Indian Journal of Science and Technology, *Vol 9(36), DOI: 10.17485/ijst/2016/v9i36/94556, September 2016*
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

A Study on the Types of Effective Climatic Conditions and Parameters Producing Sediment and Sedimentation in Dams' Reservoirs (Case Study: Lali Area, Khuzestan, Iran)

Abdolreza Alijani[1], Nader Kohansal Ghadimvand[2]*, Mohsen Aleali[3], Mohammad Reza Espahbod[2] and Ali Meysami[4]

[1]Geology-Sedimentary Lithology and Sedimentology, Islamic Azad University of Science and Research, Tehran, Iran; arz.alijani@yahoo.com,
[2]Geology Department, Islamic Azad University of Tehran North Branch, Tehran, Iran; n-kohansalghadimvand@iau-tnb.ac.ir, dr.ESPAHBod@gmail.com
[3]Geology Department, Islamic Azad University of Science and Research, Tehran, Iran; aleali.mohsen@gmail.com
[4]Geology Department, Islamic Azad University of Shahr-e- Ray, Tehran, Iran; m_meysami@gmail.com

Abstract

Background/Objectives: Since sediment and sedimentation are very significant in civil projects specifically in dams' reservoirs, it is essential to scrutinize this issue and its influential conditions and parameters. Climatic conditions are identified as one of the important factors in this regard. Hence, this study aims to investigate these conditions as well as the parameters affecting sedimentation in basins and sediment conditions specially water catchments with high potential to make erosion and produce sediment[1]. Karun basin is considered as one of these basins in which Lali area is located. **Methods:** The amount of sedimentation relies on the area's climatic parameters including the height, temperature, relative moisture, day light hours, wind, evaporation, rainfall, freezing and, etc. The current research considers Lali area, Khuzestan province, as a conceptual-sedimentary model and analyzes its variables. **Results:** It is determined that rainfall and height parameters affect erosion and sedimentation the most, while the day light hours and freezing affect them the least. A huge amount of sediments made by erosion are transported from the upstream of the water catchment to the downstream and they are sometimes settled in the area and plain of Lali. **Conclusions:** It is essential to search for suitable alternatives to diminish damages resulted from erosion, transportation and sediment settlement along the sediments direction specifically in dams reservoirs. This research is directed into determining the conditions of sediments and their relation with Lali area's influential parameters and conditions. Holistically, the outcomes can pave the way for researchers to conduct studies on dam construction.

Keywords: Climatic Parameters, Dams Reservoirs, Lali Area, Khuzestan, Sediment

1. Introduction

As sediment and sedimentation are very significant in civil projects specifically in dams' reservoirs, it is essential to scrutinize this issue and its influential conditions and parameters. Climatic conditions are identified as one of the important factors in this regard. Hence, it is essential to investigate these conditions as well as the parameters affecting sedimentation in basins and sediment conditions specially water catchments with high potential to make erosion and produce sediment[2]. Karun basin is considered as one of these basins in which Lali area is located. Lali area is actually placed 200 km away from the north of Khuzestan province and it is one of the sub-branches of the large Karun. The surface of this area is more than 323

**Author for correspondence*

km^2. From the geological point of view, it is located in the zone of the folded Zagros in Iran[3,4].

A sediment basin and its conditions are actually referred to a part of the earth holding its specific physical, chemical and biological-climatic specifications. However, some of the factors affecting the increase or decrease of its volume and amount haven't been considered such as height, temperature, freezing, sediments, relative moisture, day time light, wind, evaporation and rainfall[4,5]. The intended sedimentary model analyzes these parameters and variables related to the climate and sediment hydrology, sedimentary conditions and the physiography of water catchment Lali area[6,7].

Annually, a huge volume of sediments are transported from the upstream of basins into their down streams in different forms and this great amount of sediments damages humans and nature, these sediments come from different origins. Figure 1 indicates the geographical map and the accessible ways to Lali area, Khuzestan. This is while, the erosion amount of the lithological units and transporting sediments to sedimentary basins are considered as parameters determining the geomorphological, accumulation specifications of parameters and the replacements of sedimentary masses. Therefore, erosion, sediments transportation in sedimentary basins and sedimentation in dams' reservoirs shorten the life span of dams. In fact, it is crucial to scrutinize the processes affecting sedimentation[8].

The results of this research can identify the actual parameters affecting sedimentation in order to control the sediments transportation and enhance the life span of rivers by taking suitable alternatives.

