52north

exploring horizons

Annual Report 2022

Innovation and Technologies for Research Data Infrastructures

Preface

2022 was an exciting and very rewarding year! The strategic and structural changes 52°North completed in 2021 proved to be forward-looking and led to a number of interesting and successful projects. Following our new mission, established in 2021, to support Open Science through Open Data and Open Source Software, we have contributed to the development of Research Data Infrastructures (RDI) in different contexts. In projects ranging in size from a few days to several years, we have designed and implemented new features and improved the usability of open source software-based RDIs.

Through our active involvement in higher education, we have been able to expand our team in numbers and disciplines. Watching 52°North grow has been especially rewarding, as it provides the necessary impetus to move our ideas and concepts forward. We hope to continue this trend and are grateful for the contributions of our entire staff.

52°North's overall focus in 2022 was to extend RDIs to a wider community. We have continued gathering requirements from a wide range of stakeholders for the ongoing development of our information tools and solutions. In the process, we have seen an increasing importance of climate change information in all of our projects. Past observations are used to assess and validate trends. Model results are combined with in-situ data to better understand predictions. In-situ and remote sensing data are collected to monitor environmental impacts. Climate services are tailored to the needs of citizens, providing essential information for better informed decisions. Disaster risk reduction and management services are designed to better cope with extreme weather events. This report summarizes 52°North's activities in 2022 that address these information needs through various projects.

We look forward to the coming year with confidence and enthusiasm to continue innovating RDI and spatial information solutions in close and equal collaboration with our partners and customers. Please do not hesitate to contact us if you have any questions or ideas you would like to share with us.

Münster, January 2023

Dr. Benedikt Gräler   *Dr. Simon Jirka*   *Matthes Rieke*

Table of Contents

About 52°North

Spatial Information Research

52°North is a private, non-profit R&D organization based in Münster, Germany. Our mission is to increase the value of geodata and geographic information technologies in science, business and public administration through applied research and knowledge-intensive services.

Our research software engineers have a strong background in the application of scientific methods and excellent software engineering practices. They have extensive knowledge of the state-of-art technologies and GeoIT trends, such as cloud-native technologies, geoAI or big data analytics. We contribute to research and innovation projects and provide professional services to build operational high-end GeoIT solutions.

52°North stands for Open Science and Open Innovation based on a collaborative open source software development process.

STAFF

25
software engineers, data scientists, business administration, trainees…

17.43
full time equivalents

16
permanent contracts, 9 temporary employments

Facts and Figures

FOUNDED

September 2006

SHAREHOLDERS

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

MANAGEMENT

Dr. Benedikt Gräler

Dr. Simon Jirka

Matthes Rieke

REVENUES

~ 1,496 M €
in total

58%
billable hours spent
on research
projects

42%
billable hours spent
on fully funded R&D
and professional
services

Research and Development

Innovating Methods and Technologies to Unlock the Value of Geospatial Data

Spatial data play a key role in supporting environmental planning, smart mobility, renewable energy forecasting, climate change adaptation, disaster risk reduction and risk management, and many other applications. Our mission is to facilitate the availability and use of spatio-temporal data by innovating the methods and technologies for creating, managing, sharing, analyzing and visualizing the derived information.

52°North focuses on three interrelated areas. **Research Data Infrastructures (RDI):** The development of RDIs is based on 52°North's experience in Spatial Data and Spatial Information Infrastructures (SDI/SII). A key component is the provision of Analysis Ready Data (ARD) for subsequent processing and analysis workflows. This is closely related to Spatial Data Science. **Spatial Data Science:** The true value of existing data sets can only be unlocked by transforming data into information. Using classical and modern machine learning (ML) approaches, we facilitate this transition. **SDI Innovation:** This addresses the technical solutions used to bring SDI and analysis to life. The research and development of new SDI architectures and concepts on modern IT systems facilitates the discovery of geospatial data's true potential.

We believe that applied research is best complemented by the development of operational solutions to create tangible added value in practice. This combination transforms scientific results into relevant "innovations". 52°North supports the development of operational solutions by offering professional services, such as training and consulting, software engineering or data analysis. A central idea is co-development with our project partners, customers or a wider community, such as end users of our information tools. This allows us to address real world problems with our innovations. The following sections provide an overview of our research and development activities.

Research Data
Infrastructures

Enabling the efficient flow, management and visualization of research data

When we talk about Research Data Infrastructures, we are referring to all aspects related to the collection, management, discovery, sharing, and visualization of data that describe the past, present, or future state of the environment. This includes not only data generated by sensors (e.g., measurements of air pollutant concentrations and water levels), but also information collected by humans (e.g., observations of animals or plants) and predictions calculated by models (e.g., weather models). The Research Data Infrastructures team supports our partners and customers along the entire process chain from data acquisition to visualization.

Dr. Simon Jirka leads a team focused on new approaches and technologies for research data infrastructures. He and his team are currently addressing the following challenges

- Connecting to sensor hardware: investigating how to efficiently integrate new sensors into (research) data infrastructures, e.g. using IoT technologies such as MQTT.
- Data storage and management: optimizing data models and supporting the provision of metadata to ensure correct interpretation of research data.
- Sensor data management: supporting the management of sensor data as an important element of research data infrastructures.
- Semantic interoperability: contributing to and promoting the use of vocabularies.
- Data availability to users: advancing data access interfaces and encodings.
- Efficient data delivery: enabling push/event-driven communication patterns to ensure timely delivery of data.
- Data visualization: improving methods for visualizing and exploring dynamic research data to enable better communication of the collected information.
- Citizen Science: facilitating the establishment of citizen observatory initiatives by providing dedicated reusable building blocks.

Our activities also result in active contributions to international standardization efforts. We drive interoperability through our participation in the Open Geospatial Consortium (OGC) and the European INSPIRE framework.

Simon Jirka

Head of Research Data Infrastructures

MINKE

Metrology for Integrated Marine Management and Knowledge Transfer Network

MINKE enables scientists to have a better understanding of measurement data and to combine data of different quality levels.

The H2020 project MINKE integrates key European marine metrology research infrastructures to propose an innovative framework of 'quality of oceanographic data' for European actors monitoring and managing marine ecosystems. MINKE proposes a new vision for the design of marine monitoring networks. It regards accuracy and completeness as the driving components of quality in data acquisition. This new vision will be framed in a helix model of innovation that incorporates all the elements involved in the monitoring network design:

- context (ocean health): identifying the Essential Ocean Variables (EOVs) as the key parameters to monitor
- civil society (NGO, makers community, social media and Citizen Science platforms): key actors for ensuring data completeness
- academia: researching new methods to ensure the accuracy and the global quality of the final products, developing tools for integrating the information of top qualified oceanographic instruments and low-cost instrumentation
- industry: improving the performance of the observations with new instrumentation, data transmission systems and cost-effective technologies
- governments: providing the legal and socio-economic frameworks to develop the proposed network

52°North co-leads a dedicated work package on data harmonization. The core topics of this work package include the evaluation of interoperability standards, the investigation of integration options for the European Open Science Cloud, the handling of uncertainty information, as well as, the link to data aggregation platforms such as EMODNET.

In 2022, 52°North's team focused on aspects related to data harmonization. A comprehensive review of the partners' needs concerning the description of data quality and data gathering workflows, data publication, and data discovery provided the basis for these activities. In a next step, 52°North assessed relevant standards and technologies based on their suitability to

KEY TECHNOLOGIES

> 52°North Sensor Web Suite
> OGC API Connected Systems
> ISO/OGC Observations and Measurements (O&M)
> OGC Sensor Model Language (SensorML)

FACTS

Duration:
04/2021 - 03/2025

Website:
https://minke.eu/

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Research and Development

fulfil the project's objectives and identify necessary enhancements. The team documented their findings in a dedicated deliverable on data harmonization best practices. Furthermore, they developed architectural approaches for integrating the MINKE developments with the European Open Science Cloud (EOSC) and marine research data aggregators.

PARTNERS

- **Coordinator:** Consejo Superior de Investigaciones Científicas (CSIC), Spain
- Institut français de recherche pour l'exploitation de la mer (Ifremer), France
- Hellenic Centre for Marine Research (HCMR), Greece
- Consorcio para el diseño, construcción, equipamiento y explotación de la Plataforma Oceánica de Canarias (PLOCAN), Spain
- Universitat Politècnica de Catalunya (UPC), Spain
- Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGC), Italy
- Consiglio Nazionale delle Ricerche (CNR), Italy
- Istituto Nazionale di Ricerca Metrologica (INRiM), Italy
- Service hydrographique et océanographique de la Marine (Shom), France
- Norsk institutt for vannforskning (NIVA), Norway
- National Oceanography Centre (NOC), United Kingdom
- Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), Italy
- Physikalisch-Technische Bundesanstalt (PTB), Germany
- Université d'Aix-Marseille, France
- Universidad Católica del Norte, Chile
- Anel.lides Sl, Spain
- Laboratoire national de métrologie et d'essais (LNE), France
- Institut d'Arquitectura Avançada de Catalunya (IAAC), Spain
- Suomen ympäristökeskus (SYKE), Finland
- Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans), Belgium
- European Multidisciplinary Seafloor and water-column Observatory - European Research Infrastructure Consortium (EMSO ERIC), Italy
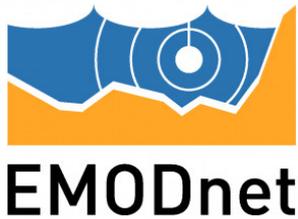
FUNDING

EMODnet Ingestion III

European Marine Observation and Data Network

Marine data ingestion and safekeeping in and for EMODnet

The European Marine Observation and Data Network (EMODnet) brings together more than 160 organizations to improve the harmonized sharing of marine data. As part of the larger EMODnet context, EMODnet Ingestion 3 continues the work of it predecessors on facilitating the data publication process. This in particular included the EMODnet Data Ingestion Portal, which helps data managers publish their data following open data principles.

52°North's role in EMODnet Ingestion is focused on Sensor Web technologies. Based on results from previous projects and currently ongoing international standardization efforts, we support the consortium in challenges related to sharing near real-time observation data streams. This includes not only the development of best practices and guidance, but also the creation of dedicated demonstrators and show cases.

In 2022, 52°North continued the work started in the previous EMODnet Ingestion 2 project, working with several partners to enable research vessels to share their near real-time tracking data using interoperability standards, such as MQTT and the OGC SensorThings API. We further refined the resulting data publication workflow built on top of the Eurofleets Automatic Reporting System (EARS) and described it in related publications.

52°North's focus in EMODnet Ingestion 3 is the use of the OGC SensorThings API to provide live event data from research vessels. Another major topic is the integration of OPeNDAP/ERDDAP services with Sensor Web infrastructures. This includes in particular the collaboration on the OGC API - Connected Systems in the respective OGC standards working group. 52°North will provide an implementation of this proposed standard, i.e. a successor to the OGC Sensor Observation Service and the OGC Sensor Planning Service, based on pygeoapi.

KEY TECHNOLOGIES

> Sensor Web
> OGC SensorThings API
> MQTT
> Angular
> ERDDAP
> OPeNDAP
> OGC API - Connected Systems
> pygeoapi

FACTS

Duration:
3/2022 - 3/2024

Website:
https://www.emodnet-ingestion.eu/

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Professional Services
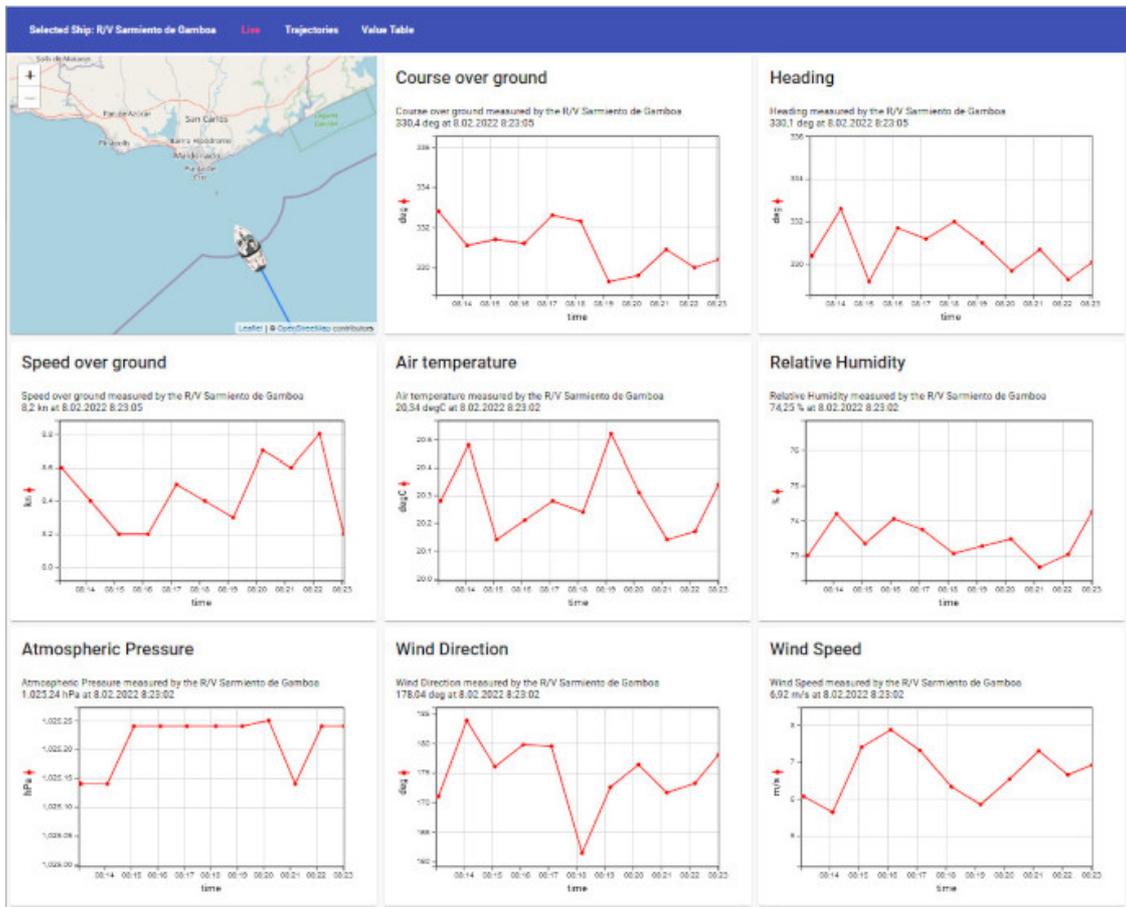
Eurofleets dashboard

PARTNERS

- 44 partners from all over Europe
  52°North is a subcontractor of Maris B.V., The Netherlands

FUNDING

JERICO-S3

Joint European Research Infrastructure of Coastal Observatories

JERICO-S3 facilitates the integration of marine sensing technology into research data infrastructures to better observe the coastal ecosystem.

The Joint European Research Infrastructure for Coastal Observatories (JERICO-RI) is a system of systems strengthening the European network of coastal observatories. It provides a powerful and structured European Research Infrastructure (RI) dedicated to observing and monitoring the complex marine coastal seas. JERICO-RI aims to

- provide services for the delivery of high-quality environmental data
- enable access to solutions and facilities as services for researchers and users
- create product prototypes for EU marine core services and users
- support excellence in marine coastal research to better answer societal and policy needs.

JERICO-S3 (Joint European Research Infrastructure of Coastal Observatories: Science, Service, Sustainability) will provide a state-of-the-art, fit-for-purpose and visionary observational RI, as well as expertise and high-quality data on European coastal and shelf seas. It will significantly enhance the current value and relevance of the JERICO-RI by implementing the science and innovation strategy elaborated in the JERICO-NEXT project.

JERICO-S3 targets a more science-integrative approach to better observe the coastal ecosystem. In turn, this will elevate the scientific excellence of the regional and local ecosystems. The project implements major user-driven improvements in terms of observing the complexity of coastal seas and continuous observation of the biology, access to facilities, data and services, best practices and performance indicators, as well as innovative monitoring strategies. These also cover cooperation with other European RIs (EuroARGO, EMSO, DANUBIUS, ICOS, EMBRC, LIFEWATCH) and international scientific communities, industry and other stakeholders, and aligning strategy with COPERNICUS/CMEMS, EMODNET and GEO/GEOSS.

KEY TECHNOLOGIES

- > Sensor Web
- > OGC SensorThings API
- > Java
- > JavaScript
- > Helgoland Sensor Web Viewer
- > OGC Sensor Model Language (SensorML)

FACTS

Duration:
02/2020 – 01/2024

Website:
https://www.jerico-ri.eu/

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Research and Development

52°North focuses on technological innovation activities. We work on the advancement of Sensor Web components, such as the Helgoland Sensor Web Viewer and data access services based on the OGC SWE standards. Our aim is to improve the usability of interoperable data exchange workflows and concepts for marine sensor data.

In 2022, 52°North focused on evaluating new standards that could potentially be relevant to the project. These included the new OGC API family of standards, as well as the SensorThings API 2.0 standard currently under development. 52°North also helped prepare the development by providing custom Sensor Web components.
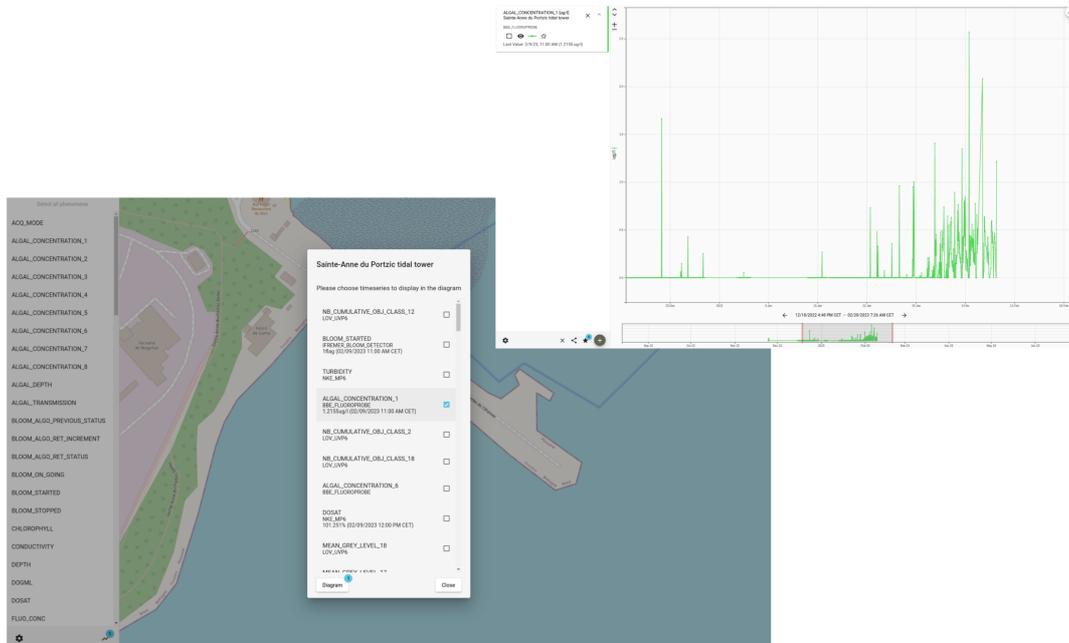
Helgoland visualization of the **cEGIM pre-demo data** off the coast of Brest, France

PARTNERS

39 partners, including:

- **Coordinator:** Institut français de recherche pour l'exploitation de la mer (Ifremer), France
- Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung (AWI), Germany
- Consiglio Nazionale delle Ricerche (CNR), Italy
- ETT S.p.A., Italy
- European Global Ocean Observing System (EuroGOOS), Belgium
- Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung GmbH (HZG), Germany
- Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGC), Italy
- Plataforma Oceánica de Canarias (PLOCAN), Spain
- Royal Belgian Institute of Natural Sciences, Belgium
- Universitat Politècnica de Catalunya (UPC), Spain

FUNDING

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 and project stations in the North and Baltic Seas. These platforms measure a range of parameters at different depth and height levels. Once a year, a ship approaches the stations to measure profiles of a range of parameters. 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 a SensorThings API server and client components that allow exploration and visualization of the available observation data. The 52°North's Helgoland Sensor Web Viewer is used for this purpose.

The main taskof this project is to extend the Sensor Web Viewer to support profile data and to harmonize the presentation of time series and profile data. Special emphasis was placed on improving the usability of the viewer and adding a convenient approach for selecting profile data for visualization.
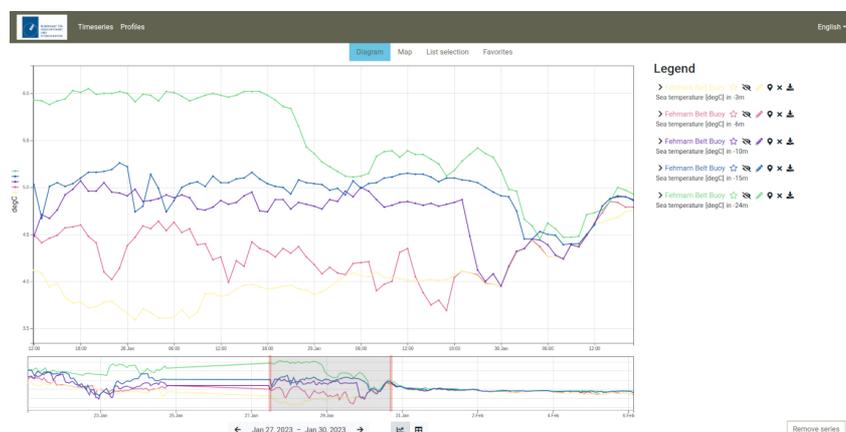
Fehmarn Belt buoy water temperatures at various depths

CUSTOMER

- German Federal Maritime and Hydrographic Agency (BSH), Germany

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SOS Extensions for AQUARIUS Data Management System

Enhancing the 52°North SOS server to enable interoperable sharing of hydrological data

AQUARIUS is a hydrological software system developed and sold by Aquatic Informatics. It enables organizations to acquire, process, model and publish water information. Several regional councils in New Zealand use this system to manage their hydrological data. Some of these councils need to provide an SOS interface in combination with WaterML 2.0 in order to interoperably share the hydrological data collected and simultaneously fulfill corresponding data provision obligations. To address this issue, the 52°North SOS Server uses AQUARIUS as a data source.

52°North's task was to extend the SOS AQUARIUS proxy server to meet the specific requirements of the regional councils, such as providing qualifier and code quality/grade information in WaterML 2.0. As a result, the updated Sensor Web installation was optimized to deliver hydrological data with all the necessary contextual information required by hydrological experts.

