A Study on the Spatial Analysis Model to Decide Medical Institutions/Mental Health Centers for Disaster Victims

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***Abstract*— The National Emergency Management Agency of South Korea has established a Disaster Victims Psychology Support Center. The Disaster Victims Psychology Support Center can enable victims who got psychological damage from disasters to return to their daily lives through healing activity, field visits and advice of experts. The previous Psychology Support Center System managed the information of disaster victims through an independent database. However, this paper proposes a system that is developed to identify medical institutions and mental health centers within a distance of radius, based on the potential Hot-Spot areas of disaster victims using the GIS Systems. The proposed system can efficiently support selection of appropriate institutions for disaster victims using their location and age, classification of damage, and damaged parts of the body. Also, this spatial analysis can assist to decide on a policy based on the location of disaster victims and the extent of damage. Therefore, this paper can provide the required information to support decision making based on the concentrated areas for disaster victims.**

***Index Terms*— Disaster Victims Psychology Support Centers, Geographic Information Systems, Spatial Analysis, Hop Spot Analysis.**

I. INTRODUCTION

CURRENTLY, society is experiencing an increase in natural disasters such as typhoons, floods, and landslides due to global warming, as well as artificial disasters such as terrorism and explosions. Therefore, there are an increasing number of victims of natural disasters. The damage suffered by disaster victims can be divided into primary damage, such as physical harm, and secondary damage such as psychosocial harm which can result in social maladjustment and schizophrenia. Commonly, secondary damage results in more ongoing social problems than primary damage. Recently, attention to secondary damage has been growing in South Korea, thus the government organization has established the Disaster Victims Psychology Support Centers to heal secondary damage in advanced countries. The National Emergency Management Agency of South Korea is operating the Disaster Victims Psychology Support Center with the cooperation of subsidiary organizations/allied society, and the support of medical institutions, local schools and guides. However, the Disaster Victims Psychology Support Center in South Korea is currently unable to provide effective services to disaster victims because of an ineffective system[1]. So, the development of a support system for improvement and management of disaster victims Psychology service delivery system must be considered. And be adducing necessity about development of disaster slogan system[2], the administrator is also adducing the necessity of database sharing and system construction for integrated management of disaster victims[3]. In relation to psychology support in a foreign country, in the international public network program, the United States of America is operating emotional health management programs and crisis counseling support programs in the Emotional Health Center[4]. Currently, the support system is continuing in a direction that considers the position of disaster for effective management of disaster victims based on Geographical Information Systems[5]. Furthermore, related institutions are supervising statistical information - that is the number of injured, and the damage rate of each area because there are not spatial properties in statistical materials of previous Psychology Support Centers.

Therefore, this paper proposes a spatial analysis model of disasters and victims using a spatial database based on GIS to provide decision making for system administrators [6]. This study considers expeditious connections to medical institutions and mental health centers of hot spot areas for psychotherapy and damage treatment. Therefore, this paper also outlines a Buffer Analysis function for analysis of medical institutions and mental health centers within the radius scope, based on hot spot areas of disaster victims.

II. RELATED WORKS

Recently, the importance of Geographical Information Systems has been growing, and spatial statistics analysis has been executed using spatial properties based on GIS. System administrators can determine new results via spatial statistics analysis because spatial properties are

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included in previous general statistics for management of disaster victims. This paper constructs an integrated prototype system and service for psychology support based on spatial information using properties and location data of disaster victims, damage information, related institution for effective management and analysis of disaster victims[7]. A map system has been designed based on the pattern of crime distribution using visual spatial analysis that considers previous spatial distribution and optical properties of hot spot analysis[8]. Comparison, analysis, and interaction through spatial autocorrelation analysis are one of GIS spatial statistics analysis functions .The distribution throughout the city has also been studied[9].

We have studied the distance of medical institutions and the users' residential district, as well as the accessibility to medical institution using GIS. It has been used to analyze opportunity and equality based on the location of the medical institutions that have better awareness, such as hospitals in the capital areas[10]. The relationship between hospitals and the number of patients based on spatial location of the area using GIS type methodology has also been analyzed[11]. Furthermore, we studied a way to connect ITS systems with GIS technique and established a strategy that can have prompt and effective patient transmission when an emergency disaster situation occurs[12].

