EFFECT OF NITRATE CONTAMINATION IN GROUNDWATER- A WORLDWIDE CONCERN

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ABSTRACT: Nitrate is a prevalent groundwater and surface water contaminant that is a major contributor to global groundwater contamination. Due to nitrogen fertiliser runoff from urban lawns and agricultural fields, nitrate levels in streams and rivers can reach dangerous levels. Many plant species, including the majority of edible ones, require it for growth; but, if it gets into water where it is not needed, it creates a problem. Both a serious environmental issue and a health risk result from this. Foods are preserved with sodium nitrite, particularly meats that have been cured. Additionally, nitrate may occasionally be added to serve as a container for nitrite. Almost 80% of air we breathe is composed of nitrogen, which is a significant component of the earth's atmosphere. All nitrates are primarily produced by atmospheric nitrogen gas. In a process known as nitrogen fixation, some plants transform this into organic nitrogen. Nitrate, which is dissolved nitrogen, is the most common type of ground water pollution. Numerous chemical and biological processes, such as nitrification and denitrification, affect the amount of nitrate in ground water. This review focuses on the extent of nitrate contamination and its impact on human population worldwide.

Keywords: *Nitrate contamination, carcinogens, groundwater, methemoglobinemia, world, India, health risk*

INTRODUCTION: A precious natural resource with substantial social and economic ramifications is groundwater. In an environmental sense, groundwater supplies also directly support rivers, lakes, and wetlands. Resources for groundwater, both in terms of quantity and quality are being impacted by global concerns brought on by elements including climate change, land use, and population growth. One of the main contaminants in groundwater is nitrate ($NO3^-$). Nitrate poisoning of the environment and dangers to human health are already major global problems, and high amounts of nitrate in groundwater can exacerbate these problems. A person who consumes water with high nitrate contents may experience an almost immediate reaction (acute toxicity) and have a higher chance of developing methemoglobinemia, also known as "blue baby syndrome," wherein the blood is unable to adequately oxygenate all of the body's cells (Uhlman and Artiola, 2011). Numerous malignancies, including bladder, urothelial, gastric, colorectal, and brain tumors, have been linked to prolonged exposure to high nitrate levels in drinking water (CDPH 2013). In rural areas, farmers' use of chemical and organic fertilisers, as well as, to some extent, the effluents from residential sewage systems, are the main contributors to the issue of groundwater nitrate contamination (Levallois et al. 1998). Nitrate and nitrite are two examples of chemicals that can affect groundwater resources. The average level of groundwater resources has increased recently due to a variety of circumstances, including the spread of sewage from urban, industrial, and agricultural sources (Jalili et al. 2018).

MATERIALS AND METHODS: By looking for published studies on chronic arsenic poisoning and the connection between its toxicity and different diseases, including cancer, in Pubmed, Pubmed Central, the CDC, and Google, the appropriate material for this review paper was found. Original studies and review articles from around the world made up these research projects. Vague descriptions of exposure were discarded, and only published data were taken into account. One of the requirements for inclusion isinformation gathered from reliable sources of publications on the subject. The study excluded the use of other languages.

RESULTS AND DISCUSSION:

Nitrate contamination:

The "perfect storm" may happen, resulting in the direct consumption of relatively high volumes of surface flood-contaminated groundwater due to the inherent properties of groundwater (i.e., out of sight, out of mind) and the widely held belief that aquifers are a pure source of drinking water due to natural attenuation (Andrade et al. 2018). Wells are the main source of drinking water in rural parts of many underdeveloped countries; these groundwater sources are typically untreated. An important source. of nitrate is drinking water from groundwater. Nitrate in groundwater can come from a variety of places, including incorrect wastedisposal, animal farm waste, the use of nitrogenous fertilizers, crops (such as Chinese cabbage, kale, and carrots), etc. Nitrogen easily percolates from the soil into the groundwater along with irrigation water or replenished precipitation. Groundwater pollution is extremely intricate, frequently challenging to detect, and has long-lasting effects. Groundwater is harder to clean up after pollution than surface water is. Nitrate-nitrogen exposure in humans is thought to be significantly influenced by diet, especially leafy green vegetables (Klein et al. 2013). In developing nations, the majority of septic tanks have leakage issues, which directly contribute to nitrate leaching into the groundwater. Also, there have been instances of practices such as open defecation causing nitrate contamination in groundwater systems (Gao et al. 2012). Waste produced by dairy systems, livestock, livestock farming faeces, cattle herds, feedlots, and other poultry systems is a substantial source of nitrate inputs into groundwater. Nitrates can harm fish by causing a condition called "brown blood illness." The haemoglobin present in human blood as well as the blood of other warm-blooded animals interacts directly with nitrates to form methemoglobin. Red blood cells' ability to transport oxygen is decreased by methemoglobin. The sickness is especially dangerous to infants under three months of age. Methemoglobinemia, popularly known as "blue baby disease," is the outcome (Kumar et al. 2012). Since it can produce carcinogenic nitrosamines in certain conditions, such as an acidic stomach, nitrate is regarded as dangerous (Ma et al. 2018). Many health hazards have been linked to dietary nitrate intake. Many very physiologically reactive nitrogen oxide molecules are created in the tissues and blood as well as in the stomach's acidic environment.

Occurrence of Nitrate in Groundwater on Global Scale-

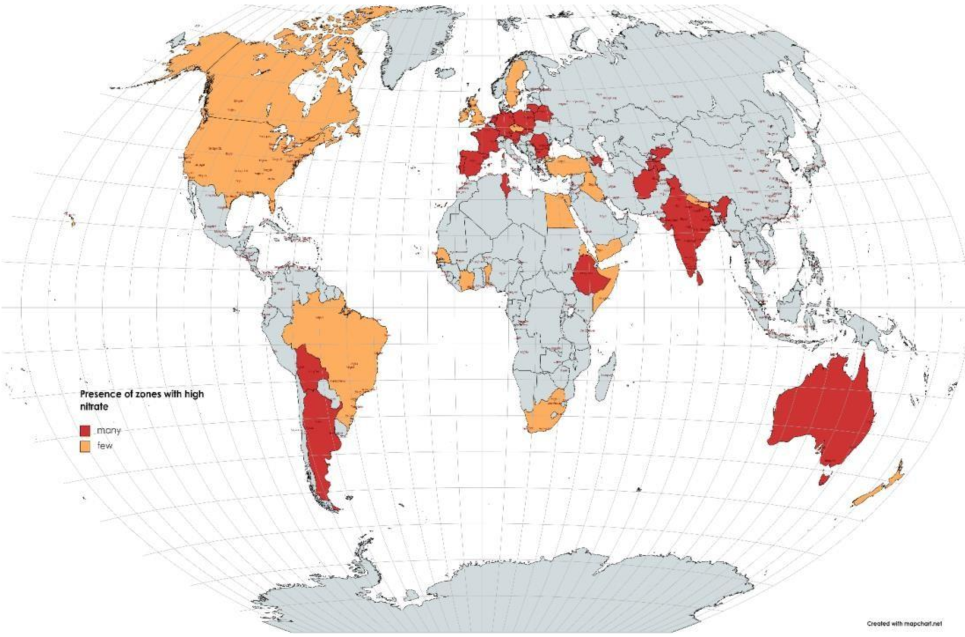

Fig. 1. Zones with significant levels of groundwater nitrate pollution are shown on the global map (Source: IGRAC, 2012)

Figure 1 shows the nations where nitrate pollution is an issue. Efforts must be concentrated on improving the equilibrium of nutrients provided in the fields and decreasing and restricting the amount of nitrogen added to the soil using fertilizers in order to decrease the danger of agricultural lake pollution (Lawniczak et al. 2016).

