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The effect of Caspian Sea level rise on the environment of the sand dunes of Mazandaran, Iran

Homayoun Khoshravan [1], Tahereh Alinejadtabrizi [2]*, Alireza Naqinezhad [3], Samereh Tirgan[4]

[1] *Water research institute, ministry of Energy; h_khoshravan@yahoo.com*
[2*] *Department of Environmental Engineering, Graduate Faculty of Environment, University of Tehran; n.alinejhad.t@gmail.com*
[3] *Department of Biology, Faculty of Basic Sciences, University of Mazandaran; anaqinezhad@gmail.com*
[4] *Department of Biology, Faculty of Basic Sciences, University of Mazandaran; samereh.tirgan@yahoo.com*

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ABSTRACT

Sand dunes are crucial factors related to stability of the coasts, and vegetation plays a decisive role in their creation. In this research paper, analyzing the effects of the Caspian Sea level fluctuations and human intervention on transformation of habitats and biodiversity of coastal plants on sand dunes is assumed as the main goal. The morphological structure of coastal sand dunes and the biodiversity of their plant species were investigated by selecting 11 transects in the eastern coast of the central Mazandaran (Babolsar-Amirabad), also the major changes of the sand dunes in coastal lands were evaluated during the period of the Caspian Sea water level rise, 1978-1995, using the remote sensing. The results showed that coastal dunes in the southern coasts of the Caspian Sea are divided into three groups, intact or healthy, semi-healthy and completely destructed. In total, 174 plant species belonging to 134 genera and 75 families were identified in coastal embankment ecosystems as well as in active, middle and back sand dunes of the coast. The impacts of human intervention (changes in land cover and land use) and some increase in the Caspian Sea level during 1978-1995 were identified as factors affecting the damage of coastal sand dunes.

1. Introduction

Protecting coastal sand dunes is very important especially in integrated coastal zone management (ICZM) programs. As they play a very effective role in stability of coastal areas against erosive forces. loss of these important natural resources, increases sensitivity and severity of coastal vulnerability [1]. Moreover, the rise in the level of sea and ocean water levels, greatly lead to magnify the risk of erosion and flooding of coastal areas. Compatible plants with coastal environments play a very pivotal role in the formation, development and morphological stability of sand dunes [2]. They provide conditions for the formation of small sandy hills through different biological structures, and gradually, they create a small thickness of soil layer on the developed sand dunes and ultimately create specific environmental conditions for continuity of survival and sustainability of other flora species. Generally, the southern shores of the Caspian Sea are sandy in most areas, and sandy hills are extensively visible in some coastal areas. Unfortunately, during 1978-1995, the increase of the Caspian Sea level by 250 centimeters resulted in the destruction of a large part of coastal embankment and sand dunes [3]. Moreover, the development of human activities such as construction of commercial and fishing ports, coastal protection walls, roads and urban improvement over the last few decades, have caused irreparable damages to sand dunes and their biodiversity of flora species [4]. Therefore, in this scientific paper, studying the rate of sand dunes erosion, displacement of the coastline of the Caspian Sea and the ecological response of various habitats of flora species are considered as main problems which are affected by water level fluctuations. In other words, the main aim of the study is investigating changes in coastal complications (ditches and sand dunes) during the period of incensement in the Caspian Sea level, considering human interference and changes in the Caspian Sea level as factors affecting the damage and destruction of coastal land

