Geospatial workflows and potential applications to the Sustainable Development Goals of countries in West Asia

Ameer Abdulla, PhD
Senior Advisor, European Topic Center for Spatial Analysis, Spain
Associate Professor, University of Queensland, Australia

Main contributors:

- Ameer Abdulla (ETC-UMA Senior Advisor; Assoc. Prof. GCI,UQ)
- Dania Abdul Malak (ETC-UMA; Director)
- Christoph Schröder (ETC-UMA; GIS and Data Specialist)
- Marco Trombetti (ETC-UMA; Landscape Ecology and Management Specialist)

Outline

I. Critical role for spatial and temporal information to systematically monitor biodiversity loss and human use
II. Clear workflows are essential to develop monitoring frameworks and useful spatial indicators that can pragmatically measure SDGs (land, coastal and marine related)
III. National workflows standardize data to develop indicators that allow regional comparability and prioritization of interventions

Outline

I. **Critical role for spatial and temporal information to systematically monitor biodiversity loss and human use**

II. **Clear workflows are essential to develop monitoring frameworks and useful spatial indicators that can pragmatically measure SDGs (land, coastal and marine related)**

III. **National workflows standardize data to develop indicators that allow regional comparability and prioritization of interventions**

Potential of spatial information to monitor biodiversity loss and human use

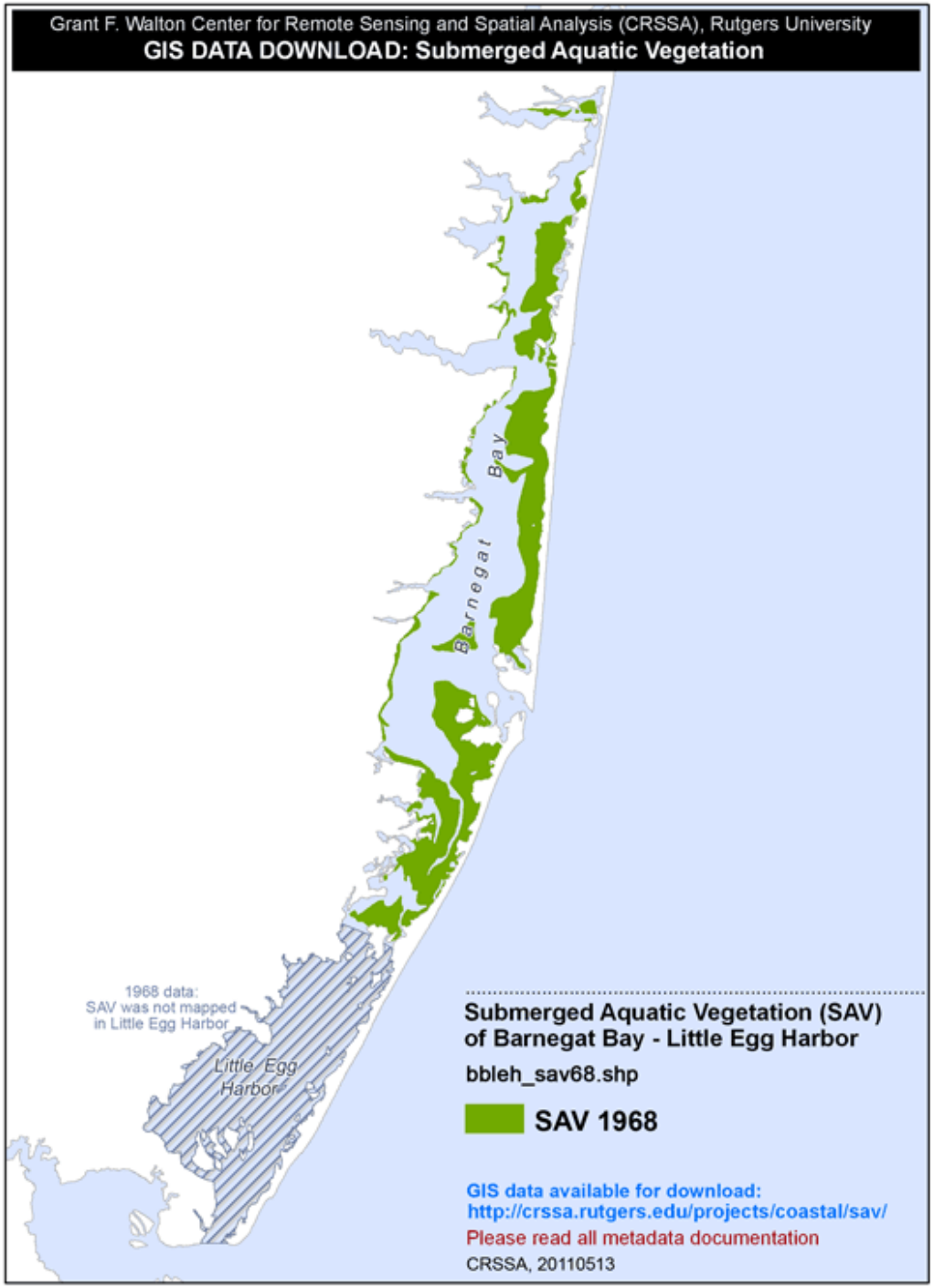
- Monitoring can be done through
  - data coming from observation (inventories, field sampling, field mapping, remote sensing, image interpretation) **=> precise and standardised**
  - modelled data **=> less precise, used for gap-filling**
- Independently of the source, any type of data generated needs to be validated
  - Stake holders
  - Ground truthing in the field

Types of spatial data used for SDG assessments

- NSDI fundamental layers
- Topographic reference layer
- Statistical data with geographic reference
- Sampling/survey data
- Modelled data
- Reporting data
- Remote sensing data

