Practice of Low-Cost River Training Works on the Bank of Mohana River in Kailari Rural Municipality, Nepal

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ABSTRACT

Purpose: *Kailali, the district that lies in the Far-west of Nepal witness the sever flood and the damage caused by it annually. This study helped us to assess the practice and impact of low-cost River training works in Mohana River of Kailari Rural Municipality to prevent flood control.*

Design/Methodology/Approach: *The study was conducted during the period from March 2022 to May 2023. Field observation, in-depth interview, focus group discussion and questionnaire survey were the major tool applied for the investigation.*

Findings/Results: *The major effect related to river encroachment was land inundation. Further, it was seen that the local people preferred the low-cost river protection works done by utilizing local resources such as bamboo. They believe this technology is easy to execute, cheaper and can be constructed quickly during the time of emergency. During study it was also found that there are government and other non-government agencies supporting to these low-cost techniques for riverbank protections.*

Originality/Value: *The study would like to suggest that the low-cost river protection works should be identified by the government at different level and promote these kinds of nature-based technologies that use local resources.*

Paper Type: *Causal-comparative Research*

Keywords: Flood, River training structures, Low-cost, Mega structure, Bamboo, catchment area, bank erosion, encroachment of river.

1. INTRODUCTION :

All designing works developed in a bolt which are expected to direct and affirm the stream to the bolt channel and to manage the waterway bed setup for viable and safe development of floods and stream residue. River training works may have to be carried out for flood protection, to maintain a navigable channel, and last but not least to prevent bank erosion and/or outflanking of a bridge or weir. (UNESCO-IHE, 2013) [1].

Stream preparing works incorporate cross over structures (e.g., crotches, prod barriers, spikes), longitudinal designs (e.g., bank revetments, guide bunds) and structures on the waterway bed (e.g., fixed layers, twist way weirs, actually look at dams). Experienced waterway engineers share some common-sense insight that isn't promptly clear to fledglings or laymen. For example, crotches or spikes pointing downstream draw in streams to the waterway bank as opposed to redirecting them from the bank. Genuinely redirecting or repulsing crotches have an upstream tendency. Another model is that the heaviest fluvial assault on preparing structures for the most part happens around bank full circumstances as opposed to flood conditions (Mosselman, 2006) [2].

Mohana River flowing along the India Nepal trans-boundary in far western Nepal and major tributary of Karnali River is also flood prone river. Mohana river watershed gets its monsoon rainfall from the weather phenomena developed from the Arabian Sea. The table 1 below shows the historical flood events and effected community of Mohana Watershed. Recently, the major rivers Mahakali, Seti and Karnali of western Nepal were flooded due to heavy downpour of rainfall in the month of June in 2013. The monsoon phenomena of Arabian Sea with the strong westerly wind moved to mid and far western

region of Nepal and it caused the heavy monsoon rain. The floods and landslides cause death of several people and damaging huge amount of property [3-6].
In 2008 a weighty precipitation in far western locale impacted the mountain regions with a progression of avalanches and the Terai regions were impacted by floods (Adhikari, 2013) [7]. Every one of the streams beginning from the Churia slopes spilled over with bank full releases, dissolved contiguous agrarian grounds, stored sands and sediment on neighbouring houses, and immersed settlements for quite a long time. The East-West thruway was disintegrated in two-three spots in Kailali and Kanchanpur areas alongside harms to water system projects, transmission lines, and other public and confidential framework.

2. STATEMENT OF PROBLEMS :

The Mohana Waterway is the biggest stream going through provincial district. This isn't a snow-took care of waterway; it starts from the southern slants of the Chure range. In the review region, this is the longest as well as the biggest stream and it is perpetual in its sort. The mean month to month wet season release (August) lies in the reach between 150-1500 m3/s and the mean month to month dry season release (April) ranges between 7-29 m3/s (Thapa, 2016) [8]. During the storm, the stream moves huge stones and free totals. As results, there has been an expansion in the riverbed. In the Kailari Rustic Region, there are very nearly 60 settlements; Though 25 Settlements are alongside Mohana Waterway. Among them, in light of optional source, three settlements were seen as profoundly impacted from the flood. Consequently, four settlements (Khonpur, New Mohanpur, Badka Ratanpur and Lalpur) were the designated in this review.

3. OBJECTIVES :

To assess the practice and impact of low-cost River training works in Mohana River of Kailari Rural Municipality to prevent flood control.

4. METHODOLOGY :

The Primary data are collected by semi structured questionnaires, in-depth interviews, focus group discussion and field observation in Mohana River.
The secondary data related to this study are collected from the published and unpublished official records and the similar studies of Mohana river and books, reports, documents, maps/ drawings, photographs etc. related to the study area.
In this study, primary data as questionnaires is collected among the questionnaires distributed. The respondents are affected area villagers, social worker and concerned authority. Also, professional expert interview is also taken for this study. Focus group discussions were also conducted at along the Mohana River.

4.1 Field Observation:

In this method visiting the alignment and observing the main issued areas is carried out which could be particularly helpful to collect the real data. The affected within the area under consideration is taken for the study. The data of different structural measures collected from related agencies are verified in the field and physical verification of the function of the anti-flood measures in the area under consideration is done to get real picture of the works done in the past.

4.2 Focus Group Discussion:

Discussion with the related community group is conducted and the data is collected according to the structured question. Local users and local public representatives are involved in each FGD based on references [6-10].

4.3 In Depth Interview:

In depth study is conducted with the public representatives of the study area and with the expertise of river training works. Data were collected, verified and analyzed using references [9-15].

4.4 Questionnaire Survey:

In this study, scaled questions are used to get the responses from the representing the involving river training works in Mohana river and other such as Engineer, consultant, contractors, teacher, social worker and policy makers based on references [12, 16, 17, 18, 19, 20, 21].

4.5 Data Analysis

Collected data are grouped and analyzed by frequency analysis using MS- Excel.

Relative Importance Index (RII):

The RII is used to evaluate the ratings of the respondents with Likert 7-point scale [22] as:

$$RII = \Sigma W/AN = (7n\,7 + 6n\,6 + 5n\,5 + 4n\,4 + 3n\,3 + 2n\,2 + 1n\,1)/7N$$

Where,

W the weighting given to each factor by the respondent, ranging from 1 to 7; n7 number of respondents selecting total strongly agree; n6 number of respondents selecting total agree; n5 number of respondents selecting total somewhat agree; n4 number of respondents selecting Neither agree nor disagree; n3 number of respondents selecting somewhat disagree; n2 number of respondents selecting disagree; n1 number of respondents selecting total strongly disagree; and N the total number of respondents. Cost analysis was done based on actual bills.

