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Sedimentary Environment of the Indus River in Pakistan. How Anthropogenic Activities Impact Sediments

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Sedimentary Environment of the Indus River in Pakistan & How Anthropogenic Activities Impact on Sediment.

Submitted by Usman Khan

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`Abstract

Indus River is the longest river in the Asian territory. Originated from Tibet Mountain northwest of Pakistan. Routed from the northern part of Gilgit and flow to word plan area passed through different provinces and flow with sedimentary flux connected with many small and large tributaries the tectonically the birth of the rive due to collision of Indian and Eurasian plate that are called Indus suture Plains zone (ISPZ). The main geology composed of igneous and metamorphic rock. The river passed in the various climatic zone with different regions mostly climate is subtropics arid and sub arid to subequatorial. The northern area mostly coved by monsoon system variation of seasonality takes place in the month of May to Oct high flow with increase sedimentary flux special in monsoon time. Anthropogenic activities locally and widely in terms of construction of dams water canals for irrigation purposes, mining exploration, and industries and factories all flux flow in different tributaries impacted on physical and chemical behaviors of the sediments. The primary impact of anthropogenic processes is the reworking of weathered soil smectite which is an indicator of chemical weathering and which increases in the offshore record after around 5000 years ago. This material indicates greater transport of stronger chemically weathered material and some of this may be caused by the erosion of old soils broken up by agriculture although we also see evidence for the incision of the big rivers into the floodplain which is also driving reworking of this type of material so the signal may be a combination of the two. The dramatic change in shape and size of the sediments by colliding each other during the high charge river.

Key words Indus River, Anthropogenic Activity, Climate zone, Monsoons Season.

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1 Introduction

The Indus River approximately 3000 km in length and most important rivers in the Asian region connects between two countries India and Pakistan (Inam et al. 2007). The world's largest river has apply a long interest of scholars since at the time of Alexander the supper great mission in the area in 325 BC (Inam et al. 2007). The greatest invention of the early and modern civilization in the south asian region of the Indus valley (Schuldenrein et al. 2004). In fact, Its origin source lies in Tibet Mountain and also a sacred mountain of Kailas, upper part of the course obviously move through the part of India, but it's mostly features (channel and drainage pattern) occurred in Pakistan (Inam et al. 2007). The tectonic information (geological and geophysical) recently suggested the river system was established as a result of plate tectonic (Indian and Eurasian plates) prior to 45 million years ago (Gupta 2008). The basin exist western part of the Tibet, Himalayas, and Karakorum. The river received massive amount of sediments with water flow from different tributaries source Shyok and Gilgit area relative some are from Kabul area began from the north area Jhelum, Ravi Beas, and Sutlej that rivers system from eastern plains of the Punjab area. The southwest area monsoon rains largely filled the Indus River even although mostly runoff from the north of Terbela dam, mostly water comes from the snow and melting of ice (Gupta 2008). The Indus River is the major river of western Himalayas in the north region. During the summer period, the drains area covers 1*106 km^2 with maximum discharge, the seasonal period the melting of glacial eventually maximum runoff advanced by the summer monsoon activity (Milliman, Qinchun, and Zuosheng 1984). Prior to damming, 450 X 106 tons per a^{-1} were discharged, comparable to Mississippi (LISTzIN 1972). The Arabian Sea deposits the sediment transported through the river course but major big Indus Fan, are the world's greatest deep-sea fans, a total length distance is 5 X 106 km^3 (Naini and Kolla 1982). The Indus river system sediment is preferentially eroded from the direction of the western Tibetan plateau and Karakorum (Inam et al. 2007). In contrast, the high Himalaya dominates the Ganges-Brahmaputra system (Clift 2002). The Indus river system reflects major potential sources of information in order to know the different activity of uplifting and erosion with the different time period of the history to word the western Himalaya and the most importantly Tibet growth has been connected to the southwest, monsoon (Kutzbach, Prell, and Ruddiman 1993). The Indus river continues to follow the route suture's strike before any type of cutting like orthogonal shape through the Himalayas in northwest Pakistan and continuously running to the south part of the Arabian Sea. The Bengal Fan's is the main feeder rivers, the Ganges and Brahmaputra, on the other hand, follow the Higher Himalaya along strike for much of the orogeny of length. In the procedure, to estimate the Bengal Fan condition how, it is swamped by a huge volume of material that derived from the rapidly unroofing Higher Himalaya (Clift 2002), with only a minor contribution from the Indian Shield in its distal area (Clift 2002). The main objective of this review paper is to analyze the sedimentary environment and climatic zones of the Indus and how anthropogenic activities have affected sedimentation.

Editorial note: Figure 1 was removed due to copyright issues.