and its morphological complications. Moreover, environmental impact assessment of flora communities has been conducted in this study. Sandy coastlines occupy only 20% of the total coastline of the world [5]. Sand dunes are usually observed in different regions with dry, semiarid and temperate climatic conditions, but their abundance decreases in tropical areas due to the highly dense vegetation in these areas, the low wind speed and moisture content in sand grains [6]. The sand dunes are affected by some important factors such as the amount of sediment processing, proper vegetation and physical properties of wind, as it can be created and developed gradually on the coastal areas in different forms [7]. Wind is very critical in erosion, while vegetation plays an important role in the stabilization of coastal hills [8]. The density and abundance of vegetation, adapted to the coastal dry environments, create small sandy hills, and gradationally, their morphological structure has been altered and sand dunes have been formed in various forms [9]. The severity of erosion vulnerability of the sand dunes depends on their morphology, climatic conditions and the hydrodynamic of the sea (tide height, wave energy, magnitude and frequency of storm) [10]. Glushko studies in 1996 on the sand dunes of the southern shores of the Caspian Sea have shown that the structure of these sandy hills is very similar to the Sand Barrier, connects to the shore after the fall of the sea level, and is separated from the sea by a wetland. Accordingly, he classified the structure of sand dunes into three groups. The first group is affected by seasonal fluctuations and sea waves. The second group consists of transient sandy hills divided into active and semi-active types. The third group includes well-established sand dunes by vegetation that is far from the beach. Most sandy dunes in the southern part of the Caspian Sea are parabolic and have been developed directly or sinusoidally in the coastal zone [12]. The results of Khoshravan study in 2013, on sand dunes on the southern shores of the Caspian Sea showed that, among total of 856 km of coastline in the southern part of the Caspian Sea, only 156 km of coastline has sand dunes, of which 98 km is located in the eastern part of Babolsar to the end of the central part of the Miankaleh peninsula. Also, the results of this study revealed that 73 km of sand dunes in Mazandaran province suffered from serious erosion. The sandy hills of the southern shores of the Caspian Sea have classified based on the disturbance rate and erosion into healthy (12.1%), semi-healthy (3.4%), leveled (9%) and 75% of them are completely destroyed in other areas. The severity of the damage to the sand dunes on the Amir Abad shore is very high due to port construction and the double impact of the Caspian Sea penetration [4]. The most important types of coastal ecosystems on a global scale are coral hills, sandy hills, mangrove forests, swamps, wetlands, rocky islands, rivers estuaries and sea ice. Comprehensive studies have been carried out around the world, on vegetation sequencing and zonation of coastal ecosystems, especially in Europe [13, 14, 15]. Morphological complications of dry sandy beaches include the coastal embankment, small hills, active sandstones, semi-stabilized and stabilized ones (Fig. 1).

Analysis of biodiversity of plants in coastal areas is one of the important factors for evaluation of environmental conditions [16]. It protects and fertilizes soil, preserves animal species and microorganisms and causes ecological balances through food chain maintenance. At the meantime it also regulates hydrological cycles (reduce runoff, increase groundwater storage), resiss against storms, floods, pests and diseases and preserves the environment through climate adjustment, carbon and nitrogen fixation, soil preservation, photosynthesis and pollutant uptake [17]. In this regard, various studies have been conducted on plant communities in the southern coast of the Caspian Sea. Important studies have been carried out on the ecological characteristics of the southern coast of the Caspian Sea and its different ecosystems have been identified [18]. Naghinezhad et al., (2006), investigated the flora and habitat diversity of vascular plants and mosses by physiognomic methods, in the Boujaq National Park, Iran's first marine-offshore national park. In another study in 2010, Naghinejad and Khoshravan studied biodiversity of plants in six international wetlands, located on the southern coast of the Caspian Sea. Threatened plant species were then examined in the Miankaleh wetland area [20, 21]. In 2007, Khodadadi has studied the habitats and flora of the Astara Steel Wetland. Seighali, (2008) studied floristic of coastal areas up to intermediate heights of Shellman River basin in Langrood city. In the present study, flora species of coastal sand dunes, located in the eastern part of Mazandaran province, in the area of Babolsar to Amirabad port are examined and identified. Meanwhile, the impact of water level fluctuations in the Caspian Sea and human interference is examined on damage of the habitat of the sand dunes.

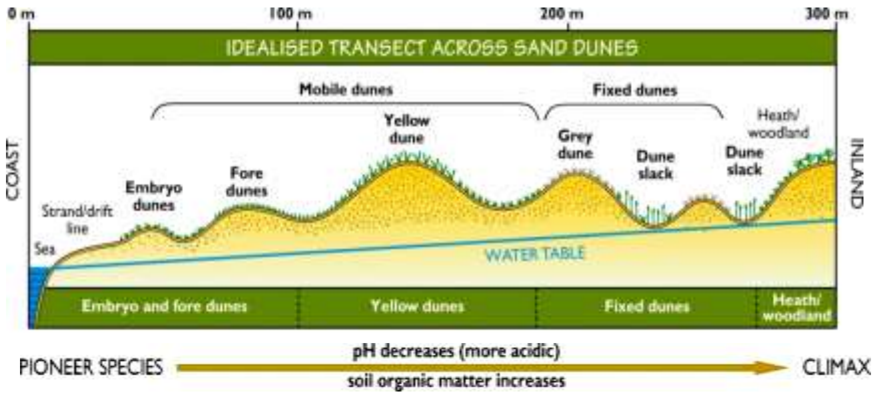

Figure 1. An overview of the sand sequence along the shoreline (www.macaulay.ac.uk)

