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WETLANDS & CLIMATE CHANGE PROJECT

EVALUATION OF CLIMATE MITIGATION POTENTIAL FOR YENİÇAĞA GÖLÜ (BOLU) AND AKGÖL (KONYA)

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Executive Summary

Wetlands are ecosystems critical for conserving biodiversity, for the services they provide and for their role in sustaining livelihoods. Their function in climate regulation, especially for peatlands, has also been clearly articulated; peatlands are the most efficient terrestrial ecosystem in storing carbon. However the current status and use of wetlands and peatlands in most parts of the world is unsustainable. The "Adaptation to Climate Change and Protection of Biodiversity through Conserving and Sustainable Use of Wetland in Turkey" project is of prime importance for Turkey as it is the first study focusing on ameliorating the biodiversity conservation function of wetlands/peatlands and linking the management and protection activities with climate change adaptation and mitigation. As a result of the project, an area of 400 ha of peatland was protected in Yeniçağa Gölü and an area of 1,000 ha gained back wetland characteristics in Akgöl. These conservation and restoration activities serve in providing high quality habitat for diverse taxa, crucial especially for threatened and rare species of the region. Furthermore as a result of the activities implemented in both areas, emissions of approximately 4,192,800 kg. C to the atmosphere was estimated to the prevented annually (eq. to 15,345 tons of CO_2). Replication of this project both in Turkey and worldwide would be beneficial primarily in terms of biodiversity conservation, and also socio-economic prosperity and climate change adaptation and mitigation.

1. Wetlands, Peatlands and Climate Change

1.1. Wetlands and Peatlands

1.1.1. Wetlands

Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. They occur where the water table is at or near the surface of the land, or where the land is covered by water (Ramsar Information Paper no.1). According to the Ramsar Convention (Article 1.1) wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. The existence of 42 types of wetlands are recognized by the Ramsar Convention including rivers and their tributaries and floodplains, lakes, estuaries, deltas, peatlands, oases, coastal areas, together with mangroves and coral reefs.

Wetlands are found in all climatic zones ranging from the tropics to the tundra (except Antarctica which has no wetlands; Adhikari et al., 2009). Covering about 570 million hectares (5.7 million km^2), 6% of Earth's land surface is made up of wetlands, of which 2% are lakes, 30% bogs, 26% fens, 20% swamps, and 15% floodplains (UNEP World Conservation Monitoring Centre). In other sources between 4 to 6% of Earth's land surface is estimated to be covered by wetlands (Mitsch and Gosselink, 2000; Adhikari et al., 2009). Mangroves cover some 240,000 km^2 of coastal area, and an estimated 600,000 km^2 of coral reefs remain worldwide (Ramsar Information Paper no.1).

Wetlands are ecosystems critical for supporting human populations for domestic needs, agriculture, industry and other economic production as well as maintenance of social and cultural integrity all around the world. Furthermore, the biological diversity evolved in and around wetlands comprises an important part of Earth's richness. This in turn results in a high diversity of ecosystem services provided by wetlands, e.g. flood control, groundwater replenishment, sediment and nutrient retention and export, water purification. The services provided by wetlands worldwide are estimated to correspond to trillions of US dollars every year (Ramsar Information Papers).

One important service of wetlands whose importance is being recognized more and more in the last decade is the mitigation of climate change. Wetlands, especially peatlands, are top long-term carbon stores in the terrestrial biosphere (Parish et al., 2008). The projected increases of pressure on water resources with the increasing human population and the threats caused by climate change urges the recognition of the importance of these systems and development of ways to restore the degraded wetlands wherever possible.

1.1.2. Peatlands

Peatlands are wetland ecosystems which are characterized by the accumulation of organic matter called peat which derives from dead and decaying plant material under high water saturation conditions (Parish et al., 2008). The accumulated plant material forms layers of peat soil up to 20 m thick – storing on average 10 times more carbon per hectare than other ecosystems (Parish et al., 2008).

Peatlands have a limited distribution on Earth. They cover approximately 400 million hectares in almost all of the countries of the world (180 out of 193 countries members of the United Nations) corresponding to 3% of the Earth's land surface (Parish et al., 2008; Çolak and Günay, 2011). Occurring primarily in the boreal, sub-arctic and tropical zones, peatlands represent at least one third of the global wetland resources. Significant areas of peatlands are found in tropical and sub-tropical latitudes where high plant productivity combines with slow decomposition as a result of high rainfall and humidity (Parish et al., 2008).

The formation of peatlands takes thousands of years and their formation is strongly influenced by climatic conditions and topography (Çolak and Günay, 2011). Peatlands may be naturally forested or naturally open and vegetated with mosses, sedges or shrubs. The peatlands existing today are mainly those which started forming in the late Ice Age and the first part of Holocene (a geological epoch which began 12,000 years ago) and continued accumulation since then (Halsey et al., 1998, Campbell et al., 2000, MacDonald et al., 2006). Today peat extracted from peatlands is used mainly for forestry, agriculture, horticulture and energy production. For these reasons, in many parts of the world, peatlands are being drained and inappropriate management practices are leading to large-scale degradation of peatlands worldwide. The degradation and destruction of peatlands has major implications for biodiversity, climate change and human populations.

1.2. Climate Change

Climate Change is the greatest environmental challenge facing the Earth. It is widely agreed to be occurring due to the influence of human related global greenhouse gas (GHG) emissions. Scientific studies reveal increasing reasons for serious concern about this issue. In 2007 the scientific world acknowledged that anthropogenic activities including land-use change, deforestation, biomass burning, soil cultivation, draining of wetlands and peatlands and fossil fuel combustion, especially since the onset of industrial revolution around 1850, were "very likely" (>90%) responsible from the increases in GHGs (Intergovernmental Panel on Climate Change (IPCC), 2007).

Earth's climate is regulated through the addition and removal of GHGs, and carbon dioxide (CO_2) is by far the most abundant of these gases. There has been a dramatic increase in atmospheric CO_2 since the industrial revolution; from approximately 280 ppm in pre-industrial era to ~ 385 ppm in 2008 (+ 37.5%) and it is presently increasing at the rate of ~ 2 ppm/yr or 3.5 Pg/yr (1 Pg or pentagram = 1 Gt = 1 gigaton = 1 billion metric ton) (World Meteorological Organization [WMO], 2006;

Intergovernmental Panel on Climate Change (IPCC), 2007).

As a result of the increase in GHGs, the average temperature of the Earth's surface has risen by 0.74° C since the late 1800s. Earth's mean temperature is projected to increase by 1.5 to 5.8°C during the 21st century (Intergovernmental Panel on Climate Change (IPCC), 2007). Even if the minimum predicted increase takes place, it will be larger than any century-long trend in the last 10,000 years (Intergovernmental Panel on Climate Change (IPCC), 2007). It is not only a threat to the biodiversity of the world but it is expected to cause other global threats such as hunger, poverty, conflicts between states, displacements etc. Agricultural yields are expected to drop in most tropical and sub-tropical regions – and in temperate regions too – if the temperature increase is more than a few degrees centigrade. These changes are considered likely to cause, at a minimum, disruptions in land use and food supply.

Scientific measurements have confirmed that human culture depends on dramatic reduction of the GHGs accumulated in the atmosphere (Intergovernmental Panel on Climate Change (IPCC), 2007). Over a decade ago, most countries became parties to an international treaty – the United Nations Framework Convention on Climate Change – began to consider what can be done to reduce global warming and to cope with those temperature increases, which are inevitable. More recently, a number of nations approved an addition to the treaty, called the Kyoto Protocol, which has more powerful (and legally binding) measures. The Protocol's commitment period begun in 2008 and ends in 2012. Turkey joined this Protocol in 2009. The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to achieve the stabilization of GHG concentrations in the atmosphere at a level below what is considered dangerous anthropogenic interference with the climate system (Rogner et al., 2007).

Natural ecosystems play an integral role in the carbon balance. Through carbon sequestration, the net flux of CO_2 to the atmosphere is decreased by 'capturing' carbon in the oceans, vegetation, soils, and porous rock formations. Carbon sequestration is the process by which CO_2 is either removed from the atmosphere or diverted from emission sources and stored in the ocean, terrestrial environments (vegetation, soils, and sediments) and geologic formations (Fig. 1). In terrestrial ecosystems sequestration takes place in biomass (primarily trees, both the above and below ground components) and soil. Protecting the forest, wetland and grassland systems and improving their management can reduce CO_2 emissions (mitigation), thereby reducing the rate and magnitude of change while providing other environmental benefits such as water quality protection and habitat conservation.

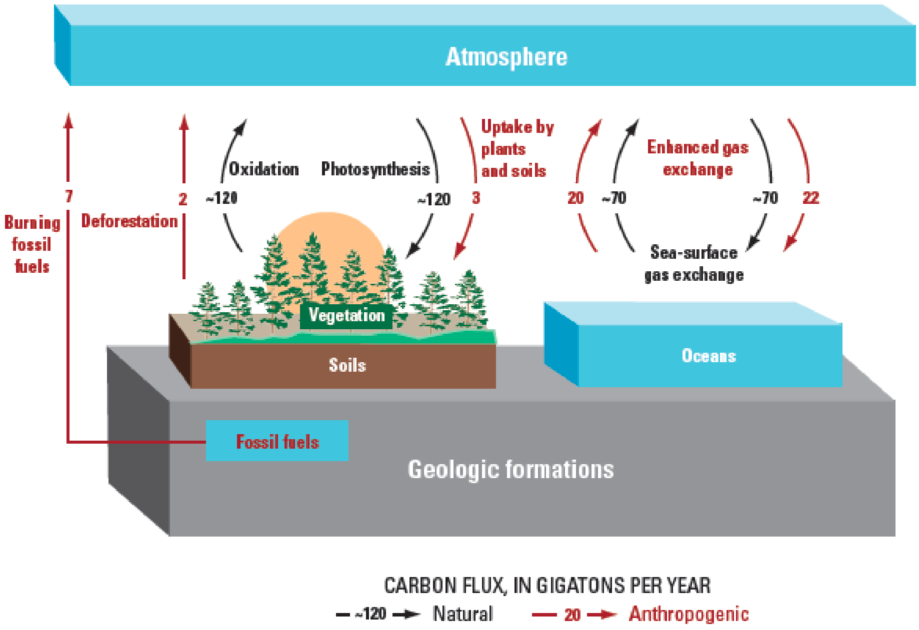

Figure 1. The global carbon cycle. Carbon naturally moves, or cycles, between the atmosphere and vegetation, soils, and the oceans over time scales ranging from years to millennia and longer. Fluxes shown are approximate for the period 2000 - 2005, as documented by the Intergovernmental Panel on Climate Change (taken from US Geological Survey).

