FLOODS AND HIGH WATERS, USING POLDERS FOR PROTECTING AGRICULTURAL LANDS FROM THE FLOODS

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Summary

High waters and floods are a widespread phenomenon on the planet. Catastrophic floods lead to human suffering and fatalities, and cause huge material damage, especially to agriculture. In the struggle against floods, one important aspect is to be able to use flooded lands for food production. This is a matter of great world significance.

This article contains brief information about floods and high waters, their causes, and methods of protecting land from the dangers of high water. The main focus is on polders, a melioration system used for the protection of agricultural land from flooding. Polders are classified as follows: non-flooding (winter), flooding (summer), controlled flooding in spring, and self-leaking polders, (in which the soil is managed for certain objectives).

Non-flooding polders are the most reliable; their purpose is the protection of agricultural land, and they may be used for either annual or perennial crops plants. They protect land from the sea, river, lake, and reservoir water floods. The methods of calculating the parameters of dams, are given, as are the calculated dependencies for indicating the charge of pumping out polders with mechanical sprinklers, and items of information on pumping stations, pumps and methods of selecting them, and the required adjustment in the volume of the pool near the pumping station and the main channel.

There are two ways of controlling the water content of the soil in polders: by "normalized pumping out", and by "middle-weighted horizon". Equations for calculating the exploitation of the upper and lower levels, to provide the desired level in the polders, are given.

The author's point of view on some issues for the future—improving of the whole construction and some separate parts of polders—is represented.

1. Introduction

The land surface of the planet has many rivers, lakes, reservoirs, seas, and oceans (Potential land Use). The volume of the water in the freshwater resources is changing all the time, sometimes very dynamically, under the influence of many natural and anthropogenic factors.

When significant rise of of the volume and level occurs, a high water episode starts. High waters that result in harmful inundation of industrial enterprises, residential and other facilities, are called floods.

In territories liable to suffer inundation, agriculture, production, and human life are at risk. Taking a look at history it is clear that many catastrophes have been caused by floods. Catastrophic floods with much damage and human fatalities still occur quite frequently in different parts of the world.

The most dangerous are floods caused by the effect of wind on the ocean, storm winds, hurricanes, downpours, jams, blockages, and destruction of dams, as it is not possible to

predict their occurrence, or only inexactly.

But, disregarding all the risks and the danger, people have always tried to settle along the banks of rivers, lakes, and the seas, using them as a means of transportation, and a natural resource of water needed for agriculture.

Over hundreds of years of living in zones liable to flood, people have created and used many methods for countering this phenomenon, allowing them to protect their interests and reduce damage.

In Egypt, soil dams were used for protecting houses, building, and valuable soils as long ago as 3400 BC). The same kind of protection was used in China, India, Eastern Bengal, Indochina, and other countries. Diversion of floodwaters, using specially dug channels, was used on the rivers Nile in Egypt and Efrat in Mesopotamia (2000 years BC). In Europe building of dams started in the eighth century BC, but basic projects for flood protection did not appear until the nineteenth and twentieth centuries.

In the Netherlands nearly 40% of all the land is situated below sea level. The tidal range of the North Sea, at about five meters, makes it very difficult to use low-lying coastal land during storm winds coming from the sea, and much land can actually be under water. Owners of land liable to occasional flooding used to make artificial hills called terpens, where they built their houses and onto which they moved their cattle at times of flood. From the tenth century they started to build roads to connect terpens, and these also were useful as protection dams.

In America the first colonists tried to solve the serious problems of coastal flooding, using flood protection methods that had been tried in Europe.

Nowadays, all the countries that experience flooding of rivers, lakes, reservoirs, and coastal regions, have completed or are still working on projects for protection of the land from floods. There is very often an intention to use the land for the agriculture and cattle breeding. Along with solving the problem of flooding, many other objectives may also be achieved, such as those connected with irrigation, drainage, electrical power production, nature conservation, recreation and tourism (Water Resources for Agriculture Production).

2. The Reasons for Floods and High Waters

The most widespread floods in the northern hemisphere are river floods caused by melting of the snow in spring. Melting of ice and snow on the huge areas where frozen precipitation accumulates over the winter can cause such an increase in flow, that the rivers are unable to transport the volume of water. The level in the river rises until it can no longer handle all the water, the banks are breached and flooding occurs.

