

# Evaluation and updates of ESA-CCI global land cover map

*For NWP needs*

S. M. Oswald, P. Samuelsson, E. Kurzeneva , B. Palmason  
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FINNISH METEOROLOGICAL INSTITUTE



**Icelandic Met  
Office**



**EUMETNET**  
EUROPEAN METEOROLOGICAL  
SERVICES NETWORK



**ZAMG**  
Zentralanstalt für  
Meteorologie und  
Geodynamik

# Aims given from EUMETNET

- According to the proposal supported by EUMETNET, the project should include
  - (i) gather and document reports on identified deficiencies and suggested corrections from all C-SRNWP institutes,
  - (ii) prepare and, with certain intervals, release corrected versions of the ESA-CCI land cover (LC) product which can be downloaded by the C-SRNWP partners, and
  - (iii) share the documentation and updated product with C3S so that their new releases can benefit from the work.

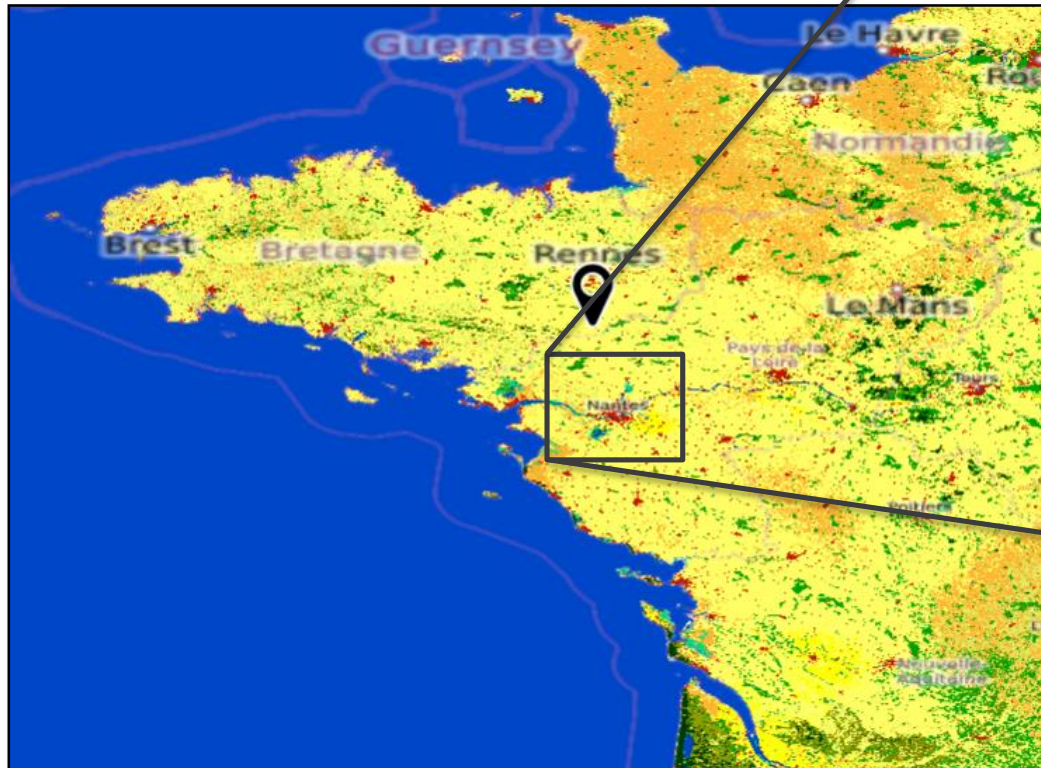
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Slide 2





# Current quality, missing information and errors

- Overall quality is good with 300m spatial resolution
- Example of Nantes in France
  - No classification for sea water
  - Urban areas just one class



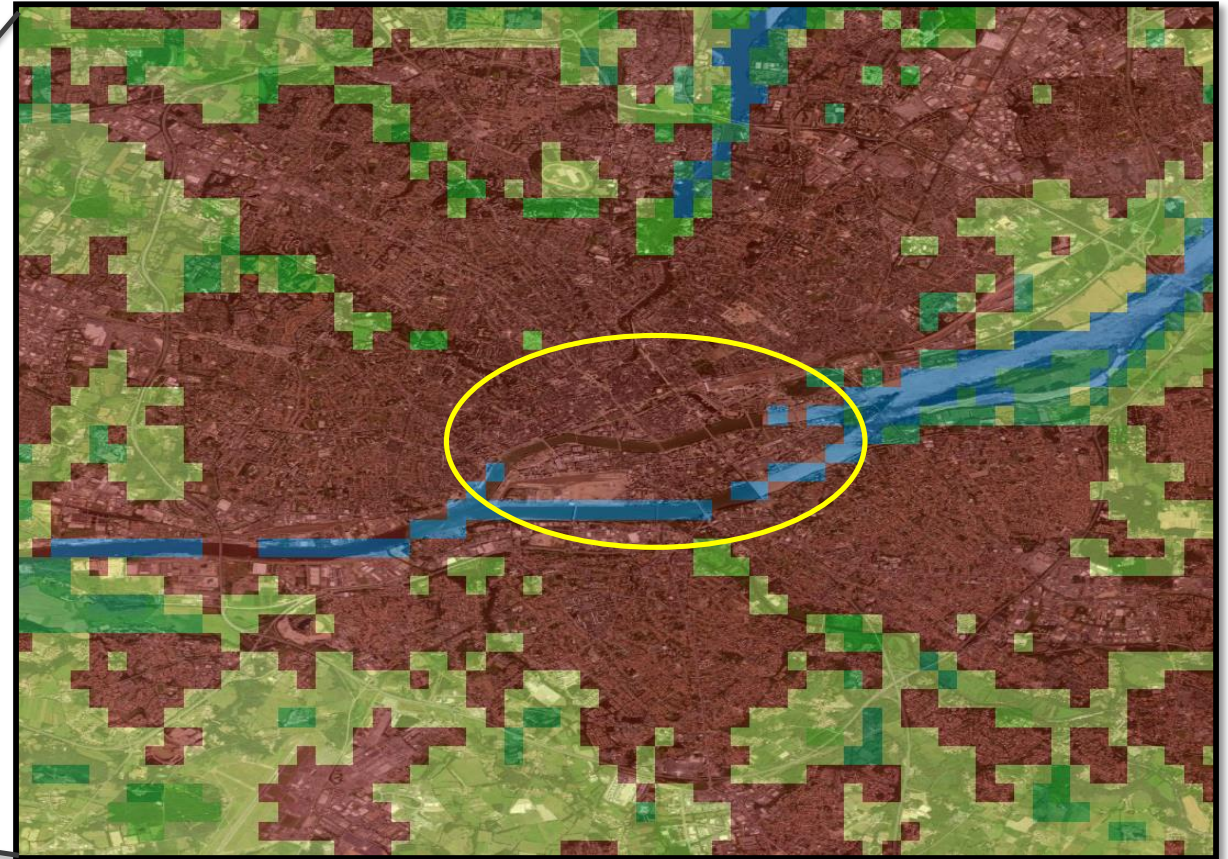
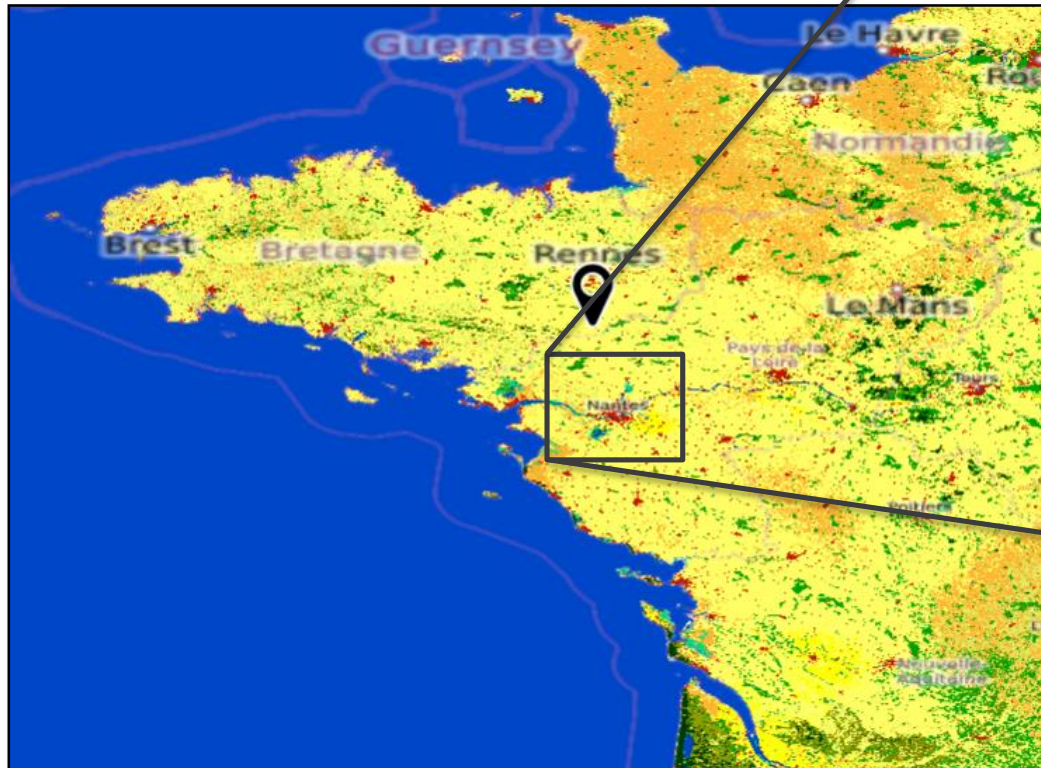
Urban areas  
Water bodies

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Slide 3



# Current quality, missing information and errors

- Overall quality is good with 300m spatial resolution
- Example of Nantes in France
  - No classification for sea water
  - Urban areas just one class
  - Water bodies sometimes too small



Urban areas  
Water bodies

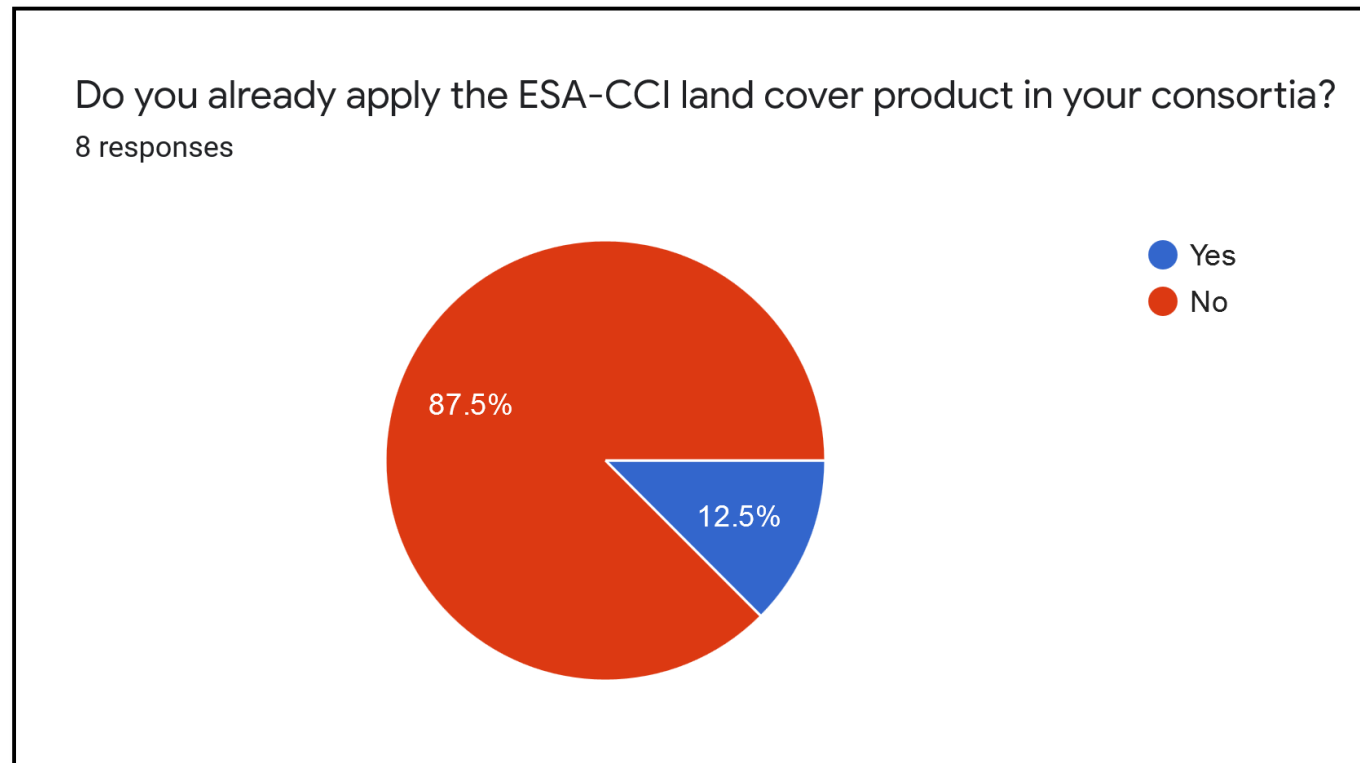
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# Motivation

