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Assessment and Monitoring of Water Quality in Mathura - A Review

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The quality of surface water, groundwater, rainwater and commercially available water was talked about based on where the pollution came from. In general, both surface and groundwater are of poor quality. Salt, heavy metals, sewage water, solid waste leachate and hydrogeological groundwater interactions are all causes of groundwater pollution. The municipal water supply is the best drinking water source for the communities of Mathura. This study reviewed findings from decades of research on water quality monitoring and evaluation in Mathura. Future prospects for water quality assessment and evaluation include the identification of emerging contaminants and micro pollutants as well as the implementation of internet-enabled devices. This research will serve to highlight the water quality assessment of Mathura in the study region for bathing, drinking and other industrial uses. Using the multidisciplinary Scopus database, all published research articles (343 total) from the past sixty years were analyzed. The integrative analysis divided the framework into thematic groups and these sections were allocated according to the year of publication, sources of articles, significant contributors and their locations, keywords and numerous other factors. Using the VOSviewer software, a co-authorship network, an inter-country co-authorship network map and a network of keyword co-occurrences were also constructed.

KEYWORDS

Groundwater, Mathura city, Water parameters, Surface water

1. INTRODUCTION

Anthropogenic activities have put a burden on water quality that is necessary for community survival [1]. However, water is a fundamental requirement for human survival. The day-to-day problems with ground and surface water have dramatically escalated and the clean water supply that is currently being used is on the edge of destruction and poses a threat. In addition to other landuse, health and food shortage challenges, one of the consequences of urbanization and industrialization is an increase in the problem of water pollution [2-4]. Over the course of the last several years, numerous areas with dry and semi-arid climates have been dealing with problems addressing drought and contaminated groundwater. Millions of families that live in towns and cities rely on groundwater as their primary source of clean and safe water because it is a vital component of the water supply. There are some substances that can dissolve in water and these chemicals have the potential to cause long-term adverse health effects and changes in taste and aesthetic problems. Surface water is getting dirty because of industrialization, population growth at a rate that has never been seen before, too much deforestation, a lot of changes to farmland and more tourism. It has been established that human activities are the primary contributors to widespread contamination of groundwater. To around one billion humans, water is not available that is fit for human consumption [5]. Approximately 2.2 million people die every year in impoverished nations as a result of diseases that are spread by water [6]. The abatement of pollution is a factor that absolutely require to be considered in order to achieve the aim of sustainable community [7]. The leaders of the world have demonstrated readiness and commitment to further improve access to better quality water. It was underpinned by Millennium Development Goals, which include reducing pollution, improving water quality and solving the problem of not having enough water [8,9].

With a population of approximately 2,874,016 people,

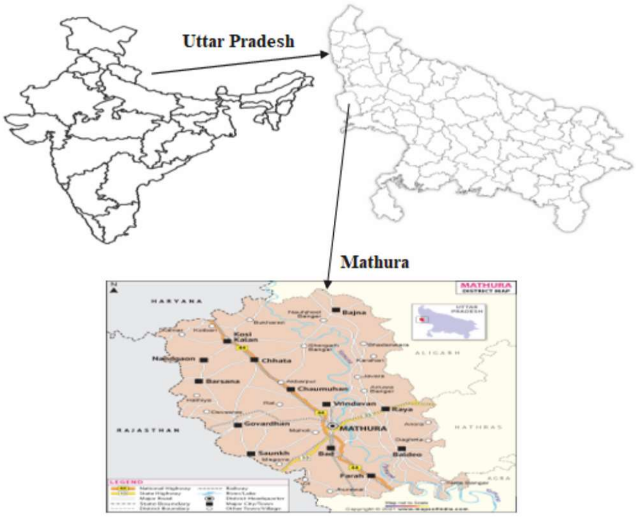

Figure 1. *Study area*

Mathura is considered to be the holy city for Hindu devotees in all of India. Surface water, groundwater and rainwater are the three types of water that can be collected for human consumption and made available to the enormous global population, which survives in both urban and rural settings. Due to water's poor quality, Mathura has a lengthy history of water difficulties (in both ground and surface water) [10,11]. Despite this, the city continues to struggle with these issues [12-14]. The introduction of new agricultural practices, an increase in tourism activities, residential activities and other types of industrial operations have all contributed to contamination of Mathura's water supply [15-17]. In addition, consumption of polluted water has directly contributed to spread of water-borne diseases in city of Mathura, including diarrhoea, cholera and a variety of other gastrointestinal ailments [18,19]. This is due to fact that getting a handle on and analyzing the quality of the water makes it feasible to determine precisely what issues there are with water contamination. Efforts have been directed at assessing and evaluating the quality of these different categories of clean and safe water sources over last several years.