On rivers whose source is in mountainous areas, floods occur as soon as the snow and ice start to melt in the mountains. The greatest rise in the level of these rivers occurs mainly in the foothills or near the mountains, where the river becomes flatter.

On land with a monsoon climate, great floods can occur as the result of downpours during the rainy seasons. Floods occur because of the short duration of the rainstorms, the rivers being unable to cope with the sudden increase in flow.

Long winter thaws, sometimes with rain, are the main reasons for winter floods.

Coastal areas can be influenced by the inflow of swollen rivers. Very extensive low-lying areas beside rivers and estuaries can be flooded when the rivers over-top their banks.

The most dangerous are floods caused by high winds. Storm winds travelling over the ocean can create huge waves which may be very long.. The wave moves with the wind, and when it reaches the seashore it can flood the low-lying land. Where rivers meet the sea, the waves can move upstream, negating the normal downstream flow, and causing the river to temporally change direction. As a result, the water level in the rivers rises and flooding occurs. On the highly populated shores of the seas and rivers in Great Britain, India, Italy, Holland, the Russian Federation, USA, and Japan, such storm water inflows have caused catastrophic harm on many occasions. The height of the water level rise, for example on the River Thames, in England, has been two and a half meters above normal levels. On the Mexican coast it has been nearly seven meters, and on the Indian coast, close to eleven meters.

In mountainous areas landslides, landslips, and movement of ice may cause blockading of the mountain rivers. When these blockades give way a huge water wave can rush downstream, destroying everything in it's way and causing great harm.

In the northern hemisphere, major floods can occur on the many rivers that are covered with ice in the winter time. On the big rivers ice jams may cause a water rise of up to eight to ten meters. When the ice jams break up, the torrential downwash of the river can create catastrophic conditions downstream.

Cyclones are very common in the atmosphere. If a cyclone starts over the sea surface the so-called horizon water fluctuations can occur—*seishi*. These fluctuations occur as the result of a drop of air pressure in the central part of the cyclone so that water moves into this area, causing a horizon rise. The water in the central part of the cyclone spreads after the cyclone has moved on or dissipated, producing outwardly radiating waves of huge volume. These fluctuation are long waves and as the water hits the shore, it may cause floods in coastal areas. Cyclones, as a rule come together with rain, downpours, and strong winds, which make the floods even more dangerous.

Of all the floods, the most catastrophic are those that are caused by earthquakes and volcanic eruptions under the sea. These can cause huge waves, called "tsunami", that can reach up to 30 meters in height, and move with great speed. When they reach the shore they destroy everything in their path.

3. Methods of Protecting Land from Floods

Under the word ‘method’ we mean a purposeful complex of technical and technological

actions, that protect land from floods and which create appropriate conditions for using flooded land.

There are the following methods of protecting land from floods:

1) Using dams for land protection;
2) Adjusting the level of a reservoir spillway;
3) Increasing the flow capacity of a waterway;
4) Storage of flood water (increase in the upper limits for storage on protected areas);
5) Adjusting the length of the flood—holding flood water for longer

Realization of each method may be made in different ways, by which we mean several specific technical, technological, organizational and other actions, that together facilitate reaching the goal. Depending on the conditions while using one and the same method, different ways may be used. Below we are going to view some of them, those that are used for preventing or reducing the harm caused by floods to agriculture.

In coastal areas, dams are used for preventing floods in low areas and any vulnerable land of high value. The water is pumped out, and the ground can be irrigated using an intensive agricultural system (in Holland and other countries). Reservoirs and lakes can be used in the same way.

Where rivers flow into the sea, dams can be constructed across the main channel and any subsidiary channels, to prevent the entry of seawater into the river during periods of high tides with onshore winds. Sluices are required to allow the river water to enter the sea. During the periods when the sluices are closed in a transverse dam, the incoming waters are held back, so the level rises behind the dam. For protection of the flood plain during such periods other dams are used, that allow the water to flow from the river to the lower parts of the system (as in Germany and other countries).

On flat parts of river flood plains, dams are used to protect constructions, irrigation networks and other elements.

