



The nexus between water, energy, and food in the context of the global risks: An analysis of the interactions between food, water, and energy security



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ABSTRACT

The purpose of this article is to analyze the interactions between water, energy, and food security, referenced in this study as the nexus between water, energy, and food, and the impacts of global risks using the [World Economic Forum's, 2017 Global Risks Report](#) as a guideline. In this analysis, the authors reveal that water, energy, and food are interdependent and essential resources demanding sustainable, integrated and intelligent management. These vital resources are susceptible to many global risks which are maximized by extreme weather events, mass involuntary human migrations, and other hazards that predominantly endanger the vulnerable communities of less developed countries. In conclusion, policies carried out by the international community, decision-makers, civil society, and the private sector, must align to target and mitigate global risks, specifically, water, energy and food security.

1. Introduction

The international community is tasked with solving a variety of complex and interrelated issues which disproportionately affect vulnerable nations most and include many challenges linked to management of water, energy, and food resources ([Bazilian et al., 2011](#)). If these problems are not effectively administered, human civilization could face major threats ([Diamond, 2005](#)). The world's population is expected to reach 8.5 billion people by 2030, rising to 9.7 billion in 2050 and to 11.2 billion in 2100 ([UN, 2015](#)). Thus, the increase in water, energy, and food demand, combined with population growth and economic development, has the potential to result in a shortage of resources.

Aside from the challenges mentioned above, humanity faces several risks, acknowledged as “global risks” which have been deeply analyzed by the World Economic Forum (WEF) in its annual Global Risks Report. These risks not only affect people and companies around the globe, but also have potential impacts on water, energy, and food security.

In this context, the nexus between water, energy, and food security emerges from a different perspective which aims to promote the

understanding of the interconnections between the management of natural resources and the importance of ensuring universal rights such as water, energy, and food ([WEF, 2011](#); [OECD, 2014](#); [Scott et al., 2015](#); [Mohtar and Lawford, 2016](#); [WEC, 2016](#)).

The main objective of this article is to understand how the global risks impact the nexus between water, energy, and food. Through a systemic analysis of the global risks, this article examines the interdependencies and vulnerabilities among these resources; moreover, it facilitates the comprehension of today's chaotic reality, promoting the development of new adaptation strategies in academia, civil society, politics and other sectors. These actions may not only diminish threats but also stimulate the development of a more secure and sustainable world.

To adequately analyze the nexus between water, energy, and food and the threats they face concerning the Global Risks Report, this paper aims to demonstrate that these resources are: a) essential, b) vulnerable, c) interdependent and, d) demanding of sustainable management.

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1.1. Water security

Ensuring permanent access to water is becoming increasingly difficult due to global transformations in today's economy, climate, and society (Hope et al., 2012). It is estimated that about 40% of the world's population will live under water-stressed conditions by the middle of the next century (OECD, 2013). Nowadays, less than 3% of the world's water is potable, and 2.5% of this freshwater is frozen (WBCSD, 2005; UN Water, 2013), creating a global scenario of vulnerability and insecurity.

According to the Global Water Partnership (GWP, 2010), water security is connected to integrated water resources management among all sectors (agriculture, energy, health...). Researchers from the Program on Water Governance (PoWG, p. 17, 2012) state that water security exists when there is “sustainable access on a watershed basis, to adequate quantities of water, of acceptable quality, to ensure human and ecosystem health”. The UN Water (2013) states that water security is associated with sustainable accessibility and availability, moreover, is essential for responding to other development problems like malnutrition and child mortality.

According to the GWP (2014), sustainable water management will improve the quality of life around the world. However, considering the dynamic changes in the world's physical and economic conditions, such as population growth and modifications in climatological conditions, which demand continuous attention and water systems adaptations, water security will never be achieved entirely.

1.2. Energy security

In the early 20th century, studies related to energy security arose in the political realm due to demands for coal and oil for use by naval fleets and armies (Yergin, 1991). In 1970, as a result of the beginning of the oil crisis, many academic institutions initiated studies analyzing the energy field (Hancock and Vivoda, 2014). In recent years, the term “energy security” has gained prominence as a consequence of terrorist threats, instability among oil-exporting countries, geopolitical conflicts, and demands to increased energy supply and boost economic growth (Yergin, 2006; Löschel et al., 2010; Cox, 2017).

