G. M. FAYVUSH, A. S. ALEKSANYAN

CLIMATE CHANGE AS THREAT TO PLANT DIVERSITY OF ARMENIA

The article discusses the forecasted climate change of Armenia as one of the major threats for plant diversity of the country. The possible changes of main ecosystems of Armenia were assessed due to climate change forecasts. On this basis, was carried out the vulnerability of rare plant species included in the Red Book of plants of Armenia. According to the results of this evaluation it was indicated that for 239 plant species from 452 included in the Red Book of plants of Armenia (Tamanyan et al., 2010) the expected climate change will not be a serious threat to their existence. These are species with relatively wide ecological amplitude and adapted to ecosystems, which can be changed to a minor extent. For 139 species the climate change could be a positive factor, they can even extend their areals on the territory of Armenia. They are mostly heat-loving species growing in the ecosystems of the lower and middle mountain belts. For 74 species the climate change could be a very serious threat, as the changed conditions do not allow them to adapt and find suitable habitat in the country. These are mainly mesophilous species of sub-alpine and alpine belts.

Climate change, rare species of the flora of Armenia, ecosystem changes, threat for the existence of plant species

Ֆայվուշ Գ. Մ., Ալեքսանյան Ա.Ս. Կլիմայի փոփոխությունը որպես Հայաստանի բուսական բազմազանության սպառնալիք: Հոդվածում կլիմայի կանխատեսվող փոփոխությունը դիտարկվում է որպես հանրապետության բուսական բազմազանությանը սպառնացող կարևորագույն վտանգներից մեկը: Աշխատանքի ընթացքում գնահատվել են Հայաստանի հիմնական էկոհամակարգերի հնարավոր փոփոխությունները կախված կլիմայի փոփոխության կանխատեսումներից: Ինչի հիման վրա էլ կատարվել է ՀՀ բույսերի Կարմիր գրքում գրանցված հազվագյուտ բուսատեսակների խոցելիության գնահատում: Ելնելով ստացված արդյունքերից ցույց է տրվել, որ ՀՀ բույսերի Կարմիր գրքում գրանցված 452 տեսակներից (Tamanyan et al., 2010) 239-ի գոյության համար ենթադրվող կլիմայական փոփոխությունները լուրջ սպառնալիք չեն հանդիսանա: Սրանք հիմնականում ունեն մեծ էկոլոգիական ճկունություն և հարմարված են այնպիսի էկոհամակարգերի, որոնք կարող են ենթարկվել չնչին փոփոխությունների: 139 բուսատեսակների համար կլիմայի փոփոխությունը կարող է հանդես գալ որպես դրական գործոն, նրանց անգամ կարող են ընդլայնել իրենց արեալը Հայաստանի տարածքում: Սրանք հիմնականում ջերմասեր տեսակներ են, որոնք աճում են ստորին և միջին լեռնային գոտիներում: 74 բուսատեսակի համար կլիմայի փոփոխությունը կարող է հանդիսանալ շատ լուրջ սպառնալիք, քանի որ փոփոխվող պայմանները թույլ չեն տա հանրապետության տարածքում դրանց հարմարվել և գտնել հարմար աճելավայրեր: Սրանք հիմնականում մերձալպյան և ալպյան գոտիների մեզոֆիլ տեսաներն են:

Կլիմայի փոփոխություն, Հայաստանի ֆլորայի հազվագյուտ տեսակներ, էկոհամակարգերի փոփոխություններ, բուսատեսակների գոյատևման սպառնալիքներ

Файвуш Г. М., Алексанян А. С. Изменение климата как угроза растительному разнообразию Армении. В статье рассматривается прогнозируемое изменение климата Армении как одна из важнейших угроз фиторазнообразию республики. Оценены возможные изменения основных экосистем Армении в связи с прогнозом изменения климата. На этой базе проведена оценка уязвимости редких видов растений, включенных в Красную книгу Армении. По результатам этой оценки показано, что для 239 видов из 452 включенных в Красную книгу растений Армении (Tamanyan et al., 2010) предполагаемое изменение климата не станет серьезной угрозой для их существования. Это виды с относительно широкой экологической амплитудой и приуроченные к экосистемам, которые могут измениться в незначительной степени. Для 139 видов изменение климата может оказаться положительным фактором, они даже могут расширить свой ареал на территории Армении. Это преимущественно теплолюбивые виды, произрастающие в экосистемах нижнего и среднего горных поясов. Для 74 видов изменение климата может оказаться очень серьезной угрозой, так как изменившиеся условия не позволят им приспособиться и найти подходящие местообитания на территории республики. Это в основном мезофильные виды субальпийского и альпийского поясов.

Изменение климата, редкие виды флоры Армении, изменение экосистем, угроза существованию видов растений

Climate change is one of the most pressing environment and development challenges confronting humanity today. Over the past few decades, evidence has mounted that planetary-scale changes are occurring rapidly. These are, in turn, changing the patterns of forcing and feedbacks that characterize the internal dynamics of the Earth System. Key indicators, such as the concentration of CO_2 in the atmosphere, are changing dramatically, and in many cases the linkages of these changes to human activities are strong. It is increasingly clear that the Earth System is being subjected to a wide range of new planetary-scale forces that originate in human activities, ranging from the artificial fixation of nitrogen and the emission of greenhouse gases to the conversion and fragmentation of natural vegetation and the loss of biological species. It is these activities and others like them that give rise to the phenomenon of global change (Rizvi et al., 2015).

The present global biota has been affected by fluctuating Pleistocene (last 1.8 million years) concentrations of atmospheric carbon dioxide, temperature, precipitation, and has coped through evolutionary changes, and the adoption of natural adaptive strategies. Such climate changes, however, occurred over an extended period of time in a landscape that was not as fragmented as it is today and with little or no additional pressure from human activities. Habitat fragmentation has confined many species to relatively small areas within their previous ranges, resulting in reduced genetic variability. Warming beyond the ceiling of temperatures reached during the Pleistocene will stress ecosystems and their biodiversity far beyond the levels imposed by the global climatic change that occurred in the recent evolutionary past.

Current rates and magnitude of species extinction far exceed normal background rates. Human activities have already resulted in the loss of biodiversity and thus may have affected goods and services crucial for human well-being. The rate and magnitude of climate change induced by increased greenhouse gases emissions has and will continue to affect biodiversity either directly or in combination with other drivers of change (www.iucn.org).

