Identification and implementation of adaptation response to Climate Change impact for Conservation and Sustainable use of agro-biodiversity in arid and semi-arid ecosystems of South Caucasus

Ecosystem Assessment Report

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Executive Summary

Armenia is a mountainous country, which is distinguished with vulnerable ecosystems, dry climate, with active external and desertification processes and frequency of natural disasters. Country's total area is 29.743 sq/km. 76.5% of total area is situated on the altitudes of 1000-2500m above sea level. There are seven types of landscapes in Armenia, with diversity of their plant symbiosis and species. All Caucasus main flora formations (except humid subtropical vegetation) and 50% of the Caucasus high quality flower plant species, including species endowed with many nutrient, fodder, herbal, paint and other characteristics are represented here. "Identification and implementation of adaptation response to Climate Change impact for Conservation and Sustainable use of agro biodiversity in arid and semi-arid ecosystems of South Caucasus" project is aimed to identify the most vulnerable ecosystems in RA, in light of climate change, assess their current conditions, vulnerability level of surrounding communities and the extend of impact on ecosystems by community members related to it. During the project, an initial assessment has been conducted in arid and semi arid ecosystems of Armenia to reveal the most vulnerable areas to climate change, major threats have been identified, main environmental issues: major challenges and problems of arid and semi arid ecosystems and nearly located local communities have been analyzed and assessed. Ararat and Vets Door regions are recognized as the most vulnerable areas towards climate change, where vulnerable ecosystems are dominant. Semi desert ecosystem: with odorant Artemisia (near Paruyr Sevak community), thorny pillow-like ecosystem, formed by Onobrichis cornuta species (near Zangakatun community) and ecosystem formed by wild cereals (in the area stretched between Aghavnadzor and Rind communities).

1. Introduction

Armenia is distinguished with its rich and unique biodiversity. The small territory of Armenia is inhabited by 3500 high quality plant species, more than 17500 species of invertebrates, of which 500 species are vertebrate animals. The number of low quality plats and micro-organisms exceeds a few ten thousands. With the density of high quality plants, Armenia occupies leading places in the world: over 100 species per 1sq/km. The significant part of biodiversity is represented by endemic and rare species. Armenia is considered to be one of world agro-biodiversity centers: pre-homeland for crops and wild relatives of domestic animals and the largest hearth of gene pool. Until now, there is a rich diversity of cereals and wild relatives of crops, which is a natural source for many new varieties of crops. Three of four species of wild wheat known in the world, are growing in the territory of Armenia: (Triticum boeoticum Boiss.), (T. urartu Tumanian ex Gandilyan) and (T. araraticum Jakubz.), which are specified with inner diversity (more than 110 different varieties):

Armenia actively exploits bio-resources of its rich nature for 5–6 millenniums, where composition of species is significantly changed, and simultaneously certain relationship is formed among human and natural biodiversity. According to the climate change scenarios adopted, in 2030 the decrease in yield of agricultural main crops by 8-14% is projected, including grains – 9-13%, vegetables – 7-14%, potato – 8-10% and fruits-5-8%. Decrease in total area of pastures and their yield by 4-10% is anticipated, including more valuable pastures in subalpine and alpine zone, by 19-22%. Decrease is possible in crop yield of meadows by 7-10%, which will lead to decrease in volumes of fodder production. The study analysis indicates that Vayots Dzor and Ararat regions are distinguished by ecosystems vulnerability and climate changes, particularly strengthened and frequent occurrences of meteorological phenomenon (droughts, sandstorms, hails, early spring frosts). For the inventory of flora, which is a base for floristic assessment, project implementation team has conducted complex studies of different ecosystems met in nearby areas of 7 communities of Ararat and Vayots Dzor regions (Paruyr Sevak, Chiva, Areni, Rind, Aghavnadzor, Getap)

2. The overall geographical, ecological and socio-economic characteristics of selected administrative districts

An Area

The total territory of Republic Armenia is 29743 km2. It occupies not large part of north-eastern area of Armenia Plateau. Maximum extent from north-west to south-east is about 360km, from west-east 200km. RA territory is divided into 10 regions: Aragatsotn, Ararat, Armavir, Gegharkunik, Lori, Kotyak, Shirak, Syunik, Vayots Dzor, Tavush. The territory of RA Vayots Dzor region is 2287,9 km. Vayots Dzor marz embraces Vayk and Yeghegnadzor regions, with 44 communities, of which 3 are urban, 41 are rural communities. The territory of Ararat region is 2096,0 km. Ararat marz embraces Ararat, Artashat and Masis regions, with 97 communities, of which 4 are urban, 93 are rural communities.

Altitude

The 76.5% of its territory is situated on the altitudes of 1000-2500 m above sea level. Amplitude of altitudes is pretty big and comprises 2720 meter. The lowest point is 800m in Ararat Valley, and the highest point is 3520m in watershed of Vardenis Mountain ranges. The highest point in Vayots Dzor region is Mountain Vardenis, with the height of 3522m, and the lowest point is in Arpa Valley, about 920m. An average height of surface area is 2220m. In lowlands of the region, up to 1400m altitude, the climate is dry, with large temperature fluctuations up to 400mm precipitations. The middle zone, which encompasses altitudes of 1400-2800mm, is typical with mountain prairie and mountain forest landscapes. The mountain prairie is distinguished by long moderate winters and 500-600mm precipitations. Forest landscape is represented by the island forms (an area is 5,7%, or 13240ha), the climate is mild, with dry, mild winters, annual precipitations comprise 700-800mm. Highland zone is characterized by alpine meadows, which mainly are on steppe slopes of high mountains, wavy and narrow mountain ridges. The climate is cold; precipitations comprise 800-900mm.

Relief

Southern mountain ranges of Armenia, where the studied territory is located, are characterized by predominance of middle and low relief structures, arid - denudation in the north-west and erosion - denudation and arid - denudation in the south – east. In the north-west part of the region, south-western wing of Geghama anticlinorium and Yerevan-Vedi synclinorium, made by upper Cretaceous, Paleogene and Miocene sediments. It is characterized by parallel, acutely curved, prominent to the north - west anticlines, separated by broad synclines. The region is characterized; a) asymmetry of different mountain ranges is distinguished with long slopes of southern exposition, with short northern exposition and non-compliance with the folding: b) dense and deep dissection of the relief, which reaches up to1,300 m in the valley of the river Yeghegis; c) intensive erosion and denudation, and active mudflow processes; d) diversity lithological composition; e) inadequate water balance; f) warm and arid climate; and at last g) almost absence of forest cover, excluding sparse and shrubs in the upper basin of Arpa river.

Depending on the relief, the complexes of physic-geographic components are subject to vertical zoning. Three mountain belts are separated here, lowland /up to 140m/, middle land /from 1400 to 2800/ and

highlands /more than2800 m/. In the region, Teksar massif has a special relief-location, which is situated between the middle part of the valley Elegis to the north and Midd-Arpin basin to the south and corresponds to Teksar brachyanticline stretching north-west, hinge of which almost coincides with the axis of mountain range, composed of volcanic sediments of Middle Eocene. Thus, in the Teksar massif direct correlation with relief and tectonics is observed. On the southern and eastern slopes of Teksar massif predominates river erosion. Valleys of rivers Malishka, Her-her, Gladzor have V-shaped transversal profile, with slopes of average steepness (20° – 25°). The depth of these valleys is more in the upstream, where it reaches 150-250m, than in middle stream. In the southern ridges, the relief mainly reflects an overall plan of the structure and is characterized by expression of direct and active tectonics. A direct correlation of relief and structure is most clearly expressed on the west of the Vayots Dzor mountain ranges, on Urts ridges, in massifs of Teksar and Yeraskh, as well as in the basins of Shagap and Middle-Arpin.

The region has intensively dissected relief, especially within the limits is folded- block of mountains with linearly elongated, narrow and not very long ranges, separated by synclinal and graben shaped basins, stretching mostly in the north-west, on sublatitudinal sub-meridianalnom directions. Significant part of the region occupies belt of middle height mountains with erosion-denudation and arid-denudation sculpture mainly in the northern and eastern part of the basin of river Arpa. The slopes dissected by quite deep (from 200 – 300m) river valleys with V shaped transversal profile.

Soils, land degradation, desertification and causes

Agricultural lands comprise 71,6% of Republic Armenia's territory, about 2129,6 thousands/ha, forest lands comprise 12,5%, specially protected nature areas-7,4%, water lands-0,9%; settlements, industrial, communication, transportation, utility infrastructures lands-5,4%, other lands-1,3%. Due to non rational use of land resources, about 80% of soils are distinguished by desertification characteristics and various degrees of land degradation. According to assessment, land degradation is a result of weathering by 50%, over-moisture 20%, mudflows and floods 30%, hail 17%, landslides 3%, rockfalls 0,5%, which affects soil crop yield an decreases biodiversity. Unequal distribution of cattle grazing, incorrect organization of hay making, use terms and imperfect norms of workload and absence of control over their maintenance: pastures, about 1125.0 thousands/ha area is mainly overgrazed, and meadows, about 127.5 thousands/ha area is disqualified in terms of productivity and plants. The surface of Vayots Dzor region is motley. In southern dry climate conditions, on the altitudes of 1100-1330m, semi-desert gray, irrigated meadow gray soils are distributed, which are continued with broad layer of mountainous brown soils on altitudes of 1500-1600m. Natural forests comprise 5,7% of the territory or 13240,1ha area. As of 2010, agricultural lands comprise 194104 ha area, of which 162170 ha is arable lands. Crop lands occupy 4476 ha area. State owned-various lands about 17371.76 ha area located in administrative borders of several communities of Vayots Dzor region is transferred under category of specially protected nature areas and allocated to "Reserve Complex" SNCO under RA Ministry of nature protection for termless right of use. Natural landscapes of Ararat region mainly have semi-desert or desert characteristics. The area is distinguished by semi-desert gray, irrigated meadow gray, paleo-hydromorphe, saline alkaline, brown, black-soil meadow-black, river-valley rising ground, soil grounds, forest gray and mountain-meadow soil types. Special attention and care is needed for semi-desert and hydro-morph saline alkaline soils.

Semi-desert gray soils occupy areas on the altitudes of 850-1250m: lowland hill-wavy planes of foothill zone of Ararat Valley and are characterized with no great power of humus horizons (25-40sm), low humus content (up to 2%), stoniness, fabric and considerable content of carbonates. Below carbonate horizons gypsum bearing layers are met. Salinization is observed in some places. Such soils have weak and average reaction

(pH 7.7-8.2), a little absorption (20-30mg/eqv.). Hydo-morph saline alkaline soils are formed in those parts of the Ararat Valley, where ground waters are mineralized and near to soil surface (1-2m). These soils are characterized by high salinization (amount of salts: 1-3%), considerable carbonate, low humus (<1.0%), high base (pH 9-11), high content of absorbed sodium. Sodan occupies significant place in among slats, which makes difficult melioration works of that soils. Agricultural lands of Ararat region comprise 156577 ha, of which arable lands are 27947,7ha.

Modern relief forming processes are expressed by weathering, denudation, erosion and sedimentation. Climate conditions of south-eastern ridges of Ararat Valley (depression) and Arpa river basin, contribute to the enhanced mechanical destruction of rocks under the influence of weathering, mainly thermal and frosty, as well as biochemical processes. Under conditions of complex tectonics and various forms of relief, folded and fold-blocky mountains of the region are distinguished by strong erosion dissection, because they were continually exposed to erosional impact. In the volcanic areas of the region, an erosional dissection is weak compared with above mentioned mountains, which is mainly linked to their young age of formation. In the basins of Arpa and Vedi rivers, characterized with their continental climate, in summer on the top of the rocks daily temperature amplitudes reach up to 40 – 500C, and sometimes even more. Under the impact of such fluctuations species are destroyed and huge quantitative materials of different formations is accumulated on the surface of relief. Under denudation, the combination of processes is considered, demolition of weathering products.

Studied territory is an intensive area of denudation, which is in functional dependence of the pace of neotectonic movements. From the territory of Armenia, layer is being denudated an average with the capacity of 1mm/year. From the upper Pliocene to the present, tectonic uplift comprises from 0.6 to 1.0 mm/year. This means, that denudation is six times weaker then tectonic uplift speed, thus, all big forms of reliefs are results of tectonic processes, and erosion performs secondary role, that is the role of sculptor. The best quantitative indicator planar washout, is a solid flow of rivers (see section Hydrology), that combines the activities of all the factors of denudation and gives the average picture of planar erosion of basin, located above this section given. For the basins of Arpa and Vedi rivers, the denudation meter is equal to 12000 years, thus layer with the thickness of 1m, washed off for 12000 years. The most intense denudation observed in the medium-zone and in the foothills, as well as in the arid lowlands with intensive development of gravity displacements. Moreover, the following picture is observed in erosion of soils: relatively small soil erosion is identified in those regions, where mainly black, meadow - steppe and mountain - steppe soils are developed.
The most soil erosion is identified in the chestnut, mountain brown and brown forest types in Vayots Dzor region. This way, soil erosion increases from mountain meadows to dry steppe chestnut and semi-desert brown soils. Deep erosion of rivers plays significant role in the process of relief formation. Formation of deep valleys is connected with tectonics uplifts and influence vivid power of rivers. In the upper Pliocene the gorge of river Yeghegis with the depth of 400-700m, was formed in the quaternary period. In the middle mountain areas, physical weathering predominates with arid denudation relief; these plots are distinguished by strong erosional dissection with temporary mountain groups. In the valleys, dissection met among lowlands, is increased by temporary watercourses and intensive physical weathering in dry climate, so that tis characterized by badlands. On the south-western slopes of outlying ridges of Ararat Valley the power of denudation increases in parallel with an increase of slope. In the lower parts, 40-80 tons is eroded from $1km^2$, in middle height mountains up to 120 tons, and on fold – blocky mountains, this index is equal to 150-500 ton.

The most intensive denudation takes place on the part of the relief, where badlands are distributed, it means in this case in the lowlands and middle lands of the basins of Arpa and Vedi rivers. In the river basins of Arpa and Vedi, erosional processes are more intensive than in Armenian territory as a whole. There are parts in the above mentioned basins, where 300-500tons is eroded from 1km^2 per year, and in some places even up to 700tons of weathered materials. Sometimes from steep slopes, 20-30tons is washed away from 1ha. This is what can cause uncontrolled implementation of agricultural works. Intensity of denudation is often increased in the result of anthropogenic activity. In some areas of studied region, the slopes are almost bare. Planar erosion is intensified on the mountain slopes due to improper organization of livestock grazing. In the middle mountain areas, road erosion has reached in large-scales due to lack of appropriate road network. Erosional processes highly depend on vertical zoning. The greater the height, the weaker the denudation processes is.

Mudflows and landslides are typical in the river basins of Arpa and Vedi. In these areas an amount of precipitations comprises 200 – 400mm; they are mostly in the form of heavy rains, which is a good factor for denudation, and frequent mudflows. Mudflows most intensively occur in the areas of sedimentary and volcanic sedimentary rocks, mainly forming fold-blocky mountains of the region, where gravity processes have an intensive development. In the case of change in relief, the great role are playing mudflow processes with saturated by 50 -60% and even 70% of solid material, threatening, distinguished by great destructive power, sudden, short nature, which wash out a huge amount of weathered material. Mudflow formation in the river basins of Arpa and Vedi, mainly connected with heavy rains or hails, if the right amount of solid material is weathered. Mudflows of basin: complex synthesis, created by many terms that for now could be characterized by combination of quantitative indicators. In the formation of mudflows phenomenon also embraces enormous topographical and geological-geomorphological factors: the size and shape of catchment basin, the level of surface dissection, slopes, especially lithological-petrographic composition of rocks and structures, exogenous processes, their interaction with endogenous processes and etc. In one mudflow, in a few hours, so much solid materials get out from basin, which is impossible for 8-10 year, under normal erosion. Distribution of landslide hearths in the river basin of Arpa, mainly linked with explosive disturbances in the chalk - Eocene sedimentary and volcanic - sedimentary rocks. Such hearths mainly located in the areas, where above mentioned rocks are distributed, that is in the river basins of Yelpin, Chiva, Rind and Aghavnadzor, on the area nearly 40km2, and have 97 active appearances. In the river basins Arpa and Vedi, especially in the areas of calcareous sedimentary rocks stretching in the form of steep and inaccessible slopes, gravity forms of relief is widespread, in the form of rockfalls, landslides, avalanches and gravity of cones. Possible climate change could lead to a weakening or strengthening of erosion processes. In what direction erosion processes will go the detail studies will help to reveal, which will be taken place in future, at least during 3-4 year.

Hydrology

The territory of Armenia is far from oceans and large seas. The power of solar radiation, the duration and mechanism of atmospheric circulation are not favorable for the formation of sufficient water resources for the territory given. Moisture in our territory comes with the help of air masses making circulation in the flow west – east. These movements are conditioned with rotation of cyclones and anticyclones, formed in boreal fronts. Under impact of high mountainous and rather complex relief, atmospheric fronts are getting active and affect extraction of moisture in the form of snow and rain. Due to unequal spatial and seasonal distribution of atmospheric precipitations, water resources also have unequal distribution. If on the slopes of outlying ridges under influence of strong winds amount of atmospheric precipitations reaches up to 1000mm, then on the closed intermountain basis an amount reaches no more than 200mm. This is the one of the most important

factors; there is almost lack of surface runoff and low density of river network on low and foothill zones. Rivers of studied regions have several common patterns conditioned with broken relief and mountain climate. One of these patterns is that nutrition of rivers is almost exceptionally takes place due to snowmelt, groundwater and rainwater. River network of Ararat and Vayots dzor regions relates to rivers basin of Araks. The biggest and abounding river in the region is Arpa (excluding the river of Araks). Under abovementioned conditions of nutrition, rivers have unstable regime and are distinguished by a large fluctuation in water level. Floods usually occur in spring, only in some cases, in September-October. In autumn and winter, there is a lowest water level in rivers observed. Increase in water level, usually occurs after heavy rainfall and snowmelt in spring. This period is extended with increase in elevation of relief, so the longer the river, the longer the period is. In the period of spring floods it comprises 50-70% of annual runoff.

One more important pattern is the nature of Mountain Rivers. Exceptionally almost all rivers in the region originate from high mountain areas, have a significant fall (1000 – 2600m), high speed and flow through narrow, sometimes impassable gorges, in many places forming waterfalls and rifts. In terms of groundwater, the regions is not distinguished, except small number and unequal distribution of ground water outflows and springs, which are mainly located on the slopes of southern exposition of Geghama and Vardenic mountain ranges. On the slopes of Urts mountain range, in the Ararat regions, hydrocarbonate mineral springs come to the surface. The Biggest River in the territory observed is Arpa r9iver, which by its length (128 km) occupies fourth place in the region. Catchment basin is 2080 km^2. The most important tributaries are Aratsoget, yelpin, Yeghegis, Her-her, Maishka, Martiros, Aghavnadzor, Grav and etc. There are several reservoirs in the region, which have been built for irrigation purposes. The biggest reservoir is Ketchut reservoir on the river Arpa in the village Ketchut near the town of Jermuk, from where derives Arpa-Sevan channel. In the Ortun reservoir on the river Aratco, spring melt waters are collected, mainly for irrigation of lands Zangakatun village and nearby villages as well. Reservoir has also water regulation goal. Reservoir near the village of Gndevaz, does water catchment and protection function and also with the help of Gndevaz canal, it being used for irrigation of agricultural lands. With the purpose of water catchment and containment, there is a cascade near Paruyr Sevk village, which consist of two small reservoirs, in which stored water is used for irrigation purposes. Waters of river Arpa fall into Sevan by unique hydraulic structure: the channel of "Arpa-Sevan" to save the level of lake. From the south-western slopes of Geghama highlands, at altitudes of 2500m, River Vedi originates from several springs and through narrow and deep valley runs to western direction. The length of the river if 58km, volume of watershed basin is 633 км², an average height of the basin is 2035m.

