Geomorphology of Sefidrood River new delta in Southern Caspian Sea coast during 80 years ago

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Abstract

A survey of the maps, aerial photographes and satellite images of Sefidrood's new delta occurring in the Caspian Sea south coast, shows that certain fundamental morphological changes have been occurring in the delta during the 80 years ago. Rapid Caspian Sea fluctuations are one of the unique particularities of Caspian Sea. Althoutgh both the rise in the water level of Caspian Sea during the years 1926-1978(about 3 m) and fall in the level of the sea during 1975-1995 (about 2 m) were influential in the process of its intrusion. But little or no attention has been paid toward the role of sediment budget changes and Sefidrood's mouth displacement in the development of the delta. The survey shows that the Sefidroods new delta influenced by the function of the waves, sea level fluctuations and the Sefidroods mouth displacement. During 1955-1964 Sefidrood's mouth was extended about 3.5-5 km farther to the northwest. The displacement process was occurring in the direction of east west in the first half of the 20th century and was adversely advancing in the second half of the past century.

Key words: Sefidrood River, delta, river mouth, Caspian Sea water level

1. Introduction

River deltas, a part of a watershed system," form under the influence of a complex of factors dynamic interaction and mixing of river water and receiver water, deposition and deposition of river and marine sediments. The economic value and environmental vulnerability of these objects necessitate the monitoring of their variations, including the study of data dynamics over many years"(Kravtsova 2001). The continuous demand for hydrocarbon fuels, agricultural land, and renewable resources will derive expanding human activity in deltas throughout the world. Efforts to explore, understand, manage and exploit these complex coastal sedimentation sites will most certainly by maintained and will likely intensify in the coming years (Coleman and et al 1986).In recent years, remote sensing images have been used widely in studying the deltas (Kravtsova 2001, Krasnozhon 1999). Some of them are: Coleman and et al 1986, Yang and et al 1999, Krasnozhon 1999, Kravtsova 2001,Barzegar and Mokaberi 1988. Satellite images can facilitate observations along the entire river system, from upper part in mountainous area to seaside and even in sea. Satellite images have great benefits in recognize similarities and differences in modern world deltas (Coleman and et al 1986).

This study with using aerial photographs, land sat Satellite images and field observation in south Caspian sea, showed that mouth changes and delta morphology under the influence of interactive relationship Caspian sea fluctuation and Sefidrood floods. Based on this theory, in different time, because dominated sea current or river flow, morphology active Sefidrood delta has changed as: cuspate, arcute, asymmetric and symmetric.

2. Area description

The Sefidrood delta river, which is located in the southern part of Caspian Sea, is similar to the Volga River in the northern basin on a smaller scale. Its watershed is about 57880 sq km and its approximate length is 710 km. Sefidrood is the longest river with the largest amount of water in north of Iran, which formed from connection Qezel ozan and Sahrood rivers in 110 km south of Sefidrood mouth (Manjiel town). This river, after passing from mountain meander valley, formed a great delta with the same name and, connect to

Caspian sea shore in the northwest of small Kiashahr port(fig 1). The morphology of the Caspian Sea shore and its latteral territory in the Iranian coast is based on the shape of the mountain ranges and their side faults such as Talesh and Alborz faults. Only in the Sefidrood delta, the shoreline extends in to the sea, because of intense sedimentation of this river; the geometrical morphology of the coast is different from lateral faults (Paluska, Degens 1992). The Sefidrood active (new) delta which is a single main channel (Kousari 1993, Krasnozhon and et al 1999), and is from the generative type with distributary branches (Kousari 1993) is limited from south to the sandy band of Hassanrud-Dastack, from north to coastal line, from west to Zibakenar small port and from east to the region of Amir Kiasar Kiashahr. Southern section limited to 37 26 northern latitude and, between 49 51 to 50 estern longitude. Aproximate area is 40 sq km. International Kiashahr lagoon's is situated on active Sefidrood delta (Khoshraftar 2005).

Fig1.Southern Caspian Seaand study area in North of Iran.

Source: Terra satellite 2003 ,with modifications.

3. Methods

3-1. Aerial images and image processing

I analyzed the temporal and spatial changes of Sefidrood new delta and its mouth using aerial photographs and land sat satellite images. Aerial photographs black and white covering the boundaries of the new Sefidrood delta for 1955, 1964 and 1982. In respect to area of new delta (40 sq km) an aerial photograph 9*9 cm in scale 1:50000 covered its surface. Digital land sat images were available for the study site for 1966, 1987, 1991, 1998, and 2001. At first digital layers composed together in Photoshop soft wear, 7 version and then analyzed with Arc view 3.2 a. More ever these images, I used other satellite images as photographs for 1955, 1977, 1983,1993,2002,2003. Therefore, I analyzed aerial photos and satellite images as instrumental and non-instrumental. In instrumental interpretation has overlain all of digital layers together in finally and then take place measuring.

3-2.Hydrologic data

I obtained daily and annual discharges for Astane gage from Guilan Province Water Organization (Energy Ministry). This gage is approximately located at 25 km south of Sefidrood mouth in near of old Astane Bridge. I used data for water years 1956-1996, where a water year extends from September 23 to September 22. I use in special case from Rudbar gage, based on high R^2 between Astane and Rudbar gages for the period of record (1946-1996). In addition, gap data calculated with use of linear regression discharge between Astane and Rudbar gages. Annual discharge statistics were derived from daily mean discharge records (m^3 s−1) for the Astane gage. Maximum, concise flood discharges and duration curve are calculated for the gage's period of record (1956–1996). All of diagrams in this stage prepared by Excel 2000 soft ware and then analyzed.

