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Climate Change Training Module Series 5

CLIMATE CHANGE AND ECOLOGICAL SYSTEMS

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CLIMATE CHANGE AND ECOLOGICAL SYSTEMS

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CLIMATE CHANGE AND ECOLOGICAL SYSTEMS

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ABBREVIATIONS

EU	European Union
AHP	Analytical Hierarchy Process
LDN	Land Degradation Neutrality
UN	United Nations
CBD	Convention on Biological Diversity
UNFCCC	United Nations Framework Convention on Climate Change
BÜGEM	Vegetative Production General Directorate
UNCCD	United Nations Convention to Combat Desertification
CICES	Common International Classification of Ecosystem Services
COP	Conference of Parties
CR	Critically Endangered (IUCN Red List Categories)
ÇEM	General Directorate of Combating Desertification and Erosion
DD	Data Deficient (IUCN Red List Categories)
DKM	Nature Protection Center
DKMP	General Directorate of Nature Protection and National Parks
EEA	European Environmental Agency
EN	Endangered (IUCN Red List Categories)
EW	Extinct in Wild (IUCN Red List Categories)
EX	Extinct (IUCN Red List Categories)
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environmental Fund
GNP	Gross National Product
GDP	Gross Domestic Product
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IDEP	Climate Change National Action Plan (2011-2023)
IDES	National Climate Change Strategy (2010-2020)
LC	Least Concern (IUCN Red List Categories)
LULUCF	Land Use, Land-Use Change, and Forestry
MAES	Mapping and Assessment of Ecosystems and their Services
MDG-F	Millennium Development Goals Achievement Fund
MEA	Millennium Ecosystem Assessment
NGS	National Geographic Society
NPP	Net Primer Production
NT	Near Threatened (IUCN Red List Categories)
OGM	General Directorate of Forestry
SLM	Sustainable Land Management
SEEA CF	System of Environmental Economic Accounting Central Framework
SEEA EEA	System of Environmental Economic Accounting – Experimental Ecosystem Accounting

SDG	Sustainable Development Goals
TEEB	The Economics of Ecosystems and Biodiversity
SOC	Soil Organic Carbon
TÜİK	Turkish Statistical Institute
UBSEP	National Biodiversity Strategy and Action Plan
UNDP	United Nations Development Programme
UNEP-WCMC	United Nations Environmental Programme-World Conservation Monitoring Center
VU	Vulnerable (IUCN Red List Categories)

EXECUTIVE SUMMARY

There exists a mutual interaction between climate change and biodiversity. Climate change affects biodiversity, which is considered at three different levels as genetic diversity, species diversity and ecosystem diversity, at all these three levels. The impact at genetic level relates to whether the specifies could adapt the changing climate conditions. Living things genetically adapt to changing conditions by mutation. However, if the change is rapid, adaptation becomes difficult. Also the climate change affects the living cycles of organisms. For example, it was determined that, under the effect of climate change, plants blossomed earlier, their growth period extended, or the birds incubated earlier. This situation brings together various risks. For example, the fact that the plants blossom earlier due to heating but that species such as bees that provide for pollination could not adapt to increasing temperature at the same speed, problems could occur in the growth of seeds and fruit. It is estimated that species that have relations between themselves (competition, mutualism, parasitism, predator/ hunt) will be negatively affected in this way. It is also expected that the populations, ecosystems and biomes migrate to higher altitudes at norther and vertical direction in latitudinal terms. In this case, it could be possible that taiga forests, for example, could expand towards the tundra, or forests at mountainous areas towards sub-alpine and alpine zone. In such a situation, species at tundra and alpine zone could face the risk of extinction if they fail to find a way to migrate towards north or a higher altitude. Again, with the effect of increasing temperatures and evaporation, it could be possible that some watery areas and aqueous ecosystems (rivers, lakes, swamps, peatlands etc) could dry out and species living in these zones could disappear. Taking into account the intense pressure on biodiversity (habitat change, invasive species, over-exploitation, pollution) and possible impacts of climate change in the future, many scientists suggest that the process named as 6th extinction could occur.

In the 1.5 ^{0}C Report published by IPCC, it is explained that if the temperature increase is 2 °C, 18% of the insects, 8% of the vertebrates and 16% of the plants will lose more than half of their geographical spread.

Same as the climate change being effective on biodiversity, the biodiversity at the level of ecosystem and biome in particular are effective on global warming and climate change. This arises due to fact that ecosystems are important pools (or reservoirs) where carbon is stored. The carbon on the earth is stored in such areas as atmosphere, oceans, vegetation and soil. Carbon could change place among these pools in various forms (CO_2, CH_4 etc.). Decrease of the carbon in a pool means that it increases in another pool and the circulation of carbon among these pools is called the carbon cycle. The most important carbon pool on the earth is the oceans. It was calculated that there are 1.75 trillion tons of carbon at the sediments that accumulate on ocean bottoms which are estimated to store around 38 trillion tons of carbon. These pools are followed by soils with an approximate carbon stock of 2 trillion. It is indicated that the carbon stored in the plants on lands is around 450-650 billion tons, and that there was a decrease in the total carbon stocks of 30 billion tons after the industrial revolution as a result of land use changes. In annual terms, 2.6 billion t C/year could be retrieved from the atmosphere by the plants through photosynthesis, and 2.3 billion t C/year in the form of carbonic acid (H_2CO_3) by the oceans as CO_2 reacts with water, and by means of living organisms with chlorophyll which live in the seas. On the other hand, carbon stored in the pools could return back to atmosphere due to such reasons as destruction of carbon pools and narrowing down of the areas. For example, 1.1 billion t C/year is released to the

atmosphere every year due to loss of pasture and agriculture areas and deforestation.

Another contribution of ecosystems in the struggle against climate change takes place by means of the ecosystem services which they provide. Ecosystem services are defined as benefits, or goods and services acquired by people directly and indirectly from ecosystems. For example, wood produced from forest, fish hunted at the seas, food, vegetables and cereals produced on the fields are the goods obtained from ecosystems. While such products and raw materials directly bring revenues, no payment is made for services such as oxygen generated by forests, floods and erosion they prevent and the carbon they store, but these benefits are acquired. Not only people but also other organisms also benefit from the ecosystems. For example, ecosystems provide the organisms with habitats, and produce food for their nutrition. Goods and services provided by the ecosystems to organisms arise from the material cycles, energy flows, nutrition chain processes in the ecosystems. In 2005, ecosystem services have been collected under four main categories by Millennium Ecosystem Assessment (MEA). These categories are provisioning, regulating, supporting and cultural services.

Studies have been launched for determining and classification of ecosystem eservices and calculating their economic value upon the ecosystems being damaged due to such reasons as pollution, excessive use or settlement, agriculture by the end of 20th century. Approaches such as natural capital accounting and determination of total economic value in addition to the recognition of ecosystem services, have become increasingly widespread due to the facts that the monetary values of goods and services produced only by people within the country are used for evaluating the economic performances of countries, and as opposed to this, benefits provided by natural assets and ecosystems are ignored. For example, in a study conducted in our country, it was determined that the forests in Bolu and Duzce provinces produced a total economic value of 716 million USD within one year, and 89.5% of this was not included in GNP calculations.

Another approach that has arisen as a result of environmental problems becoming deepened due to development oriented economic policies, which caused the destruction of natural assets. The sustainable development approach, which came to the agenda with the "Our Common Future" report prepared in 1987, has been constituting the foundation of the steps taken by the United Nations (UN) towards environmental and ecological problems since that day. The basic targets of the the Convention on Biological Diversity (CBD, the United Nations Convention to Combat Desertification (UNCCD), and the United Nations Framework Convention on Climate Change (UNFCCC), which are known as Agenda 21 and Rio Conventions, are to protect the ecosystems and reach sustainable development targets. Finally, UN 2030 Sustainable Development Goals (SDG) have been adopted by UN General Council in 2015. There is a total of 17 SDGs, of which 13th relates to climate, and 14th and 15th related to life in water and on land respectively. On the other hand, a strategic plan for preventing the loss of biodiversity by the year 2020 was prepared in the 10th Conference of Parties to The Convention on Biological Diversity (BCBD) in 2010. 20 targets were covered by this plan, which are called Aichi Targets, and these include sustainability, mitigation of impacts of climate change, increasing carbon stocks of ecosystems, and preventing habitat loss, reducing pollution and invasive species.

In our country, various laws are directly related to nature protection, including some articles of the Constitution. Articles 45, 63 and 169 of the Constitution are directly related to the protection of natural ecosystems, natural assets and agricultural lands. Laws that are directly related to the protection of nature are the National Parks Law No. 2873, Environment Law No. 2872, Forests Law No. 6831,

Cultural and Natural Assets Protection Law No. 2863 and Land Hunting Law No. 4915. Ministry of Agriculture and Forestry and Ministry of Environment and Urbanisation are jointly responsible from the management of protected areas which reached to 8.1 million hectares as of 2018. This responsibility is undertaken by the General Directorate of Nature Protection and National Parks (DKMP) and General Directorate of Forestry under the Ministry of Agriculture and Forestry, and General Directorate for Protection of Natural Assets of the Ministry of Environment and Urbanisation

The basis of plans and policies related to ecosystems and nature protection included in the reports which we are obliged to submit to UNFCCC Secretariat is constituted by National Climate Change Strategy (2010- 2020) (IDES) and National Climate Change Action Plan (2011- 2023) (IDEP) Among these, IDES include short, middle and long term strategies on the issues of control of greenhouse gas emissions and adaptation to climate change. IDEP was prepared in line with the strategies explained in IDES.

Actions in the mitigation part of IDEP could be summarized as mitigation of deforestation and forest degratation, limitation of land use changes, determination of and increasing the carbon amount stored in the pools. In relation to adaptation, actions related to nature protection were quoted more and were included in the action plan under separate headings for ecosystem services, biodiversity and forestry. There are actions related to nature protection under the headings of agricultural and food security and management of water sources. The IDEP includes 2 purposes, 9 objectives and 39 actions under the title of ecosystem services, biodiversity and forestry.

In general, targets in IDEP are related to determination and monitoring of impact of climate change on species. Similarly, whereas the determination of land use changes is included as target in IDEP, it could be considered as a shortcoming that there is no target for prevention or mitigation of land use changes. It is expected that another impact of climate change on species and ecosystems will be the migration. For this, it is recommended to plan protected areas taking into account the migration paths and potential spreading areas of species. In this direction, it is required for example to announce the protected areas in mountainous areas so as to be covered as sub-alpine and alpine zones and not to permit any barriers which could prevent migrations in these places (path, fence etc.) In addition, it could be foreseen in IDEP that there is no action on accounting recognition of natural capital and ecosystem services and on taking these into account in the investments in natural areas.

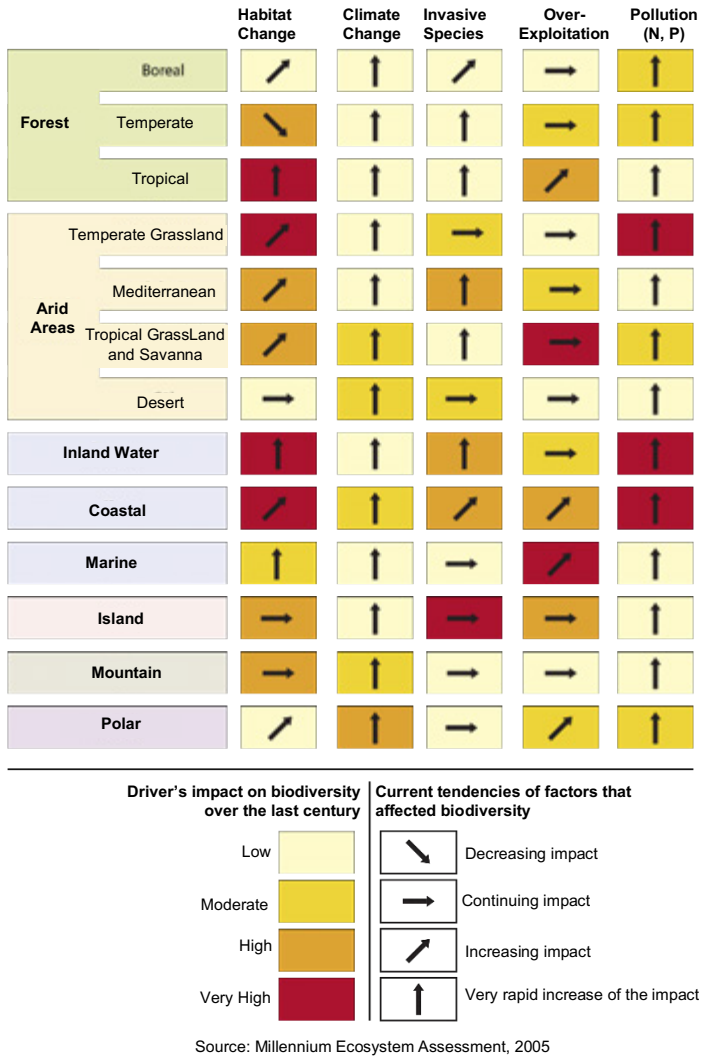
1. EVALUATION OF CONTRIBUTION OF ECOSYSTEMS AND BIODIVERSITY TO COMBAT CLIMATE CHANGE

Biodiversity is defined in the Convention on Biological Diversity as "the variability among living organisms from all sources including, inter alia, terrestrial marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (BMBCS, 1992). As it could be understood from the definition, biodiversity covers three different levels including genetic diversity, species diversity and ecosystem diversity.

Human activities that have intensified in the recent century have accelerated the loss of biologic diversity at global scale. Gitay et al. (2002) list these human activities as land use/land cover changes, habitat fragmentation, air, water and soil pollution, land degradation and deforestation, and spreading of non-native species. MEA (2005) on the other hand lists 5 main factors that cause the loss of biodiversity as habitat change, climate change, invasive species, over-explotitation and pollution. MEA (2005) also explains that factors that could be gathered under 5 main headings as demographic, economic, socio-politic, cultural and religious, scientific and technologic factors, indirectly causes the loss of biodiversity. Pereria et a. (2012) evaluated the factors that directly caused the decrease of biodiversity using the data of International Union for Conservation of Nature (IUCN) and it was demonstrated that habitat change (fragmentation) and excessive use were more prevalent. Although climate change ranks fourth in the evaluation made by Pereria et al. (2012), Leadley et al. (2010) expresses that the biodiversity losses caused by climate change in the coming decades could pass habitat fragmentations. As a matter of fact Millennium Ecosystem Assessment (MEA) expresses that the effect of climate change on biodiversity and ecosystems has been gradually increasing (MEA, 2005) (Figure 1).

The current status of species diversity is assessed by IUCN. It was determined that, of 94 thousand species examined in a research conducted by IUCN (2018), 26 thousand are in critical (CR), endangered (EN) and vulnerable (VU) category (Box 1). Taking into account the intense pressures on biodiversity and the future possible impacts of climate change, many scientists assert that the process named as 6th extinction could take place (Barnosky et al., 2011; Ceballos et al., 2015). The reason for calling the biodiversity losses which have increased in 20th century and are foreseen to increase rapidly in the future, as 6th extinction is the processes that took place for five times in the last 500 million years and the disappearance of a high majority of living species in that period. The first of these is the mass extinction that took place 443 million years ago when around 86% of the living species has disappeared. The 2nd extinction took place 359 million years ago and around 75% of the species were lost. Following extinctions occurred 251, 200 and 65 million years ago and 96%, 80% and 76% of the species disappeared respectively (Barnosky et al., 2011). It is considered that all these extinctions were caused by such reasons as global warming or cooling, increase of CO_2 concentration in the atmosphere.

