


Land Cover CCI

Data Access Requirements Document - Year 2

Version 1.1

Document Ref:	CCI-LC-DARDv2
Deliverable Ref:	D1.4-DARD
Version:	1.1
Creation Date:	2014-07-15
Last Modified:	2015-12-16

Document Authorship

	NAME	FUNCTION	COMPANY	SIGNATURE	DATE
PREPARED	G. Kirches		BC		
PREPARED	C. Brockmann		BC		
PREPARED	M. Boettcher		BC		
PREPARED	M. Peters		BC		
PREPARED	S. Bontemps		UCL		
PREPARED	C. Lamarche		UCL		
PREPARED	I. Moreau		UCL		
PREPARED	M. Vittek		UCL		
PREPARED	J. Radoux		UCL		
PREPARED	M. Santoro		Gamma RS		
VERIFIED	P. Defourny	Science Leader	UCL		
APPROVED					

Document Distribution

ORGANISATION	NAME	QUANTITY
ESA	O. Arino, F. Ramoino	

Document History

VERSION	DATE	DESCRIPTION	APPROVED
0.1	2015-10-01	First draft version, based on Year 1 document (version 1.2)	
1.0	2015-11-23	First version of the 2nd Year document, to be submitted to ESA before M3	
1.1	2015-12-16	Updated version according to RIDs received on 10/12/2015	

Document Change Record (from Year 1 to Year 2)

RID	SECTION	COMMENTS
-	1	Scope of the deliverable updated
-	2.2	New section to list all products planned in Phase 2
-	4.1	Section updated to add the 2010 global LC map and the concept of annual global LC maps
-	4.2	Update of the ancillary data needed for generated global LC maps
-	5.1	Update of the satellite data needed for land surface seasonality products

-	5.2	Update of the ancillary data needed for land surface seasonality products
-	6	Update of the introduction
-	6.1	Update of the satellite data needed for the SAR-based water body classifications
-	6.2	Update of inter-comparison and refinement data needed for the SAR-based water body classifications
-	6.3	Update of the ancillary data needed for the SAR-based water body classifications
-	7	New section to add the requirements of high resolution land cover products (both African LC map and change maps)
-	8	Section updated to add the requirements of data needed to validated all LC products

Document Change Record (from version 1.0 to version 1.1)

RID	SECTION	COMMENTS
DARDv2.0_1.0/1	Symbols and Acronyms	The link related to GlobCover Project has been added. http://due.esrin.esa.int/page_globcover.php (accessed December 14, 2015)
DARDv2.0_1.0/2	2.2	The figure has been updated following the new Gantt chart that takes into consideration the project's delay.
DARDv2.0_1.0/3	6.1	The part regarding the the processing of ASAR WSM_1P from 2002 to 2005 has been corrected and a footnote has been included.

SYMBOLS AND ACRONYMS

(A)ATSR	(Advanced) Along Track Scanning Radiometer
ALOS	Advanced Land Observing Satellite
ADD	Antarctic Digital Database
ASAR	Advanced Synthetic Aperture Radar
AOD	Aerosol Optical Depth
ATBD	Algorithm Theoretical Basis Document
BC	Brockmann Consult
CCI	Climate Change Initiative
CCI-LC	Climate Change Initiative – Land Cover
CEOS	Committee on Earth Observation Satellites
CEOS-WGCV	Committee on Earth Observing Satellites Working Group on Calibration and Validation
CGIAR	Consultative Group on International Agricultural Research
CMC	Climate Modelling Community
CMUG	Climate Modelling User Group
CRS	Coordinate Reference System
DARD	Data Access Requirements Document
DEM	Digital Elevation Model
DLR	Deutsches Zentrum für Luft- und Raumfahrt
ECMWF	European Centre for Medium-Range Weather Forecasts
ECV	Essential Climate Variables
EEA	European Environmental Agency
ENVISAT	ESA Environmental Satellite
EO	Earth Observation
ERS	European Remote Sensing Satellite
ESA	European Space Agency
FAO	Food and Agriculture Organization
FP7	7th Framework Programme for Research and Technological Development
FR	Full Resolution
GCOS	Global Climate Observing System
GCS	Geographic Coordinate System
GDAL	Geospatial Data Abstraction Library
GETASSE30	Global Earth Topography And Sea Surface Elevation
GFED	Global Fire Emissions Database
GIS	Geographic Information System

GLIMS	Global Land Ice Measurements from Space initiative
GlobCover	ESA DUE project - http://due.esrin.esa.int/page_globcover.php (accessed December 14, 2015)
GLS	Global Land Survey
GLWD	Global Lakes and Wetlands Database
GMM	Global Monitoring Mode
G-POD	Grid Processing On Demand
GRASS	Geographic Resources Analysis Support System
GTOS	Global Terrestrial Observing System
HH	Horizontal-Horizontal
HV	Horizontal-Vertical
IIASA	International Institute of Applied Systems Analysis
IGCO	Integrated Global Carbon Observation
IGOL	Integrated Global Observations for Land
IMM	Image Mode Medium
IMS	Interactive Multisensor Snow and Ice Mapping System
JAXA	Japan Aerospace Exploration Agency
JRC	Joint Research Centre
L1, L2	Level 1, Level 2
LC	Land Cover
LCCS	Land Cover Classification System
MERIS	Medium Resolution Imaging Spectrometer
MMU	Minimum Mapping Unit
MSI	Multi-Spectral Instrument
MVC	Maximum Value Composite
NASA	National Aeronautics and Space Administration
NDVI	Normalized Difference Vegetation Index
NH	Northern Hemisphere
NIR	Near InfraRed
NSIDC	National Snow and Ice Data Center
OLCI	Ocean and Land Colour Instrument
PALSAR	Phased Array type L-band Synthetic Aperture Radar
PFT	Plant Function Type
PSD	Product Specification Document
PSU	Primary Sampling Units
PUG	Product User Guide
PVASR	Product Validation and Algorithm Selection Report
PVP	Product Validation Plan

RGB	Red-Green-Blue
RGI	Randolph Glacier Inventory
RR	Reduced Resolution
S1, S2	Sentinel-1, Sentinel-2
SAGE	Sustainability and the Global Environment
SAR	Synthetic Aperture Radar
SCAR	Scientific Committee on Antarctic Research
SDR	Surface Directional Reflectance
SIB-ESS-C	Siberian Earth System Science Cluster
SLC	Single Look Complex
SLSTR	Sea and Land Surface Temperature Radiometer
SPOT	Satellite Pour l'Observation de la Terre
SPOT-VGT	SPOT-VEGETATION
SR	Surface Reflectance
SRTM	Shuttle Radar Topography Mission
SSU	Secondary Sampling Unit
SWBD	SRTM Water Body Dataset
TM	Thematic Mapper
UCL	Université catholique de Louvain
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UR	User Requirement
USGS	United States Geological Survey
VIIRS	Visible Infrared Imaging Radiometer Suite
VITO	Vlaamse Instelling voor Technologisch Onderzoek
WB	Water Bodies
WGCC	Working Group on Calibration and Validation
WGS84	World Geodetic System 84
WSM	Wide Swath Mode
WWF	World Wildlife Fund

REFERENCE DOCUMENTS

Applicable documents

ID	TITLE	ISSUE	DATE
[SoW 2013]	ESA Climate Change Initiative Phase 2 - Scientific User Consultation and Detailed Specification Statement of Work (SoW)	1.2	07.06.2013
[Technical Proposal 2014]	ESA Climate Change Initiative Phase 2 - Land Cover ECV Technical baseline for the project (update of the technical proposal with clarification and negotiation items)	1.0	13.03.2014
[URD 2014]	ESA CCI-LC Phase 2 User Requirements Document, ESA Climate Change Initiative, Land Cover ECV	1.1	30.11.2014
[PSD 2014]	CCI-LC PSD Phase 2. Land Cover Climate Change Initiative - Product Specification Document	1.1	1.12.2014

Reference documents

ID	TITLE	ISSUE	DATE
[Arino 2010]	Arino O. et al. TropForest-2010. ESA EO Category-1 research project n. 6673		2010
[ATBD 2013]	CCI-LC Phase 1 Algorithm Theoretical Basis Document, ESA Climate Change Initiative, Land Cover ECV	2.3	28.11.2013
[AVHRR 2008]	1-KM AVHRR Global Land Dataset, stitched orbits		23.06.2008
[BDOT 2004]	IGN France International, Projet BDOT – Base de données d'occupation des terres, Burkina Faso (internal report)		2004
[Beuchle 2011]	Beuchle R, Eva HD, Stibig H-J et al. A Satellite Data set for Tropical Forest Change Assessment, Int. J. Remote Sens		2011
[Bicheron 2008]	Bicheron, P., Defourny, P., Brockmann, C., Schouten, L., Vancutsem, C., Huc, M., Bontemps, S., Leroy, M., Achard, F., Herold, M., Ranera, F., Arino, O. GlobCover: products description and validation report, ESA GlobCover project		2008
[CCI 2010]	ESA Climate Change Initiative – Projects Description	1.0	09.09.2010
[DARD 2012]	CCI-LC DARD Phase I. Land Cover Climate Change Initiative - Data Access Requirements Document	1.9	08.06.2012
[Defourny 2010]	Defourny P. et al. Building a land cover reference database for 2010 to support the validation of the ESA Land Cover_CCI global land cover product. ESA EO Category-1 research project n. 8073		2010
[EEA 2006]	EEA, The thematic accuracy of CLC2000 – Assessment using LUCAS, EEA technical report no 7/2006		2006
[EEA 2007]	EEA, CLC2006 technical guidelines, EEA technical report no 17/2007		2007

ID	TITLE	ISSUE	DATE
[ERA Interim 2013]	Balsamo, G., Albergel, C., Beljaars, A., Boussetta, S., Cloke, H., Dee, D., Dutra, E., Muñoz-Sabater, J., Pappenberger, F., de Rosnay, P., Stockdale, T., and Vitart, F.: ERA-Interim/Land: a global land water resources dataset, Hydrol. Earth Syst. Sci. Discuss., 10, 14705-14745, doi:10.5194/hessd-10-14705-2013, 2013.		2013
[ESA 2010]	ESA, Terms and Conditions for the Utilisation of Data under the ESA Category-1 scheme between the European Space Agency and the Cat-1 Principal Investigator (V05/03/10)		2010
[FAO 2008]	Senegal land cover mapping, Ugo Leonardi for the United Nations Food and Agriculture Organization, December 2008		2008
[GLC 2005]	BARTHOLOME, E. M. and BELWARD A. S., 2005, GLC2000; a new approach to global land cover mapping from Earth Observation data, International Journal of Remote Sensing, *26*, 1959 - 1977		2005
[GETASSE 2013]	Getasse 3.0 Digital Elevation Model for use with AMORGOS		2013
[Giglio 2009]	Giglio, L. , Loboda, T., Roy, D.P., Quayle, B., Justice, O.J., An active-fire based burned area mapping algorithm for the MODIS sensor, Remote Sensing of Environment, Volume 113, Issue 2, 16 February 2009, Pages 408-420, ISSN 0034-4257, 10.1016/j.rse.2008.10.006.		2009
[Giri 2005]	Giri C. and Jenkins C., 2005, Land cover mapping of greater Mesoamerica suing MODIS data, Canadian Journal of Remote Sensing, 31, 4, 274-282		2005
[GlobCover 2008]	Bicheron, P., Defourny, P., Brockmann, C., Schouten, L., Vancutsem, C., Huc, M., Bontemps, S., Leroy, M., Achard, F., Herold, M., Ranera, F., Arino, O. GlobCover: products description and validation report, ESA GlobCover project		2008
[Liu 2003]	Liu J.Y., Zhuang D.F., Luo D., Xiao X., Land cover classification of China: integrated analysis of AVHRR imagery and geophysical data, International Journal of Remote Sensing, 24 (12), 2485-2500		2003
[Mayaux 2006]	Mayaux, P., H. Eva, J. Gallego, A. Strahler, M. Herold, A. Shefali, S. Naumov, E. de Miranda, C. di Bella, D. Johansson, C. Ordoyne, I. Kopin, A. Belward. Validation of the Global Land Cover 2000 Map. IEEE Transactions on Geoscience and Remote Sensing 44(7-1), 1728-1739.		2006
[MERIS 2011]	ENVISAT MERIS Products Specifications, IDEAS-SER-IPF-SPE-0798	6/A	22.06.2011
[MERIS 2011b]	ENVISAT MERIS 3rd data reprocessing, A879.NT.008.ACRI-ST	1.0	27.06.2011
[MODIS 2006]	MODIS Level 1B Product User's Guide, PUB-01-U-0202- REV B, NASA	B	22.08.2006
[MODIS 2014]	MOD10A2 / MYD10A2 snow products, Local Snow Cover Attributes, Version 5		retrieved 2014
[NIC2008]	National Ice Center. 2008, updated daily. IMS daily Northern Hemisphere snow and ice analysis at 4 km and 24 km resolution, Boulder, CO: National Snow and Ice Data Center. http://dx.doi.org/10.7265/N52R3PMC		2008
Peel et al., 2007	Peel MC, Finlayson BL & McMahon TA (2007), Updated world map of the Köppen-Geiger climate classification, Hydrol. Earth Syst. Sci., 11, 1633-1644.		2007

