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Achieving food and energy security between the current and hoped-for reality

تحقيق الأمن الغذائي والطاقوي بين الواقع الحالي والمأمول

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Abstract: The purpose of this article is to analyze the interactions between energy and food security, referred to in this study as the energy-food nexus and the impacts of global risks using the Global Risks Report in the current context of successive crises. In this analysis, we reveal that energy and food are interconnected and essential resources that require sustainable, integrated, and intelligent management. These vital resources are vulnerable to many global risks, which are exacerbated by extreme weather events, mass involuntary human migrations and other riskswhich puts vulnerable communities in less developed countries at risk. In conclusion, policies implemented by the international community, decision-makers, civil society, and the private sector must be consistent with targeting and mitigating global risks, specifically, energy and food security.

Keywords: Consumption;Food security; Price; Elasticity; Production; Export-import.
Jel Classification Codes:F6,Q18,F5, F52.

الملخص:الغرض من هذه المقالة هو تحليل التفاعلات بين الطاقة والأمن الغذائي، والمشار إليها في هذه الدراسة بالعلاقة بين الطاقة والغذاء، وتأثيرات المخاطر العالمية باستخدام تقرير المخاطر العالميةفي الوقت الراهن فيضل الازمات المتتالية. في هذا التحليل، نكشف أن الطاقة والغذاء هي موارد مترابطة وأساسية تتطلب إدارة مستدامة ومتكاملة وذكية. وهذه الموارد الحيوية معرضة للعديد من المخاطر العالمية التي تتفاقم بسبب الظواهر الجوية المتطرفة، والهجرات البشرية الجماعية غير الطوعية، وغيرها من المخاطر التي تعرض المجتمعات الضعيفة في البلدان الأقل نمواللخطر. وفي الختام، فإن السياسات التي ينفذها المجتمع الدولي وصناع القرار والمجتمع المدني والقطاع الخاص، يجب أن تتوافق مع استهداف المخاطر العالمية والتخفيف منها، وعلى وجه التحديد، الطاقة والأمن الغذائي.

الكلمات مفتاحية:استهلاك؛ أمن غذائي؛ سعر؛ مرونة؛ إنتاج؛ الاستيراد والتصدير
تصنيف JEL: F6،. Q18 ،.F5،.F52.

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1. Introduction:

The Russian war on Ukraine is an unprecedented test for the EU and its leaders. On top of the security, humanitarian, and refugee crises, they must manage its impact on our economy, and energy and food systems. With prices soaring and supply chains disrupted, they must respond to the cost-of-living crisis. Functioning energy and food systems are vital for our well-being and, ultimately, survival. And as they play a central role in driving the planetary crisis, from climate change to environmental degradation, what is done in these sectors has direct implications for the prospects for people, businesses, and the planet.

Thus, this is not the time for short-sighted decisions. The measures taken today must not lead to future regrets. Exceptional times call for exceptional measures, including in how we produce and consume energy and food. This Discussion paper identifies priorities for action to prevent the energy and food crises from spiraling out of control, and to enhance European resilience, sustainability and prosperity.The main objective of this article is to understand how the global risks affects 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.

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, because 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 because of terrorist threats, instability among oil-exporting countries, geopolitical conflicts and demands to be increased energy supply and boost economic growth (Yergin (2006); Löschel& al. (2010) and 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 (2016), energy security is composed of three main categories. 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.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. Lack of energy security, which is linked to its economic and social impacts, because of price volatility and non-competitiveness.

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

2. Energy and food security:

2.1 Energy security:

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a) Long-term energy security, which mainly concerns long-term investments planned to provide energy according tocountry'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, because of price volatility and non-competitiveness.

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2.2 Food security:

The definition of food security has been widely discussed by the academic field (Godfrayandal. (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 globalavailability of food supply resources to sustain the increasing demand for food and to recompense market prices (UN (1975)).

The World Food Summit (1996) declared, "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 multidimensionality 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 affects 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 (Godfrayand 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.

3- The Relationship between Food and Energy

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).Energy, and food are inseparable resources (WWAP (2014) and Wolfe & al. (2016)). Many regions face significant energy, and food security challenges (Miralles-Wilhelm (2016) and 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 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, 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 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)).The demand for a profound examination regarding theinterrelations between energy and food is urgent (Hoff (2011)). It will not only stimulate sustainable objectives and stability between resource users but will also facilitate the transition to a globally integrated ecosystem through encouraging strategic and integrated management (Mohtar and Lawford (2016)).