3-3.Caspian sea fluctuations data

The sea- level controles the type and magnitude of all coastal processes: breaker type, long-shore current velocities, sedimentation, and so on (Pethick 1991). Almost all of the hydrological scientists of the Caspian Sea believe that the Caspian Sea dosen't has any tidal currents (Kroonenberg and et al 1997, Dolotov and et al 2001), or if it has they are very limited (Moghaddam 2002 ,Mansimov and et al 1994). The Caspian Sea offers a unique opportunity to study the impact of sea-level change on sedimentary sequences in real time, when modern sea-level changes take place here at a pace of 100 times faster than they do along oceanic coasts (Kroonenberg and et al 2000). For considering Caspian Sea water level changes in quaternary referd to Mamedov 1997, Rychagov 1997, Kroonenberg and et al 2000.

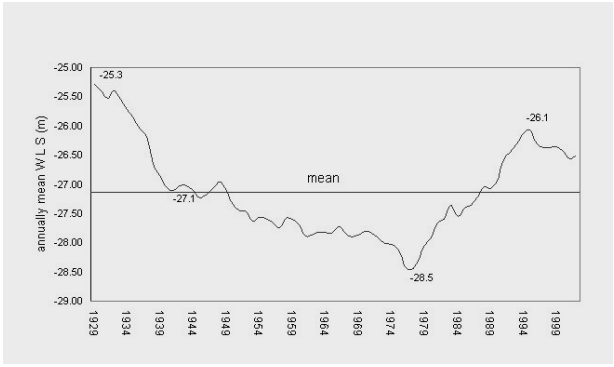
The first statistics of Caspian Sea water level fluctuation in Iran were recorded in Anzali station in 1929. This staion has the oldest recordes on Caspian Sea fluctuations and it is situated in 40 km west of the Sefidrood mouth. Their accurecy of data is about ± 0.5 cm. Measuirng the Caspian Sea level in Iran is 60 cm lower than the base point in the other counteries around the Caspian sea. In relation to the Sefidrood delta morphology considerd Caspian Sea fluctuation in two levels: annual; seasonal.

3-3-1. Annual fluctuations

For analyzing the changing trend, used the 78 years data of Anzali station (port &shipping Bauer of Anzali 2001) then by Excel soft ware 2000 the annual change diagram from 1929-2001(fig 2).Which three trend easily recognized as:Water level decrease from 1929-1977,Water level increase from 1977-1995,Water level decrease from 1995-2001.

During 48 years from 1929-1977 the Caspian Sea level changing trend shown decrease and annually the mean being 6 cm per year and total decrease being 3m,so that from -25.3 m in 1929 reached to -28.5 m in 1977. Although in this period Caspian sea was retreating but small advancing took place during 1932,1943,1947,1957,1966 and 1970, as compare with ago year, from sea level itself approximately 15 cm increased been observed. Because in coastal geomorphological investigation on sea level changing rate, in addition changing intensity of sea level is very important. Infect this period could be divided in two sub- period from 1929-1941 means during on period of 18 years, the sea level decreased approximately 2 meters, but from 1941-1977 this changing trend being mild, during 25 years, falling rate being only about 1 meter (Khoshraftar, 2005).Sea level dem in 1929 and 1977 had shown the highest and lowest respectively. From 1977 sea level has increasing trend and annually increased mean being 13 cm, in 1995 it reached to -26.1 meter. In other words during 18 years sea level incensement was 2.30 meter approximately, due to this increase of sea level it caused water-logging about 800 sq km (Caspian sea research &water resource center 2000). After decreasing water-stage from 1995 second phase of retreating began, so that sea level annually 5 cm decreased and this trend continued in 2001.

Fig 2. Caspian Sea level oscillations during 1929-2002.



Source:Data from Anzali station records (1929-2002).

3-3-2. Seasonal and monthly fluctuations

Seasonal fluctuations is not increased more than 10 cm, short change of precipitation in Caspian watershed, snow melting delay, drought and evaporation rate on sea could be considered as an important effect on entrance and evaporation rate (UNIDO REPORT 1998). Sometimes this seasonal fluctuation occurred duo to over-flowing or decreasing of rivers to shed (Ghazi 1990). Data analyzing of Anzali station shown that in early season of spring (May April) river entrance and precipitation on sea reduced to maximum rate, so Caspian sea level raised and in July it reached to maximum level (Caspian research &water resource center 1996). Totally in July & August duo to entering of Volga floods and other rivers Caspian Sea water level increase approximately up to 70 cm (Mahamed 1995). Because 85 percent of entering currents in spring season reached to sea, so in some year's duo to freezing of Volga these currents enter with delay. Often in July water- stage reached annually to it's maximum level in autumn season duo to sever wind it caused by waves (Caspian research &water resource center 1996) and autumn's precipitation in south and west coast of Caspian Sea in Iran, raised water level. Sea level from March start to rise and in July reach to it maximum level, then it level start to decrease from February reached to its minimum level (Khoshraftar 2005).