2. Materials and Methods

The study area is located at the southern coast of the Caspian Sea, between the Neka Power Plant and the eastern margin of Babolsar, with the length of 58 km (Fig. 2). This area includes the coasts of Zaghmarz, Tuskola, Islamabad, Farahabad, Larim, Kohi Kheil, Bahnamir and Bagher Tangeh Villages, from east to west (Fig. 2). This part of the southern coast of the Caspian Sea lies in the morphological zone of east of central Mazandaran [24]. The geometrical structure of the coast in this region consists of a relatively broad coastal embankment and a relatively gentle offshore slope in dry and shallow marine depths. Overlying sediments of the coastal embankment contain fine to medium-grained sand that is relatively well sorted. In some areas of this part of the southern coast of the Caspian Sea, a complete coastal profile, including sand dunes, coastal embankment, coastal area and coastline is characterized. The human occupation in coastal areas has caused some changes in sand cover areas of coasts. Moreover, various agricultural or residential uses, replaced the old coasts. In this part of the Caspian coast, important rivers enter the Caspian Sea, such as Babol Rood, Talar, Larim, Tajan, Teskarud and Nekarud, and their sand load provide conditions for the deposition of sand material in the post-coastal area. The development of sand dunes in the area has been affected by this suitable sedimentary processing in the coastal area.

2.1. Analysis of morphological deformation rate of coastal complications

To study the deformation status of coastlines, coastal embankments and sand dunes over a period of time contemporaneous with some increase in the Caspian Sea water level (1978-1995), aerial photographs of 1983 at 1: 10,000 scale and PAN images of the IRS satellite with a resolution of 5.8 m related to 2004, was used. Initially, referring to 1983 aerial photographs and PAN images of IRS satellite using 1: 25000 topographic maps, the precise geographic location of the Caspian coastlines and morphological features of the coastal dry sections were determined. The information was then stored and updated as distinct digital layers in the Geographic Information System (GIS) environment for temporal and spatial processing. Then, by dividing the study area into 11 polygons measuring 5 × 5 km (Fig. 2), the rate of coastline displacement and the erosion rate of dry section of the coastal area and deformation of sand dunes, under the influence of the Caspian water level fluctuations and human interference were calculated during various periods using comparison and overlap of the information layers created in the software (Arc-GIS 10) environment.

2.2. Identification of plant species and their biological forms

This coastal zone has been chosen for the study of vegetation and biodiversity of existing species, due to the presence of diverse and extended sand dunes.
Regarding the existence of suitable biodiversity in different coastal habitats, the study area was selected as a cross-sectional sample to evaluate the impact of the Caspian Sea water level fluctuations and human interference on sand dune vegetation biodiversity. Flora species settled in the coastal embankment, up to the dorsal end of the sand dunes were studied using a total of 78 plots measuring 5 × 5 m in 11 zones (Fig. 2) during spring and summer of 2018. In field operations, the precise geographic location of the 11 transects of study from Babolsar to Amirabad port in Behshahr was coordinated using a GPS device and placed on a digital map in the Geographic Information System (GIS) environment (Fig. 2).

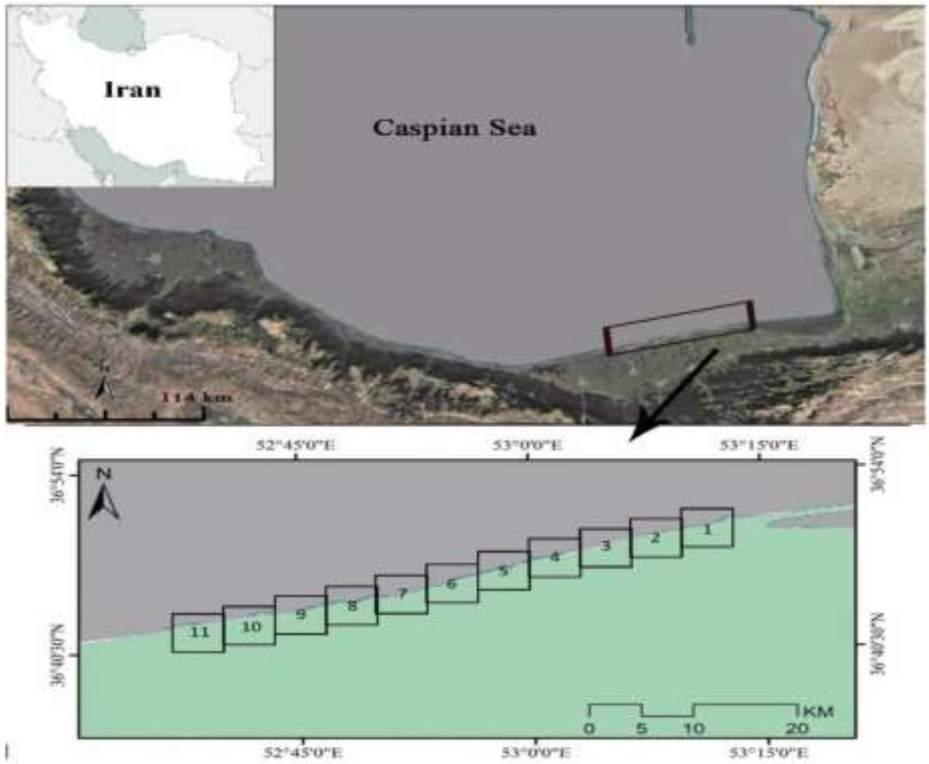

Figure 2. Geographical location of study area and 11 zones, examined in remote sensing studies

