

BEFORE THE NATIONAL GREEN TRIBUNAL**PRINCIPAL BENCH AT NEW DELHI****ORIGINAL APPLICATION NO. 351 OF 2023****IN THE MATTER OF:**

RAJA MUZAFFAR BHAT

...APPLICANT

VERSUS

UNION TERRITORY OF JAMMU & KASHMIR AND ORS. ...RESPONDENTS

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**RESPONSE TO WRITTEN SUBMISSIONS ON BEHALF OF THE
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MOST RESPECTFULLY SHOWETH:-

1. That the above-titled Application was filed under Section 14, 15 read with 20 of the National Green Tribunal Act, 2010 raising the issue of mining activity in violation of conditions in the Environmental Clearances granted by Jammu & Kashmir Environment Impact Assessment Authority (JKEIAA) under the EIA Notification, 2006 (issued under Rule 5(3) of Environment (Protection) Rules, 1986). The Environmental Clearances have been granted to the Respondents No. 5 and 6 for undertaking mining of boulders, gravel, sand and other minor minerals (Riverbed material) in Doodhganga River flowing through Budgam district of Jammu & Kashmir.
2. That vide Order dated 18.12.2023, this Hon'ble Tribunal had allowed Respondents No. 5 and 6 to file written arguments and

had allowed the Applicant to file response to such written arguments:

"4. Learned Counsel appearing for respondent nos. 5 and 6 requested that besides the argument they already advanced orally, they may also be given three days' time to file written arguments. Time is allowed. They may do so within three days after serving a copy upon Learned Counsel for applicant whereafter, Learned Counsel for applicant may have further three days' time to file his response to the said written arguments, if any new point has been taken."

3. That as per the time granted, Respondents No. 5 and 6 have filed their written arguments dated 21.12.2023. The Applicant herein is filing Joint Response to the Written Submissions of Respondents No. 5 and 6 as both the Written Submissions are identical, as per the liberty granted by this Hon'ble Tribunal. At the outset, it is submitted that the contents of the Original Application, Response of Applicant to the Joint Committee Report dated 21.09.2023 and Rejoinder dated 16.12.2023 filed by the Applicant may be read as a part and parcel and are not being repeated for the sake of brevity. Through these Written Submissions, the Applicant is only responding to the grounds raised by Respondents No. 5 and 6 in the Written Submissions dated 21.12.2023.

**RESPONSE TO THE WRITTEN SUBMISSIONS OF
RESPONDENTS NO. 5 AND 6**

**The contention of Respondents No. 5 and 6 that mining is
being undertaken only manually and prohibition on use of
JCBs is only suggestive in nature is faulty and misleading**

4. That Respondent No. 5 and 6 in Para 7(C) have submitted that the Environmental Clearances allows mining to be undertaken manually, supported by semi-mechanized methods. Interpreting the same, Respondent No. 5 and 6 have stated that using JCBs to make conditions feasible for manual mining cannot tantamount to violation of Environmental Clearance condition.
5. That the Respondents have also contended that the prohibition on use of JCBs is only suggestive in nature and therefore, heavy machinery can be used for undertaking mining in the river. Respondent No. 5 and 6 have stated that the word '*should*' in the condition that '*heavy condition like JCBs, L&T hydraulic excavators etc. **should** not be allowed*' is only suggestive in nature and not binding.
6. It is the submission of the Applicant that this is an incorrect reading of the condition of the Environmental Clearance as it completely prohibits use of heavy machinery to undertake mining. It is submitted that both parts of the Environmental Clearance condition No. 53 have to be read together to understand that manual mining should be undertaken, supported with semi-

mechanized methods, which *does not* include JCBs, L&T hydraulic excavators.

7. That in the present case, if the Environmental Clearance provides that no usage of JCBs can be undertaken, the same cannot be done in violation of law. The Hon'ble Supreme Court in catena of judgments has held that if statute provides for a thing to be done in a particular manner, then it must be done in that manner alone or nothing at all.
8. That the Hon'ble Supreme Court in ***Selvi J. Jayalalithaa & Ors vs. State Of Karnataka & Ors*** reported in **2014 (2) SCC 401** has held that when law provides for a thing to be done in a particular manner, then it must be done in that manner alone or not at all. It has held:

"34. There is yet an uncontroverted legal principle that when the statute provides for a particular procedure, the authority has to follow the same and cannot be permitted to act in contravention of the same. In other words, where a statute requires to do a certain thing in a certain way, the thing must be done in that way and not contrary to it at all. Other methods or mode of performance are impliedly and necessarily forbidden. The aforesaid settled legal proposition is based on a legal maxim "Expressio unius est exclusio alterius", meaning thereby that if a statute provides for a thing to be done in a particular way, then it has to be done in that manner and in no other manner and

following any other course is not permissible."

(Emphasis supplied)

9. That in the case of ***Hussein Ghadially v. State of Gujarat*** reported in **(2014) 8 SCC 425**, the Hon'ble Supreme Court has also emphasized on the same principle and held that:

"21.3....if the statute provides for a thing to be done in a particular manner, then it must be done in that manner alone. All other modes or methods of doing that thing must be deemed to have been prohibited. That proposition of law first was stated in Taylor v. Taylor [(1875) LR 1 Ch D 426] and adopted later by the Judicial Committee in Nazir Ahmad v. King Emperor [(1935-36) 63 IA 372 : (1936) 44 LW 583 : AIR 1936 PC 253] and by this Court in a series of judgments including those in Rao Shiv Bahadur Singh v. State of Vindhya Pradesh [AIR 1954 SC 322 : 1954 Cri LJ 910] , State of U.P. v. Singhara Singh [AIR 1964 SC 358 : (1964) 1 Cri LJ 263 (2)] , Chandra Kishore Jha v. Mahavir Prasad [(1999) 8 SCC 266] , Dhanajaya Reddy v. State of Karnataka [(2001) 4 SCC 9 : 2001 SCC (Cri) 652] and Gujarat Urja Vikas Nigam Ltd. v. Essar Power Ltd. [(2008) 4 SCC 755]..."

10. That in the case of **Appeal No. 24 of 2022 (Raja Muzaffar Bhat v. State Environment Impact Assessment Authority, Jammu & Kashmir)**, vide Judgment dated 28.09.2022, the Hon'ble Tribunal had adjudicated on the similar issue of mining being conducted by the use of JCBs. In Appeal No. 24 of 2022 as well, Respondents had raised the same ground that JCBs are being

used for removing big boulders. However, this argument was rejected by the Hon'ble Tribunal in the following manner:

"163. On this aspect, the only submission is that heavy machines like JCB etc. have been used for mining activities and, therefore, proponent has violated the conditions of EC.

*164. **Learned Counsel appearing for appellant drew our attention to specific conditions in the impugned ECs, which prohibits use of heavy machines like JCB, hydraulic excavator etc. is reproduced as under: "Mining shall be done manually minimally supported by semimechanized methods. Heavy machinery like JCBs, Excavators/L&T hydraulic excavators etc. should not be allowed. Emphasis should be given to employment of locally available labour force to address the socio-economic concerns of the locals."***

*165. **PP/respondent 4 in its reply dated 29.07.2022 in para 6 has said, "the Project Proponent has used JCBs and loaders only for the purpose of approach making since big sized boulders were lying in the approach which could not be removed manually, and also for the loading of mined minerals on the dumpers/trucks since loading of big sized boulders manually was also not feasible."***

*166. **The above stand taken by PP is an admission of use of heavy machines for excavation.** Once it is admitted that the boulders were such big sized, not capable of removal or uploading without use of heavy machines like JCBs etc., it is difficult to conceive that the same could have been be mined without use of heavy machines.*

167. When questioned from the Learned Counsel for PP that if mined boulders were so big sized that the same could not be loaded on the dumpers/trucks manually, how such boulders could have been mined from the mining area without use of such machines, we did not receive any satisfactory reply and it is said that whatever is/was the factual position that has been stated in the reply of PP."

(Emphasis supplied)

The contention of Respondents No. 5 and 6 that mining activities are not being undertaken within active water channels is factually incorrect

11. That Respondents No. 5 and 6 (in Para 7 (D) and (E)) have stated that no mining is being carried out in flowing water and have relied on the photographs attached with the Joint Committee Report for the same.
12. That the Applicant submits that the mining is taking place within active water channels by changing the water course of the river, which evident from photographs and Google Earth images annexed with the Original Application as well as the Joint Committee Report.
13. That the Applicant has annexed photographs at **Page 135** and Google Earth images at **Page 137** and **Page 149** to show in-stream mining by Respondent No. 5.
14. That the Joint Committee Report also clearly states that "*as such the mining activities go parallel to the running waters of the stream **by diverting the water***".

15. Therefore, the averment of Respondents No. 5 and 6 that no mining is being carried out in flowing water is misleading and faulty.