ID	TITLE	ISSUE	DATE
[Potapov 2010]	Potapov P, Hansen MC, Gerrand AM et al. The global Landsat imagery database for the FAO FRA remote sensing survey. Int. J. Digital Earth.1, 1753-8955		2010
[PSD Fire CCI 2011]	CCI Fire project: Product Specification Document, version 2.0., 2011		2011
[RGI 2012]	Arendt, A., T. Bolch, J.G. Cogley, A. Gardner, J.-O. Hagen, R. Hock, G. Kaser, W.T. Pfeffer, G. Moholdt, F. Paul, V. Radić, L. Andreassen, S. Bajracharya, N. Barrand, M. Beedle, E. Berthier, R. Bhambri, A. Bliss, I. Brown, D. Burgess, E. Burgess, F. Cawkwell, T. Chinn, L. Copland, B. Davies, H. De Angelis,E. Dolgova, K. Filbert, R.R.Forester, A. Fountain, H. Frey, B. Giffen, N. Glasser, S. Gurney, W. Hagg, D. Hall, U.K. Haritashya, G. Hartmann, C. Helm, S. Herreid, I. Howat, G. Kapustin, T. Khromova, C. Kienholz, M. Köonig, J. Kohler, D. Kriegel, S. Kutuzov, I. Lavrentiev, R. LeBris, J. Lund, W. Manley, C. Mayer, E. Miles, X. Li, B. Menounos, A. Mercer, N. Mölg,P. Mool, G. Nosenko,A. Negrete, C. Nuth, R. Pettersson, A. Racoviteanu, R. Ranzi, P. Rastner, F. Rau, B. Raup, J. Rich, H. Rott, C. Schneider, Y. Seliverstov, M. Sharp, O. Sigurðsson, C. Stokes, R. Wheate, S. Winsvold, G. Wolken, F. Wyatt, N. Zheltyhina. 2012, Randolph Glacier Inventory – A Dataset of Global Glacier Outlines: Version 3.2. Global Land Ice Measurements from Space, Boulder Colorado, USA. Digital Media		2012
[SCAR 2014]	Antarctic Digital Database Version 6.0		2014
[Schneider 2010]	Schneider, A., Friedl, M. and Potere, D.: Mapping global urban areas using MODIS 500-m data: New methods and datasets based on “urban ecoregions“. Remote Sensing of Environment, 114, 1733-1746.		2010
[SPOT VGT 2009]	SPOT Vegetation Instrument/Product specifications, GMES Space Component Data Access, TAP/N7950_GCS-DA/SV/002	1.0	15.04.2009
Still et al., 2009	Still, C.J., J.A. Berry, G.J. Collatz, and R.S. DeFries. 2009. ISLSCP II C4 Vegetation Percentage. In Hall, Forrest G., G. Collatz, B. Meeson, S. Los, E. Brown de Colstoun, and D. Landis (eds.). ISLSCP Initiative II Collection. Data set. Available on-line [http://daac.ornl.gov/] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. doi:10.3334/ORNLDAAC/932		2009
[Vancutsem 2013]	Vancutsem C., Marinho E., Kayitakire F., See L., Fritz S., Harmonizing and Combining Existing Land Cover/Land Use Datasets for Cropland Area Monitoring at the African Continental Scale, Remote Sensing 2013, 5(1), 19-41; doi:10.3390/rs5010019		2013
[Verheggen 2010]	Verheggen, A. and Defourny, P.: A new 300 m vegetation map for Central Africa based on multi-sensor times series. Proceedings of the Third Recent Advance in Quantitative Remote Sensing, J.A. Sobrino (Ed.), Publicaciones de la Universitat de Valencia,Valencia, Spain		2010

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

This Data Access Requirement Document (DARD) identifies all the data that are needed as input to perform the Climate Change Initiative (CCI) Land Cover (CCI-LC) project [CCI 2010]. This dataset is extended in comparison with CCI-LC Phase I. The temporal coverage will be extended into the past down to the 1990s. And it will be extended into the future using current acquisitions and acquisitions from sensors like Sentinel 1 and 2 that are expected to become available in the course of the project phase. The extension will introduce additional sensors also for the Phase I periods, mainly to fill data gaps.

Included in this document is the identification of:

- all Level 1 products from European Space Agency (ESA) and Third Party Missions (TPM) (no Level 0 products are required);
- all ancillary data;
- all in situ observation data sources as well as higher-level products needed for product inter-comparison;
- all historical archives and currently operational sources (it is not anticipated that data from sources due to become operational in the next 3 years will be required).

For each data source, the DARD includes:

- information about the originating system;
- identification of the data class (in-situ, Earth Observation (EO), model);
- specification of the sensor type and key technical characteristics;
- information about data availability & coverage (times-scale, geographic, temporal);
- source data product name & reference to product technical specification documents;
- estimates of the data quantity;
- indication of data quality and reliability;
- description of the ordering and delivery mechanism;
- identification of access conditions & pricing.

The DARD includes detailed requirements for resolving any known data access, calibration, validation and performance issues specific to the satellite ground segment processing and identifying potential algorithm upgrades enabling the regeneration of improved and most accurate input products required for the Land Cover (LC) Essential Climate Variable (ECV) [CCI 2010].

The second version of the DARD contains requirements for all products that have been / are / will be generated during the Phase 2.

1.1 CCI Land Cover project

The ESA CCI programme aims at realizing the full potential of the long-term global Earth Observation archives as a significant and timely contribution to the ECV databases required by United Nations Framework Convention on Climate Change (UNFCCC). All products will be assessed against requirements from the Global Climate Observing System (GCOS) for ECV and the Climate Modelling Community (CMC), represented within the CCI program by the Climate Modelling User Group (CMUG).

The programme is organized in 2 phases.

The CCI Phase I provided a unique opportunity for the European EO science community to define and validate innovative approaches for continuously generating and updating a comprehensive and consistent set of ECV global satellite based data products in the long term – i.e. decades hence. The focus was on a major sustained, and coordinated scientific effort to review and improve underlying processing, retrieval and validation methods.

The CCI Phase 2 will focus on the generation of long-term, consistent, global data records for each ECV, exploiting the full range of available data sets from ESA and relevant European missions with the aim to issue extended and improved globally consistent ECV data sets from all CCI projects during Phase 2. Each project must make significant, further progress towards meeting the GCOS and related user requirements, exceeding the achievements of the phase I CCI projects with quantifiable validated measure of performance.

1.2 Structure of the document

After this introduction,

- Section 2 provides an overview of the processing chains within the CCI-LC project;
- Sections 3 to 7 list all the data products required by the CCI-LC project. The information provided for each input identifies the product, its version number, the original source, the date the product is first required by the project, the sub-set of the record required, where the data are available and their size ;
- Section 8 contains a table of agreements and Cat-1 proposals for the datasets together with the current status of agreement and data procurement.

Acronyms used within the text and references to other documents can be found at the beginning of this document.

2 OVERVIEW

2.1 Phase I Processing Chain

As just mentioned, the CCI-LC Phase I delivered global LC databases made of LC state products for three epochs and of LC condition[1] products, a MERIS Full and Reduced Resolution (FR and RR respectively) time series which served as input for generating the global LC maps and a global Water Body (WB) product derived from the Envisat Advanced Synthetic Aperture Radar (ASAR) archives and auxiliary datasets. To do so, the processing was organized in four distinct modules. As a thorough description of the CCI-LC processing chain is out of the scope of this document, only an overview of the processing chain is presented in this section (Figure 2-1). More details can be found in the Phase I Algorithm Theoretical Basis Document (ATBD) [ATBD 2013].

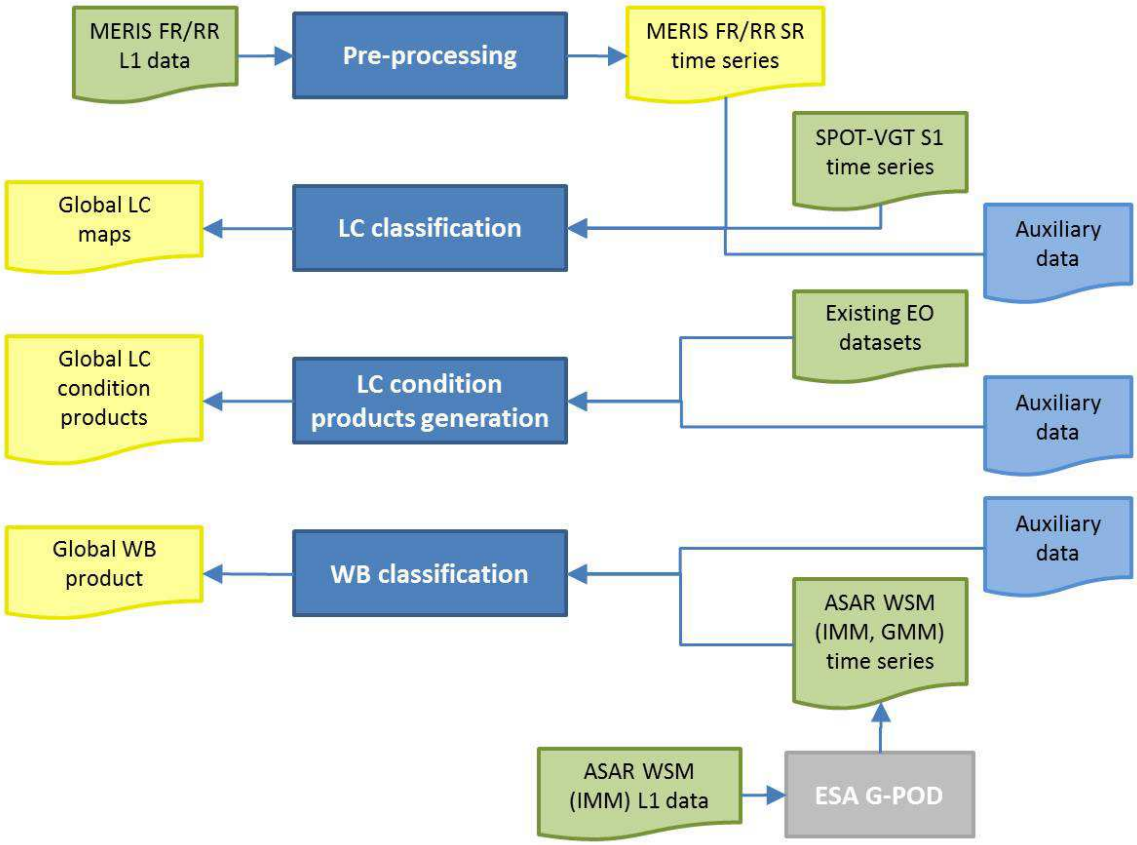

Figure 2-1 : Flowchart of the CCI-LC processing chains.