5. RESULT AND DISCUSSION :

5.1 Institutions Involved in River Training works:

There are two types of institutions involved in River training works. One is the Government body and the other one is the non-government organizations. The Government bodies like Department of Water Induced Disaster Management, Municipality Offices, mainly focus on construction of mega/ heavy budgeted structures. This technology includes construction of heavy spurs, revetment works, and dams. There is Department of Soil and Watershed Management that deals with low-cost river training works as well. The other non-government organizations such as NGOs, INGOs, and Red Cross focus on low-cost type of river training works. These organizations deal with very cheap technologies such as using bamboos, bioengineering, and more nature-based solutions.

5.2 Budgeting and Plans:

Generally, the river training works that are of low cost are done executed without planning and in actual need based or say in emergency conditions.

Whereas in case of high budgeted mega structure, the allocation of budget comes from regular planning at different stages. Periodic plan is made, and budget is allocated for such structures.

5.3 Technical Aspects:

Low costs technologies are practiced during the time of emergency; thus, the technical parameters are not considered as that of the mega structure. This technology requires less skilled human resources and generally done at the time of emergencies or when there is no sufficient budget and the areas of construction to be covered is more. It is done by utilizing local resources and local human resources. Whereas in case of in case of mega structure, this is more technically and planned construction. This requires high technology and specific human resource to execute the works. Only few resources may be locally available, rests need to be imported from other areas or factories made. It is a bit time consuming.

5.4 Practice of Low Cost Embankment Works:

In regard to the practice of the low-cost embankment works, the table 1shows the practice of the low cost river training works done in Mohana river of Kailali district.

Table 1: Details of Structures Constructed in Different Time

Year	Community	Name of the scheme	Length (m)
2011	Lalpur	Construction of Bamboo embankment and bioengineering	300

Year	Community	Name of the scheme	Length (m)
2011	Khonpur	Construction of Bamboo embankment and bioengineering	400
2011	New Mohanpur	Construction of Bamboo embankment and bioengineering	150
2011	Badka Ratanpur		150
2012	Lalpur	Construction of Bamboo embankment and bioengineering	100
2012	Khonpur	Construction of Bamboo embankment and bioengineering	150
2012	New Mohanpur	Construction of Bamboo embankment and bioengineering	250
2012	Badka Ratanpur	Construction of Bamboo embankment and bioengineering	300
2013	Lalpur	Construction of Bamboo embankment and bioengineering	150
2013	Khonpur	Construction of Bamboo embankment and bioengineering	175
2013	New Mohanpur	Construction of Bamboo embankment and bioengineering	200
2013	Badka Ratanpur	Construction of Bamboo embankment and bioengineering	225
2014	Lalpur	Construction of Bamboo embankment and bioengineering	150
2014	Khonpur	Construction of Bamboo embankment and bioengineering	200
2015	New Mohanpur	Construction of Bamboo embankment and bioengineering	300
2015	Badka Ratanpur	Construction of Bamboo embankment and bioengineering	100
2016	Lalpur	Construction of Bamboo embankment and bioengineering	100
2016	Khonpur	Construction of Bamboo embankment and bioengineering	150
2017	New Mohanpur	Construction of Bamboo embankment and bioengineering	180
2017	Badka Ratanpur	Construction of Bamboo embankment and bioengineering	150
2017	Lalpur	Construction of Bamboo embankment and bioengineering	100

Year	Community	Name of the scheme	Length (m)
2018	Khonpur	Construction of Bamboo embankment and bioengineering	300
2018	New Mohanpur	Construction of Bamboo embankment and bioengineering	250
2019	Badka Ratanpur	Construction of Bamboo embankment and bioengineering	350
2019	Lalpur	Construction of Bamboo embankment and bioengineering	100
2019	Khonpur	Construction of Bamboo embankment and bioengineering	100
2020	New Mohanpur	Construction of Bamboo embankment and bioengineering	320
2020	Badka Ratanpur	Construction of Bamboo embankment and bioengineering	240
2020	Lalpur	Construction of Bamboo embankment and bioengineering	200

5.5 Effectiveness of the low-cost river training works:

Budget provided by different agencies for maintenance of low-cost mitigation embankment works Since this technology is cheaper one, the maintenance is easily done with the limited budget. There are many government and non-government agencies which provide financial support for maintenance of the damaged embankment works shown in Table 3.

Table 2: Budgeting Agencies for Maintenance of Low-cost Mitigation Embankment Works

Year of Maintenance	Community	Agencies	Amount	Community Contribution
2011	Lalpur	VDC Office/NRCS	30000	Unskilled labour cost and few bamboos
2011	Khonpur	VDC Office/NRCS	20000	Unskilled labour cost and few bamboos
2011	New Mohanpur	VDC Office/NRCS	15000	Unskilled labour cost and few bamboos
2011	Badka Ratanpur	VDC Office/NRCS	12000	Unskilled labour cost and few bamboos
2012	Lalpur	VDC Office/NRCS/Mercy Corps	17000	Unskilled labour cost and few bamboos
2012	Khonpur	VDC Office/NRCS/Mercy Corps	14000	Unskilled labour cost and few bamboos
2012	New Mohanpur	VDC Office/NRCS/Mercy Corps	25000	Unskilled labour cost and few bamboos

Year of Maintenance	Community	Agencies	Amount	Community Contribution
2012	Badka Ratanpur	Lutheran World Federation	18000	Unskilled labour cost and few bamboos
2013	Lalpur	Mercy Corps	25000	Unskilled labour cost and few bamboos
2013	Khonpur	Lutheran World Federation	45000	Unskilled labour cost and few bamboos
2013	New Mohanpur	Mercy Corps	18000	Unskilled labour cost and few bamboos
2013	Badka Ratanpur	Lutheran World Federation	23000	Unskilled labour cost and few bamboos
2014	Lalpur	FAYA Nepal	15000	Unskilled labour cost and few bamboos
2014	Khonpur	FAYA Nepal	12000	Unskilled labour cost and few bamboos
2015	New Mohanpur	Lutheran World Federation	12000	Unskilled labour cost and few bamboos
2015	Badka Ratanpur	Ward office/Mercy Corps	16000	Unskilled labour cost and few bamboos
2016	Lalpur	Mercy Corps	25000	Unskilled labour cost and few bamboos
2016	Khonpur	Mercy Corps	18000	Unskilled labour cost and few bamboos
2017	New Mohanpur	Ward Office/NRCS	14000	Unskilled labour cost and few bamboos
2017	Badka Ratanpur	NRCS/Mercy Corps	16000	Unskilled labour cost and few bamboos
2017	Lalpur	Mercy Corps	14000	Unskilled labour cost and few bamboos
2018	Khonpur	FAYA Nepal	35000	Unskilled labour cost and few bamboos
2018	New Mohanpur	Ward Office/BASE	17000	Unskilled labour cost and few bamboos
2019	Badka Ratanpur	Mercy Corps/NRCS	28000	Unskilled labour cost and few bamboos
2019	Lalpur	Ward office/Mercy Corps	18000	Unskilled labour cost and few bamboos
2019	Khonpur	Ward office/Mercy Corps	18000	Unskilled labour cost and few bamboos
2020	New Mohanpur	NRCS	18000	Unskilled labour cost and few bamboos
2020	Badka Ratanpur	Ward Office	20000	Unskilled labour cost and few bamboos