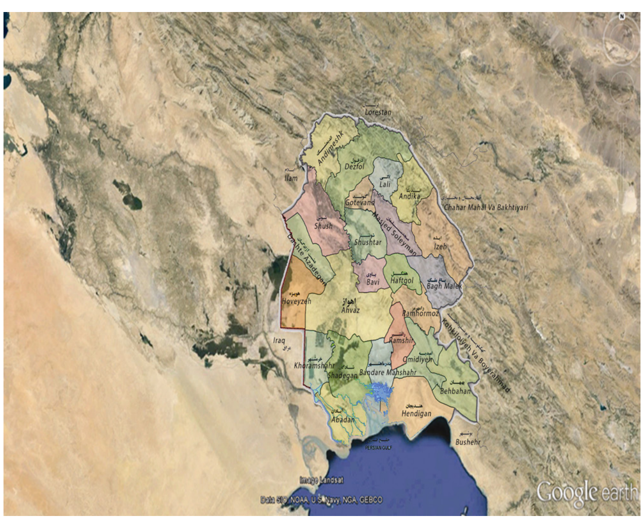

Figure 1. The map of the geographical situation and accessible ways to Lali area, Khuzestan.

2. Methodology

The intended area has been remarked as a conceptual-sedimentary model and it is necessary to detect effective variables determining the matrix of this model. Then, this essay aims at measuring the amount and influence of each variable.

The Lali area's sedimentary model conceptually includes the main climatic variables and its related factors such as temperature, relative moisture, evaporation, rainfall, flood, hydrological properties and the type of sediments (floating load, bed load and total load).

In the sedimentation process, the erosion index of the area's units and the determination of sediment redundancy percentage of each unit are figured out due to the unit surface percentage. Thus, these parameters are first investigated and then the effect and the weight of variables are evaluated in sediment production and sedimentation[9,10].

3. The Climatic Specifications of Lali Area

Climatological information is applied to identify the area's climate. The present research considers the water and climatic stations. Holistically, the heights of the intended area's water catchment ranges from 305 to 2543 m above sea level and its average height is marked 894m. Figure 2 indicates the water catchment of Lali area. The climatic stations are chosen according to height level, the geographical situation, the statistical duration of the station, accurate statistics, homogenous statistics with each other and their relative climatic similarity with some parts of Lali area and other influential and essential parameters.

Table 1 illustrates the specifications of the water catchment situation as well as stations measuring the climatic parameters. In addition, figure 2 shows the situation of dam water catchment in Lali area, Khuzestan.

The information obtained from 11 evaporating stations has been collected to determine the climate (table 1).

The climate of Lali area has been specified by the amended standard methods such as De Martonn and Emberger. According to De Martonn method, the height level of the area, the average amount of rainfall, the annual temperature and the area's dry co-efficiency are consid-

Table 1. The specifications of the water catchment situation and the stations measuring the climatic parameters in Lali area.

Height (m)	altitude	longitude	station	Water catchment	row
230	′02 - 32°	′22 - 39°	Godar Lander	Karun	1
820	′04 - 32°	′36 - 39°	Shahid Abbaspur dam	Karun	2
600	′59 - 31°	′52 - 49°	Susan	Karun	3
700	′45 - 31°	′08 - 50°	Shalue Bridge	Karun	4
525	′36 - 32°	′27 - 48°	Dez Dam	Dez	5
540	′56 - 32°	′45 - 38°	Tang Panj	Bakhtaran	6
949	′39 - 31°	′28 - 50°	Morghak	Bazfet	7
1416	′33 - 31°	′38 - 50°	Manj Shahrekord	Karun	8
2245	′58 - 31°	′17 - 51°	Borujen	Karun	9
1821	′41 - 30°	′45 - 51°	Yasuj	Bashar	10
1540	′58 - 30°	′16 - 51°	Pataveh	Bashar	11

Figure 2. The situation of Taraz water catchment in Lali area, Khuzestan.

ered as the parameters affecting the determination of the climatic type[11,7]. The area's dry co-efficiency is obtained by the following equation (Eq. 1):

$$l = \frac{P}{T+10} \quad (1)$$

Where:

P= the annual average of rainfall (mm)

T= the annual average of temperature

I= the dry co-efficiency of De Martonn

In Emberger method, the type of climate is determined based on the ratio of the area's temperature (c˚) to Emberger co-efficiency as shown in Eq. 2:

$$Q_2 = \frac{2000P}{M^2 - m^2} \quad (2)$$

Where:

P= the annual average of rainfall (mm)

M= the average of the maximum temperature in the hottest month of the year (k˚)

M= the average of the minimum temperature in the coldest month of the year (k ˚)

Table 2 illustrates the results of climate determination based on De Martonn and Emberger methods in the intended stations.