1.2.1. Climate Change and Peatlands

Wetland ecosystems play an important role in the global carbon cycle by helping to regulate climate change by storing and capturing carbon (Adhikari et al., 2009; Intergovernmental Panel on Climate Change (IPCC), 1996; Sahagian and Melack 1998). They are important in global carbon dynamics because of their large soil carbon pools, high methane (CH_4) emissions, and potential for carbon sequestration in peat formation, sediment deposition, and plant biomass (Bridgham et al., 2006).

When coastal wetlands and peatlands are included, wetlands represent the largest component of the terrestrial biological carbon pool (Dixon and Krankina, 1995). In particular, covering only 3% of the world's land surface, peatlands are estimated to be the largest carbon store, with an estimated 550 gigatonnes of carbon worldwide (Gorham, 1991; Botch et al., 1995; Vompersky et al., 1996; Lappalainen, 1996; Sheng et al., 2004; Maltby and Immirzi, 1993; Parish et al., 2008). The 550 Gt of carbon stored in peat is equivalent to 30% of all global soil carbon, or 75% of all atmospheric carbon, or equal to all terrestrial biomass, and twice the carbon stock in the forest biomass of the world (Parish et al., 2008). Furthermore in the (sub)polar zone, peatlands contain 3.5 times, in the boreal zone 7 times, in the tropical zone 10 times more carbon per ha than ecosystems on mineral soil. All these make peatlands the top long-term carbon store in the terrestrial biosphere (Parish et al., 2008).

Managing and maintaining the values of peatlands are quick and cost-effective measures to reduce as much as 10% of greenhouse emissions (Parish et al., 2008; Çolak and Günay, 2011). Around the world the intact peatlands can store around 150-250 million tons of CO_2 per year in the newly forming peat. This corresponds to twice the amount of CO_2 emission that should be decreased globally every year as identified by the Kyoto Protocol. However clearing, draining and setting fire to peatlands emits more than 3 billion tonnes of CO_2 every year, equivalent to 10% of global emissions from fossil fuels (Parish et al., 2008).

Given the prime importance of peatlands for climate change mitigation, protection and proper management measures should be taken throughout the world for these ecosystems. However, degradation of peatlands is a major growing source of anthropogenic emissions. Human interventions can easily upset the natural balance of production and decay turning peatlands into carbon emission sources. Drainage for agriculture, forestry, continued burning and other purposes for exploitation increases aerobic decay and change peatlands from sinks and stores of carbon to (often vigorous) sources. Peat extraction (for fuel, fertilizers, etc.) transfers carbon to the atmosphere even more quickly. The massive amounts of belowground stored carbon which can be released in the atmosphere as a result of the human interventions can undo much of the mitigation efforts already underway. In 1990, CO_2 emissions from peatland drainage, fires and exploitation was estimated to be equivalent to at least 15% of the CO_2 emissions of the Annex 1 Parties to the UNFCCC (Parish et al., 2008).

Other than peatlands, estuarine wetlands and some freshwater mineral-soil wetlands rapidly sequester carbon as soil organic matter due to burial in sediments (Bridgham et al., 2006). Furthermore the carbon sequestration potential of wetlands is quite substantial, more specifically in the case of forested tidal wetlands, mangroves, salt marshes, sea grass beds and tidal marshes (Crooks et al., 2011; Reyes, 2011). Large-scale emissions from ecosystem degradation and habitat conversion of these wetlands are ongoing but currently not accounted for in national greenhouse gas inventories, nor are these being mitigated sufficiently. This issue has already been identified as a gap in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. To fill this gap, an invitation was made from UNFCCC to Task Force on National Greenhouse Gas Inventories (TFI) to developing additional national-level inventory methodological guidance on wetlands. This “Wetlands Supplement” will enter into force in 2013.

1.2.2. Climate Change and Turkey

Future climate change could critically undermine efforts for sustainable development throughout the world and in the Mediterranean Basin (Intergovernmental Panel on Climate Change (IPCC), 2007). Located in the Eastern Mediterranean, Turkey is one of the countries at high risk.

The expected changes related to climate change in Turkey are increases in the mean yearly temperatures and decreases in rainfall especially in the western and southern parts of the country (Dalfes et al., 2007: Demir et al., 2008; Önol and Semazzi, 2009).

According to the A2 scenario (one of the four emission scenarios developed to explore alternative development pathways, covering a wide range of demographic, economic and technological driving forces and resulting GHG emissions; Intergovernmental Panel on Climate Change (IPCC), 2000) an increase of 3-6 °C is expected in mean temperatures by 2071-2100 (with the lowest increases in coastal regions). Also expected are a decrease of up to 40% in rainfall, a decrease in snow cover in the Eastern Anatolian and Eastern Black Sea Mountains, increase in temperatures and decreases in the surface flows – linked with decreases in rainfall – are expected. Increased intensity of heavy rainfall and flash floods, heat waves and drought are expected to lead to heavy erosion, more frequent and severe fires and desertification in central and south eastern regions of the country (Türkeş 1999, 2003; Dalfes et al., 2007).

Such significant changes in climate will certainly influence the exceptional ecosystems and biological diversity Turkey hosts. Changes in population sizes, timings of critical life cycle events (like migration, breeding), fragmentation and complete loss of habitats of living things are among the expected impacts (Zeydanlı et al., 2010). Wetlands are one of the habitats which will be heavily influenced. Loss of plant species in freshwater marshes and shallow lakes, salinization and complete desiccation are expected to occur with severe consequences for human communities and wildlife (Zeydanlı et al., 2010).

In 2007, Turkey submitted its First National Communication to the UNFCCC Secretariat (Apak and Ubay, 2007). This document was prepared in close cooperation with relevant Ministries, institutions, NGOs and the private sector, with the support of the United Nations Development Programme and the Global Environment Facility. Although not yet made public, the Second National Communication to the UNFCCC Secretariat is prepared. Additionally the National Climate Change Action Plan is prepared for the period 2011-2023 (Ministry of Environment and Urbanization, 2012). The importance of forest ecosystems for storing greenhouse gases is widely acknowledged and Turkey is focusing on developing policies to use this ecosystem service more efficiently, through sustainable management of forests, afforestation, reforestation and forest restoration (Apak and Ubay, 2007). However the role of wetlands and peatlands in mitigating climate change is little known in Turkey, and this needs to be addressed more in future policies. The project entitled "Adaptation to Climate Change and Protection of Biodiversity through Conserving and Sustainable Use of Wetland in Turkey" (hereafter Wetlands and Climate Change Project) executed by the Turkish Ministry for Forestry and Water Affairs with support from the International Climate Change Initiative and implemented by GIZ (German International Cooperation) was the first initiative addressing the importance of wetlands/peatlands for biodiversity conservation with emphasis to carbon storage, climate change adaptation and mitigation. The project was implemented in two pilot areas in Turkey, namely Yeniçağa Gölü and surrounding peatlands in Bolu Province and Akgöl in Konya Province, and aimed to create models for mitigating climate change at Yeniçağa Gölü, for adaptation to climate change in Akgöl and for conserving biodiversity in both areas.

2. Project Areas

2.1. Yeniçağa Gölü (Bolu Province)

Yeniçağa Gölü is a shallow non-stratifying freshwater lake (max. 4.3-5.2 m; Beklioğlu et al., *unpublished data*) located in the Western Black Sea region of the country in Bolu Province, Yeniçağa District. The catchment area of the lake is approximately 180 km^2 and the lake is located between 40°42' and 40°51' north and 31°55' and 32°10' east (Fig. 2; GIZ, 2010). To the west of the lake lies Bolu city centre, to the north is Mengen district, and to the south Dörtdivan (Keleş, 2007). The average annual temperature of the area is 10.4 °C and the average annual precipitation is 542.2 mm, concentrated in October and June (GIZ, 2010). The submerged plant cover of the lake is very limited probably due to non-biological induced turbidity (GIZ, 2010).

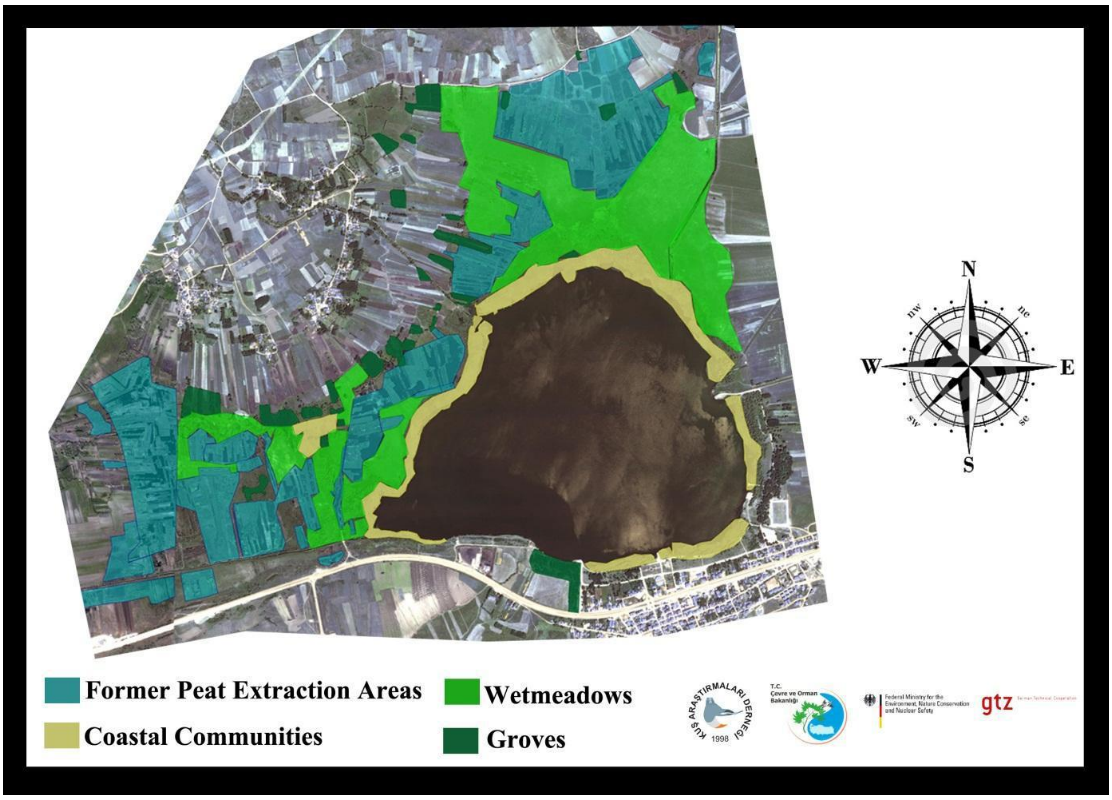

Figure 2. Yeniçağa Gölü, showing the habitats around the lake.