Year of Maintenance	Community	Agencies	Amount	Community Contribution
2020	Lalpur	Ward Office	20000	Unskilled labour cost and few bamboos

5.6 Impact of the Low-cost River Embankment Works:

Generally, this technology requires manpower with limited technical knowledge. Thus, the local people are involved in the process and thus they are engaged for certain duration earning their business. Further, the local people can sell their locally produced bamboos for the river protection works and can earn some money to run their daily living. The low-cost embankment works helps to channelize the river. When the river is channelized, the flow of river is confined to a certain confined width. This prevents cutting down of adjoining riverbanks. Due to this, the agricultural lands are also protected.This technology has decreased the dependency of the people on government fund. As majority of the new structure as well as the maintenance are done by the local people by themselves. Further, the technology is so simple that it is rapidly transferred from one community to the other community.

5.7 Major Problem of River Training Works in Mohana River:

There were 12 major problems listed related to river training works in mohana river [6, 9, 15, 18]. However, it was ranked river encroachment as the major one (RII= 0.66) and inadequate people's awareness as the minor one (RII=0.56). All options and their respective values are presented in figure 1.it is seen that river encroachment is one of the major problems. The major disturbances such as land use change, bank erosion, scoring, encroachment, dilution of riparian vegetation, and shifting of the river channel are quite evident along the Mohana River. Due to lack of awareness among people and concerned authorities, such disturbances are unmanageable at present. If the disturbances in the river continue in the current trend, they will aggravate system instability and will bring unrecoverable deterioration to the river environment. Therefore, it is important to identify present environmental condition and major disturbances to rehabilitate the river in the future because many people depend on the water of the Mohana River.

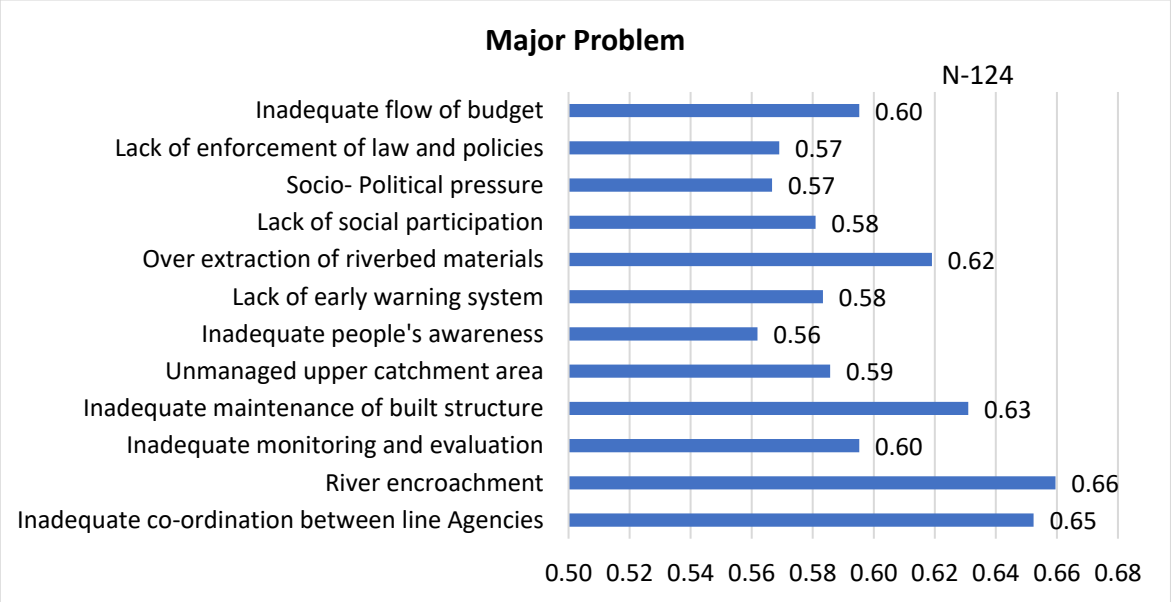

Fig. 1: Respondent Analysis on Major Problem of River Training Works in Mohana River

