

Evaluating Sediment Production Caused by the Lithology of the Geological Formations in Sedimentary Basins (Case Study: Lali Area, Khuzestan, Iran)

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Abstract

As sediments are produced and accumulated in sedimentary basins especially in dams' reservoirs and they highly affect the reservoirs life span, it is essential to scrutinize the effect of lithology and types of geological formations of an area on the life span of reservoirs specifically from the viewpoints of the erodability of these formations due to their lithology type. Lali area, Khuzestan, Iran and the water catchment of the intended area (based on geological situation and Taraz dam situation) are placed in the sedimentary-structural zone of the folded Zagros. The method of this research is based on analyzing the topography and geology maps and field work in order to identify the lithology of the geological formations. In fact, the amount of its erodability has been characterized by the type of the geological formations. The current research aims at putting the geological results, lithological data of the formations types and the outcrop of the soil-lithological units together in order to evaluate the sedimentary and erosive factors of these units and precisely identify the area's geological formations to remove the ambiguities in this issue. Studies indicate that formations made of looser gypsum and marl like Pabde-Gurpi and Gachsaran are exposed to more sedimentation and erosion than the formations made of compacted lime stone and conglomerate with silica-lime cement such as Bakhtiary and Asmari formations and the sand stones of Aghajari formation reveal the moderate to high resistance. Thus, the lithological identification of the formations, the type of sedi-

ments and their looseness and hardness contribute to detect the amount and type of deposits entering into the dam reservoir. The type and amount of these transported and deposited sediments are assessed to predict more suitable optimized ways to exploit dams' reservoirs.

Keywords

Geological Formations, Lali Area (Khuzestan), Sedimentation, Settlement, Lithology

1. Introduction

The case study is situated in Lali area, Khuzestan province in Iran and 200 km far from the north of Ahwaz province. From geological point of view, it is placed in the sedimentary structural zone of the folded Zagros. It is expected that this zone mainly holds formations of Bakhtiary conglomerate, Aghajari sand stone, Marl of Mishan, Gachsaran gypsum and Asmari lime. Furthermore, there are outcrops like Pabdeh- Gurpi, etc. [1]. Various blocks of these layers are separated and transported into the downstream of river in Lali area because of weathering and erosion factors on the area's geological formations especially on the upstream of the water catchment based on the lithology type of the rock layers. The blocks range from angular pebbles to angular to semi-angular and rounded to semi-rounded fine grains [2]. These coarse grains of alluvia sediments mainly originate from Asmari lime rock formations of Aghajari and Bakhtiary conglomerate. This research profoundly analyzes the types of such geological formations. This area has been remarkably affected by Dezful embayment (DE = Dezful Embayment) which its main folded structure has been Valachin orogeny. **Figure 1** displays the geographical situation and the accessible ways to Lali area.

Since sediment and sedimentation are the most essential factors in civil projects and establishments especially in dams' reservoirs, lots of studies have been done in this regard. However, some important geological and sedimentary points have been ignored such as affective factors on sedimentation, lithological type and the geological formations of the intended area producing and increasing the amount of sediments [3]. Furthermore, identifying the specifications of rock outcrops and sedimentary type have been considered.

2. Review of Literature

Several base studies have been done in this regard, for example, various investigations have revealed the relationship between sediments with the type of the geological formations of the area and the amount of their erodability. Norlan (1986) assessed the ratio of erodible formations as the origin of floating load in California [4]. Kasimir, *et al.* (1990) demonstrated that small basins with the ratio of looser formations affect the floating sedimentary load [5]. Khojeini and Nezhadha Shami (1998) indicated the effect of erodible formations on sediment production in Taleghan, Iran water catchment [6].

