



Single Valued Neutrosophic Set for Selection of Water Supply in Intelligent Farming

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Abstract

One of the most difficult problems in the water business is the oversight and strategic planning of basin-based water supplies. Governments are concerned with ensuring equitable growth by addressing issues like water scarcity, improving agricultural products, and supporting nutritional health. The primary contribution of this research is the introduction of a methodology for assessing agricultural water delivery systems that allow for collaboration among all stakeholders. The managing the water supply is a MADM. Multi-attribute decision-making (MADM) issues, which are characterized by inadequacy and ambiguity, may be efficiently described using single-valued neutrosophic sets (SVNSs). Several strategies, including the PROMETHEE strategy, are offered to address the MADM issue in SVNSs. The PROMETHEE technique ranks potential solutions by first having the decision maker pick a preferred function for every criterion. In this paper, the SVNS is integrated with the PROMETHEE method for water supply management in smart farming.

Keywords: Single Valued Neutrosophic Set; MADM; Water Supply; Farming

1. Introduction

There is a growing risk to future generations due to the current pattern of population expansion and a requirement to meet their needs for supplies and an increasingly polluted and unsustainable environment. Clients, providers, and legislators face significant problems as a result of the increasing need for water and the declining supply and purity of this essential fluid. Because of these problems, administrations have been considering new approaches to water usage and supply planning[1]–[3].

Concerns about future generations' ability to satisfy their fundamental requirements (water, electricity, and nutrition) were stoked by the establishment of wrong and damaging patterns in the use of natural assets and the growth of farming systems in the twentieth century[4]–[6]s. After the World Commission on Environment and Development (WCED) introduced the idea of sustainable growth in the late 1980s, scholars across many disciplines began to

consider how it could be applied to resolving issues plaguing the farming industry growth, particularly in choosing and carrying out of growth plans[7]–[9].

Disputes between parties have been successfully settled using MADM techniques. Furthermore, methodological choices are ranked according to an established set of guidelines for achieving the best possible outcome[10], [11].

Generally, choices in conventional MADM approaches are rated using clear numerical values. Decision data is frequently vague or ambiguous in MADM situations because of the complicated nature of goal objects and the individuality of people[12], [13]. Zadeh established the idea of the fuzzy set (FS) and gathered extensive research to explain fuzzy notions. The FS is a method for conveying ambiguous data. Based on this, Atanassov created the intuitionistic fuzzy set by introducing the concept of non-membership degree as an additional variable[14]–[17].

IFS takes into account both the degree of membership and the degree of non-membership. Although the FS concept has gained much traction, it is still limited in its ability to deal with some sorts of real-world uncertainty[18], [19]. Smarandache presented a neutrosophic set as a result. A truth, an indeterminacy, and a falsity membership functions are all present in the NS, which is a subset of the IFS. Researchers have since suggested a variety of other kinds of NSs, including single-valued (SVNSs), multi-valued (MVNSs), and interval (INNSs). The SVNSs serve as a case study for this paper[20]–[22].

2. Smart Farming

When information and communication technologies (ICT) are used in farming, we call it "smart farming" (SF). Scientific researchers, industry professionals, and government agencies are all incentivized to advance efforts to create and promote the usage of cutting-edge technology to aid growers on the ground since data gathered and analyzed using ICT methods help effective production operations. The European Union (EU) cites satellite imagery, farming robots, increased use of nodes containing sensors for gathering data, and the potential applications of Unmanned Aerial Vehicles (UAVs) for aerial photography and actuation as the most significant advancements and methods to be fully exploited[23], [24].

Farming with precision and other forms of "smart farming" have grown in popularity because of their promise to help feed the world's growing population. Integrating digital and data-driven agricultural applications, or "smart farming," has been shown to boost both crop productivity and food product efficiency. The worldwide presence of multiple smart farming use cases attests to the significance of this paradigm shift in agricultural practise. In Chile, for instance, farmers have been able to cut their water use for the irrigation of blueberries by as much as 70% thanks to the use of wireless sensors installed in the soil. In India, farmers have been able to save money and time by using agricultural data to better anticipate and prevent crop illnesses. Fruit growers in Slovenia have benefited from data-driven strategies like these in their battle over insects[25], [26].

However, smart farming isn't only about harvesting crops. In reality, it has revolutionized preexisting agricultural industries and influenced the whole food supply chain by applying big data analysis to deliver helpful information about the entirety of the farming method. Using smart sensors and gadgets in the field, "smart farming" improves traditional agricultural methods. Together, these sensors and tools help farmers maximize their time and efforts in the field and their harvest[27], [28].