There is sample evidence that climate change affects biodiversity. According to the Millennium Ecosystem Assessment, climate change is likely to become one of the most significant drivers of biodiversity loss by the end of the century. Climate change is already forcing biodiversity to adapt either through shifting habitat, changing life cycles, or the development of new physical traits. The Polar Bear has come to symbolize the impacts of climate change on the natural world. But it is only one of a multitude of species affected, and many of these are also well-known, much-loved and important to people (Species…, 2015).

In this article we have tried to assess the possible threat from the impact of climate change on the most rare and vulnerable plant species, included in the Red Book of Armenia (Tamanyan et al., 2010). The big part of these species are local endemics or have very restricted in their distribution and very sensitive to ecological conditions. As well many of them have global importance for world plant diversity. From this point of view they are the most vulnerable element of Armenian flora, and their conservation has priority among all other activities.

Material and Methods

The main reference data for this study have been taken the long-term meteorological information from 44 meteorological stations located throughout the country in different altitudinal belts, received from the Governmental Non-Commercial Organization "Armenian State Hydrometeorological and Monitoring Service". Current distribution of natural ecosystems in altitudinal belts and in territory of Armenia was accounted on the basis of our own long-term studies, as well as have been used literature data of vegetation of Armenia (Магакьян, 1941; Тахтаджян, 1941 и др.).

For evaluation of current distribution and confinement of the rare plant species to specific ecosystems have been used data collected during the preparation of the publication of the Red Book of plants in Armenia (Tamanyan et al., 2010).

Prediction of climate change in Armenia have been taken from the Second and Third National Communication on Climate Change in Armenia (Second…, 2010; Third…, 2015). According to data of meteorologists and climatologists changes in annual ambient temperature and precipitation in Armenia have been assessed for various time periods; the results were used in preparations for First and Second National Communications (First…, 1998; Second…, 2010). These results show that, in recent decades, there has been a significant temperature increase. In the period of 1929-1996, the annual mean temperature increased by 0.4°C; in 1929-2007 by 0.85°C; in 1929-2012 by 1.03C. The comparison of changes in the assessment of precipitation amounts for different periods demonstrates that precipitation continues to decline. Observations showed that, in 1935-1996, there was a 6% decrease in annual precipitation, while in 1935-2012 it was close to a 10% decline. The spatial distribution of changes in precipitation amounts is fairly irregular. Over the last 80 years, the climate in the northeastern and central (Ararat Valley) regions of the country has turned arid, while precipitation has increased in the southern and northwestern regions, as well as in the western part of the Lake Sevan basin.

Prediction of climate change for different scenarios of greenhouse gas emissions is given in the Third National Communication on Climate Change (Third…, 2015). Climate change in Armenia is assessed using the CCSM4 model in accordance with the IPCC recommended RCP8.5 and RCP6.0 scenarios for CO_2 emissions. Therefore, as per the RCP6.0 scenario (equivalent to the SRES B2 scenario) CO_2 concentration will be 670 ppm by 2100 and it will be 936 ppm according to the RCP8.5 scenario (equivalent to the SRES A2 scenario). Future change forecasts for ambient air temperature and precipitation have been developed up until 2100. The results indicate that the temperature will continue to increase in all seasons of the year (Table 1). However, according to the RCP8.5 scenario, starting from the mid-21th century (2041-2100) the temperature will rise at a more rapid rate. According to the RCP8.5 scenario, it is very likely that, by 2100, the average annual temperature in Armenia will be 10.2°C, which exceeds the baseline (1961-1990) by 4.7°C. Evaluation results for precipitation change (Table 2) show that, according to the RCP8.5 scenario, there might be 16.3% increase in annual precipitation in Armenia by the mid-21st century. There will be no changes in precipitation according to the RCP6.0 scenario. However, according to both scenarios for the summer months there is an expected significant decrease in precipitation in all 3 periods: in 2011-2040 summer precipitation is expected to decrease by about 23% compared to the baseline (1961-1990) period.

Table 1.

Projected changes in annual and seasonal average temperatures in the territory of Armenia compared to the average for 1961-1990, °C (Third…, 2015)

Seasons	1961-1990 average	Scenarios	2011-2040	2041-2070	2071-2100
Winter	-5.3	RCP, 6.0	1.4	2.6	3.6
		RCP, 8.5	1.7	2.8	4.4
Spring	4.3	RCP, 6.0	1.3	2.4	2.7
		RCP, 8.5	1.4	2.7	3.9
Summer	15.7	RCP, 6.0	1.9	3.0	3.8
		RCP, 8.5	2.1	4.0	6.0
Autumn	7.2	RCP, 6.0	0.8	2.3	3.0
		RCP, 8.5	1.4	3.2	4.4
Year	5.5	RCP, 6.0	1.3	2.6	3.3
		RCP, 8.5	1.7	3.2	4.7

Table 2.

Changes in annual and seasonal precipitation in the territory of Armenia compared to the average of 1961-1990, mm (Third…, 2015)

Seasons	1961-1990 average	Scenarios	2011-2040	2041-2070	2071-2100
Winter	114	RCP, 6.0	5.3	5.8	6.2
		RCP, 8.5	-5,7	16.3	2.9
Spring	211	RCP, 6.0	1.2	4.2	2.6
		RCP, 8.5	4.2	-8.0	2.4
Summer	148	RCP, 6.0	-10.1	-10.8	12.8
		RCP, 8.5	-23.0	-3.4	-13.0
Autumn	119	RCP, 6.0	5.0	3.2	1.2
		RCP, 8.5	2.5	8.6	13.6
Year	592	RCP, 6.0	5.3	5.8	6.2
		RCP, 8.5	-5.7	16.3	2.9

In assessing the vulnerability of the most important ecosystems and, therefore, the rare plant species were also used scenarios for individual seasons and different regions of the country (Tables 3, 4) that were given in the Second National Communication on Climate Change (Second ..., 2010).

Table 3.