Holistically, the height changes of the intended water catchment ranges from 305 m to over 2543 m from the sea level. Table 2 presents the climatic conditions of different height levels of the intended area's water catchment due to the measuring stations[12].

These results are also indicated in figure 3.

The results from the evaporation measuring stations reveal that the wet duration is extended from the middle of September to the middle of April and the rest of the year is identified as the dry duration one.

As observed, the area is expanded and there is a variety of heights and various climatic conditions from semi-hot in low height areas to very wet in the highest points of the intended area[13,14]. According to the fact that Karun River originates from Zardkuh Mountains in ChahrMahal Bakhtiary and the main river passes through two cold and hot climates, it is expected that the sediments hold genes of different geological, lithological, mineralogical, sedimentary and physico-chemical properties.

Results indicate that the area's height level parameter has been a parameter affecting the climate type. Therefore, the height levels under 300m are mainly identified as the dry and hot ones and heights from 300 to 600 and 700m

Table 2. Climate classification in the intended stations by De Martonn and Emberger.

row	station	Height (m)	Annual average of temperature (C°)	Annual average of rainfall(mm)	De Martonn co-efficiency (I)	Climate classification based on De Martonn method	The average of the minimum temperature in the coldest month of the year(m)	The average of the maximum temperature in the hottest month of the year(m)	Emberger co-efficiency
1	Godar lender	230	8/25	3/582	3/16	Semi-dry	C°9	C°5/45	2/54
2	Shahid Abbaspur dam	820	23	9/605	4/18	Semi-dry	C°2/6	C°5/43	55
3	Susan	600	2/33	9/853	8/25	Semi-wet	C°2/7	C°4/34	77
4	Shalu bridge	700	4/22	1/789	4/24	Semi-wet	C°4/5	C°99/43	7/68
5	Dez dam	525	2/29	3/293	3/14	Semi-dry	C°9/6	C°2/43	6/45
6	Tang Panj	540	1/24	4/1164	2/34	Wet	C°6	C°6/45	4/98
7	Morghak	929	9/19	6/503	8/16	Semi-dry	C°3/4	C°2/43	8/43

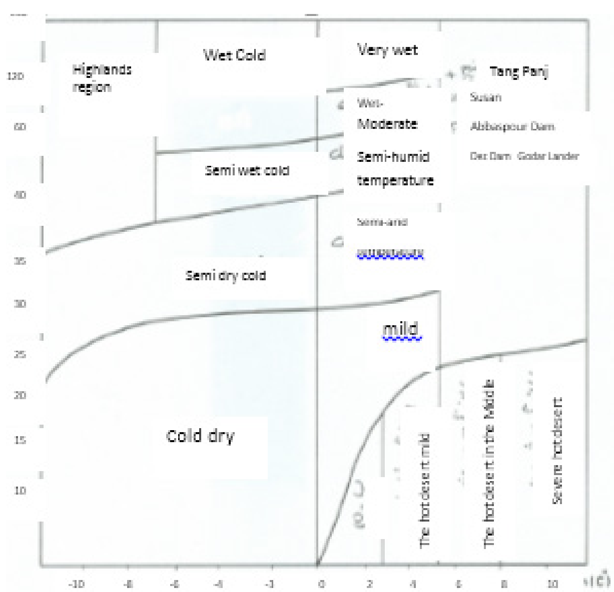

Figure 3. Determining the type of Lali area's climate by Emberger climate graph.

are classified as semi-hot and dry and wet climate and the heights ranging from 1300 to 1700m are known as the wet climate. Since the topography of the rock-soil morphology is more exposed to weathering and erosive factors in higher height level, the amounts of the destruction and sediment production get increased. Conclusively, sediment production and sedimentation are enhanced in the sedimentary basins.

4. Other Climatic Parameters

The current essay has scrutinized the relationship between climatic conditions and other affective parameters producing sediment and sedimentation in sedimentary basin like temperature, freezing, day time light, evaporation and rainfall. In addition, the effect of these parameters on producing sediment has been investigated[15]. Iran's meteorology organization has carried out the results of these measurements taken from synoptic stations of Lali area including Masjed Soleyman, Dezful and Shushtar.

Assessments and calculations demonstrate that the average of the maximum temperature is 31.6°c and the average of the minimum temperature is 19.9°c. Thus, the average of the annual temperature is 25.8°c. As expected, the average of the seasonal temperature is arranged from summer, spring, fall and winter. The amount of the temperature parameter reflects an inverse relationship with the height level. Holistically, the increase of the height level decreases the temperature degree and the reduction of height levels enhances the temperature of the area.