This report provides a detailed and methodical evaluation of research study on water quality assessment in Mathura during the past few decades. The goal of this review is to bring together and organize study results so that knowledge gaps can be found and right research scope can be set for future studies. It also presents more elaborations on the significance of water quality in sustainable development. An intensive search was conducted through a variety of research journals and other types of published material on the topic within previous sixty years to collect the necessary information for this investigation. The terms, like water, quality, Mathura were utilized. This managed to reduce the number of relevant publications without omitting any of really key ones. There are neither any such recent reviews on the topic (if Mathura is the scenario), nor are there any reviews that have the current level of depth and scope. This proves that such a complicated strategy is novel and relevant and it shows how important it is to a wide range of people in Mathura.

2. MATERIAL AND METHOD

2.1 Geographical description of study area

This section provides a meteorological, geological and hydrological overview of Mathura's location. The discussion of the quality of surface water, groundwater and rainwater in Mathura is best understood by the readers when they have a better understanding of the weather conditions. Mathura is situated in western region of India's Uttar Pradesh state. The city of Mathura is situated between latitudes 27°17' and 27° 28' north and 77°41' east. Mathura is located on the plains with average elevation of 287 m [20]. Mathura experiences the winter, summer and rainy seasons. Winter runs from November to February; summer is from March to June and monsoon is from July to September. The city's overall slope lowers into the river Yamuna from north-western to southeastern direction [21]. Although the soil is more sandy in texture and contains silt, clay, kankar and gravel, it is rich and fruitful. Grains, potatoes, oilseeds, bajra, rice and sugarcane are the principal agricultural crops [22]. The dry season has lower groundwater levels than wet season. The proximity of the water table to the source of surface pollution and the downward leaching action of precipitation during the wet season both contribute to worsening of groundwater quality. In terms of Mathu-ra's geology, the study region is a portion of Gangetic plain, which is underlain by both younger and older quaternary alluvium. The alluvial basin has silt, sand, clay and gravel deposits [23,24]. The river, ponds and bairaj are all examples of surface water in Mathura. The area surrounding Mathura is home to a number of ponds. The study area is shown in figure 1. Using VOSviewer 1.6.18, a coupling of authors, nation and keyword co-occurrence analysis was conducted in order to investigate and analyse exhaustively the logical networks of the aforementioned study field [25].

2.2 Drinking water quality standards in India

The Bureau of Indian Standards (BIS) is the organiza-

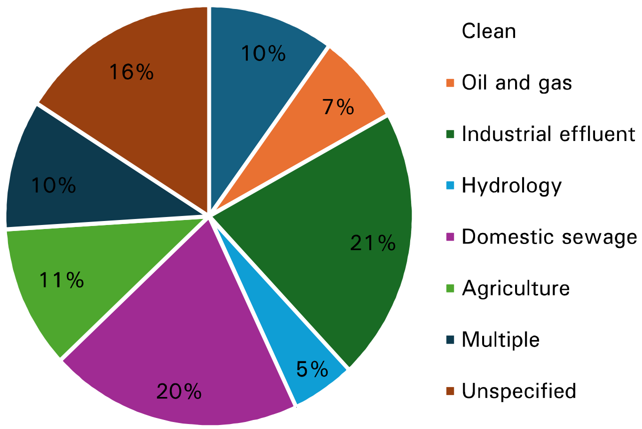

Figure 2. *Surface water contamination sources in Mathura* and *their respective contributions*

tion that sets the legally required standard for drinking water quality in India. This specifies the minimum values that must not be exceeded for the various water parameters in order for the water to be deemed safe for consumption. However, local researchers do not just base their judgement on it; they also compare it to World Health Organization standards. Table 1 shows surface water pollution in Mathura in terms of water pollutants. These guidelines serve as foundation for determining acceptable levels of pollution. The samples are typically collected, evaluated for various contaminants and characteristics, compared to these requirements and flagged when the findings are out of compliance [26,27]. Other studies have also tracked water pollution using various indices. This involves keeping an eye on other classes of microbes as well as macroinvertebrate community [28,29]. Though not specifically used as an index, the abundance and diversity of macroinvertebrates and microbes were used to inductively assess water source's quality [30]. According to several studies, sediments at the riverbed can also be used to measure water quality [31]. Overall quality of the water can be calculated using a number of different water quality indices [32]. These include National Sanitation Foundation (NSF) index, the Oregon index and Bascaron's index. Typically, process entails choosing the parameters, creating sub-indices, determining weights, averaging the weights and interpreting the final index result. Additional information is covered elsewhere [33]. Additionally, several statistical methods are used to identify the effects of seasons on quality metrics. These include multivariate statistical analysis, like principal component analysis/factor analysis, cluster analysis, correlation matrix and analysis of variance as well as univariate statistical analysis [34-38].

