Marine Technologies: Revolutionizing Ocean Knowledge

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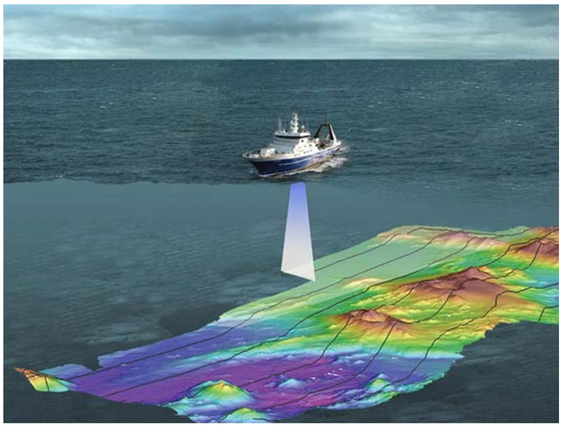
Introduction

Throughout history, humans have been directly or indirectly influenced by the oceans. Ocean waters serve as a source of food, rich minerals and a massive highway for commerce and transportation. The oceans cover over 70% of the earth's surface and support the greatest biodiversity on the planet. Oceans are also one of the largest carbon reservoirs in the Earth System, holding up to 54 times more carbon than the atmosphere. Scientists have successfully snapped a black hole, landed rovers on Mars and sent spacecraft to the moon's dark side. Yet, one of the most unexplored realms is within our planet, and that is the Ocean. The intense pressures in the deep ocean make it extremely difficult to explore. However, marine technology development is accelerating and will continue to do so in the future, which will pave the way to understand the ocean more. Today's technologies allow us to explore the ocean in increasingly organized, scientific, and non-invasive ways. With increasing scientific and technical advancements, our ability to observe the ocean ecosystem and its inhabitants are allowing us to understand and appreciate this unknown region better than ever before.

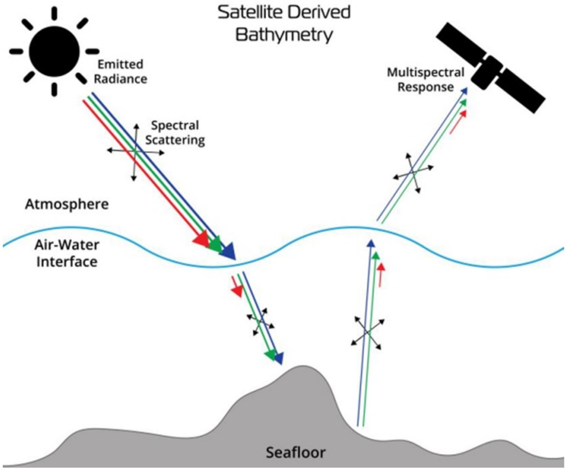
Exploring the Oceans

More than 80% of our ocean is unmapped, unobserved and unexplored. The ocean is the lifeblood of Earth, covering the maximum area of the planet's surface. We need to gather more and more data about the ecosystem, biodiversity and bathymetry of those bodies. A coordinated international effort is needed to bring together all existing data sets and identify areas for future surveys. Such an initiative is Seabed 2030. It is a collaborative project between the Nippon Foundation of Japan and the General Bathymetric Chart of the Oceans (GEBCO). Its goal is to compile all available bathymetric data and make the definitive map of the world ocean floor available to everyone by 2030.

Mapping water depths dates back to Egyptian methods from 1800 BC. However, the last 100-150 years have seen enormous advancements in the technologies and methodologies to map water bodies. Advances in Multi-beam Echo Sounders, Sonar technology, have revolutionized human understanding of the seafloor, with immense benefits to navigation, resource mapping, and fisheries.



Ocean monitoring and observations have become easier as several ground-breaking technologies emerged in this field. Many of the coastal areas are too remote or too dangerous for survey ships to ply. To gather bathymetric information on such areas, satellites are used and it is known as Satellite.

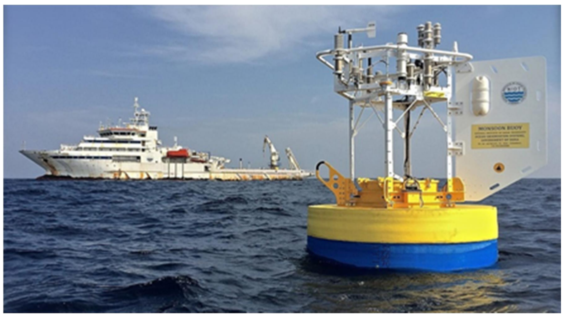


Derived Bathymetry (SDB). It is the most recently developed method of surveying shallow waters. SDB relates the surface reflectance of shallow coastal waters to the depth of the water column. It can be used as a reconnaissance tool for planned bathymetric surveys as well as to fill gaps in existing survey data coverage. In certain situations, SDB is a more viable option than traditional methods for surveying coastal environments.