[1] The "LC condition" product will be referred to as « Land surface seasonality" product in the text below.

2.2 Phase 2 products

At the end of the 3-year long Phase 2, the key global datasets for the end-users will be (Figure 2-2):

1) Global SR time series and associated metadata over different epochs and from different sensors:
    a. Time series of AVHRR 7-day composites from 1992 through 1999;
    b. Time series of Envisat MERIS Full Resolution (FR) 7-day composites from 2003 through 2012;
    c. Time series of Envisat MERIS Reduced Resolution (RR) 7-day composites from 2003 through 2012;
    d. Time series of PROBA-V 7-day composites from 2013 through 2015 (and beyond);
    e. Time series of Sentinel-3 Ocean and Land Colour Instrument (OLCI) and Sea and Land Surface Temperature Radiometer (SLSTR) 7-day composites from 2015 (and beyond).
2) Global LC maps for the 1990s, 2000, 2005, 2010 and 2015 epochs based on the above AVHRR, SPOT-VGT, MERIS FR and RR, PROBA-V, MODIS composites and associated metadata;
3) An updated global LC map for 2015 including the above Sentinel-3 OLCI and SLSTR composites and associated metadata[2];
4) A global LS seasonality product and associated metadata for the NDVI;
5) Global map of permanent open water bodies for the 2010 epoch based on Envisat ASAR time series.

In addition, prototypes products are foreseen, which will demonstrate the pre-processing and classification algorithms developed for the Sentinel-1 and -2 missions and to expand historical time series. They include:

1) Sentinel-2 and Landsat 8 time series of regional SR composites from 2014 (and beyond) and associated metadata;
2) Regional LC maps based on the above Sentinel-2 and Landsat 8 composites and associated metadata;
3) Change maps dedicated to critical LC classes and/or regions according to users' priorities based on the above Sentinel-2 and Landsat 8 composites and associated metadata;
4) Prototype water body and urban products based on Sentinel-1 SAR data, tuned geographically to the regional LC maps obtained with Sentinel-2 data;

[2] According to the availability of Sentinel-3 data in terms of quantity and timing with respect to the overall project planning

5) A consistent coarse spatial resolution LC map for continental or sub-continental regions for the 1980s based on the AVHRR Global Inventory Monitoring and Modelling System (GIMMS) dataset;

6) An EvapoTranspiration (ET) Feasibility study will be performed during the first year of this second phase. Encouraging results may lead to the production of an ET seasonality product;

7) As backup in case of delayed delivery of the reprocessed SPOT-Vegetation (SPOT-VGT) daily syntheses by the Flemish Institute for Technological Research (VITO), time series of SPOT-VGT 7-day composites from 1998 through 2012.

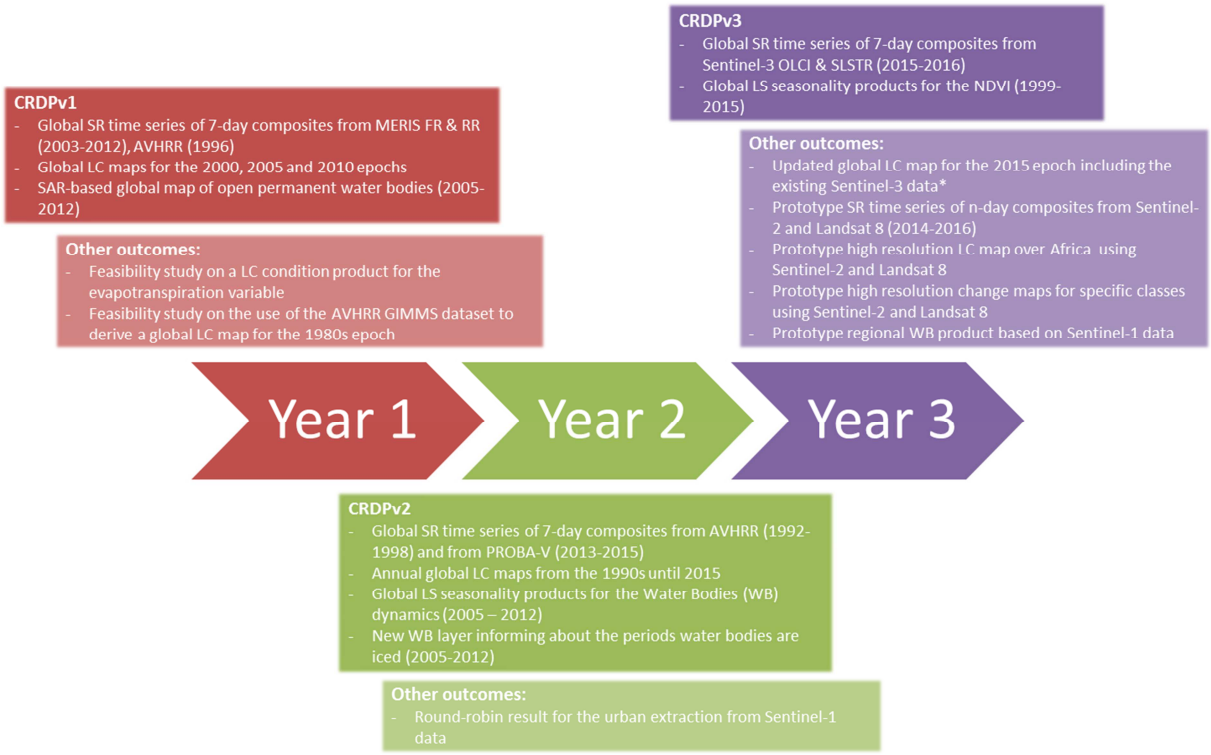

Figure 2-2: Planning of datasets to be produced in the CCI-LC Phase 2

* The reason why this update is not included in the CRDPv3 is that it will be delivered at the end of the year 3, thus not available for climate assessment

2.3 Main satellite input data for Phase 2

As already mentioned, the CCI-LC Phase 2 project aims at improving and extending the Phase I outcomes in terms of products, systems and validation [Technical Proposal 2014]. This document focuses on the datasets needed to generate the new products.

Updated and additional datasets are the basis for the improvement of the CCI-LC Phase I epochs (Figure 2-3):

- The processing of Surface Reflectance (SR) time series and LC maps will use the new reprocessed MERIS FR dataset, as well as some MODIS data for gap filling if needed.

- The improved WB product will be generated using the ASAR dataset already used in Phase 1 and an updated set of auxiliary datasets, mainly coming from high spatial resolution imagery. It is also planned that it will include dynamic aspects. In turn, this will serve to improve the classification of water bodies.
- The LS seasonality product for the Normalized Difference Vegetation Index (NDVI) will be based on the same dataset, i.e. SPOT-Vegetation (SPOT-VGT) time series.
- A water seasonality product is introduced. It is based on ASAR imagery acquired between 2005 and 2012 and is presented in form of a climatology with a 10-days interval with a pixel size of 1 km.

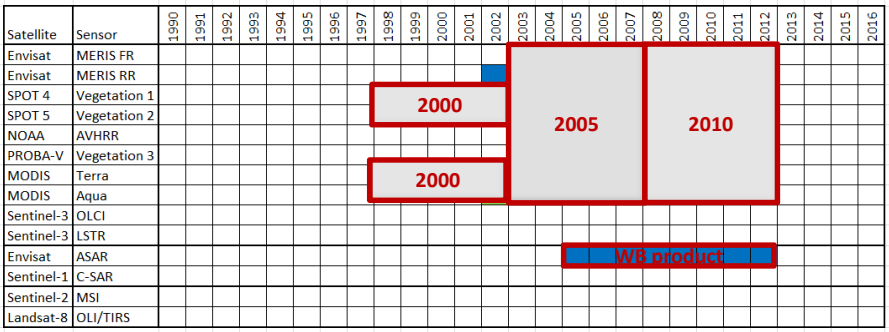

Figure 2-3: Extended inputs for the three CCI-LC Phase I epochs and the WB product

New input datasets will allow the extension of the timeline into the past and the future (Figure 2-4):

- Additional SR time series and global LC map over the 1990s and 2015 epochs will be processed, using AVHRR, PROBA-V, MODIS (and/or VIIRS), Sentinel-3 input data.
- Prototype products at higher spatial resolution are based on Sentinel 2 and Landsat 8. They will be processed for a limited time period over Africa, with focus on dynamic areas.
- A prototype water body product at higher spatial resolution is based on Sentinel-1. The region will be defined depending on data availability, synergy with the optical classification and demands from the climate research community.

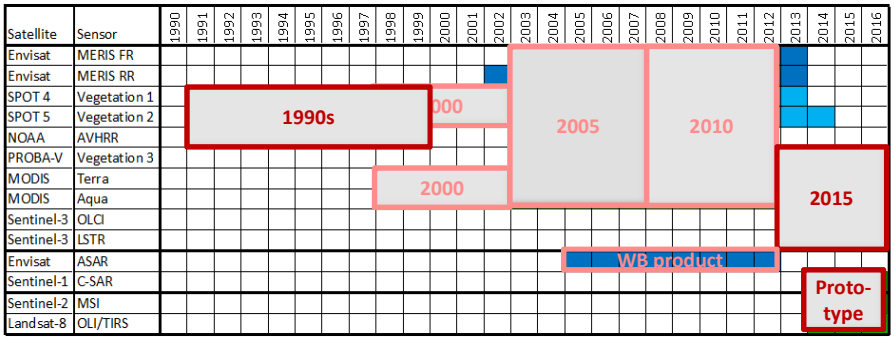

Figure 2-4: Inputs for the extended temporal coverage in CCI-LC Phase 2

In addition, two feasibility studies are conducted during the first 18 months of the project. They focus on the possibility to generate:

- A consistent coarse spatial resolution LC map for continental or sub-continental regions for the 1980s based on the AVHRR Global Inventory Monitoring and Modelling System (GIMMS) dataset;

- A LS seasonality product for the EvapoTranspiration (ET) variable.

If their results are convincing, the associated products could become official outcomes of the CCI-LC Phase 2 project. The same applies to the round-robin for urban extraction from Sentinel-1 dataset.

3 DATA REQUIREMENTS FOR LC SR PRE-PROCESSING

This section defines the data requirements for the land cover pre-processing chain. It distinguishes satellite data, ancillary data, and validation data to be used for the validation of the pre-processing chain.

3.1 Satellite data

The data acquisition and processing is done in three yearly cycles that generate an improved product and a timeline extended to the past in the first year, a timeline extended to the future in the second year, and a higher resolution LC map in the third year (Figure 3-1).

