Water is a resource taken for granted in many parts of the world. Often, water is simply a cheap resource that flows out of showerheads, faucets, and hoses, to be used at any time and place. Sadly, this condition is not the reality for much of the world, which faces ever-growing challenges to solving problems such as clean drinking water, drought, and flooding. These issues are pervasive across a variety of aspects of life, such as culture, economics, and politics. Due to this, effective water resource management decisions are of great importance and necessity. Some of the most pressing issues include groundwater contamination, water body pollution, and quickly assessing hydrologic functions.

With the advent of GIS and remote sensing technologies, many of these issues are being addressed and are having profound impact on both the management decisions as well as how data is analyzed. GIS allows for data to be consolidated and viewed spatially, which can allow for a broader audience when it comes to policy-makers. Remote sensing can help to cut down on the time and cost of monitoring issues such as total maximum daily load in a lake or other water body, as it does not require in-situ data collection. These new technologies are helping to change the way management decisions are made regarding water resources by presenting efficient, accurate, and quick methods by which to analyze data and present it.

Perhaps the most important functions of GIS and remote sensing in water resources are those of hydrologic analysis. David Maidment, in his volume on developing a model for GIS in water resources, maintains that a multi-layered approach to hydrologic analysis is both efficient and accurate. His “ArcHydro” model incorporates a variety of layers, including streams, drainage areas, surface terrain, and hydrography and utilizes these various layers to make a more complex hydrologic analysis. Remote sensing of the environment with technologies such as LIDAR gives extremely accurate elevation data to use in determining flow paths of surface water. When incorporated with GIS and its ability to layer data, the analyses can be done very quickly and easily. Another important aspect of Maidment’s argument is that GIS can be used as database management tools to document and store hydrologic data. This ability is sometimes underutilized, but the ability of GIS to store data spatially and numerically is a powerful tool. Maidment writes that the access to geodatabases that GIS offers is a significant improvement over the old binary code style databases that previous organizations and institutions have used in data analysis.

A more specific function of GIS in water resource management is that of watershed planning. Watershed management is very common on the local level of governance, since watersheds feed the water for their respective regions. David Lyon, in his book on GIS for “Water Resource and Watershed Management” writes that GIS can be utilized as an efficient tool for hydrologic analysis, much the same way that Maidment thought of GIS. Lyon relies less on a model approach to hydrologic analyses and more on the layered approach of what aspects might be most important to the watershed. He also utilizes the ability of GIS and remote sensing to use historical aerial photos to observe the change in landscape. Not only is hydrologic data being used, but also the visual data and how it has changed over time. This can be extremely informative to those attempting to analyze changes in the landscape and how they affect the watershed.

Groundwater quality is often the most important topic when discussing water resource management. Because of its importance to the drinking waters of a region, groundwater monitoring is an often neglected necessity. Many areas around the world have highly polluted groundwater for a multitude of reasons. Often, the areas are industrializing and do not have the time or resources to dispose of waste properly, which can lead to pollution of the groundwater, and in turn, pollution of their
drinking water. GIS, and its ability to layer data, has allowed for a more robust and detailed analysis of where groundwater pollution is, what is causing it, and how best to mitigate it. Atiqrur Rahman writes in his paper that using factors such as depth to the aquifer, net recharge, soil media, topography, and hydraulic conductivity can all be layered and correlated with one another in order to determine where the most sensitive recharge areas exist. Additionally, using land cover/land use maps of the region of Aligarh, India, he can estimate the sensitivity of these regions based on human activity on the surface.

Another example of using GIS and remote sensing in groundwater analyses is in Asadi, Vuppala, and Reddy’s paper on “Remote Sensing and GIS Techniques for Evaluation of Groundwater Quality in Municipal Corporation of Hyderabad (Zone –V), India.” Using satellite imagery such as PAN and LISS-III, they were able to georeference the imagery with the known groundpoints and data of water quality from the wells with the land use in the area. The high resolution imagery gave them a very detailed map of how the land was being used and what might be causing any problems of pollution in the region. Again, using data layers, they were able to correlate groundwater quality with land use/land cover. These two real-world examples of how GIS can be used to better understand the water resource issues of an area and how these issues can be effectively represented using GIS and remote sensing.

On a broader scale, GIS and remote sensing also have a place in water resource planning. As Giupponi and Vladimirova write in their paper on agricultural pressures on water quality in Europe, regional policy making can be enhanced by the use of GIS to spatially represent data on a large scale. Using data on both water quality and agricultural presence, a pressure map of groundwater quality can be made and can show the regions within an area as large as the EU and how water quality is affected by agricultural activity. The results showed that areas with a denser agricultural presence often experienced a reduction in water quality levels. These include the areas of the Netherlands and Belgium specifically. Although the area is broad, there may well be other factors that contribute to the water quality of a region apart from agriculture. This is an important feature of GIS, since it allows for analysis on a multitude of levels and can be switched out at any time, allowing for a much quicker and easier process.