Changes in seasonal and annual temperatures (°C) compared to the average for 1961-1990, according to PRECIS model under A2 scenario of IPCC (Second…, 2010)

Region	Winter	Spring	Summer	Autumn	Year
2030					
North East	1	1	1	0	1
Sevan Lake basin	1	1	2	2	1
Shirak	1	1	1	1	1
Aparan-Hrazdan	2	2	1	1	1
Ararat valley	1	2	0	1	1
Vayk	1	2	2	1	1
Syunik	0	1	1	1	1
Armenia	**1**	**1**	**1**	**1**	**1**
2070					
North East	3	3	3	1	2
Sevan Lake basin	3	2	4	4	3
Shirak	3	3	3	3	3
Aparan-Hrazdan	4	5	2	3	3
Ararat valley	3	4	1	2	2
Vayk	3	4	4	3	3
Syunik	1	1	3	2	2
Armenia	**3**	**3**	**3**	**3**	**3**
2100					
North East	3-5	3-5	4-5	1-3	3-5
Sevan Lake basin	4-6	3-5	5-7	5-7	4-6
Shirak	3-5	3-5	3-6	4-6	4-6
Aparan-Hrazdan	4-7	6-8	2-4	4-6	4-6
Ararat valley	2-6	4-7	1-3	2-4	3-5
Vayk	5-7	5-7	5-7	5-7	5-7
Syunik	1-3	2-3	3-5	2-4	2-4
Armenia	**4**	**5**	**4**	**4**	**4**

Table 4.

Deviations of seasonal and annual precipitation (%) compared to the average for 1961-1990, according to PRECIS model under A2 scenario of IPCC (Second…, 2010)

Region	Winter	Spring	Summer	Autumn	Year
2030					
North East	7	2	-9	7	3
Eastern shore of Lake Sevan	-7	-4	-9	-2	-8
Western shore of Lake Sevan	7	4	-5	5	4
Shirak	-11	-11	-7	-4	-8
Aparan-Hrazdan	-11	-7	-11	-7	-9
Ararat valley	-13	-9	-13	-9	-11
Vayk	-11	-11	-9	4	-7
Syunik	15	11	5	15	11
Aragats	11	11	2	13	9
Armenia	**-3**	**-3**	**-7**	**1**	**-3**
2070					
North East	15	4	-18	15	7
Eastern shore of Lake Sevan	-15	-7	-18	-4	-11
Western shore of Lake Sevan	15	11	-11	11	6
Shirak	-21	-21	-15	7	-16
Aparan-Hrazdan	-21	-15	-21	-15	-18
Ararat valley	-25	-18	-25	-18	-22
Vayk	-22	-22	-18	7	-13
Syunik	29	22	11	29	22
Aragats	22	22	4	-25	18
Armenia	**-5**	**-5**	**-14**	**3**	**-6**
2100					
North East	20	5	-25	20	10
Eastern shore of Lake Sevan	-20	-10	-25	-5	-15
Western shore of Lake Sevan	20	10	-15	15	10
Shirak	-30	-30	-20	-10	-22
Aparan-Hrazdan	-30	-20	-30	-20	-25
Ararat valley	-35	-25	-35	-25	-30
Vayk	-30	-30	-25	10	-18

Syunik	40	30	15	40	30
Aragats	30	30	5	35	25
Armenia	**-7**	**-8**	**-19**	**3**	**-9**

As a basic model for assessing the vulnerability of natural ecosystems of Armenia and for further forecasting of changes of favorable climatic conditions was used the scheme «Holdridge Life Zones» (Holdridge, 1966), which is a specific graph (Fig. 1), where the most important factors are «Bio-temperature» - temperature, which corresponds to the conditions for growth and development of plants (this is the average monthly temperature between 0° to 30°C); the average monthly precipitation and humidity of air, herewith the humidity can be ignored, since it will be automatically calculated.

Substituting the necessary meteorological data and taking into account dominant ecosystems of surroundings of meteorological stations, we carried out the adaptation of current scheme for mountainous conditions of Armenia. Specifically, for example, the position of sub-alpine meadows was determined in the scheme, which was absent. During next period was carried out substitution of changed conditions (bio-temperature and precipitation) under climate change scenarios for various periods. On this basis, was assessed the vulnerability of main natural ecosystems.

Vulnerability assessment of certain rare species, included in the Red Book of Armenia, was carried out mainly on the basis of the vulnerability of ecosystems to which they are adapted.

Results and discussion

Vulnerability assessment of main natural ecosystems shows that in the period from now until 2100 the following changes are expected (Алексанян, 2013; Aleksanyan et al., 2015; Fayvush, 2015):

Alpine meadows. Prediction of changes of bioclimatic conditions shows that the general direction of condition changes will not be in the direction of sub-alpine meadows, as expected, but in the direction of subalpine tall-grasses and expansion of wetlands.

Sub-alpine meadows. The transition is predicted to meadow-steppes, possibly extension of forest ecosystems on the territory of current meadows. In forest regions probably will occur raising of upper limit of the forest and in non-forest regions - transition to meadow-steppe ecosystems.

It has to be noticed that alpine and sub-alpine meadows are the most vulnerable natural ecosystems in Armenia.