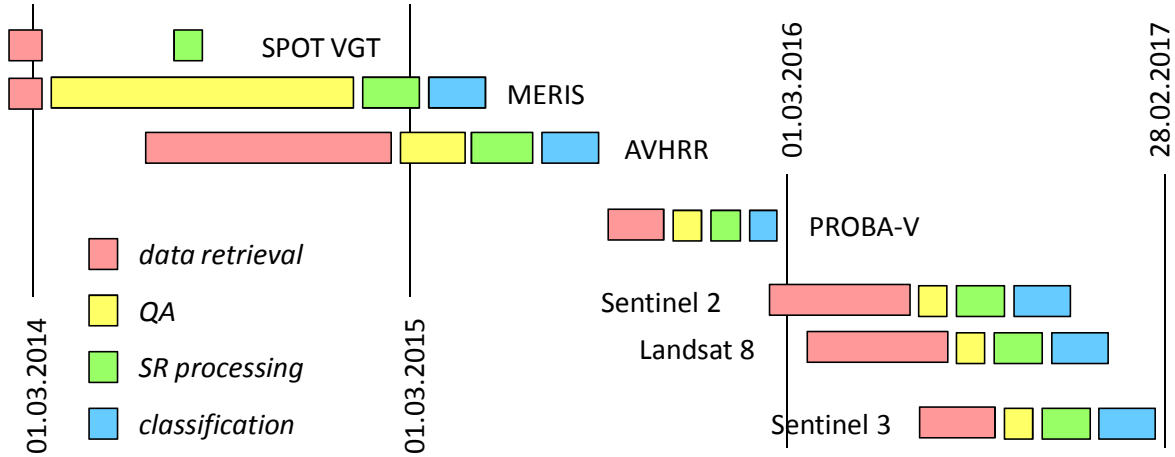

Figure 3-1: Planned data acquisition and processing schedule

Table 3-1 below describes characteristics, availability and intended use of data for LC SR pre-processing. The colour coding of the availability column reflects the current status of acquired datasets (green), known how to be acquired (yellow), and datasets that require agreements or preparatory activities (red). Only the first five lines are relevant for the first year's processing cycle.

Table 3-1: LC SR pre-processing earth observation datasets

PRODUCT	COVERAGE	INPUT	OUTPUT	AVAILABILITY	USE	COMMENT
ENVISAT **MERIS FRS** L1B v2013 [MERIS 2011]	global 2003-2012/04	140 TB	36 TB	ESA delivered on NAS	Reprocessing of Phase I epochs 1st year	Quality issues (assessment TN)
ENVISAT **MERIS RR** L1B 3rd [MERIS 2011b]	global 2003-2012/04	25 TB	3 TB	ESA delivered on NAS	Reprocessing of Phase I epochs 1st year	-
SPOT **VTG** P [SPOT VGT 2009]	global 1998-2012	9 TB	4 TB	CNES (through VITO)	Backup for Spot VGT S1	-
AVHRR noaa-11 and 14 L1B 1km [AVHRR 2008]	global 1992-1999	5 TB	1 TB	USGS GUI to download single files	1990s period 1st year	Download too time-consuming, complete data set has been delivered by USGS on request
Sentinel-3 **OLCI** L1B	global 2015-	115 TB	2 TB	ESA data hub	2015 epoch when available	Volume estimation based on data from mid 2016 on
Sentinel-3 **SLSTR** L1B	global 2015-	110 TB	2 TB	ESA data hub	2015 epoch when available	Volume estimation based on data from mid 2016 on
Proba-V L1 TOA 300m	global 2013-	112 TB	4 TB	ESA/VITO	2015 epoch 2nd year	optional analysis of the 100m product
Sentinel-2 **MSI** Level 1	Africa 1 year	165 TB	72 TB	ESA data hub	higher resolution 2nd year (TBC)	-
Landsat-8 OLI/TIRS L1T	Africa 1 year	33 TB	24 TB	USGS earthexplorer.usgs.gov	higher resolution 2nd year (TBC)	30 day composite may be merged with MSI output
Overall data volume		**1054 TB**	**176 TB**			

Notes:

- SPOT VGT P: The preferred dataset is the SPOT VGT S1, at this stage of project SPOT VGT P is only a backup in case of delayed delivery of reprocessed SPOT VGT S1
- PROBA-V L1 TOA: The data volume has been extrapolated from one day of data (01.04.2014)
- Sentinel 3 Ocean and Land Colour Instrument (OLCI) and Sea and Land Surface Temperature Radiometer (SLSTR): ESA has confirmed that CCI projects get access to the data on the data hub. The access can be tested with Sentinel 1 data.
- Sentinel 2 Multi-Spectral Instrument (MSI) L1: Data volume has been estimated using assumptions: S2A generates 750 TB L1 data per year, Africa comprises 22% of the land surface, the acquisition strategy is balanced with weights of the continents proportional to their land surface area.
- Landsat 8 L1 data volume has been extrapolated from one scene of one day: there were 411 day scenes of L1T at 01.07.2013, one scene had 1 GB. The assumption is that Africa comprises 22% of the global data.

3.2 Ancillary data

Table 3-2 describes the characteristics and the availability of the auxiliary data needed for the pre-processing of the main satellite data used in the CCI-LC project.

Table 3-2: LC SR pre-processing ancillary data

PRODUCT	COVERAGE	QUANTITY	AVAILABILITY	USE	COMMENT
ENVISAT Attitude and Orbit	2002-2012	~11 GB per year	ESA http://earth.esa.int/	Pre-processing with AMORGOS	Acquired and available at BC
Getasse 3.0 Digital Elevation Model	global	288 files of 12 MB	ESA http://earth.esa.int/services/amorgos/	Pre-processing with AMORGOS	Acquired and available at BC
CCI-LC Global WB product	global	70 MB	ESA CCI-LC project	Land-Sea Mask	depends on analysis (see notes below)

Notes:

- For the pre-processing, a consolidated land-water map is required in order to capture most of the terrestrial surface including isolated islands. The alternative to be considered is the land-sea-mask used in Sentinel data.

3.3 Validation data

Table 3-3 describes the characteristics and the availability of the data used to validate different pre-processing steps.

Table 3-3: LC SR pre-processing validation data

PRODUCT	COVERAGE	QUANTITY	AVAILABILITY	USE	COMMENT
CEOS CalVal Working Group on Calibration and Validation (WGCC) LandNet Sites	~5 representative sites (1 per continent) Selected period from 2002-2010	<1 GB	CEOS - NASA	Validation of SDR intermediate products	Already used in Phase I
PixBox Data	~150 000 manually selected and classified pixel from different sensors	<1 GB	-	Validation of Pixel identification	Data set will be continuously expanded to the different used sensors
Aerosol Optical Depth (AOD)	+/- 10 stations over the continents Selected period from 2002-2010	<1 GB	AERONET	Validation of aerosol estimation	
Landsat Thematic Mapper (TM)	~20 products over selected regions and a selected period from 2002-2010	60 MB per product	USGS	Validation of geo-location algorithm	

Optionally, depending on the validation results and if considered necessary for further validation, additional products from GlobSnow and from MODIS will be used for algorithm inter-comparison.

4 DATA REQUIREMENTS FOR GLOBAL LC MAPS

This section defines the data requirements for the classification chain that will generate the global LC maps. These products take the form of a series of annual global LC maps from the 1990s until the present time.

4.1 Satellite data

The annual global LC maps will rely on EO datasets coming from five different sensors: MERIS, SPOT-VGT, AVHRR 2, PROBA-V and Sentinel-3[3].

MODIS time series are also planned to be used for gap filling - if needed - for years later than 2012. In this context, they are considered as auxiliary data and described in the following section (4.2).

The classification module ingests pre-processed time series. The MERIS, AVHRR, PROBA-V and Sentinel-3 SR products are generated by the project, in contrast with the SPOT-VGT SR time series. These inputs are described in section 3.1.

The annual maps are not produced independently. They are derived from a unique baseline LC map which is generated thanks to the entire MERIS FR and RR archive from 2003 to 2012. This 10-year baseline LC map is then back- and up-dated using (i) AVHRR time series from 1992 to 1999, (ii) SPOT-VGT time series from 1999 to 2013 and (iii) PROBA-V and Sentinel-3 time series from 2014 to 2016.

Table 4-1 lists the satellite dataset used in order to generate the annual LC maps. Datasets that are generated by the project are detailed in section 3.1. The SPOT-VGT time series, which comes from an external source, is detailed in Table 4-2.

Table 4-1: Satellite data sources used to generate the global LC maps

GLOBAL LC DATABASE	REFERENCE PERIOD	SATELLITE DATA SOURCE
Baseline 10-year global LC map	2003-2012	MERIS FR/RR global SR composites between 2003 and 2012
Annual LC maps	1992-1999	Baseline 10-year global LC map AVHRR global SR composites between 1992 and 1999 to identify LC changes occurring during this period and generate multi-annual LC maps by back-dating the baseline
	2000-2002	Baseline 10-year global LC map SPOT-VGT global SR composites between 1999 and 2002 to identify LC changes occurring during this period and generate annual LC maps by back-dating the baseline

[3] According to the availability of Sentinel-3 data in terms of quantity and timing with respect to the overall project planning

GLOBAL LC DATABASE	REFERENCE PERIOD	SATELLITE DATA SOURCE
	2003-2012	Baseline 10-year global LC map SPOT-VGT global SR composites between 2003 and 2012 to identify LC changes occurring during this period MERIS FR global SR composites between 2003 and 2012 to map at 300m resolution the changes identified with SPOT-VGT and to generate annual LC maps by back- and up-dating the baseline
	2013-2015	Baseline 10-year global LC map SPOT-VGT global SR composites of 2013 to identify LC changes occurring during this period PROBA-V and Sentinel-3 global SR composites between 2014 and 2016 to identify LC changes occurring during this period and generate annual LC maps by up-dating the baseline

Table 4-2: SR time series used as input for the classification

PRODUCT	COVERAGE	INPUT	AVAILABILITY	USE	COMMENT
SPOT VTG S1 (daily synthesis)	Global 1999-2013	7 TB	CNES (through VITO) delivered on NAS	Generation of annual LC maps from 1998 to 2013 (1st and 2nd year)	Currently, the reprocessed version that accounts for calibration VGT-2 drift) Next and last re-processing expected in 2015
PROBA-V (daily synthesis)	Global 2014-2015	1.3 TB	ESA/VITO	Generation of annual LC maps from 2014 to 2015 (2nd year)	Currently pending decision about the version (TOA or TOC)

4.2 Ancillary data

Table 4-3 describes the characteristics and the availability of the ancillary data needed for the classification processing chain. This chain includes two main components: the classification component which generates the baseline 10-year global LC map from the MERIS archive and the change detection component which identifies land cover changes and back- and up-date the baseline to generate the annual maps. Table 4-3 includes the ancillary data for both of them.

Table 4-4 presents the characteristics and availability of the current LC datasets used to build a reference LC database. This database is used in the classification chain, either as a training dataset for the learning machine algorithm or for the labelling of the clusters generated by the unsupervised algorithm. This list is likely to be completed as the project progresses and new datasets become available.