- To understand what meteorologists need for the NWP
  - Survey with all C-SRNWP surface members
- Eight colleagues take part
  - Meteo France
  - Met Ireland
  - Metoffice UK
  - CMCC Italy
  - DWD Germany
  - OMSZ Hungary
  - ARSO Slovenia
  - CHMI Czech Republic
- **Only 1 out of 8** use the land cover map

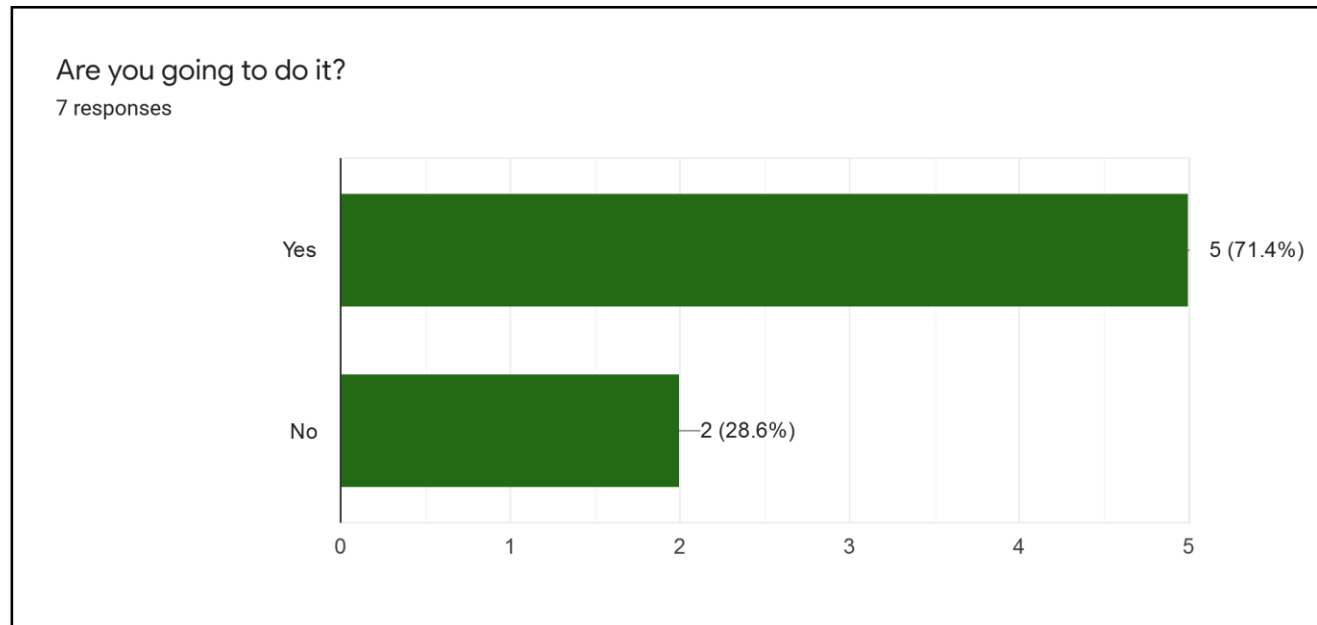
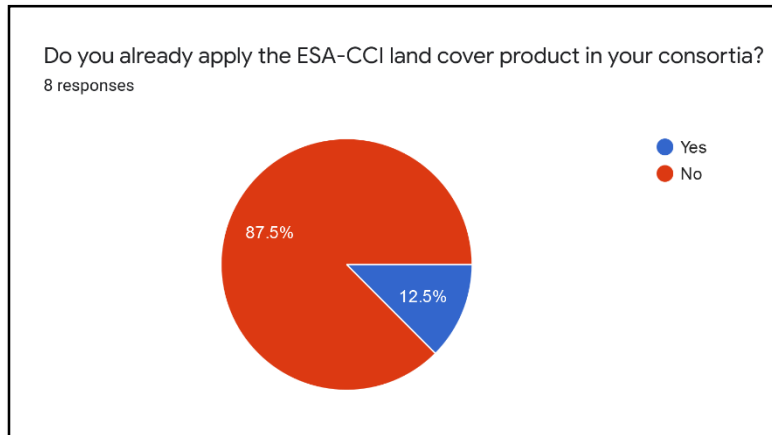
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# Survey with all ACCORD members

- But they would use it if:
  - The water mask is better,
  - A distinction between fresh and salt water
  - Urban areas should have more than one class

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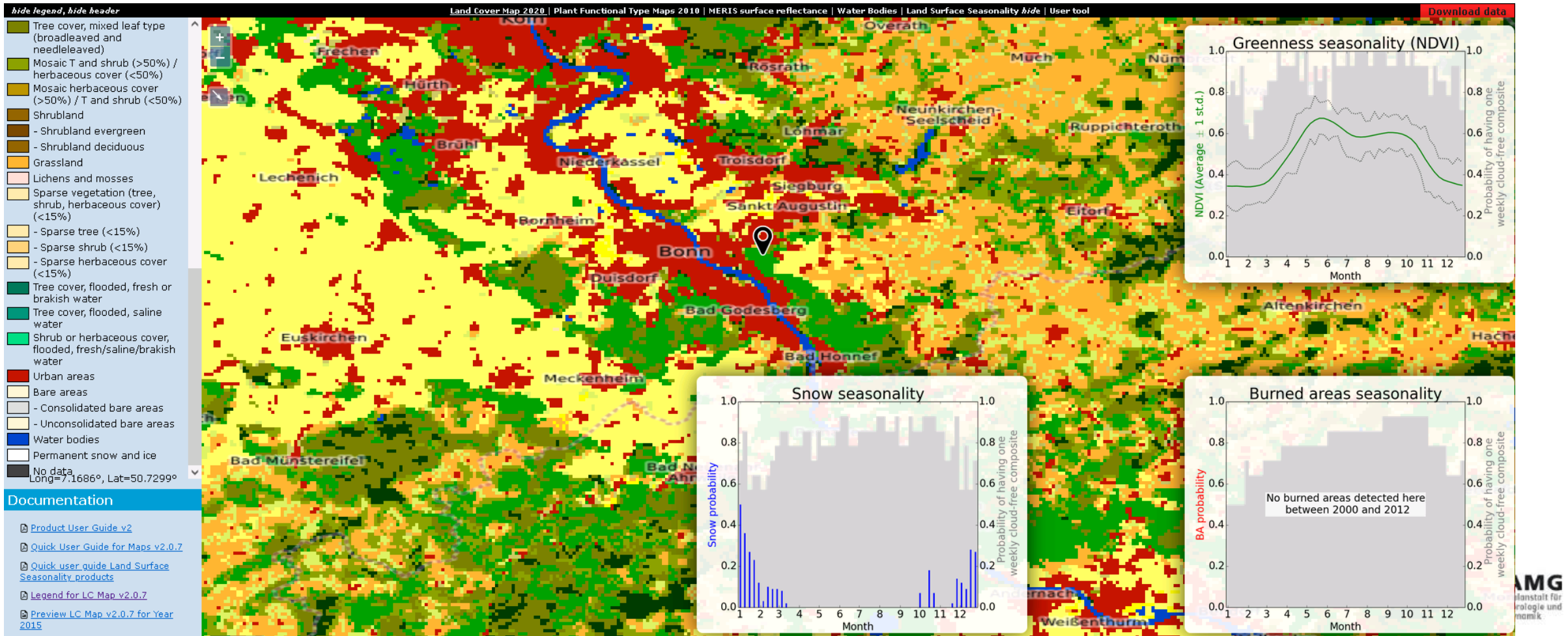




# Members need

- Distinction between fresh water and salt water
- Urban areas should have more than one class

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# Finding a reference water mask

- Several products exists as e.g.
  - MODIS land water mask → latest from 2015
  - Copernicus water mask → spatial extent only -62 till 80° latitude

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# Finding a reference water mask

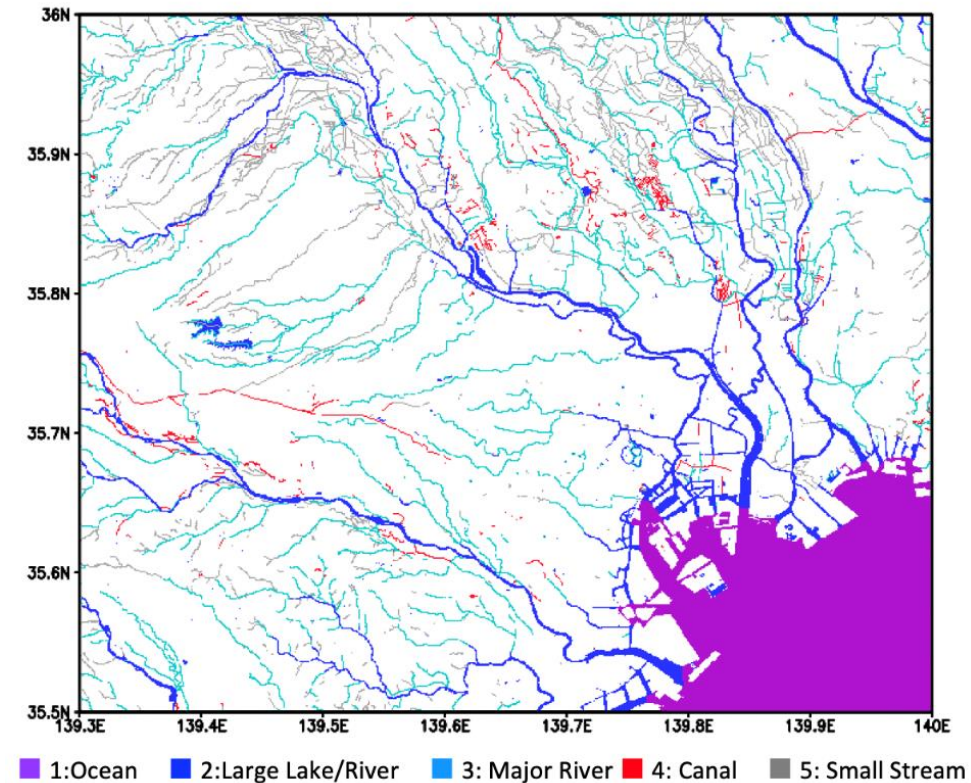
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  - **high spatial resolution** (polygons), and
  - crowd sourced layers

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  - crowd sourced layers
- Global Hydrology and Water Resources Engineering institute (University of Tokyo)
  - Github repository to create own global water mask
- Use of a **majority algorithm** to create a 300m water mask
  - with salt and fresh water distinction

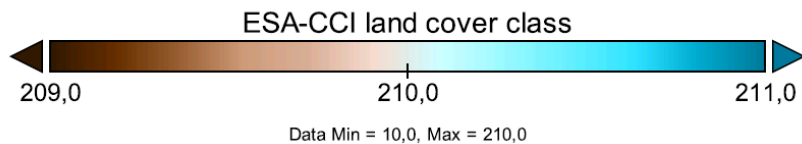
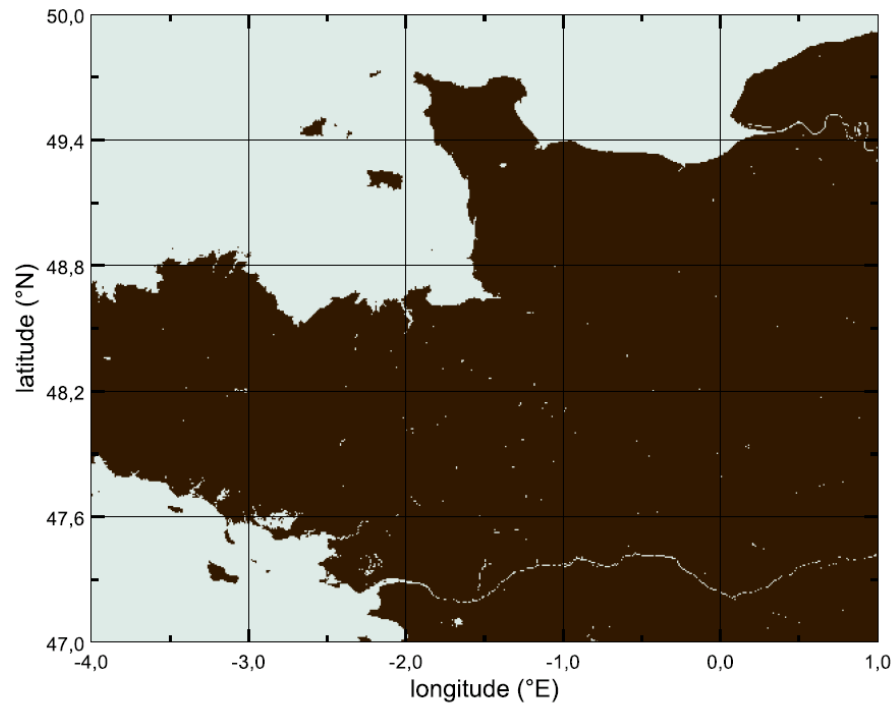
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# Open Street Map as reference?

