Potential Impacts of Climate Change on Groundwater Quality

Zahid Aziz, Ph.D.
Division of Science and Research; NJDEP

October 2023

State of New Jersey
Phil Murphy, Governor

Department of Environmental Protection
Shawn M. LaTourette, Commissioner

Division of Science & Research
Nicholas A. Procopio, Ph.D., Director

Visit the DSR website:
https://dep.nj.gov/dsr

Acknowledgments:

We are grateful for the constructive input and reviews provided by scientists throughout the department including Nicholas Procopio, Metthea Yepsen, Robert Newby, Kirk Raper, Heather Genievich, and Giacomo deFalco at Division of Science and Research, and Raymond Bousenberry, Catherine Jedrzejczyk, and Gregory Wissink at Bureau of Water Resources & Geoscience.

Please cite this document as: Aziz, Zahid. 2023. Potential Impacts of Climate Change on Groundwater Quality. Division of Science and Research. New Jersey Department of Environmental Protection. Trenton, NJ. 56 pages. Available at https://dspace.njstatelib.org/handle/10929/112368

Contents

Summary

This report synthesizes available scientific literature on the potential responses of different hydrogeological and biogeochemical processes to climate change and discusses how these processes could impact groundwater quality. This review suggests that the effects of climate change are likely to cause ephemeral and long-term impacts on groundwater quality driven by modifications of hydrogeological processes, including precipitation, groundwater recharge, discharge, capacity, and seawater intrusion. These modifications would influence biogeochemical reactions and the ultimate chemical fate and transport of contaminants, and are likely to drive the variability of both anthropogenic and geogenic contaminants.

Below are some specific examples of hydrogeological and geochemical changes and associated groundwater quality changes that are likely to occur as a result of climate change:

1. Climate change is expected to raise groundwater temperature in urban and rural areas. Changes in groundwater temperature would increase mineral solubility and microbiological activities, which has the potential to elevate concentrations of certain major elements such as silica (Si); potassium (K); fluorine (F); heavy metals including copper (Cu), cadmium (Cd), nickel (Ni), lead (Pb), lithium (Li), and zinc (Zn); redox-sensitive elements including arsenic (As), iron (Fe), manganese (Mn), phosphorus (P); and dissolved organic carbon (DOC) in the shallow groundwater.
2. Groundwater recharge delivers electron acceptors (such as oxygen (O_2^{2-}), nitrate (NO_3^-), ferric iron (Fe^{3+}), sulfate (SO_4^{2-}), organic carbon, and pollutants into the aquifer, which impact existing subsurface geochemical conditions and affect the dissolved concentrations of a wide variety of contaminants, including redox-sensitive trace elements. Rising groundwater levels due to increased recharge would saturate the normally unsaturated soil layer, reduce oxygen levels, and mobilize natural trace elements and anthropogenic contaminants stored in the unsaturated layer. Therefore, recharge under changed frequency and intensity of precipitation related to climate change poses increasing threats to groundwater by mobilizing geogenic contaminants (such as As and Mn) and anthropogenic contaminants such as NO_3-, hydrocarbons, other organic contaminants, emerging contaminants (such as per- and polyfluoroalkyl substances and microplastics), and pathogenic microorganisms into aquifers.
3. Climate change is expected to cause large changes in precipitation frequency and intensity, leading to extreme weather events like more frequent flooding and drought. Flooding can make the surface soil anaerobic and mobilize geogenic contaminants like As, Fe, Mn, P, and other metals such as chromium (Cr), molybdenum (Mo), and vanadium (V) in soils which eventually are transported to shallow aquifers via infiltration and recharge. During droughts, decreased precipitation causes a decline in groundwater recharge and level, which may lead to the mobilization of contaminants such as NO_3, SO_4, and As due to the altered redox condition in the aquifer.

4. In coastal areas, shallow groundwater is expected to respond dynamically to sea-level rise (SLR) leading to seawater intrusion (SWI), rising groundwater levels, and coastal flooding. The increase in salinity by SWI can mobilize metals (As, Cd, Co, Cu, Hg, Pb, Se, V, Ra) from soils/sediments to groundwater through cation exchange and desorption by chloride (Cl) and organic complexes. Similarly, rising groundwater and coastal flooding are likely to affect contaminant concentrations in shallow coastal aquifers.

Climate change will have a broad impact on groundwater quality. However, quantification of the impacts is difficult due to the complex responses of the hydrogeological system to climate variability, range of scenarios associated with climate models, and global socio-economic developments that will determine the scale of changes to the climate system. Denser networks of groundwater observation points for long-term monitoring are essential to provide necessary baseline data and supplement existing data sources. Such monitoring networks would improve the quantification of hydrogeological systems that are likely to be affected by climate change at local to regional scales.

1.0 Introduction

Approximately 33% of the New Jersey public supply water is from groundwater withdrawal and about 13% of New Jersey residents (approximately 1 million people) obtain their drinking water from private wells (Dieter et al. 2018; NJDOH, 2022). Furthermore, groundwater baseflow plays a significant role in maintaining biodiversity and habitat quality for sensitive ecosystems in lakes, rivers, and coastal lagoons (Humphreys 2006; Kløve et al., 2011; Eamus et al., 2015; Havril et al., 2018; Chiloane et al., 2022; KarisAllen et al., 2022; Boulton et al., 2023). As climate change continues to raise global temperatures and modify weather patterns, the effects of climate change can be expected to impact the water cycle (Figure 1) and groundwater resources in a variety of complex ways (Cuthbert et al., 2019a; Allan et al., 2020; Douville et al., 2021; Peters-Lidard et al., 2021; Gascuel-Odoux et al., 2023). Increasing temperature, precipitation, and sea-level are among the major phenomena likely to impact New Jersey's water resources as a direct result of climate change (NJDEP, 2020). These changes will affect the hydrological cycle by altering recharge, groundwater levels, flow processes, and storage (Green et al. 2011; Jyrkama and Sykes 2007; Stuart et al. 2011; Deshmukh et al., 2022; Swain et al., 2022). Climate models indicate a general increase in annual precipitation, flooding associated with extreme precipitation, and storm surges along New Jersey and other northeast states coastlines (Karl et al., 2009; Mallakpour and Villarini, 2015; Bevacqua et al., 2020; NJDEP, 2020; Swain et al. 2020; DeGaetano, 2021, Nazarian et al., 2022; Jong et al., 2023).

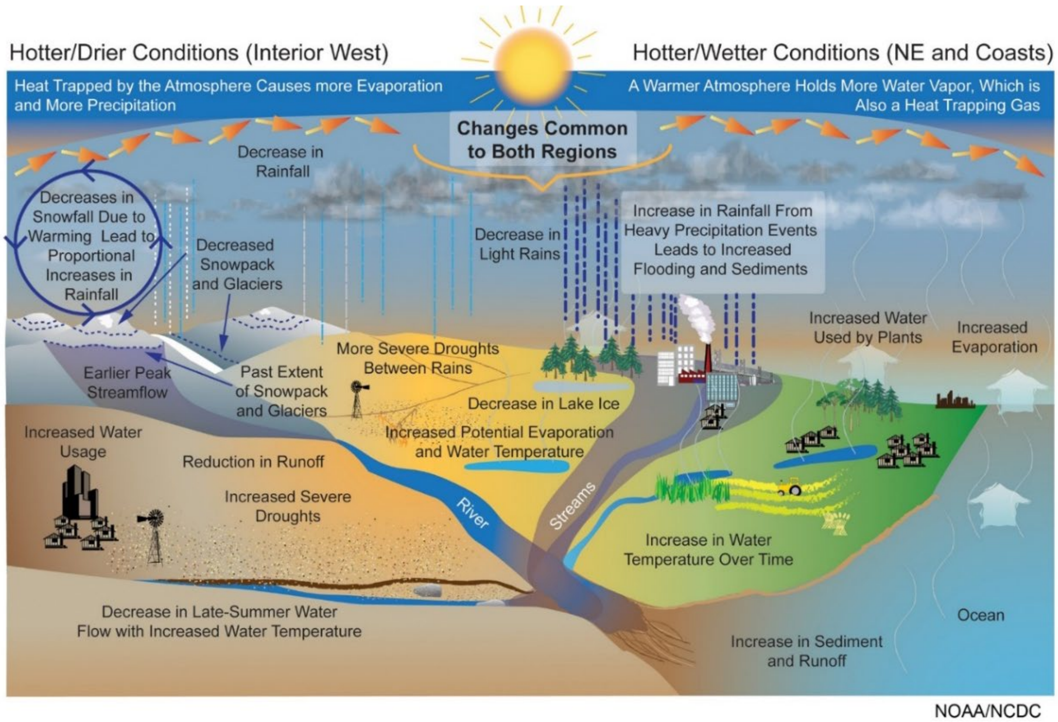

Figure 1. Projected changes in the water cycle. Increasing temperature, precipitation, and sea-level are primary effects of climate change on water resources (Source: Karl et al., 2009).

Notably, a greater proportion of the annual rainfall is expected to occur during fewer events, with longer dry periods between the events (Karl et al. 2008; Melillo et al. 2014; Xue 2022). Decreased precipitation and longer dry periods during summer months may lead to more frequent and extended droughts (Trenberth, 2011; Krakauer et al., 2019; NJDEP, 2020; Polasky et al., 2022). Several studies have explored the potential impacts of climate change on water resources, particularly concerning surface water (Murdoch et al., 2000; Piao et al 2010; Bates et al., 2008; MacDonald GM, 2012; Arnell and Hughes 2014; Haddeland et al., 2014; Mimikou et al., 2000, Duran-Encalada et al., 2017; Cooley et al., 2021; Golub et al., 2022; IPCC, 2022; Xin et al., 2022; Wang et al., 2023). However, knowledge of the potential effects of climate change on groundwater, which is a significant component of the public water supply and water use in New Jersey (NJDEP, 2017) and across the United States (AGI, 2017; Dieter et al., 2017), is still limited (e.g. Bates et al., 2008; Bovolo et al., 2009; Green et al. 2011; Holman et al., 2012; Taylor et al., 2013; Barbieri et al., 2021; Uhl et al., 2022).

The response of groundwater to climate change is an intricate process, as climate change will affect hydrogeological processes and groundwater resources directly and indirectly (Earman and Dettinger, 2011; Green et al. 2011; Taylor et al., 2013; Liesch and Wunsch, 2019; Amanambu et al., 2020; Barbieri et al., 2021; Uhl et al., 2022). Groundwater aquifers are recharged mainly by precipitation or through interaction with surface water bodies (Figure 2), therefore the direct influence of climate change on precipitation and surface water ultimately affects groundwater systems (Kumar, 2016). Recent studies investigating the effects of climate change on groundwater focus primarily on processes that affect groundwater quantity, such as recharge, groundwater level, discharge, and storage (Eckhardt and Ulbrich, 2003; Dragoni and Sukhija, 2008; Kundzewicz et al., 2008; Döll, 2009; McCallum et al., 2010; Ng et al., 2010; Gunduz and Simsek, 2011; Hanson et al., 2012; Kumar CP, 2016; Condon et al., 2020; Haidu and Nistor, 2020; Riedel and Weber, 2020; Al Atawneh et al., 2021; Arias et al., 2021; Ascott et al., 2022; Boumaiza et al., 2022; Dehghani et al., 2022; Swain et al., 2022; Gordu et al., 2023). However, studies of the impacts of climate change on groundwater quality remain limited, even though water quality, and not quantity, may be a more limiting factor for future potable usage (Green et al. 2011; Gurdak et al. 2012; Ayotte et al., 2015; Zhou et al., 2021; Geris et al., 2022; Lapworth et al., 2022; McMahon et al., 2022; Warziniack et al., 2022).

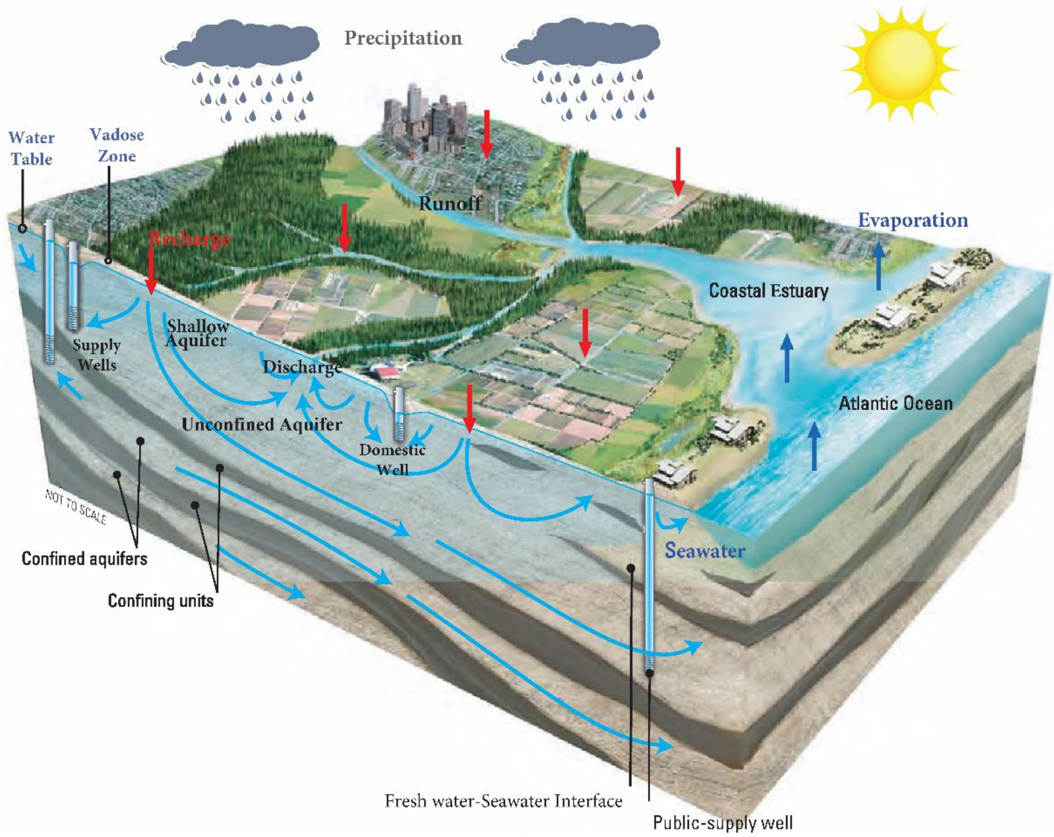

Figure 2. – Northern Atlantic Coastal Plain surficial aquifer system and its interactions with the climate. Groundwater recharge occurs from precipitation and surface water bodies. Groundwater flows through aquifers from recharge areas to discharge areas. Climate change affects groundwater resources by modifying processes such as recharge, groundwater level, discharge, and storage. The location of fresh water-seawater interface is driven by sea level rise and groundwater withdrawal (figure: modified from Denver et al., 2015).

Available studies show that climate change is likely to cause groundwater temperatures to increase (Menberg et al., 2014, Riedel T, 2019; Epting et al., 2020), seasonal declines in recharge and water levels from frequent and prolonged droughts (NJDEP, 2002; Schreiner-McGraw, et al. 2021), rising water level in response to enhanced recharge associated with increasing precipitation and flooding (Bjerklie, et al., 2012; Knott et al., 2019; Hemmerle and Bayer, 2020), and seawater intrusion related to sea-level rise (NJDEP, 2020; Jasechko et. al., 2020).

In general, groundwater quality is controlled by the amount of rainfall, the chemical nature of recharge water, surface water resources, and geochemical processes occurring within the aquifer (Etikala et al., 2019). Therefore, the sensitivity of groundwater to climate change depends, in part, on the depth of the groundwater table, where groundwater in shallow (typically less than 30 feet deep from the ground surface) unconfined aquifers (as depicted in Figure 2) is expected to be more responsive to climate change than groundwater at deeper depths or in a confined aquifer systems (Healy and Cook, 2002; Nolan and Hitt, 2006; Gunduz and Simsek, 2011; Klove et al., 2014; Menberg et al., 2014; Epting et al., 2021; Hare et al., 2021; Lam et al., 2021; Malakar et al., 2021; Benz et al., 2022; KarisAllen et al., 2022; Seidenfaden et al., 2022). Correspondingly, any modification to hydrogeological and geochemical processes, such as groundwater temperature, recharge, groundwater level (water table) fluctuation, sea-level change, and seawater intrusion would likely cause more pronounced changes to shallow groundwater quality. Shifts in these geochemical and hydrogeological conditions within an aquifer can cause the mobilization of both geogenic and anthropogenic contaminants from primary minerals or initiate their release from soils and sediments into groundwater, where they pose a much larger risk to human and ecological health (Fakhreddine et al., 2021; Zhao et al., 2023). For example:

- Changes in groundwater temperature would affect the solubility of minerals, impacting the groundwater chemistry of shallow aquifers.
- Organic matter (organic carbon) and/or electron acceptors such as O_2^{2-}, NO_3^-, and SO_4^{2-} introduced into the aquifer system via recharge would impact existing subsurface geochemical conditions through redox reactions that control the dissolved concentrations of a wide variety of contaminants, including redox-sensitive trace elements such as As, Fe, Mn and P.
- Rising groundwater levels would more frequently saturate the unsaturated soil layer, reduce oxygen levels, and mobilize and increase natural trace elements and anthropogenic contaminants stored in the unsaturated layer. Similarly, a decline in groundwater level would concentrate contaminants and/or change geochemical (redox) condition in the aquifer, which would affect the groundwater quality.
- Increased groundwater salinity (salinization) due to seawater intrusion would also increase the trace metal mobility significantly due to its influence on cation exchange equilibrium.

Despite the potential changes to groundwater quality from climate change-induced modifications of hydrogeological processes, the extent and rate of interactions between climate processes, hydrogeological and geochemical processes are not well understood (Arias et al., 2021). Deteriorating groundwater quality could pose long-term technical and economic challenges for groundwater and drinking water management and soil and groundwater remediation efforts.

This report is an assessment of hydrogeological and geochemical processes in shallow unconfined aquifers that are likely to be affected by climate change through a variety of mechanisms, including groundwater temperature change related to global air temperature change, changes in groundwater recharge rates and groundwater levels associated with changes in spatiotemporal precipitation patterns, as well as seawater intrusion (salinization). This report synthesizes existing literature and publications on potential responses of different hydrogeological and geochemical processes to climate change and discusses how these processes would impact groundwater quality based on current scientific knowledge of hydrogeology and geochemistry.

2.0 Literature Review and Methodology

This review synthesizes information from a variety of scientific material including books, peer-reviewed journals, and reports by government and state agencies. There are numerous studies published in the past several decades assessing the complexity of climate change and its impact on water resources. Some have discussed possible modifications of hydrogeological and geochemical processes in response to different climate scenarios. However, little is known about how such alterations of hydrogeological and geochemical processes may have already changed and/or will change groundwater quality in a changing climate. A comprehensive review of the literature summarizing and identifying hydrogeological and geochemical processes and their potential to change groundwater quality is an invaluable contribution to our current scientific understanding of the impacts of climate change.

3.0 Impacts on Groundwater Quality

There are many potential impacts of climate change on groundwater quality through modification of existing hydrogeological and geochemical processes, and it would be unrealistic to comprehensively include all the impacts in this review. Rather, the impacts that are relevant to the state of New Jersey and other northeast states are the primary focus of this review. Quantification of these impacts is difficult due to the complex responses of the hydrogeological system to climate variability, range of scenarios associated with climate models, and global socio-economic developments that will determine the scale of changes to the climate system. The extent and rate of changes will depend on the degree of adaptation and reduction of future carbon dioxide (CO_2)

emissions and hydrogeological system response. Quantitative analysis of climatic impacts on groundwater quality will not be explored in detail in this review, rather, this paper will focus on the broad implications of climate change on groundwater resources. Within the scope of this report, descriptions of different hydrogeological and geochemical processes, associated alterations due to climate change, and the potential effects of these altered processes on the groundwater quality are organized into the following categories: (1) groundwater temperature; (2) groundwater recharge; (3) extreme events (flood and drought); (4) sea-level rise (seawater intrusion, groundwater level rise, and coastal flooding); and (5) climate change impacts on anthropogenic contaminants, their transport, and remediation.

3.1 Groundwater Temperature and Quality

Shallow groundwater temperatures are mostly a function of the land surface temperature (Kurylyk et al., 2015; Benz et al., 2017), and are influenced primarily by diffusive or advective (with the infiltrating/recharge water) mechanisms (Kurylyk et al., 2015). However, fluctuations in groundwater temperature are attenuated with increasing depth or with increasing distance from recharge locations (Anderson, 2005; Bhaskar et al., 2012; Kurylyk et al., 2013; Kurylyk et al., 2015; KarisAllen et al., 2022). Although urbanization has a substantial influence on groundwater temperature (Taylor and Stefan, 2009; Mueller et al., 2018; Tissen et al., 2019; Böttcher and Zosseder, 2022), several natural factors, such as the mean temperature above the ground surface, thickness and thermal conductivity of the vadose zone (unsaturated soil layer), precipitation, infiltrating surface waters, and regional groundwater flow affect the groundwater temperature in undeveloped, rural, and urban areas (Calvache et al., 2011; Benz et al., 2017; Burns et al., 2017; Epting et al., 2020).

Various studies have reported annual groundwater temperature increases between 0.01°C and 0.13°C over multiple decades at shallow depths (< 30 ft from the surface) in less-disturbed rural areas (Maxwell and Kollet, 2008; Park et al., 2011; Bloomfield et al., 2013; Kurylyk et al., 2014; Kurylyk et al., 2015; Menberg et al., 2014; Colombani et al., 2016; Mastrocicco et al., 2018; Riedel T, 2019; Hemmerle and Bayer, 2020; Egidio et al. 2022). This subtle increase in groundwater temperature could be attributed to the magnitudes of the long-term increase in mean groundwater temperature being dampened by up to 70% compared to the change in surface temperature (Menberg et al., 2014). Furthermore, the mean subsurface temperature's response to the surface temperature usually lags for several years (Menberg et al., 2014; Bucci et al., 2020). A set of global climate models (GCM) and numerical simulations predict that the groundwater temperature at shallow depth (<30 ft) may increase within a range of 1.2–3.3°C by 2080 for a range of potential future climate changes (low to high CO_2 emissions) (Gunawardhana and Kazama, 2011; Arias et al., 2021; KarisAllen et al., 2022). These models demonstrate the depth dependency of warming, where temperature increases are more pronounced at shallower depths for a given timeframe and climate scenario (KarisAllen et al., 2022). Also, an analytical heat transfer model has projected that for a very high CO_2 emission (2 x current emission) scenario, the mean annual temperature of shallow groundwater could rise by about 2.6–3.7°C by the end of 2100 in the Minneapolis/St. Paul area (Taylor and Stefan, 2009). The same model has also projected that groundwater temperature may increase up to 4°C when the effect of urban ground surface temperature on groundwater is considered. However, the very high CO_2 emission scenario, which depicts a worst-case scenario in the future, may not occur because of current global policies to reduce carbon emission and increase use of renewable energy (Hausfather and Peters, 2020).

A likely way that the groundwater would be affected by the surface temperature warming is through recharge especially from warmer surface water bodies such as lakes and streams/rivers (Epting et al., 2020). For example, a significant temperature increase (1°C) in groundwater over a couple of decades was observed in alluvial aquifers on the Swiss Plateau, which are recharged by river-bank infiltration (Figura et al., 2011). An increasing trend in surface water temperatures (both in lakes and streams/rivers) has been observed over recent decades in the USA and at a global scale (Michel et al., 2020; Woolway et al., 2020; Hare et al., 2021). Historical observations indicate that surface water temperatures have increased worldwide at a global average rate of 0.33°C per decade which is similar to or in excess of air temperature trends (Michel et al., 2020; Woolway et al., 2020). Several models predict an increase in median annual river temperatures ranging between 0.9°C for low-emission and 2-3.5°C for high-emission scenarios at the end of the century (2080–2090) (van Vliet et al., 2013; Piotrowski et al., 2021; Michel et al., 2022). Therefore, the source of groundwater recharge and the future climate conditions are likely to play an important role in determining groundwater temperature and subsequent groundwater quality changes in the future.

Elevated temperature can cause changes in biogeochemical processes, such as mineral weathering, chemical adsorption and desorption, gas solubility, and microbial redox processes in the subsurface environment, leading to groundwater quality changes (Brons et al., 1991; Appelo and Postma, 2005; Bates et al., 2008; Banks, 2012; Bonte et al., 2013a, 2013b, 2013c; Jesußek et al., 2013a; Jesußek et al., 2013b; Bonte et al., 2014; Kurylyk et al., 2014; Menberg et al., 2014; Possemiers et al., 2014; Saito et al., 2016; Lipczynska-Kochany, 2018; Riedel, 2019). In general, occurrences of elevated concentrations of Si, K, and F in groundwater are associated with higher temperatures and are due to the dissolution of minerals in aquifers (Welch and Ullman, 2000; Elango and Kannan, 2007; Bonte et al., 2013b; Saito et al., 2016; Riedel, 2019). Also, elevated temperatures decrease O_2 saturation through increased microbial respiration rates and reduced solubility and pH (Garcia and Gordon 1992; Yagasaki et al., 2006; Foulquier et al., 2009; Figura et al., 2013; Munz et al., 2019; Riedel, 2019). For example, an increase of 1°C in groundwater temperature can result in a 4% decline in O_2 saturation and a minimal decline in pH (Riedel, 2019). Consequently, increased temperature and lowered pH would increase the mobilization rate of heavy metal, such as Cu, Cd, Ni, Pb, Li, and Zn (McLean, 1992, Chuan et al., 1996; Li et al., 2013; Chen et al., 2016; Zhang et al., 2018; Lüders et al., 2020; Qasem et al., 2021; Iordache et al., 2022). Thermally-induced desorption and/or mobilization of organic compounds, such as natural organic matter (OM), dissolved organic carbon (DOC), or organic contaminants from soils and sediments, has also been observed at higher temperatures (Karickhoff et al., 1979; Brons et al., 1991; Ten Hulscher and Cornelissen, 1996; Delle Site, 2001; Kaiser et al., 2001; Plazinski et al., 2009; Wang et al., 2010; Bonte et al., 2013b; Saito et al., 2016; Lipczynska-Kochany, 2018; Riedel T, 2019). Warmer temperatures within aquifers stimulate the microbial community (Ghiorse and Wilson, 1988; Price and Sowers, 2004; Jesußek et al., 2013a; Westphal et al., 2017; Retter et al., 2021) which promotes reducing geochemical conditions fueled by DOC (Selim, 2012). As an aquifer becomes geochemically reducing, redox-sensitive elements such as As, Fe, Mn, and P will be released in the groundwater by reductive dissolution of iron oxides and other minerals (Chapelle et al., 1955; McMahon and Chapelle, 2008; Barringer et al., 2010; Mladenov et al., 2010; Bonte et al., 2013b; Mailloux et al., 2013; McMahon et al., 2018). Moreover, temperature has significant impacts on the occurrence and rate of NO_3-, SO_4^{2-}, and Fe reduction (Weber et al., 2010; Jesußek et al., 2013b; Possemiers et al., 2014; Shirokova et al., 2016; Schilling et al., 2019).

Changes in groundwater temperatures are likely to be subtle (1-2°C) at the end of the century (2080-2090) in response to surficial warming associated with climate change. Groundwater warming driven by climate change is likely to cause elevated concentrations of some major elements (Si, K, and F), heavy metals (Cu, Cd, Ni, Pb, Li, and Zn), redox-sensitive elements (As, Fe, Mn, and P) and DOC in shallow groundwater. However, groundwater quality change is a slow and diffuse process, which would be apparent only after a prolonged period of time if the surface temperature continues to rise due to climate change.

3.2 Groundwater Recharge and Quality

Natural groundwater recharge occurs through two major pathways depending on hydrogeologic setting (Alley et al. 2002; De Vries and Simmers, 2002; Healy, 2010; Amanambu et al., 2020; Li et al., 2021) - diffuse rain-fed recharge and focused recharge via leakage from surface waters (stream/river, lakes, etc.). Diffuse recharge occurs through direct infiltration from rainfall, snowmelt, and surface ponding that occurs uniformly over a large area (Stephens, 1994; Scanlon et al., 2002; Small, 2005; Ng et al., 2009; Barron et al., 2012; Wirmvem et al., 2017; Zhu et al., 2020; Schilling et al., 2021). Alternatively, focused or localized recharge occurs when fast and concentrated water infiltrates from discrete surface water bodies and drains through preferential flow paths (Lawrence and Upchurch, 1982; Winter, 1983; Scanlon et al., 2002; Wirmvem et al., 2017; Meixner et al., 2016; Ren et al., 2019; Hughes et al., 2021), particularly in areas with karst, fractured crystalline bedrock, and glaciated bedrock/outwash formations (Hartmann et al., 2017), similar to the geologic setting in the physiographic provinces of norther New Jersey. Precipitation (the distribution, amount, intensity, and timing) and evapotranspiration losses are the climate elements that primarily affect groundwater recharge (McCallum et al., 2010; Ng et al., 2010; Beigi and Tsai, 2015; Zomlot et al., 2015; Thomas et al., 2016; Jayakumar and Lee, 2017;

Al Atawneh et al., 2021), regardless of the recharge pathway. In response to warming temperatures, increased evapotranspiration can decrease the amount of precipitation that runs off as surface water or infiltrates to the subsurface as recharge leading to declined groundwater levels (Condon et al., 2020). Thus, heavy precipitation may not always increase recharge unless it exceeds evapotranspiration (Scanlon et al., 2005; Adane et al., 2019; Amanambu et al., 2020). Moreover, land use/land cover and underlying geology determine, in large part, whether a water surplus (precipitation minus evapotranspiration i.e., runoff) would infiltrate and be stored in the subsurface (Nolan et al., 2007; Reese and Risser, 2010; Taylor et al., 2013; Kløve et al., 2014; Mohan et al., 2018; Riedel and Weber, 2020). Some studies have predicted increased groundwater recharge due to projected increases in precipitation in the southwestern (McKenna and Sala, 2018; Borchardt, 2022), northern high plain (Meixner et al., 2016; Lauffenburger et al., 2018; Kishawi et al., 2022), and northeastern/north central (Ng et al., 2010; Crosbie et al., 2013; Rossman et al., 2014; Beigi and Tsai, 2015; Tillman et al., 2016; Bedaso et al. 2019) regions of the United States.