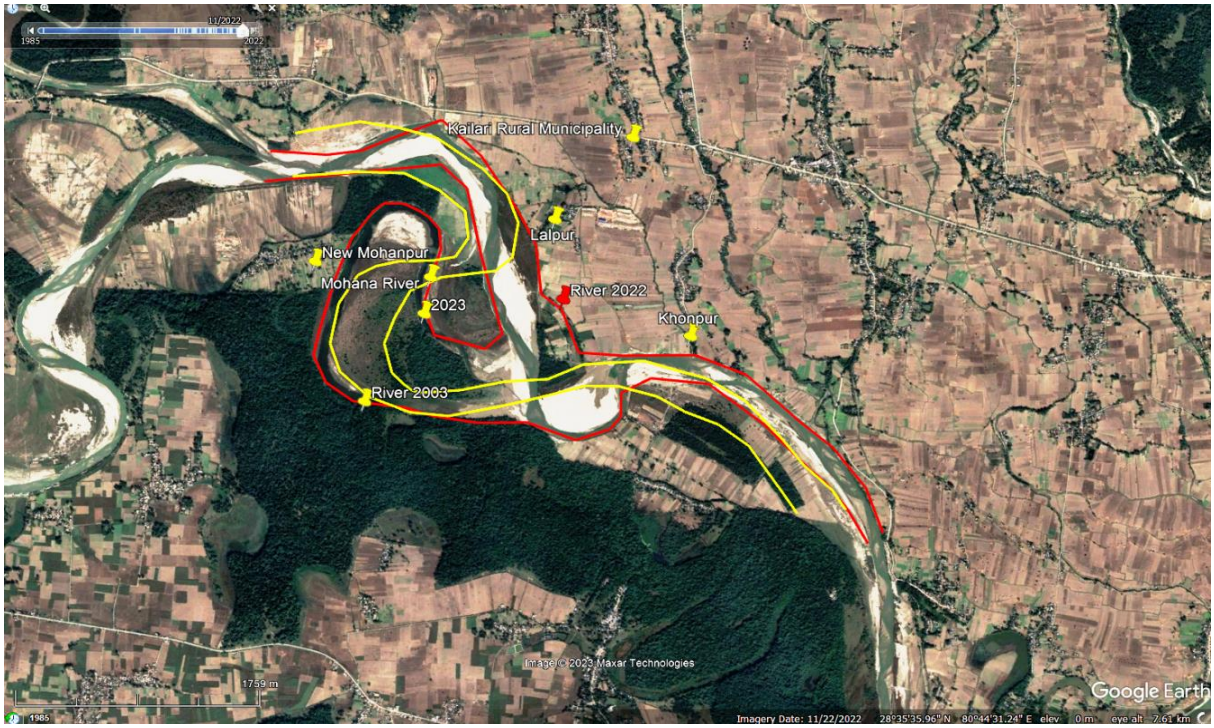

Fig. 2: Satellite image of study area in different time frame

Fig. 3: Mohana River in 2003 and in 2022

Fig. 2 & 3 shows the study are where community and the river Mohana is seen. The satellite image shows the community in different time lie. The yellow is the one showing the flow of river in 2023 and the red one is the flow line in 2022. Very drastic changes are seen. This is the result of unscientific play with riverbanks and river course of flows.

5.7.1 Cause of Inadequate Coordination between Line Agencies:

There were 5 major causes listed related to inadequate co-ordination between line agencies. The respondents responded differently for different causes. However, it was ranked inadequate plan and programs as the major one (RII=.64) and lack of knowledge as the minor one (RII=.56). All options and their respective values are presented in figure 4.

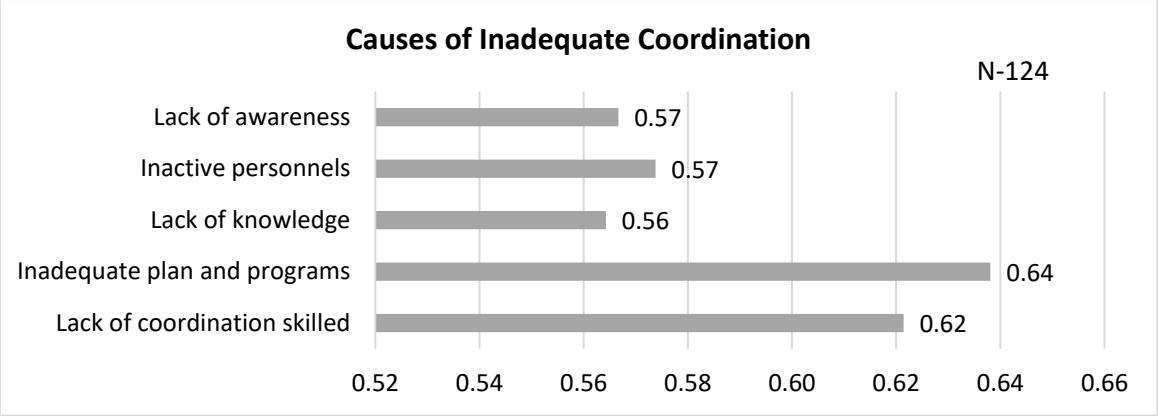

Fig. 4: Causes of Inadequate Coordination between Line Agencies

From KII analysis, it is seen that the there are inadequate plans and programmes. Generally, the one who are at decision making, generally fails in producing effective plans for river trainings. This could be the reason, they are new to the locality and focuses more on other infrastructures such as highway, buildings, or the issues related to the river problem may not be addressed to the level of decision making. Though the nation has entered to federal governance system with three tiers of control unit, there is no clear policies and acts on natural resources. There are still conflicts in different level of government. Along with this, there are insufficient experts in the areas. This is also causing issue at local level as per discussion from KII and FGD.

5.7.2 Causes of River Encroachment:

It was ranked width of river should be fixed as major one (RII=0.75) and lack of management of flood plain area as minor one (RII=61). All options and their respective values are presented in figure 5.

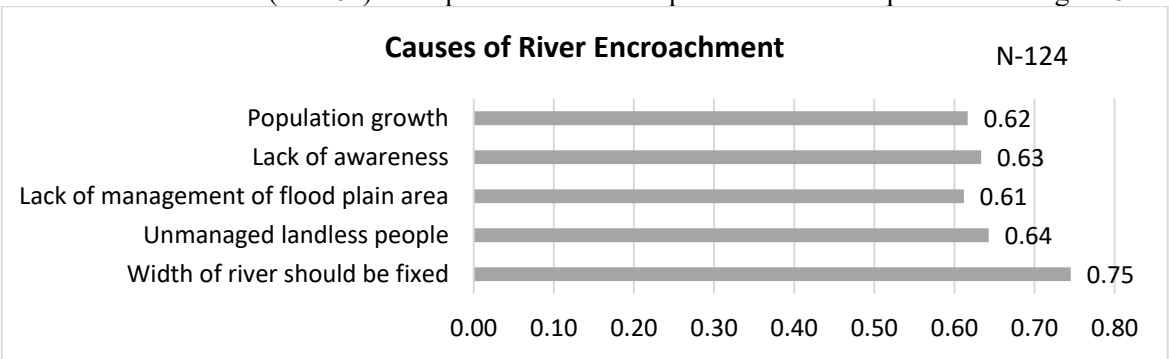

Fig. 5: Causes of River Encroachment

From KII and FGD, it is found that, the public want the river to be channelized. They want both bank of the river to be fixed so that there will not be any riverbank erosion and the river will flow in a defined path and direction. There are two types of relation between river and society. One is self-sustaining where the river is used as per need of the community such as irrigation systems are installed in the natural flow of river and society uses it. The other is self-limit where the river is used without disturbing the natural flow of the river. Other reason as per discussion, it is found that the riverbed materials are excavated haphazardly without following norms of the government. The government allocates certain quantity to be excavated but at field it is different.