- Bretagne/Normandy as example with classes of
  - Land (209)
  - Water bodies (210)

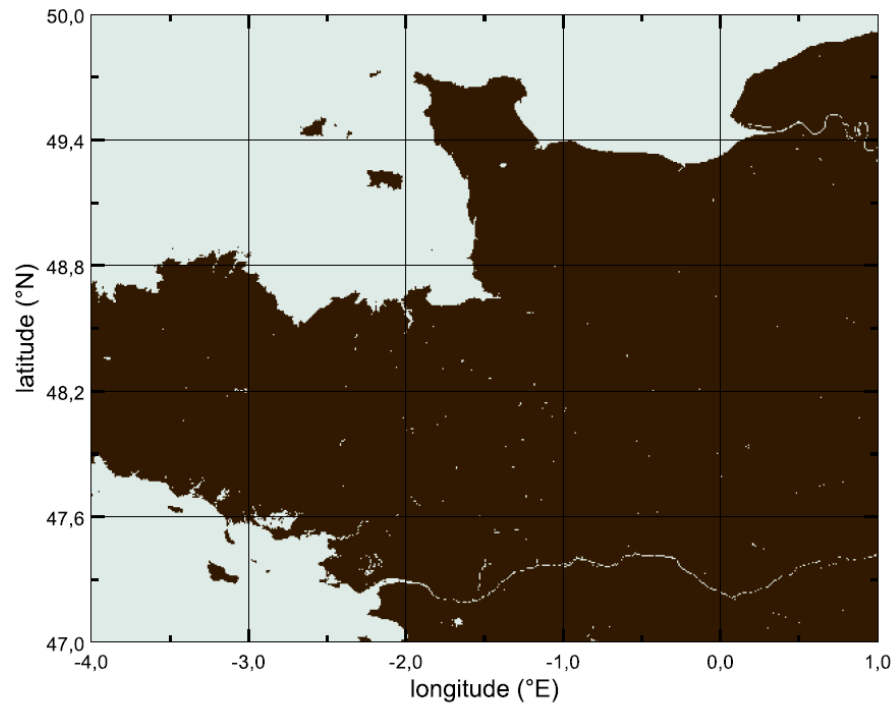


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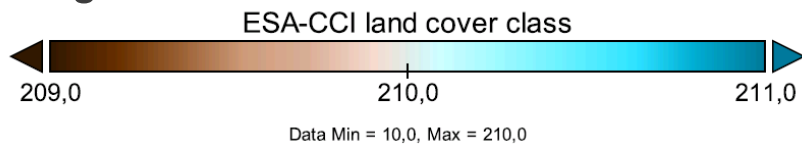
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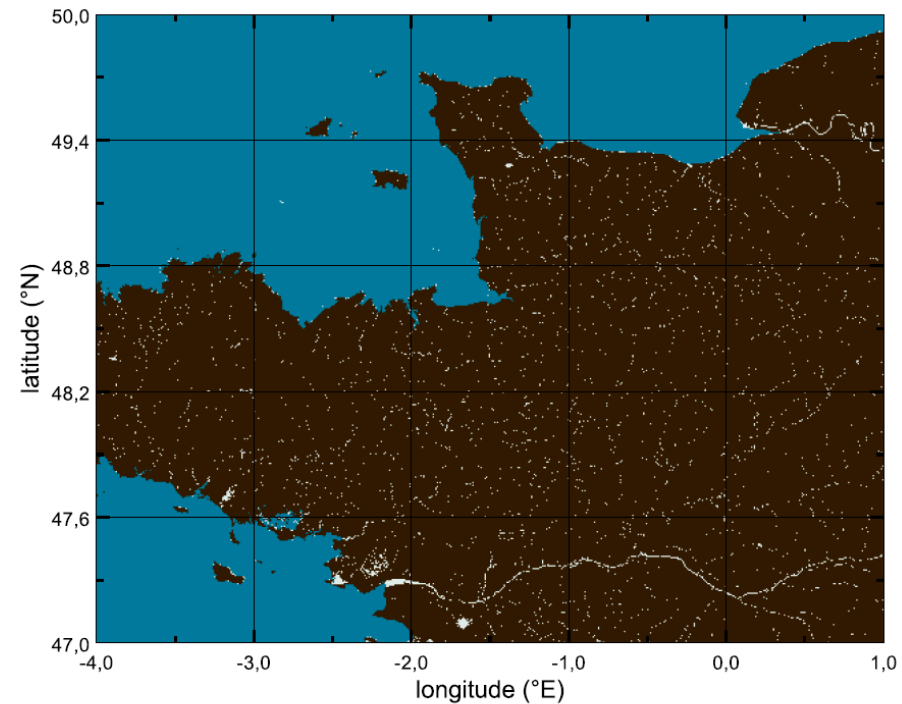
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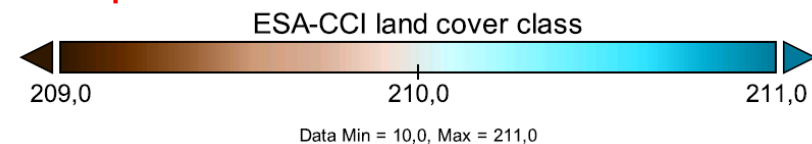
Original



New class of saltwater (211)



Proposed

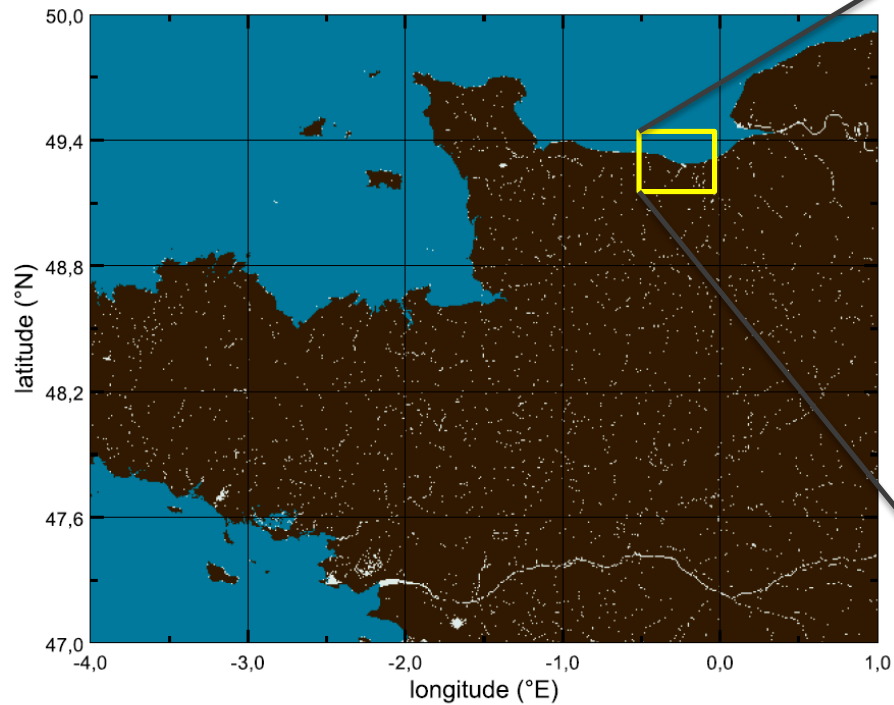




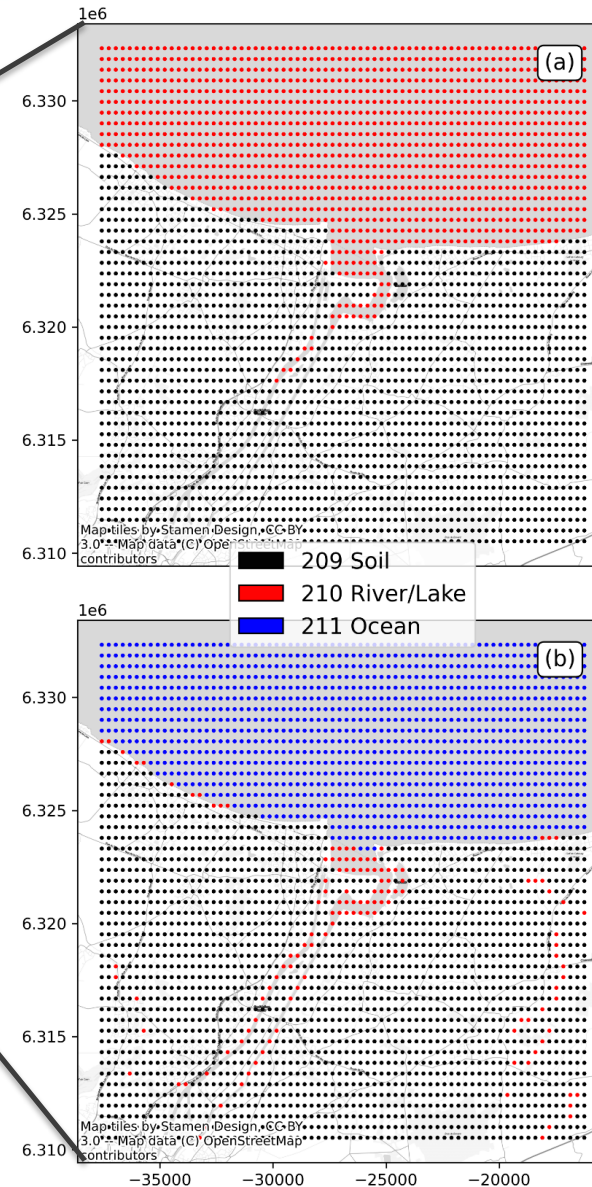
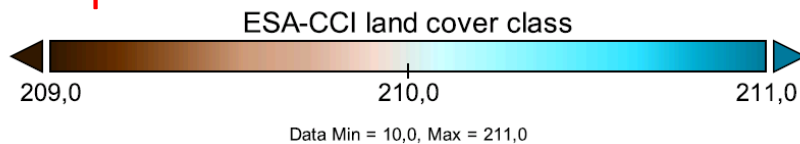
# Open Street Map as reference?

- Example zoom in the area of Caen, France

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Proposed



Original

Proposed

## Open Street Map as reference?

- Keep in mind that ESA-CCI LC map should be updated globally
- **Climate change** effects the environment quicker than we think

