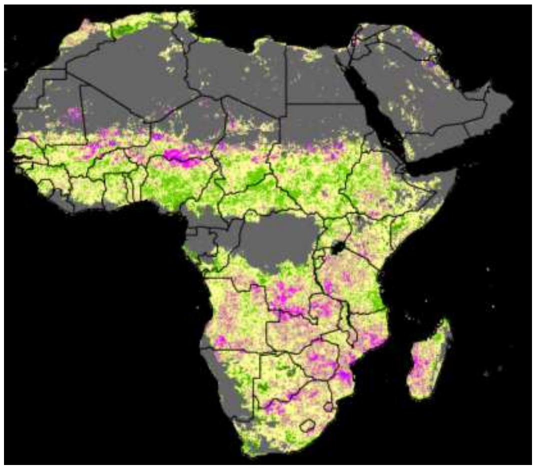
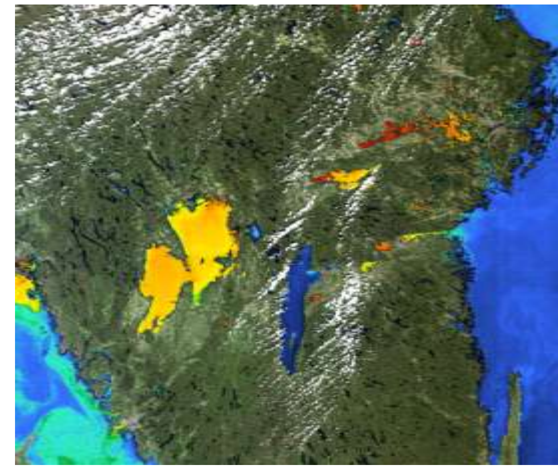
diversity drylands

diversity inland waters



esa

Diversity II



Carsten Brockmann

Diversity II Project Manager

Brockmann Consult, Germany





International Environmental Conventions

- Dramatic environmental problems affecting our planet have mobilised governments, scientists and environmental organisations over the world.

- As a result, several **Multilateral Environmental Agreements (MEAs)** have been signed that aim at reducing environmental degradation.

The United Nations Conference on Environment and Development (UNCED), also known as the 'Earth Summit', held in Rio in 1992.
It resulted in the definition of the 'Agenda 21' plan of actions and the subsequent signature of different multilateral agreements such as

- the UN Convention to Combat Desertification (**UNCCD**),
- the UN Convention on Biodiversity (**CBD**)
- the UN Framework Convention on Climate Change (**UNFCCC**).

ESA and International Environmental Conventions

- ***UNFCCC,***
  UN Framework Convention on Climate Change
- ***UNCCD,***
  UN Convention to Combat Desertification
- ***CBD,***
  UN Convention on Biodiversity
- ***Ramsar,***
  Intergovernmental Convention on Wetlands
- ***WHC,***
  World Heritage Convention

CBD

UN Convention on Biological Diversity

http://www.cbd.int/

The Global Biodiversity Outlook (GBO)

- **Sept 2002**, 2nd Earth Summit, Johannesburg
  "*achieve by 2010 a significant reduction in the rate of Biodiversity loss*"
- **Year 2010**,
  International Year of Biodiversity
- **May 2010**,
  Global Biodiversity Outlook 3
  "*2010 targets have not been met*"
  "*State of Biodiversity: Collective failure*"
- **Sept 2010**, UNGA 65th Session
  "*first high level meeting on Biodiversity*"
- **Oct 2010**, UNCBD COP-10, Nagoya
  "*new strategic plan for the coming decade with a 2020 mission and a 2050 vision*"

June 2012: Rio+20 Earth Summit
United Nations Conference on Sustainable Development (UNCSD)

GBO-3 key messages

Natural habitats continue to decline in extent and in integrity

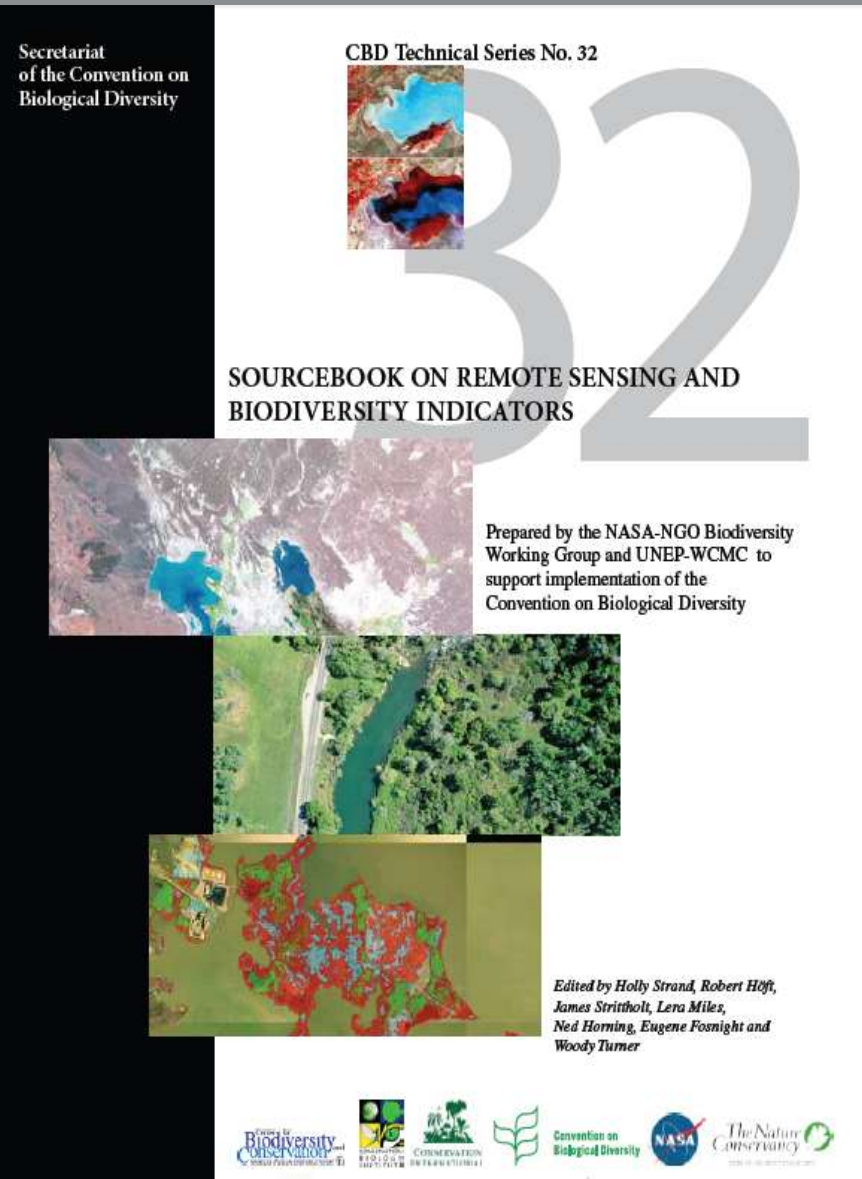
Five main pressures continue to affect biodiversity and are either constant or increasing in intensity:

- Habitat loss
- Unsustainable use and overexploitation of natural resources
- Climate change
- Invasive alien species
- Pollution

BUT ….

- Some 170 countries have national biodiversity strategies and actions plans
- Important progress in developing mechanisms for research, monitoring and assessment of biodiversity
- The real benefits of biodiversity, and the costs of its loss, are progressively reflected within economic systems and markets.

CBD Sourcebook on Remote sensing



"….Technological advances, refined methodologies and growing databases make our systems for monitoring biodiversity increasingly effective…. Remote sensing is without a doubt one of the indispensable tools for detecting changes in multiple facets of biodiversity over time…"

UN-CBD Secretariat Technical Series No. 32,

"Sourcebook on Remote Sensing and Biodiversity Indicators"

Space contribution to UN Convention on Biodiversity

CBD Focal Areas	Headline Indicators
Status and trends of the components of biological diversity	▪ *Trends in extent of selected biomes, ecosystems & habitats* ▪ *Change in status of threatened species* ▪ *Coverage of protected areas*
Sustainable use	▪ *Area of forest, agricultural and aquaculture ecosystems under sustainable management*
Threats to biodiversity	▪ *Trends in invasive alien species (IAS)*
Ecosystem integrity and ecosystem goods and services	▪ *Connectivity / fragmentation of ecosystems* ▪ *Water Quality of freshwater ecosystems*

CBD global headline indicators to assess progress towards the 2010 biodiversity target

UNCBD COP VII, decision VII/30

Diversity II

esa

- Contribute to the CBD programs of work on the biological diversity of respectively inland water and drylands ecosystems,
- global assessment of the availability of freshwater and of its quality with the provision of key observations over large perennial inland waters (lakes and reservoirs)
- assessment of the status and trends of the biological diversity in dry and sub-humid lands.

diversity
inland waters

diversity
drylands

Specific Objectives

- Produce and deliver a number of Earth Observation (EO) application products
  - Parameters:
    - Inland Waters
      - availability of freshwater
      - quality of freshwater, reflected in its water constituents such as chlorophyll-a and/ or suspended matter concentration, as well as by its temperature
    - Drylands and sub-humid lands
      - Net Primary Productivity (NPP), and/ or related indices on the vegetative/ biomass productivity
      - Rain use efficiency and/ or related indices on the land/ vegetation conditions (status and degradation)
  - Status maps, associated change maps, status indicators and trend indicators aggregated at different spatial and temporal levels

Dimension of the Work

- Spatial extension
  - 300 large perennial inland waters
  - ≥20 dryland areas, globally distributed, 10 million km^2
- Temporal coverage
  - 10 years of ENVISAT data: 2002 - 2012
- Instruments
  - Optical visible, optical thermal, active and passive microware sensors:
    - ENVISAT: MERIS, AATSR, RA-2 and ASAR
    - Complemented by selected HR products
    - Preparing Sentinel 2, Sentinel 3 and Proba-V

The 6 cornerstones of our Approach

1. Link biodiversity users and EO experts
2. Selection of best algorithms
3. Software and production
4. Validation
5. Communication and product dissemination
6. Preparing the future

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1. Link biodiversity users and EO experts

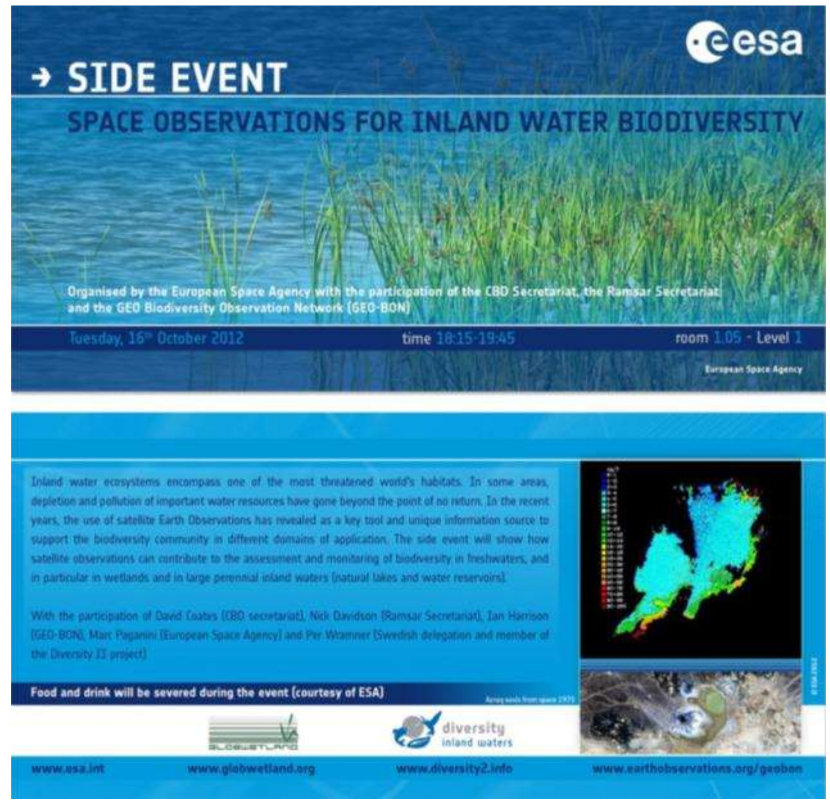
- Diversity User Bureau (DUB)
- User Consultation meetings
- Promotion activities
- Analysis of documentation and comments received