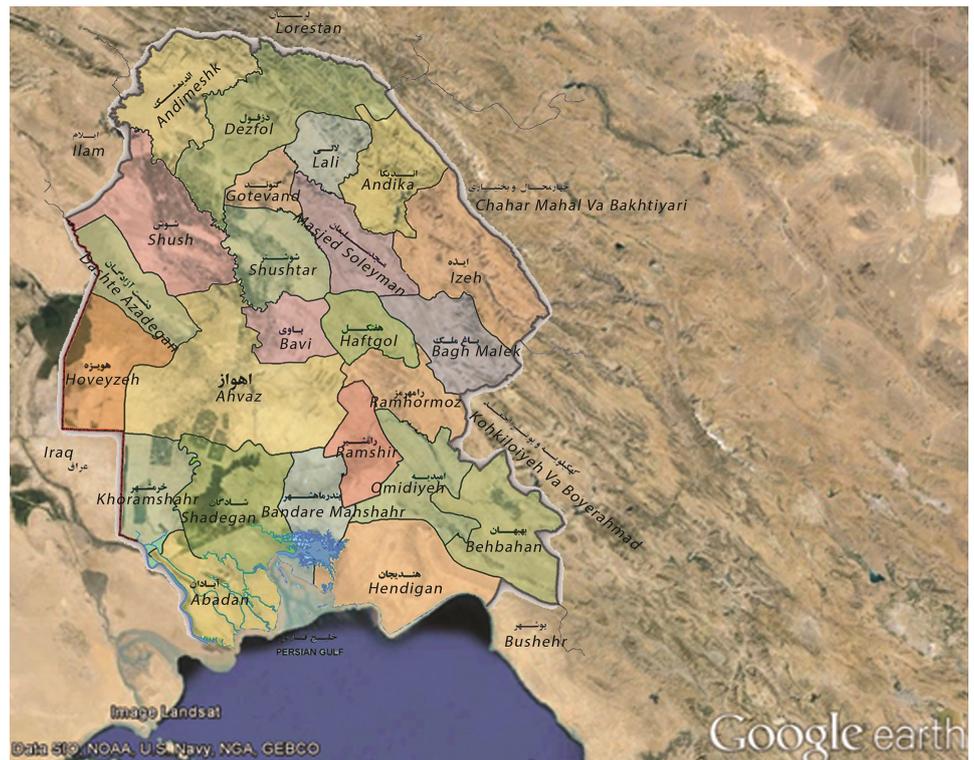


Figure 1. The geographical situation and the accessible ways to Lali area, from Google earth.

Aminsobhani (1998) proved the impact of sedimentation on marl and shale erodible formations in Namak Lake of Iran [7]. These studies demonstrate the amount of sensitivity to erosion in geological formations and sedimentations in the basins. Furthermore, erodible geological formations highly affect sedimentation in water catchments. Moreover, the amount of sedimentation relies on the surface area of the water catchment basin and the surface ratio of the erodible formations out of the whole basin. In case there are formations with looser lithology, the amount of sedimentation will be enhanced.

3. Methodology

Field work studies on the geological formations of the area specify both the lithology type of the area and the resistance of this type of lithology due their physico-mechanical properties of the rock layers. The type of the geological formations and the lithology of these formations have been specified by analyzing the geology and topography maps of the water catchment upstream of the sedimentary basin and field work in Lali area. The method of this research is based on analyzing the topography and geology maps and field work in order to identify the lithology of the geological formations. In fact, the amount of its erodability has been characterized by the type of the geological formations

According to various geological formations, changes in the types of layers, different physico-chemical especially mechanical properties and the erodability and strength of

the soil and rock masses, it is demonstrated that these geological formations are able to produce sediment. In this research, these specifications are first identified and then the area's geological formations are scrutinized from the viewpoint of the potential of producing less or more sediments [8]. Holistically, it is specified that formations with low erosion and more strength are less probable to produce sediment. In contrast, formations with high erosion and less strength can produce sediment [9].

4. Geological Setting

The erosion amount of the lithological units and sediments transportation to sedimentary basins are recognized as one of the key factors determining the geomorphological properties, the accumulation specifications and the replacement of the sedimentary masses [10]. From morphological point of view, this situation is placed approximately 250 m away from the crossing point of Harkesh and Taraz Rivers and it has a strait shape made by the floods from Harkesh River. **Figure 2** indicates a view of Taraz Dam situated in the dam axel in which the morphological extension and river bed of Harkesh River (HR). In addition, **Figure 3** features out a view of the porous lime stone (I). there inter-beds inside gypsums of Gachsaran formation (Mg) which are seen as small and big blocks (up to 2 m diameter) on the ground.

The conditions of its extensions both at the right and left sides are as below:

- Right side extension: The slope of the extensions from top to bottom include: 70° above the heights as long walls and declining from the bottom of the wall to the alluvia terraces of the lower level (17°). It is scored that the slopes become less than 5°.
- Left side extension: 75° of the higher levels are like long walls extending to the downstream, trenches and road way, the extension slope is 35° - 40°.

The sedimentary process influences the erosion index of the area's units and the determination of the sediment abundance percentage of each unit in the area.



Figure 2. A view of Taraz Dam situated in the dam axel in which the morphological extension and river bed of Harkesh River (HR) clearly shown. The alluvium of the river bed-Qt-the old alluvium as alluvia terrace, S-foundation outcrop (Sarsen), Bcc, Bci, Bcs and Bct are the conglomerate units of Bakhtiary formation. The layers are somehow horizontal.



Figure 3. A view of the porous lime stone (l), there inter-beds inside gypsums of Gachsaran formation (Mg) which are seen as small and big blocks (up to 2 m diameter) on the ground.

The general appearance of the morphological specifications is as the following.

Lime stone pebbles have surrounded parts of the conglomerate bed rock at the river bed and the foundation outcrop is observed and the high level of the bed rock of the alluvia is indicated.

The right side extension is more even than the left one for the sake of streams specifically in the upper part of the left extension [11].

Both extensions are bedded in the conglomerate layers of Bakhtiary formation and are somehow horizontal.

The old left alluvia of Harkesh River are observed as a long strip on the right side of the river, but they have become like alluvial terraces.