To identify hazards to navigation, i.e. rocks, wrecks, shoals and underwater structures, several technologies have been developed. They not only help to make navigation safer but also assist in understanding the evolution of the marine environment, movement of water and sediment with archaeological values. One such technology is Synthetic Aperture Sonar (SAS). It is an emerging type of Sonar that uses an artificial or synthetic array to capture high-resolution images. SAS can be used for imaging cultural heritage sites like shipwrecks, classifying habitat or biological organisms, and characterizing seafloor sediment makeup.

Autonomous technologies are also being developed to fill the gaps of survey coverage of the oceans quickly. Autonomous Vessels are being tested in civilian, military and hydrographic sectors. A fleet of Autonomous Hydrographic Survey vessels can be extremely helpful to reduce the gap in bathymetric coverage of the world's oceans.

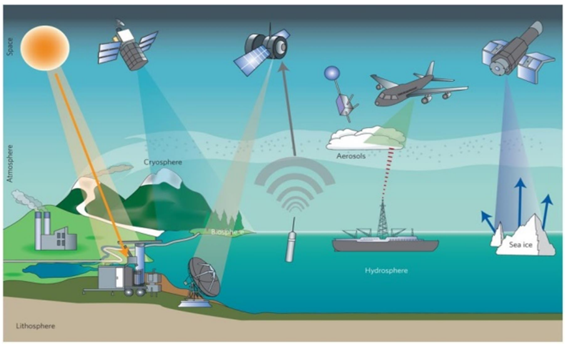
Oceanography, also known as oceanology, is the study of the physical, geological, chemical, biological and environmental aspects of the ocean. It is an important science, which covers a wide range of topics, including ecosystem dynamics, ocean currents, waves, and geophysical fluid dynamics, plate tectonics and the geology of the seafloor; and fluxes of various chemical substances and physical properties within the ocean and across its boundaries. Since the earth's water bodies are far greater than landmass, the oceans also play a significant role in the global climate. So, oceanography inextricably links with Meteorology. No single nation or technology is capable of observing or understanding the vast oceans or global climate alone. A large array of systems and technologies has



been developed to monitor the global phenomenon of oceanography and meteorology around the world oceans.

Newer, better connected and intelligent technologies are enabling stand-off observations of the world's ocean environment around the year. Few examples of such global observational technologies are ARGO buoys, Air-Sea Interaction Meteorology System (ASIMET), Geostationary Satellites & Observatories etc.

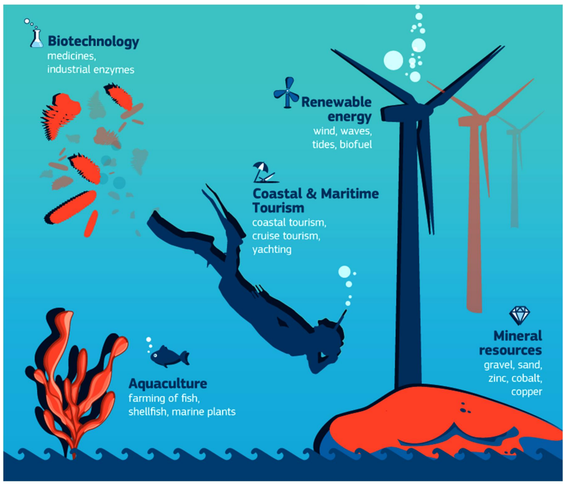
Remote Sensing (RS) has become an essential tool for the management of the marine environment. Researchers are able to use satellite data to assist in mapping out marine regions, including sea grasses, corals, mangroves, wetlands, and even shallow benthic environments. Satellite data currently enable the researchers to determine significant wave height, ocean currents, change in the marine environment and ecosystem. Geographic Information System (GIS) technology has made it possible to organize and integrate this data, produce maps, and conduct scientific analysis in order to improve our understanding and assist us in making vital decisions.