diversity drylands

diversity inland waters

प्रकृतिः रक्षति रक्षिता

Nature Protects if She is Protected

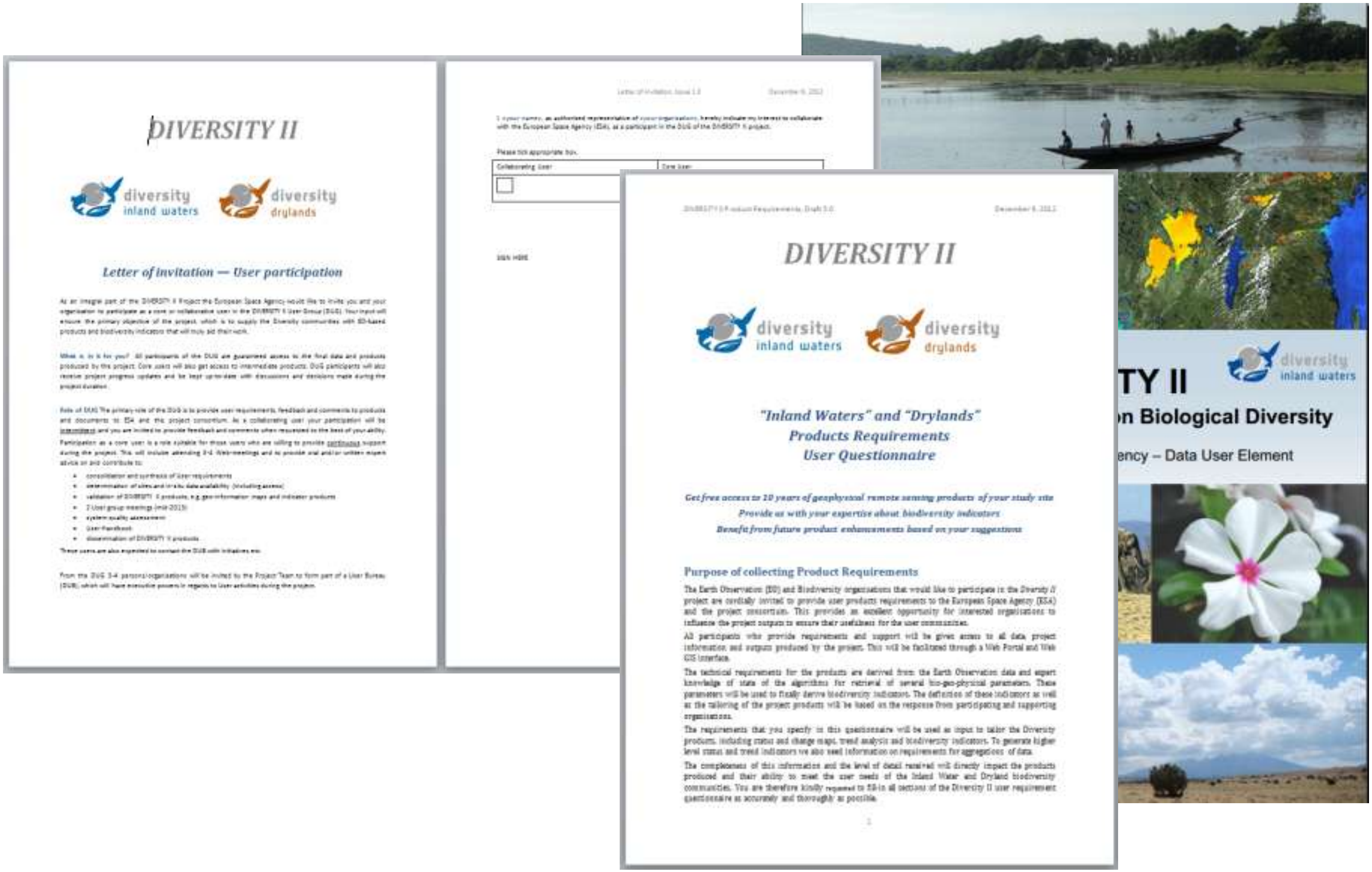


XI Conference of Parties

CONVENTION ON BIOLOGICAL DIVERSITY

HYDERABAD INDIA 2012

User Participation



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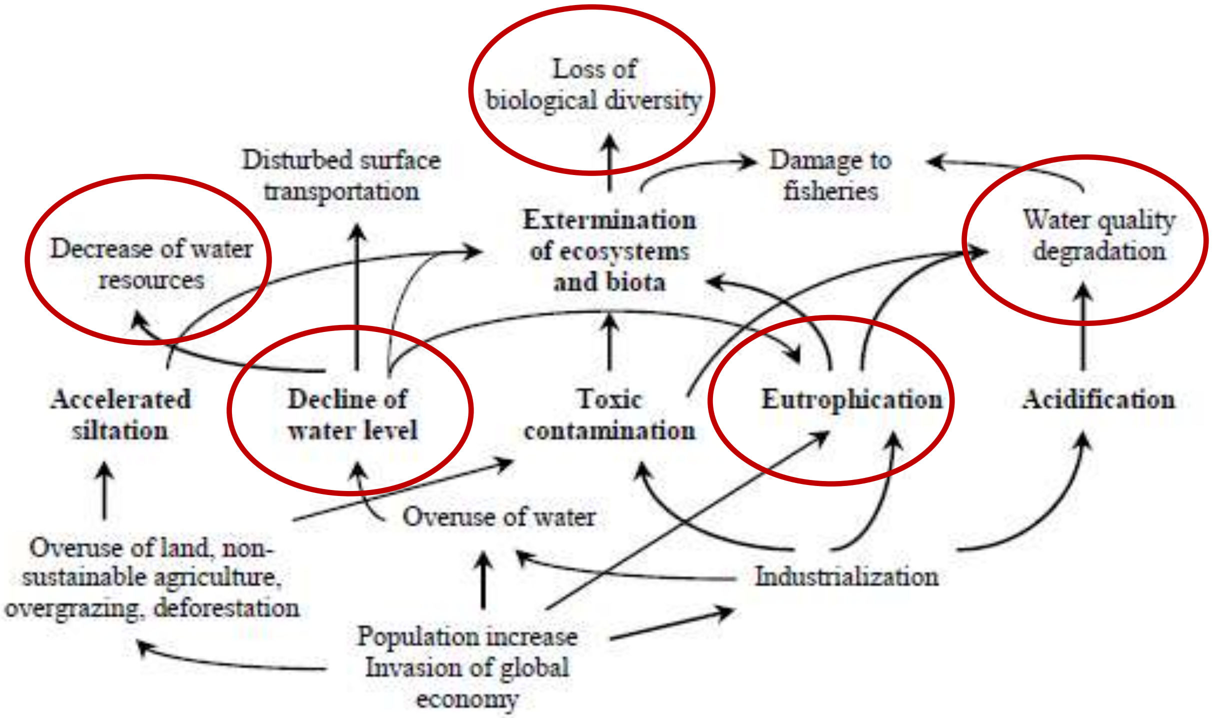
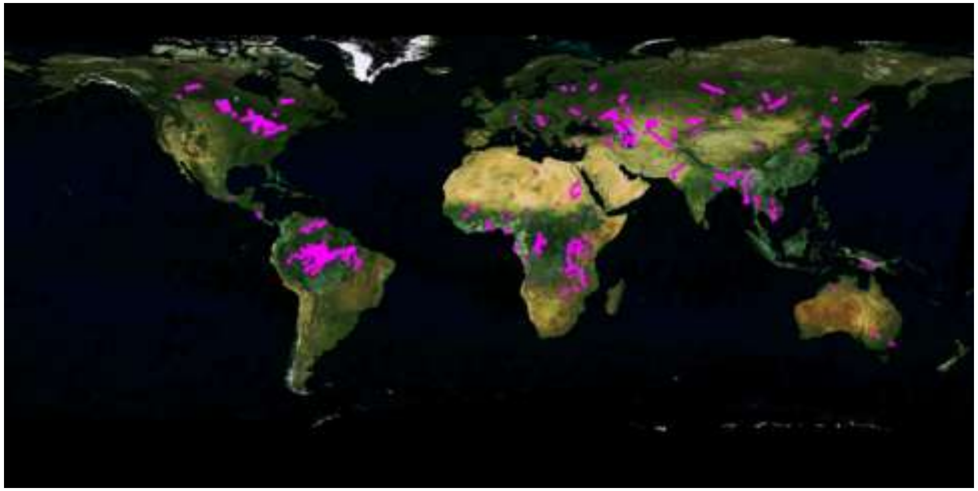
Major environmental problems in lakes and reservoirs

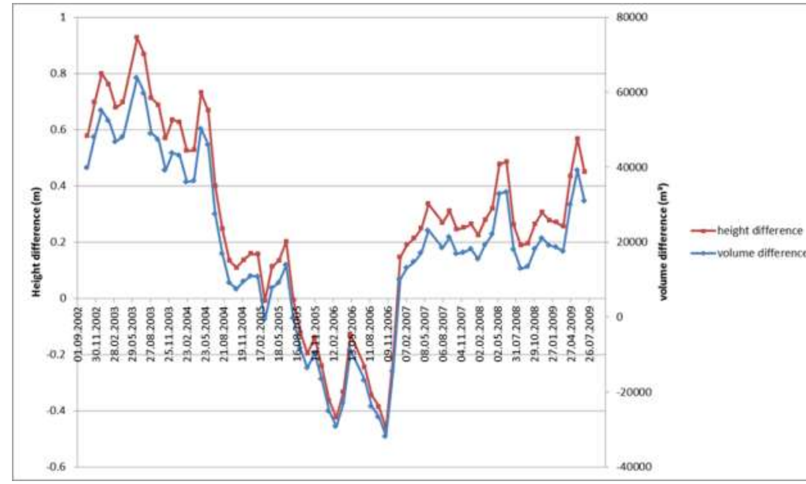


After UNEP

Water Quantity: Water Level



Coverage of RLH products, Rivers and Lakes Project

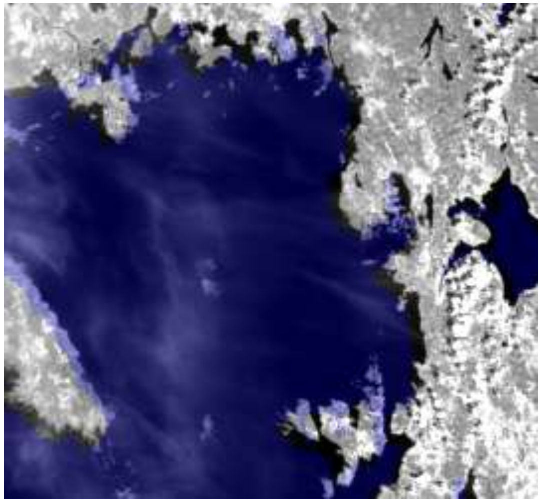


Time series Lake Victoria for the parameters height difference (red) and volume difference (blue)

- CFI Product, easy readable
- Information provided: time, height difference to reference, volume difference
- Quality unknown → QC needs to be developed, implemented and tested
- Lack of coverage in Northern Europe