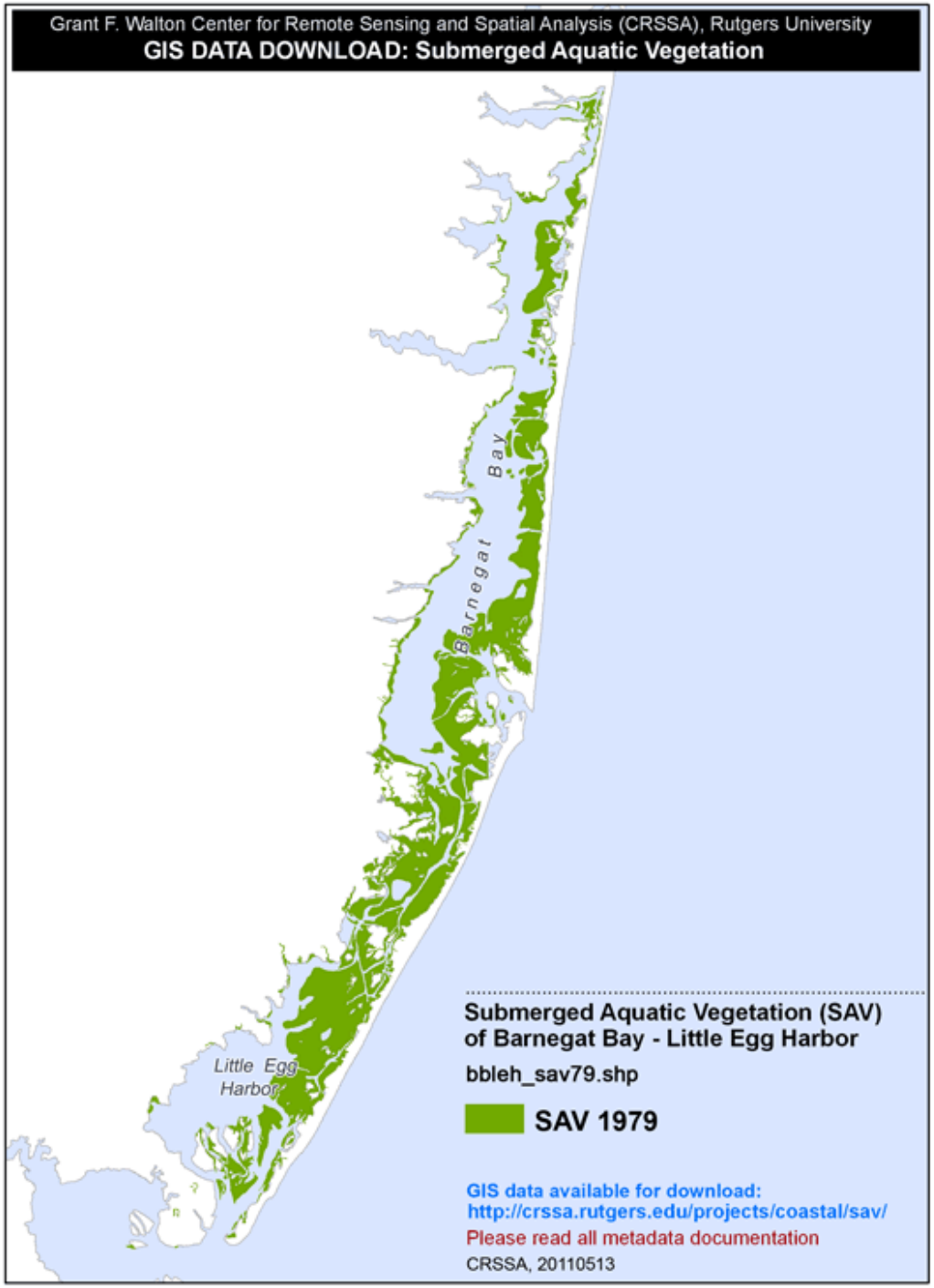
Sampled field data

Submerged Aquatic Vegetation



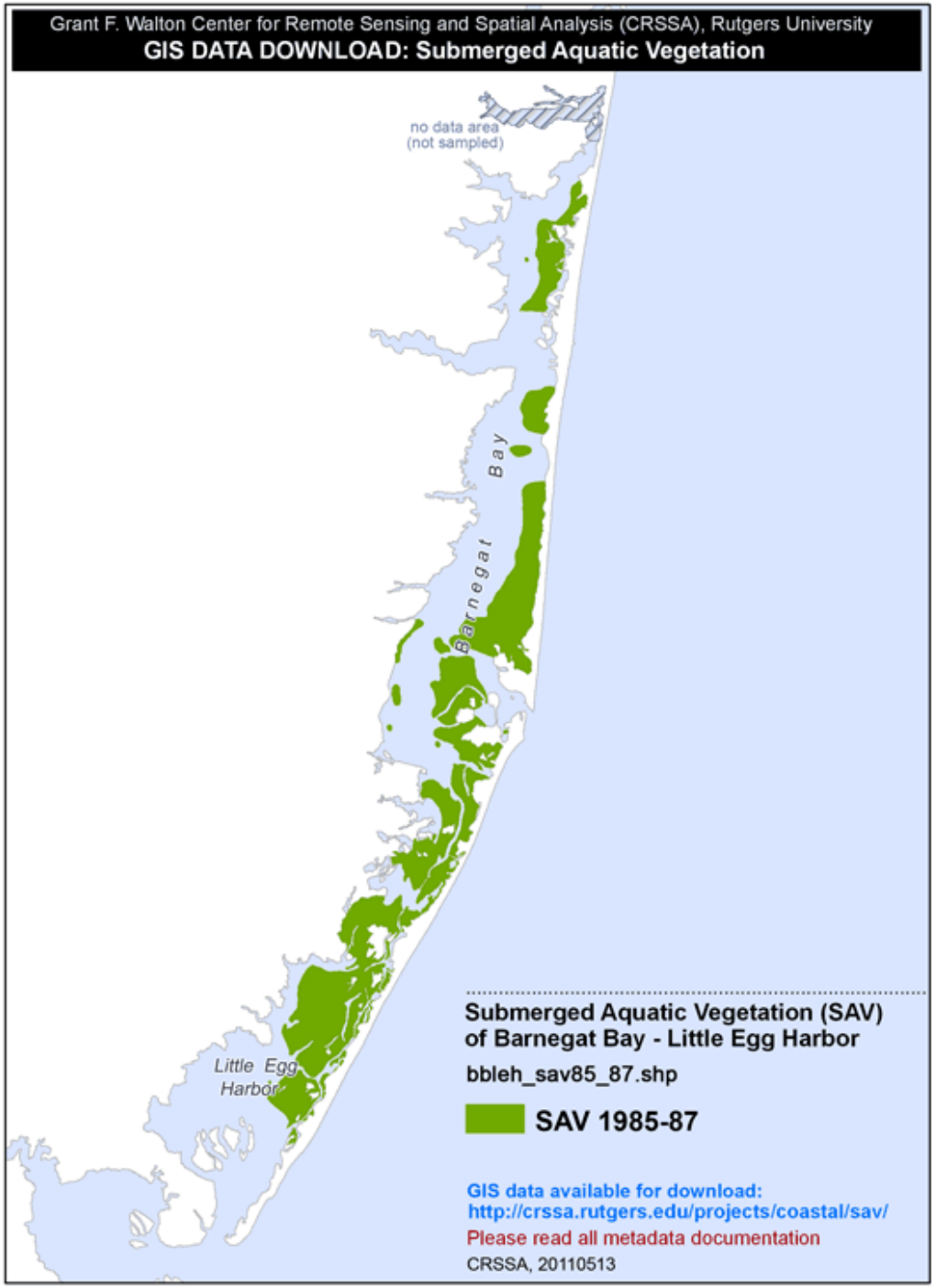
Sampled field data

Submerged Aquatic Vegetation



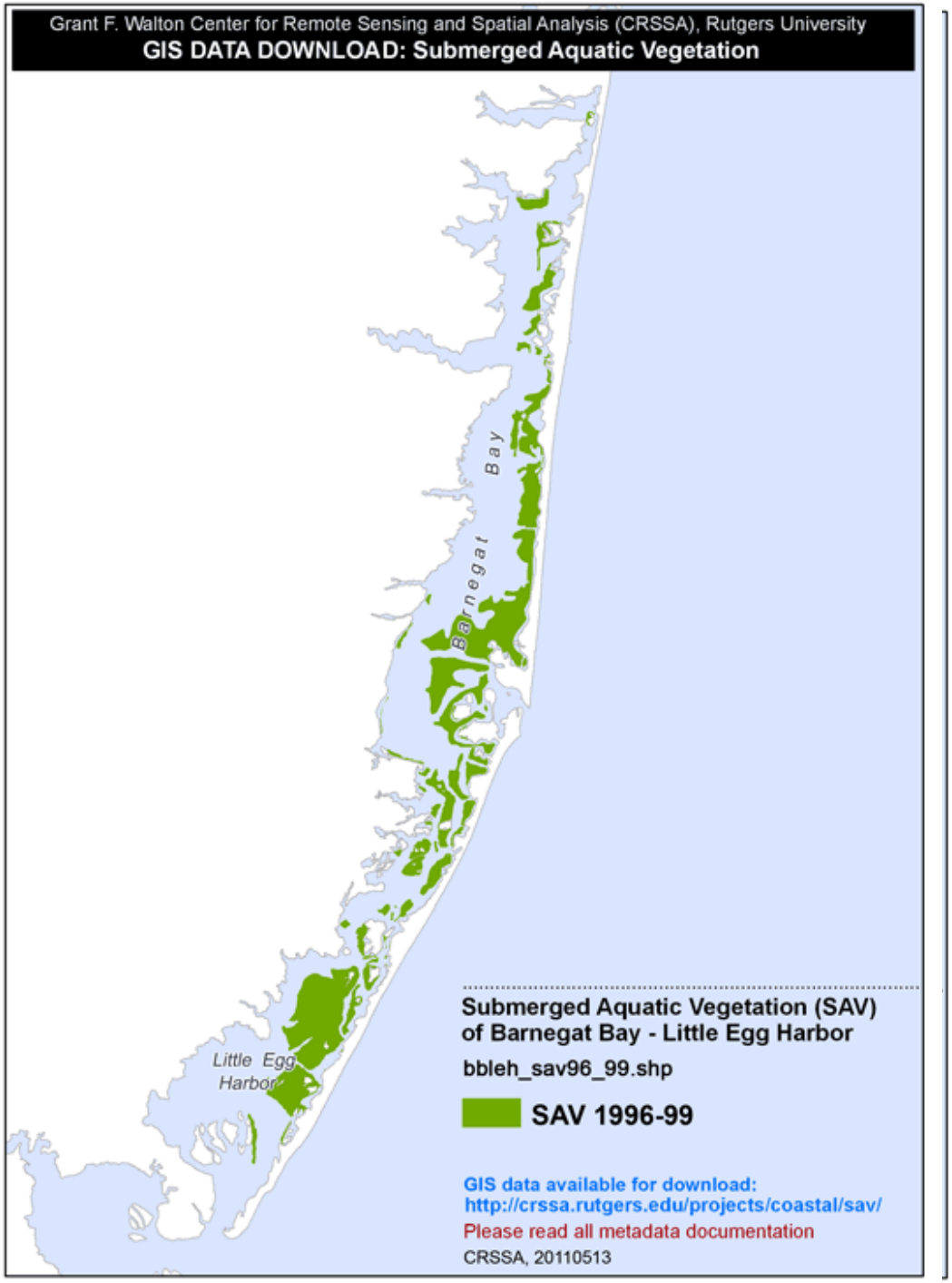
Sampled field data

Submerged Aquatic Vegetation



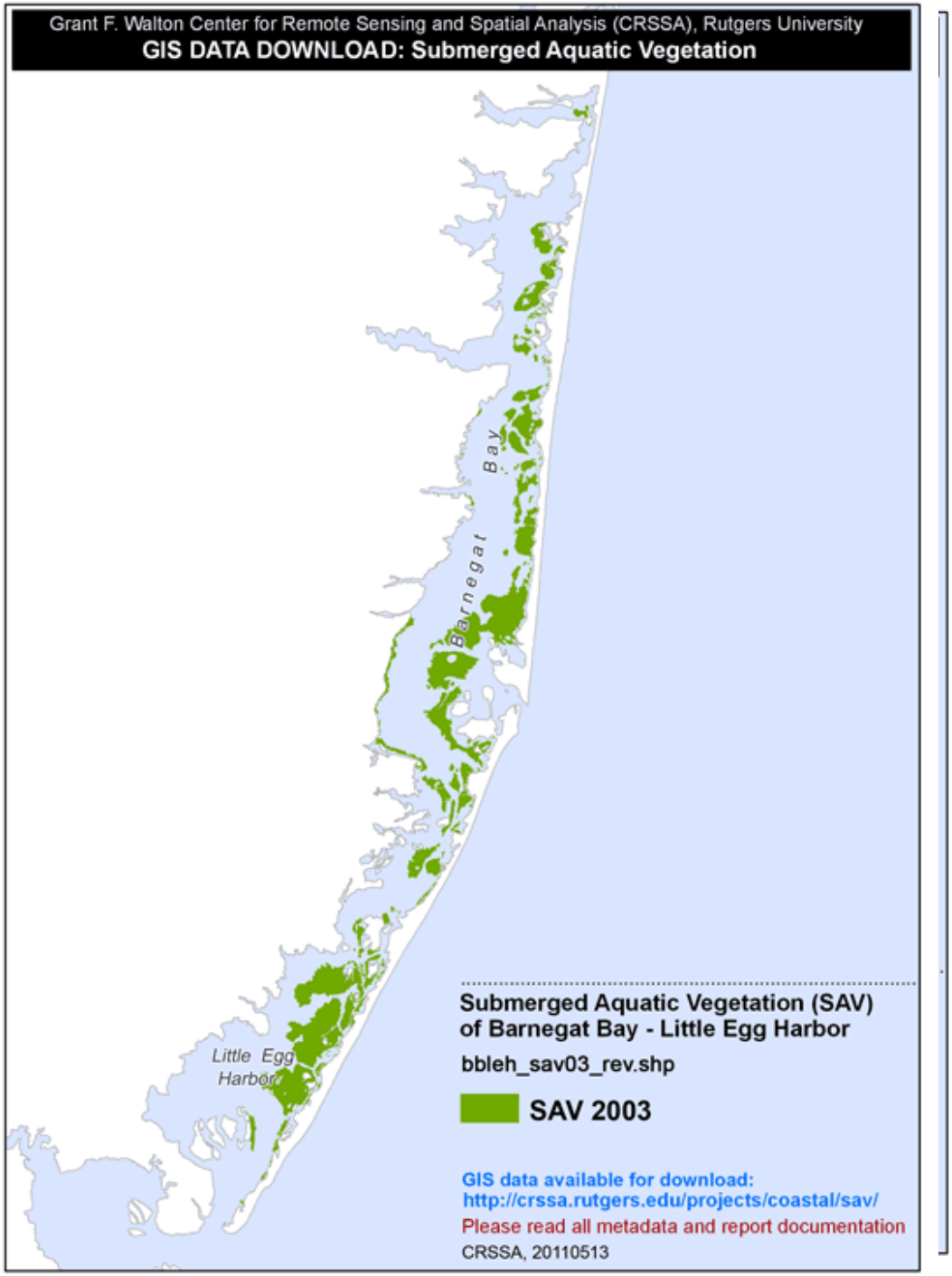
Sampled field data

Submerged Aquatic Vegetation



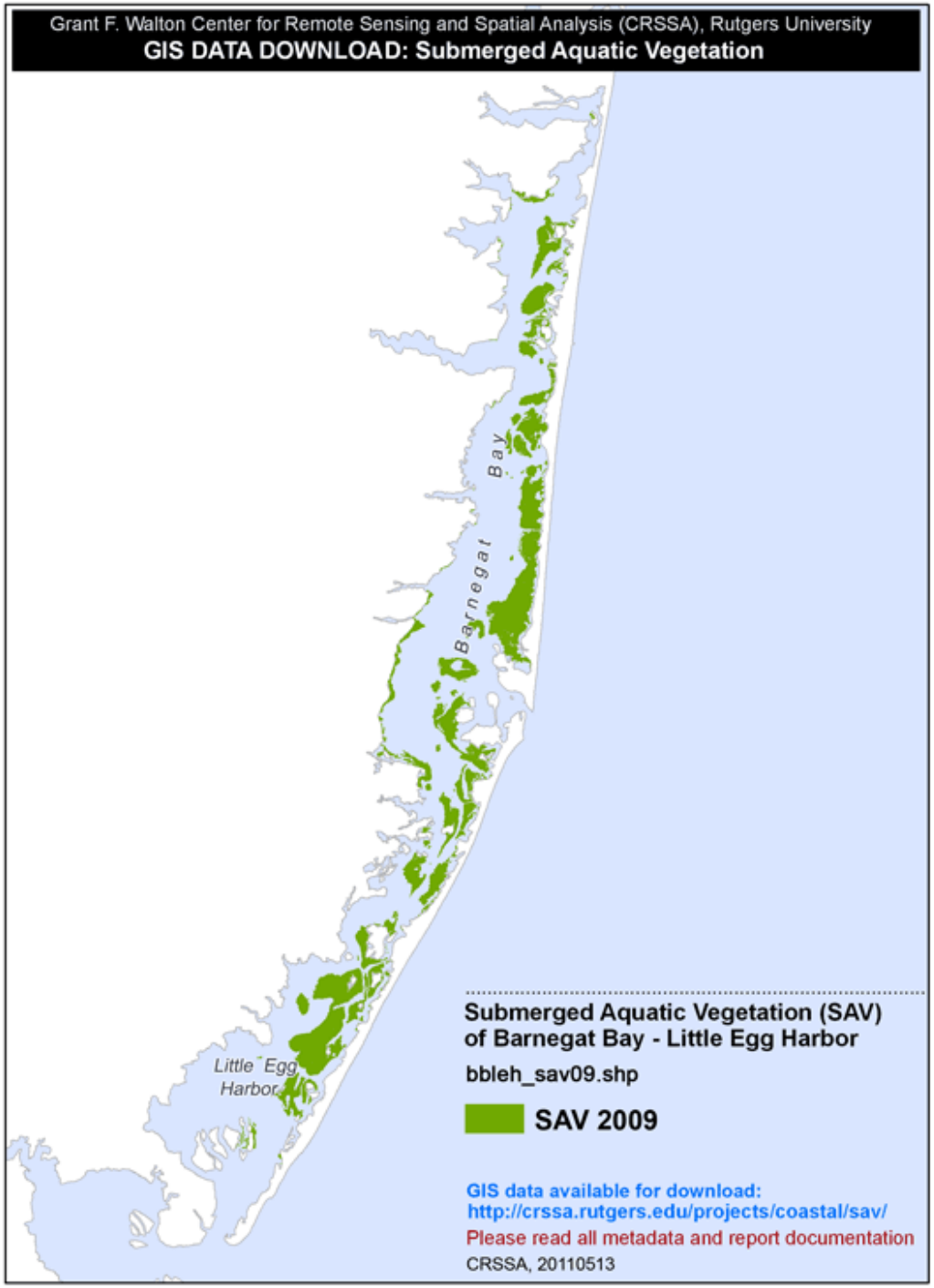
Sampled field data

Submerged Aquatic Vegetation



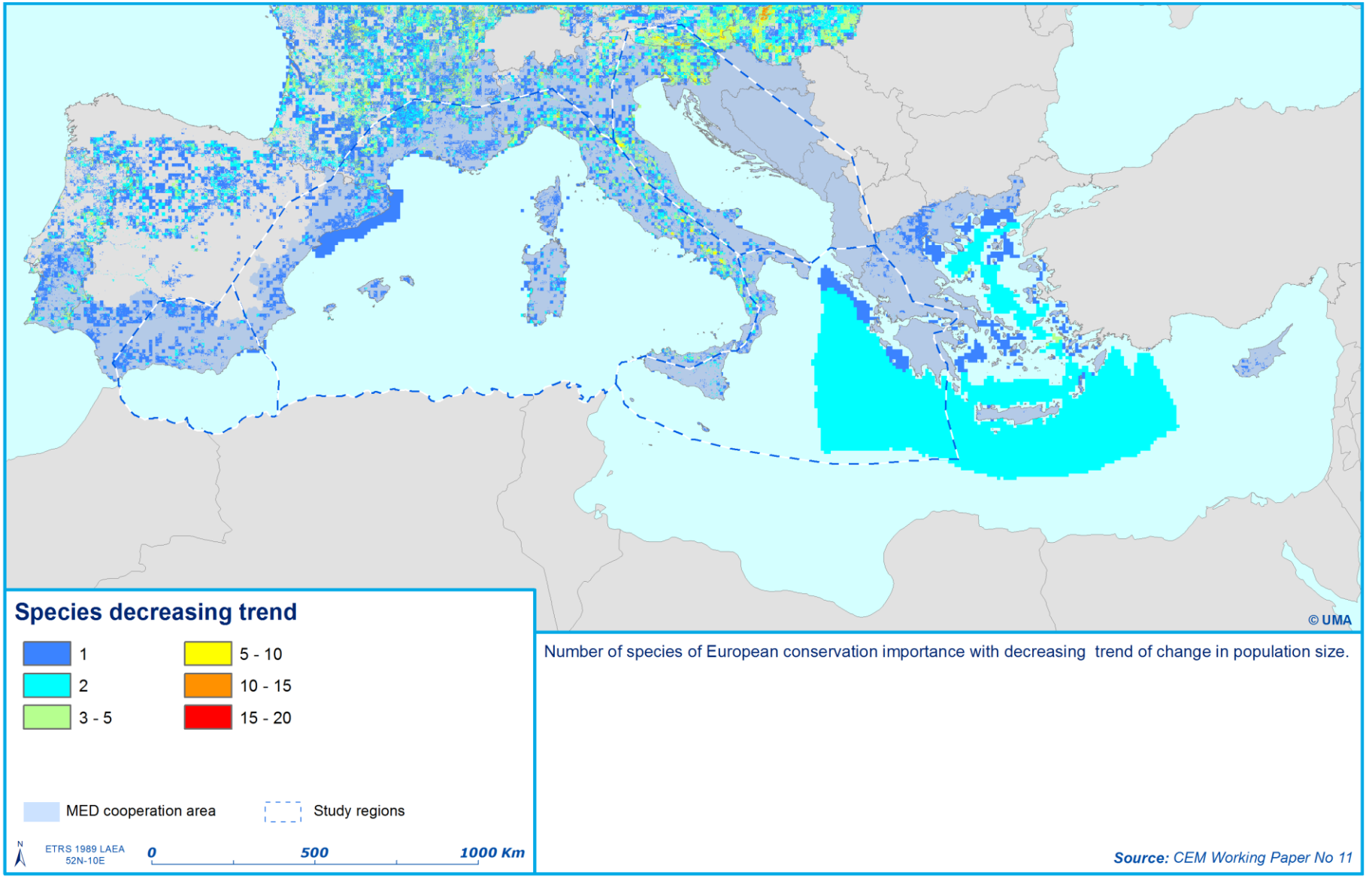
Sampled field data

Submerged Aquatic Vegetation



Reporting data

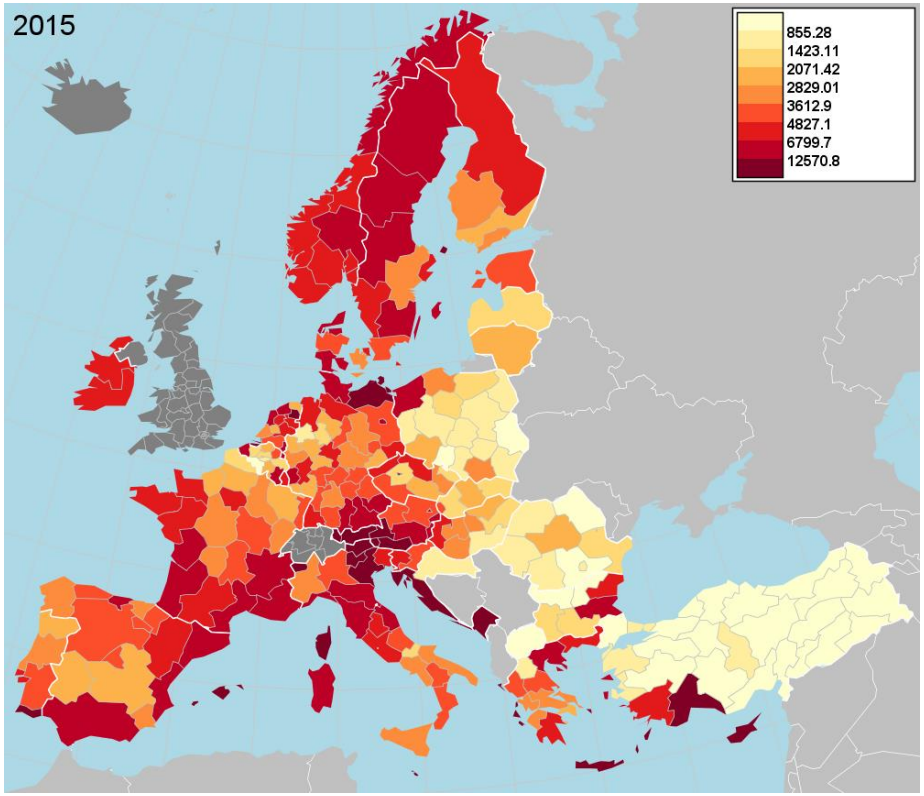
Species of Conservation Importance

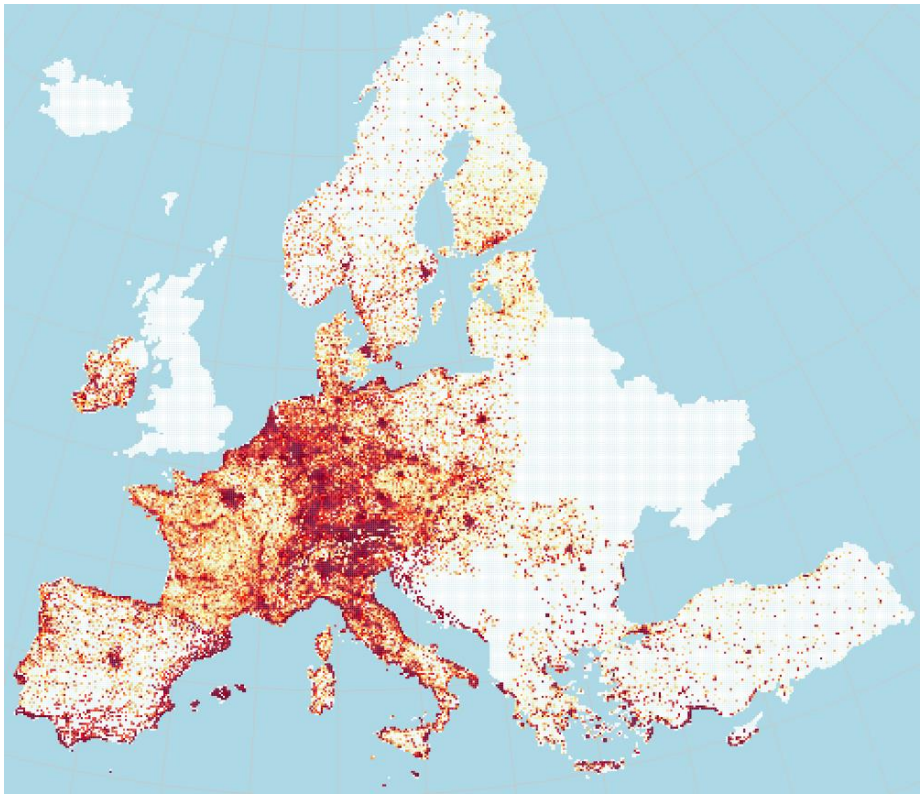


Number of species of European conservation importance with decreasing trend of change in population size.

Source: *CEM Working Paper No 11*

Disaggregating (sub)national statistics

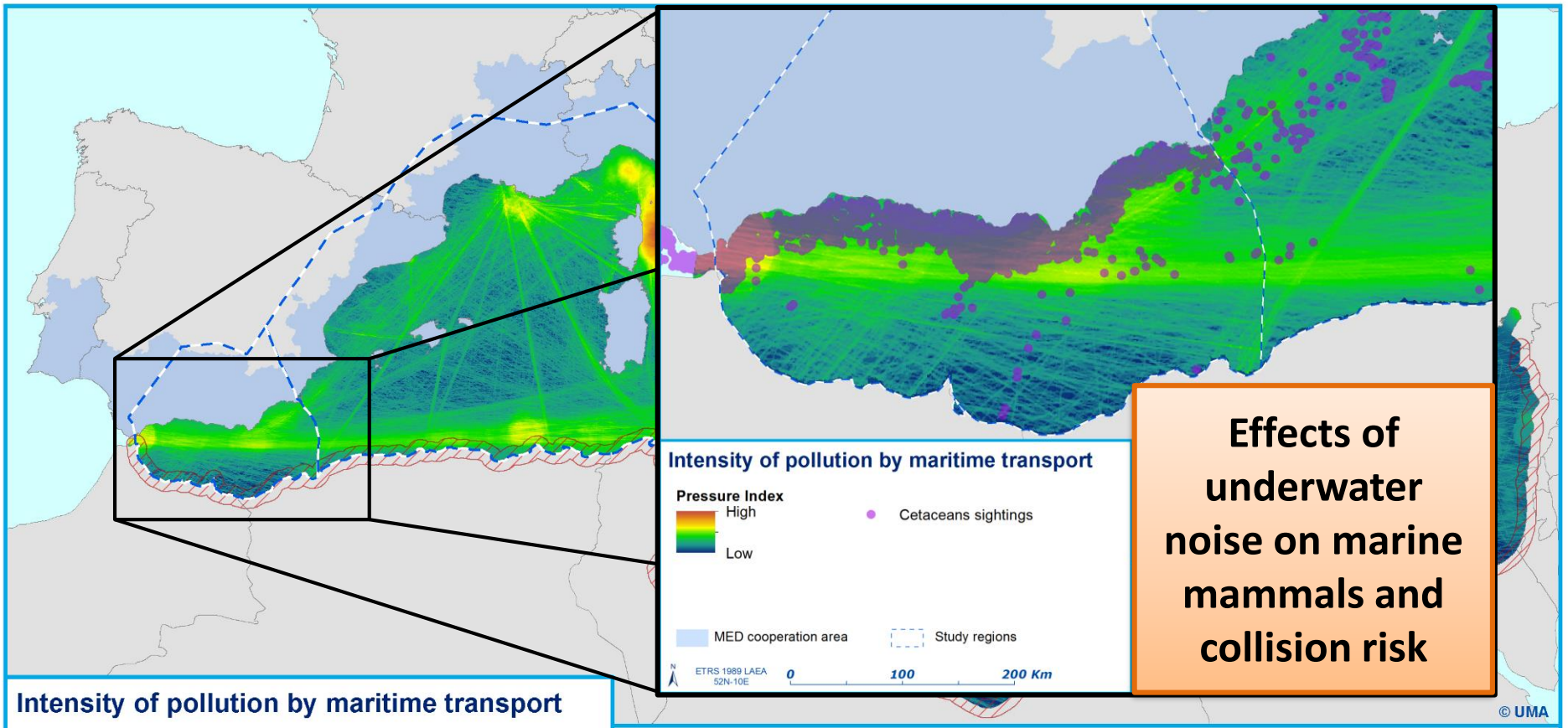




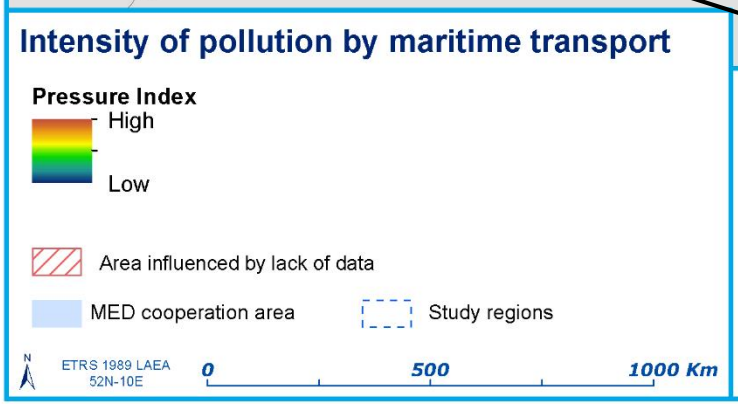
Number of nights spent at hotels (2015) at categorical NUTS 2 level (left) and at 10km grid level (right)