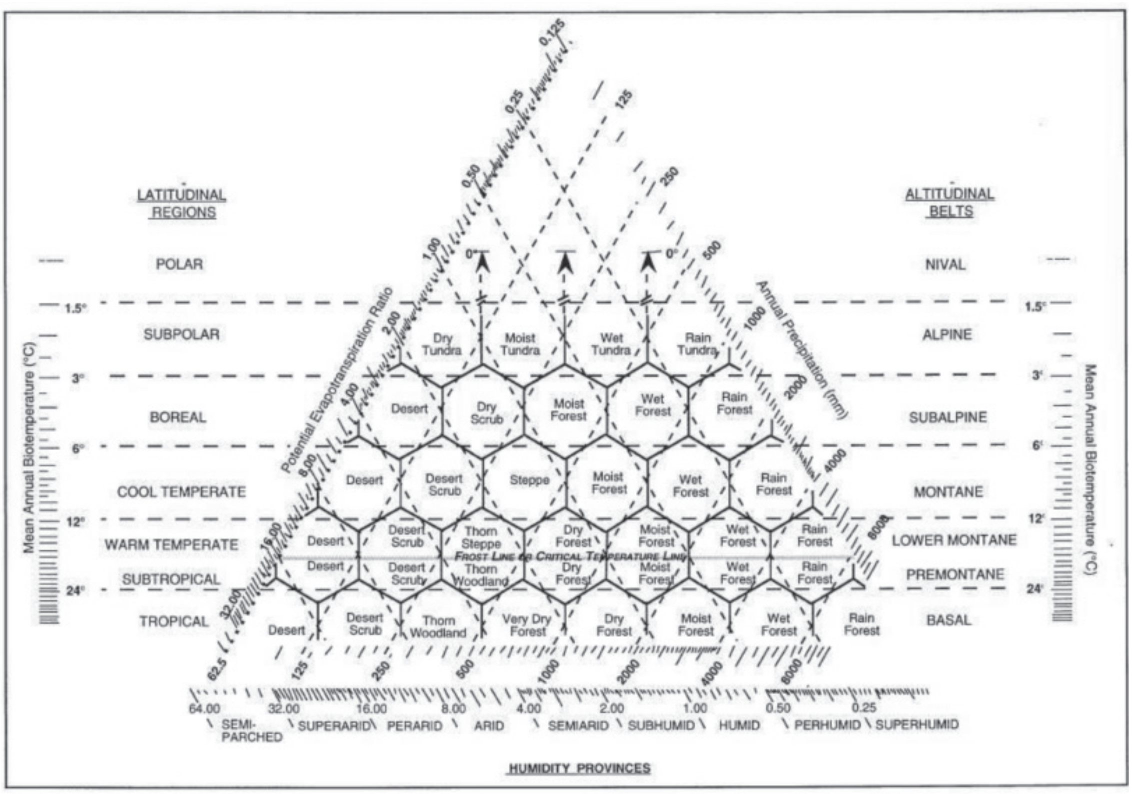

Fig. 1. Holdridge’s Life Zones

Forests. In the humid forests of the middle belt probably will begin processes of xerophytization, thinning and penetration of plants of the steppes, arid woodlands and shibliak. Some xerophytization of wet forests will move it into the humid forests. Modern forests of subalpine zone with time will be replaced to common humid forests, there will occur rising of upper limit of forest vegetation with a corresponding shift of subalpine crooked forests and park forests.

Meadow-steppes. Mostly is expected to transition of these ecosystems the steppes, in some cases (when the amount of precipitation will be increased), the formation of subalpine tall-grasses, and sometimes will be possible extension on the territory of modern forest ecosystems.

Steppes. The general direction of ecosystem changes is xerophytization. The modern dry steppes can be replaced to phryganoids, the areas of traganth steppes will be expanded. Current relatively mesophile steppe ecosystems can be replaced to drier sub-types.

Semi-desert. In the most of cases, is assumed the conservation of semi-desert vegetation, with an extension of phryganoid zone. Also is expected expansion of areas of desert ecosystems, such as solonchaks and saline deserts.

Shibliak and arid woodlands. In general, the conditions of these ecosystems will conserve and even slightly will increase, but natural regeneration of trees and shrubs can be worsen, and eventually these ecosystems, especially in the lower mountain belt can be replaced to phryganoids.

Petrophilous ecosystems and **wetlands** are intrazonal, and their vulnerability depends on their altitudinal and geographical locations.

In summary, the proposed changes of conditions in main natural ecosystems of Armenia are given in the Table 5*.

After analyzing of possible changes of ecosystems under climate change, we've assessed the threats for individuals of plant diversity from this factor. Of course, we've focused on rare and endangered species, included in the Red Book of Armenia.

As we know, in the Red Book of plants of Armenia (Tamanyan et al., 2010) 452 species of vascular plants are included, while already here for 87 species the climate change is referred as one of the main threats for their existence in the territory of Armenia.

During analysis of possible impact of climate change on rare and endangered plant species, we have taken into account not only the possible changes in ecosystems and the ecological amplitude of the adaptation of these species, the diversity of habitats in which these species can be conserved, the abundance of their populations, but also other internal and external factors. Herewith it is necessary to consider that climate change can have both negative and positive impacts on populations and distribution of rare and endangered species.

Assessing all these factors, we've concluded that for 239 species included in the Red Book of Armenia expected climate change will have no significant impact. These species generally grow in ecosystems that are preserved under any scenario of climate change, or they have fairly wide ecological amplitude, so they can adapt to the changing conditions or easily find new habitats in the case of forced migration.

According to our hypotheses for 139 plant species included in the Red Book of plants of Armenia as a result of climate change conditions will significantly improve (Table 6). At first, these are thermophilous species, for wider distribution of which now clearly amount of effective temperatures is missing. Herewith frequently doesn't matter their relation to one or another ecological group of water demand. In particular, among these plants are moisture-loving species (hydro- and hygrophilous), which are growing in water, on the banks of reservoirs, or mesophilic species - growing in forests of the lower mountain belt, including early spring ephemera (eg, *Sternbergia fischeriana, Pteridium tauricum Oenanthe silaifolia, Carpesium abrotanoides, Rorippa spaskajae* et al.).

Therefore, for all these species expected climate change cannot be considered as a threat for their existence in the territory of Armenia and should pay attention to reducing the negative impact of other factors.

Table 6.

Plant species included in the Red Book of plants of Armenia, for which the expected climate change is not a threat for existence or will act as positive factor

Species	Category in the Red Book of Armenia	Ecosystems
Pteridium tauricum V.Krecz.	CR B 1 ab(iii) + 2 ab(iii)	Fringes, riversides
Allium akaka S.G.Gmel.ex Schult. et Schult.	CR B 1 ab(iii) + 2 ab(iii)	Phryganoids, stony places
Sternbergia fischeriana (Herb.) M.Roem.	CR B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Fringes, shibliak

