ECOLOGY STUDIES '21

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COASTAL LAGOONS IN TURKEY: LANDSCAPE CONTROVERSIAL ISSUES IN SUSTAINABLE PLANNING FRAMEWORK AND PROPOSALS

ESRA TEKELİ, FATMA AYÇİM TÜRER BASKAYA

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Abstract

Since the early years of human history, coastal areas have always been accepted as attractive areas by people due to ecological, social, and cultural reasons. As one of the critical components of coastal areas, a coastal lagoon is a coastal stretch of shallow water almost cut off from the open sea by a barrier. With their geographic and hydrodynamic characteristics, coastal lagoons have critical importance with their biological diversity and ecological richness.

There are sure some affirmative and negative impacts of the developing and transforming age. While these impacts positively affect the socio-economic developments in coastal areas, they also cause stimulation in environmental pressures on natural areas. This imbalance in development reveals the need to find optimum solutions in sustainability. The interplay between the components becomes more and more critical every day to keep pace with socio-economic developments while ensuring the sustainability of the areas' landscape characters and values with minimal damage.

This study handles coastal lagoons in Turkey, which are landscape character areas with their landscape richness, by scrutinizing the administrative framework considering a balanced use and protection.

Mapping studies are carried out via GIS technology, using ArcGIS 10.3.1 software with Universal Transverse Mercator (UTM) coordinate system. The administrative framework is identified through local and central government administrative units, legislative documents, and current plan types.

This study aims to determine the cultural and natural landscape values of coastal lagoons in Turkey and develop sustainable landscape planning strategies. To develop studies on coastal lagoons, five coastal lagoons with different urban dynamics are selected as Akyatan, Paradeniz, Koycegiz, Buyukcekmece, and Terkos. Therefore due to the environmental dynamics and factors they examine, these cases enable developing discussions on different sustainable landscape planning strategies.

Increasing environmental alterations and transformations emerge in coastal areas, especially on coastal lagoons, which are transitional zones between land and sea. Through the case study comparisons, this study discusses the interplay between managemental circumstances and the current situations of coastal lagoons in Turkey in order to reveal planning strategies for them within a landscape approach.

Keywords: Landscape planning strategies, Coastal lagoons, GIS, Case study comparisons

INTRODUCTION

Since the early years of human history, coastal areas have always been accepted as attractive areas by people due to ecological, social, and cultural reasons. These unique areas are dynamic and sensitive transitional zones where the interface between the land ecosystem and the aquatic ecosystem (Clark, 1996 pp.1) (Beatly, Brower, and Schwab, 2002 pp.1).

As one of the critical components of coastal areas, a coastal lagoon is a coastal stretch of shallow water almost cut off from the open sea by a barrier (Kjerfve, 1994 pp.1). With their geographic and hydrodynamic characteristics, coastal lagoons have critical importance with their biological diversity and ecological richness.

There are sure some affirmative and negative impacts of the developing and transforming age. While these impacts positively affect the socio-economic developments in coastal areas, they also cause stimulation in environmental pressures on natural areas (Celliers, 2015 pp.409). This imbalance in development reveals the need to find optimum solutions in sustainability. The interplay between the components becomes more and more critical every day to keep pace with socio-economic developments while ensuring the sustainability of the areas' landscape characters and values with minimal damage.

In the last decades, the developing and transforming world conditions have caused the emergence of differences in water policies. One of the most current issues is the protection and sustainability of wetlands (Owens, 2004 pp.1-2). The other one is the efforts to minimize the natural disasters and artificial pressures occurring in coastal areas. Despite the coastal lagoons' vulnerable characteristics, both of these issues are critical conditions.

Landscape character is "the whole of the elements that distinguish one landscape from another" (Uzun, 2018). Landscape Character Assessment (LCA) is an analysis used to define the combinations of landscape characteristics of the area by mapping and detailing the landscape character types of the areas. It allows the distinctive features of the area to come to the fore (NatureScot, 2019). The European Landscape Convention (ELC), which entered into force in Turkey in 2003, undertakes to determine the landscapes, analyze the strengths and pressures that transform them, record the changes, define the landscape quality goals, and implement the regulations for protecting, managing and/or planning the landscape (Uzun, 2018). Due to this convention, Landscape Character Assessment is a method that must be used in studies to be carried out on an area.

LCA studies at different scales in many various fields in Turkey have been discussed until today. These studies have been guiding in many academical issues. However, LCA has not been conducted on wetlands before.

Turkey is a peninsula country with a long coastline and different kinds of coastal morphologies. One part of Turkey's coastline's fragile environment is coastal lagoons that always need special attention and protection to ensure their sustainability. In the studies conducted on coastal lagoons in Turkey until today, issues such as general conditions of lagoons, socio-economic structures, populations and growth parameters of fish caught, pollution of the waters, and physicochemical parameters have been emphasized.

Inandik (1965), Kirdagli (1999), Kabdasli et al. (1996), Bayrak (2013), and many researchers have researched the above topics related to coastal lagoons in Turkey. Bayrak, 2013, is the most detailed study ever prepared in Turkey. The lagoons in Turkey have been evaluated in terms of their geomorphological formation and spatial use. In addition, various recommendations have been made regarding the problems threatening the lagoons. However, any study has addressed coastal lagoons in the context of LCA and presented long-term strategies for coastal lagoons.

This study handles coastal lagoons in Turkey, which are landscape character areas with their landscape richness, by scrutinizing the administrative framework considering a balanced use and protection. This study aims to determine the cultural and natural landscape values of coastal lagoons in Turkey and develop sustainable landscape planning strategies. To develop studies on coastal lagoons, five coastal lagoons with different urban dynamics are selected as Akyatan, Paradeniz, Koycegiz, Buyukcekmece, and Terkos. Therefore, these cases enable developing discussions on different sustainable landscape planning strategies due to the environmental dynamics and factors they examine.

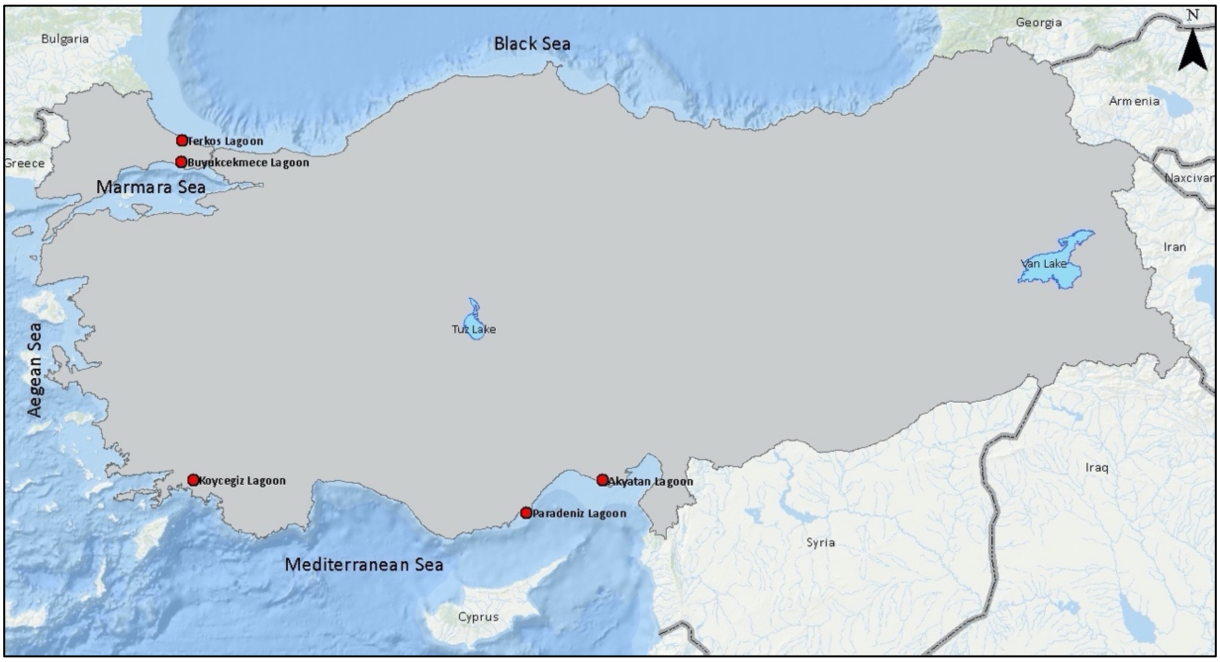

Figure 1. Location of Turkey and selected coastal lagoons in Turkey.

Lagoon habitats are becoming increasingly fragile to uncontrollable human activities such as increased nutrient loads. These areas are terrestrial water basins that can cause eutrophication (Vignes et al., 2009 pp.49). Protection measures for coastal lagoons are increasingly considered an option by many countries to design out water resources' environmental degradation.

In order to be included in this protectionist approach, Turkey has signed many international conventions and has made many regulations. But all these legal regulations and international conventions do not include all of the coastal lagoons in Turkey. So, there is no explicit protection status of coastal lagoons in Turkey. Each law is made to protect different lagoons.

MATERIALS AND METHOD

This study handles coastal lagoons in Turkey, which are landscape character areas with their landscape richness, by scrutinizing the administrative framework considering a balanced use and protection.

In this study, mapping studies for selected coastal lagoons are carried out via GIS technology, using ArcGIS 10.3.1 software with Universal Transverse Mercator (UTM) 3 Degree coordinate system with European Datum 1950.

Within this study's scope, a three-phased evaluation process is developed, which are “identification of selected coastal lagoons in Turkey”, “the administrative framework”, and “developing sustainable landscape strategies for selected coastal lagoons in Turkey” (Figure 2). Selected coastal lagoons in Turkey identifies in the first phase.

According to Corine 2018 Land Cover Data, land use varieties determine in the buffer area of 250 meters from the lagoon's shoreline. These areas between the lagoon and the land are very rich in biological and ecological terms with their flora and fauna features. In the second phase, the current administrative framework is explained in the three main classes as “local and central government administrative units”, “legislative documents”, and “current plan types”. In the last phase, sustainable landscape planning strategies develop for selected coastal lagoons in Turkey.

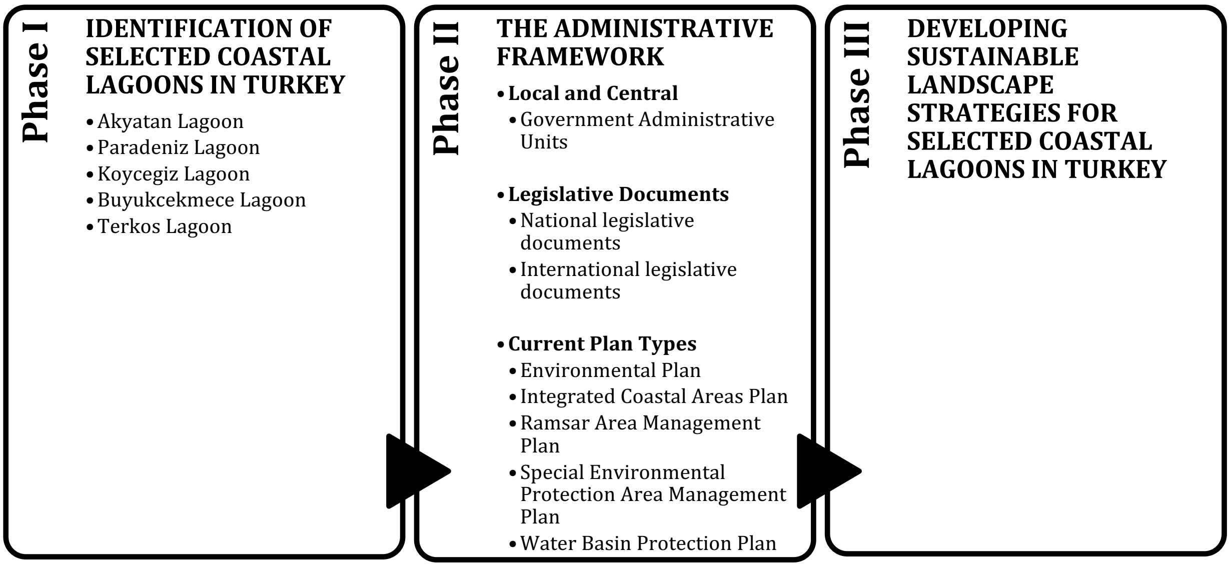

Figure 2: The flowchart illustrating the evaluation process developed within this study.

STUDY AREA

In this study, coastal lagoons are selected as the location of four different sea coasts of Turkey. Each has different urban and/or rural dynamics and land use patterns. They are home to many endemic plants and endangered animals. All these features have been tried to protect and ensure the environmental sustainability of selected lagoons in Turkey.

1. Akyatan Lagoon

Akyatan Lagoon is located in Adana and it is the largest coastal lagoon in Cukurova (Adana) captured by Seyhan River and Tarsus (Berdan) Stream and drainage waters. Depending on the freshwater inlet, evaporation rate, and wind, the lagoon depth varies and is shallow mainly (Altan et al., 2004 pp.43).

The lagoon's surrounding areas are generally used for agricultural purposes. Although a part of the area is used as pasture, grazing is prohibited in the afforested dune areas. A "dalyan", a traditional fishery, has been built in the lagoon that opens to the sea and fishing activities are carried out in this part (Divrak et al., 2008 pp.79).

Rich habitat diversity such as permanently irrigated lands, broad-leaved forests, mixed forests, transitional woodland shrubs, beaches and dunes, salt marshes, and coastal lagoons are located around the lagoon (Table 1). Since this unique area is a breeding and wintering place for many bird species, it is crucial for birds during the year. It is also an Important Bird Area (IBA) and a Key Biodiversity Area (KBA) (Figure 3) (Yarar and Magnin, 1997 pp.209; Eken et al., 2006 pp.420). Akyatan Lagoon and its surroundings have many protection statuses to ensure the sustainability of all these valuable qualities.

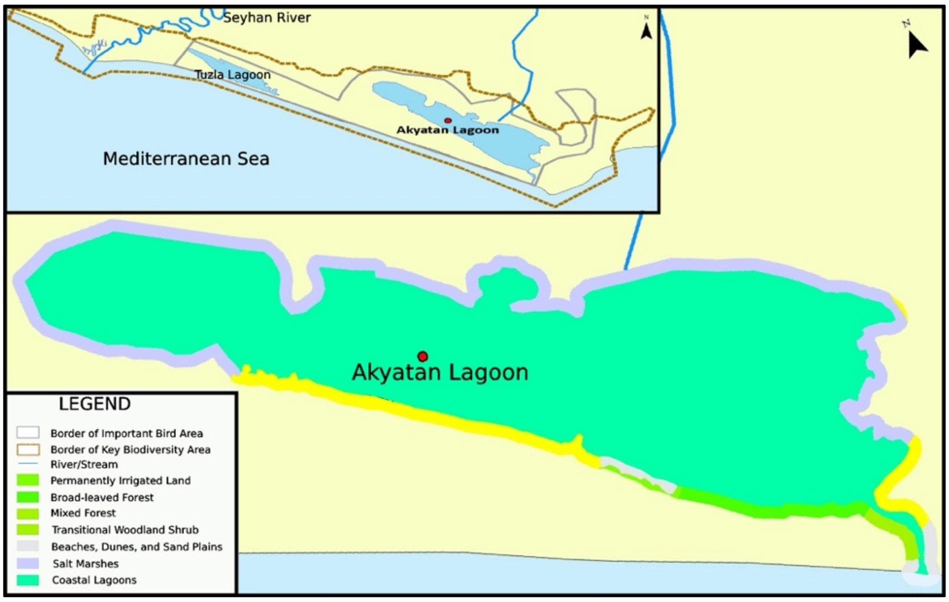

Figure 3: Akyatan Lagoon's Corine 2018 Land Cover map and boundary of Important Bird Area.

In 1997, Akyatan Lagoon and its surroundings were declared Grade 1 Natural Site Area because of being nesting and spawning area of Caretta carettas. Akyatan Lagoon was declared a Ramsar Area in 1998 due to the diversity of habitats and animals (Sonmez and Aytuk, 2011 pp.28). Thus, it has been committed at the international level that laws and regulations will preserve its ecological character. In 2005, this area was declared as Wildlife Protection and Improvement Area. In 2020, Akyatan Lagoon was finally proclaimed as Natural Site-Nature Conservation Area, Natural Site-Sustainable Protection and Controlled Usage Area, and Special Environmental Protection Area to ensure its sustainability ecological features (Ministry of Environment and Urbanization [MEU], 2020a)

In addition to all these announced protection statuses, three upper-scale plans regarding the Akyatan Lagoon were also prepared. Ramsar Site Management Plan (2011), Mersin-Adana 1/100.000 Scale Environmental Plan (2013), and Iskenderun Bay (Adana-Mersin-Hatay) Integrated Coastal Areas Plan (2015) entered into force (Divrak et al., 2008; MEU, 2020b; MEU, 2015).

CORINE CODE	**CORINE LAND COVER CLASSES**	**AREA**	
		ha.	**pct. (%)**
212	Permanently Irrigated Land	69155,3	85,8%
311	Broad-leaved Forest	101	0,1%
313	Mixed Forest	554,6	0,7%
324	Transitional Woodland Shrub	211,8	0,3%
331	Beaches, dunes, and sand plains	610	0,8%
421	Salt Marshes	5062,6	6,3%
521	Coastal Lagoons	4888	6,1%
	TOTAL	**80583,3**	**100,0%**

Table 1: Corine 2018 Akyatan Lagoon Land Cover Classes.

Although many national and international precautions have been taken for the protection and sustainability of Akyatan Lagoon and its surrounding, there are great numbers of threats in the area. The most critical threat is interventions to the water regime. Within the scope of State Hydraulic Works's Lower Seyhan Irrigation Project, some small swamps and seasonal wetland habitats were destroyed by drying within the land draining range. The dune area, approximately 2500 ha. extending between Akyatan Lagoon and Mediterranean Sea has been afforested since the 1960s. Due to the acacia (Acacia), eucalyptus (Eucalyptus), and pine (Pinus) trees planted for dune stabilization, the dune area has been dramatically altered and small swamps and ponds have formed in the pits located between the dunes. In recent years, the conversion of dunes into agricultural lands and excessive use of groundwater have caused the deterioration of the water balance and the dune structure in the area. Chemicals coming from the intensive farming areas in the center of the Cukurova Delta and industrial and residential areas rapidly pollute the lagoon. In addition to all these, secondary housing construction is planned in the lagoon protection area's territory (Divrak et al. 2008; Yarar and Magnin, 1997; Eken et al., 2006).

Since Akyatan Lagoon is a Ramsar Area and an important wetland, it is under the responsibility of the Ministry of Agriculture and Forestry - General Directorate of Nature Conservation and National Parks and Adana Provincial Directorate of Environment and Forestry (locally). Cukurova University, Hacettepe University, Adnan Menderes University, WWF (World Wildlife Foundation), and Nature Association carry on many studies to ensure the area's sustainability.

2. Paradeniz Lagoon

Paradeniz Lagoon is one of the most important and less degraded coastal lagoons in the Mediterranean Sea, in Mersin. It is a wetland formed transported sediments where the Goksu River reaches the Mediterranean. It is slightly salty, has a maximum depth of 1,5 m, and is permanently connected to the sea by a channel (MEU, n.d.a). There is no vegetation in the lagoon. The dunes are remarkably untouched and are worth preserving because they have a dynamic structure and are a Grade 1 Natural Site Area.

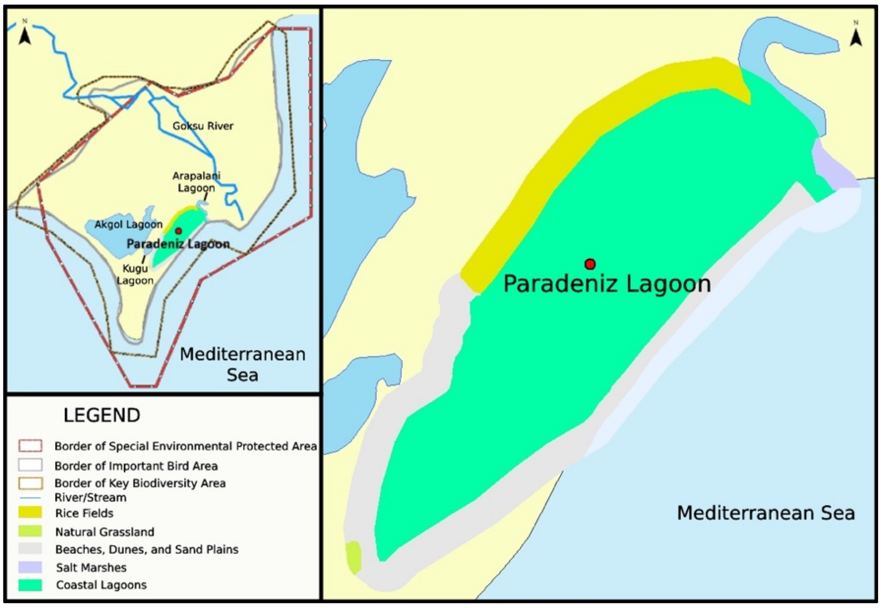

Figure 4: Paradeniz Lagoon's Corine 2018 Land Cover map, Important Bird Area, and Special Environmental Protection Area boundaries.

Rice fields, natural grasslands, beaches and dunes, salt marshes, and coastal lagoons (e.g. Akgol, Kugu, and Arapalani lagoons) locate around the Paradeniz Lagoon (Table 2). In the area's territory, especially irrigated agriculture, animal husbandry, fishing (coastal and open sea fishing), and a small number of eco-tourism activities are carried out (Yarar and Magnin, 1997 pp.197).

CORINE CODE	CORINE LAND COVER CLASSES	AREA	
		ha.	pct. (%)
213	Rice Fields	153	5,7%
321	Natural Grassland	48	1,8%
331	Beaches, dunes, and sand plains	1708	63,5%
421	Salt Marshes	209,3	7,8%
521	Coastal Lagoons	571,9	21,3%
	TOTAL	**2690,2**	**100,0%**

Table 2: Corine 2018 Paradeniz Lagoon Land Cover Classes.