CUSTOMER

- Bay of Plenty Regional Council Toi Moana, New Zealand

KEY TECHNOLOGIES

> 52°North Sensor Web Suite
> Helgoland Sensor Web Viewer

FACTS

Duration:
07/2022 – 09/2022

Contact:
Simon Jirka
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Project Type:
Professional Services

EDIS

Extension of the PEGELONLINE Infrastructure (EDIS)

EDIS provides the German Federal Waterways Administration with new ways to deliver critical measurement data faster and more reliably, for example, in the event of flooding.

The ITZBund is a service center providing IT services to federal agencies in Germany. They operate the PEGELONLINE platform, an important infrastructure that yields a broad range of hydrological measurement data collected along German waterways.

52°North provides consulting to evaluate event-based communication techniques to more efficiently deliver (geospatial) information, such as measurement data, in real-time. Our team specifically considers approaches to reduce the latency of data delivery and minimize server loads using push-based communication protocols such as MQTT and AMQP. In addition to evaluating protocols, we investigate potential approaches to structuring the delivered data, ensuring access control, supporting the development of client applications such as dashboards, and integrating event-based workflows into the existing IT infrastructure.

Our software engineers complement these activities by upgrading PEGELONLINE's existing Sensor Web components. These include the current 52°North SOS implementation as well as the Helgoland Sensor Web Viewer.

Activities in 2022 were twofold. The 52°North team completed upgrading PEGELONLINE's Sensor Web components. This included not only updating the 52°North SOS, but also customizing the Helgoland Sensor Web Viewer to provide optimized accessibility. The second large task was to create and implement an architecture for the event-based delivery of measurement data. After a comprehensive evaluation of architecture options for integrating incoming measurement data and system deployment, 52°North focused on the system's implementation. First tests with selected users are planned for 2023.

KEY TECHNOLOGIES

> 52°North Sensor Web Suite
> SensorThings API
> MQTT
> AMQP
> Apache Kafka

FACTS

Duration:
07/2021 - 06/2024

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Professional Services
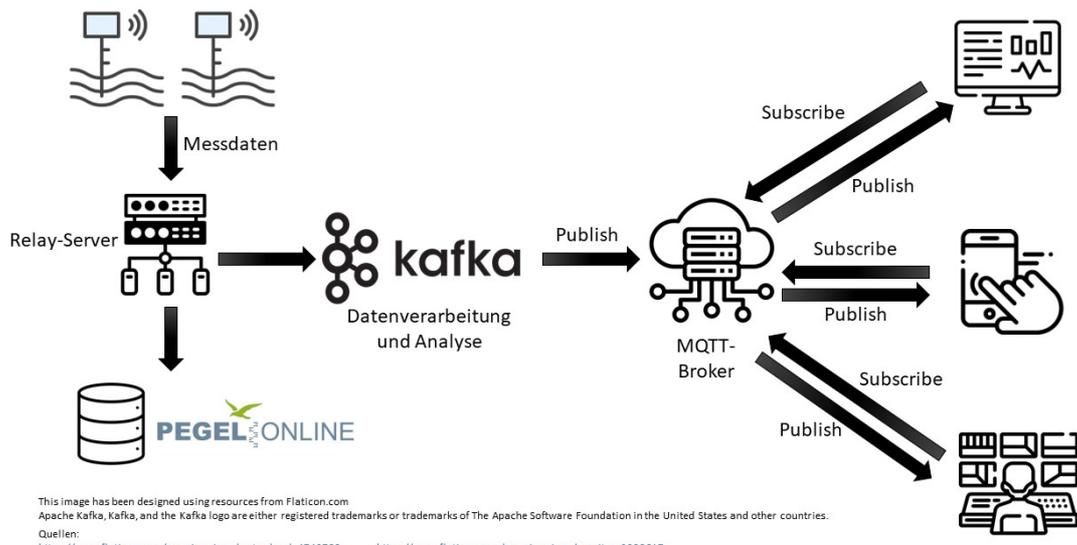
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Quellen:
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https://www.flaticon.com/premium-icon/server_2318786

EDIS architecture

CUSTOMER

- Informationstechnikzentrum Bund (ITZBund), Germany

Cos4Cloud

Co-designed Citizen Observatories Services for the EOS Cloud

Cos4Cloud supports citizen observatories to increase the quality and quantity of their data and facilitates the re-use of the collected data by the scientific community, relying on the European Open Science Cloud.

Cos4Cloud (Co-designed citizen observatories for the EOS Cloud) designs, prototypes and implements 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 used to implement these services 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 provide mechanisms to ensure the visibility and recognition of data contributors and tools to improve networking between various stakeholders. Novel innovative digital services have been developed by integrating Citizen Science products generated by different providers. The consortium implements the services according to open standards to ensure their interoperability. The European Open Science (EOS) Cloud hub provides an agile, fit-for-purpose and sustainable site, including a discovery service, to both traditional and citizen scientists.

Stakeholders in society, government, industry, academia, agencies, and research drove a user-oriented design of the new services by co-designing the service requirements. Cos4Cloud integrated 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 contributed to the definition of the architecture and the development of interoperability standards, profiles and best practices. We led the project work to define a set of agile methodologies and documentation instructions. Our other contributions included interoperability, conformance and performance testing, and technology readiness assessment. Additionally, we supported networking, dissemination, and international standardization activities.

KEY TECHNOLOGIES

> European Open Science Cloud (EOSC)
> OGC Sensor Web Enablement (SWE)
> Spatial Data Infrastructure Concepts

FACTS

Duration:
11/2019 - 02/2023

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

Contact:
Simon Jirka
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Project Type:
Research and Development

In 2022, our team finalized the fit-for-purpose agile methodology that respects the individual differences of all partners. It provides the framework for team-level technical development and overall integration of project-level activities (e.g., co-design process) throughout the project lifecycle. In addition, we created an agile testing plan to ensure that the features developed and the integration of citizen observatories and services developed serve the project's overall goal.

Our software engineers also helped develop the service architecture, focusing on interoperability. We contributed to the STAPlus extension for the SensorThings API (v1.1). The extension leverages data modeling and workflows in citizen observatories. It covers not only aspects focused on citizen science, but also, for example, observation ownership, licensing, and their relationships, and can be applied to other domains as well. With partners SecureDimensions and CREAF, we submitted the OGC Best Practice for using SensorThings API with Citizen Science. The OGC community has approved the Best Practice document for publication.

Agile methodology - big picture
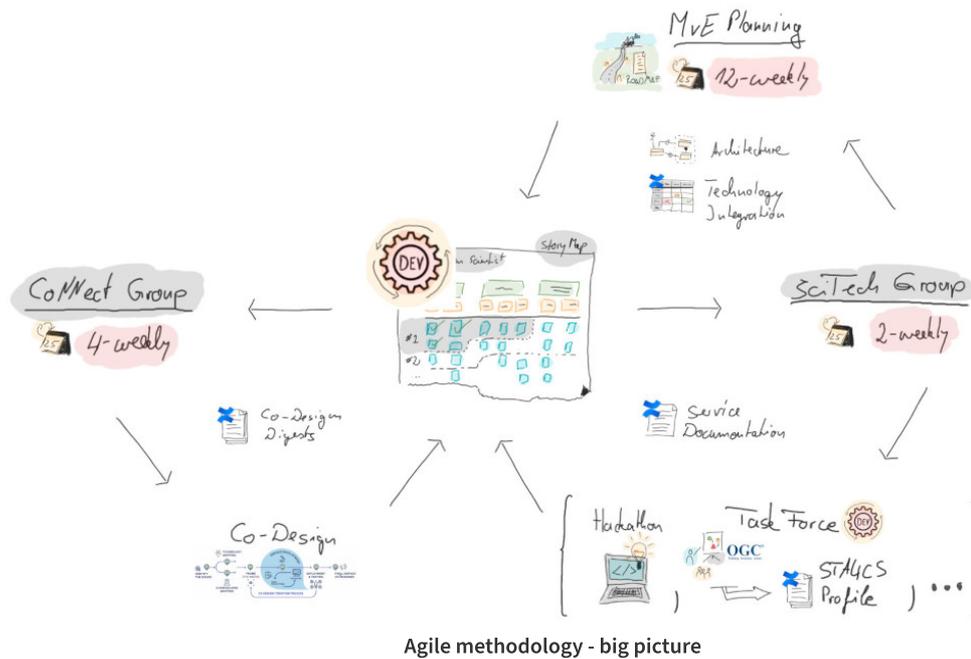
PARTNERS

- **Coordinator**: Consejo Superior de Investigaciones Científicas (CSIC), Spain
- Conservation Education & Research Trust (EarthWatch), United Kingdom
- Centro de Investigacion Ecologica y Aplicaciones Forestales (CREAF), Spain
- Institut national de recherche eninformatique et automatique (INRIA), France
- DYNAIKON LTD, United Kingdom
- Bineo Consulting S.L., Spain
- Pocket Science, The Netherlands
- The Open University (OU), United Kingdom
- Secure Dimensions GmbH (SD), Germany
- Sveriges lantbruksuniversitet (SLU), Sweden
- Ethniko kai Kapodistriako Panepistimio Athinon (NKUA, Greece
- Verein der Europäischen Bürgerwissenschaften e.V. (ECSA), Germany
- Trébola Organización Ecológica, Colombia
- Science for Change S.L. (SfC), Spain

FUNDING

Creating Interfaces

Data Management for Citizen Science Projects

Creating Interfaces project results provide new (participatory) approaches and tools to better understand the Food-Water-Energy-Nexus.

Creating Interfaces has explored 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 built local capacity through innovative approaches in knowledge co-creation, governance and exchange.

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

The development of socio-technical interfaces and decision support tools was driven by the needs of stakeholders, the FWE actors, and members of the public following an Urban Living Lab framework. Users/co-creators, tested and evaluated creative solutions and ideas, e.g. citizen science tools and approaches.

52°North developed interoperable citizen science and decision support workflows for providing data collection and analysis functionality. This was part of different Urban Living Labs and Citizen Science approaches in the three partner cities: Tulcea (Romania), Wilmington (USA) and Slupsk (Poland). We evaluated existing Citizen Science concepts, advanced the identified baseline components identified and contributed our findings to international standardization activities aimed at increased interoperability among Citizen Science projects. According to our partners' specific requirements, we also customized identified tools and frameworks.

KEY TECHNOLOGIES

> JavaScript
> Wq
> PostgreSQL

FACTS

Duration:
05/2018 – 05/2022

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

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Research and Development

52°North's activities in 2022 focused on finalizing the project. This included last adjustments to the tool set, as well as contributions to the project's final deliverables and reports.
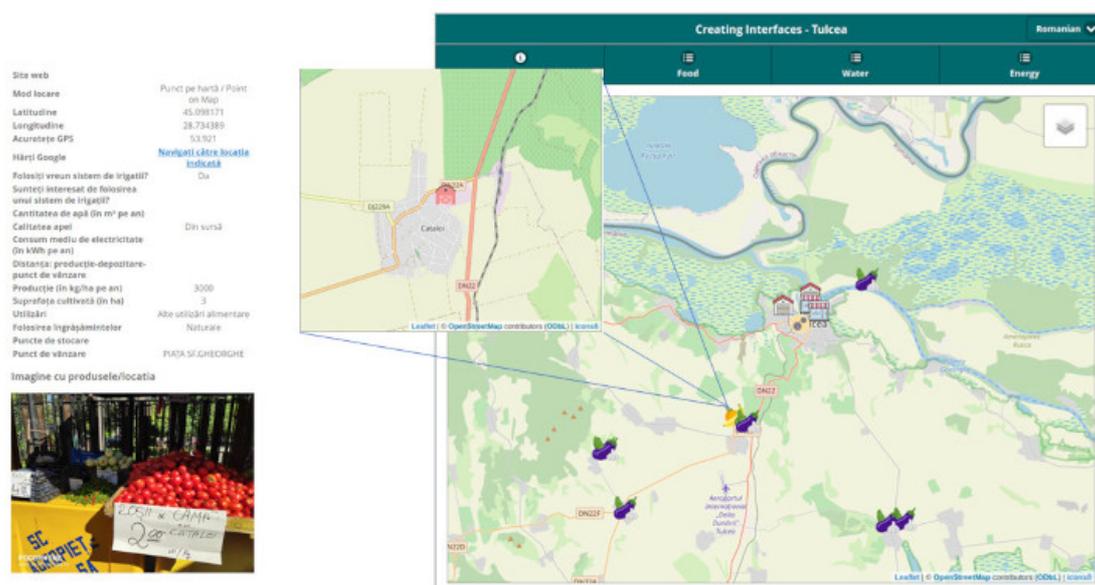
Information on local producers collected near Tulcea, Romania

PARTNERS

- **Coordinator:** EIfER – Europäisches Institut für Energieforschung, Germany
- University of Delaware, School of Public Policy and Administration, USA
- The National Center for Atmospheric Research (NCAR), USA
- University of Warwick, Centre for Interdisciplinary Methodologies, United Kingdom
- Pracownia Zrównoważonego Rozwoju (PZR), Poland
- SweGreen, Sweden,
- Nicolaus Copernicus University Toruń, Institute of Sociology, Poland
- Danube Delta National Institute for Research and Development (DDNI), Romania
- Royal Institute of Technology, Sweden

FUNDING
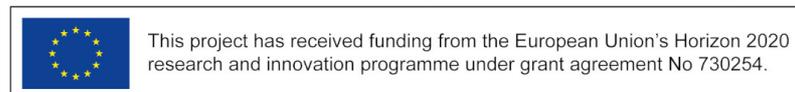
data.europa.eu

European Data Portal Managed Services

Enabling the sharing of Open Data across Europe

This project facilitates the sharing of open data resources across Europe. The central element is the new data.europa.eu portal, which was launched in the spring of 2021. It serves as a core component of the public sector data infrastructure that includes data sources from the European Union, its institutions and European countries. The data.europa.eu portal offers three key pillars:

- Facilitate the use of public data resources across Europe via a single point of access: The portal offers over 1.5 million datasets across 36 countries and 76 EU institutions and bodies;
- Support to EU institutions and European countries: This includes helping national open data policy owners to build communities of practice, in which they receive training and consultancy to improve, sustain and document data publishing practices;
- Socio-economic benefits: Investigating the socio-economic benefits of re-using public data resources and provide stimuli to foster the use and showcase the value of using open data.

52°North cooperates closely with Netcompany-Intrasoft, con terra, Fraunhofer FOKUS and Capgemini Invent to develop a component for the map-based visualization of geospatial data. In addition, 52°North contributes to the advancement of the underlying data infrastructure, for example, by exploring how to best integrate near-real time data streams.

In 2022, 52°North's team worked on enhancing the geospatial data visualization component. This comprised, for example, a new user interface design, an improved preview of metadata, as well as options for flexibly using the viewer for additional GeoJSON data sets provided by the EU Publications Office. con terra's team and ours contributed to webinars that introduced the topic of open real-time data as well as identified new (technology) trends in the provision of geospatial data.
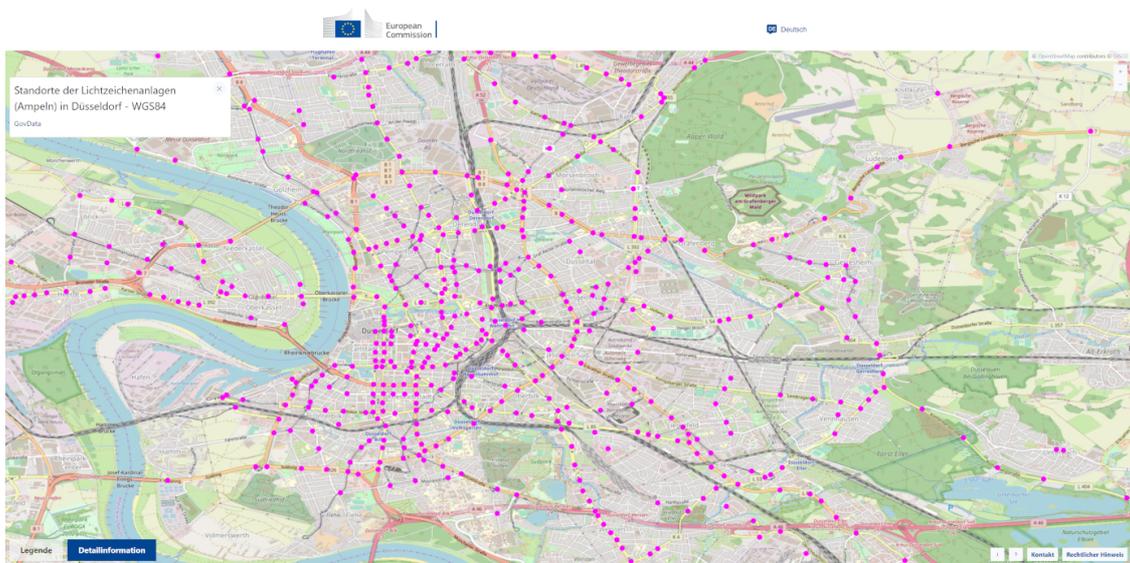
Map view of traffic light data in Düsseldorf from the data.europa.eu portal

PARTNERS (SELECTION)

- **Main Contractor**: Capgemini Invent, The Netherlands
- Netcompany-Intrasoft, Luxembourg
- con terra GmbH, Germany
- Fraunhofer FOKUS, Germany
- Agiledrop Ltd., Slovenia
- OMMAX GmbH, Germany

CUSTOMER

- Publications Office of the European Union
  52°North is subcontractor to Capgemini Invent and con terra

G.I.B. KomMonitor II

Enhancing the KomMonitor Platform

Extending the KomMonitor platform to support reachability analyses

KEY TECHNOLOGIES

> Spring Boot
> GeoTools
> JavaScript

FACTS

Duration:
09/2022 - 01/2023

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Professional Services

The KomMonitor platform supports the management, visualization, and exploration of a broad range of data: socio-demographic, city planning, infrastructure, environmental, etc. It was mainly developed by the Bochum University of Applied Sciences in a dedicated research project.

G.I.B. mbH is a state-owned company that supports the North Rhine-Westphalia state government in achieving its goals to promote employment, as well as combat unemployment, poverty and social exclusion. 52°North and the Bochum University of Applied Sciences collaborated to extend KomMonitor to support interactive and explorative reachability analyses. We developed a software component for processing spatial datasets that enables assessment of the accessibility of certain public utilities and infrastructure. In addition, the implementation of an interactive scenario planning as part of the KomMonitor Web Client will support municipalities for sustainable urban development. These enhancements were funded by the European Social Fund. Our team completed the main developments for this project in 2022.
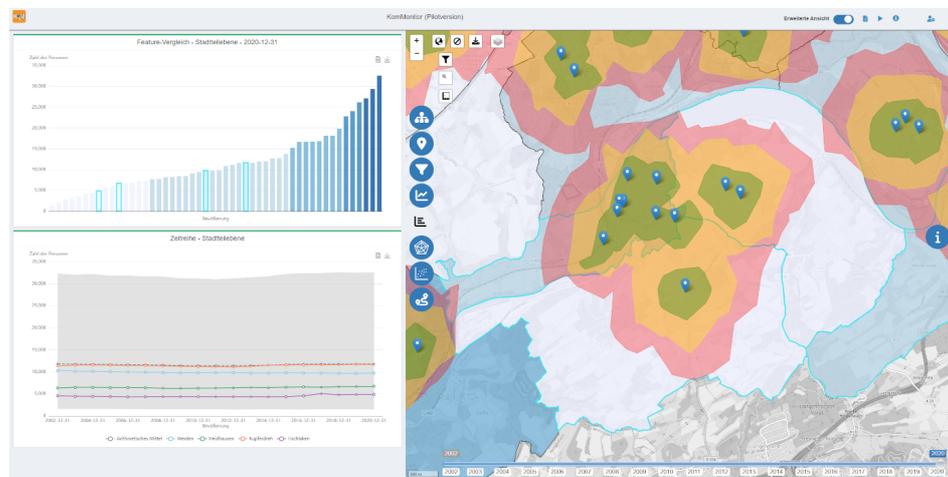
KomMonitor's reachability analyses

CUSTOMER

- G.I.B. mbH - Gesellschaft fur innovative Beschäftigungsförderung mbH, Germany

regio iT KomMonitor

Deploying the KomMonitor Platform

Launching the KomMonitor platform to support social planning tasks

The KomMonitor platform supports the management, visualization, and exploration of a broad range of data: socio-demographic, city planning, infrastructure, envirnomental, etc. It was mainly developed by the Bochum University of Applied Sciences in a dedicated research project to solve various challenges regarding urban development.

regio iT GmbH is a municipial IT service provider in North Rhine-Westphalia. The company provides IT infrastructure and services to public clients from various business fields, such as education and development or public administration. On behalf of the regio iT GmbH, 52°North launched the KomMonitor platform for the StädteRegion Aachen, an association of municipalities from the former district of Aachen and the city of Aachen and one of regio iT GmbH's customers. 52°North deployed the full Docker-based KomMonitor software stack, as well as Keycloak for access mangament, and Portainer for monitoring tasks in regio iT GmbH's IT infrastructure. The latter is responsible for maintaining the database and server systems while 52°North provides 2nd level and 3rd level support for the KomMonitor platform to support the customers' users with their technical questions. In addition, 52°North provides dedicated technical administration workshops to guide regio iT GmbH and the StädteRegion Aachen employees in administrative tasks for the KomMonitor platform.

The cost of implementing the KomMonitor platform in StädteRegion Aachen was funded by the Ministry of Labour, Health and Social Affairs of North Rhine-Westphalia as part of the social funding program "Zusammen im Quartier". Our team finished preparing the KomMonitor platform to be production-ready in 2022 and provides technical support as well as workshops in 2023.

KomMonitor Web Client shows the SGB II quota in social areas of the StädteRegion Aachen

KEY TECHNOLOGIES

> KomMonitor software stack
> Docker
> Keycloak
> Portainer

FACTS

Duration:
10/2022 - 12/2023

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Professional Services

CUSTOMER

- regio iT gesellschaft für informationstechnologie mbh, Germany

CCIKM Portal

Climate Change Information Knowledge Management Portal

The project's platform integrates a broad range of geospatial information to better understand the impacts of climate change on Bangladesh.

The United Nations Development Programme commissioned the TH Köln - University of Applied Sciences to develop the "Climate Change Information Knowledge Management Portal for Bangladesh". One of the project's components is the implementation of a solution for the management and provision of geodata required for the portal. Two central elements of the system are a GeoNode instance for the management of a broad range of spatial data, as well as, an instance of the 52°North OGC SensorThings API implementation to support the handling of time series data.

