a compression plate in front of the exit stream and will cause the formation of a wall jet.

Previous studies in the area have shown the process of river formation at the confluence of rivers, leading to drastic morphological changes in the area. Gohari and Amraei showed that sedimentation will occur in the flow separation area and erosion within the maximum current velocity [5]. This is in line with the sedimentation pattern at the confluence of the Arvand and Karun rivers. Therefore, one of the issues that should be considered in the analysis of this area is the flood currents of Karun, which can cause significant changes in the bed of the intersection of Karun and Arvand rivers.

3.2. Sediment Sampling

Sediment sampling includes sampling of riverbeds and suspended sediments. Table 3 and Figure 2 show the results of bed sediment sampling. Most of the sediments in the study area are fine-grained. Therefore the grading of sediments has been done with laser. Evaluation of the results shows that the volume of sand materials at stations in the Karun and the Arvand Rivers is about 10 per cent, and at the intersection of these rivers, about 30 per cent. Due to the drastic changes in depth at the intersection, the relative size of the materials has not been unexpected.

Also, the concentration of suspended sediments obtained at different depths from the water surface is shown in Figure 3. As it is known, sediments become denser with increasing depth. The concentration of sediment at Karun station has the lowest, and the station located at the intersection of the Arvand and the Karun Rivers shows the highest concentration of suspended sediments. The results show that the sediments of the region are fine-grained and the complexity of the flow in the confluence of the Arvand and the Karun is very significant.

Table 3. Results of bed sediment sampling

No. Station	Location of Station	Results of Grading: Bigger than 40µ (sand)	Results of Grading: Smaller than 40µ (fine-grained)
1	Karun	4%	96%
2	North of Arvand	12%	88%
3	Confluence of Rivers	30%	70%
4	South of Arvand	12%	88%

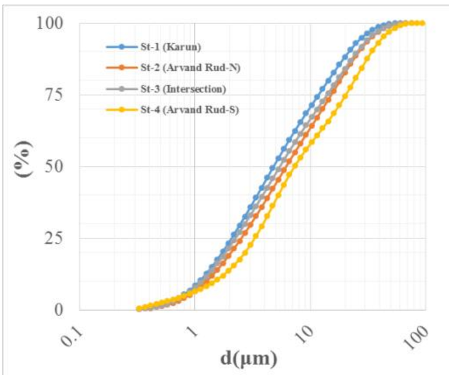


Figure 2. Results of bed sediment sampling

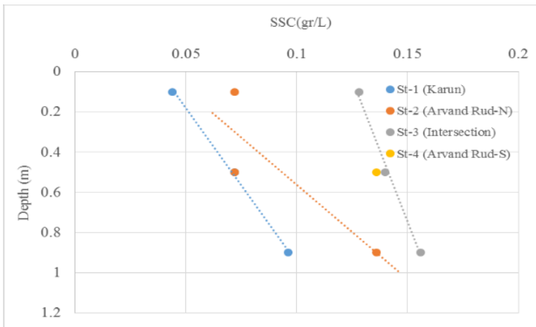


Figure 3. The concentration of suspended sediments obtained at different depths

3.3. Tide

In this section by considering the level measurement in the study area, the tide has been analyzed. Figure 4 shows the measured data of water level changes. As shown in Figure 5, there are significant changes in the water level at the beginning of the data that need to be considered.

The first step in analyzing tidal data is to find the appropriate amplitude and phase of the component with the least squares. IOS Tidal Package has been used to differentiate between water level changes caused by tides and other factors [6]. The range of tidal level changes compared to the measured levels in Figure 5 and the range and phase values of tidal components are presented in Table 4.

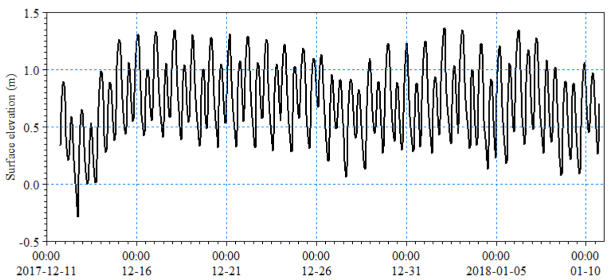


Figure 4. Changes in the water level in the area of Shahid Mousavi Shipbuilding Complex

Table 4. The amplitude and phase of tidal components based on the analysis of water level changes