Above 388 m, there are thick conglomerates on both extensions which are long and their height is scored more than 20 m. The extension of macro joints can be measured in the conglomerate layers within distance more than 1 - 2 m.

Soil and Lithological Masses at the Geological Situation

The lithological masses observed as thick layers of Bakhtiary conglomerate outcrops make more than 95% of the conglomerate aggregates of Asmari and/or older lime stones. Generally, they are rounded to semi-rounded. More precise analyses on the folded conglomerate Bakhtiary rocks indicate the following points: Coarse grain layers (the average diameter of 0.7 cm) are made of lime stones and wall making layers. The grains are paired from bad to moderate and some of them have been displaced. Some

layers hold finer grains (the average diameter of 5 cm) and their matrix is lime sand. As sand stone and silt are more than the coarse ones in these layers, some of them hold sand stones with cross-bedding [12]. There are several red inter-layers of silt and sometimes sand stone in the inter-beds of conglomerate which their width isn't more than 1m, they are exposed to more erosion than conglomerate layers and they have outcrops in the extensions of topography.

In addition, there are coarse grains of alluvia as big as pebbles, sand, gravel and stone blocks at the river bed. It seems that its width doesn't reach to more than 1m. Holistically, more than 90% of them are lime stone grains mainly belonging to the separated blocks of Asmari lime formation on the upstream of this water catchment.

Hence, the type of blocks forming these pebbles affects erosion and sedimentation. So, erosion, sediments transportation in sedimentary basins and the sedimentation of these deposits in dams' reservoirs decrease the life span of dams [13]. It is essential to study the effective processes on sedimentation. **Figure 4** shows the lithology, structure and geology map of the lithological-soil units of this position.

Table 1 summarizes the general specifications of lithological units in Lali area.

5. The Specifications of the Structural Geology of Lali Area

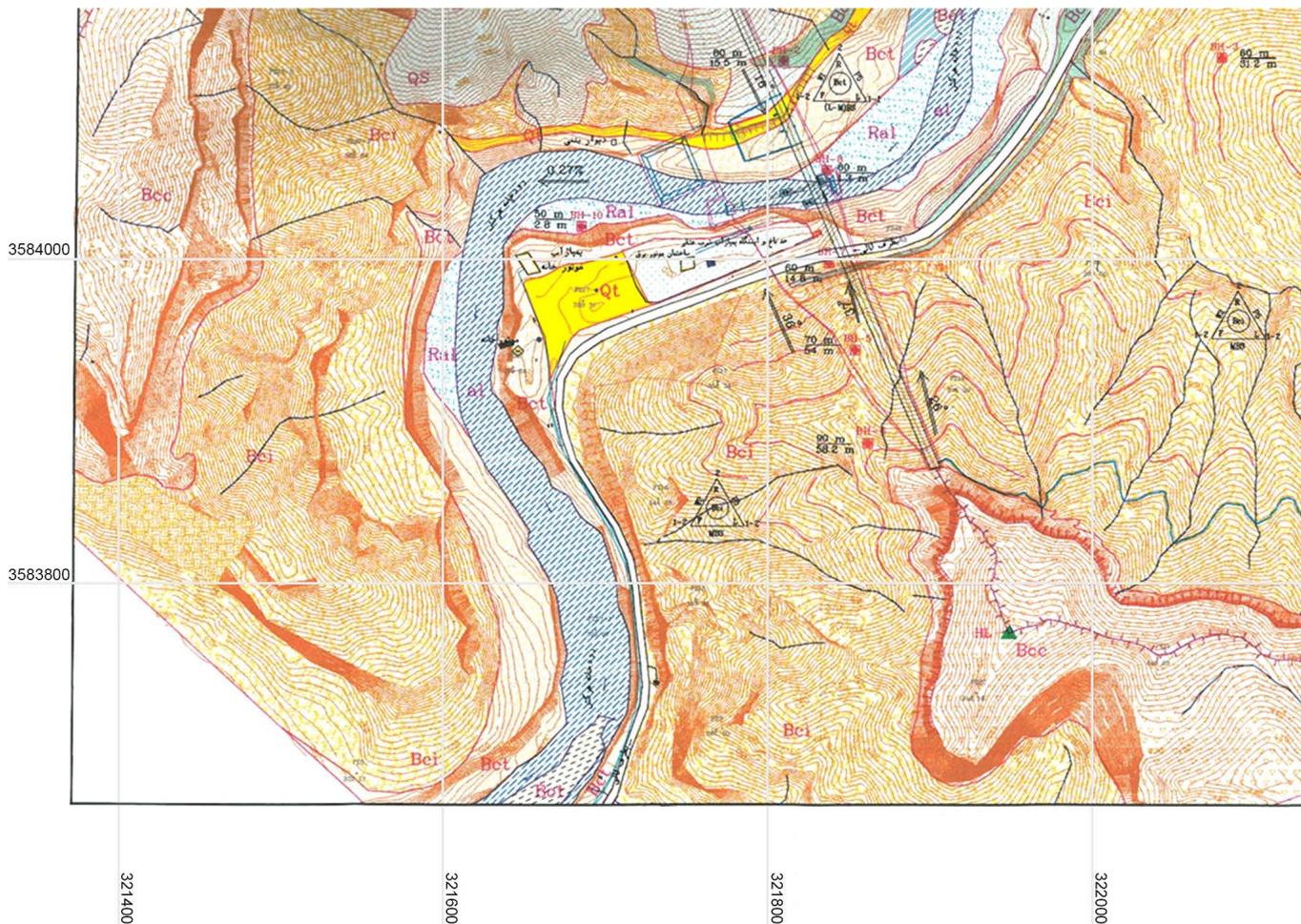
The water catchment expansion of rivers flowing through the area specially Talug and Shur rivers are situated in the sedimentary- structural zone of the folded Zagros (see **Figure 5**). Therefore, the general characteristics of this zone are as below.

