ESA CCI Essential Climate Variables: High Resolution Land Cover

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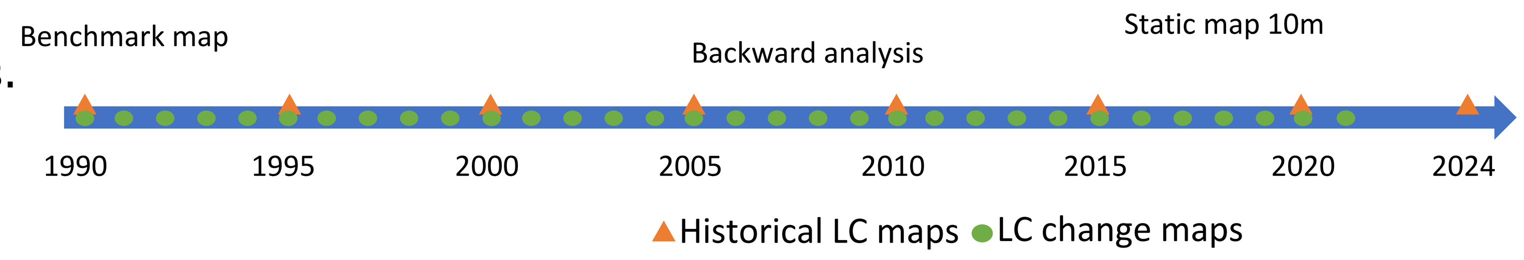
Project overview

In the context of ESA Climate Change Initiative, the **High Resolution Land Cover (HRLC) Essential Climate Variable (ECV)** involves the accurate description and analysis of land cover (LC) and LC change (LCC) using Earth Observation (EO) data with **high spatial resolution** (10-30m). LC has a key role on **weather** and **climate** since it determines the **fluxes of energy**, **water** and **greenhouse gases** (including carbon) exchanged with the atmosphere. LCC by its impact on **radiative** (albedo), **aerodynamic** (roughness), **evaporative** properties, **carbon storage**, is altering these flows with important consequences on the atmosphere. The other way round, **climate warming**, and its consequences on air **temperature** and **precipitation**, impacts **vegetation** and the **ecosystems dynamics**. This has been widely recognized by the scientific community and demonstrated by the previous CCI program, focused on the generation of Moderate Resolution Land Cover (MRLC) ECV maps at a global scale at 300m, even though more work is needed to better understand and model the land cover – climate interactions.

The project generates different products:

- A **static HRLC map** at subcontinental level at 10m as reference static input to the climate models.
- The **long-term record of regional HRLC maps** at 30m in the sub-regions every 5 years.
- The **change information** at 30 m and yearly scale for HRLC map update.
- The **rescaled** maps at intermediate multiple spatial resolutions.



