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Editorial

Water-Energy-Food Nexus in the Asia-Pacific Region

ABSTRACT

Water, energy, and food are among the most important and fundamental resources for human beings and society. Despite the large potential for efficiency and reduction of losses, the demand for these resources is likely to increase due to population growth, changes in lifestyles, climate change, and other aspect of global change. The strong interconnectedness of these three vital resources has been termed the "Nexus" in the scientific literature in recent years. While many papers claim its fundamental importance, few provide specific ideas on how to deal with this Nexus in practice. This paper introduces twenty case-studies that are highlighted in this special issue that explore the practice of the Nexus and its scientific basis with particular focus on the Water-Energy-Food Nexus in the Asia-Pacific Region.

1. Introduction

The nexus between water, food and energy has received broad attention recently in the scientific literature (Bazilian et al., 2011; Beisheim, 2013; FAO, 2014; Lawford et al., 2013a; Rahaman and Varis, 2005; United Nations ESCAP, 2013; Vogt et al., 2010) and been the focus of conferences, such as Nexus 2011 in Bonn, Nexus 2014 in North Carolina, Nexus 2014 in Bonn, and World Water Week 2014 in Stockholm. As a result, the Water-Energy-Food Nexus has become a standalone technical term.

While such a strong conceptual framing can have its drawbacks, e.g. preventing the link to other important resources, such as minerals, the Nexus has the merit of drawing specific scientific attention to a central problem area for future human existence. Numerous articles in the scientific literature have emphasized the importance and theoretical framing of the Water-Energy-Food Nexus. However, the literature is in its infancy regarding the practical aspects of policy and management approaches and methods to address the Nexus. Disciplinary and broad interdisciplinary science is still needed to advance both the theoretical and applied aspects of the Nexus, largely because of the inherent synergies and trade-offs that define the Nexus. In particular, managing the trade-offs require not only observations and data about the biophysical and natural systems of the Nexus, but also appropriate understanding of the decision-making and human systems of the Nexus. Thus, the Nexus conceptual framework requires collaborative advances from the natural and social sciences.

The purpose of this paper is to provide some key insights into this Nexus transfer of knowledge between theory and practice, policy and management, and natural and social sciences as an introduction and outline for this special issue on the Water-Energy-Food Nexus of the Asia-Pacific Region. The twenty papers in this special issue will further elucidate key principles and practical tools to address the Nexus in the Asia-Pacific Region and more broadly to other regions of the world.

1.1. Three Stages of Optimal Policies for the Water-Energy-Food Nexus

The establishment of optimal policies for water, energy, and food that is described in the literature can be characterized in three general stages. The first stage is "integrated management", which includes integrated water resources management (Rahaman and Varis, 2005) to govern the various water sectors such as agriculture, industry, domestic and others, and to integrate the governance of different water bodies such as rivers, groundwater, and lakes. The integrated energy policy also includes the governance of the production and management of the different type of energy including gas, oil, coal, hydro-power, nuclear energy, and renewable energy, and also integration of the consumption governance in different sectors. Aspects of integrated management has also been

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applied to sustainable food and agroecological systems (Gliessman, 2015). The integrated management of water, energy, and food includes spatial integration across various scales and systems, such as integrated coastal zone management (Thia-Eng, 2006).

The second stage for the establishment of optimal policies is characterized as "security", which includes security of the nation, human health, livelihood, and ecosystem service. Water security (Arnell, 2004, 1999; Bakker, 2012; Cook and Bakker, 2012; Huntjens et al., 2012; Lawford et al., 2013b; Pahl-Wostl et al., 2013), energy security (International Energy Agency, 2014), and food security (Lake et al., 2012) are treated separately, including self-production rate depending on the natural, social and political factors, diversity of the alternative resources including natural and social factors, and stability of the resources depending on the natural and economic factors that are important for the security.

The third stage for the establishment of optimal policies will be the "nexus" of the water, energy, and food systems. The nexus framework considers the integrated and interconnected nature of the water, energy, and food systems, including the associated synergies and tradeoffs that are created through the use and management of these connected resources (Bazilian et al., 2011; Beisheim, 2013; FAO, 2014; Lawford et al., 2013a; United Nations ESCAP, 2013; Vogt et al., 2010).