Figure 1: *Tendencies in the last century and today in drivers that are effective on biodiversity and ecosystems (MEA, 2005).*



Source: Millennium Ecosystem Assessment, 2005

According to a study conducted by Ceballos et al. (2015), it was determined that 468 vertebrate species became extinct between 1900-2014 due to human activities. Their distribution is 69 mammal species, 80 bird species, 24 reptiles and 146 amphibians and 158 fish species.

The effects of climate change on biodiversity are not only limited to the extinction of species as shown in Figure 2. It is expected that factors such as temperature increases, precipitation variability, increases in extreme weather conditions and melting of glaciers and increase of sea levels in connection with there, will affect biological diversity at every level from genetic level to ecosystems and even to biomes (tropical rain forests, savannas, tundra and other big life zones). It is considered that a high majority of these impacts will be negative.

Box 1: Diversity of Species in the World and in Turkey

The exact number of species in the world is unknown. 1.74 million species have been defined until 2018 in the studies carried out by IUCN. (IUCN, 2018) (Box 1 Table 1). An important part of these species comprises the vertebrates. In the world, species diversity is highest in tropical and subtropical moist broadleaf forests, while tundra is the biome with the lowest species diversity.

IUCN also assesses the hazard status of species and produces reports called red lists. Species in the red list have been evaluated according to various criteria, and include extinct (EX), extinct in the wild (EW), critically endangered (CR), endangered (EN), vulnerable (VU), near threatened (NT), least concern (LC) and data deficient (DD) category. If any species has not yet been evaluated, it is in included in the "not evaluated" (NE) category. Among the species evaluated by IUCN (2018) 40% of amphibians, 34% of coniferous tree species, 33% of corals, 25% of mammals and 14% of birds are threatened with extinction.

Box 1 Table: *Number of described and threatened species in the world and Turkey*

Living Species		World (IUCN, 2018)		Turkey (DKMP, 2008)	
		Number of Described Species	Number of Threatened Species	Number of Described Species	Number of Rare and Threatened Species
Vertebrates	Mammals	5.677	1.210	161	23
	Birds	11.122	1.469	460	17
	Reptiles	10.711	1.236	141	10
	Amphibians	7.866	2.100		
	Fish	33.900	2.385	716	
	Subtotal	69.276	8.400	1.478	50
Invertebrates	Insects	1.000.000	1.478	20.114	
	Molluscs	85.000	2.195	522	
	Crustaceans	47.000	730		
	Corals	2.175	237		
	Arachnids	102.248	171		
	Velvet Worms	165	9		
	Horseshoe Crabs	4	1		
	Others	68658	146		
	Subtotal	1.305.250	4.967	20.636	
Plants	Mosses	16.236	76	910	2
	Ferns and Allies	12.000	246	101	1
	Gymnosperms	1.052	401	35	1
	Flowering Plants	268.000	12.049	10.865	1.280
	Green Algae	6.050	0	2.150	
	Red Algae	7.104	9		
	Subtotal	310.442	12.781	14.061	1.284
Fungi and Protists	Lichens	17.000	10	1.000	
	Mushrooms	31.496	33		
	Brown Algae	3.784	6		
	Subtotal	52.280	49	1.000	
TOTAL		1.737.248	26.197	37.175	1.334

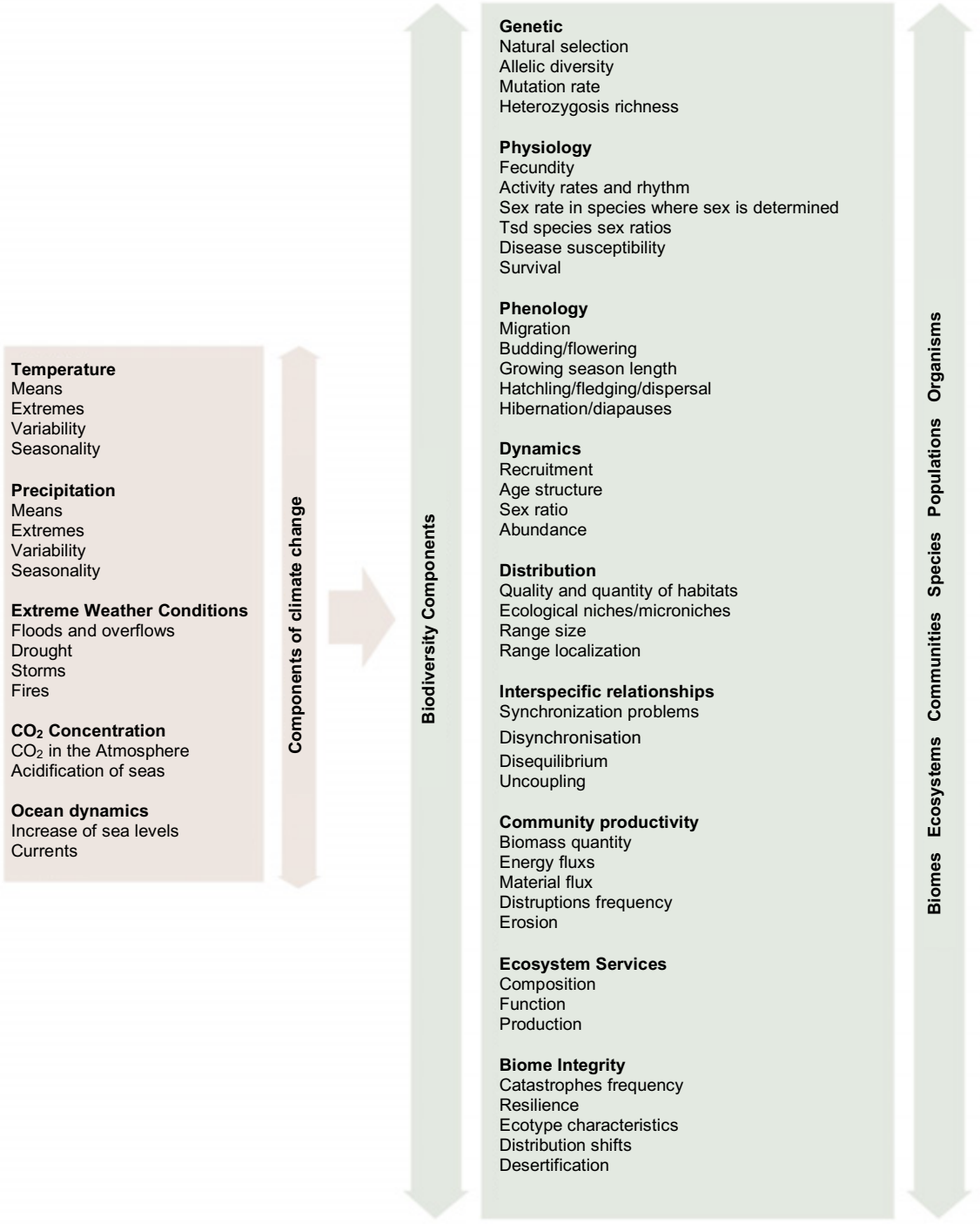
[1] Covers critically endangered (CR), endangered (EN) and vulnerable (VU) species.

Turkey is a rich country in terms of diversity of species. The biggest reason for this is that Turkey is located on the migration path of living organisms which needed to migrate in ice ages and interglacial periods. The topographic structure of our country and presence of very different local climates created areas where living organisms could take shelter during these migrations. National Biodiversity Strategy and Action Plan (UBSEP) was prepared in 2007 in relation to biodiversity in Turkey and the numbers of species could be reached from here. Within the scope of National Biodiversity Inventory and Monitoring Project, which is still ongoing, data obtained from the inventories made on the basis of provinces is processed in the Noah's Ark Database. It was explained in UBSEP that in our country there are 1.478 vertebrates, 26.636 invertebrates, 14.061 plants and 1.000 lichen species (DKMP, 2008). There are a total of 37.175 described species. It is written in the action plan that, of these species, 8 thousand (around 4 thousand plant and 4 thousand animal species) are endemic, and 50 of the animal and 1.284 of the plant species are endangered. It is estimated that 8 animal and 11 plant species have become extinct (DKMP, 2008) (Box 1 Table 1). However, the number of species increased with the studies conducted afterwards. For example, the number of birds, which was given as 460 in UBSEP, increased to 481 with the following observations (Bacak et al., 2015). Similarly, the number of Frogs and Reptiles, which was explained as 141 in the action plan, increased to 157 as suggested by Baran et al. (2012). In relation to plant species, in the book named "List of Plants in Turkey" which was published in 2012, it is indicated that, at sub-species taxons, there are 13 ground pines, 73 sword ferns, 37 gymnosperms and 11.343 angiosperm taxons, of which 3.649 are endemic (Güner et al. 2012).

The impact at genetic level relates to whether the specifies could adapt the changing climate conditions. Living organisms genetically adapt to changing conditions by mutation. However, if the change is rapid, adaptation becomes difficult. Also, the climate change affects the living cycles of organisms. For example, it was determined that, under the effect of climate change, plants blossomed earlier, their growth period extended, or the birds incubated earlier. This situation brings together various risks. For example, the fact that the plants blossom earlier due to heating but that species such as bees that provide for pollination could not adapt to increasing temperature at the same speed, problems could occur in the growth of seeds and fruit. It is estimated that species that have relations between themselves (competition, mutualism, parasitism, predator/hunt) will be negatively affected in this way. It is also expected that the populations, ecosystems and biomes migrate to higher altitudes at norther and vertical direction in latitudinal terms. In this case, it could be possible that taiga forests, for example, could expand towards tundras, or forests at mountainous areas towards sub-alpine and alpine zone. In such a situation, species at tundra and alpine zone could face the risk of extinction if they fail to find a way to migrate towards north or a higher altitude (Alo and Wang, 2008). Again with the effect of increasing temperatures and evaporation, it could be possible that some wetlands and aquatic ecosystems (rivers, lakes, swamps, peatland) could dry out and species living in these zones could disappear.

Same as the climate change being effective on biodiversity, the biodiversity at the level of ecosystem and biome in particular are effective on global warming and climate change. This arises due to fact that ecosystems are important pools (or reservoirs) where carbon is stored. The carbon on the earth is stored in such areas as atmosphere, oceans, vegetation and soil. Carbon could change place among these pools in various forms (CO_2, CH_4 etc.). Decrease of the carbon in a pool means that it increases in another pool and the circulation of carbon among these pools is called the carbon cycle.

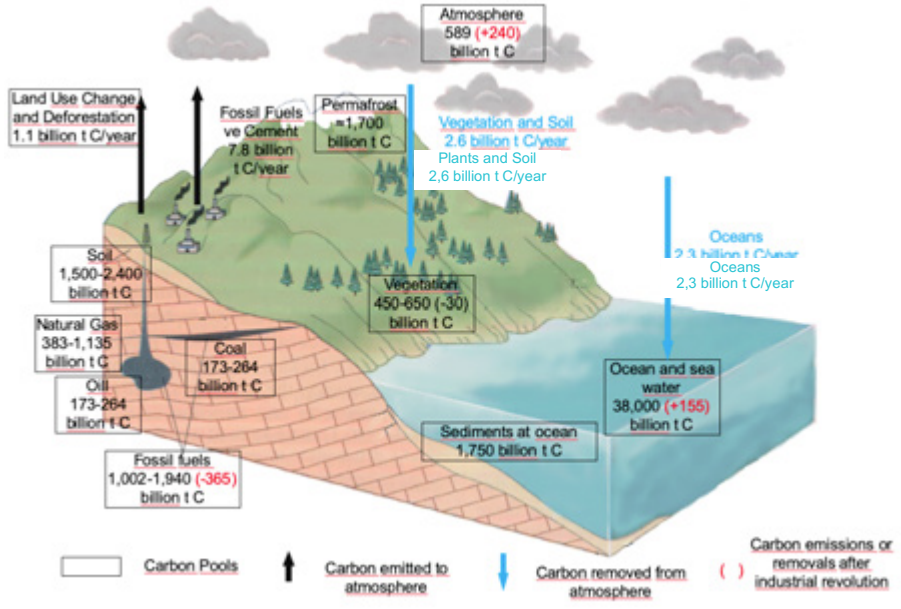
Figure 2: *Some examples of possible impacts of climate change on different levels of biodiversity (Bellard et al., 2012).*



Fossil fuels which are stored under the ground (coal, natural gas, oil and shale gas) are a separate pool. As the fossil fuels, which remained under the ground for millions of years and which do not participate in the cycle of carbon, are released to the atmosphere after the industrial revolution, as a result of which the carbon cycle is distorted and excessive carbon input was provided to the natural circulation. This situation resulted in global warming and climate changing events. Processes such as conversion of forest areas to agriculture and settlement, which are characterized as land use change in addition to CO_2 and other greenhouse gas emissions arising from fossil fuel, lead to CO_2 emissions. It was calculated that, in the period to elapse from 1750, which is considered as the start of Industrial Revolution, to 2011, a total carbon mission of 555 billion tones (2 million tons CO_2 equivalent) occurred, of which 375 billion tons are from fossil fuel consumption and cement sector (1.38 million tons CO_2 equivalent) and 180 billion tons from land use change and deforestation (0.66 million tons CO_2 equivalent) (IPCC, 2013).

The most important carbon pool on the earth is the oceans. It was calculated that there is 1.75 trillion tons of carbon at the sediments that accumulate on ocean bottoms which are estimated to store around 38 trillion tons of carbon (IPCC, 2013) (Figure 3) These pool are followed by soils with an approximate carbon stock of 2 trillion. A significant part of the carbon stocks in the soil is permafrost (frozen) soils. It is indicated that the carbon stored in the plants on lands is around 450-650 billion tones, and that there was a decrease in the total carbon stocks of 30 billion tons after the industrial revolution as a result of land use changes (IPCC, 2013). As opposed to this, it is accepted that the carbon stocks in the atmosphere which contained 589 billion tons of carbon before 1750, increased by 240 billion tons in connection with human activities, and reached to 829 billion tons (IPCC, 2013).

Figure 3: *Global carbon pools and annual carbon emmisions or removals (changed from Botkin and Keller (1995) and IPCC (2013)).*



Carbon stocks in terrestrial biomes are given in Table 1, and the boreal forests and tropical forests are the areas where the carbon is mostly stored. As it is expected, the most carbon in unit area in the vegetation in these biomes are in tropical forests. As opposed to this, in soils, more carbon is stored in wetlands and boreal forests compared to other biomes.

Table 1: *Estimated carbon stock in vegetation and soil in biomes (Janzen, 2004)*

Biomes	Area (billion ha)	Plants (billion t)	Soil (billion t)	Total (billion t)	Plants (t/ha)	Soil (t/ha)
Tropical Forests	1,76	212	216	428	120,5	122,7
Temperate Forests	1,04	59	100	159	56,7	96,2
Boreal Forests	1,37	88	471	559	64,2	343,8
Tropical Savannas and Grasslands	2,25	66	264	330	29,3	117,3
Temperate Grasslands and Shrublands	1,25	9	295	304	7,2	236,0
Deserts and Semi-Deserts	4,55	8	191	199	1,8	42,0
Tundra	0,95	6	121	127	6,3	127,4
Croplands	1,6	3	128	131	1,9	80,0
Wetlands	0,35	15	225	240	42,9	642,9
TOTAL	**15,12**	**466**	**2011**	**2477**		

It is reported that there is a total emission of 8.9 billion tons C/year, comprising 7.8 billion tons from fossil fuels and cement sector and 1.1 billion tons from land use change and deforestation released to the atmosphere annually at the beginning of 2000s as reported by IPCC (2013). It is indicated that 2.6 billion t C/year carbon is stored by the plants with photosynthesis. In oceans which are another important pool, the CO_2 reacts with water and turns into carbonic acid (H_2CO_3) and chlorophyll is released by living organisms in the seas, retrieving a 2.3 billion tons of carbon from the atmosphere annually. However, since not all of the carbon released annually could be retrieved, every year 4 billion tons of carbon accumulate in excess.

