

# A STUDY OF THE THEORY AND MODELING OF BATTLEFIELD ENVIRONMENT ANALYSIS BASED ON GEOGRAPHIC INFORMATION

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**ABSTRACT:**

Battlefield environment is the basement of the military action. It is very significant for commanders to considerate and make full use of it in decision-making. New requirement has been put forward, the extent has been widened, the degree has been deepened, and the time has been reduced, in order to have deeper research the battlefield in modern war than before, gradually the quantitative analysis has being replaced by qualitative analysis. In theoretical researching, former scholar brought forward certain analysis points, conception models and Application value, however, there is no relatively mature theoretical system in modeling, quantitative expression and indicator building, nor relative application products to study, the paper is based on the situation. Beginning with study of battlefield environment, the paper makes Hypotheses and simplicity to the factors of combat environment, works with analytic methods and tools such as computing and mathematical modeling, produces several quaintly models and methods for commander to make decision through battlefield environment analysis.

## 1. PREFERENCE

The software components exploitation of a battlefield environmental analysis aid decision supporting subsystem is base upon MGIS-II .According to the projection's realizing mode, the software adopts component Open-end Mode based On MGIS-II to proceed the second component exploitation. Each functional module ultimately accomplished with dynamic library mode is transplanted in fundamental geographical information platform. Its primary function includes Campaign Assembly Region analysis, Campaign Channel analysis and Campaign Battlefield Capacity analysis based on fundamental geographical information platform .It also offers the visualization output of thematic map as well as the output of holistic approach report template.

Find the considerate set: figure out m ……:

$$V = \{v_1, v_2 \dots, v_m\} \tag{2}$$

Where  $V =$  evaluation set  
 $u_i =$  each evaluation

Single factor consideration: every  $u_i$  in  $U$  have a …… on  $V$ , This is the subset,

$$\tilde{f} : U \rightarrow F(V) \tag{3}$$

$$u_i \mapsto \tilde{f}(u_i) = (r_{i_1}, r_{i_2} \dots r_{i_m}) \\ = \frac{r_{i_1}}{v_1} + \frac{r_{i_2}}{v_2} + \dots + \frac{r_{i_m}}{v_m} \tag{4}$$

## 2. BATTLEFIELD ENVIRONMENT FUZZY SYNTHETIC ANALYSIS METHOD

### 2.1 Fuzzy synthetic evaluation

The method makes synthetic evaluation to a subject with several factors, and the models must refers to :  
The factor set: those factors which can reflect the instinct of object, suppose that the factor set:

$$U = \{u_1, u_2, \dots, u_n\} \tag{1}$$

Where  $U =$  factor set  
 $u_i =$  factor

Where  $r_{i_n} =$  reflection of  $u_i$  to  $v_i$  (n = 1…m)

And we can get the fuzzy relation from  $U$  to  $V$  :

$$\tilde{R} \in F(U \times V) \tag{5}$$

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$$\tilde{R} = \begin{pmatrix} r_{12} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n1} & \cdots & r_{nm} \end{pmatrix} = (r_{ij})_{n \times m} \quad (6)$$

Where  $\tilde{R}$  = the fuzzy relation from U to V

Because of the different effect, we found the different evaluation with factors on  $U$

$$\tilde{A} = (a_1, a_1 \cdots a_n) \quad (7)$$

$$a_i > 0, \sum_{i=1}^n a_i = 1 \quad (i = 1, 2, \dots, n) \quad (8)$$

In the end, we can get the mathematic model with ^

$$\tilde{B} = \tilde{A} \circ \tilde{R} \quad (9)$$

### 2.2 Battlefield capacity fuzzy synthesis decision analysis

Factor sets:

$$U = \{u_1(\text{terrain}), u_2(\text{water}), u_3(\text{traffic}), u_4(\text{vegetarain}), u_5(\text{habitation})\} \quad (10)$$

Evaluation set:

$$V = \{v_1(\text{large}), v_2(\text{normal}), v_3(\text{less}), v_4(\text{little})\} \quad (11)$$

Suppose that single evaluation to "terrain":

$$u_1 \mapsto \tilde{f}(u_1) = (0.1, 0.4, 0.4, 0.1) \quad (12)$$

That is to say, the affection which terrain function in capacity calculation is 10% for large, 40 % is normal, 40 % is small and 10 % is little. With the similar:

$$u_2 \mapsto \tilde{f}(u_2) = (0.2, 0.3, 0.4, 0.1) \quad (13)$$

$$u_3 \mapsto \tilde{f}(u_3) = (0.1, 0.5, 0.3, 0.1) \quad (14)$$

$$u_4 \mapsto \tilde{f}(u_4) = (0, 0.2, 0.6, 0.2) \quad (15)$$

$$u_5 \mapsto \tilde{f}(u_5) = (0.2, 0.3, 0.3, 0.2) \quad (16)$$

Weighted distribution:

$$\tilde{A} = (0.4, 0.2, 0.2, 0.1, 0.1) \quad (17)$$

Where "Terrain" factor affects most

### 3. THE KEY TECHNOLOGIES AND SOLUTIONS OF BATTLEFIELD ENVIRONMENT ANALYSIS

#### 3.1 Searching and accessing of Spatial data and attribute data

Before thematic analyzing, we need to pick up the spatial data from polygon selection. At first we need add up spatial filter, as figure 1, cut off the origin object, such as point, line and area, and creat a group of new selection, they must have the same coordinate order, spatial reference and attribute information, such as the lenth, level, width of the road.

