A SOFT SET THEORETIC APPROACH FOR SHELTER ASSESSMENT IN HUMANITARIAN RELIEF

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Abstract - World population has witnessed an increasing trend and serious consequencesof natural disasters in recent decades. A large-scale disaster renders a remarkable number of people homeless by destroying buildings and other infrastructure. Temporary shelters constitute a crucial step of recovery and reconstruction in the aftermath of a disaster. Shelter sites are vital for an effective relief and must be strategically planned. Their importance stems from the role they playinincubating people through provision of a safe and habitable environment till the outcomes of disaster are being remedied. Communities living in disaster-prone areas should prepare themselves well in advance for any future catastrophic event. Shelter site planning decisions involve multiple actors and criteria, making themessentially humanistic and thus subjective in nature. This study adopts an approach based on soft set theory to support shelter site planning, owing to its effectiveness and vast applicability in vague and imprecise situations. An illustrative caseis used to demonstrate applicability of soft set theory in disaster relief planning.

Keywords - Decision support; Humanitarian relief; Site planning; Soft set

I. INTRODUCTION

Disaster risk management literature quotes resilience as the capacity of a society to "bounce back", resist, cope and recover quickly from the impacts of hazards (Bruneauet al., 2003; Klein et al., 2003; Timmerman, 1981). A crucial aspect of resilience lacking emphasis in contemporary disaster resilience conceptualisation is focus on preparedness (Aldunceet al., 2014). Social systems should have sufficient capacity to prepare in order to mitigate and minimise losses, suffering and social disruption (Bruneauet al., 2003; IPCC, 2012). Better planning and implementation is required at all levels to efficiently deal with the effects of a disaster (Trivedi et al., 2015).

Natural disasters like earthquakes, hurricanes, etc. result in vast devastation leading to destruction of physical infrastructure. The first step towards recovery is to ensure evacuation of population to safe displacement sites. Shelters provide immediate accommodation; medical care and food to affected people (Bayramet al., 2015) andtheir locations must be strategically planned for an efficient disaster response. They should be located at a safe distance from threat zones, and people should have easy access to essential service facilities (Kılcı et al., 2015). Disaster preparedness and response involvesmultiple actors from diverse set of purposes, interests, expertise, and logistics capacities (Balciket al., 2010). Key players involved in a humanitarian aid effort are donors, governments, the military, aid agencies, private firms, non-governmental organizations (NGOs), and logistics service firms (Kovacs &Spens, 2007).

Therefore, there is a need of an effective coordination and collaboration among the players involved. The decisions of shelter site assessment involve a number of criteria. The Sphere handbook (Sphere project, 2011) highlights some of the key considerations while selecting areas for temporary shelters. They include safety from threat zones; access toclean drinking water; good drainage system; health facilities; schools; safe and clear routes to essential service facilities;state ownership of land; terrain favourability;presence of trees; occupational access, etc.Site planning decisions involve multiple actors, all having their own set of preferences for site assessment. Such problems are humanistic and thus subjective in nature, requiring human understanding and vision systems. Furthermore, criteria also have high degree of subjectivity and uncertainty associated with them. In order to assess large number of candidate sites and arrive at a list of a few suitable ones, this study adopts soft sets theory and uni-int decision making method. Motivation for using soft sets stemmed from its effectiveness and vast applicability in vague and imprecise situations.

II. METHODOLOGY

A soft theory is a new mathematical tool proposed by Molodtsov (1999) for dealing with uncertainties related to vague decisions.

For U referring to initial universe, E as a set of parameters, $P(U)$ as the poer set of U, and $A \subseteq E$,

A soft set $F_A$on the universe $U$is defined by the set of ordered pairs

$$F_A = \{(x, f_A(x)) : x \in E, f_A(x) \in P(U)\},$$

Where $f_A : E \to P(U)$ such that $f_A(x) = \emptyset$ if $x \notin A$.

$f_A$is approximate function of F_A.

In a uni-intdecision making method, a set is reduced to its subset according to parameters of decision makers (Çağman&Enginoğlu, 2010).

Let $f_A \wedge f_B \in \wedge(U)$. The uni-intoperators for $\wedge -$products, denoted by $uni_x int_y$ and $uni_y int_x$ are defined as,

$$uni_x int_y(f_A \wedge f_B) = \cup_{x \in A} (\cap_{y \in B} (f_{A \wedge B}(x, y))), \quad (1)$$

$$uni_y int_x(f_A \wedge f_B) = \cup_{y \in B} (\cap_{x \in A} (f_{A \wedge B}(x, y))), \quad (2)$$

$$uni - int(f_A \wedge f_B) = uni_x int_y(f_A \wedge f_B) \cup uni_y int_x(f_A \wedge f_B) \quad (3)$$

For a group decision making situation with N soft sets, the equation can be extended as

$$uni - int(f_A \wedge f_B \wedge \ldots \wedge f_N) = \cup_{i,j=A}^{N} \left(uni_i int_j(f_i \wedge f_j) \cup uni_j int_i(f_i \wedge f_j) \right) \quad (4)$$

The decision making methodology of soft set theory and uni-intdecision making is applied to a case study based on Nepal. Territory of Nepal lies in high seismic hazard zone and is therefore vulnerable to destructive earthquakes. Site planning includes land suitability assessment for development of safe temporary displacement sites. Furthermore, sites are assessed and developed in accordance with universal minimum standards in life-saving areas of humanitarian response. The participants of study include officials from disaster management authority, NGOs, forest officials, etc. A structured questionnaire is administered to obtain and record responses of decision makers.

CONCLUSION

The presentstudy contributes by exploring the applicability of soft set theory and uni-int method for providing group decision support in the emergency shelter site selection problem.It may also contribute by establishing the approach as a vital planning tool that would enhance location planning decision capability of humanitarian relief system soon after a disaster strikes.

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