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Contents

Abstract

This document provides an overall summary of the work done in the CCN-1 extension of BalticAIMS project and its main results. Further details are available in the deliverables of each WP. Those are available through the project web pages https://www.syke.fi/projects/BalticAIMS under section Workplan and Deliverables.

Glossary

CCN	*Contract Change Notification*
CMEMS	*Copernicus Marine Environment Monitoring Service*
EO	*Earth Observation*
GIS	*Geographic Information System*
HELCOM	*Helsinki Commission*
MSFD	*Marine Strategy Framework Directive*
MSP	*Maritime Spatial Planning*
OGC	*Open Geospatial Consortium*
PC	*Principal Component*
SAR	*Synthetic Aperture Radar*
SID	*Sea Ice Drift*
WFD	*Water Framework Directive*
WP	*Work Package*

1 Introduction

European directives such as the Water Framework Directive (WFD) and Marine Strategy Directive (MSFD) require member states to reach good ecological status in their coastal and inland waters. In the Baltic Sea this goal has not yet been achieved. To help reach this goal the first phase of the BalticAIMS project (2021 - 2023) developed a prototype system where various diverse data sources (Earth Observation, models, in situ) were processed into analysis ready data and made accessible via several user interfaces. Stakeholders found value in the integrated thematic data collection, the ease of access and the usefulness of simple "look and explore" access as well as sophisticated programmatic interfaces and OGC services.

The Roadmap created during the first phase (Final Report available here) included large-scale and long-term visionary aspects but also small and medium term evolutions which can be put in place rather easily. The purpose of this project extension (2024-2026) was to continue the development of the system and demonstrate new services through additional user stories and use cases. The system is still a prototype, but the work done in the extension widened the thematic scope, completeness, and countries covered. For example, Klaipeda University (KU) joined the team as a new partner to facilitate interaction with the user community in Lithuania and to expand the services towards the Curonian Lagoon. In addition to the above ESA requested the team to include tasks for Finnish Meteorological Institute (FMI) with an objective to further develop and provide of a demo sea ice monitoring service based on the use of ICEYE SAR data.

The work package (WP) structure and logic of the extension is shown in Figure 1. The following chapters provide information about the objectives, actions, and results of each work package. Further details are in the deliverables available through the web pages of the project (https://www.syke.fi/projects/BalticAIMS) under section Workplan and Deliverables.

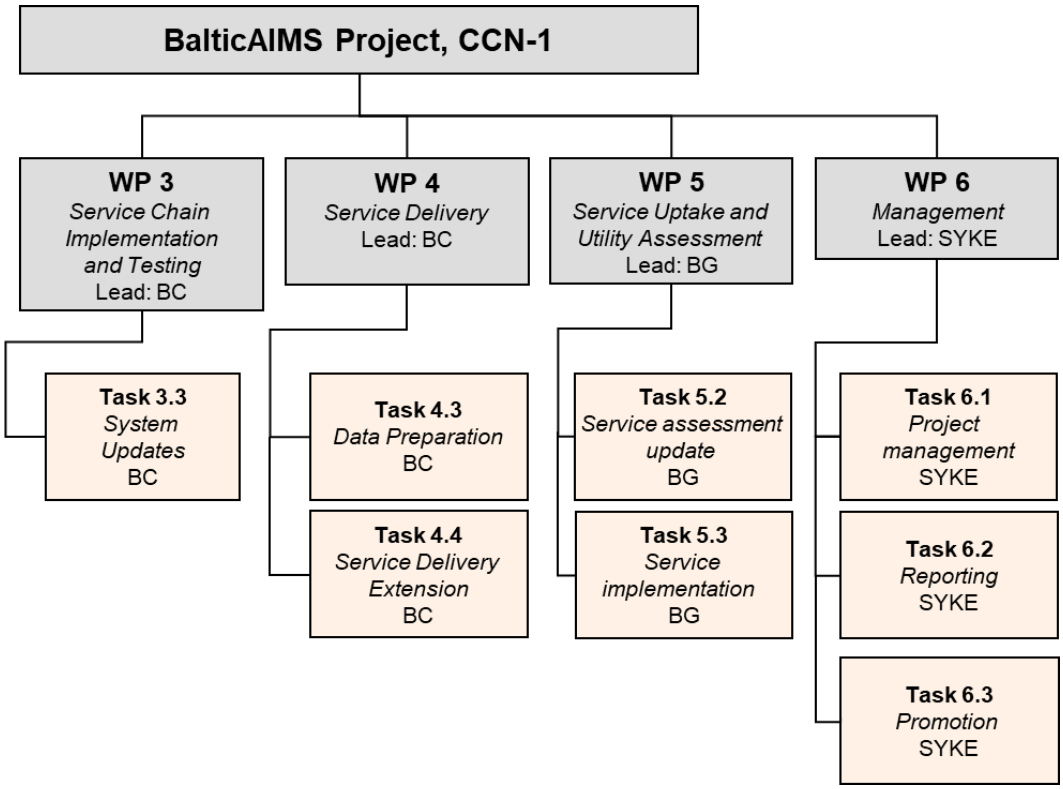

Figure 1. Work package structure of the Baltic+ BalticAIMS CCN-1 extension.