Table 4-3: Characteristics of LC classification ancillary data

PRODUCT	SPECIFICATION	SPATIAL AND TEMPORAL COVERAGE	VOLUME	AVAILABILITY	USE	COMMENTS
CCI-LC Global WB product	Global WB product derived from ASAR data, existing WB products and auxiliary datasets 150 m spatial resolutionFormat: GeoTiff Source: ESA CCI-LC project	Global Coverage 2000-2012	70 MB	ESA CCI-LC project	Water class of the global LC map	
MODIS global surface reflectance	MOD09GQ for TERRA and MYD09GQ for AQUA – v5 Daily images, 2 spectral bands, 250m spatial resolution Format: HDF-EOS Source: NASA	Global From 2013 to present	280 MB per 10° x 10° tile and per day	NASA website (direct download – acquisition in progress)	Potential use for gap filling for years later than 2012 (over areas with an insufficient PROBA-V or Sentinel-3)	

PRODUCT	SPECIFICATION	SPATIAL AND TEMPORAL COVERAGE	VOLUME	AVAILABILITY	USE	COMMENTS
	MOD09GA for TERRA and MYD09GA for AQUA – v5 Daily images, 7 spectral bands, 500m & 1km spatial resolution Format: HDF-EOS Source: NASA	Global coverage From 2013 to present	85 MB per 10° x 10° tile and per day	NASA website (direct download – acquisition in progress)	Potential use for gap filling for years later than 2012 (over areas with an insufficient PROBA-V or Sentinel-3 coverage)	
GlobTemperature Level 3 Product	Monthly Land Surface composites (+ residual data, day and night difference, anomalies, delta) 9km spatial resolution Format: GeoTiff Source: ESA	Global coverage From 08/1991 to 2009	Quantity not yet known	Provided by ESA Available at UCL	Improvement of the discrimination between LC classes	

PRODUCT	SPECIFICATION	SPATIAL AND TEMPORAL COVERAGE	VOLUME	AVAILABILITY	USE	COMMENTS
3D Global Vegetation Map	3D vegetation maps derived from airborne radar and lidar sensors (UAVSAR and LVIS in particular) 1km spatial resolution Format GeoTiff Source: NASA	Vegetation at the global scale 2003-2009	890 MB	NASA website http://lidarradar.jpl.nasa.gov/ (direct download)	Characterization of the vegetation height of key LC classes	
C4 fraction map	Percentage of vegetation (0-100) which possess the C4 photosynthetic pathway 1 degree spatial resolution GTiff Source: ISLSCP Initiative II Collection.	Global	1Mo	Available on-line from Oak Ridge National Laboratory Distributed Active Archive Center http://daac.ornl.gov/	C3/C4 distinction	Still et al., 2009
Updated world map of the Köppen-Geiger climate classification	Climate classes 0.1 degree spatial resolution GTiff Source: University of Melbourne	Global	1.06 Mo	Available from the University of Melbourne http://people.eng.unimelb.edu.au/mpeel/koppen.html	Biome delineation	Peel et al., 2007

PRODUCT	SPECIFICATION	SPATIAL AND TEMPORAL COVERAGE	VOLUME	AVAILABILITY	USE	COMMENTS
Randolph Glacier Inventory (RGI 5.0)	- global inventory of glacier outlines - shp - source: Global Land Ice Measurements from Space initiative (GLIMS)	Nineteen regions covering glaciers worldwide	2 Go	http://www.glims.org/RGI/	Support to permanent snow and ice class of the global LC map	
Antarctic Digital Database 6.0	- Antarctic coastline - shp - source: Scientific Committee on Antarctic Research (SCAR)	Antarctica	100 Mo	http://www.add.scar.org/home/add6	Support to permanent snow and ice class of the global LC map	
Most accurate and up-to-date land cover datasets	See Table 4-4	For the most comprehensive period since 2000	See Table 4-4		Building of a global compilation of most accurate and up-to-date land cover datasets to be used in the classification chain	Continuously updated

Table 4-4: Preliminary list of land cover datasets that are planned to be used either for supervised classification and/or for a land cover reference database compilation

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
GlobCover	Global LC map [GlobCover 2008] LCCS legend Spatial resolution: 300m Extent: global Years: 2005 Format: GeoTiff Source: ESA	300 MB	ESA website Direct download	OA: 73.14% for the 2005 product [Defourny 2010] OA: 67.5% for the 2009 product
GLC2000	Global LC map [GLC 2005] LCCS legend Spatial resolution: 1km Extent: global Year: 2000 Format: GeoTiff Source: JRC	33 MB	JRC-Land Resource Management Unit website Direct download after registration	OA: 68.6% [Mayaux 2006]
GLC2000 – South America map	Regional LC map [GLC 2005] LCCS legend Spatial resolution: 1km Extent: South America Year: 2000 Format: GeoTiff Source: JRC	4.8 MB	JRC-Land Resource Management Unit website Direct download after registration	Undefined accuracy
GLC2000 – Europe	Regional LC map [GLC 2005] LCCS legend Spatial resolution: 1km Extent: Europe	3.5 MB	JRC-Land Resource Management Unit website Direct download after registration	Undefined accuracy

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
	Year: 2000 Format: GeoTiff Source: JRC			
GLC2000 – Africa	Regional LC map [GLC 2005] LCCS legend Spatial resolution: 1km Extent: Africa Year: 2000 Format: GeoTiff Source: JRC	3.8 MB	JRC-Land Resource Management Unit website Direct download after registration	Undefined accuracy
GLC2000 – Greenland	Regional LC map [GLC 2005] LCCS legend Spatial resolution: 1km Extent: Greenland Year: 2000 Format: GeoTiff Source: JRC	0.2 MB	JRC-Land Resource Management Unit website Direct download after registration	Undefined accuracy
GLC2000 – Asia	Regional LC map [GLC 2005] LCCS legend Spatial resolution: 1km Extent: Asia Year: 2000 Format: GeoTiff Source: JRC	11.0 MB	JRC-Land Resource Management Unit website Direct download after registration	Undefined accuracy
GLC2000 – New Zealand	Regional LC map [GLC 2005] LCCS legend	0.1 MB	JRC-Land Resource Management Unit website	Undefined accuracy

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
	Spatial resolution: 1km Extent: New Zealand Year: 2000 Format: GeoTiff Source: JRC		Direct download after registration	
GLC2000 – Fiji	Regional LC map [GLC 2005] LCCS legend Spatial resolution: 1km Extent: Fiji Year: 2000 Format: GeoTiff Source: JRC	< 0.1 MB	JRC-Land Resource Management Unit website Direct download after registration	Undefined accuracy
GLC2000 – South Asia	Regional LC map [GLC 2005] LCCS legend Spatial resolution: 1km Extent: South Asia Year: 2000 Format: GeoTiff Source: JRC	3.6 MB	JRC-Land Resource Management Unit website Direct download after registration	Undefined accuracy
GLC2000 – Southeast Asia	Regional LC map [GLC 2005] LCCS legend Spatial resolution: 1km Extent: Southeast Asia Year: 2000 Format: GeoTiff Source: JRC	1.5 MB	JRC-Land Resource Management Unit website Direct download after registration	Undefined accuracy

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
Corine Land Cover	Maps derived from photo-interpretation Scale: 1:100.000 Extent: Europe Years: 2000, 2006 Format: ARC/Info Grid Source: EEA	Max 70MB per product	EEA website Direct download	OA for 1990: >85% [EEA 2007] OA for 2000: 87% [EEA 2006] Overall accuracy for 2006: not yet known
Land cover map of Canada	LC map derived from MODIS Spatial resolution: 250m Extent: Canada Year: 2005 Format: GeoTiff Source: CCRS	45 MB	Producers (CCRS) to be contacted Available at UCL	Undefined accuracy
Canada ACI map	Canada crop extent Spatial resolution: 30 m Extent: Canada Year: 2013 Source: Agriculture and Agri-Food Canada (AAFC) Format: GeoTiff	15 GB	AAFC Direct download	OA: 85%
United States National Land Cover Database	LC map derived from Landsat Spatial resolution: 30 m Extent: US Year: 2001, 2006, 2011 Source: USGS Format: GeoTiff	1.5 GB	USGS website Direct download	Undefined accuracy
Alaska North Slope	Regional LC map based on Landsat 30 m classification and updates of existing datasets Spatial resolution: 30 m	63.9 MB	NSSI catalog Direct download	Undefined accuracy

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
	Extent: North Slope Borough (Alaska) Year: 2013 Source: The North Slope Science Initiative (NSSI) Format: GeoTiff			
Land cover classification of Greater Meso-America [Giri 2005]	Spatial resolution: 500m Extent: Central America Year: 2003 Format: Img Source: N/A	53 MB	Producers (Giri and Jenkins) to be contacted Available at UCL	OA: 77.2%
North America Environment dataset	Land Cover map coming from the fusion of 3 existing regional products Spatial resolution: 250m Scales: ~ 1:10.000.000 Extent: Canada, United States, Mexico Year: 2005 Format: Img Source: CCRS, USGS, Mexican institutions	1.05 GB	Website of the Commission for Environmental Conservation Direct download	Undefined accuracy
Africover 2000 land cover maps	National land cover maps derived from remote sensing and auxiliary data Scale: between 1:250.000 and 1:100.000 Extent: Burundi, DRCongo, Egypt, Eritrea, Kenya, Rwanda, Somalia, Sudan, Tanzania, Uganda Year: 2000 Format: Vector Source: FAO	Max 300GB per product	FAO website, after request Available at UCL	Undefined accuracy
Congo Basin vegetation types	Mapping of vegetation types derived from MERIS and SPOT-VGT time series Spatial resolution: 300m	900 KB	UCL-Geomatics website Available at UCL	OA: 71.9% [Verheggen 2010]

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
map	Extent: Cameroon, Congo, Gabon, Burundi, Central African Republic, Equatorial Guinea, Republic Democratic of Congo, Rwanda Year: 2010 Format: GeoTiff Source: UCLouvain-Geomatics, Belgium			
Burkina-Faso land cover database [BDOT 2004]	LC map obtained from photo-interpretation of high resolution images Scale: 1:200.000 Extent: Burkina Faso Year: 2002 Format: vector Source: IGN France International	112 MB	Producers (IGNFI) to be contacted Available at UCL	OA: 84%
GLCN LC maps	LC map obtained by photo-interpretation of Landsat ETM images and aerial photos Extent: Senegal, Bhutan, Nepal, Uruguay, Afghanistan, Pakistan (Sindh and Punjab provinces); Scale: 1:100.000 Year: 2005 Senegal, 2000 Bhutan and Nepal, 2011 Uruguay, 2014 Afghanistan and Pakistan, Format: vector Source: Global Land Cover Network (GLCN)	Senegal 65 MB, Bhutan 35 MB, Nepal 156 MB, Uruguay 178 MB, Afghanistan 27 MB, Pakistan 12 MB	GLCN website Direct download	OA: Senegal 75.35%, Uruguay 85% Bhutan, Nepal, Afghanistan, Pakistan undefined
Southern Africa land cover database	Compilation of existing LC datasets into a single standardized database Spatial resolution: 1 km Extent: Southern Africa - South Africa, Tanzania, Zimbabwe, Zambia, Botswana, Namibia, Mozambique, Malawi, Swaziland, Lesotho	40 MB	CSIR website Direct download	

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
	Year: 2002 Format: vector Source: Southern African Development Community (SADC)			
Cropland mask over Africa [Vancutsem 2013]	Compilation (harmonization and post-processing) of existing LC or Land Use dataset over Africa Format: GeoTiff Source: JRC	40 MB		
National land cover map of China [Liu 2003]	Spatial resolution: 1 km Year: 2000 Format: ARC/INFO Grid Source: Chinese Academy of Science	6 MB	Chinese Academy of Science, under request Available at UCL	Undefined accuracy
Cambodia land cover map	LC map obtained from visual interpretation Scale: 1:500.000 Extent: Cambodia Year: 1996 Format: vector Source: JICA	108 MB	JICA Available at UCL	Undefined accuracy
Australia - National Dynamic Land Cover Dataset	LC map based on an analysis of a 16-day MODIS EVI composite collected for the period 2000 - 2008 Spatial resolution: 250 m Extent: Australia Year: 2000 - 2008 Format: GeoTiff Source: Geoscience Australia and the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)	281 MB	Geoscience Australia - Australian government Direct download	

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
New Zealand land cover database	Map obtained from Landsat 7 ETM+ imagery, with 43 classes Spatial resolution: 30m Extent: New Zealand, near shore islands, Chatham islands Years: 2001, 2002		Available at UCL	OA: 93.9%
Global mangrove atlas	Map of mangroves obtained using Landsat data Spatial resolution: 30m Extent: global Year: 2000 Format: IGE (Erdas Imagine) Source: USGS	65 MB	USGS website Direct download	Undefined accuracy
MODIS map of global urban extent	Map of urban extent obtained from MODIS [Schneider 2010] Spatial resolution: 500m Extent: global Year: 2001-2002 Format: GeoTiff Source: Center for Sustainability and the Global Environment (SAGE)	3.47 GB	Producers (Schneider) under request Available at UCL	OA: 93% [Schneider 2010]
SERVIR 2010 LC maps	LC maps of East African countries based on Landsat data and historical maps Spatial resolution: 30 m Extent: Rwanda, Botswana, Malawi, Namibia, Zambia, Uganda, Tanzania, Ethiopia Year: 2010, 2014 Uganda, 2008 Ethiopia Source: Regional Centre of Mapping of Resources for Development (RCMRD)	~ 6 GB	RCMRD Geoportal Direct download	OA: 77.07% Tanzania 79.11% Uganda 76.95% Namibia 76.41% Rwanda 77.1% Malawi 77.07% Botswana Undefined for Zambia and

