LANDFORM TYPE ANALYSIS ON AERIAL PHOTOGRAPHS. ITS PRINCIPLE AND ITS TECHNIQUES

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Abstract A systematic classification of landforms is of fundamental importance for field sciences such as geology, pedology, plant ecology, limnology, *etc.* The author has worked out such a classification, of which the basic unit has been defined by him as "landform type". The criteria by which a landform type is determined are mentioned. The best way of identifying landform types is an analysis of aerial photographs, because these not only give much information about the land surface, such as micro-relief, drainage pattern, ground water condition, cultural features *etc.*, but also show clearly the relationship between all these factors. The landform types can be delineated on the photographs and be named after a field check if necessary. Landform types can be grouped into higher catagories of classification. Landform analysis finds several practical applications.

Résumé Une classification systématique des formes de paysage revêt une importance fondamentale pour les sciences de terrain comme la géologie, la pédologie, l'écologie botanique, la limnologie, etc. L'auteur s'est essayé à une telle classification dont l'unité de base définie par lui est le "type de forme paysagique" ("landform type"). Les criteria servant à déterminer un type de forme paysagique sont mentionnés dans cette note. Le meilleur moyen d'identifier des types de formes paysagiques consiste en une analyse de photographies aériennes, car celles-ci ne fournissent pas seulement de nombreux renseignements sur la surface du sol tels le micro-relief, le réseau de drainage, les eaux phréatiques, les cultures, etc., mais elles montrent également clairement les relations qui unissent tous ces facteurs. Les types de formes paysagiques peuvent être individualisés sur les photographies et recevoir un nom après un contrôle sur le terrain si cela est nécessaire. Il est possible ensuite de les grouper à un niveau supérieur de classification. L'analyse des formes paysagiques trouve plusieurs applications pratiques.

Zusammenfassung Eine systematische Klassifizierung der Geländeformen ist von grundsätzlicher Bedeutung für Feldwissenschaften wie die Geologie, Bodenkunde, Pflanzenökologie, Limnologie usw. Der Verfasser hat eine solche Klassifikation ausgearbeitet deren Grundeinheit durch "Geländeformtyp" ("landform type") von ihm bezeichnet worden ist. Die Kriteria, wodurch ein Geländeformtyp bestimmt wird, werden erwähnt. Das beste Mittel um Geländeformtypen zu identifizieren ist eine Analyse von Luftbildern, weil diese nicht nur viel Auskunft über die Geländeoberfläche erteilen, wie Mikrorelief, Entwässerungsnetz, Grundwasserbeschaffenheit, Kulturkennzeichen usw., sondern auch den Zusammenhang zwischen allen diesen Faktoren deutlich zeigen. Die Geländeformtypen können auf den Bildern umrissen und wenn nötig nach einer Geländeprüfung, benannt werden. Geländeformtypen können in höhere Klassifikationskategorien gruppiert werden. Die Geländeformanalyse findet verschiedene praktische Verwendungen.

Introduction

Establishment of a landform classification should be one of the fundamental jobs for such geographic sciences as geography, geology, geomorphology, pedology, plant ecology *etc.* and many attempts have been made to do so on a chorographic scale. For example, N. M. Fenneman (1914, 1916, 1928) set up 8 major provinces and many minor sections in the U.S.A. Classification, not only on a chorographic scale but also on a topographic scale is gradually

becoming important. As an example of this recent trend, Polish geomorphological maps on a scale of 1 : 50,000 can be mentioned, and also "Naturräumliche Gliederung Deutschlands" (1953). D. L. LINTON (1951) stated that "site" is the smallest unit of landform, and can be grouped in broader units such as "stow" and "tract".

The author also proposed a system of geomorphological regions using landform type as the smallest unit of landform classification; stepping up to series, association, section and province (1950, 1956, 1961). The points to be discussed in such a systematization of geomorphological regions will be as follows:

a. How to identify landform types and how to systematize them into larger units.
b. To clarify the relation between landform types and regional units of soils and geology.
c. To clarify the significance of geomorphological regions in the geographical sciences.

In this paper the author will discuss items a. and b.

Identification of landform type

The land surface consists of various landform types which will be identified by morphological development and genetic features. In order to understand the geomorphological structure, it will be necessary primarily to identify each landform unit. The author has named such a unit of landform a "*Landform Type*". Identical landform types should have the following four characteristics: a. development in about the same period of time; b. morphological similarity; c. a similar genesis, and d. similar constituent material.

It is not so easy to identify landform types using these four criteria. Fortunately, however, geomorphologists realize that these four criteria bear a close relationship to each other and it is possible to use morphological characteristics as primary criteria. In order to identify landform types, not only the morphological characteristics, but also the boundary of the landform type as identified by morphological characteristics should be considered. If it is possible to recognize the boundaries, it will also be possible to introduce the techniques of the analysis of landform types from aerial photographs.