Modelled data based on observed data

Pollution by maritime transport



Effects of underwater noise on marine mammals and collision risk

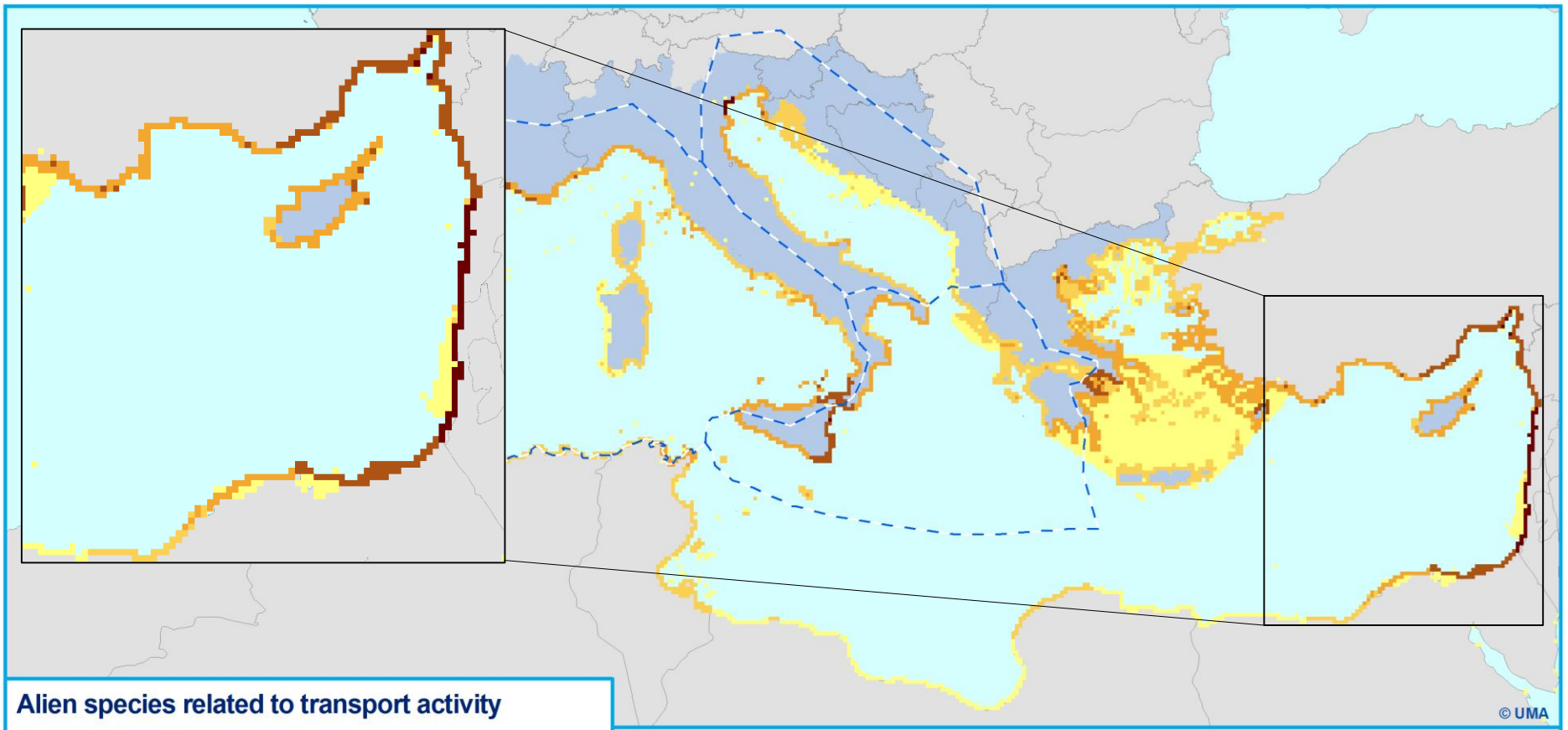


The map represents the degree of pressure based on the intensity of transport in the Mediterranean Sea. Three variables were taken into account: vessels traffic, port activity and oil spills.
Shipping data (Halpern et al., 2008) provide an estimate of the occurrence of ships at a particular location, and therefore an estimate of the amount of pollution they produce (via fuel leaks, oil discharge, waste disposal, etc.), under the assumption that traveling ships primarily affect their immediate waters. The dispersal of port-derived pollution was modeled as a diffusive plume based on data of transport of goods (thousand tonnes) and passengers (thousand passengers). Pressures generated by oil spills and other pollution releases are represented as a density layer based on data registered by the REMPEC, and also the oil spills map generated by Cinirella et al, 2012 (based on JRC 2009 data).

Source: *Eurostat, 2012*
Ocean-Based Pollution, NCEAS, 2008
REMPEC, 1977-2014; Cinirella et al, 2012

Combination of observed & modelled data

Invasive Alien Species (IAS) due to maritime transport

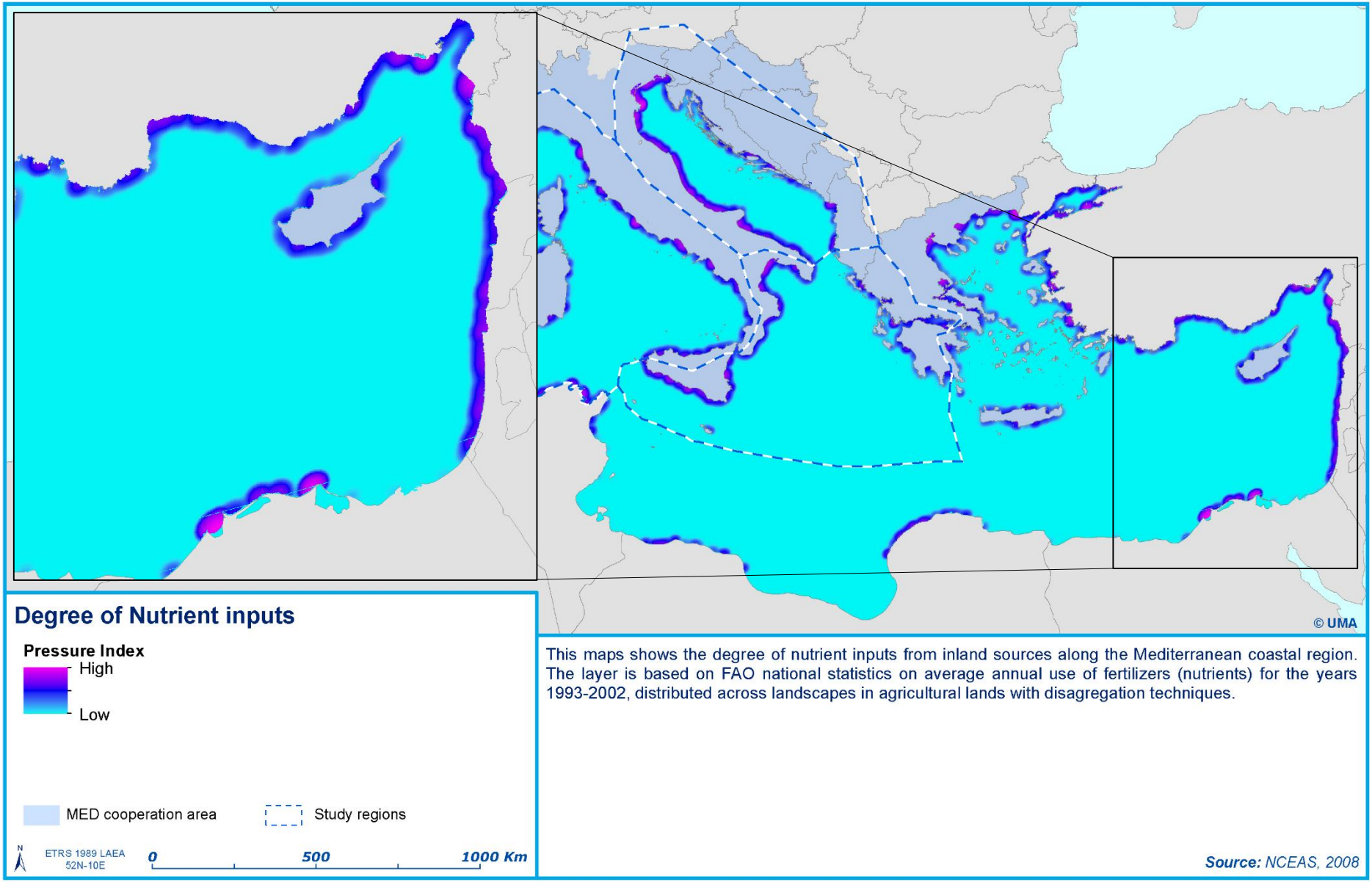


Introduction of alien species by transport is represented by the total number of species that have been introduced due to the activities of vessels and ports in the Mediterranean Sea, according to EASIN (JRC) data. Number of species is distrubed in a grid cell with a resolution of 10 km. Map classifications are based on EASIN criteria.

Source: *EASIN database, JRC, 2014*

Modelled data based on national statistics

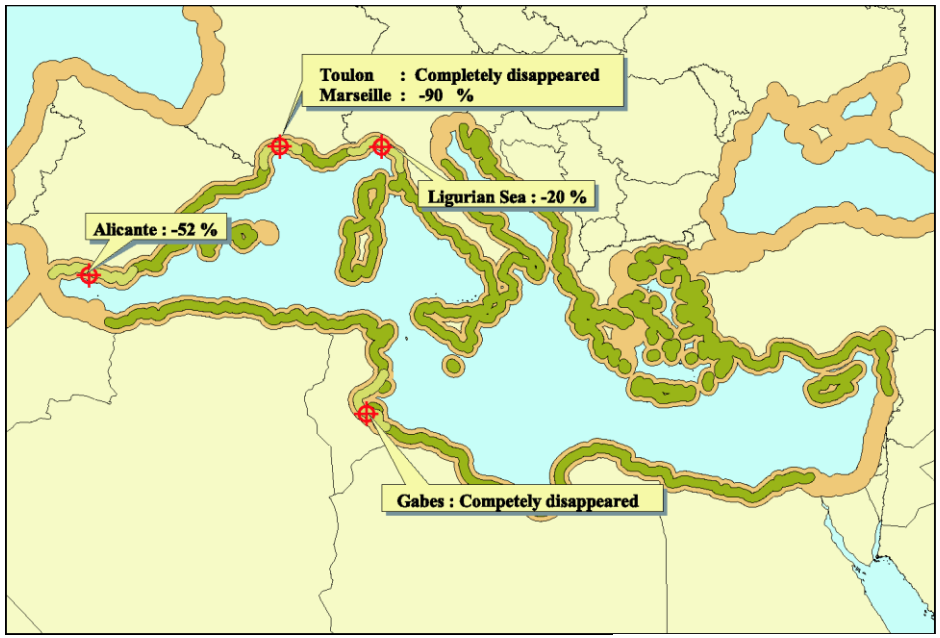
Nutrient Input

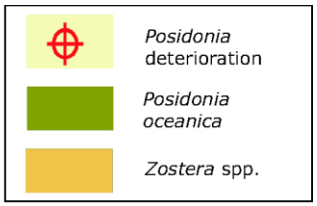


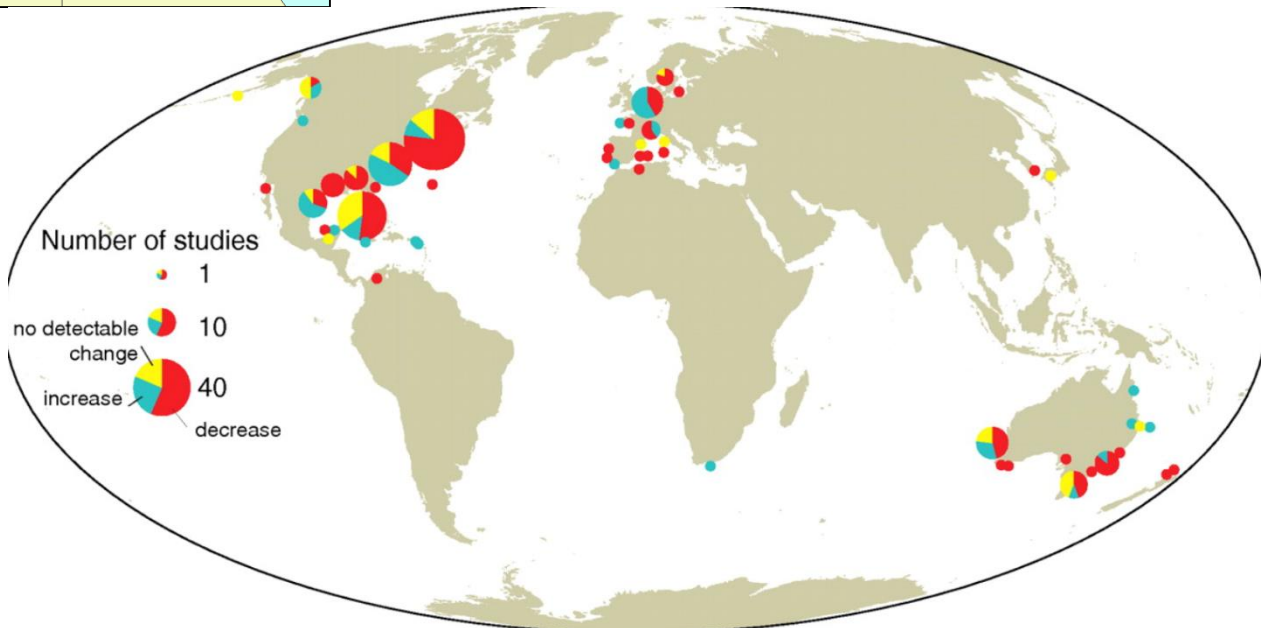
This maps shows the degree of nutrient inputs from inland sources along the Mediterranean coastal region. The layer is based on FAO national statistics on average annual use of fertilizers (nutrients) for the years 1993-2002, distributed across landscapes in agricultural lands with disagregation techniques.

