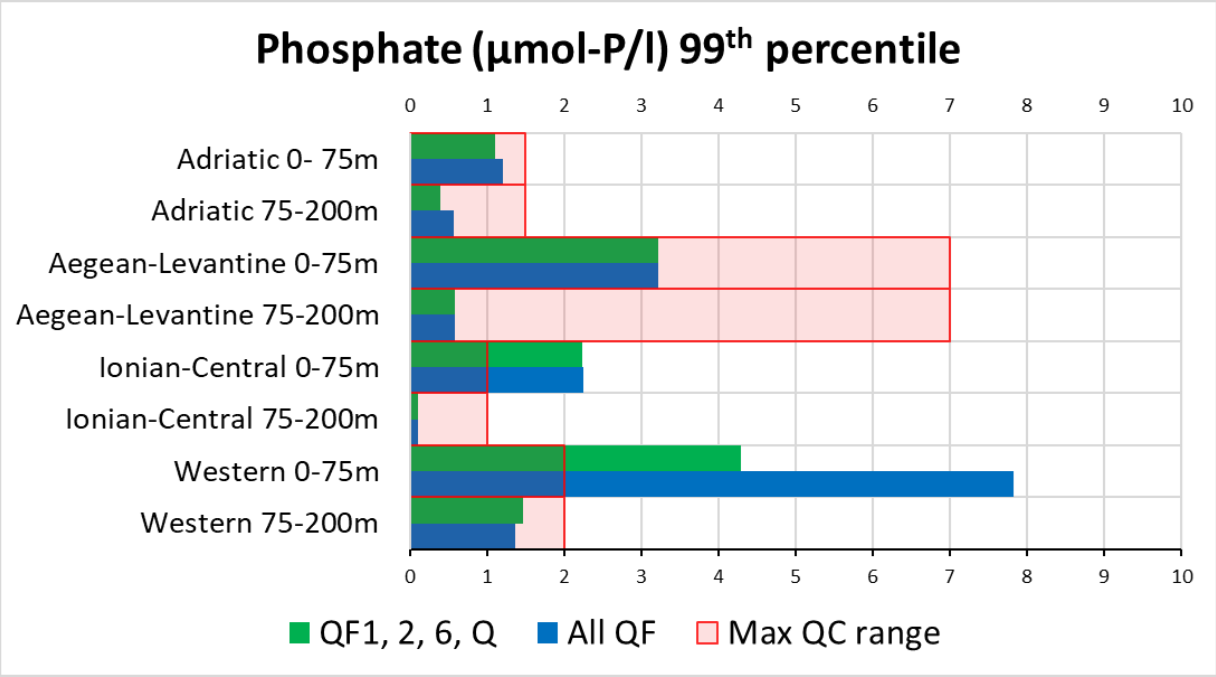

- ➔ most of variability in the 0-75 m
- ➔ Even the highest upper ranges per sub-basin will not fit a large part of data in the upper layer concentrations in coastal waters
- ➔ Ranges too low for the Aegean-Levantine also >75m
- ➔ Data exceeding Upper ranges would be coded as “bad data”