Climate

Ararat region is situated in south-eastern part of the Armenia. The climate of the region is continental with warm sunny summers and cold winters. The region is one of the arid regions in Republic. In July, in Ararat Valley an average temperature fluctuates within 24-26^{0}C: An absolute maximum temperature recorded in Republic was 43^{0}C, which was observed in Artashat town, in the capital of Ararat region. An average quantity of annual precipitations in Ararat Valley comprises 200-250mm, while in summer a quantity of precipitations recorded on average doesn't exceed 32-36mm. Hydro-meteorological observations are not conducted in all communities.

Vayots Dzor region is situated in the southern part of Republic. The climate is dry in generally, continental with cold or moderate cold winters and hot or warm summers. In lowlands of the region, where the project area is located, the climate is arid with large fluctuations in temperature and quantity of precipitations up to 400m. Air temperature in lowlands can reach up to +40^{0}C in summer and -35^{0}C in winter. Areas with middle height (1400-2800m) have a view typical to mountain-steppe and mountain-forest areas. Mountain-steppe

zones are distinguished by long lasted mild winters and quantity of precipitations up to 500-600mm. In forest cover areas, which are scattered across the area of region, the climate is mild, dry with mild winters. An annual quantity of atmospheric precipitations comprises 700-800mm. High mountain zone is characterized by alpine meadows, which are located on steppe slopes of mountains. In this zone, the climate is characterizes by cold weather, the quantity of precipitations comprises 800-900mm.

Landscapes (trends of changes and dynamics, anthropological reasons)

On the studied areas of the region, following types of landscapes mainly distributed: semi desert, arid steppes, mountain steppes, mountain forests and meadows. Semi desert landscapes distributed on the south-western slopes of mountains bordering Ararat Valley, in the riverbed of Arpa, with narrow band (width 1-2km), length of 16km, to the village Malishka on the altitudes of 900-1200m, in separate places reaches up to 1400m. Semi-desert landscapes are distinguished by dry continental climate with moderate cold winter and hot summer. An amplitude of maximum temperature reach up to 69^0. In this zone, colds last from 4 to 5 months, sometimes even less. In the described zone, due to great daily temperature variations, bare rocks are exposed to intensive physical weathering, destroys and converted into large blocks, sun-gravels, the sand and clay. Formed material, by steep slopes is transferred down and accumulates in the bottom, with the form of removal cones, and on the gentle slopes remains in the place. Inadequate quantity of atmospheric precipitations creates favorable conditions for the formation of only arid-semi desert landscapes. A significant part of rainfall fallen on steep rocky slopes are quickly evaporated under high temperatures, and the remained part runs off on the surface. This occurs due to geological structure and water resistance of rocks. Quantity of precipitations doesn't exceed 400 mm and falls mostly in spring in the form of rain. Sometimes the snow fallen here melts immediately, which prevents the formation of permanent snow cover. In certain years, formed snow cover remains no more than 1-2 months. Soil formation conditions in this zone are not favorable. Rapid denudation weathered material; poor vegetation cover and semi-arid climate negatively affect the process of soil formation. In this regard, alluvial floodplain of the river Arpa and terraces covered by alluvial-meadow irrigated soils are exceptions. Rocky slopes are covered by weakly developed brown and light-brown soils with content of 0.5% humus and significant quantity of carbonates salts. In such nature conditions, the formation of dense vegetation cover is excluded. In general here is a friganoid vegetation cover, represented small-leaved plants and pillow shape plants, proper eluvial sedimentary covers of the rocky and rocky slopes of valley of the river Arpa. This part of the Phrygana, is mostly represented by scrubby bushes, almonds, ephedra, juniper, cherry and etc. Sorrel, wild barley, wheat and other friganoid plants on the slopes are rarely formed – rich grass cover.
These types of landscapes are characterized by poor vegetation cover, brown semi desert soils and irrigated lands. Flat floodplain parts are covered by alluvial soils and turfy meadow plants, and areas of slopes of valleys, are covered with brown, rocky semi desert soils with friganoid and wormwood - cereal vegetation. Friganoid covers here mainly represented by undersized forms of plants, such as zhester, almonds, ephedra, astragalus, and others. The floodplain areas of Arpa River are typical by gallery-forest, which mainly consist of different varieties of willows. Fauna is mostly represented by reptiles, in which poisonous snakes are distinguished (viper, snake), reptiles and frogs.

Landscapes of arid steppes occupy rather large areas and stretch to the height of 1700m. In this belt, Aghavnadzor, Azatek and Gladzor plateaus are situated, which composed of alluvial-proluvial-gravel, clay and sand sediments. Main mountains are well represented within the borders of the bell, mainly composed of limestone rocks. These are dry and heavily eroded mountains, on the steppes of which, badlands are widespread with a typical heavily dissected relief. Lowlands's belt of the region is characterized by dry steppe that stretches along the Valley of Arpa River and in middle mountain belt, embracing mountain slopes

with altitudes up to 1700-1800m. Landscape belt of dry steppes is wider in the West (8-10km) and East, near the town of Vayk it narrows up to 2km. Another part of the belt stretches to the North and along the Valley of Yeghegis up to village Karaglukh. Landscapes of dry steppes are distinguished by arid continental climate with moderate cold winters and hot summer. An average temperature of the coldest month is equal to -4,4^{0}C, and in the august, an average temperature is equal to 24,4^{0}C. Average annual quantity of precipitations comprises 400mm. Landscapes of dry steppes occupies large areas on the steppes of Urst ridges in the neighbourhodd of Vedi village. These areas are uneven, sometimes consist of marls and limestone, the climate is very dry, relative humidity is negligible, rivers' water level increases after snowmelt and rain, which disappear in summer, in cracks of rocks and irrigated channels. Based on the above factors, we could firmly state, that the entire landscape of the foothill of Ararat Valley has semi-desert and desert nature. In this belt, especially its lower parts are dominated by brown soils, with clearly expressed humus horizons. These soils are fertile and sometimes reach a height of 1800m. On all the main foothills of mountain ranges and slopes, the number of landscape subtypes and plant formations are developed, having form of steppes, freegan, томиляров, хамад and in some areas even mountain forests are met. Landscapes of mountain steppes occupy the territory with a height from 1700 to 2300m and mainly distributed on Karmrashen, Gndevaz, Martiros, Artavan acclamation and Jermuk volcanic plateaus. Soil cover here, is represented by dark-brown and steppe-meadows types of soils. The belt is characterized by astragalus, xerophilous and meadow-steppe plant formations. In this belt, mountain – brown soils are mainly distributed. Under irrigation these soils are very favorable to grow cereals. The belt of medium height mountains is characterized by landscape type of mountain forests, which are met in separate nature stops, situated in the river valleys of Arpa, Her-her, Yeghegis and Darb, in neighborhoods of Jermuk resort and in the other spots as well. Existance of forest landscape in the river valleys, conditioned with exposition of slopes, originality of microclimatic conditions in these regions and in the end, that human hand has not reached them. Climate conditions in this belt are distinguished by moderate cold – continental and relatively humid summer. Annual quantity of atmospheric precipitations comprises 600-700mm, which reaches its maximum in the May month. Permanent snow cover is formed in December and remains till April month. Average monthly temperature in January is -8,1^{0}C, minimum is -35^{0}C. An average temperature in June is 15,1^{0}C.

Soils of this belt are low power compared with other forests areas in Armenia. Here, soils are mostly represented by brown soils of mountain forests, which are distinguished by small quantity of humus and have low developed structure. Forests consist of leafy tree species, dominated by oak. Trees are small and undersized and sometimes like bushes. Forests of this region are mainly relict, among which, the special place occupies junipers, which are mostly composed of bushes with light colored trunks. The most characteristic type of middle-mountainous landscape of the medium mountain belt, it's a mountain steppe, which makes continuous lane and reaches up to 2400m. Medium mountain belt is characterized by moderate-cold climate with cold and long winter. In the closed valleys, winters are severe with frequently repeated freezing weather. Summer is warm, relatively humid, sometimes with dry periods. An annual quantity of atmospheric precipitations comprises 500-600mm, of which 300-350mm is in April-October. Spring rains are mainly heavy and accompanied with lightning. Permanent snow cover is formed in winter, which remains over 4 months. Snowmelt begins in April and lasts until the end of May. Relief diversity and vastness of belt (vertically) became the reasons for diversity of soils. Soil cover is represented by brown, black soils and rocky-meadows soils. Vegetation cover of the belt consists of only different types of grass. Following types of steppes are represented by astragalus, sorrel, xerophilous - herbage and meadow – steppes. This belt is more characterized by tragant steppe, which was formed in the site of former former oak and juniper forests. Landscapes of mountain meadows are located above 2200-2300mm and have harsh climate condition. An average temperature in January -10^0 – 13^0, quantity of annual precipitations comprises 800-900mm.

Permanent snow cover maintains until the mid-June. Spring is distinguished by dry-cold weather, and summer: with mixed-warm weather. The moisture here is formed not only from precipitations, but also with the help of condensation vapors directly on the surface of ground. In lower parts of the relief, certain amount of atmospheric precipitations is accumulated, forming small, not deep lakes with diameter of 50-200m, part of which in summer become swampy. Here distributed mountain-meadow soils like black soils. Meadows are covered by various colorful alpine covers.

Flora and vegetation

In the nearby areas of several communities of Ararat and Vayots Dzor regions, (Paruyr Sevak, Zangakatun, Chiva, Areni, Aghavnadzor, Getap), below presented ecosystems are vulnerable from different ecosystems met in those territories.

N	Ecosystem	Community	Location	Dominant species
1	Worm-wood semi-desert	Ararat Marz, Paruyr Sevak community	To the north from Paruyr Sevak community, the slopes of Urts mountainous ridge - average steepness, southern exposition and roundish relief	Artemisia fragrans (Asteraceae)
2	Thorny pillow-like vegetation site	Ararat Marz, Zangakatun community	To the north from Zangakatun community, on the steep slope on the right hand side of the reservoir	Onobrychis cornuta (Fabaceae)
3	Steppe ecosystem with dominance of wild cereals	Vayots Dzor Marz, Aghavnadzor community, Rind community	Nerqin Dzor site, the slope with average steepness, southern exposition; towards arable land of Rind community	Triticum boeoticum, Triticum araraticum

Wormwood semidesert

The dominant species of the wormwood semidesert is wormwood (Artemisia fragrans), belonging to Asteraceae family of high vascular plants. It is a small semi-shrub with lignified basis, with stems and leaves covered by white hairs and multi-flower inflorescence. This dominant species is accompanied mainly by xerophylous and xeromorphous bushes (large and small) as well as perennial and annual plant species. The tentative floristic composition of the wormwood semidesert ecosystem is presented in Annex 1 on the basis of the literature1, field surveys implemented by the expert during many years as well as identification of the collected herbarium specimens collected during the field visits implemented in late autumn 2011 in the frame of this project. In the result of floristic assessment it appeared that numerous annual plants (45 species) are represented in the wormwood semidesert. Out of them there are 18 ephemerous (short-lived) species. Their life-span is very short, approximately 2-6 weeks, starting from February. The abundance of annual plants, which in general is typical for semidesert ecosystems, is also characteristic for the selected vulnerable site.

[1] Mirzoeva N., 1956, Proceedings of the Institute of Botany of Armenian SSR; Takhtajian A., Federov An., 1972. Flora of Yerevan, Leningrad; Flora of Armenia, 1954-2011, volumes 1-11.

In the floristic spectrum the perennial plants make 16 species. There are numerous semi-shrubs (15) – short, with woody bases, often densely branched and with compact vegetative part, sometimes thorny (Acantholimon armenum, Cousinia armena) or densely haired plants (Phlomis orientalis, Stachys inflate); the mentioned characteristics are the result of lengthy adaptation to living in semidesert arid conditions. The trees and bushes in the selected site are represented by 4 thorny species from different genera and families.

Geophyte species (a life form, represented by rhizome, bulbous, tuberous plants with regeneration buds located in the soil at certain deepness) are represented by numerous species belonging to different genera of monocotyledonous plants. These genera include Gagea, Iris, Allium, Ornitogalum, Gladiolus, Muscari, Bellevalia, Tulipa and others. The vegetation of geophytes and annual plants, especially ephemerous ones is closely linked with precipitation, due to which they vegetate during the spring months.

In spite of the fact that wormwood semidesert compared to high mountainous pastures is a low-value pasture, the wormwood semidesert has significant economic role for agricultural development in the arid regions. In order to evaluate its significance it is crucial to have the picture of phenological changes of wormwood semidesert (details will be presented in the final report). Thanks to its phenological features it serves as a fodder base, namely winter pasture for the live-stock, including neat and small cattle in the area.

In case of climate change and temperature increase in accordance with predicted scenarios, the wormwood semidesert will be subject to unfavorable transformations.

Thorny pillow-like vegetation site

According to A.Takhtajian2, the thorny pillow-like vegetation is called also tragacanth vegetation in case it is composed of various species of resiniferous locoweeds (Astragalus – Fabaceae). This type of vegetation is close to Mediterranean phrygana; it is one of its variations. There is also a view that tragacanth vegetation has secondary origin and it originated from tragacanth steppe in the result of water erosion of the soil. In Armenia this type of vegetation has disjunctive/interrupted dissemination. One of the characteristic features of tragacanth vegetation is the presence of a dominant species, which is a hemispheric pillow-like perennial xerophytic plant; it is accompanied by small bushes and perennial and annual plants.

To the north from Zangakatun community, in the vulnerable pillow-like vegetation site selected by us the dominant species is Onobrychis cornuta from Fabaceae family. It is a perennial very slow-growing pillow-like hemispheric thorny bush up to 60 cm high, with very short and lignified stems, shortened internodes, small leaves arranged on the surface of pillows. The mentioned morphological features ensure limited surface for evaporation and protect from animals, well-developed root system allows getting strongly attached to the rocky substrate even in very poor soils and others – all contributing to viability of the mentioned ecosystems in arid and semiarid conditions.

The pillow-like vegetation was not specially studied in Armenia. There are few sources providing some data on floristic composition of these ecosystems. However, with use of the data obtained during our late autumn field visit and registration, the tentative list of flora (by life-forms) of the selected ecosystem was composed (Annex 2). The floristic assessment revealed that there are many perennial plants (22 species) in that ecosystem, out of them many are covered by glandular hairs (Lamiaceae family) and oil-bearing plants. As it was expected there are also many small trees and bushes (Crateagus, Prunus, etc.) mainly from Rosaceae family with large nutritious tasty fruits. They all have genetic relation with and are the base for the cultivated varieties.

[2] Takhtajian A., Fedorov An. 1972, Flora of Yerevan, Leningrad.

According to the literature, there are also many annual plants in this ecosystem (species composition is not mentioned), especially ephemerous plants, which vegetate at non rocky soils. It is also mentioned that the species composition of annual plants is a bit different from the species of semi-desert flora. It can be supposed that geophytes are also present in the pillow-like ecosystem, especially as during the field visit the dry and hardly recognizable remnants of species belonging to genera Ornitogalum, Gladiolus, Muscari, Bellevalia were collected. There are numerous mosses in this ecosystem.

The economic significance of pillow-like ecosystem is obvious, as it is a daily pasture, though the roundish pillows of rather closely located thorny Onobrychis cornuta are not eatable for live-stock. However, the steppe vegetation between pillows, which is getting more intensive when going up to the slope due to decrease of pillows, is a good pasture. Even with its not high bio-productivity, the pillow-like ecosystem serves as pasture for the community and has important significance for cattle-breeding development. In case of global climate change with increase of temperature and decrease of precipitation in accordance with the predicted scenarios the pillow-like vegetation will be subject to transformation with decrease of species composition of fodder plants and their productivity.

Steppe ecosystem with dominance of wild cereals

The presence of wild cereals and their habitats in Dareghegis floristic region were first discovered by G.Garaseferyan[3], according to whom 3 species of wild wheat grow there (*Triticum dicocoides, T. aegolopoides* and *T. thaoudar*). To avoid taxonomic details, it should be just stated that according to the modern literature (Flora of Armenia, volume 11, 2011) the mentioned names are synonims of two wheat species – *T.boeticum* and *T.araraticum*; consequently, in Dareghegis only 2 species of wheat occur. G.Garaseferyan mentioned also local names of wheats, used by rural inhabitants, as well as local names for the wheat habitats in Aghavnadzor, Getap and Vayots Dzor (Hopik, Apana, Nerqin Dzor, Sharakyatner and others), also about their use as spring food for shepherds or as summer natural hay-making area.

Data on the other species present in this steppe ecosystem rich in wild wheats are missing in G.Garaseferyan's and further studies.

Our field study was carried out in Nerqin Dzor site of Aghavnadzor community at the altitude of 1200-1300 m above sea level. The remnants of wild wheat straw do not allow identifying their species. However, on the basis of dry remnants of the other plants it was possible to identify the following species.

Trees, bushes and semi-shrubs: *Acantholimon sp.(Plumbaginaceae), Astragalus microcephalus (Fabaceae), Atraphaxis spinosa (Polygonaceae), Rhamnus pallasii (Rhamnaceae), Salvia dragocephaloides (Lamiaceae), Tanacetum argyrophyllum (Asteraceae), Stachys inflate (Lamiaceae).*
Plants: *Achillea bebersteinii (Asteraceae), Acillea milifolium (Asteraceae), Alhagi pseudoalhagi (Fabaceae), Allium sp (Alliacea), Alyssum sp. (Brassicaceae), Carlina vulgaris (Asteraceae),Centaurea behen (Asteraceae), Eringium billardieri (Apiaceae), Echnops sp.(Asteraceae), Gypsophylla sp. (Caryophyllaceae), Helianthemum sp. (Cistaceae), Marrubium parviflorum (Lamiaceae), Salvia viridis (Lamiacea), Scabiosa rhotata (Dipsacaceae), Sideritis montana (Lamiaceae), Stizolophus balsamita (Asteraceae), Taeniatherum crinitum (Poaceae).*
A number of thorny plants registered during our field survey indicate about grazing in the area. The existence of meadow mouse holes indicates about the presence of fodder base, which is probably linked with wild wheat's.

[3] G.Garaseferyan, 1938. Wild wheats of Daralagyaz. Proceedings of the Institute of Botany. Issue 1, Yerevan: 85-89.