Figure No. 1 Brief Indus River Map Source https://www.grida.no/resources/6692

2 Background.

a. Geology/Tectonic Setting.

The uplift of Himalayas largely incorporates and deformed northern area of Indian continental plate and Prior to the collision, India continental plate set down in equatorial latitudes, with fine-grained sediments, more specifically formations that include limestone, dominating part the shelf and high-slope area (Henderson et al. 2010). India and Eurasian plate collided, sedimentation quickly alter to sandstones and build new mountain ranges during this process uplifting and erosion take place. The sequence includes the formation predominately shales and sandstones the document poratic start mountain uplifting and eventually the birth of river along the line of collision septer between Indian and Eurasian plate to be called Indus suture Plains zone (ISPZ). Although the northwest movement of Indian plate retard after beginning collision with Eurasia and the subcontinent that has not stopped although continued move towards north to Asia. So this particular result, India plate build the mountain ranges as a result of the collision, we observed recently day. The northern Indian plate edge was buried as looks deformed and heated before come back quickly of the surface as a result of erosion, but the remaining part is driven by extensional faulting triggered by the collapse of the giant mountains under exceed weight. The major range of Himalayas represent the remaining deformed northern Indian plate boundary (edges) mainly intruded by rock bodies (granite) and then uplifted substantially 22 million years ago. The major compressional force that deformed plates and migrated towards the southern region of the Indian plate with the passage of time. In this case, the new different ranges are developed in the less Himalaya. (Henderson et al. 2010).

Tectonic activity continued as a result of erosion in the valleys and surrounding ranges that uplift to high heights. The most similar and sudden example mounts "Nanga Parbat" closely located to the Kohistan region (Indus south). The ranges of the uplifting Nanga Parbat have been the rate of >1cm per year over the freshest geological times, as considering major and fastest well-known rates in the world. The massif ranges that move towards northwest and southwest. Similarly, the plains of a particular province of the Sindh shelf, itself developed in late time (cretaceous), later 70 million years ago. India is relatively reattached from the Seychelles Island. The moderate rate of subsidence and the rate of sedimentation that has described the shelf and slope south-east area of Karachi and in contrast with the coastal line and marine geology towards the west region. (Henderson et al. 2010).

Editorial note: Figure 2was removed due to copyright issues.

Figure No. 2 Northern Area Tectonic Map

3 Hydrology and Seasonal variation.

The Indus River that is passing different provinces of Pakistan cover different climatic zones. In the southwest region Pakistan Sindh and Punjab climatic variation consists of subtropic arid and sub arid to subequatorial. So in that portion atmospheric circulation over the higher part of the basin mainly lie in the monsoonal as typical of the tropic and sub tropic latitudes. This variation in climatic zone results in two distinct seasons. Common weather time observed in October and April, the dry northeastern part sets over the plain and also the vital portion of basin. The main direction of winds northern and northeaster part in the period of time the rainfall was not more than 100mm. In more cases, the active cyclonic takes place in summer season (May to September). Ultimately the direction of the wind changes from the southern part towards southwest and period of monsoon starts southwestern. Eventually, the rainfall increases. In this period of time, the basin is subjective to another climatic circulation, i.e trade winds air current that are closer to the earth surface that is blowing from the direction of east to west near the equator (Anon 2021a) the main path that are started from the side of the Iranian mountains and then deliver in a dry and hot air conditions). The precipitation date on the Indus basin contradictory according (Anon n.d.), as from the data the annual rainfall dropping from 500 to 125mm from the source river to its mouth. The calculations in (Kravtsova, Mikhailov, and Efremova 2009) are different; from 1270 mm in the mountain region to 100mm/year estimation. So the Indus river that are passing into the three different altitudinal landscape zones. The upper regions reach towards the river and belong to the high altitude belt. So the increase in the altitude mostly forest land with the different landscape are located in the means high of 4700 m. in this conclusion the river runs the zone of the savanna and thin forests. Mostly part of the basin are really situated in the plains of the Himalayas. (Decertified savanna) (Kravtsova et al. 2009).

Editorial note: Figure 3 was removed due to copyright issues.

Figure No.3 This image is taken from the earth observatory (**NASA**). Two images depicted Indus River shrink and swell during the seasonality of flow. In the about picture the line shows the border between two provinces Punjab and Sindh. Small portion of the Indus River is guddu barrage. During the May to November and Rabi (November to May) diverted water for irrigation purposes because the flow intensity is high the normal months.

Editorial note: Figure 4 was removed due to copyright issues.

Figure No. 4. The graph shows rate of flow during the months. The flow start from the May to the end of Oct because of Fed by glaciers and monsoon rains period. The maximum peck flow in the month of July and august.

