

Theoretical Research on Complex Mapping and Its Practical Application

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Abstract

My manuscript is divided into three parts. several theoretical problems and some basic methods in procedure of complex mapping are described in the first part of this manuscript. In the second part, the different forms and methods of complex mapping are analysed. Single complex map, complex series maps and complex atlas are the three main forms. In the third part, the principles of unification and coordination in complex mapping and practical application.

Complex mapping refers to the cartographic method and procedure that can express complex elements and phenomena as well as their interrelation simultaneously, Map is not only one of the best ways to express scientific results of the geographical investigation and research, but also an important and necessary means of geography studies. In the process of cartography reflecting the regional and complex characters of geography, the method of complex mapping develops rapidly. It becomes one of the most important means of complex research in geography and a significant link between geography and other branch disciplines. Now complex mapping is a major trend of development of modern cartography.

1 Theoretical Bases of Complex Mapping

Complex mapping regards the geographical environment and man-nature system as a mapping objective and reflects their characters of formation development, structure, quantity and quality. It also reflects the interrelationship and interaction among various elements and departments. It expresses the basic characteristic and regional differentiation of physical territorial complex, territorial economic complex and man-nature system. It provides scientific basis for regional development decision-making and counter measures of environmental management. Complex mapping not only make the study of regional investigation and planning project easy to get more comprehensive accurate and reliable conclusion, but also make all sorts of thematic maps use fully analytical results from various departments. So that it can strengthen the mutual infiltration and integrated viewpoints among various departments, and makes all sorts of thematic maps easy to compare and analyse, and provides the possibility of discovering new natural law.

Complex mapping is not only a technical work on complication and collection of maps, but also an integrated experimental research, it is a way of synthetical studies in geography. So complex mapping should be directed by a series of theories in geography.

1.1 Explore the formation and structure of physical territorial complex and territorial economic complex, study the regional differentiation and its causes, and analyse the major elements of mapping area, which contributed to different regional characteristics and their influence.

1.2 Study the mechanism and appearance of interaction and function of various elements and departments of physical territorial complex and territorial economic complex in the unified process of development. Research into the reflection on external formation structure of internal linkage among various elements of physical territorial complex and analyse the linkage form, linkage factor and index among various elements in mapping.

1.3 Study the concret appearance of physical territorial complex and its various elements, which exist in zonal law and unzonal law, regional characteristics and its collection of illustrative plates, and basic graphic characteristics of geographical unit. Analyse the reflection of the above-mentioned three layers which arised in different scale maps in the scope of mapping region. It will be the important basis for unification and coordination of classification and gradation as well as boundary line demarcation.

1.4 Study the structure of form, cause of generation, constituent substance and age of physical territorial complex, and component, structure, scale, output value and benefit of territorial economic complex. Study the reflection of relationship between physical territorial complex and regional economic complex. Analyse the classification system, classification index and mapping unit, which reflect the characters of quality, and grade method, grade index and mapping unit which reflect quantity index. So that it can provide the basis for unification and coordination of legends of maps.

The process of complex mapping is very complicated, but the most important thing is to grasp the following five basic links on basis of deep study above-mentioned.

- Determination in choosing content of subject.
- The choice of mathematical and geographical basis of mapping.
- Classification and gradation of map and legend.
- The drawing of boundary line.
- Design on expression method of map, colour index and symbol.

2 Different forms and Methods of complex Mapping

There are different formats in complex mapping. We made further experiments about single complex map, complex series map and complex atlas in various sorts of measures and scopes. We have accumulated abundant experiences and published many summarized reports in the aspect of theoretical methods.

2.1 Single Complex Map

Single complex map is to express many elements and phenomena or multiple indexes of one element on one sheet of map. In which combination map is a combined result which applies many expressive methods and means(base colour, area ruling, symbol), through combining with point, line and area of many layers to express directly various elements and phenomena or multiple indexes which have closed relation. Synthetic map expresses the results in compounding various related elements or multiple indexes of one element. Combination map has merits which allow us analyse the relationship directly among related phenomena(such as earthquake and geological structure, industrial distribution and base of raw materials)on maps, or reflect the basis of evaluation and indexes.

2.2 Complex Series Maps

Complex series maps are a set of maps designed and compiled in an unified way, reflecting certain basic situation of a region or a department. Previously the series results of maps on landforms, soil and plants were compiled by many institutes which had been organized in integrated survey. Because of the compilation was completed through divided investigating and the research group was organized in specialization, and the concluded compilation at last, so it was lack of organic relation and unified coordination. These methods caused many unavoidable problems and conflicts in the contents of map and brought a lot of difficulties in comparison and use of maps. It also restrains the application of maps in comprehensive evaluation and planning.

