THE 1976 DROUGHT IN THE NETHERLANDS

Summary of "De Droogte van 1976" by ir. P.K.M. van der Heijde, c.i., Committee for Hydrologic Research TNO, Series Reports and Bulletins # 3, The Hague, 1978.

Introduction

In The Netherlands and surrounding countries, 1976 has become known as an extremely dry and warm year. For several months precipitation was well below normal, while the temperatures, especially during the summer months, were significantly higher than normal. As a result, evaporation rates and the net precipitation deficit were very high. Because the drought extended into the surrounding countries, border-crossing rivers had strongly diminished flow rates, compounding the effects of the drought on the management of the dwindling water resources.

The Netherlands, a country of about 41,000 km^2 located at 52°N latitude, is comprised of a low-lying western and northern section (between 5m above and 7m below mean sea level -- MSL) and a somewhat higher area in the center, east and south of the country (between 5m and 322m above MSL). The country includes the delta of the Rhine river, entering from Germany, and the Meuse and Scheldt rivers, entering from Belgium. The IJssel and Marker Lakes occupy a significant area in the center of The Netherlands. Seventy percent of the land area is cultivated, about nine percent is woodland, less than five percent consists of nature areas, and the rest (almost sixteen percent) is built up. Arable farming is mainly found in the north and southwestern part of the country and in the newly reclaimed polders in the central part of the country. Livestock farming is found in the low-lying western and central sections of the country, while mixed farming can be found in the eastern and southern areas.

Climate

The Netherlands has a rather cool and wet, maritime climate with an annual mean temperature of 9.4 °C (48.9 °F) and a average annual precipitation of 792 mm (31.2 inch) as of 1976. The average monthly temperature varies between about 2 °C (°F) in January and about 17 °C (°F) in July. Precipitation is rather equally distributed during the year, as well as spatially, locally varying not more than 20% up or down the country-wide average. The wettest areas are the hills in the east-central and far south of the country; the driest in the southeast and northwest areas of the country. It is estimated that the mean annual evapotranspiration for the country is about 500 mm (including the IJssel and Marker Lakes), varying from about 4 to 5 mm/day in the summer to about zero mm/day in the winter.

Water Management in The Netherlands

Water management in The Netherlands has to balance a number of sometimes conflicting water usages, including domestic, municipal, industrial, and agricultural water supply; transportation (rivers and canals); combat of salt water encroachment (in rivers, canals, and groundwater); cooling water use; nature; and environment. These water needs are primarily the major border-crossing rivers, precipitation, and storage in reservoirs and ground water.

The Drought of 1976

During the summer of 1976, the country received only 54% of the normal average precipitation during the period March through August. The chance of reoccurrence of such an event is about 0.3 percent. However, the chance of reoccurrence of the precipitation measured in 1976 is not equal for all parts of the country. For example, in Beek (Province of Limburg), the chance of reoccurrence of the 1976 situation is considerable greater (2%) than in most parts of the coastal zone (0.3-0.5%).

During the summer months of 1976 the average monthly temperatures were significantly higher than normal (May through August was 11% higher), resulting in high potential evapotranspiration (ET) values, especially in the southern provinces. Here, the highest potential ET values were about 20% above normal. The difference between the potential ET and the precipitation, the so-called potential net precipitation deficit, reached a maximum of 444 mm (normal maximum deficit is 155 mm). In years of extreme climatological conditions, the actual ET is severely restricted by the limited availability of water and thus differs significantly from the potential ET.

Because of the exceptional meteorologic situation in 1976, the demand for fresh water was greater than normal. The next most important source of fresh water (after precipitation) consists of the runoff of the border-crossing rivers, the Rhine and the Meuse. Because large areas of these river basins were also effected by the drought, their discharges were exceptional low. During almost all of 1976, the Meuse remained below the 10% low discharge occurrence frequency. In the period April through September, the average monthly discharge values were the lowest observed for this river since 1911. The Rhine also had very low discharges, especially during May, June, and July of 1976, when monthly discharges had an occurrence probability of 2.0, 5.0, and 0.5 percent, respectively. A small discharge peak to place during early August, after which the discharge fell off again to well under the 10 percent low discharge occurrence frequency. Although by early December the discharge of the Rhine had returned to normal , one can speak of a general drought persistence period for the Rhine, beginning in October 1975 and continuing through January 1977. From the water management point of view, a recombination of the small precipitation amounts in The Netherlands with the low Upper Rhine runoffs of 1976 must be considered, even though the likelihood of such a dry spell is possibly less than one percent.

The exceptional meteorologic circumstances of 1976 also had a major influence on ground water. In almost all areas of the country, extremely low ground water levels were observed. In some places the ground water levels continued to decrease until more than a year after the end of the drought, dependent upon the depth of the ground water below the surface. In the low lying parts of The Netherlands, ground water levels were frequently lower than any levels previously observed. However, despite the moderate amounts of precipitation in the winter half year 1976-1977, the ground water levels in the winter following the drought returned to normal. In the high elevation areas of the country where shallow ground water prevails, summer ground water levels were also very low, partly as an aftermath of the low levels during the preceding spring season. Here again, the observed ground water levels were often lower than any previously observed. As a result of both the 1976 drought and below-normal precipitation in the winter of 1976-1977, the

ground water levels did not return to normal in the following summer. In the higher regions having deep ground water, especially in the Veluwe, a hilly area in the center of the country, ground water levels were already decreasing as a result of a preceding series of dry winters. This trend began in 1970 and continued through 1977, with an interruption during the winter of 1975.

For an optimal distribution of the limited fresh water available under such circumstances, knowledge of specific water needs in time and location is essential. For example, in a number of water management sectors, demand in 1976 was above normal, especially during summer months. Notably, the demands of agriculture were heavy, and other needs had to be considered, such as municipal and industrial water supply, nature conservation, navigation, cooling water supply, and recreation.

The infrastructure utilized for water distribution in The Netherlands consists of the main rivers (Rhine, Lower Rhine, Meuse, Waal, IJssel, and Scheldt), the Amsterdam-Rhine Canal, the Northsea Canal, the IJssel and Marker Lakes, and the Southern Rhine Delta. Because of low discharges of the Rhine and the Meuse, the consequences of the 1976 drought on the national water system have been quite noticeable. Navigation was hindered by low water levels in the Upper Rhine, the Waal, and the IJssel, and by navigation restrictions on the Meuse. Large variations in water level occurred in the IJssel and Marker Lakes, and salinization has occasionally threatened the Hollandse IJssel, a major supply route of fresh water for Midwest Holland.

In analyzing the influence of droughts on the regional water distribution systems, a distinction must be made between the higher and lower regions of the country. Many areas in the higher regions have little or no external water supply. Therefore, during 1976 these regions experienced significant water shortages, especially with regard to agriculture. In the lower regions of the country, the quality of the water caused problems: large-scale salinization problems occurred because fresh water for flushing water courses was lacking.

In both the higher and lower regions of the country, partial agricultural needs wer met by large-scale use of sprinkler irrigation. In areas with external water supply, surface water was used to meet these needs. In areas without such external supply, significant amounts of ground water were withdrawn for sprinkling crops and grasslands.

Because of the high temperatures of the surface water and because possibilities for enlarging their external water supplies were serious limited, users of cooling water experienced shortages from the drought. The drought also had consequences for nature. Many young forest plantations were lost, and some rare and fragile organisms and ecosystems disappeared because of large decline of ground water levels.