Fauna (endemic, red list of species, high conservation value species, invasive type, trend of changes and dynamics, anthropogenic causes)

Fauna of Ararat and Vayots Dzor regions

Each plant upwards zone, as well as semi-desert zone, has its unique fauna. The same time some types of animals due to their ecological plasticity appear almost in all landscape zones. Following animal species are typical to this region: wild pig, felis chaus, Myocastoridae, Canis aureus, rabbit, lynx, wild sheep, Bezoars Goat, Brown bear, Forest Cat. Bird species met in the region are Columba livia, partridge, and from reptiles and amphibious: Mediterranean turtles, macrovipera lebetina optusa, from invertebrates ` grape snail. In the area of Araks River, wild pig is known from animal species and hunting of which is allowed. From the species of animals registered in the RA RED BOOK and met in this area, which belonging to a class of of mammals are Ovis orientalis ssp. Gmelinii Blyth, Lutra lutra L., Otocolobus manul Pall, Rhinolophus hipposideros Bechstein, Rhinolophus mehelyi Matschie, Rhinolophus ferrumequinum Schreb., belonging to a class of birds: Pelecanus crispus Brush, Aythya nyroca Giild, Haliaeetus albicilla L., belonging to a class of reptiles: Testudo graeca L., belonging to a class of insects Onychogomphus assimilis Schneid, Proserpinus proserpina Pall., Hyles hippophaes:

Specially protected nature areas

From the specially protected areas, Khosrov Reserve and Khor Virap water-swampy area are located in Ararat region.

Khosrov Forest reserve

Khosrov forest (Khosrov reserve) covers 27 000 hectare of area. It spreads on the south-western slope of Geghama mountain rage as well as on the slopes of Urtz, Yeranos, Dahnak, Irits Ler and Khosrovasar. It located at an altitude of 1600-2300m above sea level. Since 1958 Khosrov forest is considered to be a State reserve which was formed on purpose of preserving and refining plant and animal worlds as well as for breeding new varieties. In mountain slopes a semi-desert landscape dominates. Forest cover spreads on average heights consisting of sparse forests of oak-trees. Here grows broad-leaf euonymus, mountain ash and the Caucasian honeysuckle. At higher expanse mountain prairie vegetation grows. Armenian mouflon (wild sheep) and Bezoar goat are widespread in fauna. Following species can also be met here: leopard, grizzly bear, wild boar, fox, rabbit, hare lynx, marten, wolf, badgers and etc. Forest is particularly rich in bird world. Black kite, eagle-lammergeyer, Griffon vulture, eagle, wild pigeon, seagull and etc are also met in the reserve. There are many reptiles; particularly a poisonous viper. Since 1594 the Ussurian spotted deer has been acclimatized. Geghard, Havuts Tar, Kakavaberd, medieval bridge and many other historical monuments are located in Khosrov forest. A deep river Azat flows through it, on the tributaries of which there are many magnificent waterfalls. The reserve was named Khosrov in honor of the Armenian king Khosrov II Kotak. According to Movses Khorenatsi forestations were carried out in the territory of reserve during the reign of Khosrov.

Khor Virap Wetlands Special Reserve

Based on the 2nd and 3rd articles of the Convention on “Wetlands of International Importance especially as Waterfowl Habitat”, on May 30, 2002 by the RA Government 925 Decree, in administrative borders of rural community Pokr Vedi of Ararat region of Republic of Armenia, near Khor Virap church complex on the left

side part of Araks River and the right part of the Armenian oldest capital: Artashat town, in the territory of 50.28 ha located on wet land, Khor Virap Wetland Special Reserve has been established. The main purpose of Reserve establishment is to provide conservation of ecosystem of wetlands of international importance, their flora and fauna, namely waterfowl habitats and their settlements, rare plant species and their growing spots, normal development, reproduction and sustainable use. The main targets of special protection of reserve are unique fauna of sub-Araks wetlands ecosystem and water-swampy flora.

Exiting environmental problems

- Unfavorable climatic conditions:
- Pollution of hydro systems by sewerage and solid waste:
- Due to poor standards of living, strengthen anthropogenic impact on wild relatives of crops by population, (harvest of wild nutritive medical herbs, fruits and berries, firewood getting, which is not mainly regulated: under poor awareness conditions about conservation norms needed for plants self-reproduction and their further existence.
- Land privatization is also negatively affected conservation of wild relatives of crops, as the result, wild relatives of crops are in vulnerable conditions, which grow in lands allocated by private ownership rights, due to use of new land construction or for other purposes.

Demography

Social structure and population of Ararat region

Population of Ararat regions comprises 8.2% of Republic's population: 279.7 thousands/man. Rural population of the region including 93 communities comprises 197.2% thousands/man, 70.5%. Urban population of the region including 4 towns comprises 82.5 thousands/man 29.5%. Population density 1square km is 147 man. 18 of 97 communities of the region (18.5%) have up to 1000 resident, 57 communities have 1001-5000 residents (57.8%), 23 communities have more than 3000 resident (23.7%). In the region, 5 of 93 communities are very small in the number of residents. In this regard, it is appropriate to magnify communities: combining several settlements into one community. The region is inhabited by 41.589 pensioners, 486 died fighters and military families, 843 refugees and 10333 former refuges obtained citizenship: in total 11173, of which 626 are in need of housing. 203 families of died and invalid military and refugee families are also in need of housing. An average amount of pension comprises 22.444 drams. In vulnerability assessment system, 10.050 families are registered, of which 7241 are beneficiaries.

As of 2011, the population of Vayots Dzor region comprises 56000 people. 41 of 44 communities are rural, where 65.4% of population lives (367000 residents). Tows are populated by 19300 residents. 40.9% of Vayots Dzor communities (18 communities) have up 500 residents, and 20.5% (9 communities) up to 501-1000 residents. The number of pensioners in the region comprises 10433 (2008). Refugees comprise 6.24% of region's population. According to data in 2009, there are 3543 refugees living in the region. The number of refugees during 1996-2009 has been periodically reduced (in 1996 the number was about 3917) caused by naturalization and emigration factors. In vulnerability assessment system 2615 families are registered as beneficiaries.

Industry

Ararat region is one of the industrially developed regions in Republic Armenia. 8.0% of industrial volume of RA comprises production of industrial enterprises of Ararat Region. In the years of independence, region's industry was exposed to structural changes, but the food-industry has remained the leading, specific weight of

food industry is considerably increased. Mechanical engineering and machine building industries have lost their positions. In region's industrial complex, as per production volume, industrial potential is concentrated in the Ararat region. There are 78 production enterprises function in the region, 10 of operating enterprises are large enterprises, the rest are small and medium productions. 45%of small and medium enterprises are food-processing and food manufacturing enterprises. There are more than 10 large vine-cognac factories, which occupy major significant place in the region's economy, "Ararat-cement", "Gold mining plant", Artashat and Ararat canneries, "Masis Tobbacoo", "International Masis Tobacco plants". Non-metal mineral products manufacturing is (cement, cement, limestone, azbo-cement goods, stone cutting and processing). In 2008, in January-December, industrial production volumes as per industrial organizations operating in the region, at current prices comprised 59431,7mln drams, realized products comprised 61013,4mnl.dram, of which 180474,4 million. dram in CIS countries, 1293.2 million. dram in other countries, the physical index of industrial products towards year of 2007 comprised 103,1%.

During 2010, in RA Vayods Dzor region, industrial production comprised products in7241,5 million drams (at current prices), which comprises 0,9% of produced volumes in the Republic (the regions has produced more products in in1,012,6 million dram compared with 2009). In general, over the last five years, industrial production volume in the region comprised 0,8-0,9% of production volume of republic. In the first quarter of 2011, the region has produced more industrial products by 55.6 million drams, which comprised 1,464, 9 million dram instead of products produced in the same time period in previous year comprising 1,409,3 million drams. The physical index of industrial products comprised 99,2%, which compared with the same time period of previous year is reduced by 12,7%.
Comparing industrial production volumes by comparable prices, growth in amount of 106.8 million drams has been recorded as well. The growth has been recorded in processing sector (about 46,2 million drams, in electricity sector (about 64,1 million drams), the decrease has been recorded in water supply sector (about 2,9 million drams), in mining industry (about 0,6 million drams). As of January 01, 2011, livestock products in amount of 8947,4 million drams have been produced, which comprised 3,6% of production volumes of republic, and 96,7% of production volumes produced in the same period of previous year. In crop production field, the produce in amount of 4883,5 million drams has been produced (90,3% of production volumes in the same period of previous year), which comprised 1,25% of production volumes of republic.

3. Analysis of agricultural sector (including pasture) conditions and development in selected municipalities

Armenia is known with cereals, melon-vegetable and ether plants, as well as many fruit species (wheat, barley, rye, millet, lentils, oats, peas, bean, sesame, melon, watermelon, apricots, peaches, apples, grapes, quinces, pomegranates, plums, cherries and etc), which according to paleontological studies, have been cultivated in the country's territory since ancient times. In the republic, agro-biodiversity of studied communities in represented by enormous plants having economic high value, wild relatives of crops, ancient local species, which are considered as valuable genetic resources in the food manufacturing and agriculture, and which are not far being endangered.

Climate change may cause number of emergency phenomena in the territory of RA. In the Republic the most hazardous for agriculture are droughts, sandstorms, periods of days without rain, hails, strong winds, floods and etc. Depending of climate change, decrease in number of days with intensive precipitation and increase of

precipitations with maximum intensity is observed in the territory of Armenia. This means if flood is conditioned only by water-meteorological factor, then number of floods will be reduced during the time, but will increase their capacity and amount of damages caused. Those landscape (steppe, meadow, forest) areas having surface flow and flora rarefactions will be expanded. Bottom border of the forest moves up in all cases, because of which arid landscapes also move up and occupy larger surfaces on declivities, which creates favorable conditions for floods, expansion of eroded areas. In last 20 years, climate change caused by positive gradual increase in temperature, the more is felt in arid zones, which is vividly appeared in natural meadows and pastures.

4.1 The results of the inventory of the agricultural species spread in selected municipalities including indigenous and introduced species, and the analysis of changes in tendency for the past 50 year; assessment of agricultural varieties that is traditionally used in the Region (pls. attach the full list)

According to the evidence of historical various sources, Armenia is considered leading Asian important cradle of cultivated plants. Being one of the centers of origin for cultivated plants as well, Armenia is famous with number of species of grains, vegetables and pulses, as well as fruits (wheat, barley, rye, millet, oat, peas, lentils, chick peas, broad beans, melon, watermelon, apricots, peaches, apples, grapes, quinces, pomegranate, plum, cherry), which according to archeological studies have been cultivated in the country's territory since ancient times. Excavations have shown evidence of crop growing as early as the 5th century BC. Evidence from Assyrian cuneiform inscriptions in 9th-8th centuries BC has shown that grain cultivation across Armenia is widespread. Further evidence shows that the names of the plants and their varieties are even being mentioned by Armenian chronicles, such as red sorts of apple, pear, peach and etc. However, works focused on diversity studies of crops and their wild relatives mainly have started at the end of 19th century and gained greater momentum in 1920 and carried out by Vavilov and its school.

RA Vayots Dzor Region

Vayots Dzor region of RA is situated in South-West of Armenia. The territory of the region comprises 2308 sq/m (12% of Republic's territory). The region's highland is rich in wild animals and birds: wild pigs, wolves, bears, foxes, rabbits, chamois and deer, partridge and quail.
Vayots dzor is an agricultural region. Agricultural main directions are animal husbandry and horticulture. Grain, tobacco, vegetable-melon and fodder crops are also growing here. In low and middle zones of Vayots Dzor region, population is traditionally engaged in vegetable growing, viticulture and fruit growing, and in highlands: grain, fodder crops production and livestock

Agriculture

In the region, agricultural production is mainly organized through rural farms and other business entities. As of 2010, 12497 farms and 11 other business entities engaged in agriculture are functioning in the region. Agricultural lands occupy 90.6% of region's total territory (209258.1 ha). In 2010, Vayots Dzopr region's gross production of agriculture comprised 11.9 milliard /AMD. Gross agriculture product in the region comprises 4.2% in total volume of Republic's agricultural products. The climatic conditions are favorable in low and middle zones for vegetable growing, viticulture and horticulture, and high zones for grain, fodder crops and animal husbandry.

Crop production

Crop production in total gross agriculture products previously comprised 27.7% and now leading sectors of crop production are fruit-growing, viticulture, vegetable and grain production. Seed-growing is an important precondition to increase efficiency of crop production. Fruit-growing and viticulture have important and perspective value in low and middle zones.
Over 398 hectares of vegetables and 174 hectares of potatoes are being annually cultivated in the region, which is mainly used by population for their own needs. There are 890 hectares of crop lands or perennial plants, especially alfalfa and onobrychis. There are not cultivated corn for silage, fodder beet and annual grass for green fodder preservation.
In terms of climatic condiions the region's agriculture is in risky zone and natural disasters (frosts, flodds, hail, drought) cause great damage to rural farms and business entities engaged in agriculture. Social-economic activities of trwo typical communities of Chiva and Areni located in arid and semi arid zones of Vayots Dzor region, their natural and agro-ecosystems, including existing biodiversity and recent changes occurred under impact of global climate warming are presented below.

Technical provision of Agriculture

For development of plant-growing in the region, the renewal of agricultural machinery and tools is very important. The provision of agricultural machinery and tools in the communities is on medium level. Average annual import of agromachinary comprises 4-5 units of technique in the region, but majority of communities still have needs of techniques: grain collecting combines, wheeled and crawler tractors, hay making and bale-making mechanisms. Agromachinery is distributed in different communities of the region, which makes difficulties in efficient exploitation of them.

Irrigation systems

Irrigation land areas in the region comprise 6378ha, of which 360ha is irrigated by mechanical way. Substantial works have been done to replace mechanic irrigation system into gravity feed irrigation system. "Kechut-Azatek-Zedea" and "Yeghegis-Aghavnadzor-Yelpin" gravity water pipelines are put into operation, through which around 6778ha will be irrigated.

Main challenges of environmental field

Almost all ecosystems of the region are exposed to anthropogenic impact, the result of which the threat of extinction of dozen plant and animal species are found, which is the most noticeable on forest and water ecosystems. Massive cases of infection by pests and diseases and fires have been recorded in the forests, which are also connected with climate change. Due to lack of cultivated soils in the region, soils on large steep slopes, with dissected relief, prone to landslides, flooded, subject to be covered with water, which increases land degradation and intensifies landslides. Lack of improvement measures of roads, overgrazing of pastures linked with early spring cattle movement to mountain pastures, irregular grazing on severe steep slopes leads to reduction of vegetation and gradient soil degradation, which is considered as priority issue in the region to combat against. In the territory of Vayots Dzor region, landslides are most disastrous, with their distribution and impact among dangerous external geological processes, which are constantly developing and in volumes ever-increasing a source of danger

Analyzing productivity of Agrocenosis of Chiva community, it was simplified, that an average data on agricultural production especially the volumes of crop production, livestock and produced foods for the period of 2010-2011 compared with an average data for the period of 1999-2000 are reduced by 28.3-55.7%.

Reduction of livestock and agricultural produce in the community has many reasons. Till the end of 20 century, land fertility was significantly high, due to previously used fertilizers and sowings of perennial papilionaceous crops (alfalfa, onobrychis. Yield of agricultural crops, productivity of pastures and hay fields is drastically reduced, because the livestock and manure are decreased by 55-60% in the community and region. Manure as a mean for fertilization is mainly removed from the use, and small quantities of mineral fertilizers cannot increase yield.

Climate change, as in Chiva, here is also left its significant impact, especially on apricot growth, development and yield. Snow and frosts after bloom of trees have caused drastic decrease in volumes of production of this valuable fruit type. In the last 5-6 years there was not harvest, due to which apricot orchards have been replaced with peach orchards.

On the right and left sides of the road from the community to Khachik village pastures and medows, mainly following species types of edible herbs are mainly popular: thyme, rose hip, tutsan (hypericum), sorrel, black salsify, hornbeam, wild onobrychis, tragopogon. In this community, the main causes of reduction and incomplete growth of flora is linked with human economic activity. By the way, it takes place as with industry, as well as with social-economic and agricultural activity. . Irregular collection of plant seeds and fruits, collection of greenery for edible, spice, medicinal, decorative, technical and domestic purposes, as well as overgrazing of pastures, are leaving very negative impact on diversity preservation of flora, and plants are being deprived of natural re-growth opportunities.
For agro-biodiversity conservation and struggle against desertification folloing activities are needed:

1) Create all favorable conditions for organization of long-term use of pastures, as well as management of timings and methods of exploitation of community's natural pastures.

2) Allocate great place to localization of annual and multi cereal and papilionaceous fodder plants in the field of crop rotations, in zones of farming by water.

3) For preservation and improvement of flora and vegetation in meadows, develop and invest complex of agro-measures in the form of surface and radical improvement

Chiva village is located in south-western corner of Vayots Dzor region, on the altitude of 1116m above sea level. The total area of the village is 3193ha, arable lands: 2706.2ha, perennial plantations: 288ha, backyard: 68.5ha. The main reasons for not cultivating lands are lack of irrigation water, non-fertile lands, expensive cultivation technologies and etc. As of January 01, in 2011, the number of households in the village comprises 323. Total number of cattle comprises 323, small cattle is 90, there is a 6 pigs, 3 horses, 4 donkeys, 1217 birds, 354 family of bees in the village.
More than 30% of agricultural lands are not in use for different reasons. Over 2.5 tons of grapes, 150 tons of walnuts, 35 tons of fruits, 160 tons of grain, 146475 eggs, 257 tons of milk and 24 tons of meat and other farm products are produced in Chiva village. Village doesn't have relevant reprocessing facilities. Agricultural products are mainly used for internal consumption, or barter.

Analyzing productivity of Agrocenosis of Chiva community, it was simplified, that an average data on agricultural production especially the volumes of crop production, livestock and produced foods for the period of 2010-2011 compared with an average data for the period of 1999-2000 are reduced by 28.3-55.7%

Table 5. Main indicators of agricultural production in Chiva community 1999-2000 and 2010-2011

The name of indicators	1999-2000, Average	2010-2011, Average
Cattle	859	319
Small cattle	1278	90
Bee families	716	311
Pig	63	10
Grain	57344	2170
Vegetable	2953	1275
Hay	10700	8500
peach	105	50
grape	65	25
Walnut	85	50
Pear, apple	315	220

Reduction of livestock and agricultural produce in the community has many reasons. Till the end of 20 century, land fertility was significantly high, due to previously used fertilizers and sowings of perennial papilionaceous crops (alfalfa, onobrychis. Yield of agricultural crops, productivity of pastures and hay fields is drastically reduced, because the livestock and manure are decreased by 55-60% in the community and region. Manure as a mean for fertilization is mainly removed from the use, and small quantities of mineral fertilizers cannot increase yield. Climate change has also left drastic insufficient impact. For many years, especially in the last 7 years, after blossom of stone and seed fruit trees it starts to snow and cold ocurres, because of long lasted winds and hail, vegetable crops do not yield, the crop of pastures and hay fields has worsened and fallen sharply, due to which community members avoid to increase livestock and be engaged in fruitless agriculture. The mentioned circumstances have drastic impact on Agro-biodiversity conservation. In Vayots dzor region, the study of actual condition of agro-biodiversity of Areni community located in arid and semi arid zone, inidatced that community's agrocenosis are mainly engaged in grape (150ha) and peach (154 ha) cultivation. Vegetable-melon crops are also being cultivated in the community. It is remarkable, that croplands of either for horticulture or agricultural other crops are provided with irrigation water and climate change factor did not cause great changes in volumes of agricultural and livestock production being produced in the community.