Located at 990 metres altitude, the whole lake is covered by a thick cover of reeds. The peatlands to the west and northwest of the lake are inundated intermittently depending on the water level. Yeniçağa Gölü and its surroundings used to be the most important peat extraction area in Turkey; peat has been extracted in this area during 25 years, between 1984 and 2009. The lake is located on a bird migration route and is a site with a high potential for commercial fishing in Turkey.

2.1.1. Biodiversity

Yeniçağa Gölü and its surrounding area is one of Turkey's 122 Important Plant Areas (IPA) (IPA; Özhatay et al., 2003). The lake is also an Important Bird Area (IBA; Kılıç and Eken, 2004) and a Key Biodiversity Area (KBA; Eken et al., 2006) for the rich diversity of wildlife that it hosts. The lake is located on an important bird migration route between Europe and Africa. Detailed survey results on biodiversity and species lists are present in the original project reports and their annexes.

Flora

In Yeniçağa Gölü, 345 taxa belonging to 64 families, 214 genera, 342 species, 65 subspecies and 35 varieties of plants have been recorded (Vural et al., 2011). The rates of the species regarding the phytogeographical regions are as follows: Euro-Siberian 22.9% (79), Irano-Turanian 4.6% (16), Mediterranean 3.2%% (11), Euxines 1.2% (4) and Hyrcano-Euxines 0.6% (2). Cosmopolitan and phytogeographically unknown species are 2.9% (10) and 62.6% (216) respectively.

The number of endemic taxa found in the area is 12 and the endemism ratio is 3.5% (Vural et al., 2011). One of the endemic species on the area is *Tripleurospermum rosellum var. album* which is Vulnerable (VU) according to IUCN Red List Categories (IUCN, 2001) and it is therefore assessed to be facing a high risk of extinction in the wild. As stated by Sümer (2002), other than the endemic species, there exists also 6 rare plant species in the area; *Acorus calamus*, *Najas marina*, *Carex lasiocarpa*, *Pedicularis palustris subsp. opsiantha*, *Ranunculus lingua* and *Senecio paludosus*. The region's list of flora and further details are given in Vural et al. (2011).

Five vegetation types have been identified at Yeniçağa Gölü: Aquatic communities, Coastal-Mud communities, Wet meadows, Willow Groves and Agricultural Areas (GTZ, 2010c). For a detailed vegetation map, see Figure 3.

Aquatic (Emergent and Submerged) Communities

Dense, but species poor vegetation now covers the wetlands which have formed in the former peat extraction areas. Two aquatic communities are present, covering an area of 50 hectares.

Wet Meadows

Wet meadows grow on the peat in a broad band around the lake, especially in the north and west. These vegetation communities are very rich in terms of both cover and species diversity. Ground cover is 100%, and the vegetation height is 80-100 cm. Here, rare species of Turkey's flora such as *Acorus calamus*, *Najas marina*, *Pedicularis palustris*, *Senecio paludosus* can be found. However, peat extraction activities have caused the fragmentation of the wet meadows, particularly in the north and west parts of the lake, and holes where the peat was extracted are now filled with water. These are now becoming vegetated with submerged plants, and small bushes and willow trees are seen in the older cavities. This community covers an area of 284.4 ha.

Agricultural Areas

Agriculture takes place in areas where formerly there was peat extraction. Around the villages in particular, agricultural areas are very close to the peatlands. The most commonly grown crops are cereals – wheat, barley, oats and corn. Other crops include potatoes, wild apples (*Malus sylvestris subsp. mitis*) and wild plum (*Prunus domestica*), found along the borders of the agricultural areas.

Willow Groves

Willow species are abundant near the lake and near former peat extraction areas. The most common species are *Salix fragilis*, *Salix caprea*, *Salix elaeagnos*, *Salix amplexicaulis* and *Salix cinerea*. Growing with the willows are *Acer campestre*, *Euonymus europaeus*, *Sambucus ebulus*, *Solanum dulcamara* and *Hyoscyamus niger*. Willow groves cover an area of 13 ha.

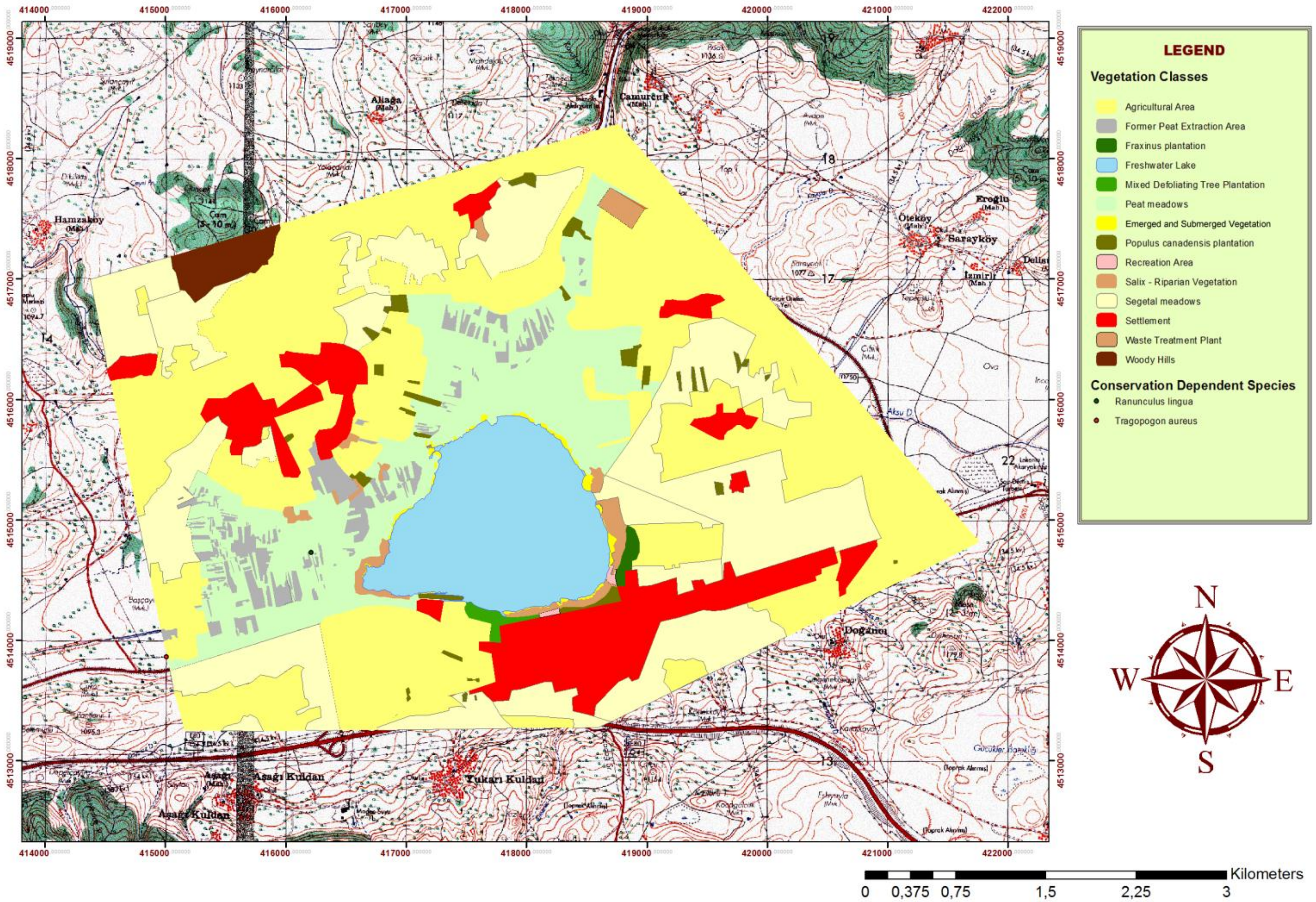

Figure 3. The vegetation types identified in Yeniçağa Gölü.

Birds

Due to the important bird species Yeniçağa Gölü hosts, the lake qualifies as an Important Bird Area (IBA; Kılıç and Eken, 2004) and a Key Biodiversity Area (KBA; Eken et al., 2006). It is located on an important bird migration route between Europe and Africa and 183 species have been recorded using the lake for breeding, resting and overwintering (Kılıç and Kasparek, 1987). According to the MidWinter Waterfowl Censuses (KOSKs) coordinated by Doğa Derneği (BirdLife in Turkey), from 1976 to 2009, 98 species have been recorded wintering here (GIZ, 2010). Furthermore, the project recorded 92 species at Yeniçağa Gölü during the spring/summer, and most of them were considered to be breeding (Özbahar et al., 2010).

