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A DEMATEL Method with Single Valued Neutrosophic Set (SVNS) in Identifying the Key Contribution Factors of Setiu Wetland's Coastal Erosion

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Abstract. This study intends to employ the decision-making trial and evaluation laboratory (DEMATEL) method to identify the influential factors contributed towards coastal erosion. This investigation specifically studies the coastal erosion in Setiu Wetlands coastal areas which located in Terengganu, Malaysia. The single valued neutrosophic set (SVNS) is used into the DEMATEL instead of crisp numbers. Twelve factors of coastal erosion with three dimensions were identified from literature review and consultation with group of experts. By considering the interrelationships among factors, DEMATEL is applied to acquire the importance and cause-effect relationships among the influential factors of coastal erosion. Obtained result reveals that coastal development gives a significant influence in contributing coastal erosion. The result from this study offers an insight for stakeholders to understand cause-effect relationships among coastal erosion factors in which can provide a precautious short or long term strategies.

Keywords: Coastal erosion, DEMATEL, Neutrosophic

INTRODUCTION

A decision-making trial and evaluation laboratory (DEMATEL) method is a well-known method for clarifying the interrelationship among the factors of multi-criteria decision making (MCDM) problem. The main feature of DEMATEL is its ability to provide a cause-effect relationship diagram which splitted factors into either causal or effect group. The DEMATEL method has been applied in various case studies such as in implementation of successful green supply chain management (GSCM) [1], GSCM adoption in a food packaging company [2] and auto components manufacturing sector [3], prioritizing investment projects [4] and many more. The traditional DEMATEL that uses crisp numbers of integer from 0 to 4 cannot handle the fuzziness and uncertainty elements. Therefore, many reseachers have worked on the extended DEMATEL method using fuzzy numbers [5-7]. Although fuzzy numbers are successfully employed in DEMATEL method, they are unable to deal with any indeterminate and inconsistent information that exists in real world. Therefore, Smarandache [8] has proposed the concept of neutrosophic set (NS) to tackle that issue. The neutrosophic set generalizes the concepts of the classic set, fuzzy set (FS), intuitionistic fuzzy set (IFS), interval-valued intuitionistic fuzzy set (IVIFS) and etc. [8]. In the neutrosophic

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set, there are three elements called truth-membership, indeterminacy-membership, and falsity-membership which represented independently. Since each element of NSs are nonstandard unit interval of $]0^-,1^+[$, it is hard to apply to real scientific problems. Therefore, Wang et al. [9-10] introduced two subclass sets of NSs which are single valued neutrosophic set (SVNS) and interval neutrosophic set (INS).

In recent years, the researches on NSs have been developed and were applied to solve various MCDM problems. Das et al. [11] proposed an algorithm approach using neutrosophic soft matrix with employing the combination of the neutrosophic set (NS) and soft set (SS). Ali et al. [12] proposed neutrosophic recommender system based on algebraic neutrosophic measures and applied it for medical diagnosis decision making problem. Besides that, Ye [13] introduced new exponential operational laws of INSs which based on crisp values and the exponents are interval neutrosophic numbers (INNs). Deli et al. [14] introduced bipolar neutrosophic set and a few of its operations. Liu and Luo [15] developed some power aggregation operators on simplified neutrosophic set (SNS). Şahin and Küçük [16] proposed the concept of neutrosophic subsethood based on distance measure for SVNSs.

Neutrosophic sets have been successfully applied and literally enhance the fuzzy theories in overall. To fill the gaps and also to get reap of the capability of neutrosophic set in handling inderminate situations, this paper proposes the single valued neutrosophic sets (SVNSs) into DEMATEL procedure. To demonstrate the applicability of the proposed method, we applied it in coastal erosion problem which is can be considered as an MCDM problem. The rest of the paper is as follows. Second section introduces some basic concepts of neutrosophic set. Third section explains the proposed neutrosophic DEMATEL method. Fourth section provides an illustrative example where the proposed methodology is tested out. Then the last section will be a conclusion.