As it could be seen, the terrestrial ecosystems (forest, steppes etc.), semi-terrestrial and water ecosystems (wetlands, seas, oceans etc.,) store significant amounts of carbon, and annually tie an important part of carbon released to the atmosphere. However, terrestrial ecosystems could turn into greenhouse gas source together with land use changes and deforestation. As a matter of fact, in the evaluations performed by FAO, it was revealed that, despite the increase in the forest areas in the temperate climate zone, the tropical forests continuously decrease and there is deforestation overall the world. Annually 3.3 million ha forest area was lost between 2010-2015 overall the world, however, this deforestation is around 5.5 million ha/year taking into account the tropical forests (Keenan et al., (2015). Calculated the amount of carbon removed from or emitted to the atmosphere annually by the forests based on FAO data. The authors determined that an excessive 0.79 billion t C/year is emitted to the atmosphere between 2011-2015 due to deforestation and forest degredation (Köhl et al., 2015).

However, the amount of carbon emitted to and removed from the atmosphere as indicated by IPCC (2013) is updated by Le Quéré et al. (2018). In the evaluation conducted by the authors between 2007

-2016, it was calculated that the carbon emissions arising from fossil fuel and industry was 9.4 billion t C/year and the carbon emissions arising from land use change and deforestation reached to 1.3 billion t C/year. The amount of carbon tied by lands and oceans increased and became 3 and 2.4 billion t C/year. However, the amount of carbon that remains net in the atmosphere increased from 4 billion tons to 4.7 billion tons/ year (Le Quéré et al., 2018).

Paris Agreement was opened for signature in UNFCCC 21st session of the Conference of the parties in 2015 due to the rapid increase of greenhouse gas emissions and the Kyoto Protocol being ineffective for decreasing these emissions. In this convention, it is indicated that greenhouse gas emissions should be decreased, and global average temperature increases be kept limited to 2°C, and even 1.5°C if possible. The importance of a temperature increase of 2°C is the estimation that following this temperature increase it will be very hard to stop global warming and climate change. Because it is foreseen that carbon stored in the carbon pools could spread into the atmosphere as CO_2 or CH_4, and the greenhouse gas emissions in the atmosphere could increase even if fossil fuel consumption is ended. Impacts of limiting the global temperature increases by 1.5°C compared to possible increase of 2°C, have been published by IPCC in the form of a report (IPCC, 2018) (Box 2).

Box 2: Things That Could Happen In Ecosystems After 1.5 ^{0}C and 2 ^{0}C Warming of the Earth

The average temperatures in the world have increased by 0.87 ^{0}C from the Industrial Revolution up to date (IPCC, 2018). It is foreseen that this temperature increase should be limited to 2^{0}C, that as a result of a warming of more than 2^{0}C, carbon stored at oceans, wetlands and tundra could be emitted to atmosphere, and the greenhouse gas emissions could continue due to changes in natural processes even if the fossil fuel oriented emissions could be stopped. It is foreseen that if no precaution is taken by IPCC, the average temperatures could increased by 4^{0}C by the end of 21st century. It is stated in the Paris Agreement, which was negotiated in 21st Conference of Parties (COP21) which gathered in Paris in 2015 and which came into force in 2016, that the temperature increases due to global warming should be limited to 2^{0}C, and even 1.5^{0}C if possible. For that reason, a report was published, which is known as 1.5^{0}C Report, at the beginning of October of 2018 by IPCC. In this report, it was emphasized that why the temperature increase should be limited to 1.5^{0}C instead of 2^{0}C. Information on what could happen in ecosystems and biodiversity in case of 1.5^{0}C and 2 ^{0}C temperature increase, is given below (IPCC, 2018).

- **Species:** In case of a temperature increase of 1.5^{0}C, 6% of the insects, 4 % of the vertebrates and 8% of the plants will loose half of their geographical range. In case that the distrubtion of species is inhibited by natural or antropogenic obstacles, 10% of the amphibians, 8% of the reptiles, 6% of the mammals, 5% of the birds, 10% of the insects and 8% of the plants can lose almost half of their geographical range. The average range loss of species in general in this case could be around 20-27%. If the temperature increase is 2^{0}C, 18% of the insects, 8% of the vertebrates and 16% of the plants will lose more than half of their geographical range.

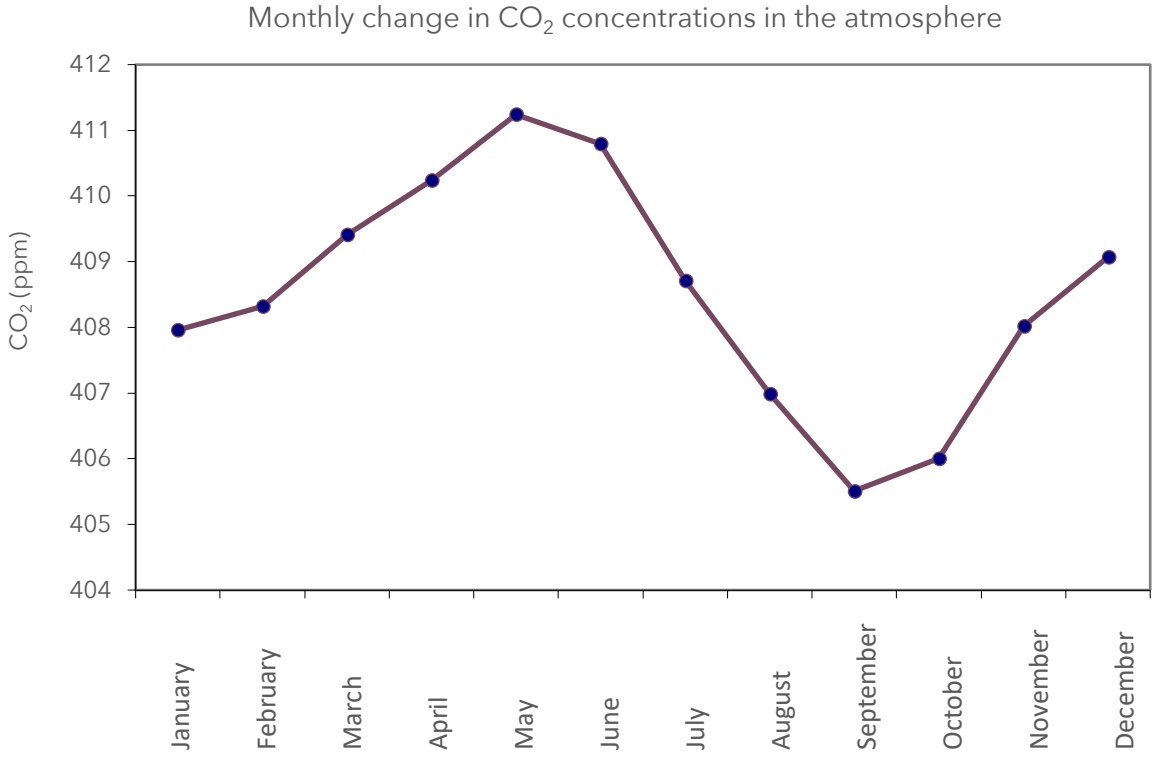
- **Biome shifts:** When the temperature increase is kept limited to 1.5 ^{0}C, it is estimated that 7% of the biomes will transform into other biomes, and in case of a 2 ^{0}C increase, almost two folds of the biomes (13%) will transform into other biomes.
- **Phenology:** Today, the phenology processes in spring in the northern hemisphere start 3 days earlier. With a warming of 1.5 ^{0}C, it will start a couple of days earlier. Keeping the warming limited to 1.5 ^{0}C could mitigate the phenologic discord among species as well as loss risks in the ecosystem services. With an increase of 2 ^{0}C, it is foreseen that phenologic process will start earlier. For example, it is estimated that the growth period in regional forests could come 10 more days earlier.
- **Carbon stocks:** With global warming, the total respiration in the ecosystems increases. In case that the warming is kept limited, the impact on net primary production (NPP) and terrestrial carbon stocks limited. With an increase of 2 ^{0}C, it is expected that there will be more increase in insects and fungi damages, as well as disasters such as storms, and fires. Such disasters can deepen the decreases in carbon stocks in the biomass and in soil.
- **Boreal forests and tundras:** Woody shrubs are already encroaching in tundra. Constraining warming to 1.5 ^{0}C would prevent the thawing of an estimated permafrost area of 2 million km^2.
- **Ecosystem services:** The decrease in ecosystem services provided by terrestrial ecosystems and oceans can be limited in the 1.5 ^{0}C temperature increase.
- **Oceans:** With a temperature increase of 1.5 ^{0}C, there can be less decrease of productivity in oceans, shift of species towards higher latitudes, damaging of fishery and changes in the ocean chemistry (e.g., acidification, hypoxia, and dead zones).
- **Coral reefs:** 70-90% of the coral reefs will disappear with a temperature increase of 2 ^{0}C.
- **Food production:** A temperature increase of 1.5 ^{0}C in regions such as West and South Africa, Sub-Saharan countries, South East Asia, Central and South America can decrease the influence in food production and yield. A temperature increase of 2 ^{0}C will lead to a loss of 7-10% in rangeland livestock.
- **Food:** The food security risks will be lower in a global warming of 1.5 ^{0}C compared to 2 ^{0}C in Sahel zone, South Africa, Mediterranean, Central Europe and Amazon regions.
- **Afforestation, reforestation and land use changes:** It is important to keep the temperature increase limited to 1.5 C due to carbon capture and storage with bioenergy, afforestation, reforestation and land use changes. However, it could be possible that land and water footprint could increase if the bioenergy, afforestation and reforestation works expand to wide areas. It is necessary to consider the effects of these studies on biodiversity, food production, carbon stocks in terrestrial ecosystems and protection of natural ecosystems.

Briefly the most important contribution of ecosystems in the struggle against climate change is that they work as carbon pool and they have significant amount of carbon stock. The destruction or disappearance of ecosystems end up with the increase of CO_2 amount in the atmosphere. For example, the drying out of wetlands in connection with climate change causes the carbon in these ecosystems to decompose rapidly, and to reach to atmosphere in the form of CO_2. Similarly, depending on warming, it could be possible that the carbon on soils in alpine zone and boreal forests could decompose.

As opposed to this, more carbon storage could be enabled by afforestation and reforestation works, and rehabilitation/restoration of the distorted ecosystems. As a matter of fact, when the trend of CO_2 concentration in the atmosphere is examined, it could be seen that the concentrations decreased between May-September that corresponds to the growth period (Figure 4).

Another contribution of ecosystems in the struggle against climate change takes place by means of the ecosystem services which they provide (Box 3).

Figure 4: *Change of atmospheric Co_2 concentrations by months in 2018 (drawn based on the data received from NOAA/ ESRL 2019).*



Box 3: Ecosystem Services

Ecosystem services are defined as benefits, or goods and services acquired by human populations directly and indirectly from ecosystems (Costanza et al., 1997). For example, wood produced from forest, fish hunted at the seas, food, vegetables and cereals produced on the fields are the goods obtained from ecosystems. While such products and raw materials directly bring revenues, no payment is made for services such as oxygen generated by forests, floods and erosion they prevent and the carbon they store, but these benefits are acquired. Not only people but also other organisms also benefit from the ecosystems. For example, ecosystems offer habitats to organisms and produce food for their feeding. Goods and services provided by the ecosystems to organisms arise from the biogeochemical cycles, energy flows, food chain processes in the ecosystems (Box 3, Figure 1). For example, chlorophyll plants in the ecosystems make photosynthesis and receive CO_2 from the atmosphere and convert it into organic matter, and during this process, they perform such functions as storage, oxygen and food production. Similarly, in the water cycle the plants decrease the speed of precipitation, ensuring that the precipitation waters leak more into the soil and the water is stored there, thus preventing erosion. The water leaking into the soil reaches to the rivers and underground waters as clean water by the filtering of the soil, and is used for meeting the water need of organisms. Studies have been launched for determining and classification of ecosystem services upon the ecosystems being damaged due to such reasons as pollution, excessive use or settlement, agriculture by the end of 20th century. In 2005, ecosystem services have been collected under four main categories by Millennium Ecosystem Assessment (MEA) (Box 3, Table 1). These categories are the provisioning, regulating, supporting and cultural services (MEA, 2005) (Box 3, Table 1).

Box 3 - Figure 1: *Relationships between (a) Cycles and energy transfer/transformation in ecosystems (Tolunay et al., 2013) and (b) ecosystem services (MEA, 2005).*

The services provided by ecosystems have been known for many years. For example, the benefits provided by forest ecosystems in our country are called as forest functions. These forest functions are production of forest products, erosion prevention, community health, nature protection, recreation, national defense, hydrologic, aesthetic, climatic and scientific functions. For a period of more than 10 years, planning of the forests is made taking into account the functions they perform.

There is no union of opinions in relation to the classification of ecosystem services overall the world. Although the Millennium Ecosystem Assessment is generally accepted, there are various classifications of some other organizations which differ from one another with small differences. Examples of these include the classification by the Economics of Ecosystems and Biodiversity (TEEB) initiative and the Common International Classification of Ecosystem Services (CICES).

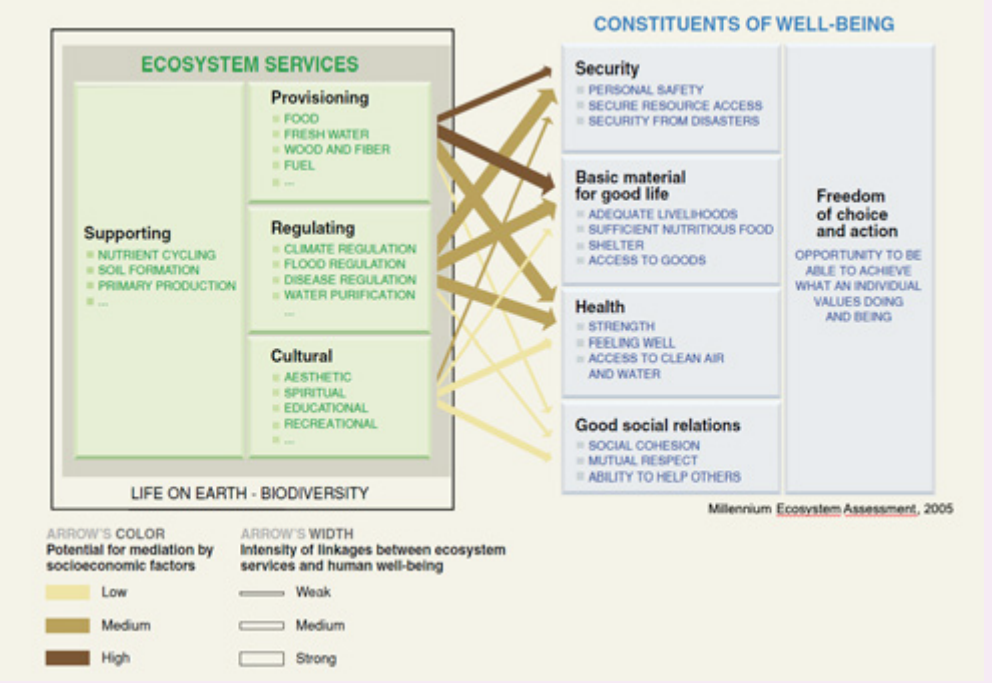
In case that the ecosystems are damaged, the services provided by them are also affected and this situation leads to distortions in the health, safety, basic life items and social relationships which constitute the human well-being. It is foreseen that climate change will negatively affect ecosystem services and decrease human well-being. Therefore, protection of biodiversity and ecosystems also means the protection of human well-being (Box 3, Figure 2).