In 2016, Paradeniz Lagoon was identified as one of 305 Important Nature Areas (INA) in Turkey by The World Conservation Union (IUCN). It is also one of the Important Bird Areas (IBA) of Europe and the Middle East and an Important Plant Area (IPA) (Figure 4) (Yarar and Magnin, 1997; Eken et al., 2006). At the same time, the area is one of the feeding grounds for the Mediterranean monk seal (Monachus monachus) and the spawning grounds for Sea Turtle (Caretta caretta), Green Sea Turtle (Chelonia mydas) (MEU, n.d.a).

Due to its rich habitat, the lagoon was declared as the Special Environmental Protection Area in 1990. In 1994, Paradeniz Lagoon was declared a Ramsar because of its rare flora and fauna diversity. In the 2000s, it was announced as Grade 1 Natural Site Area (2007) and Sensitive Area (2020) to protect its ecological characters (Veri Portali, 2021). The Ministry of Environment and Urbanisation prepared the Goksu Delta Special Environmental Protection Area (SEPA) Management Plan (1990) and the Ministry of Agriculture and Foresty designed Ramsar Area Management Plan (1999) after the lagoon was declared as Ramsar Area and Special Environmental Protection Area (MEU, n.d.a; Divrak et al., 2008 pp.110). However, these plans were not revised in the following years. In the last decade, Iskenderun Bay (Adana-Mersin-Hatay) Integrated Coastal Areas Plan (2015), Environmental Plan of the Göksu Delta Special Environmental Protection Area (2017), and Mersin-Adana Environmental Plan (2013) were prepared to ensure the sustainability of the area (MEU, 2020b; MEU, 2015).

Protection works in the field are carried out by General Directorate for Protection of Natural Assets as the central government administration, and The Silifke Special Environmental Protection Directorate organizes local works.

Despite all the measures and sanctions in this area, many elements threaten the lagoon. The most severe threat in the lagoon’s surrounding area is the interventions to the water regime. Kayraktepe Dam and Hydroelectric Power Plant (HEPP), which has been planned for many years, will stop the sediment flow to the delta and coastal line and cause coastal erosion and damage agricultural and fishing activities in the long term. When this HEPP is built, the amount of sediment carried by the Goksu River will decrease, and the natural structure of the delta will be degraded and will be endangered. Within the scope of supporting agriculture, rice agriculture is supported, which conflicts with environmental protection principles. Converting salt marshes and other natural habitats around the lagoon will increase the amount of pasture and cause uncontrolled grazing. A large number of secondary houses are being built on agricultural lands outside the SEPA. Also, wastes from agricultural areas and poaching activities are other threats to the lagoon (Gurbuz, 2000 pp.143-151; Yarar and Magnin, 1997 pp.199-201).

3. Koycegiz Lagoon

Koycegiz Lagoon is in Mugla District and connected to the Mediterranean Sea with the Dalyan Canal, a natural channel. Its coastline is Iztuzu Beach, a 4.5 km long coastal dune (Selim, 2015 pp.27). The surface of the lake is approximately 55 km^2. There are reeds and swamps around the lake and along the Dalyan Canal. These wetland ecosystems are essential habitats. On the east of Iztuzu Beach, which is shown among the top 10 most valuable beaches in the world, Alagöl is located in the west of Sulungur Lake. Many streams flow in the basin, large and small scale, continuously or seasonally. Among these, Namnam Stream is the largest one in the region (Cevre ve Orman Bakanligi [COB], 2007 pp.23-26).

CORINE CODE	CORINE LAND COVER CLASSES	AREA	
		ha.	pct. (%)
112	Discontinuous Urban Fabric	248,5	0,9%
222	Fruit Trees	2952,8	10,7%
242	Complex Cultivation Patterns	8003,5	28,9%
243	Land Principally Occupied by Agriculture	767	2,8%
311	Broad-leaved Forest	312,3	1,1%
312	Coniferous Forest	9824,1	35,5%
324	Transitional Woodland Shrub	4248,1	15,4%
331	Beaches, dunes, and sand plains	41	0,1%
411	Inland Marshes	1143,7	4,1%
511	Water Courses	120,5	0,4%
	TOTAL	**27661,5**	**100,0%**

Table 3: Corine 2018 Koycegiz Lagoon Land Cover Classes.

Freshwater lakes, reed areas, swamps, dune ecosystems, alluvial sweetgum (Liquidamber Orientalis) forests, Cupressus sempervirens communities, red pine (Pinus brutia) and a wide variety of maquis unions, and irrigated agricultural areas are unique characteristics of habitat communities around the Koycegiz Lagoon.

There are two endemic plant species in Koycegiz Lagoon's basin area. Also, it is an Important Bird Area (IBA) as it is an important breeding and wintering area for waterfowl (Figure 5). Iztuzu Beach is an Important Natural Area (INA) as it is a breeding ground for the endangered Mediterranean monk seal (Monachus monachus) and sea turtles (Caretta caretta) (MEU, n.d.b).

The most common land use of the Koycegiz Lagoon's surrounding area is coniferous forest. There are also broad-leaved forests, transitional woodland shrubs, fruit trees, complex cultivation patterns, land principally occupied by agriculture, beaches and dunes, and inland marshes (Table 3).

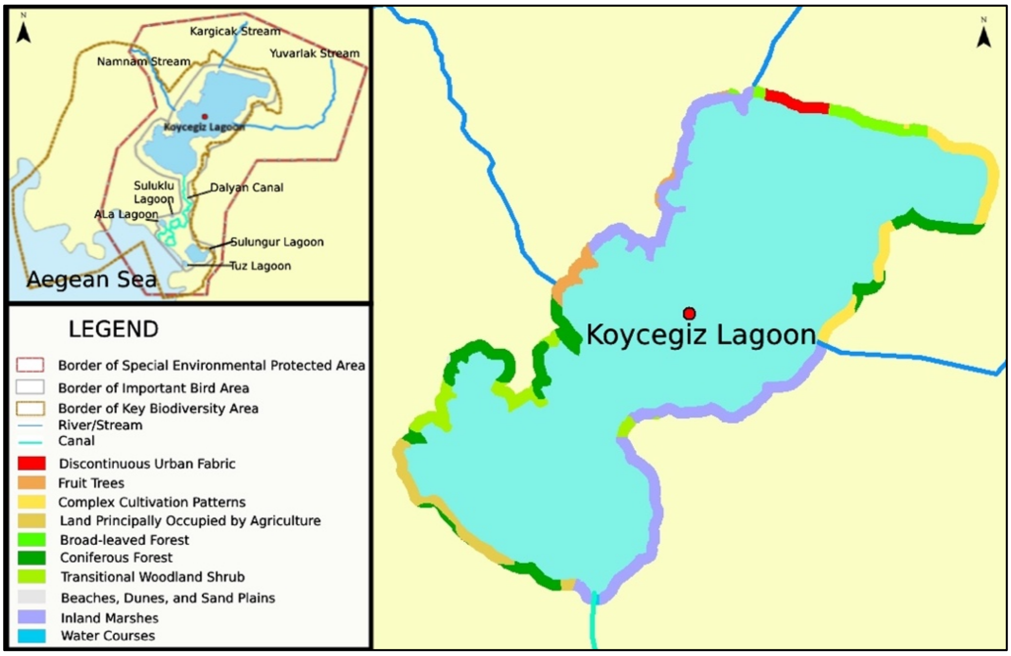

Figure 5: Koycegiz Lagoon's Corine 2018 Land Cover map, Important Bird Area, and Special Environmental Protection Area boundaries.

Koycegiz lagoon has four different protection statuses to protect the area's landscape character and ensure the habitats' sustainability. The first protection status was declared as Grade 1 Archeological Site Area for Kaunos Ancient City in 1978. In 1988, Koycegiz Lagoon's surrounding area was defined as SEPA. In 1996, Marmaris National Park was declared, a part of the Koycegiz Basin locates in this area. Southwest of the area was declared as a Wildlife Development Area in 2005 (Veri Portali, 2021).

Also, the area is protected by many laws and regulations. These are Land Hunting Law (1937), Fisheries Law (1971), National Parks Law (1983), Protection of Cultural and Natural Properties Law (1983), The Convention on the Conservation of European Wildlife and Natural Habitats (1984), Coastal Law (1990), The Regulation on Transport Vehicles to Work in Koycegiz Lake and Dalyan Channels (1992), European Landscape Convention (2003), Regulation on Protection of Water Basins and Preparation of Management Plans (2012), and Regulation on the Protection of Wetlands (2014) (Mevzuat Bilgi Sistemi, n.d.).

The Ministry of Environment and Urbanisation prepared Determination and Management Plan of Biological Wealth of Köyceğiz-Dalyan Special Environmental Protection Area in 2007, Aydın-Mugla Integrated Coastal Areas Plan (2018), and Aydın-Muğla-Denizli Environmental Plan (2011) (COB, 2007; MEU, n.d.c; MEU, 2016.).

Protection works in the Koycegiz SEPA are carried out by General Directorate for Protection of Natural Assets and General Directorate of Nature Conservation and National Parks as the central government administration, and Mugla Governorship Provincial Directorate of Environment and Forestry, Mugla Governorship Provincial Directorate of Culture and Tourism, and Regional Board for the Protection of Cultural and Natural Heritage organize local works (Eken et al., 2006 pp.

There are great numbers of threats in contravention of laws, regulations, and plans. The most striking threats in the field are caused by uncontrolled activities and unplanned construction pressure caused by tourism. Despite the protection efforts, night use and boat traffic cannot be adequately controlled during Caretta Caretta's breeding period in Iztuzu Beach. Liquidambar Orientalis forests, citrus groves, and marshes are being drained uncontrolled to transform them into agricultural areas. Afforestation works are carried out in marshy areas. Agricultural and domestic wastes pollute the lagoon. Heavy motorboat traffic in the channel between the lake and the sea - on the one hand, the natural life is disturbed, on the other hand, the constantly created waves destroy the reeds. Although restrictions have been imposed on the number of boats, lengths, and speeds, there is a failure in implementation (Selim, 2015 pp.122-125; Eken et al., 2006 pp.254).

4. Buyukcekmece Lagoon

Buyukcekmece Lagoon is located on the European side of Istanbul on the Marmara Sea coast and is fed by Karasu and Delice streams (Yarar and Magnin, 1997 pp.37). The lagoon was separated from the Marmara Sea in 1989 by Istanbul Water and Sewerage Administration (ISWA) and turned into a dam lake (Istanbul Water and Sewerage Administration [ISWA], 2019 pp.42). The lagoon is the 3rd most efficient local water resource of Istanbul in terms of annual yield and meets approximately 16.3% of Istanbul's water need (ISWA, n.d.). In addition to being a vital water resource for Istanbul, it also has an important ecological corridor in the urban ecosystem.

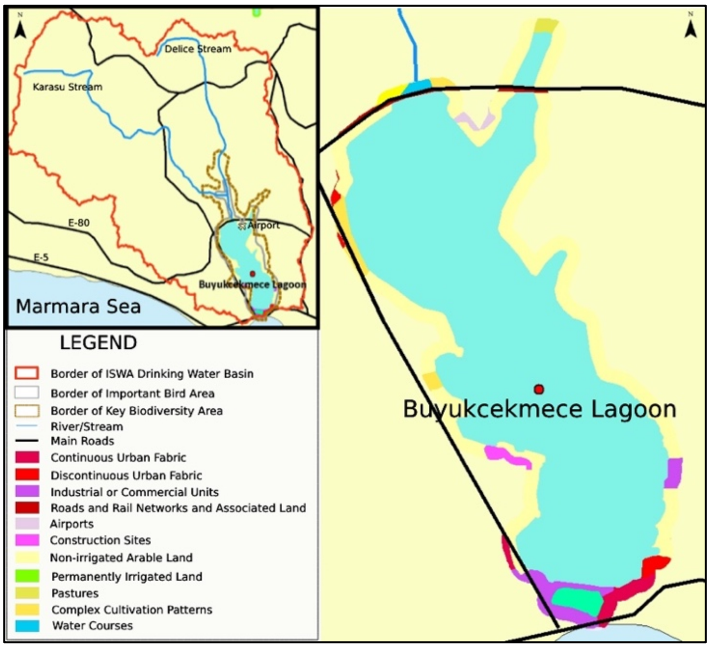

Figure 6: Buyukcekmece Lagoon's Corine 2018 Land Cover map, boundaries of Important Bird Area, and ISWA Drinking Water Basin.

Non-irrigated arable lands are the most dominant land cover around the Büyükcekmece Lagoon. In addition, there are many land cover varieties such as continuous urban fabrics, discontinuous urban fabrics, ındustrial and commercial units, main road and rail networks, an airport, construction sites, permanently irrigated lands, pastures, and complex cultivation patterns in the area (Table 4).

CORINE CODE	CORINE LAND COVER CLASSES	AREA	
		ha.	pct. (%)
111	Continuous Urban Fabric	411,1	1,1%
112	Discontinuous Urban fabric	928,5	2,5%
121	Industrial or Commercial Units	288,9	0,8%
122	Road and Rail Networks and Associated Land	6481,8	17,6%
124	Airports	25,7	0,1%

133	Construction Sites	26	0,1%
211	Non-irrigated Arable Land	27277,5	74,1%
212	Permanently Irrigated Land	921,7	2,5%
231	Pastures	64,8	0,2%
242	Complex Cultivation Patterns	239,6	0,7%
511	Water Courses	135,1	0,4%
	TOTAL	**36800,7**	**100,0%**

Table 4: *Corine 2018 Buyukcekmece Lagoon Land Cover Classes.*

The lagoon was declared a drinking water basin by ISWA in 1989 and as a Grade 3 Archaeological Site in 2016 due to the historical remains on the lagoon shore (Mevzuat Bilgi Sistemi, n.d.). Buyukcekmece Lagoon has also been designated as an Important Bird Area (IBA) by The International Bird Conservation Council (IBCC) and The International Waterfowl and Wetlands Research Bureau (IWRB) because it is an area where important habitats are sheltered, and many water birds winter over and breed, and on bird migration routes (Figure 6) (Yarar and Magnin, 1997 pp.37; Eken et al., 2006 pp.130).

In addition to its protection statuses, Buyukcekmece Lagoon is also protected by some laws and regulations such as Fisheries Law (1971), Protection of Cultural and Natural Properties Law (1983), Coastal Law (1990), European Landscape Convention (2003), ISWA Drinking Water Basins Regulation (2011), Regulation on Protection of Water Basins and Preparation of Management Plans (2012), and Regulation on Protection of Drinking-Potable Water Basins (2017) (Mevzuat Bilgi Sistemi, n.d.).

There are two upper-scale plans for the area: Istanbul Environmental Plan (under revision) (2009) and Buyukcekme Dam Lake Basin Protection Plan (2019) (Mevzuat Bilgi Sistemi, n.d.; MEU, n.d.d.).

Buyukcekmece Lagoon is located in Istanbul, one of the world's megacities, is exposed to increasing urbanization pressures day by day. Many of new residential areas do not have any sewage system. There are many industrial facilities within the water catchment basin (e.g., Catalca Organized Industrial Zone, etc.). Besides, an airport on the north coast, two main arteries of Istanbul (E-5 and TEM), connection roads to the Northern Marmara Motorway, and a railway in the north main roads in the Basin's Strict Protection Area, all of them endanger the sustainability of lagoon (Sofu, 2009 pp.156-162).

5. Terkos Lagoon

Terkos Lagoon is one of the oldest water resources in Istanbul (ISWA, 2019 pp.42). The basin is located in the north of the Çatalca Peninsula, most of which are within Istanbul's boundaries. It supplies most of the water needs of the European side of Istanbul. Among the water resources of Istanbul, it is essential to determine the protection-use criteria to be able to transfer to future generations without any damage and to continue the optimum use of the water resource, and its natural structure is the least damaged drinking water basin (Eken et al., 2006 pp.120).

Figure 7: Terkos Lagoon's Corine 2018 Land Cover map and boundary of ISWA Drinking Water Basin.

Terkos Basin ecosystem has critical features for Istanbul megacity. The region, which is rich in flora and fauna, is known for being a frequent destination for migratory birds. It is one of the IBA as it is a breeding area for important waterfowl and 17 plant taxa in the basin meet the INA criteria (Figure 7) (Eken et al., 2006; Yarar and Magnin, 1997).

CORINE CODE	CORINE LAND COVER CLASSES	AREA	
		ha.	pct. (%)
112	Discontinuous Urban fabric	80,2	0,7%
211	Non-irrigated Arable Land	845,7	7,9%
231	Pastures	53,5	0,5%
242	Complex Cultivation Patterns	232,3	2,2%
243	Land Principally Occupied by Agriculture	738,6	6,9%
311	Broad-leaved Forest	2181,9	20,3%
312	Coniferous Forest	1225,5	11,4%
313	Mixed Forest	473,6	4,4%
324	Transitional Woodland Shrub	834,8	7,8%
411	Inland Marshes	570	5,3%
511	Water Courses	56,8	0,5%
512	Water Bodies	3455,9	32,2%
	TOTAL	**10748,8**	**100,0%**

Table 5: *Corine 2018 Terkos Lagoon Land Cover Classes.*

The most dominant land use of Terkos Lagoon's surrounding is forest. Besides, discontinuous urban fabrics, non-irrigated arable lands, pastures, complex cultivation patterns, lands principally occupied by agriculture, transitional woodland shrubs, and inland marshes are the other land cover classes of the area (Table 5).

Although it has two protection statuses, namely, ISWA Drinking Water Basin and Terkos Lake Conservation Forest, there are many laws and regulations related to the area. These are Forest Law (1956), Fisheries Law (1971), Mining Law (1985), Coastal Law (1990), European Landscape Convention (2003), ISWA Drinking Water Basins Regulation (2011), Regulation on Protection of Water Basins and Preparation of Management Plans (2012), and Regulation on Protection of Drinking-Potable Water Basins (2017). Terkos Lagoon is only covered by the Istanbul Environmental plan (under revision) (2009), among the upper scale plans (Mevzuat Bilgi Sistemi, n.d.).

Although the area is one of the most protected drinking water basins in Istanbul, it is exposed to threats from many different sources. Dam projects initiated by ISWA to bring water from Strandja Mountains caused severe damage to the natural habitats by causing water regime changes. The road opened for access to the dams, with a width of 40-100 meters, damaged a large part of the forest area and destroyed the animals' habitats in the region. Quarries, which are located in Terkos Water Basin, destroy forest areas and natural vegetation. Since there are no infrastructure facilities in the settlements near the site, the streams carrying water to the Terkos Lagoon pollute the lagoon. Agricultural pesticides and livestock activities are also mixed into the lagoon (Baylan and Karadeniz, 2006 pp.158).

Another problem that causes the lagoon's natural environmental characteristics and its surroundings to deteriorate is that the natural dune vegetation has been damaged owing to the dune afforestation works. Due to the Istanbul Airport construction, several streams feeding Terkos Lagoon were destroyed, reducing the lagoon's number of water resources. Secondary residences near the lagoon and poaching activities also damage the lagoon (Eken et al., 2006 pp. 120).

If the Canal Istanbul Project is built, it may cause soil and groundwater salinization in the drinking water basin as salty water will flow from the canal. As a matter of fact, the entire project area remains within the Groundwater Operation Area. Besides, the canal will increase the construction pressure in the lagoon area (Ilhan, 2021).

RESULTS AND DISCUSSION

Since coastal lagoons are located between land and sea, they are complex areas that show the structural and biological features and functions of both regions at the same time. These shallow systems are among the primary productivity areas in the world. The biological diversity and hydrochemical properties of these areas differ depending on the time and place. Turkey is surrounded by sea on three sides; it has been noted to be different

	AKYATAN LAGOON	**PARADENIZ LAGOON**	**KOYCEGIZ LAGOON**	**BUYUKCEKMECE LAGOON**	**TERKOS LAGOON**
CITY NAME	Adana	Mersin	Mugla	Istanbul	Istanbul
CITY TYPE	Megacity	Megacity	Megacity	Megacity	Megacity
LOCATION	Rural	Rural	Rural-Urban	Rural-Urban (Mega-city)	Rural-Urban (Mega-city)
COAST OF SEA	Mediterranean Sea	Mediterranean Sea	Aegean Sea	Marmara Sea	Black Sea
NUMBER OF PROTECTION STATUSES	6	4	4	2	2

NUMBER OF MANAGEMENT PLANS		3	5	3	2	1
NUMBER OF LAWS/ REGULATIONS/ CONVENTIONS		9	7	10	8	8
THREATS	AGRICULTURAL WASTES	X	X	X	X	X
	DOMESTIC WASTES	X	-	X	X	X
	INDUSTRIAL WASTES	X	-	-	X	-
	RESIDENTIAL AREAS	X	X	X	X	X
	MEGA PROJECTS	X	X	-	X	X
	TOURISM	-	-	X	-	-
	ILLEGAL POACHING	-	X	-	X	X
	BAD STRATEGIES	X	X	X	X	X

Table 6. Evaluations on the selected coastal lagoons in Turkey.

sea coast of the selected lagoons in this study (Table 6). Akyatan and Paradeniz lagoons have a coastline to the Mediterranean, Koycegiz Lagoon to the Aegean Sea, Buyukcekmece Lagoon to the Marmara Sea, and the Terkos Lagoon to the Black Sea. Besides, all of the selected coastal lagoons are located within the metropolitan borders. Buyucekmece and Terkos lagoons are in Istanbul, one of the world's major megacities.

The Proximity To The Urban, Rural, and Urban Fringe

According to the local perspective, locations of the selected lagoons are examined, it has been determined that Akyatan and Paradeniz lagoons are located in the rural area. Therefore, these two lagoons are not directly exposed to urban pressures relative to the others. In spite of that, the other three lagoons are located in the rural-urban fringe. Koycegiz and Dalyan are the most densely populated residential areas around Koycegiz Lagoon. These settlements are areas where habitat quality is low and environmental impacts are higher compared to rural areas. The most important reason for the pressure and uncontrolled use on the lagoon is these residential areas with rapid population growth and unplanned construction.