Remote Sensing is an incredibly powerful tool in water resource management, as the authors of “Remote Sensing Techniques to Assess Water Quality” point out. Remote sensing can be used to determine a multitude of conditions of water bodies, such as chlorophyll levels, temperature, chemicals, and dissolved organic matter. This is done by understanding the backscattering signature of the remote sensing system that is used. Various conditions result in their own unique signature. The ability to acquire data that is not in-situ is very powerful since it means that both data collection and data management becomes easier.

The use of GIS and remote sensing in water resource planning issues has the potential to change the field, as it can allow for detailed, accurate, and quick analysis of topics that might otherwise have taken a number of times longer. The cost of these operations can also be greatly reduced. There is still a large amount of progress to be made on both fronts, and the use of GIS as a database management tool is certainly something that should be explored further.
Annotated Bibliography


The purpose of this book is to guide those in water resource management and hydrology to use GIS effectively. It was designed so that GIS would serve as a system by which water resource functions could be analyzed. Maidment develops a model by which hydrologic functions should be assessed with GIS. Using various layers of data, he proposes that this multi-layered approach is more efficient and can result in a more accurate assessment. The data for each other layers, such as elevation are to be acquired with systems such as LIDAR, which can give us and extremely accurate set of data to work from. In conclusion, Maidment states that GIS is a very powerful tool in both data analysis and also policy assessment of hydrologic functions and water resource issues. While the topic may be broad, Maidment did a good job of presenting it in a way that specified the various functions of GIS and how they can be applied to water resource management.


This volume is similar to that of Maidment’s in that it incorporates the ability of GIS to work in layers in order to make analyses but focuses instead on watershed analysis. This more specific focus means that the functions described are intended mainly for water resource analysis in terms of the watershed. Another interesting difference is that Lyon introduces the ability of GIS to view changes in the landscape via historical maps and aerial photos. Lyon also focuses on the ability of GIS to cut down on the time consuming processes of hydrologic analysis and make those analyses much quicker. Optimization is a large part of why GIS can be such a powerful tool in a variety of fields, including hydrology. Lyon’s conclusion is supported by his presentation of the various functions and really makes his case for how those functions can be optimized.


In this paper, Rahman incorporates GIS into groundwater quality assessment by layering data and then correlating the data to various layers. Factors such as depth to the aquifer, net recharge, soil media, aquifer media, topography, and hydraulic conductivity can all affect the groundwater quality. Using this data, Rahman uses a model called the DRASTIC that is a statistical summary that can help determine the correlation between various factors. GIS allows him to overlay the data and create areas of the map where areas are more likely to be affected by surface activity based on his statistical model. He was also able to overlay the sensitivity of the groundwater to the well data points in order to get a better picture of how sensitive these areas were. Finally, Rahman was able to use land cover/land use and determine the potential causes of this sensitivity based on human actions above. Rahman’s use of GIS to solve a specific regional problem highlights the real-world applicability of GIS in water resource management. Although the paper did include some mathematical and statistical jargon, it was fairly easy to follow.

This paper is similar to that of Rahman’s in that it focuses on groundwater quality and relies on GIS data layers to determine the most sensitive and effected areas. Asadi, Vuppala, and Reddy used a variety of satellite imagery such as PAN and LISS-III and were georeferenced with the groundpoints so they could have high resolution imagery available and accurate to the data they’re analyzing. A land use/land cover map was also developed from this satellite imagery. Known data points from the tested wells were added, and together, the various data layers form an information base from which to make a groundwater quality analysis. Interpolation was used based on the land cover and data sampling points and the most vulnerable areas become apparent. Based on this interpolation, a correlation was made between land use and land cover and groundwater quality. This paper was simpler and more concise than Rahman’s and basically covered the same topics.


This paper focuses on the application of GIS in regional policy making decisions, specifically in groundwater quality and land use policy as it pertains to the European Union. Using GIS and known data points of water quality in the EU, broad scale maps can be produced highlighting the effect of various land use practices. In particular, agriculture is the main focus of the paper as it contributes the largest amount of pollution in some areas of Europe. Due to the nature of this paper, the broad themes are easily identified, but how GIS was used and what specific functions of GIS were used was found to be lacking. Although the data was presented well enough, how the data was created using GIS was not.


This paper is the only one in my assessment that highlights the use of remote sensing in determining water quality. The authors do a very good job of describing the processes by which water quality can be assessed and the various systems that can be used. The analytical models that the authors present are daunting, but the general descriptions of the systems are helpful in identifying the functions of remote sensing in this particular field. In particular, the description of the use of multispectral data to determine the distribution of chlorophyll was well put together.