4 The Indus Fan.

In general, the Indus fan covers the area of 1.1*10 km approximately the total 1,500 km(Clift 2002). in distance and also 960 km with a maximum width and it is located in the province of Sindh (Arabian Sea).(V. Kolla (2), F. Coumes (3) 1987) Mainly the Indus fan is mature off in the passive continental margin (PCM) of the Indian and Pakistan boundary by the Chagos Laccadive Ride (CLR) direction east by Owen Murray Ridges (OMR) in the west and by the Carlsberg Ridge (a portion of mid-oceanic ridge system) in the south direction. Some ranges that are extended from the north to south Pakistan the Kirthar and Sulaiman Mountains bound by basin on the western side. The collective number of the drainage basins is 966000 km.(V. Kolla (2), F. Coumes (3) 1987). The river environmental setting with subtropical to the climate with low rainfall (35 cm/year) (V. Kolla (2), F. Coumes (3) 1987) So these sediments are in the age of Holocene with the rate of sedimentation (45 cm/ years) the sediment that are in the age of Holocene characteristic are observed variation in color like gray, dark gray and gray-green some geomorphic feature are noted interbedded sands silts and muds. The deposition of the sediments in the lowered sea levels are at the age of the late Pleistocene in fact when the sedimentation rate is highly significant (40 cm/years)(V. Kolla (2), F. Coumes (3) 1987) during Holocene. The following description are directed only late Pleistocene sediments of the Indus fan (V. Kolla (2), F. Coumes (3) 1987).

The past of the mass flux into the Arabian Sea and the Indus fan age that has been a very contentious topic (Clift 2002). Very significant and more common analysis of both Indus and Bengal fan are in characteristic features in Miocene that are developing in the triggered by the quick erosion of higher Himalayas of early Miocene period (Clift 2002). Main view highly built on the reconstruction of mass flux that moves into the Indus fan reflects an acceleration the sedimentation in the same and equal time. (E.g. Davies et al. 1995). Although, such kind of mass flux that are estimations are highly based on the scientific drill sites and the results are effectively debated. Rea (1992) by using the same dataset to instead the main purpose in order to increase the mass flux at 9-11Ma, whereas (Clift 2002) has analyze proposed accumulation rate sediment into the Indus in fact until an important increases during the Pleistocene time (c.1.8 Ma) the major problem behind the lack of consent lack of ability to identify the clear data in order the dense part of the Indus fan where the high volume of sediment is stored. Working on the part of the foreland sequences is biased the main reason the circle of the preferential sedimentation and also the erosion of these basins connected to the fluctuation in the eustatic sea level. As the accumulation are highly linked with change in sea level with the passage of time so these variations in width and depth of the foreland trough in practice always full might not be considered as a better measurement of the mass flux through the Indus system.(Clift 2002)

Editorial note: Figure 5 was removed due to copyright issues.

Figure No.5 Map of Indus fan

5 Upper Indus Basin.

The Upper Indus Basin (UIB) located extreme northern part of Pakistan parallel to the border of Chinese. The upstream catchment are extends from the Tarbela dam reservoir approximately to the coved area about 20,600 km^2 (Jabbar et al. 2020). The different researcher says different numeric estimation cover area 220,000 Km^2 (Hewitt 2011) and 200,677 km^2 (Jabbar et al. 2020). The upper Indus basin is home to relatively some of the world's highest ranges Karakorum, Himalayas, and Kush Hindu Kush (KHK) ranges with several peaks that attaining a height level of > 7000 m. (Atif, Mahboob, and Iqbal 2015) Bishop and Shroder (2010). Calculated the highest 30 total submits in the world. One of them is the second largest in the world is K2 (8611 m) (Jabbar et al. 2020). Some well-known and famous glaciers in the Kush Hindu Kush (KHK). In Pakistan (in other words UIB) total cover area Siachen (75 km)–largest in the Karakoram and the world's second-largest glaciers outside in the Polar Regions Biafo (67.9 km) third biggest in the world Baltoro (62.1 km); Batura (59.8 km); and Hisper (53.1 km) (Atif et al. 2015).

Editorial note: Figure 6 was removed due to copyright issues.

Figure No. 6 Study area map.