Buyukcekmece and Terkos lagoons are exposed to more negative changes and pressures as they are located at the urban(mega-city)-rural fringe. Rapid population growth, unplanned housing, unconscious use of natural resources, changes in the quality and quantity of water resources are the most important reasons for adverse effects in Istanbul. These changes cause the land cover in the rural and urban landscapes of the mega-city to change with increasing acceleration and the connections between ecosystems to fragment. These negative impacts are mostly seen on the lagoons of Buyukcekmece and Terkos, which are ecologically sensitive areas and supreme drinking water basins of Istanbul.

Although the selected coastal lagoons are located on different coastline of Turkey, they show similar characteristics due to the developing and transforming conditions. All of the lagoons have begun to lose their natural characteristics and have started to have a semi-natural character. Suppose long-term sustainable strategies are not developed for coastal lagoons in Turkey (considering the balance of protection and use against urban pressures), they may lose their natural character completely, especially Buyukcekmece ve Terkos lagoons.

Protection Statuses

The selected lagoons within the scope of this study are the most important nature centers of Turkey with their ecological and cultural values as well as ecosystem diversity and their national and international flora and fauna, and they need to have protection statuses to ensure their sustainability. The coastal lagoon that has the most protected status is Akyatan. It has six different protection statuses, five national and one international. The first national protection status is Grade 1 Natural Site Areas which is given due to its universal value and rarity, the vegetation, hydrology, etc. It was designated as a Wildlife Protection and Improvement Area after eight years, and 23 years later, it was defined as a Natural Site-Natural Conservation Area, Natural Site-Sustainable Protection and Controlled Use Area, and a Sensitive Area. Until 2020, the lagoon had only two national protection statuses.

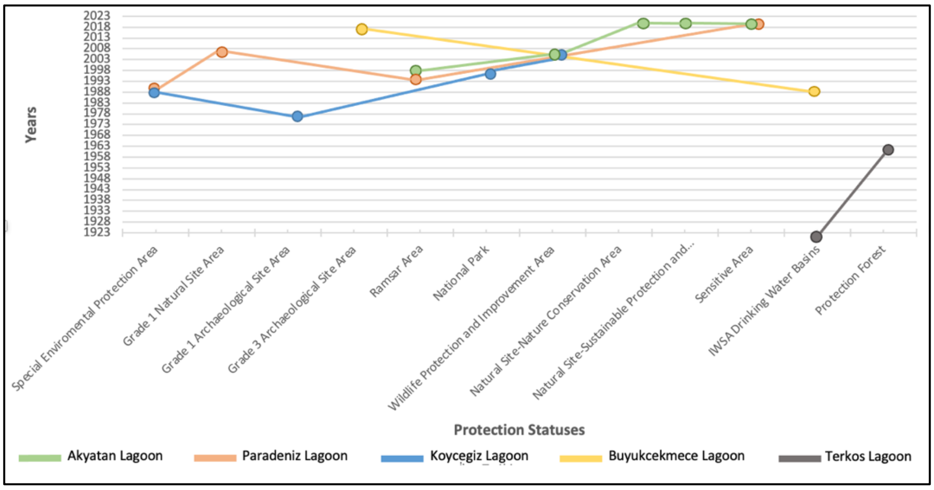

Figure 8: Proclamation dates of protection status for selected coastal lagoons in Turkey.

With the same number of protection statuses, Koycegiz Lagoon has four national protection statuses, and Paradeniz Lagoon has one international and three national protection statuses. The first protection status obtained in Koycegiz Lagoon's surroundings is for the Ancient City of Kaunos in 1978. However, the first protection status determined for the Koycegiz Lagoon was the Special Environmental Protection Area in 1988. In 1996, the southwestern part of the lagoon was determined as within the borders of the Marmaris National Park. After nine years, part of the lagoon surround was defined as a Wildlife Protection and Improvement Area. In 2020, Paradeniz Lagoon was declared a Sensitive Area. 13 years ago, it was stated a Grade 1 Natural Site Area, 26 years ago as a Ramsar Area, and three decades ago as a special environmental protection area.

The lagoons with the least number of protection statuses are the lagoons of Buyukcekmece and Terkos in Istanbul. It is tough to determine a protection status for these lagoons, which are open to continuous change and transformation with ever-changing plan decisions. Terkos lagoon is one of the oldest sources supplying water to Istanbul, and it was declared as ISWA Drinking Water Basin in 1923. In 1961, the forests around the lagoon were designated as conservation forests due to reasons such as wood raw material production, positive effects on the water cycle, and protection of soil fertility. Buyukcekmece Lagoon was declared a Drinking Water Basin by ISWA in 1989 and is one of Istanbul's most crucial drinking water sources today. In 2016, the western shores of the Buyukcekmece Lagoon were designated as a Grade 3 Archaeological Site Area due to the historical remains found on this area.

Table 6 shows that lagoons close to the megacity have less protection status. Although lagoons in rural and urban-rural areas have more protected status, they are also subject to many human pressures. The most important reason for this situation is the lack of a comprehensive legal strategy on lagoons in our country. Another reason is that the protection statuses of lagoons were given without analyzing the landscape character of the lagoons and without considering the uniqueness of the lagoons. In order to ensure the sustainability of lagoons, these points should be taken into consideration when defining their protection status.

Legıslatıve and Managerıal Conflıcts

Different ministries prepared management plans to eliminate the ecological and spatial problems seen in the selected lagoons and to ensure their sustainability. Most of these management plans have not been revised periodically or are not intended to produce holistic solutions. One management plan was prepared for the Terkos Lagoon, two for the Buyukcekmece Lagoon, and three for the Koycegiz and Akyatan lagoons. The lagoon with the highest number of management plans is Paradeniz Lagoon, which has five management plans.

The lagoons, which are the intersection and session of the water and land ecosystem, have been protected by the protection laws of wetlands and coastal laws both in Turkey and other countries. Because coastal areas allow very different spatial activities, it is critical to protect the regulations on the coast and the biotope surrounding the shore.

There are frequent changes in many laws and regulations in Turkey, especially in the coastal law. Also, many problems arise from the inadequacies in implementing, inspecting, and enforcement of the legislation. Thereby to protect the lagoons in Turkey, there are many different laws and regulations for the segmented solution. Among the lagoons selected within the scope of this study, Koycegiz Lagoon is most protected by the laws and regulations, and Paradeniz Lagoon is protected by the least number of laws and regulations.

There are laws and national-international regulations that directly and indirectly affect coastal lagoons. The fact that a lagoon has many laws and regulations does not mean that the lagoon is fully protected. Some laws conflict with each other and their sanctions are weakened. For example, although Koycegiz Lagoon and its surroundings are within the boundaries of the Special Environmental Protection Area, many pressures caused by tourism activities in the area threaten the area ecologically and endanger the lives of some animals. In addition, the conservation forests around the Terkos Lagoon are protected by Forest Law. Besides, the mines around the Terkos Lagoon are evaluated within the scope of the Mining Law and threaten the forest's existence.

In order to ensure the sustainability of the lagoons, many legal conflicts need to be eliminated. A new title should be created in the planning and legal system as 'coastal lagoon'. Most of the management plans of lagoons are not revised within the specified periods. It has been determined that the current ones are not binding in practice. Therefore, the specific features of each lagoon should be determined according to the landscape character subtitles and provide input to the management plans. Instead of only upper-scale plans, multi-scaled plans should be prepared for the characteristics of the coastal lagoons.

LAND-USE FUNCTION DIVERSITY

Riparian zones are transition areas and are 3-D ecotones that contain terrestrial and aquatic ecosystems of varying widths throughout the water body (Copernicus, n.d.). According to Corine 2018 Land Cover Data, these valuable areas are defined as 250 meters in width for rivers and land cover data have been determined. Within the scope of this study, Corine 2018 Land Cover Data in the riparian zones, which were determined by placing a 250-meter wide buffer zone around the lagoons. After that, mapping studies are carried out via GIS technology for area calculations.

There are seven different land-use functions in the riparian zone of the Akyatan Lagoon, and the most space-occupying is permanently irrigated land. This is another indication that the most considerable economic activity in the field is agriculture. In the riparian zone of the Paradeniz Lagoon, 63,5% of land use is covered by beaches, dunes, and sand plains and 21,3% by other coastal lagoons in the Goksu Delta. The remaining area consists of rice fields, natural grasslands, and salt marshes. Since both Akyatan and Paradeniz lagoons are located in rural areas, it has been determined that the land uses in the riparian zones consist of natural subtitles. This situation prevents lagoons from being directly exposed to problems arising from land use.

The most dominant land use in the riparian zone of the Koycegiz Lagoon is coniferous forests, followed by complex cultivation patterns. Besides, approximately 1% of the land use consists of discontinuous urban fabrics, which increases the possibility of the lagoon being exposed to direct urban effects. There are eleven different land uses in the riparian zone of Buyukcekmece Lagoon, and more than half of them are utilization patterns based on urban development. However, approximately 75% of the area is non-irrigated agricultural land. The riparian zone with the highest land use diversity belongs to Terkos Lagoon. The most intensive land use form of this lagoon is water bodies with an area of 3,455.9 hectares. Only 80.2 hectares of the zone are discontinuous urban fabric, and the remaining eleven land-use forms consist of natural subtitles.

The land cover in the riparian zones of Koycegiz, Buyukcekmece, and Terkos lagoons located on the urban-rural fringes is more diverse than other lagoons. Since some of the land covers around these lagoons conflict with the natural areas, diversity affects the area negatively. For example, although the Buyukcekmece Lagoon is under protection of the ISWA Drinking Water Basin Regulation, many land uses in the riparian zone of the lagoon contradict this regulation. Since the high number of laws and regulations do not mean that the area is fully protected, laws should be prepared to control the diversity of land cover in riparian zones of lagoons.

Ecological Threats and Conflicts

The protection of lagoons, which have rich biodiversity and ecological potential, is an undeniable fact. Although many national and international legal and administrative system regulations have been made, lagoons in Turkey are exposed to many direct and indirect threats. All lagoons considered within the scope of this study are affected by agricultural wastes, new residential areas, and bad management strategies. 80% of the lagoons are negatively affected by domestic wastes. The other four lagoons except Koycegiz Lagoon are directly and indirectly exposed to adverse situations arising from mega projects. Paradeniz, Buyukcekmece, and Terkos lagoons are exposed to fauna losses due to illegal poaching activities. Many factories and industrial areas around the Buyukcekmece lagoon pollute the lagoon uncontrollably with industrial wastes. The rivers feeding the Paradeniz lagoon also carry the industrial wastes of the factories located in the upper parts of the basin to the lagoon. Koycegiz lagoon, on the other hand, is the only lagoon exposed to tourism-related threats. Problems such as heavy population growth, heavy boat traffic, and the pressure on the spawning area of Caretta Caretta threaten the lagoon ecosystem, especially during the tourism season.

In order to eliminate the elements that threaten the ecological and hydrological characteristics of the lagoons, the artificial factors in the land covers of the lagoons should be controlled by laws and regulations. In addition, legal regulations should be made to prevent domestic and industrial wastes from entering the lagoons directly or into the rivers that feed the lagoons.

CONCLUSION

Coastal lagoons are ecological museums with their biological diversity, ecological features, and landscape characters. Their natural functions and land use values reveal these areas as the most critical ecosystem in the world. Thus, it is inevitable to take various measures to eliminate the problems in coastal lagoons caused by changing and developing spatial uses and protecting the coastal lagoons.

There are many laws and regulations regarding coastal lagoons at the current legal level in Turkey. Plan decisions cannot be fully implemented in this complex legal structure. There is no clearly defined single or multi-layered protection status for coastal lagoons. At the ministerial level, any directorates are dealing with the management of coastal lagoons. The sustainability of coastal lagoons only achieves with landscape ecology-based approaches. Landscape Character Assessment is definitely needed for these strategies. Also, the regulations and the plans prepared for the management of the coastal lagoons must be multi-scaled. Only the upper-scale plans are insufficient to determine the qualitative and quantitative landscape values of coastal lagoons and their surroundings. This study stands as an initial step for further discussions on the landscape management strategies toward the lagoon landscapes for the benefit of sustainability of not only one or two lagoons but the blue network within a multilayered system approach.

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A SUSTAINABLE APPROACH: EVALUATION OF WASTE ECOLOGY AND CONSTRUCTION WASTE

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Abstract

With the development of the industry, technology has advanced and the human population has increased rapidly in a short time. The rapid increase has necessitate raw material and energy consumption in every sector. In addition, it has caused the occurrence of various wastes. Waste is defined as any substance / material that is dumped, left or must be disposed of by the producer or the person who actually owns the object.

Waste poses a threat to a sustainable world but it is an opportunity for sustainable development strategies. Sustainable development strategies aims to protect the planet and to ensure the well-being of living creatures who live in present and future. For this purpose, wastes are seen as a potential new raw material and energy source, not as a stack that affects human health and needs to be disposed of. The target is to reduce the amount of waste and to utilize the waste generated. 5 different methods are applied to utilize the waste potential. The first method is to minimize the amount of materials, objects or raw materials in the usage process to prevent waste generation (Reduce). The second method is to restore the material, object and a product that has lost its function by repairing it or taking it apart (Reuse). The third method is to make unusable materials or objects part of a whole with different or the same function (Recycle). The fourth method is to process materials that can no longer be used and turn them into energy (Recovery). The fifth method is the disposal of materials that are considered to be of no benefit.

Waste is divided into various sub-categories such as urban, agricultural, industrial, mineral, domestic and construction waste. Among these categories, construction and demolition wastes constitute the most significant percentage. Therefore, construction and demolition waste will be discussed in the study. The aim is to evaluate practices that rationalize the use of construction waste, raw material, energy and contribute to ecological sustainability. Within the scope of the study, the construction waste strategies of the member and candidate countries implementing the European Union Directives were examined; countries' data were analyzed according to the target of the European Union Protocols. As a result of the study, the following evaluations were made; the main factors determining the recycling and recovery rate of construction waste are not parameters such as population and economy, but regulations and targets put into effect; that laws and strategies need to be developed at country and union level; It is critical to raise awareness of the public and institutions on recycling and material use.

Keywords: Sustainability, Ecology, Waste Management, Construction and Demolition Waste

INTRODUCTION

Waste is defined as any substance / material that is dumped, left or must be disposed of by the producer or the person who actually owns the object (T.C. Resmi Gazete, 2015).

The amount of waste is directly proportional to the material used and the human population. Especially after the Industrial Revolution, the amount of raw materials used has increased considerably due to factors such as the development of the welfare level, the expansion of the human population, destructive wars and so on. In the last century, waste generation has become unsustainable due to excessive population growth and intensive urbanization. For this reason, individuals and administrations have started to take measures according to the type of material by separating the wastes. Waste types that occur in cities are divided into 8 groups (Karakaya Çelik, 2019; URL-1):

Residential: food, textiles, plastics etc.

Industrial: Light and heavy manufacturing, fabrication etc.

Commercial: hotels, restaurants, markets etc.

Institutional: schools, hospitals etc.

Construction and demolition: construction sites, road repair, demolition of buildings etc.

Municipal services: street cleaning, landscaping, parks etc.

Process: refineries, chemical plants, power plants etc.

Agriculture: farms etc.

Approximately 15% of urban wastes are construction and demolition wastes (CDW). This rate can rise up to 50% as a result of factors such as natural disasters. In addition, 40% of the raw materials found in nature are used in construction works (Erdik Aldırmaz, 2018; Karakaya Çelik, 2019). Therefore, CDW will be discussed in this study. The aim is to evaluate practices that rationalize the use of CDW, raw material, energy and contribute to ecological sustainability. Within the scope of the study, the CDW strategies of the member and candidate countries implementing the European Union Directives were examined; countries' data were analyzed according to the target of the European Union Protocols.

2. SUSTAINABLE WASTE STRATEGY

The European Union waste protocol and the Sustainable Waste Strategy (Waste management hierarchy), which is accepted all over the world, are the decisions and actions taken in the process from the first time the material becomes unusable, until the end of the extinction period of this material. The steps of this strategy and process are as follows:

Reduce

Reuse

Recycling

Recovery

Disposal (Figure 1)

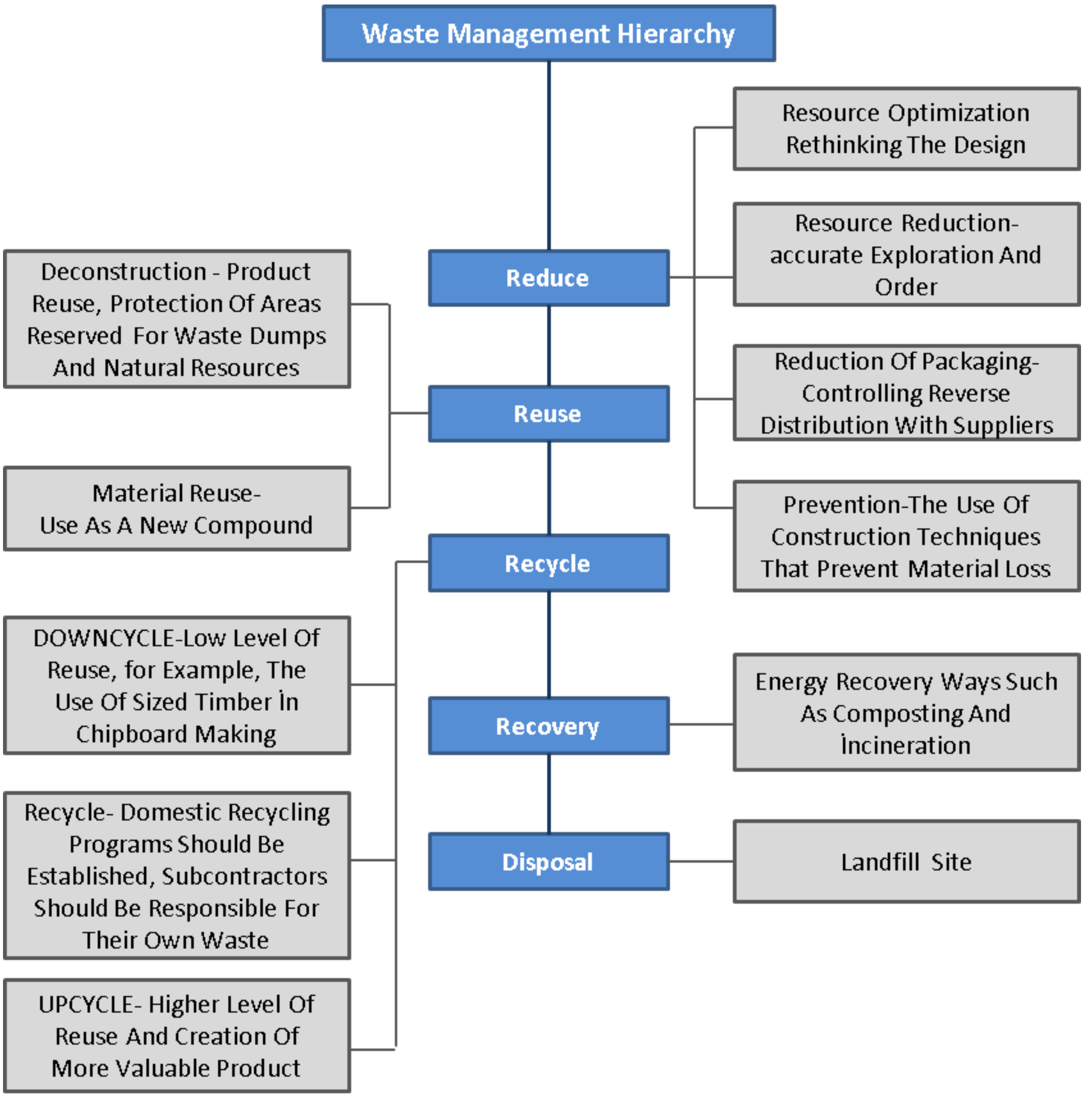

Figure 1. Waste management hierarchy (Ayan, 2013)

The waste management hierarchy refers to a management style that is evaluated from the top to the lowest level and includes certain systems. The most effective principle includes the optimization, prevention and reduction of waste generation. Reduction is possible by considering optimization at the design stage and by using resources correctly and appropriately. Considering certain requirements such as energy, cost, labor, time and technology in waste management, prevention of waste at the first step provides savings in many aspects. It is important to prioritize the higher levels of the hierarchy, as more complex needs emerge from top to down in the waste management hierarchy. The waste management hierarchy steps can be explained as follows:

Reduce; Prevention of waste generation is related to reducing the resource used and this concept constitutes the first step of sustainable waste management. The less waste generated, the less damage it causes to the environment (Keskin, 2018). This method allows for more effective management of other methods used for waste management. The waste prevention method, which reduces the use of materials and raw materials, ensures the protection of natural resources, energy savings, reduction of pollution and waste toxicity ("Sustainable Materials Management," n.d.).

Reuse; the first step of the sustainable waste strategy is to reduce waste generation, but it is not possible to prevent waste generation completely. The waste generated should be evaluated with the most appropriate method in the waste management hierarchy. The reuse strategy, which is in the second step of sustainable waste management, refers to the reutilize of wastes after no or only little processing (Keskin, 2018). Reusing waste that has not lost its value after use is an effective way to conserve natural resources and save economy ("Sustainable Management of Construction and Demolition Materials," n.d.).

Recycle; The recycling process, which is the third step of sustainable waste management, is defined as the re-inclusion of wastes that can be reused into the production process by subjecting them to various physical or chemical processes (Bozkurt, 2018). Since recycling provides the formation of a raw material, it is important to protect the raw material source to be used in the production of a new material.

Recovery; The process of converting wastes that cannot be reused or recycled into energy is called waste recovery. Waste can be converted into heat, electricity or fuel by techniques such as burning, gasification, pyrolysis, and anaerobic digestion. By converting waste to energy, a renewable energy source is obtained, the use of fossil resources is reduced, and carbon emissions are prevented by reducing the formation of methane gas in landfills ("Sustainable Management of Construction and Demolition Materials," n.d.).

Disposal; The disposal method, which is the last step of the waste management hierarchy, is the disposal of waste that cannot be recycled, reused or recovered in the waste system without harming the society and natüre (Keskin, 2018). The most widely used technique of this method is landfilling (Figure 2). Landfilling is the piling up of waste materials in predetermined areas in a planned or unplanned way. This method is the most economical method known for the disposal of wastes. It is highly used in undeveloped or developing countries (Güleç, 2004).