2 WP 3 Service Chain Implementation and Testing

2.1 Objectives

During CCN-1 the main objective of WP3 was to:

- Maintain and improve the capabilities of the service systems to enhance user experience.

In practice this meant:

- Implement the system updates defined in the CCN-1 proposal
- Develop and set up the ICEYE data flows for the sea ice service

2.2 Main results

The results are described in detail in deliverable **D3.3: Service System Update Report.**

Some of the technical developments took place during WP4 after the delivery of D3.3. Table 1 shows the end-of-project status of the development tasks mentioned in the CCN-1 proposal for the water monitoring theme while Table 2 shows the same for ice monitoring theme. Overall, the goals were reached well and Figure 2 shows the final system architecture of the water monitoring theme.

Table 1. WP3 development tasks for MSP and water quality monitoring themes.

Development task	Priority	Main partner	Status
Create a QGIS plug-in which will open datacubes	1	BC	Completed
Additional OGC interfaces (WMS with a time dimension)	1	BC	We concentrated on the xcube plug-in for QGIS which took more time than expected.
Create a set of demo JBNs	1	BC	Completed (to be updated upon user request)
Explore the option to create a specific tool “BalticAIMS” within a JupyterLab	3	BC	Not necessary
EO processing and analysis on cubes	1	BC	Completed (River Seine)
Tarkka development continuation	1	Syke	Completed
Make use of Analysis-part in Tarkka	1	Syke	Completed
Better linking of xcube for use in Tarkka to avoid current technical limitations.	3	Syke	Low priority, not implemented
Link to ESA’s Baltic cube developed for the ocean science community with the ESA DeepESDL project.	3	BC	Completed
Analyze the feasibility of transferring the system to Copernicus Dataspace Ecosystem (CDSE)	3	BC	The situation was analyzed, and the backend systems were transferred to DeepESDL due to better support for our operations.
Implement transfer to CDSE	3	BC	No longer foreseen (see above)

Table 2. WP3 development tasks for ice monitoring theme.

Development task	Priority	Main partner	Status / plan
Acquire ICEYE Scan mode and dwell mode images over the Baltic Sea test area	1	FMI	Completed
Apply multi-temporal data analysis to the ICEYE Scan mode data to estimate sea ice drift (SID) with FMI ice drift estimation algorithm	1	FMI	Completed
Study the use of SID quality in ice classification	1	FMI	Completed
Develop a neural network based ice classification method	1	FMI	Completed
Study the use of cross-correlations between the images with time gaps and the mapped images for sea ice detection and classification.	1	FMI	Completed
Compare the results with visual interpretation of the Baltic Sea ice charts and C-band SAR imagery from Radarsat-2, Sentinel-1 and Radarsat Constellation Mission (RCM).	1	FMI	Completed. The comparisons were mainly made with ice charts. C and X band imagery were also visually compared.
Study the use of multiple images with SID mapping for speckle filtering	1	FMI	Completed. This task was related to SCAN mode imagery segmentation and Dwell mode temporal filtering (first PC)
Analyze the use of ICEYE dwell mode data for extracting fine scale sea ice features and speckle filtering	1	FMI	Completed
Study the use of changing viewing angles during the Dwell mode imaging for improving sea ice detection, feature recognition and classification	1	FMI	Completed

