Research Paper

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Field Survey of Water Flow and Outflow Sediment from Karun and Arvand Rivers under Flood Conditions

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1- Introduction

Tidal river flows are very complex phenomena. The flows are usually upstream in the high tide but downstream in the low tide which prevents measuring a general flow velocity (Adib & Vafaei, 2010). To estimate sediment yield and discharge, it is required to continuously measure a complete tidal cycle (Emery & Thomson, 1996). The Arvand River is also a tidal river, which according to Pritchard, has all the characteristics of an estuary. This river forms from the Euphrates, the Tigris, and the Great Karun waters. The Great Karun basin is itself formed by two main tributaries of the Dez (northern branch) and the Karun (southern branch) rivers (Afshin, 1993). Laying on the rivers constituting the Great Karun are the five main dams of Karun 4, Karun 3, Karun 1, Masjed Soleiman, and High Gatvand on the Karun tributary as well as a major Dez dam on the Dez tributary.

According to the Meteorological Organization, the April 2019 rainfall was unprecedented in the last 50 years. On average, the rainfall in the southwestern basins was over four times as much as the previous year ("Narrative of Foods", 2019). This volume of rainfall sharply increased the inflow and outflow discharge of Khuzestan dams, causing flooding along the watercourse. The present study investigates the changes of physical parameters of the Arvand River and compares the data from the April 2017 flooding with the limited data of previous years.

2- Methodology

This study used the method proposed by Newburn (1988) to conduct the single-point measurement. Thus, samples were taken from the suspended load, flow direction and velocity, temperature, and salinity at a 60% depth in the middle of the river. Vectorial data operation began at 9:30 AM on Thursday, April 25, 2019, and ended at 10:30 AM on Friday, April 26, 2019, spanning for 25 hours to cover a complete tidal cycle. Sampling was performed discretely with a one hour-interval. The measured parameters included: flow direction and velocity, temperature, salinity, water level, suspended load

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concentration, and bathymetry across the river. This was simultaneously carried out at two stations, the locations of which are seen in Figure 2.

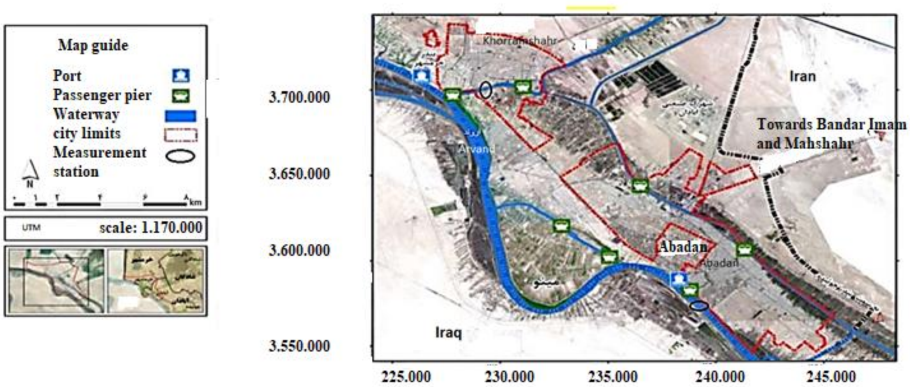

Fig (1): Area of study. The location of Karun and Arvand stations is matked on the map.

An inductive current meter was used to measure temperature, salinity, and current speed and direction. These current meters are manufactured by Germany and their vectorial data frequency is 5Hz. The river depth was measured using an echo sounder when the water level was at its highest tidal state. The device provides graphic data onto special paper. The resulting image was then digitized using Surfer software, and the cross-sectional area at the measurement point was calculated using Excel software. Using tidal data, cross-sectional area variations from water recession were also calculated.

To measure the suspended load concentration, a sample was taken from a depth of 60% in the middle of the river and transferred to the laboratory. In the laboratory, an amount of dry sediment per liter of water was measured using filter paper and scales of a thousandth of a gram accuracy.

3-Results and Discussion

3-1 Water level

Water level height changes in Karun and Arvand are 26 and 72 cm, respectively. It is also noted that the change phase of Arvand is greater than Karun. The tidal wave is periodic and, if the structural conditions of a region do not change, it repeats almost similarly in each lunar month. As Sadri Nasab et al. (2019) showed the highest tidal height at Karun and Arvand stations was measured to be 100 and 142 cm, respectively, on October 16, 2015, during the spring tide and dry season, thus, decreasing the tidal height of Karun and Arvand by 74% and 49%, respectively, under flood conditions.

3-2 Flow direction and velocity

The natural Karun River flow direction at the station is 290 ° with the flow direction being almost on the same natural river direction towards the sea during the measurement period. Although this measurement was performed at the spring tide, the sea high tide could not change the flow direction at this station. The average temporal and spatial flow velocity at the Karun station is 1.6 m/s, varying from a high of 1.9 m/s to a low of 1.1 m/s.

The natural Arvand River flow direction at the station is 145 °, with the flow being on the same natural river direction towards the sea at the high tide. Like the Karun station, the sea high tide could not inverse the flow direction at this station. The average flow velocity at the Arvand station is 1.9 m/s, varying from a high of 2.1 m/s to a low of 1.4 m/s.

3-3 Suspended sediment concentration

Because the river is exposed to flood conditions, the suspended load concentration at Karun and Arvand stations during the measurement period is less than 80 and 367 g/m3, respectively. However, according to similar measurements in the dry season on October 16, 2015, the average suspended load concentration at the Khorramshahr station has been measured at 104 g/m3, while the highest rate at 245 g/m3 (Sadri Nasab et al., 2017). In sum, the suspended load concentration in Karun is greater than that of Arvand River.

4-Conclusion

The maximum discharge flow at the Khorramshahr station was measured at 2411 m3/s and alternative paths such as Bahmanshir River seem to be used if greater volumes of water need to be discharged. In Arvand River, the average river discharge was 78883 m3/s and its maximum rate was 8566 m3/s.

The maximum suspended load concentration was also measured at 80 gr/m3, which is much lower than that under dry conditions; this indicates that the suspended sediment is a function of conditions other than the stream discharge volume. Although the suspended load concentration is not significant, the suspended load flux is notable due to the considerable high river discharge. The mean sediment flux at Karun and Arvand stations was measured to be 142 kg/s and 454 kg/s, respectively, increasing to the highs of 226 kg/s and 557 kg/s.

Because the flow direction is always sea-bound, the 2.1 PSU salinity at the Arvand station does not originate from the sea and the 0.6psu at the Khorramshahr station can be concluded to reach 2.1psu after mixing with the Tigris and Euphrates waters.

Keywords: Flood، sediment transport، River Discharge، Karoun، Arvanroud

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