52north

exploring horizons

Annual Report 2019

New Concepts and Technologies for Spatial Information Infrastructures

Preface

We live in a time of change – shaped by global societal challenges and highly dynamic technology development – particularly in the area of information technologies. Climate change, for example, is an issue that concerns us all. Through systematic observation, measurements and data analysis, we can objectively describe these global changes and their consequences and predict further development. Data provides insights and thus supports both political decision making and the willingness of citizens, business and administration to rethink and break new ground. Understanding precedes change.

52°North's mission begins here. As a private non-profit research organization, 52°North contributes applied research and professional services to develop methods, technologies and innovative applications that unlock the value of geospatial data for analysis, planning and decision making in various application domains. We develop our goals and work topics in dialogue with the 52°North partner network in order to achieve maximum synergies in cooperation with research institutions, companies and public administration.

The 2019 annual report provides an overview of 52°North's activities over the course of the year. It serves as the basis for reviews by our Scientific and Technical Advisory Board and the shareholders' meeting, which concludes the annual review and planning cycle each spring.

In 2019, 52°North further intensified its research and development activities and focused on the core topics "Geospatial Sensing", "Efficient Processing" and "Data Analytics". The use of cloud technologies and near real-time data played an important role in this context.

We look forward to 2020, to exciting research and development projects and to the inspiring collaboration with our partners and customers.

Münster, December 13, 2019

Prof. Dr. Albert Remke *Prof. Dr. Andreas Wytzisk-Arens*

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About 52°North

Unlocking the Value of Geospatial Data

52°North was founded in 2006 as an initiative for geospatial open source software and has since developed towards a research and innovation organization. In alliance with its partner network, 52°North develops new concepts and technologies, e.g. for managing, sharing and exploiting geospatial sensor data, enabling efficient near real-time processing of large-scale Earth Observation data or extracting information from spatio-temporal data with geostatistical methods and machine learning techniques.

Most of our software developments and data collections are published under a Free and Open Source Software License. This facilitates collaboration and gives users maximum degrees of freedom to apply, adapt and redistribute the software and derivative works in any combination with other software.

Lon 7° 37' 34.086" (E)

Lat 51° 57' 38.394" (N)

Facts and Figures

REGISTERED NAME

52°North – Initiative for Geospatial Open Source Software GmbH

FOUNDED

September 2006

LEGAL STATUS

> Private limited company (GmbH)
> SME (Small and Medium -sized Enterprise)

SHAREHOLDERS

> University of Münster, Germany
> University of Twente, The Netherlands
> Esri LLC, Redlands, United States of America
> con terra GmbH, Münster, Germany

ASSOCIATED PARTNERS

> Technical University Dresden, Germany
> University of Applied Science Bochum, Germany
> ITZ.Bund, Ilmenau, Germany

MANAGEMENT

> Prof. Dr. Albert Remke
> Prof. Dr. Andreas Wytzisk-Arens

STAFF

24 data scientists, software engineers, business administration, trainees

17.6 full time equivalents

17 permanent contracts

REVENUES

1.2 M Euro in total

72% billable hours spent on research projects

28% billable hours spent on professional services

REGISTERED OFFICE

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T +49 251 396371-0, info@52north.org, https://52north.org

52°North Partner Network

Innovation through cooperation

52°North facilitates an open international network of partners from research, industry and public administration. These partners form a network of excellence on the cutting edge of technological developments in the GI domain. The initiative fosters innovation in Geoinformatics through a collaborative research and development (R&D) process, develops new concepts and technologies, and evaluates rising macro trends. 52°North contributes to the network's collaborative software development, much of which ensues from joint R&D activities. This opens up innovative business opportunities, competitive advantages and helps shorten ROI cycles. In 2019, the level of cooperation varied case by case from a focused technical collaboration to joint strategic campaigns.

con terra

con terra, IT.NRW and 52°North initiated the SenSituMon project for improving the automated large-scale monitoring of flooded areas. CDI@IT.NRW, a Copernicus Data Infrastructure at IT.NRW, is another joint project. It enables efficient processing of Copernicus satellite and in situ data. 52°North staff also contributed its expertise to a significant number of con terra's professional service projects. con terra and 52°North jointly contribute to regional professional networks such as the Geonetzwerk Münsterland and the GeoIT Round Table North Rhine-Westphalia (GeoIT RT-NRW) as well as the round table's Copernicus Relay.

Esri

52°North collaborates with Esri in the field of higher education and supports the EDC (Esri Development Center) activities of the University of Münster. Within the SenSituMon project, 52°North supported the development of a fully automated near real-time EO data processing and dissemination chain based on Docker, Kubernetes and Esri Technology. As part of Google's Summer of Code, 52°North mentored a student, who developed a new WPS client for ArcGIS Pro.

Hochschule Bochum (HSBO)

52°North finalized the prospective.Harvest project with HSBO. This project came up with new methods and technologies to support the predictive planning and control of cooperative agricultural processes. HSBO and 52°North also collaborate in the WaCoDiS project and jointly develop an architecture for implementing efficient Copernicus-based services for monitoring material inputs in watercourses and dams. To improve the processing and dissemination of aggregated statistical data municipalities, 52°North contributes to the KomMonitor project led by HSBO.

Institute for Geoinformatics (IfGI), University of Münster

In 2019, 52°North's collaboration with the Institute for Geoinformatics focused on education and mentoring. 52°North staff contributed to IfGI's bachelor and master programs modules, its summer school and the Mundus career days. In addition, 52°North supervised master theses and hosted IfGI interns within the scope of their external semester. IfGI strongly supported this year's 52°North Geospatial Sensing Conference by hosting the event.

ITC, University of Twente

52°North contributed to ITC's AfriAlliance project to better prepare Africa for climate change challenges and supported ITC'S ILWIS development in terms of testing and dissemination. 52°North also supervised ITC student master theses and hosted an ITC intern.

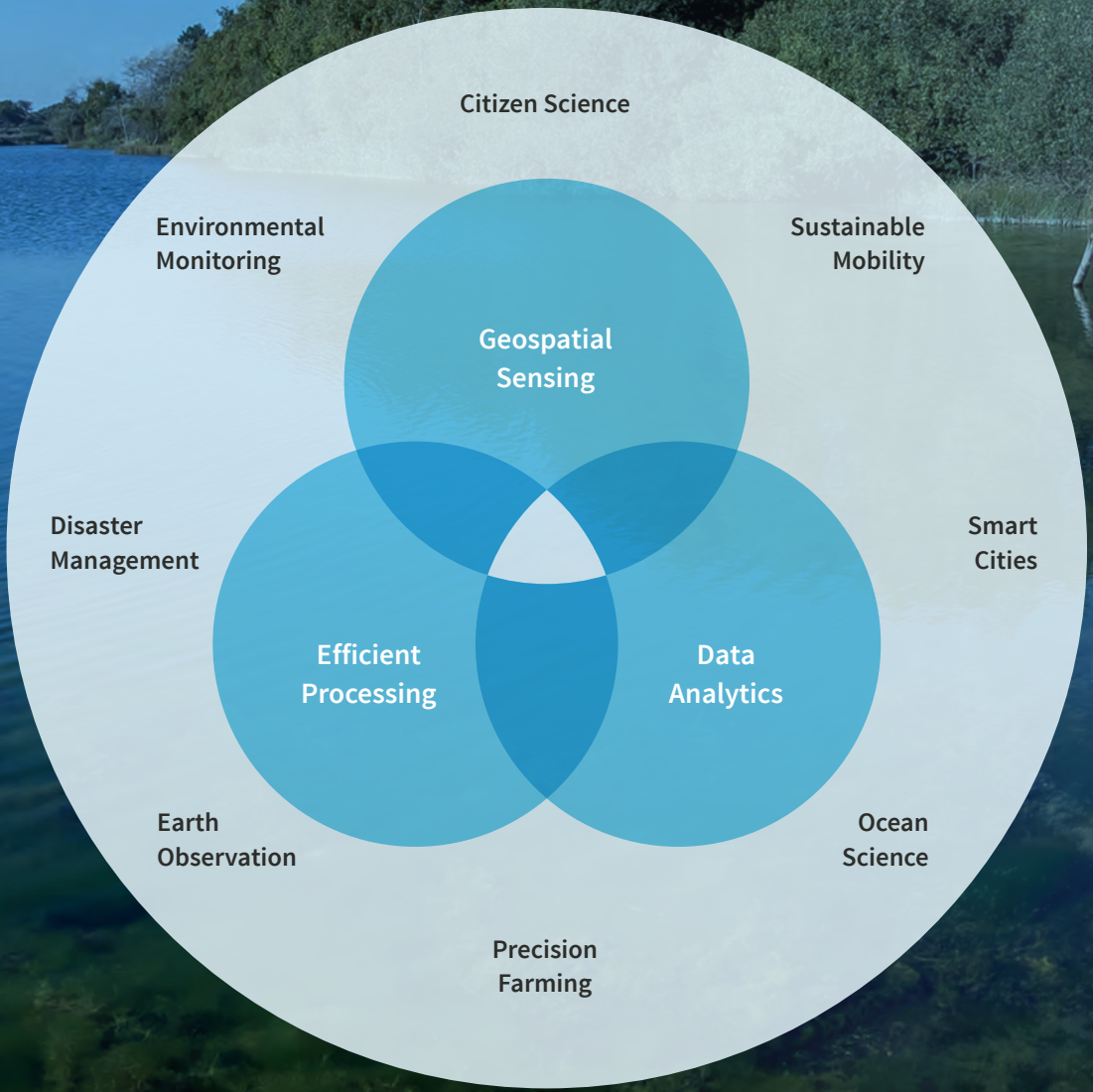
ITZ.Bund

ITZ.Bund is an associated partner of the WaCoDIS project and supports the project as an external expert. 52°North and ITZ.Bund currently share an interest in developing an event-driven architecture to support near-real time information flows at ITZ.Bund.

Technische Universität Dresden (TUD)

In order to enable a user-friendly and efficient visualization of spatio-temporal data available via the mCLOUD, 52°North and the TUD collaborated as partners in the mVIZ project. 52°North also contributed to the NFDI4Earth proposal, which is led by TUD. It aims to develop a national research data infrastructure for earth system sciences.

Research and Development



Advancing Spatial Information Infrastructures by innovating underlying methods and technologies

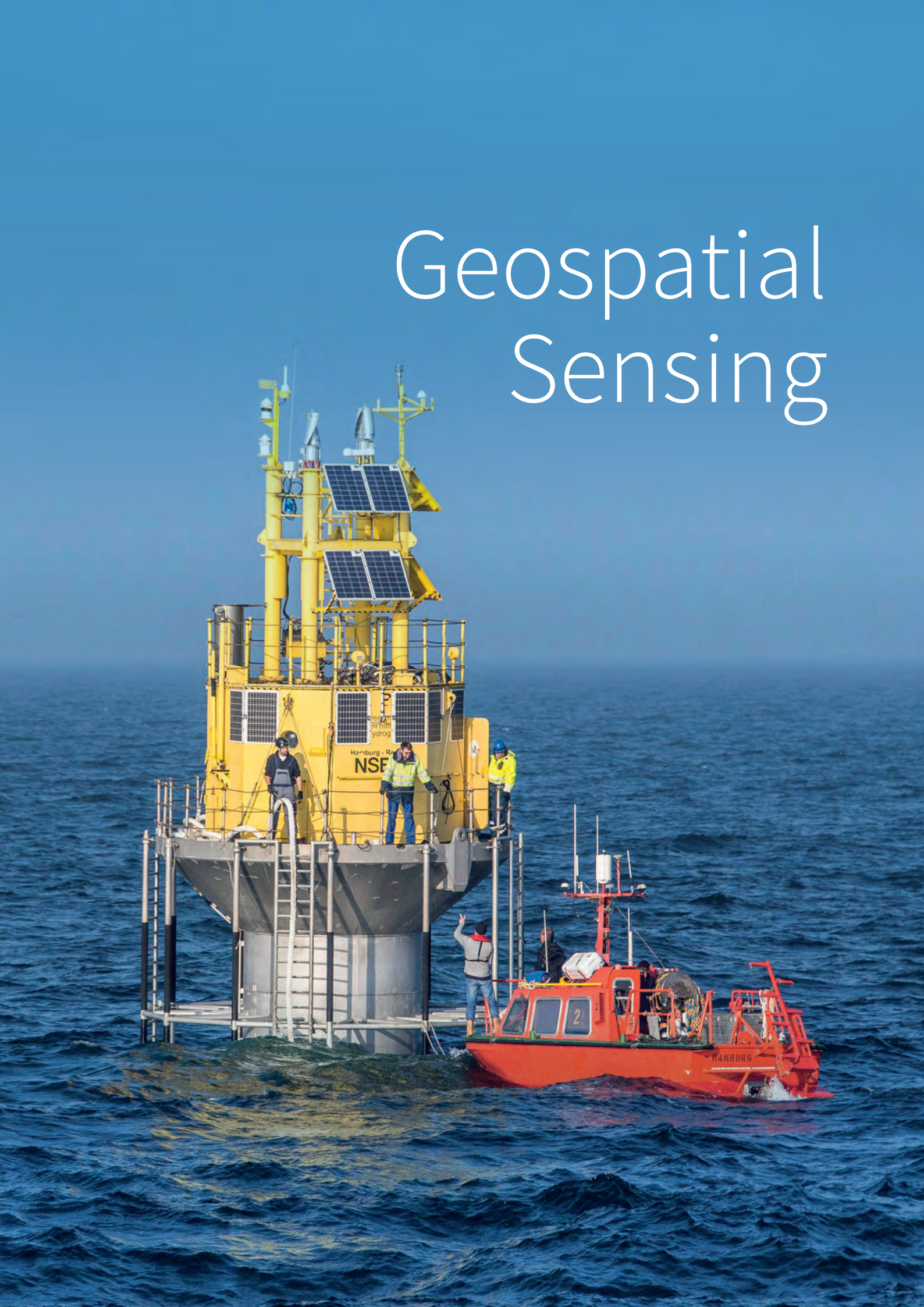
Geospatial data plays a key role in supporting environmental planning, disaster management, smart mobility, precision farming, risk assessment and many other application domains. Our goal is to facilitate the availability and use of spatio-temporal data by innovating the methods and technologies for creating, managing, sharing, analyzing and visualizing this data.

52°North has three Open Labs, each equipped with special skills to carry out applied research on a specific research topic. Open means that partners and customers can use the laboratories to collaborate on their use cases and research questions. If you are interested, just let us know.

52°North's Open Labs

Applied research must be complemented by the development of operational solutions in order to create tangible added value in practice. Only then we can speak of "innovation". 52°North supports the development of operational solutions by offering professional services, such as training and consulting services, software engineering or data analysis. In the following chapters, our Open Labs provide short reports on their research and development activities.

Geospatial Sensing



Enabling the efficient flow, management and visualization of sensor data

The Geospatial Sensing Lab works on new approaches for collecting, managing, sharing, and visualizing sensor data.

_ Connecting to sensor hardware: investigating how new sensors can be efficiently integrated into observation data infrastructures while considering sensor plug-and-play, as well as relevant Internet of Things technologies (e.g. MQTT).

_ Humans as sensors: making it easier to set up citizen observatory initiatives by providing dedicated reusable building blocks.

_ Data storage and management: optimizing data models for efficient data storage, providing metadata to ensure the correct interpretation of sensor data sets, or using and enhancing vocabularies for ensuring a certain level of semantic interoperability.

_ Data availability to users: advancing access interfaces and encodings for sensor data and enabling push-based/event-driven communication patterns to ensure a timely delivery of data.

_ Data visualization: improving methods for visualizing and exploring sensor data to allow for a better communication of the gathered information.

In addition to the release of our results as open source software and research papers, our activities also lead to active contributions to international standardization efforts. For example, we advance interoperability aspects through our participation in the Open Geospatial Consortium (OGC) and the European INSPIRE framework.

The lab develops new approaches and verifies their use and application in project activities. These comprise research and development (R&D) as well as professional services (PS).

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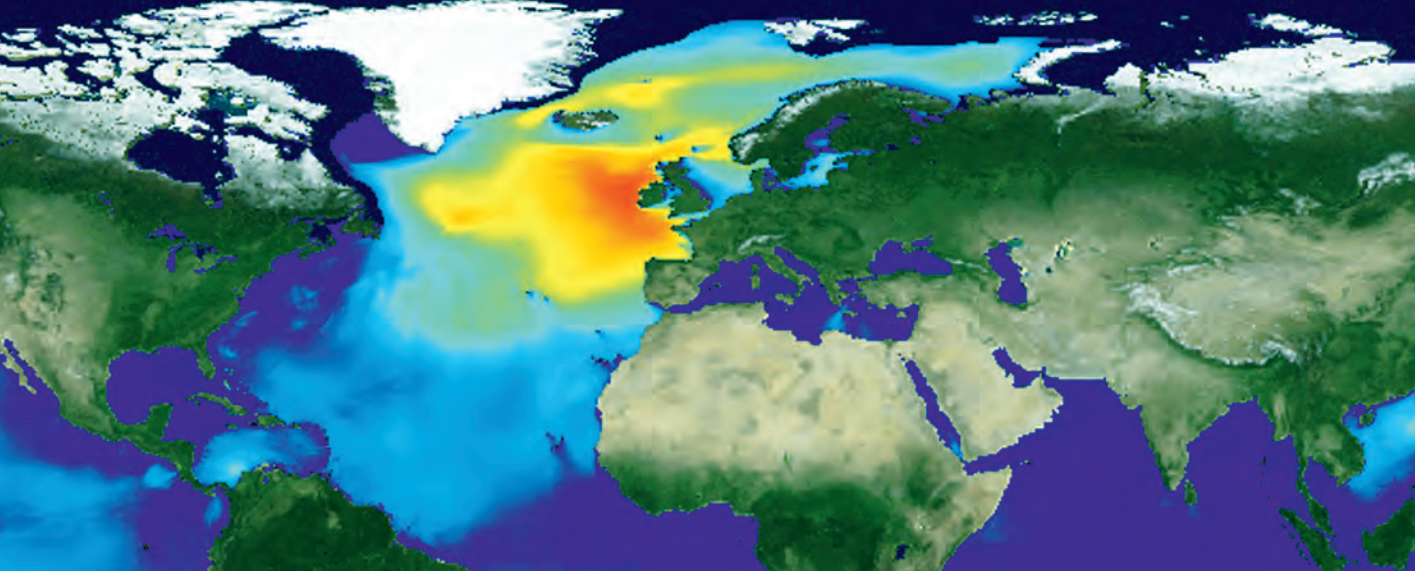


SeaDataCloud

Handling Near Real-Time Sensor Data in a Marine Research Data Infrastructure

Further developing the pan-European infrastructure for marine and ocean data management

The pan-European SeaDataNet infrastructure has been developed by national oceanographic data centers and major research institutes from 34 countries. It connects more than 100 marine data centers providing data discovery and access functionality for researchers. Furthermore, SeaDataNet is a key element supporting the European Marine Observation and Data network (EMODnet), initiated by the EU DG-MARE. It also complements the Copernicus Marine Environmental Monitoring Service.

In order to provide more efficient and faster data access for researchers, several upgrades and enhancements to reflect recent technological developments are needed. This comprises aspects, such as new types of sensors, as well as international IT concepts (e.g. cloud infrastructures) and interoperability standards (e.g. INSPIRE guidelines for observation data). Consequently, SeaDataCloud aims at improving the current SeaDataNet infrastructure by adopting cloud and high performance computing technology. SeaDataCloud cooperates with EUDAT, a network of computing infrastructures that develops and operates a common framework for managing scientific data across Europe.

The SeaDataCloud project output will result in improved access to research data. A comprehensive collection of services and tools developed to cover researchers' specific needs will be available to support marine research and enable the generation of added value products.

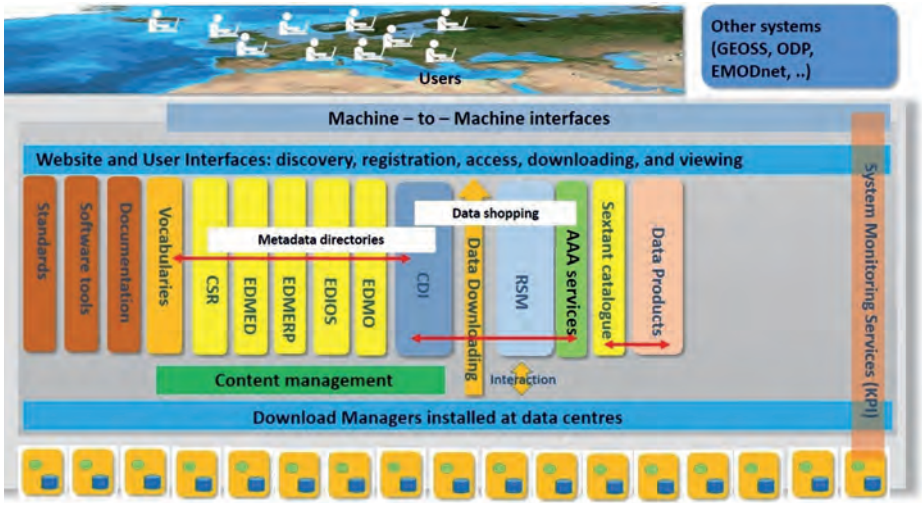
52°North is responsible for investigating new approaches on enhancing the SeaDataNet infrastructure with capabilities to handle near real-time observation data. This comprises two main tasks: the development of a SWE Ingestion Service and a SWE Viewing Service.

The SWE Ingestion Service: In order to facilitate the publication of observation data streams, 52°North worked on a concept and prototypical implementation of a Web service architecture that comprises a plug-and-play approach for sensor data publication.

SeaDataCloud

KEY TECHNOLOGIES

- Java
- JavaScript
- OGC Sensor Web Enablement (SWE)
- OGC Sensor Observation Service (SOS)
- OGC Sensor Model Language (SensorML)
- ISO/OGC Observations and Measurements (O&M)



Data collection by in situ sensors and remote sensing

It includes the description of sensor interfaces, sensor data streams (e.g. delivered through Internet of Things protocols such as MQTT) and other sensor data repositories (e.g. CSC-based data stores) as a first step. This is complemented by tools for editing such sensor data stream descriptions (including the semantics of the data) and an interpreter relying on the sensor data stream descriptions for pushing the available data into the SeaDataCloud infrastructure.

The SWE Viewing Service: 52°North explores new approaches for visualizing the previously published sensor data streams in a user-friendly manner. This covers not only the display of the data itself, but also new ideas on improving the discoverability of the broad range of published sensor data streams.

In addition, 52°North is involved in networking activities to promote and further test the SeaDataCloud developments and provide feedback to international standardization activities.

Over the course of the year, the focus of work shifted from the SWE Ingestion Service prototype to the development and enhancement of the Helgoland Sensor Web Viewer. 52°North improved the general usability of the Helgoland Sensor Web Viewer by enhancing data export functionalities, improving sensor metadata handling (SensorML), and providing easier access to datasets beyond time series data (i.e. trajectories collected by research vessels and profile measurements).

PARTNERS

> **Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), Coordinator**, https://wwz.ifremer.fr/
> **56 partners and 5 sub-contractors from 32 countries**

FUNDING

SeaDataCloud is funded by the Horizon 2020 Framework Programme for Research and Innovation (H2020-INFRAIA-2016-1) of the European Union under grant agreement number 730960.

Co-funded by the Horizon 2020 programme of the European Union

FACTS

Duration
11/2016 – 10/2020

Website
https://www.seadatanet.org/

Contact
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Project Type
Research and Development

BRIDGES

Integrating Autonomous Ocean Gliders as Sensor Platforms

Bringing together research and industry for the development of glider environmental services

BRIDGES (Bringing together Research and Industry for the Development of Glider Environmental Services) aimed to develop an innovative glider platform to support further understanding, improved monitoring and responsible exploitation of the marine environment while ensuring its long-term preservation. Factors such as robustness, cost-effectiveness, relocatability, versatility and easy deployment motivate the development of the intended ocean glider. This glider supports autonomous, long-term, in situ exploration of the deep ocean at large spatio-temporal scales.

Special engineering challenges for the glider development comprised the adaptation of an existing glider platform (the European underwater glider SeaExplorer) to deep basins of up to 5000 m depth and a flexible payload architecture for increased autonomy and support of a broader range of sensing capabilities. To achieve the ability to execute unmanned underwater operations and ensure an efficient integration of the collected observation data, one of the project's dedicated work packages dealt with interoperability and data infrastructure challenges.

52°North was responsible for the design and standardization of a Web-based architecture for integrating autonomous ocean gliders deployed as sensor platforms. A major contribution was the specification and design of a Sensor Web infrastructure especially tailored to the needs of marine gliders and researchers working with the collected data. In addition to defining the corresponding metadata profiles, we contributed (in close cooperation with the British Oceanographic Data Centre that operates a comprehensive vocabulary server) approaches forimproving semantic interoperability and the enablement of event-based data flows.

BRIDGES
BRINGING TOGETHER RESEARCH AND INDUSTRY FOR THE DEVELOPMENT OF GLIDER ENVIRONMENTAL SERVICES

KEY TECHNOLOGIES

- Data Management (OGC Sensor Web Enablement [SWE], OceanGliders NetCDF)
- Software Architectures

In 2019, 52°North focused on updating the designed software concepts and architectures. In particular, a revised version of the architecture concept was finalized as the project deliverable D3.4 “Interface standards for applications of deep and ultra-deep glider”. The concept was presented at the AGILE 2019 conference and published as a conference paper.