6 Environmental conditions

The Upper Indus Basin (UIB) climates are warm dry in summer session and cold in the winter season with have low precipitation. The environment also be happen in the temperate region mainly lies in the shadow of large mountains areas (Hewitt 2011). In fact, the monsoon winds influence lessens north-westwards, approximately 90% of the upper Indus basin (UIB) falls in the Himalayan shadow zone (HSZ) (Jabbar et al. 2020). Mainly annual precipitation of the Upper Indus Basin (UIB) at the arid valley floor is 1500 mm- 200 mm, whereas in the Gilgit region river valley at the height of 4400 m altitude, approximately the precipitation increases to 600 mm and according to the glaciological research studies, the main accumulation at the height of 5500 m reaches 1500 mm–2000 mm (Anon n.d.). The climate setting of the Upper Indus Basin (UIB) is more comparable to the eastern part of the Himalayas (Jabbar et al. 2020). Both eastern and western part has diverse climatic condition across the whole Himalayas that can be perceived eastern part more the then 3000 mm as compared to the western part. On the other hand, the western part gets less the 300 mm precipitation annually that has directly and indirectly affected term of discharge of the river (Jabbar et al. 2020). The spatial and sessional snow fluctuations varies greatly in regions. The different parts eastern and central Himalayas receive a huge amount of snowfall from the monsoon period. (Ageta and Higuchi 1984), northwest (Karakoram and UIB), and westerly circulations in the winter period mostly snow heap that comes westerly circulating winds (Jabbar et al. 2020). Disseminate that the Himalayan glacier means the central Karakorum holds again the extensive quantity of snow makes avalanches that moving downward to the steep slopes.

The topography Map of the upper Indus basin (UIB) that reflect and marked different variability from the minimum elevation less than 1000 m in the flat area, near the area of Tarbela and Mangla dam reservoirs to over the 8000 m at a number of peaks (Jabbar et al. 2020), and, according to (Jabbar et al. 2020). Although lower Indus basin (LIB) is mainly depend on the main sources of snow and glaciers melting water for the different purpose (Jabbar et al. 2020).

7 Sedimentation environment of the Indus River

The source of eroded sediments into the Indus River from the Himalayans Mountains by the action of tectonic activity (Clift and Giosan 2014). These marine sediments that reflect the longest concise archives of the continental environmental of evolution, by using the purpose the sediments rebuilt the past patterns, changing the environments and also rate of erosion at the time of deposition. These archives in turn can used to assess the influence of both climate or tectonic that have over continental environmental conditions. However by utilized marine record by its full potential, first we would know the limit of the movement of clastic sedimentary rock and particles from the continental sources to the marine sink. So the clastic sediments are after the erosion from the mountain don't relocate into the sea, but during the transportation of the sediments the ocean haven't constant efficiency speed varies from the days to weeks to > 105-106 years,(Clift and Giosan 2014) so the main fact storage and reactivation en the route. In real some many has been argued about the Asian rivers systems that have maintained for the last two million years, there has been a relatively steady and mass flow in to ocean because of the sediments buffering in a flood plain (Clift and Giosan 2014). Although there has been debate about this over timescales greater than 106 years (Clift and Giosan 2014). However, there is currently a little control in order to know effective this buffering mechanism might be on limited time scales. (Clift and Giosan 2014).

8 Traveling path of sediments

During the tectonic activity uplifted of the mountain range and sediments derived from it such as the Himalayas Koh-hindukush, Koh I safaid parachinar the Waziristan agencies ranges Sulaiman-Kirthar fold belt and Khojak Flysch sub-basins, downstream by the number of different rivers, that includes Indus river, Panjkora river, Swat river, kKabul river Kunhar river Kurram river, Gambila river , and Gomal river. The sediments are derived from different sources characterized by a varieties of sediments ranging in the age from Precambrian to Holocene. So all major kind of rock with different origins (igneous, sedimentary, and metamorphic rocks) feed rivers with their detritus. All different kind fragments of rocks including the weather product flow regime from different directions. (Sabir et al. n.d.)

After the last glaciation maximum (LGM) the sediment flux move to the Arabian Sea from the course of River that has important variability experienced. The main research work in order to the estimation of sediment that has been deposited in the major structure like an incised valley, upper Indus canyon, subaerial delta, and shelf clinoforms. The calculated deposited sediment area is 4050-5675 km^3. The deposit sediment that lies near offshore canyon. While the remaining depositional volume of the source takeplace the incision of the upper alluvial plain 10ka, mostly the huge the bulk of the sediment are originated from the narrow and deep gorges around the Nanga Parbat syntaxis the estimated amount for 32 -40% sediment flux by the despite comprising that only consider ca. 5% is the dominant source of the sediment from the

mountain Himalaya– Karakoram–Hindu Kush region. The Karakoram Mountain is also a key source, estimation for the ca. 21–27% of the cumulative amount of sediment released. However, the Sediment that are buffering in the mountains mostly seems to be hugely stopped by land sliding, which is in part that is mainly controlled by climate (Sabir et al. n.d.). The study observation in order to examine the percentage of eroded from the terraces is 5% in important river valleys with the monsoonal area of the lesser and higher Himalaya. The research is carried out to understand the primary bedrock weathering since the last glaciation of a maximum of 46% of the sediments that are finally reached to the delta. Even though climate looks like to control both source and the rate of sediment supply in the time of early Holocene, vigorous reworking from the terraces and flood plains during the time of mid-late Holocene to understand that kind of changes due to erosion patterns after 8ka delta sediments are not recorded in the changing composition. Also examining during this study-travel time of zircon grains in the bed load that will take between 7 to 14kys in order to travel to the delta with the smaller travel time for the suspended load (Clift and Giosan 2014).