In order to develop this component, 52°North supported the TH Köln - University of Applied Sciences with consulting and implementation capacities for geodata management, GeoNode and spatial databases. Our team also supported the systematic collection of requirements and the derivation of a development plan.

During 2022, 52°North continued to support the GeoNode deployment and data preparation. We developed three Angular-based dashboards that visualize climate impact, climate vulnerability and disaster risk in Bangladesh. In addition, we trained Bangladeshi staff to take over platform maintenance, carry out updates and make sure of its continuous availability.
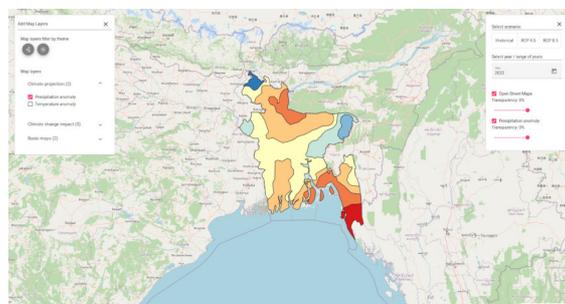
Visualization of map layers based on GeoNode instance

CUSTOMER

- Faculty of Spatial Development and Infrastructure Systems, TH Köln - University of Applied Sciences, Germany

GAIA-X

Next Generation Data Infrastructure for Europe

Evaluating the use of Gaia-X federation services for sharing geospatial data in heterogeneous cloud environments

Gaia-X is a multinational project of European member states, in-line with the European Data Strategy and co-funded by the European Commission, that supports the development of European Data Spaces by piloting architectural concepts, governance mechanisms, best practices and tools for data sharing and federation of cloud services. 52°North is an active institutional member of Gaia-X AISBL, the coordinating body of the Gaia-X Initiative.

One of the core drivers behind Gaia-X is the need for data sovereignty which means the ability to control what happens with data when being shared and processed in cloud environments within and between data spaces. Federation services (GFSX) are being employed to manage identities and verifyable credentials of participants, to conclude smart contracts and to manage trust based on common policies and a labeling framework.
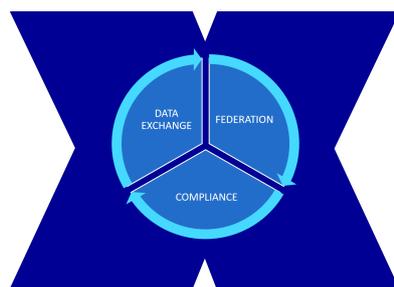
Gaia-X: Connecting Disjoint Ecosystems (CreativeCommons CC-BY-NC-ND)

52°North investigates the architectural patterns of Gaia-X and maps these to the concepts, technologies and workflows that are being used to share spatial data and spatial data services in Spatial Information Infrastructures. In 2022, our team analyzed the state of the specifications and conducted an architecture design experiment.

PARTNERS

- con terra GmbH, Germany

CUSTOMER

- Esri, USA

KEY TECHNOLOGIES
> GFSX federation services
> Verifiable credentials, credential manager
> JSON LD

FACTS
Duration:
03/2022 - 09/2023

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Professional Services

PlasticObs_plus

Developing a Geospatial Data Platform

Supporting machine learning on multisensor data from airborne remote sensing

The PlasticObs_plus research project (funding code: 67KI21014A) is part of the BMUV (Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection) funding initiative "AI lighthouse projects for the environment, climate, nature and resources". It investigates machine learning on multi-sensor data from airborne remote sensing to combat plastic waste in oceans and rivers as part of the funding program "KI-Lighthouses for Environmental Protection". The project goal is to develop an integrated measurement system for routine, quasi-synoptic acquisition and visualization of the distribution of plastic debris on the ocean surface and on shorelines or coastal strips via remote sensing and artificial intelligence methods. In addition to the intended real-time data acquisition of plastic objects by airborne sensors, downstream data analysis plays a central role in the research project.

52°North's role as subcontractor is to support the development of a platform for geodata management that will enable further processing of the raw data. This includes developing a central geo-portal, which will provide the results as web services. Ultimately, the platform will be accessible to the general public, stakeholders and responsible public agencies in order to promote sustainable solutions to environmental pollution and targeted, effective counter strategies.

PARTNERS

- OPTIMARE Systems GmbH, Germany
- Jade Hochschule Wilhelmshaven/Oldenburg/Elsflet, Germany
- everwave GmbH, Germany

CUSTOMER

- Deutsches Forschungszentrum für Künstliche Intelligenz, Germany

University of Manitoba

Managing Geospatial Research Data/ Sensor Data Streams with GeoNode

Customization and extension of a GeoNode instance to support the management of research data and sensor data streams

The Centre for Earth Observation Science at the University of Manitoba operates a data repository that hosts and shares its research data based on the FAIR principles. In collaboration between the University of Manitoba and 52°North, this platform has undergone a redevelopment process. A central element of the system is GeoNode, which handles the sharing of spatial data. In addition, the OGC SensorThings API standard is used to share real-time meteorological and water quality data. In the initial project phase, 52°North customized a first version of GeoNode. We also integrated a SensorThings API instance into GeoNode and coupled it with a dedicated dashboard application for visualizing time series data.

Our activities in 2022 concentrated on the second project phase, which comprised an upgrade of the underlying GeoNode version. This was complemented by several refinements to further improve the integration of (near real-time) time series data (e.g., adding further data sources, time series data download, better discovery and preview functionality, optimizing the metadata handling).

University of Manitoba's weather station dashboard

KEY TECHNOLOGIES

> GeoNode
> GeoServer
> Docker
> Python
> Django
> OGC SensorThings API

FACTS

Duration:
Since 09/2021

Contact:
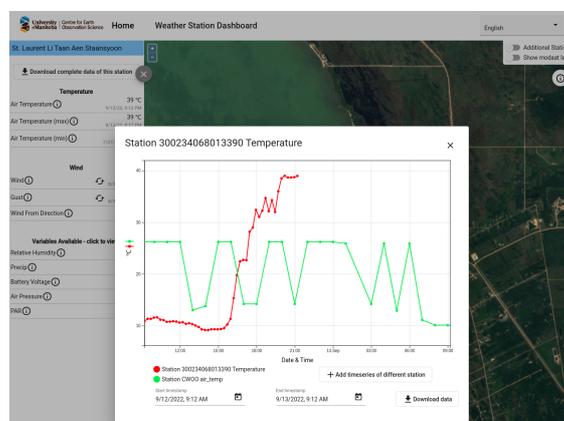Simon Jirka
s.jirka@52north.org

Project Type:
Professional Services

CUSTOMER

- University of Manitoba, Canada

28

SudaNexT

Water-Energy-Food Nexus Transition Collaboration Platform

Developing capacities for water-energy-food nexus transition in Sudan

KEY TECHNOLOGIES

> GeoNode
> Angular
> GeoServer

FACTS

Duration:
01/2022 - 12/2022

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Professional Services

The Sudan Nexus Transition (SudaNexT) project focuses on strengthening the capacities for Water-Energy-Food (WEF) Nexus at the University of Khartoum, enabling them to promote and support the transition process in the new Sudan by acting as a bridge between science, society, and policy. In addition, it aims to consolidate a partnership on higher education and research regarding WEF Nexus and Integrated Water Resources Management (IWRM) between the University of Khartoum (Sudan) and the TH Köln - University of Applied Sciences (Germany).

52°North contributed by supporting the deployment of a GeoNode instance where students and researchers from the University of Khartoum and the TH Köln - University of Applied Sciences can collaborate and share research data. In particular, Sudanese staff was trained to deploy and maintain the GeoNode instance.

CUSTOMERS

- Faculty of Spatial Development and Infrastructure Systems, TH Köln - University of Applied Sciences, Germany
- University of Khartoum, Sudan

FORLIANCE Geodata Platform

Geospatial Data Platform Consulting

Supporting the process of developing a suitable system architecture

FORLIANCE developed a Monitoring and Communication Platform to provide clients with digested and analyzed project performance data, thus improving project management and enhancing their climate action reporting. By removing the barriers for transparent data transfer along the supply chain, this platform strengthens the connection between carbon project owners and climate conscious corporates.

52°North supported FORLIANCE in the development of the Monitoring and Communication Platform. We organized a workshop and provided consulting services in 2021. The purpose of the workshop was to systematically gather the relevant requirements and use cases influencing the system design. As a workshop follow up, we analyzed the input and derived recommendations for the design and implementation strategy.

The monitoring tool delivers accurate and real-time data that users without GIS or remote sensing skills can easily analyse.

Our team realized the proposed platform by April of 2022 and implemented further improvements during the summer. It's architecture features a GeoNode instance as the backbone for all geodata and project metadata. A sophisticated metadata layer allows the system to operate a multi-tenant setup: multiple customers of FORLIANCE use the same portal to access their individual project information. This information is presented with a browser dashboard application developed with Angular and OpenLayers. In addition to the realization and deployment, we provided new FORLIANCE staff members with onboarding and training sessions. Discover more about the FORLIANCE Monitoring and Communication Platform.

CUSTOMER

- FORLIANCE GmbH, Germany

KEY TECHNOLOGIES
> GeoNode
> Angular
> Kubernetes
> GeoServer
> OpenLayers

FACTS

Duration:
10/2021 - 11/2022

Contact:
Matthes Rieke
m.rieke@52north.org

Project Type:
Professional Services

Spatial Data Infrastructure at the Julius Kühn Institute

Managing federated geodata

The goal of this series of projects is to identify, discuss and document the current and future requirements for the geodata infrastructure at the Julius Kühn Institute (JKI). Hence, 52°North supports the JKI in identifying a solution for managing geodata and creating the prerequisites for a short-term implementation of a federated research data infrastructure.

52°North has collected, discussed and documented the specific requirements for the spatial data infrastructure in a joint workshop with JKI staff from different teams and organizational units. The following technical aspects, among others, play an important role in the development of the solution approach:

- Dealing with large amounts of data
- Scalability
- Access control
- Metadata description
- Unifying endpoints and data access
- Version control
- Embedding geospatial data in web resources
- Integration into local infrastructure

In follow-up projects, 52°North prototypically implemented different aspects of the GDI. The focus in 2022 was on the integration of raster data from a rasdaman instance into GeoNode v4.

CUSTOMER

- Julius Kühn Institute, Germany

HEREON

STA Proxy for Esri Feature Service

Esri Feature Service as data source for the 52°North SensorThingsAPI

The Helmholtz-Zentrum Hereon is building a new system for managing and provisioning data from a multitude of different research campaigns. To enable collaboration with associated research institutions, the OGC SensorThingsAPI (STA) will be used to supplement the existing interfaces and allow for standardized access to campaign data. For this, 52°North developed two components:

- a Harvester to aggregate metadata from an Esri Feature Service into a local database and
- an Adapter to forward STA requests to a Feature Service.

Metadata is harvested periodically from a dedicated Feature Service and cached locally in a database. This allows for fast and efficient access by the STA. Observation data is not cached, but requests are transparently forwarded to the specific feature service and transformed into the appropriate output schema on-the-fly.

Grafana plot of water temperature and CDOM time series test data

CUSTOMER

- [Helmholtz-Zentrum Hereon GmbH](), Germany

SDI Innovations

Architectures for innovative geodata management and processing

We focus on identifying and realizing innovative solutions for transforming, managing, analyzing and visualizing data from disparate sources. The increase in the volume and variety of data, as well as the velocity of data streams, demands new and advanced methods, technologies and architectural designs to address these challenges. This is where our SDI Innovations team contributes with research and development (R&D) and professional services (PS).

Matthes Rieke leads the SDI Innovations efforts at 52°North. He and his team are working on:

- Processing Scalability: identifying and implementing requirements for horizontal and vertical scaling of processing algorithms.
- Workflow Chains and Orchestration: designing and automating complex process workflows.
- Earth Observation Data Processing: handling massive amounts of EO data in an efficient and scalable manner.
- Fit For Purpose Data: pre-processing, ingesting, and delivering raster and vector data to fit the purpose of a specific solution.
- Cloud Environments (PaaS, IaaS, SaaS): leveraging their capabilities in terms of deployment patterns, input data handling, and processing results.
- Standardization: harmonizing processing interfaces, creating and using interoperable data formats.
- Processing Transparency: strengthening reproducibility, data quality and metadata quality, and process discovery.

We address these challenges in a number of R&D and PS projects. Our research partners and customers come from academia and industry and cover a wide range of application domains, such as environmental monitoring, emerging market development, climate change, or disaster management. This diversity enables us to develop new approaches that address the needs of many real-world problems and use cases.

Matthes Rieke

Head of SDI Innovations

RIESGOS 2.0

Scenario-Based Multi-Risk Assessment in the Andes Region

Using the RIESGOS architecture, local municipalities and stakeholders can easily identify the impact of potential disaster situations and plan accordingly.

RIESGOS 2.0 is the direct successor to the successful RIESGOS project, which addressed challenges of increased risks to society caused by natural hazards, such as volcanic eruptions, earthquakes or tsunamis with a focus on the Andes region in South America. It aims to effect more efficient risk management based on more reliable information. In particular, the project addresses complex interactions, such as cascading effects of certain hazards and risks, as well as many of the underlying sources of uncertainty.

RIESGOS 2.0 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 provide the foundation of the RIESGOS 2.0 software architecture. End-users from civil protection and disaster management authorities will be able to simulate and analyze complex multi-risk scenarios.

At 52°North, we are responsible for the conceptual design and implementation of an interoperable architecture for a multi-risk analysis and information system for the Andes region. Our tasks comprise:

- the analysis of requirements,
- the design of a message-driven processing architecture that improves the overall flow data and information products,
- the implementation of selected web services as instances of the OGC API Processes,
- the conceptual design of integrating uncertainty and quality information into the data products of the distributed web services,
- a contribution to market analysis and development of exploitation perspectives (focus on the publication as open source software).

During 2022, 52°North focused on the design and realization of the message-driven processing architecture that allows the dynamic addition of supplementary analytical components. In close collaboration with GFZ and DLR, 52°North software engineers

KEY TECHNOLOGIES

> OGC API Processes
> OGC Web Processing Service
> Java
> Docker

FACTS

Duration:
03/2021 - 02/2024

Website:
https://www.riesgos.de/en/

Contact:
Matthes Rieke
m.rieke@52north.org

Project Type:
Research and Development

developed software components that enable existing *Web Processing Service* instances to be integrated into the new architecture pattern. We have verified these components using javaPS or extensions of existing processing frameworks, such as pygeoapi.
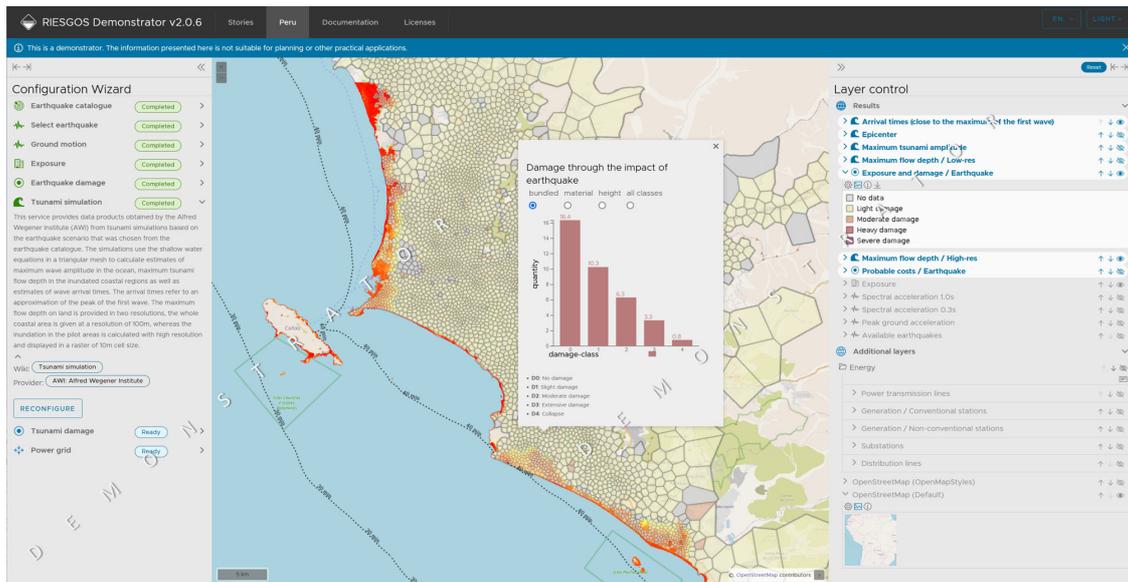
The RIESGOS demonstrator

PARTNERS

- **Coordinator**: Deutsches Zentrum für Luft- und Raumfahrt (DLR), Germany
- Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum (GFZ), Germany
- Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Germany
- Technische Universität München (TUM), Germany
- geomer GmbH, Germany
- Sachverständigenbüro für Luftbildauswertung und Umweltfragen (SLU), Germany
- DIALOGIK, Germany

ASSOCIATED PARTNERS

- GIZ GmbH, Germany
- UNOOSA/UN-SPIDER, Germany
- UNESCO, Uruguay
- MunichRE, Germany

FUNDING

EUMETSAT Cloud and Big Data Services

Cloud and Big Data Services Engineering and Operations Support

EUMETSAT's new user portal improves the workflow for discovering and consuming information and data provided by its satellites and services.

KEY TECHNOLOGIES

> JavaScript/TypeScript
  (Single Page Application)
> Angular
> OpenAPI
> Strapi CMS
> Kubernetes

FACTS

Duration:
01/2021 - 12/2023

Website:
https://data.eumetsat.int/

Contact:
Matthes Rieke
m.rieke@52north.org

Project Type:
Professional Services

The project *Cloud and Big Data Services engineering and operations support* started in 2021 and aims to continue the established portfolio of data services featuring innovative data access and discovery capabilities at EUMETSAT. The operational version of the EUMETSAT Data Store - a scalable and extensible architecture for providing online access to EUMETSAT's products - will be maintained and developed further. Besides the Data Store, additional components play an important role: e.g., a workflow engine for improving the internal data processing pipelines and established services, such as the Product Navigator. The consortium, led by CGI Deutschland, is also responsible for the maintenance and operation of the components. con terra and 52°North provide third-level support for specific architecture components.

In 2022, 52°North focused on the development of EUMETSAT's new *User Portal*. It defines a holistic approach to information and data discovery and supersedes the Product Navigator (jointly developed by con terra and 52°North), the EOPortal, as well as the user management system. After a thorough design phase, 52°North used agile software development methods to start the realization. The final *User Portal* architecture consists of a content management system based on a customized Strapi and a platform user interface developed on top of Angular and Bootstrap.

Alongside the *User Portal* development, the team worked on operational and maintenance responsibilities, by which the evolution of existing services, such as the EUMETSAT Data Store, played a central role.

EUMETSAT data services

PARTNERS

- CGI Deutschland B.V. & Co. KG, Germany
- con terra GmbH, Germany
- ask – Innovative Visualisierungslösungen GmbH, Germany

CUSTOMER

- EUMETSAT, Germany

SIMPORT

Sovereign and Intuitive Management of Personal Location Information

Raising awareness for privacy in location information

The majority of cell phone users are unaware of how their cell phone's GPS location history can lead to deep conclusions about their activities, place of residence, inclinations, beliefs or social networks. The SIMPORT project aims to raise awareness as well as design and implement measures to better protect the privacy of location information.

The consortium members work to develop guidelines and software modules to confidentially handle personal location information on a mobile device. They cooperate with partners from the industry to create open source software components to enable digital sovereignty with regard to personal location information. Users of these components can clearly visualize possible conclusions about their personal location information and better assess the advantages and disadvantages of passing on this information. Consequently, users know of the risks precisely when they have to decide whether or not they want to share their personal data.

In close cooperation with computer science and the social sciences, the researchers analyze how to improve awareness of risks and opportunities and to develop fine-grained control options for the transfer of personal location information. This strengthens the competence and sovereignty of smartphone users when deciding about their personal data. An overview of the research within the project is available in the article *"Linking location privacy, digital sovereignty and location-based services: a meta review"* (https://doi.org/10.1080/17489725.2023.2239180).

During 2022, the partners focused on developing the *SIMPORT learning app* that raises awareness for location history and conclusions that can be drawn from it. The interaction forms and patterns to improve the user experience with location privacy were also an important focus. The outcome of this research was prototyped into the *enviroCar cross-platform app* in the context of a *Google Summer of Code* project mentored by 52°North. In addition, a concept and a first prototype for a privacy toolkit has been realized. Designed as a replacement for location services within smartphone SDKs, it provides access to the device location, but also gives the full control on accuracy and resolution to the user.
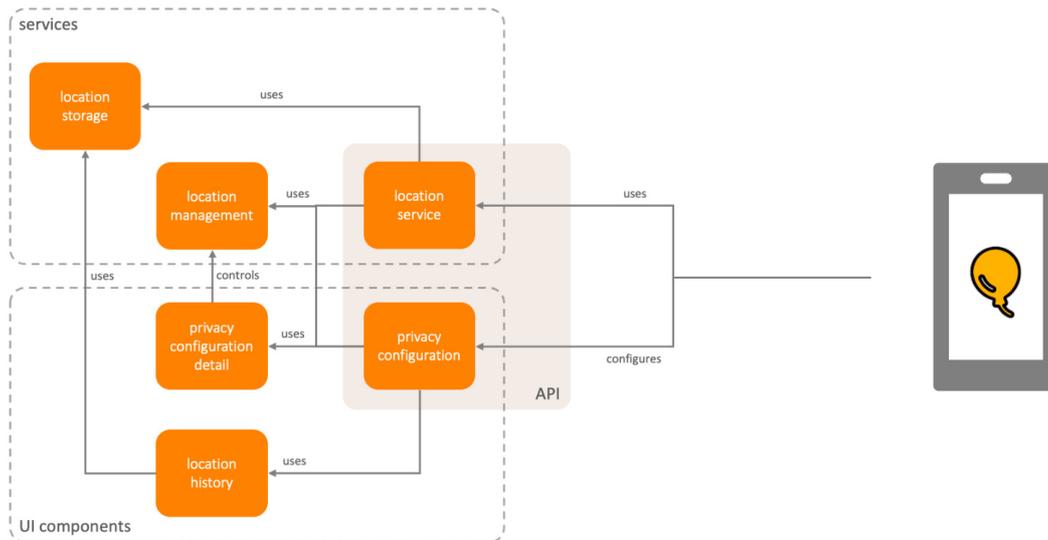
SIMPORT privacy toolkit high-level architecture

PARTNERS

- Institute for Geoinformatics, University of Münster, Germany
- FH Münster, Germany
- HERE Deutschland, Germany
- re:edu, Germany
- Universität Osnabrück, Germany

FUNDING

DVFO LHS

Digital Traffic Flow Optimization for the State Capital Stuttgart

The city of Stuttgart will be able to use the collected data to determine how weather, traffic, and driver behavior interact to affect air quality and traffic safety.