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
	Format: GeoTiff			Ethiopia
Ukraine SRI LC map	Spatial resolution: 30 m Extent: Ukraine Year: Source: Space Research Institute (Ukraine) Format: GeoTiff	72 MB	Space Research Institute (Ukraine) - under request Available at UCL	OA: >90%
Central Asia DLR LC map	Spatial resolution:250 m Extent: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan Year: 2009 Source: German Aerospace Center (DLR) Format: GeoTiff	137 MB	Producers (Klein - DLR) Available at UCL	OA: 91,22% [Klein 2012]
Indian LC map	LC map of India using AWiFS data Spatial resolution: 56 m Extent: India Year: 2011-2012 Source: Indian National Remote Sensing Centre Format: GeoTiff	~250 MB	Bhuvan Geoportal - under request Available at UCL	OA: 90,07%
Japan JAXA LC map	LC map of Japan using AVNIR-2 data Spatial resolution: 30 m Extent: Japan Year: 2006 - 2011 Source: Japan Aerospace Exploration Agency (JAXA) Format: GeoTiff	148 MB	JAXA EORC website Direct download	OA: 62,3%
GLC30 LC map	Global LC map in 30 m resolution using Landsat and HJ-1 satellite data Spatial resolution: 30 m Extent: China Year: 2010 Source: National Geomatics Centre of China (NGCC) Format: GeoTiff	1,3 GB	NGCC - under request Available at UCL	OA: 83,51%
Southeast Asia CRISP	MODIS based LC map of insular Southeast Asia	200 MB	Producers (Miettinen)	OA: 85%

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
LC map	Spatial resolution: 250 m Extent: Malaysian Peninsula, Sumatra, Java, Borneo, Sulawesi and Mindanao, western New Guinea and numerous smaller islands Year: 2010 Source: Centre for Remote Imaging, Sensing and Processing (CRISP), National University of Singapore Format: GeoTiff		under request Available at UCL	[Miettinen 2011]
Global cropland extent	Discrete cropland/non-cropland indicator map derived from MODIS based Global Cropland Probability product Spatial resolution: 250m Extent: Global Year: 2000 - 2008 Source: Global Agriculture Monitoring Project (GLAM) Format: GeoTiff	21 MB	University of Maryland website Direct download	OA : 63% for US [Pittman 2010]
CCI water body product	Global WB product derived from ASAR and Sentinel-1 dataset Spatial resolution: 150m Extent: Global Coverage Year: 2005-2015 Source: ESA CCI-LC project Format: GeoTiff	70 MB	ESA CCI-LC project	
South Africa NLC 2014	South African National Land Cover Dataset Spatial resolution: 30m Extent: South Africa Year: 2014 Source: Department of Environmental Affairs (DEA) – South Africa Format: GeoTiff	4 GB	DEA website Direct download	OA: 81.73%

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
Madagascar vegetation map	Landsat based map delimiting areas with current vegetation types. Spatial resolution: 30m Extent: Madagascar Year: 1999-2003 Source: Madagascar Vegetation Mapping Project Format: GeoTiff	1.77 GB	Madagascar Vegetation Mapping Project website Direct download	Undefined accuracy
Venezuela vegetation map	Map of vegetation types in Venezuela Scale: 1:2.000.000 Extent: Venezuela Year: 1988 Format: vector Source: Instituto Venezolano de Investigaciones Cientificas (IVIC)	7 MB	IVIC website Direct download	Undefined accuracy
Brazil forest map	Map of deforestation in Brazilian Amazon Spatial resolution: 30m Extent: Brazil Year: 2010 Source: Instituto Nacional de Pesquisas Espaciais (INPE), PRODES project Format: GeoTiff	~15 GB	INPE website Direct download	

5 DATA REQUIREMENTS FOR THE LS SEASONALITY PRODUCT

As this version of the DARD focuses on the 1st year of Phase 2, this section only describes the data requirements to generate the land surface seasonality of the vegetation greenness through the Normalized Difference Vegetation Index (NDVI). It is made with SPOT-VGT satellite data.

5.1 Satellite data

The processing of the NDVI seasonality relies first on the SPOT-VGT Level 3 (L3) daily syntheses (S1) archive from 1999 up to May 2014 (Table 5-1). To extend the NDVI seasonality time frame to 2015, PROBA-V S1 syntheses from 2014 and 2015 will be used in complement[4].

Both SPOT-VGT and PROBA-V time series are produced using the Maximum Value Composite (MVC) algorithm over all segments received during one day for the entire surface of the Earth. The pixels selected for the syntheses are based on the selection of the maximum NDVI value, to ensure coverage of all landmasses worldwide with a minimum effect of cloud cover. More precisely, the ground surface reflectance values in the red and Near InfraRed (NIR) will be used in the NDVI processing chain.

Table 5-1: Satellite data sources planned to be used to generate the global LS seasonality product.

PRODUCT	COVERAGE	VOLUME	AVAILABILITY	USE	COMMENT
SPOT-VGT S1	global 1999-2012	9 TB	VITO	Reprocessing of NDVI seasonality of Phase I	A reprocessed SPOT-VGT archive will be made available by the VITO by mid-2016
PROBA-V 1 km S1	global 2014-2015	1 TB	VITO	Update the NDVI seasonality product to 2015	The PROBA-V time series need to be compatible with the SPOT-VGT archive

5.2 Ancillary data

The post-edition steps, applied on the seasonality product to ensure conformity of land/water and glaciers delineations rely respectively on the CCI-LC Global WB product and on the Randolph Glacier Inventory (RGI) [RGI 2012] and the Antarctic coastline from the Scientific Committee on Antarctic Research Antarctic Digital Database (SCAR ADD) [SCAR 2014].

Table 5-2 describes the characteristics and availability of the above-mentioned ancillary data needed for the production of the NDVI land surface seasonality product.

[4] According to the timing of availability of the reprocessed SPOT-VGT archive and its compatibility with PROBA-V time series with respect to the overall project planning.

Table 5-2: Ancillary data sources planned to be used to generate the global LS seasonality products

PRODUCT	SPECIFICATION	SPATIAL AND TEMPORAL COVERAGE	VOLUME	AVAILABILITY	USE
CCI-LC Global WB product	- Global WB product derived from ASAR data, existing WB products and auxiliary datasets - 150 m spatial resolution - GTiff - source: ESA CCI-LC project	Global Coverage 2000-2012	70 MB	ESA CCI-LC project	To be overlaid on LS seasonality product to ensure conformity
Randolph Glacier Inventory (RGI 5.0)	- global inventory of glacier outlines - shp - source: Global Land Ice Measurements from Space initiative (GLIMS)	Nineteen regions covering glaciers worldwide	2 Go	http://www.glims.org/RGI/	
Antarctic Digital Database 6.0	- Antarctic coastline - shp - source: Scientific Committee on Antarctic Research (SCAR)	Antarctica	100 Mo	http://www.add.scar.org/home/add6	

6 DATA REQUIREMENTS FOR LC SAR-BASED CLASSIFICATION

This section defines the data requirements for the SAR-based water body classifications (static map of water bodies and water seasonality). It distinguishes satellite data, ancillary data, and inter-comparison data. The SAR-based water body product was obtained during Phase I from Envisat ASAR and contains two classes: land and permanent water. The dataset was obtained at the native resolution of the SAR data (150 m). At the end of Phase I, it was resampled to 300 m to match with the pixel size of the land cover classification. The original classification from the SAR data was consolidated and completed with ancillary data (SRTM-SWBD and optical imagery). In Phase II, the WB product is further refined with auxiliary layers and is provided at the original spatial resolution of the ASAR dataset mostly used, i.e., 150 m. This static map was obtained by exploiting multi-temporal metrics derived from the backscatter intensity provided in the SAR images. . The water seasonality product is introduced in Phase II and relies on dense time series of ASAR observations from the IMM, WSM and GM1 modes. The data product is obtained at 1 km pixel size, i.e., the spatial resolution of the GM1 mode; for this, images acquired in IMM and WSM mode are multi-looked, i.e., averaged, from their original pixel size of 150 m to approximately 1 km and resampled to 1 km. The water seasonality product consists of a climatology of water detections over the 7 years of ASAR data, with a 10-days time step. A pixel is labelled as water if the slope and intercept estimates of the function relating the ASAR backscatter to the local incidence angle falls into the region defined as "water" by a novel classification tree (see ATBD for details). The set of ASAR observations consists of measurements taken +/- 30 days around the specific day defined by the 10-day time step.

Availability of Sentinel-1 data towards the end of the first year of Phase II shall serve to derive water body products at higher resolution.

6.1 Satellite data

The following two tables (Table 6-1 and Table 6-2) describe the characteristics and the availability of the SAR satellite data to be used in the water bodies' classification.

It should be noted that access to ASAR data was granted through the Grid Processing on Demand Platform (G-POD) which archived detected ASAR data since July 2005 because of their availability on ESA's rolling archive. Data acquired between 2002 and summer 2005 was not processed on a routine basis for the rolling archive. A request to ESA to complete the database of detected images was accepted[5].

Compared to Phase I, we are introducing ALOS PALSAR mosaic backscatter data and Sentinel-1 SAR data in an attempt to improve the spatial characterization of water bodies.

[5] There is no budget foreseen for the pre-processing and classification of this additional ASAR dataset in the framework of the LC-CCI project.

Table 6-1: SAR satellite data characteristics

PRODUCT	SOURCE	SPECIFICATION	COVERAGE	FORMAT	QUANTITY	COMMENT
ENVISAT ASAR ASA_WSM_1P	ESA	75-m pixel size ~150 m spatial resolution Full swath C-band http://envisat.esa.int	2002-2012	ENVISAT	50 TB (processed to 150 m)	Raw data in archives. Detected images for 2005-2012 on G-POD platform
ENVISAT ASAR ASA_IMM_1P	ESA	75-m pixel size ~150 m spatial resolution Full swath C-band http://envisat.esa.int	2002-2012	ENVISAT	10 TB (processed to 150 m)	. Raw data in archives. Detected images for 2005-2012 on G-POD platform
ENVISAT ASAR ASA_GM1_1P	ESA	500-m pixel size ~1000 m spatial resolution Full swath C-band http://envisat.esa.int	2004-2012	ENVISAT	2 TB (1,000 m) 20 TB (150 m)	Detected images available at GammaRS. Gap fillers for WB product resampled to 150 m
Sentinel-1	ESA	SLC and detected data	2014-	Sentinel-1	N/A	Improve water body classification. SAR backscatter and possibly coherence (depending upon availability of SLC data) used.

Table 6-2: SAR satellite data availability

PRODUCT	AVAILABILITY	CONDITIONS	REQ. SUBSET	PURPOSE / TIMELINES
ENVISAT ASAR ASA_WSM_1P	Available on G-POD system. Agreement with GammaRS for use and processing on G-POD with Cat-1 Project 9209	Conditions of use defined by ESA Sentinel data policy, i.e. redistributable	2005-2012	Classification of water bodies and generation of water bodies seasonality product
ENVISAT ASAR ASA_IMM_1P	Available on G-POD system. Agreement with GammaRS for use and processing on G-POD with Cat-1 Project 9209.	Conditions of use defined by ESA Sentinel data policy, i.e. redistributable	2005-2012	Generation of water bodies seasonality product. Gap filler for WSM+IMM data for static WB classification.