Source: *NCEAS, 2008*

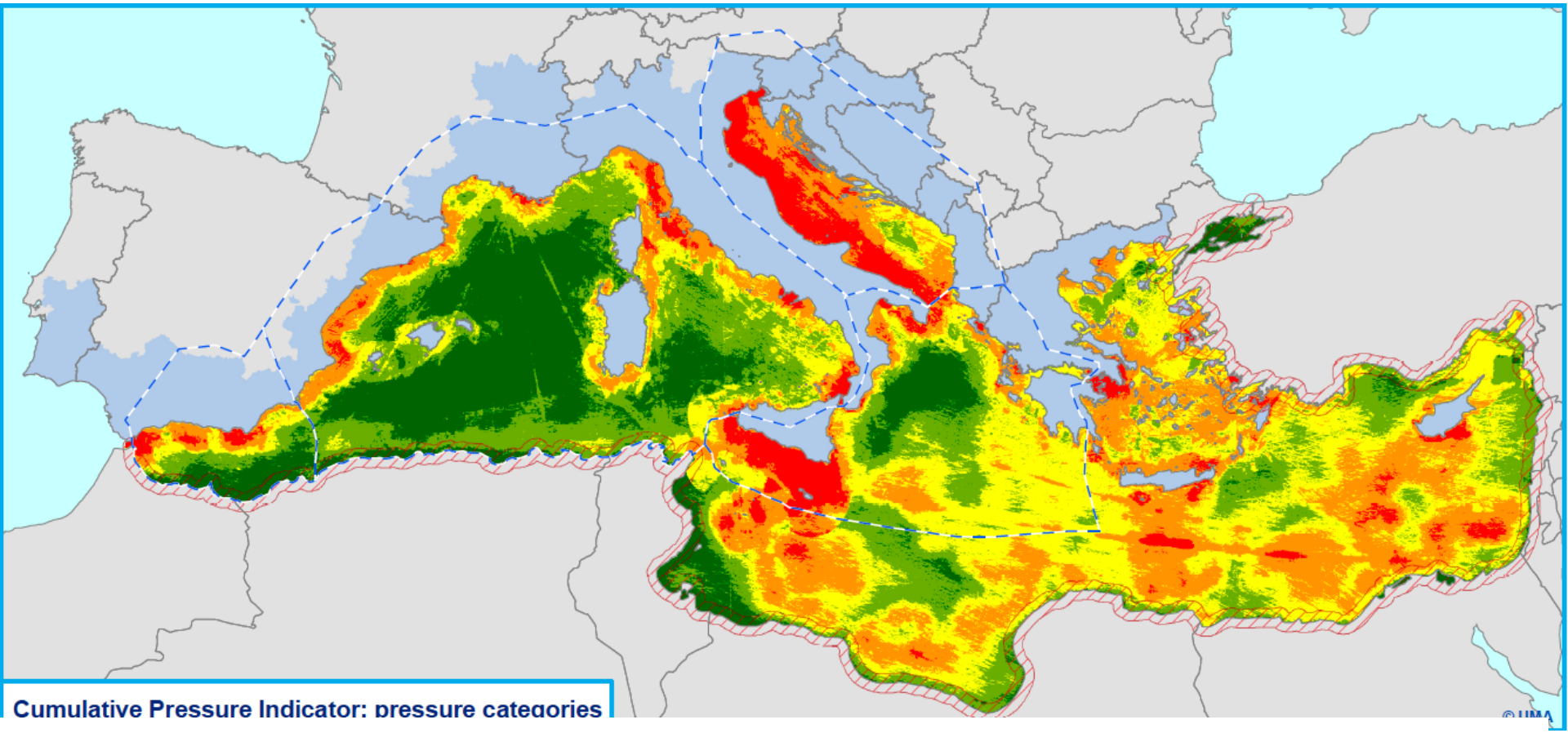
From local data to global assessment







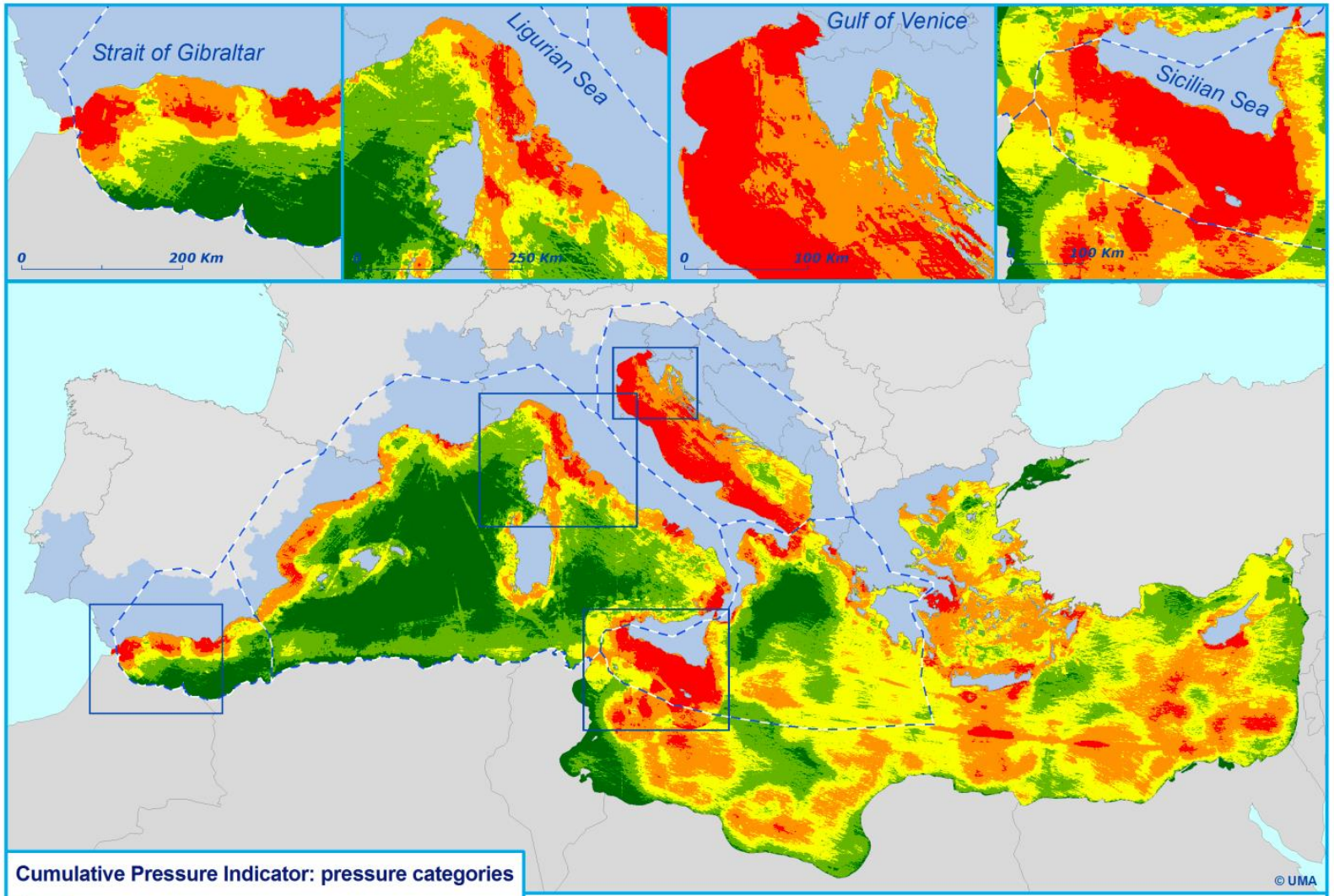
Human Pressure Indicator



$$P_T = \frac{(W_1 \cdot P_1) + (W_2 \cdot P_2) + (W_3 \cdot P_3) + (W_4 \cdot P_4) + (W_5 \cdot P_5) + (W_6 \cdot P_6)}{6}$$

Developing a Cumulative Impacts Indicator from composite data sets and models

Layer	Reference data
1. Climate change	Change in sea surface temperature (SST). NCEAS, 2008.
	Sea level rise (SLR) along the European coast. CNES/LEGOS/CNS, 1993-2013.
2. Aquaculture	Fish farms in the Mediterranean Sea. Trujillo et al., 2012.
	Shellfish production areas. EMODnet Human Activities, 2014.
3. Fishing	Fishing ports and fleet statistics. DG-MARE, 2014.
	Marine ecosystems on soft bottoms. NCEAS, 2008.
	Bathymetry. GEBCO, 2014.
	Biodiversity. EMODnet Biology Portal, 2014.
4. Marine litter	Numerical modelling of floating debris in the world's oceans. Lebreton et al., 2012.
	Fifteen-year average of total marine litter in the Mediterranean Sea. IFREMER, 2014.
5. Maritime transport	Marine exposure due to port activity. Eurostat, 2012.
	Ocean-based pollution. NCEAS, 2008.
	Oil spill density. REMPEC, 1977-2014; CNR-IIA, 2012.
6. Coastal tourism	Marinas: number of moorings. Plan Bleu, 2014; Spanish Federation of Associations of Tourist Marinas, 2014; Portbooker.com, 2014; EEA, 2014.



The map represents the Cumulative Pressure Indicator. This indicator combines the effect of six socio-economic and environmental drivers of pressure: climate change, fishing, aquaculture, maritime transport, coastal tourism and marine litter.

Source: ETC-UMA, 2015

Outline

I. Critical role for spatial and temporal information to systematically monitor biodiversity loss and human use

II. Clear workflows are essential to develop monitoring frameworks and useful spatial indicators that can pragmatically measure SDGs (land, coastal and marine related)

III. National workflows standardize data to develop indicators that allow regional comparability and prioritization of interventions

A selection of SDG indicators that rely on spatial data

Goals and targets (from the 2030 Agenda)	**Indicators**
6.6 By 2020, protect and restore **water-related ecosystems**, including mountains, forests, wetlands, rivers, aquifers and lakes	6.6.1 Change in the **extent of water-related ecosystems** over time
9.1 Develop **quality, reliable, sustainable and resilient infrastructure**, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	9.1.1 Proportion of the rural population who live within 2 **km of an all-season road**
14.5 By 2020, conserve at least 10 per cent of **coastal and marine areas**, consistent with national and international law and based on the best available scientific information	14.5.1 Coverage of **protected areas** in relation to marine areas
15.1 By 2020, ensure the conservation, restoration and sustainable use of **terrestrial and inland freshwater ecosystems** and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	15.1.2 Proportion of important sites for terrestrial and freshwater biodiversity that are covered by **protected areas**, by ecosystem type
15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a **land degradation-neutral world**	15.3.1 **Proportion of land that is degraded** over total land area

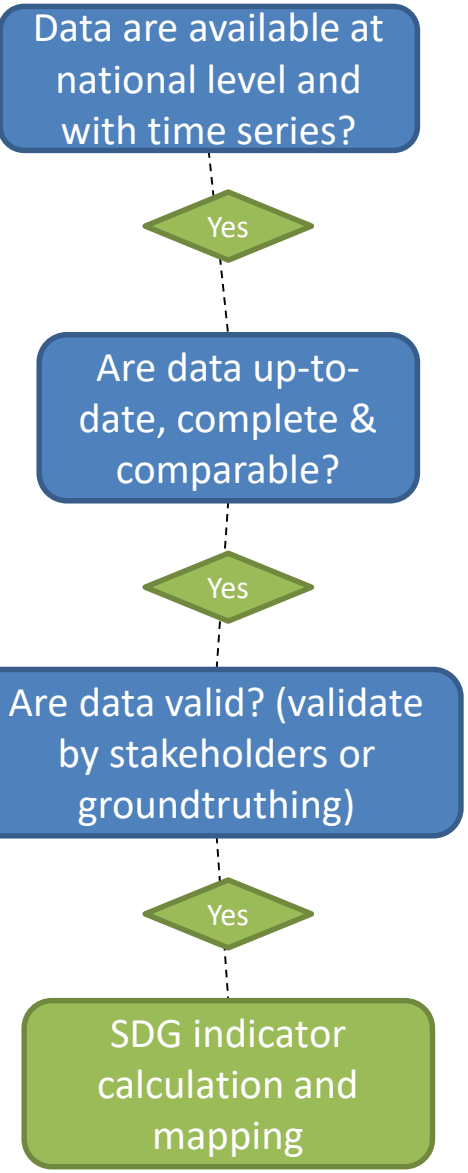
A selection of SDG indicators that rely on spatial data

Goals and targets (from the 2030 Agenda)	**Indicators**
6.6 By 2020, protect and restore **water-related ecosystems**, including mountains, forests, wetlands, rivers, aquifers and lakes	6.6.1 Change in the **extent of water-related ecosystems** over time
9.1 Develop **quality, reliable, sustainable and resilient infrastructure**, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	9.1.1 Proportion of the rural population who live within 2 **km of an all-season road**
14.5 By 2020, conserve at least 10 per cent of **coastal and marine areas**, consistent with national and international law and based on the best available scientific information	14.5.1 Coverage of **protected areas** in relation to marine areas
15.1 By 2020, ensure the conservation, restoration and sustainable use of **terrestrial and inland freshwater ecosystems** and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	15.1.2 Proportion of important sites for terrestrial and freshwater biodiversity that are covered by **protected areas**, by ecosystem type
15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a **land degradation-neutral world**	15.3.1 **Proportion of land that is degraded** over total land area

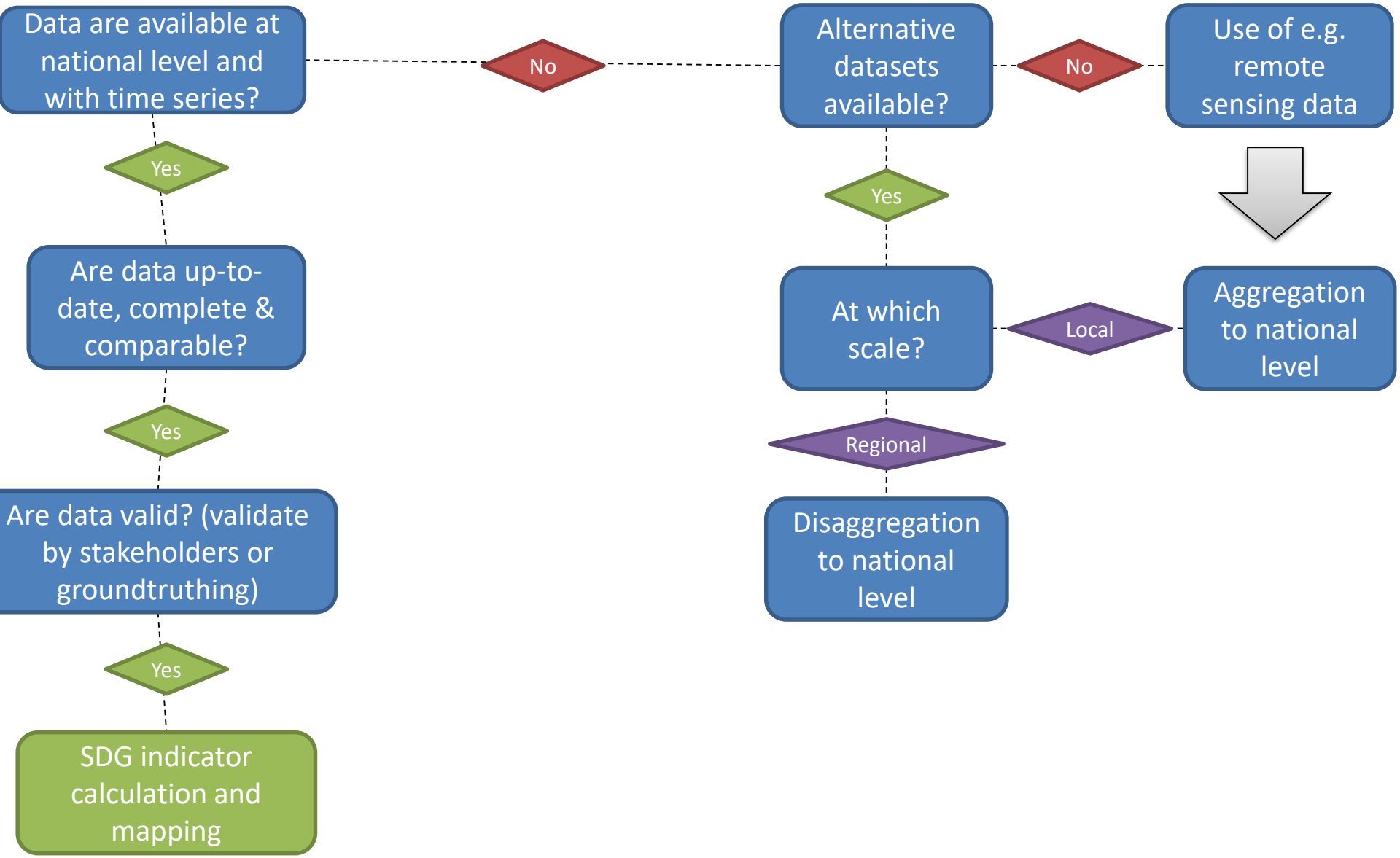
SDG indicators will require:

1. **RELIABILITY of data sources (official sources, peer-reviewed methodologies, validation, ground truthing)**
2. **HARMONISATION of data (coming from different sources) and methods**
3. **REPEATABILITY of methodologies to ensure monitoring of indicators**
4. **AVAILIBILITY of time series**

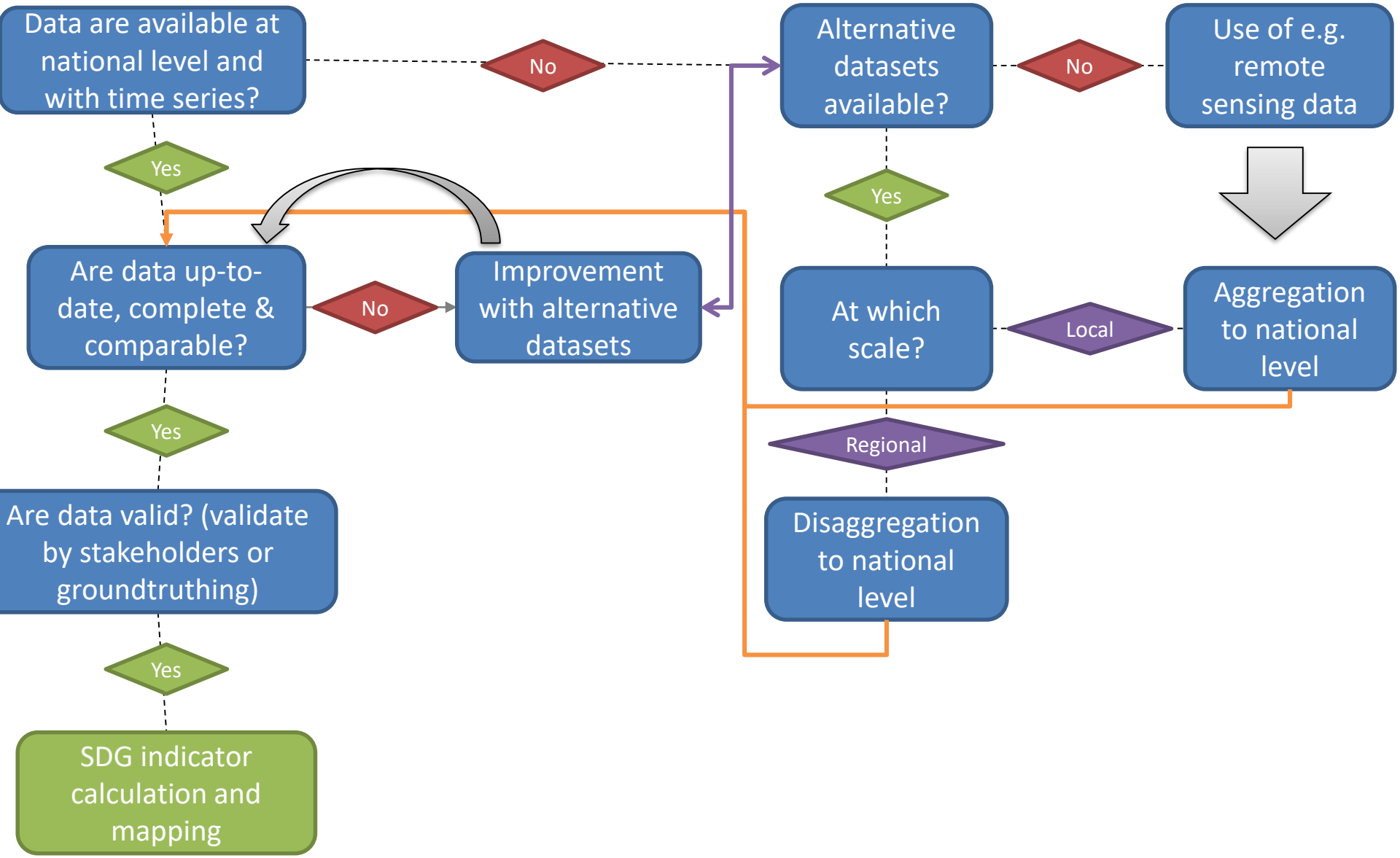
Workflow to develop SDG indicators based on spatial data



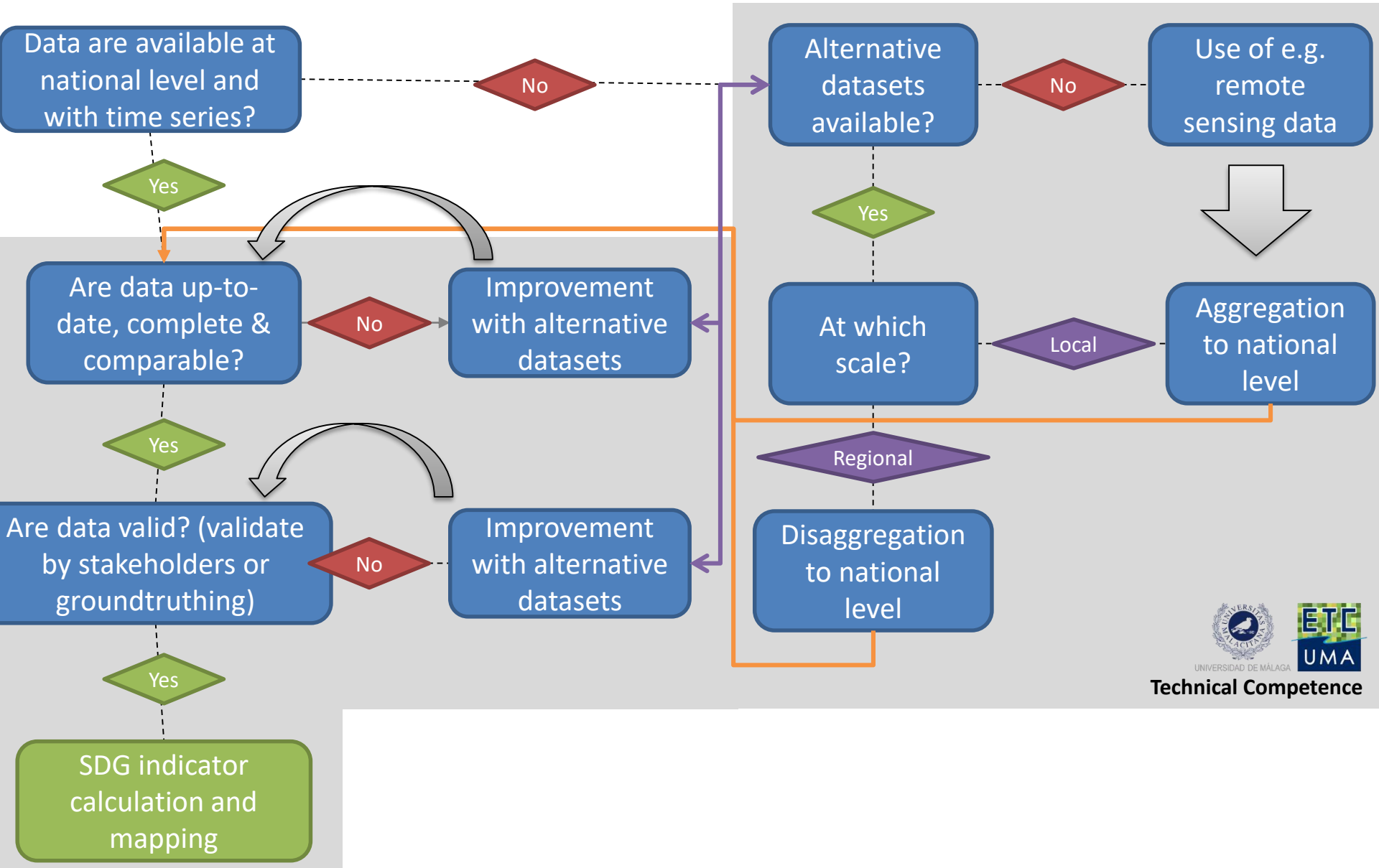
Workflow to develop SDG indicators based on spatial data