Several studies have shown that extreme (heavy) rainfall events are likely to become a significant contributor to groundwater recharge for a range of environments either by exceeding field capacity (pore-matrix flow) or due to bypass flow through macropores (Owor et al., 2009; Jasechko and Taylor, 2015; Liu et al., 2016; Thomas et al., 2016; Zhang et al., 2016; Asoka et al., 2018; Cuthbert et al., 2019; Bargués-Tobella et al., 2020; Goni et al., 2021; MacDonald et al., 2021; Boas and Mallants 2022; Guillaumot et al., 2022; Stigter et al., 2022; Taylor et al., 2022). For example, a Soil Water Balance Model (SWBM) estimated a significant increase in groundwater recharge driven by extreme precipitation from 1950 to 2010, which contributed more than 60% of the annual total groundwater recharge in the Northern High Plains (NHP) Aquifer, USA (Zhang et al., 2016). Extreme (heavy) rainfall creates temporary surface water bodies where focused recharge occurs (Crosbie et al., 2012; Taylor et al., 2013a; Reiss et al., 2019; Zheng et al., 2019; Arias et al., 2021; Seddon et al., 2021; Boas and Mallants, 2022; Taylor et al., 2022). The frequency and intensity of heavy (extreme) precipitation events are projected to continue to increase over the 21st century in response to climate change in New Jersey and other northeast states (Easterling et al., 2017; DeGaetano, 2021, Nazarian et al., 2022; Jong et al., 2023). Therefore, enhanced groundwater recharge is also anticipated in New Jersey, based on the projected increases in precipitation associated with climate change.

Recharge can alter the groundwater quality in various ways, including (i) diluting contaminants through water infiltrated from precipitation (Castaldo et al., 2021; Maroubo et al., 2021), (ii) transporting chemical compounds stored in the vadose zone to the water table (Nolan et al., 2003), (iii) introducing/delivering electron acceptors, organic carbon, and pollutants into aquifers (McGuire et al., 2005; McMahon et al., 2011; Schaefer et al., 2016; Arora et al, 2019; Curzio, 2019) and (iv) raising the groundwater level that limits the thickness of the vadose zone and mobilizes contaminants accumulated in vadose zone (Scholl et al., 2006; Lasagna et al., 2020).

Increased recharge may reduce contaminant concentrations through dilution or mixing with fresh water from precipitation and surface water sources. There is some evidence of nitrate attenuation by dilution from infiltrating groundwater recharge (Nolan et al., 2003; Taylor, 2003; Castaldo et al., 2021), though increased groundwater nitrates were attributed to increased recharge by the same studies. Similarly, Maroubo et al. (2021) observed an inverse relationship between heavy metal concentrations (cadmium and lead) and precipitation suggesting a dilution effect of increased recharge from precipitation. Other studies have shown lower concentrations of groundwater arsenic are associated with dilution and inhibition by oxic water stemming from high recharge (Aziz et al., 2008; Brikowski et al., 2014; Singh et al., 2020).

Increased recharge can adversely affect groundwater quality when recharge water causes downward mobilization or transportation of chemical compounds and pollutants stored in the vadose zone from past and present land use practices (Gurdak et al., 2007; Dragoni and Sukhija, 2008; Earman and Dettinger, 2011; Taylor et al., 2013; Klove et al., 2014; Oostrom et al., 2016; Zhou et al., 2016; Arora et al., 2019; Libera et al., 2019; Pétré et al., 2021). Enhanced recharge can cause the flushing of salts from the unsaturated zone (Amiaz et al., 2011) and increase groundwater salinity (Sugita & Nakane, 2007). For example, Małecki and Matyjasik (2002) reported a nearly tenfold increase in the average total dissolved solids concentration as rainwater infiltrated through the ground surface into the groundwater supply. In Riverton, Wyoming, three years of groundwater monitoring data indicated that Na, SO_4, and Cl, present across the site in a silt layer, were introduced into the shallow aquifer during large recharge events (USDEOE, 2019).

Recharge events deliver electron donors, primarily DOC, and electron acceptors, such as O_2^{2-}, NO_3^-, SO_4^{2-}, as well as anthropogenic organic pollutants into aquifers which can cause groundwater redox reactions and water quality changes (McGuire et al., 2005; McMahon et al., 2011; Arora et al., 2016; Schaefer et al., 2016; Yabusaki et al. 2017; Arora et al, 2019; Curzio, 2019). The redox process involves electron transfer reactions that release energy via the oxidation of labile organic carbon or inorganic compounds (electron donors) by microorganisms coupled to the reduction of electron acceptors. Therefore, redox processes control the release and/or sequestration of anthropogenic contaminants (Christensen et al., 1994; Kappler and Haderlein, 2003; Borch et al., 2010; Filippini, 2017; Curzio, 2019) and naturally occurring trace elements (As, Fe, Mn, P, S, Cd, Cr, Cu, Co, Se, Pb, Hg, and U), including their chemical speciation, bioavailability, toxicity, and mobility (Smedley and Kinniburgh 2002; McMahon et al., 2008; Du Laing et al., 2009; Borch et al., 2010; Arora et al., 2016; Wang et al., 2016; McMahon et al., 2018; Riedel and Kübeck, 2018; Kubier et al., 2019; Coyte and Vengosh, 2020; Hou et al., 2020; Dong et al., 2022; Huang et al., 2023a; Liu et al., 2023).

The most common electron donor driving redox processes in aquifers is DOC, which is either derived from sedimentary particulate organic matter in aquifers (Moore, 2018; Pracht et al., 2018; Baran et al., 2019); delivered into aquifers by recharge from vadose zones (McDonough et al., 2020a; Li et al., 2023a) and surface water bodies, such as ponds, lakes, streams, and rivers (Chen et al., 2010; Farnsworth and Hering, 2011; Inamdar et al, 2012; Shen et al., 2014; Nghiem et al., 2019; Yang et al., 2020; Gao et al., 2023; Wen et al., 2023); or anthropogenic sources, such as petroleum hydrocarbon storage facilities, and industrial solvent disposal (Kelso, 2018; Podgorski et al., 2018; Li et al., 2021; Zhai et al., 2021; Cao et al., 2023). Natural DOC concentrations in surface water derived from decaying plant material have shown an increasing trend over the last few decades attributed to increasing temperatures related to climate change (Evans et al., 2005; Jennings et al., 2009; Naden et al., 2010; Larsen et al., 2011; SanClements et al., 2012; Pagano et al., 2014; Huntington et al., 2016; Ren et al., 2016; Lipczynska-Kochany, 2018; McDonough et al., 2020b; Wen et al., 2020; Tiwari et al., 2022; Hou et al., 2023; Ming et al., 2023) ultimately leading to an increased supply of DOCs into aquifers (McDonough et al., 2020b).

Peatlands located along coastal areas around the world (Yu et al., 2011; Page and Baird, 2016; Zhong et al., 2020; Loisel et al., 2021) and in New Jersey (Johnson, 1985; Lynn and Karlin, 1985; Karlin and Andrus, 1988; Mandernack et al., 2000) serve as a significant source of DOC in groundwater (Bartsch and Moore, 1985; Broder et al., 2017; Walpen et al., 2018; Sienkiewicz et al., 2019; Lim et al., 2022; Prijac et al., 2022; Rosset et al., 2022). It is expected that the DOC supply from peatlands into aquifers will be amplified due to increased decomposition of peat under elevated temperature (Kane et al., 2014; Ritson et al., 2014; Dieleman et al., 2016; Wang et al., 2018; Leng et al., 2019; McDonough et al., 2020a and 2020b; Xu et al., 2020). The surface-derived DOC in groundwater via recharge is likely to cause microbial reduction of metal (Fe and Mn) oxyhydroxides in aquifers, leading to mobilizations of redox-sensitive elements such as As, Mn, Fe, P, and Ni (Sharif et al., 2008; Du Laing et al., 2009; Mailloux et al., 2013; Lawson et al., 2016; Postma et al., 2017; Rinklebe and Shaheen, 2017; Nghiem et al., 2019; Coyte and Vengosh, 2020; Qiao et al., 2020; Tweed et al., 2020; Akintomide et al., 2021; Huang et al., 2023a; Liu et al., 2023). Arsenic-rich glauconitic sediment and metal oxyhydroxides are present in the aquifers of the inner coastal plain of New Jersey, which are likely the source of dissolved As in the groundwater and are mobilized due to reducing geochemical conditions driven by supplied DOCs (Vowinkel et al., 2001; Barringer et al., 2010 and 2013; Pearcy et al., 2011; Mumford et al., 2012). This might explain the exceedance of the New Jersey drinking-water maximum contaminant level for As observed in some private wells (Flanagan et al., 2016; Giri et al., 2022; Seliga et al., 2022).

Electron acceptors such as O_2^{2-}, NO_3^-, and SO_4^{2-} are also transported into aquifers via recharging water, promoting oxic geochemical conditions and groundwater quality changes (Kumar and Riyazuddin, 2012; Schaefer et al., 2016; Haugen et al., 2021). In oxic conditions, trace elements such as As, Mn, P, and Fe are stable due to the formation of minerals such as Fe-arsenates and Fe-hydroxides (Fortin and Langley, 2005). High levels of NO_3 are observed in shallow groundwater throughout New Jersey due to recharge derived from agriculture areas (Böhlke, 2002a; Nolan et al., 2003), which can lead to oxidation of pyrite (Juncher Jørgensen et al., 2009; Torrentó et al., 2011; Zhang et al., 2012; Hu et al., 2020). The reduction of NO_3 coupled with pyrite oxidation has been documented as an important process limiting the movement of NO_3 in an agriculturally impacted glacial aquifer in Minnesota, as well as a coastal-plain aquifer in Maryland (Böhlke et al., 2002b and 2007). However, the oxidation of As-bearing sulfide minerals, including arsenopyrite can lead to mobilization of As in shallow groundwater (Welch et al., 2000; Hering and Kneebone, 2002; Foley and Ayuso, 2008; Garelick et al., 2009; Smedley and Kinniburgh, 2013; Houben et al., 2017; Asta et al., 2019; Erickson et al., 2021; Stolze et al., 2022; Zambito et al., 2022), which is a significant mineral source of high levels of As in the groundwater of New Jersey (Serfes et al., 2003 and 2010; NJGS, 2004). Also, geogenic metals such as Ni, Cd, and U can be released into groundwater during NO_3 reduction (Houden et al., 2017; van Berk and Fu, 2017; Riedel and Kübeck, 2018; Kubier et al., 2019; Riedel et al., 2022; Westrop et al., 2023). Westrop et al (2023) demonstrated that the influx of pore water NO_3 oxidized and mobilized naturally occurring U in High Plains alluvial aquifer in Central Nebraska. Conversely, SO_4 chemistry controls the availability of metals such as Cd, Cu, Ni, and Zn by forming metal sulfides (Du Laing et al., 2009), and depending on the geochemical conditions, SO_4 plays an important role in controlling As concentrations in groundwater. Arsenic concentrations are generally low when SO_4 levels are high (Aziz et al., 2017; Li et al., 2018), suggesting either oxidizing conditions or simultaneous SO_4 and Fe-reducing conditions that are favorable for sequestrating As and Fe by forming arsenic sulfide minerals (O'Day et al., 2004; Buschmann & Berg, 2009; Kirk et al., 2010; Burton et al., 2014; Nghiem et al 2019). However, in oxic geochemical conditions, these precipitated sulfide minerals can be oxidized, becoming a source of As, Fe, and other metals (Battistel et al., 2021). Also, sulfides from sulfate reduction can indirectly mobilize arsenic by reducing Fe and As (Rochette et al., 2000; Poulton et al., 2004; Saalfield & Bostick, 2009; Burton et al., 2014; Liu et al., 2022a; Zhou et al., 2022) and lead to the formation of complexes that dissolve arsenic (Suess and Planer-Friedrich, 2012; Feng et al., 2023a; Nghiem et al., 2023; Planer-Friedrich, 2023; Yang et al., 2023). Similarly, ammonium-generating bacteria can increase As concentration in groundwater by the reduction of Fe-oxides and As(V) to more mobile As(III) during nitrogen-metabolizing (NO_3 transformation) processes (Gao et al., 2021; Jiang et al., 2022, Feng et al., 2023a).

In general, groundwater levels respond quickly to the groundwater recharge rate. For shallow groundwater systems, recharge from precipitation influences the position of the water table (Viswanathan, 1983; Healy and Cook, 2002; van Gaalen et al., 2013; Hussain et al., 2022). The unsaturated vadose zone, located between the ground surface and the water table (Nimmo, 2006), controls the migration of contaminants to the water table due to occurrences of distinct physical and biogeochemical processes in this zone (Hopmans and van Genuchten, 2005; Holden and Fierer, 2005; Arora et al., 2019; Li et al., 2022). Therefore, changes in groundwater level that limit the thickness of the vadose zone can significantly influence the transport of DOC, electron acceptors, pollutants, (Hopmans and van Genuchten, 2005; Brusseau et al., 2013; Lusk et al., 2017; Voisin et al., 2018; Arora et al., 2019; Lebon et al., 2023), and microorganisms, including pathogenic bacteria, viruses, and protozoan parasites, to aquifers (Brennan et al., 2010; Bradford et al., 2013; Mantha et al., 2017; Alegbeleye and Sant'Ana, 2020; Humphrey et al., 2021; Zhang et al., 2022).

The vadose zone tends to retain DOC because of biogeochemical processes occurring during vertical transport, and retention efficiency depends on the vadose zone thickness (VZT), where DOC retention increases with VZT. (Pabich et al., 2001; McMahon and Chapelle, 2008; Mermillod-Blondin et al., 2015). Therefore, the supply of DOC to the aquifer would increase when groundwater levels are raised via enhanced recharge, reducing the VZT and causing changes in groundwater geochemical (redox) condition and quality. Similarly, a thinner vadose zone could increase the risks of microbial and chemical contamination of aquifers (Tedoldi et al., 2016; Humphrey et al., 2021). Indeed, microbial contamination of groundwater and outbreak of waterborne diseases linked to recharge and vadose zone thickness have been observed in both low- and high-income countries (Taylor et al., 2009; Rao et al., 2013; Engström et al., 2015; Allen et al., 2017; Chuah and Ziegler, 2018; Alegbeleye and Sant'Ana, 2020). Some studies showed nitrate concentrations in groundwater were directly related to vadose zone thickness (Turkeltaub et al., 2018; Juntakut et al., 2019). Additionally, a rising groundwater level poses the threat of groundwater contamination by saturating the vadose zone, releasing contaminants that accumulate in unsaturated soil layers. This may include the mobilization of natural elements (Gurdak et al., 2007; Mills et al., 2011; McClain et al., 2019; Jarsjö et al., 2020), anthropogenic contaminants such as NO_3 (Zhou et al., 2016; Weitzman et al., 2022), hydrocarbons and other organic contaminants (Conrad and DePaolo, 2004; McGuire et al., 2005; Molins et al., 2010; Wellman et al., 2012; Brusseau et al., 2013; Mackay et al., 2018; Mattia et al., 2020), emerging contaminants such as Per- and polyfluoroalkyl substances (PFAS) (Brusseau et al., 2020; Rovero et al., 2021; Sharifan et al., 2021; Guo et al., 2020a; Lyu et al., 2022; Nickerson et al., 2023), microplastics (Ren et al., 2021; Liu et al., 2022; Feng et al., 2023; He et al., 2023; Ranjan et al., 2023), and pathogens/viruses (Chuah and Ziegler, 2018; Alegbeleye and Sant'Ana, 2020).

Available studies indicate that PFAS tends to accumulate primarily in the soil of the vadose zone or at the air-water interface because of their sorption and surfactant properties (Sepulvado et al., 2011; Xiao et al., 2015; Weber et al., 2017; Brusseau and Van Glubt, 2019; Nickerson et al., 2020; Sharifan et al., 2021; Gnesda et al., 2022; Lyu et al., 2022; McMahon et al., 2022). PFAS accumulated in the vadose zone can act as a reservoir for long-term groundwater contamination (Barzen-Hanson et al., 2017; Weber et al., 2017; Brusseau et al., 2020; Sharifan et al., 2021; Guo et al., 2020a; McMahon et al., 2022). Thus, PFAS concentrations in groundwater are closely related to rising and falling groundwater levels, indicating mobilization of accumulated PFAS to aquifers during recharge events (Cáñez et al., 2021). Therefore, enhanced recharge due to climate change makes the groundwater more susceptible to PFAS contamination. Furthermore, contaminated surface water bodies such as rivers/lakes serve as additional sources of PFAS in groundwater (Liu et al., 2019b; Mao et al., 2023). PFAS found in New Jersey's soils, surface water, groundwater, and fish tissues (Procopio et al., 2017; McCord et al., 2020; Goodrow et al., 2020; Washington et al., 2020), are potential sources for groundwater contamination.

Microplastics (MPs), an emerging contaminant with the potential for toxic effects on human health and the environment (Chia et al., 2021; O'Kelly et al., 2022), have also been identified in groundwater systems (Kim and Lee 2020; Chia et al., 2021; Ren et al., 2021; Esfandiari et al., 2022; Samandra et al., 2022; Shi et al., 2022; Viaroli et al., 2022; Wu et al., 2022). Primary sources of MPs in groundwater include recharge from agricultural soils due to application of plastic mulches and biosolids (Wanner, 2021, Cha et al., 2023; Huang et al., 2023; Moeck et al., 2023), surface water bodies such as rivers/lakes (Severini et al., 2022; Gustavus, 2023; Shu et al., 2023), and urban infrastructure (stormwater management systems, septic tanks, wastewater treatment systems) (Liu et al., 2019; Liu et al., 2022; Koutnik et al., 2022; O'Kelly et al., 2022; Viaroli et al., 2022). The vertical movement of MPs through the vadose zone is facilitated by wetting–drying cycles associated with groundwater fluctuations driven by precipitation and infiltration/recharge (O'Connor et al., 2019; Chia et al., 2021; Liu et al., 2022; Cramer et al., 2022; Feng et al., 2023). Thus, MPs found in New Jersey's surface waters (Ravit et al., 2017; Bailey et al., 2021) are potential sources for groundwater contamination, resulting from increased precipitation and recharge under climate change conditions.

In summary, the enhanced recharge stimulated by altered precipitation patterns and influenced by climate change is likely to cause changes in physical and geochemical conditions of aquifers, leading to mobilization and transport of geogenic and anthropogenic contamination of groundwater.

3.3 Extreme Events (Flooding and Drought) and Groundwater Quality

Climate change is expected to cause changes in precipitation patterns in New Jersey, namely increased frequency and intensity of extreme events like floods and droughts (NJDEP 2020, Nazarian et al., 2022; Jong et al., 2023). Increased flooding contributes to the groundwater recharge of shallow aquifers (Doble et al., 2012; Zhang et al., 2017), and can therefore also impact the quality of groundwater by transporting DOC, electron acceptors, and pollutants (see Section 3.2), particularly in unconfined shallow aquifers with high hydraulic conductivity. Unconfined shallow aquifers with high hydraulic conductivity provide insignificant attenuation capacity for contaminants coming from polluted surface water bodies (Miotliński et al., 2012; Gowrisankar et al., 2017; Ramachandran et al., 2019; Aladejana et al., 2020). In urban areas, flooding can increase the loading of organic carbon and common urban contaminants, such as oil, solvents, and sewage, to groundwater (Green et al. 2011; Khatri and Tyagi, 2015).

A common and immediate threat to public health from flooding is microbial/pathogenic contamination of groundwater by infiltration of contaminated flood water and/or flushing of accumulated pathogens in the vadose zone (Hunter, 2003; Funari et al., 2012; Andrade et al., 2018; Rowles III et al., 2020; Pieper et al., 2021; Dzodzomenyo et al., 2022; Mapili et al., 2022; Gitter et al., 2023). For example, groundwater contamination through nutrient and pathogen loading was reported in eastern North Carolina after the flooding caused by a hurricane (Humphrey et al., 2021). Furthermore, flooding decreases redox potential (Eh) and promotes reducing geochemical conditions in surface soils, causing changes in metal solubility (Du Laing et al., 2009; Kelly et al., 2020; Ponting et al., 2021; Tang et al., 2022). Also, metal solubility could increase due to the formation of complex ions (complexation) during the dissolution of soil organic matter (SOM) caused by flooding (Kelly et al., 2020; Tang et al., 2022). Therefore, flooding can mobilize geogenic contaminants like As, Fe, Mn, P, and other metals (Cr, Mo, V) in surface soils, which eventually are transported to shallow aquifers via infiltration/recharge (Burton et al., 2008; Weber et al., 2010; Burton et al., 2014; Shaheen et al., 2014; Connolly et al., 2021; Müller et al., 2022; Fang et al., 2023; Yang et al., 2023a).

Decreased precipitation and longer dry periods, projected to occur in the warmer months, may lead to more frequent and extended droughts or drought-like conditions (Trenberth, 2011; Krakauer et al., 2019; NJDEP, 2020). Droughts have the potential to significantly impact groundwater quality (Levy et al., 2021; Petersen-Perlman et al., 2022). For example, recent studies have observed post-drought increases in NO_3^- concentrations (Jutglar et al., 2021) and certain redox-sensitive ions (SO_4^{2-}) and metals such as Fe and Mn (Aladejana et al., 2020). During drier conditions, decreased groundwater recharge causes groundwater levels to decline (NJDEP, 2002; Sen, 2015; Schreiner-McGraw, et al. 2021). Lowered groundwater exposes arsenic-iron sulfide bearing minerals to oxygen introduced by diffusion through the unsaturated zone and causes oxidation of these sulfide minerals (Welch et al., 2000; Hering and Kneebone, 2002; Foley and Ayuso, 2008; Garelick et al., 2009; Smedley and Kinniburgh, 2013; Houben et al., 2017; Asta et al., 2019; Erickson et al., 2021; Stolze et al., 2022; Zambito et al., 2022). These minerals are significant sources of high levels of As in the groundwater of New Jersey (Serfes et al., 2003 and 2010; NJGS, 2004). Therefore, mobilization of arsenic by sulfide oxidation is likely to be enhanced during drought periods and provides an explanation for observed and predicted increases in As concentrations associated with droughts (Verplanck et al. 2008; García-Prieto et al., 2012; Pili et al. 2013; Tisserand et al., 2014; Bondu et al., 2016; Ventura-Houle et al., 2018; Lombard et al., 2021).

In summary, flooding may mobilize geogenic contaminants like As, Fe, Mn, and other metals (Cr, Mo, V) in soils which eventually are transported to shallow aquifers via infiltration/recharge. Similarly, droughts also have the potential to increase contaminant concentrations of NO_3^- and As, among other compounds.

3.4 Sea Level Rise and Groundwater Quality

Increasing rates of sea-level rise (SLR) have been observed in New Jersey and globally over the last several decades (Nicholls and Cazenave, 2010; NJDEP, 2020). In coastal areas, shallow groundwater is expected to respond dynamically to SLR due to hydraulic connections with nearby high salinity coastal environments (Befus et al., 2020). Some of the most likely impacts of SLR on coastal shallow aquifers are seawater intrusion (Bosserelle et al., 2022), rising groundwater levels (Rozell, 2020; Bosserelle et al., 2022), and coastal flooding (Vitouseket et al., 2017; Hummel et al 2018; Rahimi et al., 2020).

Seawater intrusion (SWI), upward and landward movement (from hundreds of meters to several kilometers) of the seawater-freshwater interface (Andersen et al., 2005; Werner and Simmons, 2009; Werner et al., 2013; Knott et al., 2018; Jasechko et al., 2020), has the potential to be one of the leading causes of groundwater contamination resulting from rising sea-level (Alshehri et al., 2021; Jeen et al., 2021; Abd-Elaty et al., 2022). An immediate effect of SWI in New Jersey, as well as other parts of the USA, is the increase in groundwater salinity, known as salinization (Barlow and Reichard, 2010; Aynaz and Shrinidhi, 2020; Jasechko et al., 2020; Lotfata and Ambinakudige, 2020). For example, SWI has been observed up to 3 kilometers inland, forcing the closure of public- and industrial-supply wells and private wells in Cape May County, New Jersey since the 1940s (Lacombe and Carleton, 2002; Barlow and Reichard, 2010). Salinization of coastal aquifers by SWI can also involve a range of complex geochemical processes affecting water quality by mobilization of geogenic and anthropogenic contaminants. (Moore and Joye, 2021). The increasing salinity driven by SWI can significantly affect the mobility of metals including radioactive metals due to cation exchange, desorption by Cl (metal chloro-complexation), and interaction with organic complexes (Appelo and Postma, 2005; Brady and Weil, 2008; Acosta et al., 2011; Sun et al., 2015; Lazur et al., 2020; Zheng et al., 2021).

Some studies observed increases in metals (As, Cd, Co, Cu, Hg, Pb, Se, V) and other elements, such as B, Ba, Ca, Mg, Si, Sr, and radioactive metal radium (Ra) with increased groundwater salinity (Bolton, 2000; Du Laing et al., 2008 and 2009; Kiro et al., 2012; Vinson et al. 2013; Zhao et al., 2013; Sun et al., 2015; McNaboe et al., 2017; Liu et al., 2019a; Wen et al., 2019; Lazur et al., 2020; Mora et al., 2020; Papazotos et al., 2020; Moore and Joye, 2021). However, the effect of salinity on metals varies with chemical species, predominant geochemical phase, and the source of metals (Rumuri et al., 2021). An increase in Ra concentrations has been observed in drinking water wells installed in the Kirkwood−Cohansey aquifer in southern New Jersey due to increased salinity associated with road salt application (Lindsey et al., 2021). Ra concentration in groundwater increases with salinity because of competition for adsorption sites by Na^+ ions, and the formation of $RaCl^+$ and $RaCl_2$ complexes that enhance the solubility of Ra in saline waters (Langmuir and Riese 1985; Tamamura et al. 2014; McNaboe et al., 2017; Lindsey et al., 2021).

Other geochemical processes, such as redox reactions, sorption/desorption, co-precipitation/dissolution, and change in ionic strength, can also occur during SWI that affect the concentrations of major and trace elements in groundwater (Khadra et al., 2017; Mora et al., 2020; Lazur et al., 2020; Moore and Joye, 2021). Some studies showed that As desorption in aquifer sediments was higher due to increased groundwater salinity and alkalinity

(Morelli et al., 2017; Dehbandi et al., 2019; Yuan et al., 2023). Additionally, SWI inhibits the recrystallization of iron (hydr)oxides and facilitates the formation of iron sulfide leading to decreased adsorption potential of As (Yuan et al., 2023). In recent studies, the mobilization of some cations and As, Cu, Hg, Ni, Rb, and U in aquifers was driven by the desorption or dissolution of aquifer minerals during SWI (Appelo et al., 1990; Moore, 1999; Grassi and Netti, 2000; McFarland, 2010; Habtemichael et al., 2016; Khadra et al., 2017). Seawater, because of its high sulfate concentrations (Canfield and Farquhar, 2009) has stronger oxidizing capacity than freshwater, which causes oxidation of organic matter (Moore and Joye, 2021). Organic matter oxidation plays an important role in stimulating the reduction of iron and manganese oxides and the release of As, Fe, and Mn at seawater-freshwater boundaries (Snyder et al., 2004; Moore and Joye, 2021). Moreover, an increase in groundwater pH due to seawater mixing (Bozlee et al., 2008) would decrease the groundwater Eh (oxidation potential) promoting reducing conditions because of the inverse relationship between pH and Eh (Xyla et al., 1992).

Modeling studies have shown that SLR would cause the denser seawater (because of its salt content) to intrude under the fresh groundwater and force water levels to rise in coastal shallow aquifers (Masterson and Garabedian, 2007; Oude Essink et al., 2010; Bjerklie et al., 2012; Rotzoll and Fletcher, 2013; Masterson et al., 2014; Masterson et al., 2014; Walter et al., 2016; Hoover et al., 2017; Knot et al, 2019; Habel et al., 2020; Rozell, 2020). Rising groundwater levels over the past 50 years in coastal areas of Massachusetts (Douglas and Kirshen, 2022) and New England (Dudley and Hodgkins, 2013; Weider, 2014) are consistent with groundwater rise in response to the rising sea level. Factors that control groundwater rise in coastal areas are (a) groundwater recharge (Bjerklie et al., 2012), (b) groundwater discharge to tidal water bodies (SRPC, 2022), (c) the rate of SLR (Masterson & Garabedian, 2007), (d) the hydraulic connection of shallow aquifers to sea (Rotzoll and Fletcher, 2013; Befus et al., 2020), (e) the topographic/hydrographic settings (Knott et al., 2019), and (f) infrastructure systems (Habel et al., 2020). A groundwater numerical simulation of New Hampshire's coastal region has projected that mean groundwater rise (percentage of height) relative to SLR under high-emission scenario is 66% between 0 and 1 km, 34% between 1 and 2 km, 18% between 2 and 3 km, 7% between 3 and 4 km, and 3% between 4 and 5 km of distance from the coastline (Knott et al., 2019). Similarly, groundwater flow simulation indicated that the water tables in the unconfined shallow aquifer systems underlying the coastal areas of New Jersey (Fiore et al., 2018; Carleton et al., 2021) and New York (Misut and Dressler, 2021), are likely to rise in response to SLR. The rising groundwater level poses threats to groundwater by mobilizing natural elements and anthropogenic contaminants in vadose zones, as described in Section 3.2.