There are asymmetric simple folds with different slope sides. In another word, their axial surface is different. However, some of the folds less than 10 - 20 km might be vertically close to one another. As this folding style gets closer to the high Zagros, it is changed from the south-east to the north-east [14]. As expected, more irregularities are observed. Since the intended expansion is far from the high Zagros, the folds are very simple and the sedimentary layers aren't remarkably extended.

There are few faults and the length of the main ones are more than 10 km which all show the same trend of Zagros. They direct a deep slope toward north-east (more than 65° - 70°). **Figure 6**, **Figure 7**, **Figure 8** and **Figure 9** represent the distribution pattern and dispersion of the amount of fractures and the joints in the right and left sides of Harkesh River in Lali area, Khuzestan caused by tectonic activities and the effects of the erodability ratio of the formations in the area on the Schmidt network (STRERIONET) or Rose diagram. As observed, most of the fractures and sediment production have been mostly concentrated at the NW-SE of the STRERIONET. It is concluded they are along with the folds of Zagros chain of mountains in Iran, as expected.

Important faults affecting the geological structure of Lali area include: Dali fault, Sarvand-Meyboran fault (SMF), Durak fault (DRF), Jagiri fault (JF), Lali Fault (LF), Qale Khaju fault (QKF), Cheshmeh Shirin fault (CSF) fault and Chiti fault (CF).

Table 2 illustrates the specifications of all faults in the expansion of 300km in Lali area. As observed, most of the faults closer to the position are the normal ones which are gradually converted into inverse and thrust- compressive faults [15].



LEGEND

Rockmass: Bakhtiari Formation (monolithic unit)

-  Conglomerate, hard cliff forming, with several intercalation of loose conglomerate with silty matrix and easily erodible to form niches and furrow along beds
-  conglomerate, irregularly bedded (0.5 - 2.0 m) with differentially weathered/eroded aspect to form stair like slope; few thin silty beds in the upper part.
-  conglomerate with silty matrix disintegrate by ripping producing light yellow to to cream soil
-  Conglomerate, hard, thick - bedded
- Base of formation is not exposed (wallachian orogeny)

Soilmasses:

-  Gravely scree inheriting from the loose conglomeratic beds of Bcc unit, forming a highly erodible light gray veneer 1/2-1 m, in thickness.
-  Recent alluvium in the harkesh River bed:
Ral 1/2 = thin coverage of the bedrock (<1/2 m)
-  al = present alluvium in the permanent water course
-  Ral = gravel, thicker than 1 m, forming the floody part
-  (al) = gravely alluvium in the tributaries, often dray of the Harkesh River bed
-  Older River bed of Harkes, dissected as terraces very loose and erodible (undurated conglomerate).

Figure 4. The geological map (T/GE/1), Lali area, Khuzestan, Iran quoted from the geology report of Ab-Niru Consulting Engineering Company, 2005.

Table 1. The general specifications of Lithological units in Lali area.

Formation	Prominent lithology	Outcrop in the water catchment	Visible height (m)	Specifications
Daryan	Lime stone with good layers	Taluk (Sar Tang Baba Ahmad)	100 - 90	Small out crop
Kajdomi	Dark shales	Taluk	200 - 150	Impermeable
Sarvak	Gray lime stone	Chain of stone-valley	>550	Karesti to some extend
Pabde-Gurpi	Shale and marl	Chain of stone-valley	800 in total	Low permeability-high erodability
Tel Zang	Marl lime stone 50 - 70	Taluk, Sur I and Taraz	70 - 50	Step making
Amiran	Green shale, sand stone and cutting conglomerate	Taluk	250 - 200	Hard and brittle
Kashkan	Red marl, sand stone and conglomerate	Shur I	200	Low permeability-high erodability
Asmari	Beige lime stone and marl in upper part	Chain of stone-valley	400	Higher part of Karesti
Gachsaran	gypsum	Shur II	>1000	Impermeable-solvable
Mishan	Low amount of marl	Shur I, Chiti	100	Very low permeability
Aghajari	silt, sand stone and conglomerate	Shur I, Shur II, Chiti, Gazi and Taraz	>1000	Low permeability-high erodability
Bakhtiari	conglomerate	Taraz, Shur II, etc	>350	Wall maker in marl

**Figure 5.** Apart of Talug River (TR) has outcrop between Sartang and Dom Baba Ahmad (BTBA) in which marl lime stones have been emerged.