PRODUCT	AVAILABILITY	CONDITIONS	REQ. SUBSET	PURPOSE / TIMELINES
ENVISAT ASAR ASA_GM1_1P	Available at Gamma RS after routine download as ESA PI.	Conditions of use defined by ESA Sentinel data policy, i.e. redistributable	2004-2012	Generation of water bodies seasonality product. Gap filler for WSM+IMM data for static WB classification.
Sentinel-1	Routine download over several regions from Sentinel-1 data hub	Conditions of use defined by ESA Sentinel data policy, i.e. redistributable	2014-	Improvement of water body classification

6.2 Ancillary data

The following two tables (Table 6-3 and Table 6-4) describe the characteristics and the availability of auxiliary datasets to be used for the water bodies' classification. Ancillary data consist of Digital Elevation Models and ERA Interim records of weather parameters. TanDEM-X DEMs will be used for the processing of the Sentinel-1 data and related classification to water bodies. At the moment, GammaRS has available full coverage of Switzerland through a science proposal to DLR for the exploitation of Intermediate TanDEM-X DEM (12.5, 30 and 90 m) spatial resolution. Terms of availability of the final global TanDEM-X DEM are not known yet.

Table 6-3: Characteristics of auxiliary data to be used for the SAR-based water bodies' classification

PRODUCT	SOURCE	SPECIFICATION	COVERAGE	FORMAT	QUANTITY	COMMENT
SRTM-3 DEM, v 4.1	CGIAR / JRC	3 arc-second spatial resolution http://srtm.csi.cgiar.org/	+/- 60°N 2000	Plain binary	13.4Gb (zipped)	Freely available
Russian topographic maps	Private owner	3 arc-second spatial resolution http://www.viewfinderpanoramas.org	>60°N 1950-2000	Plain binary	9.4 Gb	Freely available
Canadian Digital Elevation Dataset	Geobase	3 to 12 arc-seconds spatial resolution (http://www.geobase.ca/geobase/en/data/cded/index.html)	Canada 1945-2010	ASCII	1.8 Gb (zipped)	Freely available
Elevation dataset of Alaska	USGS	3 arc-second spatial resolution http://www.webgis.com/terr_us1 deg.html	Alaska, undated	ASCII	0.2 Gb	Freely available
TanDEM-X DEM	DLR	12.5, 30 and 90 m spatial resolution	Global	Geotiff	in production	Availability not yet defined
ERA-Interim	ECMWF	0.75 degree fields of air temperature 2m, 4 observations daily	Global	NetCDF	10 Gb	Public dataset

Table 6-4: Availability of auxiliary data to be used for the SAR-based water bodies' classification

PRODUCT	AVAILABILITY	CONDITIONS	REQ. SUBSET	PURPOSE / TIMELINES
SRTM-3 DEM, v 4.1	Available at UJena and Gamma RS	None	No subset required (+/- 60°N;2000)	SAR image geocoding, support of classification
Russian topographic maps	Available at UJena and Gamma RS	None	No subset required (>60°N; 1950-2000)	SAR image geocoding, support of classification
Canadian Digital Elevation Dataset	Available at Gamma RS	None	Subsets considered (i.e. areas >60°N - 1950-2010)	SAR image geocoding, support of classification
Elevation dataset of Alaska	Available at Gamma RS	None	Subsets considered (i.e. areas >60°N - undated)	SAR image geocoding, support of classification
TanDEM-X DEM	Intermediate DEM available at GammaRS over Switzerland	not yet defined	Global	Support processing and classification of Sentinel-1 data

PRODUCT	AVAILABILITY	CONDITIONS	REQ. SUBSET	PURPOSE / TIMELINES
ERA-Interim	Dataset of air temperature at 2 m (public dataset) downloaded	None	Global	Support generation of water seasonality product

6.3 Inter-comparison and refinement data

The following two tables (Table 6-5 and Table 6-6) describe the characteristics and the availability of the datasets that are planned to be used for inter-comparison or refinement of the WB product Phase II. With respect to Phase I, we introduce two recently published global dataset at 30 m including a water body class: the Global Forest Change product which consists of a forest cover change map and includes class permanent water and the Global Inland Water product v1.0. We also include daily charts of ice cover at coarse resolution to support the detection of water dynamics.

Table 6-5: Inter-comparison and refinement data characteristics

PRODUCT	SOURCE	SPECIFICATION	COVERAGE	FORMAT	QUANTITY	COMMENT
SRTM Water Bodies (SWBD)	NASA	Land/water mask within SRTM DEM coverage http://dds.cr.usgs.gov/srtm/version2_1/SWBD/	+/- 60°N 2000	Shapefile (tiles)	< 1GB	-
GLWD (Global Lakes and Wetlands Database)	WWF	Global maps of lakes and wetlands http://www.worldwildlife.org/science/data/item1877.html	Global	Shapefile	140 MB	-
Samples on high spatial resolution imagery	Google Earth	Visualization tool (no acquisition needed) Images from 2004 to 2010	Global	Google Earth	On the fly	Repository of high resolution satellite and airborne imagery
Corine Land Cover 2006	EEA	Maps derived from photo-interpretation Scale of 1:100.000 http://www.eea.europa.eu/publications/COR0-landcover	Europe (without Russia and Switzerland) 2006	ARC/INFO Grid	600 MB	Overall accuracy not yet known
Land Resource of Russia	IIASA	GIS database of Russia http://www.iiasa.ac.at/Research/FOR/russia_cd/guide.htm	Russia 1950-2000	Shapefile	300 MB	None
SIB-ESS-C	N/A	Database (GIS and EO data) over Central Siberia http://www.sibessc.uni-jena.de	Siberia 1990-2010	GeoTiff	< 1GB	None
Global Forest Change	University of Maryland	Global map of forest cover change at 30-m spatial resolution http://earthenginepartners.appspot.com/science-2013-global-forest	Near global, 2000-2012	GeoTiff	600 GB	Not validated
Global Inland Water	University of	Inland surface water classification based on the 30-m Global Land Survey	Near global, 2000	GeoTiff	600 GB	Not validated

PRODUCT	SOURCE	SPECIFICATION	COVERAGE	FORMAT	QUANTITY	COMMENT
product v1.0	Maryland	collection of Landsat images for year 2000 http://www.landcover.org/data/watercover/.				
MS Daily Northern Hemisphere Snow and Ice Analysis	NSIDC	Northern hemisphere daily map of ice/land conditions at 4 km spatial resolution http://nsidc.org/data/docs/noaa/g02156_ims_snow_ice_analysis/index.html#geotiff_format	Northern hemisphere, 1966-	Plain binary	13 GB / year	Not validated
Randolph Glacier Inventory (RGI 5.0)	Global Land Ice Measurements from Space initiative (GLIMS)	Global inventory of glacier outlines http://www.glims.org/RGI/	Nineteen regions covering glaciers worldwide	SHP	2 Go	None
Antarctic Digital Database v6.0	Scientific Committee on Antarctic Research (SCAR)	Antarctic coastline http://www.add.scar.org/home/add6	Antarctica	SHP	100 Mo	None

Table 6-6: Inter-comparison data availability

PRODUCT	AVAILABILITY	CONDITIONS	REQ. SUBSET	PURPOSE / TIMELINES
SRTM Water Bodies (SWBD)	Available at Gamma RS	None	No subset required (+/-60°N, 2000)	Comparison with the CCI-LC water bodies product
GLWD (Global Lakes and Wetlands Database)	Available at Gamma RS	None	Global	Comparison with the CCI-LC water bodies product
Samples on high spatial resolution imagery	On Google Earth (only visualization)	None	Global	Comparison with the CCI-LC water bodies product

Corine Land Cove 2006	EEA website Available at Gamma RS	None	Europe (without Russia and Switzerland) 2005	Comparison with the CCI-LC water bodies product
Land Resource of Russia	IIASA website Available at Gamma RS	None	Russia 1950-2000	Comparison with the CCI-LC water bodies product
SIB-ESS-C	SIB UJena website Available at Gamma RS	None	Siberia 1990-2010	Comparison with the CCI-LC water bodies product
Global Forest Change	Univ. Maryland, Available at UCL and Gamma RS	None	Near global	Comparison with and refinement of the CCI-LC water body product
Global Inland Water product v1.0	University of Maryland, Available at UCL	None	Near global, 2000	Comparison with and refinement of the CCI-LC water body product
MS Daily Northern Hemisphere Snow and Ice Analysis	NSIDC Downloaded by GammaRS	None	Northern hemisphere, 2005-2012	Definition of water body dynamics
Randolph Glacier Inventory (RGI 5.0)	Available at UCL	None	Global	Refinement of the CCI-LC water body product
Antarctic Digital Database v6.0	Available at UCL	None	Antarctica	Refinement of the CCI-LC water body product

7 DATA REQUIREMENTS FOR HIGH RESOLUTION LC PRODUCTS

This section defines the data requirements for the classification chain that will generate the high resolution LC map over Africa and the change maps dedicated to critical LC classes and/or regions according to users' priorities. These products will be based on Sentinel-2 and Landsat 8 data. As outlined in section 2.2, these products are foreseen as prototypes which will demonstrate the classification algorithms developed for the Sentinel-2 mission.

7.1 Satellite data

The high resolution LC products will rely on EO datasets coming from the ESA Sentinel-2 mission as primary source and from Landsat 8 as secondary source.

Classification and change detection chains ingest Sentinel-2 and Landsat 8 SR time series pre-processed by the project (see section 3.1). Table 7-1 lists the satellite dataset that are planned to be used in order to generate the high resolution LC products.

Table 7-1: Satellite data sources that are planned to be used to generate the global LC maps

HIGH RESOLUTION PRODUCT	REFERENCE PERIOD	SATELLITE DATA SOURCE
LC map over Africa	2015-2016	Sentinel-2 SR composites over Africa from August 2015
		Landsat-8 SR composites over Africa from 2015
Change map[6]	From August 2015	Sentinel-2 SR composites from August 2015
	From April 2013	Landsat-8 SR composites from 2015

7.2 Ancillary data

Table 7-2 describes the characteristics and the availability of the ancillary data needed for the classification and change detection processing chains. These datasets consist of (i) a suite of existing high spatial resolution maps over Africa, which will be used to calibrate algorithms and (ii) the global LC maps generated in the project that will be used as background to be sure that the high resolution products are consistent with the 300m ones.

[6] At the time being, the study area for the change maps is not yet known

Table 7-2: Characteristics of ancillary data needed for the generation of HR products

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
Africover 2000 land cover maps	National land cover maps derived from remote sensing and auxiliary data Scale: between 1:250.000 and 1:100.000 Extent: Burundi, DRCongo, Egypt, Eritrea, Kenya, Rwanda, Somalia, Sudan, Tanzania, Uganda Year: 2000 Format: Vector Source: FAO	Max 300GB per product	FAO website, after request Available at UCL	Undefined accuracy
Burkina-Faso land cover database [BDOT 2004]	LC map obtained from photo-interpretation of high resolution images Scale: 1:200.000 Extent: Burkina Faso Year: 2002 Format: vector Source: IGN France International	112 MB	Producers (IGNFI) to be contacted Available at UCL	OA: 84%
GLCN Senegal LC map	LC map obtained by photo-interpretation of Landsat ETM images and aerial photos Extent: Senegal Scale: 1:100.000 Year: 2005 Format: vector Source: Global Land Cover Network (GLCN)	65 MB	GLCN website Direct download	OA: Senegal 75.35%
SERVIR 2010 LC maps	LC maps of East African countries based on Landsat data and historical maps Spatial resolution: 30 m Extent: Rwanda, Botswana, Malawi, Namibia, Zambia, Uganda, Tanzania, Ethiopia Year: 2010, 2014 Uganda, 2008 Ethiopia	~ 6 GB	RCMRD Geoportal Direct download	OA: 77.07% Tanzania 79.11% Uganda 76.95% Namibia 76.41% Rwanda 77.1% Malawi

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
	Source: Regional Centre of Mapping of Resources for Development (RCMRD) Format: GeoTiff			77.07% Botswana Undefined for Zambia and Ethiopia
South Africa NLC 2014	South African National Land Cover Dataset Spatial resolution: 30m Extent: South Africa Year: 2014 Source: Department of Environmental Affairs (DEA) – South Africa Format: GeoTiff	4 GB	DEA website Direct download	OA: 81.73%
Madagascar vegetation map	Landsat based map delimiting areas with current vegetation types. Spatial resolution: 30m Extent: Madagascar Year: 1999-2003 Source: Madagascar Vegetation Mapping Project Format: GeoTiff	1.77 GB	Madagascar Vegetation Mapping Project website Direct download	Undefined accuracy
Global mangrove atlas	Map of mangroves obtained using Landsat data Spatial resolution: 30m Extent: global (African subset required) Year: 2000 Format: IGE (Erdas Imagine) Source: USGS	65 MB	USGS website Direct download	Undefined accuracy
CCI-LC Global WB product	Global WB product derived from ASAR data, existing WB products and auxiliary datasets Spatial resolution: 150 m Extent: global (African subset required)	70 MB	ESA CCI-LC project CCI-LC viewer Direct download	Accuracy assessment in progress

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
	Year: 2000-2012 Format: GeoTiff Source: ESA CCI-LC project			
CCI annual land cover maps	Global LC map [GlobCover 2008] LCCS legend Spatial resolution: 300m Extent: global Years: 1990s, 2000 to 2015 on an annual basis Format: GeoTiff Source: ESA	3 GB by map	ESA CCI-LC project CCI-LC viewer Direct download	OA: 73.14% for the 2005 product [Defourny 2010]

8 DATA REQUIREMENTS FOR GLOBAL LC MAPS VALIDATION

During the CCI-LC Phase I, a validation database was built over the 2000, 2005 and 2010 epochs. The input satellite and auxiliary data used for building this database are documented in the Phase I DARD [DARD 2012].