O1		K1		S2		M2		Z0	
Amp.	Phase	Amp.	Phase	Amp.	Phase	Amp.	Phase	Amp.	Phase
0.02	0.0606	0.2077	20.77	0.0551	146.45	0.3086	73.51	-	0.72

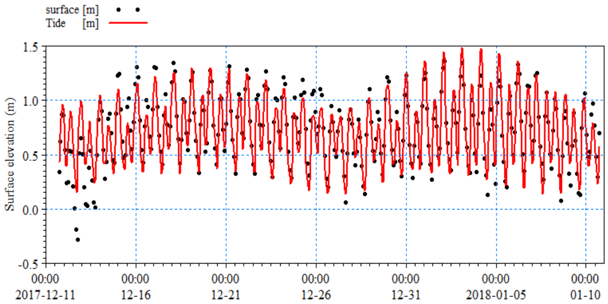


Figure 5. Changes in the water level in the area of Shahid Mousavi Shipbuilding Complex

The value of F is approximately equal to 0.74, which indicates that the tide type is mixed but is mostly semi-diurnal. Therefore, it is expected that two peaks and two bottoms with different intensities will be observed every day [7].

$$F = \frac{K_1+O_1}{M_2+S_2} = \frac{0.2077+0.0606}{0.3086+0.0551} \approx 0.74 \quad (1)$$

Another parameter that is considered is the difference between measured values and tidal values, which shows the effect of environmental factors such as wind set-up, interaction of tidal components, flow phase difference in two different environments, and upstream river flow. Figure 7 shows the residual value of the water level and its positive and negative values. By considering the geographical location of the study area, one of the impressive parameters in the water level is the Karun River which seems to prevent the spread of tides inside the river whenever the flow rate is significant. Considering that the measurements were made in the winter, a sharp difference in the initial range could be the result of a significant flow in the Karun River. However, due to the construction of a dam upstream of the river, the amount of dam overflow reduced so can cause the significant influence of tide and salty water in the river, the remaining positive value confirms this.

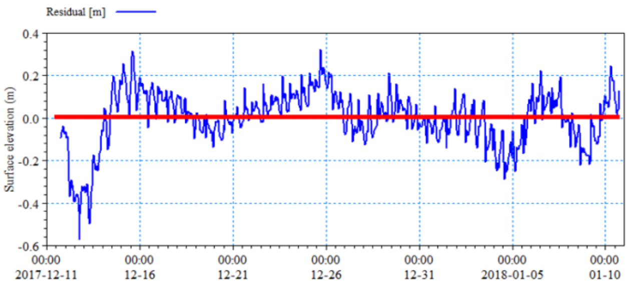


Figure 6. The difference between the level changes of the measured water level and the tidal values

3.4. CTD

In this part of study examined the result of measurements. The components of flow velocity in x and y direction, salinity, heat, and salinity are measured in three depths. Water level changes have also been measured at the same time as some of these measurements. Figure 8 shows the time interval of the measurements. As is clear, measurements were made in two periods, minimum and maximum tides.

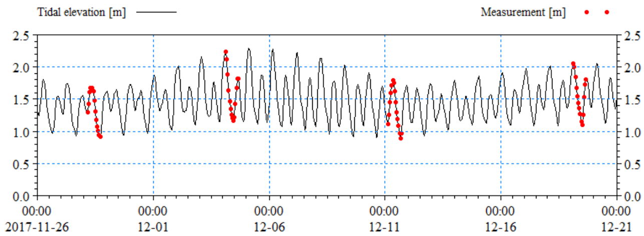
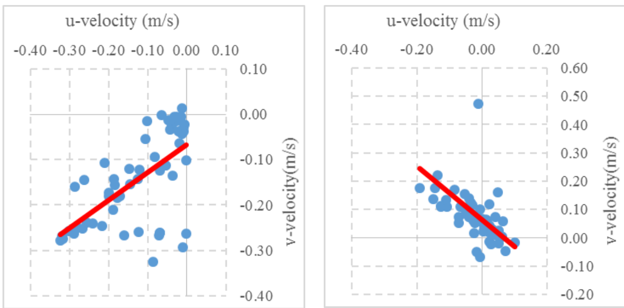