Water Quantity: Extent

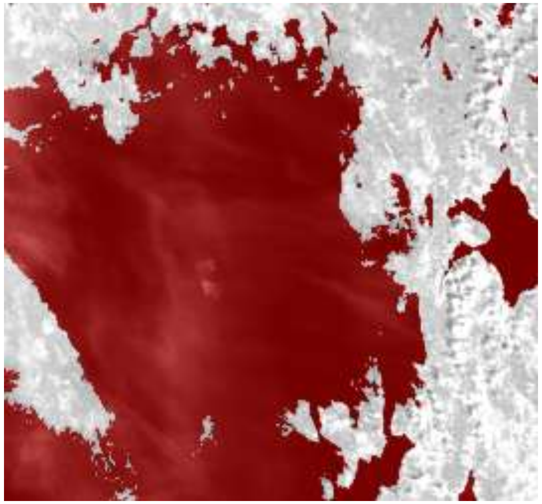
Standard Water Mask



MERIS tie point grid: GTOPO30 based,
AMORGOS precise geolocation not applicable

BEAM Processor: SRTM based,
AMORGOS improvements
taken into account

SAR Water Bodies

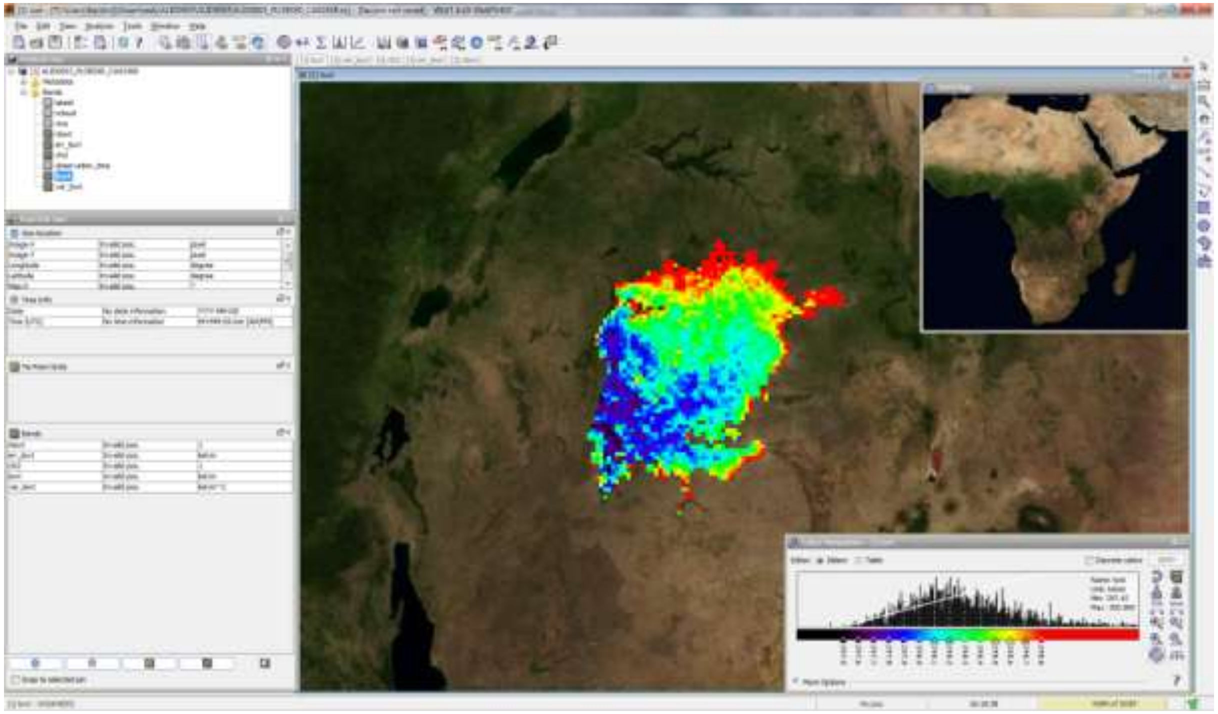


Water surfaces are temporal variable
In radar backscatter (wind induced
roughness)

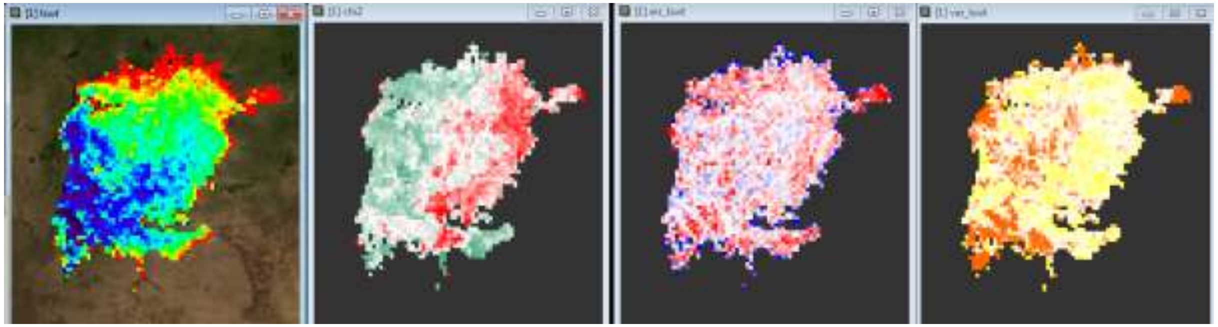
Analysis of ASAR WS full mission
Dataset

Original resolution: 150
Consolidated product at 300m,
matching MERIS FR

Lake Water Surface Temperature



LWST in BEAM

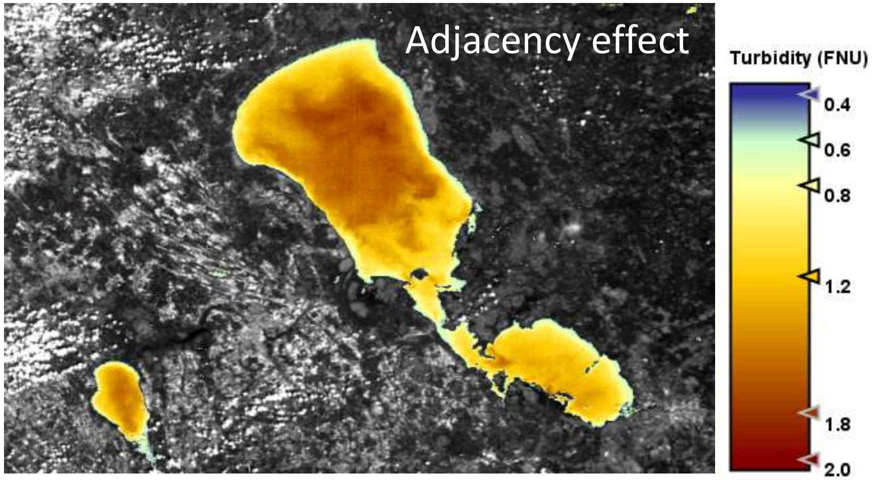


Example for LSWT, CHI2, ERR_LSWT, VAR_LSWT, Lake Victoria

Provisional Inland Waters Processing Chain

1. Subsetting (childgen)
2. Geometric Correction (AMORGOS)
3. Radiometric correction (BEAM Smile Correction, Calibration)
4. Land-water masking (SAR Water Bodies or SRTM)
5. Cloud screening (BEAM IdePix + temporal filter + more?)
6. Adjacency Correction (probably BEAM ICOL)
7. Atmospheric Correction (to be investigated)
8. Optical Water Type Classification (to be investigated)
9. Retrieval of Chl-a, TSM, YS, turbidity, Secchi Depth (to be investigated: CC, BEAM FUB-WeW, 2 or 3 band ratio algos, Case2R, Forward-NN …)
10. Collocation with CFI data: Water extent, height, Lake ST (ARC from AATSR)
11. Indicator 1: Spatial and temporal integration, change indicators (BEAM/Calvalus Mosaicing, Binning, BEAM time series tool)
12. Indicator 2: Combined Biodiversity Indicators Calculation (to be defined)
13. Map generation
14. Time series, Trend retrieval
15. QC

Atmospheric Correction over Water

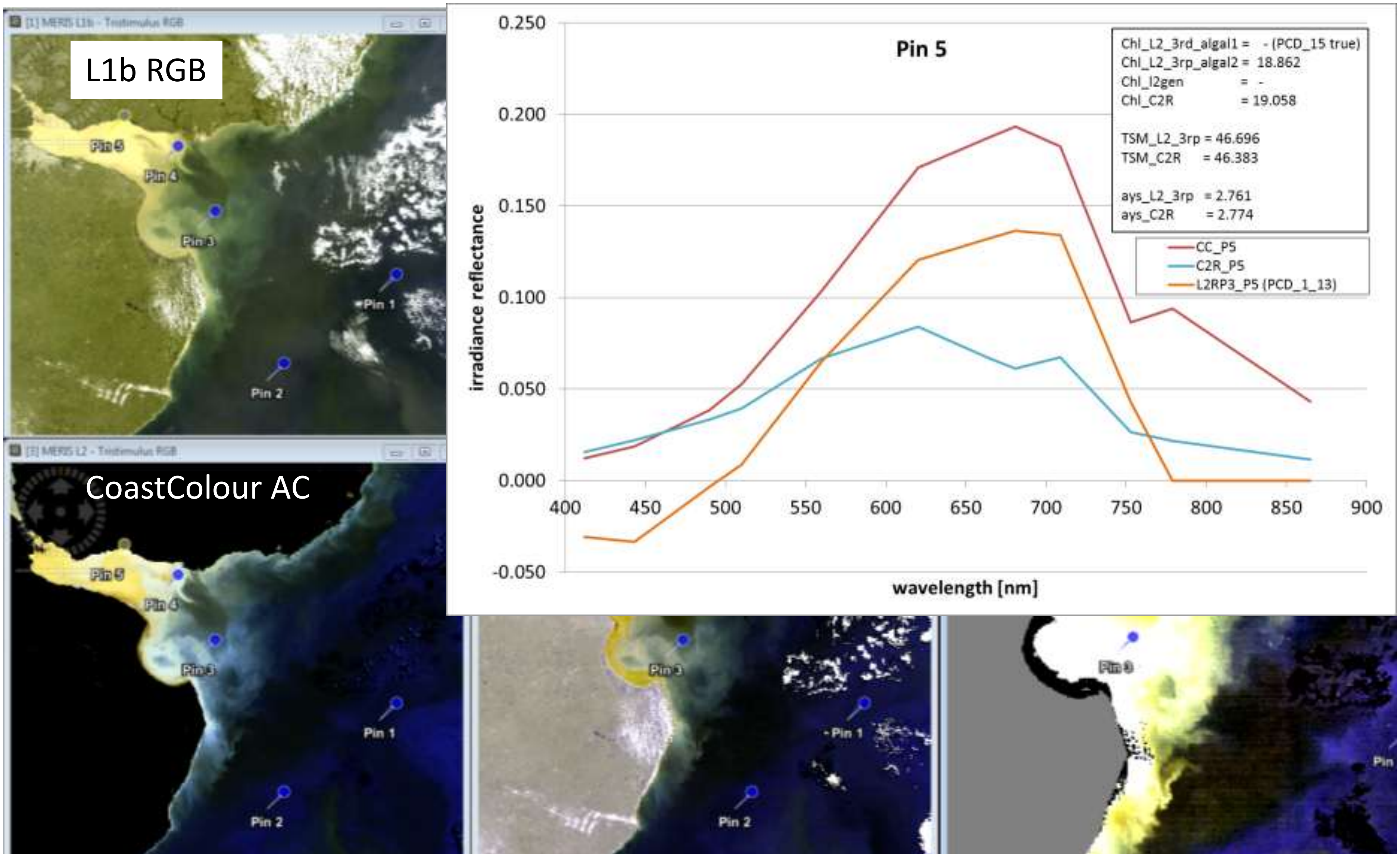


Turbidity, Lake Peipsi, Estonia

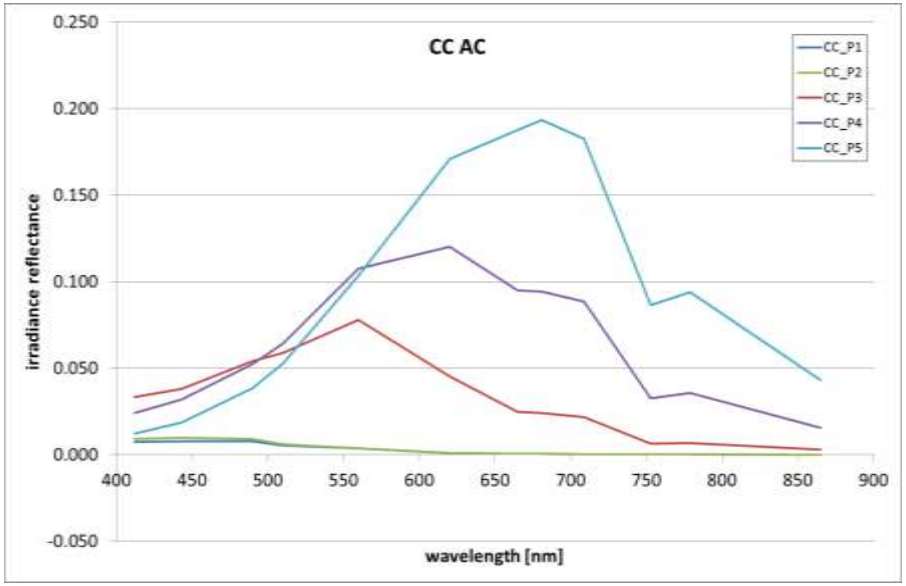
- Aerosol models are critical
  - CoastColour results
  - NASA mixture model
- Different technical approaches
  - CoastColour neural network
  - SeaDAS NIR/SWIR method
  - FUB NN inversion (correlations)
- Method intercomparison
  - Validation with Aeronet