As there is more weathering and erosion in rock-soil formations in higher height levels and the temperature parameter gets reduced in higher levels, it is observed that layers are destroyed more. In another word, there are more sedimentation and sediment production. Therefore, there is no significant relationship between temperature parameter and sediment production. It means that the

Table 3. The average amounts of the annual and seasonal temperature in the intended stations (c°).

summer	spring	winter	fall	Absolute minimum	ABSOLUTE maximum	average	Minimum average	Maximum average	Height(m)	station	row
7/36	2/28	15	3/33	5/2-	51	8/25	3/19	2/32	330	Godar lander	1
5/34	25	14	4/20	5/5-	5/50	33	6/16	3/29	820	Shahid Abbaspur dam	2
2/34	25	8/12	7/20	0	50	2/34	5/16	9/29	600	Susan	3
1/34	2/24	4/11	9/19	1-	5/39	4/27	2/15	6/29	700	Shalu bridge	4
4/36	8/26	3/12	5/21	5/1-	5/38	2/24	1/19	3/29	525	Dez dam	5
4/37	2/26	2/11	5/21	5/1-	5/51	1/24	3/18	8/29	540	Tang Panj	6
9/30	9/21	7/9	2/17	5-	28	9/19	3/12	6/27	949	Morghak	7
7/26	3/18	6/6	8/13	18-	26	4/16	3/8	5/24	1416	Sanj Shahrekord	8
9/18	5/11	4/0	5/7	5/28-	28	4/9	3/0-	5/19	7245	Borujen	9
2/24	4/16	5/3	8/11	19-	34	7/14	6	4/23	1821	Yasuj	10
4/25	4/17	6/6	1/13	5/9-	46	6/15	3/6	9/24	1540	Pataveh	11