Workflow to develop SDG indicators based on spatial data



Workflow to develop SDG indicators based on spatial data



Outline

I. Critical role for spatial and temporal information to systematically monitor biodiversity loss and human use

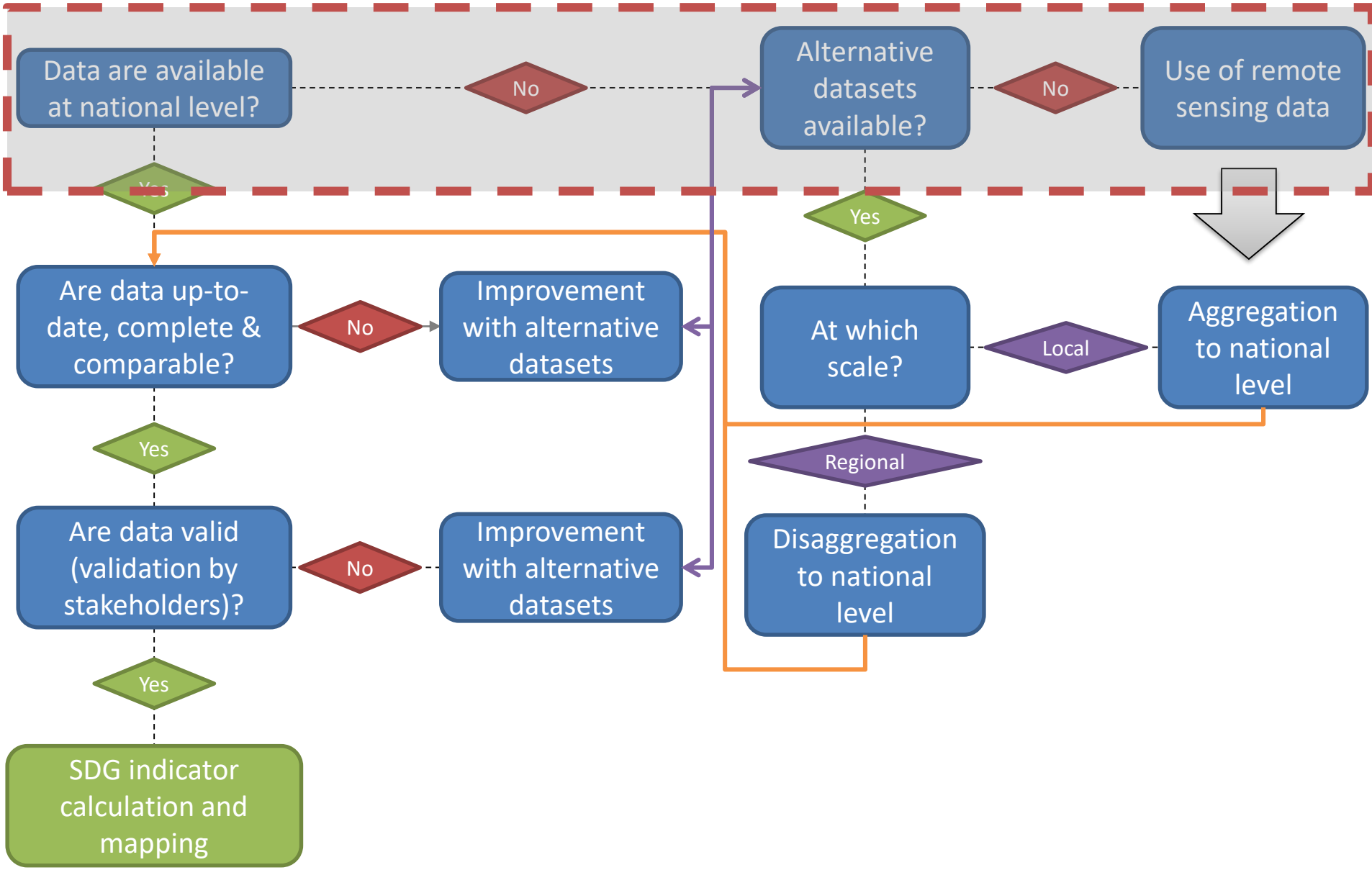
II. Clear workflows are essential to develop monitoring frameworks and useful spatial indicators that can pragmatically measure SDGs (land, coastal and marine related)

III. National workflows standardize data to develop indicators that allow regional comparability and prioritization of interventions

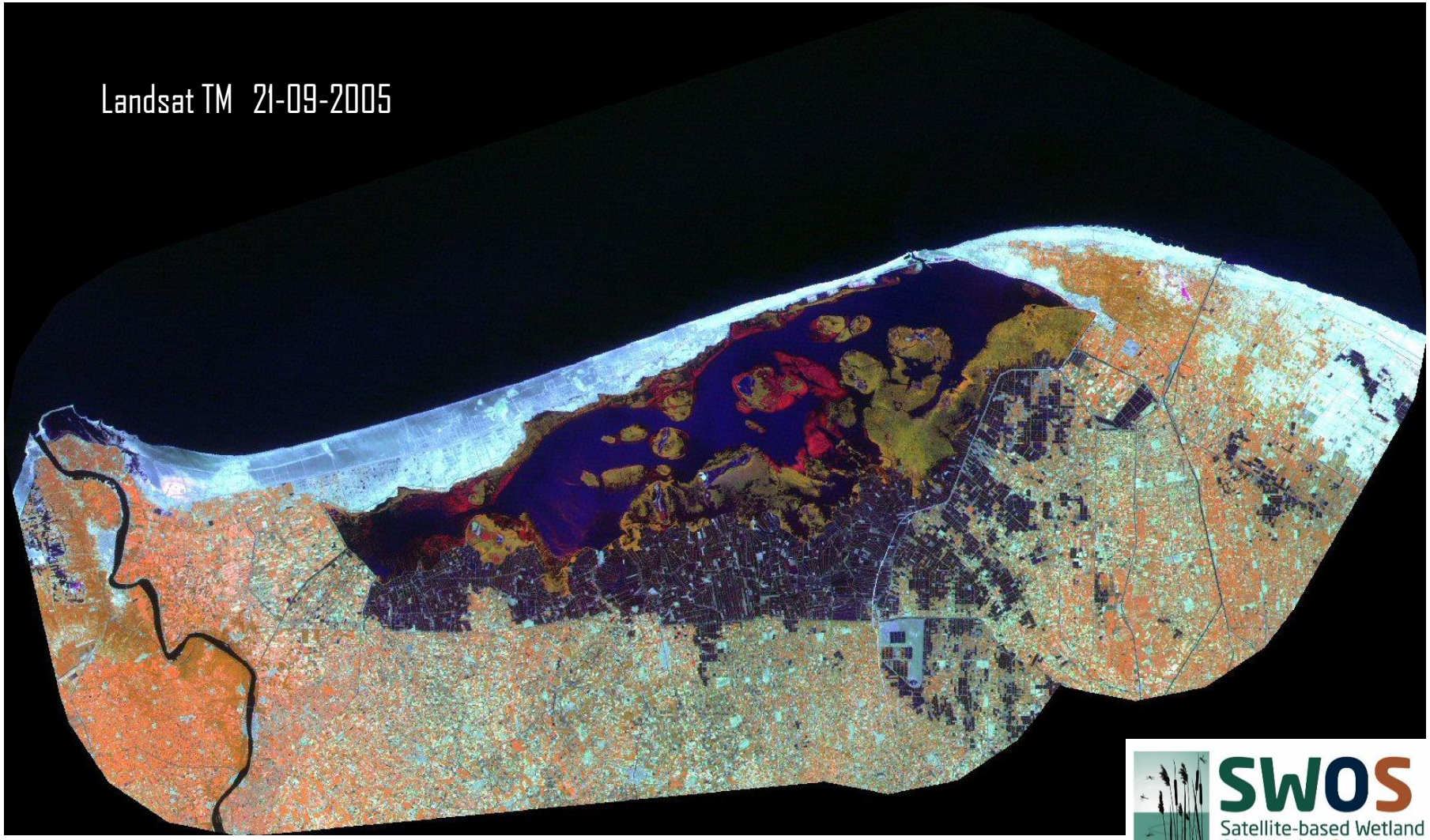
SDG indicators

Goal 6. Ensure availability and sustainable management of water and sanitation for all	
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	6.1.1 Proportion of population using safely managed drinking water services
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	6.2.1 Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	6.3.1 Proportion of wastewater safely treated
	6.3.2 Proportion of bodies of water with good ambient water quality
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	6.4.1 Change in water-use efficiency over time
	6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources
6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	6.5.1 Degree of integrated water resources management implementation (0-100)
	6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation
6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	6.6.1 Change in the extent of water-related ecosystems over time
6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	6.a.1 Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan
6.b Support and strengthen the participation of local communities in improving water and sanitation management	6.b.1 Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management

Workflow to develop SDG indicator based on spatial data



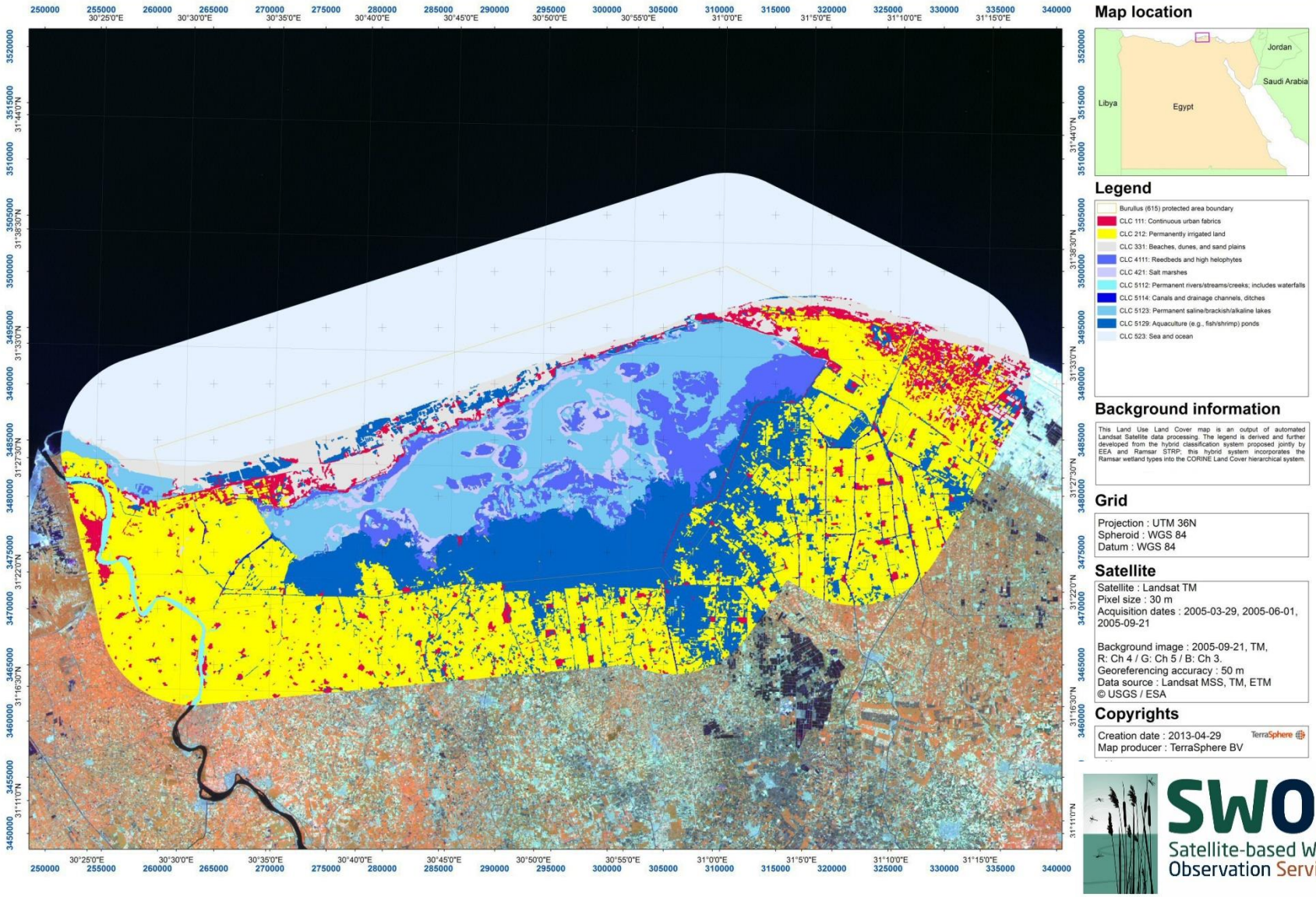
Satellite-based coastal wetland monitoring



SWOS
Satellite-based Wetland Observation Service

Satellite-based wetland monitoring

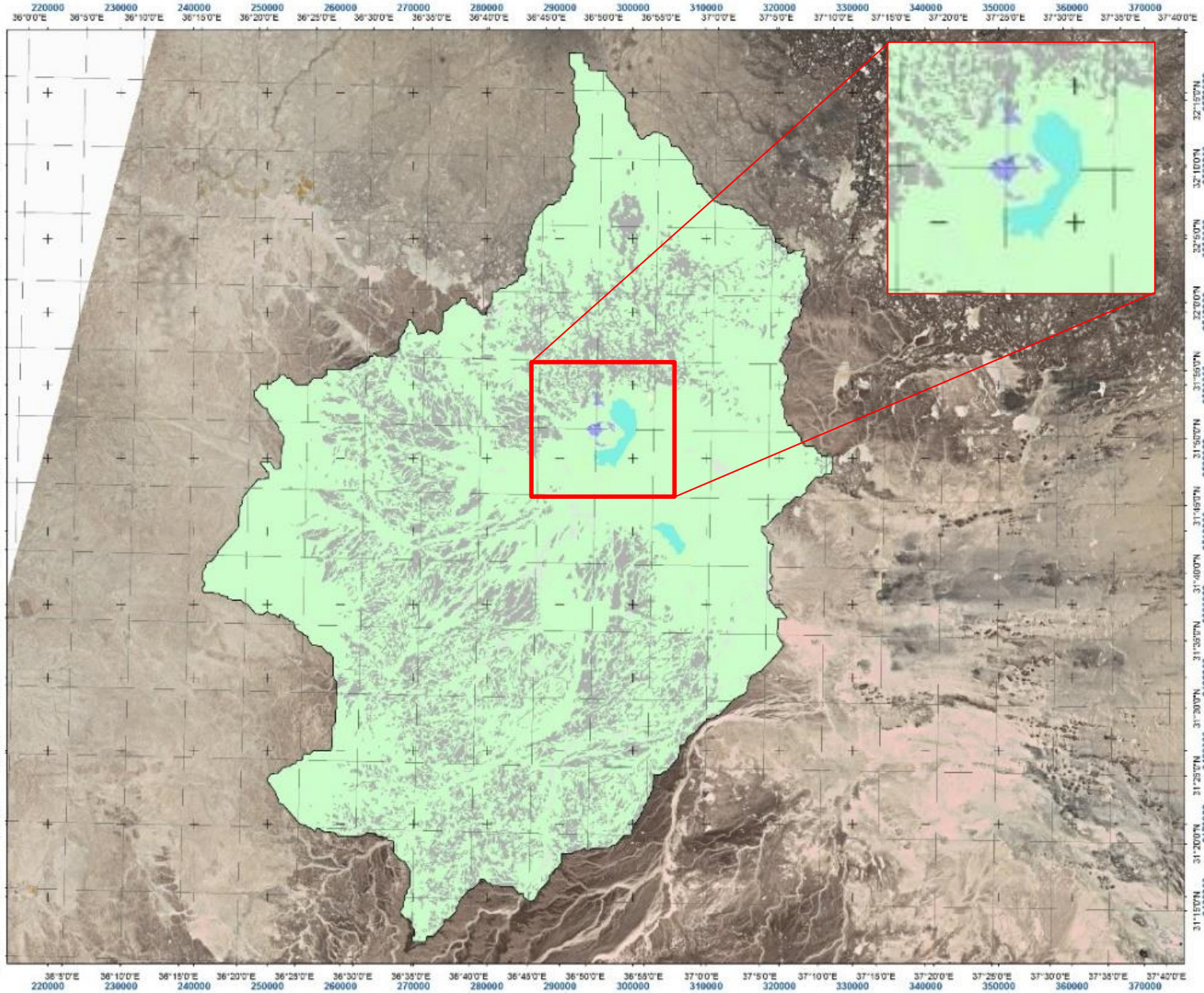
Land Use Land Cover (LULC) Burullus (Egypt) 2005



SWOS
Satellite-based Wetland Observation Service

07

SWOS LULC Azraq Jordan 1975



Legend

- CLC 2: Agricultural areas
- CLC 32: Shrub and/or herbaceous vegetation association
- CLC 33: Open spaces with little or no vegetation
- CLC 331: Beaches, dunes, and sand plains
- CLC 333: Sparsely vegetated areas
- CLC 411: Inland marshes
- CLC 4111: Reedbeds and high helophytes
- CLC 512: Inland water bodies

Background information

This map depicts the Land Use Land Cover in 1975 and is produced using a Landsat 2 satellite image.