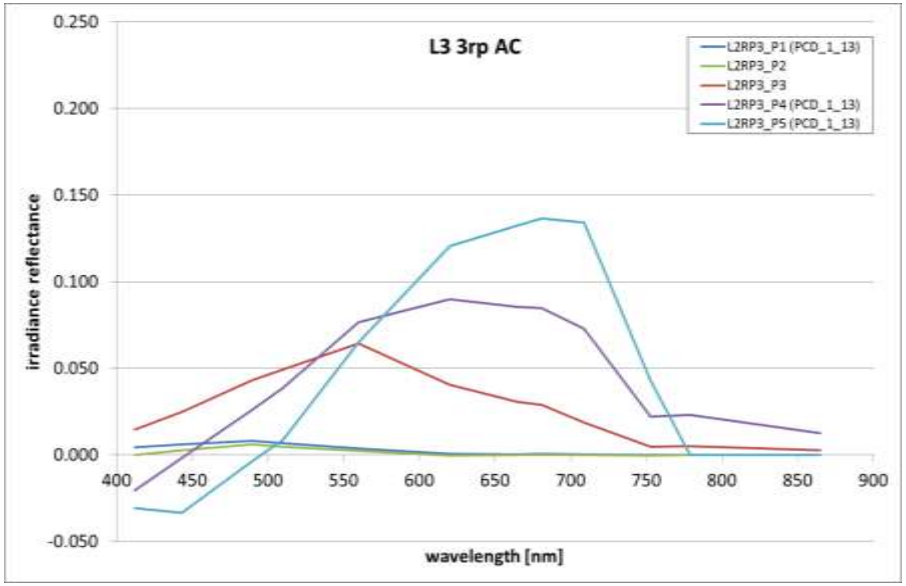
- Challenges:
  - Large range of aerosol types, including absorbing aerosols
  - Large range of aerosol optical thickness
  - Strong contrasts between land and water → adjacency effect
  - Shadowing effect of mountains
  - Surface reflexion of neighbourhood, especially from mountains
  - Water reflectance
    - CDOM dominated waters → very low signal in short wavelength bands
    - Sediment loaded waters → high reflection in the red – NIR
    - Eutrophic water → largely variable SIOPs across lakes
    - Bottom reflection

CoastColour AC: Rio de la Plata



Comparison CC – standard 3RP



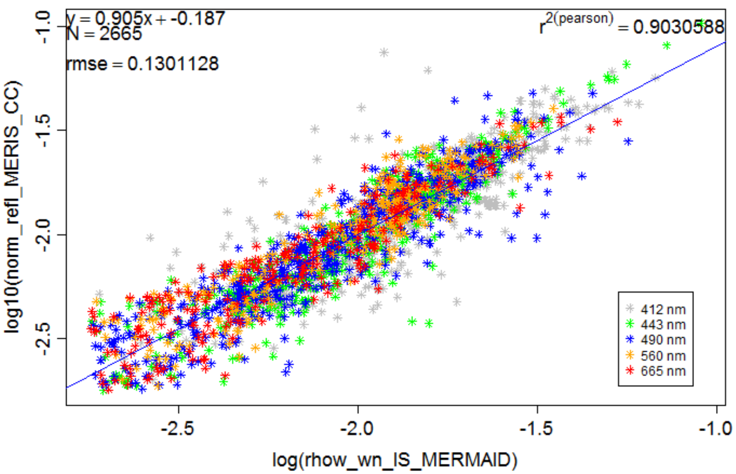


CoastColour AC Validation

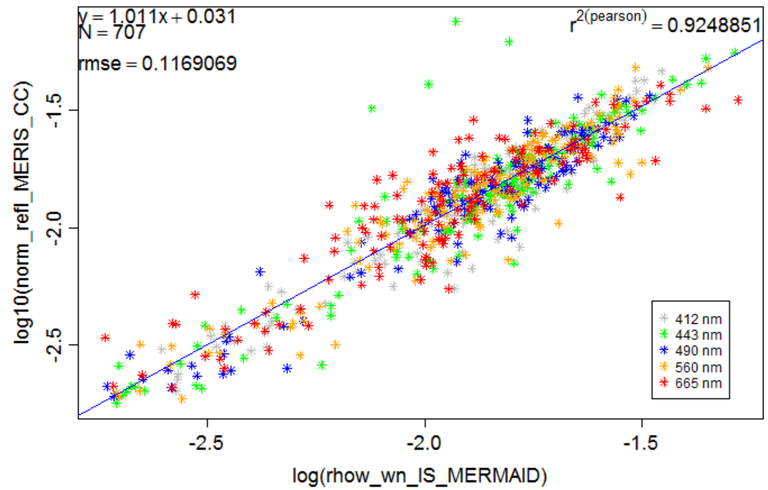
All MERMAID Samples

AAOT Northern Adriatic Sea

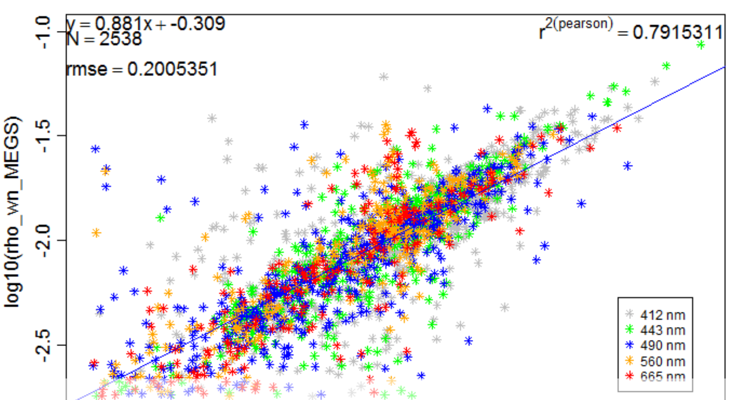
TOTAL RHO CCNN VS. IN SITU



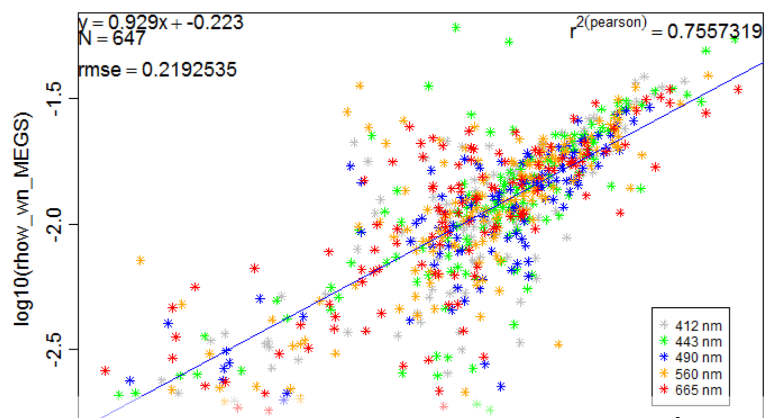
AAOT MERMAID-CCNN



TOTAL RHO MEGS VS. IN SITU



AAOT MERMAID-MEGS

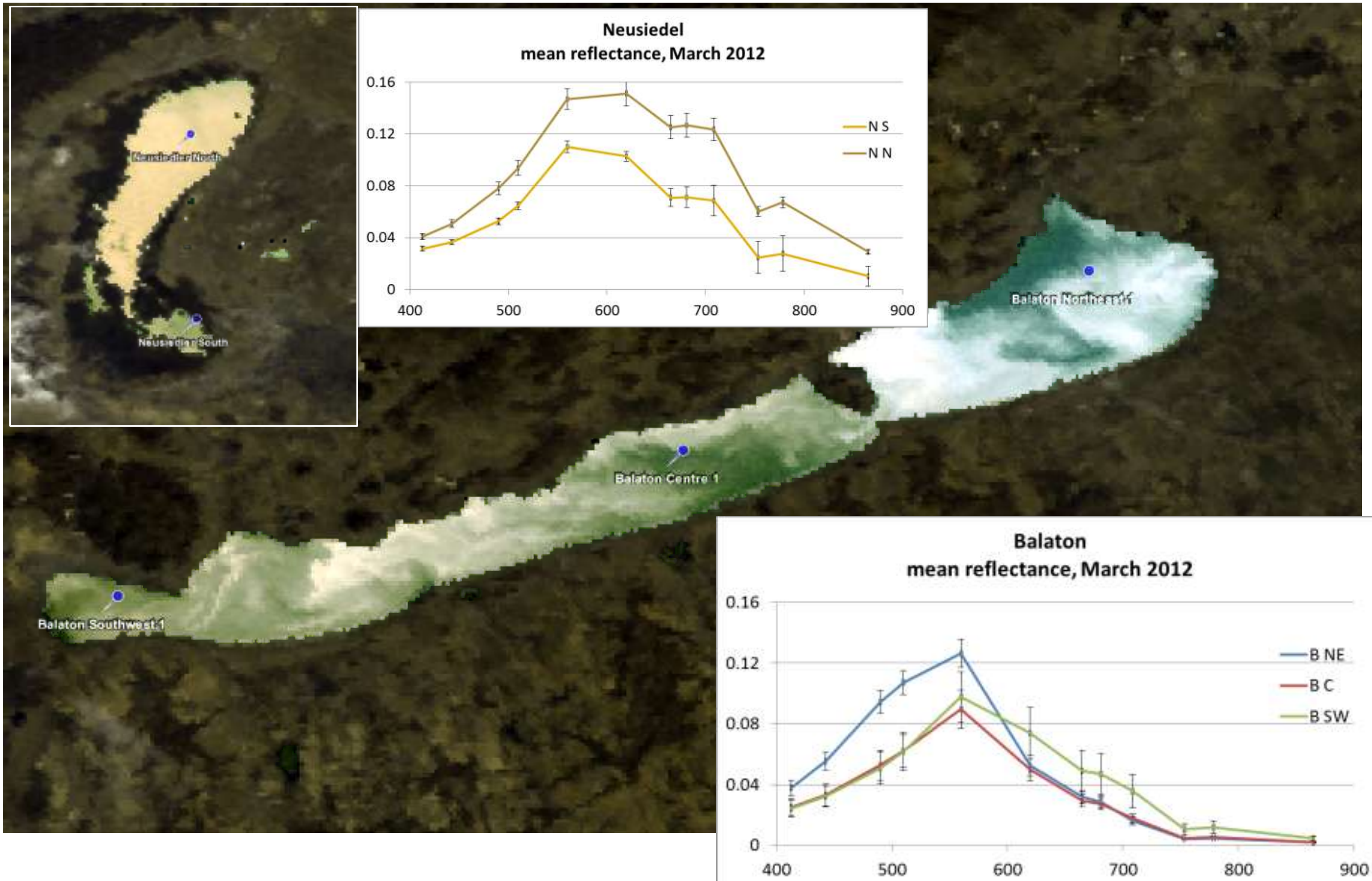


Acknowledgement to all MERMAID Pis for in-situ data (full list see hermes.acri.fr/mermaid) and ESA, ACRI-ST, ARGANS for access to the MERMAID system

diversity drylands

diversity inland waters

Lake Balaton



In-Water Retrieval

- Optical Water Type Classification
  - Potential to direct the algorithm (e.g. method selection, band selection, weighted merging, …)