Climate change, as in Chiva, here is also left its significant impact, especially on apricot growth, development and yield. Snow and frosts after bloom of trees have caused drastic decrease in volumes of production of this valuable fruit type. In the last 5-6 years there was not harvest, due to which apricot orchards have been replaced with peach orchards. In the pastures and meadows, mainly following species types of edible herbs are mainly popular: thyme, rose hip, tutsan (hypericum), sorrel, black salsify, hornbeam, wild onobrychis, tragopogon. In this community, the main causes of reduction and incomplete growth of flora is linked with human economic activity. By the way, it takes place as with industry, as well as with social-economic and agricultural activity. . Irregular collection of plant seeds and fruits, collection of greenery for edible, spice, medicinal, decorative, technical and domestic purposes, as well as overgrazing of pastures, are

leaving very negative impact on diversity preservation of flora, and plants are being deprived of natural re-growth opportunities.

Situational Analysis of Agricultural sector in Ararat region

The highest percentage of employed population's is engaged agriculture, the rural population comprises 70.6% of total population. In the region, agricultural production mainly is carried out through the farms. As of January 2011, there are 4.305 rural farms functioning in the region. In 2010, the Regional agricultural gross produce comprised 88.6 milliard drams, which is equal to the previous year's level. This comprises 16% of total volume of agricultural gross produce of Republic.

Regional climate conditions are favorable for grape and fruit cultivation; 124777.0 ha is used for cultivation, respectively vegetables 6174 ha, potato 9050ha, garden 1699ha, fodder crops 5879 ha, and grain 51220 ha. Fruit-vegetable production is significantly increased in the last years: in 2010 it comprised: fruit 9279.0 tons, grapes 88146.5 tons, vegetables 266650 tons, potato 29050 tons and vegetables 67309.0 tons. The main sectors of agriculture in the region are crop production and animal husbandry.

Crop production

Analysis of the data on crop production indicators in the region shows that crop yield indications are substantially higher than average indicators of republic, and compared with data in 2006 crop lands of grain are reduced by 3550 ha, which was caused by insufficient irrigation and inadequate fertilization of crops.

Table

	Area /thousands. ha/			crop /c, ha/			Gross crop /tons/		
	2006	2007	2008	2006	2007	2008	2006	2007	2008
Crops									
RA	182.405	176.213	172.838	11.6	25.6	24.0	212545.0	452522.2	415417.8
Region	9.01	6.05	5.46	32.0	43.0	38.9	28801.1	26005.8	21227.5
specific weight, %	4.9	3.4	3.2	275.8	168.0	162.1	13.6	5.7	5.1
Potato									
RA	33.045	31.674	34.298	163	184	189	539476	583934	648562.4
Region	0.872	0.840	1.037	305.5	318.8	316.6	26639.6	26776.0	32834.2
specific weight, %	2.6	2.7	3.0	187.4	173.2	167.5	4.9	4.6	5.1
Vegetable									
RA	24.361	25.607	24.219	320	330	340	779895	845285.1	825337.6
Region	6.195	6.813	6.009	409.3	398.5	441.2	253573	271510.7	265140.0
specific weight, %	25.4	26.6	24.8	127.9	120.8	129.8	32.5	32.1	32.1
Garden									
RA	4.025	5.884	5.446	335	350	334	134935	206295.1	182159.4
Region	0.858	1.112	1.159	379	376	431	32515	41832.4	49984.5
specific weight, %	21.3	18.9	21.3	113.1	107.4	129.0	24.1	20.3	27.4
Fruit and berry									
RA	35.403	38.02	36.748	80.8	68.4	86.4	286133	260239	317834.8
Region	7.239	7.321	7.500	120	87.7	120.5	86807.3	64205.9	91004.0

specific weight, %	20.4	19.3	20.4	148.5	128.2	139.5	30.3	24.7	28.6
Grapes									
RA	15.746	15.888	16.796	127.8	137.7	110.6	201372	218882	185131
Region	4.648	4.659	4.973	162.3	72.7	163.5	75456.2	80483.2	81317.3
specific weight, %	29.5	29.3	29.6	127.0	52.8	147.8	37.5	36.8	43.9

In 2009 arable lands in the communities of the region are reduced by 254.4 ha approximately compared with 2008. Around 230 hectares of vineyards and 25 hectares of orchards have been established in the region. This is explained by the fact that grape and fruit growing is more profitable. Around 9300 hectare lands are not cultivated because of extra wet conditions, lack of irrigation water and law solvency of small farms. There are 8000 hectares of overmoisture and salt lands existing in the regions, which are not cultivated or cultivated partially. In 2010, the quantity of produced vegetables in the region comprised 266.650 tons.

Two canneries of the region (Artashat "Artfood" and Ararat "Borodino") have procured 26.700 tons of vegetables, as for the realization of remained produce; the rural farms have faced difficulties, which have created obstacles for horticulture development. Generally, rural farms realize apricot and peach crops through private businesses, which export crops to the Russian Federation, Georgia. In 2008-2009, rural farms could not realize produce, because of difficulties connected with exporting. Since processing capacities of two canneries in the region are limited, rural farms have been facing problems in the local market in realization of products, which creates obstacles for development of fruit growing, which is very important for the region.

In 2010 vineyards areas are increase by 325ha compared with 2006 and comprised 4973ha, of which 2974ha area is technical. Over 88146.5 tons of grapes have been produced in 2010, while in 2009 it was 88168.3tons. Over 20.000 tons of grapes yield (special sorts) is being preserved in refrigeration farms by rural farms: for further realization. Increasing difficulties of grape realization in every year, may cause problems and destroy hardly grown fruitful vineyards.

Main croplands of 2009, in Ararat region are presented in the table 8

Table 8.

Manufacture plants	Ararat (ha)
Crop	2965
Vegetable	2017
Potato	92
Garden	1187
Fruit	2935
Feedings-plants	907
Grape	2131
Cigarette	82

Viticulture; fruit-growing, melon and vegetable cultivation are developed in Ararat region. Agriculture of Ararat region is in risky zone, almost every year natural disasters occur in the region: frosts, hail, long lasing drought, floods. In the result of this, agricultural field suffers in the region, especially rural farms. In 2006-2008, 9950 tones of nitric fertilizer have been provided to rural farms, and in 2007-2009, 1497kg chemical

weeds for the struggle against mice rodents. In 2006-2008 fertilizers have been purchased on account of subsidies allocated by the state and payments of population, and chemical weeds have been provided free of charge. There are also issues linked with agro-machinery: physical and moral frazzle technical suite, irrelevance of technical capacity with current land use conditions.

Irrigation system

In order to get guarantied and high quality crops it is necessary to have unobstructed irrigation system in the region. Irrigated land area in the region comprised 37828 hectares in 1998 in Ararat region. At present the total area of irrigating soils comprises 28330 hectares, (9498 ha was reduced), which has drastic impact on agricultural food production.
Since the establishment date of Ararat Municipality (1996), several activities are taken place to extend irrigation lands. 6 water user companies are engaged in Irrigation works in the region ("Artashat", "Ararat", "Arzni", "Vedi", "Mkhchian", "Masis").

Animal Husbandry

The main direction of animal husbandry in Ararat region is diary and meat industry. In 2009, compared with 2005 number of livestock is reduced by 2360 heads; number of caws is reduced by 2309. The number of sheep and goat is reduced as well by 5974, (in 2005 the number was 74833, and in 2009 the number was 68859). The reduction of livestock is closely connected with the fact that the region is located near the city, as well as with the low prices of livestock products, and reduction of small cattle is connected with high priced export of great quantities of sheep and goats, which according to our studies will promote increasing of small cattle in future

Number of livestock and comparative volumes of livestock products are presented in the table 10.

Table 10. As of January 1, 2009

	cattle		Pig	Sheep and goat	Sold meat live weight Thousands/ tons	Milk Thousands/ tons	Egg, Million, unit
	Total	Including caw					
2005	43041	19609	8833	74833	8.8	44.5	42.9
2006	42868	18980	14387	67998	16.5	43.0	43.0
2007	43393	18876	15905	69721	14.8	44.0	45.0
2008	43620	19048	13061	72006	13.0	45.5	35.5
2009	40681	17300	13441	68859	13.7	42.0	37.0

Weaknesses of agricultural sector in Ararat region

1. Not efficient use of soil resources;
2. Incomplete infrastructures of realization of agricultural products and poor conditions of inner-community and inter-community roads;
3. Disintegration of production /small sized rural farms/;
4. Due to lack of resources of agricultural machinery used in agriculture, agro technical and zoo technical demands are incomplete;

5. Poor condition of infrastructures of agricultural production and in accordance with requirements of production, very slow process of their formation;
6. Inter and inner economic poor condition of irrigation network, their noncompliance to agricultural standards, big losses of irrigation water, high specific weight of water supply, incomplete relations between water suppliers and users;
7. Inadequate condition of genealogy, lack of genealogical farms, very low specific weight of livestock under artificial insemination;
8. Low level of technical provision, technical and physical outdated techniques, which caused high price cost of automatic works and in relevance to them, the formation of high rates, lack of organization of joint use of techniques.
9. Lack of amelioration and water supply works aimed at improvement of soils, especially extra wet and waterlogged soils, pastures, hayfields;
10. Lack of corporations in the field of agricultural service;
11. Lack of industrial capacities for processing of agricultural raw materials;
12. Lack of agricultural wholesale markets in the region;
13. Lack of small corporative enterprises engaged in trade of agricultural products.

Situations of Agro-biodiversity and social-economic development of Paruyr Sevak and Zangakatun communities located in arid steppe zone of Ararat region has been studied, which are presented separately

Paruyr Sevak Community

Main fields of Economy

Table 11. Indicators of Community's economy 2010-2011

Main fields of economy	% in the total
Agriculture	96
Cattle-breeding	20
Apiculture	6
Farming	35
Horticulture	35
Trade	1.5
Transport-communication	-
Services	2.5
Total	100

The population is mainly engaged in horticulture and cattle breeding, 95% of profit received in the result of economic activities in generally comes from agriculture. 102 of 160 private farms of the community are

engaged in agricultural filed. 30% of which are involved in farming, 5% is in cattle breeding, 65% simultaneously is engaged in farming and cattle breeding.

Farming

In the field of farming, the region is specialized mainly in horticulture and crop production, which has given 78% of realized agricultural product in 2010-11. Following fruits are cultivated in the community: apricot, almonds, grape, peach, cherry, and etc.

Table12. Shares of the main types of agricultural products realized in the total volume of realization in 2010-2011 (estimated revenue received from agricultural products)

Agricutural prodct types	% in the tatal
Grain	1
Fruit /grape/	35
Fruit /peach, apricot/	10
Vegetable crops / watermelons, melons/	33
Dairy	6
Meat	12
Honey	3
Total	100

Over 35% of cultivated lands is used for horticulture. The largest proportion of gardens occupies apricot, peach gardens (7.5 % of the land area used for horticulture) and vineyards (92.5%). Following type of vegetable-crop production are grown in the community: watermelons, melons. Autumn sowing wheat of cereals is mainly sowed for households own needs, the yield is 20-25 c; and has a tendency to decrease during the years. The main reasons of such situation are low yield lands, lack of irrigation water and especially clime change.

Around 100 households are engaged in animal husbandry, of which two are considered as large farms. Community pastures are large in territory, but with less vegetation and are quickly getting arid (May-June months). Besides this, the major part of the pastures, before transfer under ownership of community, has been owned by non-residents of the community, who prohibit the access of livestock into leased areas. Quite a large area of pastures is located under border defense zone and not used as well. Young cattle are being sent to the pastures, which belong to neighboring communities.
The most developed sphere in animal husbandry is cattle breeding. In recent years reduction of small cattle livestock is remarkable, which is conditioned by the lack of young labor, (with above mentioned situation of pastures).

There are 2000-3000 birds: oviparous chickens and turkeys in the community. Swine breeding is in low level of development which is linked with the lack of fodder base. Grain crops are mainly imported from neighboring residential with high prices, which makes swine breeding non-profitable. Bee keeping is sustainable in the community. 25 families are engaged in bee keeping, of which only 20 families realize honey. There are 400 beehives in the community. The revenue received from the beekeeping comprises 5% of total revenue of agriculture. During the last years, beekeeping is started to spread extensively in the

community. Population is well aware of the nuances related to beekeeping. In summer, the bees are being also moved to the upland communities.

Table13. Croplands of Agricultural plants for 2011 year

Crop names	Area, ha.	Average productivity c./ha.
Watermelon	60	45
Melon	5	25
Grapes	196	20
Apricot	9	20
Peach	10	40
Corn	5	20
Potato	0,08	200

Study and assessment of Zangakatun Community of Ararat Region

The village is situated on the altitude of 1650-1700m above sea level in foothill Zone. The highest peak is Mt. Gndasar with the height of 2947m, and then Mt. Hunut with the height of 2060m., and etc. The community is bordered by the Autonomous Republic of Nakhijevan, with the length of 25 km, in the result of this, about 500 hectares of pastures are not being used and 60 hectares of arable lands are used partly. The village's climate is cold in winter and cool in summer. Agriculture, flora and fauna are more suffered from the frequent occurrence of arid and drought years.

The population of the village comprises 1167, of which 52% men. The social structure of population is

1. Children (0-6 years old) _____ 71
2. Pupils (7-17 years old) _____ 225
3. 18-65 years old. _____ 850
4. Pensioners _____ 222
5. Disabled people _____ 23
6. Capable to work _____ 700
7. Refuges _____ 0
8. Unemployed _____ 0
9. Families _____ 394
10. Registered in the system of "Paros" _____ 60
11. Number of Registered voters _____ 850

The administrative territory of the community is 5039 ha, of which

1. Arable _____ 762ha
2. Hayfield _____ 94ha

3. Pasture _____ 3822 ha
4. Not used soils _____ ----- ha
5. Canyon _____ 6,4ha
6. Field road _____ 28ha
7. Cemetery _____3,8has
8. Yards _____ 125ha
9. School _____ 4,6ha
10. Monuments _____1,2ha
11. Intercommunity streets _____ 6ha
12. Privatized soils _____ 726ha
13. The size of each soil _____ 1,4ha
14. State reserve soils _____ ----- ha
15. Community own lads _____ 4266 ha

Table15. Indicators of yield of agricultural crops grown in Zangakatun Community of Ararat region in 2000 – 2011 and 2010-2011

Crop names	Average yield 2000-2001, c/ha	Average yield 2010-2011, c/ha
Grapes	65	37
Apricot	50	40
Peach	70	60
Apple	105	89
Walnut	90	85
Watermelon	187	105
Melon	-	-
Wheat	35	21
Potato	244	189
Grass (annual, perennial)	4,3	3,6

The population is mainly engaged in horticulture and animal husbandry. Privatized arable lands are used for corn and barley cultivation, but this sphere of agriculture connected with weather. Drought often leads to “0” productivity. 80 % of arable lands are not being cultivated because of expensive fuel and low yield and lack of techniques and spare parts. Irrigation water is sufficient, but because of incomplete irrigation system and lack of inner network, it’s impossible to increase an area of arable lands, which would promote increase of crop productivity.

Agro-biodiversity of the mentioned communities, as one of the important components of general biodiversity, has unique place in biodiversity of arid and semi-arid regions in the Republic, which are presented by number of high value plants, wild relatives of crops, endemic breeds, old local sorts, which are viewed as valuable genetic resources for food production and agriculture. Significance and necessity of agro-biodiversity preservations increases even more, and becomes one of the important components of the policy of the field of agriculture and nature protection. Having stable genes in genotype towards different diseases, pests, as well as biotic factors, the components of agro biodiversity are valuable baseline materials in the selection: promoting economic growth, national autonomy, food safety and the same time play important role in ensuring environmental balance. The mentioned regions being one of the centers of origin of crops are known with sorts of cereals, vegetable crop and oil plants, as well as various fruits (wheat, barley, lentil, rye, oat, cob, watermelon, melon, apricot, grapes, pomegranate, pear, apple etc), which according to ancient studies have been cultivated in the area from ancient times.

In the agro-biodiversity of arid and semi-arid regions, ether, resin, paint և vitamin producing types of edible, fodder plants, herbs, honey producing sorts are distinguished, which have high value and their conservation is important to ensure not only sustainability of ecosystems in regions, but also social-economic development and nature protection of the Republic. We can state, that factors having negative impacts are different, including both natural and anthropogenic threats (climate change, natural disasters, overuse of bio-resources, environmental pollution, high level of poverty, lack of lack of moral psychological atmosphere in public, low level of eco-education, existence of incomplete legal framework and etc.), and leaving the situation not regulated may cause irreversible consequences on the ecological balance. Climate change is considered as irreversible threat on biodiversity and particularly productiveness and sort conservation of agro biodiversity, especially in arid and semi-arid regions, where gradual increase in positive temperature and lack of precipitation in the process of vegetation are leading to loss of soil moisture in more quantity, in the result of which their quantity is reduced in natural meadows and pastures, as well as croplands, resulting reduction of yield.
Studying the dynamic of yield of agricultural crops in two neighboring communities located in arid zone of Ararat region, it turned out, that average indicators of yield of agricultural crops in 2010-2011 cultivated in the communities of P.Sevak and Zangakatun compared with average indicators in 2000-2011 have dropped drastically. It is appropriate to mention that this pattern (on drop) is the same in two communities. If in the community of P. Sevak, the yield drop of grain, fruit-vegetable and grape comprised 8.0-50.0% in the last ten years, then drop of yield of crops in Zangakatun community comprised 9.2-47.0% for the same time period (tables on indicators of yield of agricultural crops are placed in analysis section of given communities).

In the mentioned communities, in the last 10-15 years, winds and sandstorms became more frequent caused by climate change, which have drastic negative impact on growth and development of sorts of hydrophilic plants in growing in agro-ecosystems, in the result of which, in natural pastures located in the territory of communities small islands of vegetation is noted and ecosystems are in mosaic type. Vegetation in natural pastures is drastically worsened in the mentioned communities, the pastures are in aging stage and the flora is much reduced, even implementation of surface improvements in those areas it’s not efficient economically, for this reason, radical improvements are necessary, namely, eradicate soil layer and natural vegetation of pasture through sowing, artificial grass sowing, establish sowing pastures (of course in the areas, which are located up to gradient of 15^0).

Studying and analyzing current situation and incurred changes of agro-biodiversity in recent time period (over 10 years) in number of communities located in arid and semi-arid areas of Ararat and Vayots Dzor regions, we came into following conclusions:

1. Climate change has caused profound changes in the structure of agro ecosystems in the communities located in arid steppe zone of Ararat and Vayots Dzor regions, land degradation, trends of agro-biodiversity productivity reduction are seen everywhere (floods, landslides)
2. In the result of climate change, agro biodiversity and its productivity of studied communities P.Sevak, Zangakatun (Ararat region) and Chiva (Vayots dzor) have become more vulnerable.
3. To raise productivity of agricultural crops growing in the mentioned communities, elaboration of precise system of measures is necessary to mitigate and adapt negative phenomena caused by climate change.
4. For preservation and improvement of flora and vegetation in meadows, develop and invest complex of agro-measures in the form of surface and radical improvement.
5. Create all favorable conditions for organization of long-term use of pastures, as well as management of timings of exploitation of community's natural pastures; and collection methods of herbs, edible, fodder types, honey and resin producing plants.

4.2 Results of the inventory of the wild relatives of agricultural species and the analysis of the tendency of changes for the last 50 years

Traditional use of agro-biodiversity and in-situ conservation

Armenia is one of the oldest centers of world civilization. It was one of the main areas of development and dissemination of farming in the world. The Armenian Nation has been dealing with farming since ancient times. The proof for this is rich ethno-botanical materials excavated in Historical Armenia, which belong to 8 century BC as well as coalified remnants of wild relatives of cultivated plants, belonging to 5 century BC.