* See color illustration pages

Actinolema macrolema Boiss.	EN B 1 ab(ii,iii,iv) + 2 ab (ii, iii, iv)	Semi-desert
Aphanopleura trachysperma Boiss.	EN B 1 ab(ii,iii) + 2 ab(ii, iii)	Semi-desert
Bupleurum pauciradiatum Fenzl ex Boiss.	VU* B 1 ab(ii,iii) + 2 ab(ii,iii)	Shibliak, open arid woodlands
Dorema glabrum L.	CR B 1 ab(i,ii,iii,iv,v) + 2 ab(i,ii,iii, iv,v)	Phryganoids
Eryngium wanaturii Woronow	EN B 1 ab(ii,iii,iv,v) + 2 ab(ii,iii,iv,v)	Steppes, meadow-steppes
Falcaria falcarioides (Bornm. et H.Wolff) H.Wolff	CR* B 1 ab(ii,iii,iv) + 2 ab(ii,iii,iv)	Wetlands, saline soils
Ferula szowitsiana DC.	VU* B 1ab(ii,iii,iv) + 2 ab(ii,iii,iv)	Semi-deserts
Hohenackeria exscapa (Stev.) Kos.-Pol.	EN B 1 ab(ii,iii,iv) + 2 ab(ii,iii,iv)	Semi-deserts, dry steppes
Oenanthe silaifolia M. Bieb.	CR B 2 ab(ii,iii,iv)	Wetlands, saline soils
Peucedanum pauciradiatum Tamamsch.	CR B 1 ab(ii,iii,iv) + 2 ab(ii,iii,iv)	Phryganoids
Szovitsia callicarpa Fisch. et C.A.Mey.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Semi-desert, dry steppes
Aristolochia iberica Fisch. et C.A.Mey. ex Boiss.	EN B 1 ab(i,iii,iv) + 2 ab(i,iii,iv)	Forests
Asphodeline lutea Rchb.	CR B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Forests, fringes
Asphodeline taurica (Pall.) Kunth	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Steppes, meadow-steppes, steppe shrubs
Amberboa amberboi (L.) Tzvel.	CR B 1ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Semi-desert
Amberboa iljiniana Grossh.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Semi-desert
Amberboa moschata (L.) DC.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Semi-desert, dry steppes
Amberboa sosnovskyi Iljin	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Semi-desert, phryganoids
Amberboa turanica Iljin	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Semi-desert
Calendula persica C.A.Mey.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Semi-desert, shibliak, open arid woodlands
Carpesium abrotanoides L.	EN* B 1 ab(ii,iii) + 2 ab(i,ii,iii)	Wetlands
Centaurea alexandrii Bordz.	EN B 1 ab(ii,iii) + 2 ab(i,ii,iii)	Phryganoids, open arid woodlands
Centaurea arpensis (Czer.) Wagenitz.	EN B 1 ab(ii,iii) + 2 ab(i,ii,iii)	Phryganoids, open arid woodlands
Centaurea erivanensis (Lipsky) Bordz.	VU* B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Semi-dert, steppes, phryganoids, traganth communities
Centaurea vavilovii Takht. et Gabrielian	CR B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Steppes, meadow-steppes
Cousinia erivanensis Bornm.	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Phryganoids, open arid woodlands
Cousinia gabrieljanae Takht. et Thamanjan	EN B 1 ab(i,ii) + 2 ab(i,ii)	Shibliak
Cousinia megrica Takht.	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Shibliak, open arid woodlands

Cousinia qaradaghensis Rech. fil.	CR B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Open arid woodlands
Cousinia tenella Fisch. et C.A.Mey.	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Semi-desert
Crupina intermedia (Mutel) Walp.	VU* B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Open arid woodlands
Echinops polygamus Bunge	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Phryganoids
Lactuca takhtadzhianii Sosn.	EN B 1 ab(ii,iii) + 2 ab(ii,iii)	Semi-desert, steppes
Rhaponticoides hajastana (Tzvelev) Agababian et Greuter	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Steppes
Rhaponticoides tamanianae (Agababian) Agababian et Greuter	CR B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Steppes, steppe shrubs
Scorzonera gorovanica Nazarova	EN B 1 ab(iii) + 2 ab(iii)	Semi-desertt, sandy desert
Tomanthea carthamoidos (DC.) Takht.	CR A 2abc; B 1 ab(i,ii,iii,iv,v) + 2 ab(i,ii,iii,iv,v); C 1 + 2(i); D	Semi-desert, phryganoids
Tomanthea daralaghezica (Fomin) Takht.	EN B 1 ab(ii,iii) + 2 ab(i,ii,iii)	Steppes, phryganoids, open arid woodlands
Tragopogon collinus DC.	EN B 1 ab(iii) + 2 ab(iii)	Semi-desert, phryganoids
Tragopogon tuberosus K. Koch.	VU B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Steppes, meadow-steppes, steppe shrubs
Leontice armenica Belanger	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Semi-desert
Nonea polychroma Selvi et Bigazzi	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Semi-desert
Nonea rosea (Bieb.) Link.	VU* B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Steppes, open arid woodlands
Rochelia cardiosepala Bunge	EN B 1ab(i,ii,iii,v) + 2 ab(i,ii,iii,v)	Steppes
Crambe armena N. Busch.	CR B 1 ab(iii) +2 ab(iii)	Semi-desert
Diptychocarpus strictus (Fisch.) Trautv.	CR B 1 ab(ii,iii) + 2 ab(ii,iii)	Semi-desert
Hesperis persica Boiss.	EN B 1 ab(iii) + 2 ab(iii)	Steppes, phryganoids
Leptaleum filifolium (Willd.) DC.	EN B 1 ab(iii) + 2 ab(iii)	Semi-desert
Pachyphragma macrophyllum (Hoff.) N. Busch	CR B 1 ab(iii) + 2 ab(iii)	Forests
Peltariopsis grossheimii N. Busch.	CR B1 ab(iii) + 2 ab (iii)	Phryganoids
Pseudoanastatica dichotoma (Boiss.) Grossh.	EN B 1 ab(iii) + 2 ab(iii)	Phryganoids
Rorippa spaskajae V. I. Dorof.	CR B1ab(iii)+2ab(iii)	Wetlands
Sameraria glastifolia (Fisch. & C. A. Mey.) Boiss.	CR B 1 ab(iii) + 2 ab(iii)	Phryganoids
Thlaspi umbellatum Stev.	CR B 1 ab(iii) + 2 ab(iii)	Phryganoids, shibliak, open arid woodlands
Cercis griffithii Boiss.	CR B 1 ab(iii) + 2 ab(iii)	Semi-desert, phryganoids
Campanula propinqua Fisch. et C. A. Mey.	VU* B 1 ab(iii) + 2 ab(iii)	Phryganoids
Allochrusa takhtajanii Gabr. et Dittr.	CR B 1 ab(iii,v) + 2 ab(iii,v)	Semi-desert
Arenaria brachypetala (Grossh.) T. N. Popova	CR B 1 ab(ii,iii,iv) + 2 ab(ii,iii,iv)	Semi-desert, phryganoids