Many coastal communities, including in New Jersey, rely on on-site septic systems for treating wastewater. In general, a properly functioning septic system requires at least two feet of soil to provide filtration by removing solids and bacteria/pathogens from wastewater (USEPA, 2002). Therefore, the rising water table may lead to septic failures and groundwater contamination through nutrient and pathogen loading (Mihaly, 2018; Cox et al., 2020).

Increased surface-water flooding due to storm surges and tides would be a common consequence of SLR (Nicholls, 2002; Strauss et al., 2012; Woodruff et al., 2013; Neumann et al., 2015; Moftakhari et al., 2017; Kulp and Strauss, 2019; Habel et al., 2020; Griggs and Reguero, 2021; Johnston et al., 2021; Thompson et al., 2021; Alarcon et al., 2022; Bilskie et al., 2022; Lopes et al., 2022; Reguero and Griggs, 2022; Wing et al., 2022) and the rising groundwater is likely to exacerbate coastal flooding hazards (Rahimi et al., 2020; Bosserelle et al., 2022; Su et al., 2022). Therefore, shallow aquifers in coastal areas are vulnerable to seawater infiltration due to coastal floodings and tidal inundations. The potential adverse effects of flooding on groundwater quality of shallow aquifers, which include transportation/infiltrations of DOC, electron acceptors, pollutants, and pathogens, are discussed in section 3.3. Also, seawater intrusion induced by coastal flooding can significantly affect the mobility of metals in soils/sediments due to cation exchange and the presence of Cl and organic complexes, as discussed above in this section. Many coastal sediments, including those in the United States, are significant sources of both anthropogenic and natural contaminants (Santschi et al., 2001; Barringer and Szabo, 2006; Vane et al., 2008; Barringer et al., 2013; Qian et al., 2015; Maruya et al., 2016; Sakizadeh, 2020; Paul et al., 2021). Therefore, coastal floodings in response to SLR can lead to the mobilization of geogenic contaminants like As and other metals in soils, which eventually are transported to shallow aquifers (LeMonte et al., 2017; Izaditame et al., 2022).

In summary, the increasing salinity driven by SWI can mobilize metals (As, Cd, Co, Cu, Hg, Pb, Se, V, and Ra) from soils/sediments to groundwater due to cation exchange and the presence of Cl and organic complexes. Similarly, rising groundwater and coastal flooding are likely to affect contaminant concentrations in shallow coastal aquifers.

3.5 Climate Change and Contaminant Transport and Remediation

Climate change could impact large numbers of contaminated sites as climate change and the associated extreme weather events can undermine the effectiveness of site remediation efforts (US EPA, 2013; Jesus et al., 2015; Libera et al., 2019; O'Connor et al., 2019a). This is due to shifts in hydrogeological and geochemical conditions of aquifers which can affect the contaminant’s fate and transport, as well as long-term operations and management of remediation sites.

Substantial groundwater level fluctuations are likely to occur over the next century in response to variations in rainfall intensity and frequency expected under climate change conditions (Nygren et al., 2020; IPCC, 2022, Sections 3.2, 3.3 and 3.4). Furthermore, groundwater recharge is predicted to be enhanced under future climate scenarios due to projected increases in precipitation (Section 3.2). These modified hydrogeological conditions may strongly influence contaminant mobilization, transport and fate, and the risk for receptors (Cavelan et al., 2022; Xu et al., 2022). For example, higher recharge would mobilize contaminants in the vadose zone and move them down to the aquifer (Zuo et al., 2021; Cavelan et al., 2022). Furthermore, increased recharge would augment hydraulic gradients by raising the groundwater level, resulting in enhanced plume mobility and mixing/dilution of contaminants in groundwater due to faster groundwater flow (Marshall et al., 2000). Given these conditions, increased recharge rates caused by climate change effects may enhance plume mobility and increase pollution load in downgradient locations (Gupta and Yadav 2017). Inversely, a decrease in recharge would result in decreased plume mobility and reduce the mixing and dilution of contaminants (Libera et al., 2019; Xu et al., 2022). Also, recharge and seasonal water level fluctuations in aquifers control the redox process and contribute to the natural attenuation of contaminants in aquifers (Böhlke, J.K., 2002a; McGuire et al., 2005; Scholl et al., 2006; Yadav et al., 2012; Rezanezhad et al., 2014; Van De Ven et al., 2021; Cavelan et al., 2022). Recharge delivers electron acceptors, such as O_2^{2-}, NO_3^-, SO_4^{2-}, and Fe^{3+}, that cause significant changes to anaerobic, contaminated aquifers and are important for natural attenuation of contaminants (McGuire et al. 2005; McMahon et al., 2011). The upward/downward movements of a contaminant plume, caused by water level fluctuations, can lead to the entrapment of pollutants in the form of isolated blobs (residual masses of contaminants) in pore spaces (Libera et al 2019). These residual pollutants trapped in the porous soils become lasting sources of pollution (Yadav and Hassanizadeh 2011; Libera et al 2019). Therefore, it is crucial to understand the response of contaminated unconfined aquifers to recharge events for the design and evaluation of effective bioremediation and natural attenuation strategies. As discussed earlier, more extreme droughts and heavy precipitation events (and associated floods) are likely to occur more frequently due to climate change and will likely influence soil moisture content. Several studies have shown that microbial respiratory activity that controls the degradation of contaminants in the soil also depends strongly on moisture (Xiang et al., 2008; Butcher et al., 2020; Vu et al., 2022).

An increase of a few degrees Celsius in the mean surface and groundwater temperature is expected (IPCC, 2022). Higher temperatures associated with climate change are likely to stimulate microbial activity, thus potentially enhancing biodegradation of organic and other pollutants (Anthony, 2006; Ali, 2010; Baczynski et al., 2010; Zeman et al., 2014; Bajaj and Singh, 2015; Bargiela et al., 2015; Liao et al., 2016; Alkorta et al., 2017; Westphal et al., 2017; Gaur et al., 2018; McAlexander and Sihota, 2019; Riedel et al., 2019; Retter et al., 2021; Cavelan et al., 2022). Thus, this phenomenon may affect temperature-dependent mobilization and biodegradation processes which would greatly shift the effectiveness of some remediation systems, including bioremediation and monitored natural attenuation (MNA). In general, solubility increases with temperature for most organic compounds and metals (Delle Site, 2001; Wang et al., 2010; Ossai et al., 2020; Cavelan et al., 2022). Furthermore, organic matter enhances the solubility and mobility of metals and other pollutants through complexation and binding (Murphy and Zachara, 1995; Weng et al., 2002; Wang et al., 2007; Aiken et al., 2011;

Daugherty et al., 2017; Lipczynska-Kochany, 2018; Adusei-Gyamfi et al., 2019; Tang et al., 2022a). Therefore, climate change is likely to play a significant role in the fate and transport of pollutants by changing the structure and quantity of organic matter and modifying interactions between organic matter, metals, and sediments in aquifer (Lipczynska-Kochany, 2018; Cavelan et al., 2022).

Sea-level rise is also expected to impact many contaminated sites. This is an important consideration for New Jersey as the state has the second highest number of Superfund sites in the United States (Gómez, 2021; Kiaghadi et al., 2021). Many of these sites are in low-lying coastal regions and have the potential to release hazardous contaminants that could pose risks to public health into aquifers. For example, the rising groundwater due to heavy precipitation and flooding in response to SLR can remobilize pollutants dormant in the soil at contaminated sites. Moreover, SLR is likely to reduce the hydraulic gradient in inland and coastal areas which would affect the transport and dispersion of contaminants (O'Connor et al., 2019a; Guo et al., 2020).

To summarize, the effects of climate change create both risks and opportunities, which should be considered during remedial design and long-term planning.

4.0 Conclusions and Knowledge Gaps

This review examines the present and future impacts of climate change on groundwater quality based on our current knowledge. The review of available scientific literature suggests the effects of climate change on groundwater quality may be a slow and long-term process that will affect groundwater quality by modifying hydrogeological processes such as precipitation, groundwater recharge, discharge, aquifer storage/water level, and seawater intrusion. These modifications influence biogeochemical reactions, chemical fate, and the transport of contaminants. Changes in hydrogeological and biogeochemical processes induced by climate change are likely to cause long-term and seasonal variability both in anthropogenic and geogenic contaminants (Levitt et al., 2019; Degnan et al., 2020; Henri et al., 2020; Lasagna et al., 2020; Lee and Murphy, 2020; Guo et al., 2021; Mailloux et al., 2021). Thus, it is crucial to understand the time scales of change in contaminant concentrations in drinking water wells for contaminant regulation, mitigation, and, eventually, the reduction of human exposure to harmful contaminants (Degnan et al., 2020). For example, some studies showed that geogenic contaminants, such as As and other anthropogenic contaminants, have variable seasonal and long-term concentrations, related to water level fluctuations and climate variability (Goovaerts et al., 2005; Ayotte et al., 2015; Levitt et al., 2019; Jarsjö et al., 2020; Lasagna et al., 2020; Degnan et al., 2020; Spaur et al., 2021). Furthermore, the increasing salinity driven by SWI is likely to mobilize As in coastal areas (Section 3.4), which can lead to considerable and systematic underestimation of As mobilization and future changes. Therefore, this warrants the collection of multiple samples throughout the year to avoid failure to document potential exceedances of a human health standard when wells may be sampled under low concentration conditions (Degnan et al., 2020; Mailloux et al., 2021). This more frequent sampling approach may be particularly important for private wells because of their lesser testing frequency than public-supply wells (Degnan et al., 2020; O'Neill et al., 2022; Seliga et al., 2022).

As the review indicates, climate change will affect groundwater quality in several different ways, however, quantification of the impacts is difficult because of uncertainty in climate projections, global socio-economic developments, and the complex responses of the hydrogeological system to climate variability (Clark et al., 2016; Refsgaard et al., 2016; Reinecke et al., 2021; Mensah et al., 2022; Huggins et al., 2023). Long-term monitoring studies which include a denser network of groundwater observation points are necessary to improve the quantification of hydrogeological systems that are likely to be affected by climate change at local to regional scales.

Groundwater is likely to play a critical role in meeting the increased water demand in the future because of substantial declines in surface water availability due to climate change and other natural and anthropogenic impairing factors (MacDonald, 2010; Taylor et al., 2013; Wada et al., 2013; Elliott et al., 2014; Haddeland et al., 2014; Flörke et al., 2018; Bierkens and Wada, 2019; Brown et al., 2019; Allan et al., 2020; Sanchez et al., 2020; Akhtar et al., 2021; Abbas et al., 2022; Swain et al., 2022; Warziniack et al., 2022; Qiu et al., 2023). Therefore, the likely increased groundwater extraction needed to meet the future water demand could aggravate declining water tables, causing a loss of groundwater storage, and decreasing water quality in many already stressed aquifer systems. Impacts associated with climate change, are expected to increase over time and are already in motion because of historic releases of CO_2 and the inertia of the climate system (Meehl et al., 2005; Mertz et al., 2009; Brown et al., 2019), thus mitigation and adaptation strategies will need to be identified in order to adequately address the consequential alterations of groundwater quantity and quality (Berrang-Ford et al., 2011; Brown et al., 2019; Hanifehlou et al., 2022; Stigter et al., 2022; Maheshwari, 2023; Scanlon et al., 2023).

References

1. Abbas, S.A., Xuan, Y. and Bailey, R.T., 2022. Assessing Climate Change Impact on Water Resources in Water Demand Scenarios Using SWAT-MODFLOW-WEAP. *Hydrology*, *9*(10), p.164.
2. Abd-Elaty, I., Kushwaha, N.L., Grismer, M.E., Elbeltagi, A. and Kuriqi, A., 2022. Cost-effective management measures for coastal aquifers affected by seawater intrusion and climate change. *Science of The Total Environment*, *836*, p.155656.
3. Acosta, J.A., Jansen, B., Kalbitz, K., Faz, A. and Martínez-Martínez, S., 2011. Salinity increases mobility of heavy metals in soils. *Chemosphere*, *85*(8), pp.1318-1324.
4. Adane, Z., Zlotnik, V.A., Rossman, N.R., Wang, T. and Nasta, P., 2019. Sensitivity of potential groundwater recharge to projected climate change scenarios: A site-specific study in the Nebraska sand hills, USA. *Water*, *11*(5), p.950.
5. Adusei-Gyamfi, J., Ouddane, B., Rietveld, L., Cornard, J.P. and Criquet, J., 2019. Natural organic matter-cations complexation and its impact on water treatment: A critical review. *Water research*, *160*, pp.130-147.
6. Aiken, G.R., Hsu-Kim, H. and Ryan, J.N., 2011. Influence of dissolved organic matter on the environmental fate of metals, nanoparticles, and colloids.
7. Akhtar, N., Syakir Ishak, M.I., Bhawani, S.A. and Umar, K., 2021. Various natural and anthropogenic factors responsible for water quality degradation: A review. *Water*, *13*(19), p.2660.
8. Akintomide, O.A., Amer, R.M., Hanor, J.S., Datta, S. and Johannesson, K.H., 2021. Pleistocene sands of the Mississippi River Alluvial Aquifer produce the highest groundwater arsenic concentrations in southern Louisiana, USA. *Journal of Hydrology*, *595*, p.125995.
9. Aladejana, J.A., Kalin, R.M., Sentenac, P. and Hassan, I., 2020. Assessing the impact of climate change on groundwater quality of the shallow coastal aquifer of eastern Dahomey basin, southwestern Nigeria. *Water*, *12*(1), p.224.
10. Alarcon, V.J., Linhoss, A.C., Kelble, C.R., Mickle, P.F., Sanchez-Banda, G.F., Mardonez-Meza, F.E., Bishop, J. and Ashby, S.L., 2022. Coastal inundation under concurrent mean and extreme sea-level rise in Coral Gables, Florida, USA. *Natural Hazards*, *111*(3), pp.2933-2962.
11. Al Atawneh, D., Cartwright, N. and Bertone, E., 2021. Climate change and its impact on the projected values of groundwater recharge: A review. *Journal of Hydrology*, *601*, p.126602.
12. Alegbeleye, O.O. and Sant'Ana, A.S., 2020. Manure-borne pathogens as an important source of water contamination: An update on the dynamics of pathogen survival/transport as well as practical risk mitigation strategies. *International Journal of Hygiene and Environmental Health*, *227*, p.113524.
13. Ali, H., 2010. Biodegradation of synthetic dyes—a review. *Water, Air, & Soil Pollution*, *213*(1), pp.251-273.
14. Alkorta, I., Epelde, L. and Garbisu, C., 2017. Environmental parameters altered by climate change affect the activity of soil microorganisms involved in bioremediation. *FEMS microbiology letters*, *364*(19).
15. Allan, R.P., Barlow, M., Byrne, M.P., Cherchi, A., Douville, H., Fowler, H.J., Gan, T.Y., Pendergrass, A.G., Rosenfeld, D., Swann, A.L. and Wilcox, L.J., 2020. Advances in understanding large-scale responses of the water cycle to climate change. *Annals of the New York Academy of Sciences*, *1472*(1), pp.49-75.
16. Allen, A.S., Borchardt, M.A., Kieke, B.A., Dunfield, K.E. and Parker, B.L., 2017. Virus occurrence in private and public wells in a fractured dolostone aquifer in Canada. *Hydrogeology Journal*, *25*(4), pp.1117-1136.
17. Alley, W.M., Healy, R.W., LaBaugh, J.W. and Reilly, T.E., 2002. Flow and storage in groundwater systems. *science*, *296*(5575), pp.1985-1990.
18. Alshehri, F., Almadani, S., El-Sorogy, A.S., Alwaqdani, E., Alfaifi, H.J. and Alharbi, T., 2021. Influence of seawater intrusion and heavy metals contamination on groundwater quality, Red Sea coast, Saudi Arabia. *Marine Pollution Bulletin*, *165*, p.112094.
19. Amanambu, A.C., Obarein, O.A., Mossa, J., Li, L., Ayeni, S.S., Balogun, O., Oyebamiji, A. and Ochege, F.U., 2020. Groundwater system and climate change: Present status and future considerations. *Journal of Hydrology*, *589*, p.125163.
20. American Geoscience Institute, 2017. Groundwater use in the United States, Fact Sheet 2017-002.
21. Amiaz, Y., Sorek, S., Enzel, Y. and Dahan, O., 2011. Solute transport in the vadose zone and groundwater during flash floods. *Water Resources Research*, *47*(10).
22. Andersen, M.S., Nyvang, V., Jakobsen, R. and Postma, D., 2005. Geochemical processes and solute transport at the seawater/freshwater interface of a sandy aquifer. *Geochimica et Cosmochimica Acta*, *69*(16), pp.3979-3994.
23. Anderson, M.P., 2005. Heat as a ground water tracer. *Groundwater*, *43*(6), pp.951-968.

24. Andrade, L., O'Dwyer, J., O'Neill, E. and Hynds, P., 2018. Surface water flooding, groundwater contamination, and enteric disease in developed countries: A scoping review of connections and consequences. *Environmental pollution*, *236*, pp.540-549.
25. Anthony, I.O., 2006. Biodegradation alternative in the cleanup of petroleum hydrocarbon pollutants. *Biotechnology and Molecular Biology Reviews*, *1*(2), pp.38-50.
26. Appelo, C.A.J., Willemsen, A., Beekman, H.E. and Griffioen, J., 1990. Geochemical calculations and observations on saltwater intrusions. II. Validation of a geochemical model with laboratory experiments. *Journal of Hydrology*, *120*(1-4), pp.225-250.
27. Appelo, C.A.J., Postma, D., 2005. Geochemistry, Groundwater and Pollution, second ed. Balkema, Rotterdam.
28. Arias, P., Bellouin, N., Coppola, E., Jones, R., Krinner, G., Marotzke, J., Naik, V., Palmer, M., Plattner, G.K., Rogelj, J. and Rojas, M., 2021. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change; Technical Summary.
29. Arnell, N.W. and Lloyd-Hughes, B., 2014. The global-scale impacts of climate change on water resources and flooding under new climate and socio-economic scenarios. *Climatic change*, *122*(1), pp.127-140.
30. Arora, B., Spycher, N.F., Steefel, C.I., Molins, S., Bill, M., Conrad, M.E., Dong, W., Faybishenko, B., Tokunaga, T.K., Wan, J. and Williams, K.H., 2016. Influence of hydrological, biogeochemical and temperature transients on subsurface carbon fluxes in a flood plain environment. *Biogeochemistry*, *27*(2), pp.367-396.
31. Arora, B., Dwivedi, D., Faybishenko, B., Jana, R.B. and Wainwright, H.M., 2019. Understanding and predicting vadose zone processes. *Reviews in Mineralogy and Geochemistry*, *85*(1), pp.303-328.
32. Ascott, M.J., Macdonald, D.M.J., Sandwidi, W.J.P., Black, E., Verhoef, A., Zongo, G., Tirogo, J. and Cook, P., 2022. Time of emergence of impacts of climate change on groundwater levels in sub-Saharan Africa. *Journal of Hydrology*, *612*, p.128107.
33. Asoka, A., Wada, Y., Fishman, R. and Mishra, V., 2018. Strong linkage between precipitation intensity and monsoon season groundwater recharge in India. *Geophysical Research Letters*, *45*(11), pp.5536-5544.
34. Asta, M.P., Wang, Y., Frutschi, M., Viacava, K., Loreggian, L., Le Pape, P., Le Vo, P., Fernández, A.M., Morin, G. and Bernier-Latmani, R., 2019. Microbially mediated release of as from Mekong Delta peat sediments. *Environmental Science & Technology*, *53*(17), pp.10208-10217.
35. Aynaz, L. and Shrinidhi, A., 2020. Degradation of groundwater quality in the coastal aquifers of the USA. *Sustainable Water Resources Management*, *6*(3).
36. Ayotte, J.D., Belaval, M., Olson, S.A., Burow, K.R., Flanagan, S.M., Hinkle, S.R. and Lindsey, B.D., 2015. Factors affecting temporal variability of arsenic in groundwater used for drinking water supply in the United States. *Science of the Total Environment*, *505*, pp.1370-1379.
37. Aziz, Z., Van Geen, A., Stute, M., Versteeg, R., Horneman, A., Zheng, Y., Goodbred, S., Steckler, M., Weinman, B., Gavrieli, I. and Hoque, M.A., 2008. Impact of local recharge on arsenic concentrations in shallow aquifers inferred from the electromagnetic conductivity of soils in Araihazar, Bangladesh. *Water Resources Research*, *44*(7).
38. Aziz, Z., Bostick, B.C., Zheng, Y., Huq, M.R., Rahman, M.M., Ahmed, K.M. and Van Geen, A., 2017. Evidence of decoupling between arsenic and phosphate in shallow groundwater of Bangladesh and potential implications. *Applied geochemistry*, *77*, pp.167-177.
39. Baczynski, T.P., Pleissner, D. and Grotenhuis, T., 2010. Anaerobic biodegradation of organochlorine pesticides in contaminated soil–significance of temperature and availability. *Chemosphere*, *78*(1), pp.22-28.
40. Bailey, K., Sipps, K., Saba, G.K., Arbuckle-Keil, G., Chant, R.J. and Fahrenfeld, N.L., 2021. Quantification and composition of microplastics in the Raritan Hudson Estuary: comparison to pathways of entry and implications for fate. *Chemosphere*, *272*, p.129886.
41. Bajaj, S. and Singh, D.K., 2015. Biodegradation of persistent organic pollutants in soil, water and pristine sites by cold-adapted microorganisms: Mini review. *International biodeterioration & biodegradation*, *100*, pp.98-105.
42. Banks, D., 2012. *An introduction to thermogeology: ground source heating and cooling*. John Wiley & Sons.
43. Baran, A., Mierzwa-Hersztek, M., Gondek, K., Tarnawski, M., Szara, M., Gorczyca, O. and Koniarz, T., 2019. The influence of the quantity and quality of sediment organic matter on the potential mobility and toxicity of trace elements in bottom sediment. *Environmental Geochemistry and Health*, *41*(6), pp.2893-2910.
44. Barbieri, M., Barberio, M.D., Banzato, F., Billi, A., Boschetti, T., Franchini, S., Gori, F. and Petitta, M., 2021. Climate change and its effect on groundwater quality. *Environmental Geochemistry and Health*, pp.1-12.
45. Bargiela, R., Mapelli, F., Rojo, D., Chouaia, B., Tornés, J., Borin, S., Richter, M., Del Pozo, M.V., Cappello, S., Gertler, C. and Genovese, M., 2015. Bacterial population and biodegradation potential in chronically crude oil-contaminated marine sediments are strongly linked to temperature. *Scientific reports*, *5*(1), pp.1-15.

46. Bargués-Tobella, A., Hasselquist, N.J., Bazié, H.R., Bayala, J., Laudon, H. and Ilstedt, U., 2020. Trees in African drylands can promote deep soil and groundwater recharge in a future climate with more intense rainfall. *Land Degradation & Development*, *31*(1), pp.81-95.
47. Barlow, P.M. and Reichard, E.G., 2010. Seawater intrusion in coastal regions of North America. *Hydrogeology Journal*, *18*(1), pp.247-260.
48. Barringer, J.L. and Szabo, Z., 2006. Overview of investigations into mercury in ground water, soils, and septage, New Jersey Coastal Plain. *Water, Air, and Soil Pollution*, *175*(1), pp.193-221.
49. Barringer, J.L., Reilly, P.A., Eberl, D.D., Mumford, A.C., Benzel, W.M., Szabo, Z., Shourds, J.L. and Young, L.Y., 2013. Arsenic in New Jersey Coastal Plain streams, sediments, and shallow groundwater: effects from different geologic sources and anthropogenic inputs on biogeochemical and physical mobilization processes. In *US Geological Survey Scientific Investigations Report 2013-5107*.
50. Barringer, J.L., Mumford, A., Young, L.Y., Reilly, P.A., Bonin, J.L. and Rosman, R., 2010. Pathways for arsenic from sediments to groundwater to streams: biogeochemical processes in the Inner Coastal Plain, New Jersey, USA. *water research*, *44*(19), pp.5532-5544.
51. Barron, O.V., Crosbie, R.S., Dawes, W.R., Charles, S.P., Pickett, T. and Donn, M.J., 2012. Climatic controls on diffuse groundwater recharge across Australia. *Hydrology and Earth System Sciences*, *16*(12), pp.4557-4570.
52. Bartsch, I. and Moore, T.R., 1985. A preliminary investigation of primary production and decomposition in four peatlands near Schefferville, Québec. *Canadian Journal of Botany*, *63*(7), pp.1241-1248.
53. Barzen-Hanson, K.A., Roberts, S.C., Choyke, S., Oetjen, K., McAlees, A., Riddell, N., McCrindle, R., Ferguson, P.L., Higgins, C.P. and Field, J.A., 2017. Discovery of 40 classes of per-and polyfluoroalkyl substances in historical aqueous film-forming foams (AFFFs) and AFFF-impacted groundwater. *Environmental science & technology*, *51*(4), pp.2047-2057.
54. Bates, B., Kundzewicz, Z. and Wu, S., 2008. *Climate change and water*. Intergovernmental Panel on Climate Change Secretariat.
55. Battistel, M., Stolze, L., Muniruzzaman, M. and Rolle, M., 2021. Arsenic release and transport during oxidative dissolution of spatially-distributed sulfide minerals. *Journal of Hazardous Materials*, *409*, p.124651.
56. Bedaso, Z.K., Wu, S.Y., Johnson, A.N. and McTighe, C., 2019. Assessing groundwater sustainability under changing climate using isotopic tracers and climate modelling, southwest Ohio, USA. *Hydrological Sciences Journal*, *64*(7), pp.798-807
57. Befus, K.M., Barnard, P.L., Hoover, D.J., Finzi Hart, J.A. and Voss, C.I., 2020. Increasing threat of coastal groundwater hazards from sea-level rise in California. *Nature Climate Change*, *10*(10), pp.946-952.
58. Benz, S.A., Menberg, K., Bayer, P. and Kurylyk, B.L., 2022. Shallow subsurface heat recycling is a sustainable global space heating alternative. *Nature communications*, *13*(1), pp.1-11.
59. Bevacqua, E., Vousdoukas, M.I., Zappa, G., Hodges, K., Shepherd, T.G., Maraun, D., Mentaschi, L. and Feyen, L., 2020. More meteorological events that drive compound coastal flooding are projected under climate change. *Communications earth & environment*, *1*(1), pp.1-11.
60. Bhagat, C., Puri, M., Mohapatra, P.K. and Kumar, M., 2021. Imprints of seawater intrusion on groundwater quality and evolution in the coastal districts of south Gujarat, India. *Case Studies in Chemical and Environmental Engineering*, *3*, p.100101.
61. Bhaskar, A.S., Harvey, J.W. and Henry, E.J., 2012. Resolving hyporheic and groundwater components of streambed water flux using heat as a tracer. *Water Resources Research*, *48*(8).
62. Beigi, E. and Tsai, F.T.C., 2015. Comparative study of climate-change scenarios on groundwater recharge, southwestern Mississippi and southeastern Louisiana, USA. *Hydrogeology Journal*, *23*(4), pp.789-806.
63. Bellot, J. and Chirino, E., 2013. Hydrobal: An eco-hydrological modelling approach for assessing water balances in different vegetation types in semi-arid areas. *Ecological modelling*, *266*, pp.30-41.
64. Benz, S.A., Bayer, P. and Blum, P., 2017. Global patterns of shallow groundwater temperatures. *Environmental Research Letters*, *12*(3), p.034005.
65. Berrang-Ford, L., Ford, J.D. and Paterson, J., 2011. Are we adapting to climate change? *Global environmental change*, *21*(1), pp.25-33.
66. Bierkens, M.F. and Wada, Y., 2019. Non-renewable groundwater use and groundwater depletion: a review. *Environmental Research Letters*, *14*(6), p.063002.
67. Bilskie, M.V., Angel, D.D., Yoskowitz, D. and Hagen, S.C., 2022. Future flood risk exacerbated by the dynamic impacts of sea level rise along the Northern Gulf of Mexico. *Earth's Future*, *10*(4), p.e2021EF002414.
68. Bjerklie, D.M., Mullaney, J.R., Stone, J.R., Skinner, B.J., and Ramlow, M.A., 2012, Preliminary investigation of the effects of sea-level rise on groundwater levels in New Haven, Connecticut: U.S. Geological Survey Open-File Report 2012–1025, 46 p., at http://pubs.usgs.gov/of/2012/1025.