The farming in Armenia since ancient times has been developed on the basis of rich genetic resources of wild plants, which were abundant in the nations' living area. At present farming is one of the activities/occupations for Armenian Nation and one of the main livelihood sources.

More than half of about 3500 high vascular plants registered on the territory of Armenia are wild relatives of cultivated plants. There are many such species in the families of *Fabaceae, Asteraceae, Rosaceae* and *Poaceae*. There are also many endemic and rare species, which are registered in the Red Book of Armenia on the basis of internationally accepted IUCN criteria (IUCN, 2001, version 3.1). Some species are included in the annexes of CITES and Bern Conventions.

In the surveyed communities the identification of ABD traditional use was done on the basis of questionnaire, which included respective questions. At present the results of questionnaires are under study.

In addition, in the result of separate meetings in the regional administrations and communities, the preliminary list of the most commonly used plants was identified. Out of tree-bush forms various species of plum (*Prunus divaricata*), berberis (*Barbaris vulgaris*) and hawthorn (*Crataegus orientalis, Crataegus sp.*) are used. The majority of species used for food are plant species. The list of species traditionally used in almost all communities is presented below:

- *Urtica dioica*

- *Malva neglecta*
- *Astrodaucus orientalis*
- *Falcaria vulgaris*
- *Rumex crispus*
- *Hippomarathrum microcarpum*
- *Asparagus officinalis*
- *Zosima absinthifolia*
- *Sempervivum globiferum*
- *Tragopogon sp.*

It is typical that each community uses those ABD representatives, which are common in their area. They are collected by community members in limited amounts and used as food in fresh and dry condition, also processed: plants – boiled, fried, seasoned, fruits and berries – in jams and juices. Edible, spicy and medicinal plants are collected in limited amounts also for selling, which is done in small shops along the main highway or markets in large cities.

In the result of search for wild relatives of cereals, in the western part of the Vayots Dzor region, on the altitudes of 1200-1300m the field surveys conducted, have demonstrated, that onn the steep slope of Nerqin Dzor site in the area with southern exposition between two not deep gorges the wild wheat (*Triticum*) is dominant species. The area is like homogenous agricultural field (looks like being sowed). There are few bushes (*Rhamnus pallasii, Atraphaxis spinosa*). They are more numerous in two lateral gorges. The species of wild wheat (also whether it is one or more species) was not possible to identify as there was only straw remnant. However, according to literature data two species of wild wheat – *Triticum boeticum* and *T. araraticum* grow here.

In wild wheat area, on the basis of dry remnants of plants the following species were registered in the area: *Sideritis montana, Salvia dragocephaloides, Salvia viridis, Marrubium parviflorum, Stachys inflata, Tanacetum argyrophyllum, Alyssum sp., Helianthemum sp., Eryngium sp., Echinops sp., Achillea sp., Nigella sp. Gypsophila sp.* and others.

In Apana site the wild wheat is not as homogenous as in Nerqin Dzor site. However, they are numerous and grow at the altitude of 1300 m in thorny bush *(Astragalus, Rhamnus, Acanthalimon)* associations on more of less roundish areas of more rocky places. It can be supposed that the same two above mentioned species of wheat grow here. In the Vayots Dzor region, searching activities to identify growing places of wild wheat are mostly important. In the result of which, it was simplified, that in parallel with Chiva and Areni communities which were studied and selected, the settlements of Aghavnadzor, Getap and Rind need to be studied as well, where implemented field visits allowed to identify places of wild *Poaceae* family /cereals, especially wild wheat mentioned in the literature.

4.3 Results of the pastures plants inventory and analysis of the tendency of the changes for the last 50 year

Mountain slopes, as pastures nearby Paruyr Sevak community of Ararat region are located on the altitudes of 1000-1200m. The landscape is wavy type, covered by stony slopes formed from lava and volcanic rocks, where temporary water flows or not deep gorges of floods exist. Following plant species were registered in the area. The dominant species of the wormwood semi-desert is wormwood (*Artemisia fragrans*). It is a small

semi-shrub with lignified basis, with stems and leaves covered by white hairs and multi-flower inflorescence (Appendix 3, photo 2). According to the survey during the field trip, which confirm the literature data, the semi-shrubs of wormwood grow irregularly at the distance of 25-35 cm from each other making 5-7 semi-shrubs on each 1 sq.m. The distance between semi-shrubs is getting more in the steeper and more rocky areas. At the moment of our field survey the wormwood semi-shrubs were in the stage of their autumn vegetation. In the monotonous dry grass cover they stood out as the groups of short alive stems covered by alive leaves.

The field registration of species implemented for identification of species composition of wormwood semi-desert revealed that the dominant species - wormwood is accompanied mainly by xerophilous and xeromorphous bush and perennial and annual plant species. The bush species are represented by sparsely growing short thorny species *Atraphaxis spinosa, Acanthalimon armenum, Astragalus microcephalus* and in some places especially on the gorge slopes – by tall tree-like species *Rhamnus pallasii*. Out of semi-shrubs and perennial plants the followings are rather common: *Tanacetum argyrophyllum,Thymus kotschianus, Teucrium polium, Scutellaria karjaginii, Kochia prostrate, Capparis spinosa, Centaurea squarrosa, Eryngium billardieri, Cousinia armena, Achillea biebersteinii, Verbascum sp.* and others. In the general landscape there are small areas, where there is no wormwood and instead there are homogenous areas of *Stachys inflata, Tanacetum argyrophyllum, Atraphaxis spinosa* or other species.

It is known that in the wormwood semidesert there are more annual plants than others. However, at the moment of our field survey only limited remnants of annual species were present, out of which it was possible to clearly identify the following species: *Ziziphora tenuior, Sideritis montana, Consolida persica* (a few plants in flower), *Xeranthemum sqarrosus, Alyssum linifolium, Bromus sp.* and others.Out of the bulbous plants characteristic for the wormwood semidesert, which reach ultimate development in April-May, it was possible to identify several remaining long stems (with fruits) of the species of *Muscari* and *Bellevalia* genera. From *Poaceae* family, almost everywhere there were big groups of remnants of the annual species *Taeniatherum crinitum*. In some places there were few plants belonging to genera *Stipa, Bromus* and others. Zangakatun community is located in the south-eastern part of Ararat region, on the Valley of upstream of Aratso River, on the left side tributary of Araks River. The field survey was implemented near the water reservoir located to the north from the community, on the pasture slope on the left bank of the River Aratsoget. From community to reservoir the mountain slopes on both river banks are covered by similar thorny pillow-like vegetation. The surveyed site was located at the altitude of 1800 m above sea level. The edificator species of the steep slope of south-west exposition is Onobrychis cornuta (Fabaceae family) represented by pillows of different sizes. In the not deep gorge starting from the top of the slope the species is completely missing. The species Onobrychis cornuta is a thorny bush with very dense and branched lignified stems and bright violet flowers. Very short stems of the same height are so dense and compact that the plant looks like a hemisphere attached to the ground. The pillow-like life form of the plan is the way to get accustomed to dry conditions.

In the result of species registration with the aim of identification of the preliminary BD species composition, it was revealed that the dominant species in the surveyed area is accompanied by several species of short bush and not tall trees: Spirea crenata, Cotoneaster sp., Crataegus orientalis, Crataegus sp., Prunus divaricata and others. The mentioned species at the moment of survey were in the stage of fruiting and were fully covered by bright color fruits. There were numerous remnants of perennial plant species, such as Tanacetum chiliphyllum, Salvia verticillata, Hypericum scabrum, Teucrium polium, Nepeta sulphurea, Centaurea sp., Betonica orientalis, Scutellaria orientalis, Cerinte minor, Linaria sp., Anthemis trumfettii, Cephalaria sp.,

Artemisia absinthium, Xeranthemum sqarrosus, as well as numerous species representing Poaceae family. There were many representatives of bryophyte. The species composition of annual plants was not possible to identify.

The moderate steep slopes on the left side of the Yerevan-Yeghegnadzor highway are mainly cultivated; they belong to Zangakatun communiaty. However, in some places the pillows of *Onobrychis cornuta* are present.

Vayots Dzor Region

The field surveys were implemented nearby Areni community Vayots Dzor region on the roundish mountainous slope located on the left side of Areni-Khachik road. This dry slope of western exposition is dominated by xerophilous plant association with main edificator species *Rhamnus pallasii* in the form of short narrow-leaved shrubs. There are numerous fruit-covered shrubs of *Rosa* and *Atraphaxis spinosa* and in some places shrubs of *Crataegus* and *Cotoneaster* with bright red small roundish fruits.

Out of perennial plant species mainly occurs *Capparis spinosa*. The following plant species are numerous: *Marrubium parviflorum, Artemisia incana, Poterium poligamum, Potentilla recta, Teucrum polium, Hypericum scabrum, Salvia dragocephaloides, Tanacetum chiliophyllum, Helichrysum sp., Helianthemum sp., Verbascum sp., Ziziphora sp*.,as well as thorny species *Carlina vulgaris, Cousinia sp., Cirsium sp., Echinops sp.* belonging to *Asteraceae* family. Dry remnants of numerous species belonging to family *Poaceae* also occur, out of which the groups of annual species *Taeniatherum crinitum* are more common. In some places in limited areas there are xerophilous species *Stachys inflata, Sideritis montana* and *Xeranthemum sqarros*. At this stage in the result of preliminary ABD assessment on the basis of dry remnants of plants it can be mentioned that nearby Areni community the plant associations mainly consist of xerophilous plants.

In the western part of the Vayots Dzor region, on the bank of downstream of Yelpin river the field survey was implemented in the not deep gorge of the mountainous slope of northern exposition on the right side of the road and the open slope nearby, which are pastures belonging to the community. In the gorge the xeromorphous bushes of *Rhamnus pallasii* and *Atraphaxis spinosa* are numerous. On the open slope plants met in some places. Grass cover consists of *Artemisia fragrans, Tanacetum argyrophyllum, Marrubium parviflorum, Nepeta meyerii, Teucrium polium, Achillea biebersteinii, Zygophyllum fabago, Verbascum sp., Comphorosma sp., Salsola sp., Euphorbia sp., Eryngium sp.* and other species. There are numerous thorny pillow-like species (*Acanthalimon sp.),* in some places thorny *Caparis spinosa*, and *Stachys inflate* is also distinguished in limited areas.

4.4 Condition of the status of conservation of agricultural species and their wild relatives (in-situ and ex-situ conservation, protected area where conservation and protection are carried on, Gen-bank and ex-situ collections, where these plants are being protected/preserved; past, ongoing or planned projects in this regard).

In 1958 for In-situ conservation of Agro-biodiversity, several specially protected areas have been established. Their establishment has been linked with conservation of forest areas and enormous fruit trees (walnut, pear tree, apple tree, cornel and etc) and berry-fruit bushes of agro-biodiversity met in those areas, (hazelnut, currant, grossularia, blackberry, raspberry and etc). Due to extension of SPNA Network, later in 1981, Erebuni State reserve has been established with the purpose of preservation of gene pool of cereals and their growing places. At present, in-situ conservation of Agro-biodiversity more effectively is being implemented in specially protected nature areas, which occupy 10% of republic's territory and encompass 60 % of species composition of biological diversity.

Current system of specially protected nature areas in Armenia include:

- 3 state reserves ("Khosrov forest", "Shikahogh" and "Erebuni"), which correspond to IUCN ia category, and where scientific actives and cognitive tourism by specific separate routes are only allowed,
- 4 national parks ("Sevan", "Dilijan", "Arpa lake" and "Arevik"), which correspond to IUSN II category and according to area-operational zoning are divided to preserve, reserve, recreation and economic zones,
- 26 state reserve, which correspond to IUCN IV category and where any activity which is contrary to the purpose of parks is restricted and prohibited,
- 230 nature monuments, which correspond to IUCN III category. They are represented by the following types: geological 109, hydro-geological 48, hydrographic 38, nature-historic 16 and biological 19. "Tandzut" nature monument embraces wild relatives of Agro-biodiversity, which is a natural environment for Pyrus syriaca, P. caucasica and other species.

It is planned to establish many new SPNAs, of which the followings will have important significance in terms of Agro-biodiversity conservation:

"Gnishik" national park is planned to be established in river basin of Gnishik and Grav. This national park will have international and national great importance for conservation of genetic resources of wild relatives of cereals.

"Jermuk" national park will embrace also "Jrmuk", "Herher" and Jermuk hdyrographic" reserves, where many wild fruit and berry species of crops of agro-biodiversity grow: pear tree (pyrus), applea tree (Malus), plum (prunus), almond (Amygladus), rowan (Sorbus), hawthorn (Grataegus), currant (Ribes) and dewberry (Rubus) and etc.

"Vorotan" reserve which will embrace middle part of the watershed basin of Vorotan River, where many crop varieties of Agro-biodiversity grow, including warm loving species pomegranate (Punica), fig (Ficus), almond (Amygladus), plum (Prunus) and etc.

"Kirants" reserve, which will be established between the mountain-arms of Mtnasar and Kirants, on the watershed of Voskepar and Karahan/Kirants rivers. Many wild relatives of cultivated fruit and berry-fruit tree-bush species are growing here: grape (Vitis), pistachio (Pistacia), (Diospyros) and etc.

It should be noted, that in terms of in-situ conservation of Agro-biodiversity, there still exist many unsolved issues, linked with clarification of boundaries, confirmation of regimes and other issues, as well as scientific researches of Agro-biodiversity and monitoring implementation. These negatively affect objectives directed on conservation and sustainable use of Biological Diversity and especially agro-biodiversity.
Out of in-situ conservation of SPNAs, ways of solving of improving situation are included in strategy of Agricultural Sustainable development (RA Government decree N682 on 14 April 2004, which is reviewed by the RA Government Decree N1826 on 30 November 2006).
In the events of mentioned strategy for 2006-2015 are planned:

- Project implementation on improvement of natural meadows (pastures) and provision with water
- Assistance in conservation of wild relatives of agricultural crops

These will be conducted on following ways:

a) Creation of genetic bank of crops and those wild relatives,
b) Establishment of nurseries and plantations of species with an economic value,

c) Forest restoration, implementation of forest construction other measures,
d) Implementation of complex measures aimed at forecast of occurrence of natural disasters (drought, sandstorm, floods, deluge, soil salinization and etc) and mitigation of their consequences,
e) Balanced/sustainable use of natural resources,
f) Provision of genetic diversity of crops, including conservation of wild relatives of crops:

In the result of measures undertaken towards weakening of pasture tensions near settlements by RA Ministry of Agriculture, it was recorded reduction of tempos of degradation of pasture ecosystems and loss of fodder species.

4.5 Major risks of the influence on agro-biodiversity and local species, including those facing the elimination risk.

The negative impact on representatives of agro-biodiversity is mainly linked with anthropogenic and natural factors. Negative impact of natural factors on agro-biodiversity is expressed by frequency of global climate change, hydro-meteorological hazardous phenomenon, global warming and the processes in the result of it. Forest logging, extending of artificial pastures and meadows, overgrazing of pastures, plowing of prairie and semi-desert landscapes, increase in irrigated lands, non regulated harvest of edible plants, herbs, fruits, berries, land privatization and etc also contribute to reduction of Agro-biodiversity. Along with above mentioned anthropogenic negative impacts, land privatization has also negatively affected on conservation of Agro-biodiversity. In the result of this process, representatives of agro-biodiversity growing on lands allocated by private ownership rights are in vulnerable conditions: due to use of new lands for plowing, construction or for other purposes.

Fires and massive infection cases by pests and diseases have been recorded in forests, which are linked also with climate change. Due to lack of cultivated lands, steep slopes with dissected relief, flood prone, deluged, lands with risk to be covered by water are being used, which increases land degradation and intensifies landslide phenomenon.

Lack of road improvement measures, overuse of pastures linked with early spring cattle move to mountain pastures, irregular grazing lead to decrease in vegetation on steep slopes and gradient degradation of soils, which is considered as a priority issue to combat against in the region. Landslides caused and continue to cause a great damage to residential houses, infrastructures, lifeline facilities, production capacities, environment located in landslide zones. Landslides threaten health of residents and uninterrupted utilization of communication lines. They are reasons for depopulation of settlements, destruction of historic and cultural values, impoverishment of population poverty and evacuation, hindering development of communities and population growth. Yearly increasing challenges of crop realization, may become a reason for destroy of hardly grown fruitful orchards.

5. Current climate change and climate change scenario for selected areas

5.1 Assessing current change in climate elements

- Perennial/long-term Climate change characteristics
- Methodology for assessment of current climate change
- Extreme Climate indices
- Climate-Related Natural Disasters

Information on climate

Overall, the climate of Armenia is formed under influence of dominating western-eastern humid air masses, which are active in spring and summer on one side, and with intrusions of northern cold and southern hot and

dry air masses that prevail during winter and summer. Some impact is also made by intrusion of eastern air masses (especially in winter season). All such air masses are significantly deformed in the mountainous ranges of the country. Moving up to mountainous highlands such air masses form precipitation, while moving down along the slopes they get warmer and the relative humidity of air reduces. In a result two drastically different agro-climatic zones have been formed in the territory of the country. The first zone is represented by relatively humid forests with mild winters – the forested areas of Lori, Tavush and Syunik marzes. The second zone is characterized with dry continental climate and is represented by all the rest marzes of the republic.

The climate of Armenia is highly variable, even on small territories, due to the country's complex relief. Almost all types of climatic patterns can be observed in Armenia - from dry sub-tropical to frosty highlands. In the southern plain regions the climate is arid and extremely continental. In the northern mountainous regions the climate is milder and damper. The average annual temperature is 5.5°C. The highest average range of temperature is 12-14°C (in Alaverdi and Meghri). Negative average annual temperatures are recorded at the altitude of 2500 m and higher. Summer is temperate. The average temperature in July is 16.7°C, although in Ararat valley it varies between 24-26°C. The absolute maximum temperature is recorded in Artashat (43°C), whilst the absolute maximum temperature for Yerevan is 42°C. Winter is cold. January is the coldest month of winter with an average temperature of -6.7°C. The absolute minimum temperature is recorded in Paghakn (-42°C). Winter is temperate in northeastern and south-eastern regions of the country.
An average annual precipitation in Armenia is 592 mm ranging from 114 mm in the semi-desert zone to about 1000 mm in the high mountains. The most arid regions are Ararat valley and southern region. The annual precipitation here usually varies within 200-250 mm. The highest annual precipitation - up to 1000mm - is observed in high-altitude mountain regions. In Ararat valley the average precipitation during summer does not exceed 32-36 mm. The project area is located in two transboundary marzes: Ararat and Vayots Dzor. Ararat marz is situated in the south-western part of the Republic of Armenia. The climate of Ararat marz is continental with hot sunny summers and cold winters. The marz is considered as one of the most arid regions of the country. The average temperature for July in Ararat Valley it varies in the range of 24-26°C. The absolute maximum temperature in the republic is 43°C, recorded in Artashat, capital of Ararat marz. The average annual quantity of precipitation in Ararat valley is 200-250mm, while during the entire summer the quantity of precipitation on average does not exceed 32-36mm.
Vayots Dzor marz is situated in southern part of the Republic of Armenia. The Vayots dzor climate on the whole is arid, continental, with cold or moderate cold winters and hot or warm summers. In the lowland parts of the marz, where the project areas are located, the climate is arid, with large fluctuations of temperature and precipitation of up to 400mm. The temperature of the air in the lowland parts can reach up to + 40°C in summer and - 35°C in winter. Medium elevated areas located at the altitudes of 1400-2800m have typical mountainous-steppe and mountainous-forest landscape. Mountainous-steppe zones are distinguished with long-lasting mild winters and precipitation of 500-600mm. Forested areas are scattered, the climate is mild, dry, winters are mild and the amount of annual precipitation comprises 700-800 mm. High-mountainous zone is characterized by alpine meadows located on the steep slopes of the mountains. Climate in this zone is cold; precipitation comprises 800-900 mm.