The International Energy Agency (IEA, 2016) defines energy security as “the uninterrupted availability of energy sources at an affordable price”. According to IEA, energy security is composed of three main categories a) long-term energy security, which mainly concerns long-term investments planned to provide energy according to a country's economic development and sustainable environmental needs; b) short-term energy security, which focuses on the ability of the energy system to respond promptly to sudden changes in the balance of supply and demand; and c) lack of energy security, which is linked to its economic and social impacts, as a result of price volatility and non-competitiveness.

Energy security is essential to support basic human needs and economic necessities (Kruyt et al., 2009) and represents a critical feature regarding systems planning in the environmental, technical, political and social realm (Augutis et al., 2017). However, energy security may be vulnerable to climate change and other global risks, increasing tensions around this resource.

1.3. Food security

The definition of food security has been widely discussed by the academic field (Godfray et al., 2010) due to its global significance and its social and economic impacts on the development of nations (Gentilini and Webb, 2008). The concept of food security encompasses a broad scope, allowing different interpretations of its definition (Maxwell and Smith, 1992).

The need to create a particular concept for the term arose in 1974 when the World Food Conference defined food security as the global

availability of food supply resources to sustain the increasing demand for food and to recompense market prices (UN, 1975). The World Food Summit (1996) declared that “food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life”. These definitions reinforce the multi-dimensionality of food security (accessibility, availability, stability, and utilization).

Food insecurity, on the other hand, occurs when people do not have social, physical and economic access to food (FAO, 2009). According to Gundersen and Ziliak (2015), this insecurity also significantly impacts public health, making it challenging to fight off chronic diseases, diabetes, asthma, and insomnia.

Many world leaders recognize the need to minimize the adverse consequences of food production on the environment. As a result, agricultural producers face greater competition for land, water, and energy (Godfray et al., 2010; Lal, 2010). This paired with population growth, which will increase demand for food by 60% by 2050, creates a complex and chaotic scenario (Alexandratos and Bruinsma, 2012) that demands global cooperation and exhaustive research regarding food security and adaptation strategies to promote environmental protection.

1.4. The Nexus between water, energy and food

The Integrated Water Resource Management (IWRM), formed in 1971, is a sustainable development process that aims to promote awareness concerning the issue of global water security through education, investigations, and the exchange of information between countries (Mohtar and Lawford, 2016). The establishment of the IWRM represents the acknowledgment of the interconnections between water, energy, and food. The IWRM recognizes water as a fundamental resource for social and economic development. At the Bonn 2011 Nexus Conference, the term “water, energy, and food security nexus” was popularized and diffused internationally, especially among academic, political, and business fields (OECD, 2014).

Water, energy, and food are inseparable resources (WWAP, 2014; Wolfe et al., 2016). Many regions face significant water, energy, and food security challenges (Miralles-Wilhelm, 2016; ESCWA, 2015). Understanding the relationship between these resources allows countries to establish effective sustainable development strategies and policies based on accurate and systemic data, avoiding and mitigating interconnected risks (IRENA, 2015).

The establishment of food, water, and energy security is a global challenge. Thus, as the demands for these resources rise, it is becoming increasingly necessary to fully understand the interdependencies between them. The adverse consequences of climate change, in addition to political, social and economic obstacles, intensify these difficulties, affecting the management, availability, allocation, and usage of resources (Miralles-Wilhelm, 2016).

Analyzing the nexus between water, energy, and food not only ensures a better understanding of these resources and their interconnections but also allows for the comprehension of their production and distribution systems. The importance of this study also arises from legal, social and economic matters, which share a deep connection with these resources. Hence, the profound and sensitive interactions between water, energy, and food, demand attention and awareness to the risks and unexpected consequences that faced by society (King and Carbajales-Dale, 2016).

The interdependencies concerning the nexus between water, energy, and food are the result of an extremely complex system. Thus, developing a viable solution that provides stability for these resources simultaneously is extremely challenging (Meadows, 2008).

As shortages in natural resources increase and economic and population growth rates rise, the significance of the nexus becomes evident. The demand for a profound examination regarding the

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