The deep ocean domain is complex in nature. So far, we have learned about our planet's underwater habitats through the use of satellites, shipboard sensors and divers. These technologies scratch only the surface of the oceans. Over the last few decades, scientists have developed Submersible/ ROV technologies capable of meeting the many challenges that the deep sea imposes upon explorers. It allows us to dive to depths where utter darkness, crushing pressures, and freezing temperatures prohibit Self-Contained Underwater Breathing Apparatus (SCUBA) operations. Submersibles alone enable us to explore the abyssal depths and contribute a significant portion of oceanography, especially marine biology and marine geology.

Using the Oceans Sustainably

Oceans are vast reservoirs of food, energy and other resources representing a unique opportunity for innovations in pharmaceuticals, the development of industries, and sustainable solutions. As such Marine Biotechnology seeks to harness the ocean's vast potential with the application of modern technological tools. However, we must use the technologies with particular consideration for preserving and nurturing the marine ecosystems. The consequences of disturbing the fragile maritime environment will last longer and will be detrimental to our planet's existence. Marine biotechnology enables us to identify, extract and use applications in various sectors to benefit society, ranging from food/feed to pharmaceutical and biomedical industries. This sector of the ocean space industry is expected to grow about 10% per annum in the coming years.



Marine Resource Exploration and Exploitation is basically focused on the search for hydrocarbons. Apart from traditional oil and gas industries, new sources of mineral resources are being sought from the oceans. Technologies used to explore the ocean include submersibles, remotely operated vehicles (ROVs), diving/scuba gear, buoys, mega corers, water column samplers, and sonar for mapping. With the latest high-resolution geophysical exploration technology, scientists are now able to detect oil and gas deposits in the seabed and other geological layers to a depth of 12 kilometers. As a consequence, in recent years, numerous substantial new deposits have been discovered or newly surveyed.

Technology still lacks in regards to the viable use of Deep Ocean Mining mineral deposits. Deep-sea mining addresses the recovery of resources from the ocean floor for commercial purposes. Offshore operations involves the extraction of minerals such as nickel, cobalt, zinc, copper, silver, gold, and manganese nodules using specialized subsea equipment. Advances in offshore and underwater technologies such as the use of autonomous systems, deep-sea vehicles, cutters and collectors etc. will enable the economic harvest of valuable minerals from the ocean floor in near future.

We all are aware of the hazards of fossil fuel. Fossil fuels (coal, oil, natural gas, gasoline) are polluting the environment and have serious long-term consequences for the earth like sea levels rising, acidification of the oceans and frequent storms. The world needs a cleaner, renewable form of energy or Green Energy. The rapid deployment of renewable energy includes advancing economic development, improving energy security, enhancing energy access and mitigating climate change. The ocean is a vast source of Marine Energy. The ocean waves, currents, tides, salinity and temperature differences can be used to generate electricity to power homes, transport and industries. Several potentially viable ocean-based alternative energy technologies are in use or will be used in the near future to lessen the dependency on fossil energy.

As the world economy continues to expand, the coming digital revolution will help the shipping sector to meet future challenges. So, what will ships look like in the next 30 years? The Global Maritime Technology Trends 2030 identified the eight transformational technologies - Advanced Materials, Big Data Analytics, Robotics, Sensors, Propulsion and Powering. Communications, Shipbuilding and

Smart Ships which will have a profound impact on ship system design and operation in the next 15 years. Maritime shipping is well expected to remain as the primary means of trade transportation in the foreseeable future, and situational awareness systems are being developed for mariners to augment navigational safety and reduce crew fatigue.

Conclusion

The world is in the midst of a global technology revolution. Advances in computer and information technology, as well as advances in marine technology and other fields, have been growing in recent decades, with the potential to bring about significant transformations in all aspects of life. Today's technology allows us to investigate the ocean in a scientific and sustainable manner. With continuing scientific and technological advances, we are now better equipped to observe the ocean environment and its residents. As per the UN's Sustainable Development Goals 14 (SDGs 14), governments have agreed on an ambitious global agenda, i.e conserve and sustainably use the oceans, seas and marine resources for sustainable development. SDG 14 sets out a wide-ranging set of targets for better stewardship of ocean resources to prevent and reduce marine pollution; sustainable management and protection of marine and coastal ecosystems; address the impacts of ocean acidification; regulate harvesting and end overfishing, IUU fishing and destructive fishing practices, conserve coastal and marine arcs etc. Technologies can help to solve the environmental challenges and to improve operational efficiency in the maritime world of the 21st century. There is an increasing need to develop sustainable technologies for ocean space exploration, exploitation and conservation. Therefore, we must continue to develop environment-friendly marine technologies to explore and use the oceans for the existence of our planet. We must not forget, the ocean is important for the entire human race and we must emphasize its use only for the benefit of mankind.

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