Processing chains for land-cover map products

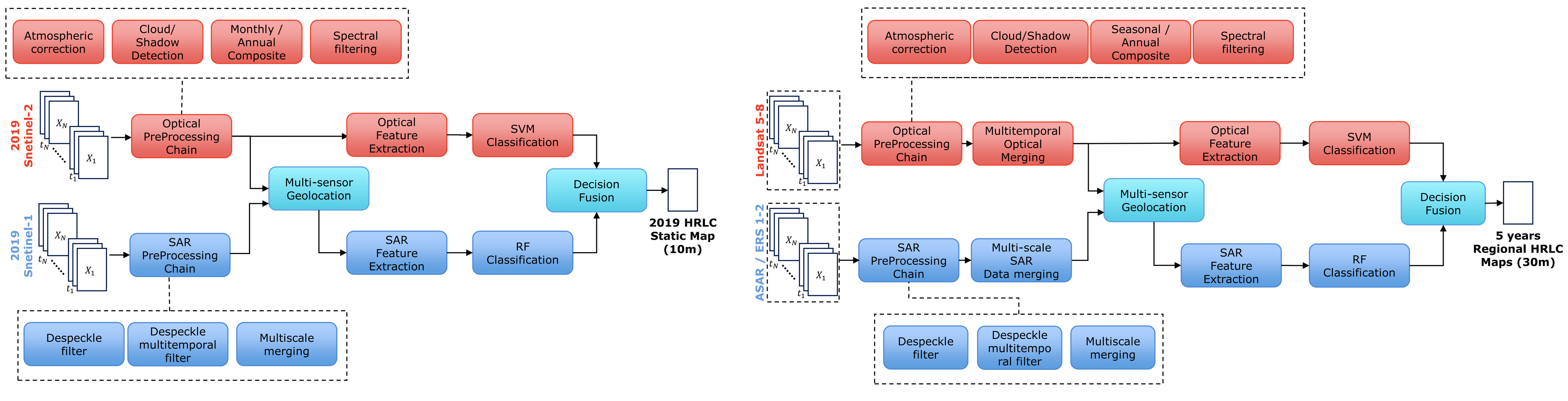


Fig. 1 – Processing chain for producing: (a) the 2019 static HRLC map at subcontinental level at 10m as reference static, and (b) the long-term record of regional HRLC maps at 30m in the sub-regions for historical analysis every 5 years.

