Geographical Information Systems (GIS) collect, manage, sort and display geographical information. They consist of hardware, software, liveware and data which come in two types (geographical/locational & attribute/statistical data elements). GIS is used in many fields such as marine science and data science due to a myriad of benefits and its ability to handle complex spatial data.

Maguire highlights GIS ability to use implicit references to derive explicit references which links different datasets together. It also has amazing commercial application due to its ability to address different socio-scientific problems and supporting decision-making, becoming an important player in data sciences. These key benefits have only just begun to be explored as technologies and computing power will evolve and more operating systems become available to the public.

7 years later, GIS is no longer locked behind software and as more data is accessible to the public via the Internet, which led to the rise of WebGIS. While Hardie lamented that a raster type image is generated, he noted that the client didn’t need to do anything for information retrieval. Another issue he mentioned is data copyright and cartographic design of webGIS sites. He anticipates that WebGIS will continue to evolve to the point where it acts like a standalone GIS as new plugins, browsers, Java and other scripting languages are developed.

Martinez et al. state WebGIS became the main player of GIS functionality delivery over the internet by leveraging webservices and open standards, allowing broad access to geospatial information which played a key role during the COVID-19 pandemic in supporting pandemic management and education. With new technological advances like cloud computing, WebGIS now offers better scalability, performance, processing and interactable visualizations. However, they need to constantly improve upon existing technologies, an issue not just limited to GIS. Other drawbacks mentioned are: uneven adoption of standards, security issues and inadequate user training. Regarding future GIS research, they suggest looking into cloud computing/web architectures to explore stable implementations and reusable geospatial-orientated technology to improve user experiences and security of geospatial data.

Geospatial Cyberinfrastructure (GCI) combines data resources, network protocols, computing platforms and combinational services to perform science applications. Yang et al. note its use in climate sciences and ocean studies as it integrates phenological research, satellite and radios to perform real-time climate research and forecasting. GCIs are a multi-domain collaboration effort, and they note that future research should integrate social science. They recommend research to support real-time decision-making with high performance and, water management (determine behaviour and composition of water and adapt to societal needs). Finally, some noteworthy limitations and future research include: difficulty of seamless collaboration across domains, developing GCIs to match different needs, converting data into information, and transitioning to cloud computing.

In marine sciences, GIS is used due to its multidisciplinary nature, ability to handle complex spatial data, integration of data-science techniques and applications for many marine fields while providing solutions for marine-specific problems and allowing scientists to predict and respond to negative environmental changes effectively. GIS also evolved to handle spatio-temporal problems, which is important as coastal data has high spatio-temporal instability. As mentioned earlier, GIS fosters collaboration between marine scientists, data scientists and industries but differences in knowledge that don't necessarily intersect can lead to difficulties. GIS is great for real-time decision-making and predictive analysis but requires high-quality data to reduce uncertainty something data scientists still struggle with today despite research is being done to circumvent this.

GIS gained popularity for geospatial conservation by incorporating ecological, climate change data into prioritization models. This is noteworthy especially in a time where climate change is an important part of our lives, having effective data-science tools which incorporate them allows for conservation of high-risk areas. Cobb et al. note that, GIS and cost-effective methods led to a mismatch between what reality and decision-making models' outputs due to a bias on less threatened areas, which is a major issue. Another issue is the lack of use of social dimensions in conservation case studies due to a lack of collaboration between researchers and communities whose livelihoods are impacted by GIS decision tools.

In land system sciences (LSS), GIS is used to map, monitor, and analyze land use and cover changes, by integrating environmental and social data to support sustainable land management to meet the UN's SDG. Dong et al. mentions that GIS are used due to advances in remote sensing, crowdsourced data, machine learning, phenology-based analyses algorithms, cloud computing and high-performance computing. However, with advancements, more issues will arise. One recurring theme is the security and quality of data. Despite good accessibility, crowdsourcing doesn't necessarily mean good quality data, causing decision-making models not necessarily making good decisions. Regarding privacy, as technology evolves, so does the strength of malicious attacks leading to major concerns.

Overall, GIS has evolved significantly over the years and they have furthered various fields due to it's ability to handle vast amounts of complex spatial data. GIS's capabilities will continue to improve as technology advances, machine learning models being made more reliable and cloud computing's emergence. However, there are various challenges surrounding data quality and security, multi-disciplinary collaboration difficulty that need to be addressed. If we overcome these issues, not only will the future of GIS be in strong hands, they will play an even stronger role in advancing climate change awareness and further data sciences.

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