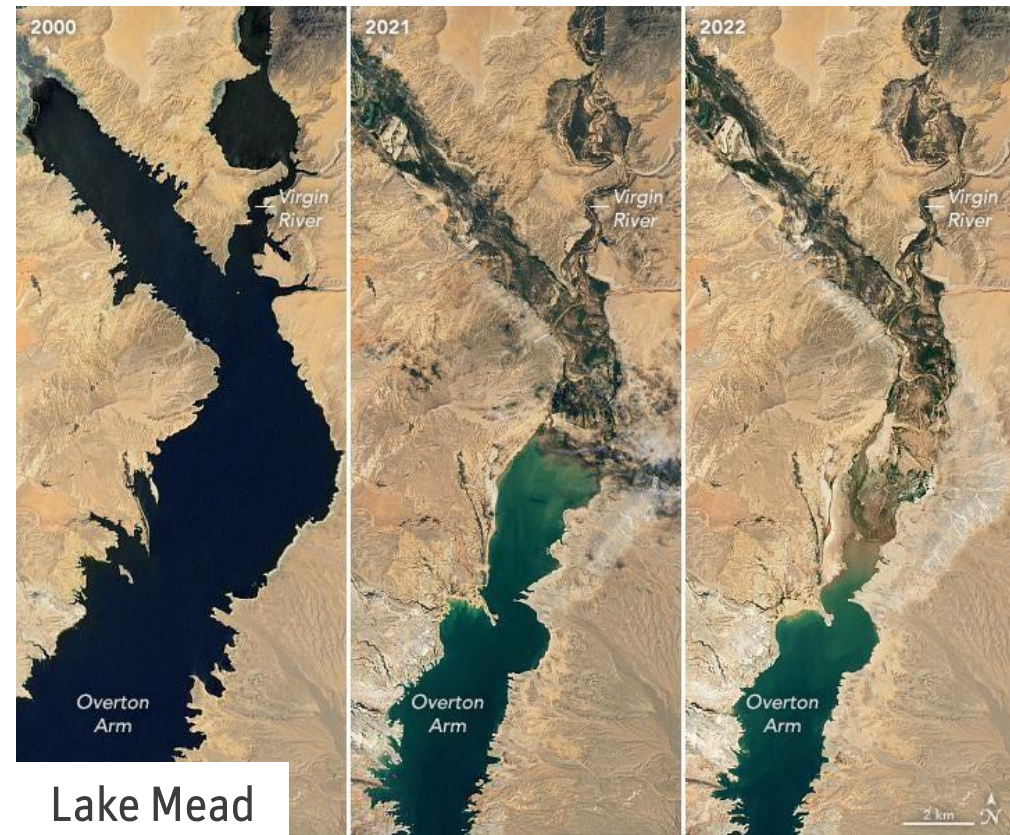
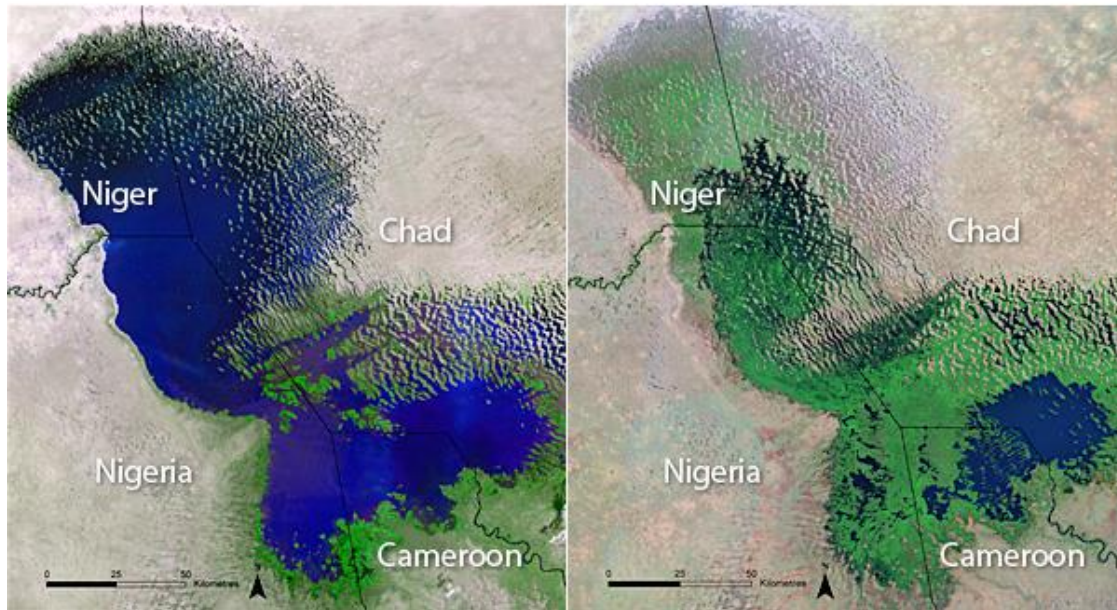
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Lake Chad 1972 / 2007



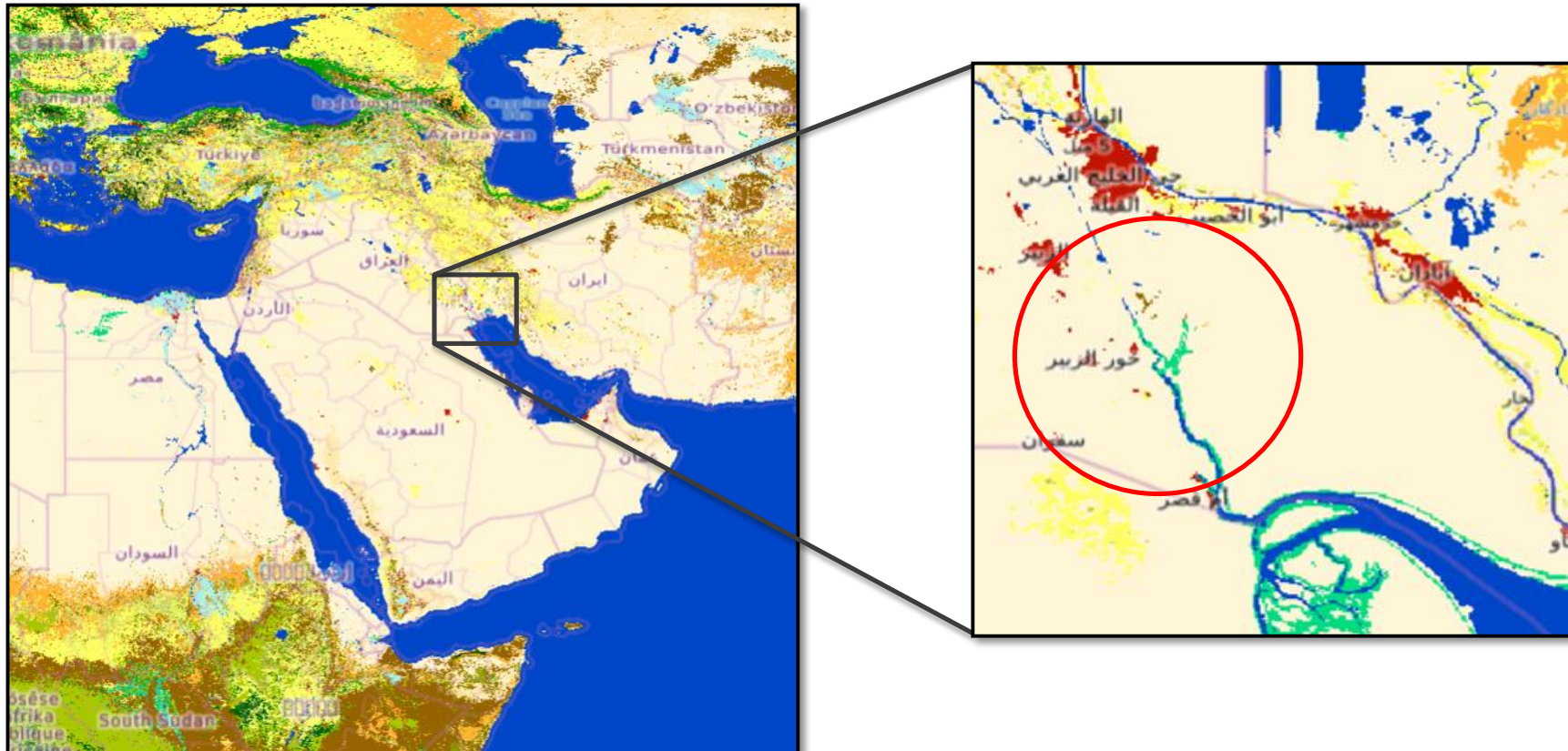
Lake Mead



# Open Street Map as reference?

- Keep in mind that ESA-CCI LC map should be updated globally
- **Climate change** effects the environment quicker than we think
- Desert and sub-tropical areas are most effected

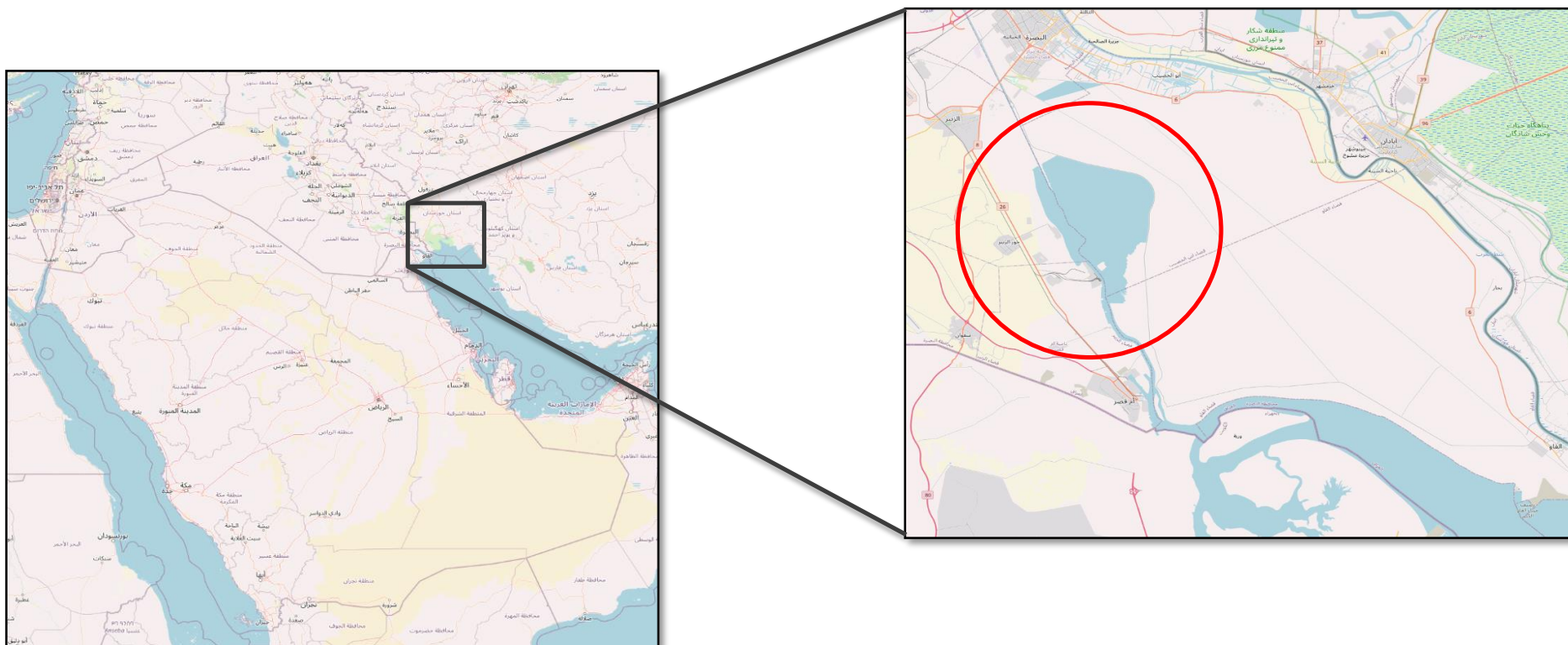
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# Open Street Map as reference?

- Same area but for Open Street Map

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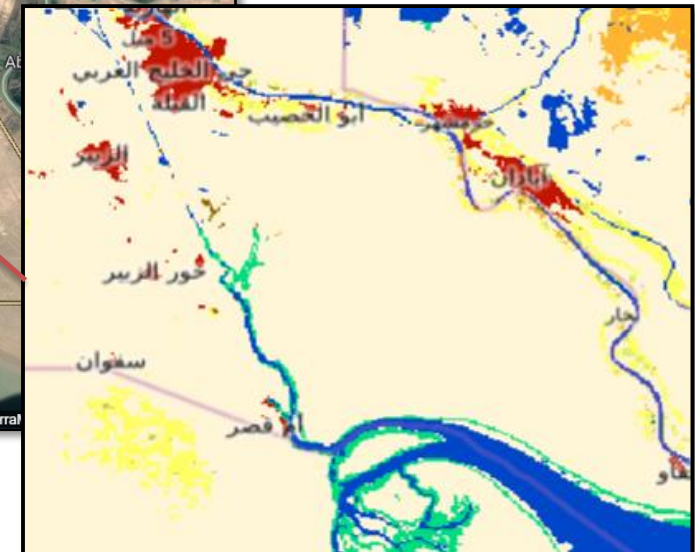
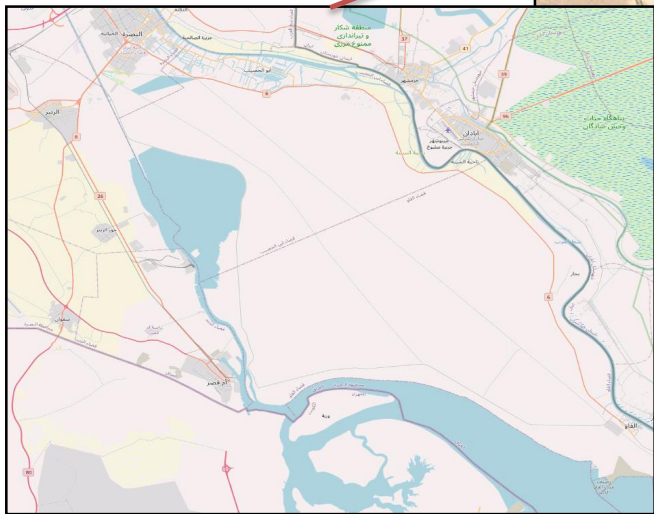