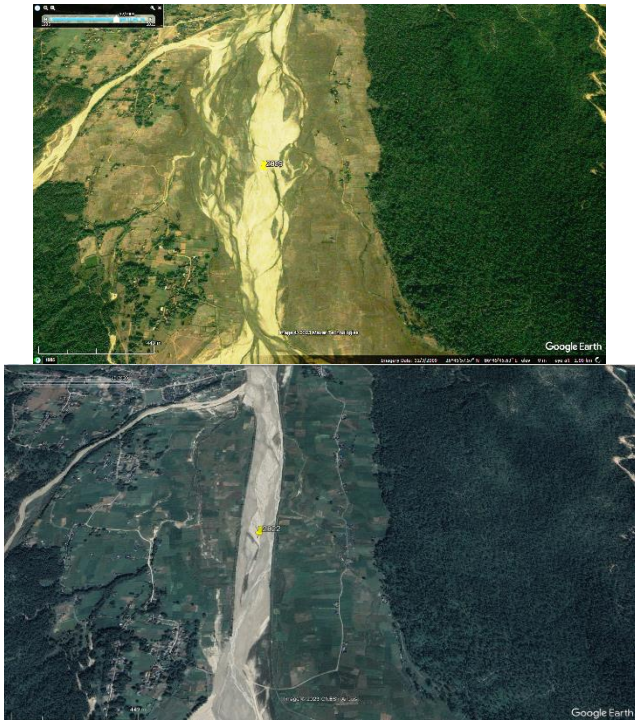

Fig. 6: River Encroachment before (2013) and after (2022) Channelization

Fig 6 shows two satellite images of chure originated rivers. The left is the one from 2013 and the right is one from 2022. It is seen that in the left, there is no channelization done and the river encroachment is easily visible. But in case of the right one, after channelization, the river has maintained its own flow alignment.

5.7.3 Causes of Inadequate Monitoring and Evaluation:

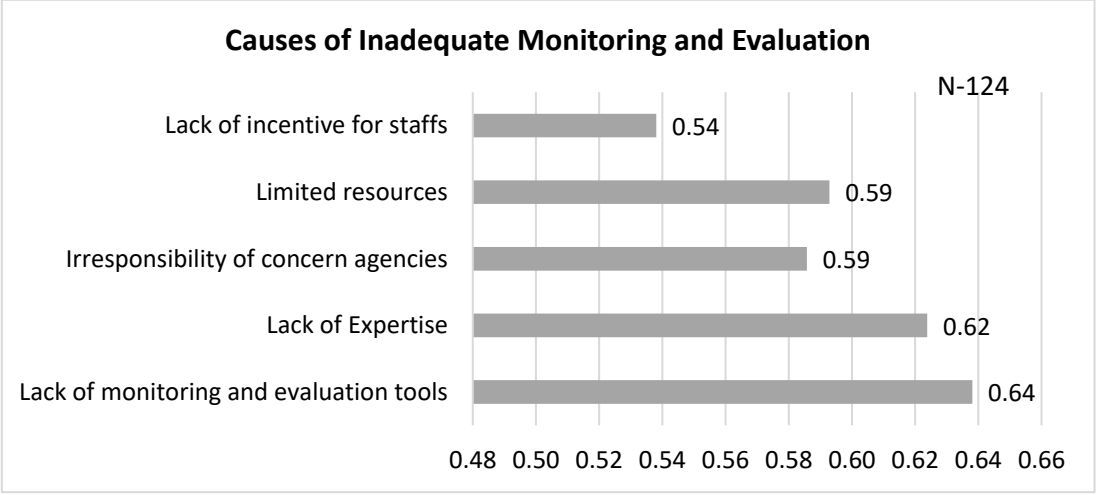

Fig. 7: Causes of inadequate monitoring and evaluation

It was ranked the lack of monitoring and evaluation tools as the major one (RII= 0.64) and lack of incentive for staff as the minor one (RII=0.54). All options and their respective values are presented in figure7. Generally, it is seen that, the low-cost river training works are executed in emergency conditions, and it is executed without proper planning. From KII and FGD it is found that some part of budget is allocated by local level for emergency works. But the planning is not as that of the heavy or mega structures. Other reason it could be that the planning is done for bigger budgeted infrastructures. For this the compulsory quality assurance, monitoring techniques and tools are properly developed. But in case of low cost one, since it is executed at the time of emergency and in quick time, so there is not

practice of monitoring and evaluation tools as that of the mega structure. Local level has not developed any effective monitoring and evaluation tools as that of centrally controlled mechanism responsible for implementation of mega structure as per KII and FGD.

5.7.4 Causes of Inadequate Maintenance of Built Structure:

There were 5 major causes listed related inadequate maintenance of built structure. However, it was ranked the limited budget as the major one (RII= 0.65) and lack of skilled manpower as the minor one (RII=0.57). All options and their respective values are presented in figure 8.