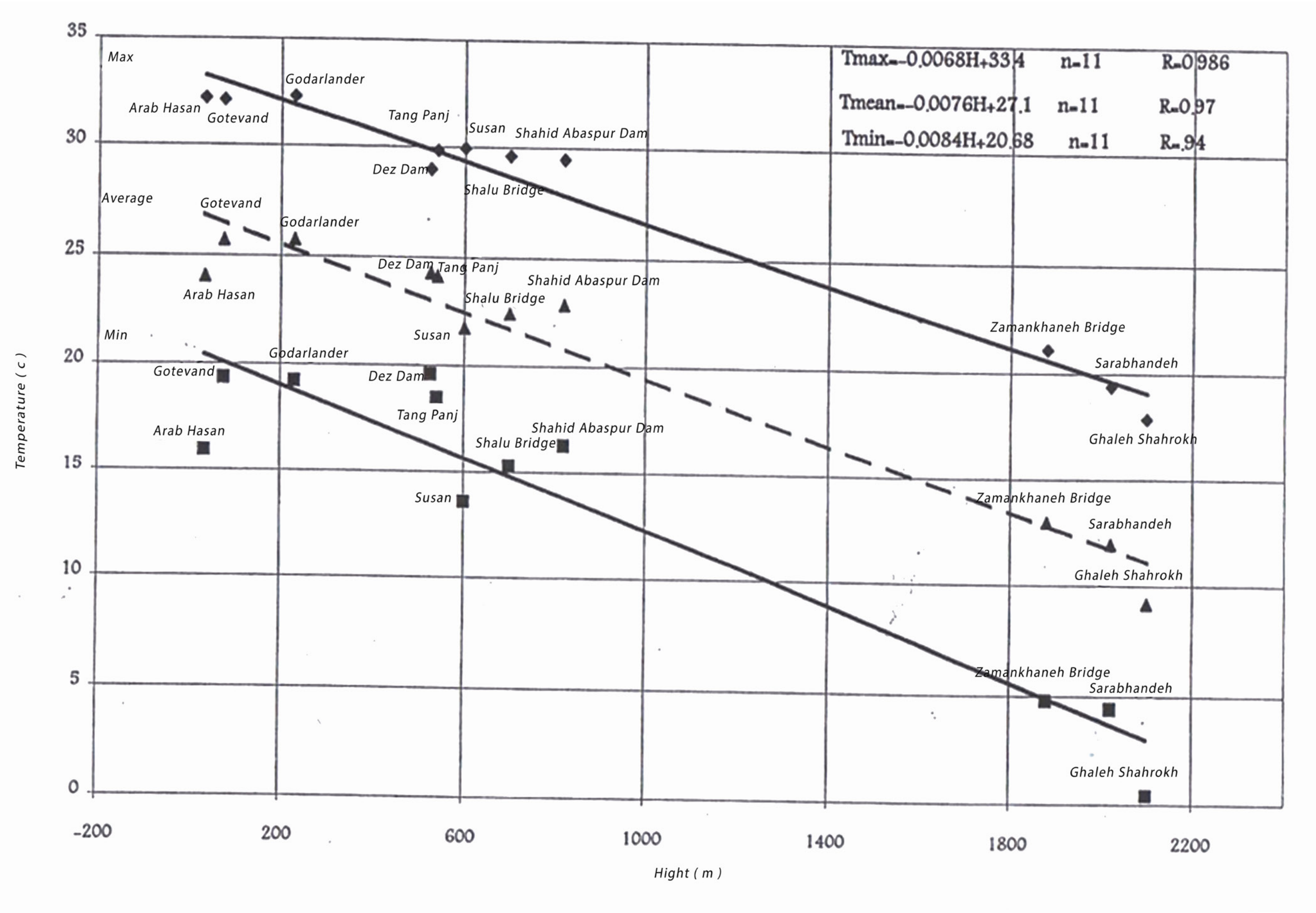

Figure 4. The gradients of the annual average of temperature, maximum average and minimum average of temperature in Lali area.

decrease of temperature makes soil particles separate and it affects the homogenous structure of soil and soft lithological layers like marl and silt stone. As a whole, the sediment production gets increased[16]. In addition, temperature goes up and the water in the texture and water pores are evaporated and soil gets destroyed. Table 3 displays the average of the seasonal temperature and seasonal stations.

Figure 3 presents the average gradients of the annual, minimum, maximum and seasonal temperature in Lali area.

Freezing parameter is extended from December until the end of February. Statistics show that there are only 6 freezing days within a year. So, this parameter cannot effectively influence sediment production and sedimentation in Lali area.

According to statistics, the average of the relative moisture starts from July and it increases to its climax in January as %37, it shows a decreasing trend from February. This parameter can both increase and diminish the sediment production and sedimentation. In fact, the lack of moisture and soil dryness can accelerate sediment and sedimentation.

The day time light parameter indicates the number of light and sunny days. Due to statistics, the maximum average of the light and sunny hours is within June to august as 11.3, 11.1 and 10.9 and its minimum belongs to December as 5.1.

The increasing trend of light hours starts from February and continues to June. Since this parameter is light and can increase the temperature, it can hasten the erosion process and affect sedimentation. The speed and the direction of wind is another parameter highly considered in the area's climatology. Statistics indicate that the average of the annual speed of wind ranges from 6.7 km to 10.2 km. Its speed is scored 10.2 km/s in Lali area. As this parameter enhances erosion process of rock-soil formation, it will be affective on sediment production and sedimentation.

The maximum average of annual evaporation is 3094mm with 525 height level and its minimum is 1546mm with 1880 height parameter. So, evaporation is decreased in higher height level. Furthermore, approximately 46% of the annual evaporation belongs to summer, 29% to spring, 18% to fall and 7% to winter. The highest amount of evaporation percentage is observed in July and august which is 16% and September and June scores 14% of the annual evaporation.

The average amount of the annual evaporation is 2904mm, the average amount of the annual evaporation has been recorded 2177mm in Lali area.

Remarking the fact that evaporation parameter increases moisture in soil particles, it affects the erosion process and soil destruction as well as sedimentation and sediment production. As a result, more evaporation can destroy soil texture and increase sediment production[17].

From the view point of rainfall, there are different cycles in a forty to fifty statistical duration in the area. The dry durations score 65% of the whole cycle and wet years mark 35% of the statistical cycle. In fact, the longest of dry cycles are more. Table 4 presents the average amount and the percentage of the annual and seasonal rainfall in the intended stations. As a matter of fact, the average of the annual long term rainfall scores the maximum of 1312 mm in Gusheh Bridge with the height level of 1700 mm and the minimum of 239mm in Harmaleh station with the height of 38m higher than the sea level.

Table 5 illustrates the average amounts and the monthly rainfall percentages in rainfall measuring stations. It rains the most in winter and it is scored that 55% of the annual fall belongs to winter, almost 30% to autumn, 15% to spring and almost none or 0.5% to summer.

It rains the most in November, January and February from 17% to 22%. It rains 10% to 16% in March and April. Totally, more than 99% of Lali area's rainfall happens from October to May.

The co-efficiency of the annual rainfall changes has been 30% to 40% in all stations. This co-efficiency tends to 40%. It is simply concluded that there is no constant rainfall and the frequencies are somehow remarkable in the area.

Figure 5 depicts the gradient of the annual rainfall in the area. This graph features out the annual rainfall in mm according to the situation of the height level of each station. Eventually the annual rainfall off the height level is calculated by the following formula:

$P = 98.466H^{0.2897}$

P: the annual average of the rainfall (mm)

H: the height level (m)

The outcomes imply that the annual rainfall average is about 510mm in the water catchment basin during a year. As the height levels goes up the amount of the rain is increased and the decrease of the height level reduces the amount of rain.