# Open Street Map as reference?

- Clear answer
  - NO!
- Only as sea mask

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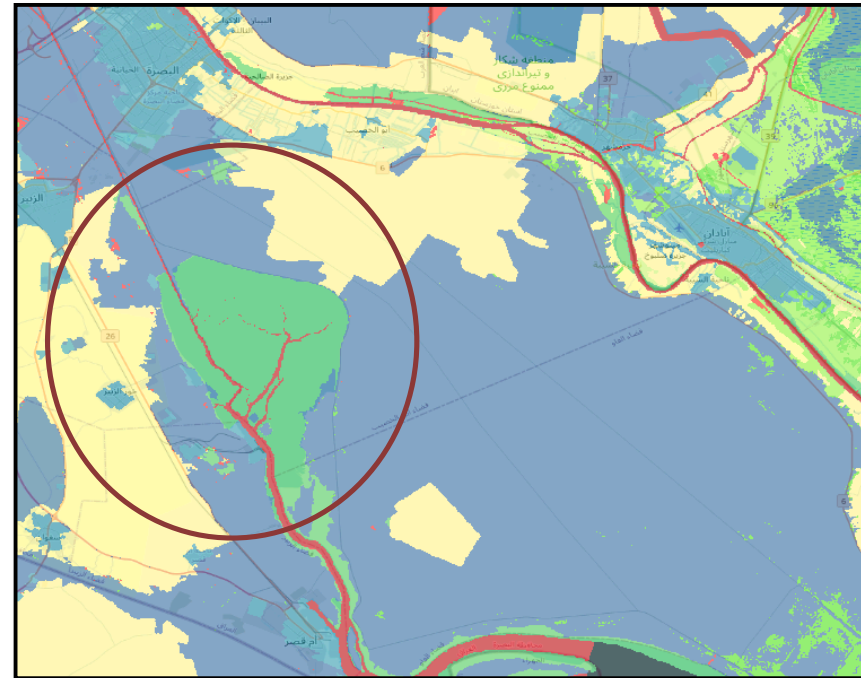
- 30m resolution
  - TM5 ETM+, and OLI multispectral images of Landsat
  - HJ-1 (China Environment Satellite) and the 16-meter resolution GF-1 (China High Resolution Satellite)

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  - TM5 ETM+, and OLI multispectral images of Landsat
  - HJ-1 (China Environment Satellite) and the 16-meter resolution GF-1 (China High Resolution Satellite)
  - Released in 2020

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# Complete water correction

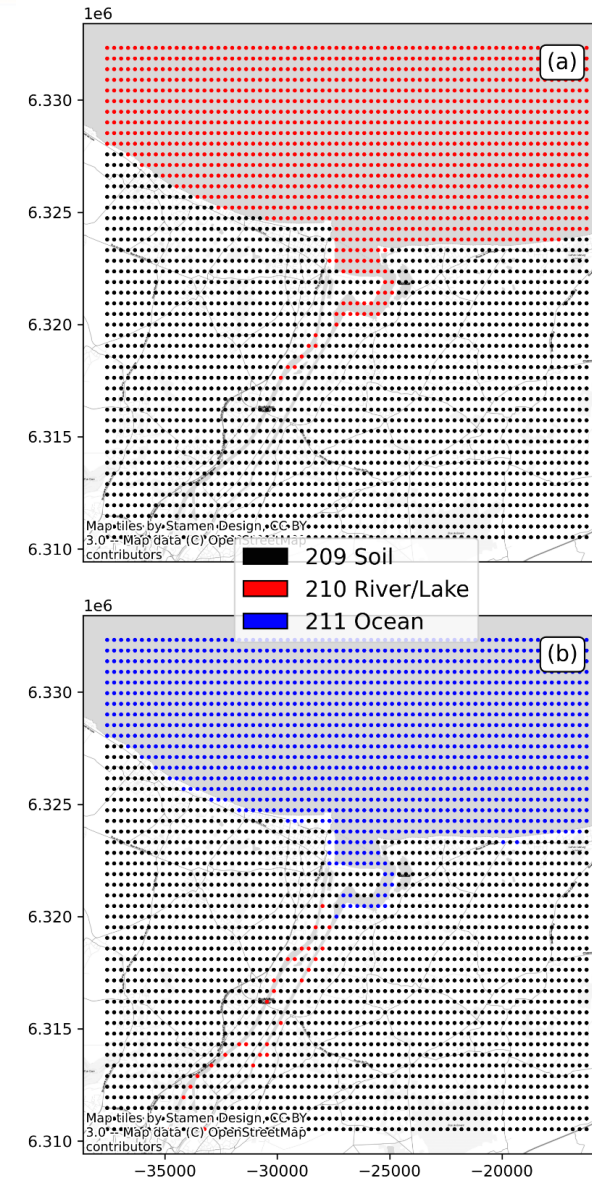
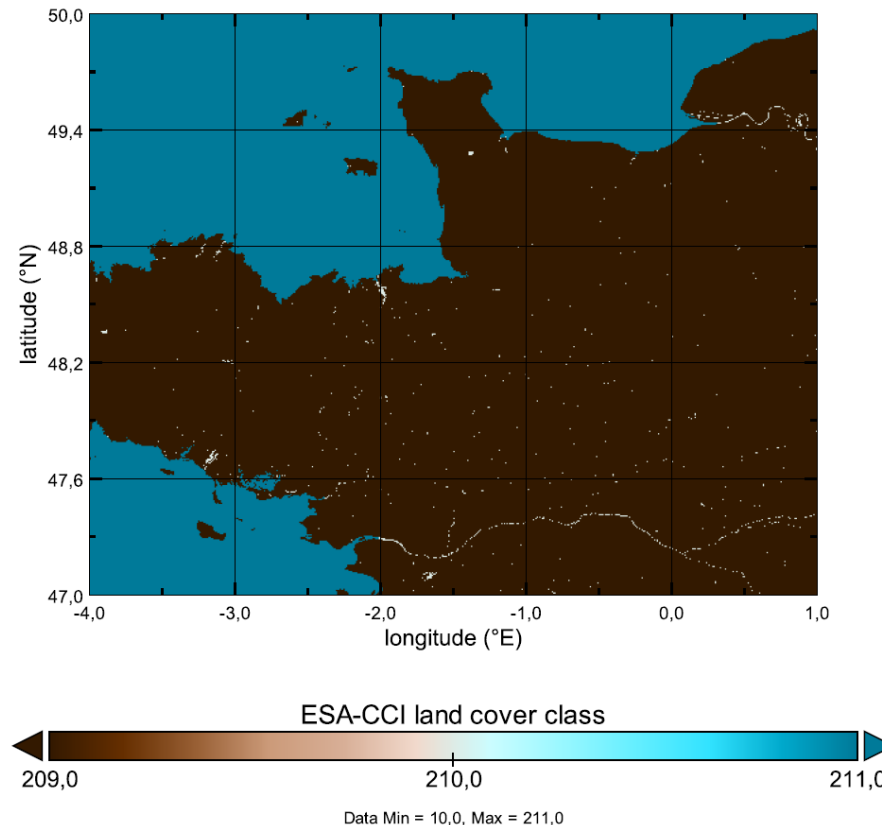
- Use **Open Street Map for Ocean** (salt water – classified as 211)
  - (Small) Islands are better covered (due to polygons)
- GlobalLand30 for fresh water correction
  - Recently generated
  - Very high spatial resolution (30m)

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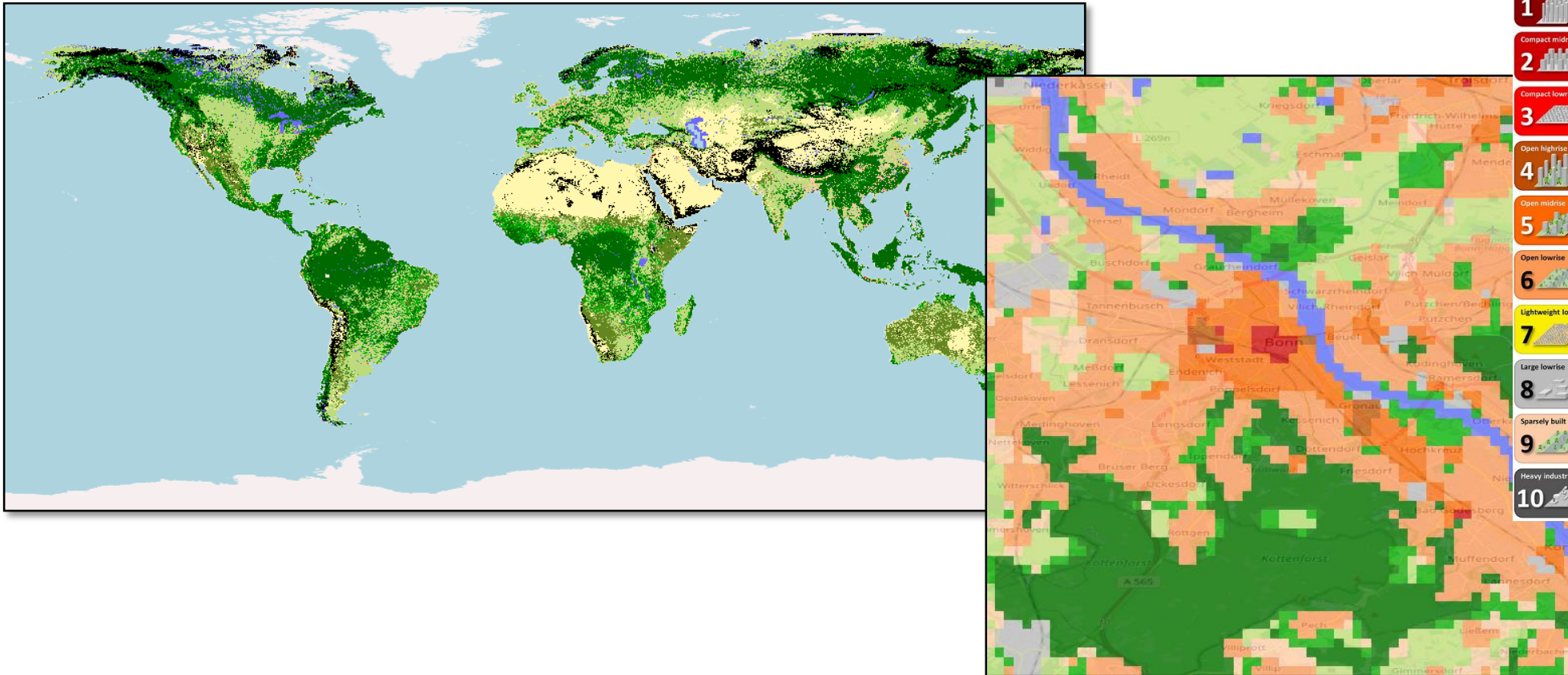
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













## Local Climate Zones (LCZ)

- Global map with 100m resolution (published March 2022 by Demuzere et al.)
- Only urban area classes (1 till 10) are used