In recent decades the intensity and frequency of hazardous hydro-meteorological phenomena has increased. Among the natural hazards, Armenia is mostly affected by droughts, early spring frosts, heat/cold waves, hailstorms, mudflows, landslides, storms, fogs and forest fires. Table 14 presents data on natural hazards registered in Ararat Marz.

Marz	Dry conditions	Drought	Seasonal	Hailstorm	Early frosts

	(0-low, 5-high)	(0-low, 5-high)	flooding (0-low, 5-high)	(0-low, 5-high)	(0-low, 5-high)
Ararat	4	5	2	4	5

Data on first and last frost as well as duration of no-frost period registered at Areni station are presented in the table 22 below:

Station	Last frost			First frost			Duration of no-frost period (days)		
	average	earliest	latest	average	earliest	latest	average	earliest	latest
Areni	28 III	1 III	22 IV	8 XI	3 X	3 XII	224	190	258

Table 28 presents data on natural hazards registered in Vayots Dzor Marz.

Marz	Dry conditions (0-low, 5-high)	Drought (0-low, 5-high)	Seasonal flooding (0-low, 5-high)	Hailstorm (0-low, 5-high)	Early frosts (0-low, 5-high)
Vayots Dzor	2	3	4	2	2

Observed changes in climate and projections

The results of various studies carried out based on meteorological observation data show that Armenia has been warming during the last decades. The anomalies of annual air temperature and total precipitation for 1935-2007 over Armenia estimated with respect to the base period 1961-1990 are presented in figures 3 and 4 respectively.

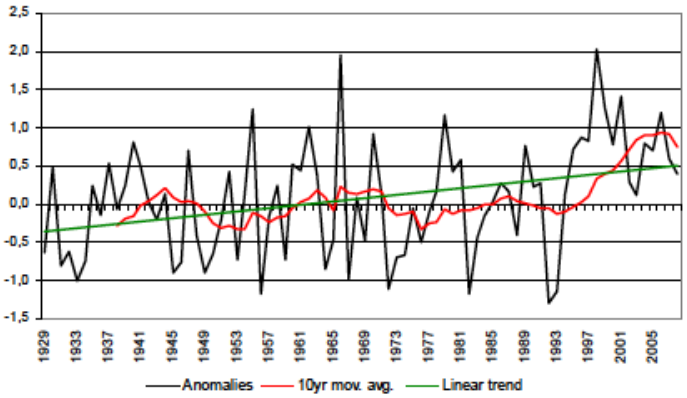


Figure 3. Observed annual air temperature anomalies compared to 1961-1990 baseline mean (black line), their decadal moving averages (red line) and linear trends (green line)

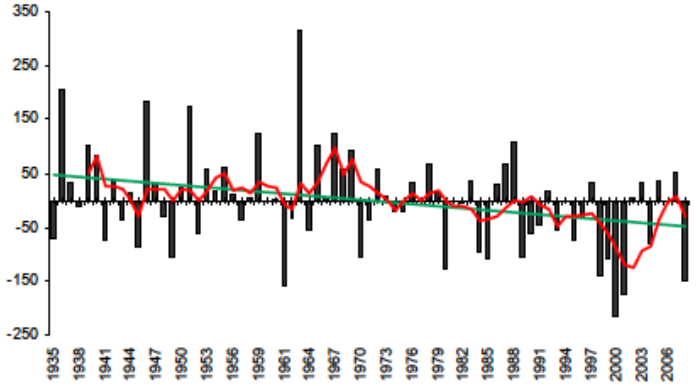


Figure 4. Observed precipitation anomalies compared to 1961-1990 baseline mean

(black line), their decadal moving averages (red line) and linear trends (green line)

During the last 80 years the annual air temperature has been increased by 0.85°C and the precipitation has been reduced by 6%. However, it should be noted that the changes of temperature and precipitation vary from region to region and from season to season. Thus, during the period 1935-2007, in summer months (June, July, August) the temperature has increased by 1°C, whereas in winter (December, January, February) the increase is not statistically significant – about 0.04°C.

The forecasts for Armenia show a significant and consistent increase in temperatures projected for the three time slices: 2030, 2070 and 2100. Analyses were made through PRECIS climate model, and the results obtained for the period 2071-2100 (see figure 7) were compared with the classical climate distribution (see figure 8).

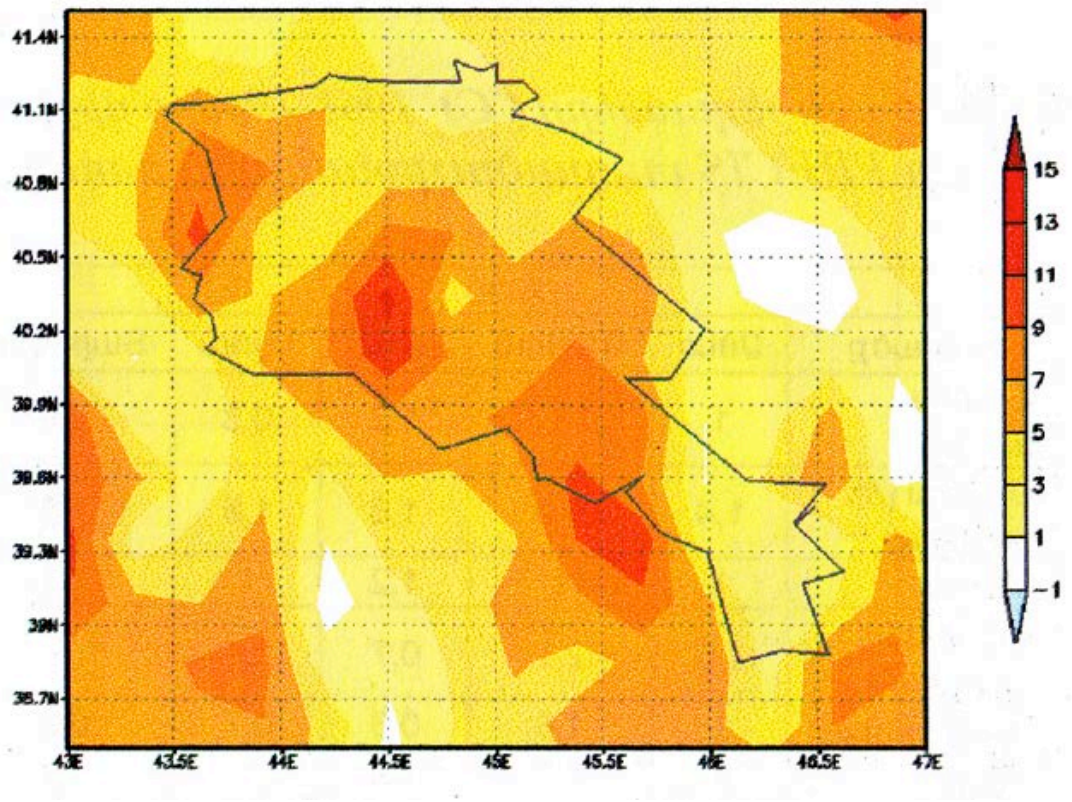
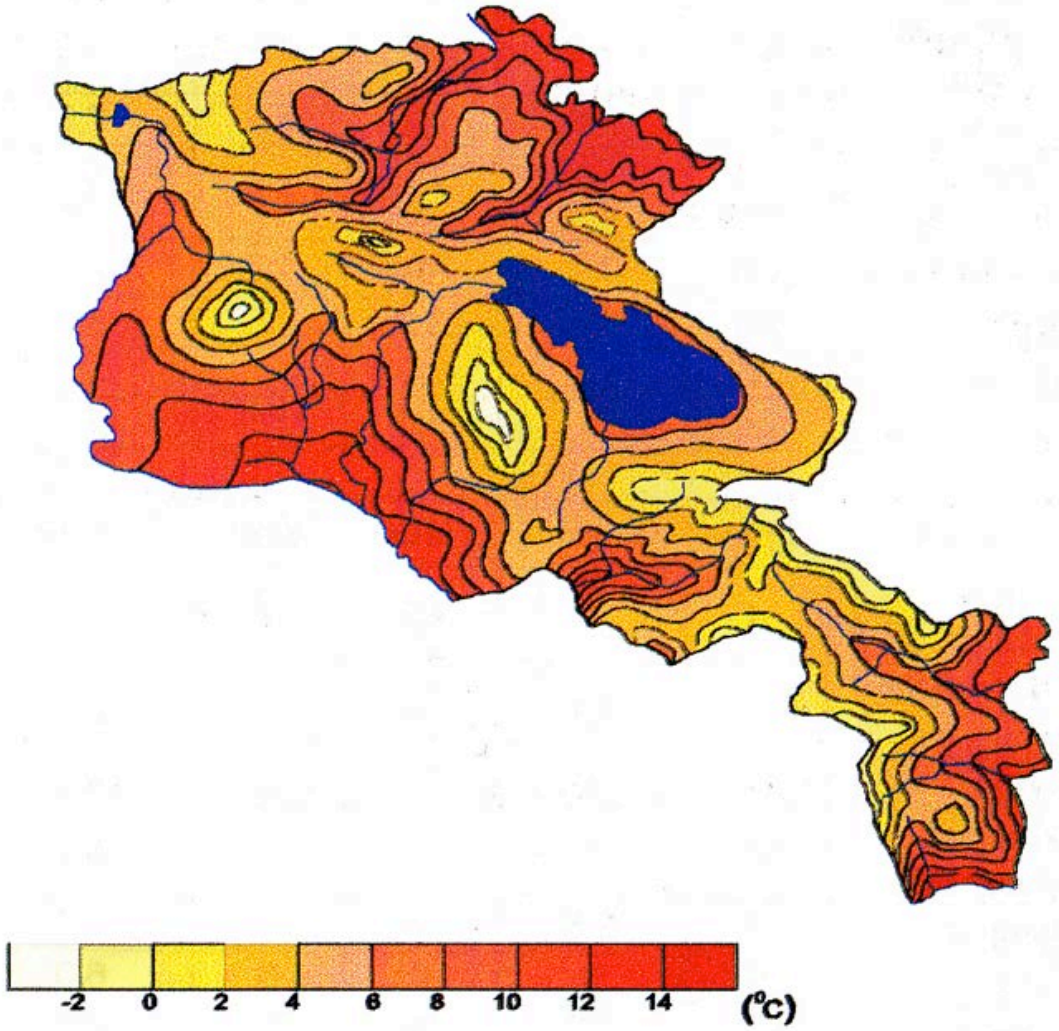


Figure 7. Forecasted changes in air temperature by 2100
in accordance with PRECIS regional model



Results of the forecast of the change in air temperature are presented in table 30. The increase of air temperature shall be maximal in summer season (about 5-9°C warmer). There are regional variations within Armenia. West and central region, particularly Ararat Valley shall experience higher warming than rest of the country during all the seasons. Temperature over southern part of Armenia (Suniats highland) shall become mildly warmer. Annual mean surface temperature anomalies for 2071-2100 compared to baseline climatology have essentially same features as the ones described for seasonal mean anomalies. The central and western regions of Armenia shall experience more warming than the rest of the region in the country. Annual temperatures will rise by 4-7°C by the end of 21st century.

Table 30. Changes in seasonal and annual temperatures (°C) compared to 1961-1990 baseline average (PRECIS model under A2 scenario)

Area	Winter	Spring	Summer	Autumn	Annual
2030					
Ararat valley	1.05	1.6	0.32	0.7	0.96
Vayk	1.05	1.78	1.78	1.05	1.4
2070					
Ararat valley	2.5	3.6	1.0	1.7	1.7
Vayk	2.5	3.9	3.9	2. 5	3.2

2100					
Ararat valley	2-6	4-7	1-3	2-4	2.5 - 5
Vayk	5-7	5-7	5-7	5-7	5-7

According to the PRECIS results, in the period of 2071-2100, the total soil moisture in Armenia will increase during spring months (March, April, May) compared to the average (1961-1990), and in summertime the total soil moisture may possibly decrease. These results are in line with precipitation forecasts and the fact that snow melt will start earlier due to the increase in spring temperatures. The relative air humidity, according to the model, will reduce in the same period in all seasons of the year except autumn, compared to the average for 1961-1990 (table 31).

Table 31. Deviations of seasonal and annual precipitation (%) compared to the average for 1961-1990 (PRECIS model under A2 scenario)

Area	Winter	Spring	Summer	Autumn	Annual
2030					
Ararat valley	-13	-9	-13	-9	-11
Vayk	-11	-11	-9	+4	-7
2070					
Ararat valley	-25	-18	-25	-18	-22
Vayk	-22	-22	-18	+7	-13
2100					
Ararat valley	-35	-25	-35	-25	-18
Vayk	-30	-30	-25	+10	+30

In autumn, the humidity will reduce negligibly in the central regions, and a relative increase in humidity may be observed in north-eastern and southern regions. In spring, the air will be 4-8% drier in the central regions and 2-4% drier in north-eastern and southern regions of the country. The maximal reduction of humidity is anticipated in winter and summer (10-14%). Annual relative humidity shall reduce by 5-10% and more.

Lower precipitation levels combine with higher average temperatures to increase evaporation rates and reduce winter snowpack and spring run-off: as a result less water reaches streams and rivers. For a number of Armenia's rivers the greatest cause of reduced flow will be less accumulation of snow and ice, with lower winter precipitation and slightly higher winter temperatures. Snowmelt is responsible for 20 - 40 % of total river flow in the country, with most important sources of snow and ice accumulating at 1800 - 2800 meters above sea level. In terms of declining river flow due to reduced snowmelt, Armenia's most vulnerable river basins located in the project marzes are Arpa, Azat and Hrazdan. Armenia's total river flow is projected to drop 7 % by 2030 and 24 % by 2100. Climate change in Armenia has been pronounced by more frequent and severe weather events, such as droughts, spring frosts, hails, floods, mudflows, winds and forest fires. During the past decade extreme weather events have been recorded to accelerate.

6. Assessment of Ecosystems and agro-biodiversity vulnerability to climate change. Identification of the most vulnerable areas and species

Although all ecosystems having such dry climatic conditions as ones in Armenia are vulnerable to global climate change, the most distinguished from them however, is Ararat Valley, where annual precipitation

fluctuates from 200-250 mm and in summer does not exceed 32-26mm. Insufficient amount of atmospheric precipitation favours formation of dry semi-desert landscapes. In rocky hills, precipitation quickly evaporates due to high air temperature, in other places it is removed by surface runoffs. Local geological structure and rock impermissibility also foster quick run-off. Fast denudation of the affected land, poor vegetation cover and dry climate adversely affect land formation process. In such natural conditions, formation of densely vegetated areas is impossible. Here, mainly friganoid cover is present. In the community Paruyr Sevak significant area is occupied by wormwood semi-desert; small-leaf bushes and cactus-type vegetation cover the area in the community Zangakatun. As vulnerable ecosystems for this study, where direct impact of climate change is more tangible, semi-desert landscapes of Arart marz and dry steppe landscapes of Vayots Dzor marz were selected. Not only the increase of temperature and frequency of droughts, but also degradation of land, loss of crop productivity and decline of living standard of rural residents demonstrate the latter.

6.1 Selection of indicators for assessment of vulnerability of agro-biodiversity to climate change and detailed description of methodology used for vulnerability assessment and analysis

	Rind	Aghavnadzor	Chiva	Areni	Getap	Paryur Sevak	Zangakatun
Criteria							
Location above sea level (m)	1200-1400	1450-1500	1090-1150	1000-1200; precipitation: 250-300 mm	1310	1256	1650-1700
Number of residents	1628	2095	892	2006	2355	720	1167
Factually living	1528	2095	892	1984	2150	701	1100
Vulnerable society: pensioners and disabled	306, of which pensioners 249, disabled 57	423, of which pensioners 351, disabled 63, refugees 9	209, of which pensioners 176, disabled 33, refugees 9	350, of which pensioners 292, disabled 58	125	64, of which pensioners 20, disabled 32, refugees 12	245, of which pensioners 222, disabled 23
Main activity	Agriculture, animal husbandry, horticulture	Vineyard, wine production, gardening	Vineyard, wine production, gardening	Vineyard, wine production, gardening	Gardening, tobacco production, vegetables growing	Agriculture 35%, Animal husbandry 20, gardening 35, apiculture 6	Gardening and partially animal husbandry, apiculture 530
Sources of income	Grape 60 ha, peach 30 ha, apricot 10 ha, vegetables, wheat, barley, potato, alfalfa	Vineyard, gardening	Wheat, barley, alfalfa, potato, cabbage	Wine production grape 120 ha, apricot 57 ha, vegetables 50 ha	Gardening, vegetables growing, tobacco production	Horticulture, grape: 35%+10% apricot, vegetables 33%	
Average income (per capita)	5000	30000	20000	25000	20000	1000-2000	5000

Poverty trends and dynamics (numbers of registered in "PAROS")	53	38	41	53	75	89	60
Main causes of change	Droughts, early Spring and late Fall frostbites	Destruction of vineyard and gardens by frostbites	Droughts damage 30% of yield	Loss of yield due to droughts		5th category of the land	Droughts, Spring frostbites
Administrative area (ha)	4366.92	4682	2822	5380	1812	1971	5039
Area of agricultural land (ha)	1506.34		2138			1886	4678
Damaged land area (ha)	Around 50					1334.1: mined 300, salty 50, not profitable 180	Landslide: 6
Arable land, of which irrigated (ha)	333.5/16.7	466	288	285	336	716.6/314.0	762, almost 80% of arable land is not used
Pastures, of which irrigated (ha)	1121.46	1071	375	1463	absent	946.5	3822
Pasture condition	Poor		200 ha is not used				500 ha is not used
State of use			Not used 1475	Not used 3480			
Cattle heads	large 609, small 293	large 1200, small 1200	large 328, small 65	large 240, small 0	large 483, small 87	large 202, small 326	large 580, small 1150
Frequency of droughts	Each 2-3 years	Frequent				Each 1-2 years	Each 1-2 years
Spring frostbites	Consecutive 7-8 years	Consecutive 7-8 years	Consecutive 7-8 years			Each 3-4 years	Each 3-4 years
Vulnerable ecosystems	Steppe ecosystem with dominating wild grain species	Steppe ecosystem with dominating wild grain species			River ecosystem	Wormwood steppe	Cactus vegetation
Ecological problems	Due to privatization, threatened wild grain plantations, cutting of wild fruit trees, loss of	Due to privatization, threatened wild grain plantations	Pollution by domestic waste water	Flooding of River Arpa, loss of land by 30 households	Pollution by domestic waste and effluents. High quality of undergrou nd water, land	Pollution by sewary, loss of productive soil	Landslides, land contaminatio n by sewage

	biodiversity				flooding due to frequent river flooding		
Garbage transportation	Each 10 days	Individually	Individually. Local administration allocated a dumping area.	Individually		Each 2 days. Local administration allocated a dumping area.	
State of irrigation system	Irrigation system is damaged, losses – 45%.	Irrigation system is damaged, losses – 45%. 20% of the residents do not use irrigation water.	Irrigation system is damaged, losses – 45%.	Irrigation system is damaged, losses – 45%.	Irrigation is supplied to 70-80% of the population, though the river flows through the village.	Irrigation is supplied to 25-30% of the population. A part of the system is buried under anti-tank hills.	Reservoir for water accumulation exists. However, irrigation system is damaged, losses – 50%.
Sewerage state	Absent	Absent	Absent	Absent	Absent, diged toilets or river discharge.	The system has drawbacks. Sewerage line ends near the school.	Absent
Drinking water system		Village demands are satisfied. Losses 15-20%.	Losses -25%		Satisfaction of the demand by 60%.		
Residents' willingness for improvement programs	95%	80%			90%	90%	

6.2 Assessment of ongoing climate change impact on agro-biodiversity according to the selected indicators

Studying the dynamic of yield of agricultural crops in two neighboring communities located in arid zone of Ararat region, it turned out, that average indicators of yield of agricultural crops in 2010-2011 cultivated in the communities of Paruyr Sevak and Zangakatun compared with average indicators in 2000-2011 have dropped drastically. It is appropriate to mention that this pattern (on drop) is the same in two communities. If in the community of Paruyr Sevak, the yield drop of grain, fruit-vegetable and grape comprised 8.0-50.0% in the last ten years, then drop of yield of crops in Zangakatun community comprised 9.2-47.0% for the same time period (tables on indicators of yield of agricultural crops are placed in analysis section of given communities). In the mentioned communities, in the last 10-15 years, winds and sandstorms became more frequent caused by climate change, which have drastic negative impact on growth and development of sorts of hydrophilic plants in growing in agro-ecosystems, in the result of which, in natural pastures located in the territory of communities small islands of vegetation is noted and ecosystems are in mosaic type. Vegetation in natural pastures is drastically worsened in the mentioned communities, the pastures are in aging stage and the

flora is much reduced, even implementation of surface improvements in those areas it's not efficient economically, for this reason, radical improvements are necessary, namely, eradicate soil layer and natural vegetation of pasture through sowing, artificial grass sowing, establish sowing pastures (of course in the areas, which are located up to gradient of 15^0).