**REPLY OF THE APPLICANT TO THE SUBMISSIONS OF
RESPONDENTS NO. 5 AND 6 ON REPLENISHMENT STUDY
FOR DOODHGANGA STREAM**

16. That Respondents No. 5 and 6 (at Para 9) have stated that replenishment studies have been conducted for Doodhganga Nalla which is titled '*Geological Report on Minor Mineral Resource Estimation, Hydrology, Hydrogeology and Replenishment Studies of Nalla Doodhganga and Shaliganga, District Budgam, J&K UT*'.

**A. The replenishment studies were conducted only for
sand and sediments and not for boulders, therefore,
removal of such boulders from the river cannot be
allowed**

17. That Respondents No. 5 and 6 have been granted Environmental Clearances dated 06.07.2021 for mining of minor minerals. Replenishment studies (for field season 2021-22) have been conducted after the grant of Environmental Clearances as is clearly mentioned in the Environmental Clearances at Page 52 (for Respondent No. 5) and Page 119 (for Respondent No. 6).

18. That these replenishment studies have been conducted only for sand and other sediments and not for boulders.

19. It is the submission of the Applicant that boulders are an integral part of the river ecology and since they cannot be replenished and

no replenishment study has been done for them in the present case, removal or mining of the same cannot be allowed to continue.

20. That the Respondents cannot be allowed to mine for extinguishable resources that do not have the possibility of replenishment. Therefore, in absence of a study on replenishment of boulders, no mining of the same should be allowed.

Impact of removal of boulders from the river ecology

21. That the Applicant is placing on record multiple research articles to show the importance of boulders on the river ecology and mining or removal of such boulders can impact the fluvial situation of the rivers.

22. That in an article titled "*Gravel and boulders mining from mountain stream beds*" published in the International Scientific Conference on Civil Engineering-Infrastructure- Mining, it has been noted that removal of boulders can be disastrous for fluvial situation of rivers, for river ecology and river engineering works.

Copy of article titled "*Gravel and boulders mining from mountain stream beds*" published in the International Scientific Conference on Civil Engineering-Infrastructure- Mining is annexed herewith as

ANNEXURE A-1.

23. That in an article titled "*Large boulders help shape huge canyons, researchers find*" dated 04.06.2019 published in the University of Colorado emphasizes on the importance of boulders in shaping the rivers.

Copy of article titled "*Large boulders help shape huge canyons, researchers find*" dated 04.06.2019 published in the University of Colorado is annexed herewith as **ANNEXURE A-2**.

24. That removal of such boulders from the rivers can have impact on the river morphology, aquatic biodiversity, soil and landscape as stressed upon in an article titled, "*Environmental Impact of River Bed Mining- A Review*" published in International Journal of Scientific Research and Review in the following manner:

"EFFECTS OF RIVER BED MINING ACTIVITY IN AND AROUND THE RIVER ECOSYSTEM:

1. Effect on River Morphology

*River morphology means the shapes and direction of river channels. **The river channel morphology is a combination of many processes and environmental condition in which erodibility and composition of the bed and banks viz. Sand, stone, boulder; erosion by natural and anthropogenic activity, affect the formation of the river path.***

Some anthropogenic activity like mining of riverbed materials (sand, gravel, stone and boulder) within a river channel causes the erosion and degradation of the river bank. The major effect of river morphology by the riverbed Mining activity is given by many others.

...

3. Effect on Aquatic Biodiversity:

Rivers are the habitat of many Aquatic animals, its cover the major portion of fresh water animal's phytoplankton, Zooplankton, Benthos and fishes.

The bed material like Sand, stone and boulder are the Habitat of these animals. The riverbed mining activity affects these animals by removing of the sand, boulder and stones from the river. The turbidity of water affects the Phytoplankton and zooplankton. The Benthos are found on the lower side of stones and boulder, by removing the stones and boulder the habitat of benthos destroyed and its effect the population of the benthos in a river system. The riverbed mining activities affect the reproduction and characteristics of spawning nests of fish like salmon and trout.

...

5. Effect on Soil and Landscape

Sand and gravel mining activity responsible for shifting of river channel, degradation of river bank land, loss of fertile land, and changing in the landscape area. The high demand of sand and gravel, illegal mining is increase. In some area, the people remove the fertile soil from the agricultural land and after they take out the boulders from the agriculture land."

(Emphasis supplied)

Copy of article titled, "*Environmental Impact of River Bed Mining- A Review*" published in International Journal of Scientific Research and Review are annexed herewith as **ANNEXURE A-3**.

25. That, in light of the above, it is clear that boulders form an integral part of the river ecology and mining or removing them from the rivers can have devastating impacts. Since boulders cannot be replenished, removal or mining of the same should also not be permitted to take place.

**REPLY OF THE APPLICANT TO THE SUBMISSIONS OF
RESPONDENTS NO. 5 AND 6 WITH RESPECT TO THE FACT
THAT THEY WERE NOT INVOLVED IN ILLEGAL MINING**

26. That Respondents No. 5 and 6 have stated in Para 8 that as per the letter dated 27.12.2022 of the District Mineral Officer (mentioned in Order of this Hon'ble Tribunal dated 30.05.2023), Respondents No. 5 and 6 were not involved in illegal mining.

**A. The Joint Committee constituted by the Hon'ble
Tribunal in the present matter has noted the illegal
mining by Respondents No. 5 and 6**

27. That the Joint Committee constituted by the Hon'ble Tribunal in the present matter had submitted a Report dated 08.08.2023 wherein violations by Respondents No. 5 and 6 with respect to usage of heavy machinery and in-stream mining were noted.

28. It is submitted that the violations noted in the Joint Committee Report are recent as opposed to the observations made by the District Mineral Officer in its letter which is 27.12.2022.

29. That the Joint Committee has clearly noted that mining has happened in violation of Environmental Clearance condition at Block No. 11 and Block No. 12 when the site inspection was conducted.

**B. Environmental compensation was imposed on the
owners of the heavy machinery/ vehicles and not on
the project proponent**

30. That it is also pertinent to note that the letter dated 27.12.2022 makes it clear that Respondents No. 5 and 6 were not found involved in illegal mining due to the fact that the seized vehicles/ machinery were not recorded on the name of lease holders of the said block.

Copy of letter dated 27.12.2022 of the District Mineral Officer is annexed herewith as **ANNEXURE A-4**.

31. It is the submission of the Applicant that just because the vehicles were not found recorded in the name of Respondents No. 5 and 6, it does not imply that illegal mining was not being done by them. The lease holders, in most circumstances, hire heavy machinery from third parties to undertake mining. As per the letter dated 27.12.2022, the District Mineral Officer has only imposed compensation on the tractor/ tipper/ machine owners who were undertaking mining. However, they have failed to impose compensation on the lease holders of those lease, at the behest of whom the owners of heavy machinery were using their vehicles.

32. That the environmental compensation is needed to be imposed on the project proponents who have obtained the Environmental Clearances and not the owners of the machinery/ vehicles.

C. The letter dated 27.12.2022 does not comment on the violation of Environmental Clearance conditions by Respondents No. 5 and 6

33. That the letter dated 27.12.2022 of the District Mineral Officer does not provide information on the violation of Environmental

Clearances conditions by Respondents No. 5 and 6 and therefore, no conclusion can be drawn regarding undertaking mining activities in violation of conditions of Environmental Clearance.

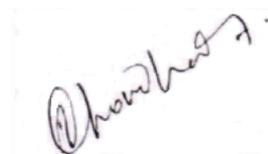
34. That the Joint Committee Report has also substantiated the grounds raised by the Applicant with respect to violation of Environmental Clearance conditions relating to usage of heavy machinery and conducting in-stream mining by Respondents No. 5 and 6.

35. In light of the above facts and circumstances, the Hon'ble Tribunal may be pleased to pass appropriate Orders/ directions.

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Gravel and boulders mining from mountain stream beds

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Abstract. Mountain stream gravel is very often legally and illegally mined and gravel is removed from river beds sometimes on the very large scale which is disastrous for fluvial situation of rivers, for river ecology and river engineering works done for flood protection such as river revetments, bridges and all hydraulic structures. This situation makes a big problem for all river managers. Thus gravel mining of the mountain streams in the Polish Carpathians is the subject of many scientific studies when we observe river problems, but also it has a place in Slovakia. This paper deals with such problems additionally showing examples of such bad practices.

Keywords: mountain stream, gravel mining, river bed, Carpathians

1 Introduction

One of the essential factors affecting the way in which the mountain rivers and streams flood, is bed and bank stability. This stability depends on the condition of the gravel cover lying on stream beds, so-called stream bed armouring. The better the armouring of a mountain stream, the smaller the probability of the stream breaking its banks during flooding, and, as a result, the safer the channel of the stream [1, 2, 3, 4]. Sediment mining in alluvial channels: physical effects and management perspectives. Unfortunately, there has recently been more and more cases of uncontrolled digging of gravel and boulders out of mountain stream channels. This results in catastrophic damage to the stability of stream beds and banks [3, 5].