Grid

Projection:	UTM 37 N
Spheroid:	WGS 84
Datum:	WGS 84

Satellite

Satellite:	Landsat 2
Pixel size:	60m
Acquisition dates:	28-06-1975
Background image:	28-06-1975
Data source:	© USGS / ESA

Copyrights

Creation:	22-08-2016
Producer:	info@rssgmbh.de

N

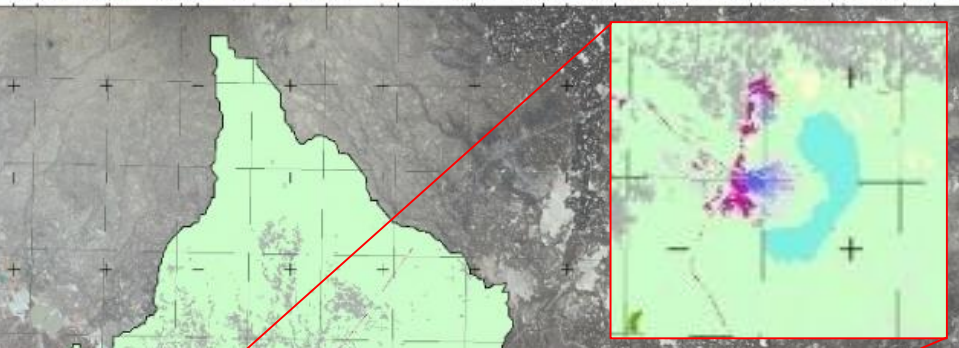
Scale 1:175,000

0 5,000 10,000 15,000 Meters

SWOS
Satellite-based Wetland Observation Service

07

SWOS LULC Azraq Jordan 1991



Legend

- CLC 1: Artificial surfaces
- CLC 124: Airports
- CLC 2: Agricultural areas
- CLC 31: Forests
- CLC 32: Shrub and/or herbaceous vegetation association
- CLC 33: Open spaces with little or no vegetation
- CLC 331: Beaches, dunes, and sand plains
- CLC 333: Sparsely vegetated areas
- CLC 411: Inland marshes
- CLC 4111: Reedbeds and high helophytes
- CLC 512: Inland water bodies

Background information

This map depicts the Land Use Land Cover in 1991 and is produced using a Landsat 5 satellite image.

Grid

Projection:	UTM 37 N
Spheroid:	WGS 84
Datum:	WGS 84

Satellite

Satellite:	Landsat 5
Pixel size:	30m
Acquisition dates:	15-06-1991
Background image:	15-06-1991
Data source:	© USGS / ESA

Copyrights

Creation:	22-08-2016
Producer:	info@rssgmbh.de

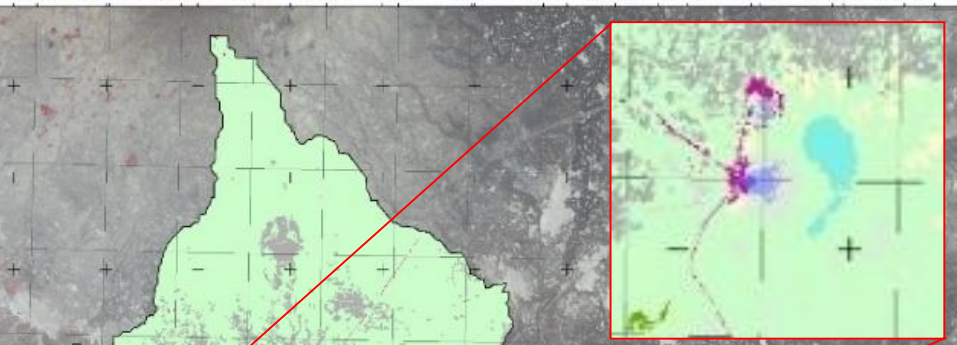
N

Scale 1:175,000

SWOS
Satellite-based Wetland Observation Service

07

SWOS LULC Azraq Jordan 2005



Legend

- CLC 1: Artificial surfaces
- CLC 124: Airports
- CLC 2: Agricultural areas
- CLC 31: Forests
- CLC 32: Shrub and/or herbaceous vegetation association
- CLC 33: Open spaces with little or no vegetation
- CLC 331: Beaches, dunes, and sand plains
- CLC 333: Sparsely vegetated areas
- CLC 411: Inland marshes
- CLC 4111: Reedbeds and high helophytes
- CLC 512: Inland water bodies

Background information

This map depicts the Land Use Land Cover in 2005 and is produced using a Landsat 5 satellite image.

Grid

Projection:	UTM 37 N
Spheroid:	WGS 84
Datum:	WGS 84

Satellite

Satellite:	Landsat 5
Pixel size:	30m
Acquisition dates:	20-05-2005
Background image:	20-05-2005
Data source:	© USGS / ESA

Copyrights

Creation:	22-08-2016
Producer:	info@rssgmbh.de

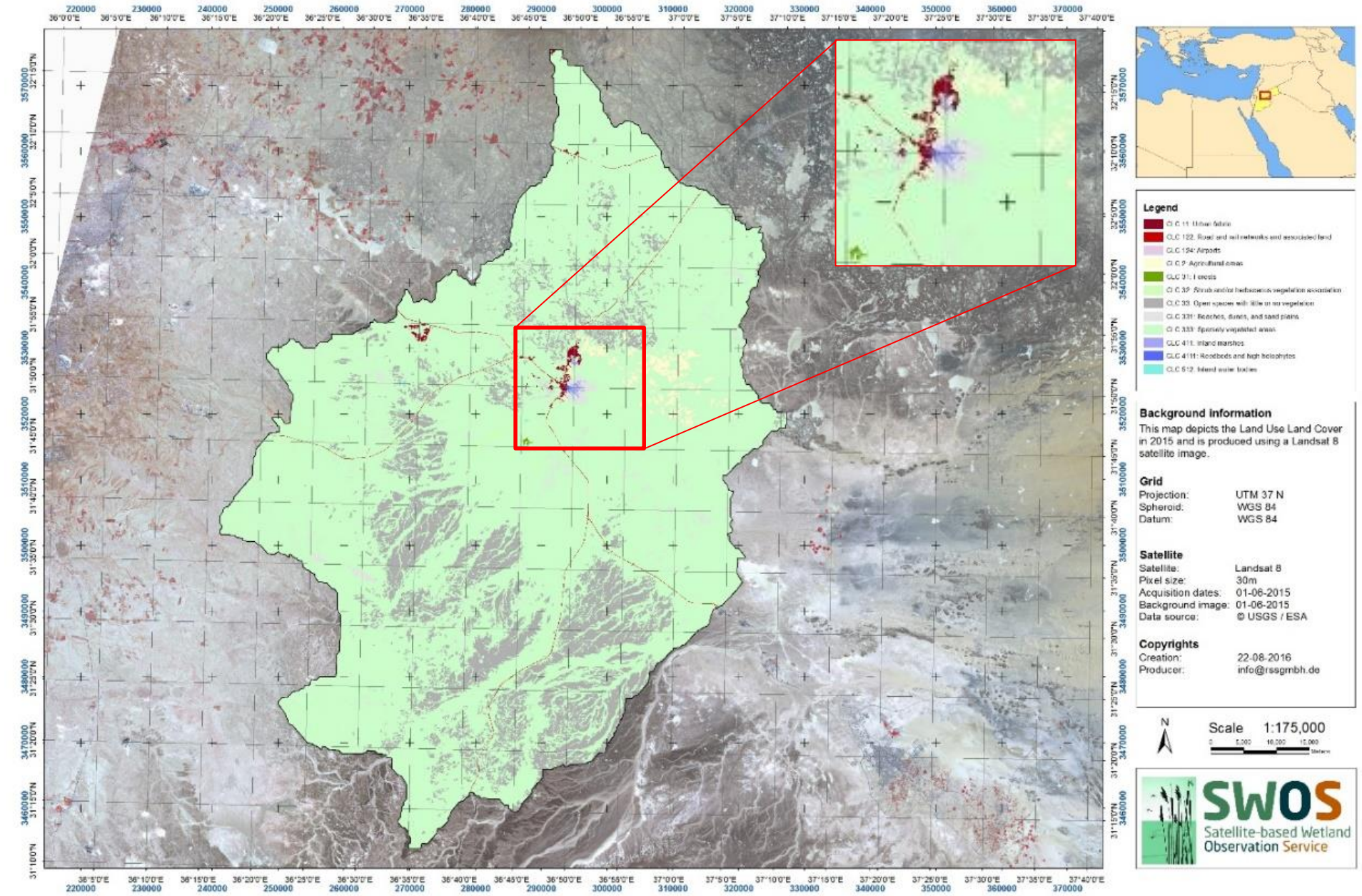
N

Scale 1:175,000

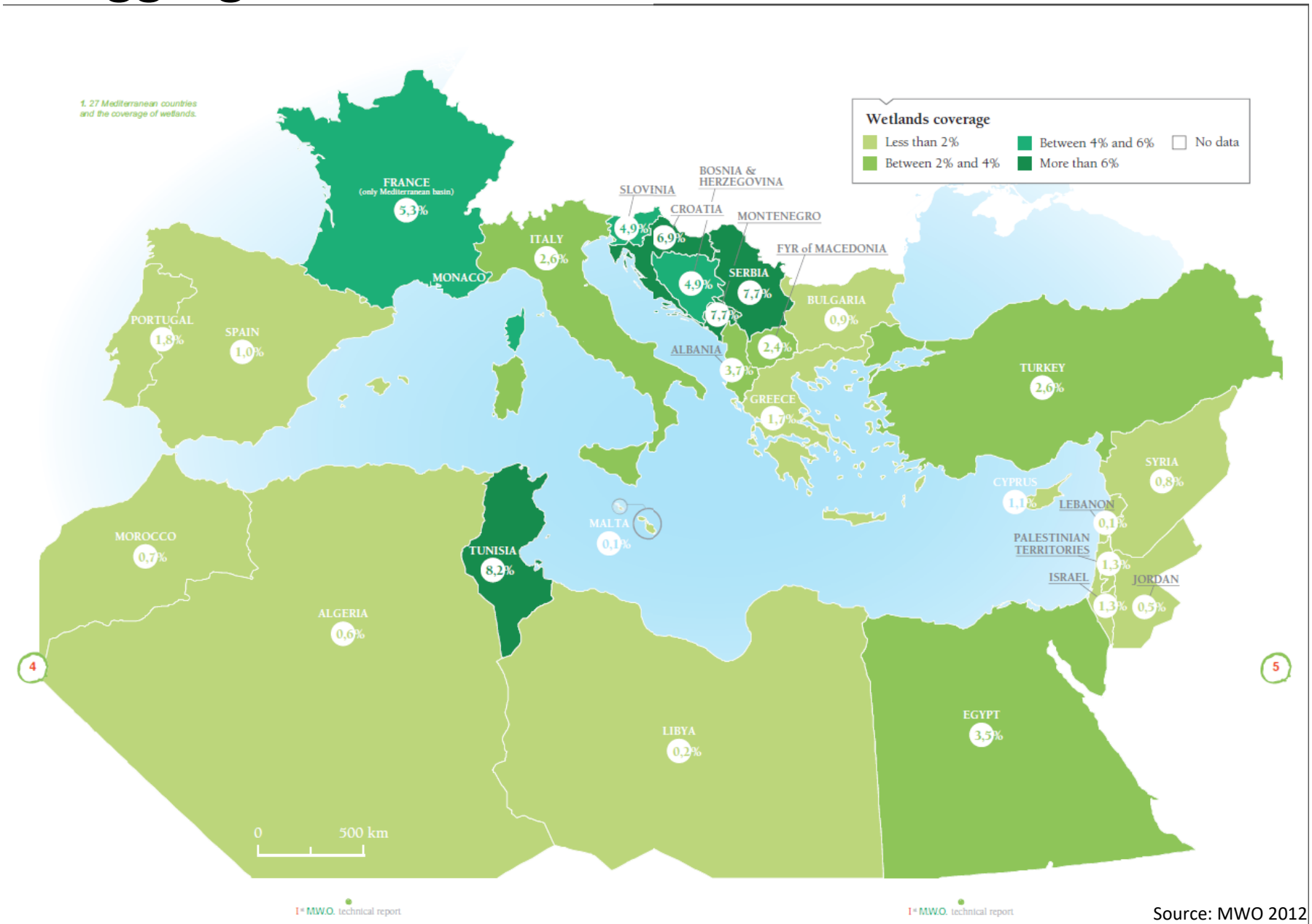
SWOS
Satellite-based Wetland Observation Service

07

SWOS LULC Azraq Jordan 2015



Aggregation of site data to national extent data

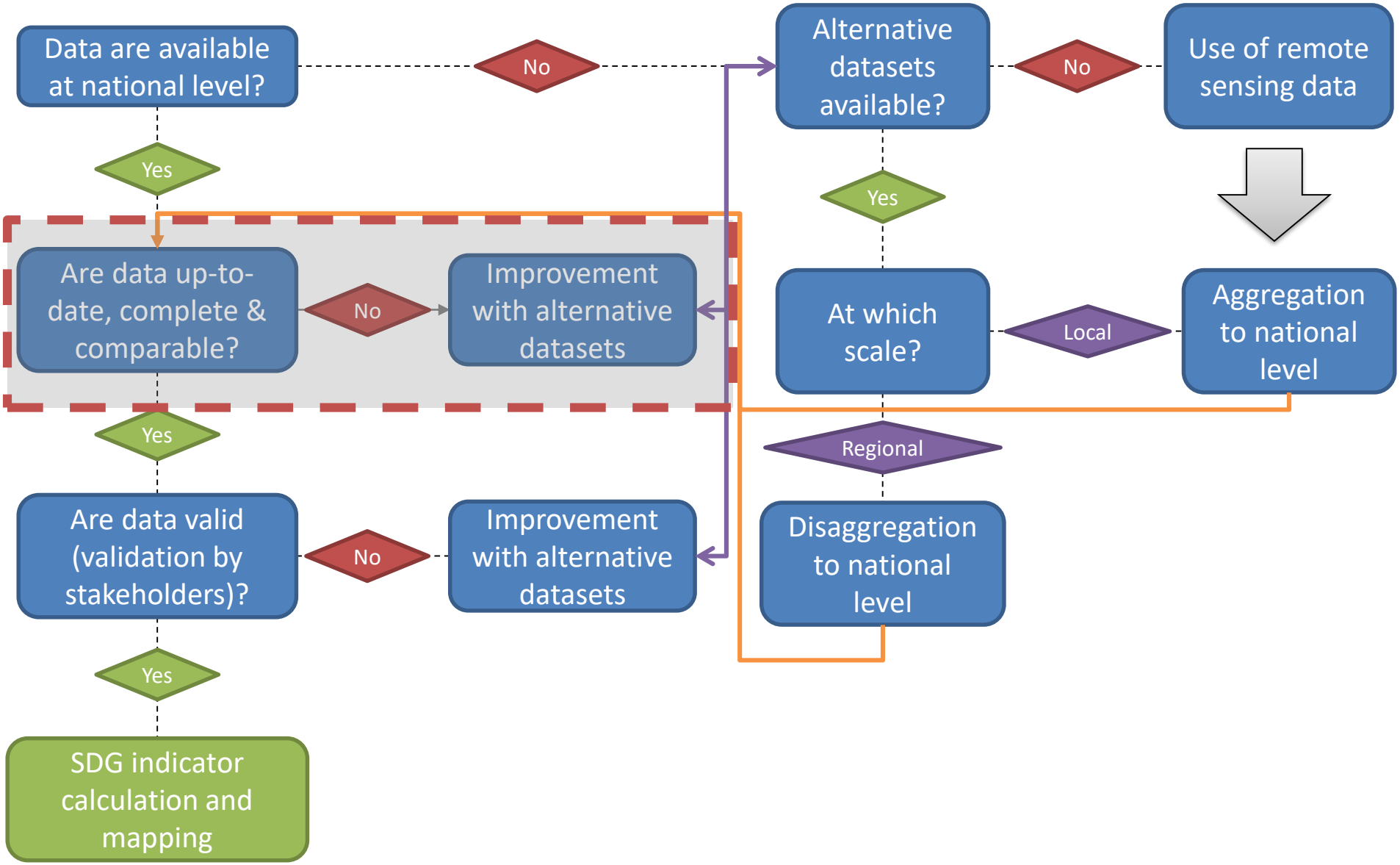


Source: MWO 2012

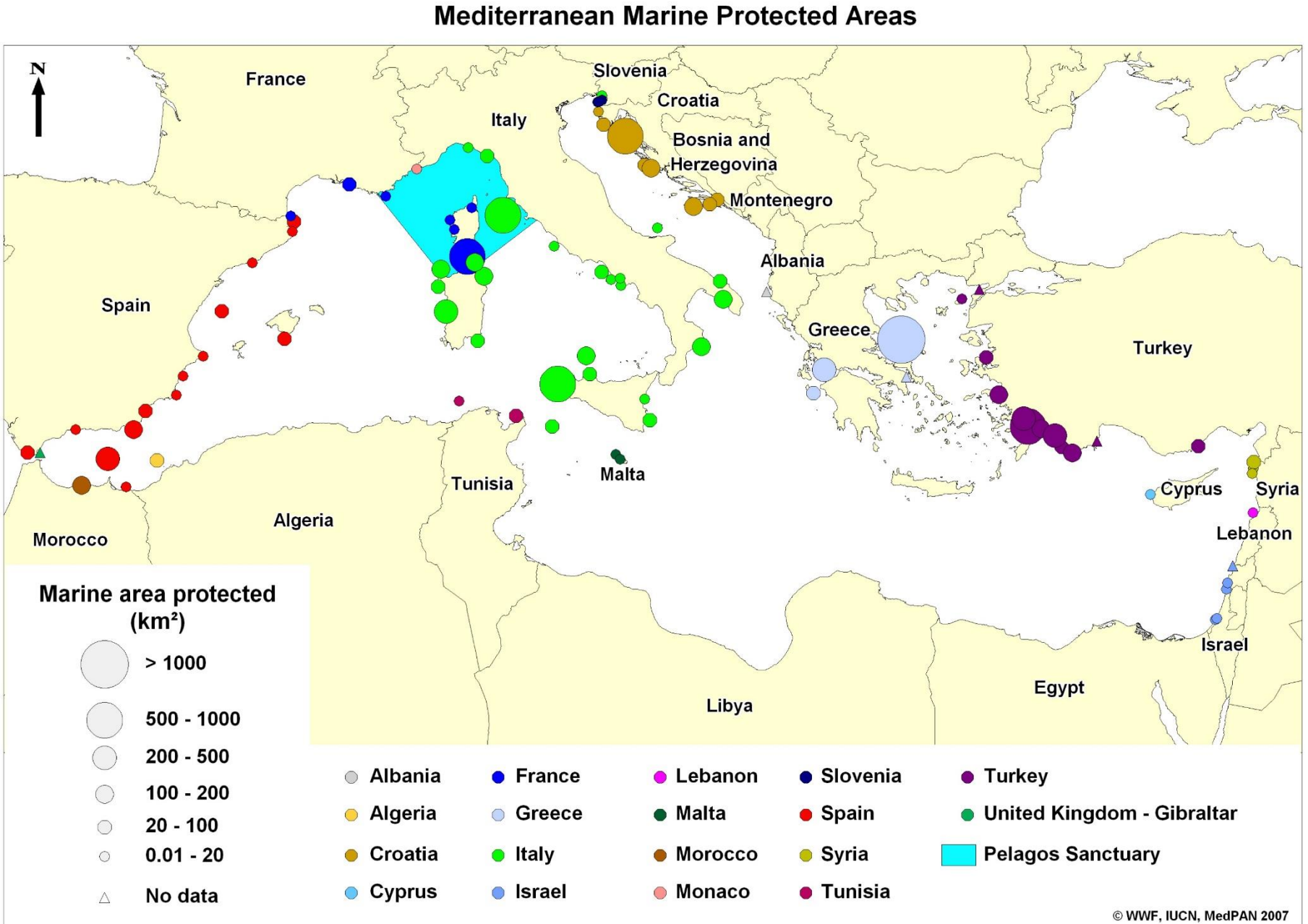
SDG indicators

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development	
14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution	14.1.1 Index of coastal eutrophication and floating plastic debris density
14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans	14.2.1 Proportion of national exclusive economic zones managed using ecosystem-based approaches
14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels	14.3.1 Average marine acidity (pH) measured at agreed suite of representative sampling stations
14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics	14.4.1 Proportion of fish stocks within biologically sustainable levels
14.5 By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information	14.5.1 Coverage of protected areas in relation to marine areas
14.6 By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation[b]	14.6.1 Progress by countries in the degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing
14.7 By 2030, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine	14.7.1 Sustainable fisheries as a proportion of GDP in small island

