Chapter 16
Graphene-Based Materials for Water Treatment and Purification

Neeraj Kumari
K. R. Mangalam University, Gurugram, India

Meena Bhandari
K. R. Mangalam University, Gurugram, India

ABSTRACT

The supply of clean and safe water in an adequate amount and sustainable way is a global challenge as the presence of toxic organic and inorganic contaminants in water bodies has become one of the most alarming issues. The technologies used for the treatment of water and its desalination remain ineffective in removing the contaminants, especially contaminants present in trace concentration, and was not feasible in disseminated water treatment system globally. Recently, a lot of efforts have sought to enhance various physico-chemical properties of nanomaterials to overcome the shortcoming of technologies. The chapter revealed different technologies for treating wastewater, challenges, and issues faced during treatment and potential applications of advanced materials. The main emphasis is given to the role of graphene-based nano-adsorbents. Under the umbrella of nanotechnologies, different approaches have been discussed for the fabrication of graphene oxide-based nano-adsorbent along with the interaction of contaminants with graphene oxide.

INTRODUCTION

Planet Earth is no longer functioning in the way as it used to be earlier due to the impact and influence of humans. Homo sapiens are the principal drivers for the change of climate. Anthropogenic activities produce an impact on the environment, and the environment, in turn, impacts humans. 97% of Earth is covered with water yet only 3% is available for drinking purposes as rest of it is stored in the form of polar ice or in the sea. Human interferences affect the quality of ground and surface water as well as the

DOI: 10.4018/978-1-7998-7356-3.ch016

Copyright © 2022, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

natural water cycle. Potable water with good quality is essential for human beings and the water cycle is mainly responsible for maintaining of its fixed proportion and management. Interference of humans alters the distribution, quantity, and quality of water resources which is highly essential not only for survival but also for the production of food (Cosgrove and Loucks, 2015). Degradation of water quality is a great threat to humanity, especially in developing countries. The presence of the unwanted entities which impact human health as well as the environment leads to pollution (Sasakova et al, 2018). Industrialization, population explosion, increased standard of living, urbanization, growing GDP and economic development, religious ceremonies performed at river ghats, inefficient water management, and losses during the distribution lead to the increased water contamination and exploitation of water resources as well as a scarcity of water. Phenomena like climate change also impact the distribution of water. Pollution of water bodies affects certain organisms living in water and disturbs biodiversity. Innumerable physical, chemical, and biological impurities make water unfit for drinking (WHO, 2017). Globally 12% of people are using unsafe drinking water. Almost half of the population (nearly 47%) face water scarcity for at least a month a year. By 2050 this number will increase to 52% (United Nations World Water Development Report, 2018; Boretti and Rosa, 2019). Every year 730 million sewage wastes are being discharged into the water bodies or rivers. 90% of sewage in developing countries are added into the water bodies (Mekonnen and Hoekstra, 2016, Wada et al, 2016).

Water is essential for every activity but majorly 72% of it is used for agriculture. 16% of water is utilized for households' purposes and industries use 12% of water withdrawals (UN-Water 2021). As per estimation, 7.5 litres of water per person per day is needed for drinking and making food. 50 liters of water per day per person is required for washing clothes, maintaining personal hygiene, and for house cleaning, etc. (Howard and Bartram, 2003). Water availability per capita at the national level is expected to diminish by 40 to 50% by 2050 due to the fast population increase and economic demand (Data, 2010).

Clean Water Act established in 1972 emphasizes the need for control and restoration of chemical, physical, biological integrity of water present in the water bodies. This is the reason that providing clean and safe drinking water to all is one of the sustainable developmental goals proclaimed by the United Nations (Dinka, 2018). More than 2 billion people are being affected by the scarcity of water and problems related to water pollution. This number would increase up to 3.9 billion in future (Nicolai et al, 2014).

PROBLEMS AND CHALLENGES WITH GROUND AND DRINKING WATER

The effluents discarded from industry, sewage, farming, and household activities lead to water pollution. The impurities that can be present in water include the inorganic ones (Al, As, Mn, Ni, fluorides, nitrites, dissolved solids, etc.), organic impurities (volatile organic compounds, fertilizers, pesticides, trihalomethanes etc.), biological or microbial impurities. The presence of biological impurities results in the appearance of water-borne diseases such as polio, cholera, typhoid fever, dysentery, and infectious hepatitis while the presence of chemicals may result in acute nausea, vomiting, skin ailments, hypertension, cardiotoxicity, fetal abnormalities, damage to liver, brain, and kidney or lead to carcinogenicity (Bayantong et al, 2021).

23 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/chapter/graphene-based-materials-for-water-treatment-and-purification/299888

Related Content

Offshore Wind Turbine Site Selection in the Northern Aegean Sea by Utilizing GIS-Based Maritime Spatial Planning and Exergy Efficiency
Arife Tugsan Isiacik Colak, Hamid Reza Soltani Motlagh, Gizem Seneland Cigdem Goksel (2023). *Opportunities and Challenges in Climate-Friendly Clean Water and Energy Technologies (pp. 90-121).*
www.irma-international.org/chapter/offshore-wind-turbine-site-selection-in-the-northern-aegean-sea-by-utilizing-gis-based-maritime-spatial-planning-and-exergy-efficiency/322453

Groundwater Resource Investigation Using Isotope Technology on River-Sea Systems
Oleg Bogdevich, Gheorghe Duca, Manuela Elisabeta Sidoroff, Adrian Stanica, Aurel Persoiuand Ashok Vaseashta (2022). *Handbook of Research on Water Sciences and Society (pp. 87-100).*
www.irma-international.org/chapter/groundwater-resource-investigation-using-isotope-technology-on-river-sea-systems/299875

Remote Sensing Methodology to Study Wetlands Under Conditions of Climate Change: Case Study of Ukraine
Inna Romanciuc, Lesia Yelistratova, Alexandr Apostolovand Victor Chekhniy (2022). *Handbook of Research on Water Sciences and Society (pp. 556-572).*
www.irma-international.org/chapter/remote-sensing-methodology-to-study-wetlands-under-conditions-of-climate-change/299898

Impacts of Climate Change on Coastal Communities
Isahaque Ali, Rameeja Shaik, Maruthi A. Y., Azlinda Azman, Paramjit Singh, Jeremiah David Bala, Adeleke A. O., Mohd Rafatullah, Norli Ismail, Akil Ahmadand Kaizar Hossain (2020). *Decision Support Methods for Assessing Flood Risk and Vulnerability (pp. 42-59).*
www.irma-international.org/chapter/impacts-of-climate-change-on-coastal-communities/233456

Quantification and Evaluation of Water Erosion: Application of the Model SDR – InVEST in the Ziz Basin in South-East Morocco
Souad Ben Salem, Abdelkrim Ben Salem, Ahmed Karmaoui, Mohammed Khebiza Yacoubiand Mohammed Messouli (2020). *Decision Support Methods for Assessing Flood Risk and Vulnerability (pp. 140-161).*
www.irma-international.org/chapter/quantification-and-evaluation-of-water-erosion/233461