In that case, the sediment removing from the river channels supports the river adjustment to new hydraulic and morphological conditions. Generally, in case of Slovakian case studies, we can distinguish between gravel mining directly in the low flow active

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channel and on the part of floodplain area besides channels. The river response on this kind of interventions on the initially natural river system with decreased volume of sediment related with multiplied water energy concentrated in active channels. Gravel mining directly from channels caused negative morphological responses of the river system on the several connectivity levels (channel-bed, channel-bank and channel-floodplain). Predominant vertical erosion was during high discharges usually accompanied by intensive bed wash-out. Acceleration of the bed erosion processes led to deepening and narrowing of the river channels. After downstream transport of the last remaining sediment, the river channel started incise to the bedrock as a hungry water consequence. Hungry water means, that water with lack of sediment has higher tendency to pick up sediment. This lead to increasing in-channel erosion processes. One flood event with sufficient high magnitude of discharge (> 20 -years RI) or several smaller consecutive floods (5-10-years RI) well supported expansion of the defecting vertical erosion in upstream direction as consequence of backwater erosion. In addition, the straightening of the low flow channels led to disruption of the dynamic structure of the channel morphology (e.g. island area growth) as well as decrease its ability to further lateral bank erosion. On the connectivity channel-floodplain level the river system lost important lateral eco-hydrological connectivity with side floodplain area. Gravel mining activities concentrated more to floodplain area affected the further morphological processes mainly during high discharges (floods) and decrease ecological values. Changed topographic floodplain structure by mining mechanisms developed the predisposition for frequent formation of the new avulsion channels during floodplain inundation supported by the presence location of mining pits.

In this paper we present some examples of mountain stream bed degradation in Poland and Slovakia. For Polish part of the analysis we have chosen the streams in the Zawoja village region. These are the Czatożanka and Jałowiecki streams which, together with the Jaworzynka stream, form the Skawica river. In addition, we wrote this part of the text immediately after the tragic consequences of floods in the Suski region (Zawoja village is located in this region) which could be witnessed by the authors whilst taking hydrological measurements during the flood in the last ten days of July in 2010.

As the second three examples for our analysis we chosen the braided-wandering Belá River and two sinusous laterally active the Topľa and the Ondava River from north-east Slovakia. Gravel mining was legally connected with these river systems in near history as well as in presence. In addition, the one of them, the morphologically specific and rare the Belá River was exposure to morpho-ecological devastation by safeguarding works related with sediment mining and movement after flood event (5-years RI, 19.7.2018) during last summer.

1.1 Case study from Poland

Jalowiecki stream in Zawoja – illegal gravel mining

In order to understand why gravel and boulders cannot be exploited with impunity, one has to answer the question of where gravel and boulders in streams come from. For the period of the last 1.5m years (in geology. this period is called the Quaternary) and especially for the period of the last 11 000 years (in the Holocene Epoch) streams which have their sources on the slopes of Babia Góra carry a bed load of gravel and boulders. Gravel and boulders of various sizes are transported by streams during high waters. Streams, in their steepest sections located near their sources, act as gullies in which the material eroded from the massif is carried down to lower sections of streams. Gravel and boulders are then moved to a stream region with much smaller degree of steepness than in

the stream source region. The transport of gravel takes place along the steepest section of the stream, for instance, in the Jałowiecki stream, it is from its source to the so-called Małe Widły in Zawoja Składy and in the Czatożanka stream, the steepest section is from its source to Zawoja Czatoży.

The transport of sediment (grains of the size of 1-2 mm to 19 or more cm) takes place during high waters. When the stream bed slope falls suddenly, the transported gravel and boulders are deposited. This process also occurs in streams in the Zawoja region. Transported material from Babia Góra is deposited as bars and alluvial fans in the lower regions of the Jałowiecki stream, the Czatożanka stream and the Skawica river. The transport of the material lasts until the stream stabilises, that is, until the stream has a bed slope that provides the balance between the stream or river strength and load. In theory, a river which has reached its equilibrium profile neither erodes nor accumulates its bed load; it only transports it. Thus, the river strength is enough to transport the bed load (this results from the so-called river equilibrium curve which can be prepared for each stream). Although, in reality this equilibrium is unstable, in practice only large floods can disrupt it. The mechanism of bed load transport down the stream, then down the river and into the sea is continuous and the bed load is broken down so that boulders change into cobbles, cobbles change into pebbles and pebbles change into sand.

Let us stop at the moment when the first gravel and boulders start being deposited right below the steep sections of streams. In the discussed example in the village of Zawoja, the material is deposited in the region of Małe Widły. Some of the material stays in that section, the rest, probably the excess of the material, is transported to the lower sections of Skawica. Gravel formations of streams and rivers deposited by their waters and left on these sections are called alluvial deposits. Along the sections where the bed load is deposited, the stream erodes only in its own alluvia and forms various kinds of channel forms, mainly bars. At the same time, except for the creation of the above-mentioned condition of equilibrium in the longitudinal profile of the stream, the natural armouring is formed on the channel bed. Gravel and boulders lying on stream side bars protect its banks naturally. They are compact and often very durable. Boulders lying in a channel resemble the layout of tiles on a house roof and they naturally strengthen the stream bed (referred to as bed imbrications). Thus, stream equilibrium is achieved in which the stream itself forms such an armoured bed that it can withstand short-term high waters. Of course, when the catastrophic one-hundred-year flood occurs, this armour is destroyed and we cannot protect ourselves from it. We have to be aware that there are no river training structures that can protect us from such floods, with the possible exception of huge storage reservoirs.

Another question that may be asked concerns what happens to the stream bed which is in some kind of an optimal condition when we remove some gravel from the section where a significant bed load was deposited – the answer is not explicit. Everything depends on the amount of bed load that is removed and from which section of the stream it is removed. It is well known that human settlements have always been connected with rivers and streams. Since people started building houses, the main building material was not only wood but also stone and gravel and the easiest way of getting this building material seemed to be digging it out of stream beds. Such activities took place in the Zawoja region until the year 1939. However, most of the building material was acquired from quarries. There were two quarries in the Zawoja region. Taking gravel from streams was sporadic and boulders were used only to decorate the underpinning of houses. However, there is a difference between the amount of gravel used before the Second World War and the amount of gravel used now. At the beginning of the twenty first century, along the abovementioned section of the Skawica stream in Zawoja Górna, there were between ten and twenty houses. Even when we take into consideration the whole Zawoja region until the year 1945, there were only a few hundred buildings. If each farmer had taken two carts of stones from the stream to

build their houses, then, for example, for 800 houses they would have taken together $2 \times 400 \text{ kg} \times 800 = 640$ tonnes of boulders and gravel. The stream can replace this amount of material over a period of 50 years.

After the year 1945, the development of reinforced building industry caused a rapid demand for gravel. Mass exploitation of gravel and especially boulders began. Boulders were used mainly for foundations and because the means of transport and excavation have changed, the bed material was dug out on an unprecedented scale. If instead of two carts, we take three 6 to 8-tonne dumper trucks, then for 4 000 houses (this is the current number of houses in Zawoja), 96 000 tonnes of bed material have been taken from the stream over the last 50 years. Such an amount of bed load cannot be replaced in even 500 years.

From the author's calculations, it appears that the transport of bed load in Czatożanka and Jałowicki streams region was about 14 000 tonnes after the year 1950. This means that from the channels of the discussed streams, much more gravel was removed than reached the Małe Widły region. What does this mean for the stream channel? As mentioned above, streams tend to reach some kind of equilibrium and such an equilibrium is generated after the bed load is taken out of the stream (Fig. 1). When a stream doesn't receive enough bed load from Babia Góra, it starts to erode its own bed and banks. Next, it starts to cut into the bed deeper and deeper, often through gravel formations and rock stratum. This means that the stream is deprived of its protective cover – the previously mentioned armouring – it is like a skinned living organism. The consequence of such a condition is the Jałowicki and Czatożanka streams cutting into their beds to a depth of approximately 80 cm in some places, even over 1 m over the period of the last 50 years (on the basis of the author's estimated calculations, observations and field interviews).