3. Neutrosophic PROMETHEE

Newly improved MCDM algorithms provide interactive learning, and one such approach is the PROMETHEE group of outranking strategies. The PROMETHEE-II procedure was employed for this work. Alternatives are compared head-to-head, and the choices of the decision-makers are aggregated according to every factor. When compared to other approaches for multi-criterion analysis, PROMETHEE-II is a very straightforward ranking approach, both conceptually and practically[29]–[33]. Figure 1 shows the phases of this approach.

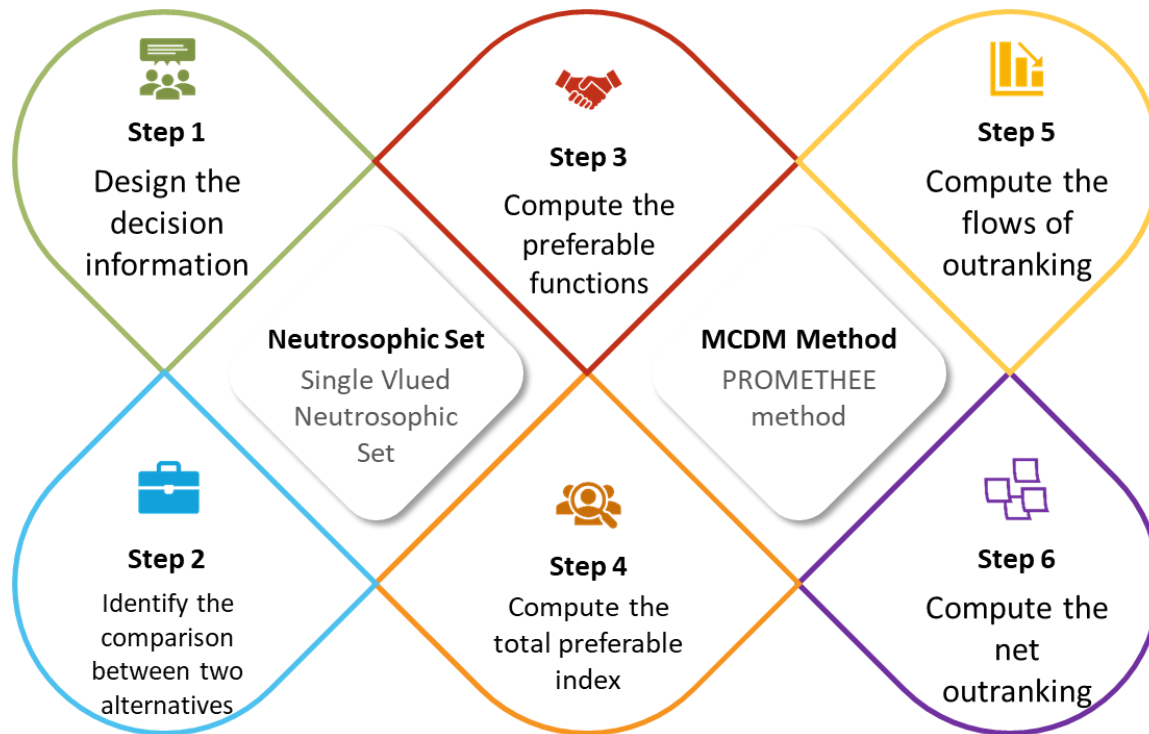


Figure 1: The phases of PROMETHEE approach.

Step 1. Design the decision information

The decision information is built by the decision makers between criteria and alternatives.

Step 2. Identify the comparison between two alternatives.

The pairwise comparison between set of two options is determined as:

$$C = r_j(x) - r_j(y) \tag{1}$$

Where the r refers to the value in decision information, x and y are two options.

Step 3. Compute the preferable functions as:

$$f_j(x, y) = H(C_j(x, y)) \tag{2}$$

Step 4. Compute the total preferable index as:

$$T(x, y) = \sum_{j=1}^n w_j f_j(x, y) \tag{3}$$

Step 5. Compute the flows of outranking as:

The leaving and the entering

$$L^+(x) = \sum_{b \in X} \frac{T(x, y)}{n-1} \tag{4}$$

$$L^-(x) = \sum_{b \in X} \frac{T(x, y)}{n-1} \tag{5}$$

Step 6. Compute the net outranking as:

$$L(x) = L^+(x) - L^-(x) \tag{6}$$

4. Results

This section presented the application of SVN PROMETHEE method. The initial analysis involves considering how important certain standards of sustainability are. Decision-makers (i.e. members of the local water business, members of water customers, and members of consulting experts) were commissioned to analyze four sustainable criteria using the paired-contrasting matrix approach, for which certain surveys were modified as shown in Table 1. There are 12 criteria and 8 alternatives are used in this paper. The 12 criteria are shown in Figure 2.