Source to sink transport of sediment

The source of erosion are (sediments) deep in to sea driven by tectonic forcing or climate change. Asian monsoon system sensitive that influence in indus river which giver better opportunity in order to estimate the nature of the sediments (recognition) in to river basin under the different climatic conditions. Although the rate of erosion in northwest region are linked to the summer monsoon rain and also linked with tectonically uplift rocks. In this case scenario the greater in erosion and faster in sediment transported together increase with chemical weathering although it is also linked with climate change. During the last Glacial maximum (LGM) and Post Last Glacial maximum sediments are stored with in the delta plain and shelf clinoforms system. So the high monsoon influence the high supply rate of sediments. Sediment is mostly delivered to the submarine fan. (Clift and Jonell 2021).

9 Anthropogenic activity across the Indus River

In Pakistan shortage of electricity in order to cope with these challenges by constructing dams, barrages, and across the river.(Vercruysse and Grabowski 2021) The major longest Indus River in Pakistan taken potential advantages in terms of constructing dams and use for agriculture purposes. This kind of anthropogenic activities carried out in Pakistan, especially northwest area effect on the sediment environment of Indus River and its tributaries globally and locally. The network of river system which stretches from Tibetan autonomous region by route of china through the Indian lands Himachal Pradesh and Punjab, and connected by the Indus River (IR) in Pakistan. Geomorphic active system experienced major anthropogenic variation (water and Sediment fluxes) with the time construction of civil structures (hydropower bridges and roads) and extensive network of the canals system for water abstraction. The major origin of two rivers from India (Sutlej and Beas) and adopt the route for the catchment boundaries between India and china, one of the dam (bhakra) is constructed in the river of Sutlej. The origin of the Sutlej River from the lake of rakshastal in the Tibet as springs in ephemeral stream. Sutlej river basin along ago and detached Sutlej due to the tectonic activity (Anon 2021b) The Bhakra dam in Pakistan, and the Pong dam constructed in the Beas river in India which are predominantly extended in order to fed rain and the purposed by the irrigated cropland disperse patches of the urban area and also grassland (Vercruysse and Grabowski 2021). Both Bhakra and Pong reservoirs mainly used for multi propose for hydro-power generation, irrigation, and regulation

of high-level flows during the time of monsoon season (Vercruysse and Grabowski 2021). In fact, due to human activity, some rivers will also increase in load, particularly in other cases the land clearance and catchment disturbance, another way the load will also reduce due to the build dam. Mostly rivers basins current trends to the sediments load that will reflect the two alternative controls, the trend changing through the time periods as the comparative balance of two controls shifts. Many more in some river basins anthropogenic impact will incorporated with changes driven by the recent climate change [23]

9.1. Known geomorphic activities involving humans include

- New land changes in term of deforestation and role related to the slop failure and soil erosion.
- Agriculture land, evolving techniques tillage, irrigation system and subsurface water extraction may cause in order to increase in soil erosion, creep, siltation and subsidence at the local level.
- Quarry and its related role in river channel and hill slop changes and cause in instabilities and subsidence.
- Material mobility systems, that evolving in soil erosion and riverbed scouring.
- Constructions of dams, and channel, diversions, and channel deepening ultimately coastline erosion.
- Globally climate warming and its various impacts on the system that may changes in various factors change in precipitation intensity, that includes the intensity of cyclones, desertification and an accelerated hydrological cycle (Syvitski and Kettner 2011).

9.2. KEY DRIVERS

The past for the existent of rivers that presented and provide the evidence of two key drivers of changes behaviors sediments load of the various rivers, for catchment of disturbance, are connected to the human activities in term management land and deforestation, grazing, cultivation, irrigation and intensive monoculture on other hand urbanization building constructions, sewerage and runoff and solid waste disposal. The industrial activity in the sector of mining exploration and industries and factories. Major human activity in field of civil engineering may include Roads, Rivers engineering, canals railways lines, highways and reservoirs (dams) most highlighted anthropogenic activity along different zone of the Indus River (Walling 2008).