Fig. 1. Illegal gravel mining in Polish Carpathians: excavators and lorries in work and river gravel bed degradation after illegal gravel activity

Another problem connected with taking gravel and boulders from mountain stream channels is the destruction of river training structures. Since a stream tends to level its bed,

it cuts into its stratum practically along its entire length. All attempts to balance the bed fail. Let us imagine, as an example, a bridge or gabion baskets along a section of a stream. Even if somebody takes gravel 1 or 2 kilometres downstream from a stream training structure or a bridge (even the load of a few dumper trucks), these structures which have their foundations and usually serve their purpose for several dozen years are immediately scoured. The bed under these structures lowers and eats into the bank, thus the structures start to overhang the stream. Recently built expensive revetments are destroyed after a few years. For the price of 100 m of bank revetments and a few weirs reducing the stream slope, a housing estate can be built. The same situation is with bridges. The best example is the bridge over Jałowiecki stream, upstream from the local National Park Museum, which was supported with one weir 10 years ago. Today, it is supported by a few-metre-high cascade of weirs. Another example is the gabion revetment and the bridge abutments in the region of guesthouse 'Filip' in Zawoja Wilczna. As a consequence of gravel exploitation along the section from Duże Widły upstream to the region of Old Chapelin Wilczna, and, in the spring of 2000, digging and mechanical pushing through the stream bed, the above-mentioned bridge will very shortly require a support with a weir and the revetments near the 'Filip' guesthouse is already scoured. River training structures, including weirs and bridges, are designed for a specific stream bed slope. Their function is to stabilise that slope, to dissipate the energy of a river during flood, to aid the natural process of bed armouring and to secure the river channel. If the bed material is taken out from sections located downstream of the structures, these structures lose their stability and they are destroyed. As the consequence, during flood events, people may lose their possessions and even their lives and the stream changes into a wild beast destroying everything in its path.

1.2 Case study from Slovakia

Belá River – in-channel gravel extraction

The Belá River presents very rare and valuable multi-thread river system in Slovakia affected by human impact and environmental changes. Approximately 140000 m³ of gravel were extracted along 7 km long river reach during 50 years (1950–2000) as the flood protection action for Liptovský Hrádok and Dovalovo settlements as well as for the protection of road and railway bridges [6]. This material was used for construction industry. The intensive gravel mining (continued until 2000) resulted in the upstream channel incision and extension of a knick point zone located on the system of cross-valley faults. Termination of gravel-mining activity together with the river response to the occurrence of 5- to 10-year floods in 1993-2003 led to increasing bank erosion, avulsion and chute cutoffs occurrence and lateral and vertical accretion.

Nowadays gravel extraction on the Belá River is related with stabilizing works after flood event (5-7 years RI) during summer 2018. Realization of this works were declared according the second and third degree of flood activity in the Belá River catchment and were aimed to protection of private property and citizens' lives. However, according to official documents the main reason was channel overflow what endanger the road operation. These works was aimed to removing of the gravel bar accumulation (46 600 m³ planned in total), moving of the river sediment (24 000 m³ planned in total) and redirection of the channel course (Fig. 2). Practically, along the river length the specific morphological processes typical for the multi-thread Belá River were suppressed to minimum. Individual terrain reconnaissance in August 2018 reveals that total channel improvement overgrew the range of planned works and the channel and bed armouring was destroyed by the operation of heavy mechanisms. On the several river reaches we registered an artificial development of the new channel shape (wide "U") with concentrated water course within shallow low

flow channel and isolated floodplain from the active channels due to 2 m high new artificial banks. This type of river regulation including gravel extraction and gravel replacement were also occurred on the river reaches where the residential area is missing and there was no threat to property rights and lives.



Fig. 2. River gravel bed degradation after illegal gravel activity on Slovakians rivers.

Topľa and Ondava River –floodplain and in-channel gravel extraction

The Ondava River and the Topľa River represent similar situation on the Eastern part of Slovakia. Here, gravel extraction was analysed based on gravel pits mapping on aerial Figs from 1949 to 2009. The new gravel-pit company was established between 2013 and 2014, even others gravel-pit companies are situated in the study the Ondava River near Breznica and Stropkov settlements, and near Kurime, Bardejovská Nová Ves and Bardejov settlements respectively. Based on gravel pit area identification, the largest volume of extracted gravels was found in 1981 for both study rivers. On the Ondava River the gravel pit area represented 19,52 ha and on the Topľa River was identified area 23,22 ha of mining pit. The gravel mining during study time span 1949 – 1987was predominantly focused on

floodplain area. Nowadays gravel extraction (2002 – 2009) is concentrating to active channel area where the volume of gravel mining is permitted by the mining license up to 1000 m³ per year for one company. This extracted sediment volume is aimed to restrict the sediment supply to the Domaša water reservoir. Channel bed is formed by gravel fraction (from 2 to 64 mm) with average proportion 84,1 % for the Topľa River and 81,8 % for the Ondava River. Average grain size D₅₀ is for the Topľa 33,09 mm (-5,02 Phi) and 35,23 mm (-5,08 Phi) for the Ondava. In addition to gravel extraction both rivers are lateral dynamic with intensive migration of channel. Erosion protection is ensured by channelization and artificial embankment in areas of settlements but in other section was channel modified and straighten to the original state, gravel materials are pre-load in the form of dikes near active channel without reinforcement (Fig. 3, 4).

We could conclude that gravel mining has significant influence on morphological processes during last study period (after 1987) when the formation of sinuous single-thread river pattern was registered. We can identify a several evolution phases for both rivers. The first one is channel degradation as a reaction of the climatic changes on the end of the Little Ice Age. The second one is riparian forest development (stabilization phase) between 1981 and 1987 supported by low flood activity. Extreme flood events after 2002 as well as gravel mining led to intensive erosion processes (1,9 m bedrock incision on the Ondava River) and new floodplain vertical benches creation. This vertical differentiation on the Topľa River is not so significant. Rinaldi et al. [2] conclude that braided rivers with higher sediment supply are more sensitive to gravel mining than sinuous and meandering river with lower sediment supply.



Fig. 3. River gravel bed degradation after illegal gravel activity on Slovakiens rivers.



Fig. 4. Gravel mining on the Ondava River near the Breznica village (A) and channel destruction by mechanisms (B).

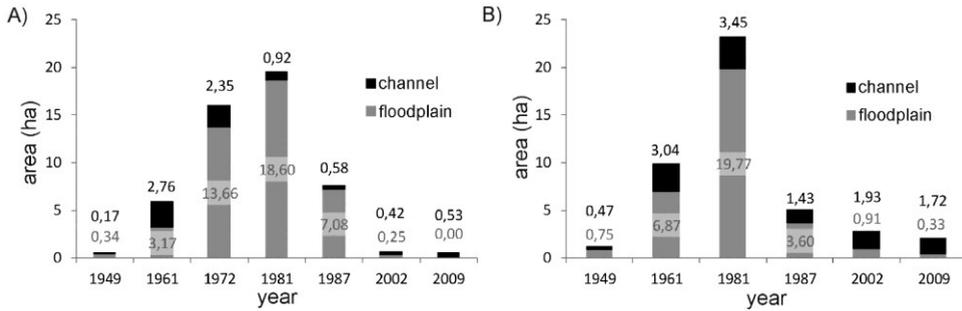


Fig. 5. The gravel pit area identified on the floodplain and active channel for the Ondava River (A) and Topľa River (B) during study time span 1949 – 2009.

The largest volume of gravel extraction, calculated on the basis of the excavation area, took place at both the Ondava River and the Topľa River in 1981, where the gravel pit area represented 19,52 ha on the Ondava River, respectively 23,22 ha on the Topľa River. Their area then decreased dramatically. The largest volume of mining in the study period was on the floodplain area (Fig. 5).

2 Summary

To summarise, the uncontrolled acquisition and mining of bed material, with or without authorities' permission, undoubtedly leads to disastrous consequences for the stream channel and the stream training structures. The stream channel is deprived of its natural protection – bed armouring. Banks of such a stream channel are scoured over a long distance and far upstream from the place where the bed material was taken out. Money spent by local authorities on stream training is wasted and stream flood protection damaged. People who have experienced the disaster caused by floods in the region of the stream basin, where the gravel is exploited on a mass scale, could not only have other elements of infrastructure built but could also avoid the total destruction of their belongings during smaller floods. An additional aspect of the uncontrolled acquisition of gravel from stream bed is the destruction of the biological life of streams; stream bed invertebrates are killed, which results in a significant decrease in the fish population.

In addition to the description of the mechanism of gravel and boulder removal from mountain streams, it is important to propose some kind of remedy for the existing situation. Should the excavation of gravel from stream be prohibited? Is it sensible, in the current economic circumstances and almost a complete sense of impunity, to Fight the uncontrolled excavation of stream bed material? We think that thorough education of villagers about the problems discussed earlier is needed. Village inhabitants should be aware of the threats that are caused by taking gravel from streams. If there are permits to take gravel introduced, they should be issued by specialists and should state the amount of gravel that can be dug out. Furthermore, the gravel should be taken under the supervision of guards or representatives of institutions which would issue such permits. Certainly, the whole procedure would be cheaper than the annual repair of stream revetments. Experts,

preferably coming from outside of the region, must state where this gravel can be taken from and whether it should be taken at all. We think that this is possible, for example, upstream/downstream of debris dams or storage reservoirs. Somebody should perform a thorough calculation of what is more beneficial: repair of damaged stream channels, constant repair of revetments and bridge abutments, Fighting with the effects of small floods; help in aggregate acquisition and delivering it to people so that they can build their houses. All measures taken should absolutely have the same purpose – to make people aware that they harm themselves when they damage stream beds and, as a consequence, they should refrain from uncontrolled excavation of gravel from mountain streams. Overall, the constructive dialog and cooperation between experts and authorities directly responsible for flood-protection works, sediment balance, channelization, etc. offers new challenges how to address the key issues for improvement sustainability of the river management. Recommendation for the river management relates to restriction of illegal gravel mining from the active channel area which accelerate new local erosive bases with migration potential in upstream direction (backward erosion). Water and streams are the most valuable gift that nature has bestowed upon us, but if we disrespect them, they may prove to be our worst enemy.