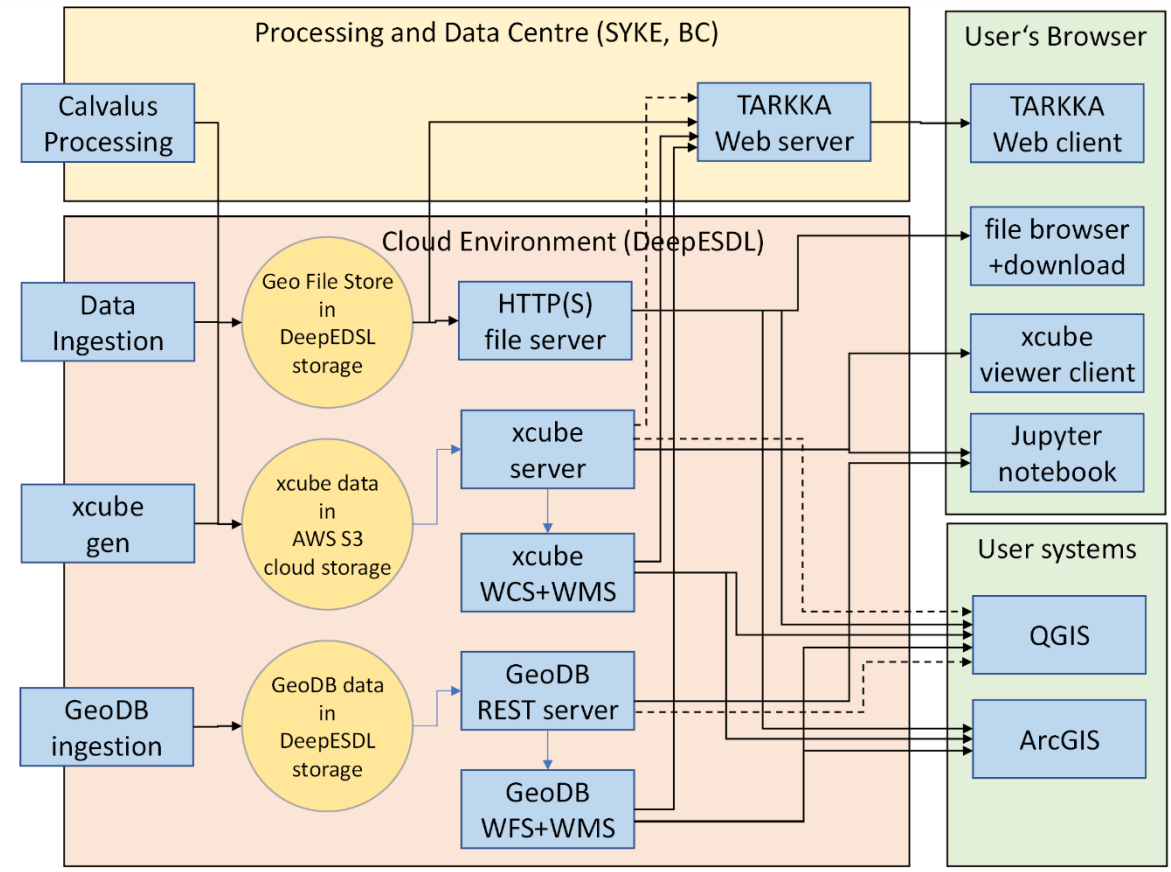

Figure 2. System architecture of BalticAIMS service system for the water theme.

3 WP 4 Service Delivery

3.1 Objectives

The main objectives of the WP were:

- Continue the service delivery
- Develop and demonstrate new use cases and user stories based on cases identified in the original project and new ones identified during the extension phase.

3.2 Main results

The results are described in detail in deliverable **D4.2 Service Operations and Service Chain Performance Report Update**. Table 3 shows the end-of-project status of the development tasks mentioned in the CCN-1 proposal for the water monitoring theme while Table 4 shows the same for the ice monitoring theme. In both themes the objectives were reached well.

Table 3. WP 4 tasks for MSP and water quality monitoring themes.

Development task	Priority	Main partners	Status
Continue the service delivery	1	BC, Syke	The services were available without major interruptions
Develop additional user stories	1	Syke, BC, KU	Completed. See Table 5 for more details

Table 4. WP 4 development tasks for ice monitoring theme.

Development task	Priority	Main partner	Status / plan
Review the current process of tasking Copernicus Contributing Missions (CCM) imagery for the operational ice charting, focusing on the Baltic Sea domain (image delivery and processing lead times etc.		FMI	Completed
Test the tools of SAR image tasking process (for example SaVoir software) and make a recommendation		FMI	Feasibility of SaVoir was briefly assessed, however the current workflow of ordering SAR images at FMI is not very compatible with such software.
Review the ordering process of ICEYE imagery and apply the lessons learned to both ICEYE data and other CCM data		FMI	Completed
Identify issues in image delivery to the ice charting, and other end users, and make improvements accordingly		FMI	Completed
Scale up the FMI operative chain if the increase in image volume requires it		FMI	Will be scaled according to the incoming data volumes, currently no need for scaling
Test making short videos or animations of consequent SAR images to illustrate visually the movement of ice		FMI	Completed
Develop an automated machine learning (ML) based approach to support the analyst who is drawing the ice map with a GIS tool		FMI	In plans, will require integration of all the Copernicus Marine Service product data to generate an initial polygon-wise automated ice analysis in the GIS-tool compatible format

Table 5. Showcases and their user stories (the ones implemented during the extension are in bold).

