Water-Energy-Food (WEF) nexus under changing climate and mtigation technologies

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Introduction

Climate change has been considered as a threat multiplier, increasing human-related security issues such as food and water scarcity in climate-vulnerable regions. For human well-being, poverty reduction and sustainable development, water, energy and food are essential. Land and land use can be affected by climate change and the environmental dangers associated with climate change, such as droughts and floods. Climate change and variability, mitigation and adaptation actions such as afforestation, consumptive use of water for irrigation, reuse of greywater, rainwater harvesting, and micro irrigation practices can significantly conserve surface and groundwater systems. Water usage and agricultural production are affected by changes in energy usage and types of energy production (for example, fossil fuels being replaced by hydropower or biofuels). The consequent conflicts over water distribution and between the water, energy, and food sectors raise further worries about the long-term management of surface and groundwater bodies, particularly international environmental.

Recent developments have focused national attention on the connections between water and energy infrastructure. More than 250 thousand villages in 266 districts across 11 states have been impacted by non-availability of water in India. Non-availability of water constrained the operation of some power plants and other energy production activities.

Several current trends are further increasing the urgency to address the water-energy nexus in an integrated and proactive way in that area are listed below:

1. Climate change has already begun to affect precipitation and temperature patterns across India.

2. Population growth and regional migration trends indicate that the population in arid areas will continue to increase, further impacting the management of energy and water systems.

Water, Energy and Food (W-E-F)

The nexus of water, food, and energy are critical to long-term development. A growing global population, increased urbanisation, changing diets, and economic expansion are all driving demand for all three. Agriculture consumes most of the world's freshwater resources. In contrast, food production and supply consume more than a quarter of the world's energy.

The close connections between these vital areas require a well-integrated strategy to ensure global water and food security, sustainable agriculture, and energy production. The WEF nexus is concerned with the challenges surrounding the need to balance competing demands on the water to address water, food and energy security under a changing climate. The WEF nexus promotes a systems perspective, emphasising holistic and cross-sectoral approaches to decision-making and planning. This approach is particularly relevant for sustainable development and climate change, where the connections between water, energy and food are vital.

Water scarcity affecting food production

India with a significant population consumes more water than any other country. Groundwater accounts for over 65 per cent of India's total water consumption, and it plays a critical role in the economic and social growth of the country. Agriculture, residential use, and industrial use are India's three most water utilising sectors. As a result of the growing demand for water and the depletion of accessible water, ensuring a reliable supply of high-quality water is becoming increasingly important. Decision-makers in all three domains are increasingly focusing on water resource management, ecosystem protection, water supply and sanitation.

Renewable energy and Agriculture

The world's growing energy need, alongside increasing population, led to the continual use of fossil fuel-based energy sources such as coal, oil and gas. This became problematic by creating several challenges such as depletion of fossil fuel reserves, greenhouse gas emissions and other environmental concerns. These problems will create unsustainable situations, eventually resulting in a potentially irreversible threat to human societies. Hence the need to shift towards renewable technologies in the agricultural sector for production and storage.

Currently, agricultural regions around the globe have been subject to extensive and increasing water constraints. Major droughts in parts of India and around the world have affected agricultural production while diminishing surface and groundwater reserves. Extreme hydrological events, like floods and droughts, are also expected to be more frequent. Due to

expanding urban population density and water needs from the energy and manufacturing sectors, farmers in many locations will face increased competition from non-agricultural users. Therefore, there is a need to ensure food demand for the world.

Water quality is anticipated to decrease in many places. Irrigated agriculture continues to be the largest water utilisation practice of the world. Agriculture irrigation accounts for 70% of global water use and more than 40% in several European nations. Excess irrigation depletes aquifers water and can result in severe environmental externalities, resulting in depletion of the water table in the area. Furthermore, agriculture continues to be a significant source of water pollution. Runoff from fertiliser-induced water, pesticide use, and livestock effluents contribute to canal and groundwater pollution. There is a need to act at the farm, watershed, and national levels to enable a transition to a more sustainable and profitable agriculture sector that is robust to water hazards. There are various water-saving technologies which could be implemented to find solutions to optimise agricultural water utilisation and enhance the storage life of food, ensuring security and availability, which are as follows:

Implementing water-saving technologies

Technologies need to be adapted on the ground scale to implement the idea of the Water-Energy-Food Nexus to enable proper use of the available water for crop and energy production. Some of the emerging technologies are discussed further

Drip irrigation system

A drip is a slow-release system that delivers water through the emitters directly into the soil close to the roots.

Sprinkler irrigation system

Sprinkler irrigation is a method of watering lawns and fields that mimics natural rainfall. The principal method of moving water through a network of pipes is pumping. Sprinklers separate it further, causing it to into small water drops that fall to the earth.

Wastewater treatment with 3D membrane

Groundwater pollution can be treated by wastewater treatment which can be costly, which is why cost-cutting 3D printing technology has proven to be innovative where. 3D membranes, pumps and feed spacers are examples of products where 3D printing has produced high-quality, reasonably priced alternatives to conventional technology. The ecosystem may be harmed by nutrients, pathogenic bacteria, biodegradable organics, suspended particles, and biodegradable organics, which makes technological advancements in wastewater treatment even more crucial as water shortage increases.

Rainwater Harvesting

In order to retain rainwater for later use, runoff from buildings and other impermeable surfaces is collected during rainwater harvesting. This usually entails collecting rain from a roof. Rain gather in gutters, direct the water through downspouts and eventually into a storage container. It is possible to install a noticeable first flush system that was produced with precision using 3D printing. An approach toward water, food and energy conservation and its associated technologies need to be adapted. Therefore, this would ensure the minimal utilisation of resources available to meet the demands.