3 Final remarks

On the 2nd August 2001, a few days after the tragic flood of Maków Podhalański, dumper trucks took 40 tonnes of gravel and boulders from the Czatożanka stream in Zawoja, just upstream of a bridge in Małe Widły. Such activities leave huge sections of banks removed measuring even up to twenty metres. This leaves us with the awareness that there might be further breaks in the stream banks upstream and that this may pose a threat to nearby buildings along the Czatożanka stream. The Czatożanka stream channel may become deeper and deeper may be by one millimetre, maybe by half a millimetre. Some people may say that this is not much, but in 50 years' time, it could be another metre.

The multi temporal analyses on the Belá River proved that the active river zone area decreased from 2,5 km² with average channel width 108,1 m in 1949 to 1,4 km² with average channel width 60,8 m in 2009 due to changed environmental condition (decreased recurrence interval of floods, land use and land cover in catchment, anthropogenic influences) [7, 8]. The last study period (2009) was specific by stabilization of central bars and their transformation to islands what affected the overall simplification trend of the Belá River pattern from braided to transitional wandering-braided one [8, 9, 10]. Lately gravel mining and river sediment replacing definitely support this trend in time when the opposite nature-based management approaches and challenges (channel renaturalization of the rare and unique river system in Slovakia - NATURA 2000, protected area) are the most desirable [7, 11, 12, 13, 14]. Similar development on the east Slovak the river Ondava and the Topľa with decrease channel width from 87.6m to 32.6m and from 62.1m to 27.2m confirms the necessity to protect so vulnerable natural elements [15, 16, 17, 18]. Responsible river management with protection from gravel mining and green approaches to reduction flood risk are essential for sustainable development of natural active channels.

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Large Boulders help shape huge canyons, researchers find

 colorado.edu/asmagazine/2019/06/04/large-boulders-help-shape-huge-canyons-researchers-find

June 4, 2019

By [Clay Bonnyman Evans](#) • Published: June 4, 2019

CU Boulder geology grad students show how boulders influence canyon formation

Anyone who enjoys whitewater rafting in places like the Colorado River owes a debt of gratitude to the enormous boulders that create the foaming undulation known as rapids, and new research appears to shed more light on how these big rocks help shape the towering canyons around them.



CU Boulder researcher Charles M. Shobe

Charles M. Shobe and Rachel C. Glade, geology graduate students at the University of Colorado Boulder, argue in an article recently published online in the prestigious journal *Geology*—and scheduled for publication in print in July 2019—those same rocky monoliths play a major role in the geologic evolution of such canyons across vast spans of time—perhaps even more than the channels themselves.

“Our results imply that the existing, channel-driven models for canyon evolution may be overly simplistic, even when canyons evolve under a steady external forcing,” they write.

“People have been interested in river canyons for a long time, how they control the landscape and erosion,” says Glade, whose research focuses on the geomorphology of canyon walls and who completed her PhD last month. “But there is not a lot of understanding about how they work physically.”

The paper is co-authored by the pair’s faculty advisors, Distinguished Professor of Geology Robert Anderson and Professor of Geology Greg Tucker.



CU Boulder researcher Rachel C. Glade

Shobe and Glade created a computer model to understand the complex, two-way interplay between river-bottom boulders and hillsides to determine the course of canyon evolution.

Rivers that flow through “soft” geological formations tend to be wide and flat, like the Mississippi or South Platte. But rivers that flow across “resistant rock formations”—those with hard “caprock” in the upper layers—tend to form narrow canyons with steep upper hillsides. From a bird's eye view, canyon rims—the cliffs marking the canyon edge—form a bell shape as the canyon widens downstream.

Initially, erosion will carry sediment downstream, eventually loosening large blocks that tumble into the river below. At first, the presence of such blocks tends to slow the process of erosion, which in turn makes hillsides less steep.

“You can see that the bigger the blocks are, the more pronounced the bell shape of the canyon,” Glade says. “The big blocks slow down a canyon’s ability to erode over time and play a major role in changing canyon shape.”

However, Shobe and Glade’s model showed that rather than simply slowing down the process, the presence of large boulders in the channel created a feedback loop with steep hillsides, resulting in an oscillating rate of erosion and canyon evolution.

“This interplay between channel and hillslope dynamics results in highly variable long-term erosion rates,” they write.

While they can definitely move in large floods, when they are big enough, they can sit there for hundreds to thousands of years. That’s why the size of boulders is so important in shaping rivers.

“The prediction is, if intrinsic features of rock layers govern eventual shape, then the larger pieces the rock fractures into”—generally speaking, the harder the rock, the larger the block —“the more bell-shaped the canyon is going to end up and the more unpredictable the erosion dynamics will be,” Shobe says.

This spring, the pair were given an opportunity to field-test the model’s predictions, courtesy of a grant from the Geological Society of America. They traveled to northern New Mexico where they used a drone to photograph canyon walls and boulders in Rio Grande, and are now in the process of creating a 3D map of the area surveyed.

They are testing one of their main model predictions: “The size of the boulders corresponds to the steepness of the canyon walls,” Glade says. “If there’s a pile of big boulders, the steeper the walls should be.”

The model allows for the movement of blocks downstream at times of higher flow, but the researchers found erosion marks in the field indicating that boulders have been wedged in place for a long time.

“While they can definitely move in large floods, when they are big enough, they can sit there for hundreds to thousands of years,” Shobe says. “That’s why the size of boulders is so important in shaping rivers.”

Shobe and Glade write that these “channel-hillslope dynamics” are significant enough to outweigh other factors, such as the rate of geologic uplift, “calling into question the ability of landscapes to record tectonic and climatic signals or to reach a steady state during this time.

Better understanding how canyons with resistant rock formations are formed has implications beyond geology, Shobe says.

“The erosion and breakdown of rock is intimately connected with the climate cycle and the balance of CO₂ in the earth’s atmosphere. The rates at which rock is eroded, and sediment is transported, is tied to the climate cycle as well as the long-term evolution of biodiversity,” he says.

It is uncommon for two PhD candidates to publish ground-breaking new research in a prestigious journal.

“We’re really pleased,” Shobe says. “This collaboration shows that two grad students can get together and come up with something new and unique while learning to collaborate as early-career scientists.”

From glacial landslides to the secrets of beaver dams, world’s top geoscientists present latest science...

International Journal of Scientific Research and Reviews

Environmental Impact of River Bed Mining- A Review

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ABSTRACT

The River plays a most important role in the terrestrial and aquatic ecosystem. Rivers are under immense pressure due to the various kinds of natural and anthropogenic activities among which indiscriminate extraction of construction grade sand and stones, are the major factor. River Bed Mining is the major activity occurring in all over the world for constructing the buildings, urbanization, roads and industries. The demand for the river bed materials increasing day by day due to manmade activities which may led the major environmental effects in and around terrestrial as well as aquatic ecosystem. For the development purposes the natural resources like river bed material (Sand, gravel, Cobbles and boulder) are the major raw material. The development of the country is mainly focused on the growth of urbanization and indusrtization of that country. The increasing demand of river bed materials, the illegal mining (sand mafia) and mining in the agricultural field, floodplain area are increase and its effect the health, physical process and different function of rivers, degradation of the riparian zone, degradation of aquatic and terrestrial biodiversity. There are many environmental effects are generated due to the unscientific and up hazard river bed mining. The present review paper deals with the environmental effects of indiscriminate River Bed Mining from the catchments basin of the river.