Figure 2. Landfill practice examples (URL-2 and 3)

3. CONSTRUCTION AND DEMOLITION WASTE (CDW)

The construction sector consumes 16% of fresh water resources, 25% of tree resources, 30% of material resources and 40% of energy resources in construction and operation processes. (Sarıbaş, 2018). These wastes generated by various activities have negative environmental, economic and social effects. Materials that arise due to construction activities and natural disasters and that do not physically contribute to any work after use are called CDW (Bozbeı, 2004). CDW can be in various amounts and percentages in different regions of the world. While this ratio can take different values between 15% and 50% of the solid waste amount in the world; it is on average 36% in the European continent. (Figure 3) (URL-4).

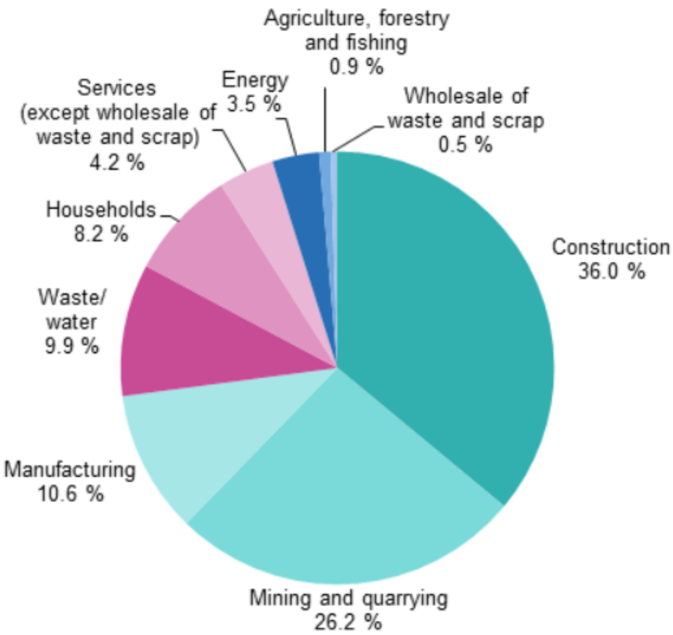

Figure 3. Solid waste rate graph generated as a result of economic activities in the European Continent (URL-4)

CDW can occur in different stages of construction or building use. These wastes can be divided as follows (Ertosun Yıldız, 2017):

The wastes generated during site works before construction (excavation wastes)

The wastes generated during construction

The wastes generated during the use of the building

The wastes generated by the demolition of the building whose service life is over

Nowadays, many countries and unions have adopted various waste management strategies by developing legal regulations and protocols to take precautions against the damages of construction waste. With these waste management strategies, it is aimed to prevent environmental problems and to minimize the carbon footprint of the product in a closed cycle by ensuring material transformation from waste to source. One of the most successful examples of achieving this goal is the European Union practices. The European Union has implemented waste management targets and incentives for countries. The data of the countries aiming to achieve this targets in implementing sustainable waste strategies is presented in the section "3.2. Analysis".

3.1. European Union Construction Waste Management and Strategy

The European Union enacted the "The Waste Framework Directive" numbered 2008/98 EC in 2008 in order to prevent waste generation, protect the environment and human health, and reduce the negative effects of resource use. In this directive, the waste management is constituted by a five-stage "waste hierarchy". In addition, the directive includes targets for 2020 regarding waste management. One of these targets is: "By 2020, the preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous CDW excluding naturally occurring material shall be increased to a minimum of 70 % by weight." (Directive 2008/98/CE, 2008).

In line with these targets, the European Union has published the “EU Construction & Demolition Waste Management” protocol in 2016, which will contribute to the achievement of the Waste Environment Directive target and provide more recycling. The protocol, developed to be implemented in all member countries of the EU, includes guiding practices for both politicians and institutions. In this protocol, in addition to the directive adopted in 2008, the responsibilities of the public and private sectors regarding waste generation and management were determined, and recommendations were given on the recycling methods of waste and marketing of recycled materials. The protocol, which is part of the Circular Economy Package, aims to contribute to the correct management of CDW and recycled materials. The reuse, recycling and recovery of CDW have been determined as the priority of the waste management strategy in terms of resource efficiency, sustainability and cost savings within the scope of the determined targets and protocol (European commission, 2016).

Analysis

An additional protocol was published in 2016, which has the same objectives as the directive published in 2008 for the waste recycling targets of the European Union. This Protocol provides information about the implementation methods that can be used to achieve the 2020 waste targets.

Within the scope of this study, the research data conducted in 2010 and 2018 regarding the status of the strategic targets in the process were analyzed for 37 countries. The aim is to compare the status of country data relative to each other and discuss the reasons affecting the results.

Table 1 presents the amount of CDW, population and economic growth rates, which are considered to affect the CDW data for the countries and years identified.

Table 1. Data on waste strategies of European Union member and candidate countries (URL-4)

Countries	**2010 Data**				**2018 Data**			
	Population	GDP and Main Aggregates	CDW (Ton)	CDW Recovery Rate	Population	GDP and Main Aggregates	CDW (Ton)	CDW Recovery Rate
Luxembourg	502 066	40 177.8	8 866 757	98	602 005	60 053.1	7 320 296	98
Ireland	4 549 428	167 673.7	1 609 762	97	4 830 392	326 986.1	1 903 058	100
Norway	4 858 199	2 591 479	1 542 803	44	5 295 619	3 553 900	5 653 304	63
Denmark	5 534 738	1 810 925.6	3 142 215	-	5 781 190	2 253 558	11 999 141	97
Netherlands	16 574 989	639 187	78 063 887	100	17 181 084	773 987	101 661 367	100
Austria	8 351 643	295 896.6	20 927 070	92	8 822 267	385 361.9	48 883 069	90
Iceland	317 630	1 680 966.9	12 289	75	348 450	2 840 088.6	51 034	99
Germany	81 802 257	2 564 400	190 990 217	95	82 792 351	3 356 410	225 260 606	93
Sweden	9 340 682	3 573 581.1	9 381 226	78	10 120 242	4 828 306	12 383 239	90
Belgium	10 839 905	363 140.1	16 852 673	17	11 398 589	460 419.4	22 658 151	97
Finland	5 351 427	188 143	24 645 393	5	5 513 130	233 696	15 715 231	74

France	64 658 856	1 995 289	260 699 131	66	67 026 224	2 360 687	240 207 094	73
United Kingdom	62 510 197	1 606 027	118 910 602	96	66 273 576	2 141 792	137 798 233	98
Malta	414 027	6 815.8	988 070	16	475 701	12 587.4	1 974 801	100
Czechia	10 462 088	3 992 870	9 353 673	91	10 610 055	5 409 665	11 601 305	92
Italy	59 190 143	1 611 279.4	59 340 134	97	60 483 973	1 771 565.9	60 829 199	98
Cyprus	819 140	19 410	461 227	0	864 236	21 432.5	1 053 325	64
Lithuania	3 141 976	28 033.8	356 772	73	2 808 901	45 491.1	620 285	99
Slovenia	2 046 976	36 363.9	1 509 476	94	2 066 880	45 862.6	669 341	98
Spain	46 486 619	1 072 709	37 946 523	65	46 658 447	1 204 241	38 075 987	75
Estonia	1 333 290	14 863.1	436 289	96	1 319 133	25 937.6	2 192 957	95
Poland	38 022 869	1 446 844	20 818 234	93	37 976 687	2 121 555	16 950 306	84
Portugal	10 573 479	179 610.8	1 287 140	58	10 291 027	205 184.1	1 397 749	93
Hungary	10 014 324	27 431 270	4 072 214	61	9 778 371	43 350 353	6 103 907	99
Slovakia	5 390 410	68 188.7	1 786 430	-	5 443 120	89 505.5	541 876	51
Latvia	2 120 504	18 022.7	21 551	-	1 934 379	29 142.5	310 772	97
Romania	20 294 683	528 514.5	734 946	47	19 533 481	951 728.5	647 151	74
Greece	11 119 289	224 124	2 086 080	0	10 741 165	179 727.3	2 286 467	97
Turkey	72 561 312	1 167 664.5	-	-	80 810 525	3 758 315.6	-	-
Croatia	4 302 847	329 431.5	7 656	2	4 105 493	385 376.6	1 259 569	78
Bulgaria	7 421 766	74 434.1	78 880	62	7 050 034	109 743.4	193 186	24
Serbia	7 306 677	3 250 581.3	-	-	7 870 324	5 072 932.2	550 436	81
Montenegro	619 001	3 125.1	-	-	622 359	4 663.1	137 860	-
North Macedonia	2 052 722	437 295.5	-	-	2 075 301	660 878.2	35 617	100

Bosnia and Herzegovina	3 844 046	25 365	-	-	-	33 444.1	122 919	-
Albania	2 918 674	1 239 644.6	-	-	2 870 324	1 635 714.6	-	-
Kosovo	2 208 107	4 402	-	-	1 798 506	6 725.9	-	-

Considering the data in Table 1, in this study, the relationship between the population and CDW, the relationship between economic growth and the amount of CDW, the recycling and recovery rate of CDW are analyzed. These analyzes are as follows:

Relationship between population and CDW amount; population is one of the main factors affecting the amount of CDW. For a sustainable future, it is necessary not only to ensure the waste recycling rate, but also to reduce the amount of waste per person. As a result of the analysis made for this purpose:

Data from 33 of 37 countries has been reached

Population from 33 of 37 countries increased

Per capita CDW rate from 7 of 37 countries decreased, 7 of them remained stable and 19 of them increased (Figure 4).

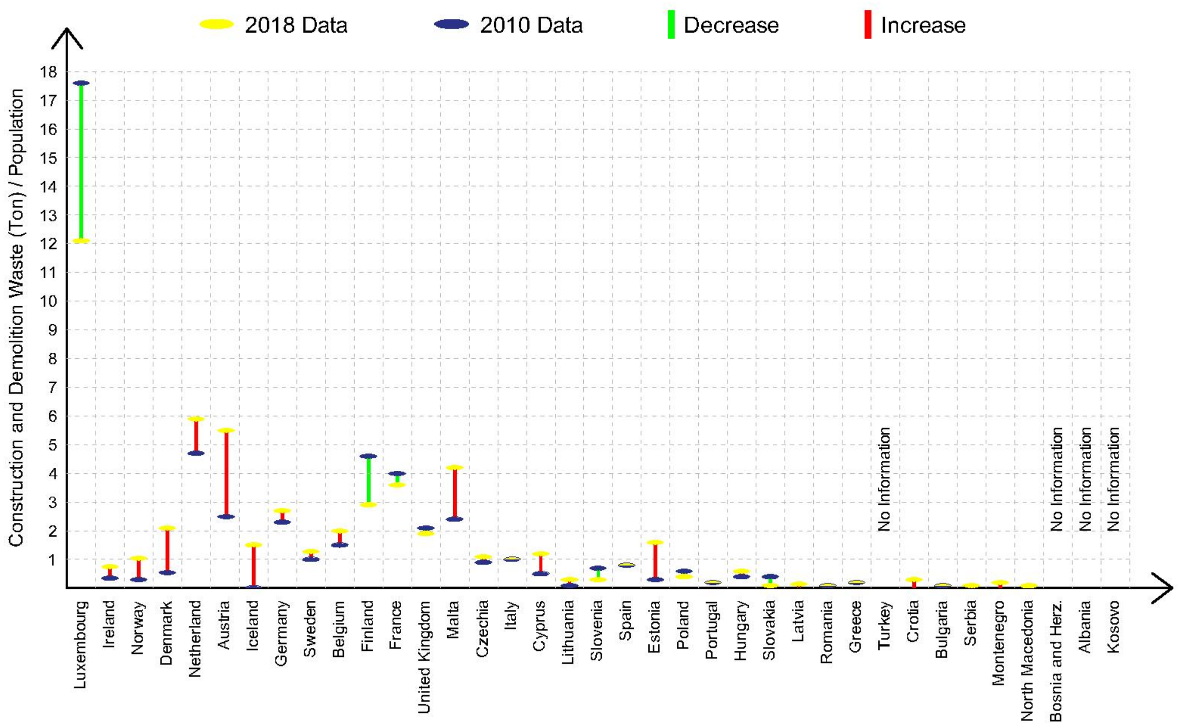

Figure 4. The graph of per capita CDW data compared to 2010 and 2018

Relationship between economic growth and CDW amount; another important issue affecting the amount of CDW is economy. Because one of the main sources of economic development and investment is construction activities. As a result of the analysis on economic growth and the amount of CDW:

Data from 30 of 37 countries has been reached

While the economy of 29 countries had improved, the economy of 1 country had deteriorated, Among the countries with economic growth, 6 of them decreased the amount of CDW, while 22 of them increased the amount of CDW (Figure 5).

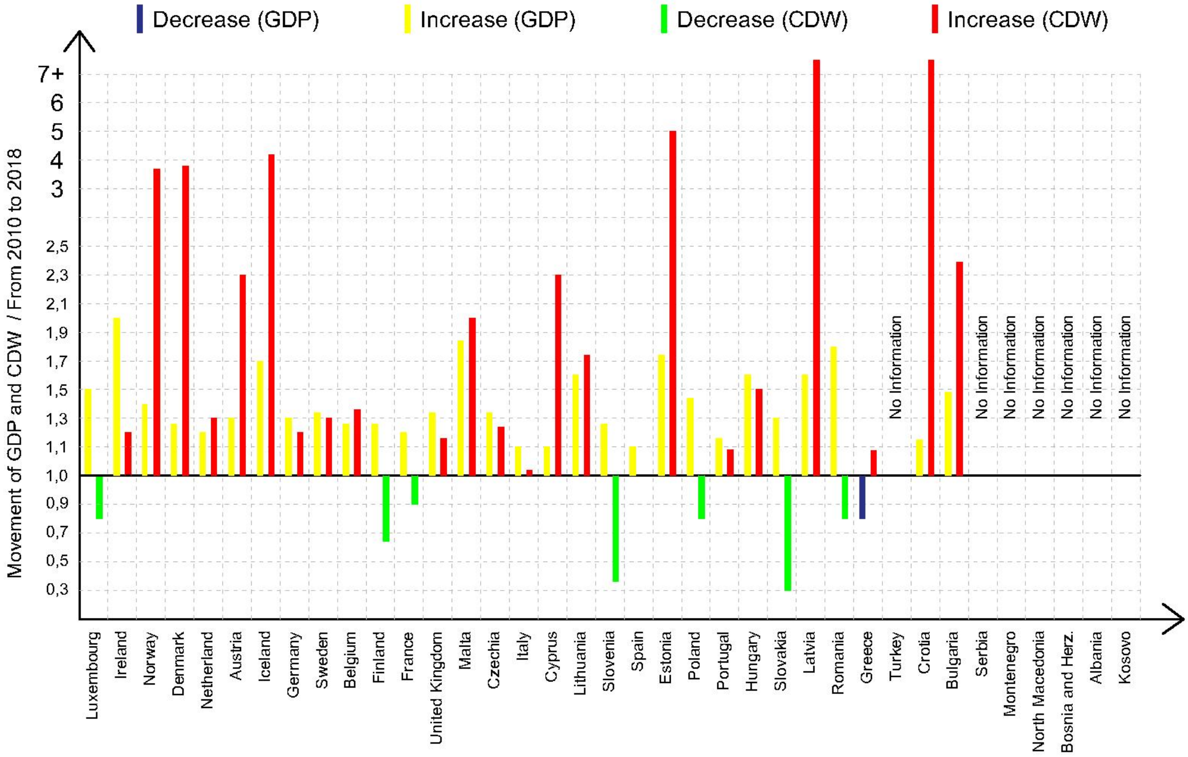

Figure 5. The graph of the change in the economy and CDW amount compared to 2010 and 2018

CDW recycling and recovery rate; in accordance with the protocol of the EU, countries must recycle and recover at least 70% of CDW in 2020. Within the scope of this target, the 2010 and 2018 data of the countries were analyzed and a change graph was created. As a result of the analysis:

Data from 5 of 37 countries hasn't been reached, data from 5 of them are incomplete and data from 27 of them has been reached,

Among these 27 countries, the CDW recycling and recovery rate of 20 countries increased, 5 countries decreased and 2 countries remained stable,

CDW recycling and recovery rate of 28 countries is above the target (70%) (Figure 6).

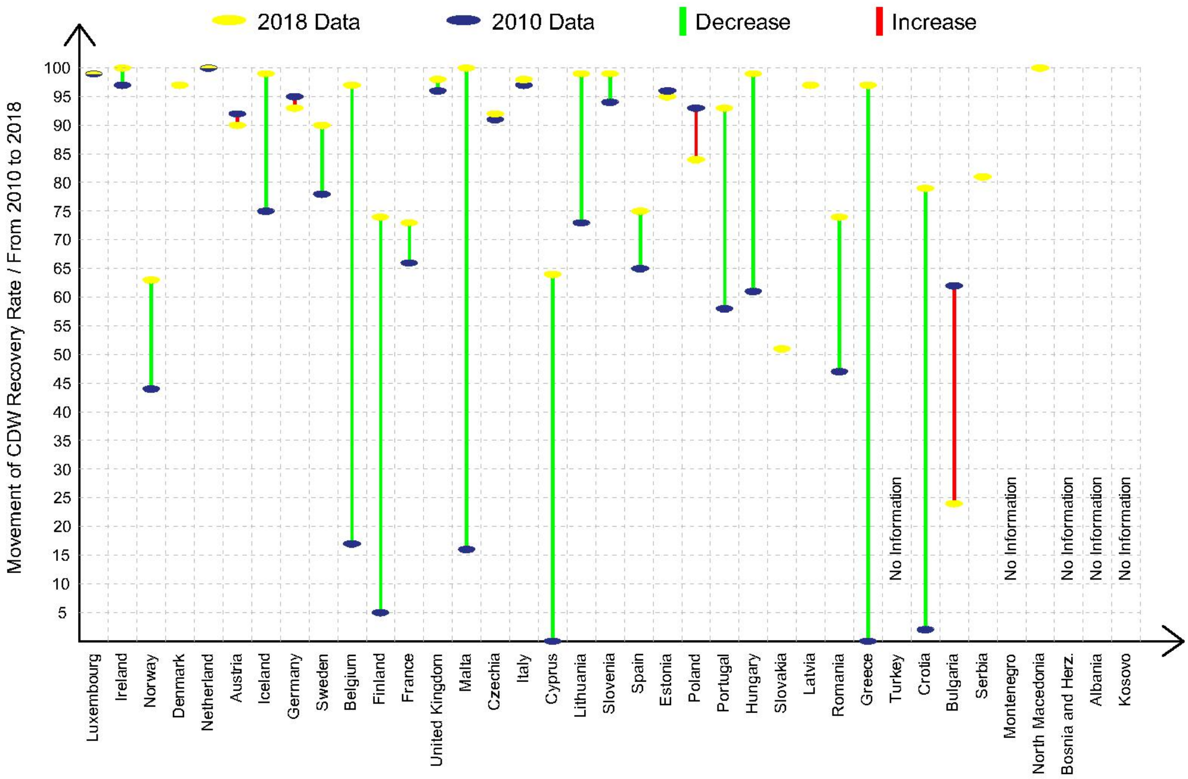

Figure 6. The graph of the change in the CDW recycling and recovery rates of the countries compared to 2010 and 2018

4. DISCUSSION

One of the organizations that set targets and succeed in sustainable waste management is the European Union. When the European Union member and candidate countries are examined, the following can be said in general:

The population of the countries and the amount of CDW are directly proportional.

Among the analyzed countries, the population of 12 countries has decreased, but only 1 of these countries has a decrease in the amount of CDW per capita.

Relationship between CDW and population; The population number is directly proportional to the CDW, but the amount of CDW per capita is determined by the country strategy, not by population increase or decrease.

The relationship between economic development and the amount of CDW differs. Economic development can enable construction activities or construction activities can improve the economy, but there have been many exceptional development differences between the data of them.

In countries with relatively developed economies, the rate of CDW recycling and recovery is generally above average. It is thought that the reason for this may be the initial investment required for recycling (recycling facilities etc.) as well as the country strategy.

The recycling and recovery rate of the CDW of the European Union member and candidate countries is generally high. 75% of the 37 analyzed countries (28 countries) are above the target determined as of 2018. The rate from 3 of the other analyzed countries is in an increasing trend.

The main reason for this data is the incentives for the recycling targets set by the European Union Commission. The European Union Commission has set specific targets for countries. These targets are updated and regulated in certain periods. Countries reaching their targets can carry out R&D studies on waste strategies and establish innovative facilities thanks to the incentives.

5. RESULTS

As long as people continue to exist, they need to produce, and they have to consume. Therefore, waste generation is inevitable. This study aimed to compare the CDW recycling of EU countries and to discuss the reasons that affect the success and failure in this sense. When the methods of the countries that succeeded in this study are examined, the development of the waste strategy and the things to do for CDW can be listed as follows:

Regulations should be arranged at the level of the country or unions, and the relevant institutions and organizations should be authorized to apply.

Waste tax (tax on special wastes such as excavation waste) and its penalty should be regulated as a law,

Responsibilities assigned to public and private organizations should be determined and inspected,

Public and commercial organizations should be raised aware of the use of materials / supplies and the separation of wastes,

Firms or institutions that collect waste should perform this work at different times depending on the type of waste,

Lectures or seminars on effective material and energy use should be given in vocational training.

In order to sustain the ecosystem and provide a livable environment for future generations, human beings should be made conscious on the basis of societies about using raw materials effectively and nature cleanly. The knowledge that develops with awareness should be carefully handled in the construction sector, which constitutes a significant part of the waste generation, and the practices of successful countries in this sense should be an example to others.

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ECOLOGICAL, ECONOMICAL AND AESTHETIC USE OF EARTH-SHELTERED STRUCTURES IN ARCHITECTURE

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Abstract

Since the period when people started to live in a settled order, they have benefited from the soil to create shelter, protection and living spaces, and by the time of the industrial age, they largely abandoned the earth material. To reduce greenhouse gases, global warming and dependence on fossil fuels, the soil has come to the fore again today, and thus the place of soil and soil in architecture has been rediscovered.