As part of their "Digital Traffic Flow Optimization" project, the state capital of Stuttgart intends to set up an environmentally sensitive traffic management system. This system will include existing components and those currently under development in the overall architecture. It will also supplement further components and integrate various vehicle, traffic and environmental data to form a new overall system.

52°North supports SSP Consult by providing services to enable the use of the enviroCar platform for its purposes in the project. We provide operational and technical support for the platform and software as well as software development and consulting services. Software developments include:

- detection of extreme accelerations and decelerations,
- continuous provision of measurement data, and
- support of software development, data preparation and data analysis.

During 2022, the project reached the integration phase. SSP, GEVAS and 52°North designed the data messaging architecture. It uses a Kafka message broker to disseminate real-time measurements of ongoing trips in Stuttgart.

KEY TECHNOLOGIES

> enviroCar ecosystem
> Android
> Java
> Kafka

FACTS

Duration:
09/2021 - 10/2023

Contact:
Matthes Rieke
m.rieke@52north.org

Project Type:
Professional Services
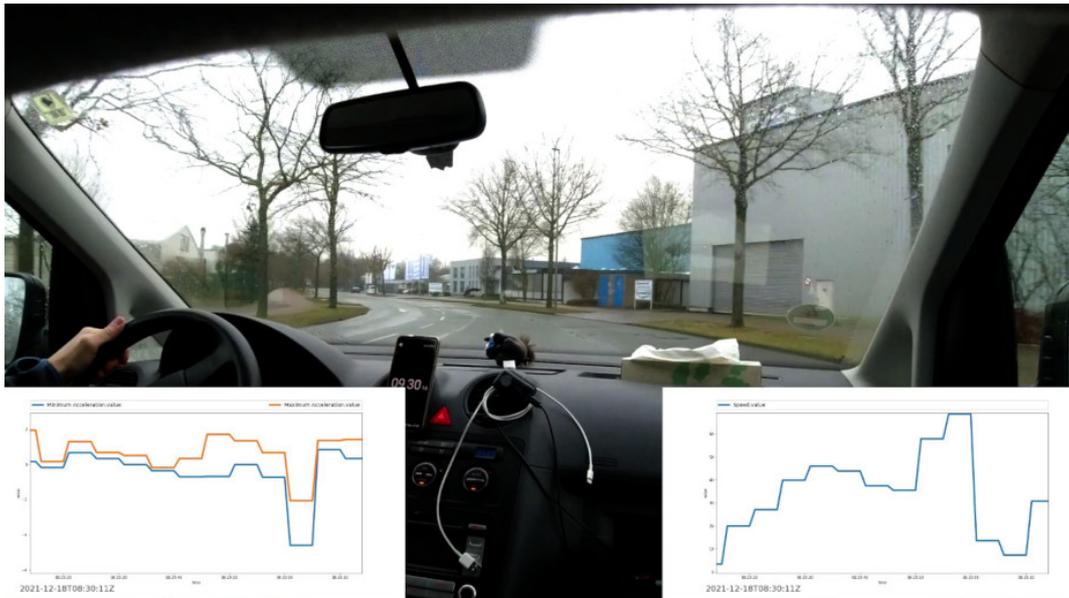
Capturing vehicle accelerations with enviroCar

PARTNERS

- GEVAS software GmbH, Germany
- PRISMA solutions EDV-Dienstleistungen GmbH, Germany
- Trafficon - Traffic Consultants GmbH, Germany
- SSP Consult, Beratende Ingenieure GmbH, Germany
- IVU Umwelt GmbH, Germany

CUSTOMER

- SSP Consult, Beratende Ingenieure GmbH, Germany

FUNDING

The Digital Traffic Flow Optimization project is funded by the Federal Ministry for Digital and Transport (BMDV) and the state capital of Stuttgart (LHS).

Volkswagen Commercial Vehicles Map Data Analysis

Data Analysis for Automated Driving

The analysis toolbox will help Volkswagen Commercial Vehicles consistently assess service area candidates for assisted driving cars.

The Operational Design Domain describes the boundary conditions under which a driving automation system is designed to function. This includes environmental and geographical information as well as the requisite presence or absence of certain traffic or roadway characteristics. At Volkswagen Commercial Vehicles a specific team defines such boundary condition definitions for the development and testing process but also allows them to evaluate potential service areas for Mobility as a Service applications. Due to our expertise in geospatial data analysis and efficient processing of high volume geodata, Volkswagen Commercial Vehicles contracted 52°North to develop a toolbox that enables the automatic derivation of these characteristics from available spatial datasets.

The content-rich road network data offered by Open Street Map builds the foundation for the analysis toolbox. It enables the derivation of basic properties, such as the distribution of road types, speed limit or number of driving lanes for a given area of interest.

OSM's Overpass Turbo API.

The toolbox will support complex analysis capabilities, such as statistics on curve radius, the impact angle of junctions or their complexity as well. The system reconciles two different analysis concepts:

- basic analysis using the Overpass Turbo API
- complex statistics using the Python library osmnx in combination with a PostGIS database

The outcome of the project is a Python toolbox that enables the Volkswagen Commercial Vehicles team to automatically derive statistics for worldwide service area candidates.

CUSTOMER

- Volkswagen Commercial Vehicles, Germany

OGC CITE Consulting

Issue Management and Feature Development for OGC's TEAM Engine

Ensuring true interoperability through OGC web service testing

The Open Geospatial Consortium (OGC) sought development support for their *TEAM Engine* (Test, Evaluation, And Measurement Engine), in particular, for maintenance and evolution of the core framework, existing test suites and test suite candidates. The TEAM Engine is a Java-based application for testing web services and other information resources. It executes test suites developed using the popular TestNG framework, OGC Compliance Test Language (CTL) scripts, and possibly other JVM-friendly languages. It is lightweight and easy to run from the command line or as a web application. The TEAM Engine can be used to test almost any type of service or information resource. It is the official test harness used by the OGC's compliance program.

52°North has previously participated in activities related to the OGC API Processes test framework as part of the OGC Testbed-17. The software consulting services continue on this basis. We carried out this project in close collaboration with OGC and lat/lon as the overall manager of the TEAM Engine.

After a successful first iteration, this collaboration between the OGC and 52°North was recently extended for another year.

PARTNERS

- lat/lon GmbH, Germany

CUSTOMER

- Open Geospatial Consortium (OGC), USA

Thünen Atlas Extension

Hands-on Developments for GeoNode

Developments for the next iteration of the Thünen Atlas

The Thünen Institut is on the verge of migrating their existing *Thünen Atlas*, which is based on GeoNode 3.x, to the next major release, version 4.0. In the context of this effort, they identified several features to improve the user experience, as well as the platform's capabilities for data exploration and analysis. 52°North and the Thünen Institut collaborate on the following project to realize this set of new features.

This project covers several thematic aspects. The main focus is on:

- improvements for the provision of maps by extending the default MapStore2 widgets and views,
- automatic synchronization of datasets across multiple GeoNode instances to improve publication workflows,
- support for tabular (non-spatial) datasets and visualization of these in dashboards.

The team of software engineers executes the project following agile software development methods. In addition to the technical development, a strong focus lies on communication with the GeoNode developer community as we plan to integrate the majority of features into the upstream code base.

The *Thünen Atlas* landing page

CUSTOMER

- Johann Heinrich von Thünen-Institut, Germany

Spatial Data
Science

Developing analytical tools to address real world problems

The constant increase in the volume and variety of available data creates a huge potential for answering a wide range of questions. In order to understand this data and to derive answers, we need analytical tools to model the relationships that emerge from it. Dr. Benedikt Gräler, who leads the Spatial Data Science activities, and his team develop data-driven solutions to real-world problems. Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) are common themes across several R&D projects. Geoinformation and Spatial Data Science can play a key role in planning and communicating actions to decision makers, stakeholders and the general public.

By exploring and researching analytical tools ranging from linear statistics and the latest multivariate distributions to modern machine learning (ML) and artificial intelligence (AI) approaches, we develop solutions that are appropriate for the problem at hand given the data available. This requires a solid understanding of data and business. We use and contribute to open source tools where possible and encourage Citizen Science.

We are involved in several R&D and PS projects covering a range of topics. The challenge of making Earth Observation time series accessible and providing unified processing and analysis tools has been and remains an engineering task to solve several open questions. The meaningful integration of heterogeneous data sources (from geospatial observations to official statistics) and the adaptation of ML and AI algorithms to the specificities of spatial and spatio-temporal data are central themes of future tasks. A common goal is to develop tools that are of high value to end users. Therefore, a co-design approach often helps to identify the relevant questions within a project and enables us to provide meaningful solutions.

Benedikt Gräler

Head of Spatial Data Science

KI:STE

AI Strategy for Earth System Data

The KI:STE developments will facilitate the use of ML and AI methods for spatial data analysis applications.

Artificial intelligence (AI) methods experience rapid development and increasing use in the context of environmental data. However, this often happens in isolated solutions. Environmental and earth system sciences have yet to establish the systemic use of modern AI methods. In particular, discrepancy exists between the requirements of a solid and technically sound environmental data analysis and the applicability of modern AI methods such as Deep Learning for researchers.

The KI:STE project strives to facilitate and evaluate 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, then closing the loop with air quality. A core focus is not only to adopt and apply AI concepts to these areas, but also to train several PhD students and build an e-learning platform. This will ease and facilitate access to the algorithms and tools developed for a wider audience – from scientists to practitioners.

52°North develops the Spatial Research Data Infrastructure (SRDI) that will supply the AI processing platform with data. A requirement analysis provides 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 the data in a format optimized for the required processing. We work on the SRDI in close collaboration with the Ambrosys GmbH.

During 2022, our team drafted the SRDI architecture based on the results of the requirement analysis, which we carried out previously. We have also set up the first components stemming from the architecture. Our solution builds on the open source project GeoNode. GeoNode provides tools to collect and harmonize different data sets from different services. A searchable catalog presents all integrated data that can be assessed through machine readable APIs. Different data adapters and visualizations still need to be developed and tailored to the KI:STE project's data needs. In close collaboration with our KI:STE-partner University Bonn, we re-built their wilderness use-case as an example for a reproducible workflow. The Open Geospatial Consortium (OGC) Testbed initiative has also co-funded this effort in 2022. We have documented our findings of the workflow automation and how to make it easily reproducible. These findings will feed into further activities at OGC. Furthermore, 52°North largely contributed to the joint OpenGeoHub and KI:STE summer

school held from August 29th to September 2nd, 2022. Our team contributed lectures, a reprocucibility hackathon and joined the discussions throughout the week.
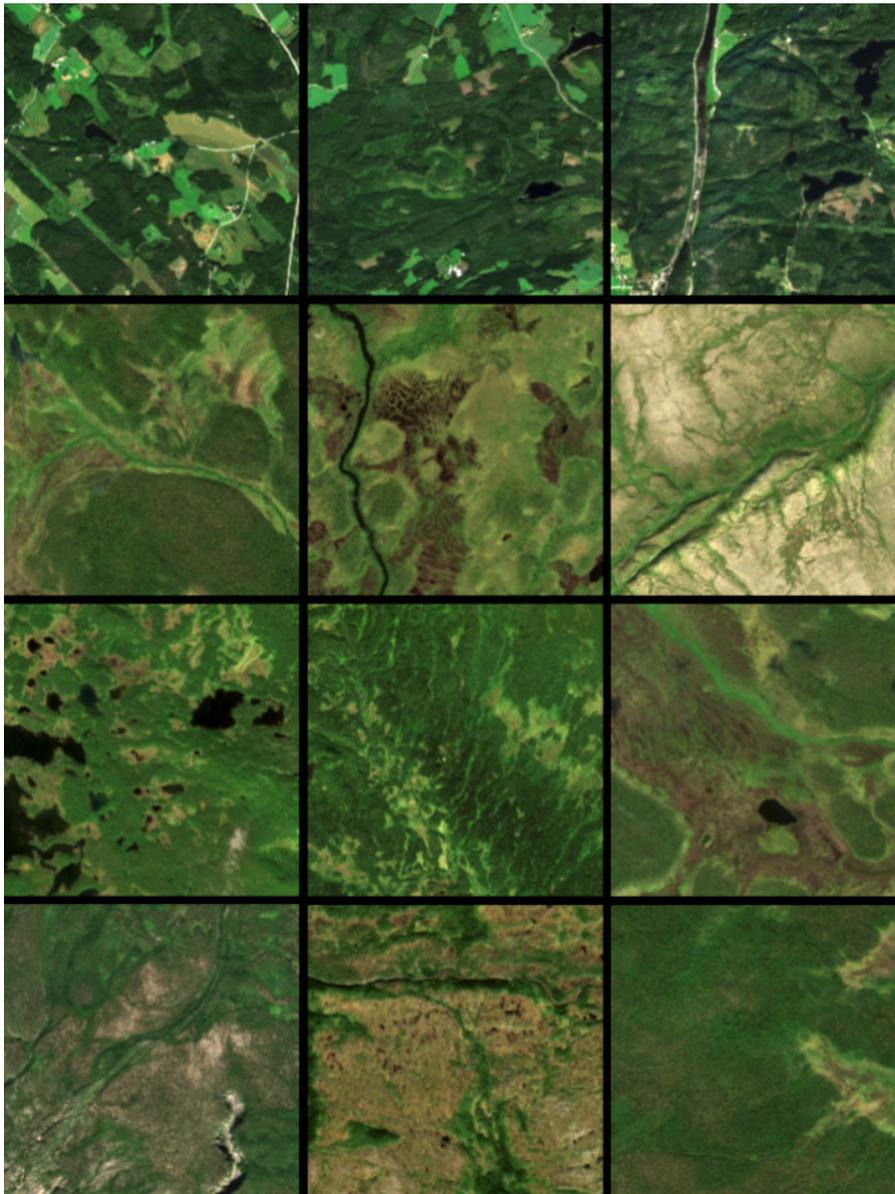
Sample scenes from the Anthroprotect data set.

PARTNERS

- Forschungszentrum Jülich GmbH, Germany
- Jülich Supercomputing Centre (JSC) und Institut für Bio- und Geowissenschaften – Agrosphäre (IBG-3), Germany
- Universität zu Köln, Institut für Geophysik und Meteorologie, Germany
- Universität Bonn, Institut für Geodäsie und Geoinformatik, Germany
- RWTH Aachen, Aachen Institute for Advanced Study in Computational Engineering Science, Germany
- Ambrosys GmbH Gesellschaft für Management komplexer Systeme, Germany

FUNDING

I-CISK

Co-Design to Reveal the Value of Climate Services

I-CISK will empower local communities to build and use tailored local Climate Services to adapt to climate change.

Climate Services (CS) are crucial to empowering citizens, stakeholders and decision-makers in defining resilient pathways to adapt to climate change and extreme events. Despite advances in scientific data and knowledge (e.g. Copernicus, GEOSS), current CS fail to achieve their full value proposition to end users. Challenges include incorporation of social and behavioral factors, local needs, knowledge and the customs of end users. I-CISK develops a next generation of end user CS, which follow a social and behaviorally informed approach to co-producing services that meet climate information needs at a relevant spatial and temporal scale. It takes a trans-disciplinary approach to developing CS by working with stakeholders in seven Living Labs established in climate hotspots in Europe, its neighbors, and Africa, to address climate change and extremes (droughts, floods and heatwaves) faced by agriculture, forestry, tourism, energy, health, and the humanitarian sectors. Together with end users, I-CISK will co-design, co-create, co-implement, and co-evaluate pre-operational CS that provide a step change in integrating local knowledge, perceptions and preferences with scientific knowledge. This co-production framework is unique as it

- links climate impact and adaptation at different temporal scales from (sub)-seasonal forecasts to climate-scale projections, and
- explicitly considers the feedback between human behavior and climate, i.e., between adaptation strategies and options, in a multi-timescale, multi-sector, and multi-hazard setting.

The novel CS will be built on a highly customizable cloud-based web platform that I-CISK develops; freely available, and easily replicable. The I-CISK co-production framework, supported by online open courses, guidelines, business stories and strategic dissemination, will catalyze the production and adoption of CS that combine end users' local knowledge with scientific knowledge, contribute to improved decisions and policies, and a flourishing market for end user CS.

52°North currently leads the analysis of the stakeholders' requirements regarding the new Climate Service platform jointly with GECOsistema. In 2022, 52°North initiated and conducted one-to-one meetings with representatives from each Living Lab to collect the stakeholders' individual expectations and needs. Our team also started discussions and developments

KEY TECHNOLOGIES

- > Research Data Infra-structures
- > GeoNode
- > Django
- > Python
- > R Programming Language
- > OGC Web Services

FACTS

Duration:
11/2021 - 10/2025

Website:
http://www.icisk.eu/

Contact:
Benedikt Gräler
b.graeler@52north.org

Project Type:
Research and Development

regarding assessing, managing and presenting the uncertainties that are an inherent component of climate models. 52°North has explored and prepared first data sets covering different Living Labs for integration into the joint I-CISK Climate Service platform. Our software research engineers have prototyped different visualization techniques in order to provide a basis for further discussions on how the information derived from the CS should be presented to the Living Labs stakeholders. During the next steps, 52°North will co-design a first prototype of the Climate Service platform and develop front-end components to combine the CS of the different end users.
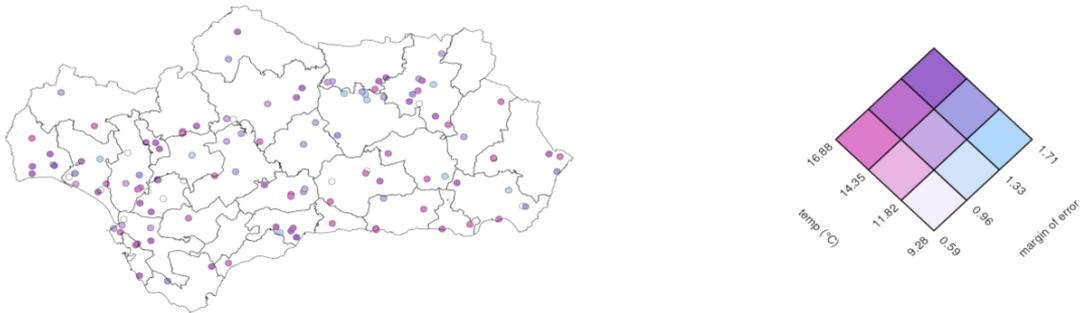
Prototype for the visualization of temperature data from meteorological stations in Andalucia, Spain

PARTNERS

- **Coordinator**, IHE Delft Institute for Water Education, The Netherlands
- European Centre for Medium-Range Weather Forecasts (ECMWF), UK
- Swedish Meteorological and Hydrological Institute (SMHI), Sweden
- VU Foundation, Then Netherlands
- CREAF, Spain
- Uppsala University, Sweden
- The Netherlands Red Cross, The Netherlands
- GECOsistema, Italy
- Caucasus Environmental NGO Network (CENN), Georgia
- Universidad Computense de Madrid, Spain
- IDEAS Science Ltd., Hungary
- EMVIS S.A., Greece

FUNDING

DIRECTED

Interoperable Tools and Governance for Disaster Risk Management

DIRECTED's federated data infrastructure will enable the planning, assessment and communication of Climate Change Adaptation and Disaster Risk Reduction measures.

The recent droughts and unprecedented floods in central Europe have disclosed our vulnerability to extreme weather events. Not only is climate change a driver of more frequent and intensifying weather extremes, demographic change and socio-economic development also exacerbate severe impacts. International frameworks for disaster risk reduction and climate change adaptation (e.g. the SENDAI framework, the EU Strategy on adaptation to climate change) acknowledge the critical need for integrating risk governance, communication and operational mechanisms to cope with extreme climate events throughout the entire disaster risk management cycle. DIRECTED aspires to foster disaster-resilient European societies by expanding the capabilities to

- utilize, communicate and exchange state-of-the art data, information and knowledge between different actors;
- boost the integration, accessibility and interoperability of models;
- improve dialog and cooperation between actors involved at all levels based on enhanced community engagement and
- develop new governance and risk management strategies using a bottom-up, value-driven co-development approach.

Central to DIRECTED are four Real World Labs. They are located in European areas that have been affected by severe weather events in the recent past or have a high probability to be affected in the near future. These Real World Labs will co-develop new governance, interoperability and knowledge production frameworks as well as demonstrate their benefits for enhanced disaster risk governance. The Real World Labs ensure that the project continuously and actively involves key stakeholders in the co-development process and addresses topical problems of multi-hazard risk management and climate change adaptation. Key to supporting the interoperability of information will be the development of an innovative federated cloud platform that enables secure and flexible access, transformation, combination and sharing of models and data. Tailored to the needs of the Real World Labs, the platform will be based on a federated architecture that meets particular requirements regarding the handling of sensitive data and models.