6.3 – 6.4 Assessment of possible influence on forecast climate change (2020-2050) to agro-biodiversity in selected criteria. Identification of Indicator species; assessment of impact of climate change on indicator species

Studying and analyzing current situation and incurred changes of agro-biodiversity in recent time period (over 10 years) in number of communities located in arid and semi-arid areas of Ararat and Vayots Dzor regions, we came into following conclusions:

- Climate change has caused profound changes in the structure of agro ecosystems in the communities located in arid steppe zone of Ararat and Vayots Dzor regions, land degradation, trends of agro-biodiversity productivity reduction are seen everywhere (floods, landslides);
- In the result of climate change, agro biodiversity and its productivity of studied communities P.Sevak, Zangakatun (Ararat region) and Chiva (Vayots dzor) have become more vulnerable,
- To raise productivity of agricultural crops growing in the mentioned communities, elaboration of precise system of measures is necessary to mitigate and adapt negative phenomena caused by climate change.
- For preservation and improvement of flora and vegetation in meadows, develop and invest complex of agro-measures in the form of surface and radical improvement.
- Create all favorable conditions for organization of long-term use of pastures, as well as management of timings of exploitation of community's natural pastures; and collection methods of herbs, edible, fodder types, honey and resin producing plants

7. CALCULATING VULNERABILTY INDICES

Three major vulnerability components

Methodology for selection of vulnerability indicators has been explained in a separate report submitted in February 2012. In accordance with widely accepted approach on vulnerability we have chosen to use the three major vulnerability components:

1. Adaptive capacity of communities to climate change
2. Exposure of communities to climate–hazards
3. Sensitivity of communities to climate–hazard exposures

Sub-components

Each of these three vulnerability components is further divided on sub-components:

ADAPTIVE CAPACITY	**Component**
Social capital	**Sub-component**
Human capital	**Sub-component**
Financial capital	**Sub-component**

Physical capital	Sub-component
EXPOSURE	**Component**
Climate hazards	**Sub-component**
SENSITIVITY	**Component**
Ecosystems	**Sub-component**
Communities	**Sub-component**
Agriculture	**Sub-component**

Vulnerability indicators

For each vulnerability sub-components, a set of vulnerability indicators has been assigned. These indicators are listed in Table 1.

Vulnerability indicators

Based on the data provided by national experts, vulnerability indicators have been assessed for each vulnerability sub-component. This has been done separately for each of the candidate pilot regions.

Scoring system

1.1 Determining vulnerability coefficients for indicators

Example 1: highest value is assigned 1.00

How did we score and rank the figures provided by the national experts? And how did we use these to produce vulnerability profile of each candidate pilot region? This can best be explained in the following two examples:

Suppose that from the data provided by the national experts on the difference between average annual rainfall of 1991-2010. vs. 1961-1990., the following results are obtained:

	Region A	Region B	Region C
Difference in rainfall (mm)	77.30	76.20	41.90

We see that Region A has the biggest difference in rainfall, which hypothetically makes it more vulnerable than the other two regions. We assign this region vulnerability coefficient 1.00, which represents the highest vulnerability coefficient (on a scale from 0.00 to 1.00). The vulnerability coefficients for the other two regions are calculated by dividing their rainfall difference values by the rainfall difference for Region A. So the vulnerability coefficient for Region B is 0.99 (= 76.29 divided by 77.30) and for region C 0.54 (= 41.90 divided by 77.30).

	Region A	Region B	Region C
Vulnerability coefficient	1.00	0.99	0.54

In the above example, region with the highest value has been assigned vulnerability coefficient 1.00. However, this is not the rule for each criteria (sub-indicator). For some criteria we'll assign the highest vulnerability coefficient of 1.00 to the region for which we obtained the lowest value. The following example illustrates it well.

Example 1: lowest value is assigned 1.00

Suppose that from the data provided by the national experts on the average monthly salary, the following figures are obtained.

	Region A	Region B	Region C
Average monthly salary (EUR)	150.00	165.00	180.00

In this case, the most vulnerable (at least hypothetically) is not region with the highest figure (as was the case with the difference in rainfall), but the region with the lowest figure (salary). In this case, we assign the highest vulnerability coefficient of 1.00 to the region with the lowest value. In our case it is Region A (again). The vulnerability coefficients for the other two regions are calculated by dividing the salary of Region A with their salaries. So the vulnerability coefficient for Region B is 0.91 (= 150.00 divided by 165.00) and for region C 0.83 (= 150.00 divided by 180.00).

	Region A	Region B	Region C
Vulnerability coefficient	1.00	0.91	0.83

The example of values and coefficients of vulnerability indicators for Armenia are presented Table 1.

Table 1: Values and coefficients of vulnerability indicators for Armenia

Vulnerability category	Type of category	Values		Vulnerabily coefficient	
		Ararat	Vajoc	Ararat	Vajoc Dzor
ADAPTIVE CAPACITY	**Component**				
Social capital component	**Sub-**				
Farm organisations	Indicator	0.04	0.09	1.00	0.42
Female work	Indicator	52.59	61.18	1.00	0.86
Human capital	**Sub-component**				
Literacy	Indicator	11.90	13.00	1.00	0.92
Education	Indicator	11.90	13.00	1.00	0.92
Agricultural education	Indicator	0.01	0.01	1.00	1.00
Financial capital	**Sub-component**				
Livestock density	Indicator	3.56	10.12	1.00	0.35
Average salary	Indicator	131.00	105.00	0.80	1.00
Physical capital	**Sub-component**				
Infrastructure	Indicator	138,473	36,176	1.00	0.26
Access to market	Indicator	2,577	628	1.00	0.24
EXPOSURE	**Component**				
Climate hazards	**Sub-component**				
Rainfall	Indicator	-9.00	13.10	1.00	0.46
Temperature	Indicator	0.60	0.01	1.00	0.02
Drought	Indicator	4.60	3.70	1.00	0.80
SENSITIVITY	**Component**				
Ecosystems	**Sub-component**				
Plant cover	Indicator	100	100	1.00	1.00
Groundwater	Indicator	7.35	0.01	0.00	1.00
Land use	Indicator	193.88	1.00	0.01	1.00
No. of varieties	Indicator	100	100	1.00	1.00
Communities	**Sub-component**				
Women	Indicator	50.80	50.00	0.98	1.00
Children	Indicator	6.74	6.17	0.92	1.00
Below poverty	Indicator	42.40	37.10	0.88	1.00
Population growth	Indicator	2.20	2.20	1.00	1.00
Agriculture	**Sub-component**				
Small-scale farming	Indicator	99.96	99.91	1.00	1.00
Rural population	Indicator	70.50	65.40	1.00	0.93
Land degradation	Indicator	48.76	30.69	1.00	0.63
Production	Indicator	16	20	1.00	1.26
Crop diversification	Indicator	59.11	0.01	0.00	1.00
Irrigation	Indicator	7.35	0.01	0.00	1.00

Agric. workers	Indicator	62.20	60.08	1.00	0.97

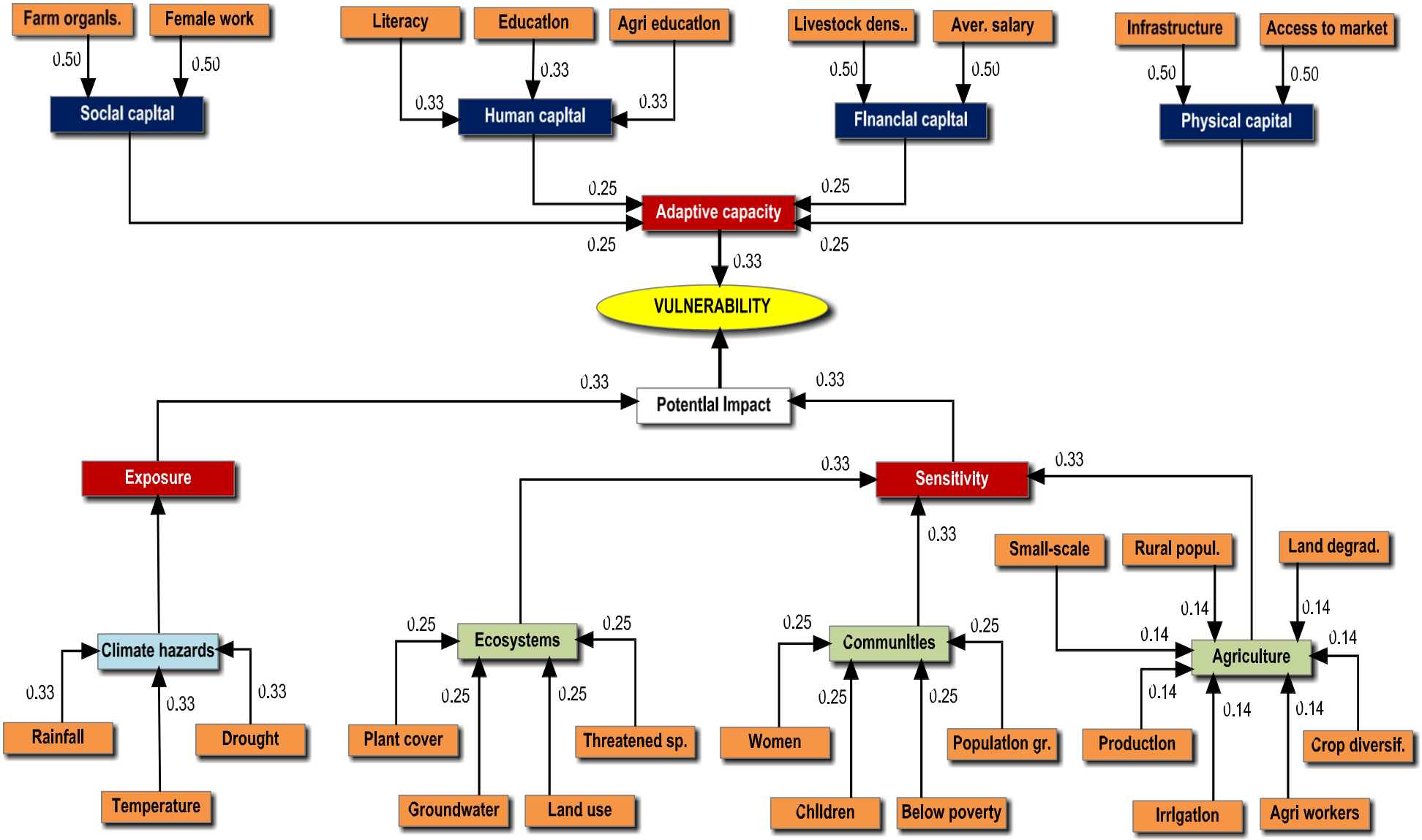


Figure 1: The aggregation of the different indicators towards the overall vulnerability with proposed weight factors

7.2 Assigning weight factors and determining component indices

Weight factors

The next step is to assign relative importance – a weight factor to each indicator and sub-components. Figure 1 provides an overview of the proposed weight factors. A separate report on methodology explains more in detailed how the weight factors have been determined.

Vulnerability indices

The vulnerability index of an indicator is calculated by multiplying its weight factors by its coefficient (calculated in the previous step). Table 2 shows weight factors, coefficients and indices (indexes) for vulnerability sub-components and indicators for the two proposed pilot regions in Armenia.

Table 2: Vulnerability indices for vulnerability indicators and sub-components for Armenia

		Ararat		Vajoc Dzor	
	Weight	Coefficien	Index	Coefficient	Index
ADAPTIVE CAPACITY					
Social capital					
Farm organisations	0.50	1.00	0.50	0.42	0.21
Female work	0.50	1.00	0.50	0.86	0.43
Subtotal			1.00		0.64
Total social capital	0.25		0.25		0.16
Human capital					
Literacy	0.33	1.00	0.33	0.92	0.31
Education	0.33	1.00	0.33	0.92	0.31
Agricultural education	0.33	1.00	0.33	1.00	0.33
Subtotal			1.00		0.94
Total human capital	0.25		0.25		0.24
Financial capital					
Livestock density	0.50	1.00	0.50	0.35	0.18
Average salary	0.50	0.80	0.40	1.00	0.50
Subtotal			0.90		0.68
Total financial capital	0.25		0.23		0.17
Physical capital					
Infrastructure	0.50	1.00	0.50	0.26	0.13
Access to market	0.50	1.00	0.50	0.24	0.12
Subtotal			1.00		0.25
					0.06
					0.63
Total physical capital	0.25		0.25		
ADAPTIVE CAPACITY			0.98		

Table 2: Vulnerability indices for vulnerability indicators and sub-components for Armenia (continue)

		Ararat		Vajoc Dzor	
	Weight	Coefficien	Index	Coefficient	Index
EXPOSURE					
Climate hazards					
Rainfall	0.33	1.00	0.33	0.46	0.15
Temperature	0.33	1.00	0.33	0.02	0.01
Drought	0.33	1.00	0.33	0.80	0.27
Subtotal			1.00		0.43
Total social capital	1.00		1.00		0.43
ADAPTIVE CAPACITY			1.00		**0.43**

		Ararat		Vajoc Dzor	
	Weight	Coefficien	Index	Coefficient	Index
SENSITIVITY					
Ecosystems					
Plant cover	0.25	1.00	0.25	1.00	0.25
Groundwater	0.25	0.00	0.00	1.00	0.25
Land use	0.25	0.01	0.00	1.00	0.25
Threatened sp.	0.25	1.00	0.25	1.00	0.25
Subtotal			0.50		1.00
Total ecosystems	0.33		0.17		0.33
Communities					
Women	0.25	0.98	0.25	1.00	0.25
Children	0.25	0.92	0.23	1.00	0.25
Below poverty	0.25	0.88	0.22	1.00	0.25
Population growth	0.25	1.00	0.25	1.00	0.25
Subtotal			0.94		1.00
Total communities	0.33		0.31		0.33
Agriculture					
Small-scale farming	0.14	1.00	0.14	1.00	0.14
Rural population	0.14	1.00	0.14	0.93	0.13
Land degradation	0.14	1.00	0.14	0.63	0.09
Production	0.14	1.00	0.14	1.26	0.18
Crop diversification	0.14	0.00	0.00	1.00	0.14
Irrigation	0.14	0.00	0.00	1.00	0.14
Agric. workers	0.14	1.00	0.14	0.97	0.14
Subtotal			0.71		0.97
Total agriculture	0.33		0.24		0.32
ADAPTIVE CAPACITY			0.71		**0.98**

7.3 Calculating the overall vulnerability index

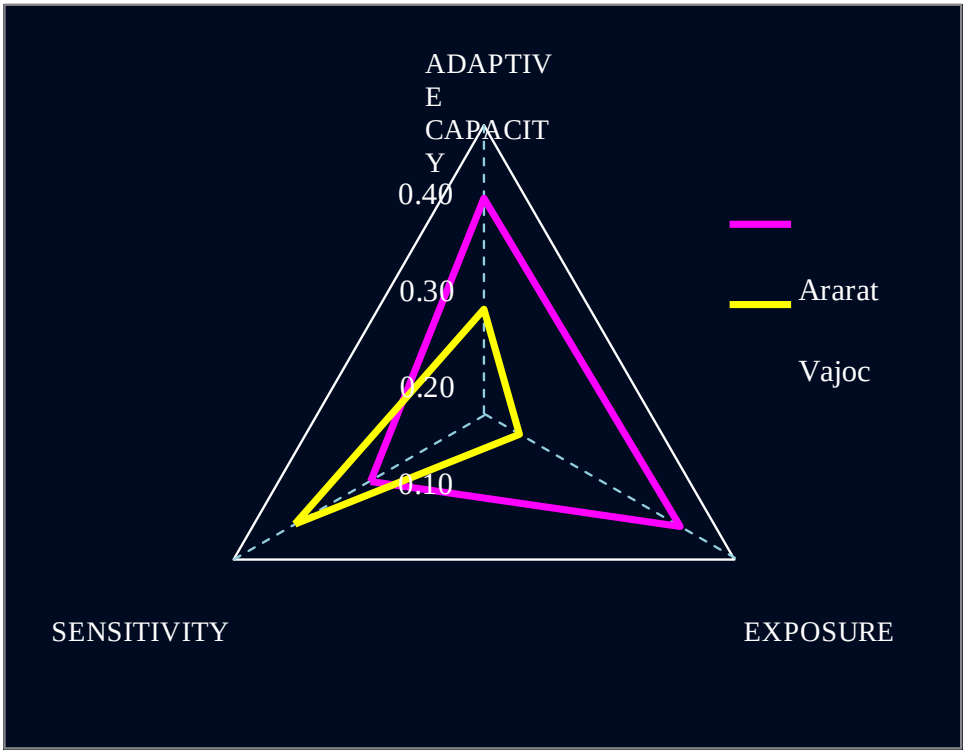
The overall vulnerability index

The overall vulnerability index is made by multiplying vulnerability component indices with their assigned weight factors. The three components are assigned an equal weighting (0.33 each), as shown in Table 3.