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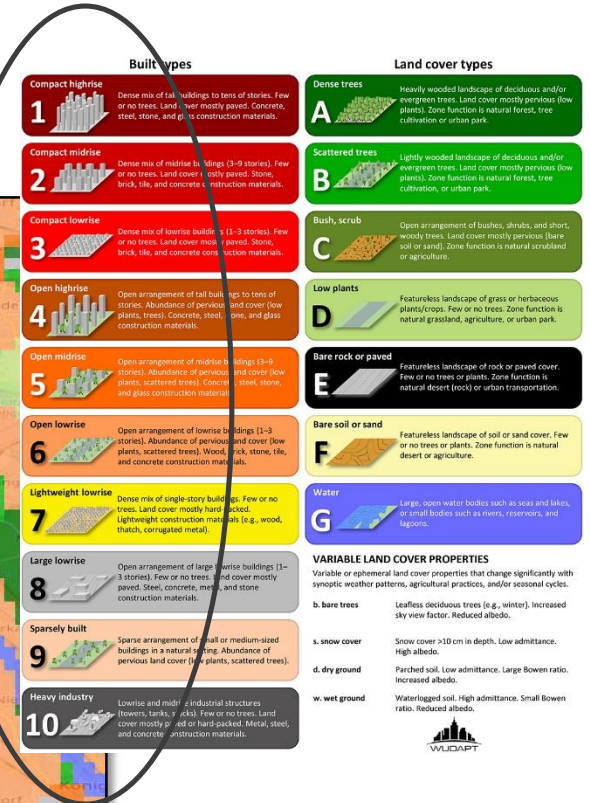
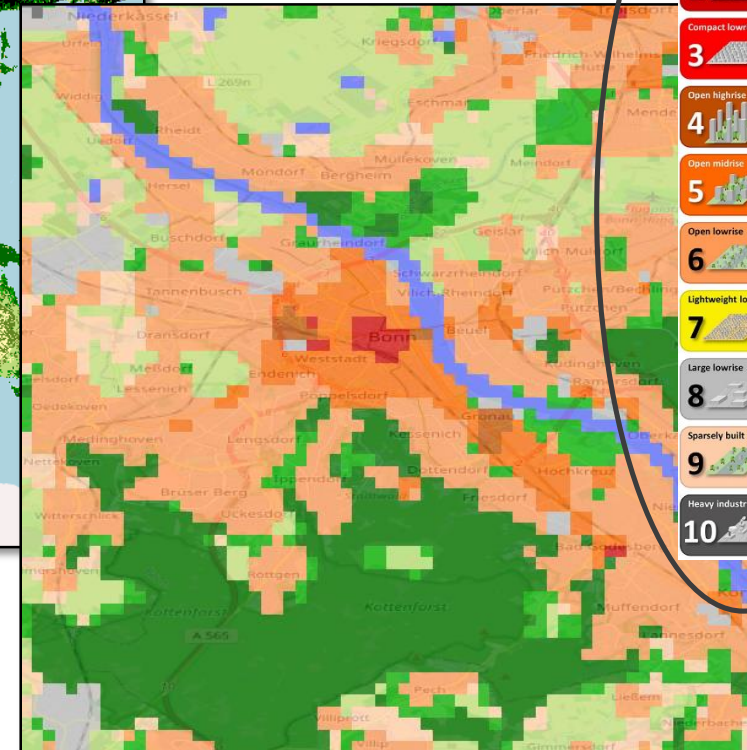
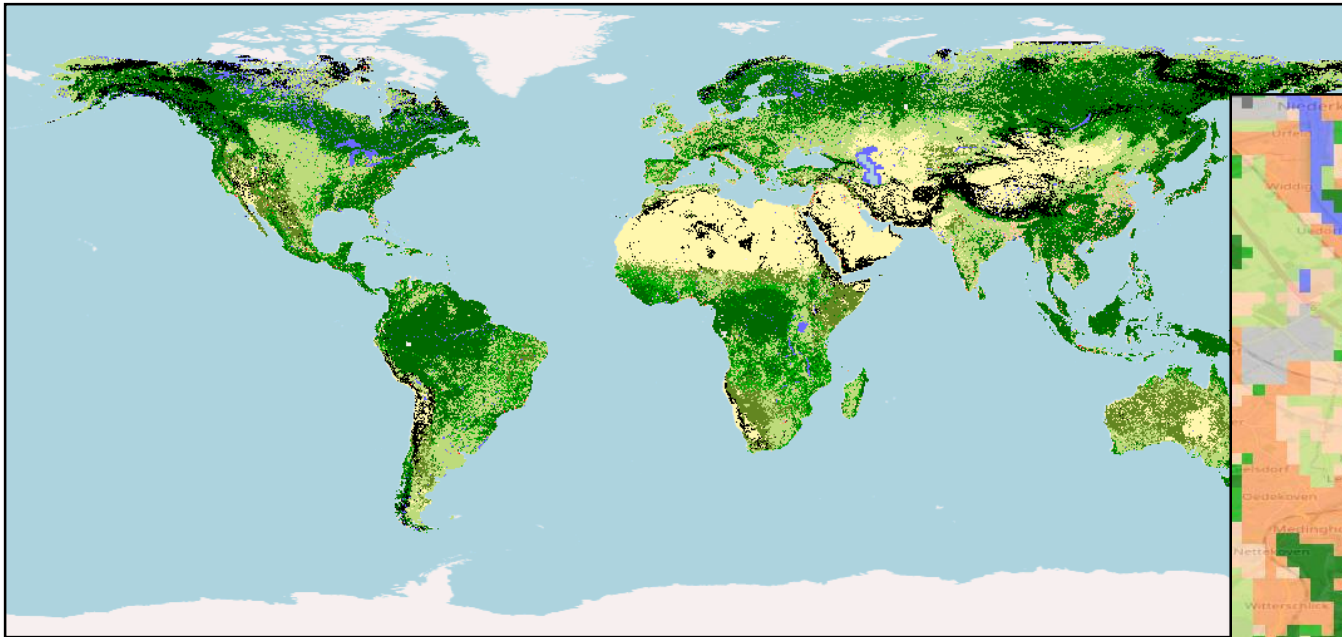
Built types		Land cover types	
<b>1</b>  <p><b>Compact highrise</b></p> <p>Dense mix of tall buildings (15-9 stories). Few or no trees. Land cover mostly paved. Concrete, steel, stone, and glass construction materials.</p>	<b>A</b>  <p><b>Dense trees</b></p> <p>Heavily wooded landscape of deciduous and/or evergreen trees. Land cover mostly pervious (low plants). Zone function is natural forest, tree cultivation or urban park.</p>		
<b>2</b>  <p><b>Compact midrise</b></p> <p>Dense mix of mid-rise buildings (3-9 stories). Few or no trees. Land cover mostly paved. Stone, brick, tile, and concrete construction materials.</p>	<b>B</b>  <p><b>Scattered trees</b></p> <p>Lightly wooded landscape of deciduous and/or evergreen trees. Land cover mostly pervious (low plants). Zone function is natural forest, tree cultivation, or urban park.</p>		
<b>3</b>  <p><b>Compact lowrise</b></p> <p>Dense mix of low-rise buildings (1-3 stories). Few or no trees. Land cover mostly paved. Stone, brick, tile, and concrete construction materials.</p>	<b>C</b>  <p><b>Bush, scrub</b></p> <p>Open arrangement of bushes, shrubs, and short, woody trees. Land cover mostly pervious (bare soil or sand). Zone function is natural scrubland or agriculture.</p>		
<b>4</b>  <p><b>Open highrise</b></p> <p>Open arrangement of tall buildings to tens of stories. Abundance of pervious land cover (low plants, trees). Concrete, steel, stone, and glass construction materials.</p>	<b>D</b>  <p><b>Low plants</b></p> <p>Featureless landscape of grass or herbaceous plants/crocs. Few or no trees. Zone function is natural grassland, agriculture, or urban park.</p>		
<b>5</b>  <p><b>Open midrise</b></p> <p>Open arrangement of mid-rise buildings (3-9 stories). Abundance of pervious land cover (low plants, scattered trees). Concrete, steel, stone, and glass construction materials.</p>	<b>E</b>  <p><b>Bare rock or paved</b></p> <p>Featureless landscape of rock or paved cover. Few or no trees or plants. Zone function is natural desert (rock) or urban transportation.</p>		
<b>6</b>  <p><b>Open lowrise</b></p> <p>Open arrangement of low-rise buildings (1-3 stories). Abundance of pervious land cover (low plants, scattered trees). Wood, brick, stone, tile, and concrete construction materials.</p>	<b>F</b>  <p><b>Bare soil or sand</b></p> <p>Featureless landscape of soil or sand cover. Few or no trees or plants. Zone function is natural desert or agriculture.</p>		
<b>7</b>  <p><b>Lightweight lowrise</b></p> <p>Dense mix of single-story buildings. Few or no trees. Land cover mostly hard-packed, lightweight construction materials (e.g., wood, thatch, corrugated metal).</p>	<b>G</b>  <p><b>Water</b></p> <p>Large, open water bodies such as seas and lakes, and small bodies such as rivers, reservoirs, and lagoons.</p>		
<b>VARIEABLE LAND COVER PROPERTIES</b> Variable or ephemeral land cover properties that change significantly with synoptic weather patterns, agricultural practices, and/or seasonal cycles.			
<b>Large lowrise</b> <b>8</b>  <p>Open arrangement of large low-rise buildings (1-3 stories). Few or no trees. Land cover mostly paved. Steel, concrete, metal, and stone construction materials.</p>		<b>b. bare trees</b> Leafless deciduous trees (e.g., winter), increased sky view factor. Reduced albedo.	
<b>Sparsely built</b> <b>9</b>  <p>Sparse arrangement of small or medium-sized buildings in a natural setting. Abundance of pervious land cover (low plants, scattered trees).</p>		<b>s. snow cover</b> Snow cover >10 cm in depth. Low admittance. High albedo.	
<b>Heavy industry</b> <b>10</b>  <p>Low-rise and mid-rise industrial structures (towers, tanks, stacks). Few or no trees. Land cover mostly paved or hard-packed. Metal, steel, and concrete construction materials.</p>		<b>d. dry ground</b> Parched soil. Low admittance. Large Bowen ratio. Increased albedo.	
		<b>w. wet ground</b> Waterlogged soil. High admittance. Small Bowen ratio. Reduced albedo.	



# Local Climate Zones (LCZ)

- Global map with 100m resolution (published March 2022 by Demuzere et al.)
- Only urban area classes (1 till 10) are used

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# Implement LCZ into ESA-CCI – Example of Cologne and Bonn

- Only urban classes which are pre-defined in ESA-CCI
  - Cells where ESA-CCI has urban classified, but LCZ not
  - → Class 6 (most common in suburban or rural areas)

