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Editorial

Decision-Making Theory and Methodology for Water, Energy and Food Security

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In recent years, water, energy, food, and their nexus have become an increasingly significant and active area of research in economic and management science, especially in terms of safety, a research area where several important problems are emerging. These problems can be considered multicriteria decision-making problems. However, few studies to date consider these problems from a multicriteria decision-making point of view. Decision-making theories are routinely based on the notion that decision makers choose alternatives that align with their underlying preferences and, hence, that their preferences can be inferred from their choices. This Special Issue aims to develop various decision-making theories and methodologies for water, energy, and food, including the evaluation of water supply, wastewater management, energy, food risk management, safety management, etc. We received countless papers on this topic, and after strict evaluation, nine papers were selected for this Special Issue. Their contributions and main contents are summarized in the following paragraphs.

In human survival and sustainable development, water security, energy security, and food security have become the three most prominent issues, but they are interrelated and directly affect each other, that is, to form a water–energy–food (WEF) nexus. Scientific understanding and correct response to the relationship between WEF is important to realize the sustainable development of natural resources. There are some deficiencies in the existing research on the input–output efficiency of the WEF system. Only a few articles can study the efficiency relationship between internal and external factors (such as the economy and environment) of the WEF system at the same time, or the research will not be perfect. Given the shortcomings of the existing research, Zhang and Xu (contribution 1) established a three-dimensional network structure to describe the water–energy–food–economy (WEF-Eco) system and established the corresponding network data envelopment analysis (DEA) model. The authors used the data from 19 provinces in Northeast, East, and Central China to show the application results of this model.

Vázquez et al. (contribution 2) modeled the hydrology of a geologically complex catchment (586 km^2) using the free-license PBD code SHETRAN. The SHETRAN evaluation took place by comparing its predictions with (i) the discharge and piezometric time series observed at different locations within the catchment, some of which were not considered during model calibration (i.e., multi-site test), and (ii) predictions from a comparable commercial-license code, MIKE SHE. In general, the discharge and piezometric predictions of both codes were comparable, which encourages using the free-license SHETRAN code for the distributed modeling of geologically complex systems.

Mladenović-Ranisavljević et al. (contribution 3) contributed to the efforts of water resources management in considering the problem of the nutrient pollution of water from a multicriteria decision-making point of view. The combined PROMETHEE and GAIA analysis in this paper included indicators of nutrients in the water (total nitrogen, nitrite, nitrate, ammonium ion, total phosphorus, and orthophosphates) to rank and evaluate significant sites along the Danube River flow through Serbia. Furthermore, the ecological quality status of the water was determined, which places the Danube River into the category of "good" to "moderate" water quality. The results represent a detailed evaluation of the

Citation: Xu, Y. Decision-Making Theory and Methodology for Water, Energy and Food Security. *Water* **2023**, *15*, 4261. https://doi.org/10.3390/w15244261

Received: 6 December 2023
Accepted: 8 December 2023
Published: 12 December 2023

sites with increased nutrient content associated with the most dominant parameters of nutrient indicators affecting water pollution at each site. The main sources of nonpoint pollution are of anthropogenic origin reflected in agricultural applications of pesticides and fertilizers, together with natural contamination of ground and water sources, while pollution from point sources arises from industrial wastewater and domestic activities. Minimizing the application of fertilizers and pesticides is a way to control pollution from agricultural activities. At the same time, proper wastewater treatment is needed to reduce point sources, although financial aspects and lack of funds are limiting factors of this control in Serbia. Therefore, the findings in this paper could serve as a starting point in identifying key sources of nutrient pollution in water for environmental scientists and water resource managers and in expanding strategies and taking long-term measures to reduce the input of nutrients into the valuable Danube River for industry experts and national authorities.

Lin et al. (contribution 4) took the Three Gorges Dam as an example and discussed the influence of river regulation decisions on the sustainable development of surrounding villages. The study used mixed research methods, snowball sampling, and convenience sampling to obtain samples. The questionnaire samples were analyzed by basic statistical tests, *t*-tests, and structural equation modeling (SEM). The respondents' opinions were collected through semi-structured interviews; finally, the results were discussed using multivariate analysis. The findings were that even though the villages were not well developed in terms of economy, environment, and natural ecology, as long as the community security could be stable, the living could be safe and convenient, people's daily life patterns and leisure behaviors could be maintained, and people could stabilize their minds and emotions and maintain physical and mental health to meet their living needs and reduce the burden. There would be time and funds to invest in leisure, tourism activities, and consumption behavior. If the above consumption patterns are continued, people will gain positive perceptions, stimulating people's willingness to invest in property purchases or to make travel plans again.