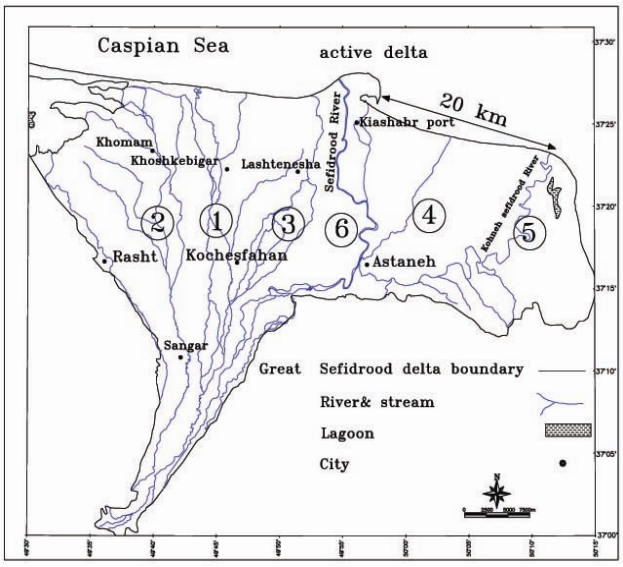
4. Discussion and Results

Sefidrood similar to other river has changed its way on delta frequently and we can sea their evidences

on delta. Those displacements were about several kilometers in past and 100 -5000 meters at present (khoshraftar 2005).probably Sefidrood has changed its way six times (paean 1996, Barimani 1976, Mahmodi 1995), and it has released it's previous way in the last stage before reaching Astaneh town and it has gone directly toward the north with forming the several meanders and it has joined to the sea after passing the Kiashahr small port (Mahmodi 1995). Abandoned delta in mouth of Kohne Sefidrood had formed from sediment deposition in route number 5(fig 3).

Aminsobhani (1991) believe that the most recent route displacement from Kohne Sefidrood (route number 5) to the present route (route number 6) and consequently the mouth displacement to Kiashahr has flooding origines and, Zistab consulting (1990) and Khoshraftar (2005) with different reasons think that displacement was caused by tectonic forces. Kousari (1993) says that the last change of the way was in 350-500 years ago, according to Krasnozhon and et al (1999) and Voropayev and et al (1998) it was about 500 years ago and according to Behzad (document N 625 Guilan university), it has occurred less than 200 years ago. Zomorodian (2002) tells from Aminsobhani, "Sefidrood connect to Caspian sea in 500 years ago in eastern part of kiashahr small port". The development of the Sefidrood new delta can be dividing: before 1950 and after it.

Fig3 Sefidrood River route displacements in quaternary.

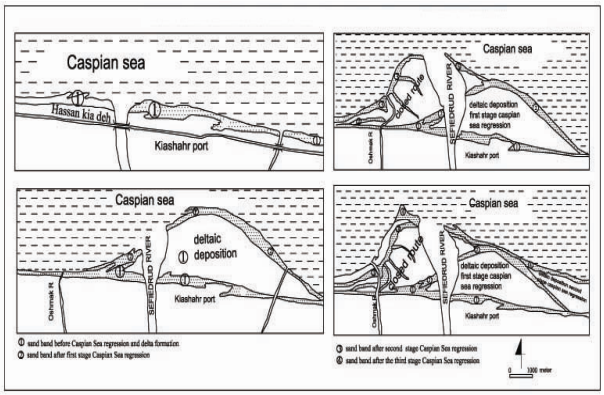


Source: Based on Mahmodi information 1995.

4-1. First period, before 1950

After Sefidrood mouth and route changed, this river connects to sea in Hassan Kia Deh (Kiashahr port at present). In this period, Caspian Sea shore was in north of Kiashahr Main Street western-eastern, and Sefidrood cut seashore as perpendicular (fig 4A). Sandy band number 1 which has -20 m elevation related to this stage. This band stretched from front of Zibakenar Hotel to Dastak (Kousari 1986). With regression of Caspian Sea, Sefidrood sediments as deltaic deposit in eastern part as special and caused widespread coastal area. Sandy band number 2 formed in this stage (fig 4B). Another time, Caspian Sea regreate and result in deposition deltaic sediments in western part and formation sandy band number 3(fig 4C). Tilt of mouth was westward. In latest stage, Caspian Sea has little regression and then increased deltaic deposits in western part. Development of sandy band number 3 closed Oshmak river mouth and sandy bands number 4-formed parallel with together (fig 4D).

Fig 4. Sefidrood new delta formation before 1950 in relation with Caspian sea level change.



Source: Kousari, 1986 with modifications.

4-2. Second period 1950-2002

4-2-1.1950-1955

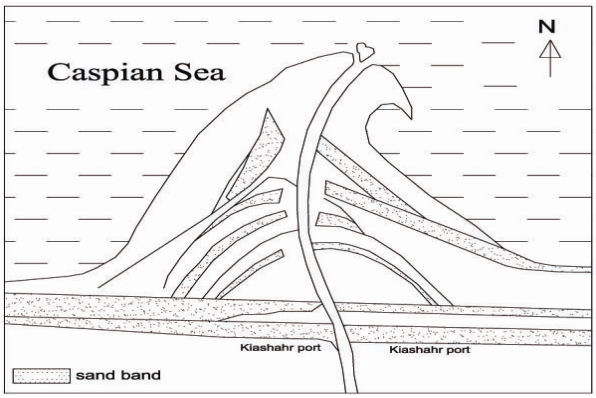
Krasnozin and his colleague's studies (color images taken with a KFA-1000 camera) show in 1929 the Sefidrood mouth was deviated to east and an island was formed in the mouth (fig 5). Also five barrier islands along the shore have been formed (Barzegar and Mokabery 1988). In this stage, Sefidrood had a single Chanel. Based on aerial photographs taken in 1955, the trend 1950 has countinued and Sefidrood active deltas asymmetrially have prograded in the Caspian Sea (fig 6). A great volume of sediment, the width of the prograted parts in the Caspian Sea and long shore currents from west to east resulted in an egel head shape with an eastern tilt and then