KEYWORDS: River bed mining, Environmental impacts, Review

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INTRODUCTION

The most important life nourishing systems of nature are a freshwater ecosystem, in which rivers are important and play a major role in the terrestrial and aquatic ecosystem. It transfers the water and minerals from the terrestrial environment to ocean realm^{1, 2}. In India, there are many perennial, annual and seasonal rivers which provide a large amount of natural resources like Sand, Gravel, and Boulder. These materials are beneficial for the development of a country in way of urbanization and industries. River bed mining is the process of removal of sand, gravel and boulders from the river. The name of this raw material is based upon their size like if the size of material >256 mm then it is categorized as boulders and size varies between 64-256 mm Cobbles, Gravel/ Pebbles size varies between (2-64 mm) are divided into 5 types because of their Different Sizes, if size varies between 32-64 mm very coarse gravel, 16-32 mm coarse gravel, 8-16 mm medium gravel, 4-8 mm fine gravel, 2-4 mm very fine gravel³. Sand is a movable, non-cohesive granular material whose size varies between 0.063 mm and 2 mm⁴. Sand also divided into 4 types because of the different size, very coarse sand (1-2 mm), coarse sand (0.5-1 mm), medium sand (0.25-0.5 mm), fine sand (125-250 μm), and very fine sand (62.5-125 μm) respectively³. The term sand is used to cover almost any rock or mineral, but technically it is limited to quartz sand with a minor impurity of mica, iron oxides and feldspar⁵. Sand and gravel occur as sedimentary beds, lenses and pockets lying on or close to the surface or inter-bedded with other sedimentary formations. They take place in the river channel and floodplain deposits, fluvial glacial deposits, seashore deposits, windblown deposits along and near water bodies, marine and freshwater sedimentary beds and desert sand dune⁶. The sand acts as a buffer against strong tidal waves and storm surges by reducing their impact as they reach the shore and it also a habitat for crustacean species and other related marine organisms. Sand is a vital part of beach attractions and hence, is important for the tourism industry⁷.

The river bed mining practice is becoming an environmental issue as the demand for sand and gravel increases in industry and construction⁶. However, an increase in population and the rise in industrial and economic developments during the past few decades have aggravated mining of river sand many folds higher than natural replenishments which really made a host of damages to river ecosystems in the world. Individuals and private companies are increasingly demanding sand for construction purposes and this has placed immense pressure on sand and gravel resources⁷. With the increase in the demand of the river bed materials resulted in illegal mining of river materials like sand, gravel and boulder from rivers and in some regions, the river sand mafia came up to dominate the region. The demand for the stone aggregates also has resulted in illegal mining of stones which resulted in deforestation and soil erosion problems⁸. Sand is mined from beaches and inland dunes

and dredged from river beds and ocean beds. The unplanned housing schemes and uncontrolled mining of river bed materials paved way for the destruction of rivers. Exploiting the natural resources for the growing needs and all atrocious and fatal to the very life of humans and other organisms on the globe. Today, the illegal river bed materials miners engage modern machinery in mining sand, which it is against the principles of mining, and destroy the resources at an alarming speed. Of course, there are environmental laws to check the adverse impact of sand and gravel mining and the like on the environment and the social life in India⁹.

Unscientific and haphazard river bed mining, in many of the occasions, lead to severe environmental problems like the degradation of the aquatic habitat of river ecosystem that need immediate attention and corrective measures. As the environmental impact of river minerals (sand, gravel and boulder) extraction becomes increasingly well understood in recent years, the practice has received increased scrutiny. The rivers that are harvested at rates in excess of natural replenishments often undergo channel degradation, causing incision of the entire river system including its tributaries. Striking cases of excessive sand and/or sediment removal are summarized by many researchers^{10, 11, 12}.

SCENARIO OF RIVERBED MINING AROUND THE WORLD

The riverbed mining activity is done in whole the world to construct the buildings, roads and urbanization. The river bed material like sand, gravel, Stone and Boulder are present in all the world rivers. The mining of these material legal and illegal, occurring because these materials are high economic value in all over the world. In the world, total 47 to 59 billion tonnes of material is extracted every year, in which river bed materials (sand, gravel and boulder) share the largest part (68% to 85%) of extracted materials. The mining activity of these materials shows the many environmental effects like air pollution, water pollution, soil pollution, noise pollution, threats to biodiversity (terrestrial and aquatic) and some socioeconomic impacts. Some researcher on all over the world studies the environmental effects created by the riverbed mining activity^{10, 11, 12, 13, 14, 15, 7}.

In all the world, the different methods like (Manually and mechanically) is used to collect this material from the natural sources (Rivers, Lake, Floodplain area, Agricultural Field). The removal of material by manual process does not show a high environmental effect in comparison to the mechanically like Joseph Cyril Bamford (JCB) tractors are used to collect the material from the river in large scale. In all over the world, many researchers show the different types of environmental effect by the extraction of river bed mining on sea shore, floodplain area, rivers, lake, agricultural field, forest area. The details of the research are given below **Table 1**.

SCENARIO OF RIVERBED MINING IN INDIA:

India is the developing country and it is the 2nd largest populated country in the world. The infrastructure, industries and urbanization are the main key points for a development/ developing country. The main raw materials for construction of these key points are natural material like sand, gravel and boulders which are obtained by the rivers viz. Perennial, seasonal, and annual. India is the mega biodiversity country and in all the states of India, there are many rivers which provide these raw materials in large amount. The perennial river, in the northern region of India, the major rivers are: Indus, Ganga River, Yamuna River, Beas River, Jhelum, Satluj, Ravi, and Chenab provide a large amount of raw material. In central India, the major rivers are the Narmada, Tapi, Son, Indravati, Mahanadi, Waingangā, Betwa, Parbati, Chambal river and in south India the major rivers are Krishna, Periyar, Godavari, Bhima, Tungabhadra, Pennar, Palar, Ponnalyar, Kollidam, and Kaveri River provide the sand and gravel in the large amount for constructing the urbanization and industries for developing the country^{8,9,16,17}.

The rapid growths of the population across all states of India are affecting the all natural resources in which sand and gravel included. The unscientific mining of these materials shows the many environmental effects in and around the river ecosystem⁶. Some studies are showing the environmental effect due to the mining activities in across India. **Table 2** shows the description of rivers in which mining activities are going and which type of material was provided by the river.

EFFECTS OF RIVER BED MINING ACTIVITY IN AND AROUND THE RIVER ECOSYSTEM:

1. *Effect on River Morphology*

River morphology means the shapes and direction of river channels. The river channel morphology is a combination of many processes and environmental condition in which erodibility and composition of the bed and banks viz. Sand, stone, boulder; erosion by natural and anthropogenic activity, affect the formation of the river path¹⁸.

Some anthropogenic activity like mining of riverbed materials (sand, gravel, stone and boulder) within a river channel causes the erosion and degradation of the river bank. The major effect of river morphology by the riverbed Mining activity is given by many others^{19, 20}.¹⁰ follows ***Upstream incision:*** the head cutting of the river system for many kilometers by the mining process in the slope of the channel bed stream. The upstream incision causes the lowering of bed material of the main channel also lower the bed material of tributaries, by increasing their slope and causes their rapid erosion. ***Downstream incision:*** The downstream

incision occurs when the sediment mining is excessive and prolonged in river or stream. The excessive mining of sediments in downstream disturbs the sediment transport and it shows the sediment deficit in the downstream. **Lateral channel instability:** the mining activity shows the channel instability, bank erosion, changing in channel width. **Bed armoring:** the excessive instream mining shows the sediment deficit leads to washing of finer grains from bed material and it developed the bed armor. **Effects of gravel bar skimming:** The changes in the continuity of sediment transport induce downstream incision and lateral it shows instability of the channel. It removes the coarser surface layer of sediment that occurs in many natural rivers, favoring bed erosion and increasing bed load transport^{10, 52}.

2. **Effect on Water Quality:**

Rivers are the major sources of fresh water ecosystem. The rivers also recharge the groundwater of an area continuously. The quality of water ecosystem (Surface and groundwater) was disturbed due to the riverbed mining activity. **Effect on Surface-water Quality:** The riverbed mining effect on the surface water quality of a river due to the removal of materials in the bed of the river. The major effect of mining activity on the surface water of any river is turbidity level, TDS Concentration and conductivity of water had been increased due to the mining. Murray et al., studied some toxic elements like Arsenic, Selenium and zinc in river water are found in high levels after the mining operation^{13, 14}. **Effect on ground water Quality:** The river bed mining causes the depletion of ground water by lowering the water table and its effect the process of groundwater recharge²¹.

3. **Effect on Aquatic Biodiversity:**

Rivers are the habitat of many Aquatic animals, it covers the major portion of fresh water animal's phytoplankton, Zooplankton, Benthos and fishes. The bed material like Sand, stone and boulder are the Habitat of these animals. The riverbed mining activity affects these animals by removing of the sand, boulder and stones from the river. The turbidity of water affects the Phytoplankton and zooplankton. The Benthos are found on the lower side of stones and boulder, by removing the stones and boulder the habitat of benthos destroyed and its effect the population of the benthos in a river system. The riverbed mining activities affect the reproduction and characteristics of spawning nests of fish like salmon and trout¹⁵.