Table 1: The information of decision.

	WSC ₁	WSC ₂	WSC ₃	WSC ₄	WSC ₅	WSC ₆	WSC ₇	WSC ₈	WSC ₉	WSC ₁₀	WSC ₁₁	WSC ₁₂
W ₁	(0.4,0.5,0.6)	(0.6,0.4,0.5)	(0.2,0.7,0.8)	(0.3,0.6,0.7)	(0.4,0.5,0.6)	(0.6,0.4,0.5)	(0.6,0.4,0.5)	(0.1,0.8,0.9)	(0.1,0.8,0.9)	(0.2,0.7,0.8)	(0.2,0.7,0.8)	(0.9,0.1,0.2)
W ₂	(0.2,0.7,0.8)	(0.7,0.3,0.4)	(0.2,0.7,0.8)	(0.2,0.7,0.8)	(0.1,0.8,0.9)	(0.4,0.5,0.6)	(0.8,0.2,0.3)	(0.8,0.2,0.3)	(0.7,0.3,0.4)	(0.4,0.5,0.6)	(0.4,0.5,0.6)	(0.9,0.1,0.2)
W ₃	(0.1,0.8,0.9)	(0.8,0.2,0.3)	(0.9,0.1,0.2)	(0.7,0.3,0.4)	(0.7,0.3,0.4)	(0.4,0.5,0.6)	(0.1,0.8,0.9)	(0.2,0.7,0.8)	(0.3,0.6,0.7)	(0.7,0.3,0.4)	(0.6,0.4,0.5)	(0.7,0.3,0.4)
W ₄	(0.6,0.4,0.5)	(0.9,0.1,0.2)	(0.6,0.4,0.5)	(0.2,0.7,0.8)	(0.1,0.8,0.9)	(0.7,0.3,0.4)	(0.7,0.3,0.4)	(0.6,0.4,0.5)	(0.4,0.5,0.6)	(0.7,0.3,0.4)	(0.6,0.4,0.5)	(0.7,0.3,0.4)
W ₅	(0.4,0.5,0.6)	(0.9,0.1,0.2)	(0.1,0.8,0.9)	(0.2,0.7,0.8)	(0.3,0.6,0.7)	(0.6,0.4,0.5)	(0.6,0.4,0.5)	(0.7,0.3,0.4)	(0.8,0.2,0.3)	(0.6,0.4,0.5)	(0.8,0.2,0.3)	(0.8,0.2,0.3)
W ₆	(0.8,0.2,0.3)	(0.8,0.2,0.3)	(0.8,0.2,0.3)	(0.7,0.3,0.4)	(0.6,0.4,0.5)	(0.9,0.1,0.2)	(0.2,0.7,0.8)	(0.1,0.8,0.9)	(0.1,0.8,0.9)	(0.6,0.4,0.5)	(0.7,0.3,0.4)	(0.8,0.2,0.3)
W ₇	(0.7,0.3,0.4)	(0.7,0.3,0.4)	(0.8,0.2,0.3)	(0.7,0.3,0.4)	(0.6,0.4,0.5)	(0.4,0.5,0.6)	(0.1,0.8,0.9)	(0.2,0.7,0.8)	(0.2,0.7,0.8)	(0.8,0.2,0.3)	(0.7,0.3,0.4)	(0.4,0.5,0.6)
W ₈	(0.3,0.6,0.7)	(0.4,0.5,0.6)	(0.2,0.7,0.8)	(0.1,0.8,0.9)	(0.6,0.4,0.5)	(0.7,0.3,0.4)	(0.8,0.2,0.3)	(0.8,0.2,0.3)	(0.7,0.3,0.4)	(0.4,0.5,0.6)	(0.6,0.4,0.5)	(0.6,0.4,0.5)

Water Supply	Transmission and water diversion
	Social effects
	Flood control
	The level of groundwater resources
	Water consumption
	Soil Conservation
	Total cost
	Regional climate
	Feasibility
	Reliability
	Watershed capacity
	Legal Considerations

Figure 2: Water supply factors in smart environment.