Bufonia takhtajanii Nersesian	CR B 1 ab(ii,iii,iv,v) + 2 ab(ii,iii,iv,v)	Phryganoids
Dianthus libanotis Labill.	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Semi-desert, phryganoids
Gypsophila stevenii Fisch. et C. A. Mey. ex Fenzl	CR B 1 ab(ii,iii) + 2 ab(ii,iii)	Shibliak
Minuartia sclerantha (Fisch. et C. A. Mey.) Thell.	EN B 1 ab(iii) + 2 ab(iii)	Deserts, semi-desert, phryganoids
Beta lomatogona Fisch. et C. A. Mey.	CR B 1 ab(iii) + 2 ab(iii)	Steppes, semi-desert
Beta macrorrhiza Stev.	VU* B 1 ab(iii) + 2 ab(iii)	Steppes, meadow-steppes
Bienertia cycloptera Bunge	CR* B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Solonchaks
Halanthium kulpianum (K. Koch) Bunge	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Semi-desert
Halocnemum strobilaceum (Pall.) M.Bieb.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Solonchaks
Halostachys belangeriana (Moq.) Botsch.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Solonchaks
Kalidium caspicum (L.) Ung.-Sternb.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Solonchaks
Salsola aucheri (Moq.) Bunge ex Iljin	EN B 1 ab(iii) + 2 ab(iii)	Semi-desert
Salsola tamamschjanae Iljin	EN B 1 ab(iv) + 2 ab(iv)	Deserts, semi-desert
Salsola tomentosa (Moq.) Spach	EN B 1 ab(iii) + 2 ab(iii)	Semi-desert
Andrachne rotundifolia C.A.Mey.	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Phryganoids
Euphorbia aleppica L.	CR B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Semi-desert
Argyrolobium trigonelloides Jaub. et Spach	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Phryganoids
Astragalus achundovii Grossh.	CR B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Semi-desert
Astragalus commixtus Bunge	CR B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Phryganoids
Astragalus corrugatus Bertol.	CR B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Saline semi-desert
Astragalus guttatus Banks et Sol.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Steppes
Astragalus holophyllus Boriss.	EN B 1 ab(i,ii) + 2 ab(i,ii)	Sandy desert, phryganoids
Astragalus montis-aquilis Grossh.	EN B 1 ab(iii) + 2ab(iii)	Petrophyton
Astragalus ordubadensis Grossh.	CR B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Phryganoids
Astragalus paradoxus Bunge	EN B 1ab (i,ii,iii,iv) + 2ab (i,ii,iii,iv)	Deserts, semi-desert
Astragalus schelkovnikovii Grossh.	CR B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Deserts, semi-desert
Astragalus vedicus Takht.	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Phryganoids
Colutea komarovii Takht.	CR B 1 ab(i,ii,iii,iv,v) + 2 ab(i,ii,iii,iv,v); C 2a; D	Phryganoids
Coronilla cretica L.	EN* B 1ab(i,ii,iii) + 2 ab(i,ii,iii)	Shibliak
Lathyrus setifolius L.	VU* 1 ab(i,ii,iii) + 2 ab i,ii,iii)	Shibliak, fridges
Lens ervoides (Brign.) Grossh.	VU* B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Phryganoids, steppes
Medicago arabica (L.) Huds.	VU* B 1ab(iii) + 2ab(iii)	Wetlands, fringes
Onobrychis hajastana Grossh.	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Steppes, phryganoids

Onobrychis meschchetica Grossh.	CR B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Shibliak
Spaerophysa salsula DC.	VU* B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Salt marshes, wetlands
Trifolium angustifolium L.	EN* B 1 ab(iii) + 2 ab(iii)	Steppe shrubs, fringes
Trifolium grandiflorum Schreb.	VU* B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Shibliak, phryganoids
Trigonella astroides Fisch. et C.A.Mey.	EN 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Phryganoids
Frankenia pulverulenta L.	CR B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Salt marshes
Gladiolus szovitsii Grossh.	EN B 1 ab(iii) + 2 ab(iii)	Semi-desert, shibliak, open arid woodlands
Iris atropatana Grossh.	EN B 1 ab(iii) + 2 ab(iii)	Phryganoids, traganth communities
Micromeria fruticosa (L.) Druce	VU* B 1 ab(iii) + 2 ab(iii)	Phryganoids
Salvia spinosa L.	EN* B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Steppes
Salvia suffruticosa Montbr. et Auch. ex Bunth.	EN B 1 ab(iii) + 2 ab(iii)	Steppes
Teucrium canum Fisch. et C.A.Mey.	CR B 1 ab(iii) + 2 ab(iii)	Steppes
Tulipa sosnovskyi Achv. et Mirzoeva	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Open arid woodlands, petrophyton
Alcea karsiana (Bordz.) Litv.	EN B 1 ab(iii) + 2 ab(iii)	Steppes
Alcea sophiae Iljin	EN B 1 ab(iii) + 2 ab(iii)	Steppes
Malvella sherardiana (L.) Jaub. et Spach	EN B 1 ab(iii) + 2 ab(iii)	Semi-deserts, disturbed habitats
Nitraria schoberi L.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Saline semi-desert
Ophrys apifera Huds.	CR B 1 ab(ii,iii,v) + 2 ab(ii,iii,v)	Shibliak
Orchis punctulata Stev. ex Lindl.	VU* B 1 ab(ii,iii,iv) + 2 ab(ii,iii,iv)	Forests, fridges, shibliak, steppe shrubs
Orchis stevenii Rchb. f.	EN B 1 ab(ii,iii,iv) + 2 ab(ii,iii,v)	Forests, meadows, wetlands
Orchis tridentata Scop.	EN* B 1 ab(ii,iii,iv) + 2 ab(ii,iii,v)	Forests
Steveniella satyrioides (Spreng.) Schlechter	EN B 1 ab (ii,iii,iv) + 2 ab(ii,iii,iv)	Open arid woodlands, fringes, glades
Cistanche fissa (C.A.Mey.) G.Beck	EN B 1 ab(i,ii,iii,iv)+ 2 ab(i,ii,iii,iv)	Salt marshes, saline semi-desert
Cistanche salsa (C.A.Mey.) G.Beck	EN* B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Saline semi-desert
Paeonia tenuifolia L.	CR B 1 ab(iii) + 2 ab(iii)	Shibliak, open arid woodlands
Acantholimon fedorovii Tamamsch. et Mirzoeva	CR B 1 ab(iii) + 2 ab(iii)	Phryganoids
Acantholimon festucaceum (Jaub. et Spach) Boiss.	CR B 1 ab(iii) + 2 ab(iii)	Phryganoids
Rhizocephalus orientalis Boiss.	VU* B 1 ab(iii,iv) + 2 ab(iii,iv)	Phryganoids, desert, semi-deserts, dry steppes
Asterolinon linum-stellatum (L.) Duby	CR B 1 ab(ii,iii) + 2 ab(ii,iii)	Phryganoids
Cyclamen vernum Sweet	VU* B 1 ab (ii,iii) + 2 ab(ii,iii)	Forests, fringes
Clematis vitalba L.	EN* B 1 ab(iii) + 2 ab(iii)	Fringes