Occurrence of Nitrate in groundwater in India-

Inorganic pollutants that contain nitrogen are frequently found. Examples include nitrate, nitrite, and ammonia nitrogen. The majority of nitrate is produced by humans and is found in agricultural products like fertilisers and manure as well as domestic wastewater (Li et al. 2021). There have been reports of nitrate poisoning of groundwater in rural parts of Tamil Nadu, Orissa, Karnataka, Maharashtra, Bihar, Gujarat, Madhya Pradesh, Rajasthan, and other Indian states (Katharina et al. 2012). According to the BIS Standard for drinking water, the upper level of nitrate content that is advised to be present in groundwater is 45 mg/l with no exceptions. According to estimates, 73 million working days are lost each year in India due to waterborne infections, which also kill 1.5 million children each year and affect 37.7 million individuals. In several Indian states, crystalline aquifers are becoming more contaminated due to anthropogenic factors than from natural sources. As so many people rely on untreated groundwater, it is crucial to identify the causes of contamination and assess the threat they pose to human health to provide a steady stream of pure water. Nitrate levels in water that are more than 50 mg/l should not be consumed owing to possible health effects. Nitrate contamination of surface water, ground water, and wells is the result of percolation and can occur from point sources like livestock facilities and sewage disposal systems or from natural sources like rivers and lakes. One of the anthropogenic causes of nitrate pollution in groundwater is waste products. A significant potential source of nitrate pollution is the runoff of fertilized crops and animal feedlots into surface waterways. Another illustration of how anthropogenic sources of nitrogen may contaminate groundwater is septic tanks. Septic system density and contaminated ground water are often connected. The underlying aquifer system experiences a wide range of nitrate occurrences as a result of crop diversity, soil type, and groundwater level (Lockhart et al. 2013). Table 1 displays the occurrences of nitrate in ground water in different districts of different Indian states where nitrate levels have exceeded 45 mg/l and the states of India affected with nitrate contamination are depicted in Figure 2.

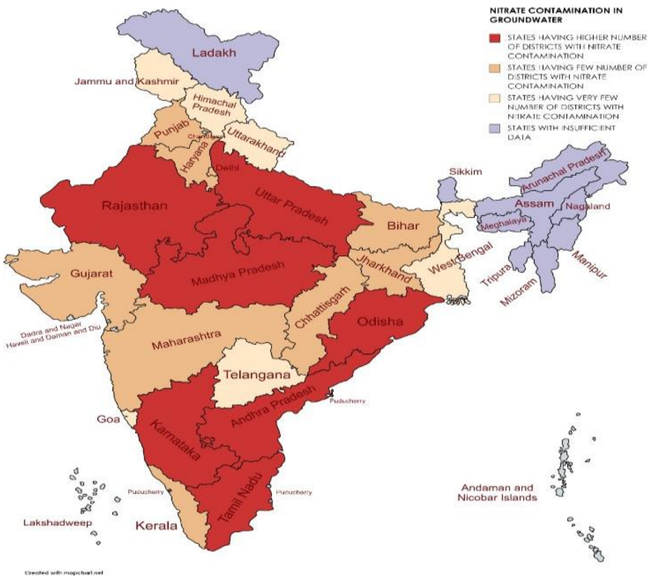

Fig. 2. Map Showing Nitrate Contamination in Groundwater in India (source- Katharina et al. 2012)

State	**Parts of Districts having Nitrate > 45 mg/litre**
Andhra Pradesh	Adilabad, Anantpur, Chittoor, Cuddapah, East Godavari, Guntur, Hyderabad, Karimnagar, Khammam, Krishna, Kurnool, Mahbubnagar, Medak, Nalgonda, Nellore, Nizamabad, Prakasam, Ranga Reddy, Srikakulam, Visakhapatnam, Vizianagaram, Warangal, West Godavari
Bihar	Aurangabad, Banka, Bhagalpur, Bhojpur, Kaimur(Bhabua), Patna, Rohtas, Saran, Siwan
Chattisgarh	Bastar, Bilaspur, Dantewada, Dhamtari, Jashpur, Kanker, Kawardha, Korba, Mahasamund, Raigarh, Raipur, Rajnandgaon
Delhi	Central Delhi, New Delhi, North Delhi, North West Delhi, South Delhi, South West Delhi, West Delhi