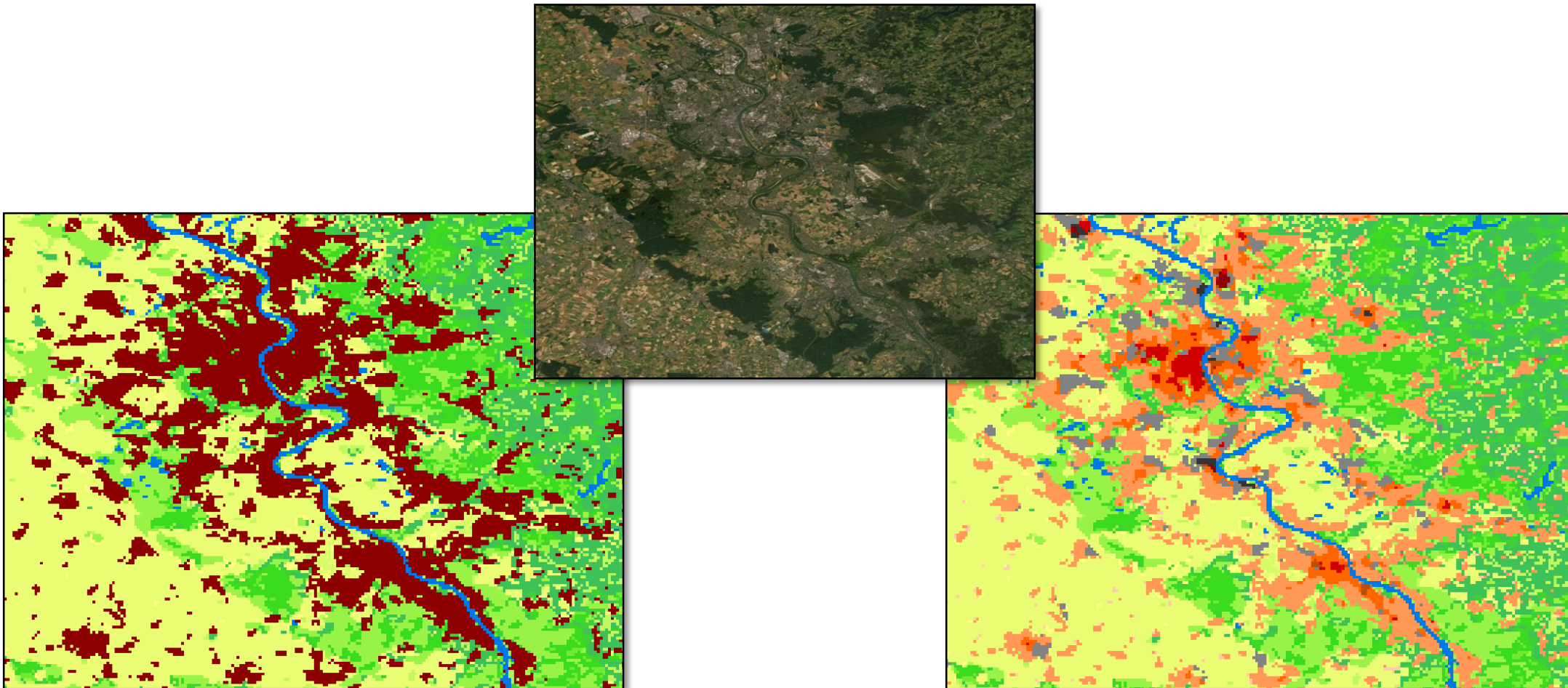




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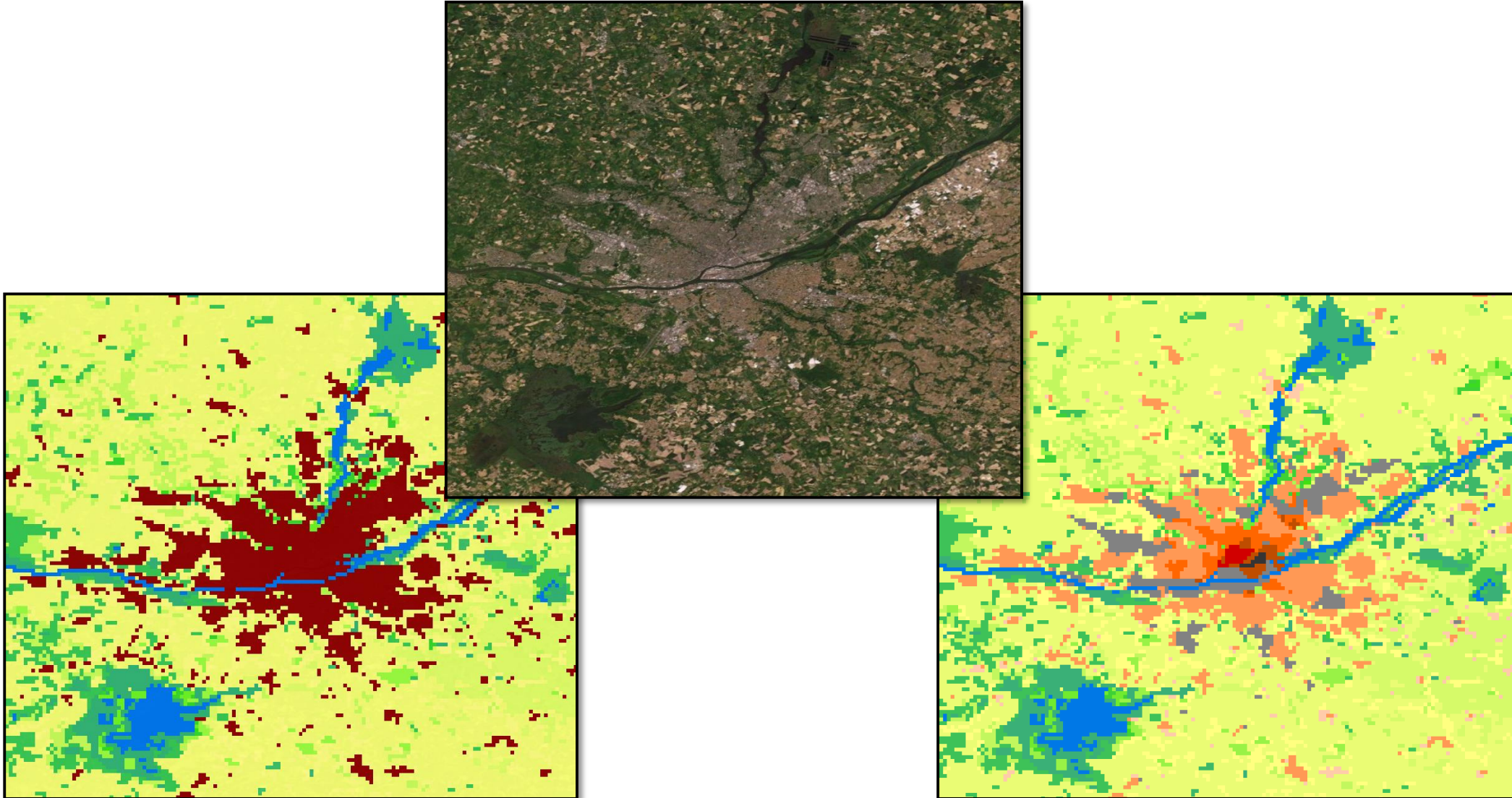
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# Implement LCZ into ESA-CCI – Example of Nantes

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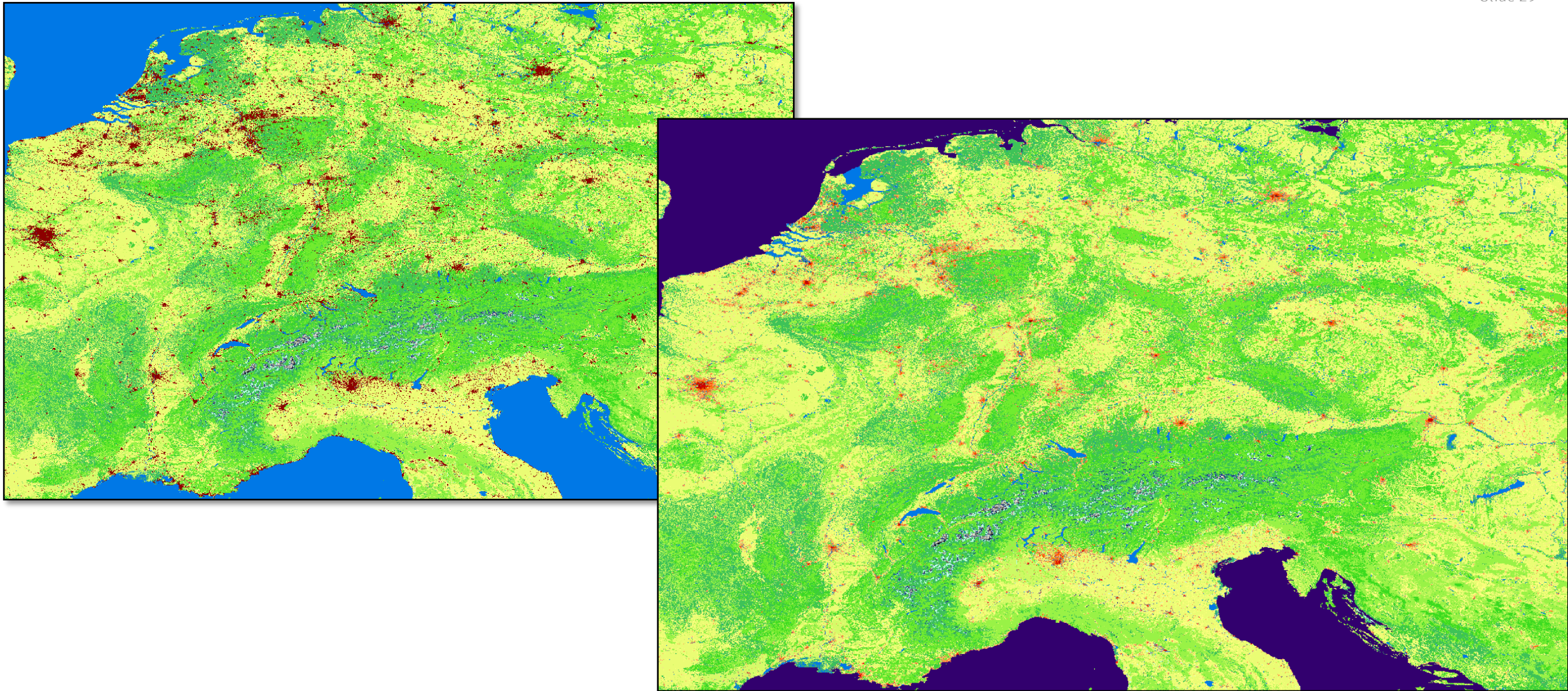




# First global corrected ESA-CCI land cover map

- Example for middle Europe

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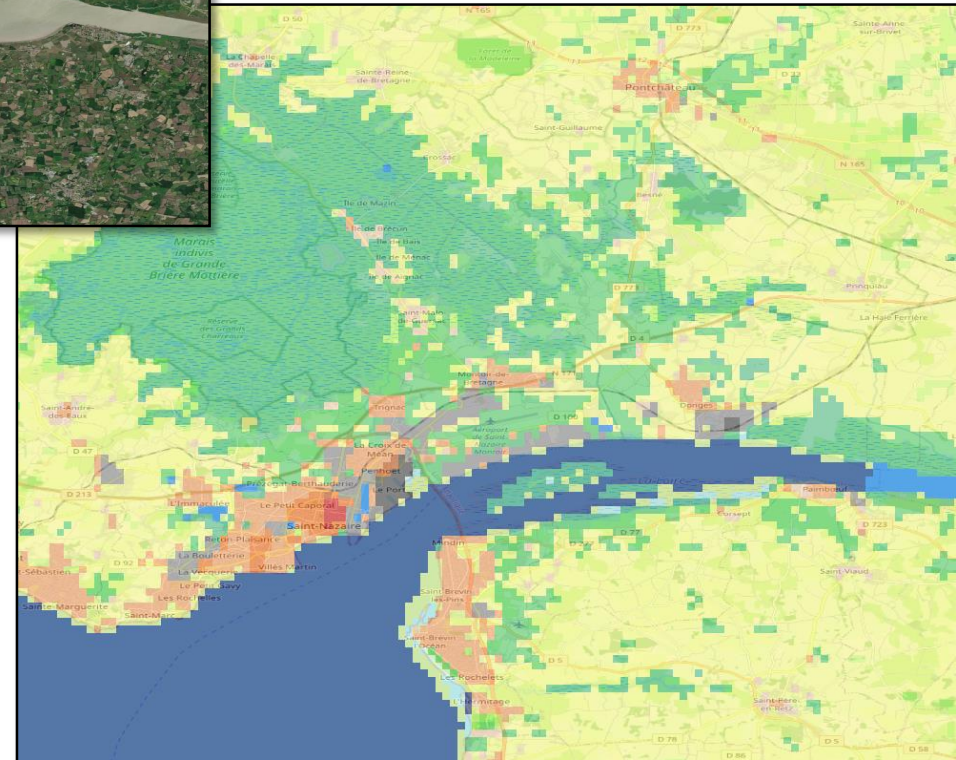
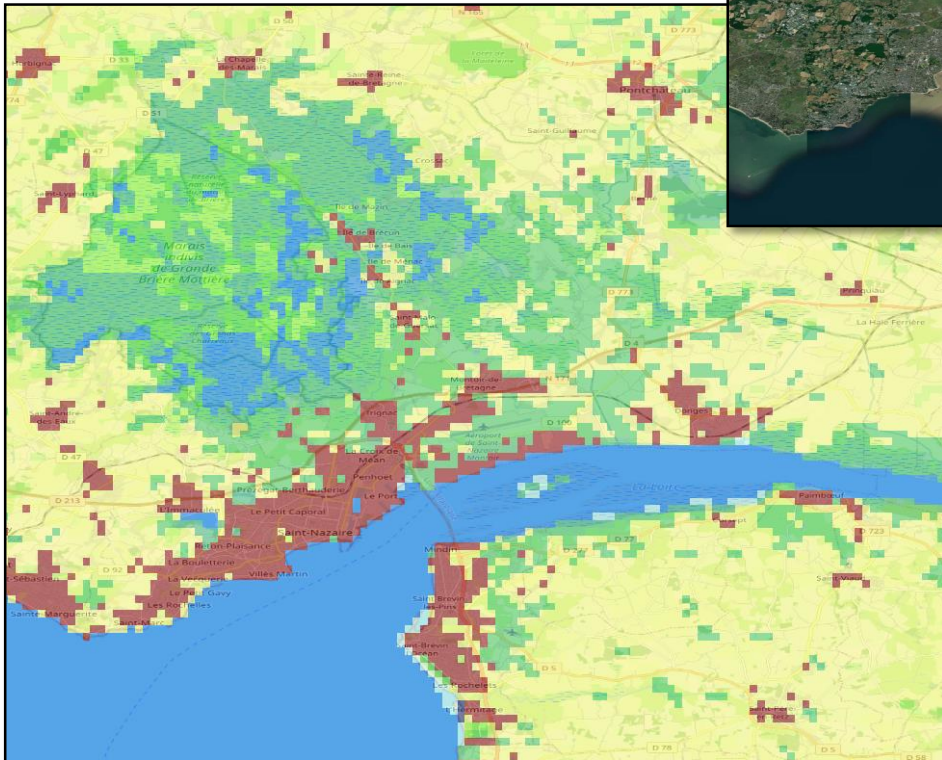




# First global corrected ESA-CCI land cover map

- Example of Saint-Nazaire, France
- River mouths and their end defined by Open Street Map

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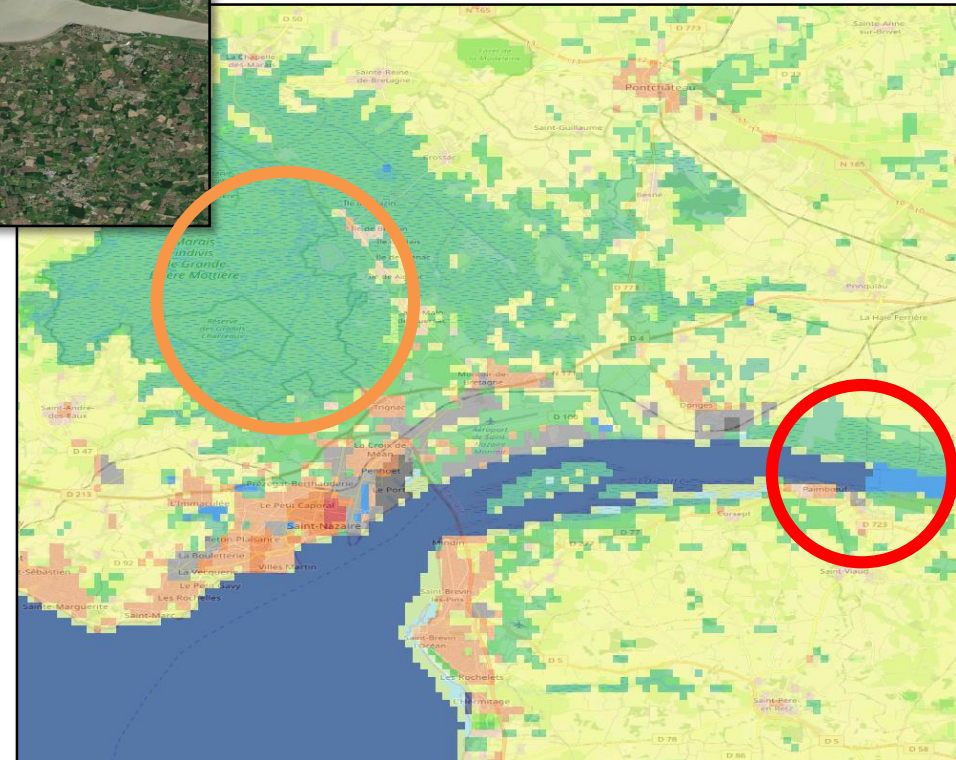
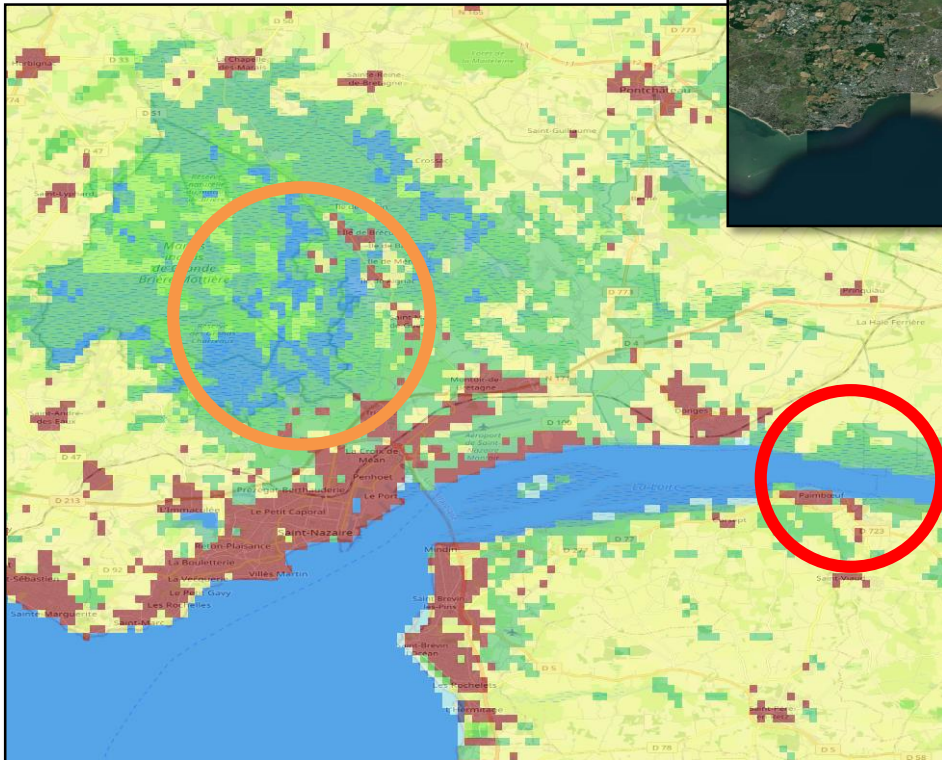