PRELIMINARIES

In this section, some basic concepts of neutrosophic sets are given.

Definition 1 ([10]) Let X be a space of points (objects) with generic elements in X denoted by x. An SVNS A in X is characterized by truth-membership function $T_A(x)$, indeterminacy-membership function $I_A(x)$, and falsity membership function $F_A(x)$. Then, an SVNS A can be denoted by $A = \{\langle x, T_A(x), I_A(x), F_A(x)\rangle x \in X\}$, where $T_A(x), I_A(x), F_A(x) \in [0,1]$ for each point x in X. Therefore, the sum of $T_A(x), I_A(x)$ and $F_A(x)$ satisfies the condition $0 \le T_A(x) + I_A(x) + F_A(x) \le 3$.

Decision making normally involves human language or commonly referred as linguistic variables. A linguistic variable simply represents words or terms used in human language. Therefore, this linguistic variable approach is a convenient way for decision makers to express their assessments. Ratings of criteria can be expressed by using linguistic variables such as very important (VI), important (I), low important (LI), not important (NI), etc. Linguistic variables can be transformed into SVNSs as shown in the Table 1.

TABLE 1. Linguistic variable and Single Valued Neutrosophic Numbers (SVNNs) [17]

Integer	Linguistic variable	SVNNs
0	No influence/ Not important	$\langle 0.1,0.8,0.9\rangle$
1	Low influence/important	$\langle 0.35,0.6,0.7\rangle$
2	Medium influence/important	$\langle 0.5,0.4,0.45\rangle$
3	High influence/important	$\langle 0.8,0.2,0.15\rangle$
4	Very high influence/important	$\langle 0.9,0.1,0.1\rangle$

The group of decision makers have their own decision weights based on their experience and knowledge in the decision problem. Thus, the weight of each decision maker may not be equal to each other. The weight of each decision maker is considered with linguistic variables and conveyed in SVNNs.

Definition 2 ([17]) Let $E_k = \langle T_k, I_k, F_k \rangle$ be a neutrosophic number defined for the rating of k-th decision maker. Then the weight of the kth decision maker can be written as:

$$\psi_k = \frac{1 - \sqrt{\left\{(1 - T_k(x))^2 + (I_k(x))^2 + (F_k(x))^2\right\}/3}}{\sum_{k=1}^{p}\left(1 - \sqrt{\left\{(1 - T_k(x))^2 + (I_k(x))^2 + (F_k(x))^2\right\}/3}\right)} \tag{1}$$

Further, in achieving a favorable solution, the group decision making is important in any decision making process. In the group decision-making process, all the individual decision maker assessments need to be aggregated to one aggregated neutrosophic decision matrix. This can be done by employing single valued neutrosophic weighted averaging (SVNWA) aggregation operator proposed by Ye [18].

Definition 3 ([18]) Let $D^{(k)} = \left(d_{ij}^{(k)}\right)_{m \times n}$ be the single-valued neutrosophic decision matrix of the k-th decision maker and $\psi = (\psi_1, \psi_2, \ldots, \psi_p)^T$ be the weight vector of decision maker such that each $\psi_k \in [0,1]$. $D = (d_{ij})_{m \times n}$, where

$$\begin{aligned} d_{ij} &= SVNSWA_{\psi}\left(d_{ij}^{(1)}, d_{ij}^{(2)}, \ldots, d_{ij}^{(p)}\right) \\ &= \psi_1 d_{ij}^{(1)} \oplus \psi_2 d_{ij}^{(2)} \oplus \ldots \oplus \psi_p d_{ij}^{(p)} \\ &= \left\langle 1 - \prod_{k=1}^{p}\left(1 - T_{ij}^{(p)}\right)^{\psi_k}, \prod_{k=1}^{p}\left(I_{ij}^{(p)}\right)^{\psi_k}, \prod_{k=1}^{p}\left(F_{ij}^{(p)}\right)^{\psi_k} \right\rangle \end{aligned} \tag{2}$$

Deneutrosophication is the process to obtain a crisp number from neutrosophic number. The definition below is the definition of deneutrosophication.