In foreign countries, there is model of FEMA/CMHS crisis counseling which is the current Psychology Support program being used in the United States for the administration of disaster victims. The disaster map system is constructed in the FEMA. This system provides past disaster area announcements, recent disaster area announcements, disasters history information and so on. This system provides disaster map services using the Web for disaster victims to manage past and present disaster information [13]. Spatial statistics analysis based on GIS have been extensively used in foreign countries, which highlights the results of crime patterns and records the spatial and time elements in the city on a map[14]. Furthermore, the Kernel Density Analysis with three-dimensional maps is being used to analyze the Time-Space pattern of Cluster/Hot spots of criminal areas in the city[15].

III. SYSTEM ARCHITECTURE

The paper retrieves medical institutions and mental health centers within a radius based on Hot-Spot areas of disaster victims. This paper proposes a model to connect the appropriate institutions to disaster victims who are in the neighborhoods of Hot-Spot areas. The paper uses Disaster Victims Psychology Support Center for effective management and analysis of disaster victims. An integrated management system for disaster victims has been constructed based on previous spatial databases. The databases consist of damage information, data for management of victims, medical institutions, and mental health centers, data for search of positional information of institutions, statistical data of disaster/victims for spatial statistics analysis based on GIS[7]. There is a module for analysis of concentrated areas of disaster victims through data collection, customized information services for disaster victims, analysis of advice from experts, spatial statistics analysis and a module of a search system that provides statistical reports. The Disaster Victim Psychology Support Center manages statistical data of disasters and victims based on GIS, and analyze Hot-Spot areas that are concentrated areas of disaster victims using tools for spatial statistics analysis[6].

The paper proposes system architecture to select medical institutions and mental health centers for disaster victims using input data, based on the results of Hot- Spot analysis. Fig 1 highlights the system structure of the proposed model.

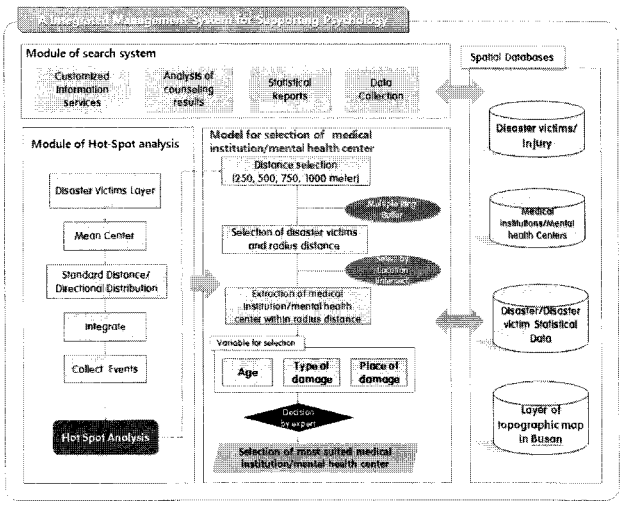

Fig. 1. Procedure of module for analysis of medical institution/mental health centers around Hot Spot areas.

This paper also presents a Multiple Ring Buffer analysis that has wide radius values for finding medical institutions/mental health centers around Hot Spot areas of disaster victims. The Multiple Ring Buffer function can set up a number of buffers. First, the system assigns four values of radius, and executes buffering analysis around Hot-Spot areas based on radius of distance. It also selects the distance of radius to connect appropriate medical institutions and mental health centers based on the disaster victims within the buffering area. For example, this system has a procedure for analysis that can count the number of institutions within a 500 meter radius from the position of the disaster victims. The system executes a Select by Location analysis function and an Intersect option function after the selection of disaster victims and distance. Administrators can easily assure the results

about analysis without system's help because number of data for analysis is a little. However, it is a difficult for administrators to select available medical centers if there are lots of extracted points of interest.

The paper presents an Intersect option in Select by Location analysis for the selection of a position within the radius automatically. Then, the some medical institutions and mental health centers within that radius are extracted.