Kiashahr bay was formed (mouth of bay was about 2 km). Several older mouths in western and southern parts of active mouths have been recognized. This trend has probably started since 1921. Formation of two-greater Island in mouth, divide river flow which eastern of them was main. Width of main mouth was about 500 m. In reverse to sefidrood, Oshmak River mouth deviated to west side. We can see sefidrood flash floods in aerial photograph 1955 which have affective role in mouth displacement (khoshraftar 2005). In this period, the Caspian Sea level was regretting in such a way that it decreased to -27.8 m in 1955.

4-2-2. 1955-1964

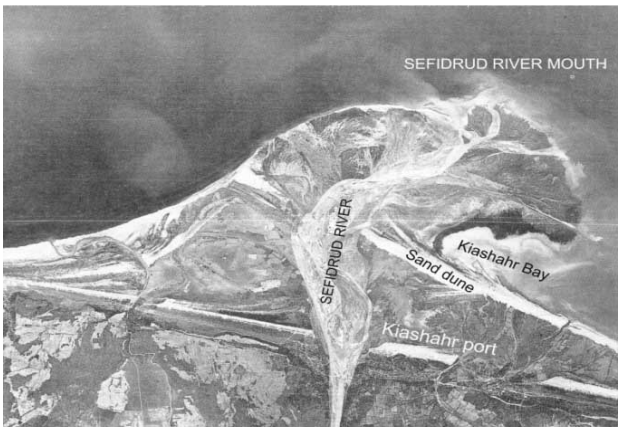
In this period when Sefidrood and its mouth changed direction to the west, intense changes took place in the Sefidrood delta morphology. In May

Fig 5. Sefidrood new delta and sand bands in 1950.



Source: Krasnozhon and et al 1999 with modifications.

Fig 6. Sefidrood new and active delta in 1955.



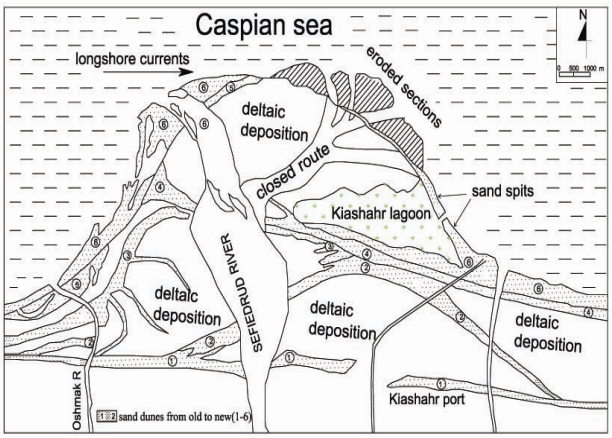
Source: Mahmodi 1995 with modifications.

1955 a flash and sever flood with discharge of about 2425 m^3/sec, recorded in Astaneh station, which seems to have changed the Sefidrood mouth from north east to north west. Unfortunately only aerial photograph this period was 1964. Behzad (document N 625 Guilan university) says that" Sefidrood have several distributary's branches in different directions in 1957." In the spring 1957 a flash flood with discharge of about 1400 m^3/sec, take place, which seems to have changed the Sefidrood mouth. This flood coincides with several mouths cited by Behzad in 1957. In other word may be after his flood, the mouth 1964 formed stabilized as main mouth. Similar to 1950, Sefidrood have several mouths in 1957, which one of them can see in 1964(fig 7).

We can see in 1964 the mouth migrated 3.5-5 km to the west, in comparison with the year 1955 and was Maine mouth for several years. With formation sand band number 6, the new mouth has prograted about 700 m forward into sea (khoshraftar 2005). In this stage, the delta was 34 sq km (Barzagar and mokabery 1988). When the mouth migrated, the sediment budget in the old mouth and its shores became negative. A small coastal cell was formed because of its formation; the sea currents and waves eroded that area completely. The asymmetrical morphology of the eagle head and the retrogation of the sea water level to the formation of sand shore and spits (N 6) in the kiashahr bay. Its length was a bout 2 km and its width was 200 m. Flash flood had been extended towards the right bank of Sefidrood River, apart of Sefidrood water entered Kiashahr lagoon via its right. Probably those floods cut sandy band number 6 in middle part and therefore Kiashahr lagoon mouth and sand spits 6 formed. Its canal width was about 150 m and its length 300 m. Sand spits in western part new mouth result in formation a long lagoon (khoshraftar 2005).

