FLOOD CONTROL FOR SPECIFIC TYPES OF FLOODS

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Summary

A flood impact on population and business is represented as damage. Flood protection is a method or a set of measures to prevent damage and eliminate loss of life in future floods. Protection measures are planned, the required means are selected, and their economic expediency is determined based on forecasting potential damage. It depends on flood power and population- and property-at-risk. Protection measures, or methods of adjustment to floods of any type, are classified into three groups: control of flood formation, damage reduction, and effect mitigation. Humans are able to prevent floods of only some types occurring in river valleys. The radical way to avoid negative effects of floods is to remove population and business from a flood hazard area. Most of human efforts are made to protect population and reduce damage caused by a flood. Numerous engineering methods of flood protection includes the construction of flood control pools and embankments. Timely flood warning is of great significance for damage reduction and people death prevention in particular. Various protection measures are taken before, during, and after flooding. A help to flood victims plays a very important part in first days and weeks after the disaster. A lack of adequate aid in this time may increase victims and loss. The past years show that the threat of floods to humankind does not become lower despite increasing efforts to protect against them. Flood protection is a complex social and economic problem that can be effectively solved only by countries with high economic potential. However even they suffer loss caused by floods.

1. Introduction

Flood, caused by overflow from a river, wind-induced surges, tides, tsunamis, or many other factors, are normal events of the earth's hydrosphere. Some of them occur regularly, like floods arising from spring melting of snow accumulated during winter, while others are occasional, such as those resulting from seaquake-induced tsunamis or break-through of the blockage of a mountain glacial lake. However they all result from the functioning of the hydrosphere and its interaction with the earth's crust, landscapes, and the atmosphere, although the causes are distinct.

The role and significance of floods in nature are diverse. Floods induce the formation of specific ecosystems with high productivity and biodiversity, in vast floodplains. During inundation, water flows carry a great amount of dissolved and suspended material, including nutrients. This material, being accumulated in floodplains, explains the high productivity of such ecosystems. It is found in many rivers of the world, e.g., the Amazon, Mekong, Amur, etc.

A sudden flood in a mountain river or even a tsunami hitting a seashore performs the function of carrying a large amount of loose material downstream, or even deep off the continental shelf.

Floods have partially favorable effects for human beings, and have been used by people from the very earliest times. Hunting, fishing, and collection of mollusks or other organisms in periodically inundated areas have been sources of valuable food and other products. One of the first human civilizations was dependent on the floods of the River Nile, which provided most of the necessary basic resources.

However the negative impacts of floods have always been dominant. Factors, such as sudden appearance, long duration of land inundation, rapid flow, erosion of channel banks, damage to settlements, and threat to human life, serve to make floods one of the most dangerous natural phenomena. The threat of flood to human life and prosperity, is not mitigated by our growing knowledge about the phenomenon and its causes, or the rapidly advancing technologies and techniques of modern society. Hence people permanently strive to improve their protection from negative effects of floods. Such measures are diverse, and even those used by primitive people are still applied.

2. Flood Effects

The inundation of land and property is a major effect of a flood. It is often accompanied by percussive waves, tsunamis, wind-induced surges, or intensive flood-related erosion. Such impacts depend on many factors such as depth and duration of inundation, flow velocity, and the various flood-generating factors.

The degree of flood hazard to people and economic facilities depends on their location in the area of inundation. This criterion is expressed as flood probability in a given part of a floodplain, seashore or lakeshore. It is used to define flood hazard zones in such areas, as shown in Figure 1. The highest flood hazard is near a river or other flood-generating water body. In Figure 1, this is shown as a zone of 1–5 year return period of floods. Further out, inundation occurs less often because of the higher terrain. In the fifth zone from the stream shown in Figure 1, the frequency is once every 50–100 years. During this event, flood effects controlled by the depth of inundation are highest near a stream or water pool and lowest in the last zone on the left. The pattern of flood hazards, shown in Figure 1, applies for any type of flood, whether it is caused by overflow from a river, wind-induced surges, tsunamis, or whatever.