Workflow to develop SDG indicator based on spatial data

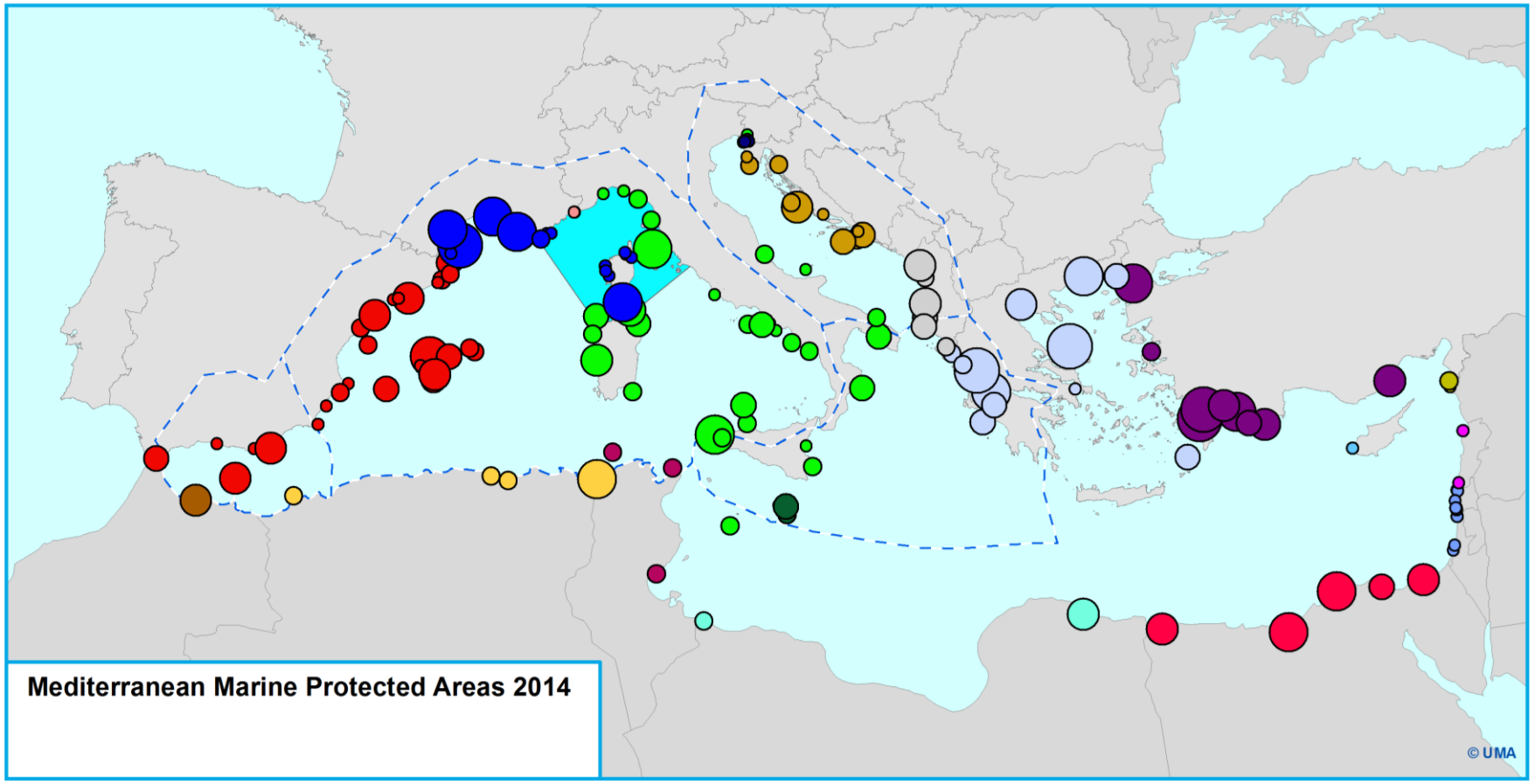


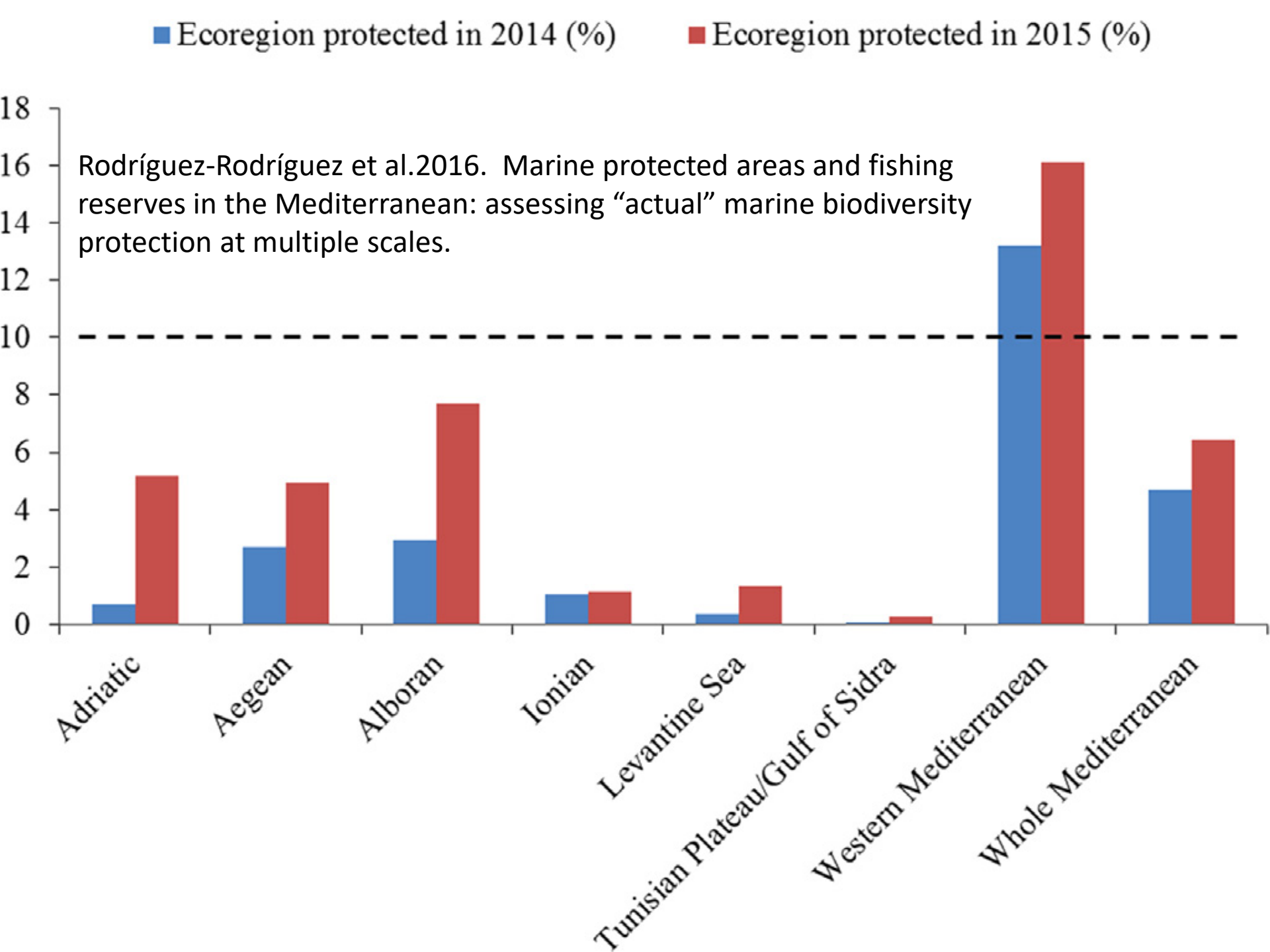
Marine Protection 2007



Marine Protection 2014

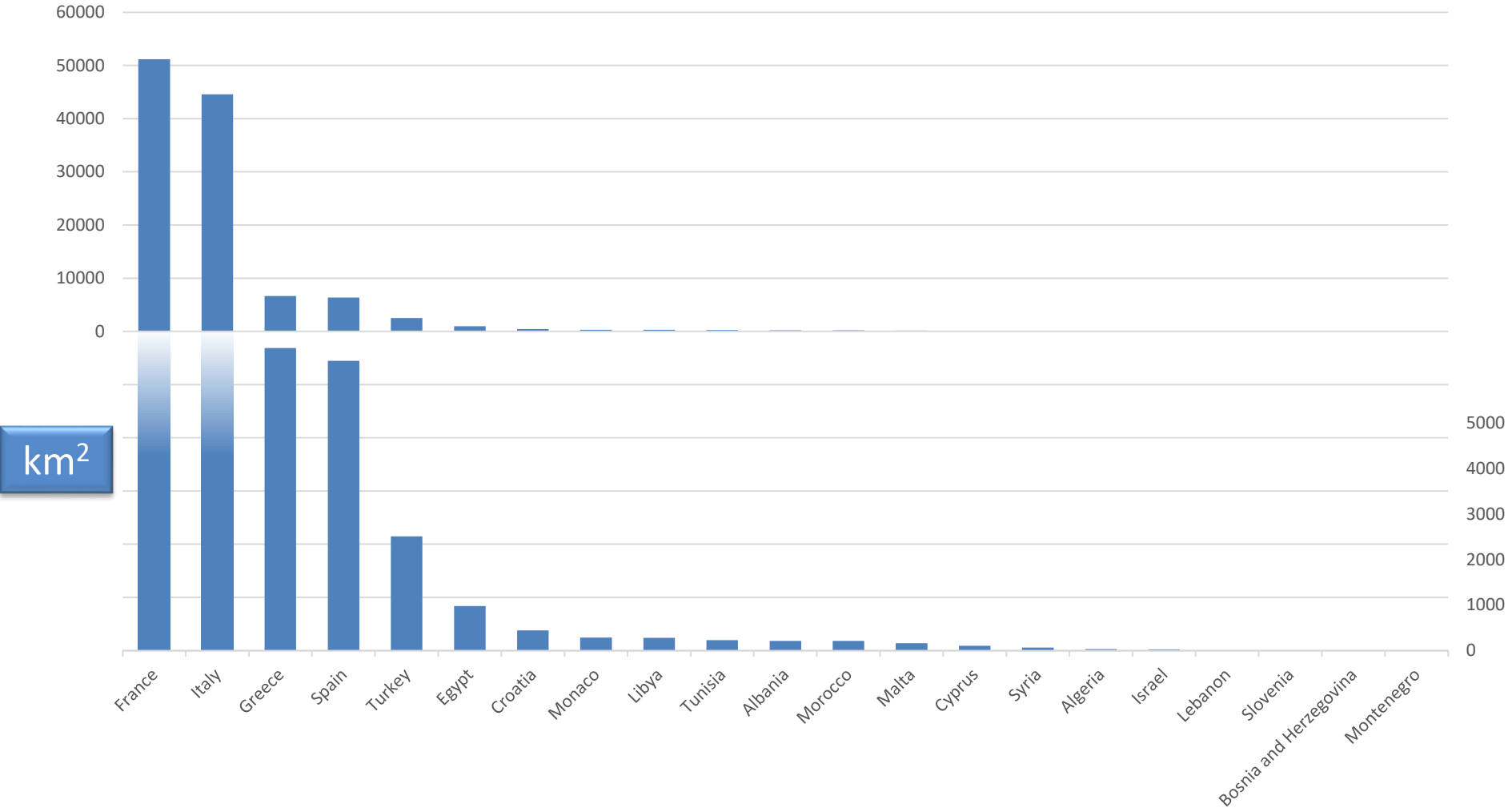
MAPAMed 2014 update (source: Rodriguez-Rodriguez et al., 2016)




Ecoregion protected in 2014 (%)
Ecoregion protected in 2015 (%)
18
16
14
12
10
8
6
4
2
0
Rodríguez-Rodríguez et al.2016. Marine protected areas and fishing reserves in the Mediterranean: assessing “actual” marine biodiversity protection at multiple scales.
Adriatic
Aegean
Alboran
Ionian
Levantine Sea
Tunisian Plateau/Gulf of Sidra
Western Mediterranean
Whole Mediterranean

Marine Protection in km^2

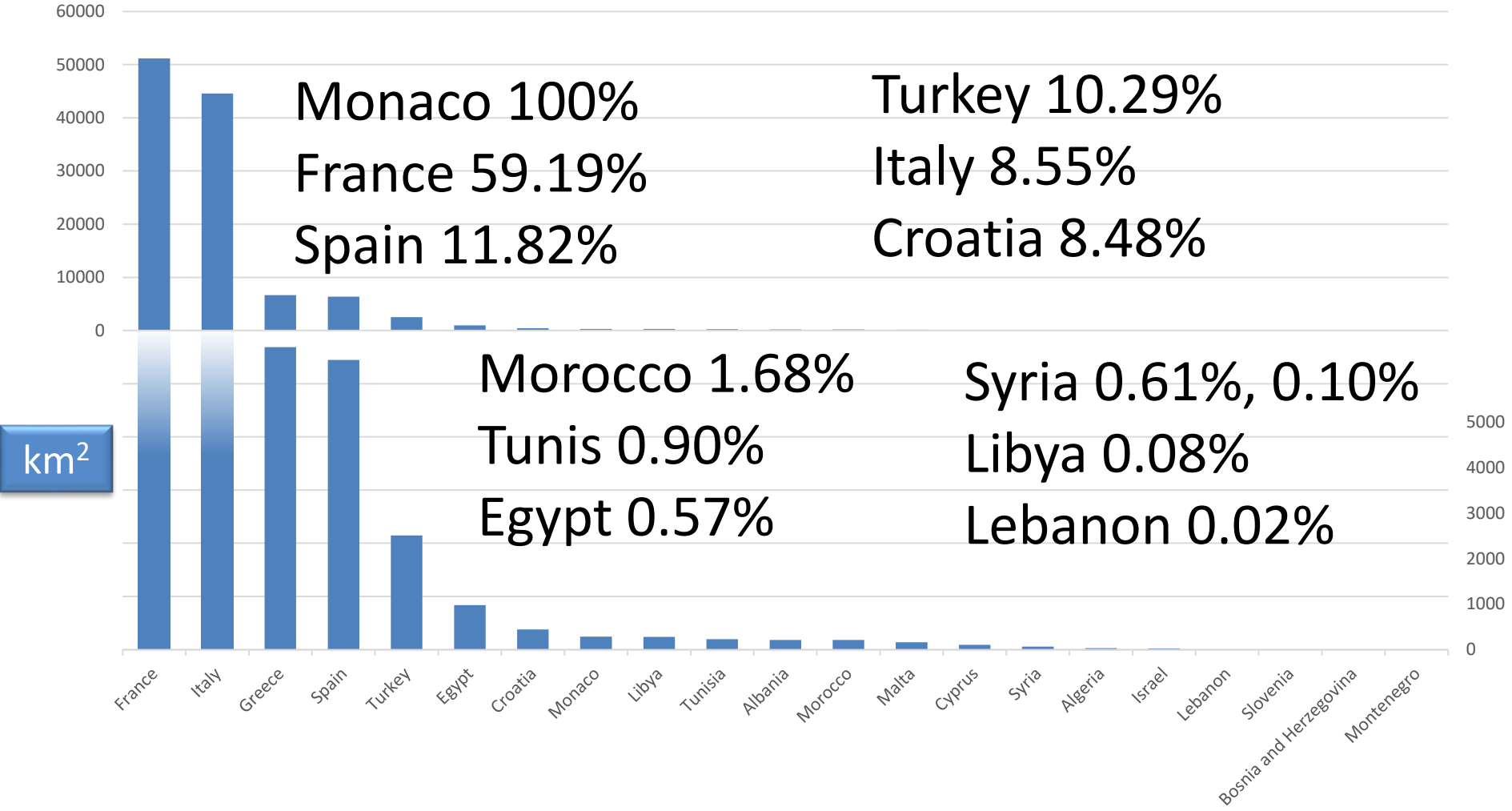
MAPAMed 2014 update (source: Rodriguez-Rodriguez et al., 2016)



Marine Protection in km^2

MAPAMed 2014 update (source: Rodriguez-Rodriguez et al., 2016)