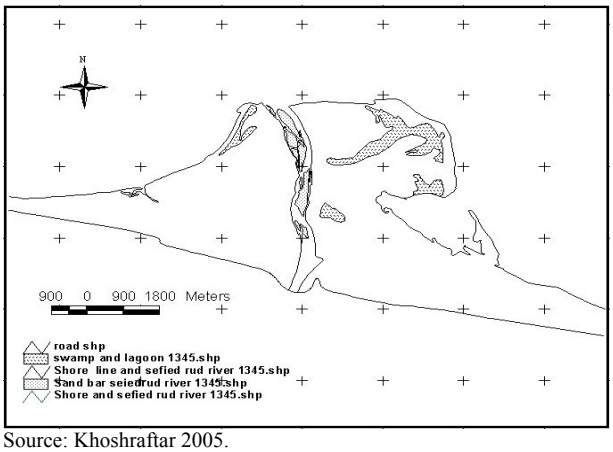
When the Sefidrood Dam was first used in 1962, sediment yielding in Sefidrood mouth was much limited (tolloei 1984) and the fast prograting of the delta into the sea was decresed (Mahamed 1995). After this, the sea prograted and the coast were eroded (Tolloei 1984) (fig 8). Comparing the duration curves and discharges Astane gags data before and after Sefidrood dam construction reveals that, flow trend and sediment rate changed effectively. In this period, days with discharge more than 400 m3/sec decreased. Decrease in the sea level water drop (about 25 cm in 9 years), starting the dam caused delta formation to limit and penetrating into the sea to decrease in comparison with the prerious period. At this stage, the Caspian Sea water level was – 27.8. Although this period was short. However, there were obvious changes in the region during this 9-year period.

Fig 7 . Sefidrood new delta and Kiashahr lagoon in 1964.



Source: Kousari, 1986 with modifications.

f ig 8 . Sefidrood new and active delta in 1965.

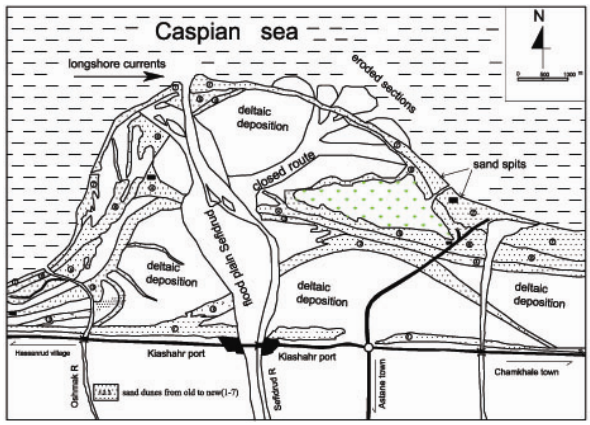


Source: Khoshraftar 2005.

Fig 9 .Sefiedrood new and active delta in 1972.

Source: NASA 1972.

Fig 10 .Sefiedrood new and active delta in 1982.



Source: Kousari, 1986 with modifications.

4-2-3. 1964-1982

Comparing the 1966 map with the 1964 aerial photographs reveals that the coastal line and mouth position changes were limited. But more islands have formed in flood plain between mouth and Kiashahr Bridge. The 1972 satellite images also show that the mouth didn't have outstanding changes (fig 9). Considering north – eastern winds with a speed of 4 to 6 m per second shows that the asymmetrical coastal cell was formed and the sediments were displaced to the east. In this Period, the Caspian Sea level fluctuations can be divided into two parts: Decrease from 1964 –1978 and increase from 1978 to 1982. Although the sea water level increased in the second period, since the increase was little, it couldn't prevent the progration of the delta. Left part of mouth has more progradation because Sefidrood flow act as natural epi and coastal sediment movement from west to east blocked. The mouth in 1966 in comparison and it divided the semi – circle delta in two equal parts. In other word connect to sea directly. The Sefidrood mouth deviated to the west in 1967 and main branch connect to Caspian Sea directly in 1969. According to Barzegar and Mokaberey (1998) measurements, the size of the delta was approximately 34 sq km in 1972. The 1982 map shows that in the period between 1964 and 1982, the mouth displaced about 1 km to the east (fig 10).During the period between 1978 – 1995, although Caspian Sea was moving forward and in Iranian coast, sea progreate to land, but it seems that the destructive phase was started by the sea's transgression and the coast exposed in to the destruction but delta was still in constructiveness phase. Therefore sand spit and sandy band number 7 formed in new delta and progreate in the sea. Older spits and sandy band such as number 6 become wider and strengthen. One of the most effective elements of this process was the execution of flashing activities in Sefidrood dam. Studying discharge changes of Sefidrood in period 1964-1982, shows that only in 1968, 1976 discharges

were 4500, 3300 m^3/sec respect and duration curve about 3 days. With starting Flashing in Sefidrood reservoir in 1980, delta formation is faster (Mahamed 1995). Based on Kousari studies (1993), the new delta since 1950 up to 1982 ,in 33 years have growth exceeds 10-15 meters annually. But Krasnozhon and et al (1999) cited "the Sefidrood delta during 1950-1980, advanced 800 m into the sea on the western side and 1600 m on the eastern side (average 27-53 m/year)".

4-2-4. 1982-1991

Sefidrood mouth position has not significant displacement in 1984 in comparing with the 1981. Continual transport sediments as take place flashing, do not any displacement decreased wave energy, and diminish coastal erosion. Land sat images taken place 35 and 112 days after seventh flashing in 1985, 1986 rivals flashing role, offshore currents and prevailing wind in tilt ting apex mouth to east. In this period take place 10 times flashing which with attention to density and volume of sediments have effective role in Sefidrood delta morphology development. The image of land sat in 1987 shows that the way of Sefidrood has changed in to semi–meander and the flood plain extend towards the east too much (fig 11 A). In contrast with Caspian Sea level rise, this image shows delta progradation and in compare with 1982 delta area increased 5 sq km. We can see distinct changes in shoreline with formation of triangle morphology. In other word formed cuspate delta with wave dominated. The width of mouth was 300 m and a crescent barrier island formed in the front. Its length about 420 m and its width was about 130 m. Also in two side of eastern mouth in distance of 200 m from seashore in deep 1.5-2 m formed a barrier island. If sea level rising, those islands moves toward inland and formed a narrow lagoon with decreasing of sea level.