52°North leads the architecture design development, as well as the platform implementation and evaluation throughout the project. An inspiring kick off meeting in November 2022 provided a preliminary glimpse of the stakeholders' needs. In cooperation with the project partners, our team then entered the first phase of documenting the current solution landscape in the Real World Labs. 52°North will also participate in defining interoperability standards for data and models in disaster risk frameworks, thus constituting an essential step towards establishing common risk management tools that combine different services, data and models in a harmonized manner.
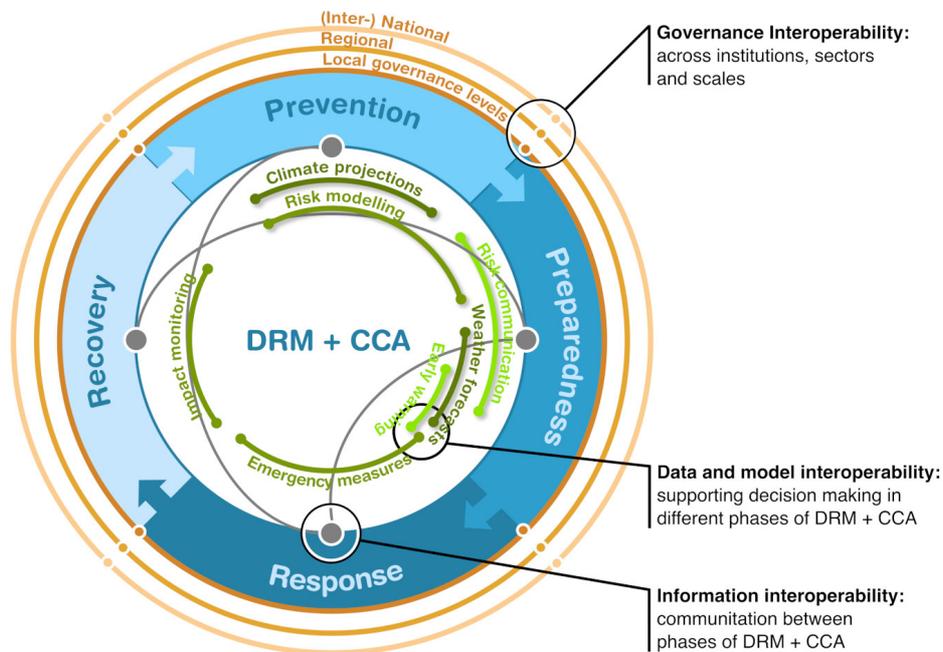
The DIRECTED concept

PARTNERS

- **Coordinator**, Technische Universität Braunschweig (TUBS), Germany
- Potsdam Institut für Klimafolgenforschung (PIK), Germany
- Danmarks Tekniske Universitet (DTU), Denmark
- GECOsistema SRL (GECO), Italy
- Research Institute for Sustainability (RIFS) Helmholtz-Zentrum Potsdam, Germany
- University College Cork (UCC), Ireland
- Region Hovedstaden, Denmark
- Agenzia Regionale per la Sicurezza Territoriale e la Protezione (ARSTPC-ER), Italy
- GENILLARD & CO, Germany
- International Intitute for Applied Systems Analysis (IIASA), Austria
- Erftverband, Germany
- Zala Special Rescue Team (ZSRT), Hungary
- Agenzia regionale per la prevenzione, l'ambiente e l'energia dell'Emilia-Romagna (ARPAE), Italy
- Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum (GFZ), Germany
- Eidgenössische Technische Hochschule Zürich (ETH Zürich), Switzerland
- OASIS Hub, USA
- S E I Oxford Office Ltd, United Kingdom

FUNDING

MariGeoRoute

MariData GeoPlatform and Routing

MariGeoRoute helps reduce the energy consumption of cargo ships by providing environmental data and forecasts and routing routines on a cloud-based data infrastructure to support energy optimized routing.
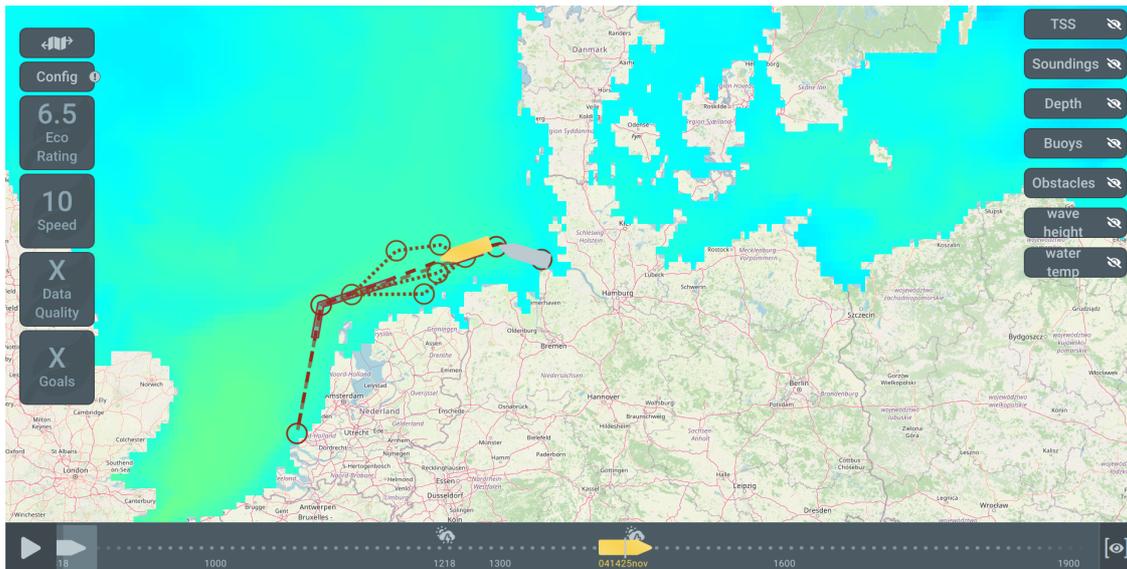
The MariData project is funded by the BMWK and aims to enable a deterministic analysis of a ship's energy demand based on environmental and physical conditions. It sensibly delineates the ship's energy demand based on various sources (e.g., waves, wind, etc.) and optimizes it by suggesting routing alternatives, speed and trim adjustments or additional services on the ship's hull.

MariGeoRoute is a subproject addressing the challenges related to needs arising from the various data demands, such as nautical maps, weather records and forecasts ranging from wind and temperature to wave heights and currents. 52°North develops an integrated data store, the GeoPlatform, which will provide data for on shore services as well as for the ships at sea. It needs to sensibly subset and preprocess the data to reduce data load. We also develop approaches based on machine learning (ML) to model the energy demand based on the data collected and derived from the consortial partners. A routing service developed by 52°North will use the data accessible in the GeoPlatform to provide routing alternatives along the smallest energy demands under constraints of nautical limitations, ship safety and delivery schedules.

In 2022, 52°North focused on further developing the GeoPlatform. We deployed an instance of GeoNode in the cloud as a central element for collecting and managing different data sets. As a result, environmental forecasts (wind, wave, currents, etc.) from the Copernicus Marine Environment Monitoring Service and the Global Forecast System are imported into the GeoPlatform automatically. Historical ship routes used to evaluate the hydrodynamical models developed by the project partners are provided via a Sensor Things API. Our team also made preparational steps to integrate Open Sea Map data into the GeoPlatform in order to incorporate sea map information in the route optimization.

Front-end development comprised collaboration with a project partner to implement a user interface for route planning. We integrated the visualization of environmental data WMS layers so that they can be considered in the route planning process to make it more comprehensible to end users. In addition, 52°North's team develops a routing algorithm based on the isochrone method. We have defined a routing API to get an optimzed route into the user interface and will implement it in the GeoPlatform in the next project phase.

KEY TECHNOLOGIES

> Open Data Cube
> GeoNode
> GeoServer
> Python
> Django
> pygeoapi
> Java
> JavaScript
> Kubernetes

FACTS

Duration:
12/2020 – 11/2023

Website:
http://maridata.org/

Contact:
Benedikt Gräler
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Project Type:
Research and Development

MariData Routing tool (Design by MariData team at the Institute for Multimedia and Interactive Systems, University of Lübeck)

PARTNERS

- Hamburgische Schiffbau-Versuchsanstalt GmbH (HSVA), Germany
- AVL Deutschland GmbH, Germany
- DST – Entwicklungszentrum für Schiffstechnik und Transportsysteme e.V., Germany
- Friendship Systems AG, Germany
- Technische Universität Berlin, Germany
- Technische Universität Hamburg
- Universität zu Lübeck, Germany
- Maritimes Zentrum der Hochschule Flensburg, Germany
- Carl Büttner Shipmanagement, Germany
- AVL Software and Functions, Germany

FUNDING
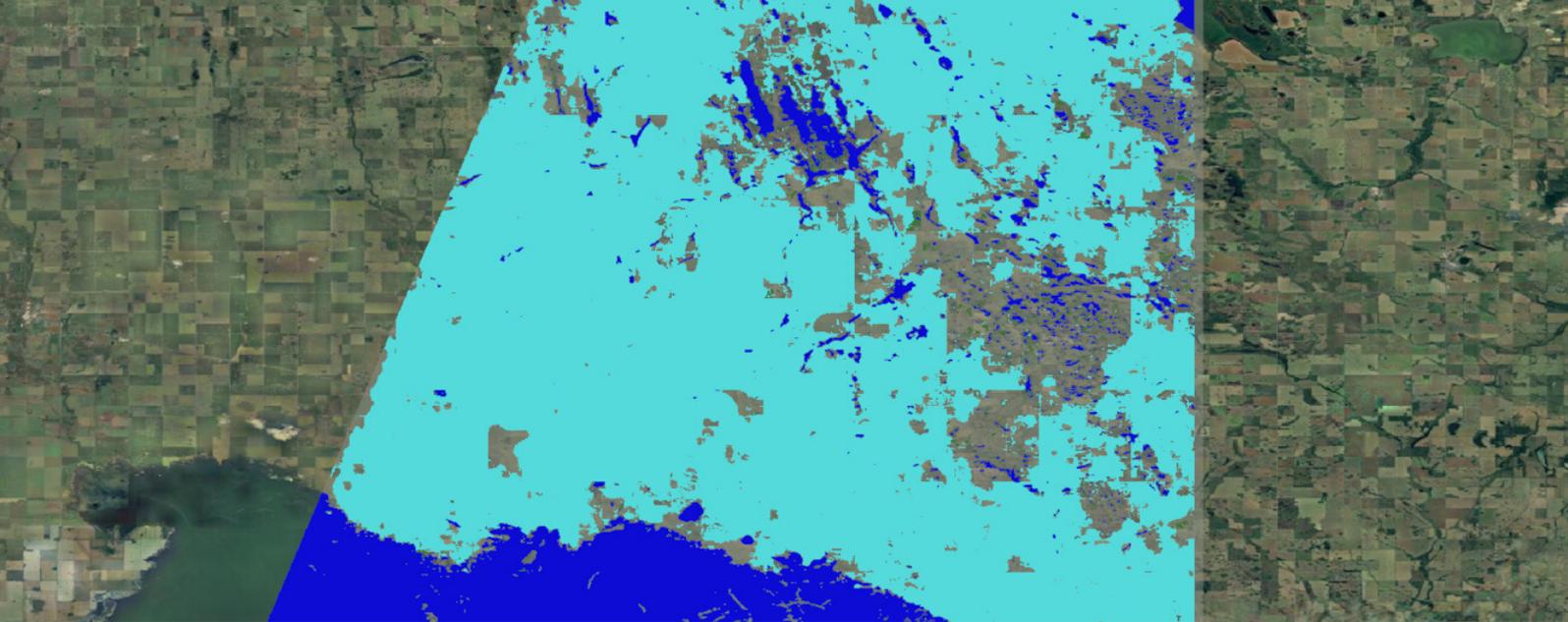
OGC Testbed-18

Identifiers for Reproducible Science

Shaping the future of geospatial data technologies

The Open Geospatial Consortium (OGC) Testbed is an annual research and development program that explores geospatial technology from various angles. It takes the OGC standards baseline into account, but at the same time allows for exploration of selected aspects from a different perspective.

"OGC Testbeds are OGC's largest Innovation Program (IP) initiatives. Testbeds boost research and development to make location data and information more FAIR: Findable, Accessible, Interoperable, and Re-Usable. Testbeds provide a unique opportunity for sponsors to tackle location data and processing challenges together with the world's leading geospatial IT experts.

In a collaborative effort, all Testbed participants, sponsors, and the OGC team work jointly on the goal to stepwise increase Technology Readiness Levels (TRL) of geospatial IT solutions, including software architecture, interface design, information and data models, as well as any related standards and specifications." (OGC Testbed-18 | OGC, 2022)

52°North participated in the task "Identifiers for Reproducible Science" of the "Future of Open Science and Building Energy Interoperability" thread. The task aimed to explore and develop best practices for reproducible scientific workflows in the field of Earth Observation. In addition, it proposed to investigate which standards are suitable to achieve reproducibility. 52°North selected a scientific study from one of its research partners as a demonstration use case. The study explores wilderness characteristics using explainable machine learning models. We used the Open Data Cube to index the AnthroProtect dataset, pygeoapi to make them available via OGC API Coverages and created STAC items to identify the data. Using Jupyter Notebooks, our team was able to visualize aspects of the trained model and predict the classification of a Sentinel-2 scene's sensitive areas as either wild or anthropogenic. The workflow is available on the Whole Tale platform, which enables the reproduction of research results by executing tales - executable research objects that capture data, code and the software environment.
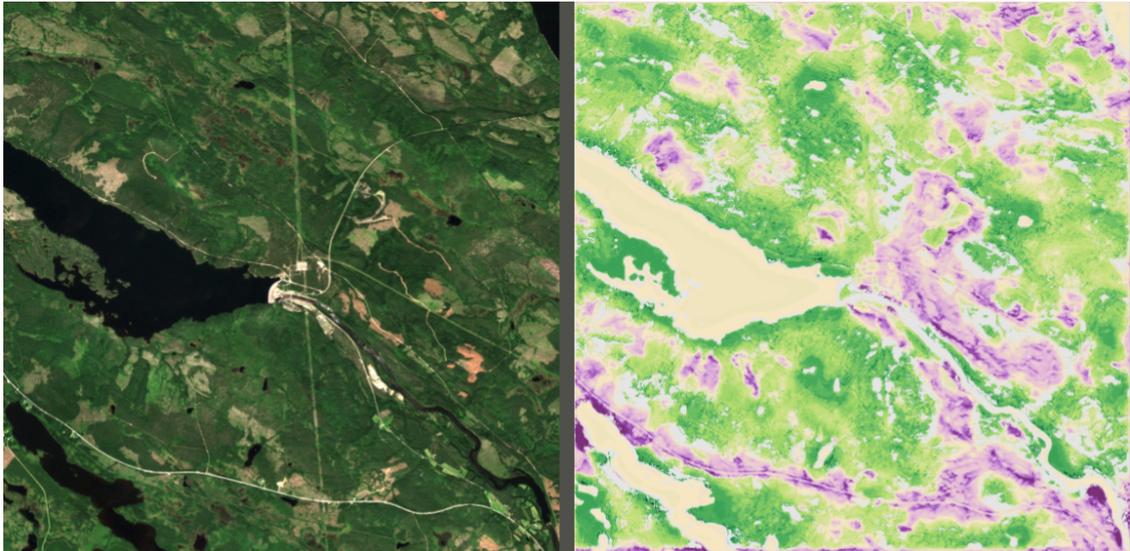
Sentinel-2 image and its sensitivity map - Areas sensitive to wilderness characteristics (green) and sensitive to anthroprogenic characteristics (purple). Image source: Stomberg, Timo T., et al. "Exploring Wilderness Using Explainable Machine Learning in Satellite Imagery." arXiv preprint arXiv:2203.00379 (2022)

CUSTOMER

- Open Geospatial Consortium (OGC), USA

PARTNERS

- Arizona State University, USA
- Ecere, Canada
- GeoLabs, France
- Health Solutions Research, USA
- Terradue, Italy

FUNDING

OGC Testbed 18 was funded by multiple sponsors, including:

- Natural Resources Canada (NRCan), Canada
- European Space Agency (ESA), France
- US National Aeronautics and Space Administration (NASA), USA

OGITO

An Open Geospatial Interactive Tool – a Community Mapping Case

KEY TECHNOLOGIES

> Angular
> OpenLayers
> QGIS Server
> PostGIS

FACTS

Duration:
10/2022 - 03/2023

Contact:
Benedikt Gräler
b.graeler@52north.org

Project Type:
Professional Services

Adapting and developing the OGITO application for new case studies

The Open Geospatial Interactive Tool (OGITO) is a open source application that supports collaborative spatial planning processes with a map table. OGITO was orginally developed by the Faculty of Geo-Information Science and Earth Observation of the University of Twente (ITC) for use in different community mapping projects, for example noise mapping in Bochum (Germany). Two new case studies with users from the cities Zwolle (the Netherlands) and Herne (Germany) examine how interactive map applications, in particular map tables, can be used by people with physical or mental disabilities. Feedback from user groups will be used to explore how to improve the accessibility of interactive mapping applications.

OGITO's web-based frontend builds upon the web application framework Angular and the open source mapping library OpenLayers. The backend uses a QGIS Server to make layers of spatial data that are defined and styled in a local QGIS project accessible for the frontend via OGC web services. PostGIS stores the spatial data that is integrated in the QGIS project.

52°North supports ITC in adapting the existing mapping application for the two new case studies. This includes the integration of case study specific spatial data as well as the improvement and further development of the application to increase usability and accessibility. Our team also plans to adjust the OGITO codebase in order to simplify the process of setting up new mapping projects for further case studies.
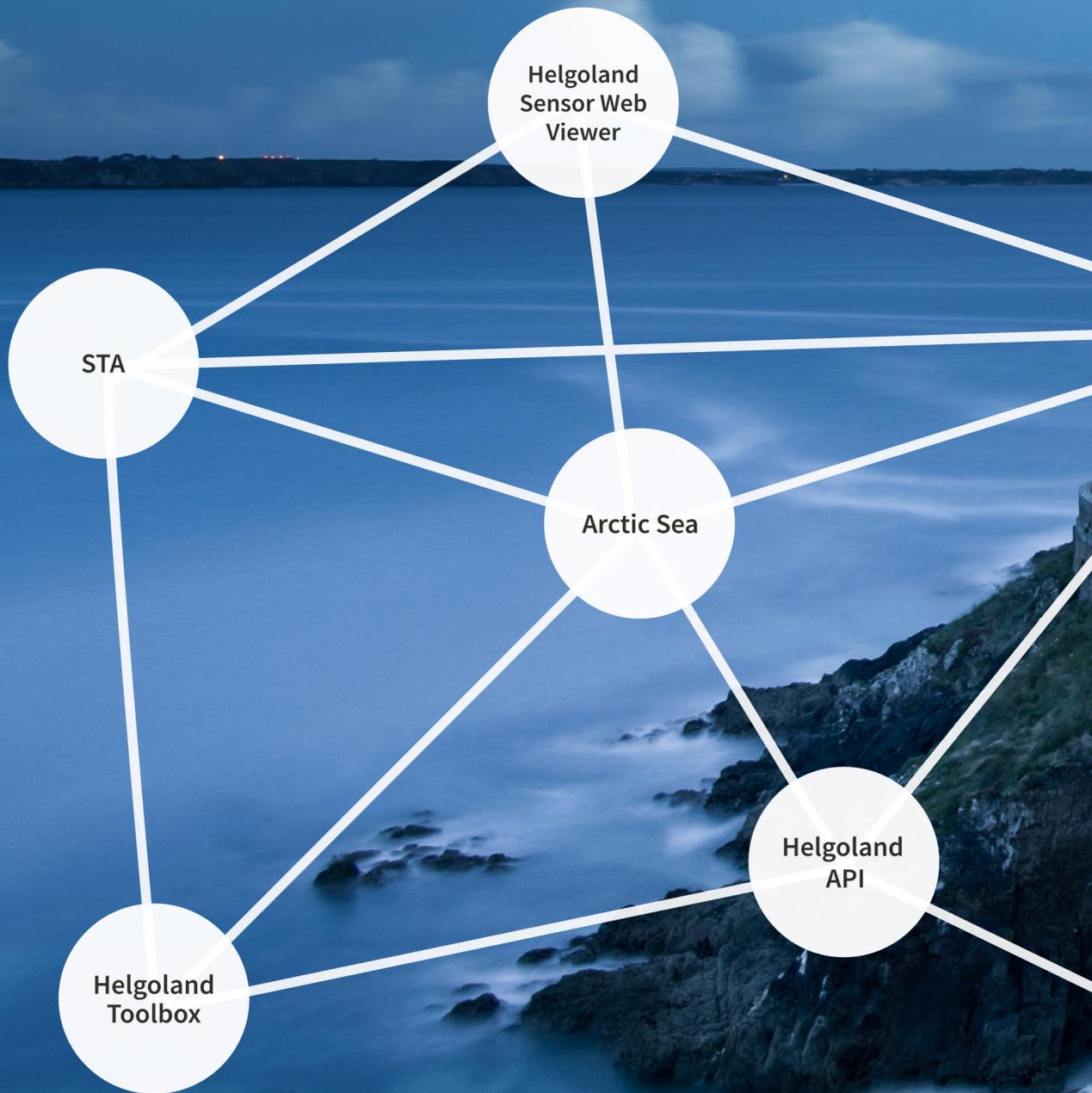
OGITO mapping application as used for noise mapping in Bochum Wattenscheid

CUSTOMER

- ITC, University of Twente, the Netherlands

Software Projects

Helgoland
Sensor Web
Viewer

STA

Arctic Sea

Helgoland
API

Helgoland
Toolbox

Open Source Projects Contributions

enviroCar suite

SOS

sos4R and sos4py

javaPS

Developing innovative technologies for advancing 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. We also contribute to major Open Source Software solutions by applying our expertise to expand, improve and use this software for our research and customers.

Arctic Sea

Backbone for OGC Services, Clients and Middleware

Easing the development of OGC related services, clients and middleware

Arctic Sea is 52°North's framework for developing OGC services, clients and middleware sharing concepts for encoding and decoding of different formats and encoding, workflows and configuration. This stack of projects 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.

Bjørnøya: Bjørnøya contains various classes for Quartz scheduling shared across Arctic Sea. These include configurations to define the execution of jobs.

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 an 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.
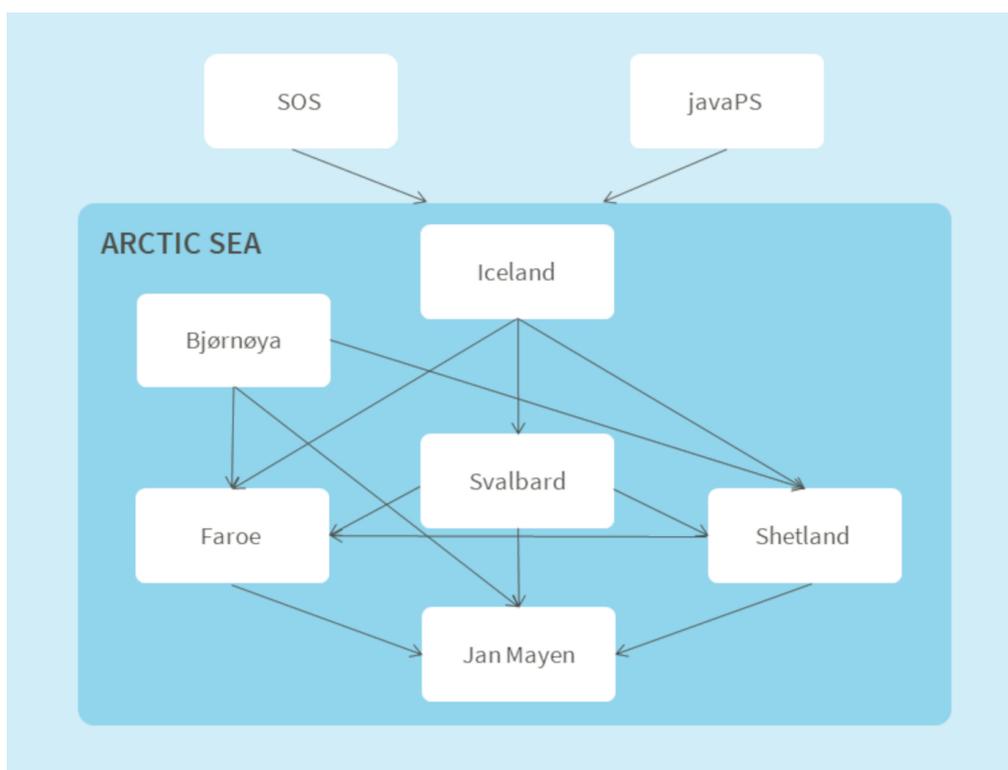
Arctic Sea modules

In 2022, our software engineers published several bug fixes and small improvements. Most notable is the refactoring of the Bjørnøya module, which provides scheduler and job configurations. We actively maintain the versions on Maven Central.