69. Bloomfield, J.P., Jackson, C.R. and Stuart, M.E., 2013. Changes in groundwater levels, temperature and quality in the UK over the 20th century: an assessment of evidence of impacts from climate change. LWEC Working Paper.
70. Boas, T. and Mallants, D., 2022. Episodic extreme rainfall events drive groundwater recharge in arid zone environments of central Australia. *Journal of Hydrology: Regional Studies*, *40*, p.101005.
71. Böhlke, J.K., 2002a. Groundwater recharge and agricultural contamination. *Hydrogeology Journal*, *10*(1), pp.153-179.
72. Böhlke, J.K., Wanty, R., Tuttle, M., Delin, G. and Landon, M., 2002b. Denitrification in the recharge area and discharge area of a transient agricultural nitrate plume in a glacial outwash sand aquifer, Minnesota. *Water Resources Research*, *38*(7), pp.10-1.
73. Böhlke, J.K., O'Connell, M.E. and Prestegaard, K.L., 2007. Ground water stratification and delivery of nitrate to an incised stream under varying flow conditions. *Journal of Environmental Quality*, *36*(3), pp.664-680.
74. Bondu, R., Cloutier, V., Rosa, E. and Benzaazoua, M., 2016. A review and evaluation of the impacts of climate change on geogenic arsenic in groundwater from fractured bedrock aquifers. *Water, Air, & Soil Pollution*, *227*(9), pp.1-14.
75. Bonte, M., Van Breukelen, B.M. and Stuyfzand, P.J., 2013a. Environmental impacts of aquifer thermal energy storage investigated by field and laboratory experiments. *Journal of water and climate change*, *4*(2), pp.77-89.
76. Bonte, M., van Breukelen, B.M. and Stuyfzand, P.J., 2013b. Temperature-induced impacts on groundwater quality and arsenic mobility in anoxic aquifer sediments used for both drinking water and shallow geothermal energy production. *Water research*, *47*(14), pp.5088-5100.
77. Bonte, M., Röling, W.F., Zaura, E., van der Wielen, P.W., Stuyfzand, P.J. and van Breukelen, B.M., 2013c. Impacts of shallow geothermal energy production on redox processes and microbial communities. *Environmental science & technology*, *47*(24), pp.14476-14484.
78. Bolton, D.W., 2000. *Occurrence and distribution of radium, gross alpha-particle activity, and gross beta-particle activity in ground water in the Magothy Formation and Potomac Group aquifers, upper Chesapeake Bay area, Maryland*. Department of Natural Resources, Resource Assessment Service, Maryland Geological Survey.
79. Borch, T., Kretzschmar, R., Kappler, A., Cappellen, P.V., Ginder-Vogel, M., Voegelin, A. and Campbell, K., 2010. Biogeochemical redox processes and their impact on contaminant dynamics. *Environmental science & technology*, *44*(1), pp.15-23
80. Borchardt, S., 2022. *Baseflow Variability Due to Changes in Climate, Basin Characteristics, and Groundwater Withdrawals in the State of Wisconsin, USA* (Doctoral dissertation, The University of Wisconsin-Milwaukee).
81. Bosserelle, A.L., Morgan, L.K. and Hughes, M.W., 2022. Groundwater Rise and Associated Flooding in Coastal Settlements Due to Sea‐Level Rise: A Review of Processes and Methods. *Earth's Future*, *10*(7), p.e2021EF002580.
82. Böttcher, F. and Zosseder, K., 2022. Thermal influences on groundwater in urban environments–A multivariate statistical analysis of the subsurface heat island effect in Munich. *Science of the Total Environment*, *810*, p.152193.
83. Boulton, A.J., Bichuette, M.E., Korbel, K., Stoch, F., Niemiller, M.L., Hose, G.C. and Linke, S., 2023. Recent concepts and approaches for conserving groundwater biodiversity. *Groundwater Ecology and Evolution*, pp.525-550.
84. Boumaiza, L., Walter, J., Chesnaux, R., Lambert, M., Jha, M.K., Wanke, H., Brookfield, A., Batelaan, O., Galvão, P., Laftouhi, N.E. and Stumpp, C., 2022. Groundwater recharge over the past 100 years: Regional spatiotemporal assessment and climate change impact over the Saguenay‐Lac‐Saint‐Jean region, Canada. *Hydrological Processes*, *36*(3), p.e14526.
85. Bovolo, C.I., Parkin, G. and Sophocleous, M., 2009. Groundwater resources, climate and vulnerability. *Environmental Research Letters*, *4*(3), p.035001.
86. Bozlee, B.J., Janebo, M. and Jahn, G., 2008. A simplified model to predict the effect of increasing atmospheric CO2 on carbonate chemistry in the ocean. *Journal of chemical education*, *85*(2), p.213.
87. Bradford, S.A., Morales, V.L., Zhang, W., Harvey, R.W., Packman, A.I., Mohanram, A. and Welty, C., 2013. Transport and fate of microbial pathogens in agricultural settings. *Critical Reviews in Environmental Science and Technology*, *43*(8), pp.775-893.
88. Brady, N.C., Weil, R.R. and Weil, R.R., 2008. *The nature and properties of soils* (Vol. 13, pp. 662-710). Upper Saddle River, NJ: Prentice Hall.
89. Brennan, F.P., O'Flaherty, V., Kramers, G., Grant, J. and Richards, K.G., 2010. Long-term persistence and leaching of Escherichia coli in temperate maritime soils. *Applied and environmental microbiology*, *76*(5), pp.1449-1455.
90. Brikowski, T.H., Neku, A., Shrestha, S.D. and Smith, L.S., 2014. Hydrologic control of temporal variability in groundwater arsenic on the Ganges floodplain of Nepal. *Journal of Hydrology*, *518*, pp.342-353.

91. Broder, T., Knorr, K.H. and Biester, H., 2017. Changes in dissolved organic matter quality in a peatland and forest headwater stream as a function of seasonality and hydrologic conditions. *Hydrology and Earth System Sciences*, *21*(4), pp.2035-2051.
92. Brons, H.J., Griffioen, J., Appelo, C.A.J., Zehnder, A.J.B., 1991. Biogeochemical reactions in aquifer material from a thermal energy storage site. *Water Research* 25 (6), 729e736.
93. Brown, T.C., Mahat, V. and Ramirez, J.A., 2019. Adaptation to future water shortages in the United States caused by population growth and climate change. *Earth's Future*, *7*(3), pp.219-234.
94. Bucci, A., Lasagna, M., De Luca, D.A., Acquaotta, F., Barbero, D. and Fratianni, S., 2020. Time series analysis of underground temperature and evaluation of thermal properties in a test site of the Po plain (NW Italy). *Environmental Earth Sciences*, *79*, pp.1-15.
95. Brusseau, M.L., Carroll, K.C., Truex, M.J. and Becker, D.J., 2013. Characterization and remediation of chlorinated volatile organic contaminants in the vadose zone. *Vadose Zone Journal*, *12*(4).
96. Brusseau, M.L. and Van Glubt, S., 2019. The influence of surfactant and solution composition on PFAS adsorption at fluid-fluid interfaces. *Water research*, *161*, pp.17-26.
97. Brusseau, M.L., Anderson, R.H. and Guo, B., 2020. PFAS concentrations in soils: Background levels versus contaminated sites. *Science of The Total Environment*, *740*, p.140017.
98. Burri, N.M., Weatherl, R., Moeck, C. and Schirmer, M., 2019. A review of threats to groundwater quality in the anthropocene. *Science of the Total Environment*, *684*, pp.136-154.
99. Burton, E.D., Bush, R.T., Sullivan, L.A., Johnston, S.G. and Hocking, R.K., 2008. Mobility of arsenic and selected metals during re-flooding of iron-and organic-rich acid-sulfate soil. *Chemical Geology*, *253*(1-2), pp.64-73.
100. Burton, E.D., Johnston, S.G. and Kocar, B.D., 2014. Arsenic mobility during flooding of contaminated soil: the effect of microbial sulfate reduction. *Environmental science & technology*, *48*(23), pp.13660-13667.
101. Butcher, K.R., Nasto, M.K., Norton, J.M. and Stark, J.M., 2020. Physical mechanisms for soil moisture effects on microbial carbon-use efficiency in a sandy loam soil in the western United States. *Soil Biology and Biochemistry*, *150*, p.107969.
102. Calvache, M.L., Duque, C., Fontalva, J.M. and Crespo, F., 2011. Processes affecting groundwater temperature patterns in a coastal aquifer. *International Journal of Environmental Science & Technology*, *8*(2), pp.223-236.
103. Cáñez, T.T., Guo, B., McIntosh, J.C. and Brusseau, M.L., 2021. Perfluoroalkyl and polyfluoroalkyl substances (PFAS) in groundwater at a reclaimed water recharge facility. *Science of The Total Environment*, *791*, p.147906.
104. Canfield, D.E. and Farquhar, J., 2009. Animal evolution, bioturbation, and the sulfate concentration of the oceans. *Proceedings of the National Academy of Sciences*, *106*(20), pp.8123-8127.
105. Cao, X., He, W., Fan, M., Shi, Y., An, T., Chen, X., Zhang, Z., Liu, F., Zhao, Y., Zhou, P. and Chen, C., 2023. Novel insights into source apportionment of dissolved organic matter in aquifer affected by anthropogenic groundwater recharge: Applicability of end-member mixing analysis based optical indices. *Science of The Total Environment*, *863*, p.160885.
106. Carleton, G.B., Charles, E.G., Fiore, A.R. and Winston, R.B., 2021. *Simulation of water-table response to sea-level rise and change in recharge, Sandy Hook unit, Gateway National Recreation Area, New Jersey* (No. 2020-5080). US Geological Survey.
107. Castaldo, G., Visser, A., Fogg, G.E. and Harter, T., 2021. Effect of groundwater age and recharge source on nitrate concentrations in domestic wells in the san Joaquin valley. *Environmental science & technology*, *55*(4), pp.2265-2275.
108. Cavelan, A., Golfier, F., Colombano, S., Davarzani, H., Deparis, J. and Faure, P., 2022. A critical review of the influence of groundwater level fluctuations and temperature on LNAPL contaminations in the context of climate change. *Science of the Total Environment*, *806*, p.150412.
109. Cha, J., Lee, J.Y. and Chia, R.W., 2023. Microplastics contamination and characteristics of agricultural groundwater in Haean Basin of Korea. *Science of The Total Environment*, *864*, p.161027.
110. Chapelle, F.H., McMahon, P.B., Dubrovsky, N.M., Fujii, R.F., Oaksford, E.T. and Vroblesky, D.A., 1995. Deducing the distribution of terminal electron-accepting processes in hydrologically diverse groundwater systems. *Water Resources Research*, *31*(2), pp.359-371.
111. Chen, M.A. and Kocar, B.D., 2018. Radium sorption to iron (hydr) oxides, pyrite, and montmorillonite: implications for mobility. *Environmental science & technology*, *52*(7), pp.4023-4030.
112. Chen, M., Price, R.M., Yamashita, Y. and Jaffé, R., 2010. Comparative study of dissolved organic matter from groundwater and surface water in the Florida coastal Everglades using multi-dimensional spectrofluorometry combined with multivariate statistics. *Applied Geochemistry*, *25*(6), pp.872-880.
113. Chen, M., Qin, X., Zeng, G. and Li, J., 2016. Impacts of human activity modes and climate on heavy metal “spread” in groundwater are biased. *Chemosphere*, *152*, pp.439-445.

114.Chia, R.W., Lee, J.Y., Kim, H. and Jang, J., 2021. Microplastic pollution in soil and groundwater: a review. *Environmental Chemistry Letters*, *19*(6), pp.4211-4224.
115.Chiloane, C., Dube, T. and Shoko, C., 2022. Impacts of groundwater and climate variability on terrestrial groundwater dependent ecosystems: a review of geospatial assessment approaches and challenges and possible future research directions. *Geocarto International*, *37*(23), pp.6755-6779.
116.Christensen, T.H., Kjeldsen, P., Albrechtsen, H.J.R., Heron, G., Nielsen, P.H., Bjerg, P.L. and Holm, P.E., 1994. Attenuation of landfill leachate pollutants in aquifers. *Critical reviews in environmental science and technology*, *24*(2), pp.119-202.
117.Chuah, C.J. and Ziegler, A.D., 2018. Temporal variability of faecal contamination from on-site sanitation systems in the groundwater of Northern Thailand. *Environmental management*, *61*(6), pp.939-953.
118.Chuan, M.C., Shu, G.Y. and Liu, J.C., 1996. Solubility of heavy metals in a contaminated soil: effects of redox potential and pH. *Water, Air, and Soil Pollution*, *90*(3), pp.543-556.
119.Clark, M.P., Wilby, R.L., Gutmann, E.D., Vano, J.A., Gangopadhyay, S., Wood, A.W., Fowler, H.J., Prudhomme, C., Arnold, J.R. and Brekke, L.D., 2016. Characterizing uncertainty of the hydrologic impacts of climate change. *Current Climate Change Reports*, *2*, pp.55-64.
120.Condon, L.E., Atchley, A.L. and Maxwell, R.M., 2020. Evapotranspiration depletes groundwater under warming over the contiguous United States. *Nature communications*, *11*(1), p.873.
121.Connolly, C.T., Stahl, M.O., DeYoung, B.A. and Bostick, B.C., 2021. Surface flooding as a key driver of groundwater arsenic contamination in Southeast Asia. *Environmental Science & Technology*, *56*(2), pp.928-937.
122.Conrad, M.E. and DePaolo, D.J., 2004. Carbon isotopic evidence for biodegradation of organic contaminants in the shallow vadose zone of the Radioactive Waste Management complex. *Vadose Zone Journal*, *3*(1), pp.143-153.
123.Cooley, S.W., Ryan, J.C. and Smith, L.C., 2021. Human alteration of global surface water storage variability. *Nature*, *591*(7848), pp.78-81.
124.Cox, A.H., Surabian, D., Loomis, G.W., Turenne, J.D. and Amador, J.A., 2020. Temporal variability in the vertical separation distance of septic system drainfields along the southern Rhode Island coast. *Water, Air, & Soil Pollution*, *231*, pp.1-17.
125.Coyte, R.M. and Vengosh, A., 2020. Factors controlling the risks of co-occurrence of the redox-sensitive elements of arsenic, chromium, vanadium, and uranium in groundwater from the Eastern United States. *Environmental science & technology*, *54*(7), pp.4367-4375.
126.Cramer, A., Benard, P., Zarebanadkouki, M., Kaestner, A. and Carminati, A., 2022. Microplastic induces soil water repellency and limits capillary flow. *Vadose Zone Journal*, p.e20215.
127.Crosbie, R.S., McCallum, J.L., Walker, G.R. and Chiew, F.H., 2012. Episodic recharge and climate change in the Murray-Darling Basin, Australia. *Hydrogeology Journal*, *2*(20), pp.245-261.
128.Crosbie, R.S., Scanlon, B.R., Mpelasoka, F.S., Reedy, R.C., Gates, J.B. and Zhang, L., 2013. Potential climate change effects on groundwater recharge in the High Plains Aquifer, USA. *Water Resources Research*, *49*(7), pp.3936-3951.
129.Cuthbert, M.O., Gleeson, T., Moosdorf, N., Befus, K.M., Schneider, A., Hartmann, J. and Lehner, B., 2019. Global patterns and dynamics of climate–groundwater interactions. *Nature Climate Change*, *9*(2), pp.137-141.
130.Daugherty, E.E., Gilbert, B., Nico, P.S. and Borch, T., 2017. Complexation and redox buffering of iron (II) by dissolved organic matter. *Environmental science & technology*, *51*(19), pp.11096-11104.
131.DeGaetano, A., 2021. Projected Changes in Extreme Rainfall in New Jersey based on an Ensemble of Downscaled Climate Model Projections. Report Prepared for New Jersey Department of Environmental Protection. October 2021.
132.Degnan, J.R., Levitt, J.P., Erickson, M.L., Jurgens, B.C., Lindsey, B.D. and Ayotte, J.D., 2020. Time scales of arsenic variability and the role of high-frequency monitoring at three water-supply wells in New Hampshire, USA. *Science of the Total Environment*, *709*, p.135946.
133.Dehbandi, R., Abbasnejad, A., Karimi, Z., Herath, I. and Bundschuh, J., 2019. Hydrogeochemical controls on arsenic mobility in an arid inland basin, Southeast of Iran: The role of alkaline conditions and salt water intrusion. *Environmental Pollution*, *249*, pp.910-922.
134.Dehghani, R., Poudeh, H.T. and Izadi, Z., 2022. The effect of climate change on groundwater level and its prediction using modern meta-heuristic model. *Groundwater for Sustainable Development*, *16*, p.100702.
135.Delle Site, A., 2001. Factors affecting sorption of organic compounds in natural sorbent/water systems and sorption coefficients for selected pollutants. A review. *Journal of Physical and Chemical Reference Data*, *30*(1), pp.187-439.
136.Denver, J.M., Ator, S.W., Fischer, J.M., Harned, D.C., Schubert, C. and Szabo, Z., 2015. *The quality of our Nation's waters: water quality in the Northern Atlantic Coastal Plain surficial aquifer system, Delaware, Maryland, New*

Jersey, New York, North Carolina, and Virginia, 1988-2009. Geological Survey Circular 1353, 88 p., http://dx.doi.org/10.3133/cir1353.
137. Deshmukh, M.M., Elbeltagi, A. and Kouadri, S., 2022. Climate Change Impact on Groundwater Resources in Semi-arid Regions. In *Climate Change Impact on Groundwater Resources: Human Health Risk Assessment in Arid and Semi-arid Regions* (pp. 9-23). Cham: Springer International Publishing.
138. De Vries, J.J. and Simmers, I., 2002. Groundwater recharge: an overview of processes and challenges. *Hydrogeology Journal*, *10*(1), pp.5-17.
139. Di Curzio, D., 2019. Hydrogeochemical and hydrodynamic features affecting redox processes in groundwater. *Acque Sotterranee-Italian Journal of Groundwater*, *8*(3).
140. Dieleman, C.M., Lindo, Z., McLaughlin, J.W., Craig, A.E. and Branfireun, B.A., 2016. Climate change effects on peatland decomposition and porewater dissolved organic carbon biogeochemistry. *Biogeochemistry*, *128*, pp.385-396.
141. Dieter, C.A., Maupin, M.A., Caldwell, R.R., Harris, M.A., Ivahnenko, T.I., Lovelace, J.K., Barber, N.L., and Linsey, K.S., 2018, Estimated use of water in the United States in 2015: U.S. Geological Survey Circular 1441, 65 p., https://doi.org/10.3133/cir1441. [Supersedes USGS Open-File Report 2017–1131.].
142. Doble, R.C., Crosbie, R.S., Smerdon, B.D., Peeters, L. and Cook, F.J., 2012. Groundwater recharge from overbank floods. *Water Resources Research*, *48*(9).
143. Dong, L., Zhang, J., Guo, Z., Li, M. and Wu, H., 2022. Distributions and interactions of dissolved organic matter and heavy metals in shallow groundwater in Guanzhong basin of China. *Environmental Research*, *207*, p.112099.
144. Döll, P, 2009. Vulnerability to the impact of climate change on renewable groundwater resources: a global-scale assessment. *Environmental Research Letters*, *4*(3), p.035006.
145. Douglas and Kirshen, 2022, Climate Change Impacts and Projections for the Greater Boston Area, Findings of the Greater Boston Research Advisory Group Report, UMass, Boston
146. Douville, H., K. Raghavan, J. Renwick, R.P. Allan, P.A. Arias, M. Barlow, R. Cerezo-Mota, A. Cherchi, T.Y. Gan, J. Gergis, D. Jiang, A. Khan, W. Pokam Mba, D. Rosenfeld, J. Tierney, and O. Zolina, 2021: Water Cycle Changes. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1055–1210, doi:10.1017/9781009157896.010.
147. Dragoni, W. and Sukhija, B.S., 2008. Climate change and groundwater: a short review. *Geological Society, London, Special Publications*, *288*(1), pp.1-12.
148. Dudley R.W. and Hodgkins G.A. 2013, Historical Groundwater Trends in Northern New England and Relations with Streamflow and Climatic Variables, *Journal of the American Water Resources Association (JAWRA)* 1-15. DOI: 10.1111/jawr.12080
149. Du Laing, G., De Vos, R., Vandecasteele, B., Lesage, E., Tack, F.M. and Verloo, M.G., 2008. Effect of salinity on heavy metal mobility and availability in intertidal sediments of the Scheldt estuary. *Estuarine, Coastal and Shelf Science*, *77*(4), pp.589-602.
150. Du Laing, G., Rinklebe, J., Vandecasteele, B., Meers, E. and Tack, F.M., 2009. Trace metal behaviour in estuarine and riverine floodplain soils and sediments: a review. *Science of the total environment*, *407*(13), pp.3972-3985.
151. Duran-Encalada, J.A., Paucar-Caceres, A., Bandala, E.R. and Wright, G.H., 2017. The impact of global climate change on water quantity and quality: A system dynamics approach to the US–Mexican transborder region. *European Journal of Operational Research*, *256*(2), pp.567-581.
152. Dzodzomenyo, M., Asamoah, M., Li, C., Kichana, E. and Wright, J., 2022. Impact of flooding on microbiological contamination of domestic water sources: a longitudinal study in northern Ghana. *Applied Water Science*, *12*(10), pp.1-10.
153. Earman, S. and Dettinger, M., 2011. Potential impacts of climate change on groundwater resources–a global review. *Journal of water and climate change*, *2*(4), pp.213-229.
154. Easterling, D.R., Arnold, J.R., Knutson, T., Kunkel, K.E., LeGrande, A.N., Leung, L.R., Vose, R.S., Waliser, D.E. and Wehner, M.F., 2017. Precipitation change in the United States.
155. Emmett, B.A., Beier, C., Estiarte, M., Tietema, A., Kristensen, H., Williams, D., Penuelas, J., Schmidt, I. and Sowerby, A., 2004. The response of soil processes to climate change: results from manipulation studies of shrublands across an environmental gradient. *Ecosystems*, *7*(6), pp.625-637.
156. Eamus, D., Zolfaghar, S., Villalobos-Vega, R., Cleverly, J. and Huete, A., 2015. Groundwater-dependent ecosystems: recent insights from satellite and field-based studies. *Hydrology and Earth System Sciences*, *19*(10), pp.4229-4256.

157. Eckhardt, K. and Ulbrich, U., 2003. Potential impacts of climate change on groundwater recharge and streamflow in a central European low mountain range. *Journal of hydrology*, *284*(1-4), pp.244-252.
158. Egidio, E., Mancini, S., De Luca, D.A. and Lasagna, M., 2022. The impact of climate change on groundwater temperature of the Piedmont Po plain (NW Italy). *Water*, *14*(18), p.2797.
159. Elango, L. and Kannan, R., 2007. Rock–water interaction and its control on chemical composition of groundwater. *Development in environmental science*, *5*, pp.229-243.
160. Elliott, J., Deryng, D., Müller, C., Frieler, K., Konzmann, M., Gerten, D., Glotter, M., Flörke, M., Wada, Y., Best, N. and Eisner, S., 2014. Constraints and potentials of future irrigation water availability on agricultural production under climate change. *Proceedings of the National Academy of Sciences*, *111*(9), pp.3239-3244.
161. Engström, E., Balfors, B., Mörtberg, U., Thunvik, R., Gaily, T. and Mangold, M., 2015. Prevalence of microbiological contaminants in groundwater sources and risk factor assessment in Juba, South Sudan. *Science of the Total Environment*, *515*, pp.181-187.
162. Epting, J., Michel, A., Affolter, A. and Huggenberger, P., 2021. Climate change effects on groundwater recharge and temperatures in Swiss alluvial aquifers. *Journal of Hydrology X*, *11*, p.100071.
163. Erickson, M.L., Swanner, E.D., Ziegler, B.A. and Havig, J.R., 2021. Months-long spike in aqueous arsenic following domestic well installation and disinfection: Short-and long-term drinking water quality implications. *Journal of Hazardous Materials*, *414*, p.125409.
164. Esfandiari, A., Abbasi, S., Peely, A.B., Mowla, D., Ghanbarian, M.A., Oleszczuk, P. and Turner, A., 2022. Distribution and transport of microplastics in groundwater (Shiraz aquifer, southwest Iran). *Water Research*, *220*, p.118622.
165. Etikala, B., Golla, V., Adimalla, N. and Marapatla, S., 2019. Factors controlling groundwater chemistry of Renigunta area, Chittoor District, Andhra Pradesh, South India: A multivariate statistical approach. *HydroResearch*, *1*, pp.57-62.
166. Evans, C.D., Monteith, D.T. and Cooper, D.M., 2005. Long-term increases in surface water dissolved organic carbon: observations, possible causes and environmental impacts. *Environmental pollution*, *137*(1), pp.55-71.
167. Fang, Y., Chen, M., Liu, C., Dong, L., Zhou, J., Yi, X., Ji, D., Qiao, J. and Tong, H., 2023. Arsenic release from microbial reduction of scorodite in the presence of electron shuttle in flooded soil. *Journal of Environmental Sciences*, *126*, pp.113-122.
168. Farnsworth, C.E. and Hering, J.G., 2011. Inorganic geochemistry and redox dynamics in bank filtration settings. *Environmental science & technology*, *45*(12), pp.5079-5087.
169. Fakhreddine, S., Prommer, H., Scanlon, B.R., Ying, S.C. and Nicot, J.P., 2021. Mobilization of arsenic and other naturally occurring contaminants during managed aquifer recharge: a critical review. *Environmental Science & Technology*, *55*(4), pp.2208-2223.
170. Feng, Q., An, C., Chen, Z. and Wang, Z., 2023. New Perspective on the Mobilization of Microplastics through Capillary Fringe Fluctuation in a Tidal Aquifer Environment. *Environmental Science & Technology*.
171. Feng, Y., Dong, S., Ma, M., Hou, Q., Zhao, Z. and Zhang, W., 2023a. The influence mechanism of hydrogeochemical environment and sulfur and nitrogen cycle on arsenic enrichment in groundwater: A case study of Hasuhai basin, China. *Science of The Total Environment*, 858, p.160013.
172. Figura, S., Livingstone, D.M., Hoehn, E. and Kipfer, R., 2011. Regime shift in groundwater temperature triggered by the Arctic Oscillation. *Geophysical Research Letters*, *38*(23).
173. Figura, S., Livingstone, D.M. and Kipfer, R., 2013. Competing controls on groundwater oxygen concentrations revealed in multidecadal time series from riverbank filtration sites. *Water Resources Research*, *49*(11), pp.7411-7426.
174. Filippini, M., 2017. Migration of chlorinated hydrocarbons in multilayer unconsolidated porous media: a case study from the Po Plain, Italy. *Acque Sotterranee-Italian Journal of Groundwater*, *6*(4).
175. Fiore, A.R., Voronin, L.M. and Wieben, C.M., 2018. *Hydrogeology of, simulation of groundwater flow in, and potential effects of sea-level rise on the Kirkwood-Cohansey aquifer system in the vicinity of Edwin B. Forsythe National Wildlife Refuge, New Jersey*. U.S. Geological Survey Scientific Investigations Report 2017–5135, 59 p.
176. Flanagan, S.V., Spayd, S.E., Procopio, N.A., Chillrud, S.N., Braman, S. and Zheng, Y., 2016. Arsenic in private well water part 1 of 3: Impact of the New Jersey Private Well Testing Act on household testing and mitigation behavior. *Science of the Total Environment*, *562*, pp.999-1009.
177. Flörke, M., Schneider, C. and McDonald, R.I., 2018. Water competition between cities and agriculture driven by climate change and urban growth. *Nature Sustainability*, *1*(1), pp.51-58.
178. Focaccia, S., Panini, G., Pedrazzoli, P. and Ciriello, V., 2021. A meta-modeling approach for hydrological forecasting under uncertainty: Application to groundwater nitrate response to climate change. *Journal of Hydrology*, *603*, p.127173.

179. Foley, N.K. and Ayuso, R.A., 2008. Mineral sources and transport pathways for arsenic release in a coastal watershed, USA. *Geochemistry: Exploration, Environment, Analysis*, *8*(1), pp.59-75.
180. Fortin, D. and Langley, S., 2005. Formation and occurrence of biogenic iron-rich minerals. *Earth-Science Reviews*, *72*(1-2), pp.1-19.
181. Foulquier, A., Malard, F., Barraud, S. and Gibert, J., 2009. Thermal influence of urban groundwater recharge from stormwater infiltration basins. *Hydrological Processes: An International Journal*, *23*(12), pp.1701-1713.
182. Ferguson, G. and Gleeson, T., 2012. Vulnerability of coastal aquifers to groundwater use and climate change. *Nature climate change*, *2*(5), pp.342-345.
183. Funari, E., Manganelli, M. and Sinisi, L., 2012. Impact of climate change on waterborne diseases. *Annali dell'Istituto superiore di sanita*, *48*, pp.473-487.
184. Gao, Z., Weng, H. and Guo, H., 2021. Unraveling influences of nitrogen cycling on arsenic enrichment in groundwater from the Hetao Basin using geochemical and multi-isotopic approaches. *Journal of Hydrology*, *595*, p.125981.
185. Gao, Z., Guo, H., Qiao, W., He, C., Shi, Q., Ke, T. and Cao, Y., 2023. Dissolved organic matter sources in high arsenic groundwater from a sand-gravel confined aquifer. *Journal of Geophysical Research: Biogeosciences*, p.e2022JG007178.
186. Garelick, H., Jones, H., Dybowska, A. and Valsami-Jones, E., 2009. Arsenic pollution sources. *Reviews of Environmental Contamination Volume 197*, pp.17-60.
187. Garcia, H.E. and Gordon, L.I., 1992. Oxygen solubility in seawater: Better fitting equations. *Limnology and oceanography*, *37*(6), pp.1307-1312.
188. García-Prieto, J.C., Cachaza, J.M., Pérez-Galende, P. and Roig, M.G., 2012. Impact of drought on the ecological and chemical status of surface water and on the content of arsenic and fluoride pollutants of groundwater in the province of Salamanca (Western Spain). *Chemistry and Ecology*, *28*(6), pp.545-560.
189. Gascuel-Odoux, C., Fovet, O., Faucheux, M., Salmon-Monviola, J. and Strohmenger, L., 2023. How to assess water quality change in temperate headwater catchments of western Europe under climate change: examples and perspectives. *Comptes Rendus. Géoscience*, *355*(S1), pp.1-11.
190. Gaur, N., Narasimhulu, K. and PydiSetty, Y., 2018. Recent advances in the bio-remediation of persistent organic pollutants and its effect on environment. *Journal of cleaner production*, *198*, pp.1602-1631.
191. Geris, J., Comte, J.C., Franchi, F., Petros, A.K., Tirivarombo, S., Selepeng, A.T. and Villholth, K.G., 2022. Surface water-groundwater interactions and local land use control water quality impacts of extreme rainfall and flooding in a vulnerable semi-arid region of Sub-Saharan Africa. *Journal of Hydrology*, *609*, p.127834.
192. Ghiorse, W.C. and Wilson, J.T., 1988. Microbial ecology of the terrestrial subsurface. *Advances in applied microbiology*, *33*, pp.107-172.
193. Giri, S., Kang, Y., MacDonald, K., Tippett, M., Qiu, Z., Lathrop, R.G. and Obropta, C.C., 2022. Revealing the sources of arsenic in private well water using Random Forest Classification and Regression. *Science of The Total Environment*, p.159360.
194. Gitter, A., Boellstorff, D.E., Mena, K.D., Gholson, D.M., Pieper, K.J., Chavarria, C.A. and Gentry, T.J., 2023. Quantitative Microbial Risk Assessment for Private Wells in Flood-Impacted Areas. *Water*, *15*(3), p.469.
195. Glassley W.E., Nitao J.J., Grant C.W., 2003. Three-dimensional spatial variability of chemical properties around a monitored waste emplacement tunnel. J Contam Hydrol. 2003 Apr-May;62-63:495-507. doi: 10.1016/s0169-7722(02)00153-5. PMID: 12714307.
196. Gnesda, W.R., Draxler, E.F., Tinjum, J. and Zahasky, C., 2022. Adsorption of PFAAs in the Vadose Zone and Implications for Long-Term Groundwater Contamination. *Environmental Science & Technology*, *56*(23), pp.16748-16758.
197. Golub, M., Thiery, W., Marcé, R., Pierson, D., Vanderkelen, I., Mercado-Bettin, D., Woolway, R.I., Grant, L., Jennings, E., Kraemer, B.M. and Schewe, J., 2022. A framework for ensemble modelling of climate change impacts on lakes worldwide: the ISIMIP Lake Sector. *Geoscientific Model Development*, *15*(11), pp.4597-4623.
198. Gómez, J.A., 2021, May. Superfund EPA: Should Take Additional Actions to Manage Risks from Climate Change Effects, Statement of J. Alfredo Gómez, Director, Natural Resources and Environment, Testimony Before the Subcommittee on Environment and Climate Change, Committee on Energy and Commerce, House of Representatives. In *United States. Government Accountability Office* (No. GAO-21-555T). United States. Government Accountability Office.
199. Goni, I.B., Taylor, R.G., Favreau, G., Shamsudduha, M., Nazoumou, Y. and Ngounou Ngatcha, B., 2021. Groundwater recharge from heavy rainfall in the southwestern Lake Chad Basin: evidence from isotopic observations. *Hydrological Sciences Journal*, *66*(8), pp.1359-1371.