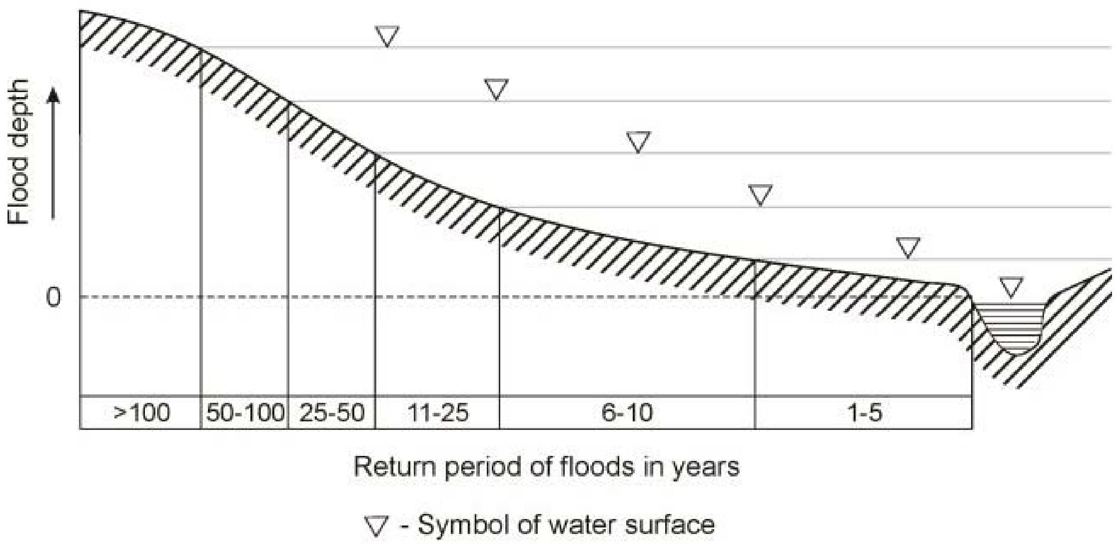

Figure 1. Hazard zones in a floodplain

Flood impacts on landscapes and ecosystems are natural consequences of their dynamics and development. However the impacts are beyond what is usual for a human population, and human-made facilities. Floods disturb the normal course of life and pose a real threat to human life and property.

3. Flood Damage

Impacts of flood on people and economies can be split into direct and indirect loss. Direct loss includes the cost of lost property, emergency measures, rehabilitating, repairing, paid-up insurance, and other reimbursements to people and organizations. Indirect loss, on the other hand, is usually difficult to estimate accurately, but it includes change in income or production in a flood hazard area, delay in transit of persons or goods, financial and business losses. This kind of loss involves people and business in remote but economically related areas, as well as in the zone of flooding.

Human casualties are also considered loss that is difficult, for obvious reasons, to evaluate. This sometimes has to be done when it is necessary to assess different scenarios of flooding and potential damage.

The key category for analyzing flood effects and planning flood control measures is the potential damage that may be caused by future potential floods. This depends on flood power and is controlled by the depth and duration of inundation, and the population and property at risk. The logic of loss formation caused by any type of flood is illustrated in Figure 2. It shows that potential damage depends on two main parameters, i.e., flood power and population- and property-at-risk. In turn, each parameter is formed by a number of factors. Flood power is a complex combination of flood depth and duration, percussive waves of floods, mudflows, tsunamis, icing, etc.