Little grebe (*Tachybaptus ruficollis*), great crested grebe (*Podiceps cristatus*), ruddy shelduck (*Tadorna ferruginea*), mallard (*Anas platyrhynchos*), garganey (*Anas querquedula*), water rail (*Rallus aquaticus*), moorhen (*Gallinula chloropus*) and coot (*Fulica atra*) are among the waterfowl which breed at Yeniçağa Gölü. The breeding status of little bittern (*Ixobrychus minutus*) and purple heron (*Ardea purpurea*) are not yet confirmed here (Kılıç and Kasparek, 1987).

The project made a concerted effort to confirm the presence of three priority bird species: common crane (*Grus grus*), white tailed eagle (*Haliaetus albicilla*) and corncrake (*Crex crex*). A summary of the key findings on these species is given below.

In Yeniçağa Gölü one breeding pair of crane was found in the northern peat areas of the lake (Bird Research Society, 2011). Areas used for feeding were agricultural and fallow fields, and wet meadows. The nesting area was meadows surrounded with marshes and the nest was built in a secure, inaccessible location in shallow waters, away from human activities. It is clear that the marshes in the north-north eastern part of the lake are crucial for the survival and breeding of this species. Further details about the foraging grounds and the important zones for the species are given in the Bird Research Society's report (2011).

The record of 14 calling male corncrakes in Yeniçağa Gölü indicated that the species was definitely breeding in the area (Gül, 2011). Corncrakes are known to require large, undisturbed and densely vegetated areas for breeding and habitats similar to this were used at Yeniçağa Gölü, mostly in the eastern and western parts of the lake.

Finally, one pair of white tailed eagle was recorded at Yeniçağa Gölü (Gül, 2011) though no young were spotted at any time during the surveys. The species most probably uses only the western poplar plantations around Hamzabey Village for roosting. No individuals were seen hunting over the lake (Gül, 2011).

Fish

The lake holds various fish species: carp (*Cyprinus carpio* and *Carassius carassius*), tench (*Tinca tinca)*, Anatolian khramulya (*Capoeta tinca*), chub (*Leuciscus cephalus*), bleak (*Alburnus alburnus*), gudgeon (*Gobio gobio*) and barbel (*Barbus spp.*; GIZ, 2010).

Reptiles
In the literature, the presence of a variety of reptile species at Yeniçağa Gölü is mentioned. Dwarf lizard (*Lacerta parva*), smooth snake (*Coronella austriaca*), European pond turtle (*Emys orbicularis*) and marsh frog (*Rana ridibunda*) are among the species recorded within the lake's catchment (Kılıç and Kasparek, 1987). *Natrix tesellata*, a very cosmopolitan species in Turkey, has also been found in the area (GIZ, 2010).

Mammals
Previous surveys carried out by Mengüllüoğlu and Bilgin, (*unpublished data*) recorded 10 mammal species in the surroundings of Yeniçağa Gölü: grey wolf (*Canis lupus*), lynx (*Lynx lynx*), Eurasian badger (*Meles meles*), red fox (*Vulpes vulpes*), beech marten (*Martes foina*), red deer (*Cervus elaphus*), wild boar (*Sus scrofa*), brown hare (*Lepus europaeus*), European hedgehog (*Erinaceus concolor*) and Caucasian squirrel (*Sciurus anomalus*; GIZ, 2010). European hedgehog (*Erinaceus concolor*) and weasel (*Mustela nivalis*) have also been recorded in the area (Kılıç and Kasparek, 1987; GIZ, 2010).

Dragonflies
The wetlands of Yeniçağa Gölü provide very important habitats for dragonflies. A total of 37 dragonfly species have been identified in the area (Ikemeyer and Olthoff, 2011), and at least two species – *Cordulia aenea* and *Leucorrhinia pectoralis* – are restricted to the peat cuttings. The protection of Yeniçağa Gölü and its peatlands is thus vital for the conservation of these species and important for others such as *Coenagrion pulchellum* and probably *Pyrrhosoma nymphula* which also tend to be confined to peat cuttings. Other species with very specific habitat requirements – such as *Aeschna isosceles* or *Coenagrion scitulum* – are also found in good numbers in these areas.

Another group of dragonflies shows a preference for standing-water habitats, which dry out in summer. Species like *Lestes dryas*, *Sympetrum flaveolum* and *Ischnura pumilio* can mainly be found in shallow ponds and seasonally flooded depressions in the fen meadows or the sedge swamp.

Two rare species were found in low numbers: *Libellula fulva* and *Pyrrhosoma nymphula* (already mentioned above). The latter is a very rare species in Turkey and this area may well be important for its conservation. Further detailed information about the dragonflies of Yeniçağa Gölü can be found in Ikemeyer and Olthoff (2011).

2.1.2. Geology, Hydrogeology, Hydrology and Soil Structure

Yeniçağa Gölü is an active depression zone, 14 km long by 3.5-4 km wide. The area is lens-shaped – wide in the middle and narrow at its eastern and western ends. It lies in the Northern Anatolian fault system and is located on the primary and secondary fault lines parallel to Gerede fault line. The lake's catchment area is a very young (Plaeo-quaternary) depression zone and various facies and old basic rocks lie below the catchment. The 384 m deep catchment is filled mainly with terrace sediments, travertine, alluvium fan sediments, intra-watershed alluvium, and swamp sediments (peat; GIZ 2010).

Kuzuviran (Hamzabey), Güzveren, Kaymaz, Ömerli, Kirenli, Fındıklı, Aksu (Deliler) and Kınalı (Adaköy) creeks are the tributaries feeding into Yeniçağa Gölü (Fig. 4); the lake discharges into Çağa Creek. A regulator (989.5 m altitude) has been built at the exit of the lake in order to increase the water level. Aksu (Deliler), Kuzuviran (Hamzabey), and Güzveren tributaries deliver water to the lake throughout the year, while the others only deliver water during wet periods, drying out in summer (GIZ, 2010).

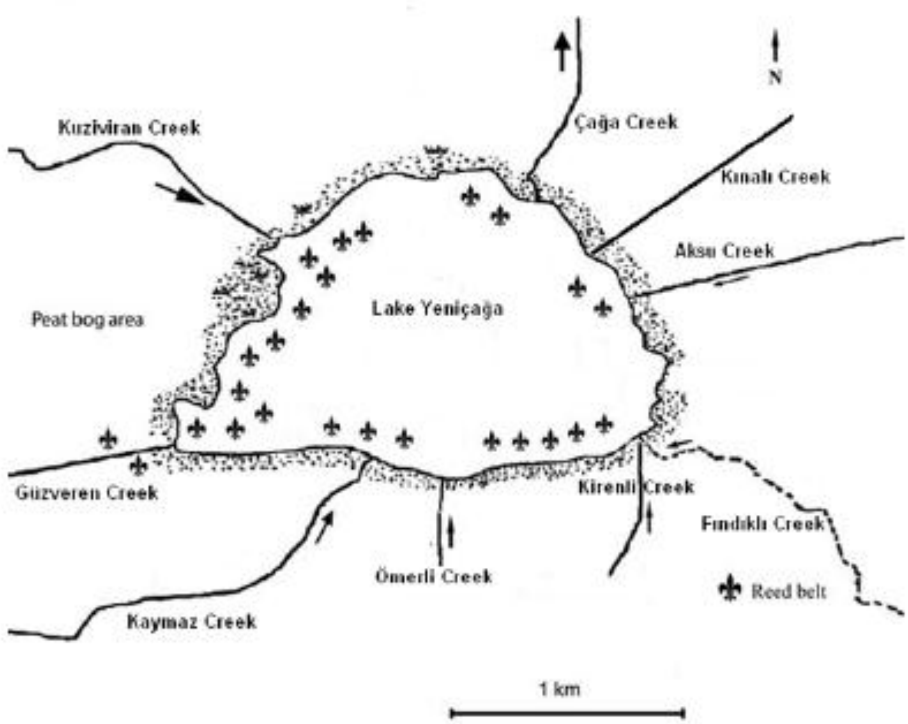

Figure 4. Tributaries and discharges of Yeniçağa Gölü.

The phytoplankton community of Yeniçağa Gölü is dominated by Cyanophyta (cyanobacteria) and green algae (Chlorophyta) Beklioğlu et al. (*unpublished data*). The list of phytoplankton species is given in GIZ (2010; Annex 5). The zooplankton community, according to Beklioğlu et al. (*unpublished data*) is dominated by copepods (GIZ 2010; Annex 6).

The peat in Yeniçağa Gölü consists of sedge and reed peat, only partially decomposed in the top few metres. Below this it has decomposed to form low-mire peats to a depth of up to 12 m. The mineral base layer, below the peat, consists of clays; within the main body of the peat there are also many submerged clay layers (GIZ, 2010b).

The upper, partially decomposed clay layers can be used for hobbying and conditionally for gardening. It is important that the dug peat has been frozen. In some areas the upper part of profile have clay layers with huge thickness and thus not appropriate for exploitation. The partially decomposed layers of the upper meters are not usable for gardening even though they have high ash content. Neither are the deeper, strongly decomposed peat usable for gardening. The area currently being exploited in the northern part has commercial potential for about a further 5 years. Likewise, the northern grassland, east and west of the drainage ditch also has commercial potential (Fig. 5). Depending on level of exploitation (to what depth and what percentage of the area) the raw material resource here has a life of 10-20 years. The grassland in the southwest of the study area contains many clay layers and is therefore only conditionally appropriate for peat digging (GIZ, 2010b).

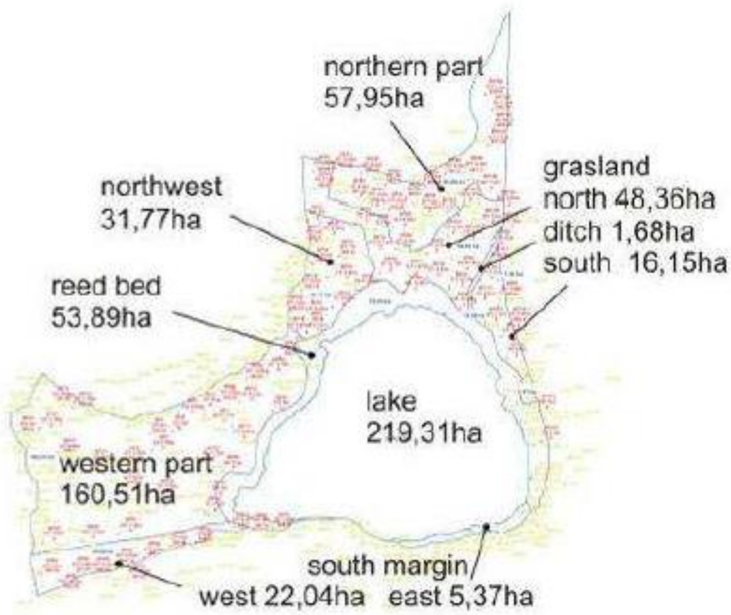

Figure 5. The different parts of Yeniçağa Gölü with size given in hectares.