- Inversion methods
  - General: Spectral matching by neural network (CoastColour, Case2R, FUB), LUT search (Mobley), PCA inversion (Neumann)
  - Specific: colour ratio, single band (e.g. for very high sediment loading)
  - Most critical: bio-optical model
    - Specific Inherent Optical Properties (e.g. Brando
    - Flexible component model (CoastColour: 5 components)

- Diversity requires fully automated procedures
  - Intercomparison of candidates over 10 lakes during experimental analysis
  - Candidates: CoastColour, FUB, red-NIR ratios, CDOM band ratios (pre-selection will be discussed this Thursday)

Indicators

- Absolute Indicators
  - “In-depths” lakes
  - Good characterisation available (SIOPs for WQ, LWST, height)
  - indicators based on absolute values

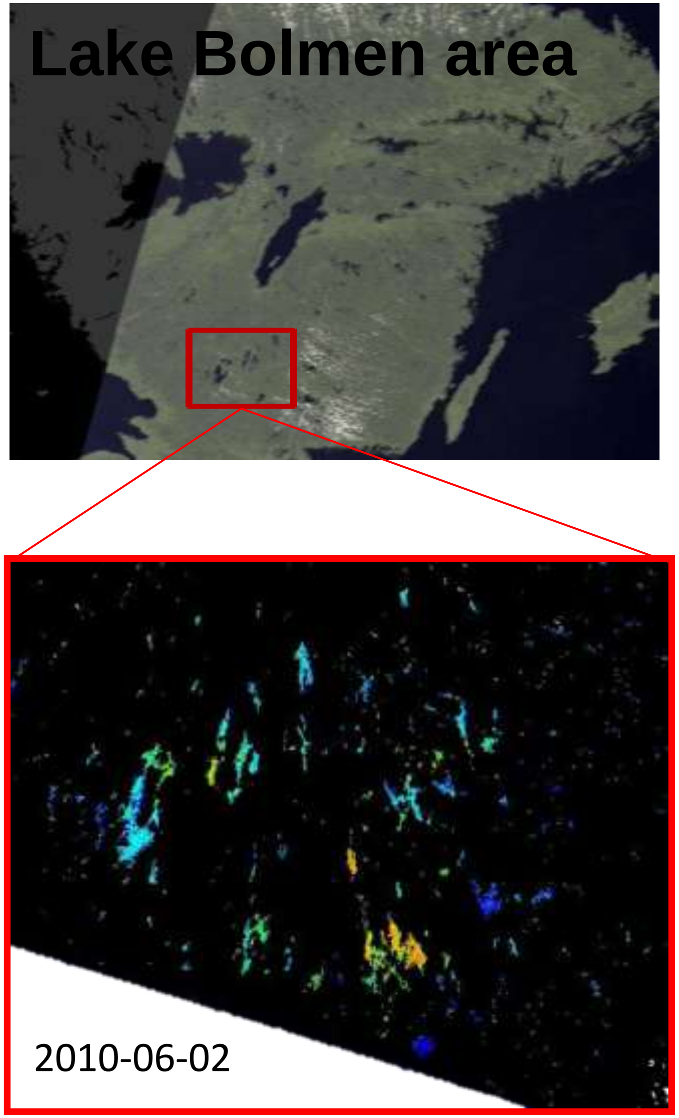
Lake Category	Chlorophyll (mg/m3)		Transparency (m)	
	Mean	Max	Mean	Min
Ultra-Oligotrophic	<1.0	<2.5	>12	>6
Oligotrophic	<2.5	<8.0	>6	>3
Mesotrophic	2.5-8	8-25	6-3	3-1.5
Eutrophic	8-25	25-75	3-1.5	1.5-0.7
Hypertrophic	>25	>75	<1.5	<0.7

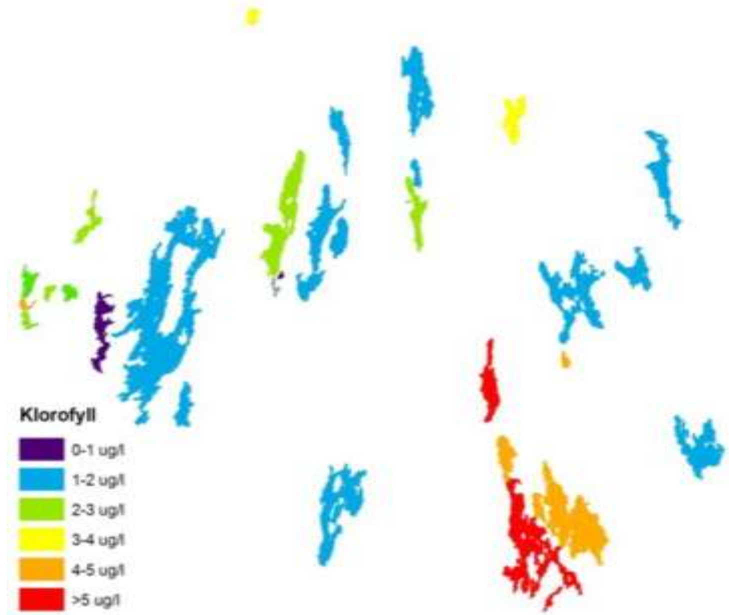
Lake	LakeStatus
Name	OL
Name	OL
Name	MESO
Name	MESO
Name	EU

- Relative Indicators
  - General approach, applicable to all lakes
  - Not sufficient in-situ characterisation available for absolute quantities
  - Indicators based on relative differences
  - Classification into “low – moderate – high” for each parameter possible
  - introduced uncertainty is assumed to be a bias → trends are reliable

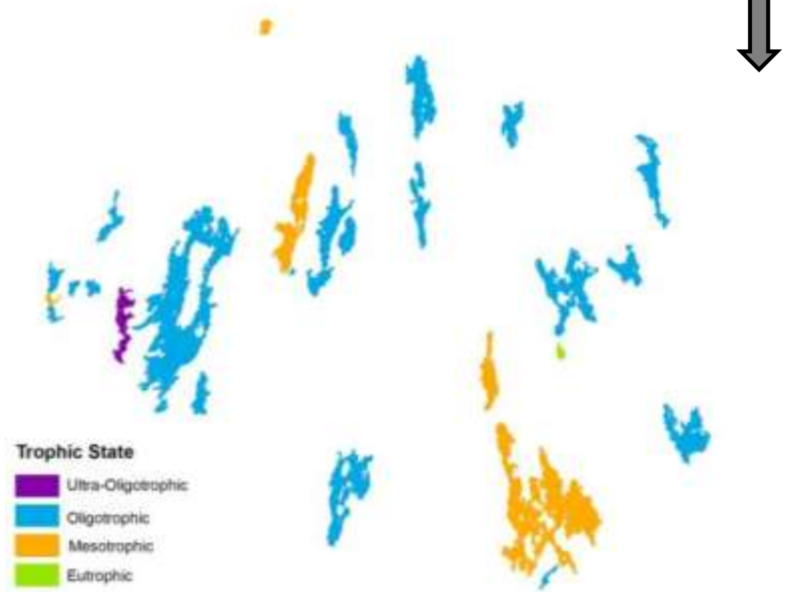
Lake	Chla Status	Secchi Depth Status
Name	Chla	SD
Name	Chla	SD
Name	Chla	SD
Name	Chla	
Name	Chla	SD
Name	Chla	SD
Name	Chla	SD
Name	Chla	SD
Name	Chla	SD

Chl a, July means, 2010-11





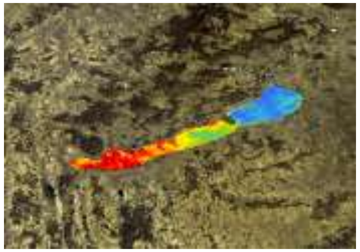
Trophic state classification



OECD, 1982

Inland Water Products

Water Quality



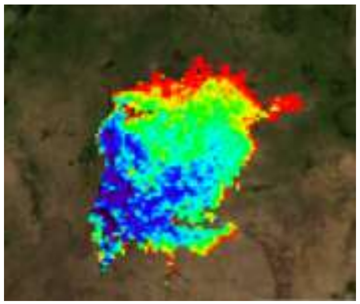
Water Constituents

Data source: MERIS Full Resolution

Parameters: Turbidity, Secchi Disk depth, chlorophyll-a concentration, suspended sediment concentration, yellow substance absorption; quality indicator; variance of parameter during averaging interval

Spatial resolution: 300m

Temporal averaging: daily / monthly / yearly (currently under discussion with users)



Lake Surface Water Temperature

Data source: AATSR (ARC Lake dataset)

Parameters: Lake Surface Water Temperature (LSWT), Uncertainty estimate for lake surface temperature, Chi-squared (goodness of fit measure for OE retrieval); Variance of LSWT over averaging period/area over averaging period/area

Spatial resolution: 0.05 degree grid / Lake-mean

Temporal averaging: None / Climatology / Timeseries

Water Quantity

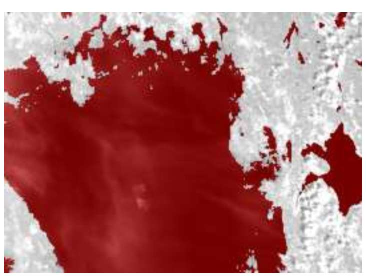
Water Level

Data source: Radar Altimeter (River and Lakes database)

Parameters: Water height difference to reference level, water volume difference

Spatial resolution: one or more points per lake (crossing points of altimeter tracks)

Temporal averaging: time series



Water Extent

Data source: ASAR WS (LC-CCI processing) + MERIS Full Resolution

Parameters: land-water mask

Spatial resolution: 300m

Temporal averaging: 1 map derived from 10 year time series; for some areas a seasonal climatology is available; temporal variability from combination with optical data

Inland Water Products

Inland Water Products

Indicators: First level indicators

First level indicators are derived from the basic parameters above by spatial and temporal aggregation in order to indicate trends.

Parameter	Indicator for
Chla	Eutrophication
TSM	Physical disturbance
Yellow Substance	Contamination
Turbidity	Physical disturbance and/or contamination
Secchi Depth	Physical disturbance and/or contamination
Temperature	Eutrophication
Volume and extend	Physical disturbance, rain fall

Map/Indicator	Derived from	Classification
Mean <Parameter> Epoch 1	Mean from period 2004-S2006	Low, moderate, high parameter concentrations/transparency
Mean <Parameter> Epoch 2	Mean from period 2007 – 2009	Low, moderate, high parameter concentrations/transparency
Mean <Parameter>Epoch 3	Mean from period 2010-2012	Low, moderate, high parameter concentrations/transparency
Lake Status	Classification	Poor, moderate, high status
Trend <Parameter> Epoch 1/2	Mean(2004-2006)/ Mean(2007-2009)	0-0.8 = negative diversity trend (NegDiv) 0.8-1.2 = No change (NoChange) 1.2+ = positive diversity trend (PosDiv)
Trend <Parameter> Epoch 2/3	Mean (2007-2009)/ Mean (2010-2012)	0-0.8 = negative diversity trend (NegDiv) 0.8-1.2 = No change (NoChange) 1.2+ = positive diversity trend (PosDiv)
Trend <Parameter> Epoch 1/3	Mean (2004-2006)/ Mean (2010-2012)	0-0.8 = negative diversity trend (NegDiv) 0.8-1.2 = No change (NoChange) 1.2+ = positive diversity trend (PosDiv)
Lake Trend	T1 and T2	POS, NEG, STABLE, UNCERTAIN

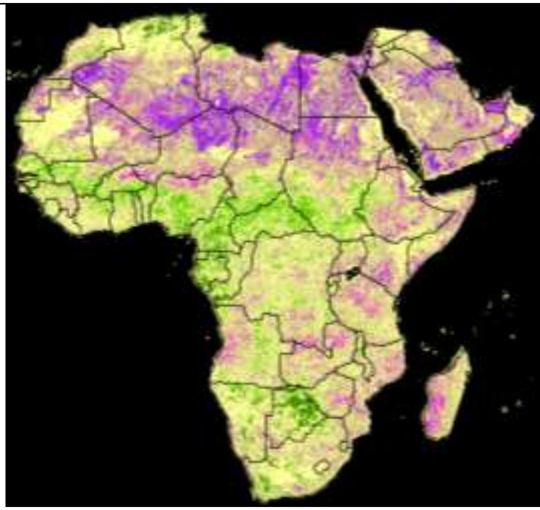
Indicators: Second level indicators

Second level indicators combine several of the above water quality and water quantity parameters, complement them with additional information such as land use, and derive a value added product that relates to biodiversity data. These second level indicators will be defined and developed during the first phase of the project.