Most species were photographed at a collection site for easier identification. Information was collected about the location and date of collection, latitude and longitude, slope, direction of slop and habitat characteristics in each sample plot. After collecting the samples, the plants were scientifically dried, pressed and transferred to the herbarium of Mazandaran University for identification. To identify the plants, scientific sources of Flora Iranica [25], colored flora of Iran [26] were used.

3. Results

3.1. Shoreline displacement, coastal and sand dunes erosion

The results of comparing aerial and satellite imagery from 1983 to 2004 show that shoreline displacement rates have slightly different values in eleven selected zones due to some increase in the Caspian Sea water levels during the above-mentioned period (Table 1). In zone 1 (Neka Power Plant), Positive displacement of shoreline related to active sedimentation process in low depth marine environment, is equal to 200 m in the western part of Nekarud River. However, in the eastern part of power plant pier, seawater infiltration process and coastal erosion have reached a maximum of 120 m water advance in dry part of the shore (Table 1). The extent of the eroded beach is 55056 square meters and the amount of sedimentation area is equal to 293610 square meters. The sand dunes in this zone are completely destroyed and their area is about 424309 square meters (Table 1). The shoreline displacement in zone 2 (Nekarud River) is negligible during the study. The shoreline displacement is slight, even at the mouth of the Neka River. But the Caspian Sea water advancement process is observed gradually to the westward from the Neka power plant, and reaches a peak of 125 m. The eroded coastal land is equal to 294092 square meters. Also, 87 percent of sand dunes have been destroyed (1028649 m^2) (Table 1).

In zone 3 there are two major rivers, Teskarud and Tajan. This zone has the biggest eroded area compared to other zones. Generally, the rate of water progress in this zone is very high. The Caspian Sea has a minimum water progress of about 97m in the eastern margin of the sea, in the Teskarud River estuary, and a maximum of 205 m around the Tajan River estuary. The eroded beach area is 763067m2, and 42% of the sand dunes (417251m^2) have been located in the Farahabad of Sari, Zone 4 shows a nearly integral trend in seawater progression. The maximum rate of the Caspian Sea water progress varies from 110 meters to at least 75m in this zone.

Table 1. Shoreline displacement rate, coastal land erosion and sand dune deformation in the study area in 1983-2004

zone	Shoreline displacement (m)		Eroded Area (m^2)	Area of sedimentation (m^2)	Area of degraded sand dunes (m^2)	Degradation of sand dunes (%)
	Maximum	Minimum				
1	200+	120	55056	293610	424309	100
2	125	125	294092	0	1028649	77
3	205	97	763067	0	417251	42
4	110	75	584484	0	533604	86
5	130	40	454308	237	223079	51
6	125	40	602474	0	105319	13/5
7	120	90	601885	0	106955	8/5
8	125	40	511741	0	128776	8
9	155	80	578840	0	670050	31
10	150	65	520699	0	1609343	72/5
11	215	65	548808	0	648468	58