According to the fact that the erosion factors, weathering and the amount of rainfall is more in higher height

Table 4. The average and percentage amount of the annual and seasonal rain in the intended station

row	station	height(m)	parameter	Seasonal rain				Annual
				fall	winter	spring	summer	
1	Lali Lali Bridge	390	amount(mm)	3/163	4/278	3/75	5/0	5/517
			Percentage (%)	16/41	8/53	5/14	1/0	100
2	Genovand Godarlander	150	amount(mm)	1/100	2/204	3/67	3/0	2/371
			Percentage (%)	37	8/53	1/18	1/0	100
3	Batevand Shushtar	75	amount (mm)	7/131	4/218	8/57	1/0	298
			Percentage (%)	6/30	9/53	5/14	0	100
4	Arab Hasan Darkhazineh	230	amount (mm)	7/177	2/334	2/79	1/1	3/582
			Percentage (%)	8/30	7/55	6/14	2/0	100
5	Shahid Abbaspur dam Susan	140	amount (mm)	9/83	7/165	1/41	1/1	9/292
			Percentage (%)	29	6/56	14	2/0	100
6	Barangard Shalu bridge	60	amount (mm)	9/104	7/184	7/51	2/0	5/330
			Percentage (%)	7/30	54	2/15	1/0	100
7	Harmaleh Dez dam	33	mount (mm)	9/85	9/135	5/28	0	3/250
			Percentage (%)	3/34	3/54	4/11	0	100
8	Talleh Zang Tang Panj	30	amount (mm)	1/96	9/164	2/35	0	1/296
			Percentage (%)	3/32	7/55	9/11	0	100
9	Gusheh bridge	820	amount (mm)	9/181	4/335	5/88	2/0	9/605
			Percentage (%)	30	4/55	7/14	0	100
10	Susan	600	amount (mm)	3/236	1/267	7/138	7/1	9/853
			Percentage (%)	9/78	7/54	2/16	2/0	100
11	Barangard	875	amount (mm)	3/194	8/363	1/106	8/0	2/664
			Percentage (%)	1/29	8/54	16	1/0	100
12	Shalu bridge	700	amount (mm)	7/217	1/329	1/141	2/1	1/789
			Percentage (%)	6/27	4/52	9/17	2/0	100
13	Harmaleh	38	amount (mm)	6/72	5/134	8/31	7/0	4/238
			Percentage (%)	3/30	56	3/13	3/0	100
14	Dez dam	575	amount (mm)	141	2/272	80	0	3/294
			Percentage (%)	6/38	2/55	2/16	0	100
15	Talleh Zang	480	amount (mm)	8/257	5/492	9/165	6/1	8/917
			Percentage (%)	1/28	7/53	18	2/0	100
16	Tang Panj	530	amount (mm)	4/341	9/619	5/202	8/0	6/1164
			Percentage (%)	4/29	2/54	4/17	1/0	100
17	Gusheh Bridge	1700	amount (mm)	7/317	754	5/230	4/0	6/1311
			Percentage (%)	2/24	5/57	4/18	0	100

Table 5. The percentage and average amount of the seasonal and annual rain in rain metric stations

row	station	height (m)	Month parameter	October	November	December	January	February	March	April	May	June	July	August	September	annual
1	Lali	390	(mm)	8/3	8/36	8/122	5/105	6/97	4/75	7/53	2/21	4/0	0	5/0	0	5/517
			(%)	7/0	1/7	7/23	4/20	9/18	6/14	4/10	1/4	1/0	0	1/0	0	100
2	Lali bridge	150	(mm)	3/1	1/21	7/67	7/71	82	7/49	9/43	4/23	0	0	3/0	0	2/371
			(%)	3/0	4/8	2/18	4/19	1/22	4/13	8/11	3/6	0	0	1/0	0	100
3	Genovand	75	(mm)	3/2	8/38	6/80	2/84	5/80	6/53	5/34	2/14	1/0	0	0	1/0	398
			(%)	6/0	8/9	2/20	2/21	2/20	5/13	9/10	6/3	0	0	0	0	100
4	Godarlander	230	(mm)	7/2	9/60	1/114	2/137	8/109	1/82	6/53	2/25	4/0	0	6/0	5/0	3/582
			(%)	5/0	5/10	6/19	7/22	9/18	1/14	2/9	3/4	1/0	0	1/0	1/0	100
5	Batevand	140	(mm)	8/1	2/20	9/52	8/62	2/57	7/35	3/31	6/9	2/0	0	1/1	0	9/292
			(%)	6/0	4/10	1/18	4/21	5/19	6/15	7/10	3/3	1/0	0	4/0	0	100
6	Shushtar	60	(mm)	5/3	9/29	5/70	1/72	1/63	5/38	3/32	1/14	2/0	0	1/0	1/0	5/340
			(%)	3/1	8/8	7/20	2/21	5/18	2/14	11	1/4	1/0	0	0	0	100
7	Arab Hasan	23	(mm)	6/1	8/25	5/58	8/50	9/46	1/38	8/20	7/7	0	0	0	0	4/250
			(%)	7/0	3/10	4/23	3/20	7/18	2/15	3/8	1/3	0	0	0	0	100
8	Dar Khazineh	30	(mm)	2	6/29	5/64	8/64	7/55	4/34	4/27	3/7	5/0	0	0	0	1/296
			(%)	7/0	10	8/21	9/21	8/18	15	2/9	5/2	2/0	0	0	0	100
9	Shahid Abbaspur dam	820	(mm)	1/5	62	8/114	119	8/123	6/92	8/64	9/22	7/0	0	2/0	0	9/605
			(%)	8/0	2/10	9/18	6/19	4/20	3/15	7/10	8/3	1/0	0	0	0	100