The satellite's image in the winter of 1991 shows that by coming up the level of Caspian sea's water from 1987 to 1995 about 2m entering the deposits which were obtained of Sefidrood floods and deposited in lagoon's western border in conic form (Crevasse) decreased lagoon's area(fig 11 B). When Sefidrood River divided into two branches in the farthest and of the sandy band number six, it increased the deposits in the western part of Kiashahr lagoon (gray color in western part of Kiashahr lagoon).With respect to 40 cm rising Caspian Sea level in 1982-1987 and diminish sediment delivery to mouth, width of barrier islands decreased and coastal lagoons limited. Analyses of the surveys show that duration curve and rate of discharge lowered strongly. High discharge, over 1000 m3/sec repeated 7 times. Its durations were lower than 2 days.

4-2-5. 1991- 2002

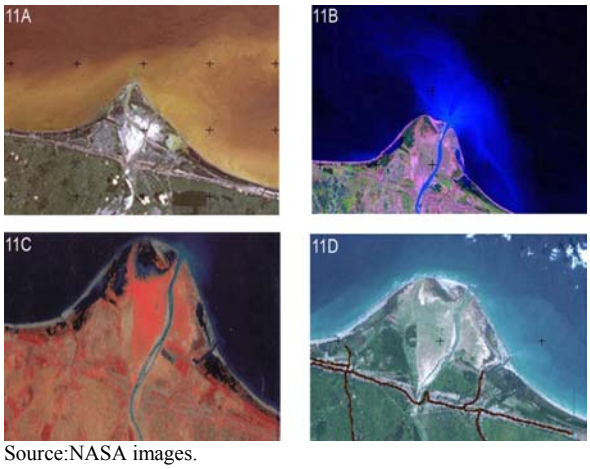
As it is seen in the satellite image, in 1991 the morphology of Sefidrood's delta in cooperation with 1982 has been changed basically, during about one decade that is related to the increase of the sea level, mouth displacements and flashing procedures. According to the satellite image's analysis and in spit of increasing the sea level, the formation of delta was progressive and the mouth tended toward the east and delta's morphology was developing gradually under the wave's influence, which was like the bird's beak. Sefidrood was divided into to branches at the end of the sandy band, number six. The northern branch with 1250m long and about 10 m wide, shed into the sea after entering the small lagoon. First, the western branch continued from the embrancement place with the south east-northwest extension with 2 km long, and then deviated toward the north with the right angle. According to the last accounting of coastal sandy band's extension, the area of the delta is about 40sq km that about 2 sq km of it is covered with the swamps and lagoons. The increase of the sea level, the area of lagoons and swamps are the characteristics of this period, too. The barrier islands in the east of original mouth and the sand spits which were formed in previous periods in Kiashahr lagoon and the western side of the original mouth was strengthened. Also, with Sefidrood floods, the floodwater was extend towards Kiashahr lagoon and resulted in forming the Crevasse sediments. Kousari believes that, in 1993 Sefidrood was pouring into the Caspian Sea in the side of the north (Kousari 1993). According to this matter that the sea level had a progressive trend, the front of Sefidrood delta was exposed to the erosion, but because of doing the flashing procedures, the rate of erosion was not great. Kaplin (1994) points that the Kura delta went back about 10-15 m in the same period.

It is seen in 1998 images that the major way of 1991 has been closed, but yet it can be recognized (fig 11C). Sefidrood new movement was directed from the river's branching place in 1991 towards the side branch, which was shorter than previous one and tended the east. In this stage, Sefidrood River is seen like single cannel that its length is

about 4 km and its width withen the boundary of Kiashahr Bridge to the sea was about 200 meters. The new mouth in comparison with 1991 has been interchanged about 800 meters towards the east. The site of deposition and movement direction sediments was changed with the replacement of the mouth, so that in closed mouth and the eastern side, the erosion caused to regression of delta's coastal line. The area of the western lagoon decreased with piling up the sands and increasing the vegetations. Whereas sand spit strengthends in the eastern side of the new mouth. In this period, the relationship between the kiashahr lagoon and the small lagoons and swamps that had been formed between the lagoon's mouth and Sefidrood mouth was cut by building a road for creating break water. Gradually, the times of the Sefidrood's overflow and entrance in to Kiashahr lagoon were decreased because of the stabilization of the right bank of Sefidrood in the Mino Abad. Furthermore, because of the sediment's deposition in Kiashahr lagoon canal, the depth of the canal has been decreased and the traffic of fishing boats and barques had some problems. The sediments of the cannel's bottom were dradged and poured in two sides of the cannel.