Box 3 Table 1: Ecosystem services (MAE, (2005) and changed from De Groot et al. (2010))

Ecosystem Service Categories	Ecosystem Services	Examples
PROVISIONING	Food	Fruit, vegetables, cereals, non-wood forest products, hunting and forest animals etc.
	Fresh water	Water for drinking, irrigation etc.
	Wood and fibre	Wood, paper, wood based board, cotton, silk, flax, renewable energy etc.
	Fish and other sea products	Fish, mussel, lobster etc.
	Ornamental resources	Plants used in landscape arrangement, jewelries, fur, aquarium fish, seashells etc.
	Mineral raw materials	Sand, gravel, soil etc.
	Medicinal resources	Obtaining effective substance, creating potential for treatment of diseases such as cancer etc.
	Other	Leather, corn etc.
	Genetic resources	Biochemical models, living things used for tests
REGULATING	Pollination and seed distribution	Transportation of pollens and seeds with such factors as insects, wind
	Climate regulation	The soil being shadows by the top crowns of trees and creating low temperatures, decrease of CO_2 by formation of carbonic acid in oceans and with photosynthesis.
	Moderation of extreme event	The forests and wetlands ensuring the water to leak into the soil, its storage and mitigation of its speed
	Waste treatment	Filtering of water in the soil, deposition of pollutant in wetlands and decomposition of organic wastes, decrease of salinity etc.
	Erosion prevention	The plants decreasing the magnitude of the precipitation, keeping the soil with their roots and preventing erosion, creating wind screen and preventing wind erosion.

Ecosystem Service Categories	Ecosystem Services	Examples
	Air quality regulation	Decreasing the dust and other pollutants in the atmosphere, generating oxygen with photosynthesis
	Biological control	The birds eating insects, snakes decreasing mice population etc.
	Resistance against invasive species	The spread of invading species being difficult in ecosystems with high resistance
SUPPORTING	Provision of habitat	Creating suitable growing / living environments for plants and animals in the nature.
	Soil formation	Weathring of bedrock, humus formation, prevention of soil erosion
	Photosynthesis (primary production)	Plants producing organic material with photosynthesis
	Nutrient cycling	Accumulation of nutrients such as N, P, K, S in organisms and biogeochemical cycle
	Water cycling	Cycle of water that takes place between atmosphere, living things, land and waters with evapotranspiration and interception, water transportation to firths and river mouth ecosystems etc.
CULTURAL	Recreation and aesthetic values	Nature walks, picnic, camping, mountaineering, water sports etc.
	Educational and inspirational values	Inspiration from the nature in such art areas as film, book, poetry, painting and areas such as engineering and architecture
	Religious and spiritual values	Place of nature in religion and cultures
	Science and Education	Scientific researches in nature, school trips

Box 3 – Figure 2: *Relationship between biodiversity, ecosystem services and human well-being (MEA, 2005).*

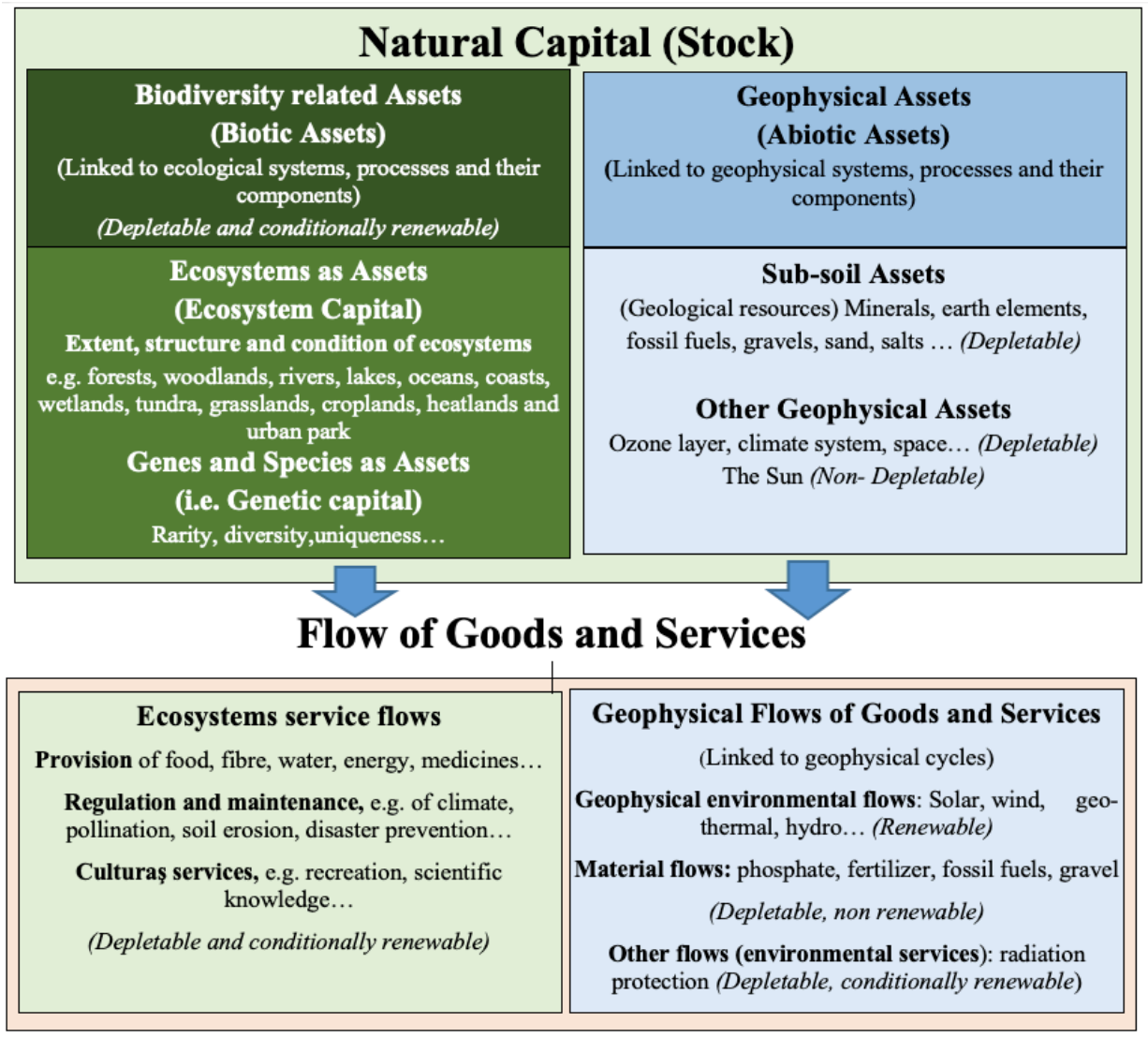


2. INNOVATIVE APPROACHES IN COMBATING CLIMATE CHANGE

Upon the gradual increase of ecological destruction caused by industrialization and rapid population increase and upon understanding that growth oriented economic policies of the countries influenced this situation, various searches have been launched. It was demonstrated that not considering the resources provided by the ecosystems in the assessment of economic development and social wealth levels of countries in 1970s, increased the environmental problems. As a matter of fact, various macroeconomic indicators such as Gross Domestic Product (GDP) are used for the evaluation of economic performances of the countries, and these indicators cover the monetary values of goods and services produced by only by people in the country. However, these indicators do not take into account the benefits provided by natural assets and ecosystems. For example, by drying the wetlands and expanding the agricultural areas agricultural revenues could be increased for certain time, however, when it becomes impossible to perform agriculture due to such reasons as salination, overflow on these agricultural areas over time, both the agriculture and wetlands could be lost and country revenues decrease. Similar situations are valid for other natural assets such as forests, mines and seas. The natural capital created by ecosystems in the countries and the contributions of these ecosystems to economy could not be sufficiently evaluated, and thus the valid economic development models increase the destruction of nature.

These problems lead to the appearance of the concept of environmental accounting. There is no clear reconciliation on this concept, and concepts such as "environmental accounting" "green accounting" "natural resource accounting" "natural capital accounting" and "ecosystem accounting" could be interchangeably used. In general, natural capital accounting could be defined as the accounting of the impacts created using ecosystem services and natural capital in an economic activity. The economic development and social wealth level of a country are connected to the capital produced, natural capital and social capital. Among these, natural capital is defined as the material or knowledge that is in the form of stock in the nature (Constanza et al., 1997). Natural capital is a concept which includes both underground assets and abiotic flows such as sun, wind, geothermal, and also the ecosystem richness and the goods and services provided by these ecosystems (Figure 5).

Figure 5: *The components of Natural Capital and associated flow of goods and services (ten Brink et al., 2015)*



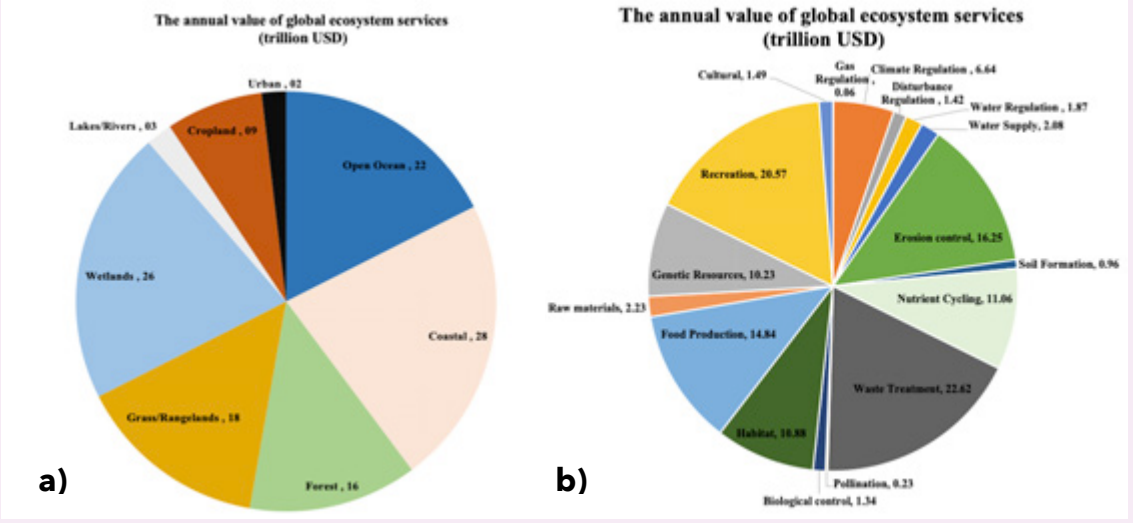
There are various approaches for the determination of economic and ecologic al value of ecosystems and natural capital. Some of these evaluate only the sub-soil assets and the flows between abiotic assets (wind, sun etc.) and some try to determine the economic value of ecosystem services. Natural capital or ecosystem accounting techniques aim at collecting information for producing statistical results at particularly national level, assisting in reflecting the contribution of natural capital and ecosystems on the wealth level of people in the country and thus ensuring that these values are taken into account in the political decision making process (WWF, 2014).

Natural capital/ ecosystem accounting approaches have launched upon ignorance of the contribution provided by natural assets to the wealth level in the national accounting systems of the countries (Box 4). One of the first steps on this issue is the preparation of the System of Integrated Environmental and Economic Accounting handbook by the UN in 1993. In 2012, this manual was revised and System of Environmental – Economic Accounting Central Framework (SEEA CF) was accepted as an international standard by the UN. In SEEA CF, information related to water, mines, energy, wood material, fishery, terrestrial ecosystems, soil, production, consumption and accumulation is given physically and monetarily with the aim of integration of the environment and economy. However, contribution of SEEA CF ecosystem services to the economy could not be reflected (Box 5). For this, SEEA Experimental Ecosystem Accounting (SEEA EEA) approach has been created. In SEEA EEA, it is aimed at establishing a connection between the services provided by ecosystems and the economy (WWF, 2014). In SEEA EEA, it is targeted at measuring the ecosystem services physically and demonstrating their monetary values, and the standards are yet to be created.

Box 4: Economic Value of Ecosystem Services at Global Scale

Upon the ecosystem services not being included in the national accounting systems and failure to assess the benefits they have provided for this reason, a series of research has been conducted in order to demonstrate the importance of ecosystem services (Costanza et al., 1997; Costanza et al., 2014). It was calculated that the economic correspondence of the benefits provided by all biomes in 1995 was annually 33 trillion USD (Costanza et al., 1997). This study was repeated for 2011 and the equivalent of ecosystem services of biomes was found as 125 trillion USD. However, since the unit values used in the calculation are different, in order to make a comparison, values of 1995 ecosystem services were recalculated using the unit values in 2011. As a conclusion, it was determined that the economic value of annual ecosystem services, which was 145 trillion USD for 1995, decreased to 125 trillion USD/year in 2011. It was explained that the decrease in economic value of goods and services produced by the ecosystems has arisen from changes in land use (Costanza et al., 2014). Considering that the goods and services provided by people overall the world in 2011 was around 70 trillion USD, the value of ecosystem services could be understood better. In the evaluation carried out by Costanza et al., (2014) for 2011, it was determined that the ecosystem services of coasts and wetlands were higher compared to other biomes (Box 4, Figure 1). At the global scale, the ecosystem service with the highest economic value is the waste treatment, which is followed by recreation and erosion control. For the comparison of ecosystem values at the level of biome, the economic values at unit area are calculated, which are shown in Box 4 Figure 2. According to this, wetlands are the ecosystems that produce the highest economic value at unit area with an annual 140 thousand USD, and of this economic value, around 80% is waste treatment service. Wetlands are followed by coasts with annual 9 thousand USD, and cities with 6,661 USD. The reason that the cities are higher compared to many ecosystems is that the recreational activities in the cities are higher. Recreation constitutes 86% of the ecosystem services produced in cities.