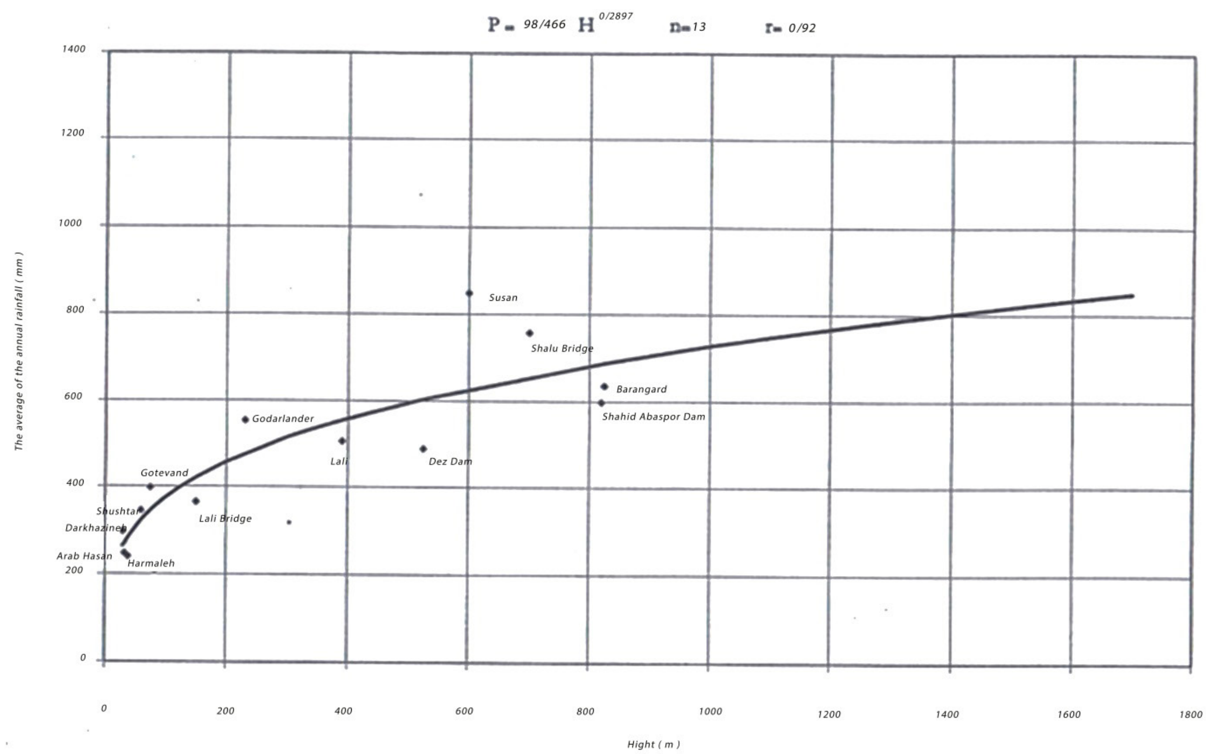

Figure 5. T the gradients of the annual rain in the intended area.

levels, some rock-soil units of this area will be destroyed and they will affect sedimentation and sediment production while flooding.

In fact, flood is expected while it rains severely in Karun water catchment. A huge amount of sediment is transported from the upstream to the downstream settled along the direction based on their weight as floating, rolling and bed loads.