200. Goodrow, S.M., Ruppel, B., Lippincott, R.L., Post, G.B. and Procopio, N.A., 2020. Investigation of levels of perfluoroalkyl substances in surface water, sediment and fish tissue in New Jersey, USA. *Science of The Total Environment*, *729*, p.138839.
201. Goovaerts, P., AvRuskin, G., Meliker, J., Slotnick, M., Jacquez, G. and Nriagu, J., 2005. Geostatistical modeling of the spatial variability of arsenic in groundwater of southeast Michigan. *Water Resources Research*, *41*(7).
202. Gowrisankar, G., Chelliah, R., Ramakrishnan, S.R., Elumalai, V., Dhanamadhavan, S., Brindha, K., Antony, U. and Elango, L., 2017. Chemical, microbial and antibiotic susceptibility analyses of groundwater after a major flood event in Chennai. *Scientific data*, *4*(1), pp.1-13.
203. Grassi, S. and Netti, R., 2000. Sea water intrusion and mercury pollution of some coastal aquifers in the province of Grosseto (Southern Tuscany—Italy). *Journal of Hydrology*, *237*(3-4), pp.198-211.
204. Green, T.R., Taniguchi, M., Kooi, H., Gurdak, J.J., Allen, D.M., Hiscock, K.M., Treidel, H. and Aureli, A., 2011. Beneath the surface of global change: Impacts of climate change on groundwater. Journal of Hydrology, 405(3-4), pp.532-560.
205. Griggs, G. and Reguero, B.G., 2021. Coastal adaptation to climate change and sea-level rise. *Water*, *13*(16), p.2151.
206. Guillaumot, L., Longuevergne, L., Marçais, J., Lavenant, N. and Bour, O., 2022. Frequency domain water table fluctuations reveal impacts of intense rainfall and vadose zone thickness on groundwater recharge. *Hydrology and Earth System Sciences*, *26*(22), pp.5697-5720.
207. Gunawardhana, L.N. and Kazama, S., 2011. Climate change impacts on groundwater temperature change in the Sendai plain, Japan. *Hydrological Processes*, *25*(17), pp.2665-2678.
208. Gunduz, O. and Simsek, C., 2011. Influence of climate change on shallow groundwater resources: the link between precipitation and groundwater levels in alluvial systems. In *Climate Change and its Effects on Water Resources* (pp. 225-233). Springer, Dordrecht.
209. Guo, Q., Zhang, Y., Zhou, Z. and Hu, Z., 2020. Transport of contamination under the influence of sea level rise in coastal heterogeneous aquifer. *Sustainability*, *12*(23), p.9838.
210. Guo, B., Zeng, J. and Brusseau, M.L., 2020a. A mathematical model for the release, transport, and retention of per- and polyfluoroalkyl substances (PFAS) in the vadose zone. *Water Resources Research*, *56*(2), p.e2019WR026667.
211. Guo, D., Thomas, J., Lazaro, A.B., Matwewe, F. and Johnson, F., 2021. Modelling the influence of short-term climate variability on drinking water quality in tropical developing countries: A case study in Tanzania. *Science of The Total Environment*, *763*, p.142932.
212. Gupta, P.K. and Yadav, B.K., 2017. Bioremediation of non-aqueous phase liquids (NAPLS) polluted soil and water resources. *Environmental pollutants and their bioremediation approaches*, pp.241-256.
213. Gurdak, J.J., Hanson, R.T., McMahon, P.B., Bruce, B.W., McCray, J.E., Thyne, G.D. and Reedy, R.C., 2007. Climate variability controls on unsaturated water and chemical movement, High Plains aquifer, USA. *Vadose Zone Journal*, *6*(3), pp.533-547.
214. Gustavus, M., 2023. From Mountain Streams to Urban Rivers: An Assessment of Microplastic Sources and Characteristics.
215. Habel, S., Fletcher, C.H., Anderson, T.R. and Thompson, P.R., 2020. Sea-level rise induced multi-mechanism flooding and contribution to urban infrastructure failure. *Scientific reports*, *10*(1), pp.1-12.
216. Habtemichael, Y.T. and Fuentes, H.R., 2016. Hydrogeochemical analysis of processes through modeling of seawater intrusion impacts in Biscayne aquifer water quality, USA. *Aquatic Geochemistry*, *22*(3), pp.197-209.
217. Haddeland, I., Heinke, J., Biemans, H., Eisner, S., Flörke, M., Hanasaki, N., Konzmann, M., Ludwig, F., Masaki, Y., Schewe, J. and Stacke, T., 2014. Global water resources affected by human interventions and climate change. *Proceedings of the National Academy of Sciences*, *111*(9), pp.3251-3256.
218. Haidu, I. and Nistor, M.M., 2020. Long-term effect of climate change on groundwater recharge in the Grand Est region of France. *Meteorological Applications*, *27*(1), p.e1796.
219. Hanifehlou, A., Hosseini, S.A., Javadi, S. and Sharafati, A., 2022. Sustainable exploitation of groundwater resources considering the effects of climate change and land use to provide adaptation solutions (case study of the Hashtgerd plain). *Acta Geophysica*, *70*(4), pp.1829-1846.
220. Hanson, R.T., Flint, L.E., Flint, A.L., Dettinger, M.D., Faunt, C.C., Cayan, D. and Schmid, W., 2012. A method for physically based model analysis of conjunctive use in response to potential climate changes. *Water Resources Research*, *48*(6).
221. Hare, D.K., Helton, A.M., Johnson, Z.C., Lane, J.W. and Briggs, M.A., 2021. Continental-scale analysis of shallow and deep groundwater contributions to streams. *Nature Communications*, *12*(1), p.1450.
222. Hartmann, A., Gleeson, T., Wada, Y. and Wagener, T., 2017. Enhanced groundwater recharge rates and altered recharge sensitivity to climate variability through subsurface heterogeneity. *Proceedings of the National Academy of Sciences*, *114*(11), pp.2842-2847.

223. Haugen, E.A., Jurgens, B.C., Arroyo-Lopez, J.A. and Bennett, G.L., 2021. Groundwater development leads to decreasing arsenic concentrations in the San Joaquin Valley, California. *Science of The Total Environment*, *771*, p.145223.
224. Hausfather, Z. and Peters, G.P., 2020. Emissions–the 'business as usual' story is misleading. *Nature*, *577*(7792), pp.618-620.
225. Havril, T., Tóth, Á., Molson, J.W., Galsa, A. and Mádl-Szőnyi, J., 2018. Impacts of predicted climate change on groundwater flow systems: can wetlands disappear due to recharge reduction?. *Journal of hydrology*, *563*, pp.1169-1180.
226. He, H., Wu, T., Chen, Y.F. and Yang, Z., 2023. A pore-scale investigation of microplastics migration and deposition during unsaturated flow in porous media. *Science of The Total Environment*, *858*, p.159934.
227. Healy, R.W., 2010. *Estimating groundwater recharge*. Cambridge university press.
228. Healy, R.W. and Cook, P.G., 2002. Using groundwater levels to estimate recharge. *Hydrogeology journal*, *10*(1), pp.91-109.
229. Hemmerle, H. and Bayer, P., 2020. Climate change yields groundwater warming in Bavaria, Germany. *Frontiers in Earth Science*, p.523.
230. Henri, C.V., Harter, T. and Diamantopoulos, E., 2020. On the conceptual complexity of non-point source management: impact of spatial variability. *Hydrology and Earth System Sciences*, *24*(3), pp.1189-1209.
231. Hering, J.G. and Kneebone, P.E., 2002. Biogeochemical controls on arsenic occurrence and mobility in water supplies. *Environmental chemistry of arsenic*, pp.155-181.
232. Holden, P.A. and Fierer, N., 2005. Microbial processes in the vadose zone. *Vadose Zone Journal*, *4*(1), pp.1-21.
233. Holman, I.P., Allen, D.M., Cuthbert, M.O. and Goderniaux, P., 2012. Towards best practice for assessing the impacts of climate change on groundwater. *Hydrogeology Journal*, *20*(1), pp.1-4.
234. Hopmans, J.W. and van Genuchten, M.Th., 2005. Vadose Zone Hydrologic Processes, *Encyclopedia of Soils in the Environment*, Pages 209-216
235. Hou, Q., Zhang, Q., Huang, G., Liu, C. and Zhang, Y., 2020. Elevated manganese concentrations in shallow groundwater of various aquifers in a rapidly urbanized delta, south China. *Science of the Total Environment*, *701*, p.134777.
236. Hou, T., Blair, N.E., Papanicolaou, A.T. and Filley, T.R., 2023. Storm pulse responses of fluvial organic carbon to seasonal source supply and transport controls in a midwestern agricultural watershed. *Science of The Total Environment*, p.161647.
237. Houben, Georg J., Maria A. Sitnikova, and Vincent EA Post. "Terrestrial sedimentary pyrites as a potential source of trace metal release to groundwater–A case study from the Emsland, Germany." *Applied Geochemistry* 76 (2017): 99-111.
238. Hu, Y., Wu, G., Li, R., Xiao, L. and Zhan, X., 2020. Iron sulphides mediated autotrophic denitrification: An emerging bioprocess for nitrate pollution mitigation and sustainable wastewater treatment. *Water Research*, *179*, p.115914.
239. Huang, S., Chen, L., Li, J., Xu, J., Xie, W. and Zhang, C., 2023a. The effects of colloidal Fe and Mn on P distribution in groundwater system of Jianghan Plain, China. *Science of The Total Environment*, *854*, p.158739.
240. Huang, H., Mohamed, B.A. and Li, L.Y., 2023. Accumulation and fate of microplastics in soils after application of biosolids on land: A review. *Environmental Chemistry Letters*, pp.1-15.
241. Huggins, X., Gleeson, T., Castilla-Rho, J., Holley, C., Re, V. and Famiglietti, J.S., 2023. Groundwater connections and sustainability in social-ecological systems. *Groundwater*.
242. Hughes, A., Mansour, M., Ward, R., Kieboom, N., Allen, S., Seccombe, D., Charlton, M. and Prudhomme, C., 2021. The impact of climate change on groundwater recharge: National-scale assessment for the British mainland. *Journal of Hydrology*, *598*, p.126336.
243. Hummel, M.A., Wood, N.J., Schweikert, A., Stacey, M.T., Jones, J., Barnard, P.L. and Erikson, L., 2018. Clusters of community exposure to coastal flooding hazards based on storm and sea level rise scenarios—implications for adaptation networks in the San Francisco Bay region. *Regional environmental change*, *18*(5), pp.1343-1355.
244. Humphreys, W.F., 2006. Aquifers: the ultimate groundwater-dependent ecosystems. *Australian Journal of Botany*, *54*(2), pp.115-132.
245. Humphrey Jr, C., Dillane, D., Iverson, G. and O'Driscoll, M., 2021. Water table dynamics beneath onsite wastewater systems in eastern North Carolina in response to Hurricane Florence. *Journal of Water and Climate Change*, *12*(5), pp.2136-2146.
246. Hunter, P.R., 2003. Climate change and waterborne and vector-borne disease. *Journal of applied microbiology*, *94*, pp.37-46.

247. Huntington, T.G., Balch, W.M., Aiken, G.R., Sheffield, J., Luo, L., Roesler, C.S. and Camill, P., 2016. Climate change and dissolved organic carbon export to the Gulf of Maine. *Journal of Geophysical Research: Biogeosciences*, *121*(10), pp.2700-2716.
248. Hussain, F., Wu, R.S. and Shih, D.S., 2022. Water table response to rainfall and groundwater simulation using physics-based numerical model: WASH123D. *Journal of Hydrology: Regional Studies*, *39*, p.100988.
249. Inamdar, S., Finger, N., Singh, S., Mitchell, M., Levia, D., Bais, H., Scott, D. and McHale, P., 2012. Dissolved organic matter (DOM) concentration and quality in a forested mid-Atlantic watershed, USA. *Biogeochemistry*, *108*(1), pp.55-76.
250. Iordache, A.M., Nechita, C., Voica, C., Pluháček, T. and Schug, K.A., 2022. Climate change extreme and seasonal toxic metal occurrence in Romanian freshwaters in the last two decades—Case study and critical review. *NPJ Clean Water*, *5*(1), pp.1-9.
251. IPCC, 2022: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844
252. Izaditame, F., Siebecker, M.G. and Sparks, D.L., 2022. Sea-level-rise-induced flooding drives arsenic release from coastal sediments. *Journal of Hazardous Materials*, *423*, p.127161.
253. Jarsjö, J., Andersson-Sköld, Y., Fröberg, M., Pietroń, J., Borgström, R., Löv, Å. and Kleja, D.B., 2020. Projecting impacts of climate change on metal mobilization at contaminated sites: Controls by the groundwater level. *Science of the Total Environment*, *712*, p.135560.
254. Jasechko, S., Perrone, D., Seybold, H., Fan, Y. and Kirchner, J.W., 2020. Groundwater level observations in 250,000 coastal US wells reveal scope of potential seawater intrusion. *Nature communications*, *11*(1), p.3229.
255. Jasechko, S. and Taylor, R.G., 2015. Intensive rainfall recharges tropical groundwaters. *Environmental Research Letters*, *10*(12), p.124015.
256. Jayakumar, R. and Lee, E., 2016. Climate change and groundwater conditions in the Mekong Region–A review. *Journal of Groundwater Science and Engineering Vol*, *4*(2).
257. Jeen, S.W., Kang, J., Jung, H. and Lee, J., 2021. Review of seawater intrusion in western coastal regions of South Korea. *Water*, *13*(6), p.761.
258. Jennings, E., Järvinen, M., Allott, N., Arvola, L., Moore, K., Naden, P., Aonghusa, C.N., Nõges, T. and Weyhenmeyer, G.A., 2009. Impacts of climate on the flux of dissolved organic carbon from catchments. In *The impact of climate change on European lakes* (pp. 199-220). Springer, Dordrecht.
259. Jesußek, A., Grandel, S. and Dahmke, A., 2013a. Impacts of subsurface heat storage on aquifer hydrogeochemistry. *Environmental Earth Sciences*, *69*(6), pp.1999-2012.
260. Jesußek, A., Köber, R., Grandel, S. and Dahmke, A., 2013b. Aquifer heat storage: sulphate reduction with acetate at increased temperatures. *Environmental earth sciences*, *69*(5), pp.1763-1771.
261. Jesus, J.M., Danko, A.S., Fiúza, A. and Borges, M.T., 2015. Phytoremediation of salt-affected soils: a review of processes, applicability, and the impact of climate change. *Environmental Science and Pollution Research*, *22*(9), pp.6511-6525.
262. Jiang, Z., Shen, X., Shi, B., Cui, M., Wang, Y. and Li, P., 2022. Arsenic Mobilization and Transformation by Ammonium-Generating Bacteria Isolated from High Arsenic Groundwater in Hetao Plain, China. *International Journal of Environmental Research and Public Health*, *19*(15), p.9606.
263. Johnson, C.W., 1985. *Bogs of the Northeast*. UPNE.
264. Johnston, J., Cassalho, F., Miesse, T. and Ferreira, C.M., 2021. Projecting the effects of land subsidence and sea level rise on storm surge flooding in Coastal North Carolina. *Scientific reports*, *11*(1), pp.1-13.
265. Jong, B.T., Delworth, T.L., Cooke, W.F., Tseng, K.C. and Murakami, H., 2023. Increases in extreme precipitation over the Northeast United States using high-resolution climate model simulations. *npj Climate and Atmospheric Science*, *6*(1), p.18.
266. Juncher Jørgensen, C., Jacobsen, O.S., Elberling, B. and Aamand, J., 2009. Microbial oxidation of pyrite coupled to nitrate reduction in anoxic groundwater sediment. *Environmental science & technology*, *43*(13), pp.4851-4857.
267. Juntakut, P., Snow, D.D., Haacker, E.M. and Ray, C., 2019. The long term effect of agricultural, vadose zone and climatic factors on nitrate contamination in Nebraska's groundwater system. *Journal of contaminant hydrology*, *220*, pp.33-48.
268. Jutglar, K., Hellwig, J., Stoelzle, M. and Lange, J., 2021. Post-drought increase in regional-scale groundwater nitrate in southwest Germany. *Hydrological Processes*, *35*(8), p.e14307.

269. Jyrkama, M.I. and Sykes, J.F., 2007. The impact of climate change on spatially varying groundwater recharge in the grand river watershed (Ontario). *Journal of Hydrology*, *338*(3-4), pp.237-250.
270. Kaiser, K., Kaupenjohann, M. and Zech, W., 2001. Sorption of dissolved organic carbon in soils: effects of soil sample storage, soil-to-solution ratio, and temperature. *Geoderma*, *99*(3-4), pp.317-328.
271. Kane, E.S., Mazzoleni, L.R., Kratz, C.J., Hribljan, J.A., Johnson, C.P., Pypker, T.G. and Chimner, R., 2014. Peat porewater dissolved organic carbon concentration and lability increase with warming: a field temperature manipulation experiment in a poor-fen. *Biogeochemistry*, *119*(1), pp.161-178.
272. Kappler, A. and Haderlein, S.B., 2003. Natural organic matter as reductant for chlorinated aliphatic pollutants. *Environmental Science & Technology*, *37*(12), pp.2714-2719.
273. Karickhoff, S.W., Brown, D.S. and Scott, T.A., 1979. Sorption of hydrophobic pollutants on natural sediments. *Water research*, *13*(3), pp.241-248.
274. KarisAllen, J.J., Mohammed, A.A., Tamborski, J.J., Jamieson, R.C., Danielescu, S. and Kurylyk, B.L., 2022. Present and future thermal regimes of intertidal groundwater springs in a threatened coastal ecosystem. *Hydrology and Earth System Sciences*, *26*(18), pp.4721-4740.
275. Karl T.R., Meehl G.A., Miller C.D. et al. (2008) Weather and climate extremes in a changing climate. Regions of focus: North America, Hawaii, Caribbean, and U. S. Pacific islands. A report by the U. S. Climate Change Science Program and the Subcommittee on Global Change Research.
276. Karl, T.R., Melillo, J.M. and Peterson, T.C., 2009. *Global climate change impacts in the United States: a state of knowledge report from the US Global Change Research Program*. Cambridge University Press.
277. Karlin, E.F. and Andrus, R.E., 1988. The Sphagnum species of New Jersey. *Bulletin of the Torrey Botanical Club*, pp.168-195.
278. Kelly, T.J., Hamilton, E., Watts, M.J., Ponting, J. and Sizmur, T., 2020. The effect of flooding and drainage duration on the release of trace elements from floodplain soils. *Environmental Toxicology and Chemistry*, *39*(11), pp.2124-2135.
279. Kelleher, C.A., Golden, H.E. and Archfield, S.A., 2021. Monthly river temperature trends across the US confound annual changes. *Environmental Research Letters*, *16*(10), p.104006.
280. Kelso, J.E., 2018. *Organic Matter Sources, Composition, and Quality in Rivers and Experimental Streams* (Doctoral dissertation, Utah State University).
281. Khadra, W.M., Stuyfzand, P.J. and van Breukelen, B.M., 2017. Hydrochemical effects of seawater intrusion in a limestone and dolomitic limestone aquifer in Lebanon. *Applied Geochemistry*, *79*, pp.36-51.
282. Khatri, N. and Tyagi, S., 2015. Influences of natural and anthropogenic factors on surface and groundwater quality in rural and urban areas. *Frontiers in life science*, *8*(1), pp.23-39.
283. Kiaghadi, A., Rifai, H.S. and Dawson, C.N., 2021. The presence of Superfund sites as a determinant of life expectancy in the United States. *Nature communications*, *12*(1), p.1947.
284. Kim, H. and Lee, J.Y., 2020. Emerging concerns about microplastic pollution on groundwater in South Korea. *Sustainability*, *12*(13), p.5275.
285. Kirk, M.F., Roden, E.E., Crossey, L.J., Brealey, A.J. and Spilde, M.N., 2010. Experimental analysis of arsenic precipitation during microbial sulfate and iron reduction in model aquifer sediment reactors. *Geochimica et Cosmochimica Acta*, *74*(9), pp.2538-2555.
286. Kiro, Y., Yechieli, Y., Voss, C.I., Starinsky, A. and Weinstein, Y., 2012. Modeling radium distribution in coastal aquifers during sea level changes: The Dead Sea case. *Geochimica et Cosmochimica Acta*, *88*, pp.237-254.
287. Kishawi, Y., Mittelstet, A.R., Adane, Z., Shrestha, N. and Nasta, P., 2022. The combined impact of redcedar encroachment and climate change on water resources in the Nebraska Sand Hills. *Frontiers in Water*, *4*, p.208.
288. Kløve, B., Ala-Aho, P., Bertrand, G., Boukalova, Z., Ertürk, A., Goldscheider, N., Ilmonen, J., Karakaya, N., Kupfersberger, H., Kvœrner, J. and Lundberg, A., 2011. Groundwater dependent ecosystems. Part I: Hydroecological status and trends. *Environmental Science & Policy*, *14*(7), pp.770-781.
289. Kløve, B., Ala-Aho, P., Bertrand, G., Gurdak, J.J., Kupfersberger, H., Kværner, J., Muotka, T., Mykrä, H., Preda, E., Rossi, P. and Uvo, C.B., 2014. Climate change impacts on groundwater and dependent ecosystems. *Journal of Hydrology*, *518*, pp.250-266.
290. Knott, J.F.; Jacobs, J.M.; Daniel, J.S., and Kirshen, P., 2019. Modeling groundwater rise caused by sea-level rise in coastal New Hampshire. Journal of Coastal Research, 35(1), 143–157.
291. Koutnik, V.S., Leonard, J., Glasman, J.B., Brar, J., Koydemir, H.C., Novoselov, A., Bertel, R., Tseng, D., Ozcan, A., Ravi, S. and Mohanty, S.K., 2022. Microplastics retained in stormwater control measures: Where do they come from and where do they go?. *Water Research*, *210*, p.118008.
292. Krakauer N.Y., Lakhankar T., and Hudson D., 2019. Trends in Drought over the Northeast United States, *Water* 2019, 11, 1834; doi:10.3390/w11091834.

293. Kubier, A., Wilkin, R.T. and Pichler, T., 2019. Cadmium in soils and groundwater: a review. *Applied Geochemistry*, *108*, p.104388.
294. Kulp, S.A. and Strauss, B.H., 2019. New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding. *Nature communications*, *10*(1), pp.1-12.
295. Kumar, C.P., 2016. Impact of climate change on groundwater resources. In *Handbook of research on climate change impact on health and environmental sustainability* (pp. 196-221). IGI Global.
296. Kumar, A.R. and Riyazuddin, P., 2012. Seasonal variation of redox species and redox potentials in shallow groundwater: a comparison of measured and calculated redox potentials. *Journal of Hydrology*, *444*, pp.187-198.
297. Kundzewicz, Z.W., Mata, L.J., Arnell, N.W., Döll, P., Jiménez, B., Miller, K., Oki, T., Şen, Z. and Shiklomanov, I., 2008. The implications of projected climate change for freshwater resources and their management. *Hydrological sciences journal*, *53*(1), pp.3-10.
298. Kurylyk, B.L., Bourque, C.A. and MacQuarrie, K.T., 2013. Potential surface temperature and shallow groundwater temperature response to climate change: an example from a small forested catchment in east-central New Brunswick (Canada). *Hydrology and Earth System Sciences*, *17*(7), pp.2701-2716.
299. Kurylyk, B.L., MacQuarrie, K.T. and Voss, C.I., 2014. Climate change impacts on the temperature and magnitude of groundwater discharge from shallow, unconfined aquifers. *Water Resources Research*, *50*(4), pp.3253-3274.
300. Kurylyk, B.L., MacQuarrie, K.T., Caissie, D. and McKenzie, J.M., 2015. Shallow groundwater thermal sensitivity to climate change and land cover disturbances: derivation of analytical expressions and implications for stream temperature modeling. *Hydrology and Earth System Sciences*, *19*(5), pp.2469-2489.
301. Lacombe, P.J. and Carleton, G.B., 2002. *Hydrogeologic framework, availability of water supplies, and saltwater intrusion, Cape May County, New Jersey* (No. 1). US Department of the Interior, US Geological Survey.
302. Lam, Q.D., Meon, G. and Pätsch, M., 2021. Coupled modelling approach to assess effects of climate change on a coastal groundwater system. *Groundwater for Sustainable Development*, *14*, p.100633.
303. Langmuir, D. and Riese, A.C., 1985. The thermodynamic properties of radium. *Geochimica et cosmochimica acta*, *49*(7), pp.1593-1601.
304. Lapworth, D.J., Boving, T.B., Kreamer, D.K., Kebede, S. and Smedley, P.L., 2022. Groundwater quality: Global threats, opportunities and realising the potential of groundwater. *Science of The Total Environment*, *811*, p.152471.
305. Larsen, S., Andersen, T.O.M. and Hessen, D.O., 2011. Climate change predicted to cause severe increase of organic carbon in lakes. *Global Change Biology*, *17*(2), pp.1186-1192.
306. Lasagna, M., Ducci, D., Sellerino, M., Mancini, S. and De Luca, D.A., 2020. Meteorological variability and groundwater quality: Examples in different hydrogeological settings. *Water*, *12*(5), p.1297
307. Lauffenburger, Z.H., Gurdak, J.J., Hobza, C., Woodward, D. and Wolf, C., 2018. Irrigated agriculture and future climate change effects on groundwater recharge, northern High Plains aquifer, USA. *Agricultural Water Management*, *204*, pp.69-80.
308. Lawrence, F.W. and Upchurch, S.B., 1982. Identification of recharge areas using geochemical factor analysis. *Groundwater*, *20*(6), pp.680-687.
309. Lawson, M., Polya, D.A., Boyce, A.J., Bryant, C. and Ballentine, C.J., 2016. Tracing organic matter composition and distribution and its role on arsenic release in shallow Cambodian groundwaters. *Geochimica et Cosmochimica Acta*, *178*, pp.160-177.
310. Lazur, A., VanDerwerker, T. and Koepenick, K., 2020. Review of implications of road salt use on groundwater quality—corrosivity and mobilization of heavy metals and radionuclides. *Water, Air, & Soil Pollution*, *231*(9), p.474.
311. Lebon, Y., François, C., Navel, S., Vallier, F., Guillard, L., Pinasseau, L., Oxarango, L., Volatier, L. and Mermillod-Blondin, F., 2023. Aquifer recharge by stormwater infiltration basins: Hydrological and vadose zone characteristics control the impacts of basins on groundwater chemistry and microbiology. *Science of the Total Environment*, *865*, p.161115.
312. Lee, D. and Murphy, H.M., 2020. Private wells and rural health: groundwater contaminants of emerging concern. *Current environmental health reports*, *7*(2), pp.129-139.
313. LeMonte, J.J., Stuckey, J.W., Sanchez, J.Z., Tappero, R., Rinklebe, J. and Sparks, D.L., 2017. Sea level rise induced arsenic release from historically contaminated coastal soils. *Environmental Science & Technology*, *51*(11), pp.5913-5922.
314. Leng, L.Y., Ahmed, O.H. and Jalloh, M.B., 2019. Brief review on climate change and tropical peatlands. *Geoscience Frontiers*, *10*(2), pp.373-380.
315. Levitt, J.P., Degnan, J.R., Flanagan, S.M. and Jurgens, B.C., 2019. Arsenic variability and groundwater age in three water supply wells in southeast New Hampshire. *Geoscience Frontiers*, *10*(5), pp.1669-1683.