During the Phase 2, this database will be extended to cover the 1990 and 2015 epoch. This activity will take place during the 2nd year of this Phase 2 and will thus be described in the DARDv2.

During the CCI-LC Phase I, a validation database was built over the 2000, 2005 and 2010 epochs. The input satellite and auxiliary data used for building this database are documented in the Phase I DARD [DARD 2012] and are reminded in this document.

During the Phase 2, this database is extended to cover the 1990 and 2015 epoch and to be usable with high resolution products

Establishing operational validation activities requires, as a prerequisite, the availability of good quality reference imagery at moderate resolution (20m x 20m - 30m x 30 m), such as SPOT HRV and Landsat-TM. The project intends to use existing reference datasets as much as possible, in particular to optimize the limited resources.

Other existing reference validation datasets are identified for cross comparison from ongoing international initiatives in which UCL and/or JRC have been involved: the GLC2000 [Mayaux 2006] and GlobCover [Bicheron 2008] validation databases.

8.1 Satellite data

Imagery at moderate resolution (20m x 20m - 30m x 30 m) coming from SPOT HRV and Landsat-TM is used as main source of satellite imagery. Google Earth imagery and multi-temporal intra-annual NDVI profiles derived from the SPOT-VGT archive for period 1998 to 2012 is used in complement to help during the interpretation phase of the moderate resolution reference dataset.

A recent product, called the Global Land Survey (GLS), was derived by reprocessing GeoCover data, a selection of good quality, orthorectified and geodetically accurate global land dataset of Landsat TM (30 m × 30 m) and Landsat ETM+ (30 m × 30 m) satellite images with a global coverage, which was created from the epochs circa 2000, circa mid-2000s and circa 2010 at 28.5 m × 28.5 m resolution by the NASA.

A global systematic sampling scheme has been developed jointly by FAO and the JRC TREES project to estimate rates of deforestation at global or continental levels at intervals of 5 to 10 years. Time-series of Landsat data are attached to each sampling location through a quality-controlled, standardized and decentralized process. For the FAO's FRA2010 RSS exercise, the South Dakota State University (SDSU) produced a global database of multi-temporal 20 km × 20 km sample tiles extracted from the USGS GLS archives [Potapov 2010]. For the portion of the sample tiles that are not available from the GLS database or have persistent cloud contamination over the Tropics or Eurasia, other Landsat imagery or alternative remote sensing data have been used [Beuchle 2011].

In the framework of the CCI-LC Phase 1 project Category-1 Proposal supported by Third Parties Missions program, the project acquired satellite imagery from SPOT-Image archive (at 20 m × 20 m resolution) at dates selected as close as possible to the year 2010 (if existing) and from SPOT-Image acquisition planning for year 2011 [Defourny 2010]. The Phase 1 project also accessed to

complementary data or information derived from other moderate satellite imagery for South America and South East Asia at dates selected as close as possible to 2010 (from the ALOS AVNIR-2 sensor at 10 m × 10 m 22 m × 22 m resolution or from DEIMOS-1 sensor at 22 m × 22 m resolution for the 1˚ × 1˚ confluence points - circa 85% covered by AVNIR-2 and 15% by DEIMOS-2 – and from Kompsat-2 (at 4 m × 4 m resolution) for the 2˚ × 2˚ confluence points - presently 60% of 2˚ × 2˚ confluence points are covered). This imagery was acquired by ESA and analyzed by JRC in the framework of the ESA category-1 project entitled “TropForest 2010” [Arino 2010].

In Phase 2, the database is extended to cover the 1990s period and the years later than 2012. In addition, the database is also made usable to validate high resolution LC products. To this end, the GLS 1990, Landsat-8 and Sentinel-2 images are considered.

Table 8-1 lists the satellite dataset used in order to validate the LC products.

Table 8-1. Satellite data used for LC products validation

PRODUCT	COVERAGE	SIZE	AVAILABILITY	USE	COMMENT
GLS-1990	Global coverage – Subsets of 20 km x 20 km 1990	Total of 7375 scenes (975 GB)	Freely available JRC for Tropics & Eurasia SDSU for rest	Validation of the LC products	1500 scenes to be extracted each epoch (2000, 2005, 2010) Sample units globally distributed (based on a systematic 1°x1° sampling)
GLS-2000	Global coverage – Subsets of 20 km x 20 km 2000	Total of 8756 scenes (2.18 TB)	Freely available JRC for Tropics & Eurasia SDSU for rest	Validation of the LC products	
GLS-2005	Global coverage – Subsets of 20 km x 20 km 2005	Total of 8651 scenes (1.64 TB)extracted	Freely available JRC for Tropics & Eurasia SDSU for rest	Validation of the LC products	
GLS-2010	Global coverage – Subsets of 20 km x 20 km 2010	Dataset still in creation	Freely available JRC for Tropics & Eurasia SDSU for rest	Validation of the LC products	
SPOT 4 HRV	Under specific locations in Europe and Africa Between 2009 and 2011	384 scenes 12 GB	ESA Cat-1 Terms & Conditions [ESA 2010] Cat-1 proposal accepted on 08/09/2010 Available at UCL & JRC	Validation of the LC products	Sample units in Europe and Africa (based on a systematic 1°x1° sampling)

PRODUCT	COVERAGE	SIZE	AVAILABILITY	USE	COMMENT
AVNIR-2 Deimos-1 KOMPSAT-2	Under specific locations in Latin America and Southeast Asia 2010		ESA Cat-1 Terms & Conditions [ESA 2010] "TropForest 2010" Cat-1 proposal Available at JRC	Validation of the LC products	Sample units distributed over Latin America and Southeast Asia (ALOS AVNIR-2 or DEIMOS-1 at 1° x 1° locations; KOMPSAT-2 imagery at 2° x 2° locations)
Sentinel-2 MSI Level 1	Global coverage – Subsets of 20 km x 20 km 2015	Dataset not yet acquired	ESA data hub	Validation of the LC products	500 scenes to be extracted over the period 2013-2016 Sample units distributed (based on a systematic 1°x1° sampling) Landsat 8 and Sentinel-2 being complementary
Landsat-8 OLI/TIRS L1T	Africa – Subsets of 20 km x 20 km 2015	Dataset not yet acquired	USGS earthexplorer.usgs.gov	Validation of the LC products	

8.2 Ancillary data

Table 8-2 describes the characteristics and the availability for the ancillary data used to validate the LC products.

Table 8-2: Characteristics of ancillary data needed for the generation of HR products

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
Google Earth	High spatial resolution imagery freely available Over the sampling units Most recent images	N/A	Freely available Google	
SPOT-VGT 10-day NDVI profiles	NDVI annual profiles on a 10-day basis Over the sampling units 1-km spatial resolution From 1998 to 2012	N/A	Freely available, only for scientific use CNES (through VITO)	NDVI LS seasonality products
GLC2000 validation database	Global coverage 2000 1265 points interpreted in LCCS	N/A	Restricted to the CCI-LC project Not public	For inter-comparison

PRODUCT	SPECIFICATIONS	VOLUME	AVAILABILITY	COMMENTS
	classifiers by international experts [Mayaux 2006]		Available at JRC	
GlobCover validation databases	Global coverage 2005 and 2009 3170 points interpreted in LCCS classifiers by international experts [Bicheron 2008]	N/A	Restricted to the CCI-LC project Not public Available at UCL	For inter-comparison

9 DATA PROCUREMENT PROCESS

The following tables list the agreements and proposals for data acquisition for the CCI-LC project in Phase I (Table 9-1) and in Phase 2 (Table 9-2) together with their respective status.

Table 9-1: Agreements for data access by the CCI-LC project in Phase I

NO	AGREEMENT / PROPOSAL	DATASET (SENSOR, SPATIAL AND TEMPORAL COVERAGE)	SUBMITTED	ACCEPTED	RECEIVED
1	Agreement (VITO)	SPOT-VGT daily syntheses S1 (global coverage, 1998-2012)	29/06/2010	05/08/2010	15/08/2010
2	Agreement (VITO)	SPOT-VGT P products (global coverage, 2005-2007)	11/01/2010	18/01/2011	01/03/2011
3	Cat-1 proposal (ESA)	ENVISAT MERIS FRS_1P (global, 2003-on) ENVISAT MERIS RR_1P (global, 2001-on) ERS ATSR2 (global, 1998-2002) ENVISAT AATSR (global coverage, 2003-2012)	17/02/2011	-	-
4	Cat-1 proposal (ESA)	ENVISAT ASAR WSM (1000 images over spatial subsets in 2005)	29/09/2010	17/10/2010	15/11/2010 30/11/2010
5	G-POD Cat-1 proposal (ESA)	G-POD processing of ASAR Wide Swath imagery for multi-purpose applications	08/04/2011	12/05/2011	Data processed on G-POD platform
6	Cat-1 proposal (ESA)	SPOT HR	31/08/2010	08/09/2010	Archived data: 07/02/2011
8	Agreement with CCI Fire	Fire disturbance (CCI output)	not available yet	not available yet	not available yet
9	Agreement for LC maps	Varying	see Table 4-3 and Table 4-4	see Table 4-3 and Table 4-4	see Table 4-3 and Table 4-4

Table 9-2: Agreements for data access by the CCI-LC project in Phase 2

SECTION	DATASET (SENSOR, SPATIAL AND TEMPORAL COVERAGE)	AGREEMENT / PROPOSAL	SUBMITTED	ACCEPTED	RECEIVED
10	Sentinel 1	Data access through Sentinel-1 science hub	October 2014	October 2014	
11	Sentinel 2	Data access principally announced/granted via ESA data hub	2014-01-24 by email via A. Chadwick	email by P. Potin, forwarded by A. Chadwick 25.03.2014	
12	Sentinel 3	Data access principally announced/granted via ESA data hub	2014-01-24 by email via A. Chadwick	email by P. Potin, forwarded by A. Chadwick 25.03.2014	
13	AVHRR L1B 1km	Open access, but we have asked for offline delivery	2014-07-24 by email via J. Dwyder	-	Data set received mid-November 2014
16	Proba-V (300m)	VITO	2014-10-15 by email	2014-10-15 by email from Erwin Wolters	Archive + continuous download from 15/10/2014
17	Landsat-8	Open access, but we may ask for offline delivery			