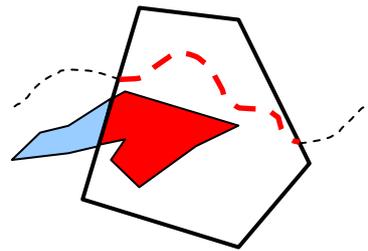


Figure 1 New selection object

#### 3.2 Rendering and drawing of thematic data

After cutting off of the selection, combining of methods and factors which set by model of military thematic analysis, we are going to cut off the selection, and gain what we need to meet demand. So that, the factor which in the same degree will be re-rendered by their own characteristics to distinguish, in the progress, Layered colors and face tracking domain are adopted to avoid the conflict with other colours.

#### 3.3 extraction and preservation of Thematic data properties

The thematic data need to be preserved by designed format, such as "\*.TGRD, \*.TIMG, \*.TDEM". in order that people can read or print it easily.

For extraction, it means that classified different value range whose attributes are not the same, and each one has several range.

For preservation, we write the colour list, attribute field and attribute into element format.

### 3.4 Production of thematic analysis report based on template

Thematic analysis template is an report about the thematic evaluation of the selected area, and it is also the systematic conclusion of the battlefield environment information. It is compared with several aspects, such as terrain, geomorphology, road, vegetarian and habitation and so on. After analyzing and statistic of each factor, with related thematic characteristic, one can differ that.

## 4. CONCLUSION

### 4.1 Building a series of affective indicators in battlefield environment analysis Primarily

The affective factors of battlefield environment analysis is composed of terrain、traffic、water、meteor and economic etc, for each factor, there is a quantitative standard. Through quantizing factors and operational data, based on former research, the paper puts forward a primary series of affective indicators in battlefield environment analysis.

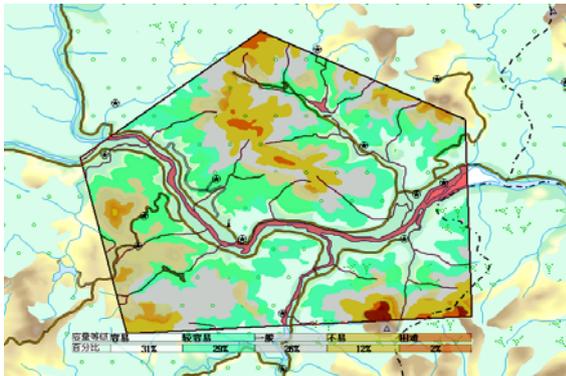


Figure 2 Capacity analysis

Combined with the projection, the paper discuss the point of battlefield environment analysis indicators in five directions detailedly : terrain、water、traffic、vegetarian and habitation. We can see the drawings form figure 1.

### 4.2 Realized quantitative expression of several fuzzy conceptions in battlefield environment analysis.

Qualitative analysis is a kind of attribute analysis method. It's a process of getting analyzed conclusion or suggestion. Based on griped relative cases, People slowly reveal the essential attribute and co-relationship among different objects. Qualitative analysis of terrain analysis is a basic judgment of commanders and staffs to operation regulations and feature, with their operation experience and military command art.

Quantitative analysis is a method of solving the problems with quantitative conception; it works with mathematic modeling which indicates co-relationships and regulations of researching objects and problems. Come up with the new science of military system engineering, quantitative analysis has being populated in military field, and also is essential to terrain analysis.

It needs several indices to portray one object's Inbeing and Characteristic ,and the evaluation of an object is not simply good or bad, high or low, but to adopt fuzzy conceptions to divide into different degrees of evaluation. Fuzzy Syntheses

judgment is one of basic mathematic methods of soft science. It is well applied in the field of science judgement, economic prediction and decision-making.

Syntheses judgement is one of basic methods of Fuzzy System Analysis, which have comprehensive application , especially in soft science. Adopting syntheses fuzzy judgement on utility model gets well economic and social benefits. The method also holds great application in many professional fields.

The fuzzy conceptions which Battlefield environment analysis involved are concerned with distribution and unit characteristics of multi-geographic elements. Generally it can not be figured simply. The paper uses principle of Application Fuzzy Mathematics, emphases on fuzzy synthesis decision-making analysis of Battlefield Capacity, incorporating the content ,influencing factor of battlefield environment analysis, proceed battlefield environment fuzzy synthesis decision-making analysis , and realized a part of expression of the quantitative conception .

### 4.3 Based on investigation, building the battlefield environmental analysis model.

Go with practical demand of battlefield environmental analysis, incorporating with military geographic information system, we built three fundamental analytical models of battlefield environmental: Campaign Assembly Region Analytical model, Campaign Channel Analytical model and Campaign battlefield Capacity model, which are realized in fundamental geography information platform. The payoff has been realized in the projection "The Display and Certification of Union Champion geographic information Service System".

In architecture, the battlefield environmental analysis frame adopts C/S computing schema. The database server offers geographic data service to each client, such as battlefield environment analysis. The database server storage vector map data , DEM data , pixel picture data , positive photograph and so on .Vector map data and DEM data is the source data of map display and battlefield environmental analysis, whereas pixel view data and positive photograph data can be used as map display and map measurement. The client terminal mainly completes the job of graphic display, map measurement and kinds of environmental analysis. The result of battlefield environment analysis is stored in client terminal.

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