Land-cover map products

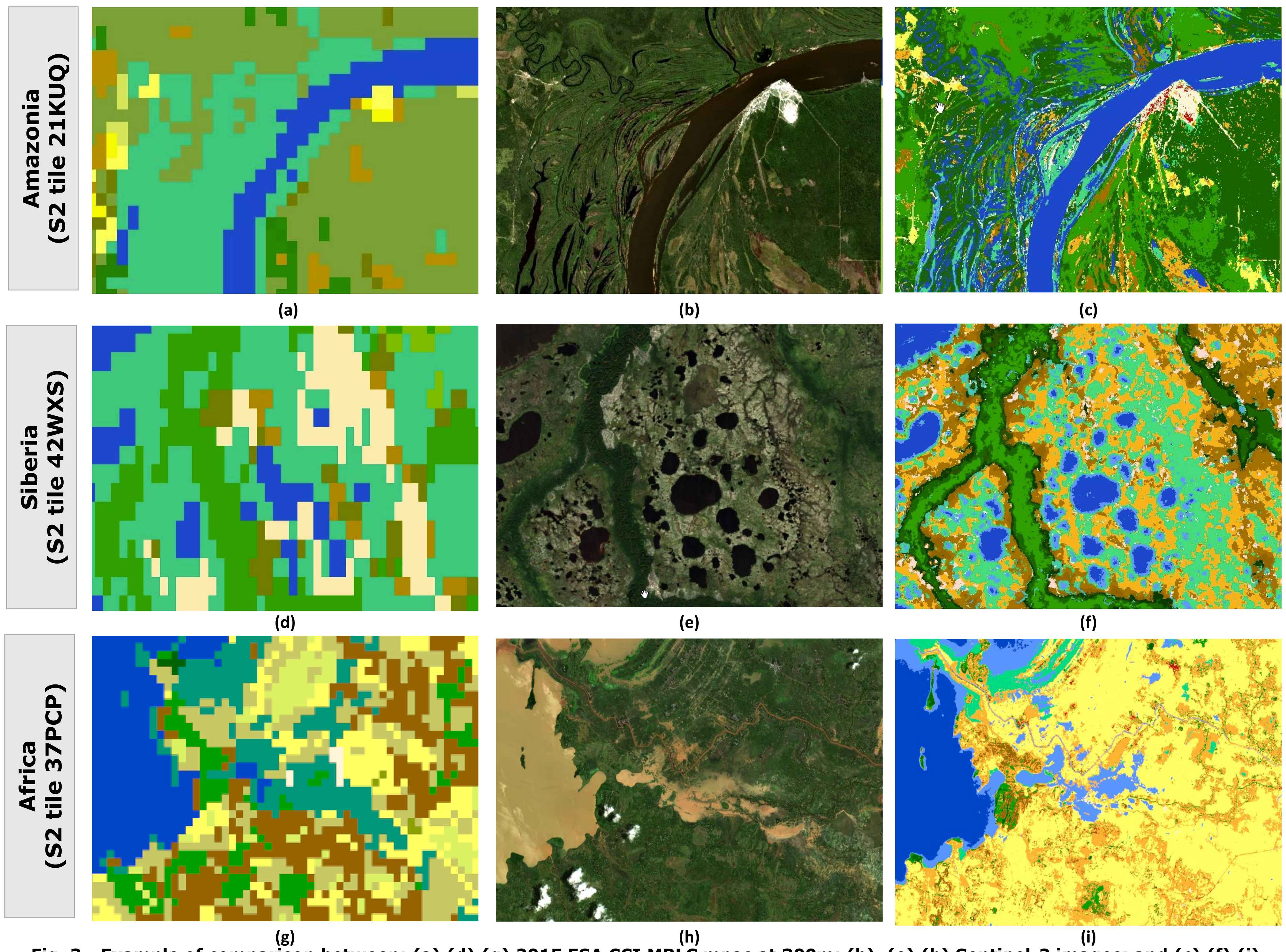


Fig. 3 - Example of comparison between: (a) (d) (g) 2015 ESA CCI MRLC mpas at 300m; (b) (e) (h) Sentinel-2 images; and (c) (f) (i) preliminary 2019 ESA CCI HRLC maps obtained by fusion of Sentinel-2 and Sentinel-1 images from 2019 time series at 10m.

Fig. 3 reports a comparison between the **2015 ESA CCI MRLC maps** and the preliminary **2019 ESA CCI HRLC maps** obtained in Amazonia (S2 tile 21KUQ), Siberia (S2 tile 42WXS) and Africa (S2 tile 37PCP). As expected, the geometrical resolution of the MRLC map (300m) is sharply improved in the HRLC one (10m). The **static HRLC maps point out many details** present in the scene, e.g., the **tributaries** that flow into the **main river** (Fig. 3a vs Fig. 3c) or the **peculiar ponds** present in Siberia (Fig. 3d vs Fig. 3f). Moreover, the increase in spatial resolution makes it possible to **capture minor classes completely missed at 300m resolution**, such as the urban areas present in the middle bottom of the Africa image (Fig. 3g vs Fig. 3i).