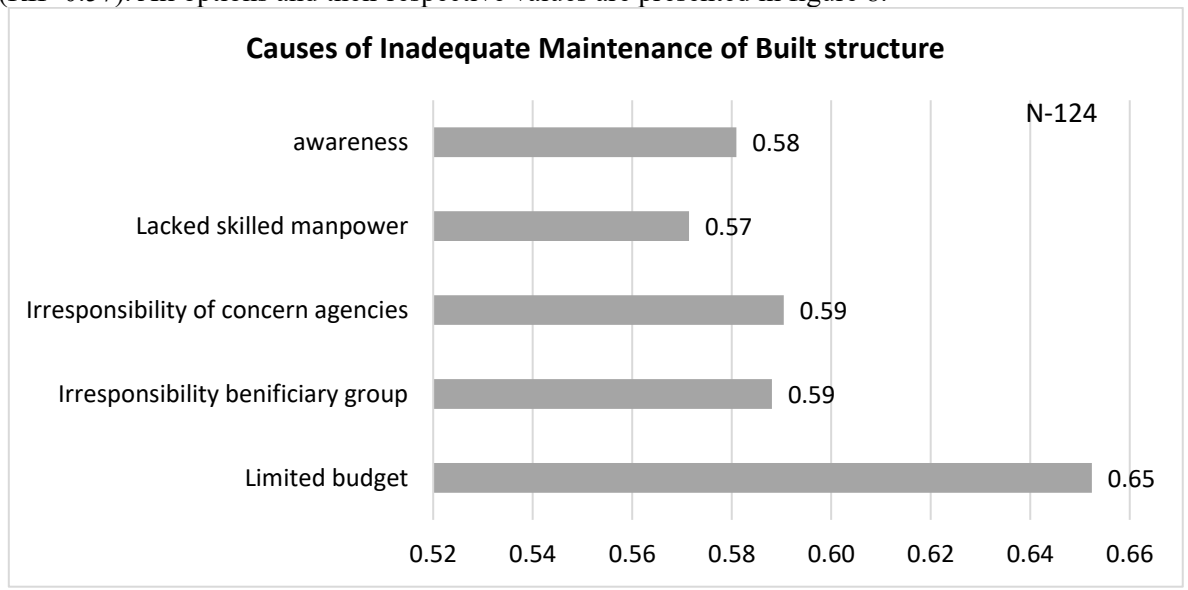

Fig. 8: Causes of inadequate maintenance of built structure

As per KII and FGD, it is found that majority of people believes there is limited budget for maintenance of built structures. Allocation of budget for construction mostly depends upon the influence of political leaders. Generally, the infrastructure that is constructed in the rule of one party, does not get repaired in the rule of other. There is always clash between them. Even the awareness of people is less. The one who is aware believes talking to the authorize agencies for repair and maintenance is just waste of time. They will not listen to us. Further the coordination between the various government agencies is also poor, so the repair and maintenance become the tough business to do. During FGD it was also found that even the mouses are responsible for damage of river training structures. Generally, mouses carry the rice and other food items into the embankments by making holes into them. During flood time, the water enters the holes created by mouses and the embankment collapses. This is also one of the reasons of failure. Solution would be construction of mega structure than reinforcing with more nature-based solutions such as bioengineering and other soft natural protections works.

5.7.5 Causes of Unmanaged Upper Catchment Area:

There were 6 major causes listed related inadequate maintenance of built structure. However, it was ranked deforestation as the major one (RII= 0.71) and lack of awareness of local community as the minor one (RII=0.60). All options and their respective values are presented in figure 8. Here from KII and FGD it is seen that the deforestation in upper Chure range is one of the greatest problems in downstream. There is extensive deforestation and unmanaged forest activities in upper Chure region. Due to this, the loosened materials are carried by the river and deposited to the downstream of the terai causing rapid aggregation of materials causing aggradation of bed level of the river. Because of this, the flood scatters everywhere causing inundation of land, agriculture, and community.

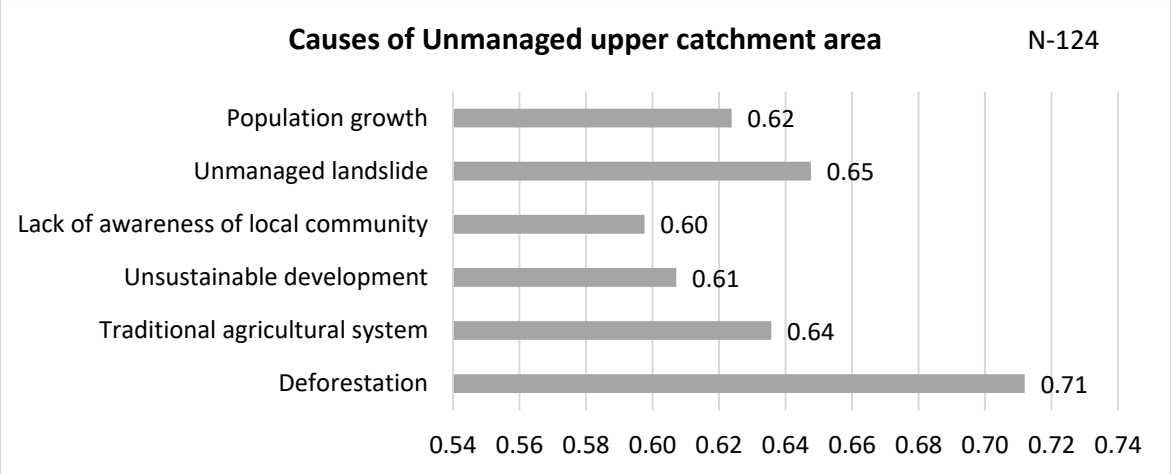

Fig. 9: Causes of Unmanaged upper Catchment Area

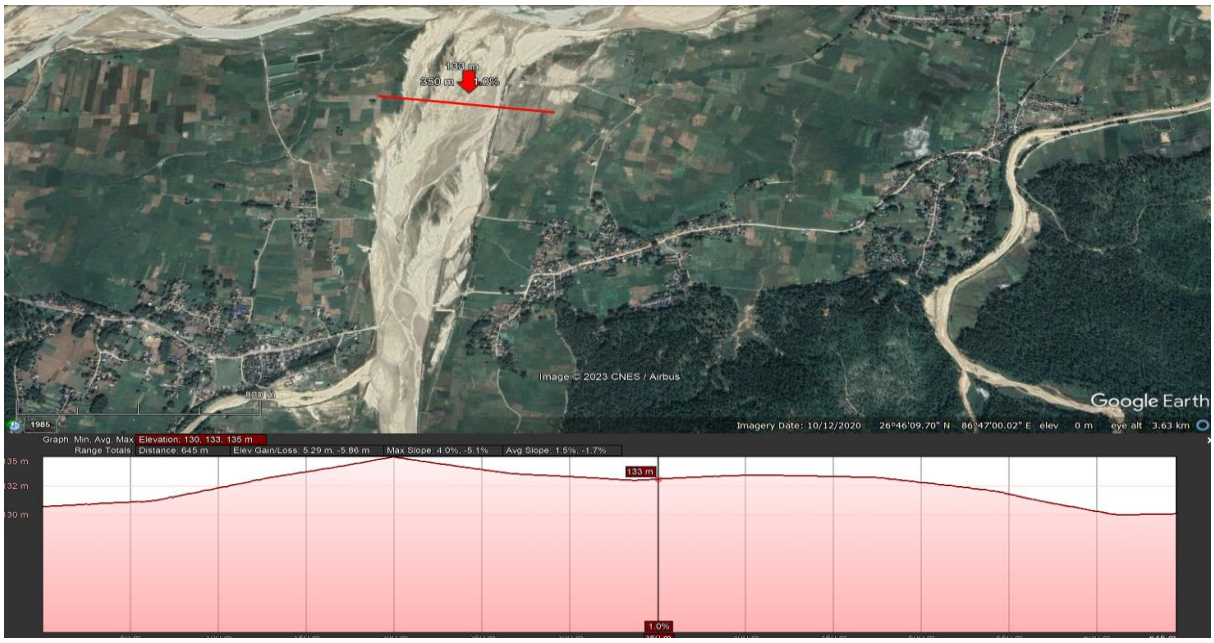

Fig. 10: Section of the River Coming from Chure Range

From fig 10, it seen that the bed of river is far above the adjoined areas. This is because of excessive materials brought down from Chure areas to the lower terai. Though there is Presdent Chure Region Protection Program, but it is also not being implemented seriously. There is much lagging into it.