***Box 4 - Figure 1**: Economic value in 2011 of a) ecosystem services provided by biomes and b) ecosystem services (drawn from data provided from Costanza et al., 2014).*



***Box 4 - Figure 2:** Economic value at unit area of ecosystem services produced by biomes (USD /ha/year) (Costanza et al., drawn from the data provided from 2014).*

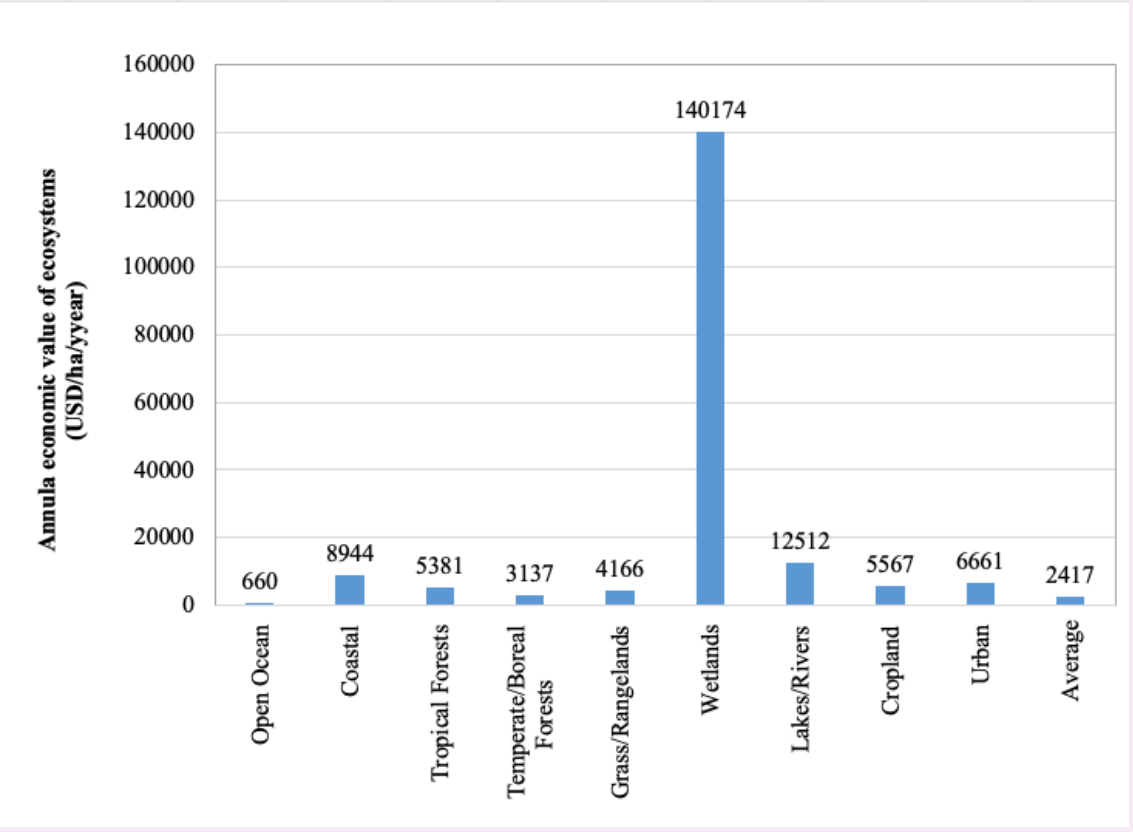
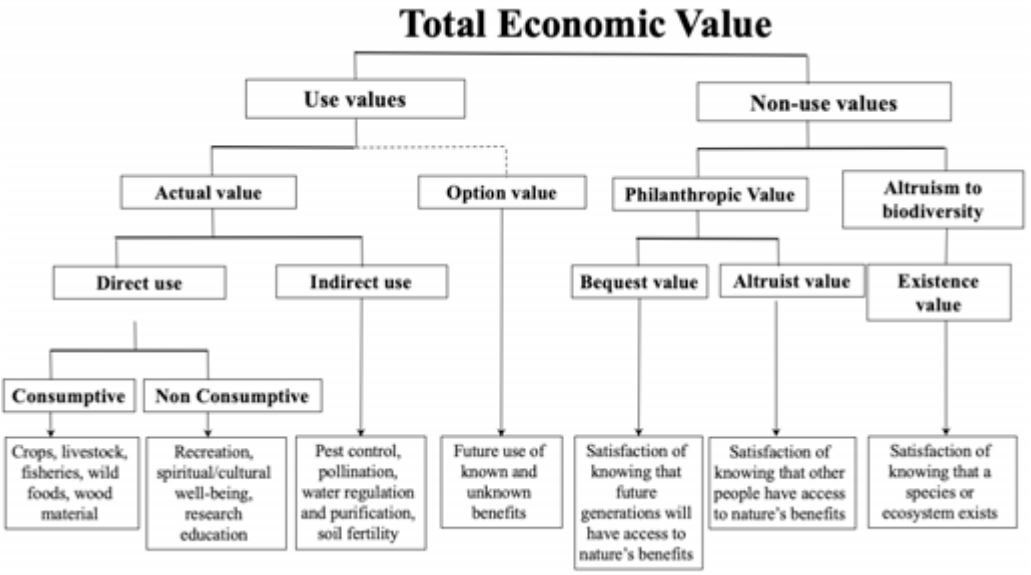


Figure 6: *Total economic value approach (Pascual et al., 2010)*



European Union (EU) 7th Environmental Action Plan includes the development of environmental – economic accounting. In EU 2020 Biodiversity Strategy, it is foreseen to map the ecosystems and member states and the status of the services provided by these ecosystems, evaluation of their economic situation and accounting of these values. For this purpose, Mapping and Assessment of Ecosystems and Their Services (MAES) initiative has been launched (MAES, 2018).

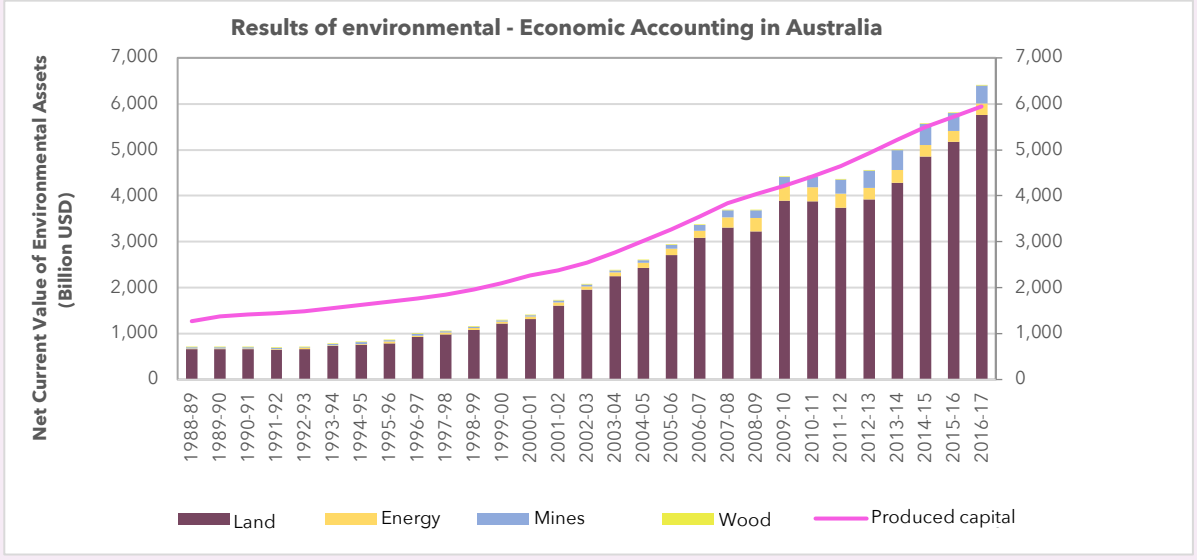
It is very difficult to determine the economic values of goods and services produced by ecosystems. The concept of value in economics is divided into two, being external and internal value. Whereas the external value is the monetary equivalent of the product at the market, the internal value bears an ethical meaning. For example, even if a living species or an ecosystem does not have any benefit for the people, it has a heritage value that could be left to future generations. For that reason, the concept of Total Economic Value determination has arisen (Figure 6) (Box 6).

Another innovative approach that is highlighted in recent years in relation to struggling against climate change is the ecosystem based adaptation. BMBCS Biodiversity and Climate Change Technical Experts Group define ecosystem based adaptation as "using biodiversity and ecosystem services in an overall adaptation strategy. It includes the sustainable management, conservation and restoration of ecosystems to provide services that help people adapt to the adverse effects of climate change" (CBD, 2009) Ecosystem based strategies which could be used for ensuring that people comply with climate change are generally based on sustainable management, protection and restoration of ecosystems (IUCN, 2009) (Table 2). Although ecosystem based adaptation approach focus on issues such as protection and improvement of ecosystem services and adaptation to climate change, it also takes into account the multiple social, economic and cultural benefits of local communities (Pauleit et al., 2017) (Box 7)

Box 5: Results of Environmental – Economic Accounting in Australia

Annual assessments are made according to the environmental economic accounting system by Australia by implementing SEEA CF. According to the evaluation made after 1988, the economic value of land, energy, mines and wood raw material, which constitute the natural capital, which was 708 billion USD in 1988-1989, increased to 6.4 trillion USD in 2017. As opposed to this, it was determined that the capital produced increased from 1.3 trillion USD to 5.9 trillion USD in the same period (Box 5, Figure 1) (Box 5, Table 1).

Box 5 – Figure 1: *Change over years of net current value of natural capital and capital produced in Australia (ABS, 2018).*



Box 5 Table: *Net current value of natural capital components in 2017 in Australia (billion USD) (ABS, 2018).*

Land		Energy		Mine		Wood	
Land	5,765.3	Natural Gas	183.5	Copper, Gold and Antimon	102.9	Plantation	9.9
		Raw Oil	21.3	Boxide	15.1	Natural Forest	1.7
		Condensate	20.9	Iron ore	243.9		
		LPG	3.8	Lead, Zinc, Silver and Cadmium	`		
		Stone coal	7.6	Nickel, Platine and Cobalt	5.1		
		Lignite	0.3	Diamond			
		Uranium	0.2	Lithium	0.1		
				Magnesite	1.4		
				Sand, İlmenite and Zircone	11.7		
				Tin	0.1		
Total	5,765.3		237.6		398.2		11.6

Box 6: Total Economic Value Determination: Bolu Forestry Regional Directorate and Duzlercami Forest Examples

The number of studies towards accounting of ecosystem services in Turkey or value determination is quite low. One of these limited number of studies took place for Bolu Regional Directorate of Forestry which covers Bolu and Duzce provinces. Significant part, if not all, of direct use, indirect use, option and non-use values have been calculated for forests in Bolu Forestry Regional Directorate up to 628,935 ha. Accordingly, the indirect utilization values for the regional directorate examined were found as 389.5 million USD annually. This was followed by direct use values with 288.2 million USD/year, non-use values with 32.3 million USD/year and option values with 6.1 million USD/ year. In the regional directorate, where the total economic value is 716 million USD Annually, it was explained that a spending of 17.5 million USD was made and the net total economic value is around 698.5 million USD (Box 6, Table 1). It was indicated in the study that 89.5% of the economic value created by the forests in one year was not included in GDP calculations (Celikkol Erbas, 2015). On unit area basis, Bolu and Duzce forests create a value of 1,139 USD/ ha/ year and only 91 USD of this comes from wood raw material.

Box 6 Table 1: *The total economic value of forests in Bolu Regional Directorate of Forestry (changed from Çelikkol Erbaş, 2015)*

Value Type	Product or Services	Total Economic Value in 2013 (million USD/year)	Total Economic Value in an unit area (USD/ha/year)
Direct use value	Timber	48.9	77.7
	Firewood	8.1	12.9
	Non wood forest products-plants	0.5	0.8
	Honey	5.3	8.5
	Recreation	12.0	19.1
	Fodder for grazing	212.8	338.5
	Hunting	0.5	0.7
	Total direct use value	288.2	458.4
Option value	Pharmaceutical	6.1	9.7
	Total option value	6.1	9.7
Indirect use value	Watershed protection (water regulation and water flow, water quality, mitigation of runoff and floods)	39.4	62.7
	Water supply	125.4	199.5
	Carbon sequestration	120.9	192.3
	Soil erosion control (nutrient loss ve flood)	103.7	165.0
	Total indirect use value	389.5	619.6
Non-use value	Biodiversity	19.2	30.6
	Existence and bequest value	12.9	20.5
	Total non-use value	32.2	51.1
	Total economic value	716.0	1138.7
General Costs and Negative Externalities	Spending for soil protection, plantation, grassland management, rehabilitation of degredad coppice oak forest	3.1	4.9
	Erosion from degraded forests	14.0	22.3
	Illegal cutting	0.4	0.6
	Total spending	17.5	27.8

Another example in Turkey took place for Duzlercami Forest located in Antalya.

Some ecosystem goods and services were determined in Duzlercami Forest within the scope of Optimizing the production of goods and services by Mediterranean forests in a context of global changes, and economic values were calculated. As a result, it was expressed that the economic value created in Duzlercami Forest was 16.15 euro/ha/year from wood production, 4.57 Euro/ha/year from biodiversity protection, 18.73 euro/ha/year from recreation and tourism and 59.74 euro/ha/year from carbon storage.

Table 2: *Examples of ecosystem based adaptation (EbA) interventions implemented to address specific climate change impacts and key beneficiaries of those interventions (Donatti et al., 2011).*

Climate Change Impacts Addressed	Ecosystem based adaptation (EbA) Intervention	Beneficiaries
Impacts of extreme rainfall or drought on downstream water users	Wetlands rehabilitation to increase water storage potential, 'soaking up' floods or releasing water gradually during droughts	Water users (communities and businesses) Communal farmers
Increased coastal erosion as a result of sea level rise and changes in wave dynamics	Coral reef resilience and protection	Coastal communities Tourism sector Fishing communities
Increased frequency or intensity of tropical storm surge and flooding	Mangrove conservation and restoration to reduce wave energy	Coastal communities Fishing communities Tourism sector
Reduced crop production due to changes in the wet or dry season or extreme weather events	Sustainable farm management (e.g., agroforestry systems, soil and water conservation practices, use of cover crops) that can buffer various climate change impacts on crop production	Smallholder farmers Large-scale farmers Rural communities

Box 7: Ecosystem Based Adaptation Works: Ecosystem Based Erosion Control in Azerbaijan

An action has been launched in Azerbaijan as a result of pasture lands being under pressure due to extreme use and impact of climate change in Ismayilli region. Hazards in the region are identified as desertification, drought, irregular rainfall, rising temperatures, land and forest destruction, loss of biodiversity. The work for the solution started with raising awareness of decision makers and farmers on sustainable management of erosion and biological diversity. Afterwards, studies such as terracing of sloping lands, afforestation with fruit trees, stabilization of river beds, formation and afforestation of fences in areas of gully erosion, and rehabilitation of eroded pastures were performed to prevent erosion. In addition, alternative income generating practices such as fruit growing, apiculture and grass production were realized. All practices have been used as an example to show decision-makers and farmers that the cost of the measures taken is effective in preventing erosion (GIZ, 2018).

3. PLACE OF INTERNATIONAL CONVENTION APPLICATIONS RELATED TO CONSERVING ECOSYSTEM AND BIOLOGICAL DIVERSITY IN THE CLIMATE COMBAT

Turkey is party to many international conventions on ecosystems and biological diversity. Some of these conventions are directly related to biodiversity and ecosystems, while others are indirectly related (Table 3). In addition, since Turkey has been carrying out candidacy negotiations, it is required to comply with directives, statutes and decisions related to biodiversity in the EU Regulations (Table 4). Conventions which are considered as "indirectly related" to the protection of ecosystems and biodiversity, are mostly related to the prevention of pollution.

"International Convention for the Protection of Birds" which was adopted in 1956 in relation to the protection of species and which is known as Paris Convention, is a milestone in relation to biodiversity. Another milestone is the "Convention on Wetlands of International Importance especially as Waterfowl Habitat", which was signed in Ramsar city of Iran in 1971 and which for that reason is known as Ramsar Convention.

