



COMMUNICATING SCIENCE WITH GIS

GIS TECHNOLOGY STRENGTHENS DANISH
RESEARCH AND HELPS INFORM THE PUBLIC

Since the time of the Vikings, Denmark has been known as a seafaring nation. In 1845, 231 sailors and scientists set off on a scientific journey, Galathea 1, that would take them south around Africa to India, visiting Tranquebar and the Nicobar Islands. It was a tough journey, and 20 men lost their lives. The results of the expedition, which was ordered by the Danish king, Christian VIII, were to be delivered in a beautifully decorated book; unfortunately, the king died shortly after the expedition returned, and the scientists argued so much that the book never became a reality.

But where the first Galathea had support from the king, the second got it from the public. When, in 1952, the deep-sea expedition Galathea 2 returned to Denmark after two years, 20,000 Danes greeted it at Langelinie quay in Copenhagen. The main reason for the support was probably that the forces behind the expedition had understood the power of communication. Reporters and journalists were onboard the ship, and every week movies about it were shown in the local theaters.

In 2006, the Galathea 3 expedition began a nine-month-long research journey at sea. This time, the expedition had the support of both the public and the royal family. Introducing the expedition at the Geological Institute in Copenhagen before the ship sailed off, Frederik, the crown prince of Denmark and protector for Galathea 3, said, *"As individuals, we all have a curiosity to explain and demystify. We want to know, explain, and tell all that we experience as humans."* This time, geographic information system (GIS) technology also played a part in the expedition's objective to

strengthen Danish research and make young people more interested in the natural sciences.

Ship information system integrated with GIS

The Galathea 3 expedition included 48 different research projects both on land and water. Most of the projects were carried out on the 112.5-meter-long vessel *Vædderen* (Ram). The National Institute of Aquatic Resources at the Technical University of Denmark (DTU Aqua) was brought in to transform the expedition ship *Vædderen* from a surveillance ship into a modern research ship. Research projects included examining Greenland's climatic history and geological development; investigating the climate, livelihoods, and production in the southwest Pacific; and following the European eel on its long and hitherto unknown journey from Europe to the Sargasso Sea, south of Bermuda.

To collect background data for the many projects onboard, DTU Aqua developed, among other things, a ship information system (SIS) customized for the expedition. The development of SIS was based on experiences from previous voyages with DTU Aqua's own research vessel, *R/V DANA*, but for the first time, SIS was integrated with GIS.

With a previous version of SIS, scientists onboard a ship could monitor and visualize their collected data. Through SIS, navigation data such as position and depth can be viewed and weather data (temperature, wind, etc.) is recorded. The ship also has a water intake system—positioned approximately five meters below the ocean surface—that measures salinity, water temperature, and more, as the ship sails along. Scientists can visualize data in 2D and tables, and the data is automatically related to a GPS point in SIS.

By supplementing SIS with geography, data can be displayed in a more intuitive way. DTU Aqua developed the customization using ESRI's ArcGIS Engine 9.1 and the 3D Analyst ArcGlobe control to create a mapping

tool that made it possible to display the route and the vessel on a globe in 3D, illustrating both its current position and direction of travel. Relative to the place where they were employed, the instruments used by the researchers could be viewed in 3D as well.

ESRI's ArcGIS software was already implemented and used day to day at DTU Aqua, so when the task arose of preparing *Vædderen* for its scientific journey, the choice of GIS technology was easy. The IT developers at DTU Aqua were already familiar with the ArcGIS interface, and the data formats matched. Another reason for choosing ArcGIS was that SIS was programmed in C#, which can also be used with ArcGIS Engine. By choosing ArcGIS technology, the diverse needs were fulfilled. With ArcIMS, DTU Aqua could update data live on the Internet from the geodatabase. ArcSDE was used to store the data shown in ArcIMS, and ArcEditor was used to read the background data and the data that came from the ship.

With ArcGIS Engine, data could be visualized on a globe through the SIS application. The mapping tool became a geographic entrance to searching, viewing, and analyzing the data, giving a new, intuitive access point to the data. Combining GIS with SIS opened the opportunity to monitor the quality of the data acquired in near real time, thus making it possible to quickly discover and correct problems such as sensor malfunctions or activities performed at erroneous locations. Working under sometimes difficult conditions with heavy seas, the ease of using SIS/GIS was a great help to the scientists.

