WATER - FOOD AND ENERGY NEXUS SYSTEMS ANALYSIS INTEGRATED POLICY MAKING TOOL

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ABSTRACT

This research discusses and analyses cutting-edge applications for water-energy-food nexus system analysis. It is axiomatic that substantial data should be acquired for a comprehensive model. The WEF nexus simulator may therefore be built to any extent by using simulated data future integral field spectroscopic (IFs and THENs) for WEF nexus interaction. The required data was then organized, and interactions (IFs and THENs) between the three subsystems were investigated. These IFs and THENs aid in our understanding of and ability to address the intricacy of the WEF. Given that the present study's objective is to review various solutions for WEF Nexus

We can now use these classifications to simplify the WEF nexus idea. In other words, the relationship between the three subsystems is demonstrated by the IFs and THENs variables. It would make sense to remove one of the following THEN variables from one subsystem if one of the IF variables in another subsystem remained. Because earlier Nexus initiatives did not provide information on how to initiate and discover interactions, it will be simple to determine interactions. This study demonstrates how a thorough nexus simulation model can access and communicate a wide range of data. The nexus model's interrelationships and interactions with other subsystems can be easily recovered thanks to this classification approach, and none of them will be missed because of ignorance of the nexus system. These IFs and THENs variables are also seen to be an excellent way to simplify the implementation of the Nexus system. The overall score for each project was then calculated by adding the weighted scores, which provided a methodical and objective way to rank the 29 irrigation and hydroelectric dam projects. This study is the first study in Iraq about water-energy and food nexus and helping to streamline decision-making at the nexus due to the size of the several sectors in the Iraqi human society

Following input from NWDS stakeholders, three new factors to take into account when deciding which irrigation project options to pursue were identified: a) Fighting poverty; b) Building irrigation projects close to Iraq's borders to ensure border security. 3) Rural Population Decline or Poverty Exodus. It's important to note that the nation places the highest priority on these three factors (Key Priorities National). Irrigation projects may now be planned in a deliberate manner that takes into account the observations of the relevant authorities thanks to the adoption of these aims together with the strategic assessment criteria. It takes scientific input to create "resource indexes."

KEYWORDS

Water, energy, and food (WEF) nexus; Sustainable livelihoods; policymaking, Food security

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PAPER INDEX

ABSTRACT

KEYWORDS

1. INTRODUCTION

2. METHODOLOGY

3. RESULTS AND DISCUSSION

    3.1. NEXUS TOOL

    3.2. ELEMENTS OF THE WEF NEXUS

    3.3. SUSTAINIBILITY INDEX

    3.3.1. ENERGY ACCESS AND DEFORESTATION

    3.3.2. BIOFUELS (AND UNCONVENTIONAL OIL AND GAS) PRODUCTION

    3.3.3. IRRIGATION AND FOOD SECURITY

    3.3.4. HYDROPOWER

    3.3.5. DESALINIZATION

    3.3.6. HOLISTIC WEF NEXUS SIMULATOR FRAMEWORK

4. CONCLUSION

5. RECCOMENDATION

REFERENCES

https://doi.org/10.17993/3cemp.2023.120151.324-344

1. INTRODUCTION

Currently, a number of interconnected, challenging concerns that pose major threats to human civilization must be addressed by the entire human society

must be addressed by the entire human society (Diamond, 2011). Several of these concerns are directly tied to the production, distribution, and use of food, energy, and water, especially in developing countries (WEF). According to Hague (2010), there are four resource pillars that underpin global security, prosperity, and equality. Despite this, little research has been done on how to streamline decision-making at the nexus due to the size of the several sectors and the challenge of weighing all three at once. As a result, laws and regulations frequently transmit mixed messages regarding problems with the economy, national security, or the environment. Also, when policy has been established by addressing more than one area, it is often done with a concentration on just two areas (Winpenny, 1992), and few methods have completely addressed the interdependencies in a larger context (McCornick et al., 2008).

The need for systems thinking is difficult to translate into government policy-making procedures (Forrester, 1994). The benefits of a more comprehensive approach to policy and regulation are anticipated to include economic efficacy, resource efficiency, enhanced livelihood possibilities, and public health. Negative outcomes may involve effects on communities, commodity pricing, sub-optimal infrastructure design, or environmental damage.

access to electricity, water, and food services of high quality. Over the past few years, the number of those adversely impacted by this has stayed mostly constant, and this trend appears to be expected to continue (at least in some areas). Security, economic, and social problems are only a few of the repercussions of this situation. Security, economic, and social problems are only a few of the repercussions of this situation. The problem of access is evident in both rural and urban contexts (Decker et al., 2000), and thus uses it as one lens through which to examine the WEF nexus.