PARTNERS

- **Association pour la Recherche et le Développement des Méthodes et Processus Industriels (ARMINES), Coordinator**, https://www.armines.net/fr
- **Christian Michelsen Research (CMR)**, https://cmr.no
- **HYDROPTIC**, www.hydroptic.com
- **BMT Isis**, www.bmt.org
- **ECORYS**, https://www.ecorys.nl
- **Université Pierre et Marie Curie (UPMC)**, https://www.upmc.fr
- **Albatros Marine Technologies**, http://albatrosmt.com/home
- **Society for Underwater Technology (SUT)**, https://www.sut.org
- **The Hebrew University of Jerusalem (HUJI)**, https://new.huji.ac.il/en
- **Cyprusubsea Consulting and Services C.S.C.S. Limited (CSCS)** https://cyprus-subsea.com
- **University of Cyprus (UCY)**, https://www.ucy.ac.cy/en
- **ALSEAMAR Alcen**, http://www.alseamar-alcen.com
- **Universidade do Porto (UPorto)**, www.uporto.pt
- **IRIS**, http://www.iris.no
- **Natural Environment Research Council (NERC)**, https://nerc.ac.uk/
- **Ocean Scan Marine Systems & Technology (MST)**, www.oceanscan-mst.com

FUNDING

BRIDGES is funded by the Horizon 2020 Framework Programme for Research and Innovation (H2020-BG-2014-2) of the European Union under grant agreement number 635359.

Co-funded by the Horizon 2020 programme of the European Union

FACTS

Duration
05/2019 – 08/2019

Website
http://www.bridges-h2020.eu/

Contact
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Project Type
Research and Development

Sensor Web Developments for BSH

Visualizing Sensor Data

Enhancing the Helgoland Sensor Web Viewer

The German Federal Maritime and Hydrographic Agency (BSH) operates several measurement platforms in the North and Baltic Seas. These stations measure a range of parameters at different depth and height levels. To enable the interoperable exchange of the measured observation data, the BSH previously ran an instance of the 52°North Sensor Observation Service (SOS) implementation that was fed by an FME process (using the transactional SOS operations).

The BSH has enhanced its infrastructure with client components that allow exploration and visualization of the available observation data. Both 52°North's Helgoland Sensor Web Viewer and con terra's map.apps (GeoSeaPortal App) are used for this purpose.

Handling the rather large number of depth/height levels at which the stations measure data proved to be a major challenge. The data selection workflow became impractical when using the common versions of map.apps and the Helgoland Sensor Web Viewer. Thus, the main tasks of this project comprised two activities.

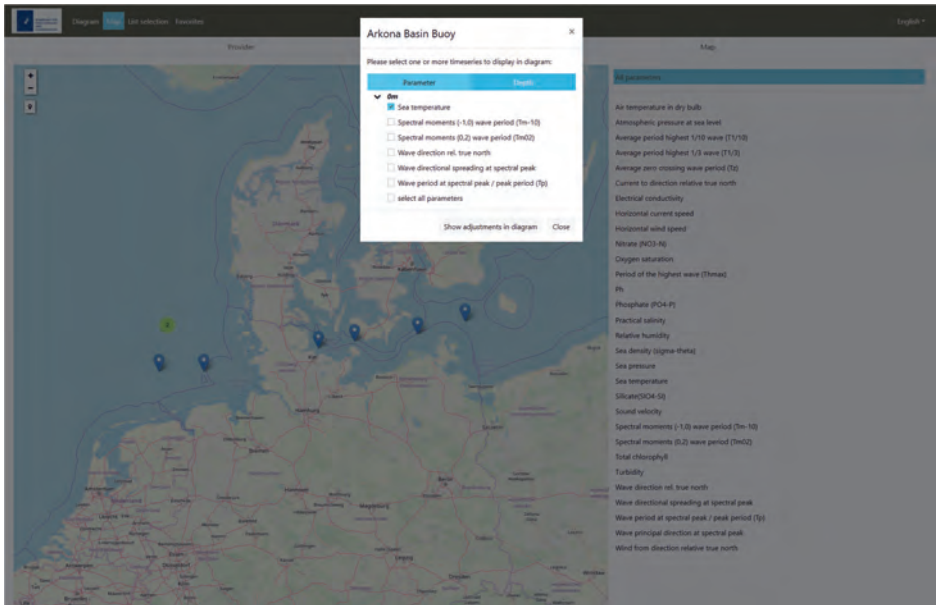
As a first step, 52°North developed an approach for expressing different depth/height levels as additional information and filter criteria in the OGC SOS and the 52°North Sensor Web REST API data models. We then developed a corresponding mapping that BSH applied in their FME data import processes.

KEY TECHNOLOGIES

- Sensor Web
- Helgoland Sensor Web Viewer
- JavaScript
- Angular
- Sensor Observations Service (SOS)
- 52°North Sensor Web REST API

In a second step, the Helgoland Sensor Web Viewer and con terra's map.apps were extended so that they can use the additional depth/height information during the data selection and visualization process. This resulted in an increased level of user-friendliness in the two Sensor Web viewing tools.

52°North's responsibilities covered all aspects related to data modelling. In addition, 52°North enhanced the Helgoland Sensor Web Viewer accordingly.



BSH's customized Helgoland Sensor Web Viewer (showing a set of measurement station in North Sea and Baltic Sea)

CUSTOMER

German Federal Maritime and Hydrographic Agency, https://www.bsh.de/
(52°North was a con terra subcontractor)

PARTNER

> **con terra GmbH**, https://www.conterra.de/

FACTS

Duration
12/2018 – 07/2019

Contact
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Project Type
Professional Services

Wupperverband Framework Contract

Sensor Web Developments for the Wupperverband

Supporting the Wupperverband's Sensor Web infrastructure

The Wupperverband (Wupper Association) is responsible for water management in the Wupper River catchment area. It covers an area of 813 square kilometers in the German Federal State of North Rhine-Westphalia. As a part of their water management tasks, the Wupperverband operates a comprehensive network of water monitoring stations that deliver a broad range of observations of hydrological and meteorological parameters.

For more than 10 years, the Wupperverband has been operating Sensor Web components to ensure an efficient data management and internal as well as external data exchange. These include a large database for managing the collected observation data, the 52°North Sensor Observation Service implementation, the 52°North Sensor Web REST API, as well as a customized version of the Helgoland Sensor Web Viewer.

52°North supports the Wupperverband in maintaining and advancing this Sensor Web infrastructure. This comprises not only regular updates of the Sensor Web components but also selected tasks to customize or extend the used software modules.

The activities in 2019 were centered around two main tasks. On the one hand, a strong emphasis was put on upgrading the existing Wupperverband Sensor Web Viewer to the latest Helgoland Sensor Web Viewer development line. 52°North ported several views of the existing Viewer to the new Helgoland development line.

On the other hand, several tasks covered the backend components. In conjunction with ongoing activities to release a 52°North Sensor Web Server 5.x version, 52°North designed and evaluated several Sensor Web data model optimizations. This was complemented by efforts to increase the performance of the Sensor Web backend to handle the increasing volume of in situ observation data managed by the Wupperverband.

KEY TECHNOLOGIES

- Sensor Web
- Helgoland Sensor Web Viewer
- JavaScript
- Angular
- Sensor Observation Service (SOS)
- 52°North Sensor Web REST API

FACTS

Duration
01/2018 – 12/2021

Contact
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Project Type
Professional Services

CUSTOMER

Wupperverband, https://www.wupperverband.de/

NIWA sos4R/SOS

sos4R and SOS for high resolution climate data

Upgrading sos4R and evaluating applicability of SOS 2.0 standard

The National Institute of Water and Atmospheric Research, NIWA (New Zealand) has been using 52°North Sensor Web components for several years. 52°North supported them in two major activities.

In addition to using the SOS for data access, NIWA would like to perform data analysis on top of this interface. The sos4R is a valuable component providing this functionality. However, the SOS standard has evolved significantly, not only during sos4R's lifetime, but also since its last major release. The sos4R has not been able to completely deal with the current SOS version 2.0 changes, thus 52°North had to upgrade the sos4R functionality package to SOS 2.0. User feedback on the current sos4R implementation also led to additional high-level functions to ease data discovery and retrieval (e.g. a convenience layer in sos4R facilitates data retrieval from SOS servers).

NIWA uses the SOS to serve different hydrological measurement values. To complement this existing infrastructure, NIWA is interested in using the 52°North SOS server to serve high resolution climate data. A project was initiated to evaluate the applicability of the 52°North SOS to serve such data and to derive recommendations for potential implementation enhancements.

After working on an initial architecture design, 52°North conducted and completed the main implementation in 2019. This resulted in two new sos4R releases. In addition to upgrading the core library, special emphasis was put on the documentation. We published a range of enhanced Vignettes with the upgraded software.

52°North also deployed a new SOS instance to support the SOS-based provision of high resolution climate data and carried out data loading. Performance evaluation and SOS sever optimization continue.

KEY TECHNOLOGIES

- OGC Sensor Observation Service (SOS)
- OGC WaterML 2.0
- OGC Observations and Measurements (O&M)
- R Programming Language

FACTS

Duration
10/2018 – 12/2019

Contact
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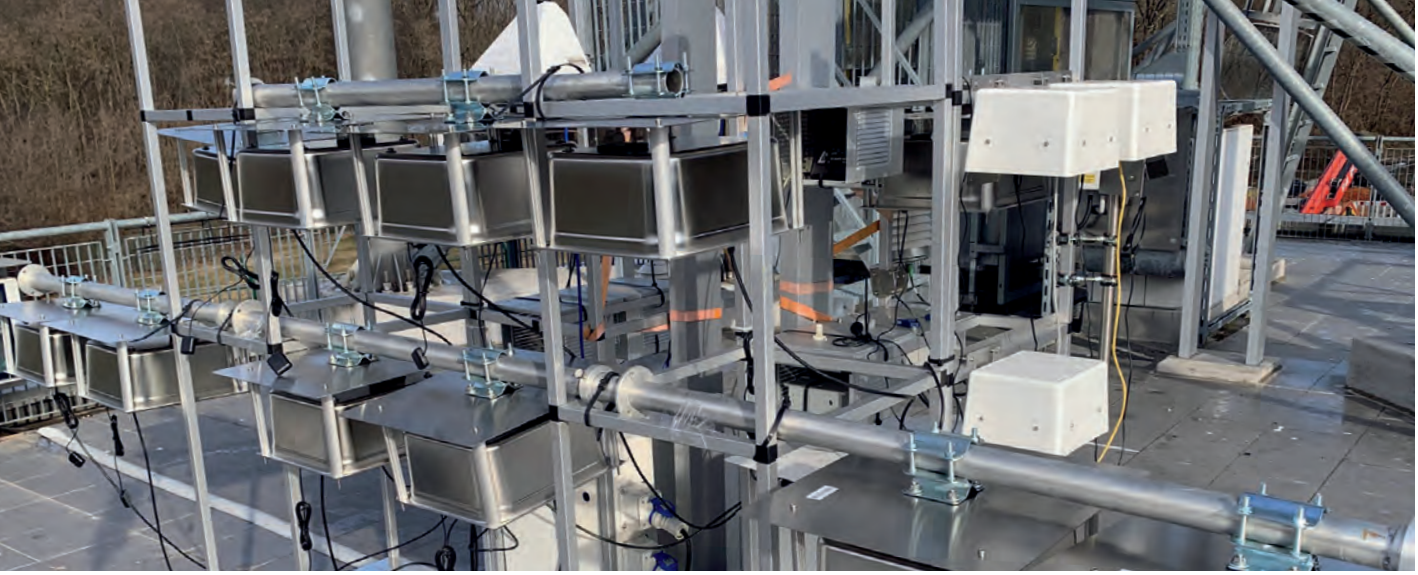
Project Type
Professional Services

CUSTOMER

National Institute of Water and Atmospheric Research (NIWA), https://niwa.co.nz/



AQSens

Air Quality Sensing

Developing a platform for integrating Citizen Science measurements and authoritative air quality data

Over the last few years, the Joint Research Centre (JRC) of the European Commission has worked extensively on ways to use lower cost sensors to complement authoritative air quality data (e.g. the AirSensEUR open hardware/software/data platform). JRC built upon this experience and initiated a new activity involving three European cities as pilot sites (Antwerp, Oslo, and Zagreb), where 85 sensor boxes will be deployed through dedicated measurement campaigns.

To support their research, JRC needs a data management platform to collect both the data of low cost air quality sensor boxes and the authoritative data measured by the official agencies. This data platform will be based on the INSPIRE-compliant interoperability standards OGC Sensor Observation Service and OGC SensorThings API specifications.

52°North will integrate a data validation process based on R/Shiny as well. It calibrates the low-cost sensor data measurements according to the official measurements. In order to enable users to view and explore the collected data, data visualization functionality will be provided. This will be based on the Helgoland Sensor Web Viewer.

In 2019, 52°North focused on requirements analysis and architecture development. This mainly comprised the design of a data import workflow, a concept for hosting the AQSens Data Platform, and the analysis of approaches for integrating a data validation process based on R/Shiny. This was complemented by the deployment of first components, i.e. the 52°North Sensor Web Server modules for supporting the OGC Sensor Observation Service and OGC SensorThings API standards.

KEY TECHNOLOGIES

- Distributed Web Architecture
- Data Management (OGC Sensor Web Enablement, OGC Sensor Observation Service, OGC Sensor Things API, PostgreSQL)
- Data Validation (R, Shiny)
- Data Visualization (Angular, JavaScript, Helgoland)

FACTS

Duration
08/2019 – 08/2021

Contact
Dr. Simon Jirka
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Project Type
Professional Services

CUSTOMER

European Commission Joint Research Center (JRC), https://ec.europa.eu/jrc/en

BelAir

Belgian Air Quality App

Enhancing the Air Quality App for the Belgian Interregional Environment Agency

Over the last few years, 52°North has worked closely with the Belgian Interregional Environment Agency (IRCEL – CELINE) to develop the BelAir air quality app. This app provides interested citizens with information about several air quality parameters as well as an air quality index in Belgium. It can create time-dependent map visualizations and present historic changes of different air quality parameters as diagrams. A set of personalization functionalities (e.g. setting user-defined locations) allows the user to adjust the app to individual information needs. Additional push notifications inform users of critical air quality situations.

The technical baseline for the BelAir app development is the Helgoland Toolbox. It aggregates different fundamental building blocks for creating Sensor Web client applications. 52°North uses the Ionic framework to build and deploy the JavaScript-based implementation as an app for Android and iPhone platforms.

After a public release at the beginning of 2019, 52°North implemented several app optimizations during the course of the year. This included usability optimization based on feedback provided by design experts (e.g. re-design of menus and views as well as user workflows). Additional important work items comprised enhanced approaches for ensuring the correct understanding of the data provided by users, a new mechanism for delivering user notifications in the case of specific conditions, performance and scalability improvements, increased robustness, as well as upgrades of underlying libraries (a major Ionic upgrade in particular).

KEY TECHNOLOGIES

> JavaScript

> Angular

> Ionic

> Sensor Web

FACTS

Duration
since 2018

Website
http://www.irceline.be/en/documentation/belair/

Contact
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Project Type
Professional Services

CUSTOMER

Belgian Interregional Environment Agency, https://www.irceline.be/en

Creating Interfaces

Data Management for Citizen Science Projects

Building capacity for integrated governance at food-water-energy-nexus in cities on water

Creating Interfaces explores socio-technical interfaces at the food-water-energy (FWE) nexus in cities near water. Aiming to increase urban sustainability, resilience, and quality of life, this project works to build local capacity through innovative approaches in coordinated knowledge creation, governance and exchange.

A multi/transdisciplinary, international team representing natural and social sciences, humanities, engineering, data and computer sciences, urban planning as well as civil society and business actors conducts research on stakeholder interactions and decision making in the FWE sectors. It explores data governance and investigates novel approaches in participatory knowledge generation and Citizen Science along with their implementation. The project helps to answer central questions surrounding the integration of such novel means of citizen-driven knowledge creation into the governance process and urban infrastructure planning procedures. Common research frameworks and a close interdisciplinary and transdisciplinary cooperation provide a basis for comparative analysis and co-production of transformative knowledge.

The development of socio-technical interfaces and decision support tools is driven by the needs of stakeholders, the FWE actors, and members of the public following an Urban Living Lab framework. This approach involves an integrative, interactive, and iterative process of stakeholder engagement to develop innovative interfaces and achieve the goals mentioned above.

52°North focuses on the development of interoperable Citizen Science and decision support workflows for providing data collection and analysis functionality. This is part of the Urban Living Labs and Citizen Science approaches in the three partner cities: Tulcea (Romania), Wilmington (USA) and Slupsk (Poland). For this purpose, 52°North evaluates existing Citizen Science concepts, advances the identified baseline components and contributes its findings to international standardization activities aimed at increased interoperability among Citizen Science projects. This also includes the

creating interfaces
water food energy

KEY TECHNOLOGIES

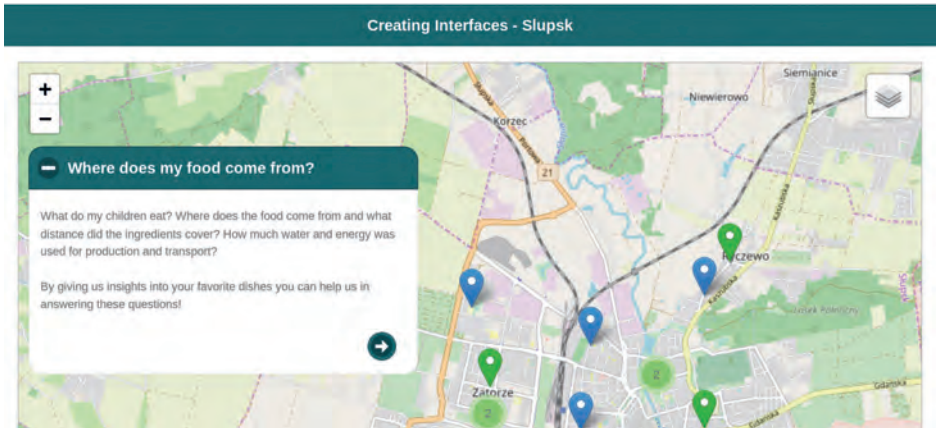
> JavaScript

> wq

> PostgreSQL

customization of identified tools and frameworks according to specific requirements. 52°North's work in 2019 comprised the evaluation of suitable technologies for enabling the data collection and data management of Citizen Science projects. The 52°North team investigated the wq framework, Survey123 for ArcGIS and the Open Data Kit. We subsequently adjusted the wq framework based on the project requirements.

In addition, 52°North contributed to the first phase of the OGC Citizen Science Interoperability Experiment by setting up an SOS server to handle Citizen Science air quality data. The results will be published as a dedicated OGC Engineering Report.



Data collection tool for gathering information about food served in kindergardens in Słupsk (Poland)

PARTNERS

- **EIfER – Europäisches Institut für Energieforschung, Germany, Coordinator** https://www.eifer.kit.edu/
- **University of Delaware, School of Public Policy and Administration, USA** https://www.udel.edu/
- **The National Center for Atmospheric Research (NCAR), USA** https://ncar.ucar.edu/
- **University of Warwick, Centre for Interdisciplinary Methodologies, United Kingdom**, https://warwick.ac.uk/
- **Pracownia Zrównoważonego Rozwoju (PZR), Poland**, http://www.pzr.org.pl/
- **Plantagon, Sweden**, http://www.plantagon.com/
- **Nicolaus Copernicus University Toruń, Institute of Sociology, Poland** https://www.umk.pl/
- **Danube Delta National Institute for Research and Development (DDNI), Romania**, http://ddni.ro/wps/
- **KTH Royal Institute of Technology, Sweden**, https://www.kth.se/

FUNDING

Creating Interfaces is funded by the German Federal Ministry of Education and Research as part of the Sustainable Urbanisation Global Initiative (SUGI)/Food-Water-Energy Nexus. This program is jointly established by the Belmont Forum and the Joint Programming Initiative Urban Europe.

FACTS

Duration
05/2018 – 04/2021

Website
https://creatinginterfaces.eifer.kit.edu/

Contact
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Project Type
Research and Development

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730254.

COS4CLOUD

Co-designed Citizen Observatories Services for the EOS Cloud

Developing interoperable components to support Citizen Science projects via the European Open Science Cloud (EOSC)

COS4CLOUD (Co-designed citizen observatories for the EOS Cloud) aims to design, prototype and implement services that address the Open Science challenges shared by citizen observatories active in the fields of biodiversity and environmental quality monitoring. To support citizen observatories, project work focuses on the development of services that help improve the data and information quality. Technologies for this include deep machine learning, automatic video recognition, advanced mobile app interfaces, and other cutting-edge technologies, based on data models and data protocols validated by traditional science. The new services will provide mechanisms to ensure the visibility and recognition of data contributors and tools to improve networking between various stakeholders. Novel innovative digital services will be developed through the integration of Citizen Science products generated by different providers. The services will be implemented according to open standards to ensure their interoperability. The European Open Science Cloud hub provides an agile, fit-for-purpose and sustainable site, including a discovery service, to both traditional and citizen scientists.

The design of new services will be user oriented and engage a wide range of stakeholders in society, government, industry, academia, agencies, and research to co-design service requirements. As a result, COS4CLOUD will integrate Citizen Science in the European Open Science Cloud, bringing Citizen Science projects as a service to the scientific community and society at large.

52°North's major contributions will be the architecture definition and the development of interoperability standards, profiles and best practices. Furthermore, 52°North will lead the definition of an agile development methodology for the project. Other

Cos4Cloud

KEY TECHNOLOGIES

- European Open Science Cloud
- OGC Sensor Web Enablement (SWE)
- Spatial Data Infrastructure concepts

contributions include work on interoperability, conformance and performance testing activities as well as the evaluation of technology readiness levels. Finally, 52°North will support networking, dissemination and international standardization activities.

Since the project started in November 2019, 52°North's activities were focused on project initialization. 52°North also worked on an agile, software development strategy and contributed to the second phase of the OGC Citizen Science Interoperability Experiment. The OGC CitSciIE will deliver input concerning the interoperable handling of Citizen Science data.

PARTNERS

- **Consejo Superior de Investigaciones Científicas (CSIC), Spain, Coordinator** https://www.csic.es/
- **Conservation Education & Research Trust, United Kingdom** https://earthwatch.org/
- **Centro de Investigacion Ecologica y Aplicaciones Forestales, Spain** http://www.creaf.cat/
- **Institut national de recherche eninformatique et automatique (INRIA), France**, https://www.inria.fr/
- **DYNAIKON LTD, United Kingdom**, https://dynaikon.com/
- **Bineo Consulting S.L., Spain**, https://bineo-consulting.com/
- **Norbert Carl Schmidt, The Netherlands**
- **The Open University, United Kingdom**, http://www.open.ac.uk/
- **Secure Dimensions GmbH, Germany**, http://www.secure-dimensions.com/
- **Sveriges lantbruksuniversitet (SLB), Sweden**, https://www.slu.se/
- **Ethniko kai Kapodistriako Panepistimio Athinon, Greece** https://www.uoa.gr/
- **Verein der Europäischen Bürgerwissenschaften e.V. (ECSA), Germany** https://ecsa.citizen-science.net
- **Trébola Organización Ecológica, Colombia**, http://www.trebola.org/
- **Science for Change S.L., Spain**

FUNDING

COS4CLOUD is funded by the Horizon 2020 Framework Programme for Research and Innovation (H2020-INFRAEOSC-2019-1) of the European Union under grant agreement number 863463.

Co-funded by the Horizon 2020 programme
of the European Union

FACTS

Duration
11/2019 – 02/2023

Website
http://www.cos4cloud-eosc.eu/

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Project Type
Research and Development

EDP2

European Data Portal 2

Enhancing the European Data Portal

The European Data Portal (EDP) is a core component for the public sector data infrastructure that the European Union and its member states have set up. This portal offers discovery functionality for and access to public data resources across Europe. It currently comprises approximately one million datasets from 34 countries.

The portal development itself is complemented by networking activities. They support member states in publishing further datasets via the portal and promote the use of open data.

The EDP 2 project continues a previous project that resulted in a first version of the EDP. The main challenges during the EDP 2 project comprise aspects regarding the migration of the metadata storage to new linked data-based approaches as well as the integration of new types of data sources, such as near real-time data streams.

52°North's work focuses on two main activities. On the one hand, we cooperate with con terra on the visualization of geospatial data based on map.apps (i.e. a preview of the content of data sources such as OGC WMS or GeoJSON). On the other hand, 52°North concentrates on the integration of near-real time data sources, such as the FIWARE Context Broker (recommended by the European Commission as a building block with their Digital Connecting Europe Facility (CEF) Building Blocks program) and the OGC Sensor Observation Service (SOS) (recommended as part of the Technical Guidance of the European INSPIRE Directive).