The examination of satellite image in 2000 shows that the mouth and route of sefidrood, in comparison with 1998, haden't any fundamental replacement. But, because the Caspian Sea was regressing, the sand spits of Kiashahr lagoon's northern part were expanded widthwise and at the most, it was about 250 meters near the mouth of canal. This canal with 1300 meters long and with the width of 50 meters has divided Kiashahr lagoon into western and eastern part that in the eastern part of the lagoon, we can gain access to sandy beach via wooden dridge which is the side the Kiashahr's forest park (maximum width of the canal in the mouth is about 200 meters). The major part of the eastern lagoon is covered with the hydrophytes plants. About 5 water bearing strates divide them via Roga (the water way between the lagoon's vegetations). As, it is seen in the satellite image, which is related to March 2001(fig 11D), the mouth of sefidrood hadn't any manifest change in comparison with 1998 and enter the sea in the north eastern part. The formation of islands is seen inside the torrential bed. The wetlands between the lagoon's mouth and Sefidrood's mouth are changed into dryness environment by increasing the height at the wetlands and just a narrow linear lagoon is seen near Kiashahr lagoon.

Fig 11 Sefidrood new delta(explanation in text).



Source:NASA images.

According to Sefidrood delta's satellite image in 2002, the mouth of Sefidrood tends to go towards the east and the width of the mouth is about 280 meters the dam - like dapper has formed with about 280 meters. The dam - like dapper has formed with about 500 meters long that one part of it is stuck to the western coast. The width of this barrier islands is about 200 meters in the junction to the land and in its point is about 80 meters. Also, we can see a breakwater in the eastern coast of canal's mouth, which connects the lagoon to the sea. As Caspian Sea is regressing in this stage, the increase of the coastal sandy bands is completely clear and it is about 300 meters with in the boundary between the mouth of Sefidrood and Oshmack River. The morphology of the coastal line which is a half circle, is symmetrical just a small part of Kiashahr lagoon has water in the northern part and the major part of it is like swamp. The northern part of the pool, between the coast and Sefidrood's torrential plain, has been dried very much that the major reasons of this event are: coming out the surface of the land, gatdering the torrential sediments of Sefidrood and the evacuation of Kiashahr port's canal sediments. Also, we can't see them in the western part, between the mouth of Sefidrood and Oshmak River in this stage, which were seen before in the dam – like islands. These dams – like islands have been a part of land by regressing the sea's water, so that first, some narrow linear lagoons were formed between the above islands and the land. After a short time, in addition to lateral replacement, have been filled with sediments, which were transferred by the waves especially in the stormy conditions.

5. Conclusions

1- The Sefidrood river delta is forming in a closed basin and different in many aspects of other Caspian Sea deltas (sush as Volga). Similar to Ibrahimov and his colleague's studies (2002) on Kura delta, the Sefidrood river delta is fluvial dominated in fall Caspian Sea level, and wave dominated in rise Caspian Sea level.

2- The height waves in the winter that comes from northwest (from Anzali toward Sefidrood mouth) transports sediment from sea bed and barrier islands toward shore and Sefidrood river mouth. If next floods have not been sufficient strength for sediment movement, the mouth nearly fixed or displacement in little distance. Moreover sediments deposition in sefidrood floods plain especially in places which sefidrood route have high angel, or meander form result to deviation. In this case, probably displacement is in great distances (for example mouth displace in end of 1955). After sefidrood reservoir construction in 1962, and other little dam such as Sangar dam, the flash floods decrease greatly. Therefore, mouth displacement as kilometers is far of view.

3- In active delta, during 80 year last, the greatest mouth displacement was 5500 m and the shortest route displacement was 100 m.Therefore with severely decrease Sefidrood flood, the route and mouth displacements would creeping.

4-because greater gradient slope in southern part of the Caspian Sea and Sefidrood delta front in sea, small Caspian sea level fluctuations have not effective role on development of Sefidrood river delta. Also human effect on sediment and water discharge as flashing sefidrood dam, decrease Caspian Sea level rise role in delta morphology.

5- Asymmetrical morphology of Sefidrood new delta in period 1950-1955 was influenced of mouth position, which changed with high floods. Sefidrood route and consequently mouth displacement caused a symmetric morphology in shoreline and delta.

6- Based on my study on maps, aerial photographs, satellite images from different months and years and at end in field, displacement of sefidrood route and mouth have been affective role in Sefidrood delta morphology that in previous research don't attention them and very exaggerates about Caspian Sea currents from west to east. The survey of different satellites images showed that yet in north east mouth, Sefidrood sediment moved towards west.

References:

1. Aminsobhani, A., 1991. Sefidrood evolution in past century. Proceeding Seventh geographical congress of Iran, Tehran University press, Iran, pp. 1- 44. (Persian).

2. Barimani, A., 1976.Caspian Sea.Tehran university press, Tehran,Iran.(Persian).

3. Barzegar, F., Mokaberi, A., 1988. Recent development of the Sefidrood delta. Iranian remote sensing center, Tehran, Iran.pp 197 – 204.

4. Behzad, A., 1975. Sedimentary phenomena in southern Caspian Sea. Document 625, Guilan University center of documents, 295-306. (Persian).

5. Coleman, J.M., Roberts, H.H., HUH, O.K., 1986. Deltaic Landforms. Geomorphology from space, NASA publication, PP.1-5.

6. Energy ministry of Iran, 2002. Caspian Sea area in 20th century (report). Caspian Sea research &water resource center, Sari, Iran.pp 1-15. (Persian).

7. Energy ministry of Iran, 1996. Caspian Sea level report in 1995. Caspian Sea scientific seasonally magazine. 2, Sari, Iran. pp 1- 25. (Persian).

8. Energy ministry of Iran, 2002. Discharge data guilan Province Rivers. Guilan province water organization, Rasht, Iran.pp. 11-15. (Persian).