Earth material, which has been used for centuries and known and referred to as a traditional material; With its natural, recyclable, economic and ecological features, has found a place in contemporary architecture and even brought a new breath to architecture by coming together with technology.

In architecture, soil can be evaluated in two different titles: earth structure and earth-sheltered. The concept of earth structure includes all kinds of building and building components in which the soil is used as a building material without firing. In this context, the wall and floor can be applied with various production techniques. If a building has a significant amount of earth in its parts that are in contact with its outer crust, it can be defined as an earth-sheltered structure. Reinforced concrete, steel, wood, adobe material can be used in the structural design of earth-sheltered structures, and the earth layer act as insulation (İncesakal, 2011).

The earth-sheltered structure can be classified as hillside, bermed and underground. In the hillside type, three walls are covered with earth, one wall allows door and window openings and is built above ground. The bermed type structure can be built above or partially below ground, covering earth walls and sometimes roof. In the underground type, the structure can be built underground or deeper than ground level, with a central courtyard or atrium (URL-1).

Earth-sheltered structures can go under the ground and maximize the building usage area in small plots. The earth excavated during the construction phase can also be reused. It effectively uses available resources, minimizing energy consumption both in construction and in the structure's use. With the soil layer acting as insulation, the interior of the building becomes cool in summer and warm in winter. This saves energy costs. It has a less external surface area, so less building material is used in its construction and building maintenance costs are also lower. Earth-sheltered structures, which are in harmony with nature and contribute to the landscape in topography, require less maintenance because of their less externally protected surfaces. It creates healthy and comfortable spaces for users; It causes minimal damage to existing land and even offers new and enriched habitats for plants and animals. Earth-sheltered structures, which create a quiet living space in harmony with the environment, allow their users to live in an isolated space. Difficulties such as taking daylight and ventilation of buildings that are sheltered against hurricanes and strong winds can be overcome with appropriate design and developing technology.

In this study, earth-sheltered structures are handled in the context of ecology, economy and aesthetics through today's museum samples. With the study, it is aimed to draw attention to the earth -sheltered structures and to contribute to increase the interest in the subject. In this context, earth-sheltered museum buildings built today are evaluated under ecological, economic and aesthetic main headings, * cover type, * climate / orientation, * plant type / rainwater use, * protection from environmental effects, * natural ventilation / lighting, * heating and cooling load * are examined under the view subheadings.

As a result of the study, it was seen that the earth-sheltered museums, which are the image structures of the city, add ecological, economic, and aesthetic value to the cities and revive the lost nature-culture-human interaction. It is thought that this situation will also be a source of inspiration for the earth-sheltered structures to be built in different scales and functions in the building sector.

Keywords: Earth, earth-sheltered structures, energy, ecology, museum

INTRODUCTION

Soil; It is the source, basis, and one of the most essential elements of life together with air, water and temperature (Tanoğlu, 2015). Soil has many functions that enable and enrich ecological, socio-economic, and cultural life. It is difficult to rank the importance of these functions because all these functions are critical to the form of life.

Functions of Soil				
The Living	Living environment for vitality	Food, fiber and fuel supply	Genetic Species Richness	Pharmaceutical Raw Material
Ecology	Nitrogen Cycle	Carbon Capture	Water Filtering / Soil Pollution Reduction	Climate Regulation Flood Regulation
Built Environment	Provides raw materials for building materials	For structures, foundation space	Cultural heritage	

Table 1. Functions of Soil (URL-2, 2020)

Soil, which has an important task in creating the built environment, can be evaluated in two basic headings as an earth-sheltered structure and earth structure in architecture. Earth structure refers to all kinds of building and building components in which the soil is used without firing. The earth-sheltered structure is that the outer shell of the building is covered with soil to a great extent. (URL-3).

The earth-sheltered structures, which are the subject of this study, were built for purposes such as shelter, protection from harsh climatic conditions, and places of worship, which have been created in different forms underground and above ground in different geographies throughout history. One of the oldest samples of earth-sheltered structures dating back to 5000 BC is the Skara Brae in Northern Scotland. Another historical sample of earth-sheltered structures is Mesa Verde in the southwestern United States. (Milanović vd., 2018).

Figure 1,2. Skara Brae, Mesa Verde (URL-4,5)

The concept of today's earth-sheltered structure started to develop in the middle of the 20th century. Earth-sheltered structures used for defence/protection purposes in World War II gained popularity again with the effect of the energy crisis caused by the 1973 oil embargo (URL-6). People looking for energy-efficient alternatives to traditional buildings have rediscovered earth-sheltered structures.

Why Earth-Sheltered Structures?

The building sector does not produce energy, it is one sector where energy is used largely. Energy consumption in the sector starts from material production and continues until the post-use phase. Earth-sheltered structures provide significant energy savings due to their thermal advantages.

According to the US National Renewable Energy Laboratory (NREL), the indoor temperature of earth-sheltered structures changes less than traditional structures. Less temperature change makes interiors more comfortable (URL-7). The earth-sheltered structure can passively use solar energy with the solar storage of the soil to virtually eliminate the need for any additional heating or cooling load. The building whose main facade is placed in the south (for the northern hemisphere) can benefit from the sun's heat. Earth-covered surfaces also act as a thermal mass to store heat and release that heat slowly into the well-insulated earth-sheltered structure (URL-7).

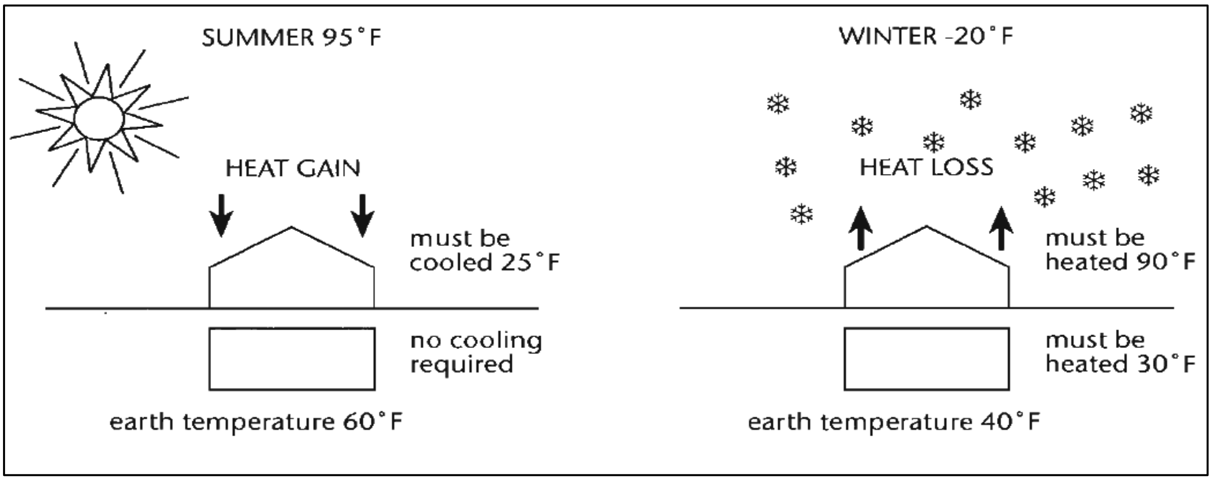


Figure 3. Summer / winter thermal advantages of the earth sheltered building (Boy, 2009)

As part of this study, the ecological, economic, aesthetic dimension of earth-sheltered structures is given in the table below.

Ecological benefits	Since the exterior of the building is mostly covered with vegetation, erosion, sedimentation and rainwater flow are controlled. It helps preserve existing habitat and biodiversity. It produces less carbon footprint. It reduces the heat island effect on cities (URL-8). Light pollution is reduced thanks to the low reflectance soil surface. Natural ventilation and natural light facilities are used.
Economic benefits	With the earth layer acting as insulation, the temperature inside the building stays constant, becoming cool in summer and warm in winter. This saves about 80% on energy costs. By adding solar energy design to the building, energy use can be reduced to zero, and hot water and heat can be provided throughout the year. Earth-sheltered structures require fewer maintenance costs due to the fewer surfaces that form the facade (URL-9).
Aesthetic benefits	The earth cover provides an aesthetic appearance by ensuring the continuity of the landscape.

Table 2. Benefits of earth-sheltered structures

EARTH-SHELTERED STRUCTURES TYPE

The difference in the formation of earth-sheltered structures has also been reflected in the names, and three different building types have been seen as hillside, bermed and underground (Hassan et al., 2013). Mud brick, wood, reinforced concrete and steel materials have been used in the structural design of the earth-sheltered structures from the past to the present, and the earth cover has served as insulation. (İncesakal, 2011).

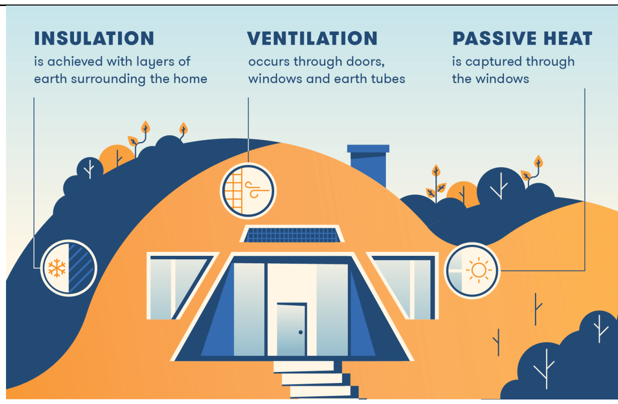
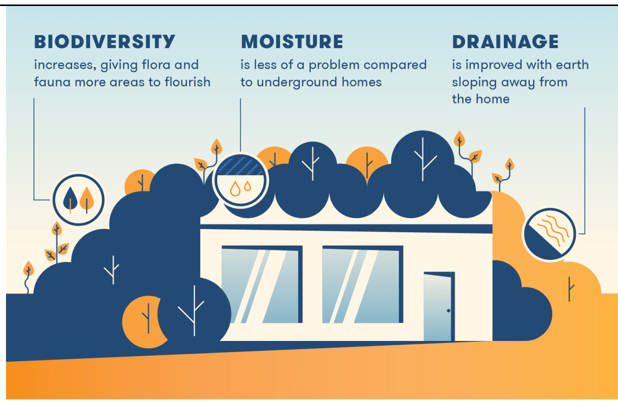
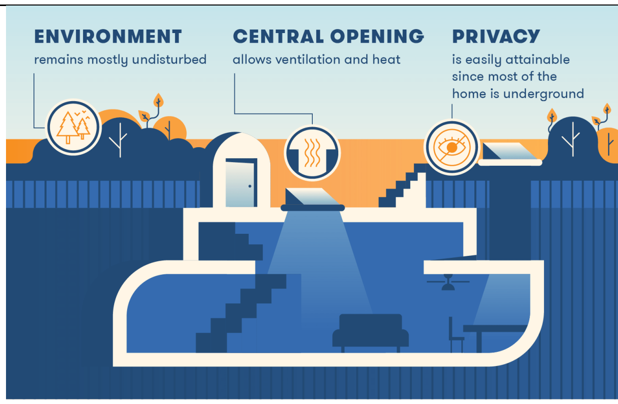
Hillside Type: It is a type of earth-sheltered structure where the structure is placed in sloping land or in the hillside. In this type of earth-sheltered structure, only one wall is exposed and all other walls are inside the hill and surrounded by earth (İncesakal, 2011). It is appropriate to build on the southern slope in the northern hemisphere and on the northern slope in the southern hemisphere, in order to effectively use solar energy. It is the most widely used type of ground cover structure in cold and temperate climates (URL-10).	 Figure 4. Hillside type (URL-11)
Bermed Type: It is a type of earth-sheltered structure built by piling soil on the outer walls of the building and creating a slope surrounding the outer walls. In this type of structure, window and door openings can be formed in one or more directions of the building by covering completely or partially with soil (İncesakal, 2011). Strategically placed skylights can provide adequate ventilation and daylight. In the Bermed type, natural light can be accessed from multiple directions.	 Figure 5. Bermed type (URL-11)
Underground Type: When almost all or all of the structure is built underground, it is called an underground structure. Access to the structure can be achieved through an atrium or courtyard design. The atrium is almost invisible from ground level, creates a special open space and protects the structure from winter winds. Passive solar gain (heat from windows) may be limited due to the location of the windows of the house (URL-1). The underground type is mostly built in hot climates (URL-11).	 Figure 6. Underground type (URL-11)

Table 3. Earth-Sheltered Structures Type

EARTH-SHELTERED MUSEUM SAMPLES

Museum; It is the place where art, culture, science and technical works or things useful for these branches are preserved, evaluated, and exhibited in order to see and benefit (Hasol, 2014). The museum concept, which first emerged with the Renaissance, has gained a monumental quality since the mid-20th century (Ozanözü & Onaran, 2015). Museums have collection, documentation, exhibition, protection, education and research functions (Ayaokur, 2014). Museums, which are the carriers of cultural heritage from past to present, are structures that are effective in shaping the consciousness of society. Today, besides the social sustainability role of museums, environmental sustainability has also become important. Using natural resources and topography effectively is important in museums, which are the city's prestigious structure. Therefore, in this study earth covers affecting the design of museums with earth-sheltered has been examined under three main headings: ecology (* cover type, * climate/orientation direction, * plant type/rainwater use, * protection from environmental effects, * natural ventilation/lighting) economy (* heating and cooling load), aesthetics (* appearance).

1.Moesgaard Museum

Figure 7,8.Moesgard Museum (URL 12,13)

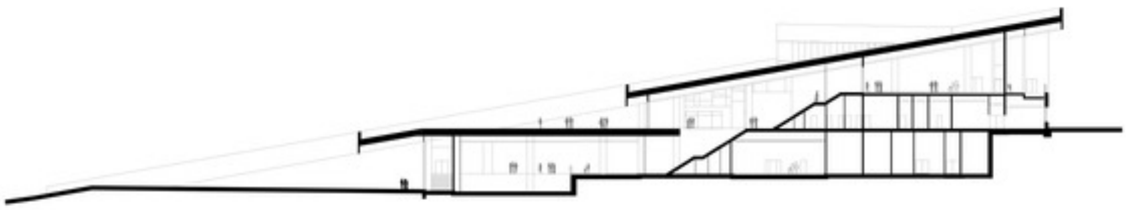


Figure 9. Section of Moesgard Museum (URL-14)

A. Architect/ Location/ Year / Function	Henning Larsen/ Denmark / 2014 / Archaeological and Ethnographic Museum
B. General Information of the Museum	Architecture, nature, culture and history unite in a single building in the Moesgard Museum. The museum which looks like it is out of the ground, has an area of 16,000 square meters. (URL-12). The sustainable strategy of the museum is integrated into architectural design. Basic elements such as the building's geometry and orientation have been thoroughly considered in order to use every square meter effectively (URL-13).
C. Information on Earth-Shelter	
C.1. Ecological	
Earth-Sheltered Type	The museum was built in bermed type.

Climate / Orientation	The museum is located in the hot humid continental climate zone (URL-15). The earth cover is in the south direction.
Plant Type / Use of Rainwater	The earth cover includes grass, moss, and brightly colored wildflowers (URL-16). Rainwater can be easily drained thanks to the museum's sloping earth cover (URL-17).
Protection from Environmental Affects	The earth cover, which slopes to the south, protects the exhibits from direct sunlight.
Natural Ventilation / Lighting	Natural lighting / ventilation is provided from the glass-enclosed parts connected to each exhibition room. In these spaces, visitors can take a bright break from the darkness of the exhibition areas (URL-13).
C.2. Economic	
Heating and Cooling Load	Located in the hot humid continental climate zone, the roof of the museum with earthen roof limits heat absorption, reducing the overall cooling requirement (URL-17).
C.3. Aesthetic	
Appearance	The rectangular roof plane rises from the topography and allows recreational use (URL-17).

Table 4. Moesgaard Museum Design Decision

2.Biesbosch Museum

Figure 10,11: Biesbosch Museum (URL-18)

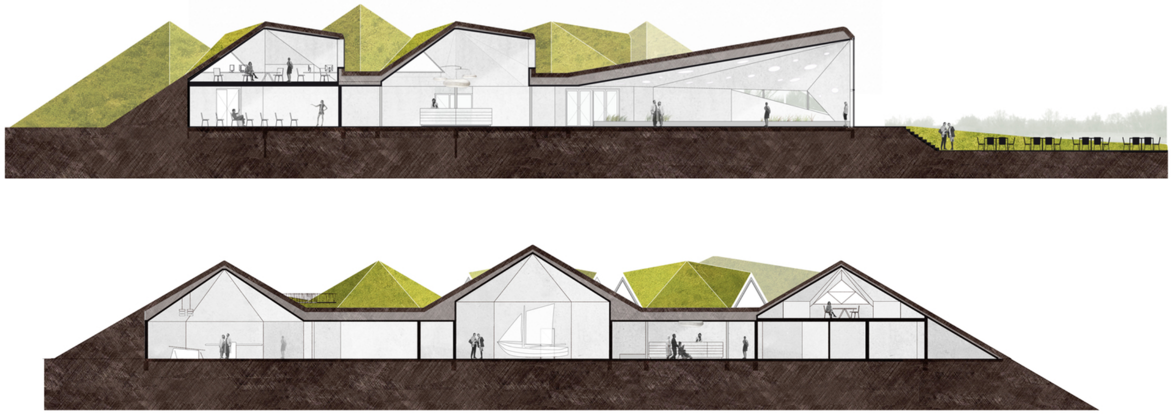


Figure 12, 13: Section of Biesbosch Museum (URL-18)

A. Architect/ Location/ Year / Function	Studio Marco Vermeulen/ Netherlands / 2015 / General
B. General Information of the Museum	The museum was built in Biesbosch National Park with the theme of water safety (URL-19). To avoid unnecessary material or energy waste, the hexagonal structure of the original Biesbosch Museum pavilions has been preserved and a new 1000 m^2 annexe has been built on the southwest side of the building. The old and new parts of the museum are surrounded by earth.
C. Information on Earth-Shelter	
C.1. Ecological	
Earth-Sheltered Type	The museum was built in bermed type.
Climate / Orientation	The museum is in the temperate-oceanic climate zone (URL-20). The earth cover is in the south, east and west directions.
Plant Type / Use of Rainwater	There are species that grasp the earth or dry the water in the earth cover's (URL-21).
Protection from Environmental Affects	The earth cover of the museum acts as insulation, increasing the acoustic performance of the museum and providing quiet spaces.
Natural Ventilation / Lighting	Large windows on the roof provide natural lighting / ventilation to museum offices.
C.2. Economic	
Heating and Cooling Load	Earth cover acts as insulation and heat buffer and this heat is used for heating in winter and cooling in summer. On cold days, heats the museum by underfloor heating (URL-18).
C.3. Aesthetic	

Appearance	The earth-sheltered museum becomes a sculptural object, adding ecological value to the land.

Table 5. Biesbosch Museum Design Decisions

3. Los Angeles Museum of the Holocaust

Figure 14,15: Los Angeles Museum of the Holocaust (URL-22)

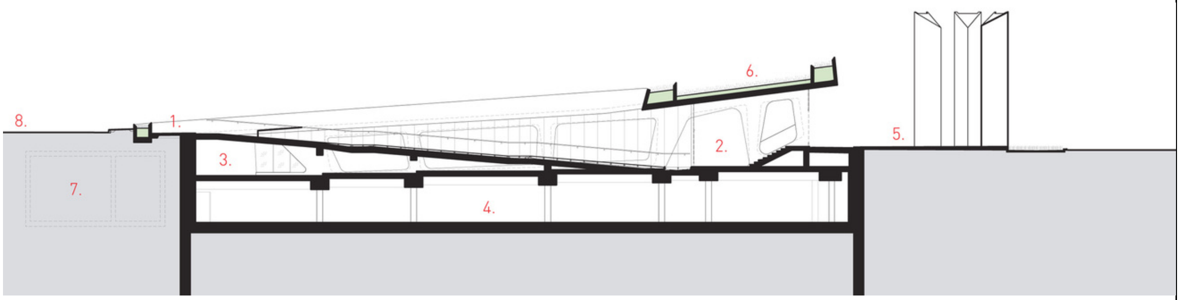


Figure 16: Section of the Los Angeles Holocaust Museum (URL-23)

A. Architect/ Location/ Year / Function	Belzberg Architects/ USA/2010/ History Museum
B. General Information of the Museum	The museum is in the park next to the Holocaust Monument. The museum was built underground in order to maintain the existing landscape of the park and to ensure the continuity of ecology (URL-22).
C. Information on Earth-Shelter	
C.1. Ecological	
Earth-Sheltered Type	The museum was built in underground type.
Climate / Orientation	The museum is in the hot summer Mediterranean climate zone (URL-24). The earth cover of the museum is inclined to the south.
Plant Type / Use of Rain Water	There are local drought-tolerant plants on the earth cover (URL-22).

	The museum is above a groundwater spring. Pipes connecting the cisterns to the roof irrigate the park vegetation, eliminating the use of tap water (URL-25).
Protection from Environmental Affects	Since the museum is in the ground, it is less affected by environmental influences such as wind and rain.
Natural Ventilation / Lighting	Although the museum is underground, over 75% of it receives natural daylight with appropriately sized openings (URL-25). The main ramp at the museum entrance contributes to natural lighting and ventilation (URL-25).
C.2. Economic	
Heating and Cooling Load	The earth cover and underground location of the museum provide heat insulation to a great extent. This is constant natural light; lowers total energy consumption for heating, cooling and lighting (URL-25).
C.3. Aesthetic	
Appearance	The museum continued the green texture by merging with the parking area and increased the usage area of the park.