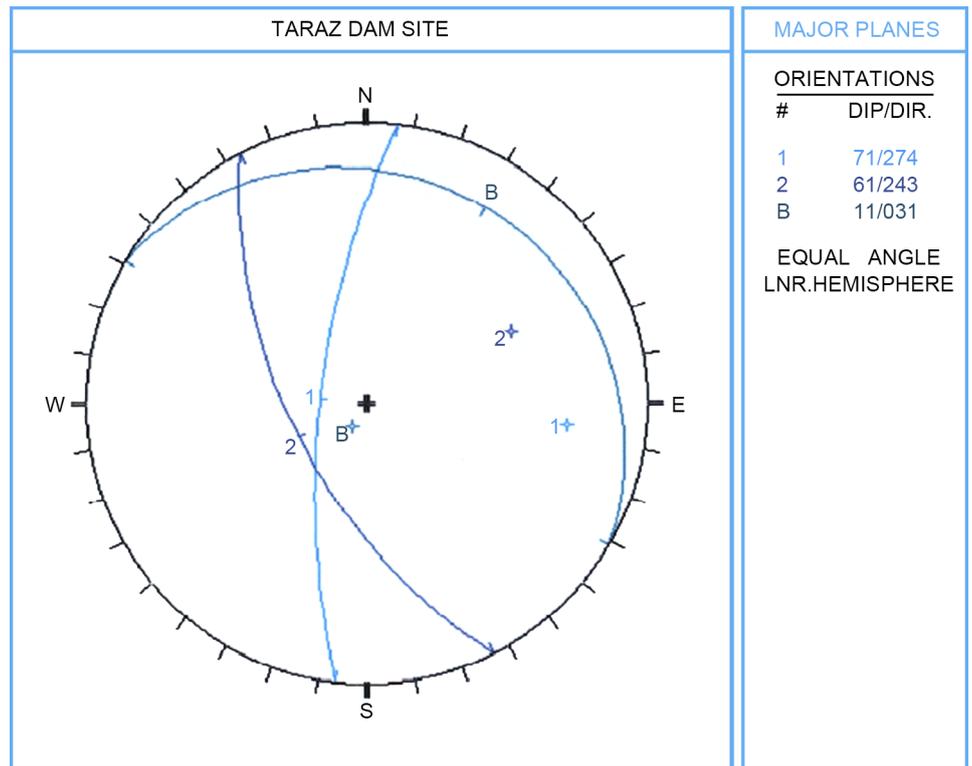


Figure 8. The equal curves of joints poles and fractures in the geological formations in Lali area.

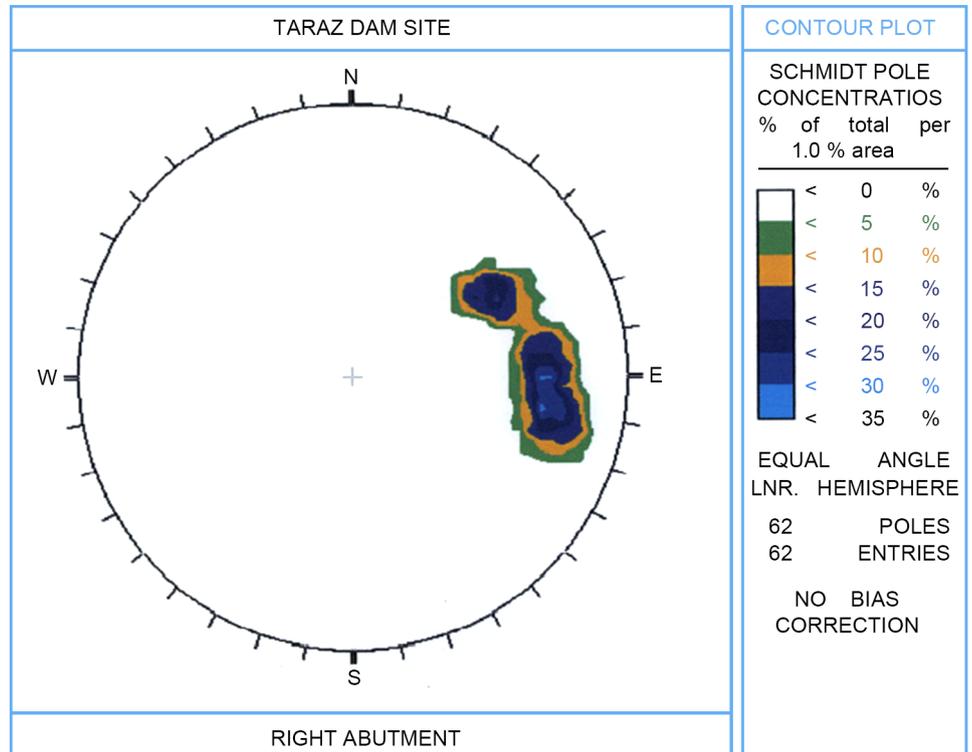


Figure 9. The situation of the fractures and joints concentration on the right abutment in Lali area.