While these steps were taken in relation to the protection of bird species and living areas, on the other hand, search for solutions started as the environmental problems, including the air pollution and acid rains that started to emerge after Second World War, started to negatively affect the ecosystems. For that reason, the UN Conference on the Human Environment, which was organized in Stockholm in 1972, is considered as the first step in the field of environment. With CITES which was signed in 1973, a limitation was brought to the trade of endangered animals. In the Barcelona Convention signed in 1976 and the protocols pertinent to this convention contain provisions in relation to both prevention of pollution and of annihilation of biodiversity. Bern Convention, which was signed in 1979, is a very important convention in relation to the protection of wild life and natural living environments. As the economic developments that accelerated in 1980s caused the environmental problems to deepen, new searches came to the agenda. This the approach of sustainable development has emerged. The "Our Common Future" report, which was prepared in 1987, defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This report, which is also named after Gro Harlem Brundtland, who prepared the report, constitutes the foundations for the steps taken towards the solution of environmental and ecological problems by UN (WDEC, 1987). As a matter of fact, the decisions that were taken in UN Conference on Environment and Development, which is considered as the most important meeting up to now in relation to environmental problems and which convened in 1992 in Rio de Janerio, have numerous references to sustainable development. In a meeting which is known shortly as Rio Summit, Agenda 21 and Rio Declaration and Forestry Principles were established, which is an action plan, and also The United Nations Framework Convention on Climate Change, The Convention on Biological Diversity and United Nations Convention to Combat Desertification, were opened to signature. These three conventions are called the Rio Conventions. Agenda 21 briefly includes the protection and better management of ecosystems, prevention of pollution, social and economic dimensions of sustainable development, development of roles of fundamental groups and implementation tools of these actions. Rio Conventions are created for providing a contribution to sustainable development which was demonstrated with Agenda 21. All three conventions are basically connected to

one another and their intersection points are to reach to sustainable development targets by protecting the ecosystems.

Table 3: *International conventions related to protection of ecosystems and biodiversity to which Turkey is a party*

Conventions Directly Related to Protection of Ecosystems and Biodiversity	**Date Turkey Signed**
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Paris)	1966
Convention for the Protection of the Mediterranean Sea Against Pollution (Barselona) ▪ Protocol for the Prevention of Pollution of The Mediterranean Sea by Dumping from Ships and Aircraft ▪ Protocol on The Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and Their Disposal ▪ Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources ▪ Protocol Concerning Cooperation In Combating Pollution Of The Mediterranean Sea By Oil And Other Harmful Substances In Cases Of Emergency ▪ Protocol Concerning Specially Protected Areas And Biological Diversity In The Mediterranean ▪ Protocol On Integrated Coastal Zone Management In The Mediterranean ▪ Protocol For The Protection Of The Mediterranean Sea Against Pollution Resulting From Exploration And Exploitation Of The Continental Shelf And The Seabed And Its Subsoil	1980
Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris)	1983
Convention on the Conservation of European Wildlife and Natural Habitats (Bern)	1988
Convention on the Protection of the Black Sea against Pollution (Bucharest) ▪ Protocol on the Protection of the Black Sea Marine Environment Against Pollution from Land Based Sources ▪ Protocol on Cooperation in Combating Pollution of the Black Sea Marine Environment by Oil and other Harmful Substances in Emergency Situations ▪ Protocol on the Protection of the Black Sea Marine Environment Against Pollution by Dumping ▪ Black Sea Biodiversity and Landscape Conservation Protocol	1994
Convention on Wetlands of International Importance especially as Waterfowl Habitat (RAMSAR)	1994
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1996
Convention on Biological Diversity ▪ Cartagena Protocol on Biosafety ▪ Aichi Biodiversity Targets	1997
United Nations Convention to Combat Desertification	1998
European Landscape Convention	2003
United Nations Framework Convention on Climate Change • Kyoto Protocol to the United Nations Framework Convention On Climate Change	2004
International Treaty on Plant Genetic Resources for Food and Agriculture	2006
International Convention for the Regulation of Whaling	2018
Conventions indirectly related to protection of ecosystems and biodiversity	
Convention on Long-range Transboundary Air Pollution • Co-operative Programme for Monitoring and Evaluation ff The Long Range Transmission of Air Pollutants in Europe (EMEP)	1983
International Convention for the Prevention of Pollution from Ships (MARPOL)	1990
The Vienna Convention for the Protection of the Ozone Layer • The Montreal Protocol on Substances that Deplete the Ozone Layer	1990
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal	1994
Stockholm Convention on Persistent Organic Pollutants	2009

Table 4: *EU Regulation Which Turkey Is Obliged to Implement In EU Candidacy Process*

EU Regulations
Council Directive 79/409/EEC on protection of wild birds (amended by directive 2009/147/EEC)
Council Directive 348/81/EEC setting out the common rules in relation to import of products obtained from whales and other sea mammals
Council Decision No. 83/129/EC related to import of baby seal furs and products obtained from these.
Council Directive 3254/91/EEC on prohibition of "leg catching traps" within the European Community and entry into European Community of leathers and other products obtained from certain wild animal species coming from countries where these traps and other methods which do not meet international humane trap standards are used
Council Directive 92/43/EEC on protection of natural living areas and wild flora and fauna
Council Directive 338/97/EC on protection of wild flora and fauna by regulating their trade
Council Decision No. 98/145/EC on ratification on behalf of European Communities of changes resolved in the 5th Conference of Parties of Bonn Convention – for the protection of migrant wild animals in Annexes I and II of the Convention.
Council Decision No. 1999/22/EC related to treatment towards wild animals in zoos
European Parliament and Council Directive No. 2000/60/EC which constitutes a framework for the Community action in the field of water policy
Council Circular No. 2494/2000/EC in relation to steps to encourage protection and sustainable management of tropical forests and other forests in developing countries
Council Circular 21732005EC in relation to Establishment of FLEGT Licensing System in relation to Timber Import to EU
Council Directive No. 865/2006/EC stipulating Detailed Rules Related to Implementation of CITES Directive No. 338/97/EC
European Parliament and Council Directive 2008/56/EC which constitutes a community action framework in the field of sea environment policy (Sea Strategy Framework Directive)
Council Directive No.1024/2008/EC Stipulating Detailed Measures On the Implementation of Directive for Establishing FLEGT Licensing System Related to Timber Import to the EU
Council Directive 1007/2009/EC Related to Trade of Seal Products
European Parliament and Council Directive No. 2013/0307/COD Related to Presentation, Preventing Spread and Management of Invading Foreign Species

The most important convention which includes provisions in relation to both protection of ecosystems and climate change is the United Nations Framework Convention on Climate Change (UNFCCC). In this convention, it is indicated first that the climate change could damage natural ecosystems, and island states, mountainous ecosystems and arid areas which bear the risk of desertification are more prone to the hazardous effects of climate change. Meanwhile, there are expressions on protection of land and sea ecosystems by approaching them as carbon pool and swallow. Also in the Kyoto Protocol, which was prepared towards this Convention, there are provisions related to transparent and verifiable reporting of greenhouse emissions/removals arising from deforestation, afforestation, reforestation and land use changes. As a matter of fact, our country has been preparing National Greenhouse Gases Inventory every year since 2006 and in this inventory the greenhouse gases released/ retained from agriculture, forest, grassland, wetlands and settlements are calculated and reported to UNFCCC Secretariat.

Within the scope of Rio Conventions, the party states convene meetings under the name of "Conference of Parties" at various periods and take various decision in relation to the conventions For example, Paris Agreement, which was opened for signature in 2015 in relation to climate change and in which the Post Kyoto roadmap was signed, was discussed in the 21st Conference of Parties.

In 2000, Millennium Declaration was adopted in the Millennium Summit in New York, and in 2002, Sustainable Development Declaration and Implementation Plan was adopted in the World Summit on Sustainable Development in Johannesburg in 2002. This declaration briefly included mitigation of poverty and environmental sustainability. Afterwards, these issues were also discussed in The United Nations Conference on Sustainable Development held in Rio de Janeiro in 2012. UN 2030 Sustainable Development Goals (SDG) have been adopted by UN General Assembly in 2015. There are a total of 17 SDGs, of which 13th relates to climate, and 14th and 15th related to life in water and on land respectively (Figure 7).

Figure 7: *UN 2030 Sustainable Development Goals (UNDP, 2018).*

On the other hand, a strategic plan for preventing the loss of biodiversity by the year 2020 was prepared in the 10th Conference of Parties to the Convention on Biological Diversity in 2010. 20 targets were included in this plan which is known as Aichi Targets (Figure 8). Of these, targets numbered 5,6,7, 10, 11, 12, 14 and 15 are closely related to 14th and 15th SDG of UN 2030 SDG, which are related to lives in water and on lands (CBD, FAO, World Bank, UNE, UNDP, n.d.).

Land Degradation Neutrality (LDN) approach was developed in 2015 within the scope of United Nations Convention to Combat Desertification. With this approach, it is targeted to prevent the degradation of the lands with the effect of various factors. The basic goal in LDN is that the amount of lands destructed overall the country should be equal to the amount of rehabilitated / restored land. 3 basic indicators have been set for this. These indicators are land use change, net primary production and soil organic carbon stocks (SOC). If one of these three indicators is negative (for example if there is any land use change) the land is considered to be degraded and SOC stocks are increased with the net primary production of the land of equal amount from the degraded lands, and thus the amount of degraded land is balanced (Orr et al., 2017). In addition to this, UNCCD 2018-2030 Strategic Framework Document which involves 5 strategic objectives has been prepared within the scope of this convention. The number 1 strategic objective in this document is: improve the condition of affected ecosystems, combat desertification/land degradation, promote sustainable land management and contribute to land degradation neutrality in LDN" (UNCCD, 2017). In summary, both with LDN approach and UNCCD 2018 – 2030 Strategic Framework Document, it will be possible to decrease the degradation of the ecosystems, protect and increase the stocks in carbon pools, and thus to provide contribution to combat climate change.

Figure 8: *CBD Aichi Targets (amended from CBD, 2010)*

A high importance is attached to nature protection works in the EU and the focus is mostly on the protection of species and habitat (Table 4). In 2011, a strategy involving 6 targets and 20 actions was adopted in order to stop the loss of ecosystem services and biodiversity by 2020. National Biodiversity Action Plan (UBEP) which covers years 2018 – 2028 has been prepared taking into account the National Biodiversity Strategy and Action Plan (UBSEP) (2007 – 2017) Aichi Targets which was published in 2008(DKMP, 2019). With the action plan in question, 7 national targets and 24 actions were defined in addition to the actions in UBSEP.

4. CLIMATE CHANGE FROM THE PERSPECTIVE OF NATURE PROTECTION

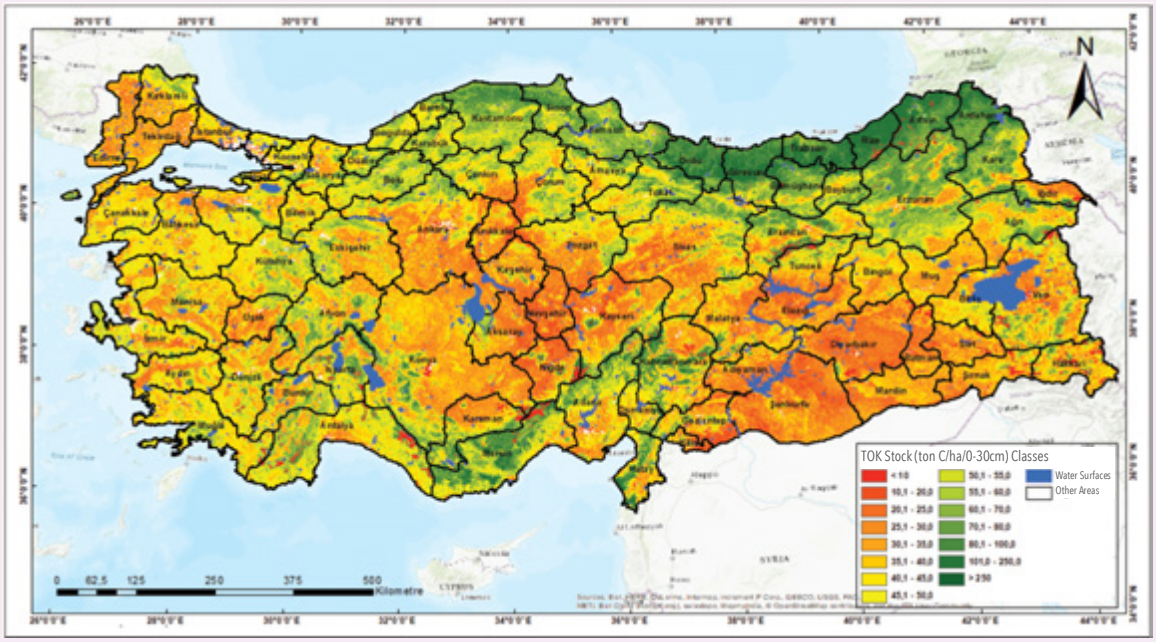
The natural ecosystems, in particular forest ecosystems, and agricultural areas in our country have a great importance in fighting against climate change since they are swallow areas. For example, as of 2016, the total greenhouse gas emission of our country was equivalent to 496.1 million tons of CO_2 and only 68.3 million tons of this could be retrieved from the atmosphere, of which 57.7 million ton is from the forests (Box 8).

Although these ecosystems are not shown in GSMH, these create many ecosystem services and produce goods and services for other living things.

Box 8 – Carbon Stocks and Annual Carbon Accumulations in Terrestrial Ecosystems in Turkey

There are important shortcomings in the researches related to carbon stocks stored in terrestrial ecosystems and watery areas in our country. Whereas the carbon amounts stored only in living trees in forests are calculated in the terrestrial ecosystems, there is no such calculation for the agricultural, pasture land and watery areas. In a study conducted by Tolunay et al. (2018), it was calculated that the carbon stocks in trees in forest areas of 22.3 million ha was 646 million tons. Tolunay et al. (2018) explain that the carbon stock in unit area in productive forests is 48.42 t/ha and the carbon stock in degraded forests is around 3.20 t/ha. The carbon in ecosystems is not only stored in the plants. Other areas where carbon is stored include leaves and other organic materials falling from plants (litter and dead wood) and soils. It is indicated by Tolunay (2011) that the carbon stock in Turkey's forests is 84.1 million in litter and 3.8 million t in dead wood. As it was explained before, in other ecosystems, there is no data in relation to carbon stocks stored in various ecosystem sections. As opposed to this, in another study which mapped the soil organic carbon stocks in Turkey (Box 8 Figure 1) and identified soil organic carbon (SOC) stocks in various land uses, it was calculated that the total SOC stock was 3.5 billion tones for a depth of 30 cm overall the country (Box 8 Table 1) (CEM, 2018).

Box 8 – Figure 1: *Soil Organic carbon stocks in Turkey (CEM, 2018)*



According to Turkey Soil Organic Carbon Map, the highest SOC stock on the unit area is on forest soils with 55.68 ton/ ha, and the lowest is on bare lands with 12.78 t/ha, and artificial (settlement) areas with 16.12 t/ha (CEM, 2018). These SOC stock values also give clue about the carbon emissions or removals that could occur as a result of land use change. For example, if a hectare of forest area is converted into agriculture, TOK stocks could decrease by around 20 tons. In addition to this, since the trees would be cut as a result of conversion, carbon stock will decrease equal to the average carbons tock on the trees (Turkey average 48.42 t/ha). In the opposite situation, afforestation of agricultural areas or empty areas will increase carbon storage.