2.3 Assessment of surface water quality

According to the determined cause of contamination, the detailed discussion of assessment and evaluation of Mathura's surface water quality will move forward. Figure 2 summarizes the surface water contamination sources in Mathura and their respective contributions. The source is typically unknown in studies; this frequently occurs in studies where focus is on observing the seasonal changes in water quality. Industrial effluents, which account for 21% of all pollution, are the primary cause, followed by abattoirs. The oil and gas sector solo makes up 7% [39]. Domestic trash and sewage (20%) are another sources of surface water contamination. This is because cities don't have many integrated sewage management systems and big rural areas often have trouble getting rid of their sewage. Agriculture and hydrogeology were also noted as sources. Studies that speculated on a vast number of potential sources of pollution but could not provide a clear source for discovered contaminants fall under the numerous headings. The following section of report will go into more depth about various causes of pollution.

2.3.1 Oil and gas exploration, production and refining: Indian Oil Corporation owns refinery in Mathura, which is the company's sixth refinery. This refinery currently has an annual refining capacity of 8,000,000 tonnes [39, 40]. In Mathura, it has been noted that gas flare-ups cause surface waters to become contaminated [17]. Surface water has also been found to contain high quantities of heavy metals from oil exploration. Major and minor spillages have occurred in these locations, causing such amounts of pollution as result of improper precautionary measures taken in the production of oil, human mistakes and technological errors.

2.3.2 Industrial activities: Effluents from numerous industries in the Mathura district are released into the waterbodies. This includes a wide variety of businesses, including those that produce vegetable and palm oils, paint, tanneries and bottlers [41]. Due to variations in processes that produce them, these effluents have different compositions and effects on surface water. The effluents from textile and paint industries frequently contain colours and heavy metals [42]. In a different study, results for total hardness and bacterial load confirmed the detrimental impact of industrial wastewater on the Yamuna river.

2.3.3 Domestic waste and sewage: Waterbodies' quality may decline as a result of discharge of residential waste and sewage into them. Micro-organisms can live

Table 1. *Surface water pollution in Mathura*

Places	Sources of water pollution	Water pollutants	References
Yamuna river	Industrial effluent	Heavy metals	[63]
Mansi Ganga, Goverdhan	Domestic Waste	Faecal and total coliform, heavy metals, potassium, temperature and total suspended solids	[64]
Rudra Kund, Goverdhan	Domestic Waste	Colour, biological oxygen demand, iron, cadmium and phosphorus	[65]
Sankarshan Kund, Goverdhan	Unspecified	Turbidity, phosphate, cadmium and lead	[66]
Langoti Kund, Gokul	Domestic Waste	Carbon, nitrate, phosphate, chloride, dissolved oxygen, biological oxygen demand, lead, cadmium and total coliform	[67]
Lalita Kund	Unspecified	Temperature, turbidity, pH, ammonia, iron and microbial load	[68]

Table 2. *Groundwater pollution in Mathura*

Places	Sources of water pollution	Water pollutants	References
Handpumps, Mathura	Human activities	Heavy metals	[22]
Tubewells, Raya	Sewage wastewater	pH, chloride, flouride, turbidity	[69]
Shallow wells, Navada	Domestic wastewater	Ca, Na, K, temperature, TDS, turbidity	[70]
Tubewells, Township	Industries waste	Colour, BOD, Fe, Cd and P	[71]
Handpumps, Jachonda	Industry waste	Cu, Fe, Cd and Pb	[72]
Handpumps, Raya	Domestic waste	Cl and F	[69]
Handpumps, Salempur	Industry and domestic waste	Cu, Fe and Pb	[72]

on sewage, so polluted waterways usually have a lot of microorganisms and low levels of other physical and chemical parameters. This was mostly because the Mathura district had a habit of discharging sewage and other household and commercial trash into the Yamuna river and other waterbodies, like ponds [43].

2.3.4 Others: This section discusses how surface waters in Mathura have been impacted by additional variables. In fish farming, the fish are raised in a pond until they are fully grown and then sold. Fish farming effluent are discharged into surface water bodies, including the Yamuna river and its tributary. The water bodies are harmed by the nutrient-rich effluent because it can cause eutrophication and algae blooms (typically contains high amounts of nitrogen and phosphorous) [44]. Waterbodies can become contaminated by surface runoff from urban and agricultural regions. Due to the wide range of activities that take place in metropolitan settings, heavy metals (including cadmium and chromium) might reach the top layer of the soil and subsequently wash off into waterbodies [45]. Other parts of the world have also seen heavy metals in topsoil as a result of urban activity. In table 2, the surface water quality data for Mathura rivers during the past few years and detrimental effects of surface run-off on waterbodies in Mathura is shown. Majority of today's polluted waters are a result of human activity. Studies that did not specifically identify their source of pollution but generic references to anthropogenic activities were labelled as having an unspecified pollution source. This is characteristic of research that looked at the water quality index to determine whether it was generally safe to drink.