2.1.3. Socio-economy

There are 20 settlements around Yeniçağa Gölü; the district capital and 19 villages. In 1990 the population of the area was 12,052, decreasing to 9,100 in 2008 (GIZ 2010). Half of the population resides in the villages. The main sources of income in the region are crop and animal farming, fishing, peat extraction and transportation. The main crops grown are wheat, barley, oat, potato, beetroot and lettuce. In addition to sheep/goats and cattle husbandry, there is also poultry farming. The number of animals in the region is given in Table 1.

Table 1. Livestock numbers (Source: Bolu Province Agriculture Directorate; GIZ 2010).

Type	Population
Bovine	2,540
Ovine	1,300
Equidae (Horses, donkeys etc.)	75
Poultry (Broiler)	240,000
Poultry (Broiler Breeder)	150,000

The lake is has a high potential for commercial fishing in Turkey. There has been no systematic recording of the catch sizes, but the estimate is 18 tons for the six months fishing season (Yeniçağa Aquatic Products Cooperative, personal communication; GIZ, 2010). Furthermore, crayfish provided a major source of income in the past, however, due to an epidemic occurred at national scale, the crayfish population at the lake has become extinct.

The main threats to the lake are agricultural runoff, atmospheric metal deposition from the motorway, untreated domestic wastewater discharge, leaching of unsanitary landfill, untreated wastewater from the slaughterhouse, peat extraction, and untreated wastewater from livestock farming (GIZ, 2010).

2.2. Akgöl (Konya Province)

Akgöl is an old riverbed with wetland formations which was drained in 1983. It is found in Upper Sakarya Basin, between Yunak and Çeltik in Konya Province, Central Anatolia and has an area of 2,302 hectares. The area lies near the Ankara-Akşehir road, between the Saray, Karayala, İshakuşağı, Odabaşı and Küçükhasan villages (Figure 6). The former size of the area was about 23,000 hectares. Today only 5 lakes survive with areas ranging from 0.24 hectares to 10.6 hectares in surface area (Bird Research Society, 2010).

Figure 6. Map of Akgöl and its surroundings.

Akgöl is located within the terrestrial climate of the Central Anatolia. The annual precipitation is 421.4 mm and 432.7 mm according to Theissen polygon and isohyet methods respectively. The amount of the rainfall considerably differs between different locations as it gradually decreases from Sultandağları in the southeast towards the north-eastern parts of the area.

2.2.1. Biodiversity

Flora

In Akgöl 165 plant species have been recorded (Vural et al., 2011). Asteraceae has been identified as the most well represented family with 30 species; the others are as follows: Poaceae, 23 species; Lamiaceae, 12 species; Fabaceae, 11 species; Apiaceae, 9 species; Cyperaceae, 7 species. Ten endemic plant species have been located at Akgöl and the endemism ratio is around 13%. All of the endemic plants belong to steppe vegetation which grows on the surrounding hills. The region's list of flora and further details are given in Vural et al. (2011).

Two types of vegetation cover Akgöl area: wetland vegetation and steppe vegetation (GTZ, 2010c). For detailed vegetation map, please see Figure 7.

Wetland Vegetation

Cladium mariscus species dominate the former lakebed. *Pragmites australis* spread throughout drainage canals. *Typha latifolia* is found inside dry canals. The lakebed has been invaded by cosmopolite plant species that live on wet sites and swamps forming a thick cover over a meter high in some places (GTZ, 2010c).

Steppe Vegetation

Intermittent steppe vegetation which lies on the north of the lake outside settlements and agricultural sites around the lakebed are *Astragalus* and *Artemisia* steppes. *Astragalus microcephalus*, *Thymus sipyleus subsp. sipyleus var. sipyleus*, *Bromus tomentellus*, *Bromus tectorum*, *Bromus japonicus*, *Festuca valesiaca*, *Globularia orientalis*, *Verbascum cheiranthifolium var. asperulum*, *Fumana procumbens*, *Eryngium campestre*, *Eryngium creticum*, *Cousinia iconica*, *Dianthus zonatus*, *Ebenus hirsutus*, *Euphorbia macroclada*, *Ziziphora tenuior*, *Logfia arvensis*, *Nigella arvensis*, *Sedum acre*, *Bupleurum sulphureum*, *Convolvulus holosericeus*, *Astragalus karamasicus*, *Xeranthemum annuum*, *Koeleria cristata*, *Centaurea urvillei*, *Melica ciliata*, *Centaurea virgata*, *Xeranthemum annuum*, *Teucrium polium*, *Velezia rigida*, *Helianthemum salicifolium*, *Consolida thirkeana* are among the species that spreading on stony cliffs on the calcareous main rock with no trees (GTZ, 2010c).

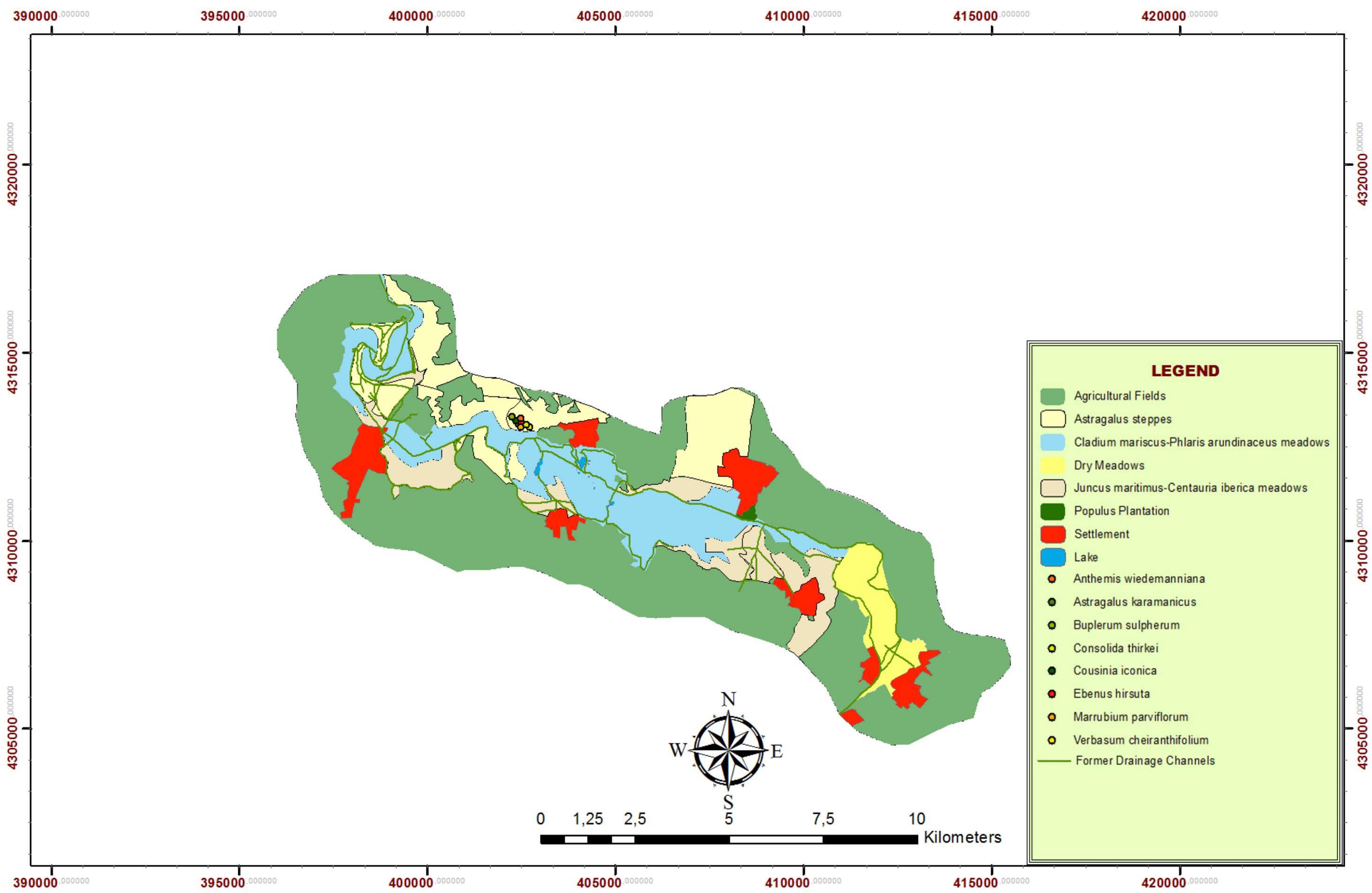

Figure 7. The vegetation types identified in Akgöl before rewetting.

Birds

There exists no information on the avifauna of Akgöl before the drainage. Interviews with the local people revealed that there were thousands of birds, mainly ducks and coots in Akgöl before the drainage was done (Bird Research Society, 2010).

In terms of bird presence, the most important place was the irrigation pond formed by Çeltik Municipality, named Akgöl, at the end of the lake bed. 23 different species were observed in and around Akgöl but all in small numbers. Little grebe (*Tachbaptus ruficollis*), black-necked grebe (*Podiceps nigricollis*), common teal (*Anas crecca*), mallard (*Anas platyrhynchos*), northern shoveler (*Anas clypeata*), ruddy shelduck (*Tadorna ferruginea*), grey heron (*Ardea cinerea*), great white egret (*Casmerodius albus*), little egret (*Egretta garzetta*), moorhen (*Gallinula chloropus*), cormorant (*Phalacrocorax carbo*), coot (*Fulica atra*), water rail (*Rallus aquaticus*), slender billed gull (*Larus genei*) and white-winged black tern (*Chlidonias leucopterus*) are among the important waterbird species observed in Akgöl. However no breeding bird species was observed in the area (Bird Research Society, 2010).