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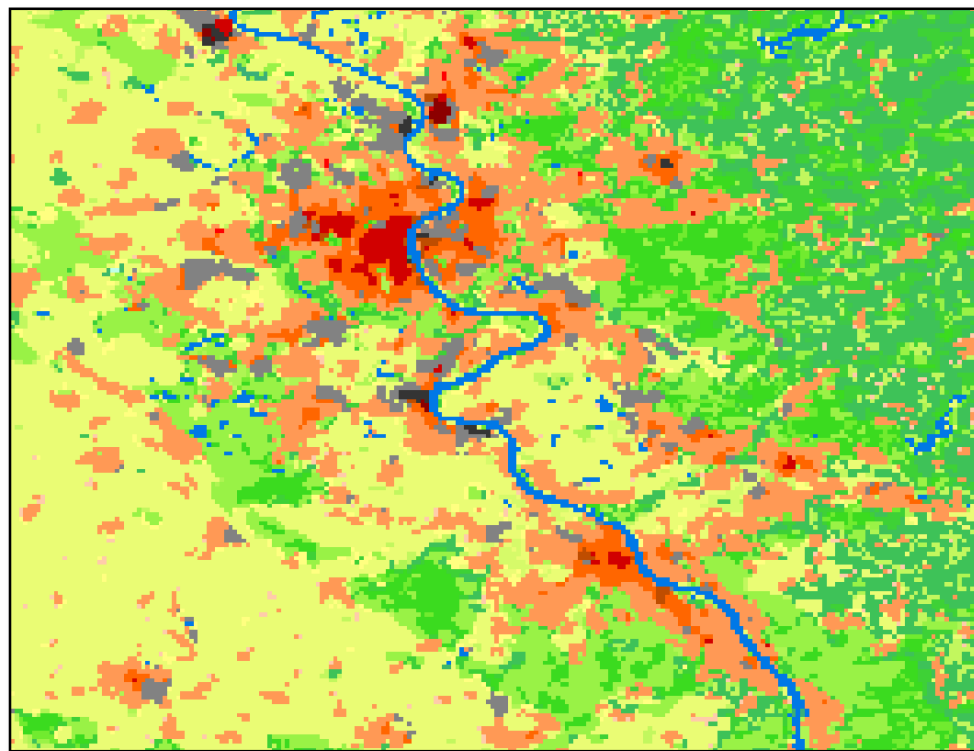
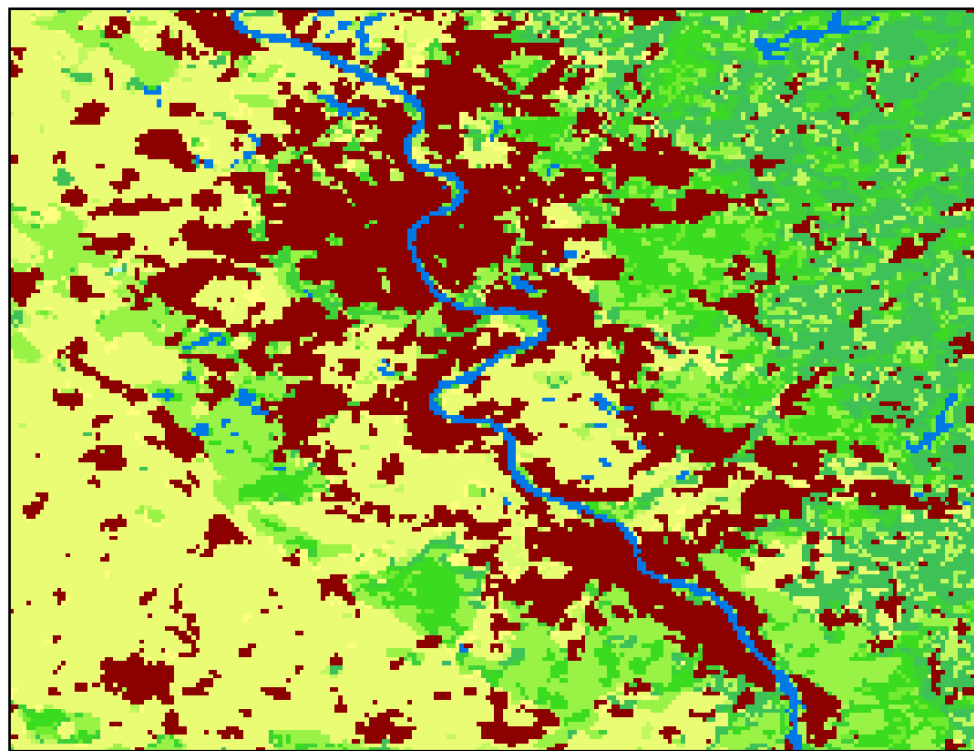
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# First global corrected ESA-CCI land cover map

- Example of Cologne and Bonn, Germany

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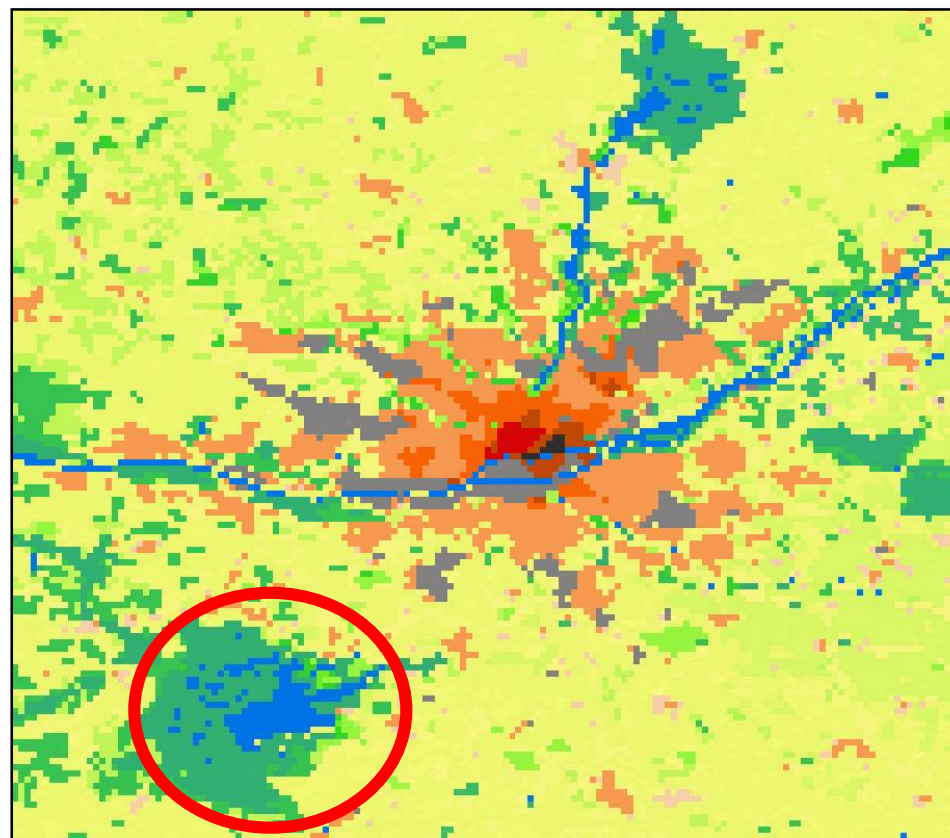
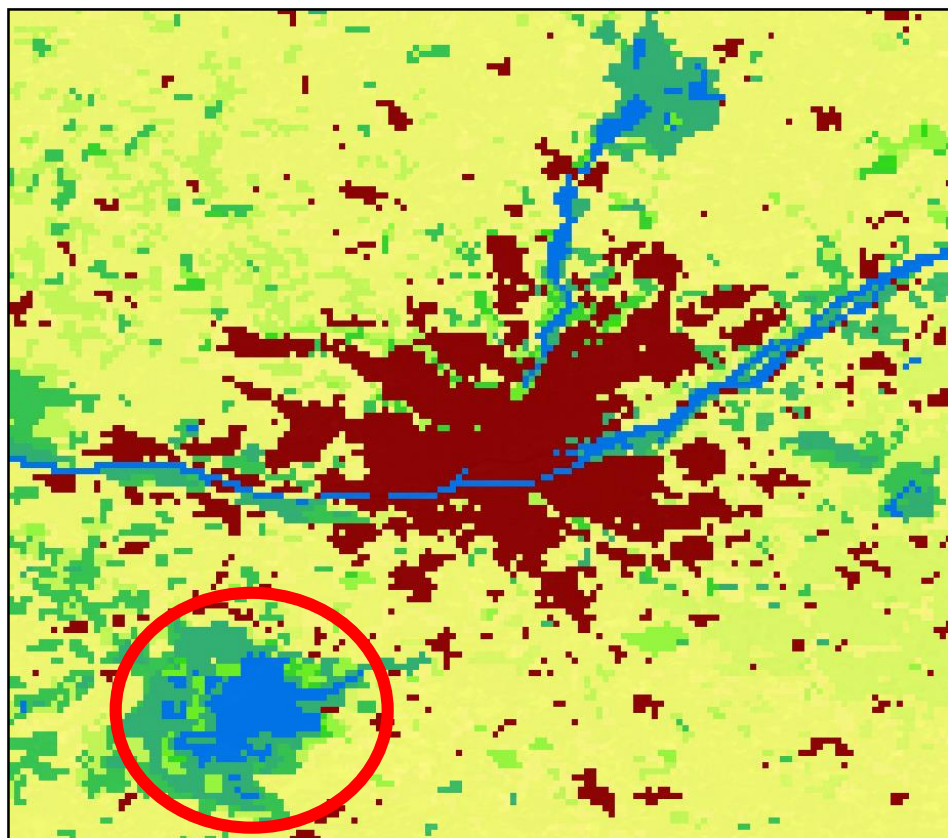




# First corrected ESA-CCI land cover map

- Example of Nantes, France

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# Summary and Outlook

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- Overall quality of the ESA-CCI land cover map is good...
  - ...but should be modified for several NWP needs
- Here, we use the **Open Street Map**, **GlobalLand30** (China) and **Local Climate Zones** to modify
  - The distinction between salt and fresh water
  - Update rivers and lakes (rapid climate change influence)
  - Use 10 classes (LCZ pre-defined) for urban areas instead of 1
- Create a web basis where C-SRNWP members can issue wrong classifications
  - Those will be corrected as soon as possible
- Use it as reference to correct past ESA-CCI land cover maps (since 1992)?

Thank you for your attention!

**Sandro Oswald**

Urban climate modeling

Section Prediction models

Department Data, Methods, Models

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**ZAMG**  
Zentralanstalt für  
Meteorologie und  
Geodynamik