9.3. Dam construction.

The key evidence construction of dams reduces sediment load in many world rivers, as described by (Milliman et al. 1984). In fact, the construction of many barrages and irrigation channels, as well as two major dams, Mangla and Tarbela, built on the main Indus river near Darband, which were completed in 1967 and 1974, (Milliman, Qinchun, and Zuosheng 1984) respectively, the IR for various purposes such as irrigation and water supply, flood control, and hydropower generation, began in the 1940s. The impact of these developments on the Indus River's annual discharge and sediment load is clear. So, in the case of the lower Indus River, annual runoff is now less than 20% of what it was prior to the development of extensive irrigation systems, which began in the 1940s, and the current annual sediment load is also less than 20% of what it was previously. (Walling 2008).

Editorial note: Figure 7 was removed due to copyright issues.

Figure No. 7 Desu Hydropower project along the Indus River.

9.4. Land clearance and catchment disturbance

Many rivers highly characterized by a high rate of sedimentation load caused by several factors deforestation, intensification of agriculture, mining, land clearance, and related activities located in various areas along the Indus rivers, resulting in increased sediment loads, as opposed to rivers where the sediment load has decreased as a result of dam construction. (Walling 2008) Furthermore, while dam construction is a relatively recent phenomenon whose impact can be documented by sediment load records dating back 40 or 50 years, there is a significant sensitivity of sediment loads in order to current environmental changes that should be arranged both in terms of the important and potential changes of the earth system, for example, consider the impact of dam construction on the environment Consider changes in the sediment loads of the world's rivers as a result of geochemical cycling, as well as the links to local and regional impacts and problems, such as the retreat of the delta shoreline due to reduced sediment supply and the distraction of coral reefs as a result of increased sediment inputs to the coastal seas. (Walling 2008).

Editorial note; Figure 8 was removed due to copyright issues.

Figure No. 8 Deforestation and land degradation northern area Indus River.

9.5. Coal mining influence central Indus basin

Mining is another human activity that has created along the Indus River's northern and southern banks. The research was conducted in the central Indus basin. As a result, we calculated the contamination of natural water and soil, as well as the anthropogenic contribution of coal mining activities. The microbiological control, depositional environment, basin morphology, mineralogy, and hydrological conditions of the area all influenced its function. Mining water has been discovered to be a major source of toxicity, raising concerns about the central Indus basin's ecological status. As a result, different elements such as iron and copper are found as anthropogenic loads, whereas different elements (Mn, Se, Cd, and Hg) are dominantly toxic. Furthermore, rainwater has the potential to transport these potentially toxic elements (PTEs) to lower agricultural lands and, eventually, to the Central Indus Basin's main water channel and the River Jhelum. The concerned organization should make proper regulation of mine tailings mandatory, as they are a potential source of toxic trace elements in the Central Indus Basin's local ecosystem For the conservation and protection of ecological resources, regular monitoring of potentially toxic elements PTEs in water quality is recommended around active and abandoned mining sites (Jabbar Khan et al. 2020).

Editorial note: Figure 9 was removed due to copyright issues.

Figure No. 9 Coal mine activity upper Indus basis postwar area
https://www.brecorder.com/news/40046958

9.6. Chemical and Physical changes in sediments in the Indus River

The chemistry of the Indus River sediments attempts to constrain the provenance of the erosion and weathering that may have resulted in the characteristics of these sediments (Ahmad et al. 1998). The grain size determines the chemistry of the sediments (Taylor and McLennan, 1985). The lithology of the area and the weathering of the combination of different silicate and carbonate rocks of the provenances regions heavily influence the geochemical importance of the Indus river water analysis. Anthropogenic activities do not appear to have had a significant impact on the water or sediment chemistry in these areas. So the Indus sediments indicates the important role of mechanical weathering and erosion (human activity) response to the Himalayan uplift and orogeny. The important factor is grain size that to be controlling by sediment chemistry (Ahmad et al. 1998). if the stabilization of neodymium isotopes in the sediments in the Delta since the mid-Holocene might partly be reflecting enhanced reworking of the floodplains starting with the agriculture associated with the Indus Valley civilization. We also saw an increase in smectite in the in the submarine Canyon that may be related to enhanced reworking due to agriculture (Clift and Jonell 2021)

I suspect the primary impact of anthropogenic processes is the reworking of weathered soils. We saw this in some Chinese deltas and I have been looking for that in the Indus. This is why because the smectite which is an indicator of chemical weathering and which increases in the offshore record after around 5000 years ago. This material indicates greater transport of stronger chemically weathered material and some of this may be caused by the erosion of old soils broken up by agriculture although we also see evidence for the incision of the big rivers into the floodplain which is also driving reworking of this type of material so the signal may be a combination of the two.(Li et al. 2020).