2.4 Assessment of groundwater quality

The general population of Mathura has access to groundwater, which is occasionally regarded as the cleanest type of water. In Mathura, groundwater is obtained either by drilling boreholes (often done mechanically) or by hand-digging wells (for sites with a high water table), which are more common in southern region of the nation. The vertical depth is where both of them diverge most. According to studies, a well's cleanliness and depth have a good correlation [46]. Leachates may have trouble reaching deeper wells and even if they do, their concentrations are lower than recommended values. As result, boreholes are regarded cleaner than hand-dug wells. Table 3 presents pollutants found alongwith information about the places tested around the country

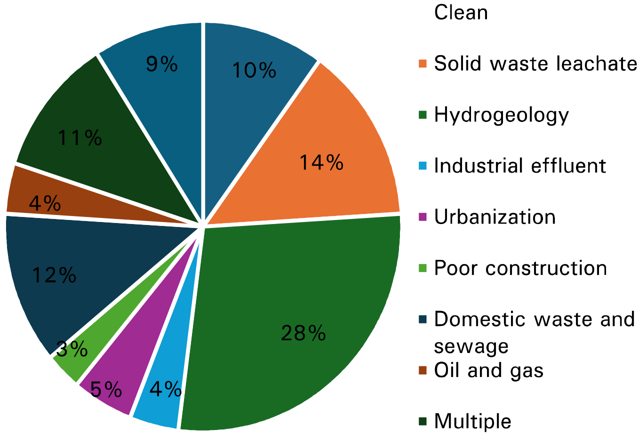

Figure 3. *Groundwater contamination sources in Mathura and their respective contributions*

over last few years. Figure 3 provides an overview of relative groundwater pollution sources in Mathura. It has been found that hydro-geology is the primary source of pollution. Because of the composition of subterranean rocks in Mathura, when they interact with groundwater, heavy metals are leached into water. Domestic garbage and sewage, as well as solid waste leachate, are other main sources [47]. The following section of the report will discuss various causes of pollution in more depth.

2.4.1 Solid waste leachate: Open dumping of solid trash is still a common practice in Mathura, mainly in the city areas. Although integrated waste management systems have been documented in certain Indian cities practise has not been completely eradicated despite these attempts [48]. Leachate from solid waste can contaminate the soil. When dumpsites and water sources are close to one another, leachate from landfills becomes a problem [49].

2.4.2 Hydrogeology: Groundwater contaminants, particularly trace metals, may be present due to mineralogy and geochemistry of rock. These hydrogeological interactions cause the metals in the rocks to leach into the water. This is presumably the cause of pollution in the majority of studies where precise source is listed as unspecified (Table 2). In a recent investigation, it was discovered that anthropogenic activities have contaminated the water in wells in both urban and rural locations with heavy metals [50]. In several locations around Mathura city, hydro-geochemical impacts on groundwater have also been documented.

2.4.3 Oil and gas exploration, peroduction and refining: The previous section provided an overview of the complications of Mathura's oil and gas industry. In Mathura, which produces oil, it is also a primary reason for groundwater pollution. Groundwater with a high hydrocarbon content should not be consumed [51]. Additionally, the mortality of soil microorganisms, which are crucial to the ecological balance, has been brought on by contaminated groundwater.

2.4.4 Others: Here, it is described how Mathura's groundwater has been impacted by different sources of contamination. Groundwater pollution may also be caused by industrial effluents. Leachates can interact with groundwater when dumped into ground surface [52]. The types of operations carried out by the local industries in the vicinity were to blame for pollutants in the water. Also, open wells in slum areas are a good example of bacterial infected well water with no surface protection.

2.5 Assessment of rainwater quality

In Mathura, there are no regulations on the technique or standard for rainwater collection for home and agricultural usage [53]. Mathura continues to use unregulated rainwater as a source of water. The rainfall itself may get contaminated by human activity when held in tanks or subterranean reservoirs before being used for final consumption or another purposes [54]. As result, it is recommended to serve at the time of consumption. In accordance with the determined cause of contamination, the detailed discussion of the assessment and evaluation of the quality of Mathura's rainwater is provided. Figure 4 summarizes the rainfall pollution sources in Mathura and their relevant contributions to the origins of rainfall pollution. The primary cause of contamination, according to observations, was the roof type used to collect rainwater. There are many elements that contribute to air pollution, including acid rain, wet scrubbing of dust particles and oil and gas. These originate from the interaction of airborne gases and foreign particles suspended in the precipitation.