Table 3: Component and the overall vulnerability indices for the two proposed pilot regions in Armenia.

	Arara			Vajoc		
Vulnerability component	Vulner. Index	Weight	Weighted Index	Vulner. Index	Weight	Weighted Index
ADAPTIVE CAPACITY	0.98	0.33	0.33	0.63	0.33	0.21
EXPOSURE	1.00	0.33	0.33	0.43	0.33	0.14
SENSITIVITY	0.71	0.33	0.24	0.98	0.33	0.33
VULNERABILITY			**0.90**			**0.68**
MOST VULNERABLE			1			2

The vulnerability indices of the three vulnerability components can be presented graphically for each region:



7.4 Ranking vulnerability indices of the proposed pilot regions

Ranking regions

The proposed pilot regions are ranked according to their overall vulnerability indices. The region with the highest overall vulnerability index is the most vulnerable from the climate change point of view. The least vulnerable region is the one with the lowest overall vulnerability index.

Ararat is the most vulnerable region

In case of Armenia the most vulnerable region is Ararat. The Vajoc region seems to be far less vulnerable than Ararat because its vulnerability index is 0.68, while the vulnerability index of Ararat region is as high as 0.90 (Table 3).

8. CALCULATION OF INDICATOR VALUES

8.1 Adaptive capacity of communities to climate change

8.1.1 Social capital

Social capital is determined suing two indicators: farm organisations and female work participation.

Farm organisations

The number if collective agricultural ventures (= co-operatives, joint ventures, partnerships, share-holding companies, etc.) are taken as a proxy for private social networks. We assume that in case/time of severe climate hazards, the potential for adaptation is higher by a group, rather than an individual. The coefficient is obtained by dividing the number of co-operatives, joint ventures, partnerships and share-holding companies by the total number of farms. Region with the lowest share of organised farm operations in the total number of farms is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

Female work participation

Female work participation is an indicator of the level of development of society. We take the percentage of the employed women in the pilot regions (incl. those employed in (semi)-subsistence agriculture). Region with the lowest percentage of female work participation is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

8.1.2 Human capital

We use three indicators to determine human capital: literacy rate, education level and agricultural education.

Literacy rate

Figures on literacy rate are taken from the Excel files provided by national experts. Region with the lowest value for literacy rate is considered to be most vulnerable and is assigned factor 1.00.

Education level

It is worth to notice that in case education level (= literate but no primary school, primary school, secondary school, college, university graduate and post-graduate) of the two regions in Armenia there is not much difference. For this reason and hoping to get more distinction between the regions, primary school is not included in the calculation. Only the summed up percentages of finished secondary school, colleges and universities are used to determine the value of the education level. Region with the lowest value for the education level is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

Formal agricultural education

Figures on formal agricultural education (= secondary agricultural school or university) are taken from the Excel files provided by national experts. Region with the lowest formal agricultural education is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

8.1.3 Financial capital

Financial capital is assessed by livestock and average salary:

Livestock density

Livestock is an asset for a family as it provides inputs in various forms (transportation, means of work in agriculture, manure, milk, etc.). In case of disasters or any impact on agriculture, livestock can serve as means of coping mechanism. It can be a source of alternative or additional income for the farmers. Thus, higher livestock density would indicate higher adaptive capacity. Livestock capital is expressed in terms of livestock density (= No. of livestock per hectare). Excel data on livestock (= number of cattle, sheep, goats, pigs and poultry) are automatically converted in Excel into so called Livestock Units. Livestock density is obtained by dividing Livestock Units by the hectares of agricultural land. Region with the lowest livestock density is considered to be most vulnerable and is assigned vulnerability coefficient 1.00. In case of Armenia, the livestock density in both regions appears to be high. This is because due to the lack of data on the permanent grassland in these regions – livestock units have been divided only with the reported (known) agricultural area.

Average salary

Average salary: regions with higher average salary are assumed to be wealthier and therefore better able to prepare for and respond to adversity. Calculation of values for average salary is explained in Chapter 1.1.

8.1.4 Physical capital

Physical capital is assessed by giving rating to infrastructure development and access to market.

Infrastructure

Infrastructure is calculated in the following way: number of inhabitants is divided by the number of preliminary, primary and secondary schools, as well as the number of colleges & universities, hospitals and Internet connections. This tells us how many inhabitants we have per one school, college, university; hospital and Internet connections. The sum of these numbers makes the infrastructure value. Region with the highest value (= number of inhabitants per one school, hospital, etc.) is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

Access to market

Access to market is calculated by summing up values for the farmers' markets and asphalt roads. Farmers' markets value is assessed by:

1. Calculating the number of people living in rural areas (=number of inhabitants multiplied by the percentage of rural population)
2. Dividing above figure with the number of reported farmers' markets. Asphalt roads are calculated by dividing the area of the region ('000 km^2) with the total number of asphalt road kilometres. Region with the highest access to market value (= number of rural inhabitants per one farmers' market and km of asphalt roads) is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

8.2 Exposure of communities to climate–hazards

In our methodology, systems' exposure to variable/changing climate is defined by the change of temperature, rainfall and occurrence of droughts.

Change in temperature

Change in temperature is expressed as the difference between average annual temperatures of 1991-2010. vs. 1961-1990. The data are taken from the Excel files provided by national experts. Region with the highest change in temperature is considered to be most vulnerable and is assigned factor 1.00.

Change in rainfall

Change in rainfall is expressed as the difference between average annual temperatures. It is calculated in the same manner as above and is explained in Chapter 1.1.

Droughts

Droughts are ideally calculated from the figures on Aridity Index (more about it can be found in the separate report on methodology and the subsequent E-mails on evapotranspiration formulas). However, in the absence of these, droughts can be calculated as the average rainfall difference for spring and summer period (March – August) of 1991-2010. vs. 1961-1990. The data are taken from the Excel files provided by national experts. Region with the highest (negative) change in rainfall during spring and summer is considered to be most vulnerable and is assigned factor 1.00.

8.3 Sensitivity to climate–hazard exposures

8.3.1 Ecosystems sensitivity to climate–hazard exposures

Plant cover

Plant cover value is calculated as the percentage of permanent grassland (= meadows and pastures) in the total agricultural area. The data are taken from the Excel files provided by national experts. Region with the lowest percentage is considered to be most vulnerable and is assigned factor 1.00.

Groundwater

In the absence of data on net groundwater availability, this value is assumed to be the same as for irrigation. See below under agriculture.

Land cover status

Land cover value is assumed to be the ratio between forest and agricultural land. It is calculated by dividing the number of hectares under forest with the number of hectares under agricultural land and multiplying this value with hundred. Region with the lowest value is considered to be most vulnerable and is assigned factor 1.00.

No. of local varieties

Originally, it was assumed that an indicator would be the number of threatened butterfly, vertebrate and flowering species of a region. However, in the absence of these data, the number of local varieties should be used instead. Unfortunately, in case of the two regions in Armenia, there were no reliable data. Consequently, the number of local varieties in both regions is assumed to be the same and both regions were assigned factor 1.00.

8.3.2 Local community sensitivity to climate–hazard exposures

Women

Climate variability is likely to have disproportionate impacts on females as compared to males. Greater reliance of women on natural resource dependent activities such as agriculture is a common feature in many countries. Changes in natural resources due to changes in the climate are more likely to affect women through various direct and indirect means such as water and fuel wood availability. The data on the percentage of women in the total population are taken from the Excel files provided by national experts. Region with the highest percentage is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

Children

Children are likely to be more vulnerable to natural disasters and extreme climate change events. The percentage of children between 0 and 7 years old are calculated by dividing their number by the number of total inhabitants. Region with the highest percentage is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

Below poverty line households

The data on below poverty line households in the pilot areas are calculated by multiplying the number below poverty line households with four (we assume that they have four family members in average). This is further divided by the number of total inhabitants and multiplied by hundred. Region with the highest value is considered to be most vulnerable and is assigned factor 1.00.

Population growth

Unfortunately, in case of the two regions in Armenia, there were no reliable data on population growth. Consequently, in both regions the population growth is assumed to be the same and both regions were assigned factor 1.00.

8.3.3 Agriculture

Percent small-scale farms

Small-scale farmers, generally subsistence farmers, are more sensitive to climate change and variability because they have less capital- intensive technologies and management practices. Estimated number of subsistence farms is divided by the total number of farms and multiplied by hundred. This gives us percentage of small-scale farms. Region with the highest percentage is considered to be most vulnerable and is assigned vulnerability coefficient 1.00. Unfortunately, in case of the two regions in Armenia, there were no reliable data on small-scale farms. Consequently, in both regions the share of small-scale farmers is assumed to be the same and both regions were assigned factor 1.00.

Rural population

The data on the percentage of rural population in the total population are taken from the Excel files provided by national experts. Region with the highest percentage is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

Land degradation

The number of hectares of degraded land – comprising land: With
- less than 2% soil organic matter
- With pH value less than 5
- Classified as "saline"
- Pasture classified as overgrazed
- Classified as prone to medium to severe erosion

With >33% surface overgrown with shrubs/bushes
With >10% surface overgrown with alien species

is summed up and divided by the total area of the region. Region with the highest value is considered to be most vulnerable and is assigned factor 1.00.

Agricultural production

Changes in agricultural production are calculated using historical data on agricultural production in the pilot regions, provided by local experts. Both crop and livestock production is taken into account. Production for the respective periods has been expressed in terms of cereal units. One cereal unit is a natural measure allowing comparison of different agricultural produce. It allows comparing not only "apples" and "pears" but also crop and livestock produce. One cereal unit (CU) is equal to nutritional value of 100 kg barley and its specific protein and starch content. Cereal units of other crop products are based on their nutritional equivalent against barley. Sugar beet for instance contains 0.27 CU, oats 0.85 CU, soyabeans 2.6 CU, etc. Cereal units of livestock products are determined as the equivalent of crop cereal units that are (hypothetically) required to produce 100 kg livestock produce (meat, milk, eggs, and wool). Agricultural productivity is assessed by multiplying data on the tonnes of crop and livestock produce with the relevant CU factors for those produce. The CU factors are taken from the German Federal Ministry of Agriculture[1]. The final value is expressed in thousand CUs. Region with the lowest value is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

Crop diversification

An agricultural region with more diversified crops will be less sensitive to climatic variations than for instance a region predominantly growing 1-2 crops only. Crop diversification value is calculated by deducting from 100 percent agricultural area, percentage of area under cereals and permanent grassland. Region with the lowest percentage is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

Irrigated area

Percentage of irrigated area out of the total agricultural area cultivated area gives an indication of the dependence on rainfall as well as utilization of surface and groundwater. Region with the lowest percentage is considered to be most vulnerable and is assigned vulnerability coefficient 1.00.

Agricultural labour

The ratio of agricultural workers to the rest of the working population is an important indicator. This is used in order to check if there is a significantly large population having high dependence on agriculture for livelihoods, which is a climate sensitive sector. The percentage of agricultural workers is calculated by dividing the number of agricultural workers with the total number of employed and multiplying it by hundred. Region with the highest percentage of agricultural workers is considered to be most vulnerable and is assigned factor 1.00.

9. Conclusions and Recommendations

Crop production

- To supply of high productivity crop seeds, fertilizers, pesticides to agricultural economies.
- To recommend re-location of agricultural plants.
- To introduce pest- and sickness-persistent species of agricultural plants.
- To select and introduce drought- and dryness-persistent hybrids, adjusted to local conditions, including protection and spreading of local traditional species with the same properties.

Development of horticulture and vineyard

In the marz, horticulture and vineyard growing are quite developed; however, the industries can be improved:

- If the storage of the produce is properly organized by storing companies i.e. when timely payment by realistic prices ensured.
- By applying of all necessary protective actions.
- By protecting and spreading of drought- and dryness-persistent species adjusted to local conditions.

Organization of efficient irrigation season

As for all studied communities worn-out condition of the existing irrigation system is a major problem and in some places such systems do not exist, it is suggested:

- To prepare programs for improvement of the irrigation systems in the target communities.
- To create reservoirs for accumulation of irrigation water on a community scale.
- To implement measures for maintaining solid humidity.

Anti-landslide program

- Assessment of landslide phenomena in the target communities and preparation of a program on anti-landslide measures.
- Exercising of regime (periodic) observations in the target communities and engineering-geological investigations (monitoring).

Mitigation and elimination of the impacts of natural disasters for agricultural economies

Improvement of the operation of anti-hail stations, and when necessary, installation of the new ones. Periodical application of anti-hailing measures.

Implementation of adaptation measures for development of animal husbandry

- Implementation of vaccinations
- Larger use of high-mountain pastures. Introduction of new livestock breeds.

Implementation of measures on biodiversity protection

- Inclusion of newly discovered populations of wild wheat species into the list of protected areas.
- Conservation program of wild fruit trees.

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9. Annexes

Annex 1

Short tentative list (by life-forms) of flora of semi-desert ecosystem consisting of wormwood

Trees and bushes

1. Astragalus microcephalus - Fabaceae
2. Atraphaxis spinosa – Polygonaceae
3. Prunus incana - Rosaceae
4. Rhamnus pallasi -Rhamnaceae

Semi shrubs

1. Acantholimon armenum – Plumbaginaceae
2. Artemisia fragrans - Asteraceae
3. Astraglus kochianus – Fabaceae
4. Astragalus ornitopodioides – Fabaceae
5. Capparis spinosa – Capparaceae
6. Cousinia armena – Asteraceae
7. Helichrysum rubicundum –Asteraceae
8. Kochia prostrata Chenop[odiaceae
9. Phlomis orientalis – Lamiaceae
10. Stachys inflata - Lamiaceae
11. Scutellaria karjaginii - Lamiaceae
12. Tanacetum argyrophyllum – Asteraceae
13. Teucrium polium - Lamiaceae
14. Thymus kotschyanus – Lamiaceae
15. Tomanthea phaeopappa – Asteraceae

Perennial plants

1. Achillea biebersteinii – Asteraceae
2. Agropyron pectinatus – Poaceae
3. Agropyron trichophorum - Poaceae
4. Carex sphenophylloides – Cyperaceae
5. Catabrosella humilis – Poaceae
6. Centaurea squarrosa –Asteraceae
7. Dianthus bicoclor – Caryophyllaceae
8. Dianthus crinitus – Caryophllaceae
9. Dianthus floribundus – Caryophyllaceae
10. Eringium billardieri – Apiaceae
11. Euphorbia seguierana – Euphorbiaceae
12. Poa bulbosa - Poaceae
13. Scaligeria glaucenscens – Apiaceae
14. Stipa caspia – Poaceae
15. Stipa hohenackeriana – Poaceae
16. Veronica orientalis – Scrophulariaceae

Biannual plants

1. Erysimum subulatum – Brassicaceae
2. Gentiana olivieri – Gentianaceae
3. Scorzonera laciniata - Asteraceae
4. Verbascum saccatum- Scrophulariaceae
5. Verbascum songaricum – Scrophulariaceae

Annual plants (*ephemerous plants are in italic*)

1. Alyssum linifolium – Brassicaceae
2. Androsace maxima – Primulaceae
3. Aegylops cylindrica – Poaceae
4. Aegylops tauschii – Poaceae
5. Aegylops triuncialis – Poaceae
6. *Alyssum linifolium - Brassicaceae*
7. *Androsace maxima - Primulaceae*
8. *Arabidopsis pumila – Brassicaceae*
9. Bromus japonicus – Poacea
10. Bromus squarrosus - Poacea
11. *Bromus tectorium – Poaceae*
12. *Callipeltis cucullaris- Rubiaceae*
13. Ceratocarpus arenarius – Chenopodiaceae
14. *Ceratocephala falcate – Ranunculaceae*
15. Consolida persica – Ranunculaceae
16. Crepis sancta - Asteraceae
17. Drabopsis nuda – Brassicaceae
18. Eriophyla verna – Brassicaceae
19. Filago arvensis – Asteraceae
20. Helianthemum ledifolium – Cistaceae
21. *Hohenackeria excapa – Apiaceae*
22. *Holosteum umbellatum - Apiaceae*
23. *Hypecoum pendulum - Papaveracea*
24. *Koeipinia linearis – Asteraceae*
25. Lamium amplixecaule – Lamiaceae
26. Lepidiun vesicarium – Brassicaceae
27. Minuartia hamata – Caryophyllaceae
28. *Papaver bilangeri – Papaveraceae*
29. *Rhizocephalus orientalis – Ranunculaceae*
30. *Roemeria hybrda - Papaveracea*
31. Scabiosa olivieri – Dipsacaceae
32. Scabiosa rtata – Dipsacaceae
33. Scleranthus annuus – Caryophyllaceae
34. Senecio vernalis - Asteraceae
35. Sideritis montana – Lamiaceae
36. Taeniatherun crinitum – Poaceae
37. Trigonella monantha – Fabaceae
38. Triplerospermum parviflorum – Asteraceae
39. Xeranthemum longipapposum – Asteraceae
40. Xeranthemum squarrosum – Asteraceae
41. *Valerianella cymbicarpa* – Valerianaceae

42. *Valerianella dufresnia* – Valerianaceae
43. *Valerianella oxyrrhyncha* - Valerianaceae
44. *Ziziphora tenuior – Lamiaceae*
45. *Ziziphora persica - Lamiaceae*

Out of geophytes numerous monocotyledon species of Gagea, Iris, Allium, Ornitogalum, Gladiolus, Muscari, Tulipa and other genera occur.

Annex 2.

Short tentative list (by life-forms) of flora of pillow-like ecosystem consisting of Onobrychis cornuta

Perennial small trees and bushes

1. Astragalus microcephalus – Fabaceae
2. Atraphaxis spinosa- Polygonaceae
3. Crataegus orientalis – Rosaceae
4. Crataegus sp. – Rosaceae
5. Cotoneaster intergerimus - Rosaceae
6. Onobrychis cornuta – Fabaceae
7. Prunus divaricara – Rosaceae
8. Rhamnus pallasii – Rhamnaceae
9. Rosa canina - Rosaceae
10. Spirea crenata – Rosaceae

Perranial semi shrubs

1. Scutellaria orientalis – Lamiaceae
2. Tanacetum argyrophyllum – Asterceae
3. Thymus kotschyanus – Lamiacea

Perrenial plants

1. Euphorbia sp. - Euphorbiaceae
2. Artemisia absinthium - Asteraceae
3. Poterium polygamum- Rosaceae
4. Dactilis glomerata - Poaceae
5. Cephalaria sp. - Dipsacaceae
6. Linaria sp. - Scrophulariaceae
7. Betonica orientalis - Lamiaceae
8. Centaurea sp. - Asteraceae
9. Nepeta nuda - Lamiaceae
10. Teucrium polium - Lamiaceae
11. Anthemis triumphetti – Asteracea
12. Salvia verticilata - Lamiaceae
13. Hypericum scabrum – Hypericaceae
14. Achillea millefolium - Asteraceae
15. Echinops sp. - Asteracea
16. Eringium billardieri – Apiaceae
17. Marrubium parvifolium – Lamiaceae
18. Dactilis glomerata – Poaceae
19. Phlomis punges – Lamiaceae

20. Potentilla recta – Rosaceae
21. Asperula glonerata – Rubiaceae
22. Verbascum sp. - Asteraceae

According to literature data there are numerous annual plants and geophytes (species composition is not mentioned), with species composition having some difference from the one of semi-desert flora.

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