10 Conclusion

The Indus River is one of the largest rivers in south Asia the maximum flow area in Pakistan. The main origin of this river from the neighboring country India. The estimated length of this river is 3,180 kms. Typically we also called this ransboundary river connective between Pakistan and India border. Indian and Asian collision as result of himaylian rang are uplifted during the collision erosion weathering take place. As a result, along the line of collision septer between India and Eurasian, this activity gave birth to the Indus River, which is known as the Indus Suture Plains Zone (ISPZ). The main rout of the flow and sedimentation to end of the Arabian Sea (Indus fan). The flow start from the rise in the western Tibet, northwest through the ladakha and the Gilgit regions of Kashmir and flow southwest through Pakistan before it empties in to the Arabian Sea Karachi. Early Holocene period was rapid of the sediment flux to the south Asia deltas but it is unknown what extent of the sediments that was freshly eroded bed rock rather than older fluvial sediments that reworked to the floodplains and the terraces in to the mountains. Indus River passes several climatic zones from subtropical arid and sub arid to subequatorial atmospheric circulation mainly lie higher part of the basin. The monsoon is typically observed in tropic and sub tropic latitude. The dry months (October and April) in northeastern part sets over the plain and piedmont portion of the Indus basin The most probably monsoon rainfall takes place in summer session (May to September) and the annual rainfall dropping from 500mm to 125mm from the source to its mouth. Major northern part of Pakistan more densely anthropogenic activity take place, the key deriving is to build (dam) hydropower reservoir in order to store the water to overcome the electric problem. These anthropogenic

activities cause the change in the environment of the Indus River. Some common activity enhance increased loads from land clearance for agriculture and the other facets such as land disturbance logging activity in the forests land mining activity and major civil engineering activity. Mining sediment that significantly move downstream sediment flux, probably which may increase the effect of subsidence in the river of the deltas as well as causing the scour around in the channel of engineering structure. The major effect of the coal mine influence the microbiological control, depositional environment, basin morphology, mineralogy, and hydrological conditions of the area.

11 References

- Ageta, Y., and K. Higuchi. 1984. “Estimation of Mass Balance Components of a Summer-Accumulation Type Glacier in the Nepal Himalaya.” *Geografiska Annaler: Series A, Physical Geography* 66(3):249–55. doi: 10.1080/04353676.1984.11880113.

- Ahmad, T., P. P. Khanna, G. J. Chakrapani, and S. Balakrishnan. 1998. “Geochemical Characteristics of Water and Sediment of the Indus River, Trans-Himalaya, India: Constraints on Weathering and Erosion.” *Journal of Asian Earth Sciences* 16(2):333–46. doi: 10.1016/S0743-9547(98)00016-6.

- Anon. 2021a. “Indus River.” *Wikipedia*.

- Anon. 2021b. “Sutlej.” *Wikipedia*.

- Anon. n.d. “Full Text PDF.”

- Anon. n.d. “Indus River - Hydrology.” *Encyclopedia Britannica*. Retrieved May 22, 2021b (https://www.britannica.com/place/Indus-River).

- Atif, Iqra, Muhammad Mahboob, and Javed Iqbal. 2015. “Snow Cover Area Change Assessment in 2003 and 2013 Using MODIS Data of the Upper Indus Basin Pakistan.” *Journal of Himalayan Earth Sciences*.

- Clift, P. D., and L. Giosan. 2014. “Sediment Fluxes and Buffering in the Post-Glacial Indus Basin.” *Basin Research* 26(3):369–86. doi: 10.1111/bre.12038.

- Clift, Peter D. 2002. “A Brief History of the Indus River.” *Geological Society, London, Special Publications* 195(1):237–58. doi: 10.1144/GSL.SP.2002.195.01.13.

- Clift, Peter D., and Tara N. Jonell. 2021. “Monsoon Controls on Sediment Generation and Transport: Mass Budget and Provenance Constraints from the Indus River Catchment, Delta and Submarine Fan over Tectonic and Multimillennial Timescales.” *Earth-Science Reviews* 220:103682. doi: 10.1016/j.earscirev.2021.103682.

- Gupta, Avijit. 2008. *Large Rivers: Geomorphology and Management*. John Wiley & Sons.

- Henderson, Alexandra L., Yani Najman, Randall Parrish, Marcelle BouDagher-Fadel, Dan Barford, Eduardo Garzanti, and Sergio Andò. 2010. “Geology of the Cenozoic Indus Basin Sedimentary Rocks: Paleoenvironmental Interpretation of Sedimentation from the Western Himalaya during the Early Phases of India-Eurasia Collision.” *Tectonics* 29(6). doi: https://doi.org/10.1029/2009TC002651.