Definition 4 ([17]) Deneutrosophication of SVNS $\tilde{N}$ can be defined as a process of mapping $\tilde{N}$ into a single crisp output $\psi^* \in X$ i.e., $f : \tilde{N} \to \psi^*$ for $x \in X$. If $\tilde{N}$ is discrete set then the vector of tetrads $\tilde{N} = \left\{ x \mid \langle T_{\tilde{N}}(x), I_{\tilde{N}}(x), F_{\tilde{N}}(x) \rangle \mid x \in X \right\}$ is reduced to a single scalar quantity $\psi^* \in X$ by deneutrosophication. The obtained scalar quantity $\psi^* \in X$ best represents the aggregate distribution of three membership degrees of neutrosophic element $\langle T_{\tilde{N}}(x), I_{\tilde{N}}(x), F_{\tilde{N}}(x) \rangle$.

Therefore, the deneutrosophication can be obtained as follows.

$$\psi^* = 1 - \sqrt{\left\{(1 - T_k(x))^2 + (I_k(x))^2 + (F_k(x))^2\right\}/3} \tag{3}$$

PROPOSED METHOD

In order to obtain the causal interrelationship of the coastal erosion factors, this paper proposes the procedure of Neutrosophic DEMATEL method as follows.

Step 1: Identify the decision goal and find out the factors influencing the goal. A questionnaire assessment is carried out to investigate the interrelationship between factors. Each expert needs to evaluate the direct influence between any two factors by an integer score 0-4 representing ‘‘no influence”, ‘‘low influence”, ‘‘medium influence”, ‘‘high influence”, and “very high influence” respectively.

Step 2: Convert the linguistic evaluations into SVNNs. From the individual crisp 0-4 non-negative integer matrices X^k, the individual decision makers' neutrosophic matrices are constructed according to Table 1. In order to get the initial direct-relation matrix A which is in the form of crisp numbers, the individual decision makers' neutrosophic matrices need to be aggregated and deneutrophied using Eq. (2) and (3) respectively. However, each of decision makers' weights must be identified using Eq. (1).

Step 3: Identify the cause-effect relationships among factors using the DEMATEL method. Based on the aggregated direct relationship matrix obtained in Step 2, the total-relation matrix can be easily calculated using Eqs. (4-5) as below.

$$D = A \times S$$

where
$$S = \frac{1}{\max\limits_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}} \tag{4}$$

$$T = D(I - D)^{-1} \tag{5}$$

where I is the identity matrix.

Then the cause-effect relationship diagram is constructed $(r_i + c_i, r_i - c_i)$.

Step 4: Analyze the cause-effect relationship diagram. The $(r_i - c_i)$ indicates the importance of each factors while $(r_i - c_i)$ is the net cause or effect group. Generally, when the $(r_i - c_i)$ axis is positive, the factor belongs to the cause group. Otherwise, the factor belongs to the effect group if the $(r_i - c_i)$ axis is negative.

ILLUSTRATIVE EXAMPLE

The factors of coastal erosion are adapted from Luo et al. [19] and finalized by the group of experts. There are three dimensions which are Natural factors (D1), Man-made factors (D2) and Socio-economic factors (D3). The finalized twelve factors of coastal erosion are hydrodynamic wave and current(C1), imbalance sediment supply (C2), storm surge (C3), tidal range (C4), global warming (C5), bottom beach profile and shoreline instability (C6), sea level rise (C7), sand mining activities (C8), coastal development (C9), coastal protection (C10), budgetary revenue (C11) and coastal zone management and policy (C12). There are three decision makers involve in providing the evaluation; DM1,DM2 and DM3. They were asked to choose an integer from 0 to 4 that represent the degree of influence of one factor towards another factor. The obtained data is analysed using the DEMATEL method. First, all individual decision makers' evaluation matrices are constructed. For instance, the X^1 matrix below is the DM1's evaluation matrix.