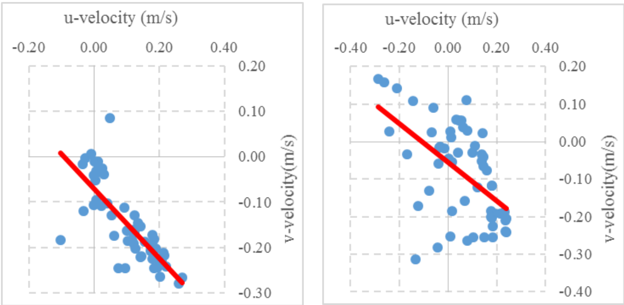
Figure 7. Measurement period (red dots)

3.4.1 Flow pattern examination

The velocity pattern in measured stations 1 to 4 is shown in Figure 8. It shows the flow velocity in different positions with the red line. Measurements made in Karun show that the prevailing flow rate in this area is towards Arvand, and the Arvand tide can only reduce the flow rate of this river locally. The direction of the flow at the station is to the north, which, considering its location, indicates the canalization of the tidal current in this area. At the intersection of the Arvand and Karun rivers, the flow is affected by the speed of the Karun Rivers. At Station No. 4, which is located south of the area, the direction of north-south flow and the amount of flow velocity are diffused, indicating that the impact of the Karun River in this area is decreasing and the tidal effect is visible.



Station No. 1 (Karun) Station No. 2 (North of Arvand)



Station No. 3 (Intersection) Station No. 4 (South of Arvand)

Figure 8. Current velocity at measuring station

3.4.2 Determination salinity and temperature pattern

The salinity and heat patterns can be examined in two ways. The first is to examine the pattern of salinity and temperature changes at a station and at different time intervals. Accordingly, the trend of salinity and temperature changes at Station 1 shows that the salinity rate at this station increased during the measurement period while the temperature decreased. In the first period, we see a decrease in the measured salinity at Station 1, which indicates that the inflow of low-salinity water source (Figure 9 and Figure 10). The sources of low-salinity water are typically rivers, lakes or aquifers associated with meteoric water.

The second way to check the salinity and temperature pattern is to compare the results of different stations over a period of time. According to this issue, the study of salinity pattern in the first period shows that the changes in this parameter in station 1 are different from stations 2 and 4, so that in station 1 the salinity decreases with increasing water level, but in Stations No. 2 and 4 increases in salinity. Examination of temperature changes shows that the process of change of this component in three stations is close to each other, so that increasing the water level increases the temperature in all three stations (Figure 11).

In the second period, the trend of salinity changes in the three stations is very close to each other (correlation coefficient between the result of station 4 and 2 is 0.81, and between station 2 and 1 is 0.93), so that in all three stations, the salinity decreases with increasing water level. Also, temperature changes in the three stations are very similar to each other (correlation coefficient between the result of station 4 and 2 is 0.93, and between station 2 and 1 is 0.88), so that with increasing water level, the temperature decreases (Figure 12).