Table 6. Los Angeles Holocaust Museum Design Decisions

4.TIRPITZ Museum

Figure 17,18: TIRPITZ Museum (URL-26)

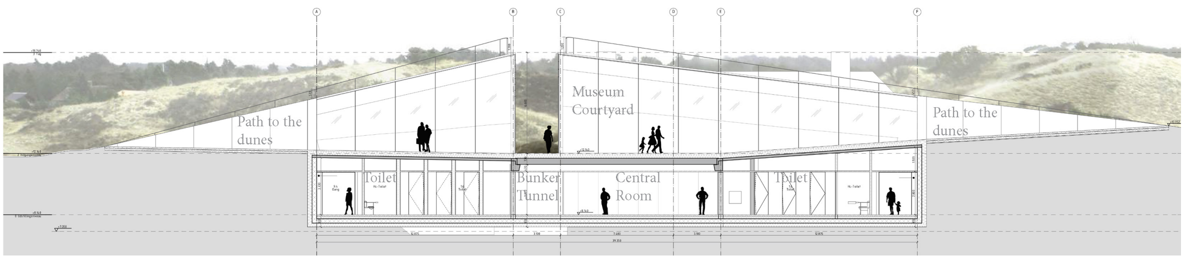


Figure 19: Section of TIRPITZ Museum (URL-27)

A. Architect/ Location/ Year / Function	BIG/ Denmark/ 2017/ History Museum
B. General Information of the Museum	The museum, which was built next to the German shelter from the Second World War, comprises four sections in a single structure placed on topography (URL-26). Four main exhibition galleries are

	built around the courtyard. Based on the historical characteristics of the campus, the project is covered with earth in order not to change the landscape and to establish a fluent dialogue between the old and the new. After visitors first encounter the shelter, they reach the museum courtyard via a ramp.
C. Information on Earth-Shelter	
C.1. Ecological	
Earth-Sheltered Type	The museum was built in underground type.
Climate / Orientation	The museum is in the temperate oceanic climate zone (URL-28). The earth cover of the museum is inclined in four directions.
Plant Type / Use of Rain Water	There are bush-type plants on the earth cover (URL-29).
Protection from Environmental Affects	The underground building is protected from the weather. The earth layer allows for quiet spaces.
Natural Ventilation / Lighting	Natural lighting/ventilation is provided inside the spaces with large windows around the courtyard under the earth cover. The courtyard underground allows natural.
C.2. Economic	
Heating and Cooling Load	It reduces heating and cooling costs with the earth's thermal mass.
C.3. Aesthetic	
Appearance	The museum attracts the attention of visitors as it is camouflaged with earth-sheltered. The museum integrates with the landscape by preserving the historical and natural environment.

Table 7. TIRPITZ Museum Design Decisions

5.Chichu Museum

Figure 20, 21: Chichu Museum (URL-30)

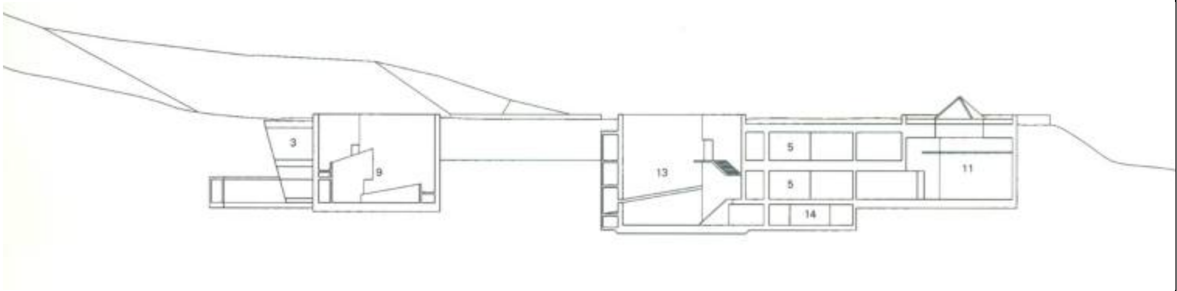


Figure 22: Section of Chichu Museum (URL-31)

A. Architect/ Location/ Year / Function	Tadao Ando/ Japan/ 2004/ Art Museum
B. General Information of the Museum	The Chichu Museum was built in Japan in 2004, rethinking the nature-human relationship. Most of the museum was built underground to avoid affecting the view of the Seto Sea. (URL-30). Chichu means 'underground' and the museum galleries set in a rugged area only preserve the works of Claude Monet, Walter De Maria and James Turrell (URL-32).
C. Information on Earth-Shelter	
C.1. Ecological	
Earth-Sheltered Type	The museum was built in underground type.
Climate / Orientation	The museum is in the subtropical climate zone (URL-33). The earth cover of the museum is inclined in four directions.
Plant Type / Use of Rain Water	The earth cover of the museum is covered with grass.

Protection from Environmental Affects	Earth surfaces protect artworks where sunlight should not come. It provides isolated and quiet spaces for art lovers.
Natural Ventilation / Lighting	The museum receives a lot of natural light from the openings on the earth cover, which changes the appearance of the artworks and the ambience of the space during the day (URL-30).
C.2. Economic	
Heating and Cooling Load	The earth layer provides heat-sound control with its insulation feature.
C.3. Aesthetic	
Appearance	Since the museum is underground, it is a continuation of the landscape. The museum does not interrupt the view with its earth cover and adapts to the topography.

Table 8. Chichu Museum Design Decisions

6. Museum of Troy

Figure 23, 24: Museum of Troy (URL-34)

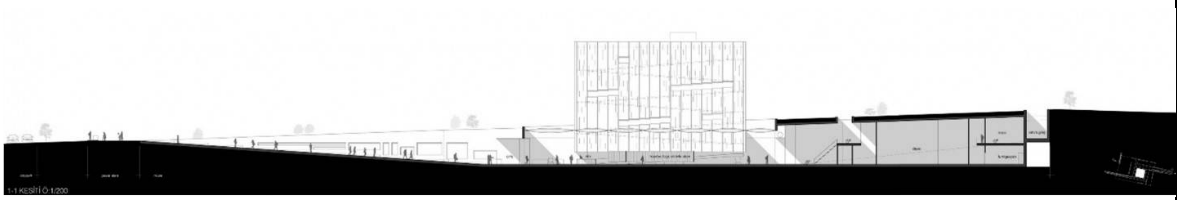


Figure 25: Museum of Troy Section (URL-35)

A. Architect/ Location/ Year / Function	Yalın Architects/ Turkey / 2018 / Archeology
B. General Information of the Museum	The archaeological museum, which is about the history of the city of Troy, gives the feeling of "an artifact removed from the excavation area" with its corten facade coating (URL-36). Access to the Troy Museum is provided from a 12-meter ramp. The part of the museum which is covered with 32x32 m^2 corten material visible from the outside, is like pottery removed from the soil; It gives the feeling of being lived behind with its unique texture (URL-34).
C. Information on Earth-Shelter	
C.1. Ecological	

Earth-Sheltered Type	The museum was built in underground type.
Climate / Orientation	The museum is in the hot summer Mediterranean climate zone (URL-37). The earth cover of the museum is inclined in four directions.
Plant Type / Use of Rain Water	5.000 m^2 earth cover contains 22 kinds of plants. Rain water is collected in the water tank next to the museum for the plants on the roof (URL-38).
Protection from Environmental Affects	Thanks to its earth protection, spaces isolated from the physical environment are got.
Natural Ventilation / Lighting	Thanks to the roof lights, natural ventilation / lighting is provided. The ramp at the entrance of the building allows natural ventilation.
C.2. Economic	
Heating and Cooling Load	Since the museum is located underground and is covered with earth, the heating and cooling load on the building is significantly reduced.
C.3. Aesthetic	
Appearance	The museum is hidden with an earth cover and the ancient city is highlighted.

Table 9. Troya Museum Design Decisions

EVALUATION

The 6 samples examined were evaluated with the tables created for the museum structure. Ecological, economical and aesthetic aspects of the samples,

Earth cover enhances the energy performance of museum buildings by increasing auditory, visual and thermal comfort,

Provides economic benefits by reducing the costs of earth cover heating-cooling,

It contributes to the acoustics of the museum by contributing to the sound insulation of the earth cover,

The earth cover offers healthier spaces for users by absorbing electromagnetic radiation,

Earth cover protects the exhibited works from direct sunlight,

It functions as a recreation as well as a museum by allowing walking on the earth cover,

Thanks to the earth cover, it allows the reuse of the area lost from the ground,

The views hidden with earth cover make the museums more interesting,

Thanks to the earth cover, museums allow not only people but also different creatures to live,

Earth-sheltered museums fulfill the role of environmental sustainability as well as social sustainability,

such information has been reached.

Conclusion

Earth-sheltered structures have been used for different purposes in different geographies from past to present and have enabled human beings to live in harmony with nature.

Museum buildings, which are the carriers of social memory, preserved the science and artworks and continued the cultural heritage.

As a result, it has been observed that museums aim to continue nature-culture-human interaction regardless of their themes, the earth cover is integrated into museum buildings with ecological, economic, and aesthetic concerns and adds a sustainable vision. It is expected that this vision will be a source of inspiration for the building sector and the application of earth-sheltered structures in building uses with different functions will become widespread in the coming years.

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LAND USE CLASSIFICATION DATASET FOR SHKUMBINI WEAP MODEL, APPLYING QGIS SOFTWARE

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Abstract

Shkumbini river basin, as one of the seven biggest river basins in Albania, requires a proper management plan. Assessment of pressures on surface water and groundwater and their influence over water resources and environment should necessarily be considered. Different uncontrolled developments that have taken place primarily in the lowlands of the river basin have been a contributing factor to the rapid intensification of the erosion process, reducing green corridors and compromising environmental balances. Furthermore, data on natural conditions in conjunction with background statistic evaluations, including land use and land cover (agriculture, forestry, roads, constructed environments, etc.) have been crucial aspects during the first attempt of building a Water Evaluation and Planning (WEAP) model for the Shkumbini river. On this basis a reliable assessment of the water body status requires an appropriate knowledge of the whole hydrological conditions that continuously change, seasonally and annually. Additionally, the assessment helps to identify and analyze essential water system vulnerabilities with regard to future climate change and development scenarios.

INTRODUCTION

This document represents a detailed description of the methodology and calculations used for the assessment of the Land Cover areas for Shkumbini WEAP model. This effort is a part of the work in process for implementing an integrated water resource management model via utilization of WEAP (Water Evaluation and Planning) system, developed by SEI (Stockholm Environmental Institute). Land cover data was originally obtained from the EU CORINE 2012 dataset, covering the calibration period of the model (1991-2016). The WEAP model development was impelemented utilizing the open source QGIS software. The watershed elements in the WEAP model allow us to calculate the areas of different land use types within a catchment and specify their corresponding hydrology through calibration process. The model works on the principle that various land use areas can generate specific run-off, although only certain land use types permit that the intensive rainfall becomes instantaneous streamflow. Other areas may retain water and release it gradually, producing a constant run-off especially during periods of low rainfall. Once the values associated with land use parameters have been obtained and organized, future scenarios can explore the outcomes of land use changes. Finally, following the WEAP format requirements (SEI, 2016), a range of other specific methodologies were applied during the dataset preparation process.

Study area: Shkumbini River basin is completely situated within Albanian territory, located in its middle part (see Figure 1). Its basin, encompassing an area about 2464 km^2 is surrounded by mountain ranges from east to west generally, higher than 1500 m above sea level such as Valamara (2375 m), Kamje (1625 m) in the west, and Shebenik (2,180 m) and the Mokra mountains (2,148 m) in the easter part. Originating from these mountains, Shkumbini river is classified as a typical mountainous river, flowing in a relatively steep slope especially for the upstream part until reaching the city of Elbasan. The mean altitude of the river basin is around 753 m above sea level. Before flowing into the Adriatic Sea, Shkumbini River absorbs the waters of its biggest tributaries such as Bushtrica, Hotoloshti, Rrapuni, Gostima, Zaranika and Kusha. The annual average discharge of the river is about 58 m^3/s. Various small glacial lakes and reservoirs are present, especially in the upper section of the river basin. The Shkumbini River intersects 5 important prefectures along its 181,4 km length: Tiranë (the capital of Albania), Elbasan, Fier, Korçë, and Dibër. It runs with meanders through a narrow river bed before entering the Adriatic Sea by the Karavasta Lagoon. Shkumbini River Basin has a total population of around 413.293 inhabitants, mostly living in western flat areas of the basin, where urban areas with the biggest population density of the basin such as Elbasani city are situated; population density for Elbasani city goes up to 3567 inhabitants/km², and that of Kavaja city up to 2549 inhabitants/km².

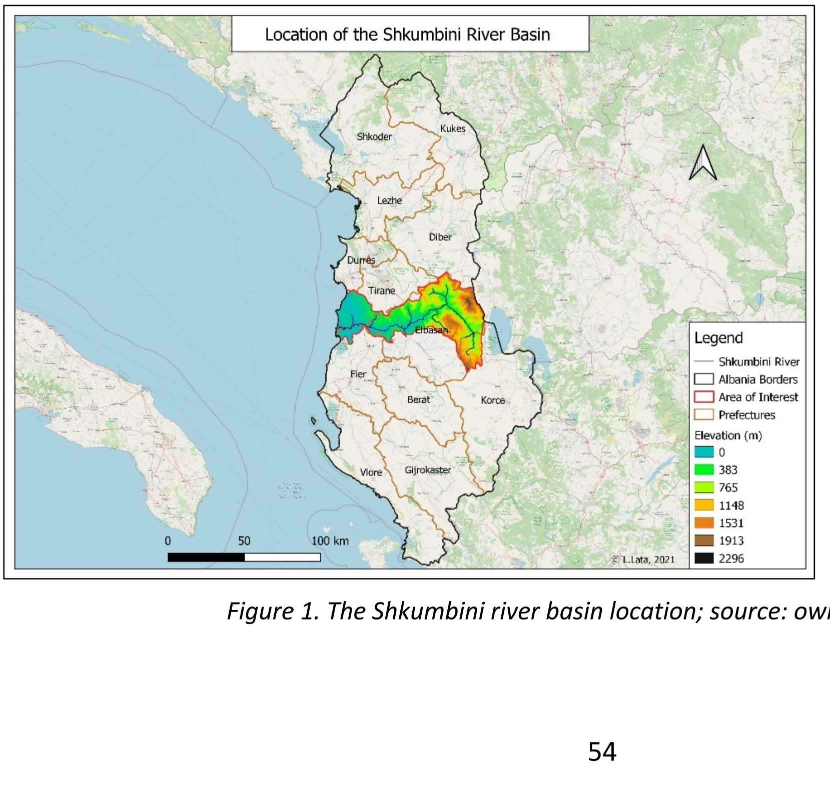


Figure 1. The Shkumbini river basin location; source: own elaboration.

The climate is typical Mediterranean, characterized by hot and dry summers and wet and mild winters. The mean annual precipitation in the catchment is 1400 mm. The snow is a normal phenomenon during the winter, especially on the eastern part of the river basin. Around half of the river basin has ultrabasic formations and the other half has calcareous and terrigenous formations, making it possible for this river basin to be rich in karst groundwater aquifers and water sources, thus providing good quality water to the above-mentioned urban areas. The groundwater availability is typically influenced by various factors such as morphological, hydrological, geographical and anthropogenic factors, however precipitation is the most significant among them.

Materials and Methods>

This manuscript is a documentation of the methods used to calculate land use areas for Shkumbini WEAP catchments. Various land use areas can generate specific run-off, however certain land use types permit the intensive rainfall to become instantaneous streamflow. Other areas may retain water and release it gradually, producing a constant run-off even during periods of low rainfall. The watershed elements in the WEAP model allow us to compute the areas of different land use types within a catchment and specify their corresponding hydrology through calibration process. Once the values for land use parameters have been obtained and organized, future scenarios can inspect the outcomes of land use change. To calculate land use by watersheds, the follwing elements are needed: a land cover vector file appropriately projected for Albania (WGS84, UTM Zone 34N), a table with the land use types (ex. Corinne's categories), and an already prepared vector/shape file with the boundaries of the Shkumbini subbasins (Figure 3 and Table 1).

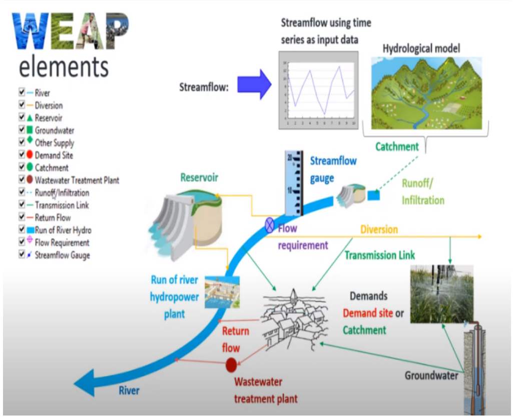


Figure 2. The main components incorporated in WEAP model; source: SEI, 2016.

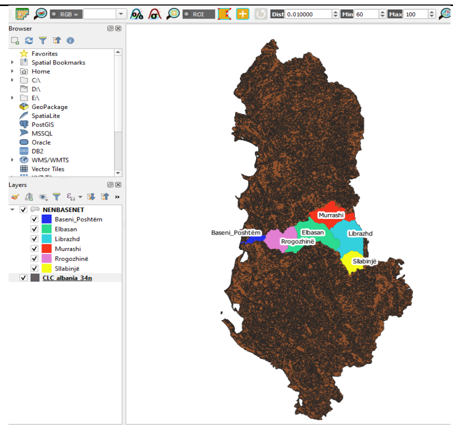


Figure 3. Land Cover vector file projected for Albania in WGS84, UTM Zone 34N and the Shkumbini subbasins in QGIS software.

A vector represents an area using points, lines, and polygons. Vector models are useful for storing data that has discrete boundaries, such as country borders, streets and land use. Vectors can hold many different categories and respective values, which can be viewed in the attribute table. On behalf of this study the watershed delineation of the Shkumbini river basin is performed, derived from a DEM (Digital Elevation Model) via utilization of the QGIS software (Figure 3). The Shkumbini surface area for the six subbasins is provided in the Table 1.

ID	Shkumbini River watersheds	Area (km^2)
1	*Sllabinjë*	248
2	*Librazhd*	586
3	*Murrashi*	448
4	*Elbasan*	668
5	*Rrogozhinë*	*391*
6	*Baseni_Poshtëm*	*123*

Table 1. Shkumbini watersheds/ subbasins surface area.

Land cover data was provided by ASIG, the relevant institution in Albania providing the geospatial data and services (ASIG, 2021). The informacion was derived from the EU CORINE 2012 dataset, collected during the calibration period of the model (1991-2016). The CLC2012 file comes with a styled file (clc_legend.qml) which is a QGIS styling file (Figure 4. a, b).

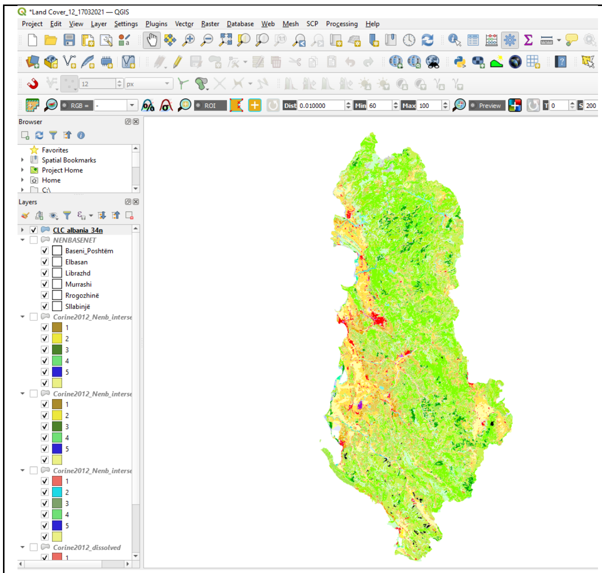
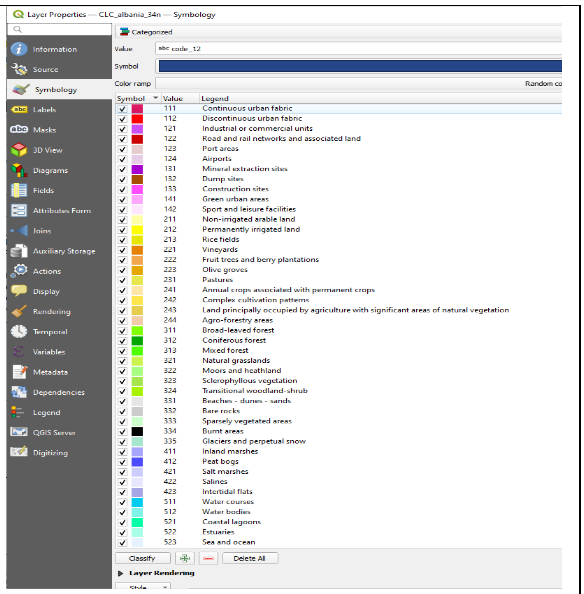


Figure 4. a) Albanian Land Cover 2012 classification in WGS 1984 UTM Zone 34N;



b) The symbology of CLC_2012 of Albania in QGIS.

This dataset provides 44 land cover classes at a scale of 1:100 000 for years 2000, 2006 and 2012. The minimum mapping unit of CORINE is 25 hectars (ha). Five meta categories in CORINE are "artificial surfaces", "agricultural areas", "forest and semi-natural areas", "wetlands", "water bodies". For input into the Shkumbini WEAP model, the classification values of the 2012 CORINE dataset were simplified into 10 types (Table 2) (where N/A means that the value did not show up in the Shkumbini watershed).

The first step in land use area calculation concerns selecting the land use types for Shkumbini river basin. The Corinne dataset (available for Albania) comes with 41 different land use types (Level 3), aggregated into 19 categories (Level 2) and 5 meta-categories (Level 1). However, not all of the 51 land use values appear in every area; with regard to the Shkumbini basin, only 44 distinct areas are represented. Using Level 1 categories of the land use types from the Corinne dataset, the following table shows how the land use types are consolidated for this project, totaling 5 different land use types.