Goa	North Goa
Gujarat	Ahmadabad, Amreli, Anand, Banaskantha, Bharuch, Bhavnagar, Dohad, Jamnagar, Junagadh, Kachchh, Kheda, Mehsana, Narmada, Navsari, Panchmahals, Patan, Porbandar, Rajkot, Sabarkantha, Surat, Surendranagar, Vadodara,
Haryana	Ambala, Bhiwani, Faridabad, Fatehabad, Gurgaon, Hissar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Mahendragarh, Panchkula, Panipat, Rewari, Rohtak, Sirsa, Sonepat, Yamuna Nagar
Himachal Pradesh	Una
Jammu & Kashmir	Jammu, Kathua
Jharkhand	Chatra, Garhwa, Godda, Gumla, Lohardaga, Pakaur, Palamu, Paschimi Singhbhum, Purbi Singhbhum, Ranchi, Sahibganj
Karnataka	Bagalkot, Bangalore, Belgaum, Bellary, Bidar, Bijapur, Chikmagalur, Chitradurga, Davangere, Dharwad, Gadag, Gulburga, Hassan, Haveri, Kodagu, Kolar, Koppal, Mandya, Mysore, Raichur. Shimoga, Udupi, Uttara Kannada
Kerala	Alappuzha, Idukki, Kollam, Kottayam, Kozhikode, Malappuram, Palakkad, Pathanamthitta, Thiruvananthapuram, Thrissur, Wayanad

Maharashtra	Ahmednagar, Akola, Amravati, Auragabad, Beed, Bhandara, Buldana, Chandrapur, Dhule, Gadchiroli, Gondia, Hingoli, Jalgaon, Jalna, Kohlapur, Latur, Nagpur, Nanded, Nandurbar, Nashik, Osmanabad, Parbhani, Pune, Sangli, Satara, Solapur, Wardha, Washim, Yavatma
Madhya Pradesh	Anuppur, Ashok Nagar, Balaghat, Barwani, Betul, Bhind, Bhopal, Burhanpur, Chhatarpur, Chhindwara, Damoh, Datia, Dewas, Dhar, Gwalior, Harda, Hoshangabad, Indore, Jabalpur, Jhabua, Katni, Khandwa, Khargaon, Mandla, Mandsaur, Morena, Narsimhapur, Neemuch, Panna, Raisen, Rajgarh, Ratlam, Rewa, Sagar, Satna, Sehore, Seoni, Shahdol, Shajapur, Sheopur, Shivpuri, Sidhi, Tikamgarh, Ujjain, Umaria, Vidisha
Orissa	Angul, Balasore, Bargarh, Bhadrak, Bolangir, Baudh, Cuttack, Deogarh, Dhenkanal, Gajapati, Ganjam, J.Singhpur, Jajpur, Jharsuguda, Kalahandi, Kendrapara, Keonjhar, Khurda, Koraput, Malkangiri, Mayurbhanj, Nawapada, Nayagarh, Phulbani, Puri, Sambalpur, Sundergarh, Sonapur
Punjab	Amritsar, Bhathinda, Faridkot, Fatehgarh Sahib, Firozepur, Gurdaspur, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Mansa, Moga, Muktsar, Nawan Shahr, Patiala, Rupnagar, Sangrur
Rajasthan	Ajmer, Alwar, Banaswara, Baran, Barmer, Bundi, Bharatpur, Bhilwara, Bikaner, Chittaurgarh, Churu, Dausa, Dhaulpur, Dungarpur, Ganganagar, Hanumangarh, Jaipur, Jaisalmer, Jalor, Jhalawar, Jhunjhunun, Jodhpur, Karauli, Kota, Nagaur, Pali, Partapgarh, Rajsamand, Sirohi, Sikar, Sawai Madhopur, Tonk, Udaipur
Tamil Nadu	Chennai, Coimbatore, Cuddalore, Dharmapuri, Dindigul, Erode, Kancheepuram, Kanyakumari, Karur, Madurai, Namakkal, Nilgiris, Perambalur, Pudukkottai, Ramanathapuram, Salem, Sivaganga, Theni, Thiruvannamalai, Thanjavur, Tirunelveli, Thiruvallur, Trichi, Tuticorin, Vellore, Villupuram, Virudhunagar
Uttar Pradesh	Agra, Aligarh, Allahabad, Ambedkar Nagar, Auraiya, Badaun, Baghpat, Balrampur, Banda, Barabanki, Bareilly, Basti, Bijnor, Bulandshahr, Chitrakoot, Etah, Etawa, Fatehpur, Firozabad, GB Nagar, Ghaziabad, Ghazipur, Hamirpur, Hardoi, Jaunpur, Jhansi, Kannauj, Kanpur Dehat, Lakhimpur, Mahoba, Mathura, Meerut, Moradabad, Muzaffarnagar, Raebareli, Rampur, Sant Ravidas Nagar, Shahjahanpur, Sitapur, Sonbhadra, Sultanpur, Unnao
Uttarakhand	Dehradun, Hardwar, Udhamsinghnagar
West Bengal	Bankura, Bardhaman