After upgrading the geovisualization component to a current map.apps version in 2019, 52°North focused on the integration of near real-time data sources. This included a cooperation with external developers to provide DCAT-AP metadata about FIWARE

EUROPEAN DATA PORTAL

KEY TECHNOLOGIES

- con terra map.apps
- DCAT-API
- JavaScript
- FIWARE Context Broker
- OGC Sensor Observation Service (SOS)

Context Broker instances so that they can be discovered via the EDP. In addition to this, 52°North has drafted approaches for metadata harvesting from OGC SOS instances and work on a preview of FIWARE Context Broker data within the geovisualization component.

Engaging the public with Open Data

CUSTOMER

European Commission (52°North is a con terra subcontractor)

PARTNERS

> **Capgemini Invent**, https://www.capgemini.com/service/invent/
> **Sogeti**, https://www.sogeti.com/
> **Intrasoft International**, https://www.intrasoft-intl.com/
> **Fraunhofer FOKUS**, https://www.fokus.fraunhofer.de/
> **con terra GmbH**, https://www.conterra.de/
> **University of Southampton**, https://www.southampton.ac.uk/
> **time.lex**, https://www.timelex.eu/
> **Lisbon Council**, https://www.lisboncouncil.net/

FACTS

Duration
02/2018 - 04/2021

Website
https://www.europeandataportal.eu/

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Project Type
Professional Services

mVIZ

Choosing the best Visualization Approaches

User-friendly and efficient visualization of spatio-temporal data available via the mCLOUD

The Federal Ministry of Transport and Digital Infrastructure (BMVI) initiated the mCLOUD as a common open data discovery portal. This portal should improve the discoverability of their open data and those of its related projects and agencies.

In order to facilitate the efficient and user-friendly exploration of available data sets, it is essential to visualize the data as quickly and easily as possible. Fast and informative visualization of open data from the mCLOUD remains difficult, especially for spatio-temporal data. Usually this data must be downloaded and converted into common data formats before visual exploration is possible.

mVIZ conducts a preliminary study, in which a methodology is developed to support the selection and creation of user-friendly visualizations for data discoverable via the mCLOUD. A resulting guideline will describe the methodology and serve as a basis for the conception, extension or improvement of visualization tools or for their further development and integration into open data portals.

The project focuses in particular on

1. the creation of an inventory of open spatio-temporal data in mCLOUD as well as an overview of available visualization and analysis tools
2. the development of a methodology for selecting appropriate visualizations for the spatio-temporal data and
3. the development of a demonstrator for supporting the visualization of selected mCLOUD data.

The design and implementation of the demonstrator application is 52°North's main contribution. It uses work from existing tools, such as the Helgoland Sensor Web Client.

KEY TECHNOLOGIES

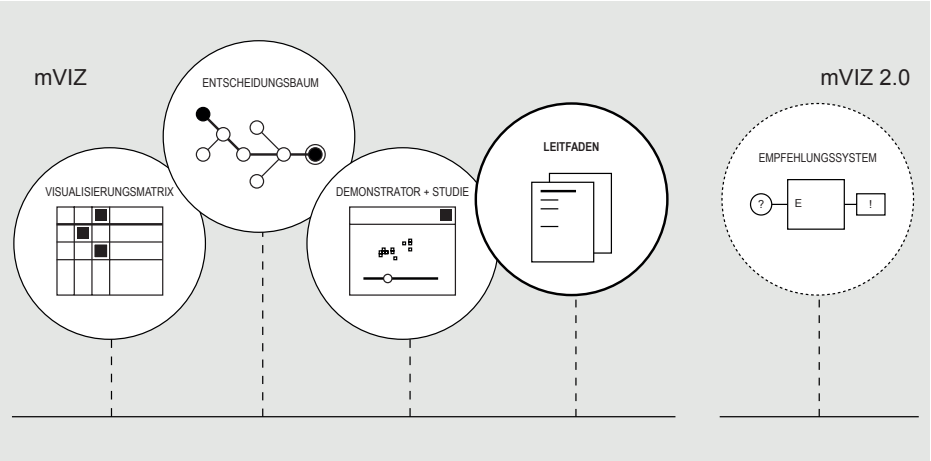
> JavaScript

> Helgoland

> mCLOUD

52°North also supports the analysis of user requirements, available data sets, and appropriate data visualization approaches. We contribute to the evaluation of approaches for the interoperable integration of open spatio-temporal data sources and provide feedback on design rules for data visualization.

During 2019, 52°North mainly contributed to the analysis of requirements and the matching of available data sets to visualization methods. The demonstrator design was developed based on the outcomes of these activities. The implementation of this demo application will run until early 2020.



mVIZ project phases

PARTNERS

> **Technische Universität Dresden (TUD), Chair of Geoinformatics, Germany**
https://tu-dresden.de/bu/umwelt/geo/geoinformatik
> **Beuth Hochschule für Technik Berlin, Germany**
https://www.beuth-hochschule.de/

FUNDING

mVIZ is funded by the German Federal Ministry of Transport and Digital Infrastructure as part of the of the mFUND program.

Federal Ministry of Transport and Digital Infrastructure

mFUND Das Startkapital für die Mobilität 4.0

FACTS

Duration
06/2019 - 05/2020

Website
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Contact
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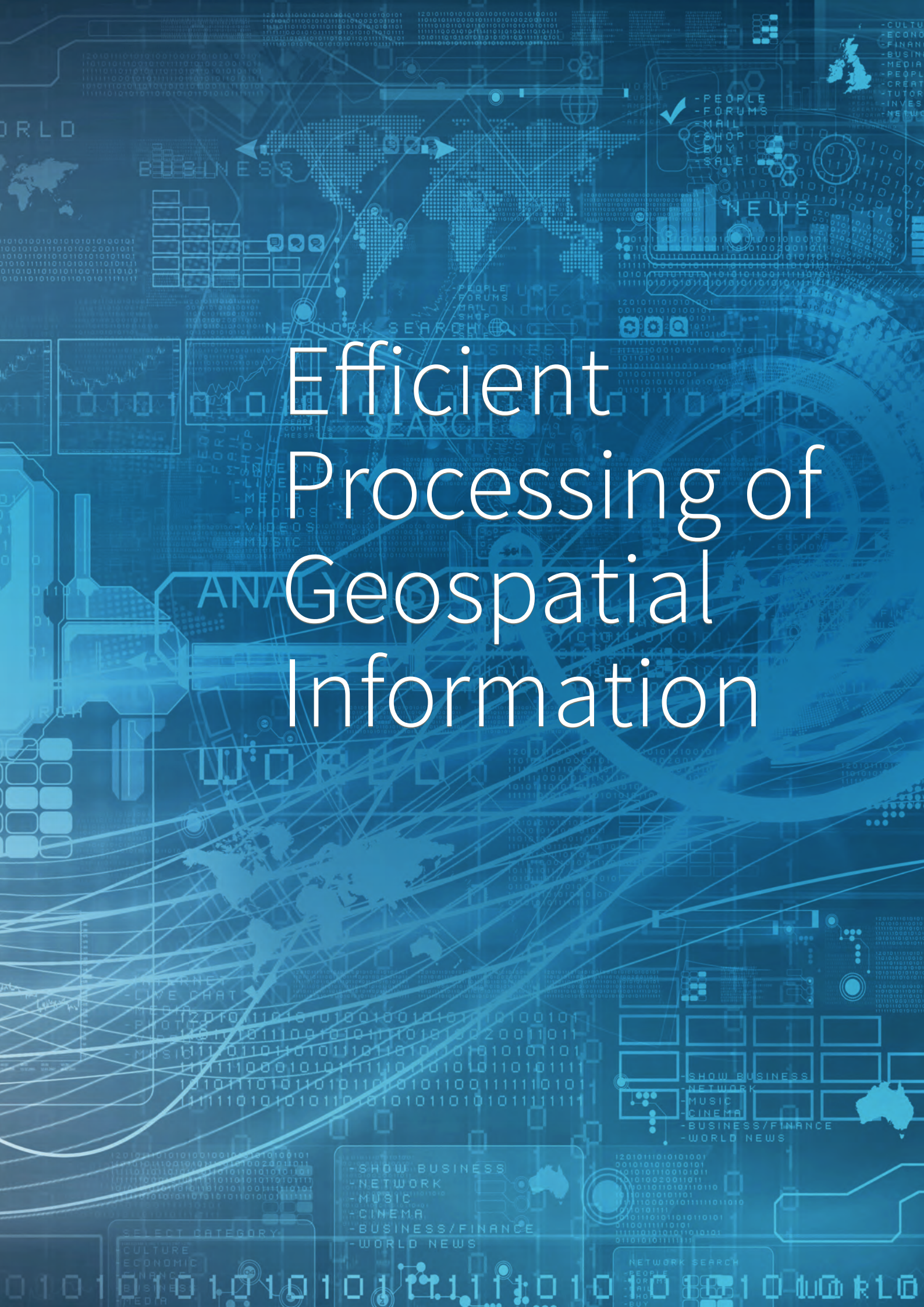
Project Type
Research and Development



Efficient Processing of Geospatial Information

Upscaling for heavy duty data processing

Geoprocessing refers to the data processing that must be performed to transform, merge, analyze and visualize data from different sources. The increasing volume and variety of data as well as the velocity of data streams requires new and advanced methods, technologies and architectural designs to cope with these challenges. This is where 52°North's Efficient Processing Lab contributes with research and development (R&D) and professional services (PS).

In 2019, the focus was on the following topics:

_ Scalability of Processing: identifying and realizing requirements for horizontal and vertical scaling of processing algorithms

_ Workflows Chains and Orchestration: designing and automating complex process workflows

_ Earth Observation Data Processing: handling huge amounts of EO data in an efficient and scalable way

_ Cloud Environments (PaaS, IaaS, SaaS): enabling their possibilities with regards to deployment patterns, handling of input data and processing results

_ Standardization: harmonizing processing interfaces, creating/using interoperable data formats

_ Processing Transparency: strengthening reproducibility, data quality and metadata quality, as well as process discovery.

We address these challenges in a number of R&D and PS projects. Our research partners and customers are from academia and industry covering various application domains. These include, for example, environmental monitoring, agricultural applications, or disaster management. This diversity enables us to develop new approaches that take into account the requirements of many real-world problems and use cases.

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RIESGOS

Multi-risk Analysis and Information System Components for the Andes Region

Developing novel concepts and components for multi-risk assessment of natural hazards

The RIESGOS project addresses challenges of increased risks to society caused by natural hazards, such as volcanic eruptions, earthquakes or tsunamis. For this purpose, it aims at more efficient risk management based on more reliable information. A particular strength is that it addresses complex interactions, such as cascading effects of certain hazards as well as many of the underlying sources of uncertainty.

RIESGOS develops novel scientific approaches related to the assessment of different hazards and risks. This includes the analysis of dynamic exposure, vulnerability and the modelling of cascading effects and possible failures.

Modular Web services integrated into a flexible and scalable multi-risk information system demonstrator will be the foundation of the RIESGOS software architecture. As a result, end users from civil protection and disaster management authorities will receive tools to simulate and analyze complex multi-risk scenarios. These are complemented by the development and investigation of strategies for information-based and dialogue-based risk communication.

The main goal of 52°North's activities is the conceptual design and implementation of an interoperable architecture for a multi-risk analysis and information system for the Andes region. The 52°North tasks comprise:

1. the analysis of requirements
2. the development of a software architecture following international standards to ensure interoperability (e.g. INSPIRE, OGC)
3. the implementation of selected components (data access, data analysis and processing, communication) into demonstrators, as well as
4. a contribution to market analysis and the development of exploitation perspectives (focus on the publication as open source software).

RIESGOS
MULTI-RISK ANALYSIS AND INFORMATION SYSTEM COMPONENTS FOR THE ANDES REGION

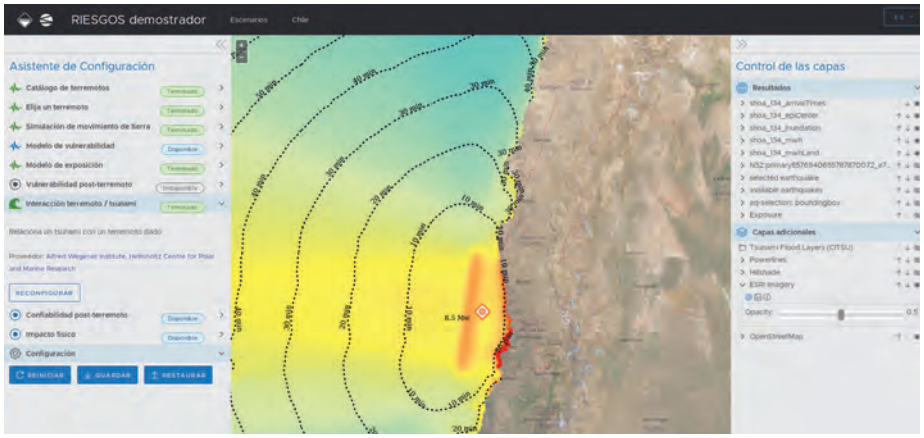
KEY TECHNOLOGIES

> Web-based Processing

> Process Orchestration

> Scientific Data Formats

2019 was an important year for RIESGOS. The system architecture designed had to be implemented and initiated. 52°North's efforts focused on the development of interoperable web services for the different thematic processes and simulation models. The javaPS – a modern implementation of the OGC WPS 2.0 standard – played an important role in the realization. The different processes were put together in a demonstrator application (developed by the DLR), which realized the orchestration of the different thematic models into scenario-driven workflows.



RIESGOS Demonstrator Application

PARTNERS

- **Deutsches Zentrum für Luft- und Raumfahrt (DLR), Coordinator** https://www.dlr.de/
- **Helmholtz-Zentrums Potsdam Deutsches GeoForschungsZentrum (GFZ)** https://www.gfz-potsdam.de/
- **Alfred Wegener Institut (AWI)**, https://www.awi.de/
- **Technische Universität München (TUM)**, https://www.tum.de/
- **geomer GmbH**, https://www.geomer.de/
- **EOMAP GmbH & Co. KG**, https://www.eomap.com/
- **plan + risk consult**, http://www.plan-risk-consult.de/
- **DIALOGIK**, http://www.dialogik-expert.de/

ASSOCIATE PARTNERS

- **GIZ GmbH**, https://www.giz.de
- **UNOOSA**, http://www.unoosa.org/
- **UN-SPIDER**, http://www.un-spider.org/
- **UNESCO**, https://en.unesco.org/
- **MunichRE**, https://www.munichre.com/de/

FUNDING

RIESGOS is funded by the German Federal Ministry of Education and Research (BMBF) as part of the funding measure "BMBF CLIENT II – International partnerships for sustainable innovations" of the framework programme "Research for Sustainable Development (FONA)".

Federal Ministry of Education and Research

FACTS

Duration
11/2017 – 10/2020

Website
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Project Type
Research and Development

SenSituMon

Large-Scale Monitoring of Flooded Areas

Integration of satellite and in situ sensor data for improving the automated large-scale monitoring of flooded areas

The SenSituMon Project strives to develop and test innovative methods and technologies for the generation of near real-time information products from satellite and in situ sensor data for the large-scale monitoring of flooded areas. The research results will serve as a basis for the development and commercialization of operational services based on the Copernicus earth observation system and other satellite missions.

Insurance companies require up-to-date information on the location, intensity and duration of floods for rapid response to flood-related damage events. In addition, the flooding history needs to be documented so that detailed information about the occurrence, frequency and duration of flooding events for the affected areas is available. This information can be used, for example, to validate flood risk assessments.

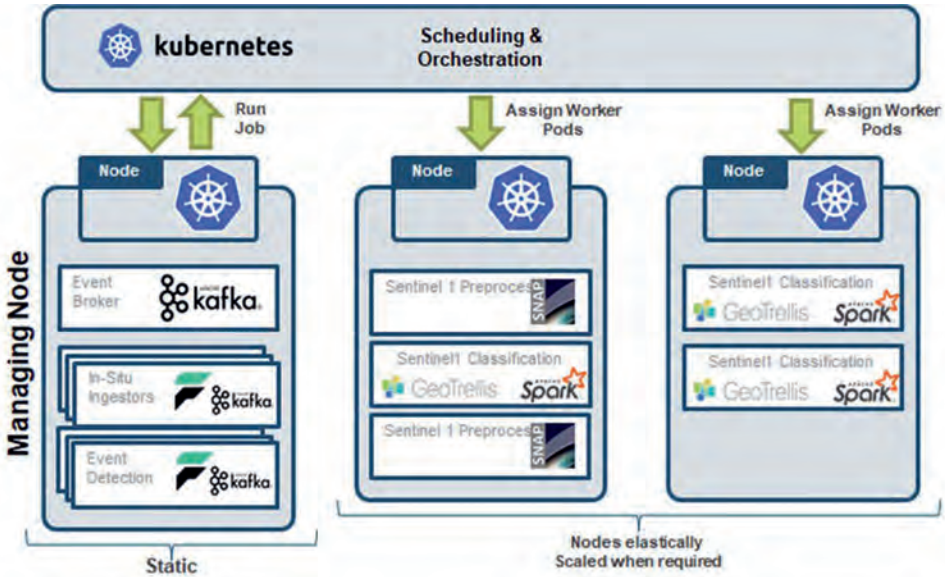
Additional requirements for monitoring flooded areas for further applications in agriculture and water management are being analyzed. Work initially focuses on North Rhine-Westphalia in Germany. Based on the results of this project phase, the scalability of the approach for Germany and Europe will be assessed.

52°North develops and evaluates new methods for the automatable spatio-temporal delineation of flood events from meteorological and hydrological measurement and observation data, such as RADOLAN (German Weather Service) and Pegel-Online (German Water and Shipping Administration). This information is used to focus data analysis that requires intensive resources on regions where significant flooding cannot be ruled out. In addition, 52°North has established an event-based and highly scalable stream processing infrastructure for the efficient and distributed processing of observation and measurement data. This forms the technical basis for the integration of in situ data that are merged "on-the-fly" from different data sources (data fusion) and integrated into the automated processing workflow. 52°North is responsible for the development of the overall architecture and contributes significantly to the integration and validation of the solution's approach.

KEY TECHNOLOGIES

> Docker
> Kubernetes
> Prometheus
> Apache Kafka
> Grafana
> RADOLAN
> KOSTRA
> Pegel-Online
> Open Stack
> Open Telekom Cloud
> Mundi WebServices
> Copernicus
> ArcGIS Image Server

In 2019, 52°North implemented Docker, Kubernetes and Kafka-based components of the processing infrastructure and integrated them with the ArcGIS-based data and visualization services to form a complete system. The infrastructure has been deployed into the Copernicus DIAS platform Mundi Web Services. The system has been running in a test and validation mode since mid-2019.



Near real-time EO data processing

PARTNERS

> **con terra GmbH**, http://www.conterra.de
> **EFTAS Fernerkundung Technologietransfer GmbH**, https://www.eftas.de/

ASSOCIATE PARTNERS

> **VdS Schadenverhütung GmbH**, https://vds.de/
> **CLAAS KGaA mbH**, https://www.claas.de
> **Wupperverband**, https://www.wupperverband.de/

FUNDING

SenSituMon is funded by the German Federal Ministry for Economic Affairs and Energy (BMWI).

Federal Ministry
for Economic Affairs
and Energy

FACTS

Duration
11/2017 – 01/2020

Website
http://sensitumon.eu/

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Project Type
Research and Development

WaCoDiS

Automated Workflows for Creating EO Products

Copernicus-based services for monitoring material inputs in watercourses and dams

The WaCoDiS research project aims to implement a geoinformation infrastructure that has been specifically optimized to account for water quality control, water protection and protection of access to clean drinking water, as well as river basin management monitoring tasks. For this purpose, Earth Observation data from the Copernicus Program, weather data (i.e. from the German Weather Service, DWD) and in situ sensor data for monitoring water bodies will be combined, merged and analyzed via innovative and automated workflows. Input data, results, and the functionalities developed will be provided and cross-linked via interoperable services.

The project will develop a WaCoDiS architecture and system design based on a detailed analysis of user requirements, as well as the technical and scientific status quo. Special consideration will be given to the integration of potentially large Earth Observation data sets (i.e. from the Copernicus Program), the integration of cloud-based processing platforms (e.g. CODE-DE) and modern communication patterns ensuring the timely delivery of information.

The WacCoDiS activities also comprise the evaluation, preparation and persistence of appropriate Sentinel and DWD data, the development of automated analysis algorithms, and the implementation of interoperable data processing and access services. Complementary to this, essential hydrological models will be adapted and developed.

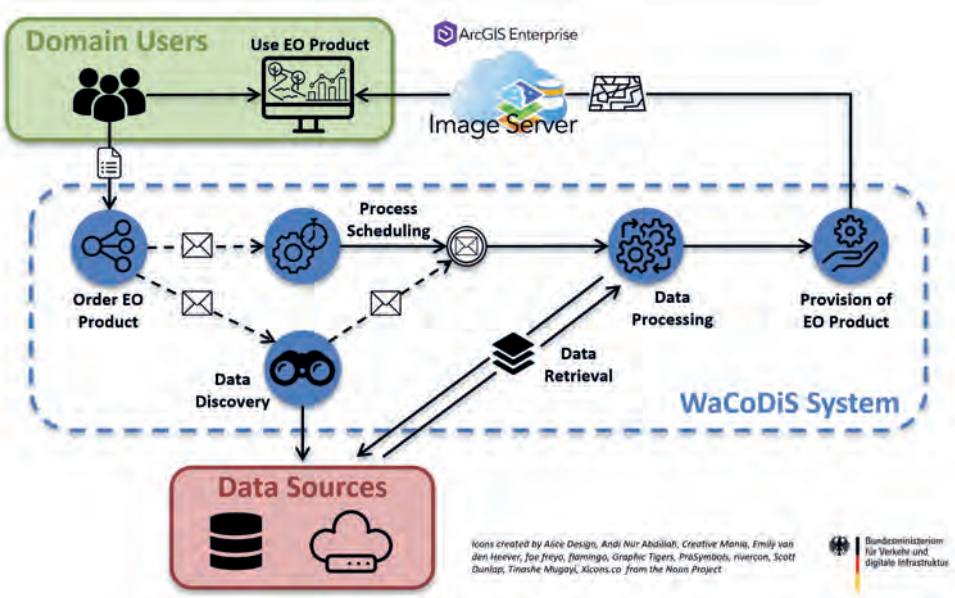
52°North's activities focus on supporting the requirements analysis, developing the system architecture (in close collaboration with the Bochum University of Applied Sciences), and implementing system components. 52°North also evaluates different approaches for enabling efficient processing of Copernicus data, interoperable provision of domain-specific processing and analysis models, as well as new technologies for data sharing. The 52°North contribution particularly focuses on event-driven communication patterns in spatial data infrastructures and cloud-based data processing approaches. Complementary work comprises the contribution of results and experience gained during

KEY TECHNOLOGIES

- > Earth Observation data
- > Copernicus
- > Sensor Web
- > Microservices
- > Cloud
- > Event-Driven Workflows
- > ArcGIS

WaCoDiS to the international standardization process and the evaluation of recent and ongoing standardization activities regarding their relevance to WaCoDiS (e.g. OGC Publish/Subscribe standard, OGC SensorThings API).

The goal for 2019 was to finalize a first version of the system architecture and realize a demonstrator application. 52°North developed the system's different microservices to manage the automatic creation of Earth Observation products. The overall system was successfully presented at the consortium meeting in June. During the remainder of the year, 52°North gathered feedback on the demonstrator application and realized corresponding adjustments to the system in multiple cycles.



WaCoDiS workflow

PARTNERS

- **Bochum University of Applied Sciences, Coordinator**
  https://www.hochschule-bochum.de/
- **Wupperverband,** https://www.wupperverband.de/
- **EFTAS Fernerkundung Technologietransfer GmbH**, https://www.eftas.de

ASSOCIATE PARTNERS

- **ITZBund (Informationstechnikzentrum Bund, Ilmenau)**
  https://www.itzbund.de
- **Netteverband**, http://www.netteverband.de
- **Niersverband**, https://www.niersverband.de

FUNDING

WaCoDiS is funded by the German Federal Ministry of Transport and Digital Infrastructure (BMVI) as part of the of the mFUND program.

Federal Ministry of Transport and Digital Infrastructure

mFUND Das Startkapital für die Mobilität 4.0

FACTS

Duration
08/2017 – 07/2020

Website
https://wacodis.fbg-hsbo.de/

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Project Type
Research and Development

CDI@IT.NRW

Copernicus Data Infrastructure at IT.NRW

Efficient processing of Copernicus satellite and in situ data

The LANUV NRW Competence Center Remote Sensing uses Copernicus data to monitor protected biotopes. However, the available IT infrastructure is not sufficient to cope with the resulting data volumes and intensive computational processing processes. Other state authorities in North Rhine-Westphalia see themselves in a similar situation. IT.NRW provides central IT infrastructure services to the state authorities in its capacity as a national data center. It intends to expand its range of services for the use of remote sensing data. For this development, IT.NRW uses an agile process. A number of pilot projects are used to develop structures and answer questions that contribute to the sustainable development of an efficient Copernicus data infrastructure for the state administration in NRW.

The first pilot project focused on the detection and qualification of orchards in NRW. As part of the project, the technical requirements for the most extensive automated processing of Copernicus (S2) data and other in situ data sources (e.g. DEM, DSM, ATKIS) were created. Basic questions concerning data organization, the efficient processing of Copernicus data, and the ArcGIS based dissemination of Copernicus data and derived information products in the IT infrastructure of the state administration were also answered.