Code	**CORINE Land Use**	**Shkumbini WEAP Land Use**
1	Continuous urban fabric	Artificial, non-agricultural vegetated areas
2	Discontinuous urban fabric	Artificial, non-agricultural vegetated areas
3	Industrial or commercial units	Artificial, non-agricultural vegetated areas
4	Road and rail networks and associated land	Artificial, non-agricultural vegetated areas
5	Port areas	N/A
6	Airports	Artificial, non-agricultural vegetated areas
7	Mineral extraction sites	Artificial, non-agricultural vegetated areas
8	Dump sites	N/A
9	Construction sites	Artificial, non-agricultural vegetated areas
10	Green urban areas	N/A
11	Sport and leisure facilities	Artificial, non-agricultural vegetated areas
12	Non-irrigated arable land	Arable land
13	Permanently irrigated land	Arable land
14	Rice fields	N/A
15	Vineyards	Permanent crops
16	Fruit trees and berry plantations	Permanent crops
17	Olive groves	Permanent crops
18	Pastures	Pastures
19	Annual crops associated with permanent crops	Heterogeneous agricultural areas
20	Complex cultivation patterns	Heterogeneous agricultural areas
21	Land principally occupied by agriculture, with significant areas of natural vegetation	Heterogeneous agricultural areas
22	Agro-forestry areas	N/A
23	Broad-leaved forest	Forests
24	Coniferous forest	Forests
25	Mixed forest	Forests
26	Natural grasslands	Scrub and/or herbaceous vegetation associations
27	Moors and heathland	Scrub and/or herbaceous vegetation associations
28	Sclerophyllous vegetation	Scrub and/or herbaceous vegetation associations

29	Transitional woodland-shrub	Scrub and/or herbaceous vegetation associations
30	Beaches, dunes, sands	Open spaces with little or no vegetation
31	Bare rocks	Open spaces with little or no vegetation
32	Sparsely vegetated areas	Open spaces with little or no vegetation
33	Burnt areas	N/A
34	Glaciers and perpetual snow	N/A
35	Inland marshes	Wetlands
36	Peat bogs	N/A
37	Salt marshes	Wetlands
38	Salines	N/A
39	Intertidal flats	N/A
40	Water courses	Waters
41	Water bodies	Waters
42	Coastal lagoons	N/A
43	Estuaries	N/A
44	Sea and ocean	N/A
48	NODATA	N/A
49	UNCLASSIFIED LAND SURFACE	N/A
50	UNCLASSIFIED WATER BODIES	N/A
255	UNCLASSIFIED	N/A

Table 2. CORINE Land use classes in 2012 (left) and WEAP generalized land use classes (right)

After some styling edits in QGIS and making the subbasins transparent:

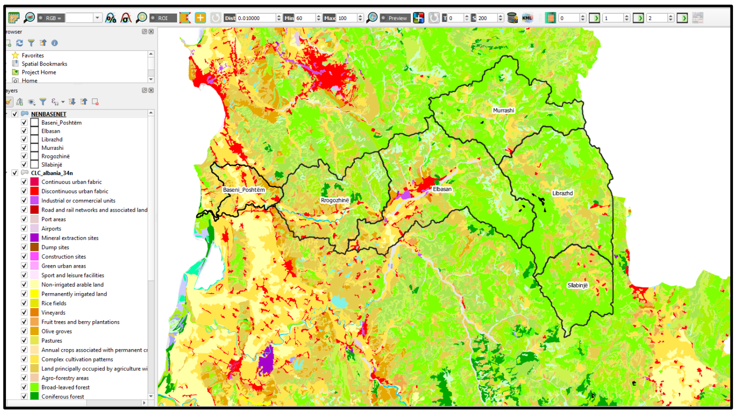


Figure 5. Shkumbini watersheds borders in QGIS (in the background is Albanian CLC_12 shape file).

For the aggregated land cover classes, the derived percentages should be fixed for each of the polygons. After applying Intersect algorithm in QGIS of the Corine land use/land cover classes with the subbasins, is then possible to calculate the class area of the intersected result. Then the proportion with the catchment area can be calculated, resulting in percentage per class according to the WEAP format. The new shape file is saved in the working environment in QGIS. The area is reduced as shown in Figure 6.

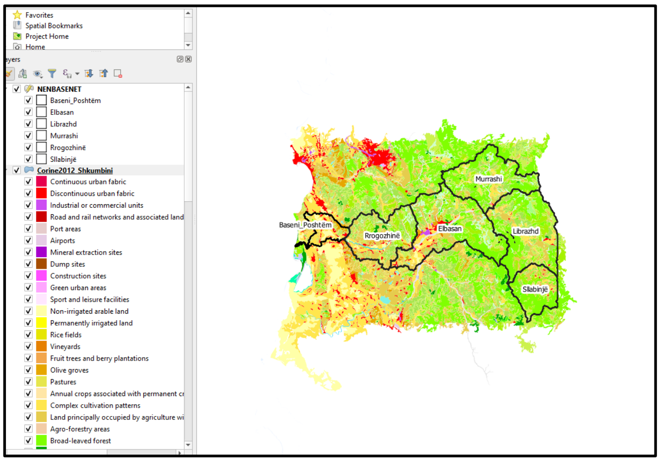
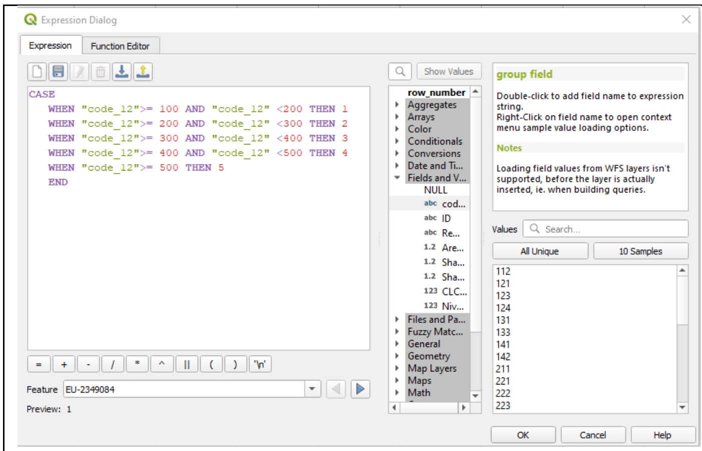
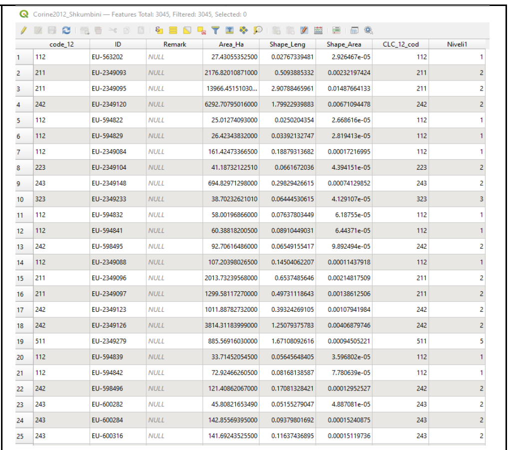


Figure 6. The interested area after applying Intersection in QGIS.

Level 3 of the Corine 2012 classes should be aggregated into the Level 1 which reduces the land cover in five classes. At the attribute table a new column is created with the name Level 1 (1 digit). This can be done through utilization of Expresion Dialog ne QGIS building up the formula as showing in the Figure 7.





Corine2012_Shkumbini — Features Total: 3045, Filtered: 3045, Selected: 0

	code_12	ID	Remark	Area_Ha	Shape_Leng	Shape_Area	CLC_12_cod	Niveli1
1	112	EU-563202	NULL	27.43055352500	0.02767339481	2.926467e-05	112	1
2	211	EU-2349093	NULL	2176.82010871000	0.5093885332	0.00232197424	211	2
3	211	EU-2349095	NULL	13966.45151030...	2.90788465961	0.01487664133	211	2
4	242	EU-2349120	NULL	6292.70795016000	1.79922939883	0.00671094478	242	2
5	112	EU-594822	NULL	25.01274093000	0.0250204354	2.668616e-05	112	1
6	112	EU-594829	NULL	26.42343832000	0.03392132747	2.819413e-05	112	1
7	112	EU-2349084	NULL	161.42473366500	0.18879313682	0.00017216995	112	1
8	223	EU-2349104	NULL	41.18732122510	0.0661672036	4.394151e-05	223	2
9	243	EU-2349148	NULL	694.82971298000	0.29829426615	0.00074129852	243	2
10	323	EU-2349233	NULL	38.70232621010	0.06444530615	4.129107e-05	323	3
11	112	EU-594832	NULL	58.00196866000	0.07637803449	6.18755e-05	112	1
12	112	EU-594841	NULL	60.38818200500	0.08910449031	6.44371e-05	112	1
13	242	EU-598495	NULL	92.70616486000	0.06549155417	9.892494e-05	242	2
14	112	EU-2349088	NULL	107.20398026500	0.14504062207	0.00011437918	112	1
15	211	EU-2349096	NULL	2013.73239568000	0.6537485646	0.00214817509	211	2
16	211	EU-2349097	NULL	1299.58117270000	0.49731118643	0.00138612506	211	2
17	242	EU-2349123	NULL	1011.88782732000	0.39324269105	0.00107941984	242	2
18	242	EU-2349126	NULL	3814.31183999000	1.25079375783	0.00406879746	242	2
19	511	EU-2349279	NULL	885.56916030000	1.67108092616	0.00094505221	511	5
20	112	EU-594839	NULL	33.71452054500	0.05645648405	3.596802e-05	112	1
21	112	EU-594842	NULL	72.92466260500	0.08168138587	7.780639e-05	112	1
22	242	EU-598496	NULL	121.40862067000	0.17081328421	0.00012952527	242	2
23	243	EU-600282	NULL	45.80821653490	0.05155279047	4.887081e-05	243	2
24	243	EU-600284	NULL	142.85569395000	0.09379801692	0.00015240875	243	2
25	243	EU-600316	NULL	141.69243525500	0.11637436895	0.00015119736	243	2

Figure 7. a) Expresion Dialog for Land cover aggregation from Level 3 to Level 1 of the CLC_2012.	*b) Attribute table after aggregation*

After saving the file, the Dissolve function was applied because there will be many polygons having the same land cover class; this should be considered as one Feature (Figure 8).

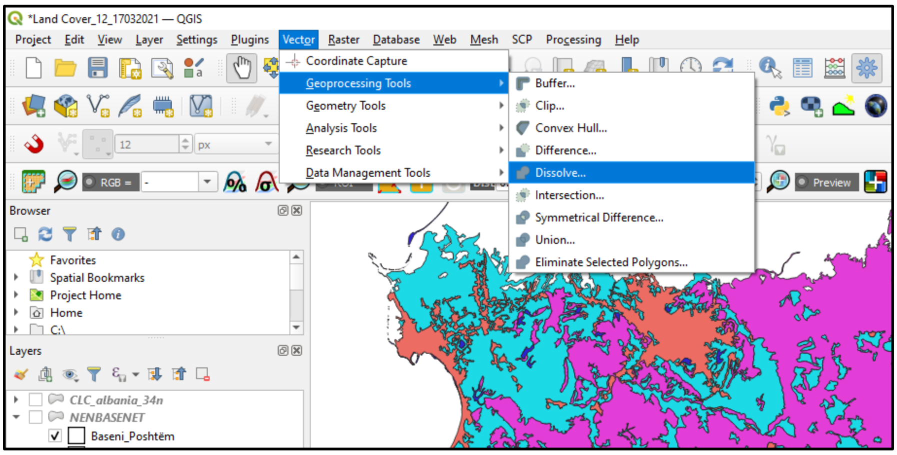


Figure 8. Applying Dissolve function based in the Level 1 of the CLC 2012.

The dissolved file is saved and the land cover classification is aggregated based on Level 1 field; as an example each polygon with number 1 will become one Feature and so on. Therefore, there is a reduction in the Corine land cover into five classes (1-5) as shown in the Figure 9.

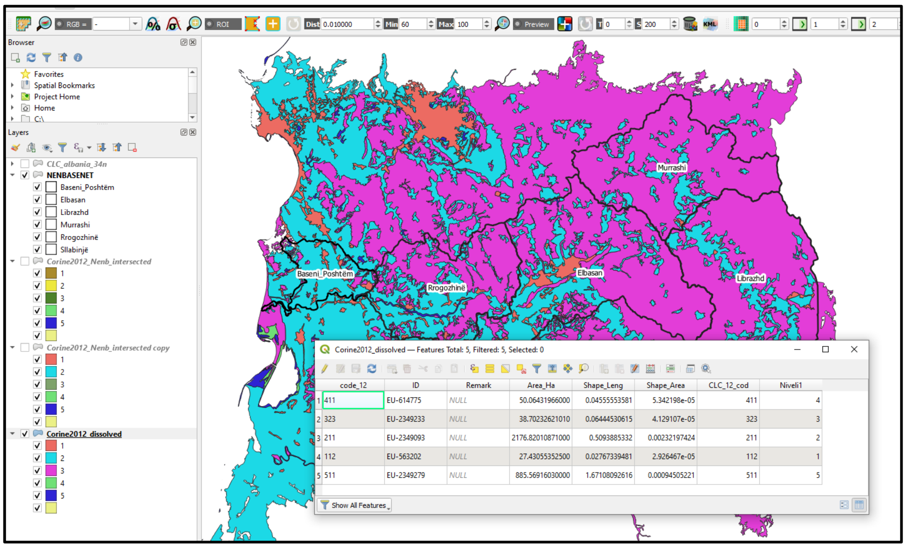


Figure 9. Dissolved Land cover into the Level 1 of the CLC_2012 (5 classes).

If we apply again the Intersection algorithm of the five Corine land cover classes with the Shkumbini watershed polygons, then it is possible to have the percentage of each of the classes in each of the subbasin/watershed. The output was saved (Figure 10. a,b).

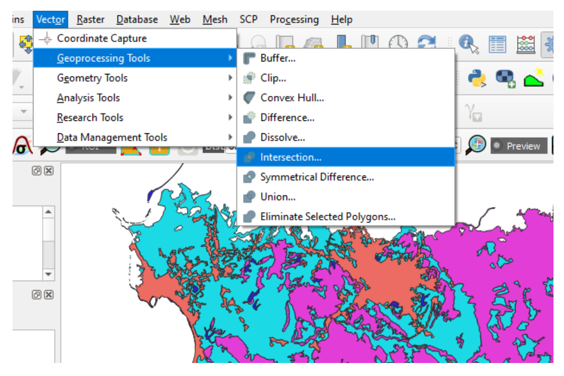
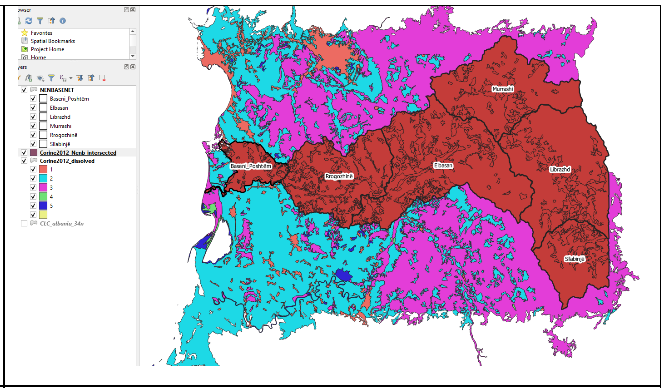


Figure 10. a) Browsing for applying Intersection of the polygon watersheds with the CLC 2012 classes.



b) The intersected polygons

Figure 11 shows only the Land Cover in the Shkumbini cachments, reduced into the five classes after applying the same styling as before in QGIS, so that each value represents a point in a spectrum of 1-41 using a color ramp.

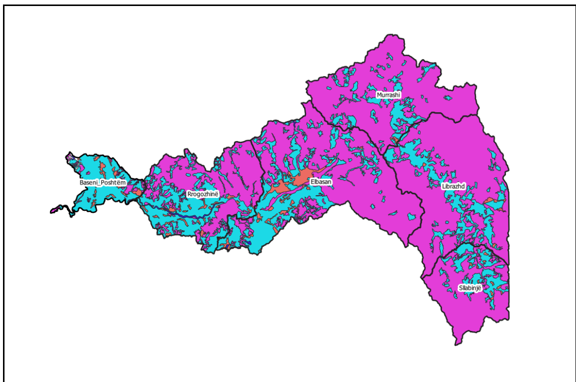
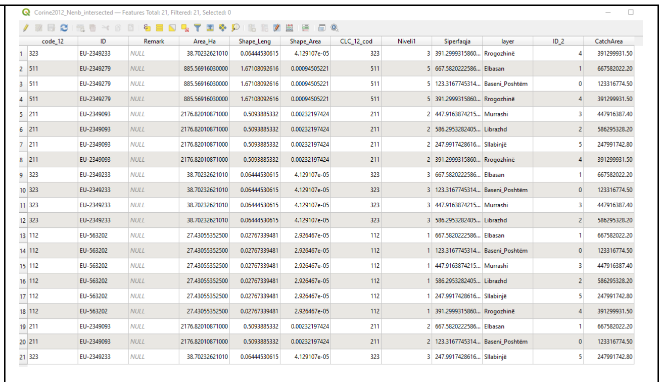


Figure 11. a) Corine Land Cover classes in each of the Shkumbini subbasins


Corine2012_Nenb_intersected — Features Total: 21, Filtered: 21, Selected: 0

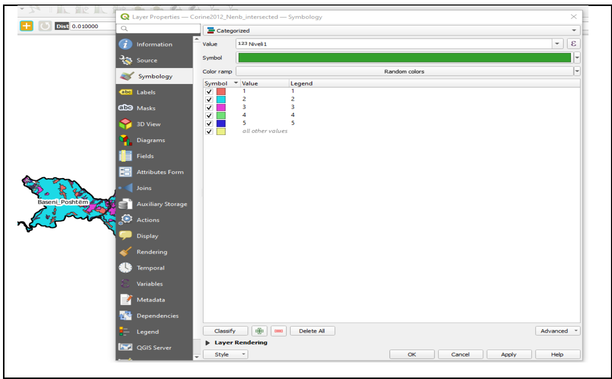
	code_12	ID	Remark	Area_Ha	Shape_Leng	Shape_Area	CLC_12_cod	Niveli1	Siperfaqja	layer	ID_2	CatchArea
1	323	EU-2349233	NULL	38.70232621010	0.06444530615	4.129107e-05	323	3	391.2999315860...	Rrogozhinë	4	391299931.50
2	511	EU-2349279	NULL	885.56916030000	1.67108092616	0.00094505221	511	5	667.5820222586...	Elbasan	1	667582022.20
3	511	EU-2349279	NULL	885.56916030000	1.67108092616	0.00094505221	511	5	123.3167745314...	Baseni_Poshtëm	0	123316774.50
4	511	EU-2349279	NULL	885.56916030000	1.67108092616	0.00094505221	511	5	391.2999315860...	Rrogozhinë	4	391299931.50
5	211	EU-2349093	NULL	2176.82010871000	0.5093885332	0.00232197424	211	2	447.9163874215...	Murrashi	3	447916387.40
6	211	EU-2349093	NULL	2176.82010871000	0.5093885332	0.00232197424	211	2	586.2953282405...	Librazhd	2	586295328.20
7	211	EU-2349093	NULL	2176.82010871000	0.5093885332	0.00232197424	211	2	247.9917428616...	Sllabinjë	5	247991742.80
8	211	EU-2349093	NULL	2176.82010871000	0.5093885332	0.00232197424	211	2	391.2999315860...	Rrogozhinë	4	391299931.50
9	323	EU-2349233	NULL	38.70232621010	0.06444530615	4.129107e-05	323	3	667.5820222586...	Elbasan	1	667582022.20
10	323	EU-2349233	NULL	38.70232621010	0.06444530615	4.129107e-05	323	3	123.3167745314...	Baseni_Poshtëm	0	123316774.50
11	323	EU-2349233	NULL	38.70232621010	0.06444530615	4.129107e-05	323	3	447.9163874215...	Murrashi	3	447916387.40
12	323	EU-2349233	NULL	38.70232621010	0.06444530615	4.129107e-05	323	3	586.2953282405...	Librazhd	2	586295328.20
13	112	EU-563202	NULL	27.43055352500	0.02767339481	2.926467e-05	112	1	667.5820222586...	Elbasan	1	667582022.20
14	112	EU-563202	NULL	27.43055352500	0.02767339481	2.926467e-05	112	1	123.3167745314...	Baseni_Poshtëm	0	123316774.50
15	112	EU-563202	NULL	27.43055352500	0.02767339481	2.926467e-05	112	1	447.9163874215...	Murrashi	3	447916387.40
16	112	EU-563202	NULL	27.43055352500	0.02767339481	2.926467e-05	112	1	586.2953282405...	Librazhd	2	586295328.20
17	112	EU-563202	NULL	27.43055352500	0.02767339481	2.926467e-05	112	1	247.9917428616...	Sllabinjë	5	247991742.80
18	112	EU-563202	NULL	27.43055352500	0.02767339481	2.926467e-05	112	1	391.2999315860...	Rrogozhinë	4	391299931.50
19	211	EU-2349093	NULL	2176.82010871000	0.5093885332	0.00232197424	211	2	667.5820222586...	Elbasan	1	667582022.20
20	211	EU-2349093	NULL	2176.82010871000	0.5093885332	0.00232197424	211	2	123.3167745314...	Baseni_Poshtëm	0	123316774.50
21	323	EU-2349233	NULL	38.70232621010	0.06444530615	4.129107e-05	323	3	247.9917428616...	Sllabinjë	5	247991742.80

b) The attribute table of the Corine Land Cover classes

In the Attribute table of the new vector file, a new field should be added, as it is necessary to know the area of each Feature, calling it class area. Execution of the $area function in the Field Calculator makes it possible to find the area of each of the Level 1 of the CLC 2012 classes in each of the subbasins. The final step is finding the proportion and calculating the percentage that each class does occupy in each of the subbasin. For that a new field needs to be added in the Attribute Table (calling it Percentage). In the Expresion Dialog, through the formula (ClassArea/CachArea)*100 the percentage is calculated and the results are shown in the Figure 12 (*Perqindja* means Percentage).

layer	ID_2	CatchArea	ClassArea	Perqindja
Baseni_Poshtëm	0	123316774.50	11609912.41	9.4
Elbasan	1	667582022.20	35312054.03	5.3
Librazhd	2	586295328.20	4478906.42	0.8
Murrashi	3	447916387.40	1105269.40	0.2
Rrogozhinë	4	391299931.50	12721435.10	3.3
Sllabinjë	5	247991742.80	3543887.26	1.4
Baseni_Poshtëm	0	123316774.50	95809121.95	77.7
Elbasan	1	667582022.20	205244340.80	30.7
Librazhd	2	586295328.20	121861596.30	20.8
Murrashi	3	447916387.40	74759697.99	16.7
Rrogozhinë	4	391299931.50	166208907.50	42.5
Sllabinjë	5	247991742.80	62904201.63	25.4
Baseni_Poshtëm	0	123316774.50	12879155.54	10.4
Elbasan	1	667582022.20	425813492.80	63.8
Librazhd	2	586295328.20	459954822.30	78.5
Murrashi	3	447916387.40	372051419.90	83.1
Rrogozhinë	4	391299931.50	208063910.70	53.2
Sllabinjë	5	247991742.80	181543660.80	73.2
Baseni_Poshtëm	0	123316774.50	789856.02	0.6
Elbasan	1	667582022.20	1212134.81	0.2
Rrogozhinë	4	391299931.50	4305673.94	1.1

Figure 12. Percentage of each CLC 2012 class in each of the Shkumbini subbasin.