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 boilerplate code and 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

- JERICO-S3
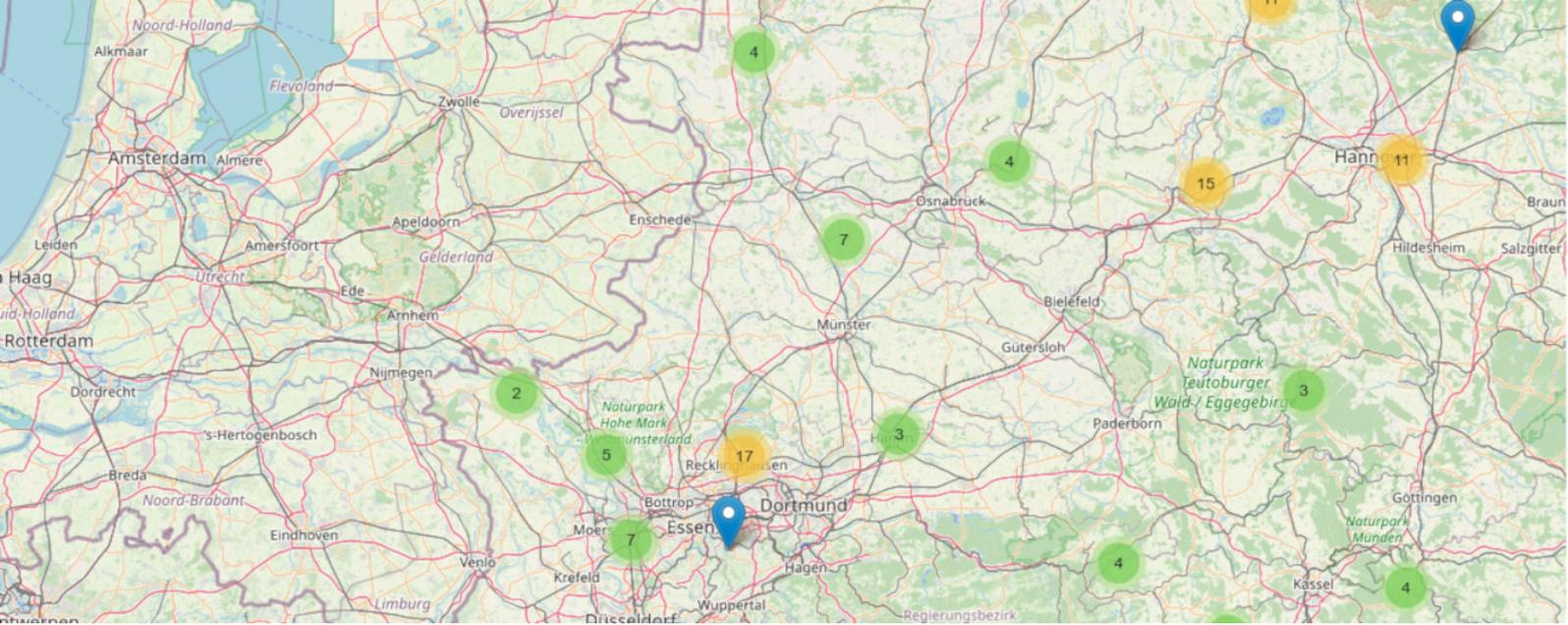- Cos4Cloud
- NeXOS
- COLABIS
- SeaDataCloud
- ODIP II
- ConnectinGEO
- GeoViQua
- WaCoDiS
- MuDak-WRM
- BRIDGES

DOWNLOAD

GitHub: https://github.com/52North/arctic-sea

Maven Central: https://search.maven.org/search?q=g:org.n52.arctic-sea

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

The Helgoland Sensor Web Viewer can connect to different Sensor Web endpoints (via the 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. In addition to the Sensor Web endpoints, the Viewer can also connect to OGC SensorThings APIs.

Our Sensor Web Viewer is based on the Helgoland Toolbox. It integrates the different toolbox modules into a viewing application that can be easily customized according to the requirements of specific users.

52°North's software engineers focused on bug fixing and code base maintenance in 2022.
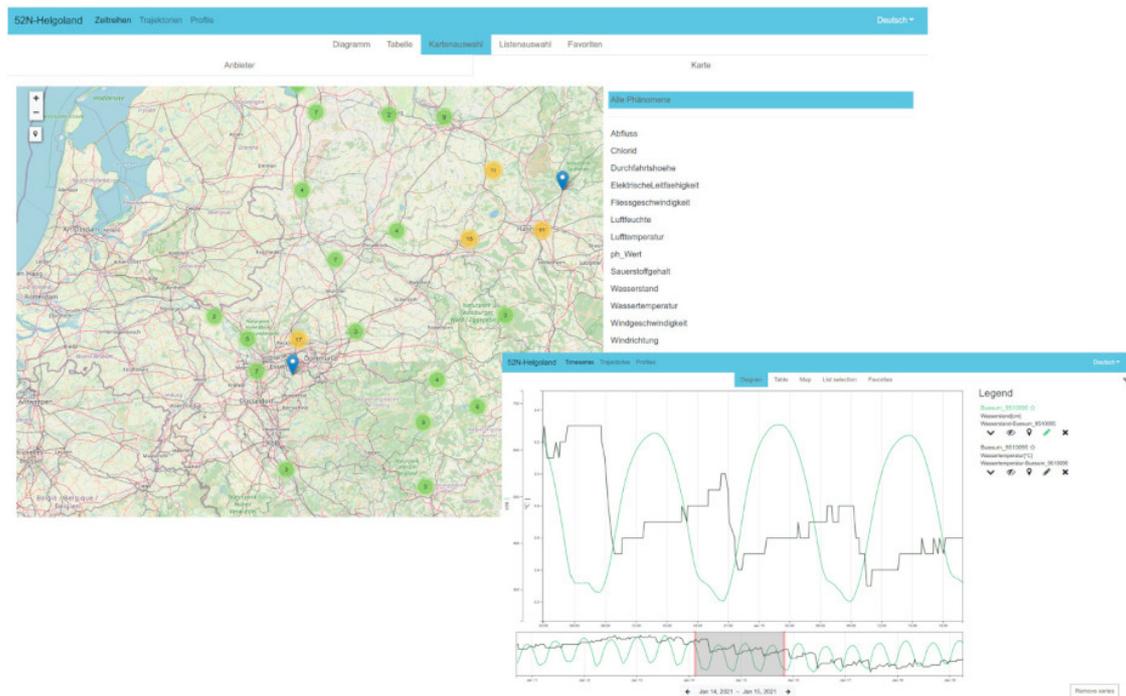
Helgoland Sensor Web Viewer

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), Germany
- Wupperverband, Germany
- SeaDataCloud
- WaCoDiS
- MuDak-WRM

DOWNLOAD

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

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. We also built additional applications (e.g., the BelAir app, smle, or the developments resulting from the TaMIS project) upon this library.

The most important functional modules comprise:

- Core
    - Communication with the APIs (Helgoland API and OGC SensorThings API)
    - Important common services (local storage, time)
    - Central interfaces and abstract classes
- Caching
    - Request Caching with Angular Interceptors
- d3
    - Trajectory Graph component
    - Time series Graph component
- Depiction
    - Legend entries
    - Table view of data
- Map
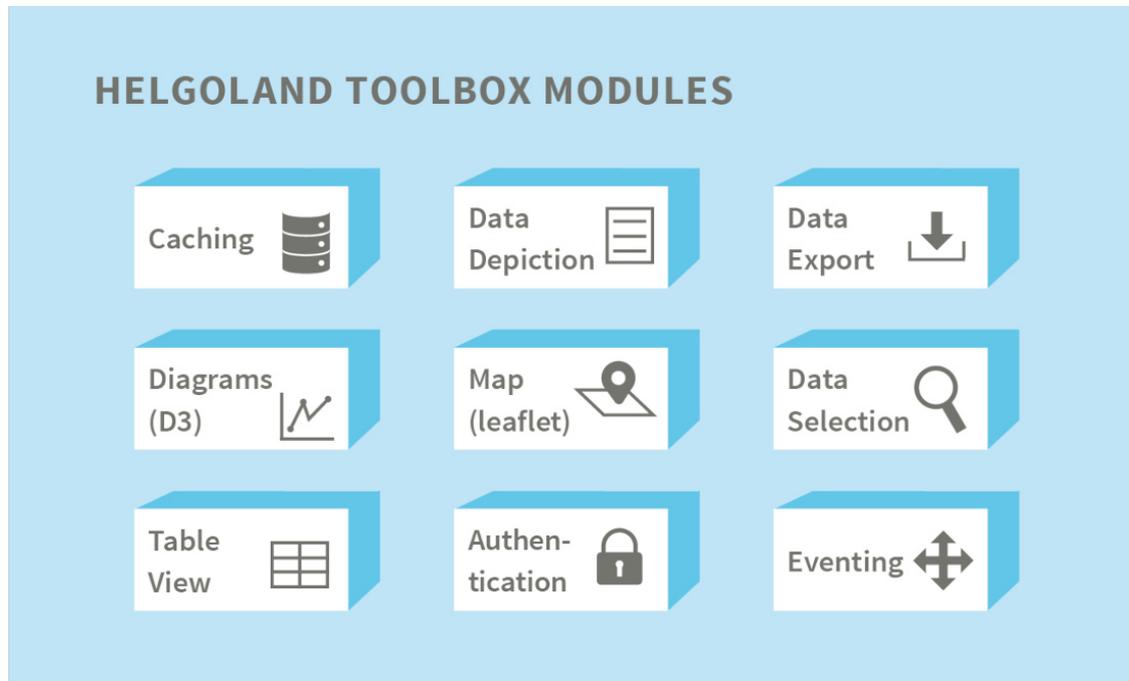   - Controls (Geo-Search, Locate, Zoom, Extent)
    - Map Selector component

- Selectors
  - List Selector for observation data
  - Service Selector for data sources.

In 2022, 52°North software engineers focused on regular code maintenance.

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

- EMODnet Data Ingestion Portal
- SeaDataCloud
- Federal Maritime and Hydrographic Agency (BSH)
- Wupperverband
- WaCoDiS
- MuDak-WRM
- mVIZ

DOWNLOAD

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

sos4R and sos4py

R and Python clients for OGC SOS

Easing 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 apply 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, but without any knowledge about the underlying OGC Sensor Web Enablement standards.

The package sos4py follows the same idea in a python environment. Since sos4py is a relatively new development, it does not yet provide the same range of functionalities as sos4R does.

```python
In [13]:  1  # Interactive map using folium
          2
          3  lngs = list(fluggs_sites['geometry'].apply(lambda coord: coord.x))
          4  lats = list(fluggs_sites['geometry'].apply(lambda coord: coord.y))
          5  avg_lat = sum(lats) / len(lats)
          6  avg_lngs = sum(lngs) / len(lngs)
          7
          8  # folium uses (lat, long) or (y, x), respectively
          9  locationlist = [[site.y, site.x] for site in fluggs_sites['geometry']]
         10
         11  m = folium.Map(location=[avg_lat, avg_lngs], zoom_start=10)
         12  for point in range(0, len(locationlist)):
         13      popup = folium.Popup(folium.IFrame(html=fluggs_sites['site_name'][point], width=200, height=80))
         14      folium.Marker(locationlist[point], popup=popup).add_to(m)
         15  m
```

```
In [20]:    1  x1 = fluggs_obs[(fluggs_obs['site']==sites[0])]['time_stamp'].to_numpy()
            2  y1 = fluggs_obs[(fluggs_obs['site']==sites[0])]['value'].to_numpy()
            3
            4  x2 = fluggs_obs[(fluggs_obs['site']==sites[1])]['time_stamp'].to_numpy()
            5  y2 = fluggs_obs[(fluggs_obs['site']==sites[1])]['value'].to_numpy()
            6
            7  plt.figure(figsize=(12,5))
            8  plt.plot(x1,y1,label=sites[0])
            9  plt.plot(x2,y2,label=sites[1])
           10  plt.xlabel('Time')
           11  plt.ylabel(fluggs_obs['phenomenon'][0] + " " + fluggs_obs['procedure'][0] + " in " + fluggs_obs['unit'][0])
           12  plt.legend()
           13  plt.show()
```
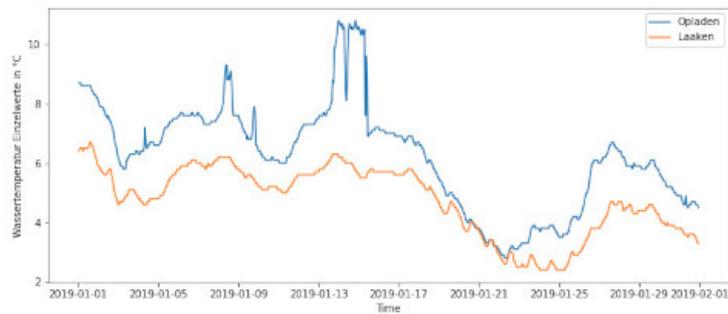

Jupyter notebook illustrating the use of sos4py

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
- NIWA

DOWNLOAD

GitHub: https://github.com/52north/sos4R, https://github.com/52North/sos4py

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).

It 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.

A major development in 2022 was the improvement of the common database model harmonization. The model provides observation data via the OGC SOS, Helgoland API, and SensorThings API interfaces. In addition, we continued to optimize the SOS's performance and stability.
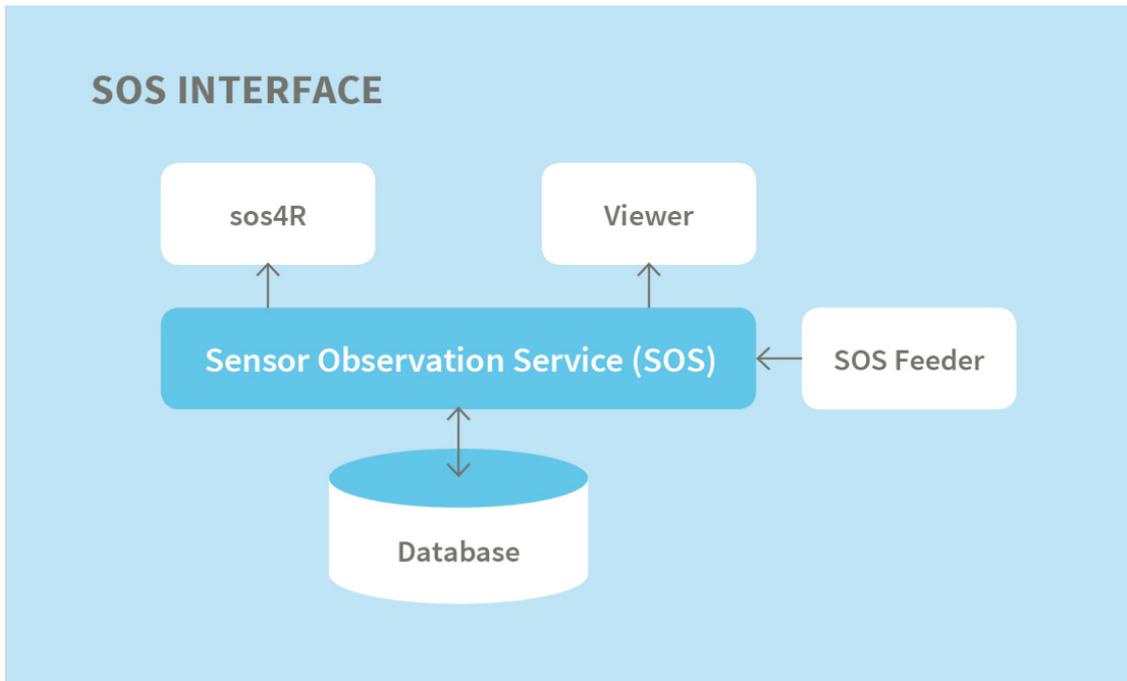
BENEFITS

- 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
- MariData
- Cos4Cloud
- Aquatic Informatics
- Otago Regional Council
- Wupperverband
- Federal Maritime and Hydrographic Agency (BSH)
- … and many more

DOWNLOAD

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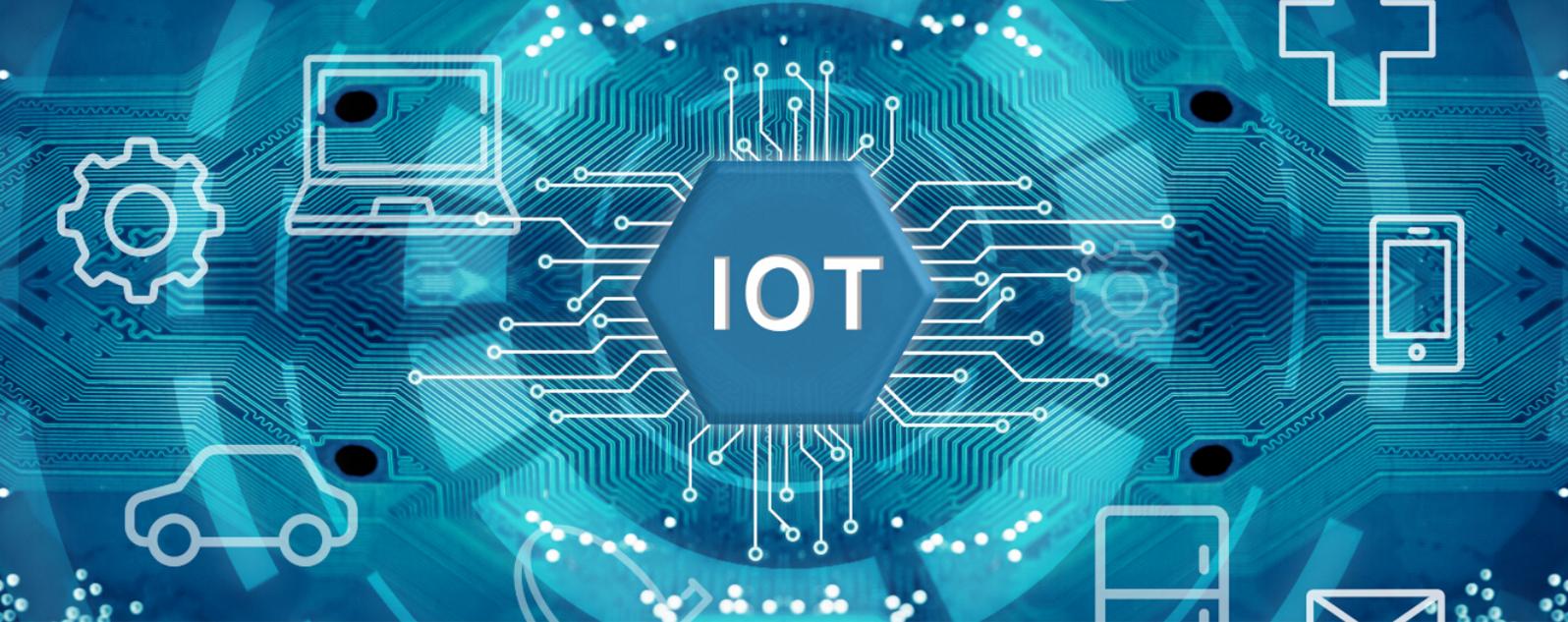
STA

SensorThings API

Efficient access to sensor data via the OGC SensorThings API

The STA module complements the 52°North Sensor Web Server with support for the "OGC SensorThings API Version 1.1 Part 1: Sensing" specification. It provides support for the following Conformance Classes (tested for standard compliance):

- Sensing Core
- Create-Update-Delete
- Filtering Extension
- Observation Creation via MQTT
- Receiving Updates via MQTT.

Additionally the 52°North STA implementation provides various supplemental features for ease-of-use and added functionality.

52°North's software development activities in 2022 focused on code base maintenance and performance optimizations. Additionally, we continued our work on the following challenges:

Citizen Science Extension: During work on the Cos4Cloud project in 2021, the consortium identified a need for guidance on how to use the STA for Citizen Science data. This guideline was subsequently developed during 2022 and culminated in the publication of the "OGC Best Practice for using SensorThings API with Citizen Science" (OGC 21-086).

STA-as-Interface: The Hereon Project does not use the STA as a primary storage, but as a supplementary interface to the existing datastore. To enable this workflow, our team developed a harvesting module that extracts, transforms and loads all metadata from the existing ESRI Feature Service into a local cache. We accomodated measurement values by adapting the STA with a module to transparently proxy requests to the original API. This maximizes performance without needing to mirror all data into a dedicated STA datastore.