52°North supported the requirement analysis as well as architectural design and implementation of the Docker/Kubernetes based infrastructure.

All work, with the exception of the requirements analysis, was carried out in 2019.

KEY TECHNOLOGIES

> Docker
> Kubernetes
> Python
> ArcGIS

FACTS

Duration
11/2018 – 11/2019

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Project Type
Professional Services

CUSTOMER

> **State Agency Information and Technology North Rhine-Westphalia – IT-NRW**
https://www.it.nrw/

PARTNERS

> **con terra GmbH (main contractor)**, https://www.conterra.de/
> **EFTAS Fernerkundung Technologietransfer GmbH**, https://www.eftas.de/

EUMETSAT EOWS Pathfinder

Earth Observation Web Based Services

Designing the next generation of Online Data Access Services

As part of an evolution to its data services, EUMETSAT has set up a series of Pathfinder Projects to explore new data access capabilities. Their aim is to develop a new portfolio of data services within 2020. The Earth Observation Web Based Services (EOWS) project framework has the goal to design and realize a set of Pathfinder Projects. In a consortium led by CGI Deutschland, 52°North works with con terra, ask visual and GeoSolutions to develop a flexible, scalable and extensible architecture for providing access to EUMETSAT's products.

52°North focuses on the development of the web application for intuitive EO data access. The application is designed to provide an easy-to-use web interface for end users in order to identify EO products of interest. It comprises a search interface with spatial, temporal and thematic filters. The users are able to examine the details (e.g. the spatial footprint, sensing time, satellite instruments used) and start the download of single or multiple products.

In the latest development iteration, the main focus was on the integration of the feedback provided by EUMETSAT's users. The look and feel of the Data Access UI (formerly known as the "OLDA UI") has been completely overhauled. In collaboration with UI/UX experts of CGI, 52°North realized a modern and lightweight user interface that includes additional convenience features, such as a shopping cart functionality. Intuitive filter widgets have also been introduced to provide the user with the best possible experience.

CUSTOMER

> **EUMETSAT**, https://www.eumetsat.int/

PARTNERS

> **CGI Deutschland B.V. & Co. KG**, https://www.de.cgi.com/de
> **con terra GmbH**, https://www.de.cgi.com/de
> **ask – Innovative Visualisierungslösungen GmbH**, https://askvisual.de/
> **GeoSolutions S.A.S.**, https://www.geo-solutions.it/

KEY TECHNOLOGIES

> JavaScript/TypeScript (Single Page Application)
> Angular
> OpenAPI

FACTS

Duration
05/2017 – 04/2020

Website
https://olda.eumetsat.int/

Contact
Matthes Rieke
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Project Type
Professional Services

prospective.HARVEST

Digital logistic chain management for harvesting silage maize

Methods and technologies to support predictive planning and control of cooperative agricultural processes

prospective.HARVEST aims to realize an information infrastructure that proactively supports agricultural processes, using silage maize harvesting as an example. An open, service-oriented architecture has been specified, implemented and tested. It provides novel services for planning and controlling the harvesting campaign and pro-active adjustment of the harvester by utilizing various data sources, such as the machines themselves, Copernicus satellite data or other external data sources.

prospective.HARVEST

KEY TECHNOLOGIES

- > OpenAPI
- > REST
- > Docker
- > Spring Cloud
- > Consul
- > ELK-Stack
- > RabbitMQ
- > Open Telekom Cloud

52°North's contribution focused on the specification of the general prospective.HARVEST architecture, its implementation and setup. This included the definition of a common data model, the specification of service APIs to offer flexibility and processability throughout the architecture, and the general setup for base architectural components. These components enable architectural requirements, such as service discovery, centralized logging and configuration, as well as event-driven and real-time exchange of information between the components (e.g. data coming from machines). In addition, 52°North designed and developed basic processing services, such as a routing service for agricultural machines and a service for computing time/distance matrices between a set of fields and field access points based on OpenStreetMap data.

Moreover, 52°North was responsible for the deployment environment in the Open Telekom Cloud. We set up a dockerized deployment environment that enables the partners to easily and continuously deploy their components. Finally, 52°North supported the integration and evaluation of the different prospective.HARVEST components in three different field tests.

The project was finalized in 2019, i.e. the final iteration of the prospective.Harvest architecture was specified, implemented and tested. The evaluation of the final field test in 2019 revealed that the overall system is stable and provides helpful planning recommendations for each step of the harvest chain.

Optimizing the harvesting process using geospatial data

PARTNERS

- **CLAAS E-Systems KGaA mbH & Co KG, Coordinator**
  http://www.claas-e-systems.com/
- **CLAAS Selbstfahrende Erntemaschinen GmbH**, https://www.claas.de/
- **green spin GmbH**, https://www.greenspin.de/
- **365FarmNet GmbH**, https://www.365farmnet.com/en/
- **Deutsches Forschungszentrum für künstliche Intelligenz GmbH**
  https://www.dfki.de/web/
- **Hochschule Bochum**, https://www.hochschule-bochum.de/

FUNDING

prospective.HARVEST is funded by the Federal Ministry of Food and Agriculture in accordance with the parliamentary resolution of the German Parliament, Grant no.: 2815700915.

Federal Ministry of Food and Agriculture

Federal Office for Agriculture and Food

FACTS

Duration
08/2016 – 11/2019

Website
https://www.prospective harvest.de/de/startseite.html

Contact
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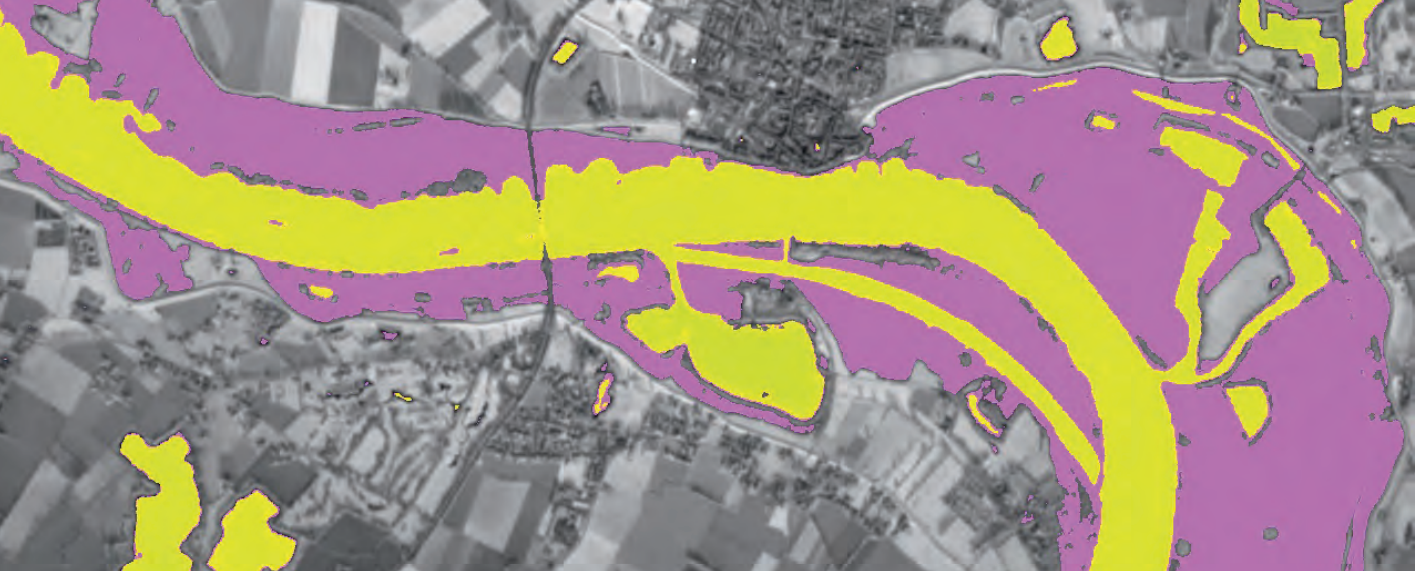
Project Type
Research and Development



OGC Testbed 15

New Levels of Interoperable Geospatial Data Processing

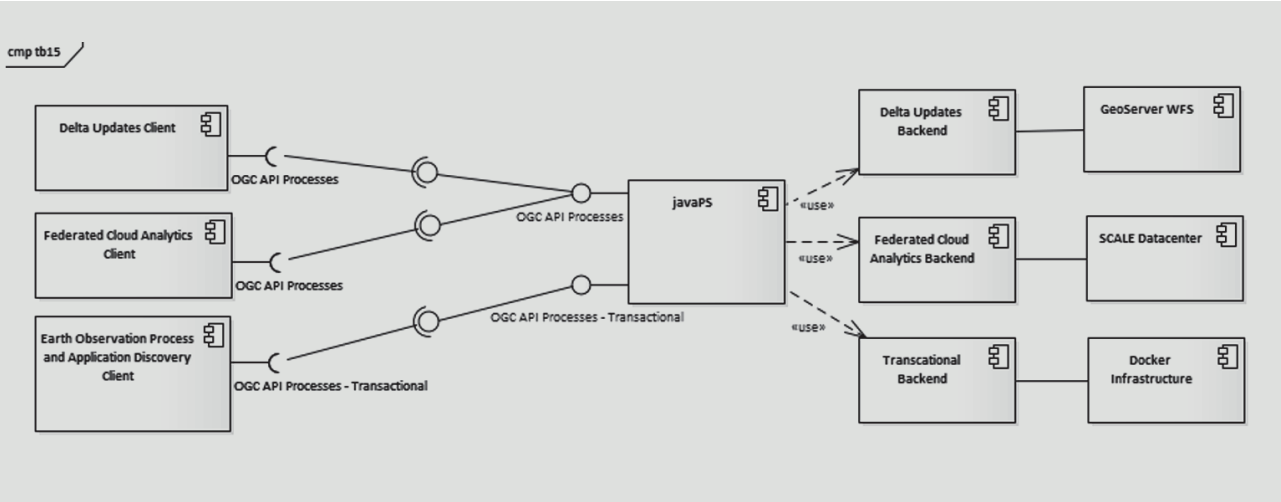
Developing OGC API Process standard

The Open Geospatial Consortium's (OGC) Testbed 15 is part of the OGC Innovation Program, which provides global, hands-on, collaborative prototyping for rapid development and delivery of proven candidate specifications to the OGC Standards Program. These candidates can then be considered for further action. The 15th iteration of the OGC Testbeds focused on a set of thematic topics, namely Machine Learning, Data-Centric Security, Delta Updates to Data, Earth Observation Process and Application Discovery, Federated Cloud Analytics as well as Portrayal. These different topics are organized in individual threads that are considered separate projects with potential thematic overlap.

52°North participated in the Delta Updates (DU), Earth Observation Process and Application Discovery (EOPAD) and Federated Cloud Analytics (FCA) threads. In all threads, the contribution focused on the development, testing and improvement of the upcoming OGC API Processes standard. We extended the 52°North javaPS to support this standard's REST API and data model. Thematically, 52°North developed several use cases, in which the OGC API Processes played an important architectural role. For example, a distributed processing system for Earth Observation data was developed in the EOPAD thread. Docker-based processes and algorithms were made available via the javaPS. The discovery of available web-based processes was established by automated interaction with a catalogue service for EO applications.

KEY TECHNOLOGIES

> Web Processing
> javaPS
> OGC API Processes
> Earth Observation
> Copernicus



javaPS processing backends created within Testbed-15. The clients developed by other Testbed participants used the implemented REST APIs.

PARTNERS

- **CubeWerx Inc.**, https://www.cubewerx.com/
- **Helyx SIS Ltd.**, https://www.helyx.co.uk/
- **Spacebel s.a.**, https://www.spacebel.be/
- **DEIMOS Space S.L.U** http://www.elecnor-deimos.com/delegacion/deimos-space-madrid/
- **George Mason University**, http://csiss.gmu.edu
- **Terradue Srl**, https://www.terradue.com/portal/
- **Solenix Deutschland GmbH**, https://www.solenix.ch/
- **ImageMatters LLC**, https://www.imagemattersllc.com/
- **rasdaman GmbH**, https://www.rasdaman.com/

FUNDING

The OGC Testbed 15 was funded by multiple sponsors, including:

- **European Space Agency (ESA)**, https://www.esa.int/
- **Defence Science and Technology Laboratory (Dstl)** https://www.gov.uk/government/organisations/defence-science-and-technology-laboratory
- **Natural Resources Canada (NRCan)**, https://www.nrcan.gc.ca/
- **US Geological Survey (USGS)**, https://www.usgs.gov/
- **US National Aeronautics and Space Administration (NASA)** https://www.nasa.gov/

FACTS

Duration
04/2019 – 11/2019

Website
https://www.opengeospatial.org/projects/initiatives/testbed15

Contact
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Project Type
Research and Development

OGC Routing Pilot

Developing a web-friendly API for Routing on Road Networks

Implementing OGC API Processes prototype

The goal of the Open Routing API Pilot was “to develop an API that allows requesting routes from different providers in a coherent, standardized way via Web protocols”. The pilot developed a Route Exchange Model and Web-friendly Routing API to be served by the upcoming OGC API Processes standard. Different datasets (e.g. HERE road network, OpenStreetMap) were used with different routing algorithm implementations to prove the interoperable design of the Routing API and the underlying data model. The Pilot activities developed both a process profile for the OGC API Processes as well as a lightweight convenience API defined with an OpenAPI 3.0 specification.

52°North’s two central contributions were the improvement and testing of the OGC API Processes interface for the application of routing as well as the prototypical realization of an OGC API Processes implementation. The latter was based on an extended version of the 52°North javaPS software framework. Overall, the focus lay on the developer-friendly design of the two APIs. 52°North documented the major outcomes in two Engineering Reports as well as in the creation of a set of Change Requests for the upcoming OGC API Process standard specification. A set of videos demonstrate the concept and realization of the Routing Pilot and its Web APIs (see QR Code).

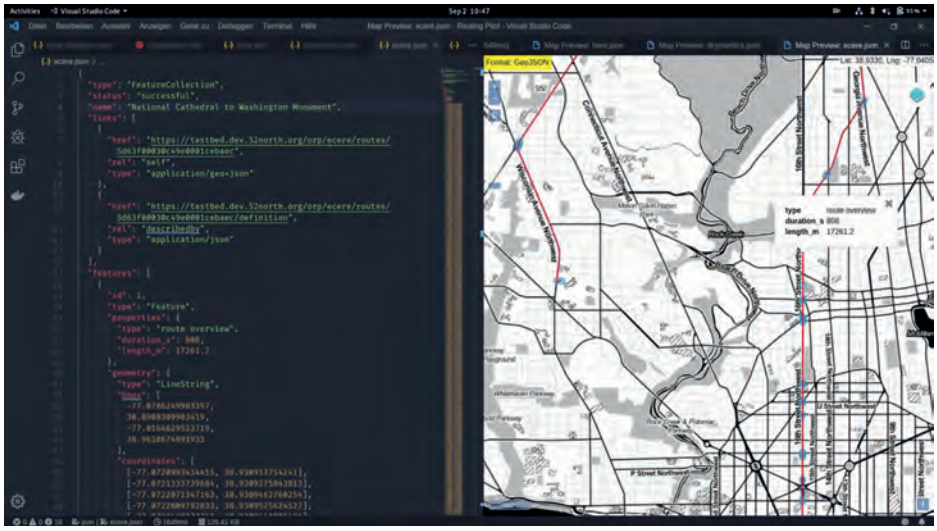
KEY TECHNOLOGIES

> Web Processing

> JavaPS

> OpenAPI

> OGC API Processes



Prototypical realization of OGC API Processes implementation

Video demonstration

PARTNERS

> **Ecere corporation**, http://ecere.ca/
> **GIS Research Center at Feng Chia University (GIS.FCU)** http://www.gis.tw/en-US
> **Helyx SIS Ltd., https://www.helyx.co.uk/**
> **interactive instruments GmbH**, https://www.interactive-instruments.de/
> **Skymantics LLC**, https://skymantics.com/
> **HERE**, https://www.here.com/

FUNDING

The OGC Routing Pilot was funded by the following sponsors

> **Strategic Alliance Consulting, Inc.**, https://www.strategicaci.com/
> **Army Geospatial Center (AGC)**, https://www.agc.army.mil/

FACTS

Duration
05/2019 – 09/2019

Website
https://www.opengeospatial.org/projects/initiatives/routingpilot

Contact
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Project Type
Research and Development


Spatio-Temporal
Data Analytics

Developing analytical tools to address real world problems

The Spatio-Temporal Data Analytics Lab strives to develop data-driven solutions to real world problems. The volume and variety of data is constantly increasing and hence provides a large potential to answer a range of questions. To understand these data and to model relationships emerging from it in order to derive answers, analytical tools are required and need to be developed.

Exploring and researching analytical tools from linear statistics, recent multivariate distributions to modern Machine Learning (ML) and Artificial Intelligence (AI) approaches, the lab develops an appropriate solution for the problem at hand given the data available. A prerequisite is a solid data and business understanding. We use and contribute to open source tools where possible and encourage Citizen Science.

The lab addresses different R&D and PS projects covering a range of topics. One is the prediction of traffic safety based on the relationship between ambient conditions of accidents and events derived by driver assistance systems. These systems are used to predict the traffic safety for forecasted ambient conditions on road networks. We also work on the improvement of traffic management based on floating car data trajectories. The challenge of making earth observation time series accessible and providing unified processing and analysis tools has been and remains an engineering topic solving several open questions. The meaningful integration of heterogeneous data sources (from geospatial observations to official statistics) and adopting ML and AI algorithms to the special characteristics of spatial and spatio-temporal data are central themes of forthcoming tasks.

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PreASiSt

Predictive Analytics for Traffic Safety

Assessing the applicability of predictive policing and predictive analytics for improving traffic safety

The objective of PreASiSt is to assess whether general concepts of predictive policing can be adopted and applied to the field of traffic safety. The motivation of predictive policing is to predict crimes before they occur.

In terms of traffic safety, a model should help to understand and capture conditions that could trigger an accident. Forecasts of these variables can be used to predict and evaluate the risk of accidents. Based on these risks, the police can plan and take measures to increase traffic safety in these areas. In order to identify relevant parameters, this project approaches the problem from a theoretical and data driven view point, using the Cross Industry Standard Process for Data Mining (CRISP). The city of Bremen provided a detailed history of traffic accidents and other relevant data sets and their local police contribute expert knowledge.

52°North focuses on data analytics. We investigate both the suitability of available data sources for predictive data analysis and the use of machine learning methods for creating accident risk prediction models. However, data understanding can only be achieved by understanding the underlying processes. Hence this work is done in close collaboration with the German University of the Police (DHPOL) and the local experts from the Bremen Police.

During 2019, 52°North put a large effort into acquisition and preparation of the data. Work included the examination of different data sources to determine their potential use for predictive policing. This resulted in the integration of a subset of promising data sets (traffic counts in Bremen, weather data, accident data based on EUSKA, traffic data from HERE, OSM road network) in a common database for analysis. 52°North also developed a model based on machine learning algorithms that extracts the information on accident occurrences from this huge data set.

KEY TECHNOLOGIES

- R and Python for Data Analytics
- QGIS, ArcGIS
- HERE Traffic Analytics, BMW Live

Hotspots of traffic accidents in Bremen's inner city

PARTNERS

> **Deutsche Hochschule der Polizei – DHPol**, http://dhpol.de

ASSOCIATE PARTNERS

> **Polizei Bremen**, https://www.polizei.bremen.de/
> **Gesamtverband der Deutschen Versicherungswirtschaft e.V. – GdV (gdv.de) – Unfallforschung der Versicherer (UDV)**, https://udv.de
> **TSC – Beratende Ingenieure für Verkehrswesen**, http://mvup.de
> **con terra GmbH**, http://www.conterra.de

FUNDING

PreASiSt is funded by the German Federal Ministry of Transport and Digital Infrastructure (BMVI) as part of the of the mFUND program.

Federal Ministry of Transport and Digital Infrastructure

mFUND
Das Startkapital für die Mobilität 4.0

FACTS

Duration
03/2019 – 02/2020

Website
https://www.bmvi.de/SharedDocs/DE/Artikel/DG/mfund-projekte/preasist.html

Contact
Dr. Benedikt Gräler
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Project Type
Research and Development

CITRAM

Citizen Science for Traffic Management

Improving the provision of information for traffic management and environmentally conscious driving

The CITRAM project develops new concepts and technologies that will help improve the provision of information for traffic management as well as the development of environmentally aware driving behavior. At the heart of this development is the coupling of system components that enable scientists, traffic engineers and citizens to collaborate on knowledge acquisition concerning driving in motorized traffic (Citizen Science for sustainable mobility).

The urban institute provides data from the municipal information infrastructure (IoT platform Urban Pulse) and develops a traffic light phase assistant (EcoMat), which takes into account the dynamic control of traffic light systems. Deggendorf University supports the integration of electric vehicles. 52°North complements the existing Citizen Science platform enviroCar with interfaces to the urban information infrastructure and electric vehicles, develops new and improved analysis functions, and supports near real-time communication with the rest of the system components. Based on the data generated by the partners' system components, TSC Traffic Engineering develops value added services for municipal traffic management. Measurement campaigns and practical tests in the cities of Krefeld, Hamm and Chemnitz help to evaluate the concepts and developments.

52°North's main task is the development of new and improved analysis methods for XFCD trajectories. New features include the near real-time aspect of data processing, the support of data from electric vehicles, and the enhancement of MapMatching and HotSpot analysis for network related road data (such as energy consumption). The efficient integration of the Citizen Science platform enviroCar into an open landscape of data provision and information retrieval systems (e.g. QAD Services, driver assistance systems) requires new architectural concepts that cover the aspects of event driven systems, scalable process chains and lightweight microservices.

KEY TECHNOLOGIES

> Android
> Java
> MongoDB
> Apache Kafka
> PostGreSQL
> Geoserver
> OpenStreetMap

Based on a requirements analysis, 52°North developed an architecture for the project's components that supports the project's goals and enables the interaction of the systems involved. This also required a redesign of the envirocar system architecture. The enviroCar app can now automatically acquire data and record tracks without an OBD adapter, using the transport mode detection. 52°North developed and implemented new algorithms for estimating energy consumption and CO2 emissions. The integration of the OpenStreetmap database was the prerequisite for the development of new MapMatching algorithms, data analysis (QAD interface) and improved visualization.

Comparison between speed limits and average velocities (Red: < 50% of limit – green > 80% of limit)

PARTNERS

> **Urban Software Institute GmbH**, https://www.ui.city
> **TSC Beratende Ingenieure für Verkehrswesen**, https://www.mvup.de
> **Technische Hochschule Deggendorf**, https://www.th-deg.de
> **Stadt Chemnitz**, https://www.chemnitz.de
> **Stadt Hamm**, https://www.hamm.de
> **Stadt Krefeld**, https://www.krefeld.de

FUNDING

CITRAM is funded by the German Federal Ministry of Transport and Digital Infrastructure (BMVI) as part of the of the mFUND program.

Federal Ministry of Transport and Digital Infrastructure

mFUND Das Startkapital für die Mobilität 4.0

FACTS

Duration
09/2018 – 08/2020

Website
http://www.citram.de

Contact
Prof. Dr. Albert Remke
a.remke@52north.org

Project Type
Research and Development

MuDak-WRM

Improved Reservoir Management with Easily Parameterized Models

Multidisciplinary data acquisition as key for globally applicable water resource management

Water is a highly valuable good worldwide. It must be managed with care in order to fulfill the needs of diverse consumers. The quality of a water reservoir not only depends on the reservoir itself, but is also influenced by the surrounding environment and the entire catchment. While in situ monitoring of a reservoir provides detailed data, it is also very costly. The MuDak-WRM project aims to identify proxies that provide insights into the quality of a reservoir. These should be detailed enough for mid-range management and applicable worldwide.

Specific goals are the complexity reduction of current water reservoir (management) models, their parameterization based on a minimal data set, the development of a central data delivery service, wrapping models in web processing services (WPS) and a common visual web-based water quality exploration tool. A key constraint is the parameterization based on Sentinel data and a minimum of additional in situ measurements in order to achieve a globally applicable but nevertheless sensible monitoring framework.

A central data access point should provide and merges in situ and remote sensing data. 52°North develops of an open source service that grants access to spatial and spatio-temporal data from in situ sensors, measurement campaigns, drones and Sentinel missions. A key challenge originates from the data's different spatial and temporal resolutions, where autonomous in situ sensors continuously report measurements within minutes at fixed locations, field campaigns can produce data acquired in seconds along 3-dimensional trajectories and remote sensing data is collected on a daily scale with a large 2-dimensional coverage.