Table 2. The specifications of faults in the expansion of 300 km in the Lali area.

Row	Fault name	Total length (km)	Fault type	Activity in quaternary	Distance to the geological situation (km)
1	Main Zagros rifting fault (MZRF)	>1500	Thrust (compressive)	+	88
2	Zagros mountainous edge fault (ZMEF)	>1000	Thrust (compressive)	+	11
3	Zagros fallen fault (ZFF)	>400	Thrust (compressive)	+	115
4	Dezful Embayment fault (DEF)	>200	Thrust (compressive)	+	30
5	Kabir Kuh fault (KKF)	80	Thrust (compressive)	-	108
6	Kamar Ab fault (KAF)	53	Thrust (compressive)	-	26
7	Liruk Mafron fault (LMF)	100	Thrust (compressive)	-	52
8	Doplan fault (DF)	100	Thrust (compressive)	-	110
9	Dena fault (DF)	110	Right sliding	-	210
10	Ramhormoz fault (RHF)	100	Thrust (compressive)	+	80
11	Aghajari fault (AF)	100	Thrust (compressive)	+	157
12	Ragsefid fault (RSF)	80	Thrust (compressive)	+	225
13	High Zagros fault (HZF)	>250	Thrust (compressive)	-	57
14	Ardel fault (AF)	135	Thrust (compressive)	-	66
15	Khoram abad fault (KAF)	60	Thrust (compressive)	-	115
16	Kuhsefid fault (KF)	80	Thrust (compressive)	-	205
17	Dorud fault (DF)	100	Thrust (compressive)	+	103
18	Nahvand fault (NF)	100	Thrust (compressive)	+	159
19	Sahneh fault (SF)	100	Thrust (compressive)	-	257
20	Fereydunshahr fault (FF)	175	Thrust (compressive)	-	100
21	Aligudarz fault (AF)	125	Thrust (compressive)	-	124
22	Zarab fault (ZF)	125	Thrust (compressive)	-	77
23	Gharun fault (GF)	45	Thrust (compressive)	+	212
24	Deli fault (DF)	22.5	Thrust (compressive)	-	21.5
25	Ghale Khaju fault (GKF)	35	normal	+	23
26	Sarvand Meyboran fault (SMF)	35	Thrust (compressive)	-	23
27	Jagiri fault (JF)	12	Right sliding	-	28.5
28	Durak fault (DF)	24	thrust	-	26.5
29	Lali fault (LF)	25	normal	-	1
30	Cheshmeh Shirin fault (CSF)	25	normal	-	26
31	Chiti fault (GF)	12	normal	-	12.7
32	GandomEiz fault (GRF)	16	thrust	-	11.5

6. Discussion

From geological point of view, Lali area is situated in the structural zone of the folded Zagros and it affects other structures. It is expected that this zone mainly holds formations of Bakhtiary conglomerate, Aghajari sand stone, Marl of Mishan, Gachsaran gypsum and Asmari lime. Furthermore, there are outcrops like Pabdeh-Gurpi. Various blocks of these layers are separated and transported into the river downstream in Lali area because of weathering and erosion factors on the area's geological formations. Kasimir, *et al.* (1990) demonstrated that small basins with the ratio of looser formations affect the floating sedimentary load. Khojeini and Nezhadha Shami (1998) indicated the effect of erodible formations on sediment production in Taleghan, Iran water catchment. Ghami Arusmahalleh and Aminsobhani (1998) proved the impact of sedimentation on marl and Shale erodible formations in Namak Lake of Iran [16]. The morphological specifications of the intended area reveal that the north part of the basin is totally in the ridge-valley mountainous unit and the southern parts are in Dezful embayment. In another word, two morphological zones can be marked in the water catchment: the northern mountainous zone and Dezful embayment zone. Parallel valleys and uprising parts along with Zagros characterize the northern mountainous zone. There are narrow valleys and other vast alluvia plains. The mountains are usually anticline. There are many blocks affecting the erosion of these walls and their fractures make soil fine grains and conglomerate blocks and increase sedimentation [17]. The outcrops of Bakhtiary conglomerate are found as long walls and very deep macro joints (more than 50 - 60 m). There are dissolving pores in gypsum stones in the water catchment of Shur River at the depth of more than 15 - 20 m. The stratigraphic units identified in the northern morphological zone are chronological as the following: Formations of Darian, Kazhdomi, Soruk, Gurpi, Pabdeh, Shahbazan or Taleh Zang, Amiran and Asmari have scored a widths of 3500 m. Lime, shale and marl rock units have been alternatively made in these sedimentary units and ridge-valley structure is observed for the sake of their very different stratigraphic rock foundation [18]. The lime stones of the Asmari formation occupy almost more than half of the ridge-valley of Bakhtiary zone. The formation thickness reaches to 350 - 400 m. The highest part of Asmari formation holds an alternation of lime stone and marl layers specifically in the north east side of Bala Ahmad anticline. The karst process is considered as one of the important remarks on Asmari formation. At the axial part of Baba Ahmad anticline, the Asmari lime stone layers are somehow horizontal and they have made 10 meter walls. Notably, the width of layers and looser marl or marl lime stone layers feature outa step like landmark. According to the lithology type and its looseness or hardness, some lithological units and formations are harder and some of them are looser. As a result, looser units affect sediment production and sedimentation the most [19]. Moreover, the type of the lithological units should be also considered. Marl limes or silica lime produce different sediments. Consequently, looser marl materials produce more sediments and harder silica materials produce less sediments [20]. Hence, fine grain sediments as size as silt and clay are made as the result of erosion, materials transportation and mal and silt marl