9. Gazi, I., 1990. Caspian Sea fluctuations: Volga River and delta in satellite images. Journal Researches in Geography, 26, Tehran University press (Persian).

10. Guilan province geography teacher, 1995. Guilan province of geography. High school book second year, Rasht, Iran. (Persian).

11. Ibrahimov, B.V., Hoogendoorn, R.M., Boels, J.F., 2002. History of recent Kura Delta development, Azerbaijan NOW Workshop Holocene Caspian Sea L level Change. 21-22 October 2002.

12. IGCP 481 Project Cuspate dating Caspian sea level change may14-16, 2004, Baku, Azerbaijan

13. Kapline, P.A., 1994. Environmental conditions of the Caspian Sea in relation with sea-level rise Seasonally magazine Water & Development. 1, 19-34.(Persian).

15. Kazanci, N., Gulbabazadeh, T., Leroy, S.A.G., Ileri, o., 2003. Sedimentary and environmental characteristics of the Gilan-mazenderan plain, northern of Iran: influence of long-and short –term Caspian Water Level fluctuations on geomorphology. Journal of Marine system 46,145- 168.

16. Khoshraftar, R., 2005. Geomorphologic evolution Sefidrood delta. PhD Thesis, geography faculty, Tehran university, Iran. (Persian).

17. Khoshraftar, R., 2005. Geomorphologic evolution Kiashahr lagoon using aerial photographs, satellite images. 9th international conference on environmental science and technology. Rhodes, Greece, PP 381-387.

18. Kousari, S., 1986. Development of the Sefidrood delta. Journal rushed amozesh zamin shenashi. 7, 31-41(Persian).

19. Kousari, S., 1993. Development of the Sefidrood delta. The first scientific seminar on the water balance and fluctuation of Khazar Sea. Ramsar, Iran.

20. Kravtsova, V.I., 2001. Analysis of delta dynamics based on space images. Water resources. 28, 364 - 370.

21. Krasnozhon, G.F., Lahijani, H., Voropayev, G.V., 1999. Evolution of the delta of the Sefiedrud River, Mapping Sciences and Remote Sensing. 36, 256-264.
22. Kroonenberg, S.B., Rusakov, G.V., Svitoch, A.A., 1997. The Wandering of the Volga Delta: A Response to Rapid Caspian Sea-Level Change. Sedimentary Geology. 107, 189-209.
23. Kroonenberg, S.B., Badyukova, e.n., Storms, J.E.A., Ignatov, E.I., Kasimov, N.S., 2000. A full sea-level cycle in 65 years: barrier dynamics along Caspian shores, Sedimentary Geology, 134, 257-274.
24. Lansat images, TM 1991, 1998, ETM+ 2000, 2001, 2002
25. Mahmodi, F.A., 1995. Natural face and geology Guilan province. Research group of Iran. (Persian).
26. Mahamed, A., 1995. Sources and use of water in Guilan province. Research group of Iran. (Persian).
27. Mamedov, A.V., 1997. The Late Pleistocene-Holocene history of the Caspian Sea. Quaternary International. 41/42, 161-166.
28. Mansimov, M., Aliyey, A., 1994. Caspian Sea level. www.azer.com/aiweb/categories/magazine/23_folder/23_articles/23_caspiansea.html- 11k.
29. Moghaddam, P.R., Alaee, M.J., Ashasi, A., Soltanpour, M., 2002. A numerical Investigation of Beach Profile Changes in Southern Coasts of the Caspian Sea. Fifth International Conference on Coasts, Ports and Marine Structure. Iran- Ramsar 14-17 October 2002.
30. Paean, L.A. M., 1996. Caspian Sea. Hedayat press. Raht, Iran. (Persian).
31. Paluska, A., Degens, E.T, 1992. Das Quartar Des Kaspischen. Tehran, Geological survey of Iran. (Translated in Persian).
32. Pethick, J., 1991. An introduction to coastal geomorphology. Routledge, Chapman and Hall, Inc, Fifth impression.
33. Rychagov, G. I., 1997. Holocene oscillations of the Caspian Sea, and forecasts based on palaeogeographical reconstructions. Quaternery International,41/42, 167-172.
34. Transportation and Road ministry of Iran, 2002. Records of Caspian Sea level change 1929-2002.Anzali Port and Shipping Broad, Iran.
35. Tolloei, A., 1984. Caspian Sea protection project in Dastak area. Ab magazine, 2. Iran.
36.Unido,1988.CaspianPollutionReport.www.caspianenvironment.org/eracl/unido_htm.
37. Voropayev, G.V., Krasnozhon, G.F.,Lahijani,H.,1998.Riverin deltas in Caspian Sea..Caspian Sea research &water resource center, Sari,Iran.pp1-7(Persian).
38. www.caspage.citg.tudelft.nl/project.html.caspage: dating Caspian Sea level change. IGCP
39.Yang, X., Damen, M.C.J., Vanzuidams, R.A., 1999. Use of Thematic Mapper imagery with a geographic information system for geomorphologic mapping in a large deltaic lowland environment internatonal journal remote sensing.20,659-681.
40. Zomorrodian, M.G., 2002. Geomorphology of Iran 2. Ferdowsi University press. Mashhad, Iran. (Persian).
41. Zistab consulting, 1990. Stabilization and reorganization Sefidrood river project. Water organization Guilan province. (Persian).