$$X^1 = \begin{pmatrix} 0 & 4 & 3 & 0 & 1 & 4 & 2 & 2 & 1 & 4 & 4 & 4 \\ 1 & 0 & 1 & 0 & 3 & 4 & 3 & 1 & 4 & 4 & 4 & 4 \\ 3 & 3 & 0 & 0 & 3 & 3 & 3 & 3 & 4 & 4 & 3 & 4 \\ 1 & 3 & 4 & 0 & 2 & 4 & 3 & 3 & 4 & 3 & 4 & 3 \\ 3 & 4 & 4 & 4 & 0 & 3 & 4 & 3 & 4 & 4 & 4 & 4 \\ 2 & 4 & 2 & 2 & 3 & 0 & 1 & 4 & 2 & 4 & 3 & 3 \\ 4 & 3 & 4 & 2 & 4 & 4 & 0 & 3 & 4 & 4 & 4 & 4 \\ 1 & 4 & 3 & 1 & 3 & 4 & 2 & 0 & 4 & 3 & 4 & 4 \\ 4 & 4 & 4 & 1 & 2 & 4 & 4 & 3 & 0 & 4 & 4 & 4 \\ 4 & 4 & 2 & 2 & 2 & 4 & 4 & 2 & 3 & 0 & 4 & 2 \\ 3 & 4 & 2 & 1 & 2 & 2 & 4 & 3 & 4 & 4 & 0 & 4 \\ 2 & 4 & 1 & 0 & 1 & 3 & 3 & 4 & 4 & 4 & 4 & 0 \end{pmatrix}$$

The individual decision makers' matrices which are in 0 to 4 crisp numbers are converted to SVNNs as Table 1. The step is omitted due to page limitation. Then,compute the initial direct-relation matrix A based on Eq. (2).

$$
A = \begin{bmatrix}
0.000 & 0.854 & 0.678 & 0.672 & 0.407 & 0.875 & 0.648 & 0.468 & 0.597 & 0.800 & 0.817 & 0.799 \\
0.632 & 0.000 & 0.390 & 0.516 & 0.621 & 0.854 & 0.729 & 0.566 & 0.800 & 0.817 & 0.854 & 0.817 \\
0.815 & 0.815 & 0.000 & 0.672 & 0.621 & 0.842 & 0.748 & 0.621 & 0.796 & 0.854 & 0.743 & 0.854 \\
0.706 & 0.770 & 0.875 & 0.000 & 0.433 & 0.875 & 0.815 & 0.748 & 0.766 & 0.815 & 0.817 & 0.815 \\
0.842 & 0.800 & 0.884 & 0.854 & 0.000 & 0.815 & 0.900 & 0.648 & 0.854 & 0.800 & 0.817 & 0.817 \\
0.743 & 0.817 & 0.505 & 0.678 & 0.566 & 0.000 & 0.566 & 0.817 & 0.743 & 0.854 & 0.815 & 0.770 \\
0.817 & 0.748 & 0.817 & 0.743 & 0.784 & 0.817 & 0.000 & 0.748 & 0.854 & 0.854 & 0.817 & 0.854 \\
0.632 & 0.854 & 0.748 & 0.632 & 0.770 & 0.854 & 0.743 & 0.000 & 0.800 & 0.770 & 0.854 & 0.796 \\
0.854 & 0.884 & 0.828 & 0.597 & 0.648 & 0.800 & 0.800 & 0.770 & 0.000 & 0.817 & 0.800 & 0.744 \\
0.800 & 0.854 & 0.468 & 0.648 & 0.648 & 0.817 & 0.800 & 0.468 & 0.729 & 0.000 & 0.817 & 0.483 \\
0.632 & 0.706 & 0.483 & 0.339 & 0.433 & 0.589 & 0.677 & 0.748 & 0.817 & 0.817 & 0.000 & 0.854 \\
0.433 & 0.766 & 0.221 & 0.221 & 0.349 & 0.597 & 0.566 & 0.800 & 0.817 & 0.875 & 0.854 & 0.000
\end{bmatrix}
$$

The importance of three decision makers may not be equal to each other according their experience in coastal erosion. Their decision commands are considered as linguistic variables expressed in Table 1. The importance of each decision maker expressed by linguistic variable with its corresponding SVNN is shown in Table 2.