layers of Aghajari and settled all along the river direction. Holistically, particles have been deposited as floating sedimentary load (clay-silt fine grains) and the rolling sedimentary load (as size of pebbles and sand). Land sliding phenomenon accumulates sediments at the bottom of mountains extension as deposits transported towards the lower parts because of erosion and weathering phenomenon in lithological formations and tectonic factors making fracture in lithological layers like joints and faults [21]. **Table 3** displays the amount of erodability and sedimentation of the geological formations based on the lithology type in Lali Area, Khuzestan, Iran.

7. Conclusions

There is actually a collection of lithological units in this morphological zone called Fars Group including: Gachsaran, Mishan and Aghajari. Bakhtiary conglomerate is on these units aging back to Miocene-Pliocene. The units are as below: Gachsaran formation aging back to Miocene is situated in Zagros Mountains on the lime stone of Asmari formation. In this expansion, Mishan formation embraces gray marls which are highly affected by erosion and it doesn't have an outstanding outcrop, but some layers alternatively formed on Gachsaran formation. In addition, Mishan formation or Gachsaran formation are mostly made of red clastic rocks with sand stone and conglomerate inter-beds called Aghajari aging back to Miocene-Pliocene. Bakhtiary conglomerate has two characteristics in this expansion: 1) Bakhtiary conglomerate has been placed on older rocks after orogeny. 2) Tectonic forces after forming Bakhtiary lithological unit only make some mild slopes and joints. In another word, other layers of Bakhtiary formations are almost horizontal. In fact, its outcrops are found everywhere on the highest topography parts of Dezful embayment. The geological situation of Taraz has been detected in these Bakhtiary conglomerate layers. There is an alluvial unit all through the

Table 3. The amount of erodability and sedimentation of the geological formations based on the lithology type in Lali Area, Khuzestan, Iran [22].

	Lots of sediments (10)	Moderate sediments (5)	Low sediments (0)
Surface geology	<ul style="list-style-type: none"> • sea Shale • gypsum and Andesite content marls • the layers of stiff rocks and Shale • sandstones 	<ul style="list-style-type: none"> • moderate stiff rocks-metamorphic rocks • crumpled or moderately weathered stones • moderately fractured stones • granites (igneous) • fine limy stones • conglomerate • lime stone with thick layers 	<ul style="list-style-type: none"> • stiff and compacted formations • dolomites • huge alluvial layers
Soils	<ul style="list-style-type: none"> • fine texture and highly dispersed, sore alkaline, high ability to expansion and compaction • granular silt and fine gravel • gravel • gravel texture- Lummi made of granite 	<ul style="list-style-type: none"> • moderate texture • dispersed boulder • limy layers • pebble texture 	<ul style="list-style-type: none"> • containing high percentage of boulder • stiff textured clay • containing high organic substances