Throughout this 2008 Worldwide Economic Forum annual conference (Forum), 2011), a "nexus" connecting water, energy, and food was established, and the WEF nexus has been classified as a global risk in 2011. (Hoff, 2011). "Initiating Generally Characterized by some combination for the Green Economy" marked a turning point by suggesting the energy security, food, and integration of water. The purpose of the conference was to ensure that the relationship between food security, energy, and water was "explicitly addressed in decision-making." Three years later, at the 'Sustainability in the Water–Energy–Food Nexus' meeting (Mohtar and DIE, 2014), policy and scientific communities from throughout the globe issued a call to action to create policies addressing a holistic nexus approach. Additionally, a nexus strategy that connects the Sustainable Development Goals (SDGs) is required (Weitz et al., 2014). Last but not least, UN Secretary-General Ban Ki-moon emphasized the significance of a "nexus" approach and suggested that environmental, social, and economic factors be combined (Caputo et al., 2021). The main forces behind the WEF nexus discussion are the strains currently affecting our global civilization along with new, related, and anticipated challenges. Due to population increase, the agricultural industry will need to treble its present food supply by 2050. (Wichelns, 2010). Currently, agriculture uses around 71% of all water withdrawals worldwide (Young and Esau, 2015) (Choudhari et. al, 2022). By 2050, the world's water consumption is expected to need to increase by 55% in order to keep up with expanding industry, power production, and home usage. The world's population is expected to grow by more than 40% while experiencing significant water stress (Zhongming and Wei, 2014). Finally, almost 15% of the world's water flows were utilized by the energy sector in 2010 (Van der Hoeven, 2013) and generated two thirds of the world's GHG emissions (Olejarnik, 2013). Techniques like desalination, pumping, and purification require a lot of energy to ensure alternative water supply. Between 2007 and 2013, the quantity of power used for desalination in the Middle East and North Africa region, which accounts for 38% of global desalination, quadrupled (IRENA, 2013). The development of biofuels accounted for two-thirds of the increase in worldwide maize production between 2003 and 2007 (Bank, 2008), which acted as a trigger for the 2008 jump in food prices, which were mostly brought on by subsidies for biofuels (Rudaheranwa, 2009).

Water, energy, and food security for the present and future generations is a challenging undertaking. Policymakers have a lot of power and duty when it comes to regulating the various pieces of the jigsaw puzzle. Although the scientific community has made progress in understanding and predicting future challenges, questions still exist regarding the most efficient way to convey this knowledge to the community of decision- and policy-makers. Lack of appropriate tools prevents decision-makers from taking into consideration different

resource allocation plans and understanding trade-offs between different systems. Existing tools handle certain nexus elements. Weap (Mroue et al., 2019), LEAP (Hoff, 2011), and MuSIASEM are a few examples of this (Giampietro et al., 2013) , and CLEWS (Ramos et al., 2021). WEAP (Water Evaluate and Plan) employs an integrated strategy to plan water resources. LEAP (Long-Range Energy Alternatives Planning System) is geared towards energy policy analysis and the assessment of climate change mitigation. MuSIASEM (MultiScale Integrated Analysis of Societal and Ecosystem Metabolism) is a technique for describing the fluxes of various societal systems. In order to determine the connections between interdependent sectors, CLEWS (Climate, Land, Energy, and Water Strategies) develops an integrated design methodology.

2. METHODOLOGY

A database was created that included publications that were published all across the world and were pulled from Google Scholar and the Web of Science. The following keywords were used as search terms: "water-energy nexus," "water-food nexus," "water-energy-food nexus," "climate change & food energy-water nexus," "bioenergy & water," "water-energy nexus & modelling." To pinpoint nexus applications in natural resource management, policy-related research has also attracted a lot of attention. We supplemented papers on environmental issues, resource recovery, water footprints, energy generation, and food consumption patterns in order to cover a broad spectrum of pertinent studies. Then, we weed out irrelevant studies by reviewing their conclusions and abstracts. The final sample included a large number of publications that provided rationale for addressing the nexus quantitatively and proposed a modelling methodology that would aid in the creation of effective laws and regulations. Brief case studies that highlight the need for this kind of research and the required institutional changes are also included. The current political focus on access issues offers an opportunity to reevaluate the requirement for successful inter-disciplinary assessments. The objective of this effort is to provide groundwork for more in-depth future research. As a result, we provide in-depth citations from the pertinent literature.

3. RESULTS AND DISCUSSION

There are other clear links between food and energy; consider biomass production, which uses plants a source of energy and has grown in popularity in countries such as Argentina and Brazil in recent years. This "new renewable" energy source uses water that would otherwise be used for irrigated agriculture for food production and relies on plant growth to produce energy, which could lead to a decline in food production (because of associated decreases in agricultural land for the production of food). The biological function of the forest may have been impacted by the biomass created from the forest waste. As a less anticipated result of using plants for energy, food prices could rise.

3.1. NEXUS TOOL

There are tight links between the food sector, energy, and water. As demands on these resources continue to rise, there is a rising necessity to develop, quantify, and comprehend the trade-offs involved with the future management and planning of these systems [Figure 1]. Water has been utilized to generate hydroelectricity and cool thermal power stations. Hydraulic fracturing has an effect on groundwater: gas and oil extraction pose the risk of polluting surrounding aquifers and reducing the availability of potable water or agriculture. Energy, on the other hand, is required for extracting groundwater and current irrigation methods, as well as for the whole urban water cycle, from transportation to delivery to treatment. The close relationship between water and food is most evident in agriculture's requirement for water and irrigation, in which the share of water utilized by the agricultural sector ranges from 70–80 percent to 80–90 percent. In many nations, the priority of water usage is regulated by law, and irrigation is often placed second to home consumption.