2.5.1 Air quality: CO_2, NOx and SO_2 are acid anhydrides that are emitted into the atmosphere as a result of combustion activities, such as vehicular exhaust, the roasting of metal ores, etc. Acid rain can result from precipitation cleaning these gases away. In the case of greenhouse gases, they breakdown during precipitation and produce acid anhydrides, which result in acid rain. Heavy metals that are suspended in precipitation because of vehicular emissions also gets dissolved in it and contaminate rainwater [55].

2.5.2 Roof type and age: In circumstances when pre-

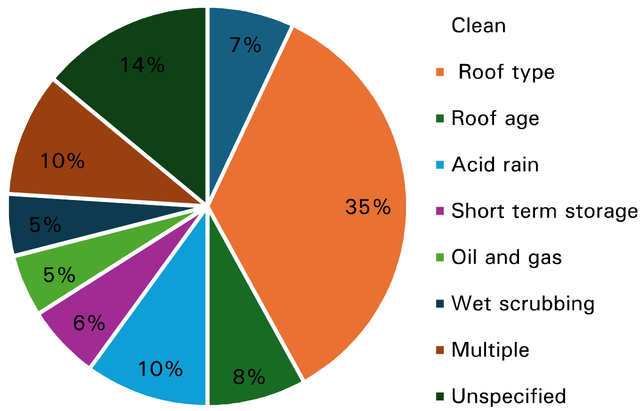

Figure 4. *Rainwater contamination sources in Mathura and their respective contributions*

cipitation is captured via roof runoff, the origin or kind of the roof and the extent of its deterioration can have an effect on water cleanliness. Oxides and metal ions may continuously erode into water. Most physical and chemical standards were below acceptable limits, which helped explain why results were mostly good. Studies evaluated asbestos and aluminium sheets and found few variations in the water quality [56].

2.6 Commercially available water

Even though commercially available water in Mathura does not have a typical origin of clean water, section discusses the quality evaluation and pollution problems surrounding this water. For the delivery of pipe-borne water, only large areas have an effective underground pipe network. As a result, bottled water (in sachet or bottle form) is increasingly being offered commercially in stores, canteens, on street and practically anywhere that sells food. The most common names for commercially supplied water are pouch water and water bottles. The Bureau of Indian Standards is in charge of making sure that bottled water sold in Mathura is of good quality. The main problem with bottled and sachet water is how quickly quality degrades over time, especially with the latter. Although there is a high likelihood of hazardous occurrences throughout manufacturing operation that could cause significant contamination [57].

2.7 Significance of water quality in sustainable development

Indigenous researchers have talked about several facets of sustainable development in the relevance of Mathura over the years. Poverty, energy, waste disposal and economic diversification are all addressed [58]. Consideration must also be given to significance of water quality assessment and tracking in perspective of Mathura. In order to achieve sustainable development, the quality of water that the general public has access to is crucial. It also aims to cut down on pollution, enhance water quality and solve the problem of water shortage [59]. If the recent contaminant penetration into the hydric sources in Mathura proceeds, this goal would be impossible to achieve. Additionally, several other SDGs and high water quality are closely linked. One of the foundational components of excellent health and well-being is having access to clean water sources (16th and 17th SDG). Therefore, it is clear that improving water quality is necessary to fulfil SDGs. It is also a crucial component of sustainability.

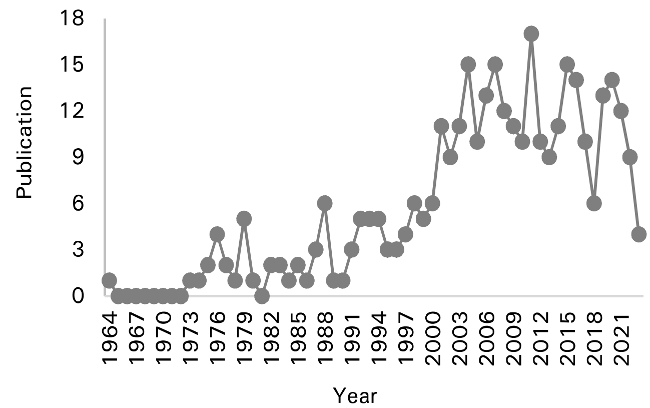

Figure 5. *Yearwise publication on ground* and *surface water monitoring*

3. RESULT AND DISCUSSION

3.1 Ground and surface water quality assessment based on publication

Figure 5 illustrates the annual publications related to the groundwater and surface water quality evaluation from 1964 to 2024. Interest in the aforementioned topic is at the low end of the scale from 1964 to 1974, but because of increasing awareness of water quality assessment, a sharp increase in number of publications can be seen from 1975 to 2023. The volume of articles published increased from 1 to 17 in 2011. It demonstrates a maximum tilt of researchers and scientists in the field of water quality assessment. Table 3 illustrates the breakdown of publication by affiliation with total 343 publications. The researchers emphasized the international collaboration in area of water quality assessment that constitutes the percentage as United States Geological Survey (20%), Wageningen University and Research (13.33%), University of Guelph (10%), Helmholtz Zentrum fur Umweltforschung (10%), United States Environmental Protection Agency (10%), Universidad Jaume I (8.33%), Chinese Academy of