Box 8 Table 1: *Change of soil organic carbon stocks by land use in Turkey (CEM, 2018)*

Land Use Classes	Area (ha)	Area (%)	SOC Amount (t C/ha)	SOC Stock (t C)	SOC Stock (%)
Forest	24,180,644	31.64	55.68	1,346,434,101	38.33
Grassland	23,568,338	30.84	49.77	1,172,981,521	33.39
Agriculture	26,316,375	34.43	35.96	946,317,555	26.94
Naked Areas	1,172,581	1.53	12.78	14,981,558	0.43
Artificial Areas	796,519	1.04	16.12	12,838,873	0.37
Wetlands and Water Surfaces	393,100	0.51	49.71	19,542,037	0.56
Total	76,427,557	100	45.97	3,513,095,645	100

The stock carbon amounts in the carbon pools in the ecosystems could change annually in the form of emission or removal. The CO_2 in the atmosphere is received by the plants and turned into biomass. Litter such as leaves, branches and fruit which fall from the plants could accumulate on the forest floor or soil. However, with the decrease of growing stock, fast decomposition of organic carbon in the litter and soils or land use changes, the carbon is emitted back to the atmosphere. Our country regularly prepares Greenhouse Gases National Inventory Report every year and submits to United Nations Climate Change Framework Convention Secretariat (TUIK, 2018). In this report, greenhouse gases received from and emitted to the atmosphere annually are calculated for 6 land uses in Land Use, Land Use Change and Forestry (LULUCF) sector. However, in this report, the amount of carbon accumulated or emitted in litter and soils is not calculated, but only the emission/removal amounts arising from land use changes and carbon tied only by the plants, are reported. According to this, 37.2 million tons of CO_2 has been retained as a result of photosynthesis in forest areas and 50 thousand tons of CO_2 has been retained in agricultural areas in the year 2016. Besides, as a result of afforestation works, it was indicated that 23.2 million tons of CO_2 was tied. As opposed to this, there is 2.7 million tons of CO_2 from grasslands and 45 thousand CO_2 emission from lands converted into artificial areas. In net terms, annually 57.7 million tons of CO_2 is received from the atmosphere by lands in our country (TUIK, 2018). Besides, as a result of using the trees cut from the forests as industrial wood, the carbon is stored in the products such as furniture etc. It is included in our national greenhouse gases inventory that 10.6 million tons of CO_2 is accumulated in such products which are named as harvested wood products. In total terms, 68.3 million tons of CO_2 has been received from the atmosphere in 2016 (TUIK, 2018).

Although there are no expressions in our laws directly related to climate change, there are numerous regulations, including the Constitution, related to the protection of forests, agricultural and pasture lands. Article 45 of our Constitution includes the provision: "The State facilitates farmers and livestock breeders in acquiring machinery, equipment and other inputs in order to prevent improper use and destruction of agricultural land, meadows and pastures". It is indicated under Article 169 that the protection of forests and expansion of their fields would cannot be subject to easement except in the public interest and that no narrowing could be made on the borders of the forest other than various agricultural areas such as fields, vineyards, orchards, olive groves which technically and scientifically ceased to be forest before 31/12/1981, and whose use for agricultural or stockbreeding purposes has been found advantageous, and in respect of built-up areas in the vicinity of cities, towns or villages. Article 63 states that "the State shall ensure the protection of the historical, cultural and natural assets and wealth, and shall take supportive and promotive measures towards that end". These articles are directly related to the protection of natural ecosystems, natural assets and agricultural lands.

As regards to laws, there are five main laws related directly to the protected areas. These are the National Parks Law No. 2873, Environment Law No. 2872, Forests Law No. 6831, Cultural and Natural Assets Protection Law No. 2863 and Terrestrial Hunting Law No. 4915. The protected area categories under these laws are given in Table 5. Ministry of Agriculture and Forests and Ministry of Environment and Urbanisation are jointly responsible from the management of protected areas which reached to 8.1 million hectares as of 2018. This responsibility is undertaken by the General Directorate of Nature Protection and National Parks (DKMP) and General Directorate of Forestry under the Ministry of Agriculture and

Forests, and General Directorate for Protection of Natural Assets in the Ministry of Environment and Urbanization. At global scale, 17% of the terrestrial areas and 7% of the marine areas are protected (UNEP-WCMC, IUCN and NGS, 2018). In our country, the protected areas are 10% of the surface area. In addition to the laws mentioned above, there are provisions directly or indirectly related to the protection of biodiversity in laws such as Pasture Lands Law No. 4342, Agriculture Law No. 5488 and Seed Growing Law No. 5553.

Species protection and monitoring projects are being carried out by DKMP General Directorate and General Directorate for Protection of Natural Assets in relation to the protection of nature. These institutions also prepare management plans for the protected areas that are under their responsibility. However, these plans and projects limitedly include issues related to impacts of climate change and adaptation.

Table 5: *Laws related to protected areas in Turkey and protected area categories in these laws*

National Parks Law No. 2873	Forest Law No. 6831	Cultural and Natural Assets Protection Law No. 2863	Environment Law No. 2872	Terrestrial Hunting Law No. 4915
▪ National Park ▪ Nature Park ▪ Natural Monument ▪ Nature Reserve	▪ Protective Forest ▪ Seed Stand ▪ Seed Garden ▪ Gene Protection Area ▪ Urban Forest (Given in the Protected Areas Statistics announced by DKMP though not written in the Law) However, urban forests are required to be considered as protected area).	▪ Natural Site ▪ Natural Assets ▪ Caves ▪ Monument Trees	▪ Special Environmental Protection Area ▪ Wetlands (wetlands with local and national importance) ▪ Ramsar Area	▪ Wild Life Rotection Area ▪ Wild Life Development Area

Table 6: *Number, size of protected areas in Turkey, regulation and responsible institutions as of 2018 (accessed from: http://www.says.gov.tr/istatistik; accessed from: http://www.milliparklar.gov.tr/resmiistatistikleryeni; DKMP, 2019)*

Name	Number	Total Area (ha)	Legislation	Responsible
Nature Reserve Area	30	46,797	National Parks Law No. 2873	TOB-DKMP
National Park	44	846,288	National Parks Law No. 2873	TOB-DKMP
Natural Monument	112	7,488	National Parks Law No. 2873	TOB-DKMP
Nature Park	243	106,453	National Parks Law No. 2873	TOB-DKMP
Wild Life Development Area	81	1,189,305	Terrestrial Hunting Law No. 4915	TOB-DKMP
Wild Life Protection Area	1	8,000	Terrestrial Hunting Law No. 4915	TOB-DKMP
Ramsar Area	14	184,487	Ramsar Convention	TOB-DKMP
Wetland With National Importance	48	714,133	Regulation on Protection of Wetlands	TOB-DKMP
Wetland With Local Importance	9	10,289	Regulation on Protection of Wetlands	TOB-DKMP
Biosphere Reserve	1	25,258	UNESCO Human and Biosphere Program	TOB-DKMP
Special Environmental Protection Areas	18	2,582,970	Decree Law on Establishment of Special Environment Protection Agency No. 383	ÇŞB-TVK
Natural Site	2,434	1,991,700	Cultural and Natural Assets Protection Law No. 2863	ÇŞB-TVK
Natural Asset (Monument Tree)	8,724		Cultural and Natural Assets Protection Law No. 2863	ÇŞB-TVK
Natural Asset (Cave)	249		Cultural and Natural Assets Protection Law No. 2863	ÇŞB-TVK
Protection Forest	55	251,519	Forest Law No. 6831	TOB-OGM
Gene Protection Forests	308	42,093	Forest Law No. 6831	TOB-OGM
Seed Stands	321	42,228	Forest Law No. 6831	TOB-OGM
Seed Gardens	185	1,424	Forest Law No. 6831	TOB-OGM
Urban Forest	142	10,444	Forest Law No. 6831	TOB-OGM
Total		8,060,876		

5. EVALUATION OF TURKEY'S CLIMATE CHANGE POLICY DOCUMENTS IN TERMS OF REALIZATION OF ECOSYSTEM PROTECTION TARGETS

Turkey has not signed UNFCCC for a long period of time since it was included under Annex I and Annex II lists of the convention. However, upon it was accepted that our country had a different situation from other countries included in the Annexes in the 7th Conference of Parties held in Marrakesh city of Morocco in 2001, and that it was removed from the list in Annex II and to remain in Annex I, it was signed in 2004. Upon this, various reports were started to be submitted to UNFCCC Secretariat after 2006. First of these are the greenhouse gases national reports which have been prepared since 2006 and are reported annually. In these reports, greenhouse gas emissions/removals arising from energy, industrial processes and product use, agriculture, land use, land use change and forestry (LULUCF) and waste sectors are calculated for overall country. Another report which we are obliged to prepare since 2007, the First National Communication on Climate Change, has been submitted to the Secretariat. The national communication includes the policies and measures towards decreasing greenhouse gases in addition to greenhouse gases inventory, as well as future scenarios and the adaptation measures to be taken. National communications which are required to be submitted every four years, were later than other countries since our country signed UNFCCC later, and 2nd, 3rd, 4th and 5th National Communications were submitted as single submission in 2013. 6th National Submission was send in 2016, while 7th was sent in 2018.

Following the first national communication, the National Climate Change Strategy (2010 -2020) (IDES), which is the basic policy document of our country in climate change, was prepared. After this strategy document, Climate Change National Action Plan (2011- 2023) (IDEP) was prepared, which included things to do in relation to mitigation of greenhouse gases and compliance with climate change (CSB, 2011).

While these works were being carried out in our country, actions were started to create a roadmap for post-Kyoto pursuant to UNFCCC, and the countries were asked to prepare Intended Nationally Determined Contribution (INDC) report for year 2030 before the 21st Conference of Parties held in Paris in 2015.

Climate Change Biannual Report, which is another report that is required to be prepared, was presented to UNFCCC Secretariat in 2016. The first Biannual Report was prepared jointly and the third is reported in 2018.

The reports which are compulsory to be prepared and the IDES and IDEP include various inventory results in relation to nature protection as well as goals. For example, greenhouse gases are identified in the national inventory annually as emissions or removals caused by forest, agriculture and grassland areas of our country. The results of this inventory are included in the national communications and biannual reports. The national communication also includes the expected climate change effects of ecosystem services on terrestrial, inland water and maritime ecosystems and mentions the works realized within the scope of climate change adaptation. For example, in the 6th National Communication of Turkey, the National Biodiversity Strategy and Action Plan and Protected Areas and Climate Change National Strategy were emphasized.

INDC, which is another international policy document which is prepared, includes plans related to agriculture and forestry. For example, in relation to agriculture, it was explained that land unification, support of minimum cultivation of soil and rehabilitation of grassland and meadow would be completed. In relation to forests, the targets included the mitigation of land degradation, expansion of carbon pools, rehabilitation of degraded forest areas and implementation of afforestation action plans (INDC of Turkey, 2015).

The basis of plans and policies related to ecosystems and nature protection included in the reports which we are obliged to submit to UNFCCC Secretariat, constitutes IDES and IDEP. Among these, IDES include short, middle and long term strategies on the issues of control of greenhouse gas emissions and adaptation to climate change. The mitigation strategies which are considered to related to nature protection in IDES are given below (CSB, 2012).

- Developing strategy towards demonstrating the status of deforestation and forest degradation and solution of the problems;
- Assessment of impacts of climate change on forest ecosystems and carrying out researches towards adaptation strategies and producing policies based on these researches.
- Establishing standards towards protection, improvement and efficient use of the lands, and ensuring that the soils are used according to their capability classes;
- Ensuring that the laws which are enacted for the protection and improvement of agriculture, grasslands and grasslands are effectively implemented;
- Increasing the amount of absorbes in forest and agricultural areas;
- Planning the forests in line with upper basin management principles in order to protect water resources and ensure their sustainability;
- Taking measures towards mitigating the pressure of urbanization on rural and natural areas;

Adaptation strategies in IDES related to the issue of nature protection are as follows:

- Accelerating the actions towards preventing forest fires that will increase due to the negative effects of climate change and protection of carbon pools which decreased due to deforestation, protection and development of natural forests and carry out afforestation;
- Taking effective measures against pests such as insects, fungi and others that could possibly increase in forest areas;
- Continuing the development of scientific studies in relation to sustainable use of natural resources;
- Determining the effects of climate change on water resources (in terms of quantity and quality) and developing implementation recommendations towards adaptation for vulnerable regions;
- Determining the possible negative impacts of climate change on vulnerable ecosystems, urban biotopes and biodiversity, performing vulnerability assessments and taking measures for protecting these;
- Accelerating the researches for developing animal and plant species resistant against heat, drought, diseases and pests.
- Determining on a regional basis the cereal species that have high tolerance against drought and ensuring the seed production (CSB, 2012).

IDEP was prepared in line with the strategies explained in IDES. The action plan included objectives and goals on the basis of sectors in the issues of mitigation of greenhouses gases and adaptation to climate change, as well as actions to be performed within the scope of these.

Actions in the mitigation part of IDEP could be summarized as mitigation of deforestation and forest degradation, limitation of land use changes, determination of and increasing the carbon amount stored in the pools. In relation to adaptation, actions related to nature protection were quoted more and were included in the action plan under separate headings for ecosystem services biodiversity and forestry. There are actions related to nature protection under the headings of agricultural and food security and management of water sources (ÇŞB, 2011)..

The IDEP includes 2 purposes, 9 objectives and 39 actions under the title of ecosystem services, biodiversity and forestry directly related to nature conservation (Table 7). It is foreseen that many of these actions would be carried out between 2011-2015.

Table 7: *Purposes and objectives in relation to ecosystem services, biodiversity and forestry within the scope of adaptation to climate change in IDEP (CSB, 2011).*

PURPOSES	OBJECTIVES
PURPOSE UO1. Integration of the climate change adaptation approach to ecosystem services, biodiversity and forestry policies	OBJECTIVE UO1.1. Reviewing the existing strategies in terms of adaptation to the impacts of climate change
PURPOSES UO2. . Identifying and monitoring the impacts of climate change on biodiversity and ecosystem services	OBJECTIVE UO2.1. Identifying and monitoring the effects of climate change on the species in forest land
	OBJECTIVE UO2.2. Identifying the land use changes due to the impacts c climate change in forest land
	OBJECTIVE UO2.3. Monitoring the health of forest ecosystems
	OBJECTIVE UO2.4. Carrying out research and devolepment activities oriented to identify and monitor the effects of climate changes in protected areas
	OBJECTIVE UO2.5. Taking into consideration the climate change adaptation activities in the socio-economic development of forest villagers, and thereby supporting rural development
	OBJECTIVE UO2.6. Identifying and monitoring the effects of climate change on the mountain, steppe, inland water, marine and coastal ecosystems and on the ecosystem services they provide, and developing measures for adaptation to climate change
	OBJECTIVE UO2.7. Integrating climate change adaptation into the marine and coastal zone management framework
	OBJECTIVE UO2.8. Protection of forests against fires

In general, targets in IDEP are related to determination and monitoring of impact of climate change on species. It is highly positive that the determination of land use changes is included as goal in IDEP. As a matter of fact, in a study in which the problems towards protection of biodiversity in our country are evaluated with Analytic Hierarchical Process (AHP) method, the most important problem was determined as land destruction (Karagoz et al., 2016). Connection of fragmented habitats to one another with ecological corridors in one of the most recommended measures in adaptation to climate change, and it will be beneficial to include this in the revision of IDEP. It is expected that another impact of

climate change on species and ecosystems will be the migration. For this, it is recommended to plan protected areas taking into account the migration paths and potential spreading areas of species. In this direction, it is required for example to announce the protected areas in mountainous areas so as to be covered as sub-alpine and alpine zones and not to permit any barriers which could prevent migrations in these places (path, fence etc.) However, such types of measures are not present in the IDEP. In addition, it could be seen that there is no action on accounting recognition of natural capital and ecosystem services and on taking these into account in the investments in natural areas.

It will be beneficial to include relevant actions to revise the regulations related to nature protection in IDEP in line with EU directives and international conventions.