3.1. Methodology Presentation:

Acomprehensiveconsideration of the 2017 WEF Global Risks Report was conducted. The Annual Global Risks Report (2017) focuses on the global risks impacting countries and large companies and assesses the risks to each type of security (energy and food). According to Jackson (2000), a system represents more than the sum of its parts. This statement can be applied to nature as well since nature cannot be divided into isolated sections; it requires connectivity between its components instead. Biderand al. (2011) analyzes that three concepts must be examined for a full comprehension of systemic analysis:

- The interrelation: the way things are connected and their consequences.
- The perspectives: the form in which scenarios of different global visions are overseen; and
- The limits: prevention of a system that reaches everyone.

Definitively, an analysis contemplating examples of each of the risks and its impacts on water, energy and food security was conducted. This study, using scientific methodology, describes how extreme weather events, large-scale involuntary migrations, large-scale terrorist attacks, natural catastrophes and other risks impact water, energy, and food security.

3.2.Global risks linkage:

Global risks are linked to specific events, which negatively affect security, health, environmental, economic, or technological matters. According to Cutter & al. (2015) and Engel &Strasser (1998) the global risks are connected to the globalization process and to society's individualization, which leads to instability and insecurity. According to the WEF (2014), the global risks are events that cause significant negative impacts to countries and industries over a 10-year period. Generally, global risks are “systemic risks”. This concept implies that when something affects one portion of an interdependent system, there is a high probability that the entire system will be consequently affected since it is composed of interconnected parts (Kaufman and Scott (2003))

The impact of global risks on water, energy and food security is different for each of the sources. Among the 30 risks introduced by the 2017 Global Risks Report, 26 of them may impact water, and/or energy, and/or food security. Concerning these 26, only 9 risks manifest direct impacts on the nexus between water, energy, and food security simultaneously, see Table 1. The Examination of the global risks affecting foodand energy security shows that the geopolitical and environmental risks are the most threatening risks concerning the nexus. The demand for elaborating a more detailed reflection of how each risk impacts these resources is urgent. Below is a detailed analysis, describing how each global risk can impact the nexus between water, energy, and food.

Table 1 : Major global risks affecting food and energy security.

	Risks	Energy	Food
Economic	- Failure/ shortfall of critical infrastructure - Asset bubbeles in a major economy - Deflation in a major economy - Failure of a major financial mechanism or institution. - Severe enrgy price shock - Unmanageable inflation - Fiscal crisess in key economics - High structural unemployment or under unempolyment		
Environmental	- Extrem weather events - Falureof climate change mitigation and adaptation - Major biodiversity loss and ecosystem collapse - Majornatural deasters - Man-made environmental damage and deaster		
Geopolitical	- Failure of governance - Failure of regional or global governance - Interstate conflict with regional consequences - Large-scale terrorist attacks - State collapse or crisis		
Social	- Failure of urban planning - Rapid and massive spread of infectious diseases - Water crisis - Food crises - Large-scale involuntary migrations		
Tchnological	- Adverse consequences of technological advances - Large scale cyberattacks - Breakdown of critical information infrastructure and networks		

3.3. The Economic risks

Including the current economic risks, only failure of critical infrastructure impacts the nexus. The lack of investments in infrastructure affects key sectors, such as transportation, electricity, telephony, and sanitation. The degradation of these services disturbs economic and social development. We present in Table 2some potential impacts of economic risk on food, water, and energy security.

Table 2. Economic risks

	Energy security	Food Security
Failure of critical Infrastructure	Energy is both a determining and limiting factor for economic growth and devolpment (Goldemberg, 2000;Kessides and W'ade, 2011; Voxy et al, 2013).	Infrastructure is crucial for food production and processing (Godfrey et al2010; Hanjra and Qureshi 2010 Shively and Thapa, 2017.

3.2.1. Disaster/Underperformance of critical infrastructure

Disaster/Underperformance of critical infrastructure impacts many regions globally. For example, in Africa food security has been deeply affected due to this matter. To address the continent's problem, it is crucial to understand the founding reason for this enormous vulnerability concerning food insecurity. First, food insecurity arises when:

- there is a shortage of food production due to weather events (droughts, flood etc.);
- when the food supply production is smaller than the population it reaches; and
- when these food prices are expensive due to high oil prices, transportation, and commodities market fluctuation.