Reseda globulosa Fisch. et C.A.Mey.	CR B 1 ab(ii,iii,iv) + 2 ab(ii,iii,iv)	Phryganoids
Amygdalus nairica Fed. et Takht.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Open arid woodlands, phryganoids
Rubus takhtadjanii Mulk.	EN B 1 ab(i,ii) + 2 ab(i,ii)	Fringes, disturbed habitats
Rubus zangezurus Mulk.	EN B 1 ab(ii) + 2 ab(ii)	Forests, fringes, shibliak
Jaubertia szovitzii (DC.) Takht.	VU* B 1 ab(iii) + 2 ab(iii)	Phryganoids
Leptunis trichodes (J. Gay) Schischk.	EN* B 1 ab(iii) + 2 ab(iii)	Phryganoids
Verbascum atroviolaceum (Sommier et Levier) Murb.	EN B 1 ab(iii) + 2 ab(iii)	Steppes, shibliak
Verbascum erivanicum E.Wulf	CR B 1 ab(iii) + 2 ab(iii)	Phryganoids
Verbascum formosum Fisch. ex Schrank	EN B 1 ab(iii) + 2 ab(iii)	Fringes, glades, open arid woodlands
Verbascum megricum (Tzvel.) Huber-Morath	EN B 1 ab(iii) + 2 ab(iii)	Shibliak, open arid woodlands
Smilax excelsa L.	EN B 1 ab(i,ii,iii,v) + 2 ab(i,ii,iii,v)	Fringes, open woodlands
Atropa belladonna L.	VU B 1 ab(ii,iii,iv) + 2 ab(ii,iii,iv)	Forests, glades, disturbed habitats
Lycium anatolicum A.Baytop et C.Mill.	EN B 1 ab(ii,iii,iv) + 2 ab(ii,iii,iv)	Phryganoids, disturbed habitats
Valerianella kotschyi Boiss.	CR B 1 ab(iii) + 2 ab(iii)	Steppes, phryganoids

On the other hand, according to a the conducted modeling of changes of ecosystems and habitats due to the climate change, for 74 species of vascular plants, included in the Red Book of plants of Armenia, this factor will be the one of threats to determine the possibility of their existence in Armenia (Table. 7).

Table. 7.

Plant species included in the Red Book of plants in Armenia, for which climate change can be expected as the main threat for existence

Species	**Category in the Red Book of Armenia**	**Ecosystems**
Athyrium discentifolium Tausch ex Opiz.	EN* B 1 ab(iii) + 2 ab(iii)	Rhodorets
Botrychium lunaria (L.) Sw.	VU* B 1 ab(iii) + 2 ab(iii)	Meadows
Polystichum lonchitis (L.) Ruth.	EN B 1 ab(iii) + 2 ab(iii)	Meadows
Ophioglossum vulgatum L.	CR B 1 ab(iii, iv) + 2 ab(iii, iv)	Forests
Thelypteris palustris Schott	CR B 1 ab(iii) + 2 ab(iii)	Wetlands
Acanthus dioscoridys L.	CR B 1 ab(iii) + 2 ab(iii)	Meadow-steppes
Acorus calamus L.	EN B1 ab(i,ii,iii,iv) + 2 ab(ii,iii)	Wetlands
Sagittaria sagittifolia L.	CR B 1 ab(ii,iii,iv) + 2 ab(i,ii,iii,iv)	Wetlands
Sagittaria trifolia L.	CR B 1 ab(ii,iii,iv) + 2 ab(i,ii,iii,iv)	Wetlands
Allium derderianum Regel	EN B 1 ab(iii) + 2 ab(iii)	Petrophyton
Allium egorovae Agababian et Ogan.	CR B 1 ab(iii) + 2 ab(iii)	Meadows
Sternbergia colchiciflora Waldst. et Kit.	EN B 1 ab(ii,iii,iv) + 2 ab(i,ii,iii,iv)	Semi-desert, dry steppes
Antennaria caucasica Boriss.	EN B 1 ab(iii) + 2 ab(iii)	Meadows

Anthemis caucasica Chandjian	EN B 1 ab(iii) + 2 ab(iii)	Meadow-steppes, meadows
Centaurea elbrusensis Boiss. et Buhse	EN* B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Meadows
Centaurea schelkovnikovii Sosn.	CR B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Meadows, petrophyton
Centaurea takhtadzianii Gabrielian & Tonjan.	CR B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Steppes, disturbed habitats
Echinops ritro L.	CR B 1 ab(i,ii,iii) + 2 ab(i,ii,iii); D	Meadow-steppes
Grossheimia caroli-henricii (Gabrielian et Dittr.) Gabrielian	CR B 1 ab(iii) + 2 ab(iii)	Fringes, disturbed habitats
Inula acaulis Schott et Kotschy ex Boiss.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Meadows, wetlands
Sonchus araraticus Nazarova et Barsegian	CR B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Salt marshes
Tanacetum zangezuricum Chandjian	EN B1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Paracaryum laxiflorum Trautv.	CR B 1 ab(i,ii,iii,v) + 2 ab(i,ii,iii,v)	Steppes
Didymophysa aucheri Boiss.	CR B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Draba araratica Rupr.	EN B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Draba hispida Willd.	CR B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Eunomia rotundifolia C.A.Mey.	EN B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Isatis takhtajanii V.Avet.	EN B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Physoptychis caspica (Habl.) V.Boczantzeva	EN B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Pseudovesicaria digitata (C.A.Mey.)Rupr.	CR B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Dianthus cyri Fisch. et C.A.Mey.	EN B 1 ab(ii,iii) + 2 ab(ii,iii)	Salt marshes, shibliak
Silene eremitica Boiss.	EN B 1 ab(ii,iii,iv) + 2 ab(ii,iii,iv)	Semi-deserts
Silene meyeri Fenzl. ex Boiss. et Buhse	EN B 1 ab(i,iii,iv,v) + 2 ab(ii,iii,iv,v)	Alpine petrophyton
Silene raddeana Trautv.	EN B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Microcnemum coralloides (Loscos et Pardo) Font-Quer	EN B 1 ab(iii,iv) + 2 ab(iii,iv)	Salt marshes
Salsola soda L.	EN B 1 ab(iii) + 2 ab(iii)	Wet solonchaks
Colchicum ninae Sosn.	EN B 1 ab(i,ii,iii,v) + 2 ab(i,ii,iii,v)	Wetlands
Merendera sobolifera Fisch. et C.A.Mey.	CR* B 1 ab(i,ii,iii,v) + 2 ab(i,ii,iii,v)	Salt marshes
Carex oligantha Steud.	CR B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Carex pendula Huds.	EN* B 1 ab(iii) + 2 ab(iii)	Forests, wetlands
Carex pyrenaica Wahlenb ssp. *micropodioides* (V.I.Krecz.) Kandjan	CR B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Eriophorum latifolium Hoppe	VU* B 1 ab(iii) + 2 ab(iii)	Meadows
Kobresia persica Kuek. et Bornm.	CR B 1 ab(iii) + 2 ab(iii)	Meadows
Cephalaria nachiczevanica Bobr.	CR B 1 ab(iii) + 2 ab(iii)	Sub-alpine meadows
Rhododendron caucasicum Pall.	EN B 1 ab(iii,iv) + 2 ab(iii,iv)	Rhodorets
Vaccinium uliginosum L.	EN B 1 ab(iii) + 2 ab(iii)	Meadows
Astragalus agasii Manden.	CR B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Alpine petrophyton