Food, energy, and water seem to be interdependent resource systems that confront several difficulties, such as a growing world publication, economic crises, hunger and poverty, and climate unpredictability. To address these issues, our traditional resource allocation model must undergo a paradigm shift to account for their intricate interdependencies. In pursuit of this objective, the authors have created a resource allocation plan evaluation platform (WEF Nexus Tool 2.0) that intends to assist decision-makers in establishing water-energy-food-informed sustainable resource management techniques.

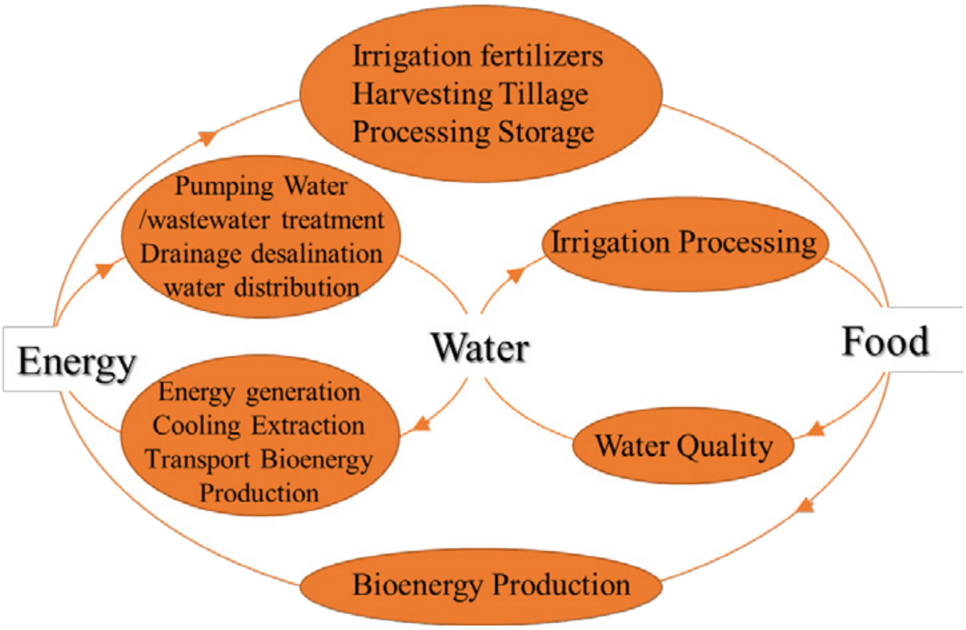

Figure 1. The resource management strategy Guiding Tools

The WEF Nexus Tool 2.0 is a shared platform that brings together scientific knowledge and policy input to detect present and predicted bottlenecks in resource allocation patterns, as well as potential trade-offs and possibilities to address resource stress concerns. The scenario-based approach aims to clearly quantify the relationships between the three sources while taking into account the consequences of population increase, climate change, changing policies and economies, and other stressors. It allows the user to construct scenarios for a certain nation by specifying the following parameters:

a) Water portfolio: identifying various water sources and the quantities needed for each.

b) Food portfolio: Assessing local food production vs. imports, as well as agricultural production technology.

c) Finding forms of energy for water and agricultural output as part of an energy portfolio.

Despite the fact that the water-energy-food framework seems general, the tool's situations seem to be location-specific and specified by the local variables of the research location. Local food yields, energy and water availability and needs, accessible technology, and land demands are only a few examples. The user defines the attributes, which allows

for the production of country-specific identities. The WEF Nexus Tool 2.0 allows users to view and evaluate resource needs across scenarios, as well as compute each scenario's sustainability index. The Sustainable Development Goals (SDGs) Acceleration Tool Kit from the United Nations Development Organization just included the tool. With the use of the application, users can simulate a variety of situations with varying degrees of food self-sufficiency, access to water and energy sources, and imports and exports. There is a description of the output, including the amount of water needed (m3), the amount of energy needed locally (kJ), the amount of carbon dioxide that needs to be released locally (tonne CO2), the amount of land needed (ha), the amount of money needed (QAR), the amount of energy needed to be imported (kJ), and the amount of carbon dioxide that needs to be imported (ton CO2). The user can look up and check how many resources are used in each of the available situations. The user might also be able to determine the relative relevance of each system (carbon through import, energy through import, financial, land, local carbon, local energy, and water).

3.2. ELEMENTS OF THE WEF NEXUS

The descriptive elements of the EWF nexus contain various elements that are simple to recognize, like (Global Risks, 2011):

a) Several billions of people lack access to all three factors (quality, quantity, or both).

b) All elements are in high demand across the world.

c) All elements are limited by resources.

d) All elements are "global goods," implying worldwide commerce and having global consequences.

e) All elements have variable geographical accessibility and supply and demand fluctuations.

f) Global warming and the environment are intertwined in all of them.

g) All these elements have serious security concerns because they are essential to society's functioning.

h) All of these elements work together in highly regulated markets. All of these things need the clear identification and handling of hazards.