For countries to mitigate and adapt from these vulnerabilities, traditional living methods must be substituted by highly technological approaches and increasing infrastructure investments in rural areas, consequently rising food production.

Disaster or deficit of critical infrastructures (lack of investment in energy, transportation, and communication) influences energy security by increasing fuel costs, raising the price of commodities, and causing potential debts for consumers.

3.2.2.The Environmental risks

Two of the five global risks listed on the 2017 Global Risks Report display direct connections to the nexus. The extreme weather events and the

failure of climate-change mitigation and adaptation significantly threaten the nexus between energy, and food, formore details see Table 3.

Table 3 . Environmental risks

	Energy security	Food Security
Externe eather events	Storms, landslides, floods, and forest fires, for instance, could affect the production and distribution of energy	Intensification of weather event can negatively impact the foodsupply and the food security of vulnerable regions
Failure of Climate change mitigation and adaptation	Rising temperatures will require more enrgy production to cool home reduce the effeciency of nuclear power plants, and hinder the productionand distribution of energy (CCSP,2008; EPA, 2016; U.S Global Change research Program 2014…	Climate change, which impacts and changes security habits, will spread water security arround theworld. Extreme weather events will becomemore frequent, affecting agriculture. Thiswill risk global security and results invountary migrations (nature climate change 2016)

3.2.3.Ultimate weather and climate-change mitigation and adjustment:

The ultimate weather events consequences regarding food security are historically recognized. In 2011, a drought struck East Africa, triggering a regional food crisis, which affected 13 million people. In Somalia, more than a quarter of a million people died of starvation (WEF, 2016).

Breakdown of climate-change mitigation and adaptation affects food security in a diverse range of ways. When governments and companies do not promote preventative and adaptive actions, companies are affected, lose protection, and the global community is negatively impacted (WEF, 2016).

These events directly impact energy security. The demand for energy is proportional to increases in temperature. In the United States, if temperatures increase to 1 °C, the demand for energy will rise by 5–20% (for cooling environments) and demand for energy to heat will drop to 3–15% (CCSP, 2008; EPA, 2016). The increase in temperatures will limit our capacity of power generation and ability to reliably deliver electricity (EPA, 2016).

4. Geopolitical risks:

In thenext table 3 we shows that of the six geopolitical risks mentioned in the 2017 Global Risks Report, four directly impact the nexus. Interstate conflicts and large-scale terrorist attacks threaten food, water, and energy security on a global level resulting potential failures regarding national, regional or global governance in the international community. These are delicate risks which could jeopardize society and thus demand global awareness.

Table 4 : Geopolitical risks

	Energy security	Food Security
Failure of National Governance	Instabilities ofenergy distribution, increased monopolies, market disruption, and price instability (Goldthau, 2012 …)	Hindrances of the development of policies that lead to food security (Godfrey et al. 2010
Interstate conflicts with regional consequences	Energy resources, especially fossil fuels, can motivate conflicts and lead to infrastructure breakdown when these disputes increase. (Mansson, 2014; Colgan 2014.)	Destruction of sources of food can cause increases in food prices as well as food shortages (Brinkman, 2013; Scanlan and Jenkins 2011…
Large-Scale terrorist attacks	Attaks on energy infrastructures threaten energy supply, affecting energy security (yergin, 2006; Cohen et al, 2011..)	A political threat to food security istheso-called agroterrorism, attacks which compromise, agriculture infrastuructur. These attacks could be carried out through concentrated viruses, …(Prescott, 2016…)

4.1. Failure of regional or global governance:

According to Bakker et al. (2008), failure of global and regional governance regarding water management causes:

- Decrease in consumer rights to essential services;
- Lack of political rights;
- Neglection of poor communities by a government focused on serving the elite; and
- Economic hindrances which connect more impoverished families.

Failure of national, regional or global governance arises when problems related to famine and food insecurity occur. Sovereign governments are

responsible for developing programs and policies that stimulate agricultural business and lead to food security (Paarlberg, 2002).

Some researchers believe that global and local energy governance is the most important part of energy security (Goldthau and Witte, 2009; Mckenzie, 2011), while others prefer to focus on the "deficiencies" of energy security (Florini and Sovacool, 2009, 2011). Failure of national governance, in this scope, could result in energy distribution instability, increased monopolies, market disruption, and price volatility (Karlsson, 2007; Goldthau, 2012).