52°North assesses the storage of gridded data in different databases (SciDB, Geoserver) according to the fast retrieval of pixel time series. Web coverage and Web map services (OGC WCS and WMS) facilitate the access. The sensor observation service (OGC SOS) provides in situ measurement data. Web processing services (OGC WPS) provide

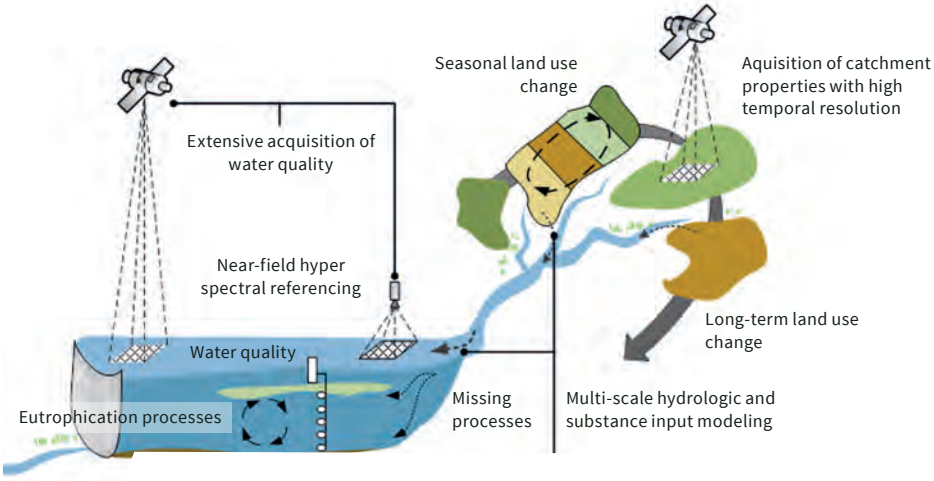
MuDak-WRM

KEY TECHNOLOGIES

- Sensor Observation Service (SOS)
- Geoserver
- SciDB
- Web Coverage Service (WCS)
- Web Mapping Service (WMS)

models developed by the consortium that build upon the centralized data. 52°North and the Wupperverband develop a joint interface to the reservoir data.

In 2019, the MuDak-WRM Spatial Data Infrastructure (SDI) evolved to meet the partners' needs. A project workshop in Curitiba resulted in the integration of the local Brazilian dam operator's obsevation into the proejct's SDI. In order to support the use of remote sensing imagery, 52°North evaluated different solutions to integrate raster stores into SDI and implemented a solution based on Geoserver. The Wupperverband developed a viewer for the SDI. Furthermore, 52°North and the Wupperverband cooperated closely to develop a pragmatic approach to support scientists in the publication of CSV encoded research data via the MuDak-WRM infrastructure.



Detailed prognosis of water quality and availability

PARTNERS

> **Karlsruher Institut für Technologie (KIT)**, http://www.kit.edu/
> **Universität Koblenz Landau**, https://www.uni-koblenz-landau.de/de
> **Hydron GmbH**, https://www.hydron-gmbh.de/dienstleistungen/
> **Wupperverband**, https://www.wupperverband.de/
> **EFTAS Fernerkundung Technologietransfer GmbH**, https://www.eftas.de/

ASSOCIATE PARTNERS

> **Sanepar**, http://site.sanepar.com.br/
> **Universidade Federal Do Paraná (UFPR)**, http://www.ufpr.br/portalufpr/
> **Universidade Positivo**, https://www.up.edu.br/
> **EMATER**, http://www.emater.pr.gov.br/
> **Instituto das Águas do Paraná (Auguas Paraná)** http://www.aguasparana.pr.gov.br/
> **Agência Nacional De Águas (ANA)**, http://www.aguasparana.pr.gov.br/

FUNDING

MuDak-WRM is funded by the German Federal Ministry of Education and Research (BMBF) within the program Global Resource Water (GRoW).

Federal Ministry of Education and Research

GRoW WATER AS A GLOBAL RESOURCE

FACTS

Duration
04/2017 – 07/2020

Website
http://www.mudak-wrm.kit.edu/

Contact
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Project Type
Research and Development

KISTE

KI STrategie für Erdsystemdaten

AI for the analysis of Earth Observation data

KISTE aims at facilitating and evaluating the use of AI for remote sensing Earth Observation data for a range of applications. The fields studied in the project range from air quality to clouds and radiation to snow and ice propagating as well as water that drives vegetation, closing the loop with air quality again. A core focus is not only to adopt and apply AI concepts to these areas, but to also train several PhD students and build an e-learning platform to ease and facilitate access to the algorithms and tools developed for a wider audience from scientists to practitioners.

52°North will develop the Spatial Data Infrastructure that will serve the AI processing platform with data. A requirement analysis will provide the basis for defining and developing interfaces for data acquisition and provision. The platform must react flexibly to the requirements of the AI algorithm requesting data in order to be able to provide data in an optimized processing way. 52°North will also contribute its experience from previous projects, such as SenSituMon, and develop AI analytics.

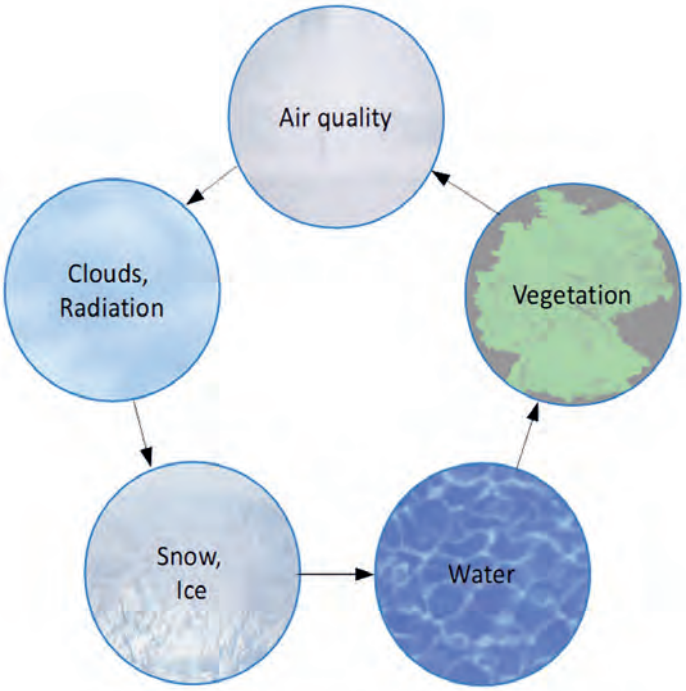
KEY TECHNOLOGIES

> Cloud

> SDI

> R Programming Language

> Python



AI for earth system data

PARTNERS

> **Forschungszentrum Jülich GmbH**, https://www.fz-juelich.de
> **Jülich Supercomputing Centre (JSC)**, https://www.fz-juelich.de/ias/jsc/
> **und Institut für Bio- und Geowissenschaften – Agrosphäre (IBG-3)**
https://www.fz-juelich.de/ibg/ibg-3/
> **Universität zu Köln, Institut für Geophysik und Meteorologie**
https://www.geomet.uni-koeln.de/
> **Universität Bonn, Institut für Geodäsie und Geoinformatik**
https://www.igg.uni-bonn.de/de
> **RWTH Aachen, Aachen Institute for Advanced Study in Computational Engineering Science**, https://aices.rwth-aachen.de/
> **Ambrosys GmbH Gesellschaft für Management komplexer Systeme, Potsdam**

ASSOCIATE PARTNERS

> PhDs will apply to become associated with the **Helmholtz School for Data Science in Earth, Life and Energy**, https://www.hds-lee.de/

FACTS

Duration
03/2020 – 02/2023

Contact
Dr. Benedikt Gräler
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Project Type
Research and Development

FUNDING

KISTE was submitted for funding by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

EOTSA Toolbox

Earth Observation Time Series Analysis Toolbox

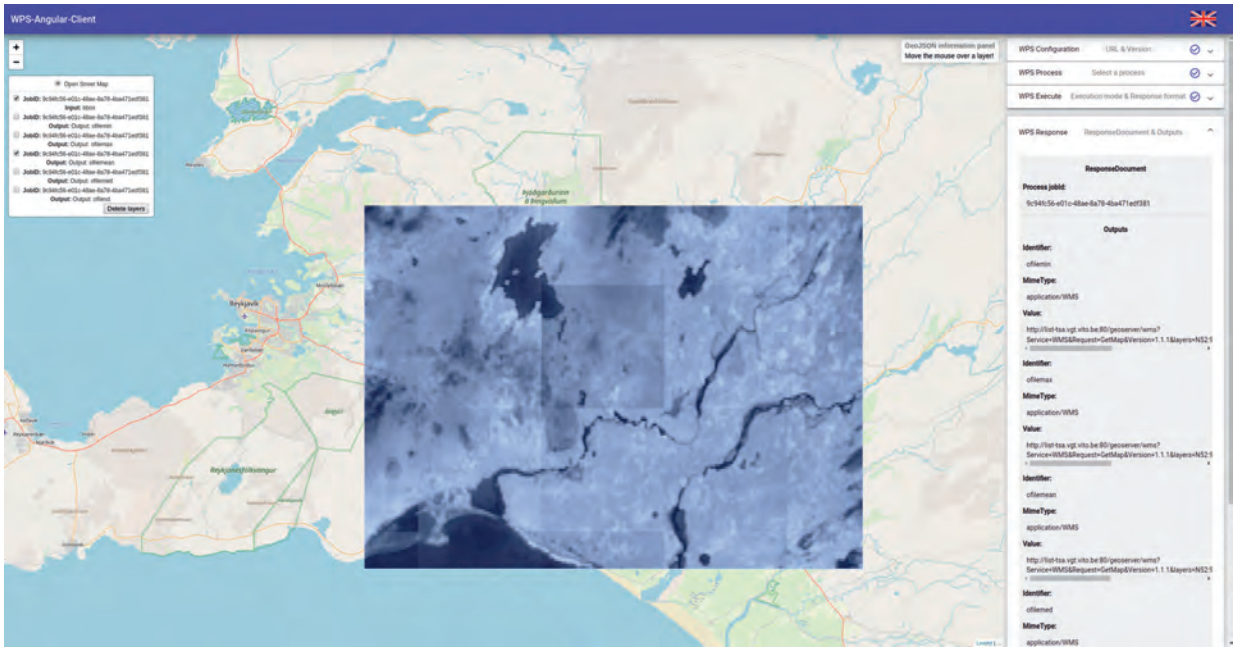
Development of an Earth Observation Time Series Analysis Toolbox for Proba-V data

The core focus of this project is the implementation of a time series analysis toolbox for remote sensing imagery in R. The toolbox is developed by LIST for ESA according to the needs of the NDVI time series analysis community. 52°North contributed to the toolbox development (outside project funding). The data is derived from the Proba-V satellite provided by the corresponding mission exploitation platform (MEP) at VITO (Flemish Institute for Technological Research NV, Belgium). The toolbox largely builds on existing specialized R packages and functions for raster and time series analysis combining these in a common framework. In order to ease access and usage of the toolbox, it must be deployed in the MEP Spark Cluster and wrapped in a Web Processing Service (WPS) using 52°North's WPS4R extension. The WPS is also re-used in the Automatic Service Builder developed by Space Applications Services NV/SA, Belgium. Hence, the analytics developed in R can be integrated into a larger workflow potentially integrating external data. The WPS provides a Webclient including a preview of the results in a map window for usage within the MEP.

Beginning in 2019, 52°North and LIST reviewed and integrated the R-scripts constituting the Earth Observation Time series Analysis Toolbox into an R package. After checking the toolbox on a local system, we put forward the integration into the larger set-up. The toolbox was stepwise deployed on the Virtual Machine running in the MEP at VITO and the associated Spark Cluster. In the next phase, 52°North wrapped the toolbox into WPS processes using WPS4R. The WPS has been deployed with its angular based Web-Client to give non-expert users access to the time series analytics. Additionally, the Automatic Service Builder (developed by Space Applications Services NV/SA, Belgium) can access and use the WPS.

KEY TECHNOLOGIES

- R, OGC Web Processing Service (WPS)
- WPS4R
- Spark
- Angular
- Geoserver
- OGC Web Mapping Service (WMS)
- OGC Web Coverage Service (WCS)



WPS Web Client view of the EOTSA Toolbox showing the tiled result layer of maxima from a pixel-wise summary statistic over the entire NDVI raster time series

FACTS

Duration
06/2019 – 09/2019

Contact
Dr. Benedikt Gräler
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Project Type
Professional Services

COSTUMER

> **LIST – Luxembourg Institute of Science and Technology**

Software Projects

Developing innovative technologies to advance spatial information infrastructures

52°North fosters applied research in the geospatial domain by managing and supporting the collaborative development of geospatial open source software. Our software is published under Open Source Initiative (OSI) approved open source licenses and hosted at GitHub.

Arctic Sea

Backbone for OGC Services, Clients and Middleware

52°North's framework for developing OGC services, clients and middleware sharing concepts for encoding and decoding of different formats and encodings, workflows and configuration

Arctic Sea is a stack of projects that eases the development of OGC related services, such as 52°North's implementation of the OGC SOS and WPS, as well as clients and middleware. It compromises the following modules.

Iceland: Iceland is a service framework that enables the development of OGC RPC (remote procedure call) based services. It features bindings for KVP, POX, SOAP, as well as JSON-based bindings. Iceland facilitates the rapid development of modular services that use Faroe for easy configuration and Svalbard for request parsing and response generation.

Svalbard: Svalbard consists of various decoders and encoders for OGC models (e.g. SensorML, O&M and SWE Common), service interfaces (like SOS and WPS) and a framework for developing these. This enables the creation of decoupled and reusable encoders and decoders for various encodings (e.g. XML, JSON or NetCDF). The object models used are found in Shetland and shared across 52°North components.

Faroe: Faroe is a configuration API currently featuring a JSON and a SQLite backend. It enables the injection and automatic configuration of settings of various types in classes, including a Spring BeanPostprocessor.

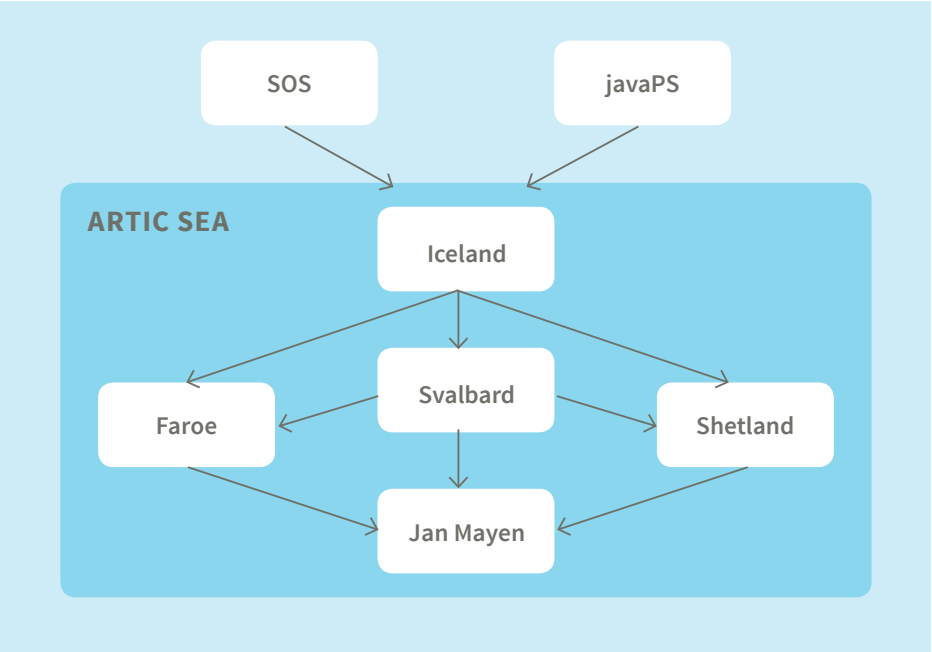
Shetland: Shetland consists of classes for OGC models like SensorML, O&M and SWE Common and various service requests and responses. These are shared across different service implementations.

Jan Mayen: Jan Mayen contains various utility classes shared throughout Arctic Sea.

In 2019, 52°North published several software releases of the Arctic Sea components. The software packages provide developers a solid base for service implementations on top of the Arctic Sea components. They are actively maintained on Maven Central.

KEY TECHNOLOGIES

- OGC Web Services
- Web Processing Service (WPS)
- Sensor Observation Service (SOS)
- SWE Common
- SensorML
- Observation and Measurement (O&M)
- Spring
- Java
- XML



BENEFITS

> The middleware component provides a robust layer to easily create web services compliant to OGC standards.
> The configuration API enables harmonized management of service properties.
> Centralized XML encoding and decoding reduces increases stability.

FIELDS OF APPLICATION

Building blocks for OGC Web Services, OGC Clients, processing of OGC schema data formats (GML, O&M, SensorML, …)

PROJECT REFERENCES

> **NeXOS**, http://www.nexosproject.eu/
> **COLABIS**, https://colabis.de/
> **SeaDataCloud**, https://www.seadatanet.org/About-us/SeaDataCloud
> **ODIP II**, http://www.odip.eu/
> **ConnectinGEO**, http://www.connectingeo.net/
> **GeoViQua**, http://www.geoviqua.org/
> **WaCoDiS**, https://wacodis.fbg-hsbo.de/
> **MuDak-WRM**, https://www.mudak-wrm.kit.edu/
> **BRIDGES**, http://www.bridges-h2020.eu/

DOWNLOAD

GitHub: https://github.com/52North/arctic-sea
Maven Central: https://search.maven.org/search?q=g:org.n52.arctic-sea

FACTS

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Helgoland Sensor Web Viewer

Web-Based Visualization of Observation Data

Enabling exploration, analysis and visualization of sensor web data

The 52°North Helgoland Sensor Web Viewer is a lightweight web application that enables the exploration, visualization, and analysis of Sensor Web data in various fields of use, e.g. hydrology, meteorology, environmental monitoring. It enables users to:

_ Explore stations or mobile sensor platforms in a map

_ Select time series data via a list selection

_ Visualize and navigate through time series data, trajectory data, profile measurements

_ Create favorites of selected time series

_ Export visualized data as CSV files

KEY TECHNOLOGIES

> JavaScript

> TypeScript

> Angular

> Leaflet

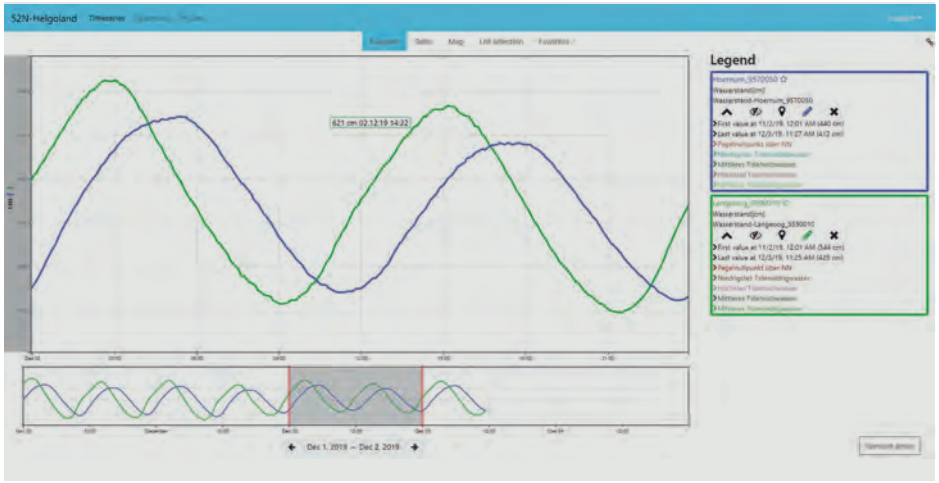
> d3

The Helgoland Sensor Web Viewer can connect to different Sensor Web endpoints (via 52°North Helgoland API). These endpoints provide a thin access layer to sensor data (e.g. offered by SOS servers' databases) via a RESTful Web binding with different output formats.

This software component is based on the Helgoland Toolbox. It integrates the different modules offered by the Helgoland Toolbox into a viewing application that can be easily customized to the requirements of specific users.

The Helgoland developments in 2019 comprised a broad range of new features and improvements. Most importantly, a new version based on the continuously updated Helgoland Toolbox was released (version 2.0). This included an upgrade to Angular 8.x. Another important enhancement is a prototypical support of the OGC SensorThings API as an additional data source beyond the 52°North Helgoland API.

We continuously improved the data presentation (i.e. profiles and trajectories) and functionality (e.g. data selection workflow, downloading of CSV-encoded data) throughout 2019. In addition, the 52°North team improved the handling of observation data collected at specific locations in different height/depth levels.



Helgoland Viewer

BENEFITS

> Lightweight, Web-based visualization of observation data
> Exploration of Sensor Web data sources (SOS, SensorThings API)
> Support of different types of observation data (time series, trajectories, profiles)
> Data download (CSV)

FIELDS OF APPLICATION

Hydrology, air quality, marine sciences, environmental monitoring

PROJECT REFERENCES

> **Federal Maritime and Hydrographic Agency (BSH)**, https://www.bsh.de/
> **Wupperverband**, https://www.wupperverband.de/
> **SeaDataCloud**, https://www.seadatanet.org/About-us/SeaDataCloud
> **WaCoDiS**, https://wacodis.fbg-hsbo.de/
> **MuDak-WRM**, https://www.mudak-wrm.kit.edu/

DOWNLOAD

GitHub: https://github.com/52North/helgoland/

FACTS

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Helgoland Toolbox

Tools for Building Web Applications

Providing reusable Components for Building (Sensor Web) Client Applications

52°North created the Helgoland Toolbox to facilitate the reuse of developments for Sensor Web client applications. It provides a range of modules that offer functionalities for building Web applications dealing with dynamic spatio-temporal data.

The Helgoland Toolbox modules are used to build the 52°North Helgoland Sensor Web Viewer. Additional applications (e.g. the BelAir app, smle, or the developments resulting from the TaMIS project) are also built upon this library.

The most important functional modules comprise:

> Core
  _ Communication with the APIs
  _ Important common services (local storage, time)
  _ Central interfaces and abstract classes
> Caching
  _ Request Caching with Angular Interceptors
> d3
  _ rajectory Graph component
  _ Time Series Graph component
> Depiction
  _ Legend entries
  _ Table view of data
> Map
  _ Controls (Geo-Search, Locate, Zoom, Extent)
  _ Map Selector component
> Selectors
  _ List Selector for observation data
  _ Service Selector for data sources

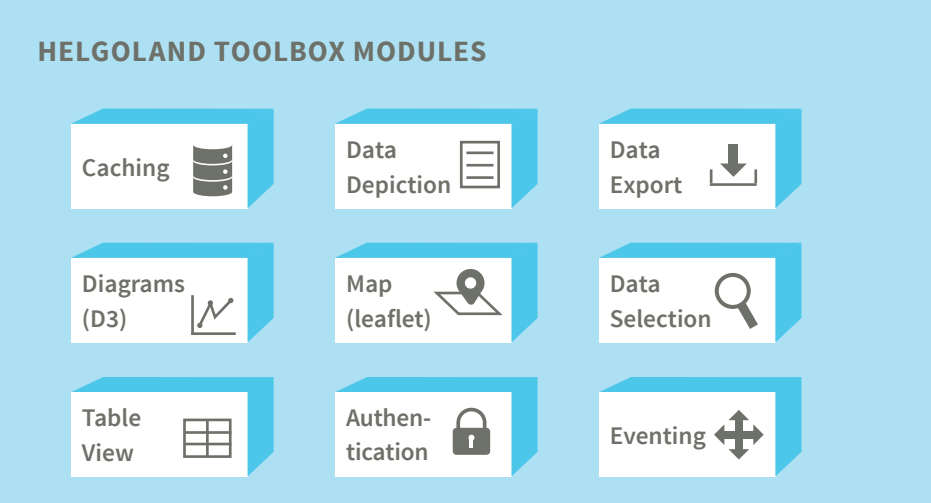
The work on the Helgoland Toolbox comprised several evolutionary improvements and enhancements that were developed as part of several projects (e.g. WaCoDiS,

KEY TECHNOLOGIES

> JavaScript
> TypeScript
> Angular
> Leaflet
> d3
> Open Layers

MuDak-WRM, SeaDataCloud, BSH, Wupperverband Framework Contract). These include:

> Enhancement to connect to instances of the OGC SensorThings API
> Improved caching
> Complementary mapping module based on open layers to support time-dependent background map layers
> Enhanced data export functionality
> Improvements in the diagram visualization
> Facet search for observation data



BENEFITS

> Reusable components for building client applications
> Modules for visualizing different types of sensor data (time series, trajectories, profiles)
> Mapping modules
> Different components for data selection

FIELDS OF APPLICATION

Hydrology, air quality, marine sciences, environmental monitoring

PROJECT REFERENCES

> **Federal Maritime and Hydrographic Agency (BSH)**, https://www.bsh.de/
> **Wupperverband**, https://www.wupperverband.de/
> **SeaDataCloud**, https://www.seadatanet.org/About-us/SeaDataCloud
> **WaCoDiS**, https://wacodis.fbg-hsbo.de/
> **MuDak-WRM**, https://www.mudak-wrm.kit.edu/
> **mVIZ**, https://mviz.geo.tu-dresden.de/
> **IRCEL-CELINE BelAir**, see page 21

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GitHub: https://github.com/52North/helgoland-toolbox

FACTS

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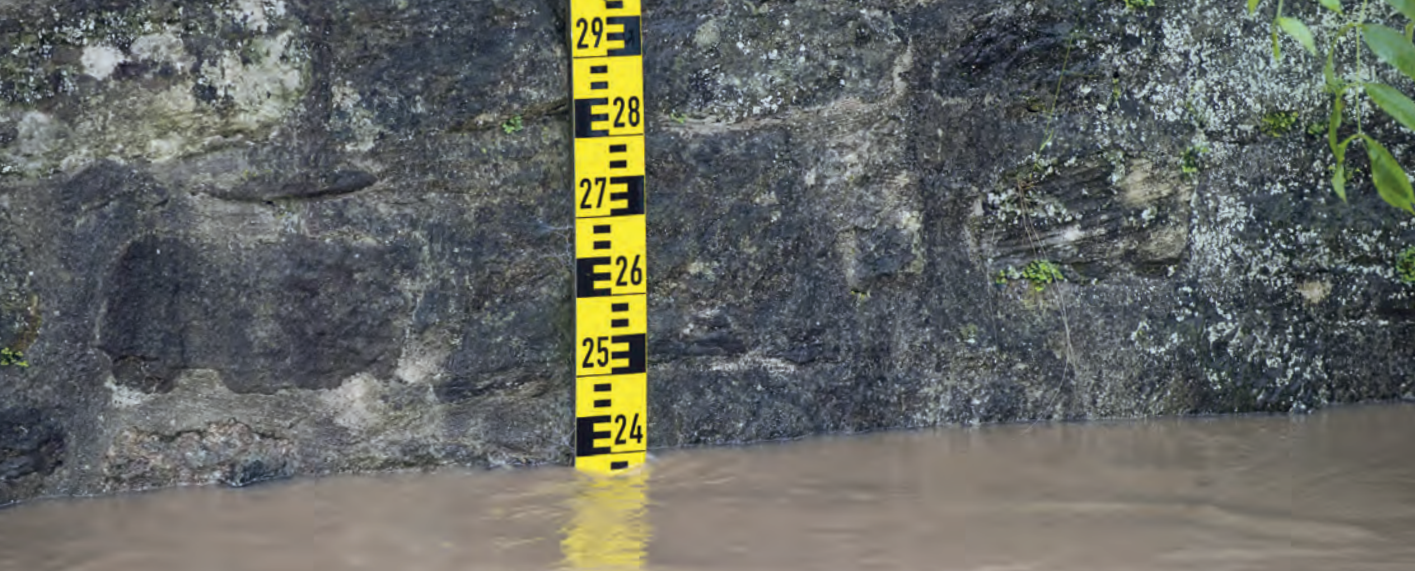


sos4R

R client for OGC SOS

Easing the access to environmental time series data from an OGC Sensor Observation Service

sos4R is an extension of the R environment for statistical computing and visualization. The user can use it to query data from standardized SOS instances (with specific consideration of the OGC SOS 2.0 Hydrology Profile) using simple R function calls. It provides a convenience layer for R users to integrate observation data from SOS servers compliant with the SOS standard without any knowledge about the underlying OGC Sensor Web Enablement standards.