SENSORTHINGS API MODULE
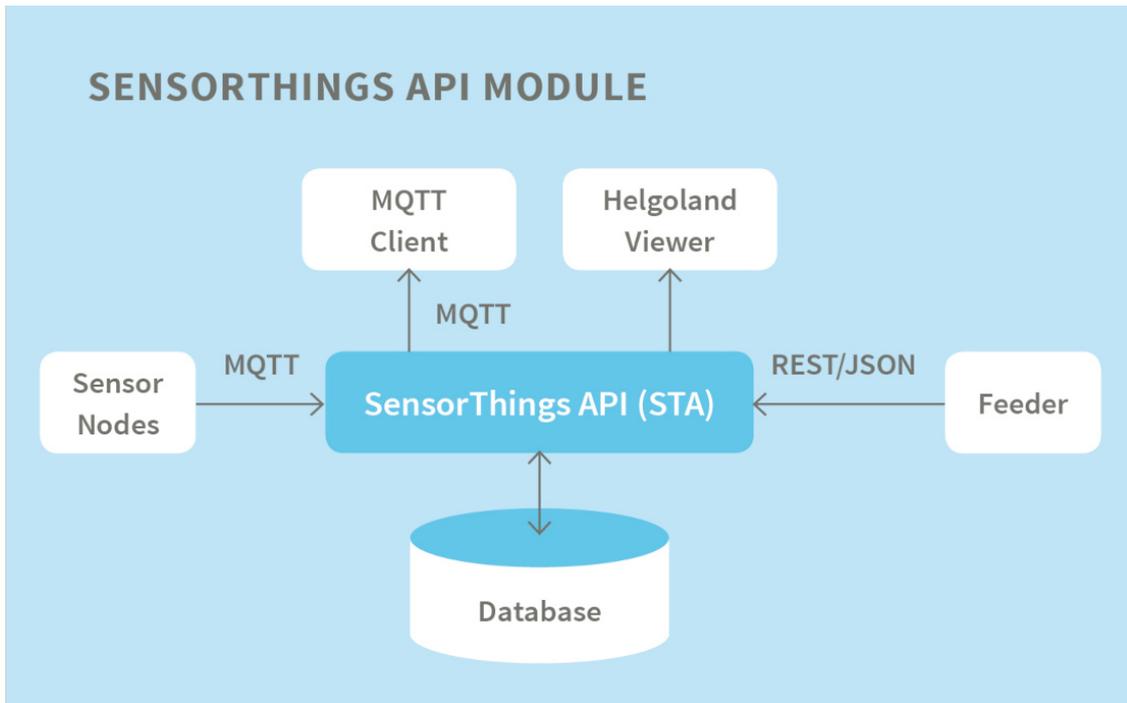
BENEFITS

- Robust implementation making use of the broad 52°North experience with Sensor Web data models
- Easy integration into the 52°North Sensor Web Server (joint database layer)
- MQTT for data publication and delivery
- Interlinking between SOS, STA and Helgoland API (e.g., data publication via STA, data retrieval via SOS and Helgoland API)

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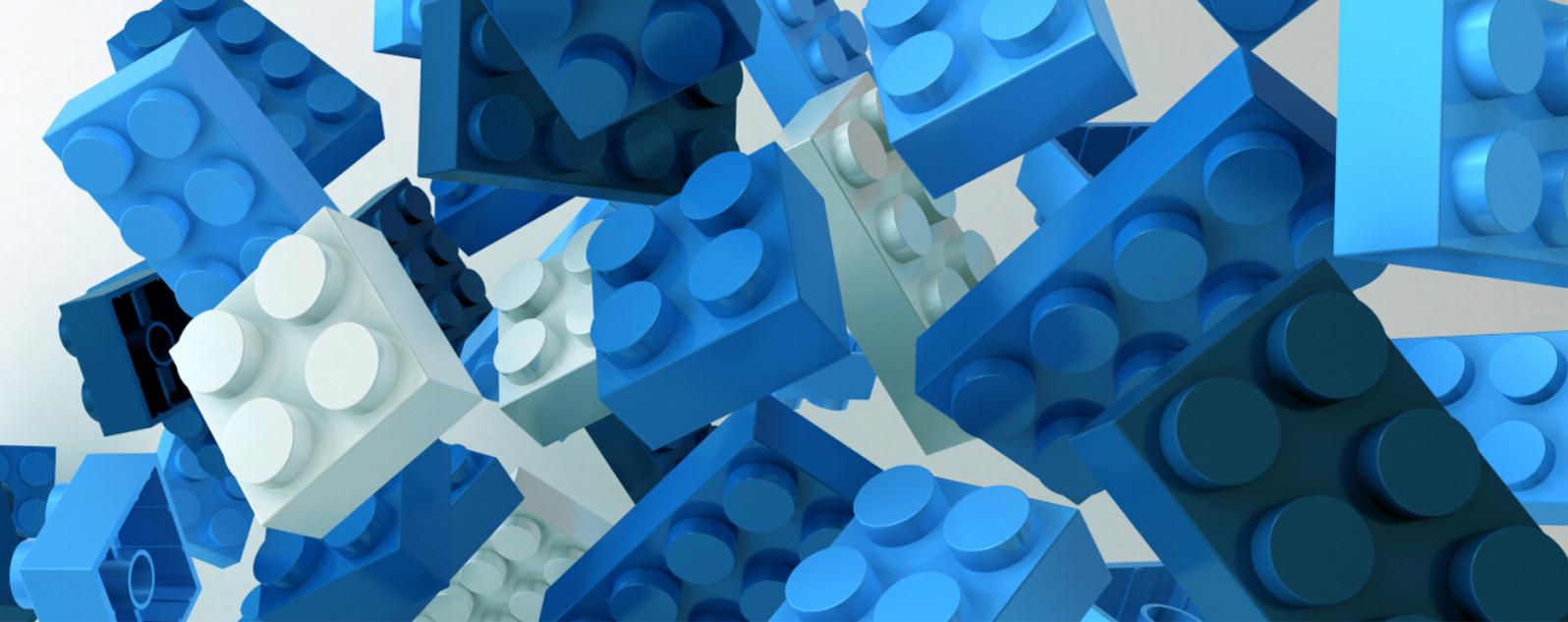
Hydrology, air quality (e-reporting), environmental monitoring, ocean sciences, tracking

PROJECT REFERENCES

- Cos4Cloud
- AQSens
- EMODnet/Eurofleets
- Federal Maritime and Hydrographic Agency (BSH)
- WaCoDiS

DOWNLOAD

GitHub: https://github.com/52North/sensorweb-server-sta

Helgoland API

Lightweight Access Layer to Sensor Data

Supporting the efficient implementation of Sensor Web clients

This lightweight API provides a complementary light access layer to sensor data via a RESTful Web binding. It offers an additional mechanism for data access, which has been optimized to reflect our 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.

Our development efforts in 2022 focused on maintenance and data model harmonization with SOS and STA. In addition, special consideration was given to performance improvements.

DEPLOYMENT OF THE HELGOLAND API
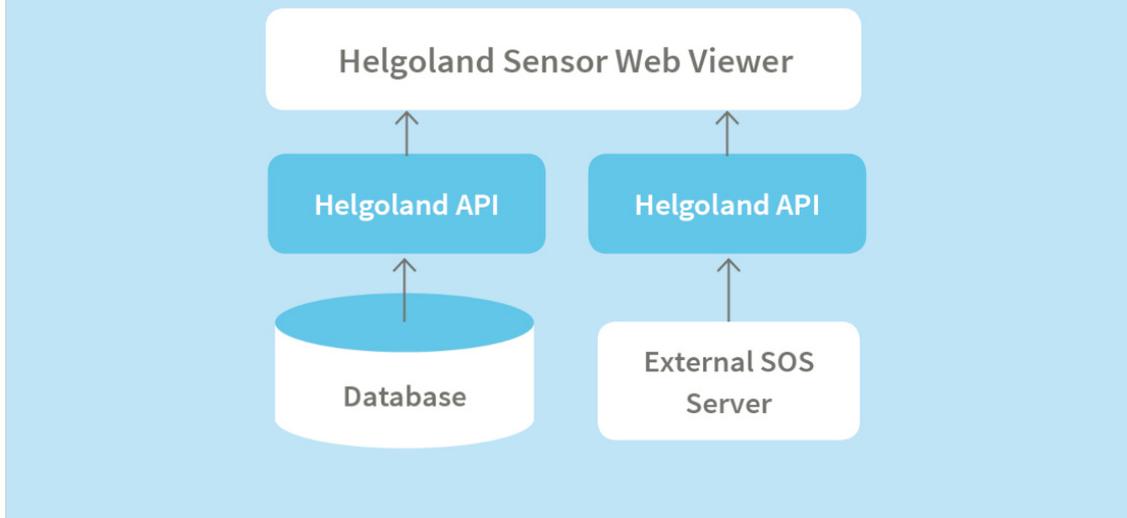
BENEFITS

- 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
- WaCoDiS
- MuDak-WRM
- IRCEL-CELINE BelAir
- NIWA
- Wupperverband
- Federal Maritime and Hydrographic Agency (BSH)
- … and many more

DOWNLOAD

GitHub: https://github.com/52North/sensorweb-server-helgoland

javaPS

Next Generation Standardized Web-based Geoprocessing

Interoperable processing framework for web applications/distributed workflow systems

JavaPS enables a standardized deployment of geo-processes on the web. One of its main goals is to provide 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.

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.

MODULAR JAVAPS ARCHITECTURE

Execute Request → JavaPS (WPS 2.0, OGC API – Processes) → Result

Inputs ↓ ↑ Outputs

Processing Backends

GeoTools Backend   Docker Backend

...
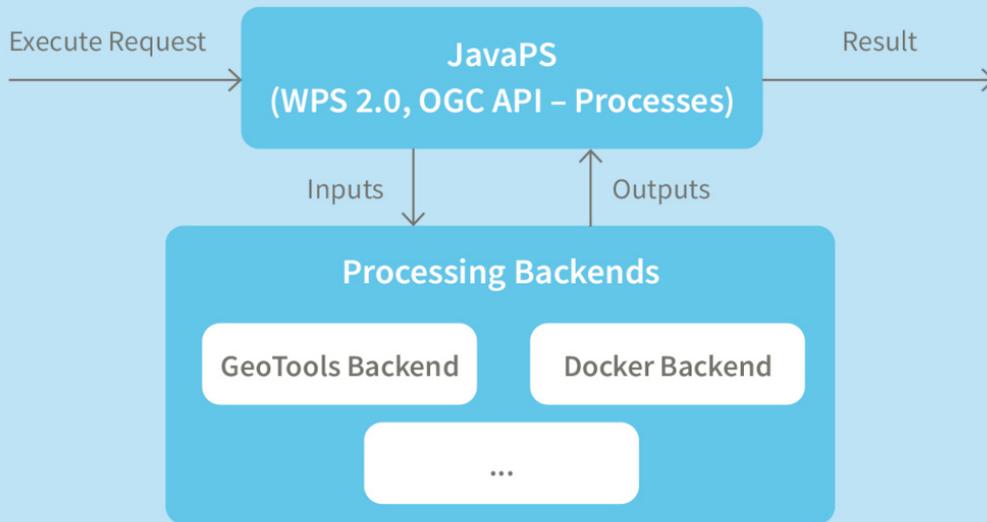
BENEFITS

- 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

- RIESGOS 2.0
- OGC Testbed 17
- OGC Testbed 16
- OGC Testbed 15
- OGC Routing Pilot
- WaCoDiS

DOWNLOAD

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

enviroCar suite

# XFCD Mobile Data Collection, Analysis, and Management

Collecting, analyzing, managing and sharing vehicle sensor data

The enviroCar suite provides a platform to collect, manage, analyze and share Extended Floating Car Data (XFCD). It comprises several individual software packages.

enviroCar Mobile Android App: 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, which enables read access to data from the vehicle's engine control. The app records this data and the smartphone's GPS position. The driver can view statistics about his drives and publish his data as open data by uploading tracks to the enviroCar server. It is then available under the ODbL license for further analysis and use. Users can also view and analyze the data via the enviroCar website. enviroCar Mobile is one of the enviroCar Citizen Science platform's components. It is continuously being developed as part of our Google Summer of Code projects.

enviroCar Server: The enviroCar server's central tasks are the enviroCar platform user management and the management of the XFCD data provided as Open Data by the enviroCar drivers. To ensure data privacy, the server anonymizes the recorded tracks external access. The enviroCar server's RESTful API offers the possibility to access statistics as well as space and time related subsets of the data in different formats.

enviroCarPy: The enviroCarPy Python package is a lean extension that wraps the enviroCar REST API to ease access to the data. It allows users to query and download XFCD data via the enviroCar Rest-API.
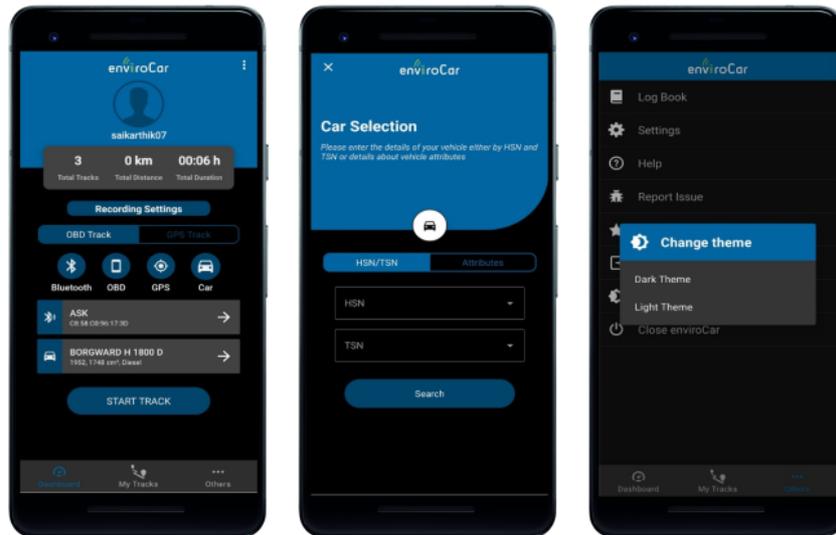
enviroCar dark theme

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
- 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
- Easier access to enviroCar data for an analysis in Python
- Several Jupyter notebooks with examples of use-cases

FIELDS OF APPLICATION

The enviroCar suite supports the collection, analysis, sharing and management 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

- DVFO LHS
- GSoC projects
- CITRAM
- enviroCar

DOWNLOADS

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

GitHub: https://github.com/enviroCar/envirocar-py

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

Open Source Projects Contributions

Contributing to Open Source Software Projects

Enhancing open source software

52°North's software research engineers not only develop 52°North software, but also contribute to a number of other open source software packages. These contributions take the form of anything from discussions and bug reports to bug fixing and code development.

Major contributions

GeoNode

52°North research software engineers have actively participated in the development of the GeoNode software framework. In several research and consulting projects various contributions have been integrated into its code base. Here, the interaction with the OSGeo community and in particular the GeoNode core developers played a central role in the daily work.

pygeoapi-odc-provider

The pygeoapi-odc-provider is a standalone Python library. Our 52°North team prototypically implemented this library during the OGC Testbed-17 Geo Data Cube project. It offers a provider plugin for pygeoapi to use Open Data Cube instances as a data resource. pygeoapi makes the data from the ODC available via OGC APIs.
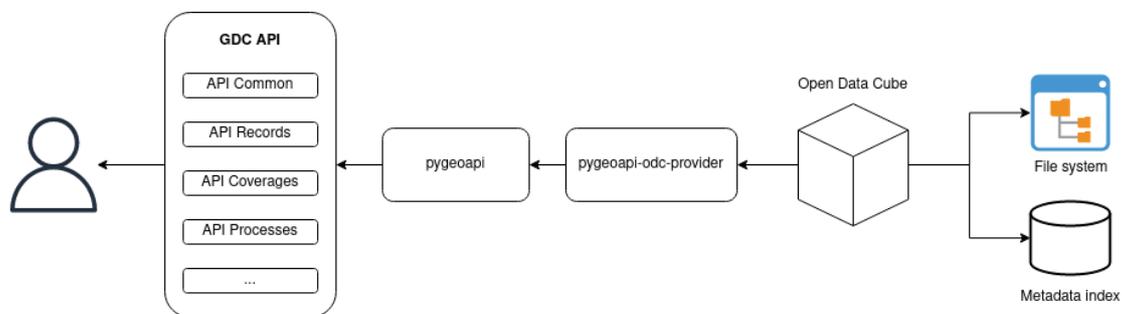
52°North server architecture

OSS Project(s): pygeoapi, Open Data Cube
Github: https://github.com/52North/pygeoapi-odc-provider

Minor contributions

Our team has also made minor contributions, such as bug reports and bug fixes, to the following projects:

pygeoapi
GitHub: https://github.com/geopython/pygeoapi/

eksctl
GitHub: https://github.com/weaveworks/eksctl

Open Data Cube
GitHub: https://github.com/opendatacube/datacube-core/
GitHub: https://github.com/52North/opendatacube-importer

NeuralHydrology
NeuralHydrology is a Python library, which aims to facilitate the training and evaluation of neural networks for hydrological use cases such as rainfall-runoff prediction. The library is authored by the AI for Earth Science group at the Institute for Machine Learning (Johannes Kepler University, Linz, Austria). Our team contributed to the project by implementing an additional evaluation metric that provides the mean absolute percentage error in the peak flow segment.

GitHub: https://github.com/neuralhydrology/neuralhydrology

Education and Mentoring

Sharing knowledge and experience

52°North staff is actively involved in higher education, working with students to develop their understanding and application of knowledge, concepts and processes. We regularly teach semester courses and conduct study projects at the Institute for Geoinformatics at the University of Münster. Our staff also prepares and delivers lectures at the Bochum University of Applied Sciences. In addition to classroom teaching, we host interns who gain insight into our day-to-day business and mentor international GSoC developers.

Courses

In 2022, our staff taught the following courses:

WS 2021/2022 and WS 2022/2023 Institute for Geoinformatics, University of Münster: Lecture and Lab on Spatial Information Infrastructures (SII) (Albert Remke and Simon Jirka)

SS 2022 Institute for Geoinformatics, University of Münster: Study Project "Open Educational Resources for Spatial Data Infrastructures" (Albert Remke and Simon Jirka)

SS 2022 Bochum University of Applied Sciences: Lecture and Exercises "Sensorintegration und - kommunikation" (Christian Autermann and Simon Jirka)

Theses Supervision

Supporting higher education, we cooperate with our academic partners in the supervision of theses. These typically have a direct link to ongoing research at 52°North.

Brand, Tobias (2022): Interoperabilität der openSenseMap API und der SensorThings API. Unpublished Bachelor Thesis, Institute for Geoinformatics, University of Münster.

Pilz, Alexander (2022): Rich Data Interfaces for Copernicus Data. Unpublished Bachelor Thesis, Institute for Geoinformatics, University of Münster.

Wessel, Fabian (2022): Konzeption einer Echtzeitdaten-Infrastruktur – Evaluierung einer Push-basierten Datenauslieferung unter Nutzung des GeoMQTT-Protokolls. Unpublished Bachelor Thesis, Bochum University of Applied Sciences.

Internships

52°North mentors Geoinformatics students to support their personal development and professional careers. We share our knowledge and experience and benefit from their curiosity and creativity. Many Masters and Bachelors programs require a certain amount of practical work. In addition to offering student jobs, we have been providing student internships since 2011. Each intern works on one of our current projects for a period of up to 6 months. During this time, 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.

Mirjeta Musallaj currently works on a Masters of Geoinformatics degree at the University of Münster. Originally from Tirana, Albania, she studied geoinformatics engineering in Tirana, completing her bachelor in 2019. Since 2020, she has been studying in Münster.

52°North's project work, in particular the MariData project, as well as our focus on open science caught Mirjeta's interest. From April - September 2022, she worked on the MariData project, extracting OpenSeaMap data from OpenStreetMap and providing the data from OpenSeaMap as WFS and WMS. Her work also included deploying the OpenSeaMap services in the cloud, as well as using the WFS data as input for an ML-based optimization of ship routes. She worked with GeoNode, GeoServer, Docker and pgSQL database.

During her internship, she learned to search for and use new tools, adapt her work for a joint project, do collaborative work and advance her knowledge on some applications and platforms. "I had a very nice experience at 52°North. I liked my team - my colleagues were very supportive - and the flexibility offered."

Mirjeta plans to work on a Master thesis on the analytic visualization of the ship trajectories (in the MariData project) at 52°North.

Parichay Kumar Mandal is originally from Bangladesh. He received his Bachelor of Science in Computer Science and Engineering at Khulna University in 2016. Recently, he has been working towards a Master of Science at the Institute for Geoinformatics, in Münster, Germany.

Attracted to 52°North's open source software development and fascinating and impactful projects, Parichay joined the MariData team as an intern, working on the acquisition and insertion of environmental data. From April - September 2022, he used GeoServer, GeoNode to develop styled layer descriptors (SLDs) for wind fields and wave heights, directions and length and provided these in the cloud. Parichay also evaluated and customized front-end solutions for Research Data Infrastructures (RDI) and Machine Learning (ML).

During his internship, Parichay learned a lot about collaborative software development and infrastructure design. He discovered new technologies and tools for geospatial data analysis and visualization as well as project management. Above all, working as a team, taught him how to adapt his own work and make it reusable for others. "My experience with 52°North was amazing. Friendly and helpful colleagues have made the experience super comfortable." Parichay plans to learn and gather more knowledge so that he can use data to provide useful and impactful services. He would also like to work on his master thesis at 52°North.

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 new contributors to open source software development. Contributors receive stipends to work on a 12+ week programming project with an open source organization under the guidance of mentors. At 52°North, we pair students with mentors and embed their work in the context of ongoing research projects. Hence, GSoC contributors gain valuable exposure to real-world software development scenarios and have the opportunity to work in areas related to their technological backgrounds and professions. In turn, we are able to improve our software projects, move forward in our projects, as well as identify and draw in new developers more easily. This helps us to expand our Open Source community.

We have been a successful mentoring organization since 2012. In our tenth year, we were one of 196 open source organizations chosen to host five of the 1,209 student projects. Three of our five projects involved improvements for and developments of the enviroCar app. The other two focused on backend developments.

**enviroCar App: Voice Command** (Dhiraj Chauhan)

Dhiraj Chauhan is a second-year computer science student based in Mumbai, India. Passionate about technology and new ideas, he loves working on Android and using his skills to contribute to the exciting technological advances that happen every day via open source. His first ever Google Summer of Code project focused on adding voice command features to the enviroCar app.

The project focused on three main goals:

- to prepare the enviroCar App for voice command integration
- to have the app recognize the user's speech and translate it to plain text
- to recognize the user's intent via natural language processing/ natural language understanding (NLP/NLU) and perform an appropriate action

Since recognizing the user's intent via NLP/NLU is not enough to integrate voice commands in the application, Dhiraj developed a request and response schema for voice commands . He also implemented custom actions for start/stop recording and a follow-up action to handle all prerequisites. Here's a flow chart explaining the whole workflow of the start-stop voice commands.