Show case	User Stories
A: Provide EO based information to be used in user legacy systems for spatial planning	
	A1: Material to support the review of MSP Plans
	A2: Human impact
	A3: Hotspots
B: Monitor the effects of nutrient flow from the drainage basin to the coastal waters	
	B1: Impact of agriculture
	B2: PLC subgroup
	B3: Monitoring of nutrient reduction measure
	B4: River load monitoring in Finland
	B5: Curonian Lagoon **B6: Seine River expansion**
C: Monitoring the impacts of coastal activities	
	C1: Dredging Helsinki
	C2: Water quality coastal Finland
	C3: HELCOM dredging & dumping
	C4: HELCOM human pressures
D: Combination of Coastal Zone mapping and CMEMS coastal water quality material	
	D1: Wind park
	D2: Aquaculture footprint
	D3: Coastal land use
E: Monitoring of temperature anomalies, upwelling & input of heat	
	E1: Helsinki city coastal water temperature
	E2: Climate change
	E3: Detection of marine heatwaves
F: Operational ICEYE for FMI ice service	
	See ICEYE section

4 WP 5 Service Uptake and Utility Assessment

4.1 Objectives

The main objective of the WP was:

- Document stakeholder feedback on the utility, performance levels and impact of the information delivered, and to explore solutions and actions for service implementation.

4.2 Main results

The results are described in detail in deliverable **D5.2: Service Utility Report Update**.

Table 6 shows the end-of-project status of the development tasks mentioned in the CCN-1 proposal for water monitoring theme while Table 7 shows the same for ice monitoring theme. The updated roadmap in D5.2 provides both short- and long-term steps toward a sustainable EO based service for the Baltic Sea.

Table 6. WP 5 tasks for MSP and water quality monitoring themes.

Development task	Priority	Main partner	Status
Assess the utility and impact of the new service provision architecture and extension of user stories and show cases	1	BG	Completed
Explore solutions for coordination and hosting of an operational service, actual service provision from 2026 and funding options	1	Syke	Completed
Organise an information and demonstration seminar for users and stakeholders to present the results	1	BG, Syke	At PM3 we decided to change the seminar to PowerPoint presentations published on the project website.

Table 7. WP 5 tasks for ice monitoring theme.

Development task	Priority*	Main partner	Status
Investigate the usage of ICEYE imagery in the operational ice charting	1	FMI	Completed. The ice monitoring service system is ready for operations once the issues related to the availability of data are solved.
Share the results with the ice charting community (ice services and International Ice Charting Working Group)	1	FMI	Presentation at the 26th IICWG

5 WP 6 Management

5.1 Objectives

The main objectives of the WP were:

- Manage the administrative, financial, and technical elements of the project including:
  - Organize meetings with ESA and stakeholders
  - Handle milestone payments
  - Quality control and deliver the deliverables and monthly progress reports
  - Create and maintain the project internal online working environment
- Coordinate the promotion of the project
  - Create and update the project website
  - Present the project at conferences and workshops

5.2 Main results

Table 8 shows the originally planned and actual meeting schedule of the project. In addition to these official review meetings the team held internal planning telecons at least once per month. The deliverables of the project are shown in Table 9 together with their delivery dates. At PM2 it was decided to invite stakeholders to the progress meetings so that they could comment on the results and plans directly. This caused some delays in the meeting schedule due to the need to factor in the availability of additional persons. Nevertheless, the participation of stakeholders had a positive effect on the meetings and by the end of the project the overall delay was small.

The webpage of the project (http://www.syke.fi/projects/BalticAIMS) was updated at the beginning of the extension and when the deliverables were published. The conference presentations included a poster at the Living Planet Symposium 2025 in Vienna and an oral presentation at the 26th meeting of the International Ice Charting Working Group (IICWG, Sep 22-26, 2025).

Table 8. Project meetings.

Meeting	Planned Date	Actual date
Kick-Off (KO) TC	KO+0	2024-08-30 (KO+0)
Progress Meeting 1 (PM1) TC	KO+3	2024-12-16 (KO+4)
PM2 TC	KO+6	2025-03-27 (KO+7)
Mid Term Review (MTR*) TC	KO+9	2025-06-10 (KO+10)
PM3* TC	KO+12	2025-11-10 (KO+15)
Service Operations Review (SOR*) TC	KO+15	2026-03-27 (KO+19)
Final Review (FR) TC	KO+18	2026-04-29 (KO+20)

* Stakeholder representatives were present.

Table 9. Project deliverables (see Table 8 for the event abbreviations).

Deliverable ID	Title	Review Event	Delivery to ESA (month/year)
D3.3	Service System Update Report	MTR	06/2025
D4.2	Service Operations and Service Chain Performance Update Report	SOR	03/2026
D5.2	Service Utility Report Update	FR	04/2026
FR	Final report	FR	04/2026