3.3. SUSTAINIBILITY INDEX

Different scenarios can be created with the programme. For example, despite the fact that one scenario uses the least amount of land, it simultaneously uses the most water. The scenario that consumes the least amount of water is also likely to be the costliest. One of the most energy-intensive scenarios, for example, could be a less expensive option financially. How do we decide which scenario to pursue? What factors do we consider? How can we determine how much of the various resource demands we can handle? How may the tool's output be used to evaluate potential techniques? The answers aren't easy to find. To examine and compare conditions, the following aspects should be included in the construction of a sustainability report: (1) scientific data to aid in the quantification of system links and physical capabilities; and (2) policy input outlining policy options and strategies.

The multidimensionality of the framework and instrument necessitates a deeper understanding and investigation of the results. Despite the conceptual framework's apparent scope, evaluations and solutions should be adapted to the specific problem at hand. The same outcomes and expenses for an idealised scenario are seen from varied perspectives by numerous governments, ministries, or decision-making organisations, and each must supply their own data. Each of the variables (carbon, energy, finance, water, or land) varies in relevance or sensitivity depending on the location. It may go beyond selecting the least resource-intensive solution to one that can be transformed into a cost-independent national goal or vision. A scenario's localized sustainability would be determined by figuring out its sustainability index using the two-step procedure shown below.

Iraq, on the other hand, the most difficult task at SWLRI is to find projects that maximize not only water and land utilization, but also food security, energy efficiency, and environmental conservation. These four areas — water, food, energy, and the environment – are so intertwined that every change in one has a direct impact on the others. The connection or interaction between these sectors emphasizes the importance of striking a delicate balance between competing uses of water, which is what this approach aims to achieve. The strategy is built around these four connections and examined in light of their interconnections. The following are the relationship categories. The water category encompasses the allocation of water across a variety of sectors, including municipalities, industry, agriculture, and the environment, as well as the numerous social and economic benefits that come with its use. Food: The food category represents the interdependence of water and food production, as well as agriculture's involvement in soil and river system health. Water and energy production in various forms, such as oil production and electricity generation in power plants, are all included in this category. The Statements Vision highlights the priorities, goals, and objectives of the ten ministries who participated in each of the four areas in the NWDS manifesto. The future vision statements (one for each of the following sectors: water, food, energy, and environment) describe the Iraqi government's goals for this sector on the page. They appear at the beginning of each chapter in this strategy. Not every chance can or should be taken. As a result, it was important to condense the lengthy list of possibilities into a more manageable set of priorities. To do so, a preliminary assessment was conducted to identify projects that are in the works or those are deemed critical to public safety. In actuality, it made sense to start with the ready-to-go projects, which are meant to be of the utmost significance to the Iraqi government. Both are established as constraints during the selection process, which means they are immediately added to the list of selected projects. The water dams and irrigation projects on the list were then evaluated using a multi-criteria screening approach. For a numerical representation of the technical, social, environmental, and economic aspects of opportunities, "strategic evaluation criteria," which are physical-factor-calculated values for hydroelectric dams and irrigation projects, were developed. The weights for each of the criteria were then determined based on the priorities specified by the NWDS stakeholder committees.

Finally, the sum of the weights was used to generate the total score for each project, providing an objective and systematic manner to rank the 29 hydroelectric dams and irrigation projects. Following feedback from NWDS stakeholders, three new elements to consider when selecting irrigation project possibilities were identified: a) Poverty alleviation 2) Developing irrigation projects near Iraq's borders to maintain national security at the border 3) The

Exodus from Poverty: Rural population exodus or reduction. It's worth noting that these three criteria are the top priority for the country (see Key Priorities National). The adoption of these goals in conjunction with the strategic assessment criteria has allowed irrigation projects to be organised in a way that is both intentional and reflective of the appropriate authorities' observations. Creating "resource indices" requires scientific input as follows:

The index of Water (WI) = Wi/Wa,

The index of Land (LI) = Li/La,

The index of locally energy (EI) = Ei/Ea,

The index of locally carbon (CI) = Ci/Ca,

The index of financial (FI) = Fi/Fa,

The index of Energy IMP (EIMP I)=EIMPi/EIMPa, and

The index of Carbon IMP (CIMP I) = CIMPi/CIMPa.

Where index = resource amount essential by scenario/allowable capacity or limit.

Resource indices are computed to normalise the tool output and detect any exceeding local limitations. Each index represents the percentage of resources that the suggested scenario is allowed to use. Because they are unfavourable in terms of local input needs, scenarios with resource indices greater than 1 are less likely to be accepted. The 'local characteristics' of the territory under investigation include the local bounds. For example, the acceptable water limit (Wa) is a percentage of all available water resources that are allocated for agricultural production; similarly, for La, the percentage of arable land. This process depends on a combination of scientific inputs and an understanding of the available resources; part of this process may involve consultation with stakeholders (i.e., ministries, governmental organizations, etc.). Acceptable energy (Ea) is a measure of the amount of energy allotted to the agriculture industry and its related activities. A national commitment to reduce carbon emissions and corresponding quotas within the agricultural sector may have an impact on an acceptable carbon limit (Ca), which is a maximum ceiling on emissions connected to agriculture and activities associated with it (such as the use of water for agriculture).