The eroded beach area is about 584484 square meters and more than 86 percent of the sand dunes in this zone (533604 square meters) have been extinct (Table 1). Zone 5 covers some part of Farahabad and Larim. The water progress in this area is maximum 130m while in the central part reaches 40m. The area of eroded coastal zone is 454308m2. Moreover, 51% of the sand dunes in this zone have been destroyed, equal to 223078m^2 (Table 1). Zone 6 is in the Larim and the Larim River is in this zone too. The trend of shoreline changes and the rate of water progress in this zone have been relatively the same. The water advance in this zone is maximum 125m while it has reached 40m in some parts of the eastern part. The eroded area is 602474m^2, and only 13% of the sand dunes in this zone have been destroyed (Table 1). The area also has broad sand dunes that remain intact, especially in the western part of the Larim River. Zone 7 contains parts of Larim and the area of Kuhi Khil village. The maximum amount of water advance in this zone is about 120m, which is occurred on the eastern and western margins of the zone. In the central part, the progress has been reduced to 90m. The eroded area is equal to 601885 square meters. About 9 percent of the sand dunes are destroyed in this zone. The area of eroded sand dunes is 106955 square meters. As zone 6, widespread sand dunes continue in this zone, with only minor changes just in the coastal face. Zone 8 is located in the areas of Chapakrood, Kohi Khel and Bahnamir villages. Widespread sand dunes are also found in this zone, which remained intact in 2004. The trend of shoreline changes and the rate of water advancement in this zone are mildly reduced from east to west. It reaches 60m in the coastal area, overlooking the Chapakrood mouth. The extent of the eroded area is 511741m2 and 8% of the sand dunes in this zone have been destroyed, with an area of 670050 m2 (Table 1). located in the Bahnamir area, In zone 9 the rate of water advance gradually increases from the east, the estuary of the Chapakrood river, to the west. with the lowest advancement in the eastern side of the zone, equal to 80m and the maximum in the western part, about 155m. There are also wide sand dunes that have been preserved during this period. The eroded coastal area is 578840 square meters. Moreover, 31 percent of the sand dunes with an area of 670050 square meters, have been destroyed (Table 1). Zone 10 is in the area overlooking the Talar River estuary, with a maximum advancement of about 150m in the eastern part and a minimum of 65m in the western part of the zone. In this area, there were relatively wide sand dunes in 1983 that remained somewhat intact during this period in the east of the Talar River; however, they completely disappeared in the western part of the river. The eroded coastal area is 520699m^2 and 72% of the sand dunes of this area, with an area of about 1609343m^2, have been destroyed (Table 1). Zone 11 overlooks the mouth of the Arab Kheil River and part of the east of Babolsar. The progress of water is less in the eastern part of the river and the minimum progress is about 65 meters. In the western part of the zone, the maximum amount of water advance is observed up to 215 meters. The extent of eroded area is 548808 square meters and 58 percent of the sand dunes in this zone, with an area of 648468 square meters, have been demolished (Table 1). A comparison of the quantities of shoreline displacement changes in the study area during 1983–2004, shows that the highest negative shoreline displacement occurred at zone 11, with amount of 215m. The lowest shoreline displacement also occurred in zones 5, 6, 8 of about 40m (Fig. 3). Only in zone 1, a positive displacement of shoreline, equal to 200m has happened during the period of some increase in the Caspian Sea level. The maximum amount of shoreline displacement was estimated to be in zone 1, equal to 320 m, followed by 150m in zone 11. Also, the smallest difference of the shoreline variations was determined to be 30m in zone 7, followed by zone 4 with changes of about 35m (Fig. 3). The maximum eroded coastal land area is 763067m^2 in zone 3, while the lowest is 55056m^2 in zone 1 (Fig. 4). The highest amount of sedimentation occurred in zone 1 is equal to 293610m^2 and the lowest reported in zone 5 is

237m^2 (Fig. 4). The highest extent of sand dunes destruction occurred in zone 10 (1609343m^2) is followed by zone 2 (1028649m^2). Also, the lowest amount of sand dunes destruction occurred in zone 6 (105319m^2) is followed by zone 7 (106955m^2) (Fig. 4).

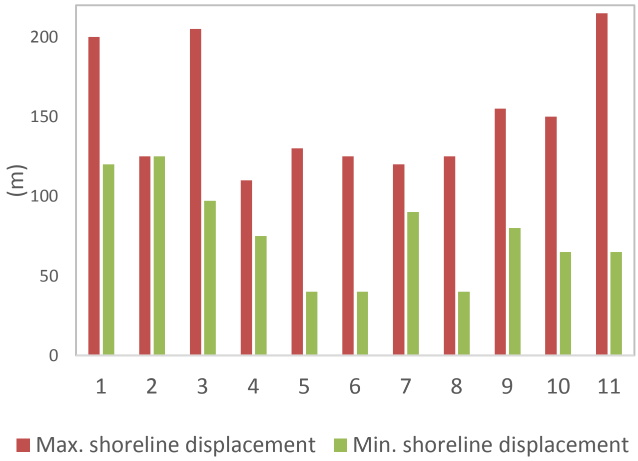

Figure 3. Comparison chart of maximum and minimum shoreline displacement due to increment in the Caspian Sea level in 1983-2004, in studied zones

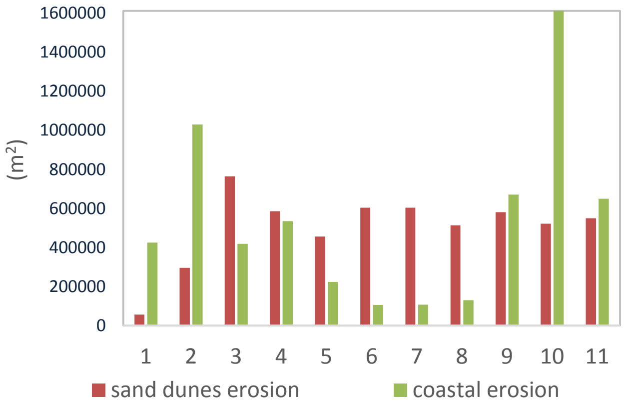

Figure 4. Comparison chart of coastal embankment and sandy dune erosion due to increment in the Caspian Sea level as well as human activities, in 1983-2004, in the studied zones