5. Discussion

While rivers transport a huge amount of sedimentary load and settle them in these reservoirs, sedimentation and sediment accumulation in dams reservoirs are inevitable. It is significant that its first important result is to decrease the useful capacity of dam reservoir and its life span.

Erosion phenomenon is considered as one of the main factors producing sediment and sedimentation in the upstream of the sedimentary basins. Environmental conditions and climatic parameters also affect erosion process and sedimentation. Activities supporting soil and water can diminish the erosion of the water catchments surfaces and sediments transportation. A huge amount of materials and sediments load have been settled based on their weight as the result of transportation and flood due to environmental conditions and influential climatic parameters.

From the conceptual point of view, the intended sedimentary model scrutinizes parameters and main climatic variables such as height levels, temperature, relative moisture, day time light, wind, evaporation and rain. Conclusively, height and rain have been considered as the most influential parameters in Lali area. Furthermore, the current research analyzed the affectivity level of climatic parameters on sediment production and sedimentation in the intended area.

6. Conclusions

Studies present that parameters including height levels and rain affect erosion phenomenon and sediment production the most in Lali area. Sequentially, temperature, relative moisture, evaporation and wind are other parameters affecting sediment production. Since the climate of the intended are heat and dry, the day time light and freezing are identified as the two parameters affecting sedimentation the least. The results of this research imply that climatic parameters specially rain and heights remarkably affect erosion phenomenon, sedimentation and sediment production[18,19]. Eventually, the suggested alternatives aim at reducing damages in civil projects and filling the dams reservoirs, investing and considering fundamental studies specifically the hydrological and climatological studies, identifying climatic parameters by establishing meteorological stations, measuring and interpreting the data before starting the projects operations in order to control sediment production in civil projects.

7. Acknowledgements

The authors would like to highly appreciate all the ones, companies, researchers and scientific experts who contributed to prepare this research, Islamic Azad University Science and Research of Tehran and the dean of geology department, Dr. Ali Solgi. The authors also thank the water and power organization of Khuzestan for the sake of their contribution. The author respectfully appreciates the head manager of Ab–Niru consultant engineering company, Dr. Hussein Jalali and the technical exclusive manager of Ab–Niru consultant engineering company, Engineer Hasan Nabavi.

8. References

1. Alizadeh A. Mashhad: Astan Ghods Razavi: The Principles of Applied Hydrology. 2010.
2. Warren JK. Springer-Verilog: Evaporates. Sediments, Resources and Hydrocarbons. 2006; p. 1035.
3. Miall AD. Whiter Stratigraphy. Sedimentary Geology. 1995; 100:5-20.
4. Zanoianu I. New York: Elsevier: Morphometery of Drainage Basin.1985.
5. Bilham E. H.M.S.O, London: The Classification of Heavy Falls of Rain in Short Periods. 1962., Charlton F. CIRIA, London: Measuring flow in open channels, A review of Methods. 1978.
6. Colman DJ, Seatena FN. New York: IAHS: Identification and Evaluation of Sediment. 1986.
7. Mashkuti AH. Tehran: Islamic Azad University of Science and Research of Tehran Press: The Application of Statistical Model in Evaluating Climatic Changes and its Effects. 2015.
8. Veatot D, Poesen J. Predicting Soil Erosion and Sediment Field at the Basic Scale Issue and Sediment – Quantitatine Models. Earth Science Reviews. 2005; 71:95-125.
9. Wilson E. New York: IEP: Hydrology in practice. 1988.
10. Trewarta G. New York: McGraw Hill Book Co.: An Introduction to Climate. 1968.
11. Solaimanik S, Lotfi A. Investigation of land Use Charges on Erosion Process Using geographical information system. International Journal of Environment Science and Technology. 2009.
12. Schwab G. et al. New York: John Wiley Inc.: Soil and Water Conservation Engineering. 1981.
13. Javanmard S, Jamali J, Abedini Y. Tehran: Jahad Daneshgahi: The Principles of Physical Meteorology and Weather Balance. 2015.
14. Feiznia S. Gorgan: Faculty of Agricultural Science and Natural Resources: Applied Sedimentology on Soil Erosion and Sediment Production. 2008.
15. Roudkivi AJ. Oxford: Prgamon press: Hydrology. 1979.
16. Shaw E. London: Van Nostrand Reinold: Hydrology in Practice. 1988.
17. Refahi H. Tehran: Tehran University: The Aquatic Erosion and its Control. 2007.
18. Sellers W. Chicago: University of Chicago Press: Physical Climatology. 1969.
19. Schwab G. et al. New York: John Wiley Inc.: Soil and Water Conservation Engineering. 1981.