A Study of Regional Differences in Flood-types—an Example of Applied Geography

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1. Introduction

In Japan, annual damages by floods in the past forty years, amount to 450 million dollars on the average and 1 500 million dollars in a year with especially violent floods. Furthermore a great number of persons were killed and lost by floods. So, how to decrease flood damages has been studied from various points of view. From a geographical standpoint, the problem can be viewed as a study of regional differences in flood-types, a viewpoint that may be useful for river improvement and decreased in flood damages. We wish to discuss the problem as an example of applied geography.
Flood-type is decided by the following factors: (1) the type of rainfall which causes a flood, and (2) the nature of the drainage area which is devastated by the flood.

2. Rainfall and flood-type

The main cause of flood is heavy rainfall in a short period of time. When a continuous rainfall exceeds 300 mm in amount, we can not avoid flood damage by the present technics of civil engineering. Although many studies have been made by meteorologists on rainfall and floods only a few studies have considered how geographical differences may affect floods. Figure 1 shows the average amount of rainfall (in black) and discharge of rivers (in white) of twelve drainage regions in Japan. The maximum monthly rainfall in the Northern Kyushu region is in July, while that in the Southern Kyushu region in August and in the Nankai and Tokai regions, in September. These figures show that the routes of typhoons gradually shift from west to east during the year. Usually the month of maximum river discharge coincides with the month of maximum rainfall, but in the San-in and Hokuriku regions along the Japan Sea Coast and the Northern Japan regions where heavy snow falls occur in winter, the maximum river discharge occurs in April-July, due to melting of snow, but the maximum rainfall occurs during the winter. In Japan, in recent years damages by floods have been experienced in August and September, caused by heavy rainfalls accompanied by typhoons, but in the past, when the technics of river embanking were not yet advanced, floods occurred in the spring, especially in regions along the Japan Sea Coast and Northern Japan, where heavy snow falls occur in winter. Floods from melting snow contain a great amount of surface soil, and thereby increase the flood damage.

3. Topography and flood-type

The regional differences of flood-type caused by the nature of the drainage area are as follows:

(1) differences of the flood-type caused by differences in the topography, geological structure and the distribution of plants;

(2) differences of flood-type caused by differences in the nature of the drainage area, which varies, for example with man's structures and activities, the state of rivers, which varies with the construction of dams, banks and bridges, the state of mountainous country, which varies with logging of forest and conversion into farmlands, and state of the plains, which varies according to its being occupied by towns and villages;

(3) the regional differences of the social and economical environment where the flood occurs, for instance, flood control system of different areas will affect the nature of the flood.

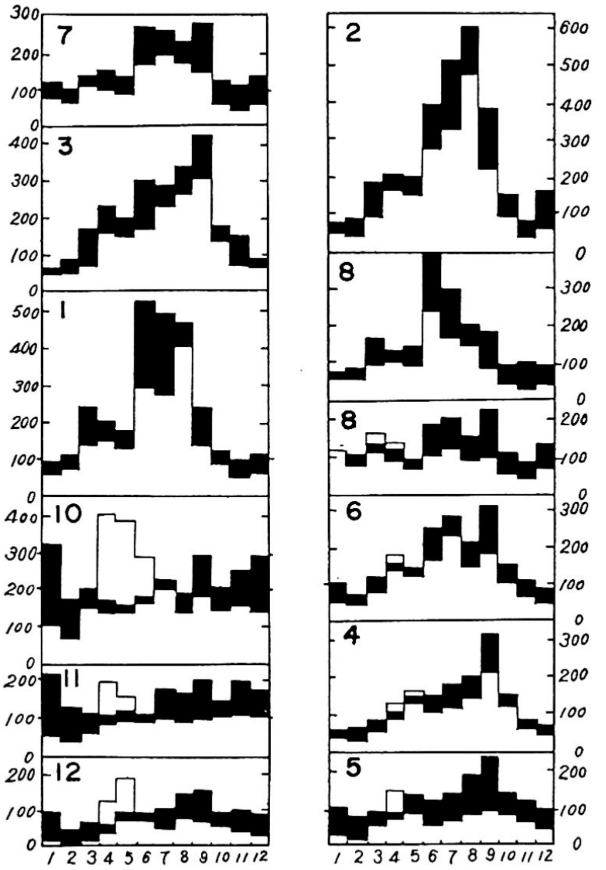
It has been well known from experience that the flood-type varies greatly according to the topographical elements, the plains, the mountains and so forth. Now we want to mention the relation of the topography to the flood-type.
We have surveyed floods of the alluvial plains of ten rivers in Japan for over one decade, and found that even in the same alluvial plain, the flood-type – the depth of the stagnant water, the period of stagnation, the direction of the current, the velocity of the current, the erosion and deposit of sand and gravels – varies remarkably according to the microtopography. For instance, in the fan, the violent deposition, erosion and changes of the stream are often seen during flood time. In the natural levee, when this district is submerged by the flood, the water drains off speedily, and deposits sand, while in the back-swamp, the period of stagnation is larger

and the water deposits silt. In this case the following factors – the fan, the natural levee, the back-swamp and the delta – have a decisive influence upon deciding the type of flood. This shows that in the case of the alluvial plain, the flood type may be traced according to micro-topography. The greater part of the alluvial plain in Japan has been formed by repetitive flooding. Examination of the micro-topography of the plain and the nature of the accumulated sand an gravel, reveal the history of floods in that region. By subclassifying the topography, we believe that we can easily tell the flood-type of the locality. The flood-types in mountainous region depend upon the erosional stages of the valley topography. When heavy rainfall occurs in a valley in a young stage of erosion, landslides occur from knickpoints, that is, in profile, between the flat-topped summits and the steep valley walls. Torrential waters carrying an enormous mass of sand and gravel flow downstream, covering the full valley floor. In the forest area, driftwood flows downstream endangering bridges and houses along the stream. In valleys of the mature stage of erosion, lateral erosion of the valley walls take place. During low-water level times, the river course meanders in the alluvial plain regions. During floods, however, the water course is straighter. The valleys in the olderstage of erosion, flood plains become larger and the mountain sides more gentle. Deeping of the valley bottom ceases, transport of sand and gravel decreases considerably, and silt is deposited on the broad, alluvial plain.