The allowed financial limit serves as a representation of the state budget amount for the scenario (Fa). EIMP and CIMP are less relevant and might be more arbitrary when it comes to how they relate to energy consumption and carbon emissions in a global setting through the transportation of products. One step toward determining specific acceptable bounds would be done by cross-sector stakeholder engagement, representing diverse resource-consuming sectors with the use of scientific information. The precise amounts of resources that ought to be provided for carrying out diverse development plans across industries would be simpler to ascertain as a result of this.

Policy preference is shown in the identification of the importance coefficient. Combining scientific knowledge with policymaking is essential in order to establish sustainable policies. Both contributions must be taken into consideration. After determining the amount of resources needed for each scenario, policy-makers must provide their feedback. This entails determining the proportional value of lowering each resource need (water, energy, carbon, land, and financial). In other words, which expenses associated with a certain situation should be reduced more than others? Through focus groups, stakeholders would rank the relevance of each resource demand according to what their policies and plans thought should be decreased the most. This would be a reflection of governmental plans and objectives. The more important it is to choose a scenario with fewer required resources, the greater the significance coefficient. If minimizing water footprint is a higher priority than other footprints, Iw (importance of reducing water need) would be greater. The sustainability index of each scenario that is suggested is then determined. This index is the result of adding the "resource indices" and the "importance coefficients" that were given to them. The scenario is more beneficial if the assessment parameter index is lower since it shows how far the parameter is from the maximum specified limit. The relevance (and sensitivity) of the provided parameter decreases as the importance coefficient does. According to the decision-maker, the scenario with the lowest score is the most sustainable.

Scenario i:

$$\begin{aligned} S\,.\,I_i = \big[& WI_i(100 - I_W) + LI_i(100 - I_L) + EI_i(100 - I_E) + CI_i(100 - I_C) \\ & + FI_i(100 - I_F) + E_{IMP}I_i(100 - I_{EIMP}) \\ & + C_{IMP}I_i(100 - I_{CIMP})\big] \times 100 \\ & I_W + I_L + I_E + I_C + I_F + I_{EIMP} + I_{CIMP} = 100 \end{aligned}$$

where 'I' is the importance factor assigned for resource, which reflects the relative importance of reducing the consumption of this resource in a scenario.

Examples from an energy perspective-

It's difficult to address all three challenges without repeating popular statistics on growth, access, and so on, or without providing confusing recommendations. We briefly discuss a few particular domains where the EWF nexus is obvious yet underutilized by systems thinking at the moment. These are not case studies, but rather sections of the EWF nexus with distinct system boundaries on which future, more extensive research could be focused.

3.3.1. ENERGY ACCESS AND DEFORESTATION

For example, only 9% of Ugandans have access to electricity, a scarce resource (Taylor, 2010); and significant environmental issues, such as overgrazing, deforestation, and (typically) low-productivity agriculture practices, all contribute to soil erosion, a major barrier to growth. 93 percent of the nation's energy requirements are met by wood. Although the rate of ensuing deforestation has decreased significantly, from 67 percent loss of forests and woods between 1962 and 1977 to 7.7 percent loss between 1983 and 1993, it remains a serious issue (including effects on water systems) (Biswas et al., 2001; Liu et al., 2008; Viswanathan and Kumar, 2005; Zahnd and Kimber, 2009). Ethiopia experiences a lot of the same issues as well. Only 3% of natural forests are still intact due to extensive exploitation. Pressure has been put on particular basins as a result of the government's initiative to supply power to all inhabitants. The Awash Basin contains mixed crop and animal farming in its higher reaches; a mix of crops, livestock, and pastoral production in its middle region; and a nomadic pastoral system with some irrigation in its bottom segment. This is similar to how much of Ethiopia's highlands are farmed. The basin generates significant hydropower with 110 MW total at three plants, or 14% of the country's capacity, and a sizable tract of arable land. The basin must make severe trade-offs since there isn't enough water to fully support agriculture and power generation demands (McCornick et al., 2008).

3.3.2. BIOFUELS (AND UNCONVENTIONAL OIL AND GAS) PRODUCTION

It is evident that initiatives to create bioenergy substitutes for fossil fuels have frequently been implemented without a thorough knowledge of the costs and benefits from a variety of viewpoints, including: deforestation, biodiversity, water, energy, lifecycle emissions, and land use change. Many factors contributed to recent food price increases, including increased fertiliser and fuel prices, and thus transportation; increased demand for biofuels driven by energy security and climate change concerns; and changing consumption patterns (Galan-del-Castillo and Velazquez, 2010; Kaphengst et al., 2009; Lange, 2011; Méjean and Hope, 2010; Peters and Thielmann, 2008; Schut et al., 2010; UN, 2007). Although there are some price consequences, there appears to be sufficient land and water available globally to cultivate a sizable amount of biomass for the production of both food and bioenergy. Natural resources are distributed unevenly, leading to significant regional inequalities and severe land and water shortages in crucial places. For instance, more than 35% of the world's population resides in China and India, both of which have fully utilized the land and water resources available for agriculture. On the other hand, a significant portion of sub-Saharan Africa and South America still have the potential to increase areas used for agricultural production in addition to experiencing significant productivity gains for current land use. This is due to the availability of suitable land and exploitable water (Müller et al., 2008). Similar problems arise with unconventional sources of oil and gas. The exploitation of tar sands (Wu et al., 2009) and shale gas (Lee and Koh, 2002) utilizes a lot more water than traditional oil and gas, respectively, and can seriously pollute water.