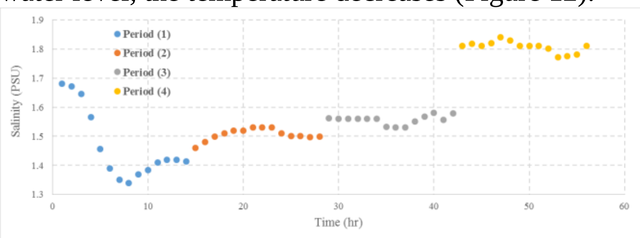


Figure 9. Salinity changes at Station 1 (Karun) at different periods

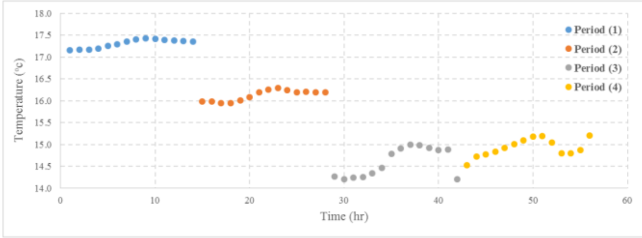


Figure 10. Water temperature changes at Station 1 (Karun) at different periods

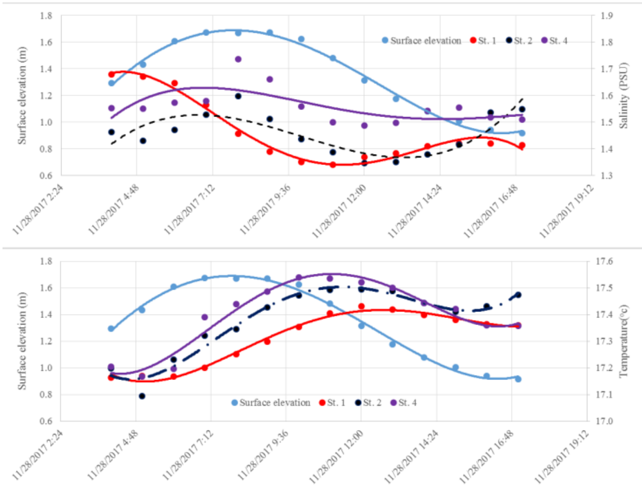


Figure 11. Changes in salinity and temperatures in different stations compared to changes in water level (tide) in the period 11/28/2017

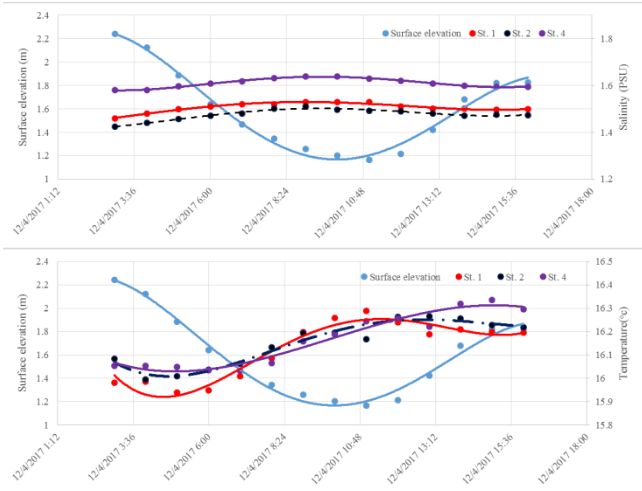


Figure 12. Changes in salinity and temperatures in different stations compared to changes in water level (tide) in the period 04/12/2017

4. Conclusions

In this study, a month-long analysis of the measured data of marine phenomena at the collision of Karun and Arvand rivers has been analyzed. These studies include tides, changes in water level, hydrography, and granulation, sedimentation and flow. Studies show that Karun flood currents have caused significant changes in the bed of the intersection of Karun and Arvand rivers, and most of the sediments in the study area are fine-grained, and at the intersection of Arvand and Karun rivers due to drastic changes. Depth of sediment is greater than that of other coarse-grained areas, and the concentration of sediment increases with depth of motion, and the lowest and highest sediment concentrations are related to Karun stations and Arvand Karun intersection, respectively. According to the measurement, it was determined that the flow regime is mixed but mostly half daily and two peaks and two depths with different intensities are expected to be observed daily and Karun river flow is one of the influential parameters in the water level. So that whenever the river flow is significant, it will prevent the tidal wave from spreading inside the river. The construction of a dam at the top of the river and the reduction of the dam's headwaters into the river cause a significant infiltration of tides and salinization of river water.

5. References

[1] Ajab pour, A., 2015. *Investigating the flow of water at the intersection of Arvand River and Karun through the influx of tidal waves*. The first national environmental conference,.

[2] Shafiee sarvestani, R., Sadrinasab, M., *Plum modeling at the mouth of the Arvand River*, 7th ICOPMAS, Tehran, Iran, 2006

[3] Etemad-Shahidi.A , et al,. 2015. *Effect of sea level rise on the salinity of Bahmanshir estuary*, Int. J. Environ. Sci. Technol., Vol.12, pp. 3329–3340.

[4] Khosravi.M, et al,. 2017,. *Observation of currrents in Karun River*, Research in Marine Sciences, pp. 50-58.

[5] Gohari, S., Amraei, M., *Study of the effect of connection angle on current characteristics in cross-channels*, Water and Soil Science, 2014, Vol. 24, pp. 243-257.

[6] Foreman, M.G., 1996. *Manual for Tidal Heights Analysis and prediction*. Pacific Marine Science Report 77-10, Institute of ocean science, Canada.

[7] Boon, J.D. 2011. *Secrets of the Tide and Tidal Current Analysis and Applications, Storm Surges and Sea Level Trends*. Woodhead Publishing,.