TABLE 2. Importance of decision makers with SVNNs

	DM1	**DM2**	**DM3**
Linguistic variable	High Important	Medium Important	High Important
Weight in SVNN	$\langle 0.8,0.2,0.15\rangle$	$\langle 0.5,0.4,0.45\rangle$	$\langle 0.8,0.2,0.15\rangle$

The decision makers' weight is determined using Eq. (1) and shown as below.

$$
\psi_1 = \frac{1-\sqrt{\left\{(1-0.8)^2+(0.2)^2+(0.15)^2\right\}/3}}{\left(3-\sqrt{0.1025/3}-\sqrt{0.6125/3}-\sqrt{0.1025/3}\right)}
$$
$$
= 0.3742
$$

Similarly, we can obtain the other decision makers' weights as above. Thus the weights of all three decision makers are as follows.

$$
\psi = (0.3742, 0.2516, 0.3742)
$$

Refer the initial direct-relation matrix *A* above, the element a_{12} can be computed using SVNSWA aggregation operator Eq. (2) with the obtained decision makers' weights and the deneutrosophic formula in Eq. (3).

$$
\left\langle 1-\left((0.9)^{0.3742}\otimes(0.8)^{0.2516}\otimes(0.8)^{0.3742}\right),\left((0.1)^{0.3742}\otimes(0.2)^{0.2516}\otimes(0.2)^{0.3742}\right),\left((0.1)^{0.3742}\otimes(0.15)^{0.2516}\otimes(0.15)^{0.3742}\right)\right\rangle
$$
$$
=\langle 0.846,0.154,0.129\rangle
$$
$$
a_{12} = 1-\sqrt{\left\{(1-0.846)^2+(0.154)^2+(0.129)^2\right\}/3}
$$
$$
a_{12} = 0.854
$$

Next is to calculate the normalized initial direct-relation matrix *D* by Eq. (4), depicted below:

$$D = \begin{bmatrix} 0.000 & 0.095 & 0.075 & 0.074 & 0.045 & 0.097 & 0.072 & 0.052 & 0.066 & 0.089 & 0.090 & 0.089 \\ 0.070 & 0.000 & 0.043 & 0.057 & 0.069 & 0.095 & 0.081 & 0.063 & 0.089 & 0.090 & 0.095 & 0.090 \\ 0.090 & 0.090 & 0.000 & 0.074 & 0.069 & 0.093 & 0.083 & 0.069 & 0.088 & 0.095 & 0.082 & 0.095 \\ 0.078 & 0.085 & 0.097 & 0.000 & 0.048 & 0.097 & 0.090 & 0.083 & 0.085 & 0.090 & 0.090 & 0.090 \\ 0.093 & 0.089 & 0.098 & 0.095 & 0.000 & 0.090 & 0.100 & 0.072 & 0.095 & 0.089 & 0.090 & 0.090 \\ 0.082 & 0.090 & 0.056 & 0.075 & 0.063 & 0.000 & 0.063 & 0.090 & 0.082 & 0.095 & 0.090 & 0.085 \\ 0.090 & 0.083 & 0.090 & 0.082 & 0.087 & 0.090 & 0.000 & 0.083 & 0.095 & 0.095 & 0.090 & 0.095 \\ 0.070 & 0.095 & 0.083 & 0.070 & 0.085 & 0.095 & 0.082 & 0.000 & 0.089 & 0.085 & 0.095 & 0.088 \\ 0.095 & 0.098 & 0.092 & 0.066 & 0.072 & 0.089 & 0.089 & 0.085 & 0.000 & 0.090 & 0.089 & 0.082 \\ 0.089 & 0.095 & 0.052 & 0.072 & 0.072 & 0.090 & 0.089 & 0.052 & 0.081 & 0.000 & 0.090 & 0.053 \\ 0.070 & 0.078 & 0.053 & 0.038 & 0.048 & 0.065 & 0.075 & 0.083 & 0.090 & 0.090 & 0.000 & 0.095 \\ 0.048 & 0.085 & 0.024 & 0.024 & 0.039 & 0.066 & 0.063 & 0.089 & 0.090 & 0.097 & 0.095 & 0.000 \end{bmatrix}$$