Then compute the weights of 12 factors as shown in Table 2.

Table 2: The importance of factors.

Factors	Weights
WSC ₁	0.091549
WSC ₂	0.119719
WSC ₃	0.049295
WSC ₄	0.070422
WSC ₅	0.091549
WSC ₆	0.119719
WSC ₇	0.119719
WSC ₈	0.028169
WSC ₉	0.028169
WSC ₁₀	0.049295
WSC ₁₁	0.049295
WSC ₁₂	0.183099

Then apply the PROMETHEE method. Then normalize the decision matrix as shown in Table 3. Then compute the pairwise comparison between alternatives using Eq. (1). Then compute the preferable function by using Eq. (2). Then compute the total preferable index by using Eq. (3). Then compute the leaving and entering outranking flow using Eqs. (4 and 5). Then compute the net outranking flow by using Eq. (6). Then rank the alternatives. Table 4 shows the net outranking flow and the rank of alternatives.

Table 3: The normalization information of decision.

	WSC ₁	WS C ₂	WS C ₃	WSC ₄	WSC ₅	WSC ₆	WSC ₇	WSC ₈	WSC ₉	WSC ₁ 0	WSC ₁ 1	WSC ₁ 1
W SA ₁	0.5305 86507	0.69 385	0.31 109 3	0.4081 42525	0.530 58651	0.693 84964	0.7233 73591	0.1632 58642	0.1632 58642	0.2856 98543	0.2856 98543	1.0611 81584
W SA ₂	0.2856 98543	0.81 629 4	0.31 109 3	0.2856 98543	0.163 25864	0.530 58651	0.9786 85597	0.9387 41276	0.8162 93621	0.5305 86507	0.5305 86507	1.0611 81584
W SA ₃	0.1632 58642	0.93 874 1	1.15 550 5	0.8162 93621	0.816 29362	0.530 58651	0.1702 0545	0.2856 98543	0.4081 42525	0.8162 93621	0.6938 49639	0.8162 93621
W SA ₄	0.6938 49639	1.06 118 2	0.75 552 3	0.2856 98543	0.163 25864	0.816 29362	0.8510 27679	0.6938 49639	0.5305 86507	0.8162 93621	0.6938 49639	0.8162 93621
W SA ₅	0.5305 86507	1.06 118 2	0.17 777	0.2856 98543	0.408 14252	0.693 84964	0.7233 73591	0.8162 93621	0.9387 41276	0.6938 49639	0.9387 41276	0.9387 41276
W SA ₆	0.9387 41276	0.93 874 1	1.02 218 2	0.8162 93621	0.693 84964	1.061 18158	0.2978 55284	0.1632 58642	0.1632 58642	0.6938 49639	0.8162 93621	0.9387 41276
W SA ₇	0.8162 93621	0.81 629 4	1.02 218 2	0.8162 93621	0.693 84964	0.530 58651	0.1702 0545	0.2856 98543	0.2856 98543	0.9387 41276	0.8162 93621	0.5305 86507
W SA ₈	0.4081 42525	0.53 058 7	0.31 109 3	0.1632 58642	0.693 84964	0.816 29362	0.9786 85597	0.9387 41276	0.8162 93621	0.5305 86507	0.6938 49639	0.6938 49639

Table 4: The net flow outranking flow.

Alternatives	Net outranking flow
WSA ₁	-0.09175
WSA ₂	0.198137
WSA ₃	-0.01204
WSA ₄	-0.10338
WSA ₅	-0.03484
WSA ₆	0.070223
WSA ₇	0.022562
WSA ₈	-0.0116

5. Conclusion

It is helpful to visualize the MADM's ambiguity using single-valued neutrosophic sets (SVNSs). In this study, we offer a novel decision-making approach for MADM situations that combines PROMETHEE and SVNSs. A new combined formula is created in the new approach by combining the formulas for calculating inflow and outflow from the PROMETHEE technique with the formula for calculating overall power. You don't have to figure out how far apart each option is or compare any two of them, thus the volume of math you have to complete is drastically cut down. Furthermore, we may improve the reliability of the option ranking by calculating the inflow and outflow employing total dominance and overall inferiority. Decision information is typically muddled in MADM situations because of the uncertainty stemming from the variety of empirical objects and subjective feelings. The N-PROMETHEE method is used to compute the importance of factors and rank the alternatives in water supply.

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