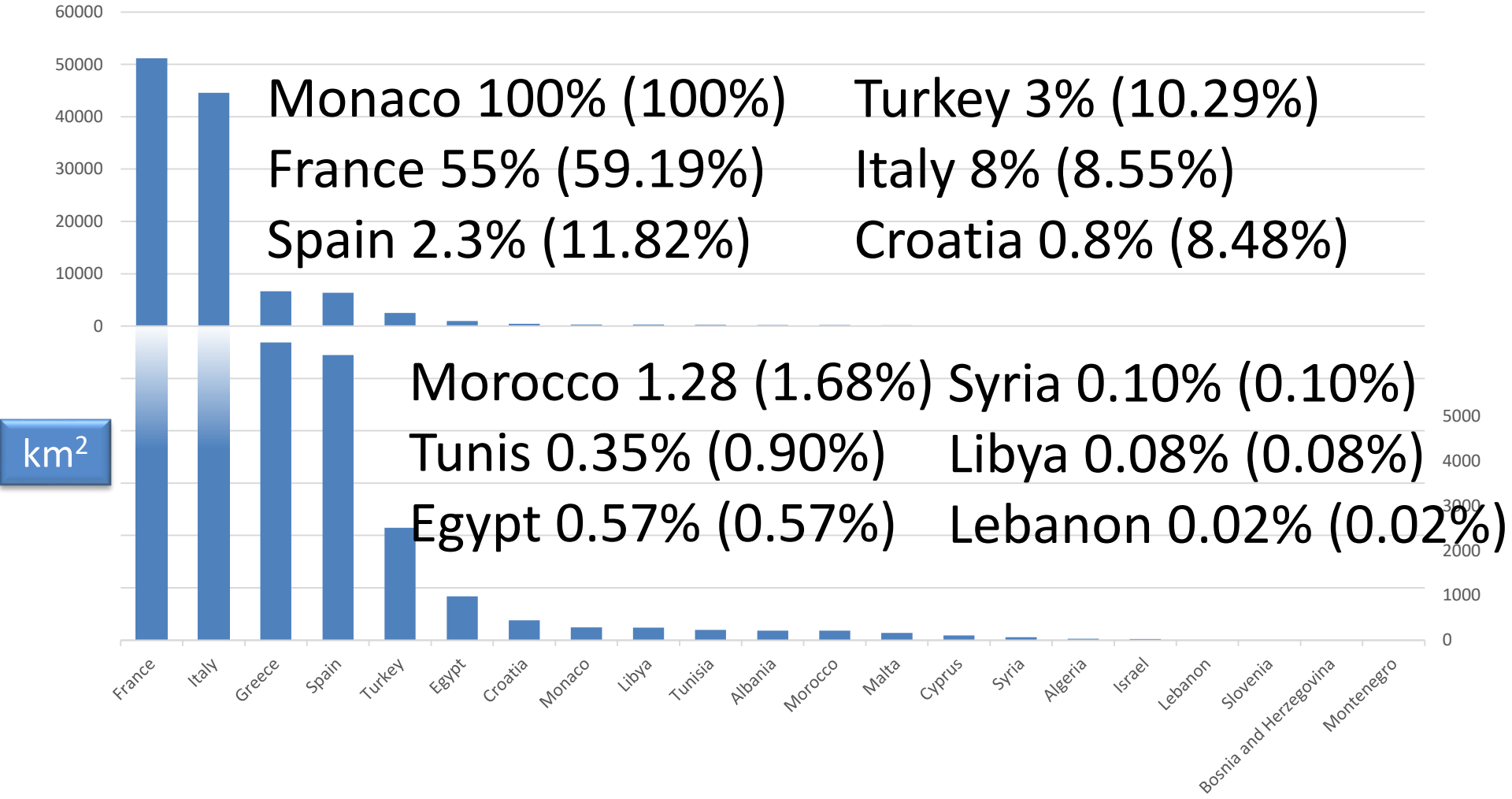
CBD Aichi Target 11 and SDG 14.5 of 10% EEZ Conservation



Marine Protection in km^2

MAPAMed 2014 update (source: Rodriguez-Rodriguez et al., 2016)

Actual Management



SDG indicators

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	15.1.1 Forest area as a proportion of total land area 15.1.2 Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type
15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	15.2.1 Progress towards sustainable forest management
15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	15.3.1 Proportion of land that is degraded over total land area
15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development	15.4.1 Coverage by protected areas of important sites for mountain biodiversity 15.4.2 Mountain Green Cover Index
15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species	15.5.1 Red List Index

Land degradation

Land Degradation

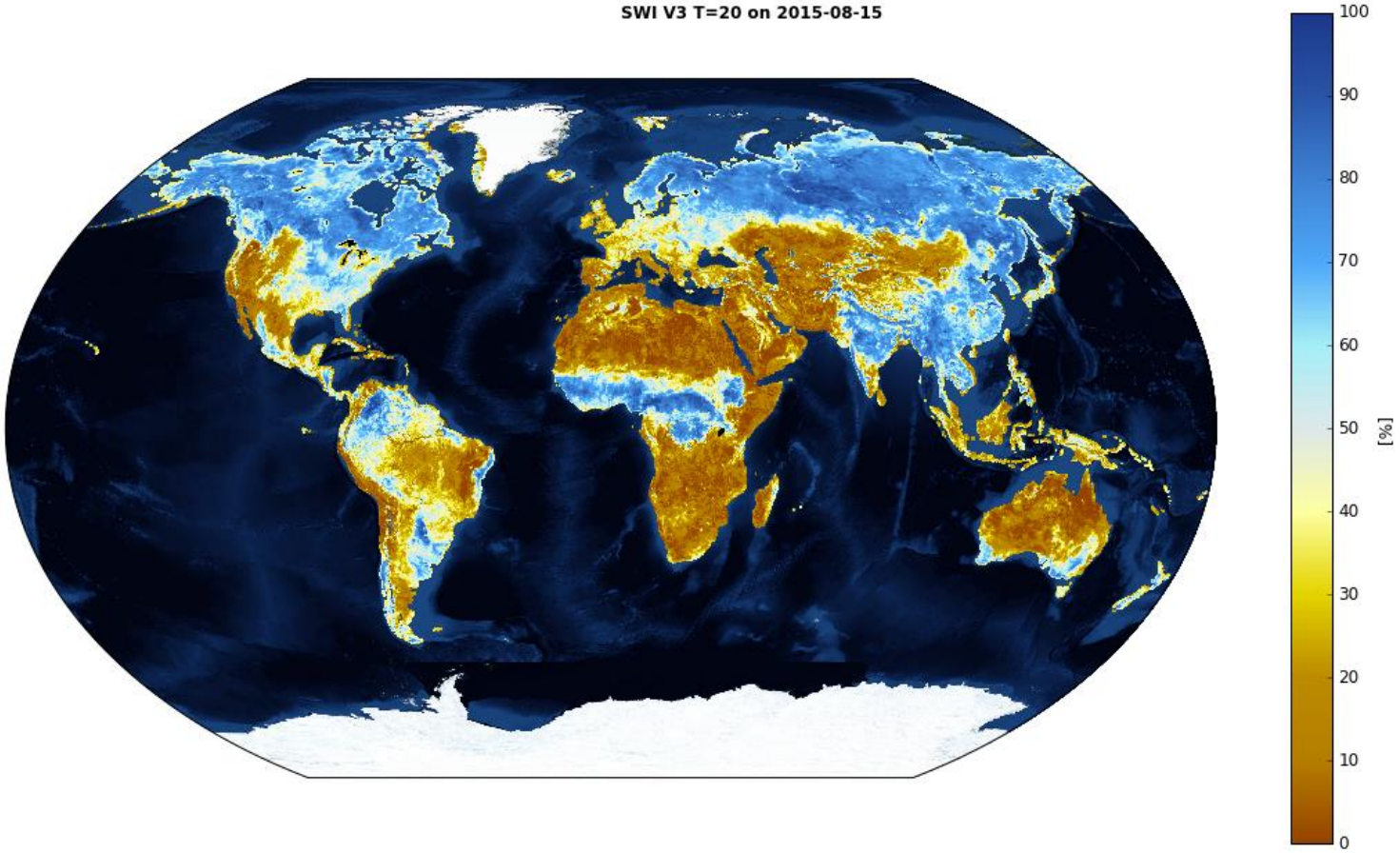
"Land degradation is the reduction or loss of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes arising from human activities." (IAEG-SDGs 2016)[5]

- Soil sealing
- Erosion
- Compaction
- Loss of soil organic carbon
- Contamination with pollutants
- Nutrient surplus/over-fertilisation
- Loss of soil biodiversity
- Desertification
- Salinisation
- Acidification
- Landslides

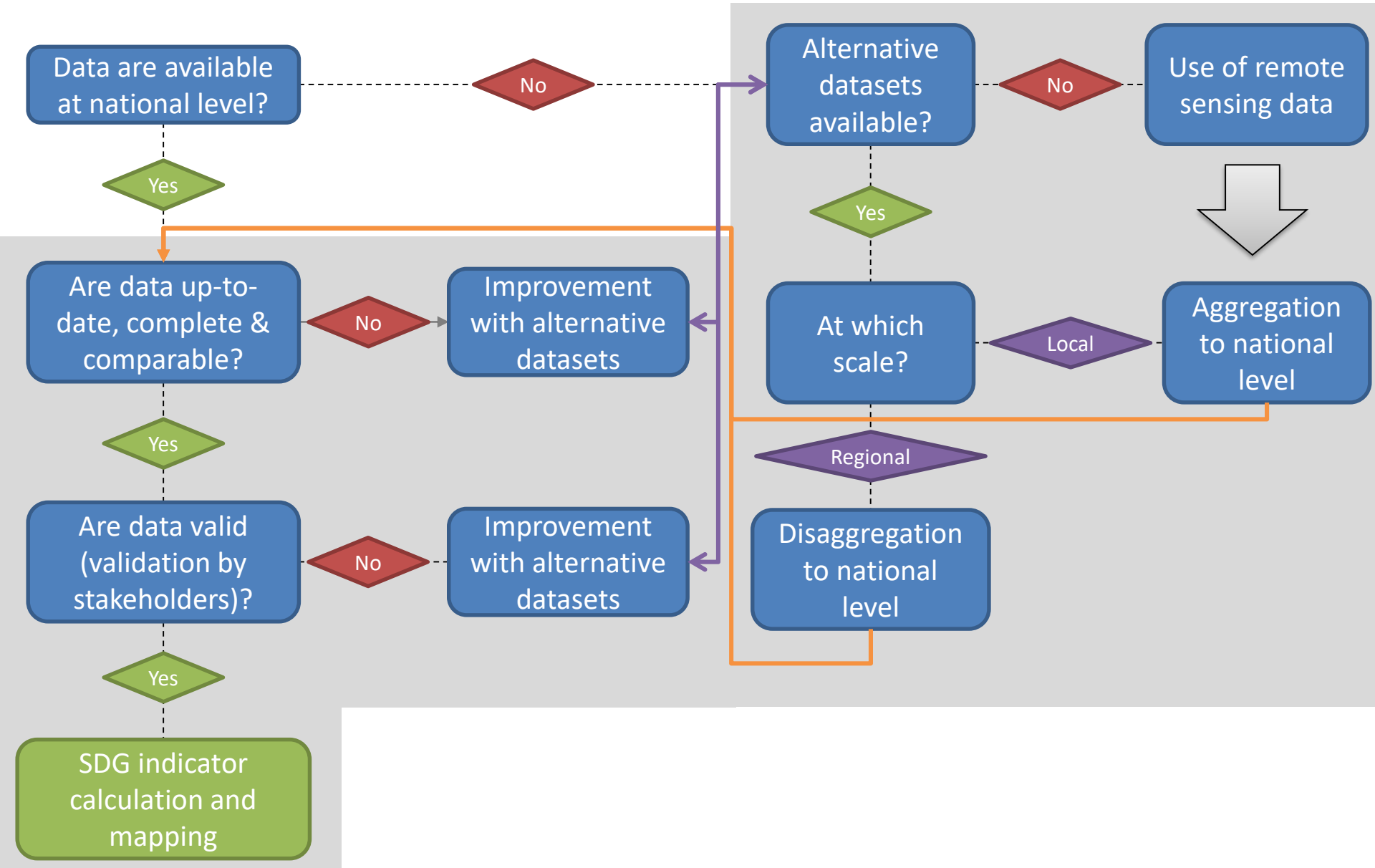
- Harmonized World Soil Database IIASA-FAO-JRC
- ISRIC World Soil Information
- Soil Geographical Database for Eurasia & The Mediterranean, JRC-INRA
- Digital Soil Map of the World, DSMW, FAO
- Remote-Sensing based data (Copernicus)

Land degradation

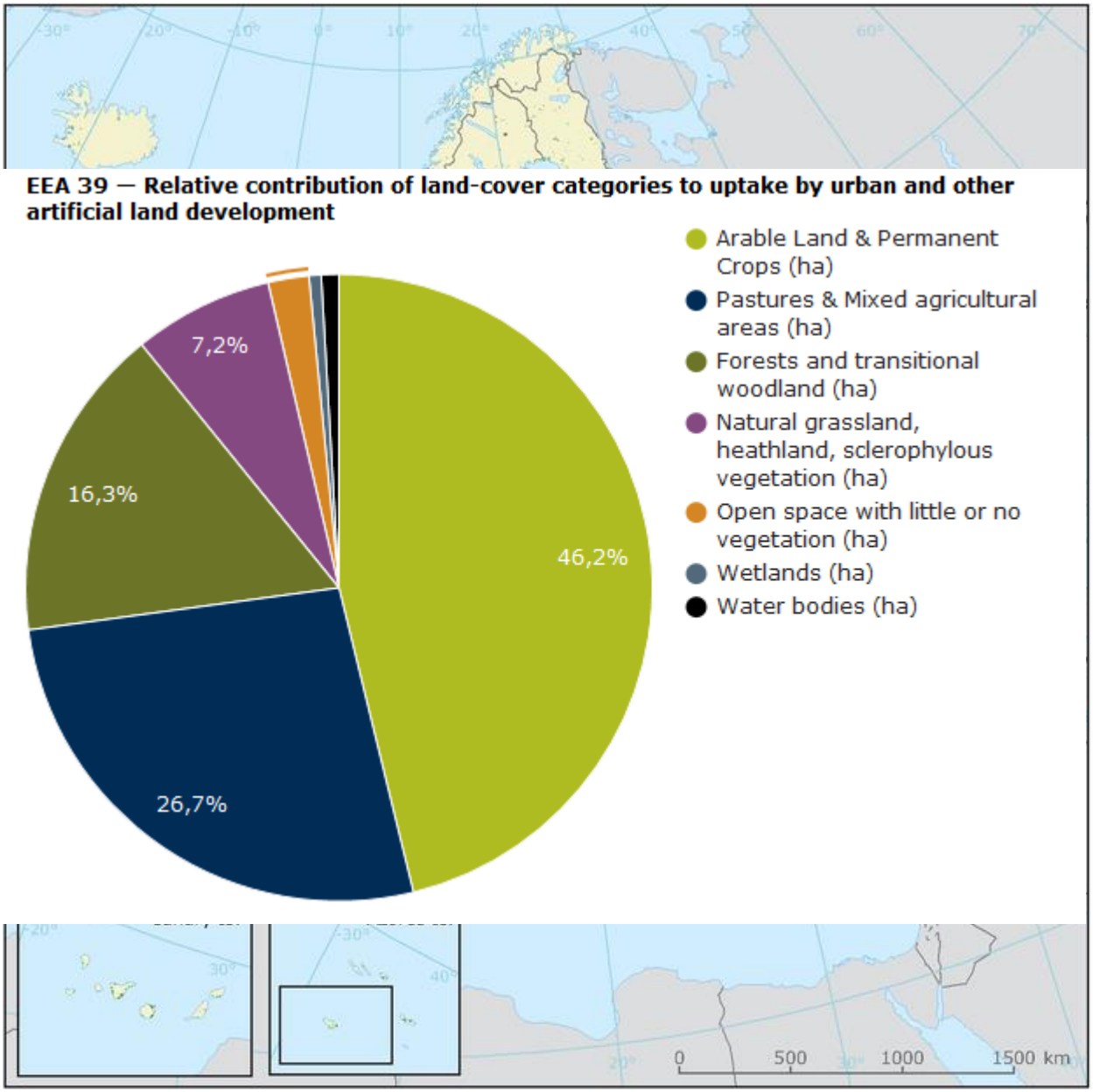
A product like the “Soil Water Index”, which quantifies the moisture conditions at various depth in soil, can be analyzed over a time series to assess potential patterns of desertification and hence land degradation.

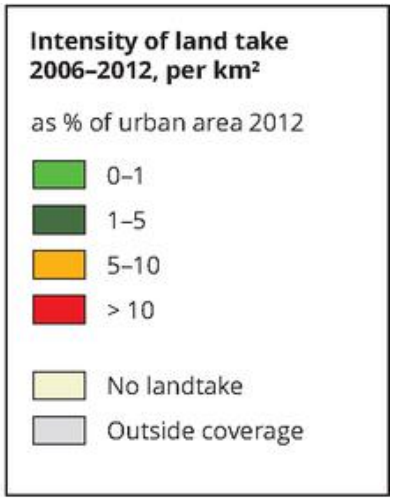


Workflow to develop SDG indicator based on spatial data



Simplified approach to SDG15





Simplified approach to SDG15

Sustainable development in the European Union

MONITORING REPORT ON PROGRESS TOWARDS THE SDGS IN AN EU CONTEXT

STATISTICAL BOOKS | eurostat

Main Messages

I. Critical role for spatial and temporal information to systematically monitor biodiversity loss and human use
II. Clear workflows are essential to develop monitoring frameworks and useful spatial indicators that can pragmatically measure SDGs (land, coastal and marine related)
III. National workflows standardize data to develop indicators that allow regional comparability and prioritization of interventions

Spatial data survey

Survey on availability and accessibility of relevant sources of spatial data for SDG indicator reporting in Selected Arab Countries under the ESCWA Development Account Programme on Data and Statistics-Pillar Environment

Spatial data survey

The survey aims to gather information about the **availability and accessibility of relevant sources of spatial data for environmental SDG indicator reporting and monitoring**.

A) **Data availability for environmental SDG monitoring** to understand which specific spatial datasets are available at your organization and, if yes, details about each dataset.

- **Population, human settlements and infrastructure**
- **Land use and land cover**
- **Biodiversity**
- **Water**
- **Air quality**
- **Marine environment**

  - Data owner, data holder
  - Data format, spatial coverage, spatial and temporal resolution
  - Data access

Spatial data survey

The survey aims to gather information about the **availability and accessibility of relevant sources of spatial data for environmental SDG indicator reporting and monitoring**.

B) Data needs and data gaps: section where you can indicate what data is missing to comply with the environmental SDG monitoring obligations.

C) Spatial data analysis, management and storage capacities assesses the capacities and knowledge available at your organization to use spatial data and tools.

Spatial data survey

Roadmap for the Workflow

1) **Collection of responses**
2) **Analysis and synthesis of results**
3) **Preparation and organisation of national workshop:**
   - **Discussion of results**
   - **Data exchange**
   - **Proposal for workflows**
4) **Feedback and data integrated**
5) **Report on Proposed National Workflow developed by ETC-UMA and UNESCUA**

For more information:

www.etc.uma.es

http://www.medmaritimeprojects.eu/section/med-iamer
http://147.84.210.211:8080/geoexplorer/composer/ (map viewer with Med-IAMER data)

http://swos-service.eu/

Email contact:
Marine.Programme@UMA.es