Chapter 2
Future of Water:
Challenges and Potential Solution Pathways Using a Nexus of Exponential Technologies and Transdisciplinarity

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ABSTRACT

We live in a fancy world of global digitization, decarbonization, artificial intelligence, smart and connected cities using 5/6G, biomimicking, and 3/4D printing living organs, yet the two looming challenges to human existence are climate change and water shortages. The two "grand" challenges contrast each other in that, while the former would affect society as a whole, the latter would affect every individual for the basic existence. Whilst existing megatrends dealing with sustainability brace themselves to mitigate global warming, it seems that, scientifically, we are unacceptably equipped to address the issue of water shortages. It is critical to articulate the future of water, which includes a paradigm shift in its production, use, reuse, recycle, and discharge. This chapter reimagines the future of water from a holistic standpoint including transdisciplinary research. The topic must be approached from a fundamental viewpoint to include historical perspectives, nature, and the latest technology advances (viz., artificial intelligence, deep learning, and exponential technologies).

INTRODUCTION

At the first glance, water appears to be one of the most simple, abundant, and pure substances, which is practically colorless, odorless, and tasteless. However, from a scientific standpoint, water possesses several complex physical and chemical characteristics, and some have yet to be explored. Furthermore, water is vital for life on Earth - where there is water there is life and where water is scarce, sustaining life is complicated (Vaseashta et al., 2021a). Water is essential to perform normal functions of the human

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body, such as homeostasis, maintaining equilibrium between exogenous and endogenous water, regulating metabolism and temperature, filtering toxins, etc., as few such examples. These functions are due to some of the most unique characteristics of water. In fact, water on our planet is not just simple H_2O, but consists of a water complex and has unique and anomalous characteristics. Among many interesting characteristics, water has anomalous thermal expansion properties thus protecting the aquatic ecosystem. Due to many other unique physical and chemical characteristics and the intrinsic nature of water, it remains an intriguing substance. Water has strong solvent properties since it mixes with and dissolves a wide range of substances and is, therefore, easily contaminated. Hence, chemicals and industrial wastes entering the environment pollute water, thus impacting food supply-chain and forages and ambient air that impact living organisms and human health. On the other hand, due to the dilution of contaminants, unless quantities are significantly large, the solvent characteristics of water tend to protect the environment. Research on ecotoxicity and its impact on human health has demonstrated significant progress that has been reported so far, as the subject is still unfolding and needs further serious attention, from a holistic viewpoint, by the scientific community for our survival. In the scientific world, water is the reagent of choice for most wet laboratory researchers for most procedures and experiments. Water supports three basic pillars of our life and survival - Safety, Security, and Sustainability (Vaseashta et al., 2021b), and water quality impact all forms of life, albeit has varying definitions (Vaseashta & Maftei, 2021).

With all the technological advances in recent years, the two impending challenges to human existence are climate change and water scarcity. The two "grand" challenges contrast each other in that, while the former would affect society as a whole, the latter would affect every individual for the basic existence. Whilst existing megatrends dealing with sustainability brace themselves to mitigate global warming, it seems that, scientifically, we are insufficiently prepared to address the issue of water shortages. The fact that the U.N. SDG has realized the importance of safe drinking water as SDG6, it presents a great responsibility on the scientific community to urgently realize the ways and means of conserving water in its pristine nature reserves. As the world population grows at a steady rate, there will be more demand for water for human consumption, agriculture, and industries and thus it is critical to articulate the future of water, which includes a strategic paradigm shift in its production, use, reuse, recycle and discharge. Figure 1 shows a survey on global challenges, and it can be noted that 100% of respondents indicated water as their area of prime concern.

Until about two and a half centuries ago, freshwater was plentifully available with almost guaranteed sustainability in its natural environments, as the quantity of water extracted continued to be replenished through the natural hydrological water cycle, which has been running perpetually with remarkable precision. The water consumption during this period has increased tremendously due to the huge increase in human population and for irrigating the expanding agricultural need in order to provide mankind food security, as well as in supporting a variety of mineral-based, water-intensive manufacturing industries, some of which produce heavy pollution. This period simultaneously witnessed the growth of electric power generation through the combustion of fossil fuels which also pushed up the demand for freshwater. The consumption of energy and water together, have brought the World to the brink of disaster through unmindful, excessive, or unsustainable consumption causing irrevocable destruction of its natural reserves or resources. However, this is not unexpected due to the compromise between convenience vs. pollution. However, with increasing technological innovations, we have the means to mitigate contaminants and with water management tools and strategies, it is possible to find better alternatives. Needless to say that it is mandatory that the water use, reuse and recycle trajectory needs to be strategically managed. Figure 2 shows data of water stress (measured in terms of availability, quality, and accessibility, sometimes

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