WORKFLOW DIAGRAM FOR STOP RECORDING VOICE COMMAND
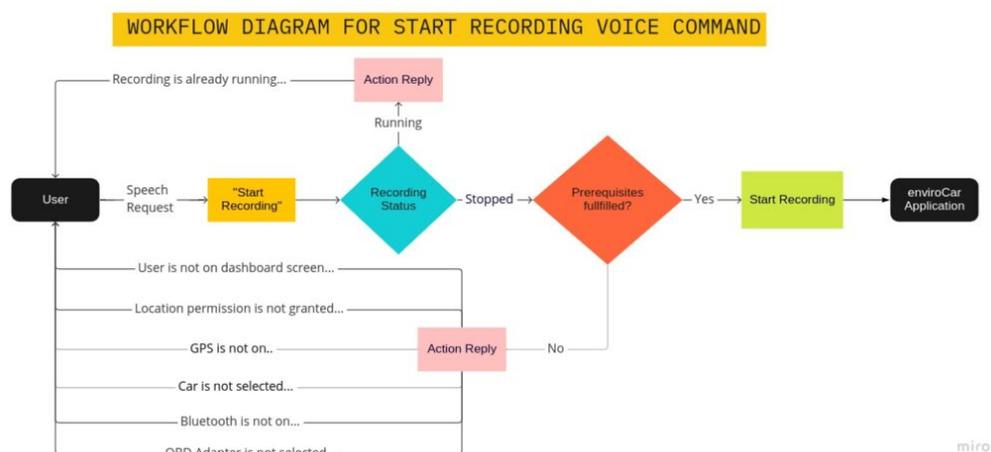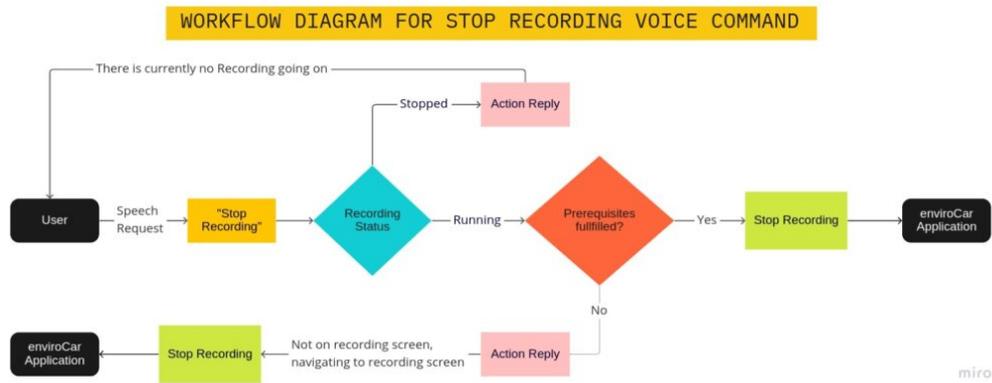
Workflow for start/stop recording voice command

"The GSoC '22 journey was an excellent learning experience. It was terrific to create something from scratch, design UML diagrams before implementing them, and see how the feature can be addressed using several techniques. Overall, my experience was enriching and has significantly advanced my developer skills. I look forward to continuing to contribute to the feature and working to become a better developer."

Blog: enviroCar App: Voice Command

enviroCar App for iOS users: adding UI for data privacy settings/control (Khyati Saini)

Khyati Saini is a third-year undergraduate pursuing her Integrated M. Tech. (dual degree) in Computer Science and Engineering from NIT Hamirpur, India. She's been working on the enviroCar platform-independent app since last year. This year's project aimed to implement UI for data privacy and control. The resulting work gives the user autonomy to control the data shared through the app and informs them how the location data is processed, thus providing informed consent.

Her project covered the following main tasks:

- implementing UI for providing informed consent to the user for location data sharing
- improving the UI of the app
- fixing bugs in the track details screen
- establishing the groundwork for Bluetooth-based OBD-II communication library

Khyati developed widgets to obtain informed consent (related to location data sharing), adjusted the default color of deactivated widgets, and added a notification badge on the dashboard screen. In addition, she researched Bluetooth/ODB-II communication and implemented first functions to enable reading, writing and subscribing to characteristics.

Confirmatory dialog box before uploading track to server

"It was a great learning opportunity. My presenting abilities improved thanks to the weekly meetings. The project progress management tools made it easier to keep organized and plan. Every day I got to learn something new. It was an incredible experience, indeed."

Blog: enviroCar App for iOS users: adding UI for data privacy settings/control

enviroCar App: Replace Libraries and Add New Features, Improvements and Bug Fixing
(Akash Ramjyothi)

Akash Ramjyothi is working on a Bachelors Technology Degree from SRM University in Computer Science Engineering. He loves working on Android Apps, as well as the Android OS (AOSP), and regularly participates in hackathons, winning a few of them in the Chennai circuit. Akash is interested in open source, because it allows him to showcase his skills to the developer community, provides interesting challenges and enables others to adapt and build on top of his contributed project.

During GSoC 22, he worked to improve the usability of the enviroCar app, focusing on replacing/ updating the deprecated libraries with newer and updated versions. This included:

- the migration of RxJava from version 2 to 3
- replacement of Butter Knife View Binding with Android Jetpack View Binding,
- implementation of RxJava based event-bus to replace Otto event-bus and
- replacement of the deprecated SQLBrite library

Architecture of RxJava-based Event Bus
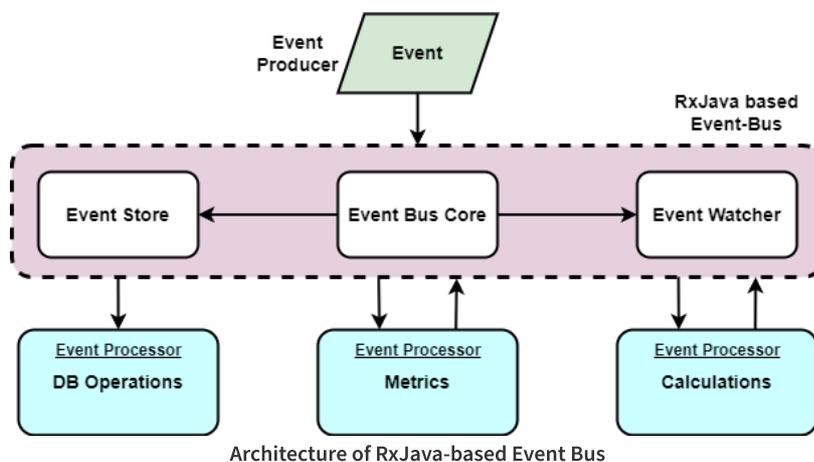
In addition, Akash added new functionalities and improved the user interface of the app. This covered an additional currency option, login/register button, swipe to refresh the tracks, locked

scrolling in the dashboard as well as a redesign for the user Sign In/Sign up.

"I will continue to contribute to the enviroCar android app by implementing better features from a user's point of view. I will also help maintain the GitHub repository and share my knowledge with new developers contributing to the app. I want to thank 52°North for giving me this spectacular opportunity to spend my summer and contribute to the enviroCar project as part of Google Summer of Code 2022."

Blog: enviroCar App: Replace Libraries and Add New Features, Improvements and Bug Fixing

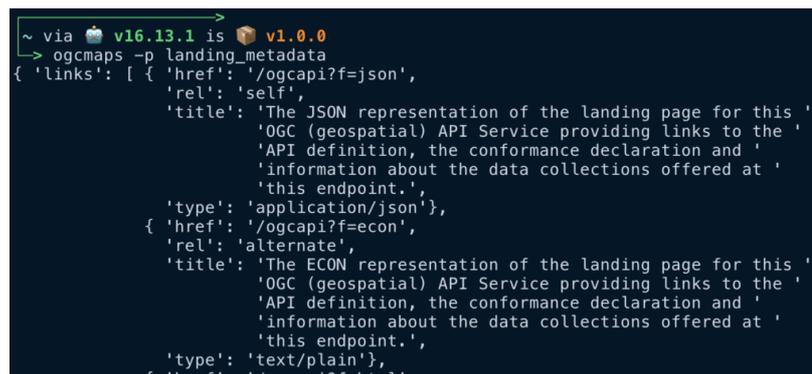**Python client for OGC Maps API** (Prakhar Gurunani)

Prakhar Gurunani, a freshman at Birla Institute of Technology & Science, Pilani, loves working as a backend developer, building services and tools for the community. This was his first time as an open source contributor in Google Summer of Code. His project focuses on developing a Python client for the OGC Maps API.

The OGC Maps API provides maps and map data through dynamically rendered electronic maps. The API has multiple endpoints, each providing geospatial data using a variety of parameters. This project aims to develop a terminal client and an API wrapper for the REST API endpoints in Python. These include the styles, collections, and the maps endpoint as a whole.

Prakhar focused on the following main objectives:

- creating a scalable API wrapper in Python
- implementing a terminal client using the helper functions from the API wrapper
- developing tests for all the endpoints
- setting up continuous integration continuous delivery (CI/CD)

The API wrapper created uses utility functions to process and parse data accordingly, which makes the wrapper highly scalable in the future. The terminal client was built using the click library. Click has various options to build CLI (Command Line Interface) apps. For example, wrapper functions are used along with some other helper functions to build the CLI commands. This indirectly serves as a bridge between the API wrapper and the terminal client. In addition, Prakahr generated documentation, tested the entire API wrapper and set up CI/CD on GitHub.

Pretty-printed JSON from the terminal client

"I thank all the mentors and organizations … I had a wonderful learning experience. Weekly meetings have helped me improve my presentation skills, making it easier for me to express my ideas and suggest a plan to go further. Working on this project has helped me to improve myself a lot and learn something new every day. It was an amazing experience."

Blog: Python client for OGC Maps API

UI for the Arctic Sea settings API (Faroe) (Sujit Jaunjal)

Sujit Jaunjal is a third year B.E student at the University of Pune, India. Since his introduction to Open Source a year ago, he has built up interest in contributing to the community. He likes to follow and play chess. This is his first Google Summer of Code.

The Arctic Sea framework's Faroe API allows users to set the properties for OGC services (e.g. Service Identification and Provider) and store the settings in JSON files. It is, however, missing a Web frontend to create, read, update and delete (CRUD) the JSON settings. Sujit's project focused on:

- creating a REST API on top of the Faroe API, which can eventually be used for performing CRUD operations
- developing a Web frontend using JavaScript or any framework of JavaScript (e.g., Angular/React) to perform CRUD operations on the JSON settings file

In the first half of his project, Suijit focused on creating a REST API that would perform the GET operation over the Service Settings data. He designed a REST API that is able to fetch the data from a .JSON format according to specific requirements. As a follow up, he developed a frontend using the React JS framework and used the CORSMAPPING library from Java to develop communication between the Java and React applications.
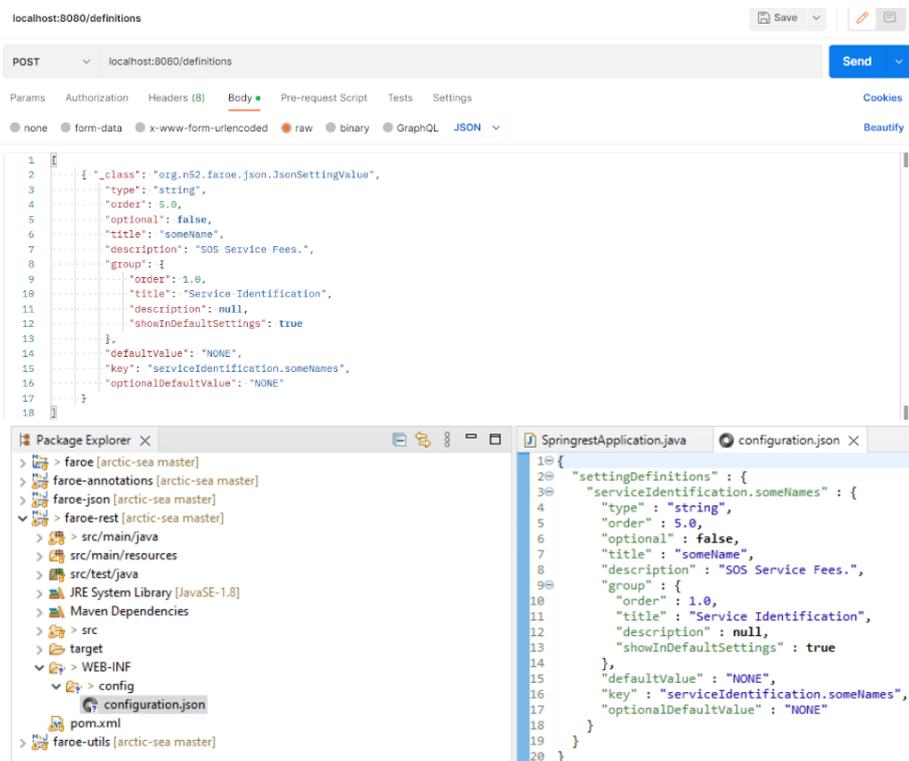
POST operation

"Building the functionalities for the Faroe project made a huge impact on my knowledge about Java, Spring Boot and ReactJS. I never thought that my focus would ever shift from Web development to Java development. The whole journey has been a rollercoaster ride right from project commencement up to the finish. Thanks to the organization and my mentors for selecting me as a GSoC contributor, I would be glad to contribute next year as well. I would also like to be a mentor for any project."

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Dissemination and Outreach

Research - develop - publish

At 52°North, we disseminate project and research results, i.e. software and architectural developments, concepts and methodologies, through various platforms. These include publications, blog posts, conference presentations, webinars and the organization of workshops and seminars. The vast majority of our open source developments are hosted on GitHub and freely accessible to a large user and developer community.

Publications

Sharing research results and developments

Autermann, Christian. "GeoNode as Research Data Infrastructure." Lecture presented at the OpenGeoHub Summer School, Siegburg, August 30, 2022. https://github.com/BenGraeler/ogh2022

Balaban, Aleksandar, Arne **Vogt**, et al."OGC Testbed-17: Attracting Developers: Lowering the entry barrier for implementing OGC Web APIs." OGC 21-019. https://docs.ogc.org/per/21-019.html.

Bermudez, Luis, Peter Vretanos, Benjamin **Pross**, Gérald Feony, and Jon Herrmann. "OGC Testbed 17: CITE Engineering Report." OGC 21-044. https://docs.ogc.org/per/21-044.html.

Drost, Sebastian, Verena Kirstein, Kian Pakzad, Simon **Jirka**, and Andreas **Wytzisk-Arens**. "WaCoDiS – Erleichterte Nutzung von Satellitendatenplattformen Am Beispiel Eines Verbesserten Gewässermonitorings." *Zfv – Zeitschrift Für Geodäsie, Geoinformation Und Landmanagement,* no. 2/2022 (2022): 104–15. https://doi.org/10.12902/zfv-0378-2021.

Drost, Sebastian, Arne **Vogt**, Christian Danowski-Buhren, Simon **Jirka**, Verena Kirstein, Kian Pakzad, and Matthes **Rieke**. "WaCoDiS: Automated Earth Observation Data Processing within an Event-Driven Architecture for Water Monitoring." In *Computers & Geosciences* 159 (February 2022). https://doi.org/10.1016/j.cageo.2021.105003.

Drost, Sebastian, Christian Malewski, and Simon **Jirka**. "Sensor Web and Internet of Things Technologies for Hydrological Measurement Data." In *Instrumentation and Measurement Technologies for Water Cycle Management*, edited by Anna Di Mauro, Andrea Scozzari, and Francesco Soldovieri, 279–93. Cham: Springer International Publishing, 2022. https://doi.org/10.1007/978-3-031-08262-7_12.

Drost, Sebastian. "Hydrological time series forecasting with Neural Networks." Blog, April 20, 2022. https://blog.52north.org/2022/04/20/hydrological-time-series-forecasting-with-neural-networks/.

Gräler, Benedikt. "Communicating Uncertainties in Bi- and Multivariate Distributions." Oral presented at the EGU General Assembly 2022, Vienna, Austria, May 23, 2022. https://doi.org/10.5194/egusphere-egu22-11075.

Gräler, Benedikt. "Integration von verteilten Geo-Daten in Forschungsdateninfrastrukturen mit Hilfe von GeoNode." Oral presented at the FOSSGIS 2022, Online, March 11, 2022. https://pretalx.com/fossgis2022/talk/MXRMY7/.

Gräler, Benedikt. "OpenGeoHub Summer School – Extremes." Lecture presented at OpenGeoHub Summer School, Siegburg, August 31, 2022. https://github.com/BenGraeler/ogh2022.

Gräler, Benedikt, Christian **Autermann**, and Matthes **Rieke**. "Die Rolle des Geoinformationsmanagements im Projekt KI:STE: KI Strategie für Erdsystemdaten." 13. Oral presented at Meeting of GeoIT Round Table NRW, Düsseldorf, June 1, 2022. https://www.gdi.nrw/organisation/geoit-round-table-nrw/sitzungen.

Granell, Carlos, Peter Mooney, Simon **Jirka**, Matthes **Rieke**, Frank Ostermann, Just van den Broecke, Alessandro Sarretta, et al. "Emerging Approaches for Data-Driven Innovation in Europe." JRC Technical Report. Ispra, Italy: Joint Research Centre, 2022. https://data.europa.eu/doi/10.2760/630723.

Jacovella-St-Louis, Jérôme, Martin Pontius, Eike Hinderk **Jürrens**, and Sufian **Zaabalawi**, et al. "OGC Testbed 17: Geo Data Cube API Engineering Report." OGC 21-027. https://docs.ogc.org/per/21-027.html.

Jirka, Simon, Christian **Autermann**, and Sebastian **Drost**. "Real-Time Delivery of Sensor Data Streams Using IoT and OGC Standards." PICO presented at the EGU General Assembly 2022, Online, May 23, 2022. https://meetingorganizer.copernicus.org/EGU22/EGU22-5407.html.

Jirka, Simon, Antje Kügeler, and Marco Hohmann. "Nutzung von OGC API Features Und OGC SensorThings API Zur INSPIRE-Konformen Bereitstellung von Umweltdaten." Oral presented at 29. Workshop Umweltinformationssysteme (UIS 2022), Online, May 13, 2022.

Jirka, Simon and Matthes **Rieke.** "Event-driven architectures for data exchange." Oral presented at ELISE Webinar: Emerging Approaches for Data-Driven Innovation in Europe, Online, January 24, 2022.

Jirka, Simon. "Real-Time Data." Webinar with Data.europa Academy, Online, April 5, 2022. https://data.europa.eu/en/academy/real-time-data.

Konkol, Markus. "Considering Data Harmonisation and Quality Information in European Marine Metrology Research Infrastructures (MINKE)." Oral presented at the EOSC Symposium 2022, Prague, November 17, 2022. https://events.eoscfuture.eu/symposium2022/.

Konkol, Markus. "Open Reproducible Research - Concepts, Challenges, and Solutions." Lecture presented at the OpenGeoHub Summer School, Siegburg, August 30, 2022. https://doi.org/10.5446/59403.

Konkol, Markus. "OpenGeoHub Summer School – Facilitating Reproducibility Using CODECHECK." Blog, September 16, 2022. https://blog.52north.org/2022/09/16/opengeohub-summer-school-facilitating-reproducibility-using-codecheck/.

Kügeler, Antje and Simon **Jirka**. "Geospatial Trends 2022: Opportunities for data.europa.eu from emerging trends in the geospatial community." Publications Office of the European Union. https://data.europa.eu/sites/default/files/report/Geospatial_Trends_2022.pdf.

Kügeler, Antje and Simon **Jirka**. "Real-time data 2022: Approaches to integrating real-time data sources in data.europa.eu." Publications Office of the European Union. https://data.europa.eu/sites/default/files/report/data_europa_eu_Real_time_data_2022_. Approaches_to_integrating_real_time_data_sources_in_data_europa_eu.pdf

Pontius, Martin. "Rasterdaten in GeoNode, DataCube." Oral presented at Workshop: Weiterentwicklung von GeoNode als Forschungsdateninfrastruktur, Münchberg, December 15, 2022.

Pontius, Martin, Sufian **Zaabalawi**, Eike Hinderk **Jürrens**, and Benedikt **Gräler**. "Reducing Cargo Ship Emissions through Energy Demand Optimized Routing." Oral presented at the EGU General Assembly 2022, Vienna, Austria, May 24, 2022. https://doi.org/https://doi.org/10.5194/egusphere-egu22-9927.

Pross, Benjamin. "Short introduction to the OGC API – Processes – Part 1: Core." Blog, April 20, 2022. https://blog.52north.org/2022/04/20/short-introduction-to-the-ogc-api-processes-part-1-core/.

Pross, Benjamin. "OGC API – Processes Update." Oral presented at the 124th OGC Member Meeting, Online, October 3 - 7, 2022.

Pross, Benjamin. "OGC API – Processes Update." Oral presented at the 123rd OGC Member Meeting, Online, June 13 - 17, 2022.

Pross, Benjamin. "Update of OGC API – Processes." Oral presented at the 122nd OGC Member Meeting, Online, February 28 - March 4, 2022.

Pross, Benjamin. "Update on OGC API – Processes." Oral presented at the 121st OGC Member Meeting, Online, December 6 - 14, 2021.

Pross, Benjamin. "Addressing Disasters Together, Two European Project perspectives." Presented at the OGC Innovation Days, Disaster Resilience and Climate Workshop, Washington, DC, USA, December 7, 2022.

Rieke, Matthes, Benedikt **Gräler**, and Simon **Jirka**. "Joining Geo Data Across Different Providers to Ease Machine Learning Applications." PICO presented at the EGU General Assembly 2022, Online, May 23, 2022. https://meetingorganizer.copernicus.org/EGU22/EGU22-11102.html.

Voigtländer, Felix. "Cold Spots in Münster." Blog, December 16, 2022. https://blog.52north.org/2022/12/16/cool-spots-in-munster/.

Werner, Micha, Ilyas Masih, Rebecca Emerton, Ilias Pechlivanidis, Marije Schaafsma, Lluís Pesquer, Giuliano di Baldassare, Marc van den Homberg, Stefano Bagli, Megi Gamtkitsulashvili, Lucia De Stefano, Benedikt **Gräler**, Györgyi Bela, and Apostolis Tzimas. "I-CISK: Towards a social and behaviourally informed approach to co-producing climate services." Oral presented at the EGU General Assembly 2022, Vienna, Austria, May 24, 2022.

Affiliations

Joining forces with the Geo-IT community

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.
https://doi.org/10.5194/egusphere-egu22-10661.

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. Dr. Benedikt Gräler is the European Representative, representing the interests of the DDGI in the European Umbrella Organization for Geoinformation (EUROGI).

Contact: https://www.ddgi.de

The European Umbrella Organization for Geographic Information (EUROGI) supports and develops the use of applications and technologies related to geographic information at the European level. 52°North delegates Dr. Benedikt Gräler as DDGI representative to the Executive Committee to ensure that German interests are considered in strategic policy planning.

Contact: https://eurogi.org/

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.

Contacts:
GDI-DE: https://www.gdi-de.org
GeoIT RT NRW: https://www.geoportal.nrw/geoit_round_table
Geonetzwerk Münsterland: http://www.geonetzwerk-muensterland.de

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