Table 3. *Top ten affiliation-wise publications*

Affiliation	No. of publications	Percentage
United States Geological Survey	12	20
Wageningen University and Research	8	13.33
University of Guelph	6	10
Helmholtz Zentrum fur Umwelt-forschung	6	10
United States Environmental	6	10
Protection Agency		
Universidad Jaume I	5	8.33
Chinese Academy of Sciences	5	8.33
USDA Agricultural Research Service	4	6.66
National Institute for Public Health and the Environment	4	6.66
University of Nebraska–Lincoln	4	6.66

Sciences (8.33%), USDA Agricultural Research Service (6.66%), National Institute for Public Health and the Environment (6.66%) and University of Nebraska–Lincoln (6.66%).

Table 4 presents a variety of authors who conduct research and publish in area of water quality assessment. The subject mentioned above has inspired the different living background of authors to contribute in this area, such as F. Hernandez (19.23%), the author is associated with University Jaume I, Castellon, Spain. J. V. Sancho (15.38%), presently researcher working with Department of Experimental Sciences, University Jaume I, Castellon, Spain. J. Bundschuh (11.53%), associated with Institute for Agriculture and the Environment, The University of Southern Queensland, Australia. The percentage distribution by other authors are as follows: J. Abu Ashour (7.69%), M.S. Andrades (7.69%), A. Antonenko (7.69%), M.A. Armienta (7.69%), V. J. Banks (8%), P. Bhattacharya (7.69%) and S. Chellam (7.69%). Figure 6 illustrates number of water quality assessment publications from leading nations. Among 67 countries, the top contributor is United States with 95 publications followed by Germany (35), India (32), United Kingdom (25), Canada (18), Netherlands (16), Spain (16), China (14), Australia (13) and Pakistan (11). Figure 7 highlights number of publications in numerous disciplines from 1964 to 2023. One can observe a spike in number of publications in recent times due to the increasing awareness related to water quality monitoring. The results revealed the highest number of publications in various disciplines such as environmental science (249), chemistry (50), medicine (43), earth and planetary sciences (39), biochemistry, genetics and molecular biology (31), agriculture and biological sciences (28), engineering (23), pharmacology, toxicology and pharmaceutics (18), chemical engineering (14) and energy (9).

Table 4. *Most prominent authors in the field of water quality monitoring*

Author's name	No. of publications	Percentage
Hernandez, F.	5	19.23
Sancho, J.V.	4	15.38
Bundschuh, J.	3	11.53
Abu-Ashour, J.	2	7.69
Andrades, M.S.	2	7.69
Antonenko, A.	2	7.69
Armienta, M.A.	2	7.69
Banks, V.J.	2	7.69
Bhattacharya, P.	2	7.69
Chellam, S.	2	7.69

3.2 Keyword occurrence analysis

The research of keyword networks was used to carry out an extensive investigation. The distance between discrete terms was used to identify the link between keywords in a text extraction-based map that is shown using VOSviewer analysis technique. A link is a space separating two or more words. The map of keyword co-occurrence item density is depicted in figure 8. We extracted only 119 keywords that appeared more than five times from the provided dataset.

3.3 Co-authorship network analysis

Researchers collaborate with other specialists to produce high-quality research and timely data. This type of collaboration stimulates innovation and broadens the scope of a research effort. Co-authorship network analysis explains scientific and research linkages and its patterns reveal authors who have worked with other authors in the data set. This co-authorship network analysis identifies the links between researchers and other network participants. The application VOSviewer was utilized to investigate the co-authorship network where authors who co-authored with atleast four other authors were considered. Consequently, 25 such authors were discovered. Figure 9 depicts co-authorship

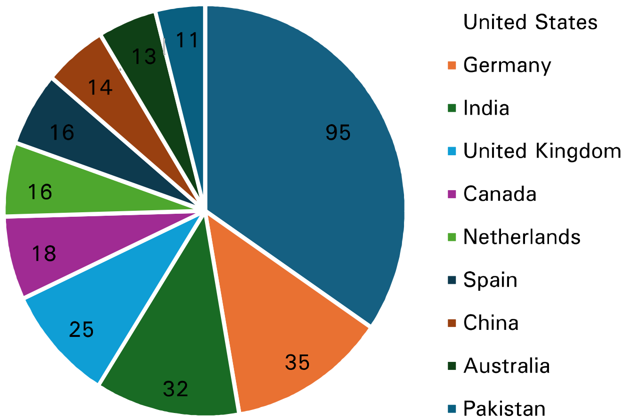

Figure 6. *Top ten prominent authors' countries having publications in water quality monitoring*