- Hewitt, Kenneth. 2011. “Glacier Change, Concentration, and Elevation Effects in the Karakoram Himalaya, Upper Indus Basin.” *Mountain Research and Development* 31(3):188–200. doi: 10.1659/MRD-JOURNAL-D-11-00020.1.

- Inam, Asif, Peter D. Clift, Liviu Giosan, Ali Rashid Tabrez, Muhammad Tahir, Muhammad Moazam Rabbani, and Muhammad Danish. 2007. “The Geographic, Geological and Oceanographic Setting of the Indus River.” Pp. 333–46 in *Large Rivers*, edited by A. Gupta. Chichester, UK: John Wiley & Sons, Ltd.

- Jabbar, Abdul, Arsalan Ahmed Othman, Broder Merkel, and Syed E. Hasan. 2020. “Change Detection of Glaciers and Snow Cover and Temperature Using Remote Sensing and GIS: A Case Study of the Upper Indus Basin, Pakistan.” *Remote Sensing Applications: Society and Environment* 18:100308. doi: 10.1016/j.rsase.2020.100308.

- Jabbar Khan, Abdul, Gulraiz Akhter, Hamza Farooq Gabriel, and Muhammad Shahid. 2020. “Anthropogenic Effects of Coal Mining on Ecological Resources of the Central Indus Basin, Pakistan.” *International Journal of Environmental Research and Public Health* 17(4). doi: 10.3390/ijerph17041255.

- Kravtsova, V. I., V. N. Mikhailov, and N. A. Efremova. 2009. “Variations of the Hydrological Regime, Morphological Structure, and Landscapes of the Indus River Delta (Pakistan) under the Effect of Large-Scale Water Management Measures.” *Water Resources* 36(4):365–79. doi: 10.1134/S0097807809040010.

- Kutzbach, J. E., W. L. Prell, and Wm. F. Ruddiman. 1993. “Sensitivity of Eurasian Climate to Surface Uplift of the Tibetan Plateau.” *The Journal of Geology* 101(2):177–90. doi: 10.1086/648215.

- Li, Yuting, Peter D. Clift, Richard W. Murray, Elise Exnicios, Thomas Ireland, and Philipp Böning. 2020. “Asian Summer Monsoon Influence on Chemical Weathering and Sediment Provenance Determined by Clay Mineral Analysis from the Indus Submarine Canyon.” *Quaternary Research* 93:23–39. doi: 10.1017/qua.2019.44.

- LISTzIN, A. P. 1972. “Sedimentation in the World Oceans: SEPM Special Publication 17.”

- Milliman, John D., Xie Qinchun, and Yang Zuosheng. 1984. “Transfer of Particulate Organic Carbon and Nitrogen from the Yangtze River to the Ocean.” *American Journal of Science* 284(7):824–34. doi: 10.2475/ajs.284.7.824.

- Naini, B. R., and V. Kolla. 1982. “Acoustic Character and Thickness of Sediments of the Indus Fan and the Continental Margin of Western India.” *Marine Geology* 47(3):181–95. doi: 10.1016/0025-3227(82)90068-8.

- Sabir, Mohammad Amjad, Syed Shafiq-Ur-Rehman, Muhammad Umar, Amir Waseem, Muhammad Farooq, and Abdur Rehman Khan. n.d. “The Impact of Suspended Sediment Load on Reservoir Siltation and Energy Production: A Case Study of the Indus River and Its Tributaries.” 9.

- Schuldenrein, Joseph, Rita P. Wright, M. Rafique Mughal, and M. Afzal Khan. 2004. “Landscapes, Soils, and Mound Histories of the Upper Indus Valley, Pakistan: New Insights on the Holocene Environments near Ancient Harappa.” *Journal of Archaeological Science* 31(6):777–97. doi: 10.1016/j.jas.2003.10.015.

- Syvitski, James P. M., and Albert Kettner. 2011. “Sediment Flux and the Anthropocene.” *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 369(1938):957–75. doi: 10.1098/rsta.2010.0329.

- V. Kolla (2), F. Coumes (3). 1987. “Morphology, Internal Structure, Seismic Stratigraphy, and Sedimentation of Indus Fan.” *AAPG Bulletin* 71. doi: 10.1306/94887889-1704-11D7-8645000102C1865D.

- Vercruysse, Kim, and Robert C. Grabowski. 2021. “Human Impact on River Planform within the Context of Multi-Timescale River Channel Dynamics in a Himalayan River System.” *Geomorphology* 381:107659. doi: 10.1016/j.geomorph.2021.107659.

- Walling, Des. 2008. “The Changing Sediment Loads of the World’s Rivers.” *Annals of Warsaw University of Life Sciences - SGGW. Land Reclamation* 39(1):3–20. doi: 10.2478/v10060-008-0001-x.