316. Levy, Z.F., Jurgens, B.C., Burow, K.R., Voss, S.A., Faulkner, K.E., Arroyo-Lopez, J.A. and Fram, M.S., 2021. Critical aquifer overdraft accelerates degradation of groundwater quality in California's Central Valley during drought. *Geophysical Research Letters*, *48*(17), p.e2021GL094398.
317. Li, H., Shi, A., Li, M. and Zhang, X., 2013. Effect of pH, temperature, dissolved oxygen, and flow rate of overlying water on heavy metals release from storm sewer sediments. *Journal of Chemistry*, *2013*.
318. Li, S., Yang, C., Peng, C., Li, H., Liu, B., Chen, C., Chen, B., Bai, J. and Lin, C., 2018. Effects of elevated sulfate concentration on the mobility of arsenic in the sediment–water interface. *Ecotoxicology and environmental safety*, *154*, pp.311-320.
319. Li, B., Rodell, M., Peters-Lidard, C., Erlingis, J., Kumar, S. and Mocko, D., 2021. Groundwater recharge estimated by land surface models: an evaluation in the conterminous United States. *Journal of Hydrometeorology*, *22*(2), pp.499-522.
320. Li, P., Zhao, C., Liu, K., Xiao, X., Wang, Y., Wang, Y. and He, D., 2021. Anthropogenic Influences on Dissolved Organic Matter in Three Coastal Bays, North China. *Frontiers in Earth Science*, *9*, p.575.
321. Li, N., Han, Z., Ren, Y., Wang, S., Hu, X. and Zeng, Z., 2022. Retarding performance of the vadose zone for nitrogen pollutants derived from municipal solid waste landfills in the red bed zone. *Journal of Environmental Management*, *306*, p.114406.
322. Li, L., Shields, J., Snow, D.D., Kaiser, M. and Malakar, A., 2023a. Labile carbon and soil texture control nitrogen transformation in deep vadose zone. *Science of The Total Environment*, *878*, p.163075.
323. Liao, X., Li, B., Zou, R., Dai, Y., Xie, S. and Yuan, B., 2016. Biodegradation of antibiotic ciprofloxacin: pathways, influential factors, and bacterial community structure. *Environmental Science and Pollution Research*, *23*(8), pp.7911-7918.
324. Libera, A., de Barros, F.P., Faybishenko, B., Eddy-Dilek, C., Denham, M., Lipnikov, K., Moulton, D., Maco, B. and Wainwright, H., 2019. Climate change impact on residual contaminants under sustainable remediation. *Journal of contaminant hydrology*, *226*, p.103518., ISSN 0169-7722, https://doi.org/10.1016/j.jconhyd.2019.103518.
325. Liesch, T. and Wunsch, A., 2019. Aquifer responses to long-term climatic periodicities. *Journal of Hydrology*, *572*, pp.226-242.
326. Lim, A.G., Loiko, S.V. and Pokrovsky, O.S., 2022. Sizable pool of labile organic carbon in peat and mineral soils of permafrost peatlands, western Siberia. *Geoderma*, *409*, p.115601.
327. Lindsey, B.D., Cravotta III, C.A., Szabo, Z., Belitz, K. and Stackelberg, P., 2021. Relation between road-salt application and increasing radium concentrations in a low-pH aquifer, southern New Jersey. *ACS ES&T Water*, *1*(12), pp.2541-2547.
328. Lipczynska-Kochany, E., 2018. Effect of climate change on humic substances and associated impacts on the quality of surface water and groundwater: A review. *Science of the total environment*, *640*, pp.1548-1565.
329. Liu, Y., Jiang, X., Zhang, G., Xu, Y.J., Wang, X. and Qi, P., 2016. Assessment of shallow groundwater recharge from extreme rainfalls in the Sanjiang plain, northeast China. *Water*, *8*(10), p.440.
330. Liu, F., Olesen, K.B., Borregaard, A.R. and Vollertsen, J., 2019. Microplastics in urban and highway stormwater retention ponds. *Science of the Total Environment*, *671*, pp.992-1000.
331. Liu, J.J., Diao, Z.H., Xu, X.R. and Xie, Q., 2019a. Effects of dissolved oxygen, salinity, nitrogen and phosphorus on the release of heavy metals from coastal sediments. *Science of the Total Environment*, *666*, pp.894-901.
332. Liu, Y., Li, X., Wang, X., Qiao, X., Hao, S., Lu, J., Duan, X., Dionysiou, D.D. and Zheng, B., 2019b. Contamination profiles of perfluoroalkyl substances (PFAS) in groundwater in the alluvial–pluvial plain of Hutuo River, China. *Water*, *11*(11), p.2316.
333. Liu, R.P., Liu, F., Sun, P.P., RM, E.W., Dong, Y., Zhang, Y.B., Chen, H.Q. and Jiao, J.G., 2022a. Research Progress of Microplastic Pollution in the Vadose Zone. *Water*, *14*(21), p.3586.
334. Liu, E., Yang, Y., Xie, Z., Wang, J. and Chen, M., 2022. Influence of sulfate reduction on arsenic migration and transformation in groundwater environment. *Water*, *14*(6), p.942.
335. Liu, Z., Du, Y., Deng, Y., Huang, Y., Zhao, X. and Li, Q., 2023. Enrichment of geogenic phosphorus in a coastal groundwater system: New insights from dissolved organic matter characterization. *Chemosphere*, *322*, p.138214.
336. Lotfata, A. and Ambinakudige, S., 2020. Degradation of groundwater quality in the coastal aquifers of the USA. *Sustainable Water Resources Management*, *6*(3), pp.1-17.
337. Loisel, J., Gallego-Sala, A.V., Amesbury, M.J., Magnan, G., Anshari, G., Beilman, D.W., Benavides, J.C., Blewett, J., Camill, P., Charman, D.J. and Chawchai, S., 2021. Expert assessment of future vulnerability of the global peatland carbon sink. *Nature climate change*, *11*(1), pp.70-77.
338. Lombard, M.A., Daniel, J., Jeddy, Z., Hay, L.E. and Ayotte, J.D., 2021. Assessing the impact of drought on arsenic exposure from private domestic wells in the conterminous United States. *Environmental Science & Technology*, *55*(3), pp.1822-1831.

339. Lopes, C.L., Sousa, M.C., Ribeiro, A., Pereira, H., Pinheiro, J.P., Vaz, L. and Dias, J.M., 2022. Evaluation of future estuarine floods in a sea level rise context. *Scientific reports*, *12*(1), pp.1-15.
340. Lüders, K., Dahmke, A., Fiedler, M. and Köber, R., 2020. Temperature influence on mobilisation and (re) fixation of trace elements and heavy metals in column tests with aquifer sediments from 10 to 70° C. *Water research*, *169*, p.115266.
341. Lusk, M.G., Toor, G.S., Yang, Y.Y., Mechtensimer, S., De, M. and Obreza, T.A., 2017. A review of the fate and transport of nitrogen, phosphorus, pathogens, and trace organic chemicals in septic systems. *Critical Reviews in Environmental Science and Technology*, *47*(7), pp.455-541.
342. Lynn, L.M. and Karlin, E.F., 1985. The vegetation of the low-shrub bogs of northern New Jersey and adjacent New York: ecosystems at their southern limit. *Bulletin of the Torrey Botanical Club*, pp.436-444.
343. Lyu, X., Xiao, F., Shen, C., Chen, J., Park, C.M., Sun, Y., Flury, M. and Wang, D., 2022. Per-and Polyfluoroalkyl Substances (PFAS) in Subsurface Environments: Occurrence, Fate, Transport, and Research Prospect. *Reviews of Geophysics*, *60*(3), p.e2021RG000765.
344. MacDonald, G.M., 2010. Water, climate change, and sustainability in the southwest. *Proceedings of the National Academy of Sciences*, *107*(50), pp.21256-21262.
345. MacDonald, A.M., Lark, R.M., Taylor, R.G., Abiye, T., Fallas, H.C., Favreau, G., Goni, I.B., Kebede, S., Scanlon, B., Sorensen, J.P. and Tijani, M., 2021. Mapping groundwater recharge in Africa from ground observations and implications for water security. *Environmental Research Letters*, *16*(3), p.034012.
346. Mackay, D., Hathaway, E., de Sieyes, N., Zhang, H., Rasa, E., Paradis, C., Schmidt, R., Peng, J., Buscheck, T. and Sihota, N., 2018. Comparing natural source zone depletion pathways at a fuel release site. *Groundwater Monitoring & Remediation*, *38*(2), pp.24-39.
347. Maheshwari, B., 2023. Managing the Invisible Under Changing Climate: A Participatory Approach for Sustaining Groundwater Use. In *Climate Risks to Water Security: Framing Effective Response in Asia and the Pacific* (pp. 61-87). Cham: Springer International Publishing.
348. Mailloux, B.J., Trembath-Reichert, E., Cheung, J., Watson, M., Stute, M., Freyer, G.A., Ferguson, A.S., Ahmed, K.M., Alam, M.J., Buchholz, B.A. and Thomas, J., 2013. Advection of surface-derived organic carbon fuels microbial reduction in Bangladesh groundwater. *Proceedings of the National Academy of Sciences*, *110*(14), pp.5331-5335.
349. Mailloux, B.J., Procopio, N.A., Bakker, M., Chen, T., Choudhury, I., Ahmed, K.M., Mozumder, M.R.H., Ellis, T., Chillrud, S. and van Geen, A., 2021. Recommended sampling intervals for arsenic in private wells. *Groundwater*, *59*(1), pp.80-89.
350. Malakar, P., Mukherjee, A., Bhanja, S.N., Ganguly, A.R., Ray, R.K., Zahid, A., Sarkar, S., Saha, D. and Chattopadhyay, S., 2021. Three decades of depth-dependent groundwater response to climate variability and human regime in the transboundary Indus-Ganges-Brahmaputra-Meghna mega river basin aquifers. *Advances in Water Resources*, *149*, p.103856.
351. Małecki, J. and Matyjasik, M., 2002. Vadose zone–challenges in hydrochemistry. *Acta geologica polonica*, *52*(4), pp.449-458.
352. Mallakpour, I. and Villarini, G., 2015. The changing nature of flooding across the central United States. *Nature Climate Change*, *5*(3), pp.250-254.
353. Mandernack, K.W., Lynch, L., Krouse, H.R. and Morgan, M.D., 2000. Sulfur cycling in wetland peat of the New Jersey Pinelands and its effect on stream water chemistry. *Geochimica et Cosmochimica Acta*, *64*(23), pp.3949-3964.
354. Mantha, S., Anderson, A., Acharya, S.P., Harwood, V.J. and Weidhaas, J., 2017. Transport and attenuation of Salmonella enterica, fecal indicator bacteria and a poultry litter marker gene are correlated in soil columns. *Science of the Total Environment*, *598*, pp.204-212.
355. Mao, R., Lu, Y., Zhang, M., Wang, C., Sun, B., Shi, Y., Song, S., Wang, P., Yuan, J. and Zhao, J., 2023. Distribution of legacy and novel per-and polyfluoroalkyl substances in surface and groundwater affected by irrigation in an arid region. *Science of The Total Environment*, *858*, p.159693.
356. Mapili, K., Rhoads, W.J., Coughter, M., Pieper, K.J., Edwards, M.A. and Pruden, A., 2022. Occurrence of opportunistic pathogens in private wells after major flooding events: A four state molecular survey. *Science of The Total Environment*, *826*, p.153901
357. Maroubo, L.A., Moreira-Silva, M.R., Teixeira, J.J. and Teixeira, M.F., 2021. Influence of Rainfall Seasonality in Groundwater Chemistry at Western Region of São Paulo State—Brazil. *Water*, *13*(11), p.1450.
358. Marshall, J.D., Shimada, B.W. and Jaffe, P.R., 2000. Effect of temporal variability in infiltration on contaminant transport in the unsaturated zone. *Journal of contaminant hydrology*, *46*(1-2), pp.151-161.

359. Maruya, K.A., Dodder, N.G., Sengupta, A., Smith, D.J., Lyons, J.M., Heil, A.T. and Drewes, J.E., 2016. Multimedia screening of contaminants of emerging concern (CECS) in coastal urban watersheds in southern California (USA). *Environmental Toxicology and Chemistry*, *35*(8), pp.1986-1994.
360. Mas-Pla, J. and Menció, A., 2019. Groundwater nitrate pollution and climate change: learnings from a water balance-based analysis of several aquifers in a western Mediterranean region (Cat). *Environmental Science and Pollution Research*, *26*(3), pp.2184-2202.
361. Masterson, J.P. and Garabedian, S.P., 2007. Effects of sea-level rise on ground water flow in a coastal aquifer system. *Groundwater*, *45*(2), pp.209-217.
362. Masterson, J.P., Fienen, M.N., Thieler, E.R., Gesch, D.B., Gutierrez, B.T. and Plant, N.G., 2014. Effects of sea-level rise on barrier island groundwater system dynamics–ecohydrological implications. *Ecohydrology*, *7*(3), pp.1064-1071.
363. Mastrocicco, M., Busico, G. and Colombani, N., 2018. Groundwater temperature trend as a proxy for climate variability. In *Proceedings* (Vol. 2, No. 11, p. 630). MDPI AG.
364. Mattia, M., Tuccimei, P., Soligo, M. and Carusi, C., 2020. Radon as a natural tracer for monitoring NAPL groundwater contamination. *Water*, *12*(12), p.3327.
365. Maxwell, R.M. and Kollet, S.J., 2008. Interdependence of groundwater dynamics and land-energy feedbacks under climate change. *Nature Geoscience*, *1*(10), pp.665-669.
366. McAlexander, B. and Sihota, N., 2019. Influence of Ambient Temperature, Precipitation, and Groundwater Level on Natural Source Zone Depletion Rates at a Large Semiarid LNAPL Site. *Groundwater Monitoring & Remediation*, *39*(1), pp.54-65.
367. McCallum, J.L., Crosbie, R.S., Walker, G.R. and Dawes, W.R., 2010. Impacts of climate change on groundwater in Australia: a sensitivity analysis of recharge. *Hydrogeology Journal*, *18*(7), pp.1625-1638.
368. McCord, J.P., Strynar, M.J., Washington, J.W., Bergman, E.L. and Goodrow, S.M., 2020. Emerging chlorinated polyfluorinated polyether compounds impacting the waters of southwestern New Jersey identified by use of nontargeted analysis. *Environmental science & technology letters*, *7*(12), pp.903-908.
369. McDonough, L.K., O'Carroll, D.M., Meredith, K., Andersen, M.S., Brügger, C., Huang, H., Rutlidge, H., Behnke, M.I., Spencer, R.G., McKenna, A. and Marjo, C.E., 2020a. Changes in groundwater dissolved organic matter character in a coastal sand aquifer due to rainfall recharge. *Water research*, *169*, p.115201.
370. McDonough, L.K., Santos, I.R., Andersen, M.S., O'Carroll, D.M., Rutlidge, H., Meredith, K., Oudone, P., Bridgeman, J., Gooddy, D.C., Sorensen, J.P. and Lapworth, D.J., 2020b. Changes in global groundwater organic carbon driven by climate change and urbanization. *Nature Communications*, *11*(1), p.1279.
371. McFarland, R.E., 2010. *Groundwater-quality data and regional trends in the Virginia Coastal Plain, 1906-2007* (No. 1772). US Geological Survey.
372. McGuire, J.T., Long, D.T. and Hyndman, D.W., 2005. Analysis of recharge-induced geochemical change in a contaminated aquifer. *Groundwater*, *43*(4), pp.518-530.
373. McKenna, O.P. and Sala, O.E., 2018. Groundwater recharge in desert playas: current rates and future effects of climate change. *Environmental Research Letters*, *13*(1), p.014025.
374. McLean, J.E., 1992. *Behavior of metals in soils*. Technology Innovation Office, Office of Solid Waste and Emergency Response.
375. McMahon, P.B. and Chapelle, F.H., 2008. Redox processes and water quality of selected principal aquifer systems. *Groundwater*, *46*(2), pp.259-271.
376. McMahon, P.B., Chapelle, F.H. and Bradley, P.M., 2011. Evolution of redox processes in groundwater. In *Aquatic Redox Chemistry* (pp. 581-597). American Chemical Society.
377. McMahon, P.B., Belitz, K., Reddy, J.E. and Johnson, T.D., 2018. Elevated manganese concentrations in United States groundwater, role of land surface–soil–aquifer connections. *Environmental science & technology*, *53*(1), pp.29-38.
378. McMahon, P.B., Tokranov, A.K., Bexfield, L.M., Lindsey, B.D., Johnson, T.D., Lombard, M.A. and Watson, E., 2022. Perfluoroalkyl and Polyfluoroalkyl Substances in Groundwater Used as a Source of Drinking Water in the Eastern United States. *Environmental science & technology*, *56*(4), pp.2279-2288.
379. McNaboe, L.A., Robbins, G.A. and Dietz, M.E., 2017. Mobilization of radium and radon by deicing salt contamination of groundwater. *Water, Air, & Soil Pollution*, *228*, pp.1-9.
380. Meixner, T., Manning, A.H., Stonestrom, D.A., Allen, D.M., Ajami, H., Blasch, K.W., Brookfield, A.E., Castro, C.L., Clark, J.F., Gochis, D.J. and Flint, A.L., 2016. Implications of projected climate change for groundwater recharge in the western United States. *Journal of Hydrology*, *534*, pp.124-138.
381. Melillo JM, Richmond TC, Yohe GW (eds) (2014) Climate change impacts in the United States: the third National Climate Assessment. U.S. Global Change Research Program, Washington, DC, p 841.

382. Menberg K., P. Blum P., Kurylyk B.L. and Bayer P., 2014. Observed groundwater temperature response to recent climate change. Hydrol. Earth Syst. Sci., 18, 4453–4466.
383. Mensah, J.K., Ofosu, E.A., Akpoti, K., Kabo-Bah, A.T., Okyereh, S.A. and Yidana, S.M., 2022. Modeling current and future groundwater demands in the White Volta River Basin of Ghana under climate change and socio-economic scenarios. *Journal of Hydrology: Regional Studies*, *41*, p.101117.
384. Mermillod-Blondin, F., Simon, L., Maazouzi, C., Foulquier, A., Delolme, C. and Marmonier, P., 2015. Dynamics of dissolved organic carbon (DOC) through stormwater basins designed for groundwater recharge in urban area: assessment of retention efficiency. *Water research*, *81*, pp.27-37.
385. Mertz, O., Halsnæs, K., Olesen, J.E. and Rasmussen, K., 2009. Adaptation to climate change in developing countries. *Environmental management*, *43*, pp.743-752.
386. Michael, H.A., Post, V.E., Wilson, A.M. and Werner, A.D., 2017. Science, society, and the coastal groundwater squeeze. *Water Resources Research*, *53*(4), pp.2610-2617.
387. Michel, A., Brauchli, T., Lehning, M., Schaefli, B. and Huwald, H., 2020. Stream temperature and discharge evolution in Switzerland over the last 50 years: annual and seasonal behaviour. *Hydrology and Earth System Sciences*, *24*(1), pp.115-142.
388. Michel, A., Schaefli, B., Wever, N., Zekollari, H., Lehning, M. and Huwald, H., 2022. Future water temperature of rivers in Switzerland under climate change investigated with physics-based models. Hydrol. Earth Syst. Sci., 26, 1063–1087, https://doi.org/10.5194/hess-26-1063-2022, 2022.
389. Mihaly, E., 2018. Avoiding septic shock: How climate change can cause septic system failure and whether New England states are prepared. *Ocean & Coastal LJ*, *23*, p.1
390. Mills, C.T., Morrison, J.M., Goldhaber, M.B. and Ellefsen, K.J., 2011. Chromium (VI) generation in vadose zone soils and alluvial sediments of the southwestern Sacramento Valley, California: a potential source of geogenic Cr (VI) to groundwater. *Applied Geochemistry*, *26*(8), pp.1488-1501.
391. Mimikou, M.A., Baltas, E., Varanou, E. and Pantazis, K., 2000. Regional impacts of climate change on water resources quantity and quality indicators. *Journal of Hydrology*, *234*(1-2), pp.95-109.
392. Ming, Y., Gao, L. and Guo, L., 2023. Dissolved and particulate organic carbon dynamics in the lower Changjiang River on timescales from seasonal to decades: Response to climate and human impacts. *Journal of Marine Systems*, *239*, p.103855.
393. Miotliński, K., Postma, D. and Kowalczyk, A., 2012. Variable infiltration and river flooding resulting in changing groundwater quality–A case study from Central Europe. *Journal of Hydrology*, *414*, pp.211-219.
394. Misut, P.E. and Dressler, S., 2021. *Simulation of water-table and freshwater/saltwater interface response to climate-change-driven sea-level rise and changes in recharge at Fire Island National Seashore, New York* (No. 2020-5117). US Geological Survey.
395. Mladenov, N., Zheng, Y., Miller, M.P., Nemergut, D.R., Legg, T., Simone, B., Hageman, C., Rahman, M.M., Ahmed, K.M. and McKnight, D.M., 2010. Dissolved organic matter sources and consequences for iron and arsenic mobilization in Bangladesh aquifers. *Environmental science & technology*, *44*(1), pp.123-128.
396. Moeck, C., Grech-Cumbo, N., Podgorski, J., Bretzler, A., Gurdak, J.J., Berg, M. and Schirmer, M., 2020. A global-scale dataset of direct natural groundwater recharge rates: A review of variables, processes and relationships. *Science of the total environment*, *717*, p.137042.
397. Moeck, C., Davies, G., Krause, S. and Schneidewind, U., 2023. Microplastics and nanoplastics in agriculture—A potential source of soil and groundwater contamination?. *Grundwasser*, *28*(1), pp.23-35.
398. Moftakhari, H.R., Salvadori, G., AghaKouchak, A., Sanders, B.F. and Matthew, R.A., 2017. Compounding effects of sea level rise and fluvial flooding. *Proceedings of the National Academy of Sciences*, *114*(37), pp.9785-9790.
399. Mohan, C., Western, A.W., Wei, Y. and Saft, M., 2018. Predicting groundwater recharge for varying land cover and climate conditions–a global meta-study. *Hydrology and Earth System Sciences*, *22*(5), pp.2689-2703.
400. Molins, S., Mayer, K.U., Amos, R.T. and Bekins, B.A., 2010. Vadose zone attenuation of organic compounds at a crude oil spill site—Interactions between biogeochemical reactions and multicomponent gas transport. *Journal of Contaminant Hydrology*, *112*(1-4), pp.15-29.
401. Moore, W.S., 1999. The subterranean estuary: a reaction zone of ground water and sea water. *Marine chemistry*, *65*(1-2), pp.111-125.
402. Moore, T.R., 2018. Dissolved organic carbon: sources, sinks, and fluxes and role in the soil carbon cycle. In *Soil processes and the carbon cycle* (pp. 281-292). CRC Press.
403. Moore, W.S. and Joye, S.B., 2021. Saltwater intrusion and submarine groundwater discharge: acceleration of biogeochemical reactions in changing coastal aquifers. *Frontiers in Earth Science*, *9*, p.600710.

404. Mora, A., Mahlknecht, J., Ledesma-Ruiz, R., Sanford, W.E. and Lesser, L.E., 2020. Dynamics of major and trace elements during seawater intrusion in a coastal sedimentary aquifer impacted by anthropogenic activities. *Journal of Contaminant Hydrology*, *232*, p.103653.
405. Morelli, G., Rimondi, V., Benvenuti, M., Medas, D., Costagliola, P. and Gasparon, M., 2017. Experimental simulation of arsenic desorption from Quaternary aquifer sediments following sea water intrusion. *Applied Geochemistry*, *87*, pp.176-187.
406. Mueller, M.H., Huggenberger, P. and Epting, J., 2018. Combining monitoring and modelling tools as a basis for city-scale concepts for a sustainable thermal management of urban groundwater resources. *Science of the Total Environment*, *627*, pp.1121-1136.
407. Müller, V., Chavez-Capilla, T., Feldmann, J. and Mestrot, A., 2022. Increasing temperature and flooding enhance arsenic release and biotransformations in Swiss soils. *Science of the Total Environment*, p.156049.
408. Mumford, A.C., Barringer, J.L., Benzel, W.M., Reilly, P.A. and Young, L.Y., 2012. Microbial transformations of arsenic: mobilization from glauconitic sediments to water. *Water research*, *46*(9), pp.2859-2868.
409. Murdoch, P.S., Baron, J.S. and Miller, T.L., 2000. Potential effects of climate change on surface-water quality in North America 1. *JAWRA Journal of the American Water Resources Association*, *36*(2), pp.347-366.
410. Murphy, E.M. and Zachara, J.M., 1995. The role of sorbed humic substances on the distribution of organic and inorganic contaminants in groundwater. *Geoderma*, *67*(1-2), pp.103-124.
411. Naden, P.S., Allott, N., Arvola, L., Järvinen, M., Jennings, E., Moore, K., Nic Aonghusa, C., Pierson, D. and Schneiderman, E., 2010. Modelling the impacts of climate change on dissolved organic carbon. In *The impact of climate change on European lakes* (pp. 221-252). Springer, Dordrecht.
412. Nazarian, R.H., Vizzard, J.V., Agostino, C.P. and Lutsko, N.J., 2022. Projected Changes in Future Extreme Precipitation over the Northeast United States in the NA-CORDEX Ensemble. *Journal of Applied Meteorology and Climatology*, *61*(11), pp.1649-1668.
413. New Jersey Department of Environmental Protection (NJDEP), 2020. New Jersey Scientific Report on Climate Change, Version 1.0. (Eds. R. Hill, M.M. Rutkowski, L.A. Lester, H. Genievich, N.A. Procopio). Trenton, NJ. 184 pp.
414. New Jersey Department of Environmental Protection (NJDEP), 2017. Groundwater Quality. Available at https://www.nj.gov/dep/dsr/trends/groundwater.pdf
415. New Jersey Department of Environmental Protection (NJDEP), 2002. Drought Update: 05/08/2002. Available at https://www.nj.gov/dep/drought/050802a.html. Accessed 3/7/2023.
416. New Jersey Department of Health (NJDOH), 2022. Health Indicator Report of Private Well Usage: Self-Reported as Main Source of Drinking Water. Updated On 07/18/2022. Available at https://www-doh.state.nj.us/doh-shad/indicator/view/PrivateWell.Year.html. Accessed 10/11/2023.
417. New Jersey Geological Survey (NJGS), 2004. Arsenic in New Jersey Groundwater
418. Neumann, B., Vafeidis, A.T., Zimmermann, J. and Nicholls, R.J., 2015. Future coastal population growth and exposure to sea-level rise and coastal flooding-a global assessment. *PloS one*, *10*(3), p.e0118571.
419. Ng, G.H.C., McLaughlin, D., Entekhabi, D. and Scanlon, B., 2009. Using data assimilation to identify diffuse recharge mechanisms from chemical and physical data in the unsaturated zone. *Water resources research*, *45*(9).
420. Ng, G.H.C., McLaughlin, D., Entekhabi, D. and Scanlon, B.R., 2010. Probabilistic analysis of the effects of climate change on groundwater recharge. *Water Resources Research*, *46*(7).
421. Nghiem, A.A., Stahl, M.O., Mailloux, B.J., Mai, T.T., Trang, P.T., Viet, P.H., Harvey, C.F., van Geen, A. and Bostick, B.C., 2019. Quantifying riverine recharge impacts on redox conditions and arsenic release in groundwater aquifers along the Red River, Vietnam. *Water resources research*, *55*(8), pp.6712-6728.
422. Nghiem, A.A., Prommer, H., Mozumder, M.R.H., Siade, A., Jamieson, J., Ahmed, K.M., van Geen, A. and Bostick, B.C., 2023. Sulfate reduction accelerates groundwater arsenic contamination even in aquifers with abundant iron oxides. *Nature Water*, pp.1-15.
423. Nickerson, A., Maizel, A.C., Schaefer, C.E., Ranville, J.F. and Higgins, C.P., 2023. Effect of geochemical conditions on PFAS release from AFFF-impacted saturated soil columns. *Environmental Science: Processes & Impacts*.
424. Nicholls, R.J., 2002. Analysis of global impacts of sea-level rise: a case study of flooding. *Physics and Chemistry of the Earth, Parts A/B/C*, *27*(32-34), pp.1455-1466.
425. Nimmo, J.R., 2006. Unsaturated zone flow processes. *Encyclopedia of hydrological sciences*.
426. Nolan, B.T., Baehr, A.L. and Kauffman, L.J., 2003. Spatial variability of groundwater recharge and its effect on shallow groundwater quality in southern New Jersey. *Vadose Zone Journal*, *2*(4), pp.677-691
427. Nolan, B.T. and Hitt, K.J., 2006. Vulnerability of shallow groundwater and drinking-water wells to nitrate in the United States. *Environmental science & technology*, *40*(24), pp.7834-7840.