network visualization diagram as displayed by the VOSviewer application. In the form of a cluster, the total strength of a researcher's co-authorship ties with other researchers is represented by their overall link strength. There is a total of one cluster, ten connections and a link strength of twenty. Cluster 1 contains the most authors (five). We also examined the network of international co-authorship. We tried to determine most intercountry participated authors. The network of worldwide co-authorship is depicted in figure 10. A nation is considered to have a minimum of five papers by the data collection. The VOSviewer programmed discovered that 41 items constitute the largest group of interconnected objects. Following intercountry co-authorship network analysis, six clusters were formed: cluster-1 (United States, Italy, Belgium, Bangladesh); cluster-2 (India, Canada, South Korea, Saudi Arabia, Iran, Ukraine); cluster-3 (Germany, Greece, China, Turkey, Pakistan); cluster-4 (United Kingdom, Netherlands, Poland, Spain, Croatia, Portugal); cluster-5 (Australia, Taiwan, Sweden, Mexico, Brazil, Bolivia) and cluster -6 (Switzerland, New Zealand, France, Austria, Czech Republic, Norway, Russian Federation, Japan).

3.4 Knowledge gap and future perspectives

Several intriguing findings that can be explored in further research have been drawn from this in-depth analysis of evaluation and assessment of water quality in Mathura. The emerging contaminants (ECs), pharmaceutically active chemicals (PhACs) and additional micropoll-utants are currently a worry for environmental resear-chers due to changing lifestyle patterns [48]. These classes of organic chemicals in Mathura's water sources have not been studied over few years. Modern society is now fundamentally reliant on digital communication technologies [60]. Monitoring and evaluating water quality with IoT capabilities is also becoming more and more popular. IoT has been used in industries, like healthcare, aquaculture and water quality evaluation, etc. [61]. Standard method to study water quality is to collect, look and write down measurements from physical samples or instruments [62]. There are no regulations governing the quality and manner of collecting rainwater for home and agricultural usages. Mathura continues to use unregulated rainwater as a source of water. It is advised that appropriate policies be implemented to account for this. To ensure that the general public has access to the highest quality water and that dishonest vendors are eliminated, Mathura's commercial water quality laws should also be more strictly enforced [54, 63].

4. CONCLUSION

Using bibliometric analysis, this study examines the appraisal and evaluation of water quality research from 1964 to 2023. This study involved a methodical analy-

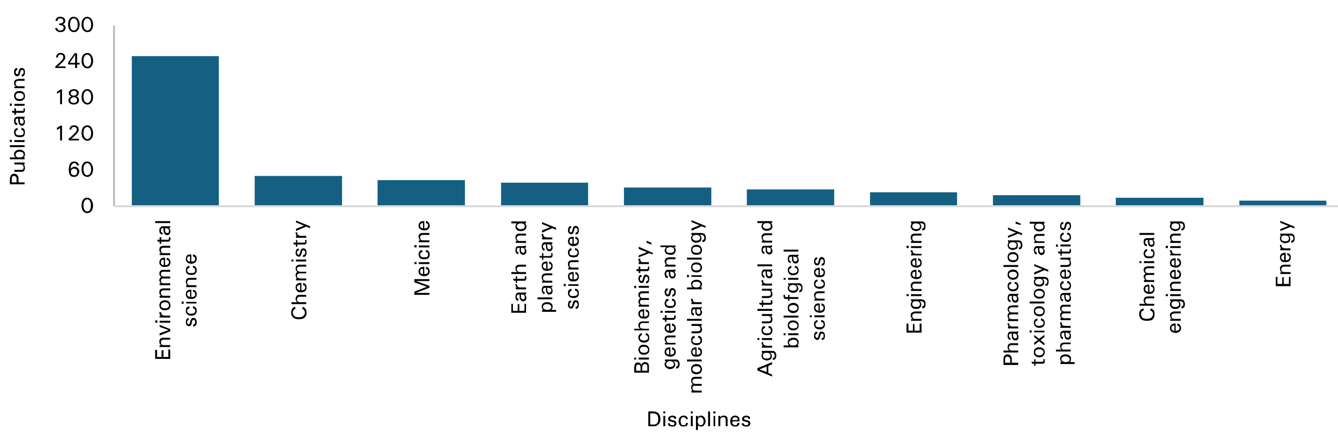

Figure 7. *Top ten most promising disciplines having publications in water quality monitoring*