Table 1. Tabular representation of nitrate contamination in India

CONCLUSION: Nitrate pollution of groundwater is a major issue today. By changing groundwater quality, it may have negative effects on ecosystem health and population health. A good governance system and effective groundwater management may lessen all of these negative effects in order to lessen the risks of nitrate pollution. However, in order to properly manage nitrate pollution in groundwater systems, researchers, water resources specialists, and policy makers need to be aware of the scope, spreading, and harshness of groundwater nitrate pollution. To put it another way, it would be smarter to promote early identification of prospective changes and widen their inspiration sources to help them decide on effective activities. In conclusion, the majority of the harmful health effects linked to drinking water nitrate are probably brought on by the combined effects of excessive nitrate consumption and endogenous nitrosation-promoting elements. Subsets of the population that are more likely to experience endogenous nitrosation have been discovered as a result of certain recent cancer and birth defect investigations. On the other hand, these persons need to be evaluated using direct methods. The majority of studies found that nitrate levels in municipal water were lower than the 50 mg/L, WHO recommendation, but we have very little knowledge about nitrate levels in private wells, which may be higher. In rural places, well water may be a major source of nitrate pollution and drinking water. It's crucial to monitor these sources as a result, especially in locations where a large number of people obtain their drinking water from wells or other surface sources.

FUTURE SCOPE: Even while traditional approaches are frequently employed, they have a number of disadvantages. Usually, necessary is a pre-oxidation phase employing chemical oxidants such ozone, chlorine, or hydrogen peroxide. Redox reactions, as well as other processes like precipitation and coagulation/filtration, produce sludge and hazardous byproducts. The limited efficacy of nitrate removal technologies (Alumina adsorption and lime softening), other documented issues include membrane fouling in reverse osmosis, the necessity for pH adjustment in coagulation, the need for reagent regeneration in adsorption technology, the need for reagent regeneration in coagulation, and interference from suspended particles, dissolved solids, and other inorganic ions in the ion exchange process. The best alternative and most economical nitrate removal approach may be bioremediation, which employs naturally existing organisms alone or in conjunction with deceased biomass/biomass remains. Despite the fact that a variety of bacteria are known to already remediate nitrate from ground water. For the yet-to-be-defined processes of nitrate detoxification and degradation, it is required to search for further effective microorganisms. The development of effective bioremediation techniques will come from an understanding of their genetic makeup and biochemistry, protecting the long-term effects of nitrate. We need to use more ground water treatment methods that are both economical and environmentally benign.

Conflict of Interest: There is no conflict of interest declared by the authors.

Author Contributions: Acquisition and interpretation of data is done by Arshiya Nabi, Susoms Gorai, Piusha Mondal, Falguni Pal. Conception, design and revising of the article are done by Dr. Pritha Pal and Dr. Sabyasachi Ghosh.

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