428. Nolan, B.T., Healy, R.W., Taber, P.E., Perkins, K., Hitt, K.J. and Wolock, D.M., 2007. Factors influencing ground-water recharge in the eastern United States. *Journal of Hydrology*, *332*(1-2), pp.187-205.
429. Nygren, M., Giese, M., Kløve, B., Haaf, E., Rossi, P.M. and Barthel, R., 2020. Changes in seasonality of groundwater level fluctuations in a temperate-cold climate transition zone. *Journal of Hydrology X*, *8*, p.100062.
430. O'Connor, D., Pan, S., Shen, Z., Song, Y., Jin, Y., Wu, W.M. and Hou, D., 2019. Microplastics undergo accelerated vertical migration in sand soil due to small size and wet-dry cycles. *Environmental Pollution*, *249*, pp.527-534.
431. O'Connor, D., Zheng, X., Hou, D., Shen, Z., Li, G., Miao, G., O'Connell, S. and Guo, M., 2019a. Phytoremediation: Climate change resilience and sustainability assessment at a coastal brownfield redevelopment. *Environment international*, *130*, p.104945.
432. O'Day, P.A., Vlassopoulos, D., Root, R. and Rivera, N., 2004. The influence of sulfur and iron on dissolved arsenic concentrations in the shallow subsurface under changing redox conditions. *Proceedings of the National Academy of Sciences*, *101*(38), pp.13703-13708.
433. O'Dwyer, J., Chique, C., Weatherill, J. and Hynds, P., 2021. Impact of the 2018 European drought on microbial groundwater quality in private domestic wells: A case study from a temperate maritime climate. *Journal of Hydrology*, *601*, p.126669.
434. O'Kelly, B.C., Pantos, O., Weaver, L., Sarris, T.S., Goli, V.S.N.S., Mohammad, A., Singh, P. and Singh, D.N., 2022. Fate and impact of nano/microplastic in the geoenvironment—ecotoxicological perspective. *Environmental Geotechnics*, *40*(XXXX), pp.1-14.
435. O'Neill, H.S., Flanagan, S.V., Gleason, J.A., Spayd, S.E., Schwartz, R.I. and Procopio, N.A., 2022. Targeted Private Well Outreach Following a Change in Drinking Water Standard: Arsenic and the New Jersey Private Well Testing Act. *Journal of Public Health Management and Practice*, pp.10-1097.
436. Oostrom, M., Truex, M.J., Last, G.V., Strickland, C.E. and Tartakovsky, G.D., 2016. Evaluation of deep vadose zone contaminant flux into groundwater: Approach and case study. *Journal of contaminant hydrology*, *189*, pp.27-43.
437. Ossai, I.C., Ahmed, A., Hassan, A. and Hamid, F.S., 2020. Remediation of soil and water contaminated with petroleum hydrocarbon: A review. *Environmental Technology & Innovation*, *17*, p.100526.
438. Oude Essink, G.H.P., Van Baaren, E.S. and De Louw, P.G., 2010. Effects of climate change on coastal groundwater systems: A modeling study in the Netherlands. *Water resources research*, *46*(10).
439. Owor, M., Taylor, R.G., Tindimugaya, C. and Mwesigwa, D., 2009. Rainfall intensity and groundwater recharge: empirical evidence from the Upper Nile Basin. *Environmental Research Letters*, *4*(3), p.035009.
440. Pabich, W.J., Valiela, I. and Hemond, H.F., 2001. Relationship between DOC concentration and vadose zone thickness and depth below water table in groundwater of Cape Cod, USA. *Biogeochemistry*, *55*(3), pp.247-268.
441. Pagano, T., Bida, M. and Kenny, J.E., 2014. Trends in levels of allochthonous dissolved organic carbon in natural water: a review of potential mechanisms under a changing climate. *Water*, *6*(10), pp.2862-2897.
442. Page, S.E. and Baird, A.J., 2016. Peatlands and global change: response and resilience. *Annual Review of Environment and Resources*, *41*, pp.35-57.
443. Papazotos, P., Vasileiou, E. and Perraki, M., 2020. Elevated groundwater concentrations of arsenic and chromium in ultramafic environments controlled by seawater intrusion, the nitrogen cycle, and anthropogenic activities: The case of the Gerania Mountains, NE Peloponnese, Greece. *Applied Geochemistry*, *121*, p.104697.
444. Park, Y.C., Jo, Y.J. and Lee, J.Y., 2011. Trends of groundwater data from the Korean National Groundwater Monitoring Stations: indication of any change?. *Geosciences Journal*, *15*, pp.105-114.
445. Paul, V., Sankar, M.S., Vattikuti, S., Dash, P. and Arslan, Z., 2021. Pollution assessment and land use land cover influence on trace metal distribution in sediments from five aquatic systems in southern USA. *Chemosphere*, *263*, p.128243.
446. Pearcy, C.A., Chevis, D.A., Haug, T.J., Jeffries, H.A., Yang, N., Tang, J., Grimm, D.A. and Johannesson, K.H., 2011. Evidence of microbially mediated arsenic mobilization from sediments of the Aquia aquifer, Maryland, USA. *Applied geochemistry*, *26*(4), pp.575-586.
447. Peters-Lidard, C.D., Rose, K.C., Kiang, J.E., Strobel, M.L., Anderson, M.L., Byrd, A.R., Kolian, M.J., Brekke, L.D. and Arndt, D.S., 2021. Indicators of climate change impacts on the water cycle and water management. *Climatic Change*, *165*(1), pp.1-23.
448. Petersen-Perlman, J.D., Aguilar-Barajas, I. and Megdal, S.B., 2022. Drought and Groundwater Management: Interconnections, challenges, and policy responses. *Current Opinion in Environmental Science & Health*, p.100364.
449. Pétré, M.A., Genereux, D.P., Koropeckyj-Cox, L., Knappe, D.R., Duboscq, S., Gilmore, T.E. and Hopkins, Z.R., 2021. Per-and polyfluoroalkyl substance (PFAS) transport from groundwater to streams near a PFAS manufacturing facility in North Carolina, USA. *Environmental science & technology*, *55*(9), pp.5848-5856.

450. Piao, S., Ciais, P., Huang, Y., Shen, Z., Peng, S., Li, J., Zhou, L., Liu, H., Ma, Y., Ding, Y. and Friedlingstein, P., 2010. The impacts of climate change on water resources and agriculture in China. *Nature*, *467*(7311), pp.43-51.
451. Pieper, K.J., Jones, C.N., Rhoads, W.J., Rome, M., Gholson, D.M., Katner, A., Boellstorff, D.E. and Beighley, R.E., 2021. Microbial Contamination of Drinking Water Supplied by Private Wells after Hurricane Harvey. *Environmental Science & Technology*, *55*(12), pp.8382-8392.
452. Pili, E., Tisserand, D. and Bureau, S., 2013. Origin, mobility, and temporal evolution of arsenic from a low-contamination catchment in Alpine crystalline rocks. *Journal of Hazardous Materials*, *262*, pp.887-895.
453. Piotrowski, A.P., Osuch, M. and Napiorkowski, J.J., 2021. Influence of the choice of stream temperature model on the projections of water temperature in rivers. *Journal of Hydrology*, *601*, p.126629.
454. Plazinski, W., Rudzinski, W. and Plazinska, A., 2009. Theoretical models of sorption kinetics including a surface reaction mechanism: a review. *Advances in colloid and interface science*, *152*(1-2), pp.2-13.
455. Podgorski, D.C., Zito, P., McGuire, J.T., Martinovic-Weigelt, D., Cozzarelli, I.M., Bekins, B.A. and Spencer, R.G., 2018. Examining natural attenuation and acute toxicity of petroleum-derived dissolved organic matter with optical spectroscopy. *Environmental science & technology*, *52*(11), pp.6157-6166.
456. Polasky, A.D., Evans, J.L., Fuentes, J.D. and Hamilton, H.L., 2022. Statistical climate model downscaling for impact projections in the Midwest United States. *International Journal of Climatology*, *42*(5), pp.3038-3055.
457. Ponting, J., Kelly, T.J., Verhoef, A., Watts, M.J. and Sizmur, T., 2021. The impact of increased flooding occurrence on the mobility of potentially toxic elements in floodplain soil–A review. *Science of The Total Environment*, *754*, p.142040.
458. Possemiers, M., Huysmans, M. and Batelaan, O., 2014. Influence of Aquifer Thermal Energy Storage on groundwater quality: A review illustrated by seven case studies from Belgium. *Journal of Hydrology: Regional Studies*, *2*, pp.20-34.
459. Postma, D., Mai, N.T.H., Lan, V.M., Trang, P.T.K., Sø, H.U., Nhan, P.Q., Larsen, F., Viet, P.H. and Jakobsen, R., 2017. Fate of arsenic during Red River water infiltration into aquifers beneath Hanoi, Vietnam. *Environmental science & technology*, *51*(2), pp.838-845.
460. Poulton, S.W., Krom, M.D. and Raiswell, R., 2004. A revised scheme for the reactivity of iron (oxyhydr) oxide minerals towards dissolved sulfide. *Geochimica et cosmochimica acta*, *68*(18), pp.3703-3715.
461. Planer-Friedrich, B., 2023. Sulfur being an overlooked promoter of groundwater arsenic contamination. *Nature Water*, pp.1-2.
462. Pracht, L.E., Tfaily, M.M., Ardissono, R.J. and Neumann, R.B., 2018. Molecular characterization of organic matter mobilized from Bangladeshi aquifer sediment: tracking carbon compositional change during microbial utilization. *Biogeosciences*, *15*(6), pp.1733-1747.
463. Price, P.B. and Sowers, T., 2004. Temperature dependence of metabolic rates for microbial growth, maintenance, and survival. *Proceedings of the National Academy of Sciences*, *101*(13), pp.4631-4636.
464. Prijac, A., Gandois, L., Jeanneau, L., Taillardat, P. and Garneau, M., 2022. Dissolved organic matter concentration and composition discontinuity at the peat–pool interface in a boreal peatland. *Biogeosciences*, *19*(18), pp.4571-4588.
465. Procopio, N.A., Karl, R., Goodrow, S.M., Maggio, J., Louis, J.B. and Atherholt, T.B., 2017. Occurrence and source identification of perfluoroalkyl acids (PFAAs) in the Metedeconk River Watershed, New Jersey. *Environmental Science and Pollution Research*, *24*(35), pp.27125-27135.
466. Qasem, N.A., Mohammed, R.H. and Lawal, D.U., 2021. Removal of heavy metal ions from wastewater: A comprehensive and critical review. *Npj Clean Water*, *4*(1), pp.1-15.
467. Qian, Y., Zhang, W., Yu, L. and Feng, H., 2015. Metal pollution in coastal sediments. *Current Pollution Reports*, *1*(4), pp.203-219.
468. Qiao, W., Guo, H., He, C., Shi, Q., Xiu, W. and Zhao, B., 2020. Molecular evidence of arsenic mobility linked to biodegradable organic matter. *Environmental Science & Technology*, *54*(12), pp.7280-7290.
469. Qiu, J., Shen, Z. and Xie, H., 2023. Drought impacts on hydrology and water quality under climate change. *Science of The Total Environment*, *858*, p.159854.
470. Rahimi, R., Tavakol-Davani, H., Graves, C., Gomez, A. and Fazel Valipour, M., 2020. Compound inundation impacts of coastal climate change: Sea-level rise, groundwater rise, and coastal precipitation. *Water*, *12*(10), p.2776.
471. Rakib, M.A., Sasaki, J., Matsuda, H., Quraishi, S.B., Mahmud, M.J., Bodrud-Doza, M., Ullah, A.A., Fatema, K.J., Newaz, M.A. and Bhuiyan, M.A., 2020. Groundwater salinization and associated co-contamination risk increase severe drinking water vulnerabilities in the southwestern coast of Bangladesh. *Chemosphere*, *246*, p.125646.
472. Ramachandran, A., Krishnamurthy, R.R., Jayaprakash, M. and Shanmugasundharam, A., 2019. Environmental impact assessment of surface water and groundwater quality due to flood hazard in Adyar River Bank. Acta Ecologica Sinica, 39(2), pp.125-132.

473. Ranjan, V.P., Joseph, A., Sharma, H.B. and Goel, S., 2023. Preliminary investigation on effects of size, polymer type, and surface behaviour on the vertical mobility of microplastics in a porous media. *Science of The Total Environment*, *864*, p.161148.
474. Rao, S.M., Sekhar, M. and Raghuveer Rao, P., 2013. Impact of pit-toilet leachate on groundwater chemistry and role of vadose zone in removal of nitrate and E. coli pollutants in Kolar District, Karnataka, India. *Environmental Earth Sciences*, *68*(4), pp.927-938.
475. Ravit, B., Cooper, K., Moreno, G., Buckley, B., Yang, I., Deshpande, A., Meola, S., Jones, D. and Hsieh, A., 2017. Microplastics in urban New Jersey freshwaters: distribution, chemical identification, and biological affects. *AIMS Environ Sci*, *4*(6), pp.809-826.
476. Reese, S.O. and Risser, D.W., 2010. *Summary of groundwater-recharge estimates for Pennsylvania* (No. 70). Pennsylvania Geological Survey.
477. Refsgaard, J.C., Sonnenborg, T.O., Butts, M.B., Christensen, J.H., Christensen, S., Drews, M., Jensen, K.H., Jørgensen, F., Jørgensen, L.F., Larsen, M.A.D. and Rasmussen, S.H., 2016. Climate change impacts on groundwater hydrology–where are the main uncertainties and can they be reduced?. *Hydrological Sciences Journal*, *61*(13), pp.2312-2324
478. Reguero, B.G. and Griggs, G., 2022. Adaptation to Coastal Climate Change and Sea-Level Rise. *Water*, *14*(7), p.996.
479. Reinecke, R., Müller Schmied, H., Trautmann, T., Andersen, L.S., Burek, P., Flörke, M., Gosling, S.N., Grillakis, M., Hanasaki, N., Koutroulis, A. and Pokhrel, Y., 2021. Uncertainty of simulated groundwater recharge at different global warming levels: a global-scale multi-model ensemble study. *Hydrology and Earth System Sciences*, *25*(2), pp.787-810.
480. Reiss, J., Perkins, D.M., Fussmann, K.E., Krause, S., Canhoto, C., Romeijn, P. and Robertson, A.L., 2019. Groundwater flooding: Ecosystem structure following an extreme recharge event. *Science of The Total Environment*, *652*, pp.1252-1260.
481. Ren, W., Tian, H., Cai, W.J., Lohrenz, S.E., Hopkinson, C.S., Huang, W.J., Yang, J., Tao, B., Pan, S. and He, R., 2016. Century-long increasing trend and variability of dissolved organic carbon export from the Mississippi River basin driven by natural and anthropogenic forcing. *Global Biogeochemical Cycles*, *30*(9), pp.1288-1299.
482. Ren, X., Zhu, B., Liu, M., Zhang, Y., He, Z. and Rioual, P., 2019. Mechanism of groundwater recharge in the middle-latitude desert of eastern Hunshandake, China: diffuse or focused recharge? *Hydrogeology Journal*, *27*(2), pp.761-783.
483. Ren, Z., Gui, X., Xu, X., Zhao, L., Qiu, H. and Cao, X., 2021. Microplastics in the soil-groundwater environment: aging, migration, and co-transport of contaminants–a critical review. *Journal of Hazardous Materials*, *419*, p.126455.
484. Retter, A., Karwautz, C. and Griebler, C., 2021. Groundwater microbial communities in times of climate change. *Current Issues in Molecular Biology*, *41*(1), pp.509-538.
485. Rezanezhad, F., Couture, R.M., Kovac, R., O'Connell, D. and Van Cappellen, P., 2014. Water table fluctuations and soil biogeochemistry: An experimental approach using an automated soil column system. *Journal of Hydrology*, *509*, pp.245-256.
486. Riedel, T., 2019. Temperature-associated changes in groundwater quality. *Journal of hydrology*, *572*, pp.206-212.
487. Riedel, T. and Kübeck, C., 2018. Uranium in groundwater–a synopsis based on a large hydrogeochemical data set. *Water research*, *129*, pp.29-38.
488. Riedel, T. and Weber, T.K., 2020. The influence of global change on Europe's water cycle and groundwater recharge. *Hydrogeology Journal*, *28*(6), pp.1939-1959.
489. Riedel, T., Kübeck, C. and Quirin, M., 2022. Legacy nitrate and trace metal (Mn, Ni, As, Cd, U) pollution in anaerobic groundwater: Quantifying potential health risk from "the other nitrate problem". *Applied Geochemistry*, *139*, p.105254.
490. Rinklebe, J. and Shaheen, S.M., 2017. Redox chemistry of nickel in soils and sediments: a review. *Chemosphere*, *179*, pp.265-278.
491. Ritson, J.P., Bell, M., Graham, N.J., Templeton, M.R., Brazier, R.E., Verhoef, A., Freeman, C. and Clark, J.M., 2014. Simulated climate change impact on summer dissolved organic carbon release from peat and surface vegetation: Implications for drinking water treatment. *Water research*, *67*, pp.66-76.
492. Rochette, E.A., Bostick, B.C., Li, G. and Fendorf, S., 2000. Kinetics of arsenate reduction by dissolved sulfide. *Environmental Science & Technology*, *34*(22), pp.4714-4720.
493. Rosset, T., Binet, S., Rigal, F. and Gandois, L., 2022. Peatland Dissolved Organic Carbon Export to Surface Waters: Global Significance and Effects of Anthropogenic Disturbance. *Geophysical Research Letters*, *49*(5).

494. Rossman, N.R., Zlotnik, V.A., Rowe, C.M. and Szilagyi, J., 2014. Vadose zone lag time and potential 21st century climate change effects on spatially distributed groundwater recharge in the semi-arid Nebraska Sand Hills. *Journal of Hydrology*, *519*, pp.656-669.
495. Rotzoll, K. and Fletcher, C.H., 2013. Assessment of groundwater inundation as a consequence of sea-level rise. *Nature Climate Change*, *3*(5), pp.477-481.
496. Rovero, M., Cutt, D., Griffiths, R., Filipowicz, U., Mishkin, K., White, B., Goodrow, S. and Wilkin, R.T., 2021. Limitations of Current Approaches for Predicting Groundwater Vulnerability from PFAS Contamination in the Vadose Zone. *Groundwater Monitoring & Remediation*, *41*(4), pp.62-75.
497. Rowles III, L.S., Hossain, A.I., Ramirez, I., Durst, N.J., Ward, P.M., Kirisits, M.J., Araiza, I., Lawler, D.F. and Saleh, N.B., 2020. Seasonal contamination of well-water in flood-prone colonias and other unincorporated US communities. *Science of the Total Environment*, *740*, p.140111.
498. Rozell, D.J., 2020. Coastal Resiliency Groundwater Considerations. *Groundwater*, *58*(6), pp.877-881.
499. Rumuri, R., Ramkumar, T., Vasudevan, S. and Gnanachandrasamy, G., 2021. Enrichment of heavy metals as function of salinity and pH of estuarine sediments, South East Coast of India. Geology, Ecology, and Landscapes, pp.1-9.
500. Saito, T., Hamamoto, S., Ueki, T., Ohkubo, S., Moldrup, P., Kawamoto, K. and Komatsu, T., 2016. Temperature change affected groundwater quality in a confined marine aquifer during long-term heating and cooling. *Water research*, *94*, pp.120-127.
501. Saalfield, S.L. and Bostick, B.C., 2009. Changes in iron, sulfur, and arsenic speciation associated with bacterial sulfate reduction in ferrihydrite-rich systems. *Environmental Science & Technology*, *43*(23), pp.8787-8793.
502. Sakizadeh, M., 2020. Spatial distribution and source identification together with environmental health risk assessment of PAHs along the coastal zones of the USA. *Environmental Geochemistry and Health*, *42*(10), pp.3333-3350.
503. Samandra, S., Johnston, J.M., Jaeger, J.E., Symons, B., Xie, S., Currell, M., Ellis, A.V. and Clarke, B.O., 2022. Microplastic contamination of an unconfined groundwater aquifer in Victoria, Australia. *Science of the Total Environment*, *802*, p.149727.
504. Sanchez, G.M., Terando, A., Smith, J.W., García, A.M., Wagner, C.R. and Meentemeyer, R.K., 2020. Forecasting water demand across a rapidly urbanizing region. *Science of the Total Environment*, *730*, p.139050.
505. SanClements, M.D., Oelsner, G.P., McKnight, D.M., Stoddard, J.L. and Nelson, S.J., 2012. New insights into the source of decadal increases of dissolved organic matter in acid-sensitive lakes of the Northeastern United States. *Environmental Science & Technology*, *46*(6), pp.3212-3219.
506. Santschi, P.H., Presley, B.J., Wade, T.L., Garcia-Romero, B. and Baskaran, M., 2001. Historical contamination of PAHs, PCBs, DDTs, and heavy metals in Mississippi river Delta, Galveston bay and Tampa bay sediment cores. *Marine Environmental Research*, *52*(1), pp.51-79.
507. Sarkar, S., Mukherjee, A., Senapati, B. and Duttagupta, S., 2022. Predicting Potential Climate Change Impacts on Groundwater Nitrate Pollution and Risk in an Intensely Cultivated Area of South Asia. *ACS Environmental Au*. 2(6), pp.556-576
508. Scanlon, B.R., Healy, R.W. and Cook, P.G., 2002. Choosing appropriate techniques for quantifying groundwater recharge. *Hydrogeology journal*, *10*(1), pp.18-39.
509. Scanlon, B.R., Reedy, R.C., Stonestrom, D.A., Prudic, D.E. and Dennehy, K.F., 2005. Impact of land use and land cover change on groundwater recharge and quality in the southwestern US. *Global Change Biology*, *11*(10), pp.1577-1593.
510. Scanlon, B.R., Fakhreddine, S., Rateb, A., de Graaf, I., Famiglietti, J., Gleeson, T., Grafton, R.Q., Jobbagy, E., Kebede, S., Kolusu, S.R. and Konikow, L.F., 2023. Global water resources and the role of groundwater in a resilient water future. *Nature Reviews Earth & Environment*, pp.1-15.
511. Schaefer, M.V., Ying, S.C., Benner, S.G., Duan, Y., Wang, Y. and Fendorf, S., 2016. Aquifer arsenic cycling induced by seasonal hydrologic changes within the Yangtze River basin. *Environmental science & technology*, *50*(7), pp.3521-3529.
512. Schilling, K., Borch, T., Rhoades, C.C. and Pallud, C.E., 2019. Temperature sensitivity of microbial Fe (III) reduction kinetics in subalpine wetland soils. *Biogeochemistry*, *142*(1), pp.19-35.
513. Schilling, K.E., Langel, R.J., Wolter, C.F. and Arenas-Amado, A., 2021. Using baseflow to quantify diffuse groundwater recharge and drought at a regional scale. *Journal of Hydrology*, *602*, p.126765.
514. Scholl, M.A., Cozzarelli, I.M. and Christenson, S.C., 2006. Recharge processes drive sulfate reduction in an alluvial aquifer contaminated with landfill leachate. *Journal of Contaminant Hydrology*, *86*(3-4), pp.239-261.
515. Schreiner-McGraw A. P. and Ajami H., 2021, Delayed response of groundwater to multi-year meteorological droughts in the absence of anthropogenic management, Journal of Hydrology, Volume 603, Part B, 2021.

516. Sea Level Rise Impacts on Groundwater Levels and Water Quality: A Vulnerability and Planning Study in Durham, New Hampshire. Final Non-Technical Report. February 2022. https://www.ci.durham.nh.us/sustainable/sea-level-rise-impacts-groundwater-levels-and-water-quality.
517. Seager, R., Ting, M., Li, C., Naik, N., Cook, B., Nakamura, J. and Liu, H., 2013. Projections of declining surface-water availability for the southwestern United States. *Nature Climate Change*, *3*(5), pp.482-486.
518. Seddon, D., Kashaigili, J.J., Taylor, R.G., Cuthbert, M.O., Mwihumbo, C. and MacDonald, A.M., 2021. Focused groundwater recharge in a tropical dryland: Empirical evidence from central, semi-arid Tanzania. *Journal of Hydrology: Regional Studies*, *37*, p.100919.
519. Seidenfaden, I.K., Sonnenborg, T.O., Stisen, S. and Kidmose, J., 2022. Quantification of climate change sensitivity of shallow and deep groundwater in Denmark. *Journal of Hydrology: Regional Studies*, *41*, p.101100.
520. Seliga, A., Spayd, S.E., Procopio, N.A., Flanagan, S.V. and Gleason, J.A., 2022. Evaluating the impact of free private well testing outreach on participants' private well stewardship in New Jersey. *Journal of Water and Health*, *20*(1), pp.1-11.
521. Selim, H.M. ed., 2012. *Competitive sorption and transport of heavy metals in soils and geological media*. CRC Press.
522. Şen, Z., 2015. Climate change, droughts, and water resources. *Applied drought modeling, prediction, and mitigation. Elsevier*, pp.321-391.
523. Sepulvado, J.G., Blaine, A.C., Hundal, L.S. and Higgins, C.P., 2011. Occurrence and fate of perfluorochemicals in soil following the land application of municipal biosolids. *Environmental science & technology*, *45*(19), pp.8106-8112.
524. Serfes, M.E., Spayd, S.E. and Herman, G.C., 2005. Arsenic occurrence, sources, mobilization, and transport in groundwater in the Newark Basin of New Jersey.
525. Serfes, M., Herman, G., Spayd, S. and Reinfelder, J., 2010. Sources, mobilization and transport of arsenic in groundwater in the Passaic and Lockatong Formations of the Newark basin, New Jersey. *New Jerset Geological Society Bulletin*, *77*, pp.1-40.
526. Severini, E., Ducci, L., Sutti, A., Robottom, S., Sutti, S. and Celico, F., 2022. River–Groundwater Interaction and Recharge Effects on Microplastics Contamination of Groundwater in Confined Alluvial Aquifers. *Water*, *14*(12), p.1913.
527. Shaheen, S.M., Rinklebe, J., Rupp, H. and Meissner, R., 2014. Lysimeter trials to assess the impact of different flood–dry-cycles on the dynamics of pore water concentrations of As, Cr, Mo and V in a contaminated floodplain soil. *Geoderma*, *228*, pp.5-13.
528. Shen, Y., Chapelle, F.H., Strom, E.W. and Benner, R., 2015. Origins and bioavailability of dissolved organic matter in groundwater. *Biogeochemistry*, *122*(1), pp.61-78.
529. Shi, J., Dong, Y., Shi, Y., Yin, T., He, W., An, T., Tang, Y., Hou, X., Chong, S., Chen, D. and Qin, K., 2022. Groundwater antibiotics and microplastics in a drinking-water source area, northern China: Occurrence, spatial distribution, risk assessment, and correlation. *Environmental Research*, *210*, p.112855.
530. Sienkiewicz, J., Porębska, G., Ostrowska, A. and Gozdowski, D., 2019. Indicators of peat soil degradation in the Biebrza valley, Poland. *Environmental Protection and Natural Resources*, *30*(2), pp.41-51.
531. Sharif, M.U., Davis, R.K., Steele, K.F., Kim, B., Hays, P.D., Kresse, T.M. and Fazio, J.A., 2008. Distribution and variability of redox zones controlling spatial variability of arsenic in the Mississippi River Valley alluvial aquifer, southeastern Arkansas. *Journal of Contaminant Hydrology*, *99*(1-4), pp.49-67.
532. Sharifan, H., Bagheri, M., Wang, D., Burken, J.G., Higgins, C.P., Liang, Y., Liu, J., Schaefer, C.E. and Blotevogel, J., 2021. Fate and transport of per-and polyfluoroalkyl substances (PFASs) in the vadose zone. *Science of The Total Environment*, *771*, p.145427.
533. Shirokova, V.L., Enright, A.M.L., Kennedy, C.B. and Ferris, F.G., 2016. Thermal intensification of microbial Fe (II)/Fe (III) redox cycling in a pristine shallow sand aquifer on the Canadian Shield. *Water Research*, *106*, pp.604-612.
534. Shu, X., Xu, L., Yang, M., Qin, Z., Zhang, Q. and Zhang, L., 2023. Spatial distribution characteristics and migration of microplastics in surface water, groundwater and sediment in karst areas: The case of Yulong River in Guilin, Southwest China. *Science of The Total Environment*, p.161578.
535. Singh, A., Patel, A.K., Deka, J.P. and Kumar, M., 2020. Natural recharge transcends anthropogenic forcing that influences arsenic vulnerability of the quaternary alluviums of the Mid-Gangetic Plain. *NPJ Clean Water*, *3*(1), pp.1-12.
536. Small, E.E., 2005. Climatic controls on diffuse groundwater recharge in semiarid environments of the southwestern United States. *Water Resources Research*, *41*(4).