During 2019, 52°North implemented a huge update of sos4R. This included the adoption of the SOS 2.0 specification and the newly developed convenience API that further eases the access of data. This API largely follows a data scientist's view on loading data into R for further analytics. In addition to the major update, 52°North refactored parts of the code and partly replaced R libraries used in SOS4R with current alternatives and successors.

KEY TECHNOLOGIES

- R Programming Language
- OGC Sensor Observation Service 2.0
- OGC WaterML 2.0
- OGC Observations and Measurements 2.0

Definition of a SOS

```
library("sos4R")
library(xts)

niwaHydro <- SOS(url = "https://climate-sos.niwa.co.nz/",
                 binding = "KVP",
                 useDCPs = FALSE,
                 version = "2.0.0")
```

Properties of the data in the SOS

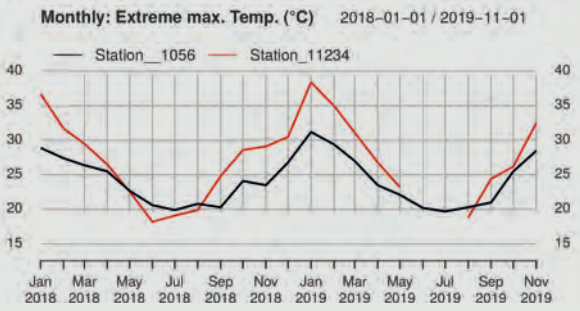
```
sites <- sites(sos = niwaHydro)
phenomena <- phenomena(sos = niwaHydro)
```

Retrieving data from the SOS

```
obsData <- getData(sos = niwaHydro,
                   phenomena = phenomena[18,1],
                   sites = sites[1:2,]$siteID,
                   begin = as.POSIXct("2017-12-10 00:00:00 UTC"),
                   end = as.POSIXct("2019-12-10 00:00:00 UTC"))
```

Conversion to time series and plotting

```
ts1056 <- xts(obsData[obsData$siteID == '1056',3],
              obsData[obsData$siteID == '1056',"timestamp"])
names(ts1056) <- "Station__1056"
ts11234 <- xts(obsData[obsData$siteID == '11234',3],
               obsData[obsData$siteID == '11234',"timestamp"])
names(ts11234) <- "Station_11234"
p <- plot(x = merge(ts1056, ts11234),
     main = "Monthly: Extreme max. Temp. (°C)",
     ylim=c(14,45))
addLegend("topleft", ncol=2, col = c("black", "red"), lty=1)
plot(p)
```



Using sos4R's convenience API to retrieve time series data of monthly extreme maximum temperatures

BENEFITS

> Easier access to environmental time series data
> Automatic generation of SOS requests
> Result handling and parsing into standard R objects
> Convenience API: Data Science oriented functions to load data

FIELDS OF APPLICATION

Hydrology, air quality, any other kind of processing of (in situ) observation data

PROJECT REFERENCES

> **MuDak-WRM**, https://www.mudak-wrm.kit.edu/
> **NIWA**, https://niwa.co.nz/ (NIWA presented the project results at a dedicated workshop at the FOSS4G SOTM Oceania 2019)

DOWNLOAD

GitHub: https://github.com/52north/sos4R/

FACTS

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SOS

Sensor Observation Service

Standardized, Web-based upload, management and download of (in situ) sensor data and metadata

The 52°North Sensor Observation Service (SOS) provides an interoperable web-based interface for inserting and querying sensor data and sensor descriptions. It aggregates observations from live in situ sensors as well as historical data sets (time series data).

The SOS enables users to:

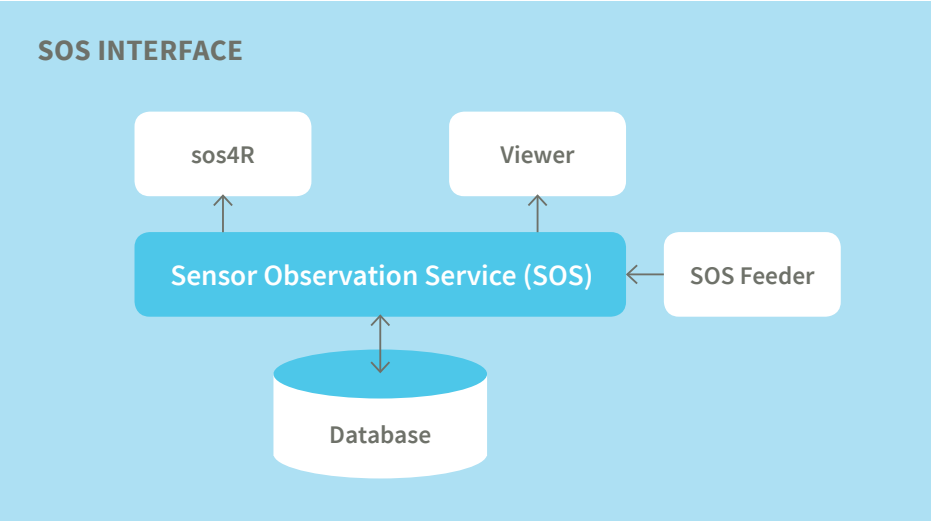
- Publish georeferenced (in situ) observation data
- Access georeferenced measurement data in a standardized format (ISO/OGC Observation and Measurements, OGC WaterML 2.0 OGC TimeseriesML 1.0, INSPIRE O&M Specialized Observations, NetCDF)
- Insert and retrieve sensor descriptions (encoded in OGC SensorML, OGC WaterML 2.0)
- Publish measurement data (near real-time, as well as archived data)
- Offer Download Services for observation data that are compliant with the INSPIRE regulations.

In 2019, 52°North accomplished major steps towards the new 52°North SOS 5.x release. This release will consolidate the three Sensor Web server modules to an integrated solution for publishing, managing and sharing (in situ) observation data.

52°North also developed and evaluated a common data model used by the SOS, the SensorThings API and the Helgoland API as a basis for the new release. This resulted in a more efficient storage of a wide range of observation data (in addition to time series data, also profiles, trajectories, and samplings).

KEY TECHNOLOGIES

- XML
- Java
- JSON
- OGC Sensor Observation Service (SOS)
- OGC Sensor Model Language (SensorML)
- ISO/OGC Observations and Measurements (O&M)
- INSPIRE Download Service
- NetCDF
- Hibernate
- PostgreSQL/MySQL/Oracle/ MS SQL Server



BENEFITS

> Full implementation of the OGC Sensor Observation Service 2.0 standard
> INSPIRE compliance (SOS as INSPIRE Download Service)
> Dedicated support for hydrological applications via the OGC SOS 2.0 Hydrology Profile
> Support of the European e-reporting workflows for ambient air quality
> Highly efficient data transfer via the optional EXI (Efficient XML Interchange) support
> Flexible integration into existing IT infrastructures (coupling to existing databases, several options for data publication)
> Comprehensive ecosystem of supporting tools and applications (Helgoland Sensor Web Viewer, sos4R, SOS importer)
> Additional data management functionality beyond the SOS standard

FIELDS OF APPLICATION

Hydrology, air quality (e-reporting), environmental monitoring, ocean sciences, tracking

PROJECT REFERENCES

> **SeaDataCloud**, https://www.seadatanet.org/About-us/SeaDataCloud
> **WaCoDiS**, https://wacodis.fbg-hsbo.de/
> **MuDak-WRM**, https://www.mudak-wrm.kit.edu/
> **IRCEL-CELINE BelAir** **(see page 44)**
> **NIWA**, https://niwa.co.nz/
> **Wupperverband**, https://www.wupperverband.de/
> **Federal Maritime and Hydrographic Agency (BSH)**, https://www.bsh.de/
> … and many more

DOWNLOAD

GitHub: https://github.com/52North/SOS

FACTS

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STA

SensorThings API

Efficient access to sensor data streams via the OGC SensorThings API and MQTT

The STA module complements the 52°North Sensor Web Server with support for the OGC SensorThings API (STA) Part 1: Sensing specification. The development of this module made significant progress in 2019. As a result, the 52°North implementation provides support for the following Conformance Classes:

_ Sensing Core

_ Create-Update-Delete

_ Filtering Extension.

It also supports the MQTT-based publication and delivery of data as defined by the STA specification.

In addition to the implementation of the conformance classes mentioned above, the 52°North team successfully tested this STA implementation for OGC compliance. As part of the testing and evaluation efforts, 52°North's partner Wupperverband successfully performed a pre-operational deployment of the 52°North STA implementation to publish and access sensor data streams.

A first full version of the 52°North SensorThings API module will be published as part of the upcoming 52°North Sensor Web Server 5.x release.

KEY TECHNOLOGIES

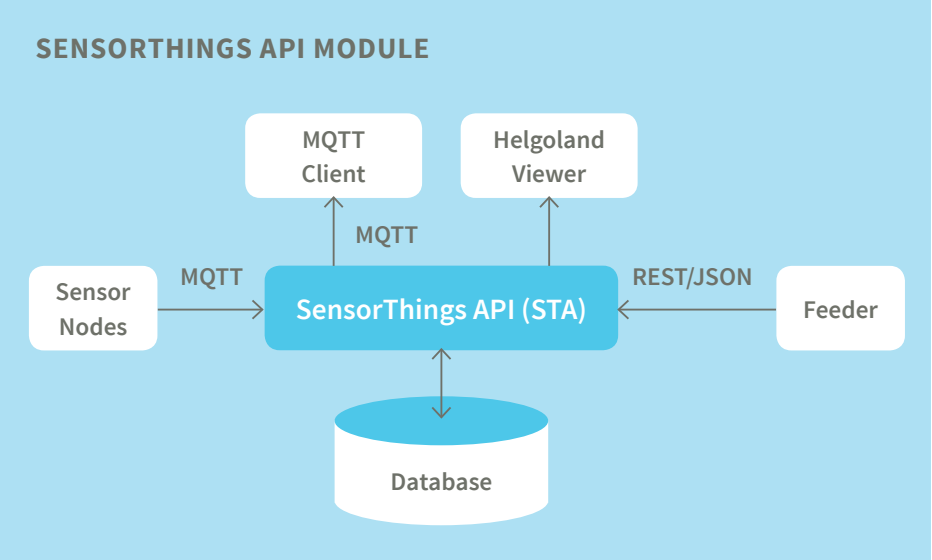
> OGC SensorThings API Part1: Sensing

> REST

> JSON

> MQTT

> Java



BENEFITS

> Robust implementation making use of the broad 52°North experience with Sensor Web data models
> Easy deployment as part of the 52°North Sensor Web Server (joint database layer)
> MQTT support for data publication and delivery
> Interlinking between SOS, STA and REST API (e.g. data publication via STA/MQTT while the published data can also be accessed via SOS and Helgoland API)

FIELDS OF APPLICATION

Hydrology, air quality (e-reporting), environmental monitoring, ocean sciences, tracking

PROJECT REFERENCES

> **WaCoDiS**, https://wacodis.fbg-hsbo.de/
> **Wupperverband**, https://www.wupperverband.de/

DOWNLOAD

GitHub: https://github.com/52North/ sensor-things

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Helgoland API

Lightweight Access Layer to Sensor Data

Supporting the efficient implementation of Sensor Web clients

This lightweight API provides a complementary lightweight access layer to sensor data via a RESTful Web binding. It offers an additional mechanism for data access, which has been optimized to reflect 52°North experience gained during the development of Sensor Web client applications. Thus, it can be considered a convenience layer that facilitates the use of Sensor Web servers.

The API provides a thin access layer offering several functionalities:

- Pre-rendering of time series data (e.g. for embedding pre-rendered diagrams into Web sites)
- Generalization of sensor data sets for reducing the transmitted data volume
- Support of different types of observation data: time series, profiles, trajectories, samplings
- Overlaying of data from multiple data sets
- Conversion of raw data to other formats such as CSV, PDF and PNG
- Comprehensive functionality for exploring, discovering, filtering and accessing observation data.

The REST API can be deployed in two modes: as a 52°North Sensor Web Server module residing on an observation database, or in a proxy mode so that external data sources can be integrated into Sensor Web environments.

Deployment of the Helgoland REST API

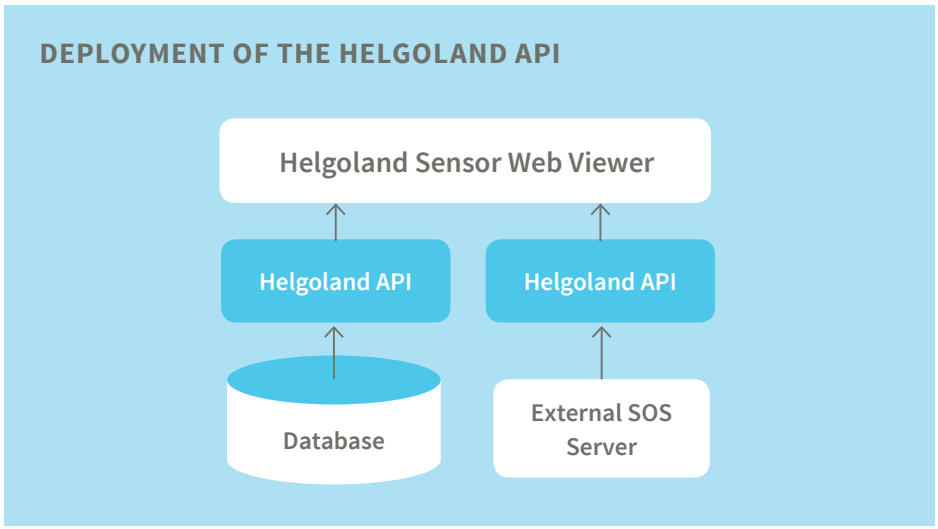
The work in 2019 was strongly influenced by the upcoming 52°North Sensor Web Server 5.x release. This included harmonizing the SOS and REST API data models into a common solution. 52°North also placed a strong emphasis on the support of additional, more complex observation types, such as profiles, trajectories, and samplings.

KEY TECHNOLOGIES

> REST

> JSON

> Java



BENEFITS

> Lightweight protocol and encoding
> Convenience functionality for client developers to increase their efficiency
> Functionality going beyond the available standard interfaces (e.g. data generalization, rendering functionality, data conversion)

FIELDS OF APPLICATION

Hydrology, air quality (e-reporting), environmental monitoring, ocean sciences, tracking

PROJECT REFERENCES

> **SeaDataCloud**, https://www.seadatanet.org/About-us/SeaDataCloud
> **WaCoDiS**, https://wacodis.fbg-hsbo.de/
> **MuDak-WRM**, https://www.mudak-wrm.kit.edu/
> **IRCEL-CELINE BelAir** **(see page 44)**
> **NIWA**, https://niwa.co.nz/
> **Wupperverband**, https://www.wupperverband.de/
> **Federal Maritime and Hydrographic Agency (BSH)**, https://www.bsh.de/
> … and many more

DOWNLOAD

GitHub: https://github.com/52North/series-rest-api

FACTS

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javaPS

Next Generation Standardized Web-based Geoprocessing

Interoperable processing framework for web applications/ distributed workflow systems

javaPS enables the deployment of geo-processes on the web in a standardized way. One of its main goals is the provision of an interoperable processing framework for web applications or distributed workflow systems. Therefore, it fully supports the OGC Web Processing Service 2.0 interface specification. True interoperability only succeeds when transmission data models are well-defined and supported. javaPS supports a broad range of standardized formats and de-facto industry standards including, but not limited to OGC GML (versions 2.x to 3.2.1), GeoJSON, Esri Shapefile, GeoTIFF or KML. In addition, GeoServer (WMS or WFS) enables the dissemination of processing results. This allows a seamless integration into existing Spatial Data Infrastructures.

KEY TECHNOLOGIES

> Java

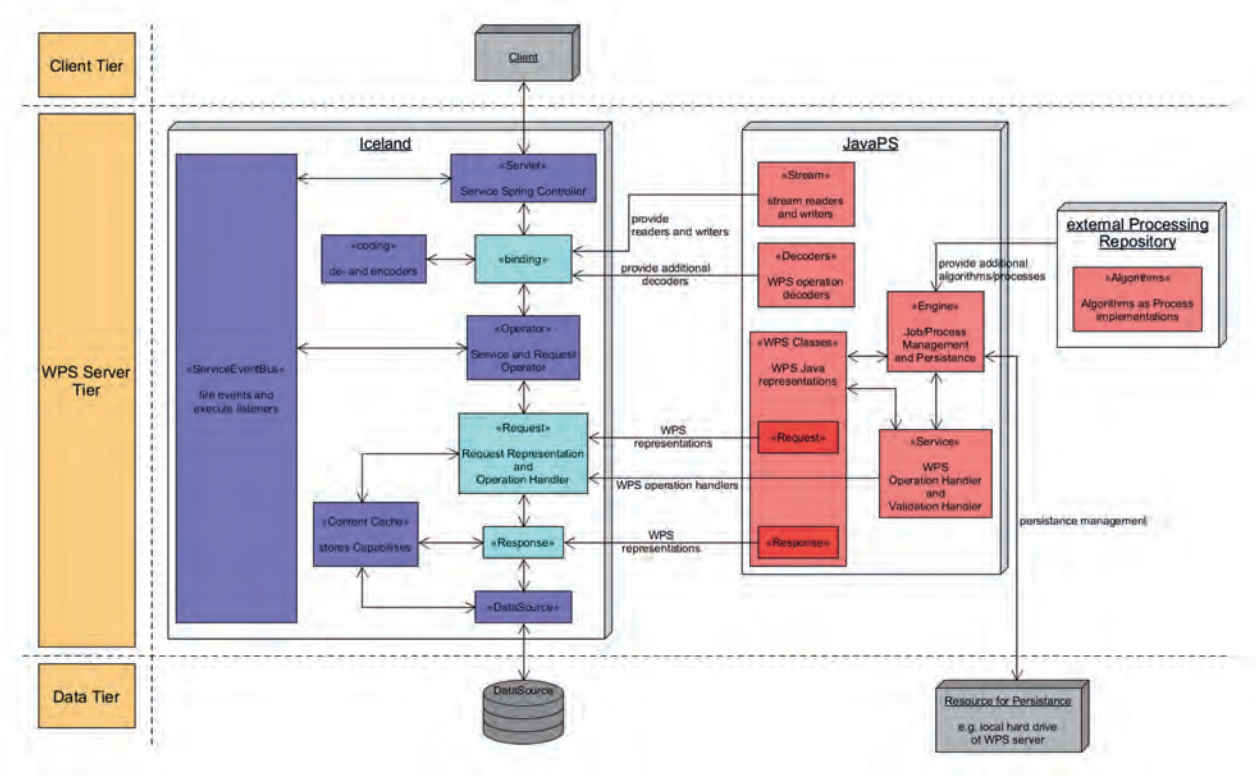
> Spring

> Arctic Sea

> OpenAPI

javaPS evolved from the longstanding 52°North WPS implementation, but uses modern frameworks such as Spring, 52°North Arctic Sea or Guava. It features a pluggable architecture for processes and data encodings.

javaPS has been the main driver within several 52°North projects. It was featured in both the OGC Testbed 15 and the OGC Routing Pilot as one of the implementations of the upcoming OGC API Processes standard. The focus of the Testbed and Pilot was to prove this new REST API in real world applications. 52°North not only created a new interface layer, but also extended the core layer to support the execution of Docker-based processes. The WaCoDiS research project deployed the javaPS to abstract different Earth Observation processing algorithms and provide a web interface within an automated workflow environment. The developments within these projects lead to an improved code base and increased stability of the overall javaPS framework.



javaPS architecture deployment

BENEFITS

> Abstraction of (existing) processing tools
> Support for the majority of standardized geo-data formats
> Lightweight API, following the latest state of the draft OGC API Processes standard

FIELDS OF APPLICATION

Web-based processing, automated workflows, earth observation, data analytics

PROJECT REFERENCES

> **OGC Testbed 15**, https://www.opengeospatial.org/projects/initiatives/testbed15
> **OGC Routing Pilot**, https://www.opengeospatial.org/projects/initiatives/routingpilot
> **WaCoDiS**, https://wacodis.fbg-hsbo.de/

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GitHub: https://github.com/52North/javaps

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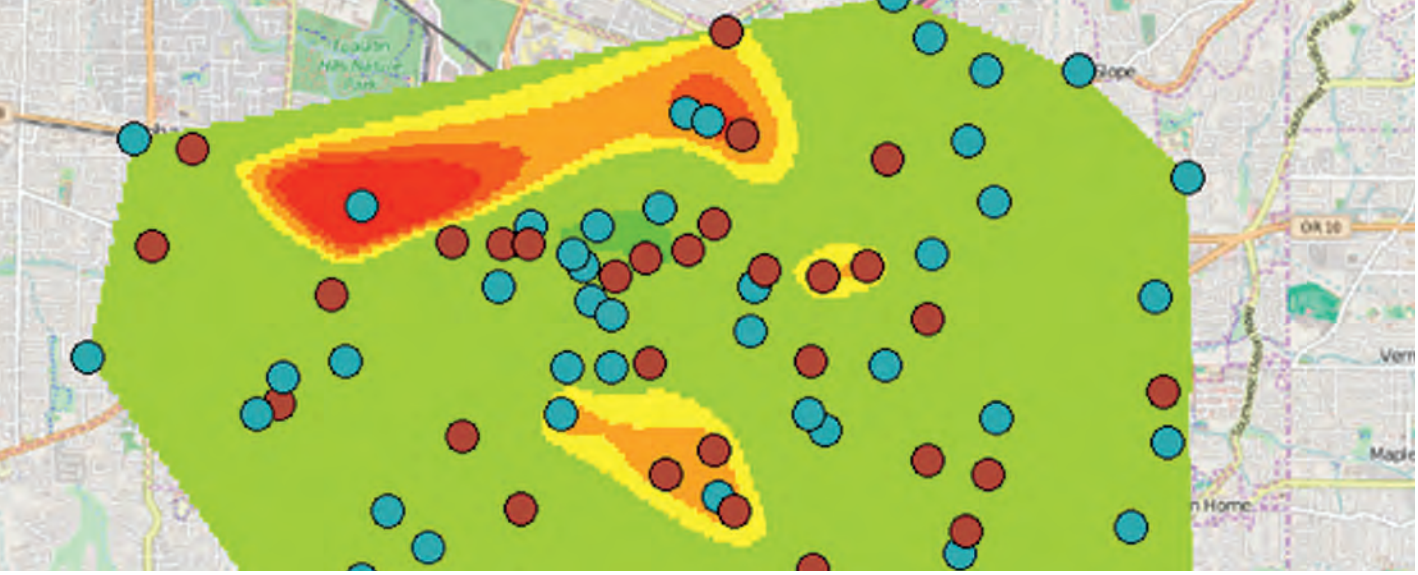


wps-ng-client

Modern Web Application for Geoprocessing

Providing an extensible lightweight single page application for web browsers

A map centred design forms the foundation of this software component. The aim is to provide a lightweight single page application for modern web browsers. The application is written on top of the Angular framework and its UI counterpart Angular Material. This makes it easily extensible due to its component-based architecture.