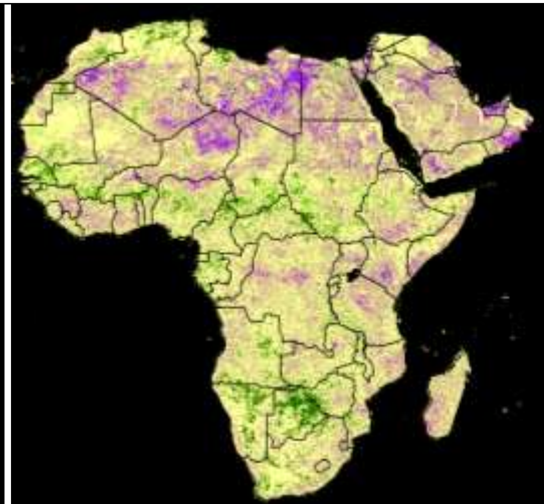
Dryland Algorithms

- Atmospheric correction
  - LandCover CCI algorithm (Round Robin result)
- EO based dryland vegetation condition assessments
  - NPP through green biomass approximated by MERIS NDVI
    - Linkage to heritage datasets from AVHRR
  - NPP through fAPAR
    - Better relationship to NPP
  - Studying relationship to SVAT model results
- Link between NPP and RUE proxies and biomass
- Combined Biodiversity Indicators in Drylands

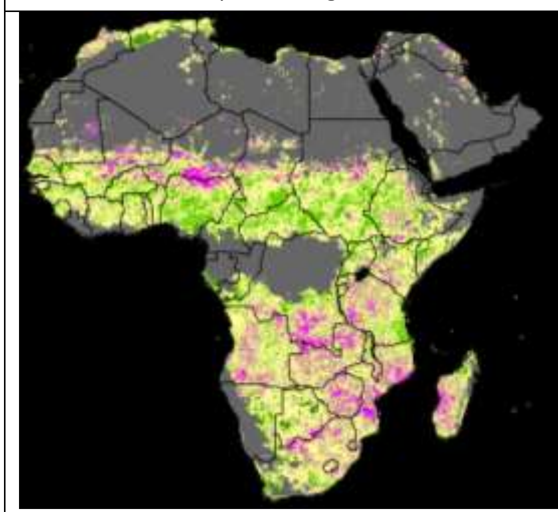
NDVI trend and residual trend



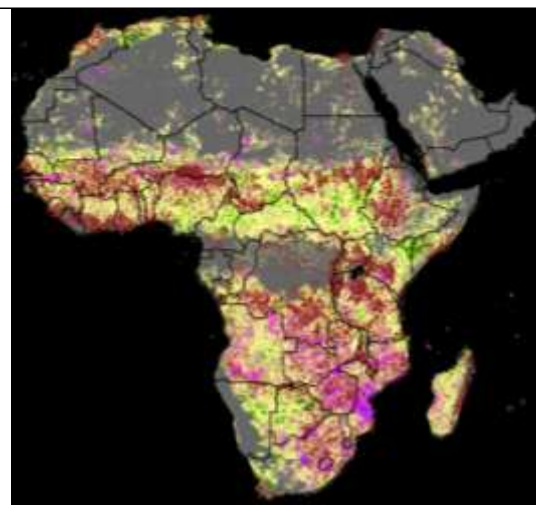
(a) Trend of NDVI 93-00/07-09, based on calendar year averages



(b) Trend of NDVI 93-00/07-09, based on biggest 6-month NDVI Sum (93-00)



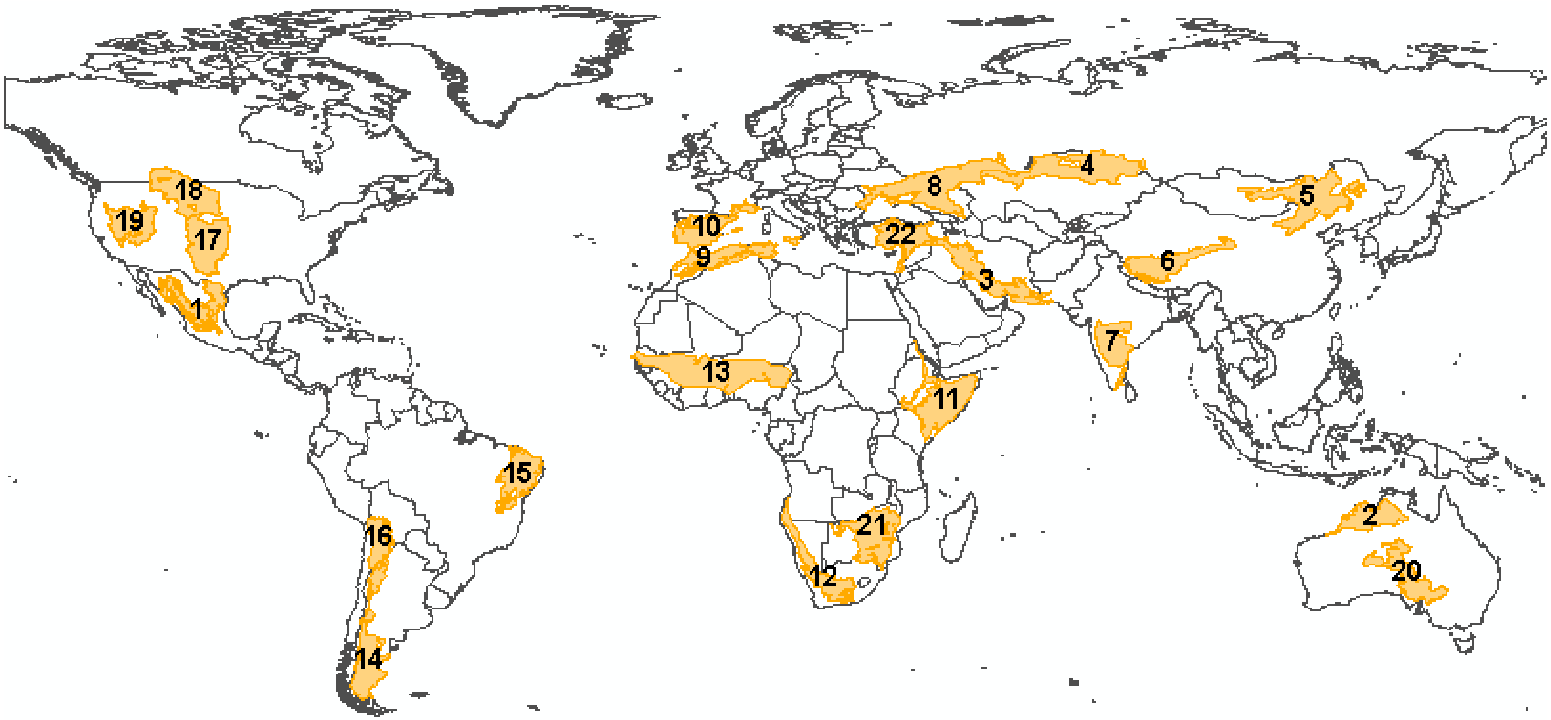
(c) Trend of NDVI-SWI residuals 93-00/07-09, based on calendar year averages



(d) Trend of NDVI-SWI residuals 93-00/07-09, based on calendar year averages with superimposed MARS crop mask of Africa (V2.2) – crops shown in a brown tone

Pearson r SWI-NDVI < 0.2	
Increase < signif. Pearson r	
Increase slope > 0.5	
Increase slope 0.25 - 0.5	
Increase slope < 0.25	
Decrease slope < 0.25	
Decrease slope 0.25 - 0.5	
Decrease slope > 0.5	
Decrease < signif. Pearson r	

Dryland test sites



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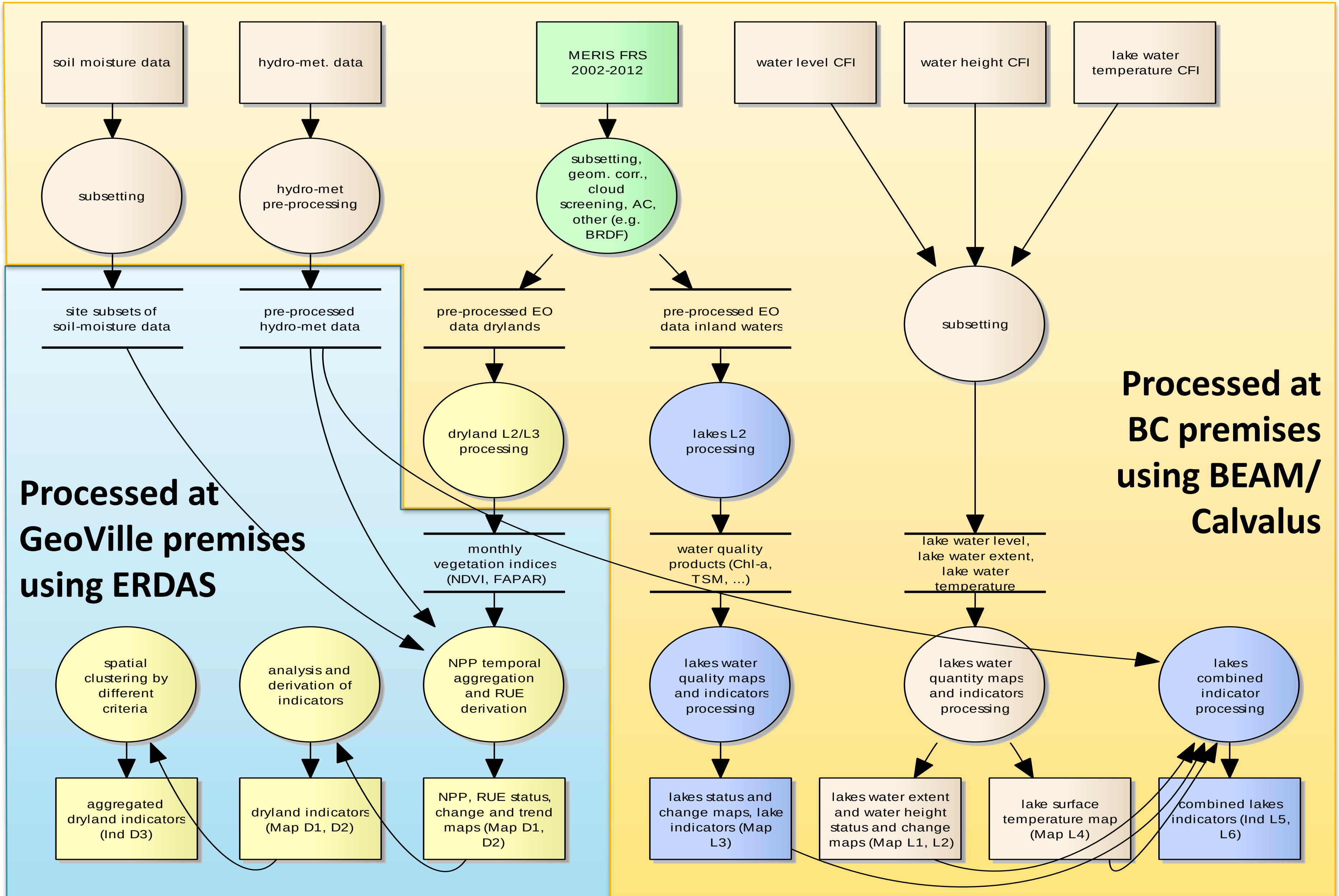
6. Preparing the future