Despite these shortcomings, it is highly positive that there is an increase in the number of researches on nature protection as well as outsources projects in recent years. One of these is the Project on Adaptation of Forest Ecosystems and Forestry to Climate Change in Seyhan Basin, which was supported by Millennium Development Goals Success Fund (MDG-F). Within the scope of the project, models which explain the current distribution of tree species overall Adana Regional Directorate of Forestry (Calabrian pine, Austrian pine, cedar and fir) were created taking into account the environmental factors and maps of areas which are expected to be vulnerable in the future and suitable growing sites with the effect of expected climate change were prepared and afterwards recommendations were listed for the adaptation of the tree species (DKM, 2011).

The project on "Technical assistance for strengthening the national nature protection system for implementation of Natura 2000 requirements", which is supported by the EU, was completed in 2018. It is explained that, with the project, institutional and technical capacity was created towards harmonization and implementation of EU Bird and Habitat Directives, species and their habitats in our country were determined, new "Systematic Protection Planning" methodology was developed for the selection of Natura 2000 areas, potential Natura 2000 areas were determined in the project area in Central Anatolia Ecologic Region, and a new Natura 2000 database compliant with EU was established (OSIB, 2018).

Another work has been carried out in Yenice and Karabuk forests within the scope of the project on Applicability of EU Natura 2000 Concept in Forest Areas of Turkey (Gungoroglu 2017). It was determined that, in the forests examined in the study, 22 plants were endemic and these were in different IUCN red list categories. Also, 12 different forest habitats were determined in Yenice and Karabuk forests, of which 7 were unique to Turkey. In the study, it was explained that many of the habitats which Turkey has were not listed in the habitat types included in EU Habitat Directives and the danger categories of the endemic plant species were unclear (Gungoroglu 2017).

It is considered that Project on Conservation and Sustainable Management of Turkey's Steppe Ecosystems, which was launched in 2017, is financed by Global Environment Fund (GEF), and being carried out by the United Nations Food and Agriculture Organization (FAO), Ministry of Agriculture and Forestry General Directorate of Nature Protection and National Parks (DKMP) and General Directorate Vegetative Production (BUGEM), will have contributions in the protection of steppes.

6. EVALUATION OF CONTRIBUTION OF PROTECTION OF AGRICULTURAL BIODIVERSITY TO TURKEY'S COMBAT CLIMATE CHANGE AND CLIMATE-SMART AGRICULTURE PRACTICES

The concept of sustainable land management (SLM) has arisen as a result of rapid increase of world population and the decrease of agricultural areas with urbanization and industrialization. In the UN Earth Summit held in 1992, sustainable land management is defined as "the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions" (Sanz et al., 2017). However, since SLM practically did not include climate change, the concept of climate friendly agricultural practices has arisen in the following years wherein the issues of protection of biodiversity, mitigation of greenhouse gas emissions and climate change adaptation have been taken into account. In year 2010, climate – smart agriculture approach was adopted by FAO, which was defined as "agriculture that sustainability increases productivity, resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievement of national food security and development goals" (FAO, 2010). Climate-smart agriculture is an approach which guides the actions required for transforming and reorienting the agricultural systems in order to efficiently support development under changing climate condition and guarantee food security. As the definition tells, the climate-smart agriculture has three main objectives (FAO, 2013).

- Sustainably increasing agricultural productivity and incomes;
- Adapting and building resilience to climate change;
- Reducing and/or removing greenhouse gases emissions, where possible

Climate-smart agriculture does not include a single technology or practice which could be implemented at global scale. Determining the agricultural production technologies and practices for realizing the three main objectives set out above (productivity, adaptation and mitigation) is an approach that requires special assessments at local level. Climate-smart agricultural practices not only target croplands, but also aim at contributing the sustainable development by mitigating the greenhouse emissions and adaptation to climate change in such areas as livestock, forestry, aquaculture. For that reason, it is based on integrating the sustainable management of processes which are directed by nature and people in different ecosystems. It involves creating policies determined in coordination not independent from one another for different ecosystems or sectors, and making this with a participatory approach (FAO, 2013).

Climate-smart agricultural practices are very wide since these involve the technology and practices to be implemented at local scale. However, the basic approach in determining the practices in question could be the identification of greenhouse gas emission sources, examination of possible climate changes and demonstrating the risks, developing recommendations for adaptation and increasing the resistance of the sectors and community against climate change (Box 9). For reaching these objectives, it is necessary to produce solutions that could differ from one another at local level such as to increase the organic substance contents of the soils, carry out water harvesting works, increase the quantity and quality of water, create integrated systems such as agroforestry or silvopastoral

(forestry – livestock), decrease food and wastes, create new markets, create value chains and marketing strategies and diversify the financing resources(FAO, 2013; Lipper 2018).

Our country is among the countries which could be most affected from the climate change. Sectors which are expected to be affected the most are agriculture, livestock, fisheries and forestry, which are directly affected from meteorological events. For example, Dellal et al., (2011) estimated a decrease of 7.6 % in wheat and barley productivity, 10.1% in corn productivity, 3.8% in cotton productivity and 6.5 % in sunflower productivity according to 2050 climate projections in Turkey. Tolunay (2016) has summarized the negative impacts that could occur on natural ecosystems and agricultural areas depending on climate change.

- Irregularity in river flows, drying out of lakes, decreasing drinking, usage and irrigation water amounts.
- Narrowing of water resources as the underground water resources are used more depending on the droughts;
- Increase in flood events especially in Eastern Black Sea and Mediterranean coasts due to heavy downpours,
- Reduction in agricultural production due to damages such as droughts, flood and overflow, hail, storm;
- Certain agricultural areas becoming unusable due to desertification;
- Using more fertilizers and drugs due to decrease of agricultural fields, productivity losses and diseases;
- The increase of sea levels and the decrease in the amount of water carried by the rivers, the salty sea water reaches the inner parts along the stream beds, salinization in agricultural areas,
- Livestock being damaged due to decrease in feed production and grasslands being damaged due to increasing drought;
- The inland waters decreasing due to drought and decrease in water products production in connection with the warming of seas;
- Increase in meat and food prices in connection with the decrease in production;
- Increase of fire, insect and fungi pests in forests and agricultural areas;
- Decrease in biodiversity and some species facing the risk of extinction;
- Some species being forced to migrate, however failing to migrate due to fragmented habitats;
- Increase in wind and water erosion;
- Increase in the number of alien species which are defined as invasive species in terrestrial and marine ecosystems

Box 9 – Climate – Smart Agriculture Practices: Pakistan Example

Various institutions, such as FAO and the World Bank, provide support to climate-smart agricultural practices in less developed or developing countries. Among these, the World Bank has created country profiles for climate-smart agriculture practices for such countries as Argentina, Mexico, Zambia, Bangladesh, Pakistan and Moldova. When creating these profiles, evaluations are made in many issues such as contribution of agricultural activities to economy, characteristics of rural population, access to basic needs, land use, agricultural input use, food security, difficulties in the agricultural sector, greenhouse gas emissions arising from agriculture, climate change projections and possible impacts of the expected climate change to agricultural activities. Following these evaluations, climate-smart practice recommendations are put forward at regional level for each of the agricultural activities. In addition, the acceptability of these recommendations is examined. Besides, climate-smart practices are evaluated from the point of product, revenue, water, soil, risks, energy, carbon and nitrogen emissions and climate smart scores are identified. After all these evaluations, institutions and policies related to climate-smart agricultural practices in all countries examined are demonstrated. Finally, the potential financial resources for climate-smart agricultural practices are listed (World Bank, 2017)

The country profile example of climate-smart agriculture practices created by the World Bank for Pakistan is given in Box 9 Table 1.

Box 9 Table 1: *Climate-smart agriculture practices recommended by the World Bank for Pakistan (created by changing from World Bank, 2017).*

	Climate-Smart Agriculture Practice	Region - Acceptance Rate	Climate Smartness	Impact of Climate-Smart Agriculture Practice
Wheat Wheat	Using drought resistant variety	Sind <30% Punjab <30%	1,3 1,2	**Productivity:** Increases productivity per unit area especially during arid periods, thus provides farmers with income **Adaptation:** Increases water use productivity. Increases resistance against humidity stress and other climate shocks. **Mitigation:** Ensures medium level mitigation in greenhouse emissions per unit food produced.
	Determining the sewing times according to season	Sind 30-60% Punjab 30-60%	1,4 1,3	**Productivity:** Increases land and product productivity per unit water. **Adaptation:** Adjusting the sewing time to the start of rain decreases the losses arising from changing weather conditions. **Mitigation:** Ensures medium level mitigation in greenhouse emissions per unit food produced.
Cotton	Integrating organic fertilizer use	Sind <30% Punjab <30%	0,7 1,0	**Productivity:** Increases production and product quality, therefore the income potentially increases. **Adaptation:** Increases the potential of the system to overcome climate shocks and improves soil quality, water retention capacity and soil functions. **Mitigation:** Ensures medium level mitigation in greenhouse emissions per unit food produced.

	Climate-Smart Agriculture Practice	Region - Acceptance Rate	Climate Smartness	Impact of Climate-Smart Agriculture Practice
	Using temperature resistant variety	Sind <30% Punjab <30%	0,9 0,7	**Productivity:** Increases productivity at unit area particularly during drought and hot periods, thus provides the farmers with revenue. **Adaptation:** Increases water use productivity. Increases resistance against humidity stress and other climate shocks. **Mitigation**: Ensures medium level mitigation in greenhouse emissions per unit food produced.
Corn	Use of early maturing varieties	Hayber Pahtunhva <30% Punjab <30%	5,0 4,7	**Productivity**: Ensures high productivity per unit area, thus there is an increase in income and profit with the decrease of production costs. **Adaptation:** Contributes prevention of product loss, increases use of usable soil water and water use efficiency **Mitigation:** Ensures medium level mitigation in greenhouse emissions per unit food produced.
	Product rotation	Hayber Pahtunhva <30% Punjab <30%	4,0 4,4	**Productivity:** Increases total production per unit area and productivity and improves income and food security. **Adaptation:** Decreases total product loss risk due to diversification of products under adverse weather conditions. **Mitigation:** Protects soil structure and organic carbon reserves. Use of cereals decreases use of artificial nitrogen fertilizer.
Stockbreeding	Fertilizer Management	North Punjab <30% South Pencap <30%	2,6 2,5	**Productivity:** Decreases production cost and thus increases the profit obtained from agriculture. **Adaptation:** Increases organic material content and microbial activities and soil health and increases agriculture possibility in ruined soils **Mitigation:** Soil characteristics are improved and a better soil capacity is provided for carbon storage. It decreases methane emissions and it could be integrated with other practices such as bio-digesters.
	Controlled Shelters	North Punjab <30% South Punjab <30%	3,0 2,5	**Productivity:** A faster growth and higher feed transformation rate is provided by means of suitable shelters. **Adaptation:** Decreases exposure to negative climate conditions, decreases the stress of the animal (For example, cold air waves). **Mitigation:** Provides better fertilizer management, thus decreases relevant greenhouse gas emissions.

Protection of agricultural biodiversity is very important in mitigating these expected effects and increasing resistance in the agricultural sector. For example, identification, production of species and races which are resistant against extended growth period, drought, frost damages, floods, insects, fungi and diseases and other problems, and disseminating their use.

For that reason, protection of genetic sources of corps, races and their relatives constitutes the basis for improving resistance against impacts of climate change, improving efficient use of resources, shortening the production cycles and receiving higher efficiency per land (FAO, 2010).

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GLOSSARY OF TECHNICAL TERMS

Allelic Diversity: Two gene couples located in mutual zones of chromosomes representing a character is called allele, and allele variety is the appearance of same phenotypic characteristics as a result of different mutations at the loci where the genes are located.

Alpine Zone: Vegetation zone in high mountains which comes after a certain height (e.g. 2200- 2400 m) where naturally no tree grows and grassy species prevail.

Land and Water Footprint (Ecologic Footprint): Biologically fertile soil and wet areas required for producing the resources consumed by an individual, a community or activity or disposing the waste created by these with the existing technology and resource method. This is called Ecologic Footprint and it is expressed in "global hectares" (kha). This includes the areas required for vegetation that will ensure waste carbon dioxide (CO_2) absorption as well as infrastructure.

Biodiversity: Differentiation between living organisms arising, inter alia, land, maritime and other aqueous ecosystems and ecological complexes of which these ecosystems are a part; diversity and ecosystem diversity among and between the species are included in this.

Biome (Major Ecosystems): The unions created by living communities that have adapted to conditions in great climate zones in the world (tropical, sub-tropical etc.). Each of the biomes which are named as great life zone comprises similar plant and animal communities. These biomes are mainly named after the name of the plant communities that prevail in that climate zone. For example, tropical rain forests, maquis, savanna, mild zone, deciduous forests, tundra etc.

Boreal: Northern geographical regions. Region which reaches from the east of Baltic Sea to the east of Asia, which is adjacent to the Arctic zone.

Diapause: The case wherein some arthropods (insects etc.) pause their development in a certain period of life under negative conditions (such as drought, high or low temperatures).

Phenology: Periodic life cycles such as gemma bursting, leaf growing, blossoming, seed spreading etc. in plants and moulting, ecdysis, copulation, inoculation, hibernation, migration etc. in animals which change seasonally and are shaped by climate conditions.

Heterozygote: The situation of alleles corresponding one another being different on homologous chromosomes.

Hypoxia: The decrease of oxygen concentration dissolved in water under saturation level in water ecosystems such as seas and lakes.

Condensate: Hydrocarbon mixture with low density.

Mangrove: Forests at sandy-clayey protected sea shores that have heaps that are rich in organic substance, brought by sea waves in tropical and sub-tropical regions.

Mutualism (Symbiosis-Common Living): Close common relationships of organisms in different species. Both two organisms positively benefit from this relationship.

Net Premier Production (NPP): Amount of organic substance that has accumulated as vegetative tissue produced with photosynthesis within a certain time limit by chlorophyll plants after deducting the organic substances produced with respiration.

Niche: The place where living things live in an ecosystem or habitat. For example, a single tree could create a habitat for various species and living things could use various parts of this tree. Whereas the squirrels are settled at tree recesses, the birds build their nests on their branches.

Parasitism: Ecologic relations wherein a species (parasites) provide its nutrients from another species which is named as host, the parasite species provides a benefit but, on the contrary, the host is continuously damaged.

Permafrost: Frost event which has been continuing for long years in arctic and sub-arctic regions and high mountainous areas. Continuous frozen soils occurred as a result of this event.

Recreation: Activities performed by people to enjoy their leisure times, get away from business tress, rest and renew themselves. These activities could be outside the city such as nature walk and picnic, or activities such as sports activities, cinema, theater, concert within the city are also accepted as recreation.

Sahel Zone: The name of the region covering Mauritania, Senegal, Mali, Burkina Faso, Niger, Chad, Sudan and Eritrea reaching from Atlantic Ocean to Red Sea on the south of Sahara Desert.

Savanna: The name given to plant communities in Monsoon zone where there are tropical summer rains with apparent arid periods. Savanna vegetation comprises intense herbaceous species and very rare single or group trees.

Subalpine Zone: The altitude zone at high mountains where the forest zone is over but the trees and bushes continue to survive. It is located between the forest border and alpine zone.

Sustainable Land Management: Use of land resources for producing the goods in order to cover changing human needs by ensuring long term production potential of such resources as soil, water, animals and plants and sustaining their environmental functions.

Taiga: Coniferous tree forests on the Northern hemisphere growing in both North America and south regions of cold and treeless tundra in Europe and Asia.

Tundra: Wide, naked and treeless areas between taigas (needle forests of north latitudes) and glaciers in North America and north of Eurasia. Generally there are mosses, grasses, herbaceous species and short bushes.

Variety: Group of individuals that could be distinguished morphologically within a species.

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