3.2. Identification of plant species in coastal dunes of the study area

174 plant species belonging to 134 genera and 45 families were identified in this study (Table 2). From these, one species belongs to Pteridophytes and 173 species belong to Angiosperms. Of the 173 species of Angiosperms, 49 belong to the monocotyledones and 124 species belong to the dicotyledones (Table 2). Poaceae strains with 41 species and 34 genera, Asteraceae with 23 species and 18 genera, Fabaceae with 14 species and seven genera and Caryophyllaceae with 10 species and seven genera are more abundant in the flora of the region.

3.3. Survey of the Biological Form and Geographical Distribution of Coastal Plants

Survey the life form spectrum of coastal plants showed that therophytes with 109 species (62.6%) had the most biodiversity in the realm of study. Then, there were hemicryptophytes with 29 species (16.6%), geophytes with 18 species (10.3%) including 15 rhizomatous geophytes and three bulbous (geophytes) plants, phanerophytes with 12 species (6.8%), chamaephytes with four species (2.2%) and helophytes with two species (1.1%) (Fig. 5).

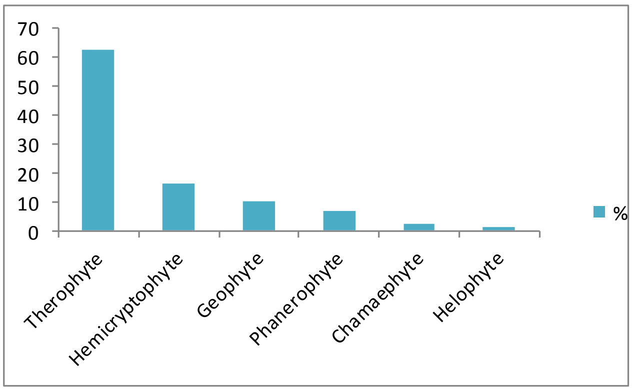

Figure 5. Comparison Percentage of plants in the realm of study

3.4. Introduction of coastal vegetation habitats

Three different vegetation habitats were identified in the study including coastal embankment habitat and primary sand dunes (Foredune), inter dunes habitat and back dune habitat. Each of these habitats contains specific vegetation cover.

3.4.1. Foredune coastal embankment and sand dunes

This coastal habitat is characterized by the presence of pioneer plant species in the coastal embankment

Table 2. Number of genera and plant species belongs to each family

Family	Genus	Species	Family	Genus	species
Equisetaceae	1	1	Meliaceae	1	1
Amaranthaceae	5	8	Moraceae	1	1
Amaryllidaceae	1	2	Onagraceae	1	1
Apiaceae	4	4	Orobanchaceae	1	1
Asparagaceae	1	1	Oxalidaceae	1	1
Asteraceae	18	23	Phytolaccaceae	1	1
Betulaceae	1	1	Plantaginaceae	1	2
Boraginaceae	2	2	Poaceae	34	41
Brassicaceae	7	7	Polygonaceae	2	4
Caprifoliaceae	1	1	Portulacaceae	1	1
Caryophyllaceae	7	10	Primulaceae	1	2
Convolvulaceae	2	4	Resedaceae	1	1
Crassulaceae	1	1	Rhamnaceae	2	2
Cucurbitaceae	1	1	Rosaceae	3	3
Cyperaceae	2	3	Rubiaceae	1	1
Euphorbiaceae	2	5	Scrophulariaceae	2	2
Fabaceae	7	14	Simaroubaceae	1	1
Gentianaceae	1	1	Solanaceae	3	6
Geraniaceae	2	2	Tamaricaceae	1	1
Juncaceae	1	2	Urticaceae	1	1
Lamiaceae	1	1	Verbenaceae	2	2
Lythraceae	1	1	Zygophylaceae	1	1
Malvaceae	2	2			

Figure 6. Indigenous plant species on coastal embankment

associated with extreme conditions on pioneering part of the beach (strandline and embryonic shifting dunes), which are usually small and low-lying. The most important plant species connected to strandline included *Cakile maritima*, *Convolvulus persicus*, *Salsola kali* and *Tournefortia sibirica* (Fig. 6), which are encountered with harsh environmental condition such as high wind velocity, sand movement and salt spray. The following part is embryonic shifting dunes which mainly associated with *Bromus madritensis*, *Bromus tectorum*, *Arundo donax*, *Lolium rigidum*, *Chrozophora tinctoria*, *Corynephorus articulates*, *Cynodon dactylon*, *Paspalum paspaloides*, *Agriophyllum squarrosum*, *Imperata cylindrica* (Fig. 7). The first stage of dune formation mainly related to embryonic shifting dunes.