1.2. Why is Nexus the Key for Global Sustainability?

There are several nexus platforms that regard the nexus as a key factor in global sustainability. The Bonn 2011 Conference emphasizes the water, energy, and food nexus (Hoff, 2011); the World Economic Forum treats water, energy, food, and climate change as the nexus (World Economic Forum Water Initiative, 2011); and the Transatlantic Academy deals with water, energy, food, land, and minerals as the nexus (Andrews-Speed et al., 2012). Recent and forthcoming Nexus platforms include those at United Nations Climate Change Conference COP22 in Marrakech, Morocco, the Dresden 2017 Nexus Conference, and several others.

These platforms have illustrated distinct methods of evaluation and analysis within the Nexus framework. For example, the commonly use "two at one time" analysis describes evaluating the two-way interactions between the water-food, water-energy, and food-energy nexus. The water and energy nexus (Byers et al., 2014; Hussey and Pittock, 2012; King et al., 2008; Rothausen and Conway, 2011) includes energy consumption for water allocation and pumping (Fig. 1 ①), water consumption for the cooling of power plant systems, and water use for hydro power generation (Fig. 1 ②). The water and food nexus (Hoekstra and Mekonnen, 2012) consists of water consumption for agriculture and aquaculture (Fig. 1 ④). The energy and food nexus (Tilman et al., 2009) includes biomass for energy (Fig. 1 ⑤) and energy consumption for food production (Fig. 1 ⑥). More finer scales of interconnections between water, energy and food are energy-food to water security (Fig. 1 ⑦), water-food to energy security (Fig. 1 ⑧) and the water-energy to food security (Fig. 1 ⑨), which are related to land use and climate change (Hoekstra and Mekonnen, 2012).

Water-energy-food nexus security is threatened by both climate and social changes (Fig. 1). The three pyramids (economy, social, and environment) of sustainable development can be classified in terms of nexus security as 1) efficiency, including saving consumptions and efficient productivities, 2) equity, including accessibility and affordability, 3) diversity, including alternative resources, 4) stability, including temporal resources variability, and 5) autonomy, including self-sufficiency. Optimal governance of the nexus security is necessary for the global sustainability and human well-being.

1.3. Water-Food Nexus Security as Optimal Governance

An example where the establishment of optimal policies between the water and food nexus is needed occurs at the linkages between land and ocean through water (including groundwater) and dissolved nutrient transports. The water-food nexus at the land-ocean interface incorporates such processes as freshwater coming from springs in the seabed and nutrient transport from land to the ocean that may be important for coastal fisheries and ecosystem health. Conversely, the flow and transport of seawater into coastal aquifers due to over-pumping may have negative consequences agriculture and food systems. Better understanding and managing types of land-ocean interactions within the water-food nexus are necessary to maximize human-environmental security and optimize the water-food connections. Therefore, coordinating governance among freshwater-food systems and coastal fisheries, which are vertically and sectorally divided, should be promoted in an integrated manner since the challenges of land-ocean interactions are complexly interconnected and interdependent. The integrated management between land and coastal areas should be integrated within inter-agency and multisectoral policy tools.

As an illustration of the Water-Food Nexus of the Asia-Pacific Region, the freshwater policy in Japan, the Basic Act on Water Cycle was newly enacted in April 2014. The act says the water is highly recognized as a public good and the Secretariat of Headquarters for Water Policy in Cabinet Secretariat as an inter-agency and a multi-sector coordinating body will be set up under the new Act. The seven different ministries and agencies are currently involved in the Japanese water management. Moreover, the groundwater and spring water, which were not previously covered by the national legislation, will now be included management target under the new Act.

On the other hand, the coastal policy in Japan, called the Basic Act on Ocean policy was enacted in 2007. Article 25 stipulates for the first time the need for integrated management of land and coastal areas. In 2008, the Basic Plan on Ocean Policy was formulated and the Secretariat of the Headquarters for Ocean Policy in Cabinet Secretariat as an inter-agency and a multi-sector coordinating body was established. Japanese coastal management includes approximately 35,000 km of coastline, and the coastlines are classified as coastal conservation areas, general public coast areas, and others. The coastal conservation areas are defined by the Coast Act as areas where shore protection facilities are located to protect a coastline from damage from sea or land movement. In addition, the coastal conservation areas are subdivided into five classifications: "Former Ministry of Construction coast", "commercial port", "fishing port" and "coast for agricultural land" and "co-management coast". Although each entity entrusts the management activities