The interdependency of food, energy and water in the quest for a sustainable future

Food, energy and water security forms the basis of a resilient economy, but as a water-scarce country with little arable land and a dependence on coal-fired power and oil imports, South Africa's economy is testing the limits of its resource constraints. The World Wide Fund for Nature (WWF) believes that a possible crisis in any of the three systems that make up the food-energy-water nexus will directly affect the other two and that such a crisis may be imminent as the era of inexpensive food draws to a close (Von Bormann and Gulati, 2014).

According to research commissioned by the WWF (Von Bormann and Gulati, 2014), what is known as the food-energy-water nexus revolves around the complex relationship between food, water and energy systems from the perspective of a sustainable and secure future for South Africa.

Water is a prerequisite for food production. It is also a prerequisite for energy production and an important input in producing fertilizers and agricultural chemicals, growing crops, raising livestock and accessing marine food resources. Both water and energy are required throughout the food value chain to process, package, transport, store and dispose of food. Furthermore, water supply systems consume energy at every stage of the water production and supply chain: water abstraction, treatment, distribution to end-users, waste-water reticulation and treatment. Finally, both energy and food production can significantly affect the quality of water bodies.

The food-energy-water nexus is central to the sustainability of South Africa's future. Unless all three elements of the system are in balance, communities cannot flourish. However, we are now faced with a system that is alarmingly out of balance, and a sustainable supply of water, food and energy is becoming increasingly less certain. Effectively averting a crisis requires enhanced information, coordinated planning and adaptation to a resource-scarce future. A flourishing economy underpinned by resilient ecosystems that can produce sufficient water, energy and food security for all into the future depends on it (WWF, 2014).

The uneven distribution of South Africa's natural resources and the location of economic development nodes in the country amplify the management constraints and inequality of access to these resources. A clear example is the fact that South Africa's coal deposits coincide with the country's best agricultural land and sources of some of the major inland rivers. This spatial complexity impacts on the effective management of food, energy and water resources, making it the foremost challenge for sustainable development in South Africa (Von Bormann and Gulati, 2014).
Until now, there has been limited recognition of the interdependence of food, energy and water from a policy and sectoral perspective. Failure to accurately understand the synergies and trade-offs between these three resources will result in millions of South Africans being at risk of hunger, waterborne diseases, energy shortages and increasing poverty (Von Bormann and Gulati, 2014). Ultimately the challenges posed by resource constraints point to a looming crisis in the provision of clean water, electricity and nutritious food, which are at the heart of national security and welfare.

According to the WWF's research, this response must focus on the effective management of resources, enabled by wider technology use and greater governance. This should be underpinned by an integrated approach to policy, planning, development and appropriate institutional capacity.

Implications for food security

The links between energy and food systems mean that energy supply and prices exert pressure on the ability of the agricultural sector to supply affordable food. The availability and cost of energy is also critical for the country's water security. According to Von Bormann and Gulati (2014), the often unconsidered cost of the economy's dependence on interbasin transfers, which require substantial amounts of energy, means that the country is already consuming large energy volumes to overcome the challenges related to its water scarcity.

South Africa's energy requirements are growing,

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and could have serious potential impacts on water requirements in future. It is projected that 65% of the country's electricity needs will still be met by coal-fired power stations in 2030 (Von Bormann and Gulati, 2014), which will continue to place high demands on the country's limited water resources. Ironically, the country's coal deposits coincide with the best agricultural land and important water catchment areas. The continued dependence on coal for meeting electricity requirements will therefore directly conflict with food production and impact on the quality of water resources.

New energy sources, such as non-conventional oil and gas production through hydraulic fracturing, and technologies such as carbon capture and storage, may be able to lower the carbon emissions of coal-fired power plants by 80 to 85%. However, these methods of fuel production are water intensive, and will only add to the pressure on water resources.

Implications for water security

The reliance of water supply systems on energy means that an energy shortage and rising energy prices pose challenges to water security. Energy shortages, specifically electricity shortages, can affect the reliability of water systems and water supply services. The rising cost of energy could also have a substantial effect on the actual cost of water supply services, necessitating tariff hikes for these services (Von Bormann and Gulati, 2014).

In South Africa, fresh water is predicted to become the determining constraint on development. However, the challenge is not only an issue of water availability; it is predominantly an issue of declining water quality. According to the WWF report, inadequate investment in water-related infrastructure that could maintain water quality at sufficient levels has added to the poor water quality.

Energy shortages can affect the reliability of water supply services, which in turn affect food security.

South Africa's commercial agriculture production is heavily dependent on irrigation, with only 12% of the total land surface area considered suitable for growing rain-fed crops, and less than 3% considered truly fertile (Von Bormann and Gulati, 2014). Irrigation accounts for 90% of vegetable, fruit and wine production, and 12% of the total area under wheat is irrigated. Therefore, although 1.5% of the land is under irrigation, this currently accounts for 30% of the country's crops (Von Bormann and Gulati, 2014). As there is limited arable land, the only feasible way to grow the agricultural sector is through irrigation.

In the food value chain, the largest proportion of water is embedded at the agricultural product stage, as opposed to the processing stage. Every product has virtual water (Von Bormann and Gulati, 2014), which represents the water embodied in the inputs required to produce the final product. The largest proportion of crop water and animal products is green water (rainfall), which is a full order of magnitude larger than blue water (irrigation) use. However, abstracted or blue water is associated with higher environmental and financial costs, such as water depletion, salinisation and soil degradation (Von Bormann and Gulati, 2014).

Implications for energy security

The country's impending water scarcity also poses a challenge for future power generation plans and electricity supply. The supply of electricity depends on water-intensive coal-fired power stations, which account for 86% of generation capacity (Von Bormann and Gulati, 2014). Efforts are being made to transition to dry-cooled coal-fired power stations, which need 5 to 10% of the water required by wet-cooled stations. Nevertheless, these power stations are still entirely dependent on water, and there is a high co-dependency between water and electricity production.

The food-energy-water nexus is not so much about the resources themselves, as it is about the relationship between them. Addressing the nexus therefore requires a quantum shift in thinking. If we are to avert a crisis in natural resource management, and ensure the national security of South Africa through the provision of clean water, electricity and nutritious food, we urgently need to identify the trade-offs and synergies at a local, national and regional scale, and recast the governance approach.

According to Von Bormann and Gulati (2014), if the necessary transformation is to occur, it must be based on sound science, accurate data and integrated, effective national policies and regulations that are consistently enforced.

References

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