The preliminary surveys carried out at the site after the restoration actions were completed (between June and October 2012) indicated the presence of more than 60 bird species using the area (*GIZ 2012, unpublished data*). Therefore it is of essential importance to carry out more detailed bird surveys in the future to assess the impact of the rewetting on the avifauna of the area.

2.2.2. Geology, Hydrogeology, Hydrology and Soil Structure

After the preparation of the Sakarya Basin Survey in 1963 by State Water Works (DSI) IV Regional Directorate, Yunak Akgöl Project Planning Report was prepared in 1972 in order to drain wetland in Akgöl and overcome the flooding problems in the areas surrounding the lake. 1977 DSI IV. Regional Directorate started to drain the lake via 33 km long Akgöl main drainage channel. The new wells dug in the drainage area from 1977 onwards led to a reasonable decrease in ground water levels. The drainage was completed in 1983 (Bird Research Society, 2010). Furthermore a pond built in 32 km south to the area, namely Topkaya pond, further limited the tributaries arriving to the area. As a result of all these interferences, catchment area of the wetland declined from 6,459 km^2 to 2,086 km^2. The inflow, which came from the 66 km long canal connecting Topkaya pond to Akgöl continued to decrease and no inflow has been measured since 2006 (Bird Research Society, 2010). The data recorded in the two streamflow observation stations in the area permits observing fluctuations in the amount of water entering and leaving the wetland since the drainage of Akgöl (Fig. 8). The annual water going out from the wetland is 23 x 106 m^3, while it was 118.6 x 106 m^3 in 1985.

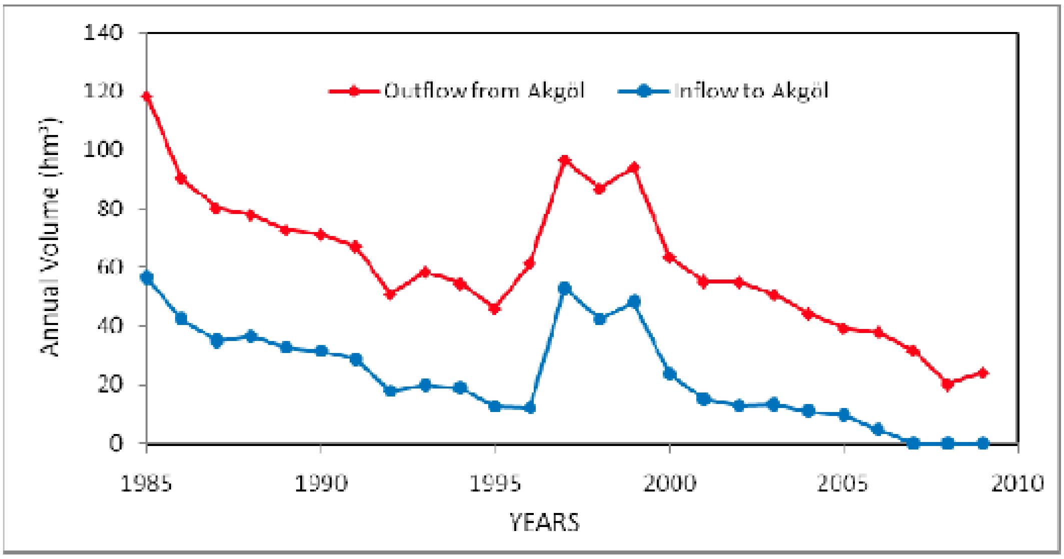

Figure 8. The annual volumes measured in the two streamflow observation stations.

Akgöl does not have an extensive connected thick peat layer so it is a wetland rather than a fen in the true sense. The upper soil profile is anthropogenic made through dewatering and oxidation, agriculture use of the last decades and the permanent burning off. In large parts of the area the upper 60 cm of the profile consists of dry structureless clay with a high part of ash (GTZ, 2010a).

The loss of the organic content in the upper layer causes small up to over 10 m caves in the surface. The depth is dependent on the content of peat and the burned mighty. In limited areas there are different layers of fen peat with changing clay sediments below the anthropogenic layer. They are built up continuously of higher demoralized sedge and reed peat with a degree of decomposition between hg 7 and hg 9. An economical relevance of the fen peat can be nearly precluded for the whole area, just locally limited peat has been cut in former times and actually there is no peat cutting (GTZ, 2010a).

2.2.3. Socio-economy

1 town (Çeltikçi) and 7 villages are present around Akgöl: Odabaşı, Küçükhasan, Adakasım, Karayala, İshakuşağı, Gökpınar villages. Nearly all of the local residents depend on agriculture and husbandry for income. Old lakebed is used by local people to grazing their animals. Fishing is very limited to ponds of the springs with fishing rods (Bird Research Society, 2010).

The local people informed on several occasions the negative impacts of drainage on their lives (Bird Research Society, 2010). In the past, fishing, hunting, reed cutting (for housing and commercial purposes), is told to be common practices of the region. Again according to the information supplied by local people, after the lake has been drained, climate of the area became rigorous, the soils in the drained land started to burn, and these changes affected fishery, stockbreeding, and wildlife very badly. Stockbreeding is told to have decreased after the drainage sharply Akgöl (Table 2).

Table 2. List of livestock in the villages around the study site (Information supplied by Muhtars; Bird Research Society, 2010).

Villages	Cattle Population		Ovine Population	
	Before the drainage of the lake	Today	Before the drainage of the lake	Today
Odabaşı	400-450	110-120	3,500-4,000	600-700
Adakasım	500-600	150-200	8,000-10,000	1,000-1,200
Küçükhasan	600-700	200-250	15,000-20,000	2,000-2,500

2.2.4. Restoration Actions

In the framework of the project restoration measures towards Akgöl was defined by the Project Team and DSI IV. Regional Directorate (Konya Province). A construction project was prepared to hold water with a seawall and to close previously opened drying canals in order to spread water in entire field. The aim was to reviving wetland ecological functions of the area by holding rainfalls in winter and spring to enable the area wet during arid summertime. As a result of the efforts, consequently the area started to hold water since September 2011 and a total of 1,000 hectares of wetland was restored in Akgöl (Fig. 9). After rewetting the burning ceased, wetland vegetation started to grow and the area started to regain its wetland ecosystem functions. In May 2012, the amount of water in the area reached the maximum level and the existence of new waterbird species was observed.

Figure 9. The area rewetted in Akgöl.

3. Estimating the Climate Change Mitigation Potential

As detailed in previous sections, wetlands, more specifically peatlands, play an essential role in climate change mitigation and a number of previous studies have examined the role of peatlands in the global carbon budget (reviewed in Mitra et al. 2005). In this section, the impact of previously conducted project activities on the climate change mitigation potential of the two project areas are evaluated using global indexes.

Within the Wetlands and Climate Change Project, several actions were taken to protect and restore the peatlands and wetlands in the two project areas.

Yeniçağa Gölü and its surrounding area used to be the most important site for peat extraction in Turkey; peat has been extracted during 25 years between 1984 and 2009. Following the suspension of peat extraction in Yeniçağa Gölü, Gölbaşı Gölleri (located in Adıyaman Province) became the priority peat extraction site in Turkey. In the project the peat potential of the area was investigated, nature protection zones were identified, and pollution of the lake was prevented.

The second project area, Akgöl, was formerly a wetland in Central Anatolia covering about 23,000 hectares; it was drained about 20 years ago. Akgöl contains some peat formations and has a highly organic soil structure. Before the project, the soil could be seen constantly burning throughout almost all of the area. During 2011, the project carried out activities to rewet 1,000 hectares. The burning ceased after rewetting, the wetland vegetation started to grow and the area started to regain its wetland ecosystem functions.

In summary, project actions at both areas aimed at slowing down and, if possible, stopping the degradation of the peatland areas. The degradation of wetlands has a direct negative impact on the biodiversity they host and have various implications on their climate functions. A research carried out on North American wetlands (Bridgham et al., 2006) concluded that the degradation of wetlands leads to:
(i) the reduction in a wetland's ability to sequester carbon (a small to moderate increase in radiative forcing depending on the amount of carbon sequestration by sedimentation in the wetland),
(ii) the oxidation of the soil carbon reserves upon drainage (a small increase in radiative forcing),
(iii) the reduction in methane (CH_4) emissions (a small to large decrease in radiative forcing depending on actual CH_4 emissions).

In light of the above information, in order to evaluate the climate change potential of the two project areas, we have estimated the amount of greenhouse gases which would have been emitted annually to the atmosphere if both areas were drained. For this, we used previous project reports (GTZ, 2010a, 2010b) and made the calculations on the amount of carbon and other greenhouse gases stored (potentially) in these areas. Global indexes were also used for calculations of greenhouse gas sinks and emissions following the methodology described in Höper (2007).

3.1. Global Warming Potential

Global warming potential (GWP) is a convenient way to compare the relative contributions of the three main greenhouse gases, namely carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) fluxes in Yeniçağa Gölü and Akgöl to the Earth's radiative balance (GIZ, 2010b). The GWP is the radiative effect of a pulse of a substance into the atmosphere relative to CO_2 over a particular period of time (commonly 20, 100 or 500 years; Ramasway et al., 2001; Intergovernmental Panel on Climate Change (IPCC), 2009). GWP is expressed as a factor of CO_2 (whose GWP is standardized to 1; Table 3).

Table 3. Global Warming Potential values (Intergovernmental Panel on Climate Change (IPCC), 2007).

Chemical species	Global warming potential time horizon		
	20-years	100-years	500- years
CO_2	1	1	1
CH_4	72	25	7.6
N_2O	289	298	153

It is important to distinguish radiative balance, the static radiative effect of a substance and radiative forcing, an externally imposed perturbation on the Earth's radiative energy budget (Ramasway et al., 2001). Thus, changes in radiative balance lead to a radiative forcing, which subsequently leads to a change in the Earth's surface temperature. For example, wetlands have a large effect on the Earth's radiative balance through high CH_4 emissions, but it is the temporal changes in the amount of emissions that represent a positive or negative radiative forcing and thus impact climate change (Bridgham et al., 2006). GWPs are widely used in policy applications, including the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and U.S. Climate Change Policy (Intergovernmental Panel on Climate Change (IPCC), 2009).