Astragalus divaricatus Boiss.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Meadows
Astragalus globosus Vahl	CR B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Meadows
Astragalus grammocalyx Boiss.et Hohen.	CR B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Meadow-steppes, open arid woodlands
Astragalus schuschaensis Grossh.	CR B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Petrophyton
Trigonella capitata Boiss.	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Wetlands
Vavilovia formosa (Stev.) Fed.	EN B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Lomatogonium carinthiacum (Wulfen) A.Br.	VU* B 1 ab(iii) + 2 ab(iii)	Wetlands
Erodium sosnowskyanum Fedor.	CR B 1 ab(i,ii,iii,v) + 2 ab(i,ii,iii,v)	Meadows
Scilla rosenii K. Koch	EN B 1 ab(i,ii,iii,iv) + 2 ab(i,ii,iii,iv)	Wetlands
Iris grossheimii Woronow ex Grossh.	EN B 1 ab(iii) + 2 ab(iii)	Steppes, open arid forests, meadow-steppes
Iris sibirica L.	VU* B 1 ab(iii) + 2ab(iii)	Wetlands
Juncus acutus L.	EN B 1 ab(i,ii,iii) + 2 ab(i,ii,iii)	Wetlands
Dracocephalum botryoides Stev.	EN B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Nepeta lamiifolia Willd	EN B 1 ab(iii) + 2 ab(iii)	Petrophyton
Linum barsegianii Gabrielian et Dittr.	CR B 1 ab(ii, iii) + 2 ab (i,ii,iii)	Salt marshes
Menyanthes trifoliata L.	VU* B 1 ab(iii) + 2 ab(iii)	Wetlands
Chamaenerion dodonaei (Vill.) Kost.	EN* B 1 ab(iii) + 2 ab(iii)	Wetlands
Amblyopyrum muticum (Boiss.) Eig	CR B 1 ab(iii) + 2 ab(iii)	Steppes
Bromopsis gabrielianae Ogan.	CR B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Bromopsis zangezura Ogan.	EN B 1 ab(iii) + 2 ab(iii)	Steppes, meadows
Triticum araraticum Jacubz.	VU* B 1 ab (iii) + 2 ab (iii)	Steppes
Triticum urartu Tumanian ex Gandilyan	EN B1ab(iii)+2ab(iii)	Steppes
Asperula affinis Boiss. et Huet	EN B 1 ab(iii) + 2 ab(iii)	Steppes, steppe shrubs
Cruciata sosnowskyi (Manden.) Pobed.	CR B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton
Thesium compressum Boiss. et Heldr.	CR B 1 ab(iii) + 2 ab(iii)	Salt marshes
Thesium procumbens C.A.Mey.	EN* B 1ab(iii) + 2 ab(iii)	Meadows, fringes
Viola caucasica Kolenati ex Rupr.	CR B 1 ab(iii) + 2 ab(iii)	Alpine petrophyton

This group of plants includes, first of all, species adapted to mesophilic conditions of subalpine and alpine zones, for which climate change will lead to a dramatic reduction of area and diversity of these ecosystems and habitats. These species are, for example, *Botrychium lunaria, Antennaria caucasica, Eriophorum latifolium, Rhododendron caucasicum, Lomatogonium carinthiacum, Scilla rosenii* and others. This group of plants includes also the inhabitants of freshwater wetland habitats of the lower and middle mountain belts, the areas of this kind of habitats will be clearly reduced due to decreasing of precipitation and increasing of temperature (*Carex pendula, Trigonella capitata, Thelypteris palustris* and others). In addition, the threat of climate change is real for mesophilic species of steppes, meadow-steppes and meadows, populations of which are small in number or are isolated from habitats, which will be available in a result of climate change. This group includes *Acanthus dioscoridys, Sternbergia colchiciflora, Grossheimia caroli-henricii, Cephalaria nachiczevanica* and others. As we have noted above, for all of these species climate change will be one of the major threats for existence, but it should be remembered, that for most of them there are other no less serious threats also, in particular, that most of them are growing in areas of intensive economic activities and negative impact of anthropogenic factor, which can be decisive.

Conclusions

Forecasted climate change will cause a change of nearly all ecosystems of Armenia, which will affect on the status of populations and distribution of many rare and endangered plant species included in the Red Data Book in Armenia. In some cases, these changes will have a positive impact and will contribute to the improvement of the status of populations and the wider dissemination of rare species.

In other cases, it will have a clearly negative impact, and in extreme cases, can lead to complete disappearance of some species from the territory of the republic. The main adaptation measures for rare plant species to climate change are the following.

1. For conservation of rare and endangered species in in-situ conditions should have healthy natural ecosystems as much as possible, to apply restoring measures for disturbed ecosystems, deal with problems of restoration of natural ecosystems on the places with completely destroyed vegetation.
2. On specially protected natural areas should have as much as possible diversity of ecosystems, habitats and microclimatic conditions. This will allow the rare and endangered species to find refuge in conditions of changing climate. That is, the network of protected areas of the country should include the most possible diversity of ecosystems and habitats, and in the planning and allocation of new protected areas, this factor should be considered mandatory (Dudley et al., 2015).
3. It's necessary to continue research of the status of populations of rare plant species of Armenia and organization of effective system of monitoring to detect the first signs of degradation and to adopt necessary measures for their conservation.
4. It should be given more attention to the abilities to save rare and endangered plant species in ex-situ conditions as living collections, seed and gene banks, on specialized plantations.

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Institute of Botany NAS RA
Acharyan str. 1, 0040, Yerevan, Armenia
gfayvush@yahoo.com, alla.alexanyan@gmail.com