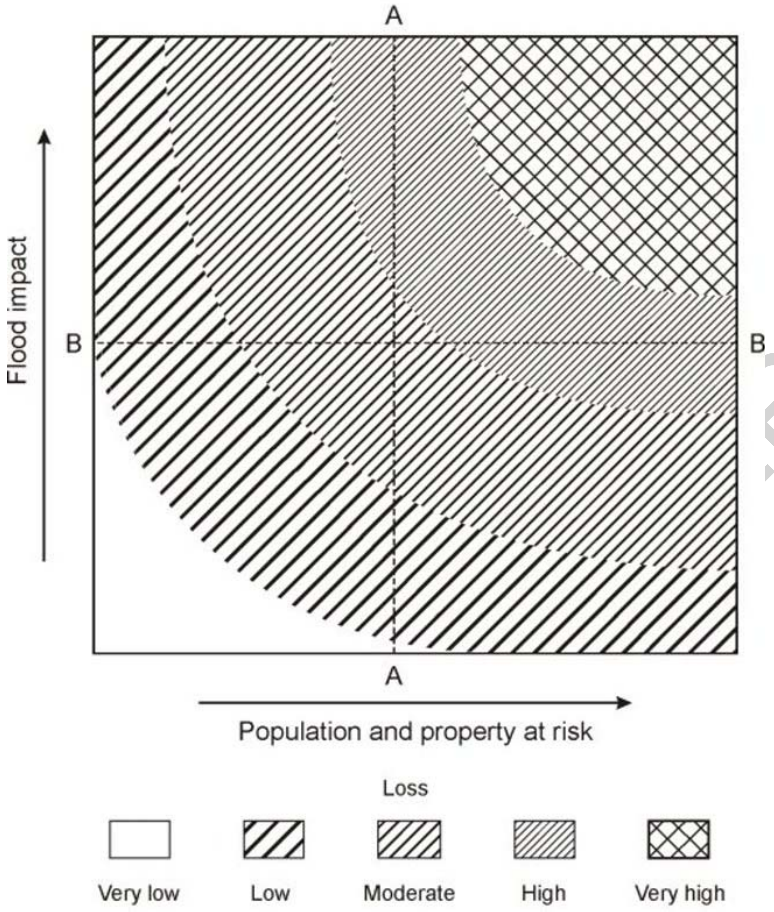

Figure 2. Damage as a function of flood power and population- and property-at-risk

The value of property-at-risk also depends on certain factors. It includes property-at-risk and its value, the cost of rehabilitation and repair if damaged, constructional features of buildings and other facilities, and the materials from which they are constructed. The value of property-at-risk is a variable that changes in both sides in time. For example, storm waves inundating a seashore at the height of summer may cause great damage to recreation infrastructure and reduce profits, but the damage from similar waves in a non-holiday season is much less.

Advanced technologies can reduce population- and property-at-risk. Progress in communication and flood warning, systems of acquiring data on flood formation and forecast, the rate of evacuation and provision of effective assistance to flood victims, makes a population somewhat less vulnerable and decreases hazards from dangerous effects of flooding. Improved buildings and facilities, and appropriate building materials, also make property in a flooding zone less vulnerable. In a general sense, these trends work towards continuous reduction of population- and property-at-risk, and is a positive trend in the permanent conflict between humans and floods.

Continuous reduction of population- and property-at-risk means that flood damage does not correlate to flood power. In other words, a recent flood and one of the same power in an area of similar population 100 years ago would cause different damage. This makes it difficult to analyze time series of damage, so forecasts of flood damage on this basis are incorrect. The problem of forecasting damage has, as yet, no satisfactory solution. The development of such forecasts depends on modeling of damage in scales ranging from an individual structure to a region.

There are a great variety of combinations of flood power and population- and property-at-risk. It is evident that the damage for a particular population- and property-at-risk is controlled by flood power and can range from very low to high (e.g. in the line A–A in Figure 2). And the same flood can do damage, ranging from very low to high (e.g. in the line B–B in Figure 2).

The message is clear. There are two major strategies to fight floods—to reduce flood power or population- and property-at-risk.

Appropriate measures according to these strategies entail considerable expenditure of financial, labor, and other resources, and decrease the efficiency of the economy in a flood hazard area. People and decision makers usually seek to achieve the optimum between potential damage and cost of protection measures. The latter should be beneficial, due to more efficient use of floodplains, seashores and shores of large lakes. Therefore, protection measures against floods are often projected for certain potential damage. For example, the storage capacity of a reservoir may be designed to decrease the power of the 100-year flood event but is not enough to prevent the 200-year flood event. This is economically justified by the cost of the 100-year flood event control. The 200-year flood event control is inexpedient because the cost of the necessary reservoir, say, exceeds the potential loss.

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Biographical Sketch

Anatoliy Fedorovitch Mandych was born in November 1936 in Ukraine. His initial professional education in hydrology was received in the Hydrometeorological College in Kharkov (Ukraine, 1951-1955). He graduated in the Geographical Faculty of Moscow State University (1955-1960), and later took a post-graduated course there (1963-1967). His specialty is that of geographer-hydrologist (science degree – Candidate of Science).

His professional experience was obtained through participation in hydrology related research at the Institute of Forest and Timber, Siberian Branch of USSR Academy of Sciences (Krasnoyarsk, 1960-1963), in Moscow State University, Geographical Faculty (1963-1967; 1972), in the USSR Research Institute of Hydrometeorological Information, World Data Center (1967-1972), in the Pacific Institute of Geography, Far Eastern Center of the USSR Academy of Sciences (Vladivostok, 1973-1978), in the Institute of Multidisciplinary Research (Khabarovsk, 1978-1984), and in the Institute of Geography, Russian Academy of Sciences (Moscow, from 1984 to the present). His key qualifications are as a hydrologist and landscape ecologist. His main fields of scientific interest are landscape hydrology, the hydrological cycle on the landscape scale, sediment transport by rivers, water resources and their transformation by human impact.

His current position is Head of the Center for Coastal and Barrier Geographic System Studies in the Institute of Geography. He has published over 80 scientific works and made over 60 presentations at scientific meetings.