3.3.3. IRRIGATION AND FOOD SECURITY

The connection between energy, irrigation, and food security in South Africa has become a serious issue (SA). Electricity rates increased by 31% between 2009 and 2010, and another 25% increase is anticipated over the next three years (Botterill, 2012; Setlhaolo et al., 2014). The agriculture industry, with its high energy requirements for irrigation, could be one of the most affected by rising energy prices. Irrigated land produces 25% of South Africa's main foods. Reduced irrigation and a move to rain-fed agriculture may jeopardise national food security, particularly during droughts. South Africa was a net food exporter from 1985 to 2008, but has since become a food importer due to population expansion and a slower increase in agricultural output. Another illustration would be Punjab, which barely makes up 1.5% of India's territory but produces 50% of the rice and wheat the government buys and distributes to feed the more than 400 million undernourished Indians. Farmers are "mining" (pumping) aquifers more quickly than they can be replenished, which is a significant problem. Since electricity is subsidized, this is partially due to insufficient price signals. As water levels drop, increased pumping is taxing an already brittle and overburdened electricity grid. In total, irrigation consumes between 15 and 20% of India's total power. Using distributed photovoltaic-powered water pumps, which can improve price signals, is one solution. PV irrigation systems are successfully used in this region when the right circumstances arise (Hussain et al., 2010; Purohit, 2007; Sallem et al., 2009).

Iraq, on the other hand, is a country wealthy in oil, with a medium income from the high law and a population of 36.4 million people in general in 2015, with 30.1 million of them living in refined regions. Despite the fact that it does not form until 5.7 in the water from local produce, the agricultural land sector is vital to the economy's survival. because of rapid urbanization, conflict, and the safe execution of execution. Furthermore, the cause of the colour shift is a reduction in water and a speeding up of the process. And these works are combined until the possibility of a distinct agricultural product is eliminated and the collection's ability to create a steady income is increased. Despite this difficulty, the country has a wonderful place for it. And, in Iraq, the national dominance line is being cultivated with the credit of the unit from the head parts in order to accelerate non-oil output, raise the distribution of the unit, and study gender equality.

3.3.4. HYDROPOWER

Hydroelectricity will continue to be the main source of power in Iraq and the Kurdistan Region. By 2030, the Kurdistan Regional Government wants to supply 15% of the region's electricity needs using hydropower. One percent of the rest of Iraq's electricity demands should be satisfied by hydropower. Five new medium-sized dams will be constructed in the Kurdistan Region by the year 2030, while ten new dams (ranging in size from small to medium) will be constructed throughout the remainder of the nation, largely along the Tigris River. Since the majority of these dams are primarily made to generate hydroelectric power, they will help conserve water and somewhat lessen floods. Some of them like the Taq Taq Dam on the Lower Zab will provide multi-purpose services. The construction of 30 new dams will increase the water storage capacity in Iraq by about 11 billion cubic meters by 2030.

The strategy's suggested dams represent Iraq's complete capacity for medium and large-scale reservoir construction. Alternative technologies, such as hydroelectric, solar, and wind energy, are another possible source of energy in Iraq. Iraq now generates electricity from hydroelectric power stations all around the country, despite their tiny output. According to the Ministry of Electricity MoEI in Baghdad, the

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production of hydroelectric power in Iraq in 2012 was the Republic of Iraq-Ministry of Water Resources Strategic Study of Water and Land Resources in Iraq 179 (excluding the Kurdistan Region) was 757.4 GW/year, or 1% of the total energy generated during the same year (2001; 21 GW/year). The average daily production of hydropower was 102 MW. Existing hydroelectric power plants can produce more, but it is limited by lower water levels at the top of the reservoirs, as well as the constraints imposed by the need to match irrigation expenses. The Ministry of Electricity estimates that power generation in Iraq, without the Kurdistan Region, for the year 2013 will be 46757 GWh/year.

The amount of water that is affected by the production of electricity is minimal (it only affects the amount of water lost through evaporation in the dams), but it may affect the timing of stream flows, both seasonally and hourly, because the timing of water releases is typically determined by the demand curve for electricity, subject to engineering and environmental limitations. Hydropower and downstream uses, such as irrigation, in-stream usage, and supporting ecosystems, may potentially conflict (Briscoe, 1999). A prominent instance of this type of conflict may be seen in Central Asia, where the Kyrgyz Republic must release water during the winter to produce energy, but South Kazakhstan and Uzbekistan want water during the summer for irrigation projects (Schmidt-Soltau, 2004). Jordan offers yet another intriguing scenario. The Jordan River and a few other river systems provide the country with the scant water it needs. Lifting, transferring, and purifying surface water—especially water from the Jordan Valley—requires energy. Importing energy has a substantial cost from a financial and foreign policy viewpoint (Scott et al., 2003). The cost of energy and water is another serious problem. Jordan is said to have utilized 25% of its power, which was mostly produced from imported oil, even before the current spikes in energy costs to manage its meager water supplies (McCornick et al., 2008).