537. Smedley, P.L. and Kinniburgh, D.G., 2013. Arsenic in groundwater and the environment. In *Essentials of medical geology* (pp. 279-310). Springer, Dordrecht.
538. Snyder, M., Taillefert, M. and Ruppel, C., 2004. Redox zonation at the saline-influenced boundaries of a permeable surficial aquifer: effects of physical forcing on the biogeochemical cycling of iron and manganese. *Journal of hydrology*, *296*(1-4), pp.164-178.
539. Spaur, M., Lombard, M.A., Ayotte, J.D., Harvey, D.E., Bostick, B.C., Chillrud, S.N., Navas-Acien, A. and Nigra, A.E., 2021. Associations between private well water and community water supply arsenic concentrations in the conterminous United States. *Science of The Total Environment*, *787*, p.147555.
540. Stephens, D.B., 1994. A perspective on diffuse natural recharge mechanisms in areas of low precipitation. *Soil Science Society of America Journal*, *58*(1), pp.40-48.
541. Stigter, T.Y., Miller, J., Chen, J. and Re, V., 2022. Groundwater and climate change: threats and opportunities. *Hydrogeology Journal*, pp.1-4.
542. Stoll, S., Hendricks Franssen, H.J., Butts, M. and Kinzelbach, W., 2011. Analysis of the impact of climate change on groundwater related hydrological fluxes: a multi-model approach including different downscaling methods. *Hydrology and Earth System Sciences*, *15*(1), pp.21-38.
543. Stolze, L., Battistel, M. and Rolle, M., 2022. Oxidative Dissolution of Arsenic-Bearing Sulfide Minerals in Groundwater: Impact of Hydrochemical and Hydrodynamic Conditions on Arsenic Release and Surface Evolution. *Environmental Science & Technology*, *56*(8), pp.5049-5061.
544. Strafford Regional Planning Commission (SRPC), 2022. Sea Level Rise Impacts on Groundwater Levels and Water Quality: A Vulnerability and Planning Study in Durham, New Hampshire, Final Non-technical Report.
545. Strauss, B.H., Ziemlinski, R., Weiss, J.L. and Overpeck, J.T., 2012. Tidally adjusted estimates of topographic vulnerability to sea level rise and flooding for the contiguous United States. *Environmental Research Letters*, *7*(1), p.014033.
546. Stuart, M.E., Gooddy, D.C., Bloomfield, J.P. and Williams, A.T., 2011. A review of the impact of climate change on future nitrate concentrations in groundwater of the UK. *Science of the Total Environment*, *409*(15), pp.2859-2873.
547. Stumpp, C. and Kammerer, G., 2021. The Vadose Zone—A Semi-Aquatic Ecosystem.
548. Su, X., Belvedere, P., Tosco, T. and Prigiobbe, V., 2022. Studying the effect of sea level rise on nuisance flooding due to groundwater in a coastal urban area with aging infrastructure. *Urban Climate*, *43*, p.101164.
549. Sugita, F. and Nakane, K., 2007. Combined effects of rainfall patterns and porous media properties on nitrate leaching. *Vadose Zone Journal*, *6*(3), pp.548-553.
550. Sun, H., Alexander, J., Gove, B. and Koch, M., 2015. Mobilization of arsenic, lead, and mercury under conditions of sea water intrusion and road deicing salt application. *Journal of Contaminant Hydrology*, *180*, pp.12-24.
551. Swain, D.L., Wing, O.E., Bates, P.D., Done, J.M., Johnson, K.A. and Cameron, D.R., 2020. Increased flood exposure due to climate change and population growth in the United States. *Earth's Future*, *8*(11), p.e2020EF001778.
552. Swain, S., Taloor, A.K., Dhal, L., Sahoo, S. and Al-Ansari, N., 2022. Impact of climate change on groundwater hydrology: a comprehensive review and current status of the Indian hydrogeology. *Applied Water Science*, *12*(6), pp.1-25.
553. Tamamura, S., Takada, T., Tomita, J., Nagao, S., Fukushi, K. and Yamamoto, M., 2014. Salinity dependence of 226 Ra adsorption on montmorillonite and kaolinite. *Journal of Radioanalytical and Nuclear Chemistry*, *299*, pp.569-575.
554. Tang, W., Guo, B., Li, Z., Zhao, X. and Gu, X., 2022. Flooding and drainage induced abiotic reactions control metal solubility in soil of a contaminated industrial site. *Chemosphere*, *297*, p.134032.
555. Tang, G., Zheng, X., Li, B., Chen, S., Zhang, B., Hu, S., Qiao, H., Liu, T. and Wang, Q., 2022a. Trace metal complexation with dissolved organic matter stresses microbial metabolisms and triggers community shifts: The intercorrelations. *Environmental Pollution*, *314*, p.120221.
556. Taylor, J.R., 2003. Evaluating groundwater nitrates from on-lot septic systems, A guidance model for land planning in Pennsylvania. *Malvern, Pennsylvania: Penn State Great Valley, School of Graduate Professional Studies*.
557. Taylor, C.A. and Stefan, H.G., 2009. Shallow groundwater temperature response to climate change and urbanization. *Journal of Hydrology*, 375(3-4), pp.601-612.
558. Taylor, R.G., Koussis, A.D. and Tindimugaya, C., 2009. Groundwater and climate in Africa—a review. *Hydrological Sciences Journal*, *54*(4), pp.655-664.
559. Taylor, R.G., Scanlon, B., Döll, P., Rodell, M., Van Beek, R., Wada, Y., Longuevergne, L., Leblanc, M., Famiglietti, J.S., Edmunds, M. and Konikow, L., 2013. Ground water and climate change. *Nature climate change*, *3*(4), pp.322-329.

560. Taylor, R.G., Todd, M.C., Kongola, L., Maurice, L., Nahozya, E., Sanga, H. and MacDonald, A.M., 2013a. Evidence of the dependence of groundwater resources on extreme rainfall in East Africa. *Nature Climate Change*, *3*(4), pp.374-378.
561. Tedoldi, D., Chebbo, G., Pierlot, D., Kovacs, Y. and Gromaire, M.C., 2016. Impact of runoff infiltration on contaminant accumulation and transport in the soil/filter media of Sustainable Urban Drainage Systems: A literature review. *Science of the Total Environment*, *569*, pp.904-926.
562. Ten Hulscher, T.E. and Cornelissen, G., 1996. Effect of temperature on sorption equilibrium and sorption kinetics of organic micropollutants-a review. *Chemosphere*, *32*(4), pp.609-626.
563. Thomas, B.F., Behrangi, A. and Famiglietti, J.S., 2016. Precipitation intensity effects on groundwater recharge in the southwestern United States. *Water*, *8*(3), p.90.
564. Thompson, P.R., Widlansky, M.J., Hamlington, B.D., Merrifield, M.A., Marra, J.J., Mitchum, G.T. and Sweet, W., 2021. Rapid increases and extreme months in projections of United States high-tide flooding. *Nature Climate Change*, *11*(7), pp.584-590.
565. Tillman, F.D., Gangopadhyay, S. and Pruitt, T., 2016. Changes in groundwater recharge under projected climate in the upper Colorado River basin. *Geophysical Research Letters*, *43*(13), pp.6968-6974.
566. Tissen, C., Benz, S.A., Menberg, K., Bayer, P. and Blum, P., 2019. Groundwater temperature anomalies in central Europe. *Environmental Research Letters*, *14*(10), p.104012.
567. Tisserand, D., Pili, E., Hellmann, R., Boullier, A.M. and Charlet, L., 2014. Geogenic arsenic in groundwaters in the western Alps. *Journal of Hydrology*, *518*, pp.317-325.
568. Tiwari, T., Sponseller, R.A. and Laudon, H., 2022. The emerging role of drought as a regulator of dissolved organic carbon in boreal landscapes. *Nature communications*, *13*(1), pp.1-11.
569. Torrentó, C., Urmeneta, J., Otero, N., Soler, A., Viñas, M. and Cama, J., 2011. Enhanced denitrification in groundwater and sediments from a nitrate-contaminated aquifer after addition of pyrite. *Chemical Geology*, *287*(1-2), pp.90-101.
570. Treidel, H., Martin-Bordes, J.L. and Gurdak, J.J. eds., 2011. *Climate change effects on groundwater resources: a global synthesis of findings and recommendations*. CRC Press.
571. Turkeltaub, T., Jia, X., Zhu, Y., Shao, M.A. and Binley, A., 2018. Recharge and nitrate transport through the deep vadose zone of the loess plateau: a regional-scale model investigation. *Water Resources Research*, *54*(7), pp.4332-4346.
572. Tweed, S., Massuel, S., Seidel, J.L., Chhuon, K., Lun, S., Eang, K.E., Venot, J.P., Belaud, G., Babic, M. and Leblanc, M., 2020. Seasonal influences on groundwater arsenic concentrations in the irrigated region of the Cambodian Mekong Delta. *Science of the Total Environment*, *728*, p.138598.
573. Uhl, A., Hahn, H.J., Jäger, A., Luftensteiner, T., Siemensmeyer, T., Döll, P., Noack, M., Schwenk, K., Berkhoff, S., Weiler, M. and Karwautz, C., 2022. Making waves: Pulling the plug—Climate change effects will turn gaining into losing streams with detrimental effects on groundwater quality. *Water Research*, *220*, p.118649.
574. U.S. Department of Energy (USDOE) Office of Legacy Management (LM), 2019. Three Years of Multilevel Monitoring Data at the Riverton, Wyoming, Processing Site That Show Contaminant Increases After River Flooding Events and a Large Recharge Event. LMS/RVT/S26137, ESL-RPT-2019-03.
575. United States Environmental Protection Agency (US EPA). 2002. Onsite Wastewater Treatment Systems Manual.
576. US Environmental Protection Agency (US EPA)., 2013. Climate change adaptation technical fact sheet: Groundwater remediation systems, EPA-542-F-13-004.
577. van Berk, W. and Fu, Y., 2017. Redox roll-front mobilization of geogenic uranium by nitrate input into aquifers: risks for groundwater resources. *Environmental Science & Technology*, *51*(1), pp.337-345.
578. Van De Ven, C.J., Scully, K.H., Frame, M.A., Sihota, N.J. and Mayer, K.U., 2021. Impacts of water table fluctuations on actual and perceived natural source zone depletion rates. *Journal of Contaminant Hydrology*, *238*, p.103771.
579. Vane, C.H., Harrison, I., Kim, A., Moss-Hayes, V., Vickers, B. and Horton, B.P., 2008. Status of organic pollutants in surface sediments of Barnegat Bay-Little Egg harbor estuary, New Jersey, USA. *Marine pollution bulletin*, *56*(10), pp.1802-1814.
580. van Gaalen, J.F., Kruse, S., Lafrenz, W.B. and Burroughs, S.M., 2013. Predicting water table response to rainfall events, central Florida. *Groundwater*, *51*(3), pp.350-362.
581. van Vliet, M.T., Franssen, W.H., Yearsley, J.R., Ludwig, F., Haddeland, I., Lettenmaier, D.P. and Kabat, P., 2013. Global river discharge and water temperature under climate change. *Global Environmental Change*, *23*(2), pp.450-464.
582. Ventura-Houle, R., Font, X. and Heyer, L., 2018. Groundwater arsenic contamination and their variations on episode of drought: Ter River delta in Catalonia, Spain. *Applied Water Science*, *8*(5), pp.1-8.

583. Verplanck, P.L., Mueller, S.H., Goldfarb, R.J., Nordstrom, D.K. and Youcha, E.K., 2008. Geochemical controls of elevated arsenic concentrations in groundwater, Ester Dome, Fairbanks district, Alaska. *Chemical Geology*, *255*(1-2), pp.160-172.
584. Viaroli, S., Lancia, M. and Re, V., 2022. Microplastics contamination of groundwater: Current evidence and future perspectives. A review. *Science of The Total Environment*, p.153851.
585. Vinson, D.S., Tagma, T., Bouchaou, L., Dwyer, G.S., Warner, N.R. and Vengosh, A., 2013. Occurrence and mobilization of radium in fresh to saline coastal groundwater inferred from geochemical and isotopic tracers (Sr, S, O, H, Ra, Rn). *Applied Geochemistry*, *38*, pp.161-175.
586. Viswanathan, M. (1983). The Rainfall/Water-Table Level Relationship of an Unconfined Aquifer. Ground Water, 21(1), 49-56.
587. Vitousek, S., Barnard, P.L., Fletcher, C.H., Frazer, N., Erikson, L. and Storlazzi, C.D., 2017. Doubling of coastal flooding frequency within decades due to sea-level rise. *Scientific reports*, *7*(1), pp.1-9.
588. Voisin, J., Cournoyer, B., Vienney, A. and Mermillod-Blondin, F., 2018. Aquifer recharge with stormwater runoff in urban areas: Influence of vadose zone thickness on nutrient and bacterial transfers from the surface of infiltration basins to groundwater. *Science of the Total Environment*, *637*, pp.1496-1507.
589. Vowinkel, E.F., Grosz, A.E., Barringer, J.L., Szabo, Z., Stackelberg, P.E., Hopple, J.A., Grossman, J.N., Murphy, E.A., Serfes, M. and Spayd, S., 2001. Distribution of arsenic in the environment in New Jersey. *The US Geological Survey, New Jersey Department of Environmental Protection, West Trenton, NJ*.
590. Vu, E., Schaumann, G.E. and Buchmann, C., 2022. The contribution of microbial activity to soil–water interactions and soil microstructural stability of a silty loam soil under moisture dynamics. *Geoderma*, *417*, p.115822.
591. Wada, Y., Wisser, D., Eisner, S., Flörke, M., Gerten, D., Haddeland, I., Hanasaki, N., Masaki, Y., Portmann, F.T., Stacke, T. and Tessler, Z., 2013. Multimodel projections and uncertainties of irrigation water demand under climate change. *Geophysical research letters*, *40*(17), pp.4626-4632.
592. Wallis, I., Prommer, H., Berg, M., Siade, A.J., Sun, J. and Kipfer, R., 2020. The river–groundwater interface as a hotspot for arsenic release. *Nature Geoscience*, *13*(4), pp.288-295.
593. Walpen, N., Getzinger, G.J., Schroth, M.H. and Sander, M., 2018. Electron-donating phenolic and electron-accepting quinone moieties in peat dissolved organic matter: quantities and redox transformations in the context of peat biogeochemistry. *Environmental science & technology*, *52*(9), pp.5236-5245.
594. Walsh, L.M., Sumner, M.E. and Keeney, D.R., 1977. Occurrence and distribution of arsenic in soils and plants. *Environmental Health Perspectives*, *19*, pp.67-71.
595. Walter, D.A., McCobb, T.D., Masterson, J.P. and Fienen, M.N., 2016. Potential effects of sea-level rise on the depth to saturated sediments of the Sagamore and Monomoy flow lenses on Cape Cod, Massachusetts.
596. Wang, R., Ma, Y., Zhao, G., Zhou, Y., Shehab, I. and Burton, A., 2023. Investigating water quality sensitivity to climate variability and its influencing factors in four Lake Erie watersheds. *Journal of Environmental Management*, *325*, p.116449.
597. Wang, S., Zhuang, Q., Lähteenoja, O., Draper, F.C. and Cadillo-Quiroz, H., 2018. Potential shift from a carbon sink to a source in Amazonian peatlands under a changing climate. *Proceedings of the National Academy of Sciences*, *115*(49), pp.12407-12412.
598. Wang, L., Yang, Z. and Niu, J., 2011. Temperature-dependent sorption of polycyclic aromatic hydrocarbons on natural and treated sediments. *Chemosphere*, *82*(6), pp.895-900.
599. Wang, X., Yang, K., Tao, S. and Xing, B., 2007. Sorption of aromatic organic contaminants by biopolymers: Effects of pH, copper (II) complexation, and cellulose coating. *Environmental science & technology*, *41*(1), pp.185-191.
600. Wanner, P., 2021. Plastic in agricultural soils–A global risk for groundwater systems and drinking water supplies–A review. *Chemosphere*, *264*, p.128453.
601. Warziniack, T., Arabi, M., Brown, T.C., Froemke, P., Ghosh, R., Rasmussen, S. and Swartzentruber, R., 2022. Projections of freshwater use in the United States under climate change. *Earth's Future*, *10*(2), p.e2021EF002222.
602. Washington, J.W., Rosal, C.G., McCord, J.P., Strynar, M.J., Lindstrom, A.B., Bergman, E.L., Goodrow, S.M., Tadesse, H.K., Pilant, A.N., Washington, B.J. and Davis, M.J., 2020. Nontargeted mass-spectral detection of chloroperfluoropolyether carboxylates in New Jersey soils. *Science*, *368*(6495), pp.1103-1107.
603. Weber, A.K., Barber, L.B., LeBlanc, D.R., Sunderland, E.M. and Vecitis, C.D., 2017. Geochemical and hydrologic factors controlling subsurface transport of poly-and perfluoroalkyl substances, Cape Cod, Massachusetts. *Environmental science & technology*, *51*(8), pp.4269-4279.
604. Weber, F.A., Hofacker, A.F., Voegelin, A. and Kretzschmar, R., 2010. Temperature dependence and coupling of iron and arsenic reduction and release during flooding of a contaminated soil. *Environmental science & technology*, *44*(1), pp.116-122.

605. Weitzman, J.N., Brooks, J.R., Compton, J.E., Faulkner, B.R., Mayer, P.M., Peachey, R.E., Rugh, W.D., Coulombe, R.A., Hatteberg, B. and Hutchins, S.R., 2022. Deep soil nitrogen storage slows nitrate leaching through the vadose zone. *Agriculture, Ecosystems & Environment*, *332*, p.107949.
606. Welch, A.H., Westjohn, D.B., Helsel, D.R. and Wanty, R.B., 2000. Arsenic in ground water of the United States: occurrence and geochemistry. *Groundwater*, *38*(4), pp.589-604.
607. Welch, S.A. and Ullman, W.J., 2000. The temperature dependence of bytownite feldspar dissolution in neutral aqueous solutions of inorganic and organic ligands at low temperature (5–35 C). *Chemical Geology*, *167*(3-4), pp.337-354.
608. Weider, K.M., 2014. A Data-Driven Study of the Water Table Fluctuations in New England over the Last 60 Years. *Masters Theses 1911 - February 2014. 543*.
609. Wellman, D.M., Freshley, M.D., Johnson, T.C. and Miracle, A.L., 2012. Contaminants in vadose zone environments. *Vadose Zone Journal*, *11*(4), pp.vzj2012-0159.
610. Wen, X., Lu, J., Wu, J., Lin, Y. and Luo, Y., 2019. Influence of coastal groundwater salinization on the distribution and risks of heavy metals. *Science of the Total Environment*, *652*, pp.267-277.
611. Wen, H., Perdrial, J., Abbott, B.W., Bernal, S., Dupas, R., Godsey, S.E., Harpold, A., Rizzo, D., Underwood, K., Adler, T. and Sterle, G., 2020. Temperature controls production but hydrology regulates export of dissolved organic carbon at the catchment scale. *Hydrology and Earth System Sciences*, *24*(2), pp.945-966.
612. Wen, Y., Xiao, M., Chen, Z., Zhang, W. and Yue, F., 2023. Seasonal Variations of Dissolved Organic Matter in Urban Rivers of Northern China. *Land*, *12*(2), p.273.
613. Weng, L., Temminghoff, E.J., Lofts, S., Tipping, E. and Van Riemsdijk, W.H., 2002. Complexation with dissolved organic matter and solubility control of heavy metals in a sandy soil. *Environmental science & technology*, *36*(22), pp.4804-4810.
614. Werner, A.D. and Simmons, C.T., 2009. Impact of sea-level rise on sea water intrusion in coastal aquifers. *Groundwater*, *47*(2), pp.197-204.
615. Werner, A.D., Bakker, M., Post, V.E., Vandenbohede, A., Lu, C., Ataie-Ashtiani, B., Simmons, C.T. and Barry, D.A., 2013. Seawater intrusion processes, investigation and management: recent advances and future challenges. *Advances in water resources*, *51*, pp.3-26.
616. Westphal, A., Kleyböcker, A., Jesußek, A., Lienen, T., Köber, R. and Würdemann, H., 2017. Aquifer heat storage: abundance and diversity of the microbial community with acetate at increased temperatures. *Environmental Earth Sciences*, *76*(2), pp.1-23.
617. Westrop, J.P., Yadav, P., Nolan, P.J., Campbell, K.M., Singh, R., Bone, S.E., Chan, A.H., Kohtz, A.J., Pan, D., Healy, O. and Bargar, J.R., 2023. Nitrate-stimulated release of naturally occurring sedimentary uranium. *Environmental Science & Technology*, *57*(10), pp.4354-4366.
618. Wing, O.E., Lehman, W., Bates, P.D., Sampson, C.C., Quinn, N., Smith, A.M., Neal, J.C., Porter, J.R. and Kousky, C., 2022. Inequitable patterns of US flood risk in the Anthropocene. *Nature Climate Change*, *12*(2), pp.156-162.
619. Winter, T.C., 1983. The interaction of lakes with variably saturated porous media. *Water Resources Research*, *19*(5), pp.1203-1218.
620. Wirmvem, M.J., Ohba, T., Nche, L.A., Kamtchueng, B.T., Kongnso, W.E., Mimba, M.E., Bafon, T.G., Yaguchi, M., Takem, G.E., Fantong, W.Y. and Ako, A.A., 2017. Effect of diffuse recharge and wastewater on groundwater contamination in Douala, Cameroon. *Environmental Earth Sciences*, *76*(9), pp.1-23.
621. Woodruff, J.D., Irish, J.L. and Camargo, S.J., 2013. Coastal flooding by tropical cyclones and sea-level rise. *Nature*, *504* (7478), pp.44-52.
622. Woolway, R.I., Kraemer, B.M., Lenters, J.D., Merchant, C.J., O'Reilly, C.M. and Sharma, S., 2020. Global lake responses to climate change. *Nature Reviews Earth & Environment*, *1*(8), pp.388-403.
623. Wu, B., Li, L.W., Zu, Y.X., Nan, J., Chen, X.Q., Sun, K. and Li, Z.L., 2022. Microplastics contamination in groundwater of a drinking-water source area, northern China. *Environmental Research*, *214*, p.114048.
624. Xiang, S.R., Doyle, A., Holden, P.A. and Schimel, J.P., 2008. Drying and rewetting effects on C and N mineralization and microbial activity in surface and subsurface California grassland soils. *Soil Biology and Biochemistry*, *40*(9), pp.2281-2289.
625. Xiao, F., Simcik, M.F., Halbach, T.R. and Gulliver, J.S., 2015. Perfluorooctane sulfonate (PFOS) and perfluorooctanoate (PFOA) in soils and groundwater of a US metropolitan area: migration and implications for human exposure. *Water research*, *72*, pp.64-74.
626. Xin, P., Wilson, A., Shen, C., Ge, Z., Moffett, K.B., Santos, I.R., Chen, X., Xu, X., Yau, Y.Y., Moore, W. and Li, L., 2022. Surface water and groundwater interactions in salt marshes and their impact on plant ecology and coastal biogeochemistry. *Reviews of Geophysics*, *60*(1), p.e2021RG000740.

627. Xu, J., Morris, P.J., Liu, J., Ledesma, J.L. and Holden, J., 2020. Increased dissolved organic carbon concentrations in peat-fed UK water supplies under future climate and sulfate deposition scenarios. *Water Resources Research*, *56*(1), p.e2019WR025592.
628. Xu, Z., Serata, R., Wainwright, H., Denham, M., Molins, S., Gonzalez-Raymat, H., Lipnikov, K., Moulton, J.D. and Eddy-Dilek, C., 2022. Reactive transport modeling for supporting climate resilience at groundwater contamination sites. *Hydrology and Earth System Sciences*, *26*(3), pp.755-773.
629. Xue, Z. and Ullrich, P.A., 2022. Changing Trends in Drought Patterns over the Northeastern United States Using Multiple Large Ensemble Datasets. *Journal of Climate*, *35*(22), pp.3813-3833.
630. Xyla, A.G., Sulzberger, B., Luther III, G.W., Hering, J.G., Van Cappellen, P. and Stumm, W., 1992. Reductive dissolution of manganese (III, IV)(hydr) oxides by oxalate: The effect of pH and light. *Langmuir*, *8*(1), pp.95-103.
631. Yabusaki, S.B., Wilkins, M.J., Fang, Y., Williams, K.H., Arora, B., Bargar, J., Beller, H.R., Bouskill, N.J., Brodie, E.L., Christensen, J.N. and Conrad, M.E., 2017. Water table dynamics and biogeochemical cycling in a shallow, variably-saturated floodplain. *Environmental science & technology*, *51*(6), pp.3307-3317.
632. Yadav, B.K. and Hassanizadeh, S.M., 2011. An overview of biodegradation of LNAPLs in coastal (semi)-arid environment. *Water, Air, & Soil Pollution*, *220*(1), pp.225-239.
633. Yadav, B.K., Shrestha, S.R. and Hassanizadeh, S.M., 2012. Biodegradation of toluene under seasonal and diurnal fluctuations of soil-water temperature. *Water, Air, & Soil Pollution*, *223*(7), pp.3579-3588.
634. Yagasaki, T., Iwahashi, K., Saito, S. and Ohmine, I., 2005. A theoretical study on anomalous temperature dependence of p K w of water. *The Journal of chemical physics*, *122*(14), p.144504.
635. Yang Y, Yuan X, Deng Y, Xie X, Gan Y, Wang Y. Seasonal dynamics of dissolved organic matter in high arsenic shallow groundwater systems. Journal of Hydrology. 2020 Oct 1;589:125120.
636. Yang, Y., Xie, Z., Wang, J. and Chen, M., 2023. Thiosulfate driving bio-reduction mechanisms of scorodite in groundwater environment. *Chemosphere*, *311*, p.136956.
637. Yang, F., Yue, S., Wu, X., Zhang, C., Li, D. and Zhu, R., 2023. Effects of flood inundation on biogeochemical processes in groundwater during riverbank filtration. *Journal of Hydrology*, p.129101.
638. Yu Z, Beilman DW, Frolking S, MacDonald GM, Roulet NT, Camill P, Charman DJ. Peatlands and their role in the global carbon cycle. Eos, Transactions American Geophysical Union. 2011 Mar 22;92(12):97-8.
639. Yuan, C., Wei, Y., Xu, X. and Cao, X., 2023. Transport and transformation of arsenic in coastal aquifer at the scenario of seawater intrusion followed by managed aquifer recharge. *Water Research*, *229*, p.119440.
640. Zambito Iv, J.J., Haas, L.D. and Parsen, M.J., 2022. Identifying the source of groundwater contaminants in West-Central Wisconsin, USA: Geochemical and mineralogical characterization of the Cambrian sandstone aquifer. *Journal of Contaminant Hydrology*, *247*, p.103966.
641. Zeman, N.R., Irianni Renno, M., Olson, M.R., Wilson, L.P., Sale, T.C. and De Long, S.K., 2014. Temperature impacts on anaerobic biotransformation of LNAPL and concurrent shifts in microbial community structure. *Biodegradation*, *25*(4), pp.569-585.
642. Zhai, Y., Han, Y., Xia, X., Li, X., Lu, H., Teng, Y. and Wang, J., 2021. Anthropogenic organic pollutants in groundwater increase releases of Fe and Mn from aquifer sediments: Impacts of pollution degree, mineral content, and pH. *Water*, *13*(14), p.1920.
643. Zhang, W., Chai, J., Li, S., Wang, X., Wu, S., Liang, Z., Baloch, M.Y.J., Silva, L.F. and Zhang, D., 2022. Physiological characteristics, geochemical properties and hydrological variables influencing pathogen migration in subsurface system: What we know or not?. *Geoscience Frontiers*, p.101346.
644. Zhang, Y., Miao, Z., Bognar, J. and Lathrop, R.G., 2011. Landscape scale modeling of the potential effect of groundwater-level declines on forested wetlands in the New Jersey Pinelands. *Wetlands*, *31*(6), pp.1131-1142.
645. Zhang, G., Feng, G., Li, X., Xie, C. and Pi, X., 2017. Flood effect on groundwater recharge on a typical silt loam soil. *Water*, *9*(7), p.523.
646. Zhang, Y., Zhang, H., Zhang, Z., Liu, C., Sun, C., Zhang, W. and Marhaba, T., 2018. pH effect on heavy metal release from a polluted sediment. *Journal of Chemistry*, *2018*.
647. Zhang, Y.C., Slomp, C.P., Broers, H.P., Bostick, B., Passier, H.F., Böttcher, M.E., Omoregie, E.O., Lloyd, J.R., Polya, D.A. and Van Cappellen, P., 2012. Isotopic and microbiological signatures of pyrite-driven denitrification in a sandy aquifer. *Chemical Geology*, *300*, pp.123-132.
648. Zhang, J., Felzer, B.S. and Troy, T.J., 2016. Extreme precipitation drives groundwater recharge: the northern high plains aquifer, central United States, 1950–2010. *Hydrological Processes*, *30*(14), pp.2533-2545.
649. Zhang, Z. and Furman, A., 2021. Soil redox dynamics under dynamic hydrologic regimes-A review. *Science of The Total Environment*, *763*, p.143026.

650. Zhang, X., Chen, Y., Li, X., Zhang, Y., Gao, W., Jiang, J., Mo, A. and He, D., 2022. Size/shape-dependent migration of microplastics in agricultural soil under simulative and natural rainfall. *Science of The Total Environment*, *815*, p.152507.
651. Zhao, S., Feng, C., Wang, D., Liu, Y. and Shen, Z., 2013. Salinity increases the mobility of Cd, Cu, Mn, and Pb in the sediments of Yangtze Estuary: relative role of sediments' properties and metal speciation. *Chemosphere*, *91*(7), pp.977-984.
652. Zhao, M., Jiang, Y., Jia, Y., Lian, X., Feng, F., Shang, C., Zang, Y. and Xi, B., 2023. Anthropogenic perturbation enhances the release of geogenic Mn to groundwater: Evidence from hydrogeochemical characteristics. *Science of The Total Environment*, p.164450.
653. Zheng, W., Wang, S., Sprenger, M., Liu, B. and Cao, J., 2019. Response of soil water movement and groundwater recharge to extreme precipitation in a headwater catchment in the North China Plain. *Journal of Hydrology*, *576*, pp.466-477.
654. Zheng, N., Yue, W., Wu, J., Hou, K., Wu, L., Guo, M. and Teng, Y., 2021. Responses of soil cadmium desorption under different saline environments and its controlling factors. *Agronomy*, *11*(11), p.2175.
655. Zhong, Y., Jiang, M. and Middleton, B.A., 2020. Effects of water level alteration on carbon cycling in peatlands. *Ecosystem Health and Sustainability*, *6*(1), p.1806113.
656. Zhou, J., Gu, B., Schlesinger, W.H. and Ju, X., 2016. Significant accumulation of nitrate in Chinese semi-humid croplands. *Scientific reports*, *6*(1), pp.1-8.
657. Zhou, Y., Li, P., Chen, M., Dong, Z. and Lu, C., 2021. Groundwater quality for potable and irrigation uses and associated health risk in southern part of Gu'an County, North China Plain. *Environmental geochemistry and health*, *43*, pp.813-835.
658. Zhou, W., Zhu, H., Hu, S., Zhang, B., Gao, K., Dang, Z. and Liu, C., 2022. Dynamic coupling of ferrihydrite transformation and associated arsenic desorption/redistribution mediated by sulfate-reducing bacteria. *Journal of Environmental Sciences*, *135*, pp.39-50.
659. Zhu, R., Croke, B.F. and Jakeman, A.J., 2020. Diffuse groundwater recharge estimation confronting hydrological modelling uncertainty. *Journal of Hydrology*, *584*, p.124642.
660. Zomlot, Z., Verbeiren, B., Huysmans, M. and Batelaan, O., 2015. Spatial distribution of groundwater recharge and base flow: Assessment of controlling factors. *Journal of Hydrology: Regional Studies*, *4*, pp.349-368.
661. Zuo, R., Zhao, X., Yang, J., Pan, M., Xue, Z., Gao, X., Wang, J. and Teng, Y., 2021. Analysis of the LNAPL Migration Process in the Vadose Zone under Two Different Media Conditions. *International Journal of Environmental Research and Public Health*, *18*(21), p.11073.