Continued

	Lots of sediments (10)	Moderate sediments (5)	Low sediments (0)
Weather	<ul style="list-style-type: none"> raining for some days with short cycles of thunder frequent heavy thunders dry climate with heavy rain run off of snow melting 	<ul style="list-style-type: none"> moderate rainfalls frequent thunders 	<ul style="list-style-type: none"> wet climate and rainfalls with low intensity mostly snowfall freezing and melting dry climate
Run off	<p>Lots of sediments(10)</p> <ul style="list-style-type: none"> high rate of discharge in surface high amount of water flow in surface hydrologic soils of group D hydrologic soils of group C 	<p>Moderate sediments (5)</p> <ul style="list-style-type: none"> maximum moderate discharge moderate amount of run-off in surface hydrologic soils of group B 	<p>Low sediments(0)</p> <ul style="list-style-type: none"> low amount of maximum discharge in surface low amount of run-off in surface unique surface run off hydrologic soils of group A
The unpaved areas	<p>Lots of sediments (20)</p> <ul style="list-style-type: none"> deep slope areas more than 30% high altitude, ups and downs slope beds flood resisting ups and downs 	<p>Moderate sediments (10)</p> <ul style="list-style-type: none"> plateau with moderate slope less than 20% expansion of flood resisting areas with fan shaped physiographic units 	<p>Low sediments (0)</p> <ul style="list-style-type: none"> slow slope areas less than 5 % expanded alluvial plain
Limited plant coverage	<p>Lots of sediments (10)</p> <ul style="list-style-type: none"> land coverage less than 20% dispersed plant coverage the lack of pebble on the ground 	<p>Moderate sediments (5)</p> <ul style="list-style-type: none"> ground coverage less than 40% remarkable plant traces dispersed trees 	<p>Low sediments (0)</p> <ul style="list-style-type: none"> the ground surface completely covered by plants, more than 70% traces of plant and boulders low permeability of rain into erodible materials
Land usage	<p>Lots of sediments (10)</p> <ul style="list-style-type: none"> more than 50% planted the whole ground is like dispersed pasture the plants recently burned the recently cut jungle coverage lots of road shears 	<p>Moderate sediments (5)</p> <ul style="list-style-type: none"> less than 25% planted less than 50% being extremely grazed less than 50% of the jungle coverage recently cut. the presence of usual roads and other constructions 	<p>Low sediments (0)</p> <ul style="list-style-type: none"> implantable land limited amount of grazing trees not recently cut with road or trails
High lands erosion	<p>Lots of sediments (10)</p> <ul style="list-style-type: none"> erosion plough, gally and a mass in more than 50% of the lands high amount of erosion 	<p>Moderate sediments (5)</p> <ul style="list-style-type: none"> the presence of various types of erosion in about 25% of the lands wind erosion with sedimentation in water canals moderate erosion 	<p>Low sediments (0)</p> <ul style="list-style-type: none"> the absence of erosion signs low erosion
River erosion and sediment transportation	<p>Lots of sediments (10)</p> <ul style="list-style-type: none"> frequent erosion at the river side the erosion at the head and the decrease of their height 	<p>Moderate sediments (5)</p> <ul style="list-style-type: none"> flow with depth and moderate continuity with frequent erosion at the river side or river bed 	<p>Low sediments (0)</p> <ul style="list-style-type: none"> wide and low deep with flat slope of streams river bed on huge rock masses with boulders or with good plant coverage on the surfaces controlled streams

expansion especially in Dezful embayment, and young and old alluvial sediments. Alluvia are usually in form of pebbles and coarse ones on rivers beds. The rivers' alluvia are also separated while flooding. Old alluvia have become flood plains at rivers banks. Their widths sometimes reach to several hundred meters. In conclusion, the oldest alluvia are changed into long and short alluvia terraces. These old alluvia look like large alluvial fans which have been smaller by erosion. Sediments are observed all around the extension of the heights. Remarkably, they sometimes cover the bed rocks of the formations. Sediments are accumulated in two forms of fine ones and stone blocks at the bottom of the long walls. The stone block deposits and fine grains have been expanded everywhere.

As a whole, the area's formations are different from one another according to the lithology type, layer material, erosion and sediment production and sedimentation. They are chronologically arranged. Pabdeh-Gurpi formation is made of shale and marl although it has low permeability and has high potential of erosion. Hence, it affects sedimentation the most.

Although lime stone is very hard, Asmari formation made of lime stone to marl lime has the characteristic of karst. Gachsaran formation made of gypsum has the ability to be solved and weathered. It can also produce sediment. Bakhtiary conglomerate is mainly hard and compacted and it doesn't have a remarkable ability to make erosion and produce sediment.

Conclusively, Pabdeh-Gurpi and Gachsaran formations are more able to produce sediments, while Asmari and Bakhtiary conglomerate affects sedimentation the least and Aghajari formation is in between. The quaternary alluvia can be transported and settled. Results specify that it is essential to scrutinize and identify the types of formations and lithological units of the upstream and the banks of the dams' reservoirs in civil projects and dam construction studies in order to find out better alternatives against sediments made by the erosion of these soil-lithological units. It is recommended to plant trees, establish berm, reduce topography slope and choose more suitable methods to control water in order to decline erosion and sedimentation.

8. Suggestions

Regarding the studies and observations in erosion phenomenon, sedimentation and sediment accumulation in geological formations the following items are suggested.

In situation of geological formations with the potential of sedimentation and erodability, there should be given a good consideration on investigations of the amount of sediment production in the geological formations situated in water catchments directing into identifying formations ready to be eroded. Presenting factors affecting the erosion process is led into selecting the most convenient methods to diminish the effect of these processes and control its harmful effects in the intended area before starting any civil project specially dam construction studies. Basic studies on the amount of sediment taken from the geological are directed into the increase of sedimentary load entering into reservoirs. Proper alternatives are taken to reduce its harmful effects

through analyzing the data of these studies.

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