4. **Effect on Riparian Biodiversity**

Riparian biodiversity includes vegetation cover on and near the river banks, which is very beneficial to control the bank erosion and provide the nutrients for the aquatic biodiversity. The mining activity instream and floodplain area of a river destroy the riparian

vegetation of the river and it shows the bank erosion¹⁶. The effect of riparian flora is due to the transportation of the River bed material from the river, floodplain mining and illegal mining near the bank of river. The riparian flora diversity is the interaction zone between the terrestrial and aquatic life. They provide food and other nutrients to aquatic animals, which is beneficial for the growth and development of the aquatic life. But due to the floodplain mining and illegal mining, the riparian floras of the rivers are destroyed like see in **Figure 1**. The degradation of riparian zone is caused by the need to create the space for stockpiles and haul roads. These haul roads created by the vehicle wheels and they formed the bare tracks. In rainy season, when water flows these tracks in continuous flow they causing erosion. After erosion material increase the Sedimentation, Turbidity and deposition of pollutants in the river²².



Figure1. The effect on riparian flora near the bank of River.

5. Effect on Soil and Landscape

Sand and gravel mining activity responsible for shifting of river channel, degradation of river bank land, loss of fertile land, and changing in the landscape area. The high demand of sand and gravel, illegal mining is increase. In some area, the people remove the fertile soil from the agricultural land and after they take out the boulders from the agriculture land^{23, 16,24,8}. The **Figure 2&3** show, how the people remove the fertile soil from the agricultural land for stone and boulder in illegal way. After remove the materials these lands are not use to agricultural purpose because of the remove of fertile soil from the field.



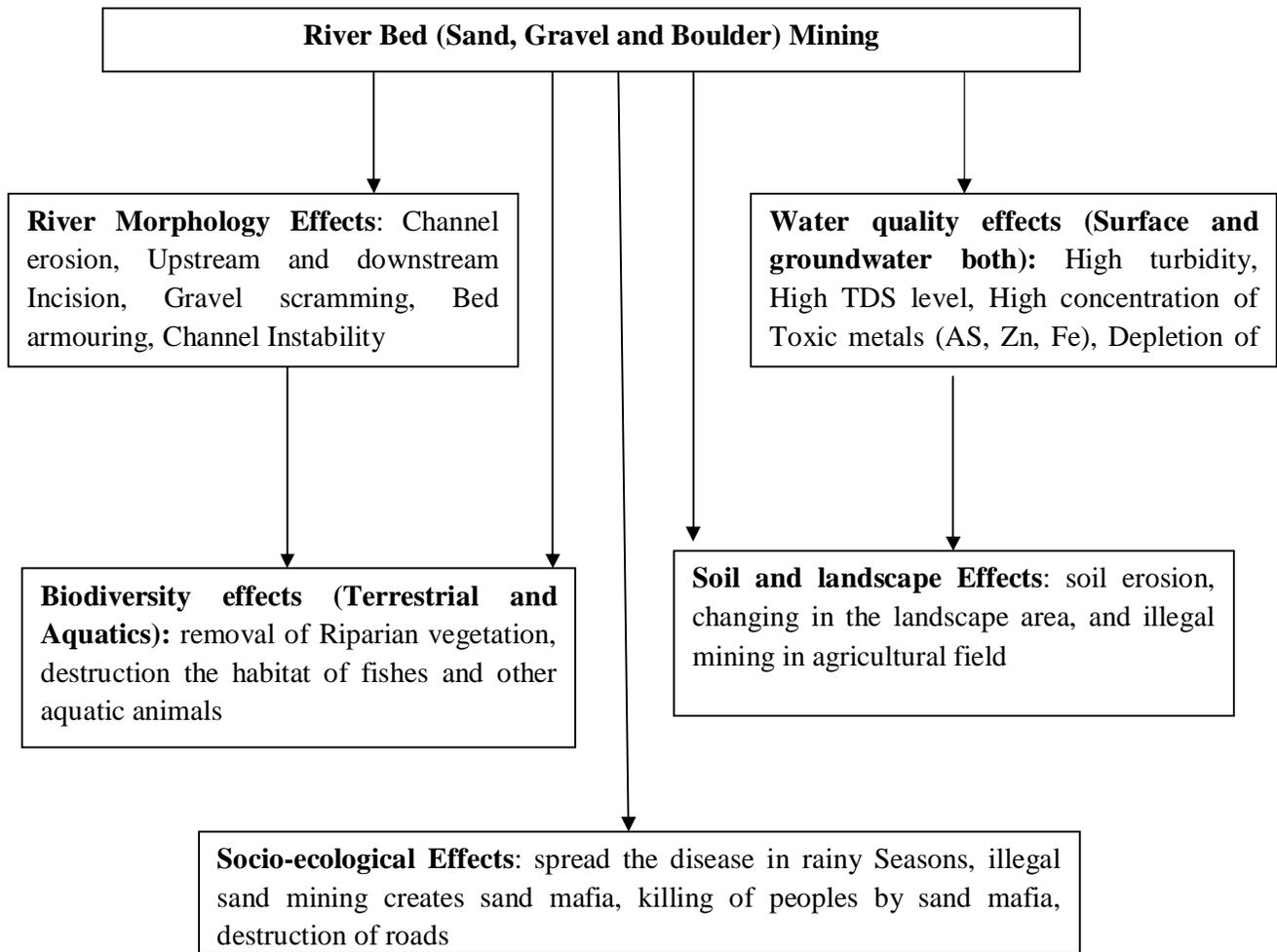
Figure 2. Illegal mining & erosion os sand near the active mining area.



Figure 3. Illegal mining activity in the agricultural field.

6. Socio-Ecological Impacts

There are some studies which show the socio-ecological impacts by the river bed mining activity in the form of loss or reduction of farm lands due to illegal mining, mining pits are the breeding habitat of the mosquitoes in rainy seasons, and spread the many diseases in local environment^{25,26}. A study is conducted on sand mining and its social impact on local society in rural Bangladesh. In this study, they conclude the impact of sand mining and business utilizing it on local society, old people of the area say, the bank erosion is increase due to the sand mining activity, they lose their houses, agricultural fields. Total 29 households have transferred their main house from mining area for erosion²⁷.



Flow Chart: The Major Effect of River Bed Mining Activity on Different Environment Variables

GUIDELINES OF RIVER BED MINING (SAND MINING)

The sand mining process is held on all over the world for construction the roads, buildings, urbanization etc. For the high demand for these raw materials, create the many problems for the environment and our society. There are a different source of river bed materials, in which rivers are the most important source. The increasing demand for these materials, it effects on health, physical process and different function of the river. The extraction of river bed materials (sand, gravel and boulder) from river bodies has to be regulated and done with the adoption of required environment safeguards. In view of the scenario of all the country has prepared the sustainable sand mining management guidelines. These guidelines are focused on preparation of the district survey report, Marine Sand Mining and its impact on Biodiversity of Marine, Management plan, issue and management of mining in cluster, mining in agricultural field, management of sand deposited after flood on agricultural field of farmer, monitoring system for sustainable sand mining information

technology system, creation of district level environmental impact assessment authority, district level expert appraisal committee for granting the environmental clearance for mining of minor minerals, exemption of certain cases for environment clearance and standard environment condition for sustainable river bed mining⁷.

MAJOR OBJECTIVES OF THE GUIDELINES FOR SAND MINING ACCORDING TO MOEF, 2016 (INDIA) ARE FOLLOWS

- To ensure the River bed mining is done in environmentally sustainable and socially responsible manner.
- To ensure availability of adequate quantity of aggregate in a sustainable manner.
- To improve the effectiveness of monitoring of mining and transportation of mined out material.
- Ensure conservation of the river equilibrium and its natural environment by protection and restoration of the ecological system.
- Avoid aggradations at the downstream reach especially those with hydraulic structures such as jetties, water intakes etc.
- Ensure that the rivers are protected from bank and bed erosion beyond its stable profile.
- No obstruction to the river flow, water transport and restoring the riparian rights and instream habitats.
- Avoid pollution of river water leading to water quality deterioration.
- To prevent depletion of ground water reserves due to excessive draining out of ground water.
- To prevent ground water pollution by prohibiting sand mining on fissures where it works as a filter prior to ground water recharge.
- To maintain the river equilibrium with the application of sediment transport principles in determining the locations, period and quantity to be extracted.
- Streamlining and simplifying the process for grant of environmental clearance (EC) for sustainable mining⁷.

CONCLUSION AND RECOMMENDATION

The extraction of river bed materials causes the destruction of in and around the area of a river ecosystem. The extraction of riverbed materials shows many effects on different environment variables. The main effect of the river bed extraction is a change in the river morphology (Upstream and Downstream incision, channel erosion etc.). The changing of river morphology shows the flood condition of a river area. The removal of river bed materials causes the water quality of surface and

ground water. High turbidity and TDS value of any surface water decrease the amount of light intensity and this condition disturb the food chain of any aquatic ecosystem because the primary producers (Phytoplankton) does not survive in the high turbid water. In the bottom of the river, stone and boulders are the major habitat of benthos and fish species. They use the bottom for reproduction and to save their larva from the predators. But Mining activity in the bottom of river depletes the habitat of benthos and fishes. Many other effects are soil erosion and land use land change pattern of an area due to illegal mining. The transportation of raw material from the river to stone crusher also shows the destruction of roads, destruction of river bank and also destruction of riparian vegetation. From the above conclusion, it is recommended that large and small-scale mining activity may be allowed after the scientific study of that area. The mining activity is banned near the ecologically sensitive area. Mining activity allowed only those rivers in which Replacement rate of material is high. Mining should be allowed at a safe distance (buffer areas) away from the road/ rail/ building/ river etc. Research and developmental activities should be strengthened for updating resource database, technologies and management. Estimate the resource availability in the local body/region wise and its extraction to be considered in a sustainable and eco- friendly manner. The mining activity should be done in a sustainable way and according to the guidelines of sand mining.