Then, the total direct-relation matrix T below can be computed by Eq. (5) and with the help of Maple software.

$$T = \begin{bmatrix} 0.510 & 0.657 & 0.509 & 0.493 & 0.457 & 0.648 & 0.582 & 0.534 & 0.614 & 0.665 & 0.662 & 0.633 \\ 0.577 & 0.572 & 0.483 & 0.479 & 0.480 & 0.647 & 0.591 & 0.545 & 0.636 & 0.667 & 0.667 & 0.635 \\ 0.644 & 0.710 & 0.484 & 0.536 & 0.520 & 0.700 & 0.643 & 0.596 & 0.688 & 0.728 & 0.712 & 0.693 \\ 0.637 & 0.709 & 0.575 & 0.469 & 0.505 & 0.707 & 0.652 & 0.611 & 0.689 & 0.727 & 0.722 & 0.692 \\ 0.691 & 0.758 & 0.613 & 0.591 & 0.491 & 0.746 & 0.703 & 0.641 & 0.742 & 0.773 & 0.769 & 0.737 \\ 0.603 & 0.673 & 0.509 & 0.509 & 0.488 & 0.579 & 0.593 & 0.583 & 0.647 & 0.690 & 0.682 & 0.649 \\ 0.675 & 0.737 & 0.594 & 0.569 & 0.560 & 0.731 & 0.598 & 0.637 & 0.727 & 0.763 & 0.754 & 0.726 \\ 0.634 & 0.722 & 0.567 & 0.538 & 0.540 & 0.709 & 0.650 & 0.538 & 0.697 & 0.727 & 0.731 & 0.695 \\ 0.660 & 0.730 & 0.579 & 0.539 & 0.533 & 0.710 & 0.661 & 0.621 & 0.620 & 0.738 & 0.732 & 0.695 \\ 0.594 & 0.658 & 0.492 & 0.493 & 0.482 & 0.643 & 0.598 & 0.534 & 0.628 & 0.584 & 0.662 & 0.604 \\ 0.544 & 0.608 & 0.463 & 0.435 & 0.435 & 0.585 & 0.553 & 0.530 & 0.601 & 0.630 & 0.543 & 0.604 \\ 0.487 & 0.571 & 0.404 & 0.391 & 0.397 & 0.544 & 0.504 & 0.499 & 0.560 & 0.592 & 0.587 & 0.475 \end{bmatrix}$$

Table 3 below expressed the direct and indirect effects of twelve sub-factors.

TABLE 3. The prominence and relation axis for cause and effect group.

Sub-factors	r_i	c_i	$r_i + c_i$	$r_i - c_i$
C1: Hydrodynamic wave and current	6.964	7.256	14.22	-0.292
C2: Imbalance sediment supply	6.979	8.105	15.084	-1.126
C3: Storm surge	7.654	6.272	13.926	1.382
C4: Tidal range	7.695	6.042	13.737	1.653
C5: Global warming	8.255	5.888	14.143	2.367
C6: Bottom beach profile and shoreline instability	7.205	7.949	15.154	-0.744
C7: Sea level rise	8.071	7.328	15.399	0.743
C8: Sand mining activities	7.748	6.869	14.617	0.879
C9: Coastal development	7.818	7.849	15.667	-0.031
C10: Coastal protection	6.972	8.284	15.256	-1.312
C11: Budgetary revenue	6.531	8.223	14.754	-1.692
C12: Coastal zone management and policy	6.011	7.838	13.849	-1.827

The obtained results is used to get the causal diagram which is plotted. The digraph of these twelve sub-factors is depicted in Fig. 1.