However, this procedure has limitation to connect customized medical institutions and mental health centers to disaster victims using positional elements because appropriate institutions may vary according to the circumstances of the disaster victims. Therefore, this paper selected three important variables in order to connect appropriate institutions to disaster victims. The variables are age of the victims, classification of damage and position of damage. First, high priority is assigned for older victims. Secondly, classification of damage can be decided according to the cause and situation of damage. Finally, the position of damage must be defined because the required treatment may vary according to the position of damage. Thus, the system identifies the appropriate institutions through the buffering and the intersect analysis, with selection variables based on the condition of the victims. The system can also select the most suitable medical institutions and mental health centers for victims based on the judgment of experts. Primary analysis can extract suitable medical institutions and mental health centers within Hot-Spot areas of disaster victims via positional elements. Secondary analysis is also used to connect medical institutions and mental health centers to victims in relation to the extent of damage. The system can connect appropriate medical institutions and mental health centers to victims via selection variables and positional analysis that considers the condition of the victims.

IV. ANALYSIS RESULTS

1) Model builder for a buffer analysis

This paper presents Multiple Ring Buffer analysis using analysis tools inside ArcMap 9.3 of ESRI to search medical institutions/mental health centers around hot spot areas of disaster victims. Fig 2 highlights the process for a model builder for the Multiple Ring Buffer analysis. Fig 2 is a general procedure in Hot-Spot analysis module of the integrated management system for disaster victims. This procedure analyzed dense areas of disaster victims via Mean Center analysis for selection of a center in the areas, Directional Distribution analysis to identify disaster patterns, Standard Distance for analysis of standard deviation, Collect Event analysis prior to Hot-spot analysis using layer files of disaster victims. The next step is to analyze Multiple Ring Buffer using Hot-Spot layer files of disaster victims. Finally, the system executes Mean Center analysis to find a center position of Hot-Spot areas using a Hot-Spot layer files.

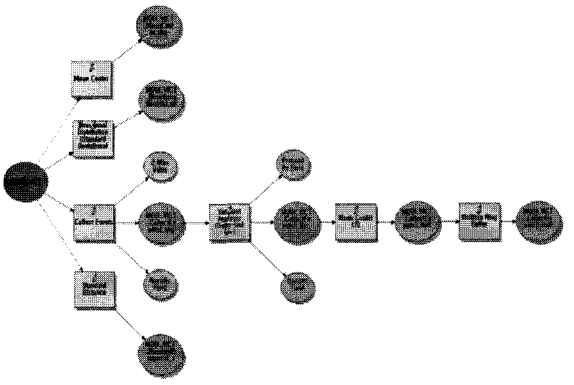

Fig .2. A Model Builder of Multiple Ring Buffer Analysis.

The system sets up a distance of radius based on Hot-Spot areas and then executes Multiple Ring Buffer analysis via the results of Mean Center analysis. The system administrators can identify medical institutions and mental health centers within the scope of radius via this procedure.

2) Result of model builder analysis

Results of buffering analysis around Hot-Spot areas of disaster victims are the same as Multiple Ring Buffer Map in Fig 3. Fig 3 shows Multiple Ring Buffer from a center of the Hot-Spot area.

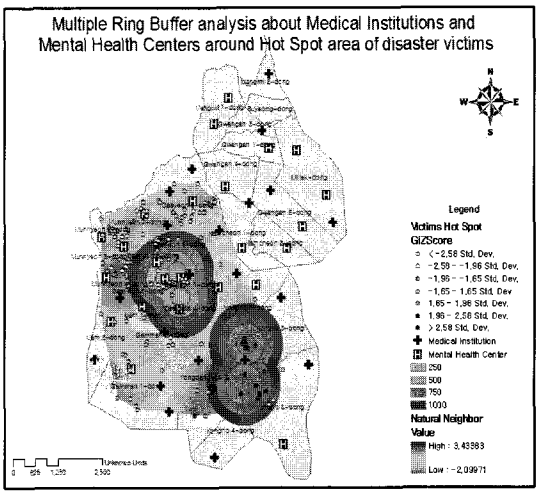

Fig .3. Result of Multiple Ring Buffer Analysis.