Analysis of landform type from aerial photographs should be carried out by experts who have at least an elementary knowledge of geomorphology and photogrammetry and who have good stereoscopic perception. In general it is recommended to use aerial photographs on a scale of about 1 : 25,000. If available, aerial photographs taken in different seasons should be used. A field check should be carried out after the analysis of aerial photographs has been completed. Each landform type analysed on aerial photographs will be marked on transparent materials or transferred to topographic maps. The use of coloured symbols and signs for marking is recommended.

The most important criteria for classifying landform types are micro-relief and morphologically discordant lines, which should be delineated on aerial

photographs. Delineated landform types should later be identified and named by a synthesis of morphological characteristics.

Genesis and type of material will not necessarily have to be known for identification, but one should be careful in definitely naming each landform type. Genesis and materials of doubtful units should be particularly checked during the field investigation.

As stated above, landform types will be grouped into landform series, associations, sections, provinces and divisions by reducing the criteria for identifying the landform type. Such systematic grouping of morphological regions will also be carried out on aerial photographs. For this purpose it is recommended that no magnification is used, because systematization should be done by broad observation. Conversely, it is practical to set up morphological regions from larger to smaller units.

Application of analysis of landform type

The Japanese Islands located on the Circum-Pacific Orogenic Zone have been subjected to tremendous crustal movements up to the present day. In other words, complicated features of landform reflect the geological and geomorphological history. Therefore, analysing the micro-geomorphological features, we can study many geological events. For example, geological structure is deduced from characteristic landform features on aerial photographs. That this is possible has been proved by photogeological studies.

Pedological analysis of aerial photographs by Dr. P. Buringh proved the advantage of aerial photographic analysis of landform units. So far as we have experienced in Japan, this method will also be very instructive for Japanese soil scientists. In the soil survey of mountainous and hilly regions and diluvial upland regions particularly, it was recognized as a technique to be recommended. It will also have to be applied to the soil survey of paddy fields. Although the paddy fields of Japan have been deformed artificially, we can trace the micro-geomorphological features of the alluvial plain on the aerial photographs by stereoscopic observation.

Analysis of landform type has been applied to land classification for land use improvement. In this case, analysis of landform type is the basis of land classification survey, and the delineated landform types are translated to land units by combining landform, geology and soils data.

The landform classification for flood prevention is also based on landform classification by means of aerial photo interpretation. We have applied the same ideas of landform classification to the population map on chorographic scale and have compiled a population density map by landform division.

Conclusion

a. Analysis of landform types will be very useful for understanding the characteristic features of land surface.

b. Aerial photographs are a very important tool in the analysis of landform types.
c. Analysis of landform types is useful not only for geomorphology, but also for other sciences and techniques related to landforms.

Discussion

Mr. C. W. MITCHELL (U.K.) asked what is the distinction between landform, geological and soil units envisaged? Can these landform units be correlated with recognized geological and soil units, and have they been thus correlated in Japan? Dr. NAKANO answered that landforms are not geological units or soil units, but that the land surface must be divided into several units by the four landform characteristics mentioned in his paper. In particular, if air photos are used for a geological or soil survey, the landform will be the primary criterion. He has been trying to discover the relationship between landforms and both geological and soil units. He has not yet succeeded, but it is becoming clear that close relationships do exist.

Dr. P. H. T. BECKETT (U.K.) remarked that the use of morphological units in soil mapping depends upon the assumption that a given combination of causes leads to a given landform and, by implication, a given combination of soils. But in some areas minor physiographic processes are dominant. These minor disturbances may determine the form of the soil pattern and the relation between recognizable landforms and soils may not be close. Did Dr. NAKANO study the closeness of the relationship between soils and landform? Dr. NAKANO answered that the relationship between soil unit and landform unit should be discussed in combination with the mapping scale. Soil units have an areal extension. This means that we can find some relationship between these units and the landform.

Prof. Dr. C. TROLL (Germany) remarked that the problem depends on the small natural units, both with respect to their descriptive differentiation and to the morphographic units or complexes. Soil complexes are correlated to morphographic complexes, but also to other phenomena. This leads to what has been called "Landscape Ecology". For this purpose he defined the term "ecotope" which has a meaning similar to "facet" and "site" mentioned by Mr. WEBSTER. There are now seven different terms, all trying to define the basic unit in the natural landscape.

Prof. N. W. RADFORTH (Canada) asked whether the peat bog is a landform type according to the speaker's use of the term? Dr. NAKANO answered that according to him a peat bog is not a landform type. The area in which peat bogs occur can be classified into several units according to his landform criteria.