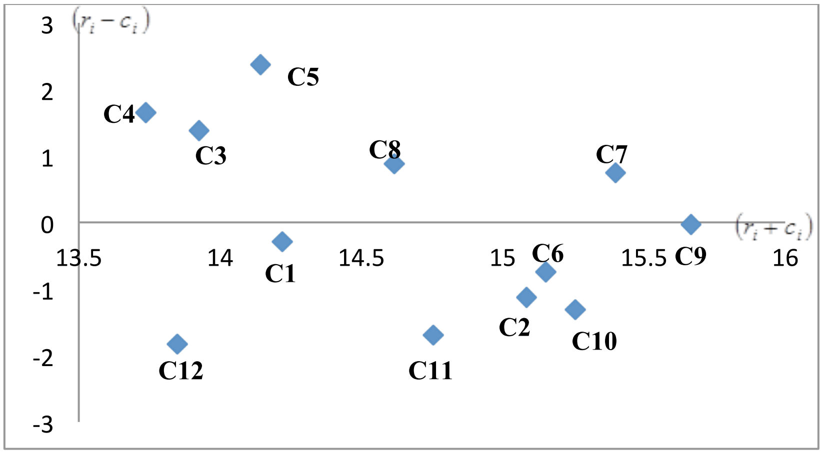

FIGURE 1. Causal effect diagram.

Based on Table 3, the importance of the twelve sub-factors can be prioritized as C9 > C7 > C10 > C6 > C2 > C11 > C8 > C1 > C5 > C3 > C12 > C4 based on $(r_i + c_i)$ values, where the coastal development is the most important sub-factors with the value of 15.667, while tidal range is the least important criterion with the value of 13.737. In contrast to the importance, storm surge (C3), tidal range (C4), global warming (C5), sea level rise (C7) and sand mining activities (C8) are net causes, whereas hydrodynamic wave and current(C1), imbalance sediment supply (C2), bottom beach profile and shoreline instability (C6), coastal development (C9), coastal protection(C10), budgetary revenue (C11) and coastal zone management and policy (C12) are net receivers based on $(r_i - c_i)$ values. Causal diagram in Fig. 1 shows that global warming (C5) is the most influential sub-factors.

In summary, we should pay much attention to cause group rather than receivers. Amongst all the factors in cause group, global warming (C5) has the highest $(r_i - c_i)$ value with 2.367 which means, C5 tends to give more impact on the whole system of coastal erosion. However, the importance of global warming are rank at ninth which could argue the fact that C5 has a great effect on the system.

In contrast, coastal development (C9) is the most important factor and mutually affects C1, C2, C6, C7, C8 and C10. This indicates that coastal development is far more important factor in coastal erosion. Though, coastal development is slightly in the effect group, but it is the most important factor. Therefore, coastal development activities must be reduced and the authority should monitor the effect of existing development along coastline as it could increase the risk of coastal erosion.

CONCLUSION

This paper has proposed a neutrosophic DEMATEL method. The proposed method has been applied to develop the cause-effect relationship among factors of coastal erosion. This proposed method has successfully adapted DEMATEL in indeterminate situation by applying linguistic variables and a neutrosophic aggregation operator. This proposed method successfully determined the importance of each factors.Furthermore, the proposed method also establish the causal and effect relationships among 12 factors. Thus, a set of 12 complex influencing factors are divided into a cause group and an effect group, and a visible cause-effect relationship diagram is constructed. In particular, on the basis of cause-effect relationship diagram, five factors (C3, C4, C5, C7 and C8) are important in coastal erosion system. It is therefore suggested that, the local authority could apply any appropriate mitigation approach in minimising the effect of coastal erosion.

The procedure presented in this paper provides a relevant model to identify critical factors among various influencing elements. This proposed Neutrosophic DEMATEL method can be also used in the field of supplier selection, manufacturing, organization management, information system and social science. Besides, it is applicable to all systems with similar profile where segmenting indeterminate factors is required.

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