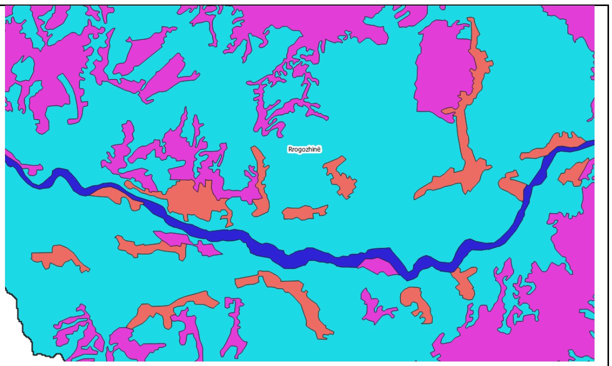


Figure 13. a) Naming of the five classes according to Corine 2012 legend sld file.	*b) View of the Corine Land Cover in the Rrogozhinë subbasin.*

Level 1	Name of the (CLC 2012) Classes, Level1
1	Artificial Surfaces
2	Agricultural Areas
3	Forest and Semi Natural Areas
4	Wetlands
5	Water Bodies

Table 3. Name of the (CLC 2012) Classes (1-5), Level1

Sum of Percentage	Column Labels					
Row Labels	**Baseni i Poshtëm**	**Elbasan**	**Librazhd**	**Murrashi**	**Rrogozhinë**	**Sllabinjë**
1 - Artificial Surfaces	9.4%	5.3%	0.8%	0.2%	3.3%	1.4%
2 - Agricultural Areas	77.7%	30.7%	20.7%	16.7%	42.5%	25.4%
3 - Forest and Semi Natural Areas	10.4%	63.8%	78.5%	83.1%	53.1%	73.2%
4 - Wetlands	0%	0%	0%	0%	0%	0%
5 - Water Bodies	2.5%	0.2%	0%	0%	1.1%	0%
Grand Total (%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4. Percentage of each CLC 2012 class in each of the Shkumbini subbasin.

Table 4 shows the final results in the Percentage form for each CLC 2012 class in every individual Shkumbini subbasins as it is required in the WEAP format (SEI, 2016).

RESULTS AND DISCUSSION

This article conveys a summary of the generalized land cover type distribution for the entire Shkumbini basin and details the methods used for its calculations. From the data presented it is clear that relatively natural land cover types dominate, mainly because of the changing topography and inaccessibility of the Shkumbini river basin. Different land use areas can produce various run-off. This means that some areas may be "flashy" so that important rainfall becomes immediate discharge, but other land use types may retain water and release it slowly, creating a steady run-off even during periods of low rainfall.

The Albanian Land Cover 2012 shapefiles are in WGS 1984, UTM Zone 34N. Using the open source QGIS software, the CORINE land use data were summarized and aggregated to the delineated WEAP catchment objects.

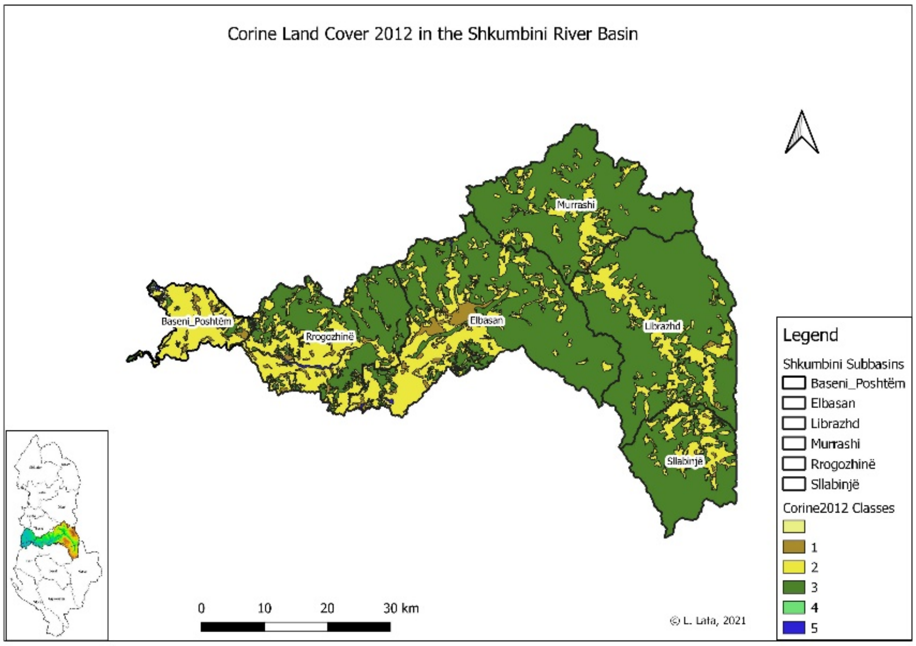


Figure 14. Level 1 Classes of the Corine Land Cover 2012.

The watersheds of the Shkumbini WEAP model were obtained on behalf of this study based on the streamflow gauges used as calibration points. The watershed delineation divides the water production within WEAP (in watershed nodes) into areas that match the subbasins above the specific streamflow gauges. This approach permits for direct water flow comparison, in the current model of Shkumbini river, to the historic data observed at the hydrological stations.

Considering the Papër streamflow gauge as an example, the tan region on the map represents the area where precipitation flow would be directed into the river section between the upstream gauge in Murrashi and the Papër streamflow gauge. The water measured at the streamflow gauge in Papër can be derived through the following equation:

Flow at Papër = Upstream Gauge Values (river flow at Murrashi) + Immediate Upstream Additional flow (Elbasan catchment inflow) – Immediate Upstream

Where "immediate upstream" means WEAP nodes physically located in the tan catchment area upstream of the Papër stream gauge (Figure 15).

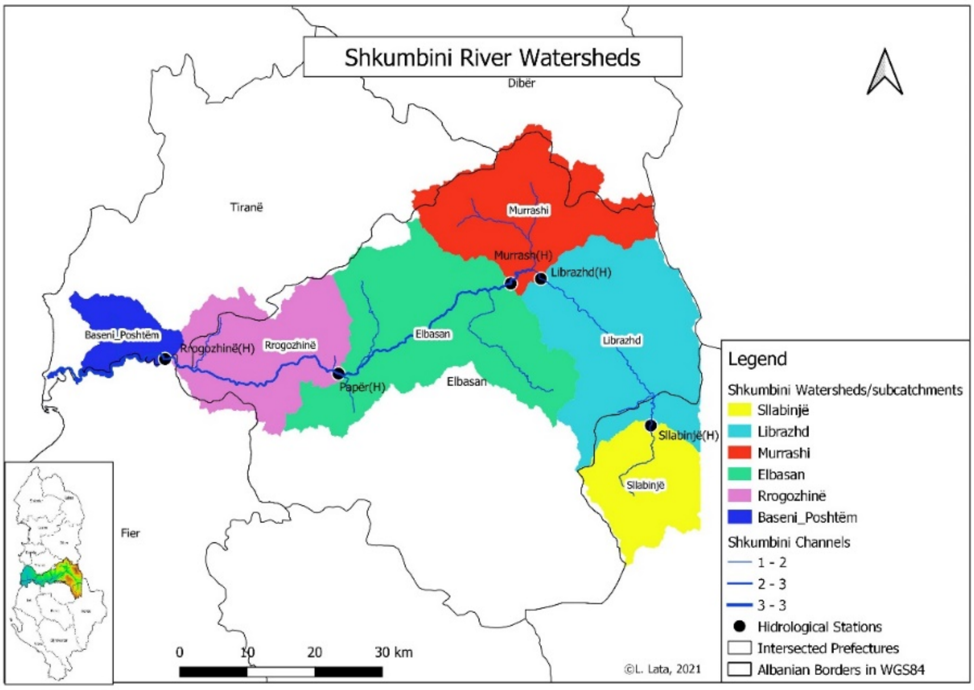


Figure 15. Shkumbini delineated catchments for the WEAP model; source: own elaboration.

The catchment was delineated using the GIS software with the SAGA Tools extension and a Digital Elevation Model (DEM); the final Shkumbini watersheds shape files have been used in the WEAP model for further analysis (Figure 16).

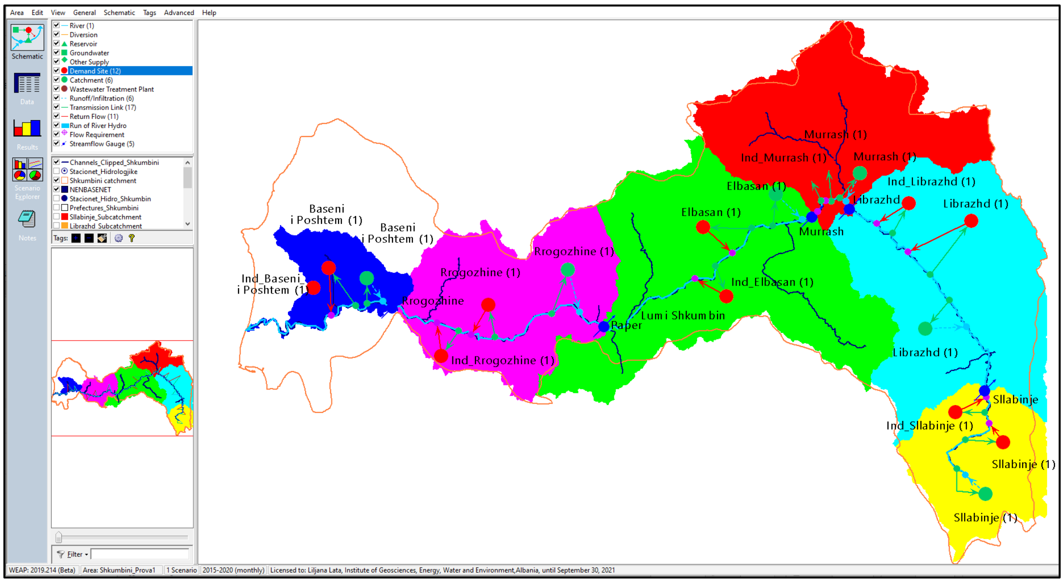


Figure 16. WEAP model schematic; source: own elaboration.

Eventually, all the model parameters are calibrated for the period during which there are historic records for both meteorological data (temperature and precipitation and relative humidity) and streamflow gauge data (average daily water level). For the Shkumbini river basin, the calibration period is from year 1991 to 2016. The Shkumbini WEAP model has a monthly time step, therefore the average daily data were aggregated into this time step.

Figure 18 shows the aggregated monthly streamflow data for the chosen stations for years 1990 to 1992. The model calibration involves the land use characteristics for catchments upstream of the five monitoring stations that were used to calibrate the model. The calibrated stations are Sllabinjë (upstream catchment: Sllabinjë), Librazhd (upstream catchment: Librazhd), Murrash (upstream catchment: Murrash), Papër (upstream catchment: Elbasan), and Rrogozhinë (upstream catchment: Rrogozhinë). The uncalibrated catchment is Baseni i Poshtëm which is assumed to have the same land use parameters to the closest station geografically, the Rrogozhinë station.

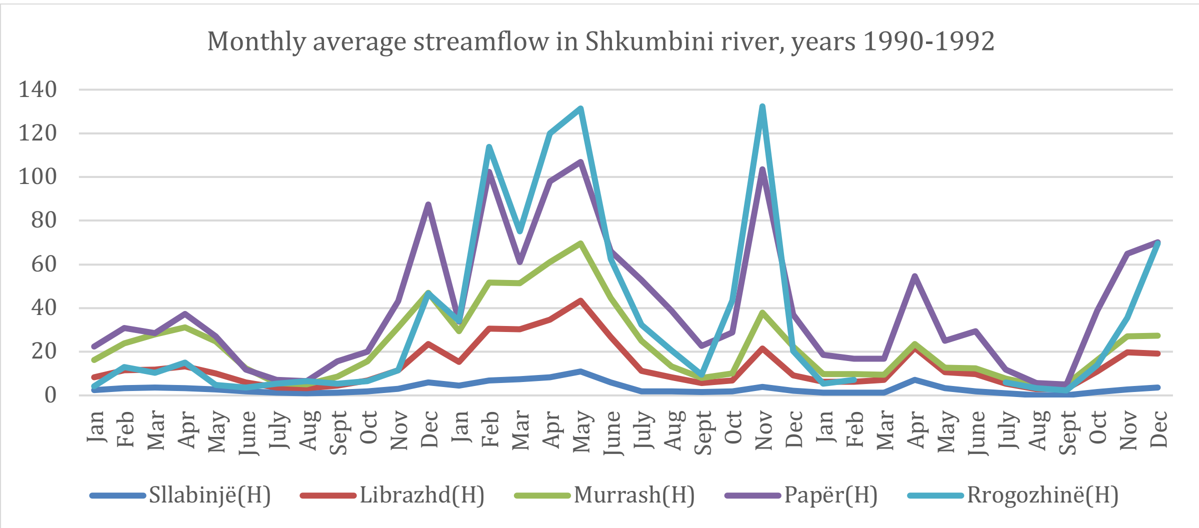


Figure 18. Monthly Streamflow for the chosen Shkumbini hydrological stations (1990-1992).

The catchment elements in WEAP allow us to calculate the areas of different land use types within a watershed and characterize their respective hydrology. Once the values for land use parameters have been established, future scenarios can examine the consequences of land use change.

Additionally, further data preparation and processing procedures were also performed during the study implementation. The resulting suitable data are entered for every element built into the WEAP schematic: water supply (e.g. rivers, reservoirs, etc.) and demand (e.g. drinking water demand, irrigation, industrial water demand, etc.) followed by the model calibration process. Finally, following the WEAP format requirements (SEI, 2016), different climate and development scenarios are prepared with the purpose of effectively representing the natural conditions of the Shkumbini river basin.

CONCLUSION

Collected water demand data for the Shkumbini river basin is structured around three major subsets: Agricultural, Industrial and Urban demand. While some data may not be available, estimates can be made based on derived parameters such as land cover, population census data and general information related to per capita water use. On behalf of this study, Shkumbini River Basin has been divided into six watersheds/subbasins with the purpose of considering as many hydrological stations as possible in the delineation model, avoiding large watersheds. The format of this data must fit the population subdivisions of the model, that were divided according to the delineated catchments. Certainly, the WEAP model outputs and results will have a certain level of accuracy and applicability depending immediately on the available data that describe the complexity of the Shkumbini WEAP system (SEI, 2016).

As the WEAP model uses the Corine dataset, a study on the impact of the land use changes can be performed making use of the WEAP system. However different kind of data are needed to characterize the soil and plant variables for each type of the land use, including soil water capacity, runoff resistance, crop coefficient values etc. The above mentioned data was largely unavailable for the specified land cover of the Shkumbini WEAP model. For this reason the land cover in each of the Shkumbini watersheds share the same quantifications, therefore they can not be distinguished, nor can land use change be studied within the current framework of the existing model. Nevertheless it is possible to examine the runoff related consequences in the Shkumbini basin, in a land use change scenario when considerably less runoff is available to discharge into the river due to the increased possibility of soil infiltration, evaporation and other water loss causes such as reforestation occurence. The examination can be done through the Land Use Change scenario by increasing the values of "Runoff Resistance Factor" for all land use types. This parameter, which varies sesonally, indicates the amount of precipitation that is converted into runoff, as opposed to the amount that infiltrates into the ground. The runoff resistance factor varies from 0 to 1000 (0 indicates that the entire precipitation turned into runoff, whereas 1000 indicates that no runoff occurs only infiltration). This parameter is very low for the Shkumbini river basin because of the steep mountain slopes in the upper part of the river basin particularly. This issue however (increasing the runoff resistance factor) is a subject of an ongoing study related to land use changes in non-irrigated natural environments.

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A STUDY ON INVESTIGATION OF THE HARD LANDSCAPE OF PARKS AND CREATING USER-ORIENTED DESIGN ALTERNATIVES WITHIN THE SCOPE OF THE URBAN HEAT ISLAND EFFECT: THE CASE OF GÖZTEPE 60. YIL PARK

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The impacts of climate change on natural systems are been felt more and more every day all across the world. In addition to being the places where the effects of climate change are felt the most, cities are among the main factors causing climate change. However, the effects of climate change are not equally observed everywhere. The regions most suffered from climate change are megacities located on seaside or oceanside. At this point, the importance of planning and design practices of cities' green areas and selection of appropriate pavement surface materials come to the fore. This study aims to propose design alternatives for the hard landscaping of parks within the scope of urban heat island and landscape design principles. In line with this goal, Göztepe 60. Yıl Park located in Kadıköy district on Anatolian side of Istanbul megacity, which has a dense structural pattern and population, was selected as the study area. The hard landscape of the park has been examined within the scope of urban heat island effect and landscape design principles. As a result of the field trip, it was discovered that the hard landscape of the park consists of uniform pavement with relatively high heat retention capacity. First of all, a visual survey was conducted among users in order to both appeal to the users and to develop design suggestions to reduce the urban heat island effect in accordance with the landscape design principles. After the survey study, suggestions were made for design alternatives according to the thermal properties of the pavement surface materials and user preferences for the hard landscape of the park. In this way, it is desired to create a guiding example for designers and practitioners in these days when climate change is beginning to affect everyone negatively.

Keywords: urban heat island, hard landscape, pavement materials, Göztepe 60. Yıl Park

ENVIRONMENTAL SUSTAINABILITY EVALUATION OF TECHNOLOGIES TO RECOVERY PHOSPHOROUS FROM INCINERATED WASTE STREAMS, BASED ON EMBODIED ENERGY AND CARBON FOOTPRINT

ARIO FAHIMI

The annual demand for P based fertilisers is constantly growing of about 3%, inducing to an inefficient use of P particularly in agricultural sector (e.g. eutrophication) and the depletion of phosphate rocks. A promising way to efficiently recover P is to address incinerated waste streams (P rich sources) as potential substitute of phosphate rocks with the possibility to reduce the volume of disposal. We report a simplified and novel approach for sustainability evaluation of new technologies, based on the use of two parameters (i.e. embodied energy and CO2 footprint) that account for the energy and emissions involved in the formation of a material. A dimensionless index, defined as SUB-RAW index, compares the results about the environmental impact of selected substituting material/process. This method is applied to any scale processes available in literature in the context of P extraction technologies, showing that chemical leaching approaches are the most suitable methods. The approach aims to represent a milestone in the evaluation of strategies to handle with resources depletion and to suggest opportunities for legislative evolution, in support of sustainable alternative to raw materials.

CHARACTERIZING URBAN ECOSYSTEMS OF THE WESTERN HIMALAYA – A CONCEPTUAL FRAMEWORK

M.M.ANEES AND P.K.JOSHI

Urban ecosystems are manifestation of human activities resulting in replaced or modified natural systems leading to disturbed regional balance. Coexistence of economic activities, ecological integrity, infrastructural deficit, poverty alleviation and population growth are posing serious challenges to urban planning. Integrated interdisciplinary studies could unwrap these multidimensional and complex interactions in urban ecosystems. The proposed study attempts a holistic systems approach to understand the links between patterns and changes to selected functional attributes in the urban ecosystems to improve the urban planning. Characterizing structural and functional components of the urban ecosystems is expected to assist in reducing environmental degradation. Structural component of the ecosystem is the modified landscape pattern and its evolution with time, while functional component is the resultant effect on functional capability namely, green infrastructure and vulnerability indicators

Indian Himalaya are one of the most populated but understudied region in terms of urban ecosystems among the mountain chains of the world. This study presents cases from the Western Himalayan Indian states which are known to be the focal point for economic activity, tourism, urban planning and management. However, the selected cities differ in their altitude, population class, factors influencing urban planning, and are expected to highlight the role played by these factors in defining urban ecosystem characters.

To understand how human induced physical actions are transforming structure and effecting function of urban ecosystems in Himalaya, this study attempts (1) to characterize spatial structural dynamism in the Himalayan cities (2) to explore landscape and morphological characteristics of urban green infrastructure (3) to enumerate distribution of inherent vulnerability among urban communities and address their causative factors. Our conceptual framework delineates that landscape pattern – including the configuration and composition of different kinds of land use and land cover patches – depicts the structural dynamism. We explored the growth trend of the cities over three decades with the help of change analysis and type analysis of satellite data and spatial metric tools. To understand the impact of urbanization on functional aspects of vegetation, we undertook landscape characterization and morphological pattern analysis of the green infrastructure. Lastly, an index-based vulnerability assessment tool (as a function of exposure, sensitivity and adaptive capacity) is proposed to develop composite vulnerability score.

Preliminary results identify spatial locations, which have been 'hotspots of growth' over decades, and additionally, help in visualizing growth type. Characteristics of urban growth type helps us in deducing the trend city adapts such as aggregation or sprawl with changing developmental needs. Green infrastructure assessment highlights the areas with increased shape complexity and isolation of patches. Larger cities show critical signs of green infrastructure fragmentation and lack of urban planning measures in urban core areas. The vulnerability assessment identifies components that have crucial role in supporting urban population at times of disasters, whether induced or natural. Socio-economic processes and geophysical-environmental characters are main drivers of such dynamism. Urban ecosystem change, shaped by these two, leads to ecological and social changes which in turn influence green infrastructure patterns and vulnerability of the region. Such evidences fill the knowledge gap on the state of urban ecosystems in the Indian Himalayan regions. We propose a systematic approach to generate such knowledge and could be used by the planners for sustainable development.