Processing Graph



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Validation Strategy

1. Methodology / Protocols
   - Preprocessing: reference to literature (GlobCover) and other projects (LC-CCI, Globalbedo); verification on samples
   - Inland water
     - Match-up analysis, satellite intercomparison
     - radiometry: MVT / MERMAID protocol
     - IOPs, concentrations: MVT / MERMAID / MERIS Lakes protocols
   - Drylands
     - Fluxnet data
   - Combined biodiversity Indicators
     - Relating production to biodiversity databases
2. In-depth validation
   - 10 lakes with high quality in-situ data available
   - 5 dryland sites
3. Full product set
   - Cooperation with and feedback from users

Validation Plan

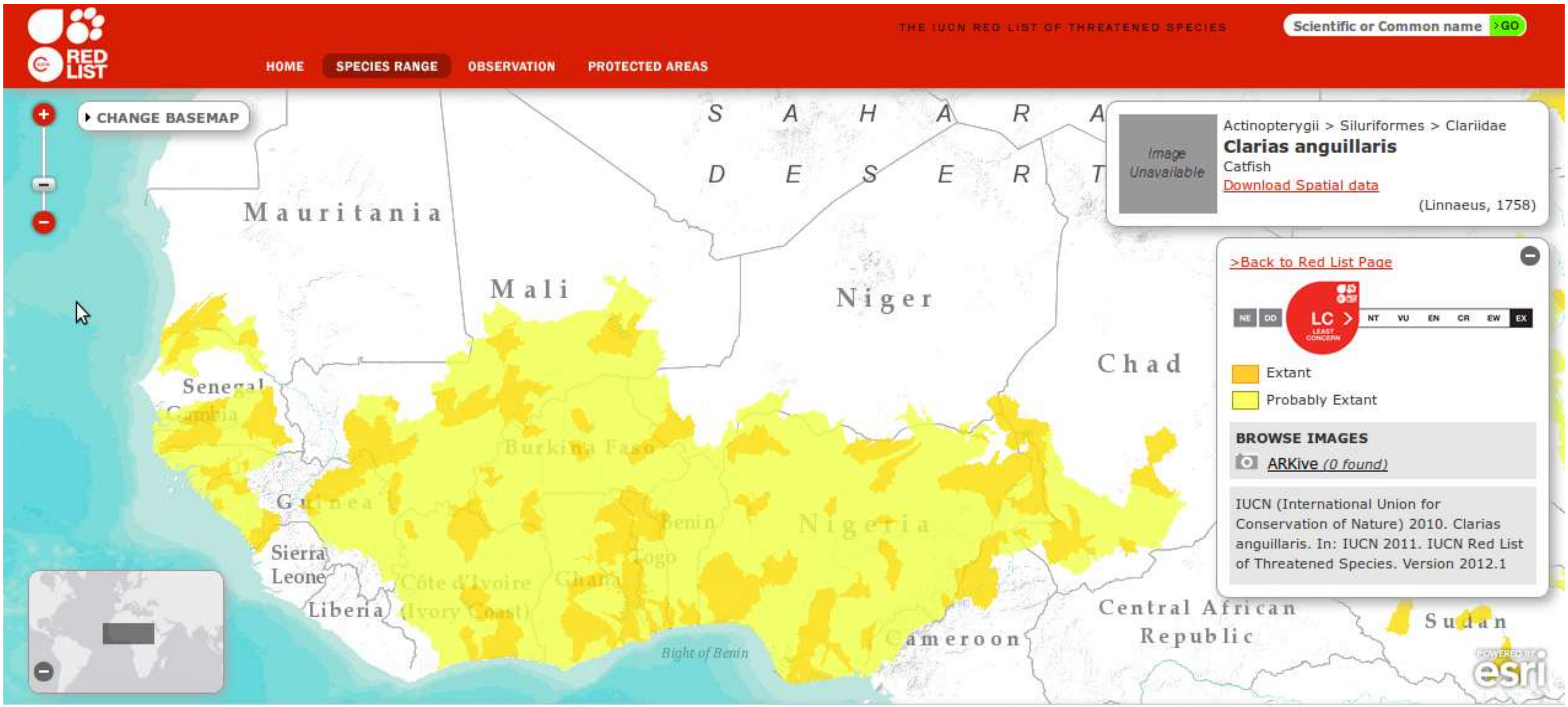
			Algorithm validation				in-depth validation		full product set validation				
	0	2	4	6	8	10	12	14	16	18	20	22	24
	KO					CDR		QAR			SDR		FR
Pre-processing													
Geometry			BC (literature, sample verification)						BC (sample verification)				
Atm. Corr.			BC (LC-CCI, sample verification.)						BC (sample verification)				
Geobiochem. processing													
in water (abs, scatt, …)			BG + BC + Consultants (comparison with simulated and in-situ)				BG + BC + Consultants (comp. w. in-situ)		BG (sample verification.)				
dryland (NDVI, fAPAR, …)			BC + Geoville (literature, verification)				BC + Geoville		BC (sample verification.)				
Indicators I (status, change)													
Chl, transpar.			BG + BC + CIBIO (comp. w. in-situ)				BG + BC + Cons + CIBIO (comp. w. in-situ)		CIBIO + users (user assessment)				
NPP, RUE			Geoville + consultants + CIBIO (comp. w. ref. data)				Geoville + consultants + CIBIO (comp. w. ref. data: rainfall from ECMWF, soil moisture from TU Vienna)		CIBIO + users (user assessment)				
Indicators II													
combined lakes indicators.			CIBIO (plausibility checks)				CIBIO (Chl or PP vers. num spec. from biodiv. databases)		CIBIO + users (user assessment)				
aggregated dryland indicators.			CIBIO (plausibility checks)				CIBIO (NPP vers. Num spec. from biodiv. databases)		CIBIO + users (user assessment)				

Provisional List of Validation Sites (Inland Waters)

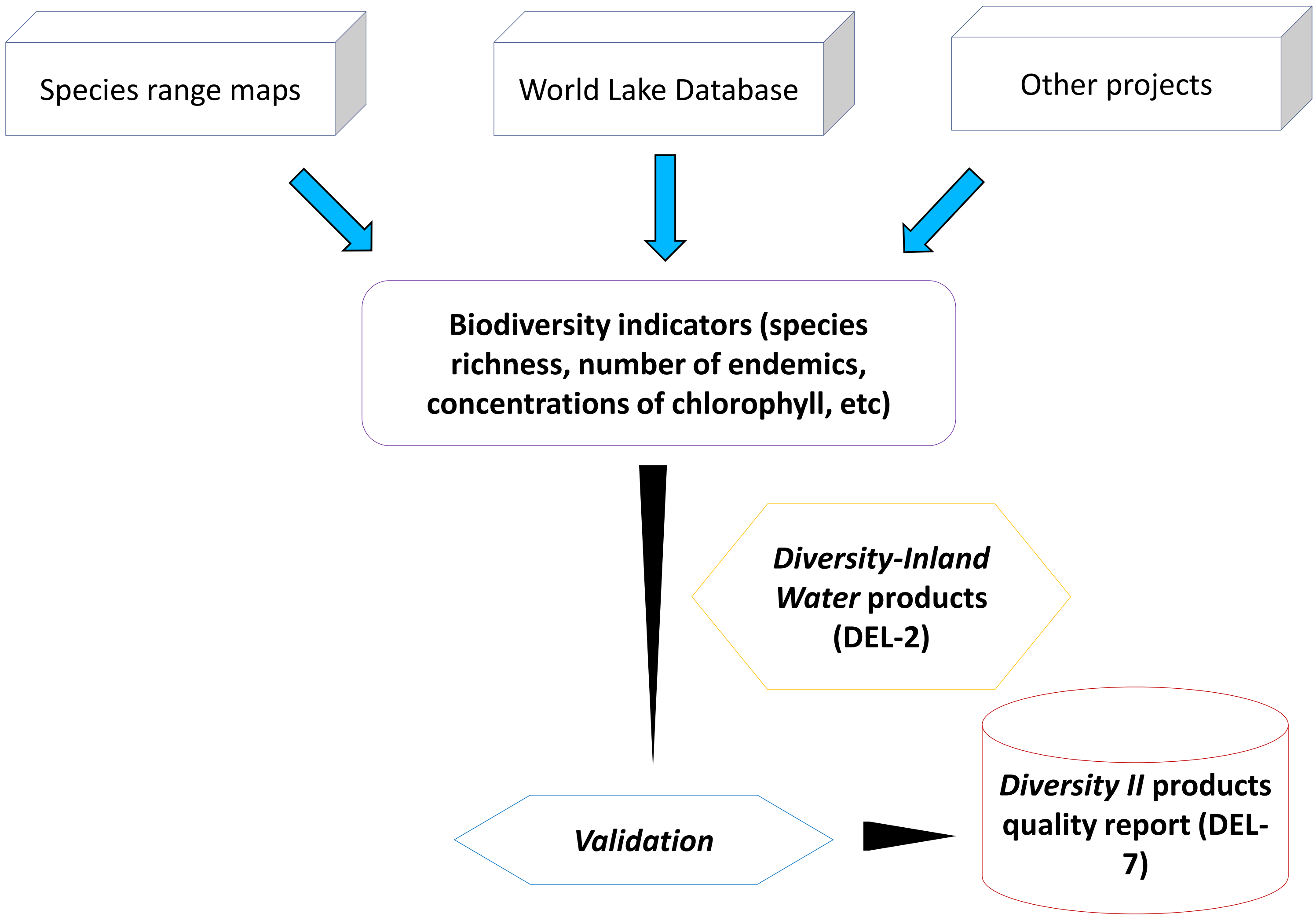
Lake	Country	biodiversity priority	ARC lake	size / km²	expert	in-situ data availability
Alexandrina	Australia	-	x	570	Arnold Dekker, CSIRO	AOPs, IOPs, concentrations (tbc) (+SIOPs for algorithm calibration tbc)
Balaton	Hungary	x	x	590	worldlakes database	chl concentration
Constance	Austria, Switzerland, Germany	-	x	540	FP7 Freshmon project (BC being participant)	AOPs, IOPs, concentrations (+SIOPs for algorithm calibration)
Erie	Canada, USA	x	x	25 657	Steve Grebb (consultant)	IOPs, concentrations (AOPs and SIOPs tbc)
Inari	Finland	-	x	1050	Sampsa Koponen, SYKE (consultant)	AOPs, IOPs, concentrations
Mälaren	Sweden	-	x	1140	Petra Philipson (team)	AOPs, IOPs, concentrations (+SIOPs for algorithm calibration)
Michigan	USA	x	x	58 000	Steve Grebb (consultant)	Concentrations, probably also AOPs, IOPS and SIOPs
Nicaragua	Nicaragua	-	x	8150	Dr. S. Spitzy, Univ. Hamburg (CoastColour)	Concentrations
Orivesi	Finland	-	x	600	Sampsa Koponen, SYKE (consultant)	AOPs, IOPs, concentrations
Päijänne	Finland	-	x	1090	Sampsa Koponen, SYKE (consultant)	AOPs, IOPs, concentrations
Peipsi	Estonia, Russia	-	x	3500	Anu Reinart, Tartu Observatory	AOPs, IOPs, concentrations (+SIOPs for algorithm calibration)
Pielinen	Finland	-	x	850	Sampsa Koponen, SYKE (consultant)	AOPs, IOPs, concentrations
Tanganyika	Burundi, Tanzania, …	x	x	32600	Steef Peters, IVM World lakes DB	Concentrations
Titcaca	Bolivia, Peru	x	x	8372	ESA (tbc) World lakes DB	From WB project (tbc)
Vänern	Sweden	-	x	5650	Petra Philipson (team)	AOPs, IOPs, concentrations (+SIOPs for algorithm calibration)
Vättern	Sweden	-	x	1910	Petra Philipson (team)	AOPs, IOPs, concentrations
Victoria	Kenya, Tanzania, Uganda	-		68460	Kai Sorensen, NIVA (consultant)	AOPs, IOPs, concentrations
Winnebago	USA	-	x	557	Steve Grebb (consultant)	Concentrations, tbc: AOPs, IOPS and SIOPs