Eine Studie der regionalen Differenzierung von Überschwemmungs-Typen – ein Beispiel angewandter Geographie

In Japan verursachen Überschwemmungen Schäden von durchschnittlich 40 Millionen Dollars im Jahr und bis zu 1500 Millionen in extremen Fällen. Die regionale Differenzierung der Überschwemmungen als Grundlage für Abhilfemaßnahmen wird als Beispiel angewandter Geographie diskutiert. Die Hauptfaktoren für eine Typisierung sind die Art der Niederschläge und die Beschaffenheit des Einzugsgebietes. Die Zusammenhänge zwischen Niederschlägen und Abflußverhältnissen von zwölf Einzugsgebieten sind in Figur 1 dargestellt. Die regionale Differenzierung nach der Beschaffenheit des Einzugsgebietes wird beurteilt nach der Topographie, Geologie und Pflanzendecke, der Art des Ausbaus des Flußsystems (Dämme, Staubecken usw.) und den sozialen und wirtschaftlichen Verhältnissen entlang dem Fluß (z. B. Organisation der Flutkontrolle usw.).

FIG. 1 A REGIONAL DIFFERENCES OF DISCHARGE-TYPE.



BLACK COLOUR : MONTHLY RAINFALL

WHITE COLOUR : MONTHLY DISCHARGE

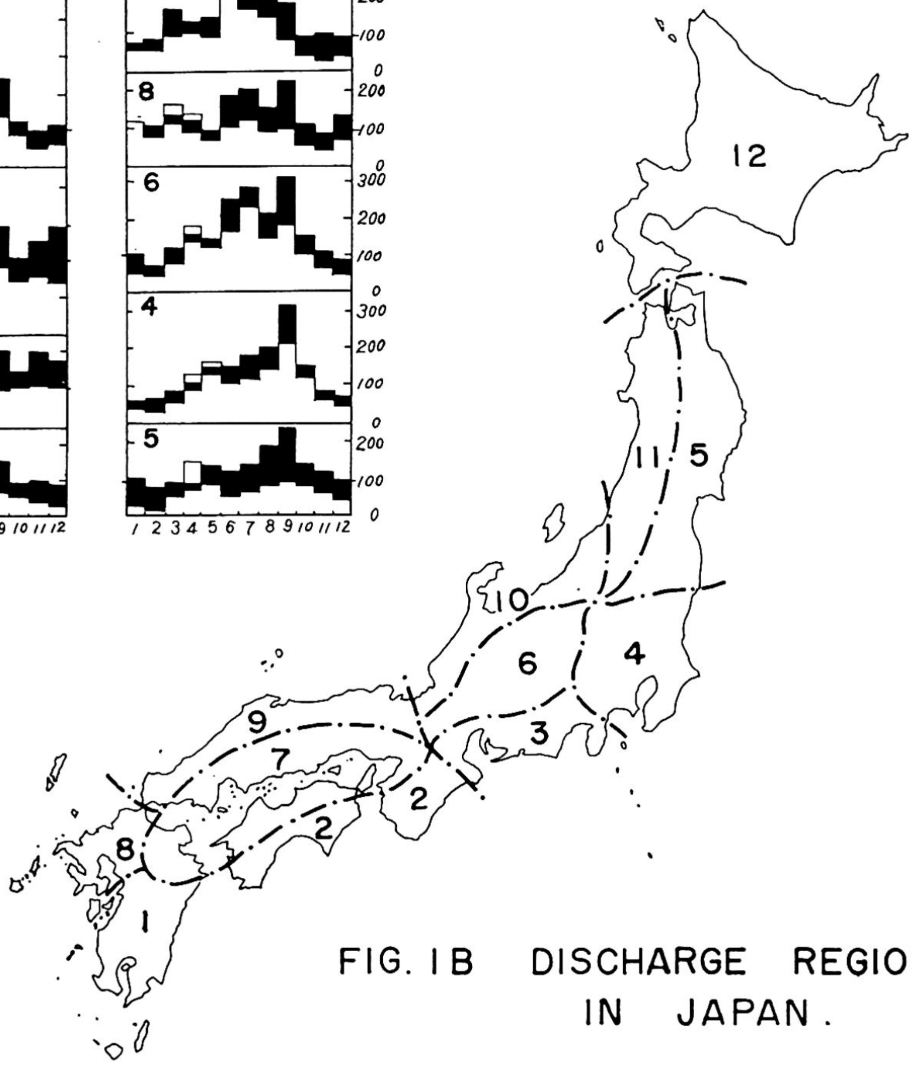


FIG. 1 B DISCHARGE REGION IN JAPAN.

1. S. KYUSHU
2. NANKAI
3. TŌKAI
4. KWANTO
5. TŌHOKU
6. TŌSAN
7. NAIKAI
8. N. KYUSHU
9. SANIN
10. HOKURIKU
11. ŌU
12. HOKKAIDO