In the study area of the Duero River Basin, located in Michoacan, Mexico, Vargas et al. (contribution 5) schematize a series of numerical indices of the Watershed Governance Prism to determine the quantitative status of water governance in a watershed. The results, presented as axes, perspectives, and prisms in the Axis Index, Water Governance Index, and Watershed Governance Prism Index, provide the conclusion that it is possible to establish and evaluate the Watershed Governance Prism Index using their numerical implementation of the Watershed Governance Prism theoretical framework. Thus, it is possible to define a quantitative status and evoke how water governance is being designed and implemented in a watershed.

Vichete et al. (contribution 6) presented a proposed water allocation model using a priority-based and hydro-economic optimization kernel as a framework for improving the quality of information for the different user sectors, stakeholders, and institutions for the water allocation decision-making process. In addition, the authors propose a method for using hydro-economic optimization models without the marginal benefit curve of water demand. The proposed model, called AcquaNetGIS, was applied to the São Francisco Transboundary System, and the hydro-economic optimization was improved, allocating 7.0% more water for all users considered, including water supply, irrigation, and hydropower. Moreover, the minimum flow downstream from the Xingó hydropower station reached 98.5% (priority-based optimization) and 99.0% (hydro-economic optimization) during the optimization period. Depending on the rules and legislation, the sustainability of water allocation based on hydro-economic externalities may be a better solution for the planning and operation of complex water infrastructure systems. Multicriteria decision-making methods should consider the results of the proposed model to understand the stochastics of the hydrological regimes and economic production based on the availability of water.

Lu et al. (contribution 7) designed a large-scale group decision making in social network (LSGDM-SN) approach based on distrust behavior and applied it to water pollution management. The purpose of this paper is to develop an LSGDM-SN method to assist managers in choosing the optimal water pollution management plan. In the presented method, fuzzy preference relations (FPRs) are used to express experts' assessment of alternatives. To utilize the proposed LSGDM-SN approach to solve the water pollution problem, a novel agglomerative hierarchical clustering (AHC) method is proposed by combining preference similarity and social relationships. Afterward, consensus feedback based on distrust behavior and social network analysis (SNA) is developed to encourage the subset to modify its FPR. A mechanism for the identification and management of distrust behavior is introduced. Based on the situations of distrust behaviors, two pieces of feedback advice are provided to the subset to adjust its FPR. Subsequently, a core function of the FPR is proposed to obtain the best solution for water pollution management. Finally, some comparative analyses and discussions demonstrate the effectiveness and feasibility of the proposed method.

Vargas et al. (contribution 8) applied a multi-criteria analysis to evaluate the best approach among six theoretical frameworks related to the integrated management of water environmental resources, analyzing the frequency of multiple management criteria. The literature review covers the period from 1990 to 2015, with a notable presence of the theoretical frameworks of Integrated Water Resources Management (IWRM), Eco-health, Ecosystem Approach (EA), Water Framework Directive (WFD), and, to a lesser extent, the Watershed Governance Prism (WGP) and the Sustainability Wheel (SW). The multi-criteria decision-making (MCDM) methods applied include AHP (Analytic Hierarchy Process), TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), and PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations). Twenty-five criteria were analyzed, such as governance, participation, sustainability, decentralization, and health and wellbeing, among others. The authors started with five criteria for evaluating the hierarchy of the six theoretical frameworks using the AHP method. Subsequently, they evaluated the five criteria using the TOPSIS and PROMETHEE methods to calibrate the results with the AHP. Then, using word counting, the authors evaluated the best approach, applying 10, 15, 20, and 25 more criteria. The results indicate that the best-integrated management alternative was the WFD, which fulfilled 47% of the management criteria. Second, with 45%, was the WGP, and third was IWRM, with 41%; less successful approaches to the criteria were demonstrated by the EA, SW, and Eco-health methods. By applying this methodology, the authors demonstrated an excellent structured tool that can aid in the selection of the most important issue within a given sector.

Arsene et al. (contribution 9) proposed a novel recommendation system design architecture that promotes water conservation behavior among residential consumers from urban areas. They analyzed 480,000 data samples from several households with different profiles to generate personalized recommendations for each household and encourage consumers to adopt measures to raise awareness and reduce water consumption. Moreover, data were collected from three different measurement points in the household (cold_sink, hot_sink, and toilet), with a sampling time of 60 s. The proposed recommendation system implements collaborative filtering combined with a set of rules to generate recommendations based on the consumption patterns of similar households. The results are promising, offering personalized feedback that could help change the consumption behavior of households if the recommendations made are followed.

We thank the authors for all their contributions to this Special Issue and all the reviewers who gave their constructive comments to help the authors improve their contributions. We hope these contributions will enrich the research of WEF and multi-criteria decision-making areas.

Conflicts of Interest: The author declares no conflict of interest.

List of Contributions:

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