Figure 7. Abundance of dominant species of Imperata cylindrica in active sand dune habitats

3.4.2. Interdune (Mobile dune)

The most important plant species correlated to sand dunes occurred on inter dunes included *Artemisia tschernieviana*, *Daucus littoralis* subsp. *hyrcanicus*, *Linaria simplex*, *Maresia nana*. The interdune is less environmentally extreme condition with large sand hills. In some areas in this habitat, the soil is well stabilized. In this coastal habitat, there are favorable environmental conditions for the growth of some plants, including *Juncus acutus*, *Phyla nodiflora*, *Equisetum ramosissimum*, *Saccharum ravennae* and *Cyperus rotundus*. The comparison of the abundance for coastal plants biodiversity in mobile dunes shows that *Artemisia tschernieviana* has the highest abundance on sand hill compared to other plant species (Fig. 8).

Figure 8. Presence of Artemisia tschernieviana and Juncus plant species in interdune habitats

Figure 9. Plant species belonging to back dunes

3.4.3. Backdunes habitat

Back sand dunes extend to the inland after the interdunes. It has a more stabilized sandy soil and higher plant species diversity than the previous two habitats. Sand displacement is very low or absent. Backdune is mainly characterized by shrubby plant species such as *Punica granatum* and *Rhamnus pallasii*. The most important plant species identified in this sand habitat included: *Punica granatum*, *Mespilus germanica*, *Prunus divaricata*, *Rhamnus pallasii*, *Paliurus spina-christi*, and *Lonicera floribunda* come from tree species and *Avena sativa*, *Eryngium caucasicum*, *Sedum hispanicum*, *Convolvulus cantabricus*, *Allium rotundum*, *Petrorhagia saxifrage*, *Brassica tournefortii*, *Silene latifolia*, *Tragopogon graminifolius*, *Asparagus officinalis*, *Orobanche nana* and *Vicia tetrasperma* are the herbaceous species which is found only in this zone. This zone, with its distance from the coastline, has the highest richness and biodiversity. Abundance and presence of plant species in the back dune habitat that are the most belong to *Punica granatum*, *Rubus sanctus* and *Rhamnus pallasii*, which are important components of this habitat (Fig.9).

3.5. The intensity of biodiversity and plant habitats destruction

The results of aerial and satellite imagery as well as field observations in 11 zones, have been indicated the intensity of severity of different biodiversity and plant habitats. Also based on the criteria of degradation and erosion, the studied habitats were divided into three groups. The first group consisted of vegetation habitats located in zones 2 and 10 where they have been under high erosion and degradation conditions (Fig. 10). In this group, all plant habitats from the coastal embankment to the end of eroded back dunes section have been eroded and destroyed. Plant habitats located in zones 1, 3, 4 and 11, had moderate degradation properties (Fig. 10). In this group, most of the plant habitats which are located in the coastal embankment and front part of the active sand dunes have been eroded due to infiltration of the Caspian Sea. Plant habitats located on transects 5, 6, 7 and 8, have very low degradation and erosion processes (Fig. 10). In this group all coastal habitats have good environmental equilibrium conditions without serious damages. Plants that are heavily present in degraded areas and replaced sand dunes include: *Euphorbia maculate*, *Melilotus indicus*, *Oenothera biennis*, *Oxalis corniculata*, *Tribulus terrestris var*. *terrestris*, *Carthamus lanatus*, *Juncus turkestanicus*, *Verbena officinalis* and *Kickxia elatine* subsp. *Crinita*.

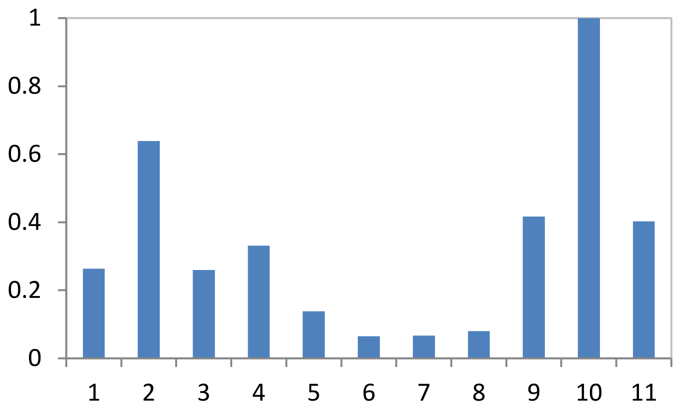

Figure 10. The rate of plant species alternation due to disturbance in 11 studied zones