ACKNOWLEDGMENT

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Table 1: Show Different Rivers and Locations Where Riverbed Mining Activities Occurring in The World

S.No.	Country/ Area	Name of River/ Tributaries/ Area	Mining Materials	Effects	References
1.	Victoria (Island Creek)	Goulbern River	Sand, Stone, and Gravel	Upstream Undermined, Destroying Road crossing and Red gum vegetation	²⁸ Carigie, 2012
2.	Western Sydney (Near Chipping Norton)	Georges River	Sand, Stone, and Gravel	Upstream incision, increasing tidal velocities, causing channel erosion	²⁹ Warner <i>et al.</i> , 1997
3.	Bathrust	Fish River	Sand, Stone, and Gravel	Course change through gravel pits	³⁰ Erskine, 1990
4.	Castlereagh	Nepean River	Sand, Stone, and Gravel	Course change through gravel pits	³⁰ Erskine, 1990
5.	Louisiana	Tangipahoa River	Sand, Stone, and Gravel	Bed degradation up to 6 m, increased erosion in downstream, highway bridge failed due to the bed degradation	³¹ Mossa and Marks, 2011
6.	Southern California	Tujunga Wash	Sand, Stone, and Gravel	Bed degradation, three bridges and seven houses were destroyed	³² Scott, 1973; ³³ Bull and Scott, 1974
7.	California	San Benito River, Stony creek	Sand, Stone and Gravel	Channel widening, loss of bridges, bed degradation upto 3 m ,Change in alinghment of stony creek, bridge damage	³⁴ Harvey and Smith, 1998; ³⁵ Kondolf and Swanson, 1993
8.	Washington State	Cowlitz River	Sand, Stone and Gravel	River Avulsion by gravel pit	³⁶ Norman <i>et al.</i> , 1998
9.	Clackamas, Oregon	Clackamas River	Sand, Stone and Gravel	Bed degradation upto 2 m and 500 m upstream of the pit	³⁷ Kondolf <i>et al.</i> , 1996
10.	Oregon	Rogue River	Sand, Stone and Gravel	Bank erosion and loss of power line tower near the river	³⁸ Klingeman, 1998
11.	California	Merced River+	Sand, Stone and Gravel	Changing in river pattern, excavated on floodplain or point bars	³⁷ Kondolf <i>et al.</i> , 1996
12.	Washington, USA	Yakima River	Sand, Stone and Gravel	Threatened an interstate highway, Channel shifted due to gravel p[its	³⁹ Dunne and Leopold, 1978
13.	Spain	Jarama River	Sand, Stone and Gravel	River Straighten due to the diversion of river through Gravel pits	⁴⁰ Uribelarrea <i>et al.</i> , 2003
14.	South America	Pilcomayo River	Sand, Stone and Gravel	Heavy metal contamination in water, sediments and macroinvertebrates	¹⁴ Smolders <i>et al.</i> , 2003
15.	South Africa	Nzhelele Valley, Limpopo province	Sand and Gravel	Land use changes, environment impacts, habitat and aesthetic beauty degradation, river system degradation, floodplain ponding and riparian zone degradation	²² Kori and Mathada, 2012
16.	Bangladesh	Tangil District	Sand Mining	Social impact on local Society	²⁷ Khan and Sugie, 2015
17.	United Kingdom		Mining	Impact on fresh water environment	⁴¹ Younger and Wolkersdorfer, 2004
18.	Northeastern Pennsylvania and	Susquehanna River	Coal mining	Impact on microinvertebrates on different river ecosystem	⁴² Bruns, 2005

	Southern new York				
19.	China	Poyang Lake	Sand Mining	Impact on Hydrology and ecosystem services of lake	⁴³ Leeuw <i>et al.</i> , 2010
20.	North central Nigeria	Luku, Minna, Nigar state	Sand mining from Land and soil	Environmental effects due to mining activity on soil and land	²¹ Ako <i>et al.</i> , 20104
21.	Illinois (USA)	Illinois River, Kings River	Gravel mining	Change in morphometry, physical habitat and sediment dynamics	⁴⁴ Brown <i>et al.</i> , 1998
22.	Southern Monterey Bay (U.S.)	Salinas River, Marina and Sand city	Sand Mining	Shoreline erosion in bay of Southern Monterey	⁴⁵ Thornton, 2007
23.	Virginia	Powell River System	Mine drainage	Impact on aquatic biota	⁴⁶ Soucek <i>et al.</i> , 2003
24.	New Jersey, U.S.A.	Offshores of New Jersey	Sand Mining	Disturbance in physical process (Wave, currents, Sediment Transport, disturbance in Aquatic fauna)	⁴⁷ Byrnes <i>et al.</i> , 2004
25.	Canada	McQuesten River	Placer Mining	Disturb the habitat of sensitive fish	⁴⁸ Pentz and Kostaschuk, 1999
26.	Nepal	Tinau River	Riverbed extraction	Higher concentration of nitrate and phosphate, Physic-chemical properties of water	⁴⁹ Dahal <i>et al.</i> , 2012

Table 2: Show the Different Rivers and Locations Where Riverbed Mining Activities Occurring in India

S.No.	State	Name of River/ Tributaries	Area/ City/ Village	Mining Materials	Geography of nearby area (Plane/ Forest/ Agriculture)	References
1	Uttarakhand	Ganga River and its tributaries	Shyampur Kangri (Haridwar)	Sand, Bajri and Boulder	Forest and Agriculture area	⁸ Kamboj <i>et al.</i> , (2012)
3	Haryana	Yamuna river	Narnaul, Gumthala	Sand and Stone Mining	Agriculture area	⁵⁰ Tejpal <i>et al.</i> , (2014)
4	Rajasthan	Banas River, Kantali River	Tonk, SIKAR, Nathdwara,	Sand and bajri Mining		¹⁷ Shekahawat(2013) Report
5	Kerala	Chalakydy, Periyar and Muvattupuzha Rivers, Achankovil, Pamba, Manimala, Meenachil, Vembanad lake, Neyyar River	Kochi, Thiruvananthapuram	Sand mining	Forest and Agriculture area	⁶ Sreebha and Padmalal (2011) ⁹ Padmalal <i>et al.</i> , (2008), ⁵¹ Shaji and Anilkaur (2014)
6	Tamilnadu	Bharathapuzha River	Chennai	Sand Mining		⁹ Padmalal <i>et al.</i> , (2008),
7	Himachal Pradesh	Beas, Sutlej, Ravi, Chenab	Bilaspur, Kangra, Chamba Kinnaur, Kullu, Lahaul-Spiti, Solan, Una, Mandi Hamirpur, Shimla, Sirmour	minor minerals like sand, stone and bajri	Forest area	¹⁶ Singh <i>et al.</i> , (2016)

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GEOLOGY & MINING DEPARTMENT

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The District Officer,
J&K Pollution Control Committee,
Budgam

No:- DMO/Bud/DGM/F-05/2903-2906

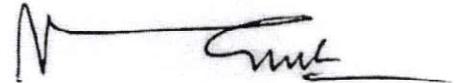
Dated: 27.12.2022

Subject:- Illegal mining in Doodhganga Nallah and penalty thereof.

Sir,

Kindly refer to the subject cited above. In this context, it is to inform that the lease holders of Minor Mineral Block No. 11 (Chadoora old bridge to Hanjigund D/S Doodhganga Nallah) and Block No. 12 (Chadoora Foot Bridge to Sogam Bridge U/S Doodhganga Nallah) have not been found involved in illegal mining within or outside the peripheries of their respective blocks. The fine realized as communicated in the Action Taken Reports furnished from time to time from this office has been collected from tractor/tipper/machine owners found indulged in illegal extraction/transportation of minerals from Doodhganga Nallah. It is worthwhile to place on record that the seized vehicles/machinery as communicated in the above said ATRs are not recorded on the name of Lease Holders of the said Blocks.

Yours faithfully,



District Mineral Officer,
Budgam

Copy to the:

1. Deputy Commissioner, Budgam for favour of information.
2. Director Geology & Mining Department, Jammu for favour of information.
3. Joint Director (K), Geology & Mining Department Srinagar for favour of information.