INFLUENCE OF GLOBAL CLIMATIC PROCESSES ON THE HYDROSPHERE REGIME

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ABSTRACT: During the last century geophysical changes, presumably natural energetic processes, resulted in gradual climatic warming. It has caused intensification of natural water exchange, continental drying, glacier retreat and ocean replenishment. Increasing anthropogenic influence makes the water exchange period longer. All these processes have resulted in a global sea level rise at a rate of 1.5 mm per year. Future warming could amplify this process significantly.

Studies of the most recent decade indicate that quite significant climatic changes are connected with geophysical processes, particularly fluctuations of natural energetic factors.

Gradual increase in the mean global surface air temperature occurred during the last century in the Northern and Southern hemispheres, both on continents and in oceans (Fig. 1). Global climatic changes during the period of observations were determined by a complex of factors, the input of solar radiation to the Earth's surface being the primary one.

Recent climatic processes are closely connected with man's influence: greenhouse gases ejection, oil film formation in the ocean, vegetational successions, water consumption, agricultural activities, etc., which in turn, influence not only human activity but the conditions of human existence.

As a result of climatic warming intensity of natural water exchange increases, continents become drier, glaciers retreat and oceans extend. Growth of anthropogenic influence intensifies water vapour exchange, increases its duration and modifies natural water quality.

The considerable influence of the Earth's planetary evolution, i.e. the geological processes changing the Earth surface, on recent natural process variations should also be taken into account. Geological studies demonstrate topographical contrasts and a hydrosphere volume increase. This conclusion can be well shown by the analysis of ocean level fluctuations during the last 300,000 - 500,000 years. Its average fall rate is 0.3 mm per year until the end of the last ice age.

Ocean level observations show a general tendency towards sea level rise during the last 250 - 300 years at a rate of 1 mm per year with relative falls and rises occurring with a

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period of some 33 years. During the recent century the rate of sea-level rise has reached 1.5 mm per year. The most intensive rise at a rate of more than 3 mm per year occurred from 1924 to 1948 (Fig. 2). Now the sea level is falling at a rate of more than 2 mm per year on 4.7 % of the world shoreline and up to 2 mm per year on 7.9 %. It is relatively stable at 24 % of stations and is rising on 48.2 % at a rate of less than 2 mm per year. On 14.3 % of the world shoreline it is rising at a rate of more than 2 mm per year.

Interannual sea level rise is determined by changes in the global water exchange system, which, in turn, is associated with thermal fluctuations (Fig. 3). Sea level has risen simultaneously with a global temperature rise of 1 °C but with a 19-year time lag.

Global temperature rise and consequent activation of evaporation are accompanied by an increase in precipitation over both oceans and continents (Fig. 4). It results in humidification, which is more pronounced in coastal and nearby continental slopes. On the whole, the last century is characterized by a precipitation increase over continents (excluding Antarctica) at a rate of 0.25 mm a year (31 km^3 or 0.03 % per year).

Thermal fluctuations have caused a significant change in the global atmospheric circulation pattern. Total evaporation from the continents changed by some 0.3 mm (or 0.07%) per year; maximum changes were 6.5 % per year. Maximum values were typical for the 20's and 50's of the twentieth century; minimum values for the 80's and 90's of the nineteenth century (Fig. 5).

In the period under consideration the inland regions of continents generally tended to become drier due to the fact that the climate tended to become warmer. Thus, the surface runoff into undrained regions of Asia reduced by some 150 km^3, or 34 % of its average value. Runoff into undrained regions of Europe fell by some 50 km^3 (or 16 %) (Fig. 6).

Runoff decrease and evaporation increase have provoked a decrease in humidity, which is most noticeable in inland regions (Fig. 7) as a level and volume decrease of inland lakes. The present period is characterized by a significant fall in groundwater resources.

Temporal variations of groundwater level and volume can be observed in many areas (33 million km^2 or 25 % of the area of the Northern Hemisphere). According to this, groundwater level has fallen since the beginning of the twentieth century, the most reliable data relating to its fall during the period 1919-1950, particularly with the acceleration of this process in 1930, 1936-1939, 1947, 1950 (Fig. 8). A slight indication of a trend towards sea level rise began in 1951. In general, on continents it was falling by 8 mm per year so that its global volume fell by 108 km^3 per year.

Calculations show that during 1880-1975 a significant change occurred in the volume of mountain glaciers (Fig. 9). During the 1880's the main trend was towards the reduction in glacier mass due to reduced accumulation from precipitation. In 1900 for a short period of time glacier balance was stable (1902, 1910, 1924) with even positive accumulation in certain years (1913, 1917). This was caused by a gradual increase in precipitation and an inadequately developed warming trend. Critical disturbance of glacier balance was recorded in the 1930's and 1940's, when maximum increase in summer temperatures coincided with a sharp (8 %) fall of precipitation. By the 60's and 70's this process slackened as a result both of summer temperature fall and an increase in precipitation. On the whole, during the period of 1882-1975 the resulting water balance of continental mountain glaciers was