4. Discussion

Rapid fluctuations in the Caspian Sea level are the most important hydrological characteristics of the area. So the rate of change in the Caspian Sea water level is more than 100 times compared to the oceans [27]. According to the latest reports from the United Nations Economic Program (UNDP), up to $15 billion of damages were imposed on the surrounded coastal states during the last phase of the Caspian Sea water level rise from 1978 to 1995. The last period of the Caspian Sea level rising, equal to 2.5m, from 1978 to 1995, caused degradation and severe coastal lands erosion, as well as environmental consequences, with the destruction of natural land cover, coastal habitats and destruction of coastal ecosystems (Kroonenberg et al., 2000). The dry part of the beach consists of sandy embankment and sand dunes, covered by diverse plant biodiversity. Plants play an important role in the stability of coastal sediments against erosive forces as well as the formation of sand dunes and the development of their morphological structure. Therefore, awareness about the ecological status of coastal areas of the Caspian Sea is of great importance for the organization of coasts and their conservation. As the results of compared aerial photos, satellite images and field observations over the period of 1983 to 2004 shows, morphological behavior of the dry coastal sector in response to increment in the Caspian Sea water levels and human interference, was very different in the 11 studied zones. Pressures of human actions in the eastern area of Babolsar and construction of the Neka power plant in this area, have caused severity in damages to sand dunes and plant ecosystems located on zones 1 and 11. In coastal areas regardless of human interference, located between the Tajan to Teskarud estuaries, the Caspian coastline displacement is the highest due to the mild coastal slope. Rivers and artificial barriers have also played an important role in sedimentary processing in the coastal zone. Therefore, with an increase in the Caspian Sea water level and the intensification of erosional forces, 200 meters of land penetration accurse into the Caspian Sea, in the eastern part of zone 1, overlooking the Neka Power Plant, (Table 1). Thus, despite the negative consequences of human role in morphological disturbance of coastal lands, it has also positive consequences. The extent of damage to coastal lands located in zones 5 to 8, is minimized and these areas have a balanced bio-structure and stable plant ecosystems. However, all the biodiversity of coastal plants in zones 2, 9, 10 and 11 are completely damaged and degraded. These subjects demonstrate the dual role of the impact of rising in the Caspian Sea level and human interference in the destruction of coastal ecosystems. The greatest displacement of the Caspian coastline occurred in zones 1, 3 and 11. These areas have been affected by industrial uses (Neka power plant) and sedimentation of the Tajan and Tskarud rivers and urban development in the coastal sector. The displacement of the Caspian Sea coast line in zones 5, 6 and 8 is much lower compared to other areas, which is strongly related to the geometrical structure of the coasts and their wide embankment. Most of the coastal land erosion occurred in zone 3 and the lowest in zone 1. This confirms the role of anthropogenic and environmental factors in deformation of coastal areas due to the Caspian Sea levels rise. The degradation of vegetation habitats as a result of rising in the Caspian Sea level, as well as the development of different land uses (agricultural, residential and industrial), have caused the loss of biodiversity and deformation of vegetation structure in some parts of the studied zones. In different coastal areas from Babolsar to Neka power plant, the species diversity located in the fore dune habitat is demolished on zones 1, 2, 10 and 11, because of numerous constructions. *Convolvulus persicus* and *Imperata cylindrica* were the most abundant species in this habitat. However, the abundance of *Convolvulus persicus* species has been drastically reduced in the dunes affected by higher degradation. *Saccharum ravennae* is observed in the habitat of fluvial dunes, in zone 9, which is part of the heavily eroded coastlines. Consequently, it can be deduced that if the process of habitat degradation is such that the soil still retains its sandy texture, along with some of the main constituents of the fluvial dunes, other species that are able to grow in sand dunes, can be replaced. It should be noted that if degradation, such as pomale and construction, continues, the soil texture may change in a short period of time, and even primary replacement plants will not be able to grow and invading plants will enter the degraded habitat. The results of comparing the biodiversity of coastal plants in middle sand dunes show that *Artemisia tschernieviana* has the highest abundance compared to other plant species in this habitat and its distribution is almost uniform in most of the studied areas. In other words, it is not available just in areas where it has faced sever destruction. *Rubus sanctus* has been present in middle sand dunes in the Mirodsar to Karfun area. Its abundance has decreased sharply with increasing degradation of middle sand dunes. *Juncus acutus* has been observed in most of the coastal areas, where the presence of this species is conditioned by an increase in soil moisture and its texture stabilization. Evidence suggests that *Maresia nana* was extinct in transects with high degradation.

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