The adjustable drain system is based on the reservoir's spillway construction. It holds back most of the incoming floodwater and allows a reduced flow to move into the downstream section. The outflow from the reservoir can be adjusted to control the level in the downstream river, allowing it to receive as much water as required, without reaching dangerously high levels.

Another means of adjusting the downstream high water level is to allow it to accumulate in channels aside from the main stream, so that they accommodate part of the flood.

Diverting the main flow may be accomplished by creating reserve spaces in the low parts of the river system. These reserve spaces, or flood-reception areas, may be allowed to fill only during periods of catastrophic floods. When they are not required for receiving floodwater they can be used as agricultural land, without flooding.

The means of increasing the flow capacity of a river is accomplished by widening and deepening of the bottom, and increasing the flatness of it's surface. The flow capacity

can also be increased by making a second waterway (a bifurcation). The total width of the two waterways can be double that of the first one so that the two can accommodate the combined flow without a rise in level.

Another method of flood control is to create an area which can be ready to receive muddy flood water, so that most of the sediment load is deposited on the ground surface. The system can be managed with the help of pumps, to ensure that material is dropped where it is wanted.

The means of controlling the length of the flood can be accomplished with the help of flooded polder systems. In this way the meliorated territory is surrounded with low dams, that are flooded by the spring high waters. The height of the dam is determined with a view to decreasing the length of the spring flood and offering protection from the calculated high water levels in summer and autumn. The reduction of the spring flood period is achieved by pumping out the water from the polder via the pumping station.

In natural conditions flood control can often accomplished in a variety of ways. Selecting one of them is based on comparing technical, technological, ecological, and economic indicators for the different variants.

4. Polders and their Classification

Originally the name "polder" was used in Holland nine to ten centuries ago, and was related to the land protected with dams from sea floods. Later, the same system of land protection was used on the flood plains of rivers, lakes, and shallow reservoirs, and they were all called polders.

Polders are classified by different attributes:

According to their situation, flood polders can be divided into three types: seashore, flood plain and low-lying. On seashore polders the territory is protected from the seawater flood; flood plains are protected from river floods, and low-lying areas are protected from lake and reservoir floods.

There are three main types of polder, with different hydrological regimes: not flooded (winter), flooded (summer), and the length of flood adjustment (spring).

Not flooded polders have surrounding dams that provide year-round protection to the area from high waters. This kind of polder protection is very reliable.

Flooded (summer) polders receive high spring floods but protect the area from the summer-autumn high waters. The dams of these polders are higher. During spring high waters the flow passes through dams, and the mode of flooding and clearing of the land is essentially natural. The period of flooding is usually short and they can be used for perennial grass or one year grass crops.

Flooded (spring) polders are used for perennial grass, but in the case of long spring floods, the grass can be covered for more than 45 days. The dams of these polders

together with the pumping station are responsible for two things: protection of the land from the summer-autumn flood to a calculated level of risk, and reduction of the duration of the spring floods so that they will not jeopardise the growth of perennial grass.

The terms "winter", "summer", and "spring" are only indirectly related to the seasons. They are used as brief terms for the three types of polders.

As regards removal of water from the polders, they can be divided into either natural discharge (self leaking) or mechanical removal.
As regards adjustment of ground moisture, polders can be regarded as either drying or drying-watering.

In terms of usage there are water exchanging polders, and polders with a straight water movement through the reservoir. In water exchanging polders, there are periods when excess water is stored outside the polder, to be moved in again during the dry period when the ground requires watering, making a water exchange.

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Biographical Sketch

Alik Pavlovich Rusetski, born in the year 1938, Belarusian.

I graduated from the Belarusian Agricultural Academy in 1961 and got the qualification of an egineer-hydrotechnician on the speciality of hydromelioration.

I worked as a lecturer of the Belarusian Agricultural Academy in the town of Gorki, Belarus. Then I worked as the head of polder drainage laboratory of the Belarusian Science-Research Institute of Melioration and Meadow Developing (BSRI of M and MD) in the town of Pinsk, Belarus. Then I worked as the Dean of the Hydrotechnical Department of the Vologda Polytechnic Institute, Russia.

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