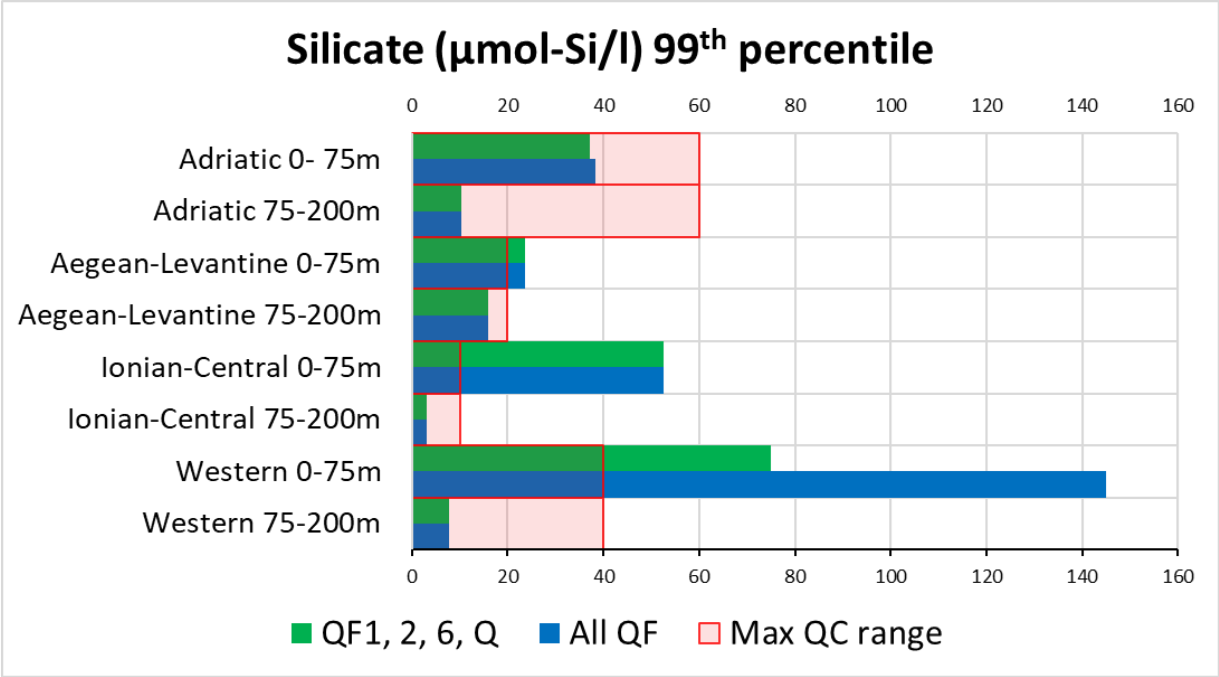



MSFD reports confirm concentrations observed

**Results:** Other nutrients:

Coastal waters:




- ➔ most of variability in the 0-75 m
- ➔ Only in the Western Med upper layer there is a significant difference between all data and QC data
- ➔ Phosphate: upper variability exceeds upper range in the Ionian and Western Med
- ➔ Silicate: upper variability exceeds upper range in the whole Med except the Adriatic

→Clear need of revised «regional ranges» for coastal waters

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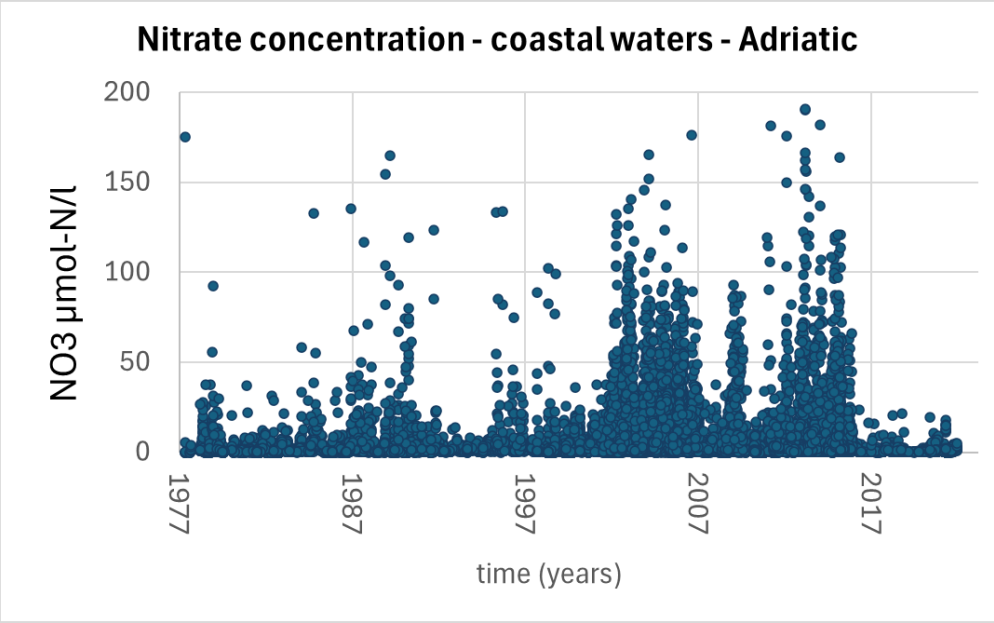
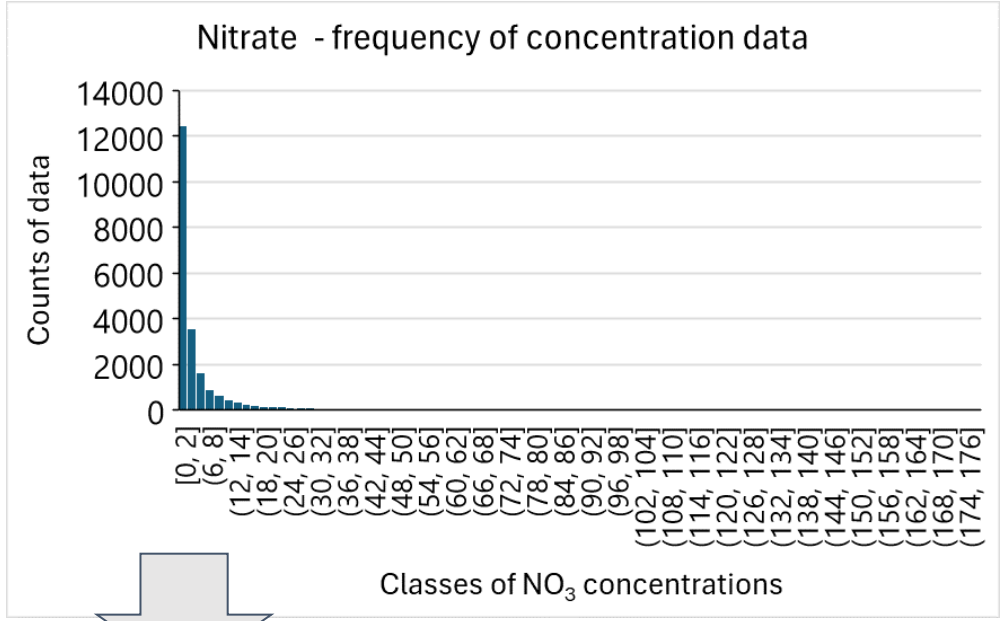
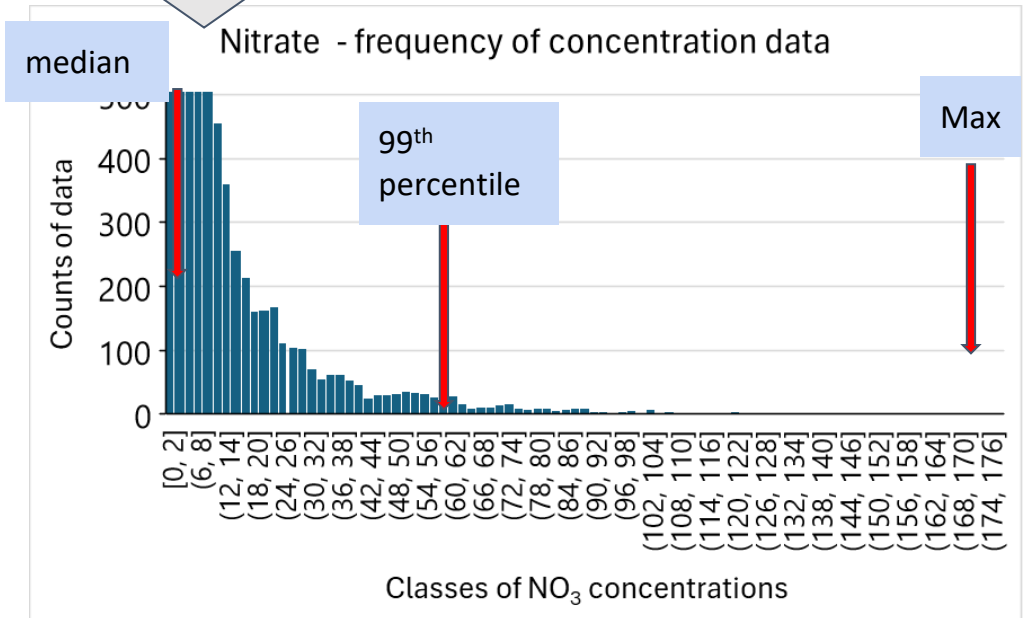
# Proposal of selection of upper concentrations to guide data Quality Control:

Given the not normal data distribution:




- 99th percentile as QF1 limit (data < 99th percentile are QF1; data > 99th percentile are QF2)
- Max as QF2 limit (data > Max are QF3)

# Main outcomes:

Considering the statistics of the major nutrients (nitrate, phosphate and silicate) in coastal and open waters (data analysed but not presented here):

- ➔ existing concentration ranges used for data QC are adequate to validate open water data
- ➔ For coastal waters, especially in the 0-75 m depth, **higher upper ranges** should be adopted for nitrate, silicate, and in the Central and Western Mediterranean also for phosphate
- ➔ This work indicates the importance of dedicated ranges for upper layers (new)
- ➔ Clearly different concentrations in the 0 - 74.99 m and 75 - 199.99 m layers
- ➔ Comparison with published data (MSFD report - Italy) supports the correctness of "out of range" data
- ➔ Concentration maxima need to be carefully inspected to evaluate if they are realistic (--> literature comparison, expert knowledge)
- ➔ *This methodology can be used also in the other sea basins*

# Shortcomings:

- ❏ Need of “coastal waters” shapefiles for all countries (official layers)
- ❏ Need to easily filter coastal data to support data QC
- ❏ *Continuum* in inland – transitional – coastal – open waters (ranges calculated using official – artificial limits!)

# Next steps:

- ❖ Analysis also on transitional waters and on further parameters (ongoing)
- ❖ Implement into data QC process: proposal to filter different water types:
  - tag in the metadata (CDI) (quick filtering on metadata)
  - provide shape files in ODV (filter on the data collections)

- ❖ Expert knowledge always required for coastal and transitional areas (not only automatic QC!)

# Thanks for your attention!

This study contributes to activities relatated to environmental data validation, required to provide data and information to support good environemntal status assessment, biodiversity conservation and maritime spatial planning, in the framework of PNNR National Biodiversity Future Center.

**Funder**: Project funded under the **National Recovery and Resilience Plan** (NRRP), Mission 4 Component 2 Investment 1.4 - Call for tender No. 3138 of 16 December 2021, rectified by Decree n.3175 of 18 December 2021 of Italian Ministry of University and Research funded by the European Union – NextGenerationEU;

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