5.7.6 Causes of Inadequate People's Awareness:

There were 5 major causes listed related lack of inadequate people's awareness. However, it was ranked for lack of co-ordination between concern agencies and people as the major one (RII= 0.65) and lack of budget for awareness program as the minor one (RII=0.60). All options and their respective values are presented in figure 11. From KII it is found that the lack of coordination between concern office and people is the main cause of inadequate awareness of people. Second is the less priority from government. People believe that the dedicated agencies responsible for river protections works do not coordinate with each other and with the community as well. Even the government do not give much priority to them. Now days a culture has developed or say people are habitual of being not aware or even they do not seek the information. In global organization, the researchers are done and the information is taken as per need. There is hierarchy chain of command. Either one is aware or not aware, it works. But in our case, there is Bureaucratic control system.

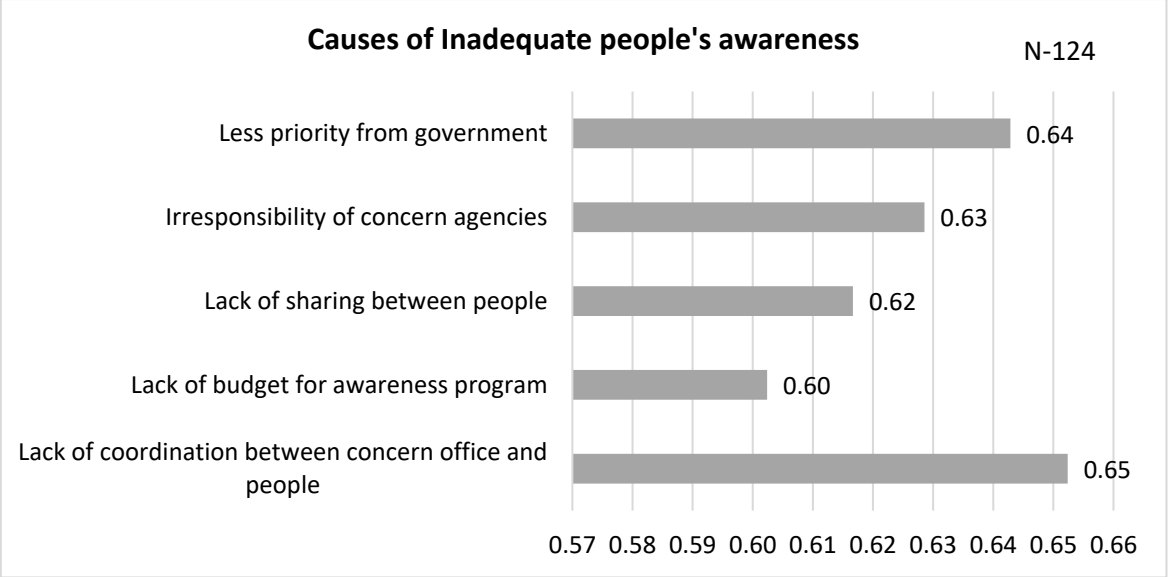

Fig. 11: Causes of Inadequate People's Awareness

Bureaucratic control is the use of formal systems of rules, roles, records, and rewards to influence, monitor, and assess employee performance. But in reality, this is not well practiced, and the people are deprived of the information causing weak in raising awareness.

5.7.7 Causes of Lack of Early Warning System:

It was ranked waiting only DHM data as the major one (RII= 0.7) and inadequate IT officers as the minor one (RII=0.63) in Fig 12. From KII it is seen that waiting only DHM data is the major cause of lack of early warning system. In Nepal, DHM is the only authorized dedicated agency for forecast and sharing information about and early warning system. There are various stages by which the information from the source to DHM and to the community transfers. SO, community people believe the DHM data is only authentic means of early warning system.

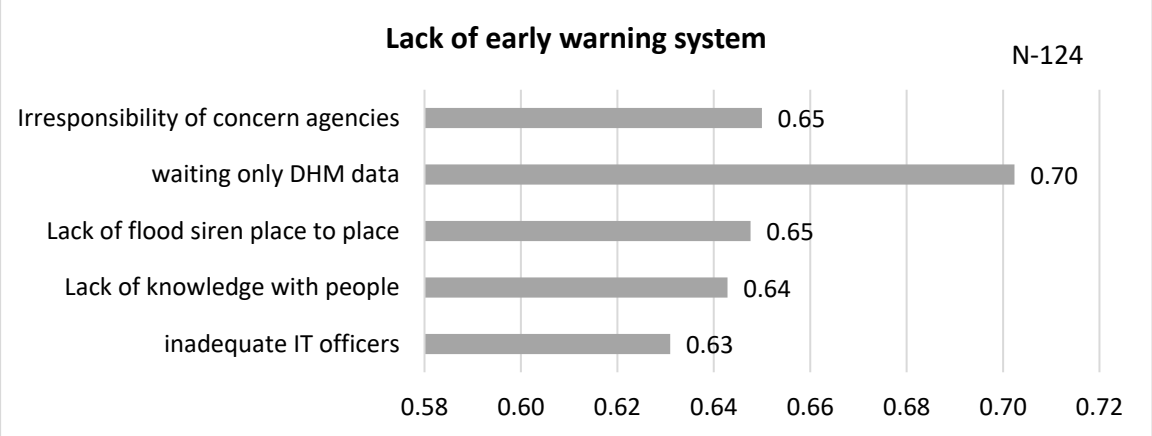

Fig. 12: causes of Lack of Early Warning System

5.7.8 Causes of Over Extraction of Riverbed Materials:

There were 5 major causes listed related over extraction of riverbed materials. However, it was ranked corruption as the major one (RII= 0.70) and artificial deficit of materials as the minor one (RII=0.59). All options and their respective values are presented in figure 13. From KII it is seen that over extraction of riverbed materials are due to corruption. People believe that due to corrupted mentality of government or authorized agencies, there is over extraction of riverbed materials.