3.3.5. DESALINIZATION

Several island communities, desalination is essential for agricultural and drinking water for large populations in North Africa and the Middle East. Desalination will become more necessary as subsurface water sources are exhausted and the human population grows. Reverse osmosis and thermally driven Multi-Stage Flash (MSF) are the two most used desalination techniques (RO), which, respectively, make about 44% and 42% of the world's capacity. Under the correct conditions, thermal desalination devices might be powered by solar energy, use distillation to separate fresh water from saline water. The brine is created when salty feed water is heated to Vaporization, enabling fresh water to steam off, leaving a highly salinized solution behind. The MSF technology has the ability to use extra thermal energy. As a consequence, huge volumes of energy and water may be produced at one station, thus meeting demand for both. Desalination energy demands are expected to rise substantially, particularly in dry areas. In the MENA area alone, water desalination is expected to increase from 8 million m3 currently to over 15 million m3 in 2030. According to research, integrated electricity and water plants might account for 33–67% of new power capacity expansions, depending on the nation (Blanco et al., 2009;

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Othmer, 1975; Peñate and García-Rodríguez, 2011; Publishing et al., 2005; Siddiqi and Anadon, 2011).There appear to be a number of alternate options, but the most of them still focus on the EWF nexus in two dimensions. The difficulty will almost probably be to create system limits that are large enough to handle the enormity of the interaction vectors while still being small enough to allow for realistic analysis. It's tough to locate examples of this approach in policy and regulation.

3.3.6. HOLISTIC WEF NEXUS SIMULATOR FRAMEWORK

Through the use of simulated data (IFs and THENs) for WEF nexus interaction, the WEF nexus simulator is scaleable. It's possible to alter the system boundaries and nexus elements by choosing various spatial sizes, but it's also crucial to keep in mind that shifting the spatial scale could result in altering nexus elements over time. All design factors would therefore overlap as the geographical scale is increased. The system borders of the WEF subsystems, which include a watershed, differ even though they confine the geographical scale to smaller limitations, with the energy subsystem's border being the greatest and the water subsystem's boundary being the lowest. Due to the significant physical constraints, each national WEF subsystem consists of its own components. Energy production is not limited to a single energy subsystem the size of a watershed or to a particular watershed, as it is in a watershed. Typically, it is made elsewhere and imported into the watershed. As a result, unless bigger geographic scales that encompass a variety of energy components could be included, it is hard to examine all of the interrelationships in the energy subsystem merely at the watershed size. Surface water and groundwater, on the other hand, are found in plenty in the watershed. As a result, these differences must be taken into account after setting system boundaries on a small spatial scale. Examining all of the linkages between WEF subsystems was the aim of this investigation. [Figure 2] depicts the WEF nexus simulator's IFs and THENs. The interactions in the WEF nexus system were given the names IFs and THENs because the output of one subsystem is thought of as an input for another subsystem. For instance, deep percolation appears to be an output of the food subsystem (THEN) that the water subsystem uses as an input (IF). Every simulation model in this class has independent THENs that are stand-alone outputs (THENs) that are not used by other subsystems. Non-nexus demands are met by the water subsystem's environmental water requirements, and non-agricultural byproducts have evolved into an example of independent outcomes in the WEF nexus system.