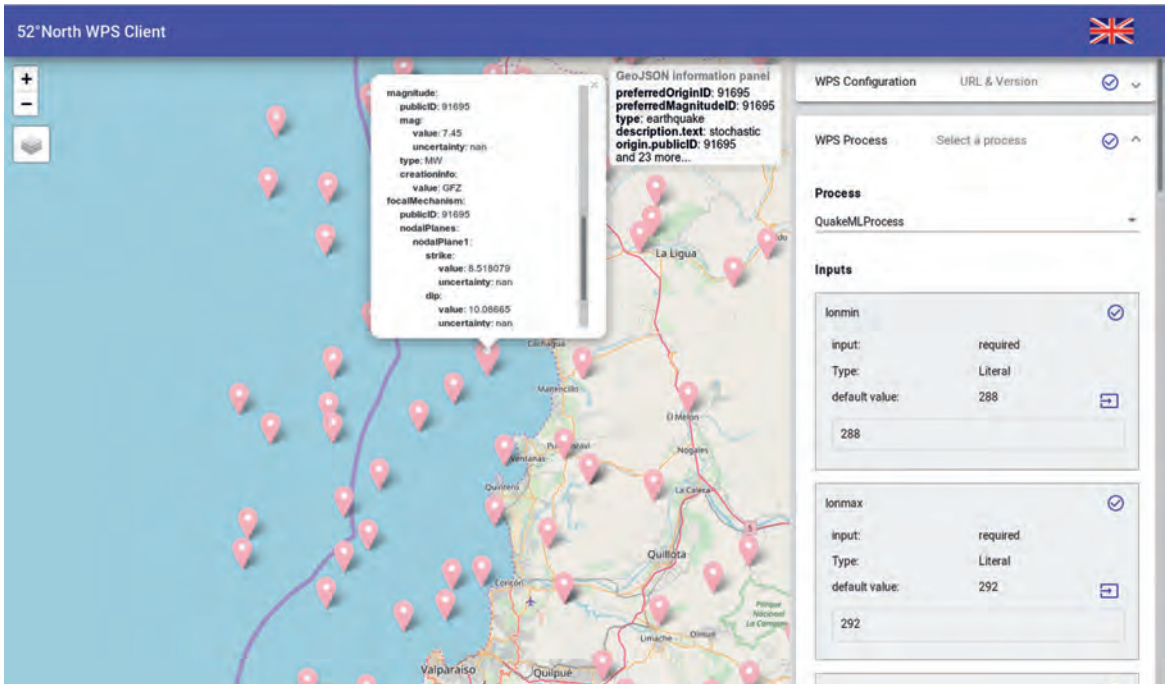
Under the hood, the application uses the 52°North wps-js library, which is responsible for the interaction with the WPS backend. A clear separation of concern is guaranteed and the application can focus on the UI/UX aspects and the visualization of input and output data. The wizard-style execution of WPS processes guides the user through all relevant steps and provides convenient functions (e.g. auto-fill parameters with default values) that creates an intuitive user experience.

The wps-ng-client architecture catalyzes the creation of individual web applications for specific use cases or scenarios. As a central UI element, the map enables developers to easily create context and associate the user with a scenario's relevant information and explain how to use the process.

Recent developments focused on increased support of input formats (e.g. different geometry types) as well as the improvement of the process result visualizations. The client has been tested elaborately with different WPS implementations (e.g. 52°North WPS, 52°North javaPS and PyWPS) to ensure its robust function.

KEY TECHNOLOGIES

> Angular
> Angular Material
> JavaScript
> TypeScript
> OpenLayers
> wps-js



wps-ng-client

BENEFITS

> Visualization of web processes' inputs and outputs
> Support for all major browsers due to the Angular framework
> Wizard-style process execution eases the interaction with WPS backends
> Lightweight component architecture makes the software easily extensible

FIELDS OF APPLICATION

Web-based processing, automated workflows, earth observation, data analytics

PROJECT REFERENCES

> **RIESGOS**, https://www.riesgos.de/en/
> **MuDak-WRM**, https://www.mudak-wrm.kit.edu/
> **OGC Testbed 15**, https://www.opengeospatial.org/projects/initiatives/testbed15
> **CITRAM**, https://citram.de/

DOWNLOAD

GitHub: https://github.com/52North/wps-ng-client

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enviroCar Mobile Android App

XFCD Mobile Data Collection and Analysis

Collecting and analyzing vehicle sensor data

enviroCar Mobile is an Android application for smartphones that can be used to collect Extended Floating Car Data (XFCD). The app communicates with an OBD2 Bluetooth adapter while the user drives. This enables read access to data from the vehicle's engine control. The data is recorded along with the smartphone's GPS position data. The driver can view statistics about his drives and publish his data as open data. The latter happens by uploading tracks to the enviroCar server, where the data is available under the ODbL license for further analysis and use. The data can also be viewed and analyzed via the enviroCar website. enviroCar Mobile is one of the enviroCar Citizen Science Platform's components (www.envirocar.org).

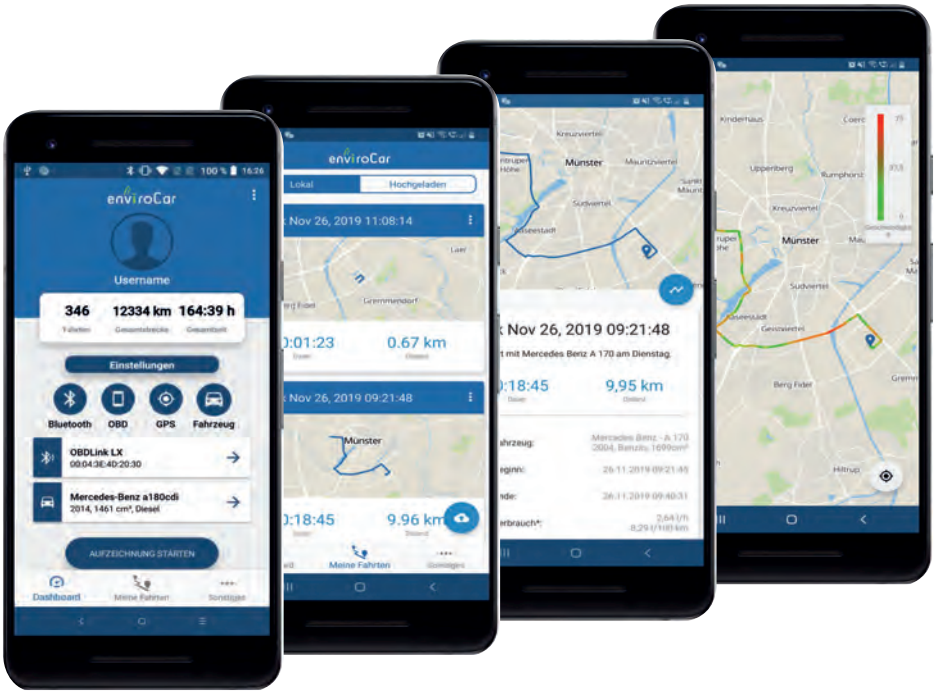
During 2019, 52°North conducted intensive reengineering. A majority of the software libraries used was also updated. This contributed significantly to the stability of the application software on various devices, using different Android versions, OBD adapters and vehicles.

52°North redesigned and simplified the user interface. Interfaces to new OBD adapters have been added and data acquisition without OBD adapters was made possible. The app can now calculate the energy consumption and CO2 emission based solely on the track data. In addition, there is automatic track recording and data publication so that it is possible to use near real-time recorded tracks.

KEY TECHNOLOGIES

> Android

> Java



New enviroCar user interface

BENEFITS

> Easy collection of Extended Floating Car Data
> Optional automation of data collection and upload
> Estimation of fuel consumption and CO2 emissions
> Publishing anonymized track data as Open Data
> Map based visualization of track data and track statistics

FIELDS OF APPLICATION

enviroCar Mobile supports the collection, analysis and sharing of XFCD data in an open Citizen Science Community. This community of scientists, traffic engineers, public administration staff and citizens work together to gain better road traffic information to reduce the environmental impact of motorized traffic and to improve road safety. The enviroCar app can be used free of charge. The data is also available free of charge, as open data to the general public.

PROJECT REFERENCES

> **CITRAM – Citizen Science for Traffic Management**, http://www.citram.de

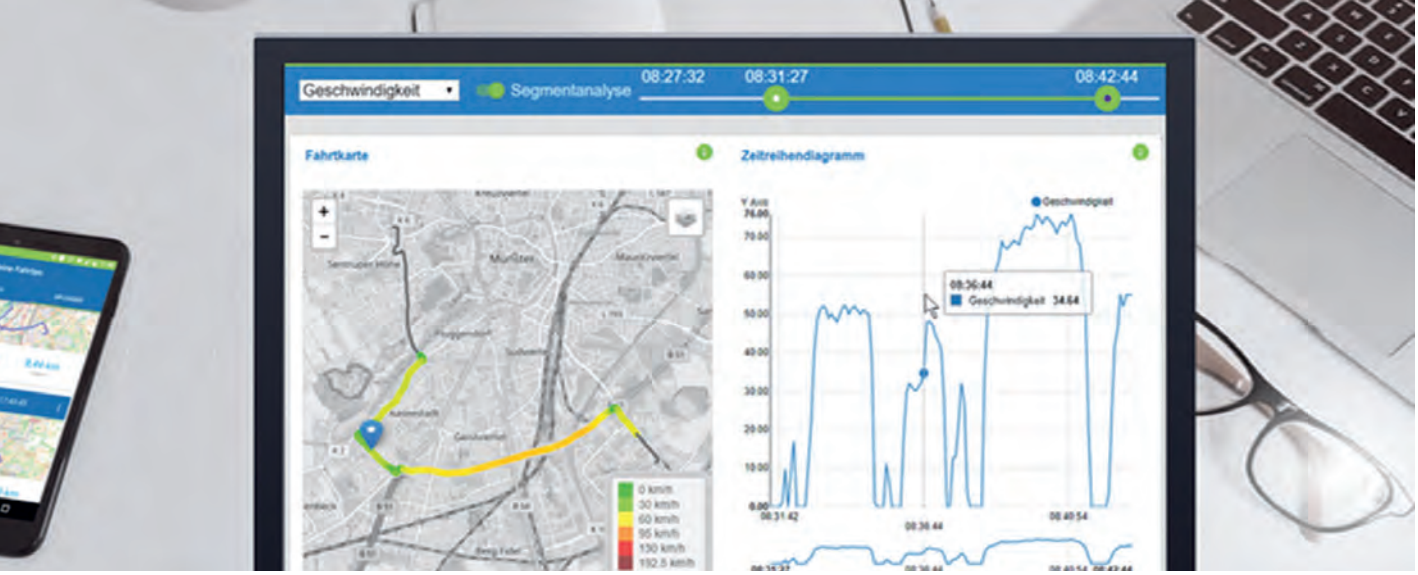
DOWNLOAD

GitHub: https://github.com/enviroCar/enviroCar-app

FACTS

Contact
Arne de Wall
a.dewall@52north.org

License
GNU General Public License 3.0 (GNU GPLv3)



enviroCar Server

User and Data Management

Managing and sharing Open XFCD

The enviroCar server's central tasks are the enviroCar platform user management and the management of the XFCD data provided as OpenData by the enviroCar drivers. To ensure data privacy, the server anonymizes the recorded tracks for external access. The enviroCar server's RESTful API provides access to driving statistics, as well as space and time related subsets of the XFCD data in various formats.

52°North reengineered user management workflows for GDPR compliance, dockerized all components, created new data analysis features (e.g. OSM MapMatching) and implemented the publication of newly created tracks via Apache Kafka. In addition, we developed an anonymous API that allows the upload of tracks without a user account.

KEY TECHNOLOGIES

> MongoDB
> Apache Kafka
> Java
> Guice
> Guava

FACTS

Contact
Christian Autermann
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License
GNU Affero General Public License 3.0 (or later versions)

BENEFITS

> User management support
> XFCD data management
> Open API for data export: JSON, CSV, SHP
> Linked Data/RDF API
> Publishing anonymized tracks via Apache Kafka
> GDPR compliance

FIELDS OF APPLICATION

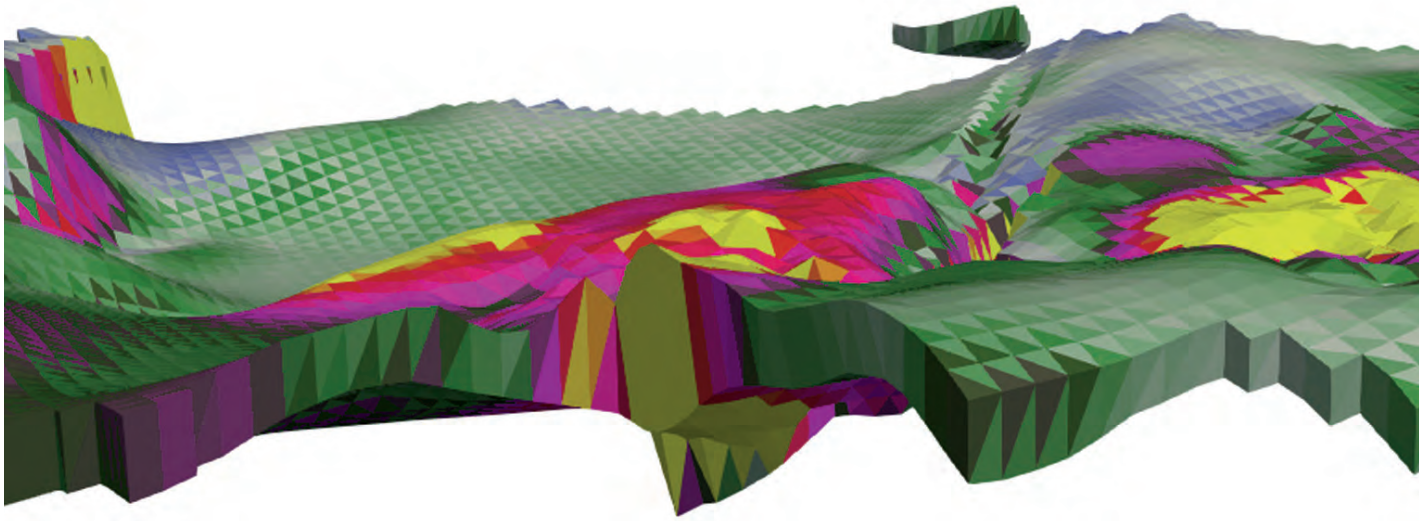
The platform supports the collection, analysis and sharing of XFCD data in an open Citizen Science Community to gain better road traffic information to reduce the environmental impact of motorized traffic and to improve road safety.

PROJECT REFERENCES

> **CITRAM – Citizen Science for Traffic Management**, http://www.citram.de

DOWNLOAD

GitHub: https://github.com/enviroCar/enviroCar-server



52n Triturus

3-D Geovisualization Framework

Java-based applications for 3-D geovisualization

52n Triturus is a lightweight Java-based framework designed to support the development of software applications in the field of 3-D geovisualization. It distinguishes between two data-models, one of which handles geo-objects ("features" in OGC/ISO jargon). The other one works with visualization objects ("display elements"). These data models are realized by interfaces or abstract Java classes, i.e. collections of "interface" classes with some basic functionality added. The object descriptions are independent of the underlying data structures . An I/O layer allows these objects to be read from different data sources, respectively writing them to various file formats, e.g. X3D, VTK data files, or plain ASCII formats.

BENEFITS

> Provision of a lightweight Java library
> Visualization pipeline as conceptual reference model
> Filter and mapper functions linking geoobjects and visualization objects

FIELDS OF APPLICATION

Terrain modeling, landscape planning, civil engineering, or any field dealing with 3-D geoinformation (x, y, and z). The 52n Geologic Toolbox provides Java classes built on top of the 52n Triturus library for geologic applications.

PROJECT REFERENCES

> **Design of underwater topography visualizations**
> **3-D analysis of geologic surfaces**
> **Provision of input interfaces for subsurface data in ArcGIS Pro**

DOWNLOAD

GitHub: https://github.com//52north/triturus, https://github.com//52north/GeologicToolbox

KEY TECHNOLOGIES

> Java

FACTS

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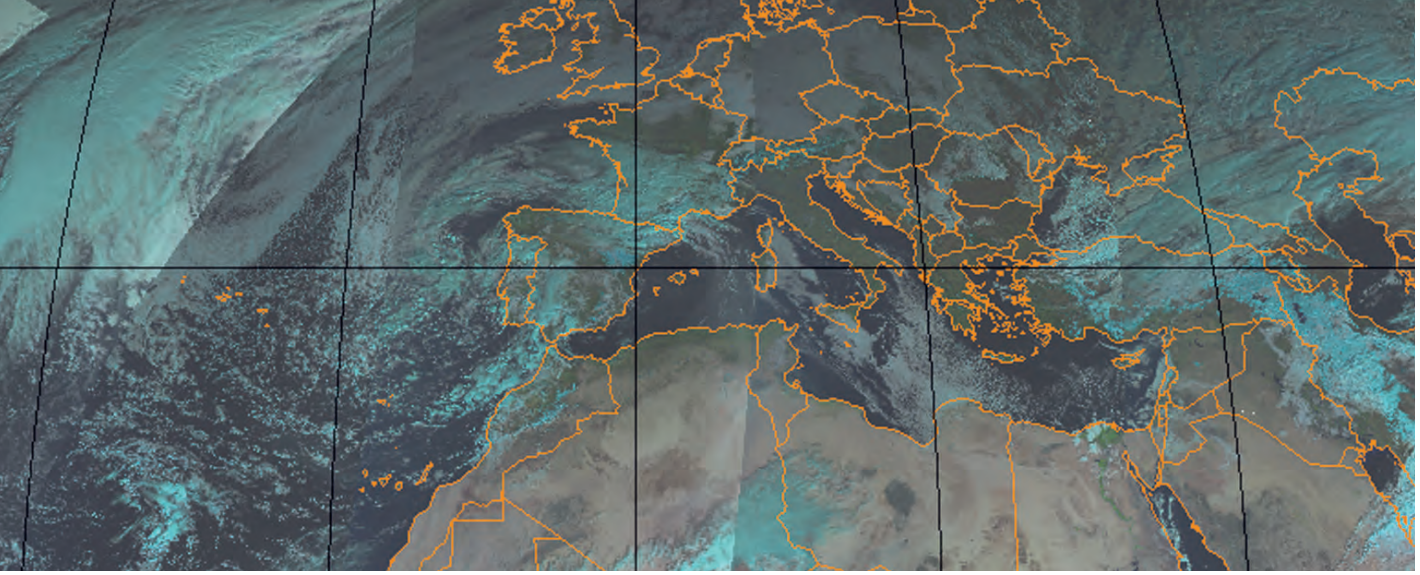
b.schmidt@52north.org

License
GNU General Public License 2.0 (52n Triturus)

Apache License, Version 2.0 (52n GeologicToolbox)



ILWIS 4

Integrated Land and Water Information System

The next generation tool framework for GIS and Remote Sensing

ILWIS 4 is a complete re-design of the well-known desktop GIS ILWIS 3, the Integrated Land and Water Information System. It is a Windows-based, integrated and modular GIS and Remote Sensing (RS) open source software. It contains a highly interactive desktop application based on drag-and-drop, map thumbnails and rich catalog functionality. The framework behind ILWIS 4 is called ILWIS-Objects. It supports the extension of functionality by means of Python scripts or by creating new -so called- connectors to new data formats, other programming languages or software libraries.

ILWIS 4 supports:

_ Teaching GIS and RS by providing an educational platform

_ Visualization of raster, vector and tabular data

_ Interactive retrieval of attribute information associated with spatial data

_ Manipulation of raster, vector and tabular data

_ Implementation/development of algorithms for air/space borne image data proessing

_ GIS analytical tools

_ Python script language for automation of repetitive procedures

_ Modeling dynamic spatial systems behaviors using modeler tools

_ Calculations on raster and tabular data using Python command lines

_ Direct access to spatial and tabular data of any format (via connectors)

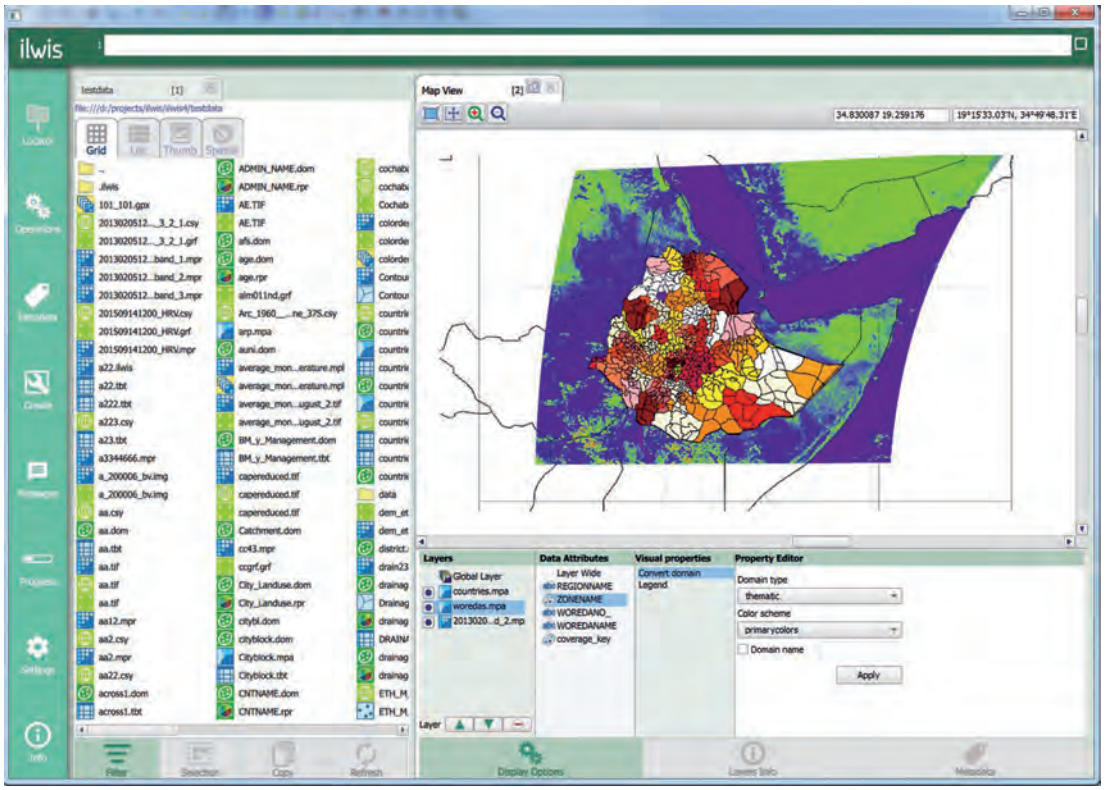
_ Multitask operations

KEY TECHNOLOGIES

> C++

> QT

> GDAL



ILWIS user interface

FIELDS OF APPLICATION

Education in remote sensing and GIS, water management, hazard, vulnerability and risk analysis

DOWNLOAD

GitHub: https://github.com/52North/IlwisObjects

FACTS

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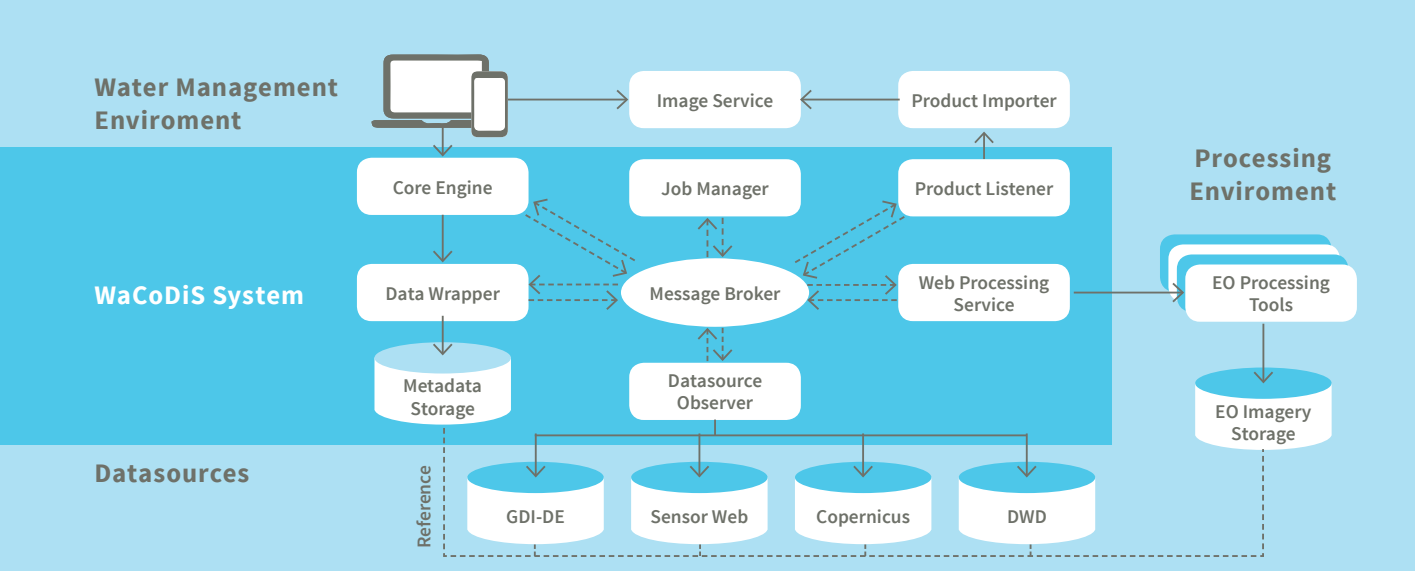
License

GNU General Public License 2.0 (GNU GPLv2)



WaCoDiS Microservice System

Event-driven Software for Automated Creation of Earth Observation Products

Enabling automated production of EO products

The WaCoDiS project aims to exploit the great potential of Earth Observation (EO) data (e.g. as provided by the Copernicus Programme) for the development of innovative water management analytics services and the improvement of hydrological models to optimize monitoring processes. Existing SDI-based geodata and in situ data from sensors that are used to monitor water bodies are combined with Sentinel-1 and Sentinel-2 data. The WaCoDiS monitoring system is designed as a modular and extensible software architecture that is based on interoperable interfaces, such as the Open Geospatial Consortium (OGC) Web Processing Service.