CCI HRLC climate regions

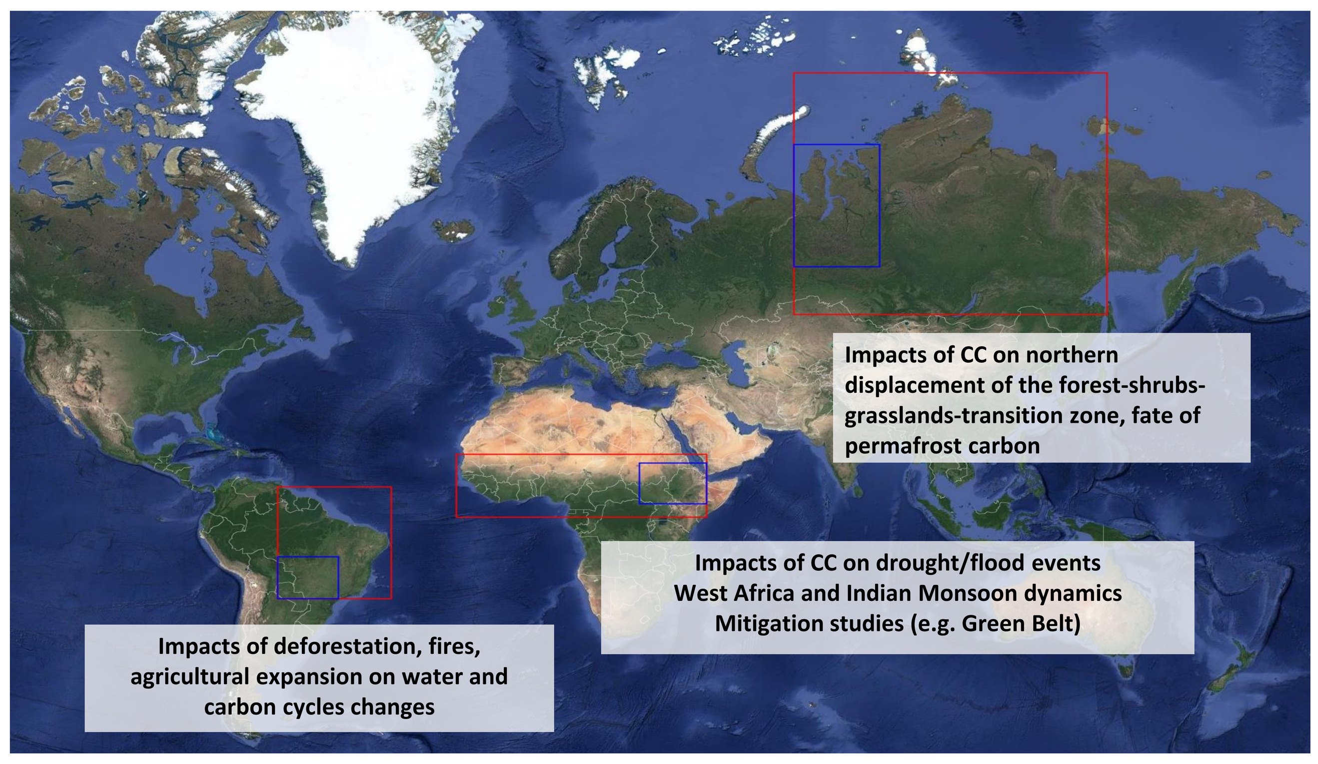


Fig. 2 - CCI HRLC climate regions defined in the project (red rectangles indicate the sub-continental areas where static maps for 2019 are generated, blue rectangles indicate the regional areas where long-term record of HRLC maps are produced).

Two processing chains have been developed for producing: (i) the **2019 static HRLC map** at **sub-continental level,** and (ii) the long-term record of regional **HRLC maps at 30m** in the **sub-regions every 5 years**.

The subcontinental and regional areas are reported in Fig.2 in red and blue, respectively, for the **three climate regions** defined in the project, i.e., **Amazonia**, **Siberia** and **Africa**.

Defined HRLC LCCS categories

HRLC CLASSES					
CODE	DN	1st LEVEL	CODE	DN	2nd LEVEL
10	1	Tree cover evergreen broadleaf			
20	2	Tree cover evergreen needleleaf			
30	3	Tree cover deciduous broadleaf			
40	4	Tree cover deciduous needleleaf			
50	5	Shrub cover evergreen	51	17	Broadleaf
			52	18	Needleleaf
60	6	Shrub cover deciduous	61	19	Broadleaf
			62	20	Needleleaf
70	7	Grasslands	71	21	Natural
			72	22	Managed
80	8	Croplands	81	23	Winter
			82	28	Summer
			83	33	Multicropping
90	9	Woody vegetation aquatic or regularly flooded			
100	10	Grassland vegetation aquatic or regularly flooded			
110	11	Lichens and Mosses			
120	12	Bare areas	121	38	Unconsolidated
			122	41	Consolidated
130	13	Built-up	131	42	Buildings
			132	43	Artificial Roads
140	14	Open Water seasonal			
150	15	Open Water permanent			
160	16	Permanent snow and/or ice	161	44	Snow
			162	45	Ice

Tab. 1 – HRLC Land Cover Classification System (LCCS) categories. The first and the second level of the HRLC classes are reported.

Discussion and conclusion

Two separate processing chains have been **developed** and **implemented** to generate the **2019 HRLC map at 10 m** and the **regional HRLC maps at 30m every 5 years.** The **static processing chain** extensively exploits the **dense time series** of **Sentinel-1** and **Sentinel-2 images**. The **historical** processing chain **handles** the relatively **low number of yearly-based images** available in archives (e.g., in 1990 Landsat-5 is the most relevant source for the optical chain).

The **processing chains** have been **tested** on the **benchmark areas** and are **currently running** on the **regional areas**. The **preliminary results** clearly point out the **importance** of **increasing** the **spatial resolution.** The **HRLC 10m products** show a marked improvement in the **detection** of the end-members **land cover classes** present **in the scene**, providing **better shapes, sharper edges** and more detailed **spatial patterns**. The quantitative performance assessment is currently in progress.

The improvement of the **detailed land cover patterns** as well as the **new detailed categories** of the **legend**, will be **essential** in determining more specifically the **interactions land cover-climate** and in improving land surface models such as **ORCHIDEE**, as it will be tested further in this project.

JOIN US!

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