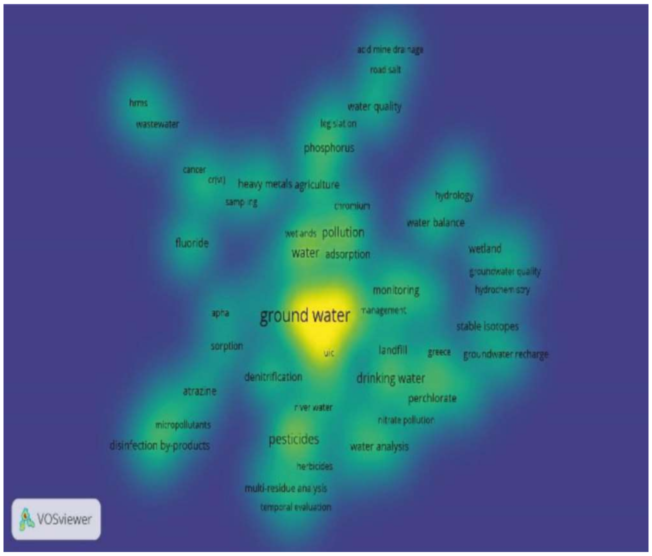

Figure 8. *Keyword occurrence analysis*

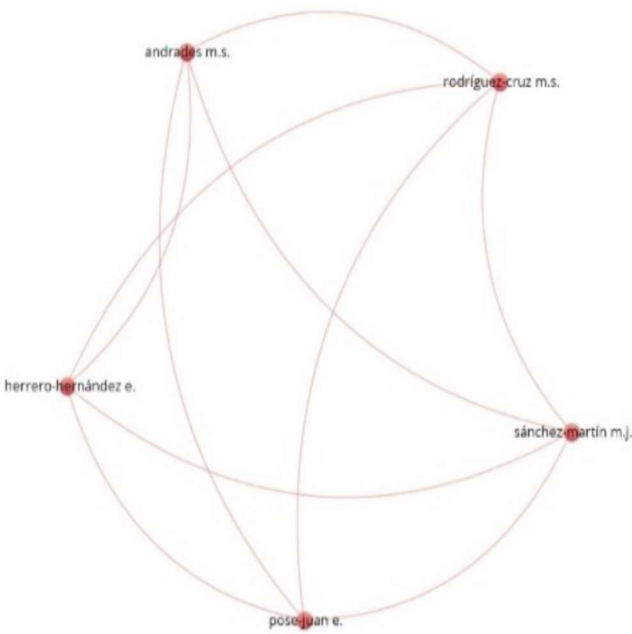

Figure 9. *Co-authorship network visualization*

sis of studies on water quality assessment and evaluation in Mathura during the previous decade. The total number of documents over this time span is 343 and the first publication on water quality evaluation was published in 1964. This was done to assess breadth of completed study, to highlight the significance of water quality in sustainable development and to support the necessity for future research to identify information gaps and clearly articulate their research domain. Petrochemical exploration, industrial effluents, domestic waste and sewage, among a number of other things,

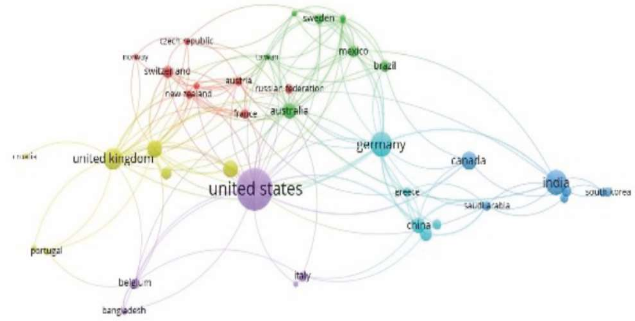

Figure 10. *Intercountry co-authorship network analysis*

are all to blame for Mathura's surface water pollution. Surface water quality was often subpar. Leachate from solid waste, sewage and groundwater-base rock interactions all contribute to groundwater pollution. Due to hydrogeology, fluoride and chloride have been found in groundwater in many parts of the city. Rainwater pollution is a result of inadequate water storage and water collection infrastructure. In Mathura, the pH of the rainfall is the biggest problem. It is remarkably cleaner in most areas than surface and groundwater sources. This is an investigation of the degree of artificial contamination from various sources rather than rainwater origin. It is interesting to note that groundwater and surface water in Mathura are less in compliance with WHO and BIS acceptable levels. Surface and groundwater have been characterized as having more problematic quality when compared directly to the other two. The population of Mathura currently has the best access to commercially supplied water (bottled or in sachets). Majority of the time, bottled water has greater quality than pouch water and bacteria are the main contaminant in sachet water. The investigation of new pollutants and micro-pollutants as well as use of IoT-enabled technology are indicated as future possibilities in the water quality monitoring and assessment in Mathura. Since water quality is so important to many goals for sustainable development, it's always a good idea to do a thorough review.

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