Inland Water Products Validation

Species range maps from International Union for Conservation of Nature (IUCN)



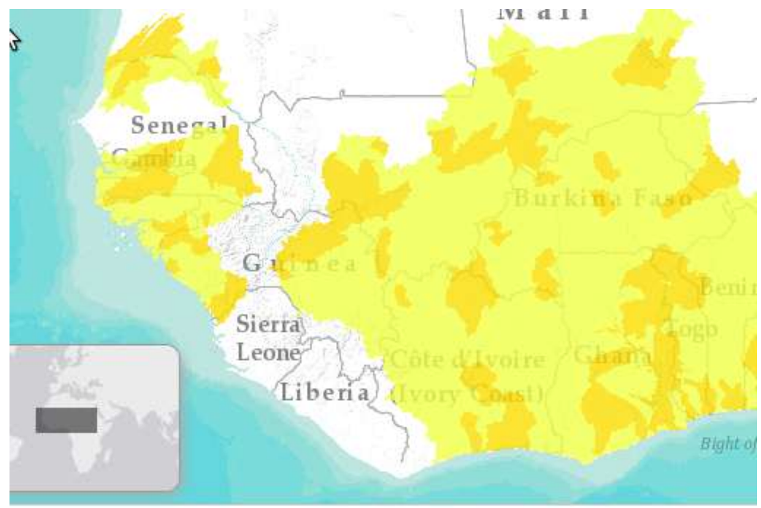
Inland Water Products Validation



Validation: Issues to be addressed

- Changes/trends indicators: species data unavailable
- Coarse diversity data: IUCN range polygons
- Available databases: Fishbase, Global Biodiversity Information Facility (GBIF), National Atlases

IUCN range polygons



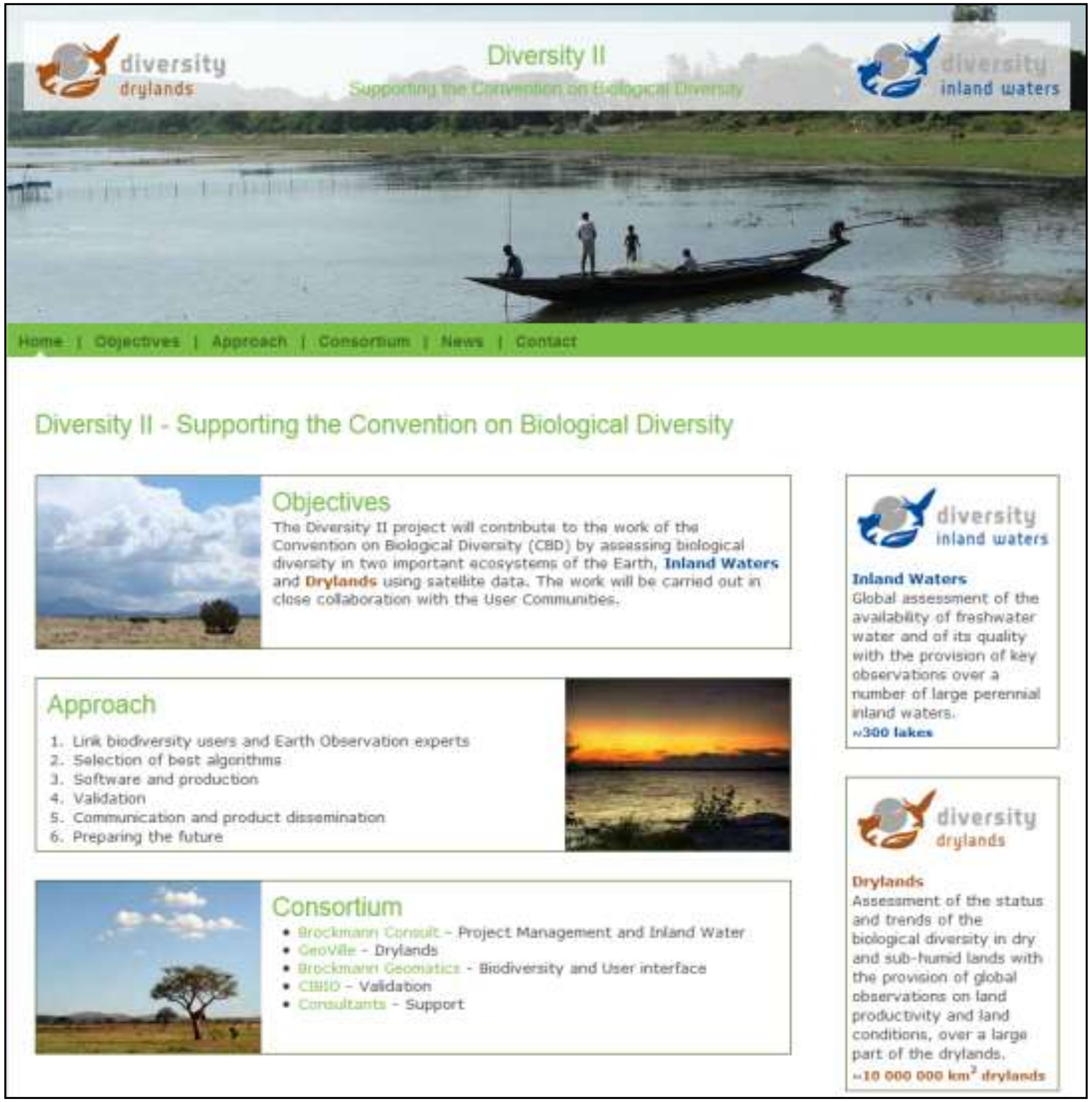
The 6 cornerstones of our Approach

1. Link biodiversity users and EO experts
2. Selection of best algorithms
3. Software and production
4. Validation
5. Communication and product dissemination
6. Preparing the future

User Interaction Means

www.diversity2.info

- Web Portal
  - Project Information
  - Algorithms and Products
  - Validation results
  - Online handbook
  - Biodiversity stories
  - Web GIS (ArcGIS Server)
- Support ESA at COP 11 and 12
- Promotional events
- Participation in conferences



The 6 cornerstones of our Approach

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Sustainability – 2020 is the goal!

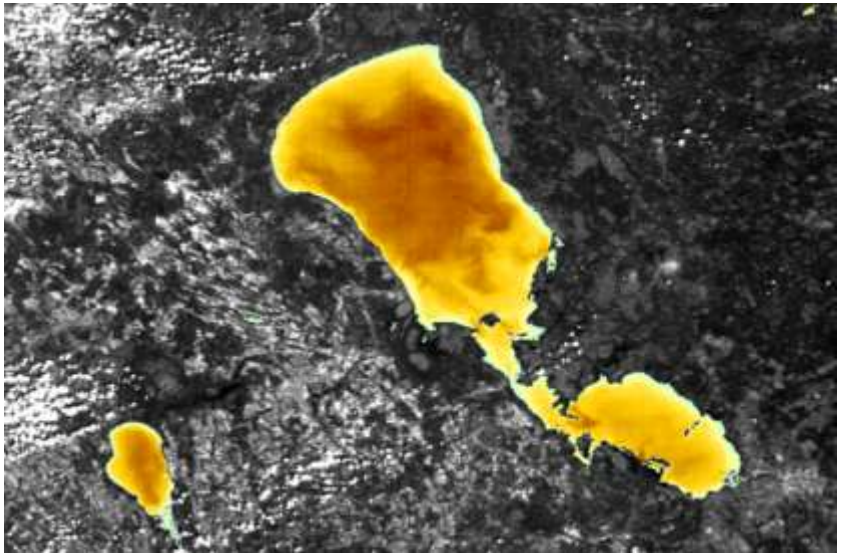
- Sentinel 2 and 3 potential
- Proba-V
  - Proba-V and SYN branch of S3; complementarity
- Cost – benefit analysis
  - Preparing a sustainable continuation in order to support CBD strategic plan until 2020
  - Costs of operational production
  - User assessment
- Enlarging the user group
- Service continuation
  - NPP VIIRS to bridge to S3
  - OCM2?
- Recommendations for additional R&D work

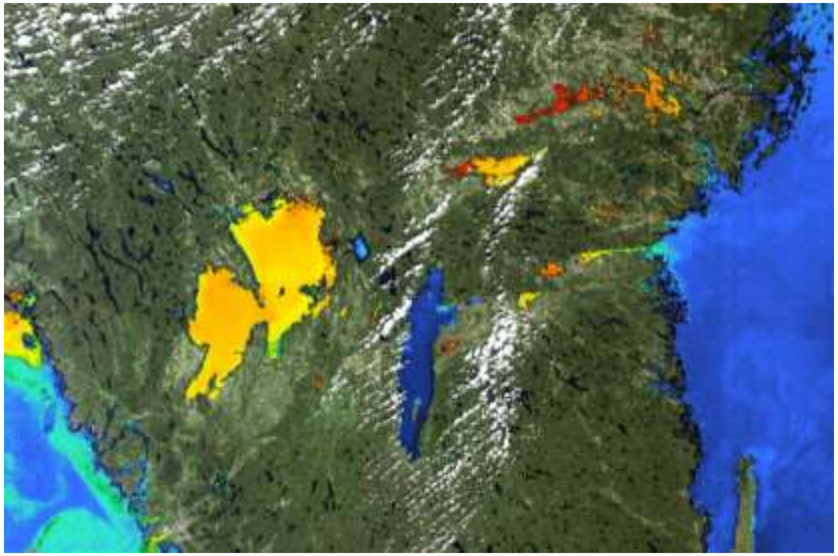
Milestones

- Kick-off: September 2012
- March 2013: Preliminary selection of algorithms
- June 2013:
  - Proof of concept: validation on 10 lakes and 3 dryland sites
  - User Consultation Meeting
- October 2013:
  - Processing chain ready
  - In-depth validation
- February/March 2013: User Consultation Meeting
- April 2014
  - Production ready
  - User handbook (biodiversity stories)
  - Quality assessment by users
- August 2014 project finish

Link with GloboLakes

- Frequent, mutual exchange of information, advice, recommendations
- EO data algorithms, SW, products: Diversity ←→ GloboLakes
- In-situ data, validation: GloboLakes ←→ Diversity





Diversity Meeting, Stirling

Thursday 13.12.2012

09:00	Welcome & logistics	Brockmann, Tyler
09:10	Tour de Table	all
09:15	Diversity II short overview	Brockmann
09:25	GloboLakes, summary of WS	Tyler
09:45	**Users and User Requirements**	
09:45	User Work Plan	Philipson
10:00	Requirements engineering (RB TOC, Questionnaire etc)	Brockmann
10:15	Requirements for Swedish Lakes	Philipson
10:25	*Break*	
10:50	GEO Inland water WG, North American Lakes	Greb
11:10	Dryland users	Brito
11:30	other user presentations	tbd
11:45	Discussion	
12:25	**Lunch**	
13:25	**Algorithms (ATBD)**	
13:25	Algorithms and processing overview	Brockmann
13:35	Preprocessing	Stelzer
14:20	Lakes AC	Odermatt
14:35	Lakes processing	Odermatt, Philipson
15:05	Break	
15:25	Land AC	Brockmann
15:35	Drylands processing	Gangkofner
16:20	Indicators	Philipson, Fensholt?, Brito?
16:40	Discussion	
	Preliminary site selection review	
17:10	Inland water site	Odermatt, Brockmann
17:25	Dryland sites	Gangkofner
17:10	Production	Fomferra

diversity drylands

Team & Key People

diversity inland waters

esa

Brockmann Consult GmbH

GeoVille Information Systems

Brockmann Geomatics Sweden AB

CIBIO Centro de Investigação em Biodiversidade e Recursos Genéticos

Consultants


Sampsa Koponen


Kai Sörensen


Steve Greb


Kurt Günther


Rasmus Fensholt