4.2. Interstate conflict with regional consequences:

Interstate conflicts significantly impact energy security by reshaping urban and rural areas, raising the likelihood of humanitarian crises, increasing countries vulnerabilities, affecting populations, industries, and the transportation sector (Cornelius and Story, 2008; USAID, 2010). "Resource wars", especially concerning the global oil industry, will transform future international dynamics. For example, Africa, asignificant producer of oil, will be drastically affected by this conflict. Additionally, since oil extractions typically occur in regions secluded from hostile territories, resource wars will be more likely to occur in depopulated or marine areas (Colgan, 2013).

Toset et al., 2000 identifies that "the previous war in the Middle East was about oil, the next war will be about water". This statement represents a real concern to interstate conflicts on water security which will certainly have regional consequences. Wars in some regions will occur more frequently due to disputes over water access; therefore, water supply will become a war instrument. Many countries with high population and economic growth will increase their demands for and reliance on water resources, potentially under another nation's control, generating conflicts and disagreements (Gleick, 1993).

4.3. Large-scale terrorist attacks:

The concept of "agroterrorism" suggests the development of terrorist strategies focused on agriculture with the potential to endanger food security (Laqueur, 1999; WFP, 2011). Damaged infrastructures lead to contamination of water reservoirs through chemical or biological agents, interrupting fresh water supply, and threatening humankind, the

environment and water security (Gleick, 2006; Copeland, 2010). Water has been used throughout history politically and militarily as a strategic resource; thus, when water demand increases, the value and vulnerability of water advances proportionally (Gleick, 2006).

Terrorist attacks on oil processing facilities, transportation, tanks and oil terminals (especially in the Middle East and the Pacific) may have several negative outcomes: millions of oil barrels could be destroyed; millions of barrels will not be able to be shipped by traditional routes; and countries, such as the United States, will demand increased production from other refineries and increase importation rates to compensate for gas shortages (Cohen et al., 2011).

4.4. Societal risk:

Regarding all of the societal risks, only failure of urban planning has a prominent impact on the nexus. The following table (Table 5) suggests that the failure of urban planning might pose an even greater challenge to food, water, and energy security, since these resources are already undergoing an increasing demand due to climate change and population growth.

4.4.1. Failure of urban planning:

Providing healthy and nutritious food to a growing urban population is a challenge that requires efficient urban planning and an inclusive agricultural and food supply system, promoting an efficient network between rural producers and urban markets (FAO, 2015). The interconnections between urban areas and food security are critical to securing sustainable international development (Dickson et al., 2015).

Failure of urban planning is a significant threat to water security. A vast part of the world's population lives in urban areas (in 2014, 54% of the world's population lived in urban areas). Urban life demands substantial amounts of water resources. Thus, resource abundance, as well as efficient urban management, is necessary to supply these demands (GWP, 2015).

More than 60% of the global energy demand comes from cities where half the world's population is concentrated (ICLEI and UN HABITAT, 2009; IEA, 2012). Studies estimate that by 2050, two-thirds of the global population will inhabit urban areas. Cities are fundamental for local and regional development and poverty reduction. Cities are also important for

economic, governmental, commercial and transportation activities (UN, 2014).
Urban planning techniques mustbe innovative, and should respond proportionally to population growth (Barnett, 1989). Therefore, urban contexts are ideal locations to implement efficient and sustainable energy practices (Cajot et al., 2017).

4.4.2. Technological risk:

After analyses of the four different technological risks acknowledged in the 2017 Global Risks Report, it was found that only one has an impact on the nexus: the adverse consequences of technological advances.