This enables a sustainable and flexible way of integrating different EO processing algorithms. In addition, architectural aspects, such as publish/subscribe patterns and messaging protocols that increase the effectiveness of processing big EO data sets, are considered.

The WaCoDiS monitoring system comprises the following components.

Job Manager: a REST API enables users to define job descriptions for planning the execution of analysis processes.

Core Engine: the Core Engine schedules jobs based on the descriptions. In addition, it is responsible for triggering WPS processes as soon as all required process input data is available.

Datasource Observer: several routines inspect the different data stores for new data, which are required for process executions.

Data Wrapper: information about all incoming required datasets are bundled within a Metadata Storage. For the purpose of defining process inputs, the Data Wrapper generates references to the required datasets from the metadata and provides these

KEY TECHNOLOGIES

> Message Driven Architectures
> AMQP
> OpenAPI
> Spring Boot
> Kubernetes

references to the Core Engine via a REST API. A Metadata Connector will listen for new datasets and then interact with the REST API in order to provide an asynchronous Pub/Sub pattern.

Web Processing Service: an OGC Web Processing Service (WPS) encapsulates the execution of analysis processes provided by EO Tools. The WPS provides a standardized interface for this purpose. Therefore, a customized backend for the 52°North javaPS implementation provides certain preprocessing and execution features.

Product Listener: this component is notified as soon as any analysis process has finished and a new EO product is available. The component fetches the product from the WPS and ingests it into one or more specific backends (e.g. GeoServer, ArcGIS Image Server). These provide a certain web service for the user to access the product.

Product Importer: for each web service backend, a certain helper component ingests the Earth Observation product into the specific backend's datastore and may set up a service on top of it. The product importer can be provided as part of the Product Listener or can be provided as an external component (e.g. a python script for importing product into the ArcGIS Image Server).

The system is currently being evaluated for different water resource management use cases. Due to the use of microservices and publish/subscribe messaging, the system is extensible by design. An application in other domains is easily realizable as long as the processing tools used support fully automated processing.

The foundation of the system architecture was laid out in the early stages of the research project WaCoDiS. In 2019, the several components of the system have been realized or significantly matured. The system was deployed to a Kubernetes cluster and has been evaluated since mid 2019. The deployment on Kubernetes allows lightweight scaling as well as rolling updates of the different microservice components.

BENEFITS

> Reduction of manual data discovery, preparation and processing
> Automated creation of Earth Observation time series
> Microservice approach allows scaling of the system

FIELDS OF APPLICATION

Water resource management, environmental monitoring

PROJECT REFERENCES

> **WaCoDiS**, https://wacodis.fbg-hsbo.de/en/home-2/

DOWNLOAD

GitHub: https://github.com/WaCoDiS/

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License
Apache License, Version 2.0

Mentoring

Sharing knowledge and experience

52°North is mentoring Geoinformatics students to support their personal development and professional careers. We share our knowledge and experience and benefit from their curiosity and creativity.

Theses Supervision

52°North promotes higher education in cooperation with, among others, the Institute for Geoinformatics at the University of Münster, ITC at the University of Twente and Bochum University of Applied Sciences.

Butzmann, Lukas (2019): Ausreißer-Detektion in Temperaturlinien auf der Grundlage von Machine Learning Algorithmen. Unpublished Bachelor Thesis, Hochschule Bochum (supervision with con terra)

Speckamp, Jan (2019): Integrating simple Event Processing into existing Sensor Web data platforms. Unpublished Bachelor Thesis, Institute for Geoinformatics, University of Münster.

Wollenhaupt, Moritz (2019): Räumliche Interpolation von In situ-Niederschlagsdaten durch maschinelles Lernen. Unpublished Bachelor Thesis, Hochschule Bochum.

Dib, Aws (2019): An Interoperability Assessment Model for OGC Web Processing Services. Unpublished Master Thesis, Institute for Geoinformatics, University of Münster

Liu, Zhihao (2019): An Agent Based Model for Traffic Speed Control Analysis. Unpublished Master Thesis, Institute for Geoinformatics, University of Münster

Köster, Milan (2019): Spatio-temporal demarcation of high water events from In Situ measurement data. Unpublished Master Thesis, Institute for Geoinformatics, University of Münster

Ohuru, Robert Ouko (2019): A Method for Enhancing Shareability and Reproducibility of Geoprocessing Workflows. Case Study: Integration of Crowdsourced Geoinformation, Satellite and In Situ Data for Water Resource Monitoring. Unpublished Master Thesis, University of Twente, ITC (Simon Jirka was on the examination committee)

Internships

Many Masters programs require a semester of practical work. 52°North has been providing such student internships since 2011. Each student works for a period of up to 6 months in current projects. They improve their software engineering skills, acquire knowledge in SDI and OGC standards, learn basic project management techniques, and gain experience in international collaborative software development.

Fadi Moubayed (10/2019 – 03/2020) works on ingesting sensor data from various sources (e.g. DWD open data) into the 52°North Sensor Web Server (OGC Sensor Observation Service implementation).
Mohammed Abdelal (10/2019 – 03/2020) works on developing a generic processing backend using container technology (e.g. Docker) and its integration into javaPS (OGC Web Processing Service implementation).

Imke Ines Klatt (10/2018 - 04/2019) worked on evaluating the ILWIS 4 Python API for its readiness to be used as a processor for Sentinel-1 data in the context of flood estimations. An additional task was the implementation of a method to estimate vegetation change in Python.

Google Summer of Code

Helping to change the world one line of code at a time

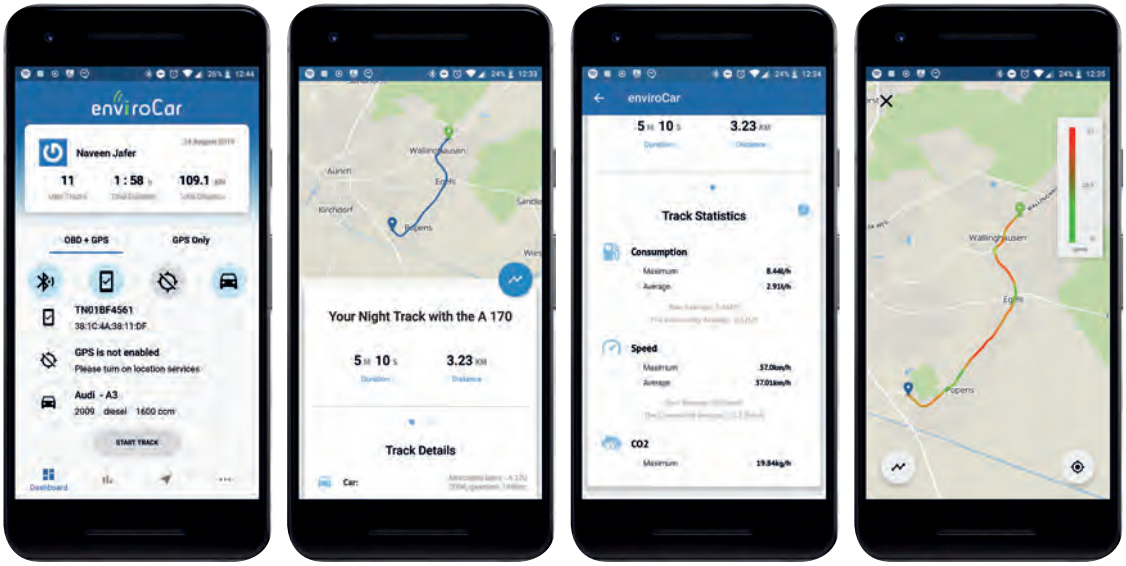
Google Summer of Code (GSoC) is a global program that focuses on introducing student developers to open source software development. Students receive stipends to work on a three month programming project with an open source organization while on break from university. At 52°North, they are paired with mentors from our partner organizations to gain valuable exposure to real-world software development scenarios and have the opportunity to work in areas related to their academic pursuits. In turn, 52°North is able to more easily identify and draw in new developers, as well as improve its software projects.

Since its inception in 2005, the program has brought together 14,762 student participants and over 24,000 mentors from 118 countries worldwide (https://summerofcode.withgoogle.com/archive/). 52°North has been a successful mentoring organization since 2012. This year, 52°North was one of 206 open source organizations chosen to host two of the 1,134 student projects.

UI / UX Improvements for the enviroCar Project

In his project, Shiva Kanth Sujit worked to improve the enviroCar Android user interface and user experience. He improved user interaction by redesigning the UI to ensure visual consistency, updating the libraries used in the app and developing additional features. It is now possible to visualize any of the data available, e.g. the different speeds during a drive. This is similar to the visualization functions in the enviroCar web application.

(https://blog.52north.org/2019/09/16/ui-ux-improvements-for-the-envirocar-project-final-blog-post/)



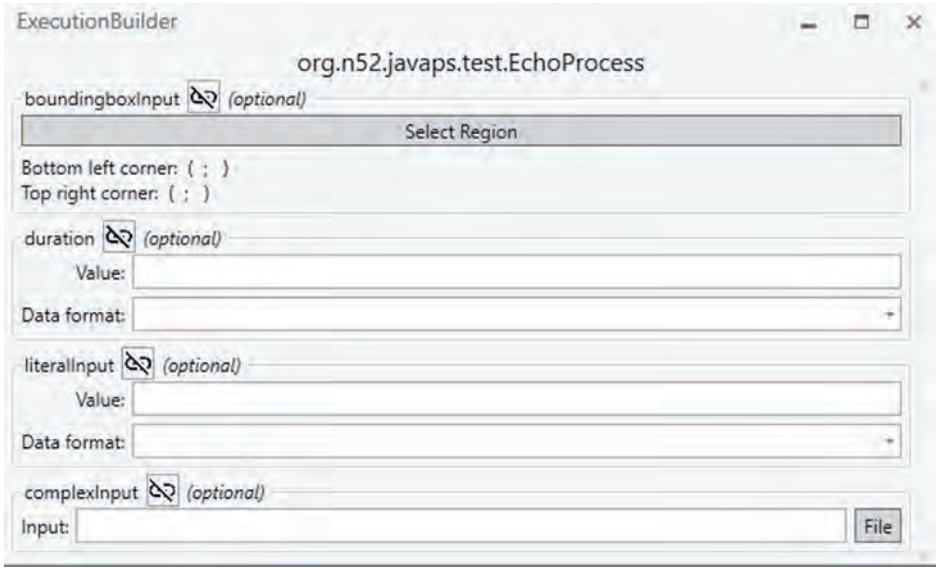
New enviroCar features

WPS.NET API and ArcGIS Pro Add-In

Mihai Stan developed a new WPS client for ArcGIS in his project. The WPS.NET implements the WPS standard version 2.0 and provides a modern API written in C#. It was created to provide an easy to use API to access the WPS services.

The Add-In was developed in particular for ArcGIS Pro users. It enables any ArcGIS Pro users to fetch data from WPS providers through a simple user interface.

(https://blog.52north.org/2019/06/04/net-wps- library-arcgis-pro-wps-add-in/)



Example of a process builder helping the user to create an execution request

Dissemination and Outreach

Research – develop – publish

52°North disseminates project and research results, i.e. software and architecture developments, concepts and methodologies, via various platforms. This includes publications, presenting at conferences, organizing workshops and seminars.

Autermann, Christian, Simon **Jirka**, and Dick Schaap. 2019. "The SeaDataCloud Sensor Web Approach". Poster presented at the EGU General Assembly 2019, Vienna, Austria, April 7. https://meetingorganizer.copernicus.org/EGU2019/EGU2019-13984-1.pdf.

Buck, Justin J. H., Scott J. Bainbridge, Eugene F. Burger, Pier Luigi Buttigieg, Matthew Casari, Kenneth S. Casey, Louise Darroch, Joaquín del Rio, Eric Delory, Philipp F. Fischer, Thomas Gardner, Ryan Heffernan, Simon **Jirka**, Alexandra Kokkinaki, Alexandra C. Kraberg, Martina Loebl, Katja Metfies, Jay S. Pearlman and Ingo Schewe. 2019. "Ocean Data Product Integration Through Innovation – The Next Level of Data Interoperability". *Frontiers in Marine Science* 6: 32. https://doi.org/10.3389/fmars.2019.00032.

Buck, Justin J. H., Jay Pearlman, Scott J. Bainbridge, Eugene F. Burger, Pier Luigi Buttigieg, Matthew Casari, Kenneth S. Casey, Louise Darroch, Joaquín del Rio, Eric Delory, Thomas Gardner, Simon **Jirka**, and Alexandra Kokkinaki. 2019. "Data Reusability and Its Role in the Democratization of Marine Data". Oral presented at the AGU Fall Meeting 2019, San Francisco, CA, USA, December 9. https://agu.confex.com/agu/fm19/meetingapp.cgi/Paper/619313.

Drost, Sebastian, Matthes **Rieke**, Simon **Jirka**, Arne Vogt, Verena Rabea Kirstein, and Andreas **Wytzisk-Arens**. 2019. "An Event-Driven Architecture Based on Copernicus Satellite Data for Water Monitoring". In *Accepted Short Papers and Posters from the 22nd AGILE Conference on Geo-Information Science.* Limassol, Cyprus: Stichting AGILE. https://agile-online.org/images/conference_2019/documents/short_papers/68_Upload_your_PDF_file.pdf.

Fechner, Thore, Albert **Remke** and Christoph Rath. 2019 "Copernicus Daten Infrastruktur @ IT.NRW – Modulare und skalierende Copernicus Datenverarbeitung". Oral presented at the 7. Deutsches Geoforum 2019, Berlin, Germany, November 27.

Fuchs, Stephan, Stephan Hilgert, Klajdi Sotiri, Adrian Wagner, Mayra Ishikawa, Jens Kern, Simon **Jirka**, Irina Klassen, Julia Krumm, Christian Malewski, Harald Rohr and Kian Pakzad. 2019. "Sustainable Management of Reservoirs - Defining Minimum Data Needs and Model Complexity". In *Conference Proceedings GRoW Mid-Term Conference*, 12–15. Frankfurt am Main, Germany: adelphi. https://bmbf-grow.de/sites/bmbf-grow.de/files/documents/webkomprimiert_proceedings_grow_midterm_conference_web_final_webkomprimiert.pdf.

Gräler, Benedikt. 2019. "R als GIS". Tutorial at the von Thünen-Institut, Braunschweig, Germany, February 18 - 19.

Gräler, Benedikt. 2019. "R als GIS". Tutorial at the von Thünen-Institut, Braunschweig, Germany, February 25 - 26

Gräler, Benedikt, Christian Malewski, Christian Förster, and Simon **Jirka**. 2019. "Integration Zeitlich Hochauflösender Fernerkundungsdaten in das Sensor Web". Oral presented at the 2. Bochumer Hydrometrie-Kolloquium, Bochum, Germany, February 20.

Gräler, Benedikt, Arne **de Wall**, and Albert **Remke**. 2019. "Citizen Science for Traffic Management and Safety". Poster presented at the EGU General Assembly 2019, Vienna, Austria, April 7. https://meetingorganizer.copernicus.org/EGU2019/EGU2019-15704.pdf.

Gräler, Benedikt. 2019. "How to Model Skewed and Heavy Tailed Distributions: An Introduction to Copulas". Workshop presented at the Spatial Statistics Conference, Sitges, Spain, July 10. https://www.elsevier.com/events/conferences/spatial-statistics.

Gräler, Benedikt. 2019. "The performance of random forest and kriging in interpolating daily rainfall". Oral presented at the Spatial Statistics Conference, Sitges, Spain, July 10. https://www.elsevier.com/events/conferences/spatial-statistics.

Jirka, Simon, Matthes **Rieke**. 2019. "Nutzung und Weiterentwicklung von OGC-Standards zur eventbasierten Verarbeitung von Beobachtungsdaten". Oral presented in the workshop "Arbeitsforum Standardisierung / mCLOUD", Bremen, Germany, March 20.

Jirka, Simon, Stephan Mäs, Laura Helene Zepner, and Petra Sauer. 2019. "Nutzerfreundliche Und Effiziente Visualisierung Offener Raumzeitlicher Daten Der MCLOUD". Oral presented at the mFUND-Konferenz, Berlin, Germany, September 26.

Jirka, Simon, and Matthes **Rieke**. 2019. "Event-Driven INSPIRE". Workshop presented at the INSPIRE Helsinki 2019, Helsinki, Finland, June 13. https://github.com/inspire-helsinki-2019/workshops/raw/master/materials/InspireHelsinki2019_Event-driven_INSPIRE.pdf.

Jirka, Simon, Matthes **Rieke**, Christian Malewski, Christian Förster, Thomas Tscheu, and Carsten **Hollmann**. 2019. "Event Detection in Water Resource Management Applications". Poster presented at the EGU General Assembly 2019, Vienna, Austria, April 7. https://meetingorganizer.copernicus.org/EGU2019/EGU2019-14026.pdf.

Jirka, Simon, Matthes **Rieke**, Albert **Remke**, Benedikt **Gräler**, and Arne **de Wall**. 2019. "Integration von In-Situ- Und (Copernicus) Remote-Sensing-Daten in Informationsinfrastrukturen Zur Umweltbeobachtung". Oral presented at the 26. Workshop Arbeitskreis Umweltinformationssysteme - UIS 2019, Münster, Germany, May 23.

Jirka, Simon, Matthes **Rieke**, Albert **Remke**, and Andreas **Wytzisk-Arens**. 2019. "Sustainable Development of Research Software - Case Study of an Open Source Approach". Poster presented at the EGU General Assembly 2019, Vienna, Austria, April 7. https://meetingorganizer.copernicus.org/EGU2019/EGU2019-15375.pdf.

Jirka, Simon, Carsten **Hollmann**, Eike Hinderk **Jürrens** and Jan **Speckamp**. 2019. "Data Import and Export within the Sensor Web". Workshop presented at the Geospatial Sensing Conference 2019, Münster, Germany, September 2.

Jirka, Simon, Jan **Schulte**, Benedikt **Gräler**. 2019. "Management and Visualization of Sensor Web Data". Workshop presented at the Geospatial Sensing Conference 2019, Münster, Germany, September 2.

Klatt, Imke Ines, and Simon **Jirka**. 2019. “Open-Source-Tools Und Analyse-Werkzeuge Zum Aufbau von SmartCity-Infrastrukturen”. Oral presented at the 1. Hamburger Smart City Workshop, Hamburg, Germany, June 13.

Jirka, Simon. 2019. “Current Developments in the Sensor Web Community”. Oral presented at the Geospatial Sensing Conference 2019, Münster, Germany, September 3.

Jirka, Simon. 2019. “WaCoDiS - Erfahrungen der 52°North GmbH”. Oral presented in the workshop “Arbeitsforum Datenbasierte Geschäftsmodelle”, Berlin, Germany, November 18.

Kügeler, Antje, Simon **Jirka**, and Eline Lincklaen Arriëns. 2019. “The European Data Portal and the Visualisation of Geoinformation and Real-Time Data”. Oral presented at the EU DataViz 2019, Luxembourg, Luxembourg, November 12. https://docs.google.com/presentation/d/1iXVp6KqnB_mwj7zYNI6mYXnT83T8ZsDhMGoK5p36U-c/edit?usp=sharing.

Malewski, Christian, Benedikt **Gräler**, Christian Förster, and Simon **Jirka**. 2019. “Kann Die Wasserqualität in Stauseen Aus Satellitendaten Abgeleitet Werden?”. *Wasser-Wirtschaft* 109 (7–8): 44–47. https://www.springerprofessional.de/kann-die-wasserqualitaet-in-stauseen-aus-satellitendaten-abgelei/17044886.

Pearlman, Jay, Mark Bushnell, Laurent Coppola, Johannes Karstensen, Pier Luigi Buttigieg, Francoise Pearlman, Pauline Simpson, Simon **Jirka** et al. 2019. “Evolving and Sustaining Ocean Best Practices and Standards for the Next Decade”. *Frontiers in Marine Science* 6: 277. https://doi.org/10.3389/fmars.2019.00277.

Pontius, Martin. 2019. “Software development in the research at 52°North”. Oral presented in the Seminar of the Geophysical Institute (KIT), Karlsruhe, Germany, December 3.

Pross, Benjamin and Arnaud Cauchy. 2019. “OGC Testbed-14: WPS-T Engineering Report”. OGC Public Engineering Report 18-036r1. http://www.opengis.net/doc/PER/t14-D025.

Pross, Benjamin, Andrey Babeyko, Massimiliano Pittore, Jörn Lauterjung, Simon **Jirka**, Matthes **Rieke**, Nico Mandery, et al. 2019. “Simulating Extreme Multi-Hazard Events with Decentralized Web-Processing Services: Towards a Better Understanding of Cascading Impact”. PICO presented at the EGU General Assembly 2019, Vienna, Austria, April 7. https://meetingorganizer.copernicus.org/EGU2019/EGU2019-16683.pdf.

Pross, Benjamin. 2019. “OGC API for Processes”. Oral presented at the OGC API Hackathon, London, June 20.

Pross, Benjamin. 2019. “OGC Hackathon Report on OGC API for Processes”. Oral presented at the OWS Common 1.2 SWG, Löwen, June 26.

Pross, Benjamin. 2019. “WPS REST/JSON: Findings from the OGC API Hackathon and Roadmap”. Oral presented at the Joint Workflow/WPS session, Löwen, June 26.

Pross, Benjamin. 2019. “OGC API – Processes: Status and next Steps”. Oral presented at the Joined WPS/Workflow session, Banff (Remote), September 9.

Pross, Benjamin. 2019. “Testbed-15 Delta Updates ER”. Oral presented at the Joined WPS/Workflow session, Toulouse, November 19.

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Affiliations

Leveraging synergies by working together in networks

The **Open Geospatial Consortium (OGC)** is an international consortium of businesses, government agencies and research organizations creating open standards to support the provision and use of geospatial information. 52°North is an OGC member with the status of a non-profit research organization. We contribute to the standards development and consensus process as well as the OGC Innovation Program with its Testbeds, Pilots and Interoperability Experiments.

Contact: https://www.opengeospatial.org

The **Association of Geographic Information Laboratories in Europe (AGILE)** promotes academic teaching and research on GIS in Europe and stimulates and supports networking activities between member laboratories. Furthermore, AGILE contributes to shaping the European GI research agenda. 52°North actively participates in the permanent scientific forum and contributes to the annual AGILE conferences.

Contact: https://agile-online.org

The **European Citizen Science Association (ECSA)** is a non-profit association that fosters the Citizen Science movement in Europe. It performs research on Citizen Science and initiates and supports Citizen Science projects. 52°North contributes to the ECSA initiatives and hosts the enviroCar Citizen Science platform for road traffic analysis.

Contact: https://ecsa.citizen-science.net/

FOSSGIS e.V. is a German non-profit association that promotes open source software and open data. 52°North participates regularly in the annual FOSSGIS conferences to promote and discuss its open source software projects within the OS community.

Contact: https://www.fossgis.de

“Deutscher Dachverband für Geoinformation” (DDGI) is the German national umbrella organization for institutions from the public and private sector as well as academia that have stakes in improving the availability and use of geospatial information. 52°North contributes to discussions and networking activities by participating in DDGI working groups and events.

Contact: https://www.ddgi.de

GDI DE (Geospatial Data Infrastructure Germany), GeoIT RT NRW (Geospatial Information Technologies Round Table North-Rhine Westphalia) and **Geonetzwerk Münsterland (Geonetwork in the Münster Region)** are associations on national, state and local levels that support the availability and use of geospatial information by stimulating the development of the spatial data infrastructure in their respective stakeholder communities. 52°North supports the goals of these associations and contributes to their activities by participating in expert groups and events. 52°North is a member of the GeoIT RT NRW and Geonetzwerk Münsterland steering committees.

Contact: https://www.gdi-de.org https://www.geoportal.nrw/geoit_round_table http://www.geonetzwerk-muensterland.de

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