Near real-time data

The information gathered by SIS/GIS was also communicated to the public via a Web site developed by DTU Aqua using ArcIMS. Data was sent from a server on the ship, via a satellite connection to a server at DTU Aqua, every hour. The Web site then showed the ship's route and displayed satellite images of the landscape when the ship was close to land. It was the first time a Danish expedition

could be followed as it happened. Information from, for instance, the water intake system was also rendered nearly live via the Internet through ArcIMS at DTU Aqua.

The results

Scientists are still working on analyzing the vast amount of data collected on the **expedition**. The Galathea 3 expedition has been well-known by the Danish public - a survey shows that more than 80 percent of the public has heard about the expedition and more than 60 percent thought it was a good or very good idea to let research, science, and communication go hand in hand.

Most of the GIS software - including ArcSDE, ArcEditor, and ArcIMS - used by DTU Aqua was donated by ESRI and its Danish distributor, Informi GIS A/S.

About DTU Aqua

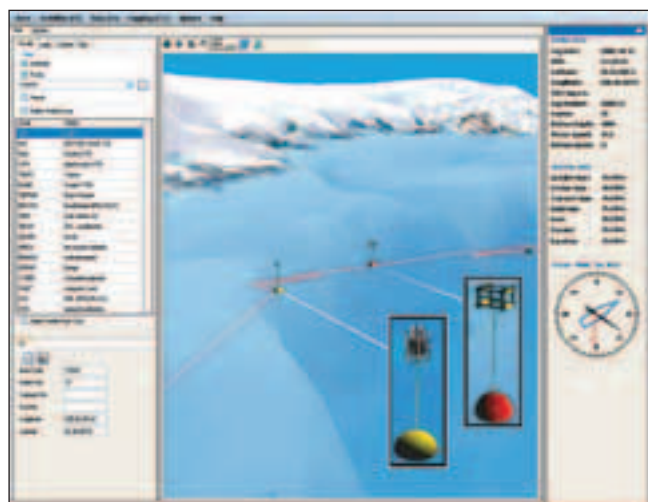
The National Institute of Aquatic Resources is part of the Technical University of Denmark. DTU Aqua performs fishery research to advise the ministry, public authorities, international organizations, industry and trade of fisheries, and other organizations. Formerly, DTU Aqua was known as the Danish Institute for Fisheries Research (DIFRES).

Contact information

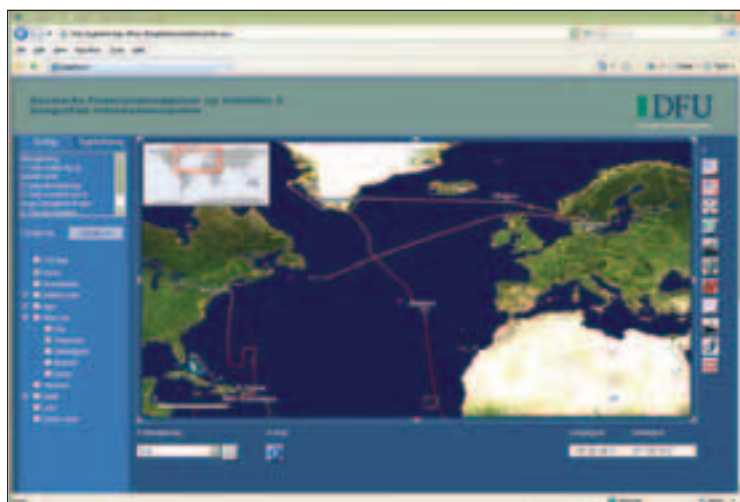
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*Image credits: Banner image is of the surveillance ship *Vædderen* (Ram), converted into a modern research ship used by the Galathea 3 expedition. Photographer Hempel A/S, in Copenhagen, August 11, 2006.*

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Integrating SIS with GIS for 3D globe view



With ArcIMS, the public could follow the expedition in realtime