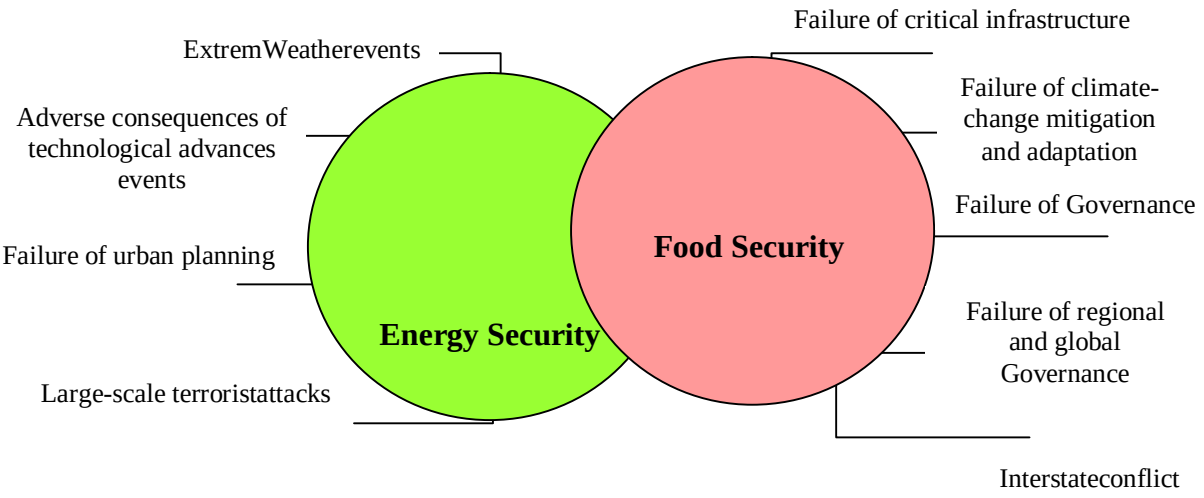
4.4.2. The adverse consequences of technological advances:

Aside from the increasing risks caused by the acceleration of technological processes, radical technological transformations, such as nanotechnology and intelligent machines, may also impose unprecedented threats to humanity, endangering food security (Bostrom, 2002).

The adverse consequences of technological advances also offer significant dangers to global water security (WEF, 2016). The WEF (2017) and highlights the importance to the survival of humanity, of studying the potential impacts of emerging technologies, such as biotechnology, artificial intelligence robots, geoengineering, and other Fourth Industrial Revolution (4IR) innovations which will cause major changes in vital water infrastructure networks (e.g. supply, wastewater treatment, flood protection, etc.).

Different forms of energy production influence the environment and energy security differently. While nuclear fusions pollute the water with radioactivity, hydroelectric plants destroy habitats and alter water flow (CMU, 2016). Therefore, it is important to increase awareness concerning these vulnerabilities among powerful policy makers (WEF, 2016).

Fig. 1. Global risks impacting the nexus between water, energy, and food security.



5. Conclusion:

The conclusion must contain summary of what was mentioned in the purpose of this analysis is to analyze the impacts of global risks on the nexus between water, energy, and food, based on bibliographical and qualitative research regarding the 2017 Global Risks Report.

The report required extensive analysis concerning the concepts of global risks, the nexus between water, energy, and food, and the security of each resource.

The analysis led to the conclusion that the most important risks are related to :

- Risks impact food security,
- Risks impact energy affordability and supply availability,
- Risks threaten water security, and
- Risks can cause significant short or long-term effects on the nexus between water, energy, and food.

The impacts of the global risks on the nexus are evident but complex. To overcome the various challenges these resources encounter (political; economic; social; technological; environmental; geographical - local,

national, and regional; and historical - current and future), countries must collaborate and implement strategic and integrated policies to improve the management of natural resources.

This research subject importance is apparent since it predicts future difficulties concerning water, energy, and food security that countries and great corporations will face. Considering it is a relatively innovative subject, these issues have been carefully discussed in international settings in conferences among chiefs of state and decisionmakers.

The cooperation between multi-stakeholders to stimulate sustainable development regarding the global risks and nexus is also of great significance. Important events discussing the management of sustainable resources such as the 2017 Dresden Nexus Conference; the Paris 2015 Climate Change agreement; the Bonn2011 Nexus Conference, and the development of the United Nations Sustainable Development Goals raised awareness for discussion and empowered governments and societies to develop policies, sustainable management plans and resolutions to ensure food, water, and energy security.
Thus, agents must work together to manage specific resources sustainably as well as in providing suggestions on how to incorporate the nexus or manage resources more sustainably.

Throughout this article, water, energy, and food security are examined as highly interconnected and interdependent resources. Therefore, the recognition of the nexus and its relationship to global risks should inspire the mitigation of adverse climate change consequences and stimulate sustainable development processes. Moreover, the development of adaptation strategies is required to avoid the global risks negative consequences, preserving water, energy, and food security.

It is reasonable to recognize that countries must overcome existing challenges and obstacles to ensure sustainable management global resources. Thus, decision-makers, heads of state, stakeholders, academics, and the civil society must commit to developing relevant measures, policies, and resource management strategies considering the variety of global risks, the alarming data, and projections for the future.

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