PRACE GEOGRAFICZNE, zeszyt 107

Instytut Geografii UJ
Kraków 2000

Ashot Volodia Khoetsian

GREENHOUSE EFFECT AND GLOBAL CHANGES OF CLIMATE (ON THE EXAMPLE OF THE REPUBLIC OF ARMENIA (RA))

Abstract: A number of global changes in environment have been observed at the end of the 20th century. Among these changes is the growth of greenhouse gas concentration in the atmosphere, which brings about the intensification of natural greenhouse effect and disturbance of natural radiation balance of atmosphere and the Earth. Being situated in the dry sector of subtropical zone Armenia is mostly affected by greenhouse effect. As a result of it, tendency to temperature increase and precipitation amount decrease is observed in the country, Droughts, hot dry winds have become frequent, dry lands have enlarged, arid mountainous landscapes have migrated upwards etc.

Key words: greenhouse effect, aridization, desertification, landscape degradation, greenhouse gases, dry wind.

Alongside the scientific-technological revolution in the 20th century, particularly its second half, climate has considerably changed to aridization, and the anthropogenic negative impact on landscape-nature has been intensified on our planet. By the end of the 20th century man consumed 14-15 bn tons of fuel, that increased the quantity of carbon dioxide. At the beginning of the 20th century the contents of carbon dioxide (CO_2) in the lower layer of the atmosphere, the toposphere, was 0.029%, at present it's 0.034%, or 0.04% (according to some authors).

The latter has intensified greenhouse effect, i.e., the gas swaddles the surface of the planet and hinders penetration of the radiation of surface warmth into the space. The more is the fuel consumption and contents of carbon dioxide in the atmosphere, the higher will the temperature on the Earth be (IPCC 1994).

Greenhouse gas increase in the atmosphere is regarded by scientists in two ways:

1) By means of greenhouse effect, the temperature increase on the over ground stratum of the surface and atmosphere of the Earth will cause the evaporation from the ocean, the increase of precipitation and carbon dioxide will stimulate the process of light synthesis like in the Carboniferous period.

2) Greenhouse effect will bring about aridization, precipitation decrease - in dry land countries, and precipitation increase - in humid lands.

As geographers-landscape scientists, we admit the second version, as the researches in the territory of the RA in the recent years state the second viewpoint so far. Being located in the central dry-continental sector of subtropical climatic zone, the RA possesses the features of arid zone. Aridization process has affected a number of countries, the RA among them (Gabrielian, Khoetsian 1999).

A national inventory of greenhouse gases has been worked up (Tsarukyan et al. 1999). With population constituting 0.06% of the population of the world, the RA contributed about 0.1% (in 1990) of global greenhouse gases emission. In 1995 the emission reduced by 80 % as a result of economic and energetic crisis in the 1990s.

The main greenhouse gases are CO_2, CH_4, N_2O, which constituted correspondingly 86.6%, 12.9% and 0.37% of emission in 1990. The overwhelming majority of it (93%) belongs to energetic sources. As a result of intensive eutrofication processes, due to man-made water level decrease, the lake Sevan became a source of methane emission. During the inventory anthropogenic emissions of the gases with indirect greenhouse effect: nitric oxide (NO_x), carbon oxide (CO) and volatile non-methane organic compounds, were estimated.

As a result of emissions and interior human microclimatic changes, an increase of average annual temperature and decrease of precipitation can be observed in the recent 4-5 decades in the territory of the RA, having dry continental climate. In comparison with the mean values for 1960-1990, the average temperature in 1998 increased by 2°C, while precipitation decreased by 10% (Tab. 1) (Melkonyan 1999; Hayrapetyan 1999).

The fact of temperature increase and precipitation decrease forms a chain reaction of desertification and aridization intensification in the area (Gabrielian, Khoetsian 1998; Gabrielian, Khoetsian 1999; Khoetsian 2000; Khoetsian, Hakopian 1999).

Tab. 1. Season and annual values of temperature and precipitation norms in 1998 in the RA.

Season	Temperature, ^{0} C			Precipitation, mm		
	Norm	1998	Difference		1998	%
Winter	-4,6	-4,1	0,5	98	75	77
Spring	5,7	7,3	1,6	198	190	96
Summer	17	19	2,0	145	127	88
Autumn	8,4	10,6	2,2	110	67	61
Year	6,6	8,2	1,6	551	459	83

As a result of precipitation decrease the average river discharge in some river basins has been reduced. At present the reservoirs constructed on rivers accumulate only 50-80% of the capacity, while, in the recent past, water filled up the reservoirs and in spring flowed out of them. Table 2 shows the average annual discharge of rivers before and after 1960. The water in the basins of selected stations isn't used in agriculture. The table demonstrates that river discharge has decreased and the decrease affects orchard-irrigation process negatively.

Temperature increase in the lower layer of atmosphere promotes evaporation capacity growth. For instance, evaporation capacity used to be 1000-1200 mm per year while, at present it has increased by 200 mm, in the lower parts (800-1300 m) of Ararat basin. As a result of it, soils get dry, the necessity in irrigation increases, while water reserves are reduced. It is necessary to use the water from lake Sevan for irrigation. It should be mentioned, that the level of this unique lake has decreased by 1 m, which is explained by water evaporation increase. Being influenced by greenhouse effect, the process of precipitation decrease is accompanied by precipitation intensity. Pluviogramme analysis demonstrates, that at present the maximum intensity of precipitation is more than 1.0 mm/min in case of 12-15% precipitation; however, it will rise to 30% and even more. According to our calculations, in case of 1.0%-0.1 % showers, in average height mountain belt it may rain intensively for a short period of time - 100-120 mm in 1 hour, and such showers may cause devastating mudflows. Showers are frequent in average height mountain belt, they occur 4-5 times per year. Thus, greenhouse effect in the RA can intensify mudflow process. At present, 60% of the territory in the RA is liable to mudflows. Precipitation decrease has caused the reduction of latent heat discharged for precipitation evaporation; consequently, temperature increases.