In 1981, we organized many specialists in deductive method of map on the basis of analysis. The advantages of this method are following three. (1) Through reading abundant information of remote sensing figure to determine accurately and to draw the boundary line of physical territorial complex. This method not only improves scientific quality in series mapping, but also speed up mapping. (2) Avoiding conflicts and problems which are brought by the investigation personnel from field work and reading figure as well as compiled mapping. It quarantees the unified coordination of various thematic maps and makes the series maps reflect well the interrelation among various elements in natural environment and brings many conveniences to compare, analyse and evaluate various maps. (3) Acquire unanimous and accurate quantity data of various typical lands and resources, especially help to set up data bank of geographical information. Through digitalization of natural geographical unit boundary line maps, various elemental maps and comprehensive evaluation was also made, planning and decision-making.

2.3 Complex Atlas

Complex atlas is a set of systematic compilation mapping in unified design, a certain range or subject with organic relation. It is a high-level form of complex mapping. Especially, compilation and publication of national atlas is not only benefit to the development of economy, sciences and culture education, but also regard as a mark of measuring the level of national science and culture. We also consider that compilation of complex atlas is not only a comprehensive research designing and technical work in mapping, but also a complicated systematic engineering in mapping. So we should use the methods and theories of systematic engineering to direct designing and compilation of atlas.

If we arrange rationally for scientific setting, the relation between the inner subsystem and the various subsystems of content, figure, work and organization, we will put the plan about compilation of atlas into practices and will improve quality of atlas, in order to finish compilation and publication of atlas in high quality. We found that the two key factors concluded, which play important role in scientific quality of atlas, are the over all designing and the unified coordination. We should work out catalogue of selection on atlas title from its purpose and usage, as well as consider the unitification, systematization compilation. We consider that concrete design must obey the following rules.

- Put emphasis on both systematization and practicability. Scientific systematization ensures the basic subject selection of various elements and department. practicability is to select subjects about natural resources and its utilization, natural hazards and its prevention, and environment pollution and its controlling. The research on these subjects will benefit mankind.

- Regional complex atlas should express prominently the characteristics of region, and reflect its specific natural conditions, natural resources, economic superiority, as well as significant cultural heritage. Complex atlas of one department must put prominence on the topic of atlas and selecting contents around the topic.
- Reflect the new results in new branches of learning and new research fields, for example, the newly-edited *Atlas of national Physical atlas of the PRC* reflects the new research results in dynamics of lithosphere, geochemistry, climatic and environmental changes. At the same time, atlas must reflect the depth of research and investigation in a region or department. And we should compile some evaluated maps, dynamic change maps and detected forecast maps.
- Select some typical regional map to reflect the character of typical region or typical phenomenon which is used as "close-up shot".

3 Unification and coordination of complex mapping

Unification and coordination are the key to ensure scientific quality in complex mapping, and one of the main criteria to judge the level of complex atlas and complex series maps. The theory and method of unification and coordination are the core of theory and method of complex mapping. We studied deeply theory and method of unification and coordination, and put forward scientific basis of the theory and principles and methods of unification and coordination at the first time. These principles and methods can resolve fairly well the unification and coordination of form and content, determine the elements and markers which must be unified and coordinated among various kinds of map. Unification and coordination include structure of subject, index of content, classification and gradation, legend and graphic form, boundary line, cartographic generalization, expressive method and map decoration etc. It almost runs through whole mapping procedures. Unification and coordination of scientific content resolve mainly two problems.

3.1 Unification and coordination of Classification, Gradation and Legend

The main object is to discover the relationship between elements and phenomena in order to compare the legends. We must select comparable classification and grade system, include classification index and gradation method, determine comparable related classification units and grade graph according to scale, and select representative zonal type, transitional type and non-zonal type, and then use unified legend structure, arrange rule and naming method.

3.2 Unification and Coordination of Boundary.

We consider that it includes four aspects as following:

- It reflects correctly natural figure of elements and phenomena. The actual figure and distribution of elements and phenomena are shown on maps. Generally they show a certain plane structure (or called as natural figure). According to their scale and range, they can be deviled into zonal boundary, regional feature and basic figure (e.g. insular, fan, belt, circle, layer, cross and spot etc.).
- It reflects correctly transitional trait in boundary line. There exist two kinds of transitional boundary line, one is obviously accident change and the other is vaguely gradual change. The former forms geological structure, geomorphological feature,

constituent substance, heat water, biology, soil etc. under the action of earth's strength in outside and inside. All of these display accident appearance, for example, fault line, piedmont line, watershed, river valley, terrace, margin of water body and glacier etc. But most natural phenomena are changing from quantity to quality gradually, so the boundary line displays gradual transition.

- boundary lines. In general, distribution of natural elements and social phenomena in space do not limit at a plane. They are stereoscopically distributed at different height and depth and crisscross, as well as folded of each other. Rational drawing boundary and from of intersection are the way to reflect correctly relationship of subordination, layer and time among phenomena which distributed in space.
- There are three conditions of boundary line of natural elements, they are overlap, partial overlap, and non-overlap. In the situation of gradual change and under different influence of natural phenomena, the boundary line will non-overlap.

Unification and coordination of complex mapping in scientific content need to take following methods:

- to provided unification and coordingation series basic maps and satellite images;
- the relative form and relationship of coordination between elements and phenomena, and reliable degree of data;
- order to control the common and obvious boundary line.

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