3.2. Methodology and Results

In order to calculate the global warming potentials of the greenhouse gases in a peatland, Höper (2007) defined emission factors for different mire characteristics and land use forms. These emission factors are used to come up with the current annual expected emissions.

Following Höper (2007), in GIZ (2010b) the peat area in Yeniçağa Gölü was classified by location, type of mire and land-use (Table 4). Based on their emission factors, total emissions were calculated for each class of peat (Table 5).

Table 4. Emission factors by mire characteristics and land-use forms (Höper 2007).

Mire characteristics and land-use forms	CO_2 kg C/ha/a	CH_4 kg C/ha/a	N_2O kg C/ha/a	GWP 500 kg C-equiv./ha/a
Natural/close to nature	-460	236	0	101
Extensive / unused	4,000	-0.3	6	4,415
Grassland	4,600	-0.3	14	5,618
Forest	4,600	-0.2	2	4,746

As a result, the current annual expected emissions is estimated at around 1,100,000 kg C-equivalent in Yeniçağa Gölü (Table 5). However previous studies demonstrated that in around 30% of the peatlands in Yeniçağa Gölü, the upper part of the peat profile is made up of clay layers, which have limited or even no emission potential. Therefore a reduction factor of 30% is applied to the estimate. As a result, current annual expected emission in Yeniçağa Gölü was estimated at around 800,000 kg C-equivalent. Using the conversion rate of C to CO_2 (as 3.66; GIZ, 2010b), the corresponding CO_2 amount stored (unless degraded) in Yeniçağa Gölü was estimated at around 2,928 t. However this value should be regarded as a minimum estimate. This is because emission factors are only identified for actual peat but not for other habitats types such as open water and reed beds. Therefore when considering the area with all its existing habitat types the amount of carbon stored will likely be higher than this estimate.

Table 5. Current annual expected emissions - in kg C-equivalent (GIZ, 2010b).

Yeniçağa Gölü		**area (in ha)**	**GWP 500 in kg C-equiv. ha-1 a-1**	**emissions in kg C-equiv. a-1**
Locations close to nature	reed bed	53.89	101	5,443
	not used areas	125,115	101	12,637
Extensive/not used	not used areas	125,115	4,415	552,383
Grassland on peat	northwest	57.95	5,618	325,563
	northeast	16.15	5,618	90,731
	southwest	22.04	5,618	123,821
Subtotal				**1,110,577**
Akgöl		**area (in ha)**	**GWP 500 in kg C-equiv. ha-1 a-1**	**emissions in kg C-equiv. a-1**
Grassland on peat		500	5,618	2,809,000
Burning peatlands		1,000		273,224
Subtotal				**3,082,224**
TOTAL				**4,192,801**

In Akgöl, restoring and rewetting an area of 1,000 ha. with a 50 cm thick burning peat layer corresponded to a CO_2-emission of about 1,000,000 kg. annually (GIZ, 2010a). The emission of approximately 273,224 kg–C annually was prevented simply by preventing the occurrence of these fires.

Approximately 50% of the rewetted 1,000 ha. in Akgöl is made up of grassland on peat and the other 50% is non-peat wetland. To calculate the potential emissions from this restored grassland on peat, the emission factors of Höper (2007) was used. Therefore while computing the climate change potential of Akgöl, both the fire prevention and rewetting peatland was taken into account and the amount of emissions prevented was estimated at around 3,000,000 kg C-equivalent. Using the conversion rate of C to CO_2 detailed in GIZ (2010b), the corresponding CO_2 amount stored (unless degraded) at Akgöl was estimated to be around 11,280 t. Again, this value should be regarded as a minimum estimate. This is because emission factors are only identified for actual peat but not for other habitats types. Therefore when considering the area with all its existing habitat types the amount of carbon stored will likely be higher than this estimate.

Overall, the restoration and protection measures taken at Yeniçağa Gölü and Akgöl have prevented emissions of approximately 4,192,800 kg-C and 15,345 tons of CO_2 annually to the atmosphere.

4. Conclusion

Wetlands are ecosystems of high importance for biodiversity conservation (Parish et al., 2008). Restoring and rewetting wetlands and peatlands provides habitat for threatened, rare species/communities, a better landscape hydrology, land use with less damage, protection from peatland fires, enhanced landscape integrity and opportunities for eco-tourism (Çolak and Günay, 2011). In addition to their importance for biodiversity conservation, wetlands, especially peatlands are critical ecosystems for climate change.

Peatlands covering only 3% of the world's land surface are estimated to be the largest carbon store on Earth. Their importance on climate change mitigation is well acknowledged by the scientific world. However human activities such as vegetation clearance, drainage, overgrazing among others both increase the vulnerability of peatlands to climate change and cause them to actually contribute to the latter. The degradation of peatlands leads to oxidation of peat soil holding large amounts of carbon reserves and thus causes the release of greenhouse gases (GHGs) to the atmosphere (Adhikari et al., 2009). Because of these large amounts of emissions, restoration of degraded peatlands and their appropriate management is one of the most cost-effective ways of retaining the existing carbon reserves and avoiding anthropogenic greenhouse gas emissions.

An expert meeting organized by the Ramsar Convention on Wetlands and the Convention on Biological Diversity (CBD) in 2007 concluded that investments in conservation and restoration of peatlands can be up to 100 times more cost effective than other carbon sequestration measures. It is possible to drastically reduce emissions through very cost-effective water management, restoration and fire prevention measures.

Wetlands and Climate Change Project is of prime importance for Turkey as it is the first study focusing on ameliorating the biodiversity conservation function of the wetlands (incl. peatlands) and linking the management and protection activities with climate change adaptation and mitigation in the country. The major focus of the project was biodiversity conservation with emphasis to carbon storage, climate change adaptation and mitigation. It is the first study evaluating the impact of conducted project activities towards protecting and restoring wetlands on climate change mitigation.

In the project, the conservation and management measures taken in Yeniçağa Gölü and Akgöl has permitted protecting an area of 400 ha in Yeniçağa and gaining a wetland area of 1,000 ha in Akgöl. These conservation and restoration activities serve in providing high quality habitat for diverse taxa, crucial especially for threatened and rare species of the region. Furthermore as a result of the project activities in both areas, emissions of approximately 4,192,800 kg. C to the atmosphere was estimated to the prevented annually (eq. to 15,345 tons of CO_2). This is equivalent to amount of CO_2 generated by burning 6,672,022 litres of petrol (2,300 kg CO_2/1,000 litres of petrol) and to the carbon stock of 27,4 hectares of temperate forests in vegetation and soil (global estimates from Intergovernmental Panel on Climate Change (IPCC), 2000b). This project provides a good example for future studies on climate change mitigation and peatland/wetland conservation in Turkey and elsewhere.

At national scale, there is a need to replicate the approach adopted in this study to other peatland and wetland sites. For this, firstly the carbon storage in wetlands and peatlands should be determined, and secondly, restoration and management measures should be taken towards these sites in order to enhance their biodiversity conservation functions and also their mitigation potentials. Below, generic management and protection recommendations are listed, however specific measures should be identified on a per-site basis using scientifically sound knowledge:

- Strict protection of intact wetlands,
- Restoration of degraded wetlands,
- Controlling peat harvesting and other removal of carbon from wetlands,
- Controlling drainage and other land and water management practices which lead to dewatering of wetlands and oxidation of peat soil,
- Controlling fires,
- Integrating wetland management into land use and socio-economic development planning by a multi-stakeholder, ecosystem based, river basin and landscape wide approach,
- Better incorporating wetland issues into global (CBD, UNFCCC, Ramsar Convention, CCD etc.) and regional policy-making processes,
- Developing a wise use approach to integrate protection and sustainable use of wetland resources to safeguard the benefits from increasing pressure from people and changing climate.

To conclude, the importance of wetlands and peatlands as natural assets acting for biodiversity conservation and also for mitigating climate change is a new topic in Turkey and is only slowly gaining its due value. The National Climate Change Action Plan of Turkey (2011-2023) sets objectives towards protecting peatlands and wetlands. The activities in this project thus constitute prime examples contributing towards the objectives listed in the Action Plan. The replication of this project both in Turkey and worldwide would be extremely beneficial in terms of biodiversity conservation and also socio-economic prosperity, climate change mitigation, and adaptation.

5. References

Apak, G., and Ubay, B. 2007. Türkiye İklim Değişikliği Birinci Ulusal Bildirimi. Çevre ve Orman Bakanlığı, Ankara.

Adhikari, S., Bajracharaya, R.M. and Sitaula, B.K. 2009. A Review of Carbon Dynamics and Sequestration in Wetlands. Journal of Wetland Ecology 2: 42-46.

Bird Research Society. 2010. Evaluation of the Hydrology and General Characteristics of Yunak-Akgöl, Konya in Order to Develop Base for the Restoration of the Area. Wetlands and Climate Change Project. Ankara.

Bird Research Society. 2011. Assessment of Breeding and Land Use of Crane (*Grus grus*) at Yeniçağa (Bolu) & Assessment of Breeding Birds of Yunak-Akgöl (Konya). Wetlands and Climate Change Project. Ankara.

Botch, M.S., Kobak, K.I., Vinson, T.S., and Kolchugina, T.P. 1995. Carbon Pools and Accumulation in Peatlands of the Former Soviet Union. Global Biogeochemical Cycles 9: 37-46.

Bridgham, S.D., Megonigal, J.P., Keller, J.K., Bliss, N.B., and Trettin, C. 2006. The Carbon Balance of North American Wetlands. Wetlands 26 (4): 889-916.

Campbell, I.D., Campbell, C., Yu, Z., Vitt, D.H., and Apps, M.J. 2000. Millenial-scale rhythms in peatlands in the Western interior of Canada and in the Global Carbon Cycle. Quaternary Research 54: 155-158.