Tab. 2. Annual average discharge of several rivers (m^3/s).

River- Observation Post	Average annual discharge (m^3/s)	
	before 1960	after 1960
Akhurian - Kaps	7,79	6,65
Marmarik - Aghavnadzor	5,0	2,57
Masrik - Tsovak	3,59	3,10
Debed - Akhtala	33,4	27,59

As a result of temperature increase that process has been intensified and snow layer melts rapidly in high mountain areas. Today, the rivers carry 4 m tons of dissolved, rolling and swinging debris out of the borders of the RA every year; the quantity of the debris grows depending on greenhouse effect.

Water balance in the RA has been disturbed. Before 1960, water balance was as follows; precipitation - 18 bn m^3, evaporation 12 bn m^3, river runoff - 6 bn m^3 (ground waters are also considered). At present, due to precipitation decrease dynamic reserves of rivers have been reduced by 1-1.5 bn m^3, having negative impact on agriculture.

Precipitation amount decrease and temperature increase has stimulated weathering. Dry air mass influence has been intensified, droughts and hot dry winds have become more frequent, rains have reduced to occasional cases.

Evident climatic changes are reflected in landscapes as well. Greenhouse effect has affected landscapes, starting aridization process which will develop in a typical mountainous country of the RA with landscape altitude zonality (Aghasyan et al. 1999).

The area of desert-semidesert zone is expected to enlarge, a new desert zone will emerge and semidesert zone will set in the lower border of forests in South-

Eastern region. In case of desert-semidesert zone enlargement and possible reduction of lake areas and dry-up of salted marshes will occur, a number of vegetation communities growing in humid areas, as well as endemic and rare kinds of plants will disappear. Steppe zone may broaden and be re-located upper to 150-200 m, causing the transformation of steppe plant communities. The present low belt of steppes will be substituted for semidesert vegetation, while the steppes will spread over subalpine vegetation. Simultaneously, the steppes will cross lower forest border. The lower forest border will be re-located upper to 100-200 m. Forests will be more vulnerable because of the breeding of number of leave-eating parasites which will cause reduction of annual wood increase. Subalpine and alpine areas and their vegetation will be endangered. Endemic and rare types of plants will be also endangered as they'll have no space for replacement.

Climate change and landscape zone border dislocation may have a great impact on very vulnerable types of fauna in Armenia. Overall biomass of soil zoocomplexes, natural habitat and number of population of some kinds of insects, reptiles may decrease; endemic and rare types may disappear. Forced migrations and reduction of dwelling areas may decrease the number of some kinds of birds as well.

To relief the negative consequences of climate change for natural ecosystems in Armenia the following measures should be taken: formation of optimal landscape zone structure for the country; isolation of reserve areas and protected natural territories for the protection from anthropogenic pressure on vulnerable ecosystems; introduction of disappearing types of flora and fauna, preservation of biocoenoses during climate changes, preservation of genofund vulnerable and valuable types by means of breeding and cultivating, preservation of seeds in special cans and etc., monitoring of vulnerable ecosystems.

References

Aghasyan A.L., 1999, *The Vulnerability and Measures of Adaptation of Ecosystems of Armenia According to the Forecast Climate Change*, [in:] *Armenia. Climate change problems. Collected articles*, Yerevan, 89-101 (in Russian).

Gabrielian H.K., Khoetsian A.V., 1998, *Deserting and Degradation of Soils in RA*, [in:] *"Land Use and state control". The Materials of the Second Scientific Conference*, Yerevan, 63-68 (in Armenian).

Gabrielian H.K., Khoetsian A.V., 1999, *Climate Change and the Problem of Desertification in the Republic of Armenia (RA),* Towards Sustainable Development of Armenia, 2, 36-39 (in Armenian).

Gabrielian H.K., Khoetsian A.V., 1999, *Landscape Degradation and the Condition of Desertification in the RA,* [in:] *Collection of scientific articles. "Geography-99"*, 127-133 (in Armenian).

Hayrapetyan K.H., 1999, *Evaluation of Predicted Climate Change of Atmosphere Precipitations on the Territory of Armenia*, [in:] *Armenia. Climate Change Problems. Collected Articles*, Yerevan, 50-58 (in Armenian).

IPCC, 1994, *Radioactive Forcing of Climate Change: Report to the IPCC from the Scientific Assessment Working Group*, WG1/WMD/UNEP.

Khoetsian A.V., Hakopian Ch.Yu., 1999, *Spatial Transformation of Ecosystems in the Republic of Armenia and their Consequences,* [in:] *"Geographies of the future"*, RGS-IBG Annual Conference, Leicester, UK, 139.

Khoetsian A.V., 2000, *The Natural Factors of Desertification in the Territory of the RA*, [in:] *Proceedings of Republican Youth Scientific Conference*, Yerevan, 96-99 (in Armenian).

Melkonyan H.A., 1999, *Variability and Predictability of Climate Changes on the Territory of Armenia*, [in:] *Armenia. Climate Change Problems. Collected Articles*, Yerevan, 10-15 (in Armenian).

Tsarukyan M.H., Marjanyan A.H., Pasoyan A.V., 1999, *National Greenhouse Gas Inventory,* [in:] *Armenia. Climate Change Problems. Collected Articles*, Yerevan, 242-250 (in Russian).

Ashot Volodia Khoetsian
Department of Physical Geography
Yerevan State University
Yerevan
Armenia