System administrators can distinguish positional information and detailed information in regards to medical institutions and mental health centers within the radius of Hot-Spot areas through the results of the buffering analysis. The administrators can also connect the most institutions located appropriately for disaster victims. This system is able to select the best suitable institution for disaster victims because the analysis considers both the condition of the victims and the positional information. If new medical institutions are established in future, this system can assist system

administrators to decide efficient policies. This system has different types of ways to connect institutions for victims using a list of general data such as previous psychology support systems, as well as information provided on a map. This system can also provide effective information for disaster victims due to the fact that the location and detailed information are provided at the same time. Fig 3 highlights the results of Multiple Ring Buffer analysis based on the Yongho-dong area and the Daeyeon-dong area that have a high rate of Hot-Spots.

The results of analysis of medical institutions/mental health centers using a radius of 250, 500, 700, and 1000 meters. Administrators can easily check the results of the analysis because institutions are not large in number. However, this paper aims to provide a framework that can automatically locate institutions around Hot-Spot areas because the number of medical institutions will increase later. Therefore, this paper uses the Select by Location function to extract automatically information within the radius using buffering. The Intersect option which is one of the Select by Location function can extract goal points within the radius. Fig 4 highlights the results of Intersect analysis using medical institutions and mental health centers that are included within the polygon of 0~250 meters in table of Multi Ring Buffer analysis.

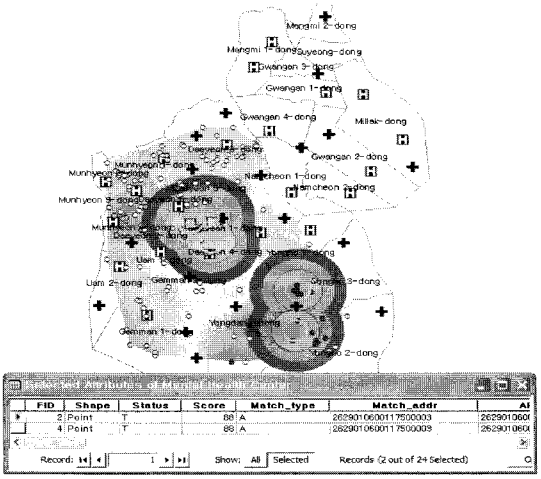

Fig .4. Intersect Results of Select by Location Analysis.

The paper verified the mental health centers of each defined area. The results of anlysis within polygon of buffer is as shown in table 1.

TABLE I
RESULT OF MULTIPLE RING BUFFER AND INTERSECT FUNCTION

(Unit : Meter)

Distance	Medical Institution	Mental Health Center
0-250	0	2
250-500	5	2
500-750	0	0
750-1000	1	1

System administrators can connect most approximal medical institution and mental health center to Hot-Spot areas of disaster victims via result of analysis. The number of medical institutions and mental health centers in Yongho-dong are deficient. And level of Hot-Spot is high. A System administrator can assist decision making support such as policies decisions when they establish a new medical institution. Finally, the system can support customized connections based on the victims opinion with detailed information of institutions.

V. CONCLUSIONS

This paper presented the Multiple Ring Buffer spatial analysis to search for medical institutions and mental health centers around dense areas of disaster victims using previous spatial databases with Disaster Victims Psychology Support Centers. The target area for the hot spot analysis is the Nam-gu district in Busan of South Korea. The result of hot spot analysis is to show the district Daeyeon-1 dong, Daeyeon-2 dong, Daeyeon-4 dong, Daeyeon-5 dong, Daeyeon-6 dong, Yongho-1 dong and Yongho-4 dong. This paper used distance of 250, 500, 750, and 1000 and then executed Multiple Ring Buffer analysis in the Yongho-dong and Daeyeon-dong area.

The number of institutions within the radius scope is five medical institutions and two mental health centers in case the distance value is from 500 to 250 meters, but there are no medical institutions or mental health centers in case the distance value is from 750 to 500 meters. There is one medical institution and one mental health center in case the distance value is from 1000 to 750 meters. The medical institutions and mental health centers are evenly distributed in Daeyeon-dong area within high hot spot levels via the results of Multiple Ring Buffer analysis. However, the number of medical institutions and mental health centers in Yongho-dong is high. Also, the system presented in this paper can connect appropriate medical institutions and mental health centers to disaster victims via damage information, location information, and intention reflection from victims.

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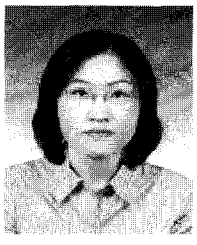

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