Crooks, S., Herr, D., Tamelander, J., Laffoley, D., and Vandever, J. 2011. Mitigating Climate Change through Restoration and Management of Coastal Wetlands and Near-shore Marine Ecosystems: Challenges and Opportunities. Environment Department Paper. The World Bank. 121, World Bank, Washington, DC.

Çolak, A.H., and Günay, T. (Eds) 2011. Turbalıklar (Mire/Peatland-Moore). T.C. Orman ve Su İşleri Bakanlığı Batı Karadeniz Ormancılık Araştırmaları Enstitüsü Müdürlüğü – Bolu Çeşitli Yayınlar Serisi No. 7, Turkey.

Dalfes, H.N., Karaca, M., and Şen, Ö.L. 2007. Climate change scenarios for Turkey. In: Güven, Ç. (Ed) Climate Change and Turkey Impacts, Sectoral Analyses, Socio-Economic Dimensions. 11-18, Ankara: United Nations Development Programme (UNDP) Turkey Office.

Demir, İ., Kılıç, G., and Coşkun, M. 2008. Climate predictions for Turkey using PRECIS Regional Climate Model: Scenario HaDAMP3 SRES A2. Proceedings of the International Fourth Symposium on Atmospheric Sciences, 25-28 Mart 2008, İstanbul, Turkey.

Dixon, R.K., and Krankina, O.N. 1995. Can the terrestrial biosphere be managed to conserve and sequester carbon? In: Carbon sequestration in the biosphere: Processes and products. NATO ASI Series. Series 1. Global Environmental Change, 33, 153 - 179.

Eken, G., Bozdoğan, M., İsfendiyaroğlu, S., Kılıç, D.T., and Lise, Y. (Eds) 2006. Türkiye'nin Önemli Doğa Alanları. Doğa Derneği, Ankara.

Gorham, E. 1991. Northern peatlands: role in the carbon cycle and probable responses to climatic warming. Ecological Applications 1: 182–195.

GIZ. 2010. İnceleme Raporu: Türkiye'deki Sulak Alanların Kullanımıyla İklim Değişikilğine Uyum ve Biyolojik Çeşitliliğin Korunması. Wetlands and Climate Change Project. Ankara.

GTZ. 2010a. Report: Peat Assessment of the Wetland of Akgöl, Turkey. Wetlands and Climate Change Project. Ankara.

GTZ. 2010b. Report: Expertise and Stratigraphic Investigations of the Peatland: Yeniçağa, Turkey. Wetlands and Climate Change Project. Ankara.

GTZ. 2010c. Common Vegetation Analysis and Developing Baseline Map for Yeniçağa Gölü Technical Report. Wetlands and Climate Change Project. Ankara.

Gül, R. 2011. Monitoring of the breeding Cranes (*Grus grus*), and assessment of occurence of the Corncrake (*Crex crex*) and White-tailed eagle (*Haliaetus albicilla*) in Yeniçağa, Bolu. Bird Research Society, Ankara.

Halsey, L.A., Vitt, D.H., and Dauer, I.E. 1998. Peatland initiation during the Holocene in continental western Canada. Climatic Change 40: 315-342.

Höper, H. 2007. Freisetzung von Treibhausgasen aus deutschen Mooren. TELMA, Bd. 37, S. 85-116 – Hannover.

Ikemeyer, D., and Olthoff, M. 2011. Dragonfly survey in the peat bog of Yenicaga lake, province Bolu, Turkey. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Eschborn, Germany.

Intergovernmental Panel on Climate Change (IPCC). 1996. Climate Change 1995: Impacts, Adaptations and mitigation of climate change: scientific technical analysis. Contribution of Working Group II to the second Assessment Report of the IPCC. Cambridge University Press, Cambridge.

Intergovernmental Panel on Climate Change (IPCC). 2000a. Emission Scenarios. Cambridge, UK: Cambridge University Press, Cambridge.

Intergovernmental Panel on Climate Change (IPCC). 2000b. Land Use, Land Use Change and Forestry. Watson, R.T., Noble, I.R., Bolin, B., Ravindranath, N. H., Verardo, D.J. and Dokken, D.J. (Eds) Cambridge University Press, UK. 375 pp.

Intergovernmental Panel on Climate Change (IPCC). 2001. Climate Change 2001: The Scientific Basis. Cambridge, UK: Cambridge University Press, Cambridge.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (Eds)]. IPCC, Geneva, Switzerland, 104 pp.

Intergovernmental Panel on Climate Change (IPCC). 2009. Meeting Report of the Expert Meeting on the Science of Alternative Metrics [Plattner, G.-K., T.F. Stocker, P. Midgley and M. Tignor (Eds)]. IPCC Working Group I Technical Support Unit, University of Bern, Bern, Switzerland, pp. 75.

IUCN. 2001. IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK. ii + 30 pp.

Keleş, I. 2007. Yeniçağa Tarihi. Yücel Ofset Matbaacılık, 236 pp.

Kılıç, D.T., and Eken, G. 2004. Türkiye’nin Önemli Kuş Alanları – 2004 Güncellemesi. Doğa Derneği, Ankara, Turkey.

Kılıç, A., and Kasparek, M. 1987. Birds of Turkey: Yeniçağa Gölü. Ornithological Society of the Middle East, Heidelberg.

Lappalainen, E. (Ed) 1996. Global Peat Resource. International Peat Society and Geological Survey of Finland, Jyska.

MacDonald, G.M., Beilman, D.W., Kremenetski, K.V., Sheng, Y., Smith, L.C., and Velichko, A.A. 2006. Rapid early development of circumarctic peatlands and atmospheric CH_4 and CO_2 variations. Science 314: 285-288.

Maltby, E., and Immirzi, P. 1993. Carbon dynamics in peatlands and other wetland soils, regional and global perspectives. Chemosphere 27: 999–1023.

Ministry of Environment and Urbanization. 2012. National Climate Change Action Plan 2011-2023. Turkey.

Mitra, S., Wassmann, R., and Vlek, P.L.G. 2005. An appraisal of global wetland area and its organic carbon stock. Current Science 88: 25–35.

Mitsch, W.J., and Gosselink, J.G. 2000. Wetlands. 3rd edition. John Wiley & Sons Inc., New York, 936 pp.

Önol, B., and Semazzi, F.M. 2009. Regionalization of Climate Change Simulations over the Eastern Mediterranean. Journal of Climate 22: 1944-1961.

Özbahar, İ., Gül, R., and Erkol, I.L. 2010. Bird Research Society Final Report: Ornithological Assessment at Yeniçağa Gölü. Wetlands and Climate Change Project. Ankara.

Özhatay, N., Byfield, A., and S. Atay. 2003. Türkiye'nin Önemli Bitki Alanları. WWF-Türkiye, İstanbul, Türkiye.

Parish, F., Sirin, A., Charman, D., Joosten, H., Minayeva, T., Silvius, M., and Stringer, L. (Eds) 2008. Assessment on Peatlands, Biodiversity and Climate Change: Main Report. Global Environment Centre, Kuala Lumpur and Wetlands International, Wageningen.

Ramaswamy, V., Boucher, O., Haigh, J., Hauglustaine, D., Haywood, J., Myhre, G., Nakajima, T., Shi, G.Y., and Solomon, S. 2001. Radiative forcing of climate change. p. 349–416. In Houghton, J.T., Ding, Y., Griggs, D. J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K., and Johnson, C.A. (Eds) Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK.

Ramsar Information Paper no. 1, http://www.ramsar.org/pdf/about/info2007-01-e.pdf

Reyes, J. 2011. Midwest Regional Carbon Sequestration Partnership Phase II, Assessment of Terrestrial Sequestration Potential in New Jersey. The U.S. Department of Energy, National Energy Technology Laboratory.

Rogner, H.-H., Zhou, D., Bradley., R., Crabbé, P., Edenhofer, O., Hare, B., Kuijpers, L., and Yamaguchi, M. 2007. Introduction. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Metz, B., Davidson, O.R., Bosch, P.R., Dave, R., Meyer, L.A. (Eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Sahagian, D., and Melack, J. (Eds) 1998. Global wetland distribution and functional characterization: Trace gases and the hydrologic cycle. IGBP report 46, 92 pp.

Sheng, Y., Smith, L.C., MacDonald, G.M., Kremenetski, K.V., Frey, K.E., Velichko, A.A., Lee, M., Beilman, D.W., and Dubinin, P. 2004. A high resolution GIS-based inventory of the west Siberian peat carbon pool. Global Biogeochemical Cycles 18: 1-4.

Sümer, N. 2002. Flora of Yeniçağa. University of Abant İzzet Baysal, Dept. of Biology Msc. Thesis, Turkey.

Türkeş, M. 1999. Vulnerability of Turkey to desertification with respect to precipitation and aridity conditions. Turkish Journal of Engineering and Environmental Sciences 23: 363-380.

United Nations Environment Programme World Conservation Monitoring Centre, http://www.unep-wcmc.org

Vompersky, S.E., Tsyganova, O.P., Glukhova, T.V., and Valyaeva, N.A. 1998. Intensity of peat accumulation by mires of Russia in the Holocene on carbon-14 datings. In: Elina, G.A., Kuznetsov, O.L., and Shevelin, P.F. (Eds) Dynamics of mire ecosystems of Northern Eurasia in Holocene. Karelian Research Centre of Russian Academy of Sciences, Petrazavodsk, pp. 47-48.

Vural, M., Ayyıldız, G., and Erkol, I.L. 2011. Vegetation analysis and mapping around Yeniçağa gölü (Bolu) and Yunak-Akgöl (Konya): Wetlands and Climate Change Project. Doğa Danışmanlık, Ankara.

World Meteorological Organization (WMO). 2006. Greenhouse Gas Bulletin: The State of Greenhouse Gases in the Atmosphere Using Global Observations up to December 2004. Geneva, Switzerland.

Zeydanlı, U., Turak, A., Bilgin, C., Kınıkoğlu, Y., Yalçın, S., and Doğan, H. 2010. İklim Değişikliği ve Ormancılık: Modellerden Uygulamaya. Ankara. Doğa Koruma Merkezi.