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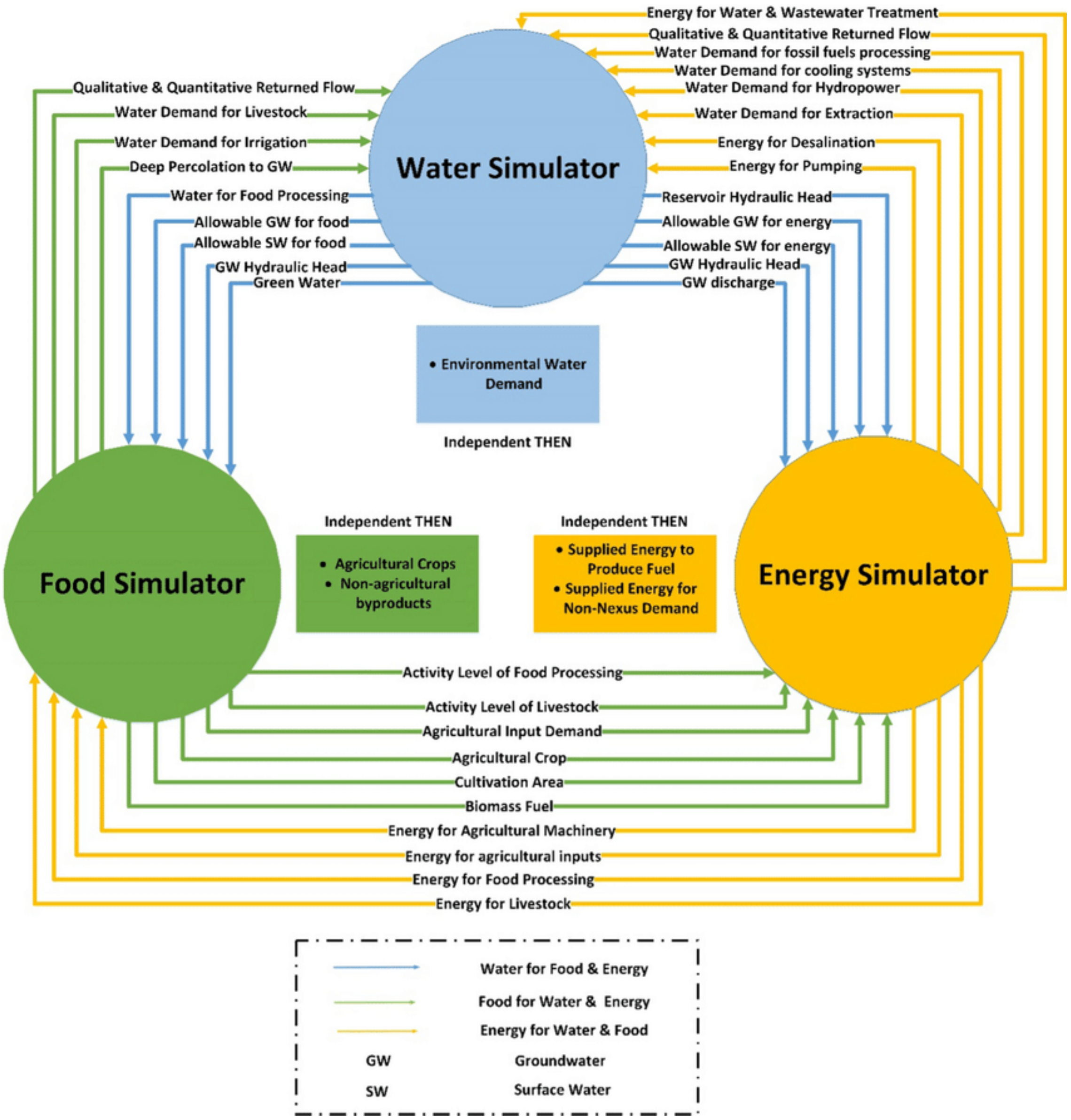

Figure 2. The interactions between the WEF nexus system (Afshar,A et al ,2012)

4. CONCLUSION

Energy modelling may benefit from a model that expands capabilities to other Nexus regions, but doing so would involve rigorous modelling concept design and the use of widely used tools. The present tools also have a lot of model overlap. These overlaps are not always bad because they allow for comparisons between different tools, shedding light on the significance of various presumptions or methods and enabling the risk/uncertainty evaluation of the model's output. In a number of European policy situations, this way of comparing model results is becoming more popular (Europea, 2015). The following are the consequences of the Nexus on energy modeling:

In the first place, to address cross-sector interdependence, resolve conflicts, and boost synergies between the energy sector and the nexus areas of climate, land, food, and water. By learning more about land markets, one can improve energy

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modeling, such as the solar and wind power potential. We need some form of creativity in food technology, engineering, and hydrology.

In order to resolve trade-offs and/or improve synergies amongst Nexus domains, governance is essential. Last but not least, transdisciplinary approaches enable the Nexus to be handled in a fashion that is driven by the needs of stakeholders (Siddiqi et al., 2013). Participatory approaches that unite business, government, academia, and civil society groups may enhance the relationship between science and policy. Comparing model results and setting a shared baseline could lead to model improvements. It is necessary to assess integrated modelling frameworks used at various scales. Nexus analysis is applicable to industrial processes as well as local, national, and international research. Increased modelling capabilities and the foundation for stronger policy recommendations could result from more Nexus research on the topic of energy modelling. If initiatives to encourage interdisciplinary team integration were coordinated, the development of spatial analysis consistency would be feasible.

5. RECCOMENDATION

There is little consensus on the most effective methods and tactics to utilize at various sizes and, most importantly, as more conferences concentrate on the complicated, developing issue of the WEF nexus, to achieve different goals. Without a doubt, there was a pressing need for fresh tools and procedures that could give personalized insights. In contrast, there are currently available technologies, such as those mentioned above, that provide in-depth analysis and critical insights for specific sectors or between any service areas in the nexus, such as water for food and energy for water. Connecting outputs and inputs among well-known models, followed by an analysis of the results at an integrated water-energy-food layer, was arguably the most difficult difficulty and demand. The water, energy, land-use, and climate strategies (CLEWS) framework is a step in the right direction and is now being tried in several locations. It entails the use of freely available technologies such as LEAP and WEAP from the Stockholm Environment Institute (respectively, the Long-Ranging Energy Alternative Planning Process and the Water Assessment and Master Plan). Integration of models across scales is also necessary to allow decision-makers to extract information and examine consequences at several scales. In order for the tools and approaches to be used in a range of global settings by informed (but not necessarily professional) practitioners, they must be readily accessible.

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