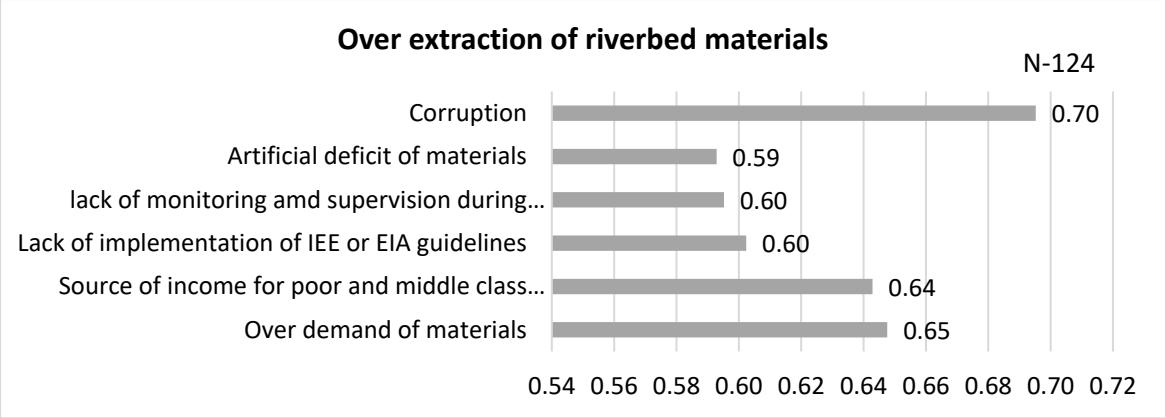

Fig. 13: Causes of Over Extraction of Riverbed Materials

It could be due to the poor governance. Proper IEE is not done. If it is done properly, it is not implemented as per the report. During fixing the rate also, the high-level technical bodies are not present and generally low level non-technical staffs are sent during rate fixing workshops. Thus, these types of issues arise. There is no provision of environment inspector; this is also causing issues at local level. These are the complete understanding of local people obtained from KII and FGD.

5.7.9 Causes of lack of Social Participation:

There were 5 major causes listed related social participation. However, it was ranked perception of corruption as the major one (RII= 0.70) and lack of social worker as the minor one (RII=0.60). All options and their respective values are presented in figure 14. From KII and FGD it is seen that lack of social participation is due to perception of corruption. This could be due to the reason that there is elite dominancy and power is concentric to certain groups only. And people believe that these are the agents who hold power of every decision making. Due to this, people distant them away from social participation.

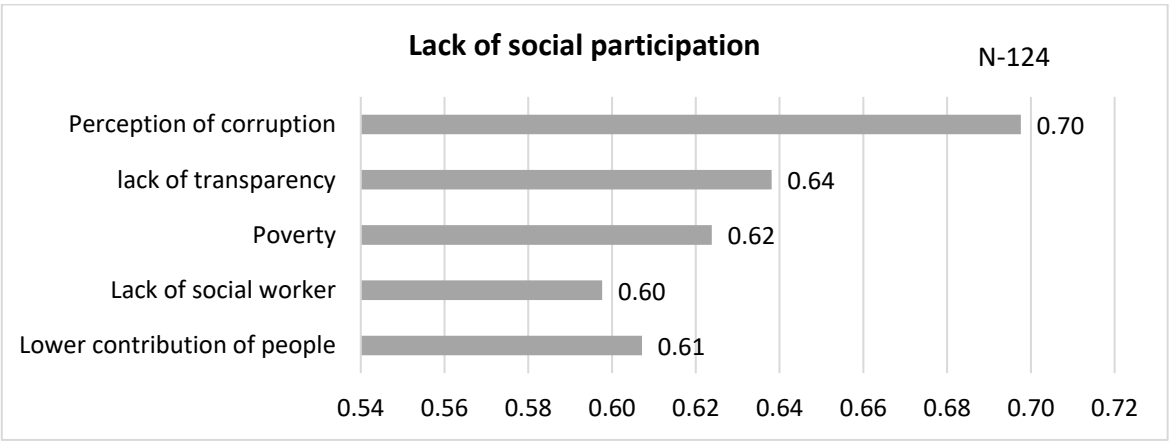

Fig. 14: Causes of Lack of Social Participation

5.7.10 Causes of Socio-political Pressure

There were 5 major causes listed related socio-political pressure. However, it was ranked over politics, corrupted mentality of representatives and lack of rule of law as the major one (RII= 0.65) and no strong rules and regulation as the minor one (RII=0.58). All options and their respective values are presented in figure 15. From KII and FGD it is seen that over politics; corrupted mentality of representatives and lack of laws are the main cause of social-political pressure. The laws and acts are not clear.

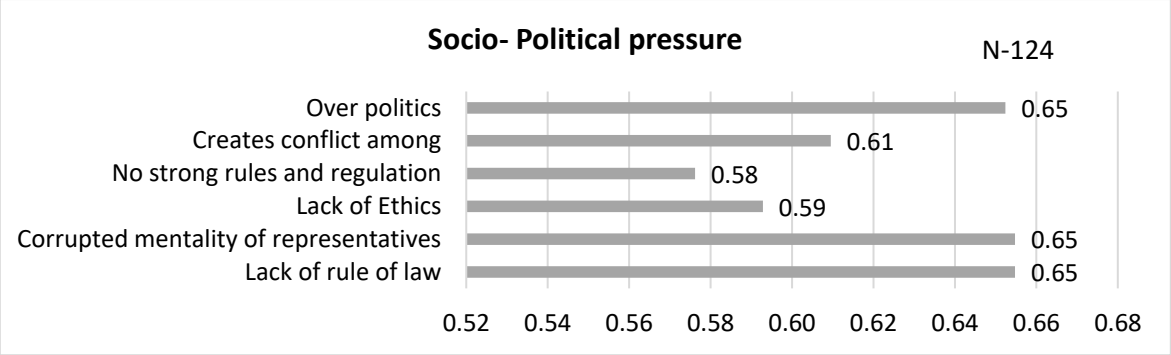

Fig. 15: Causes of Socio-Political Pressure

If it is clear, there are no agencies those implements clearly. Because of this people believes the above reason for social-political pressure.

5.8 Respondent's analysis on causes of lack of enforcement law and policies:

There were 5 major causes listed related lack of enforcement law and policies. However, it was ranked creates difficulties in works as the major one (RII= 0.66) and creates monopoly and misuse of power as the minor one (RII=0.63) in between misuse of budget and lack of transparency were there with 0.65 and 0.64 respectively.

5.9 Respondent's Analysis on Causes of Inadequate Flow of Budget:

There were 5 major causes listed related inadequate flow of budget. However, it was ranked less prioritized of river training works as the major one (RII= 0.66) and insufficient national income as the minor one (RII=0.56). All options and their respective values are presented in figure 16.

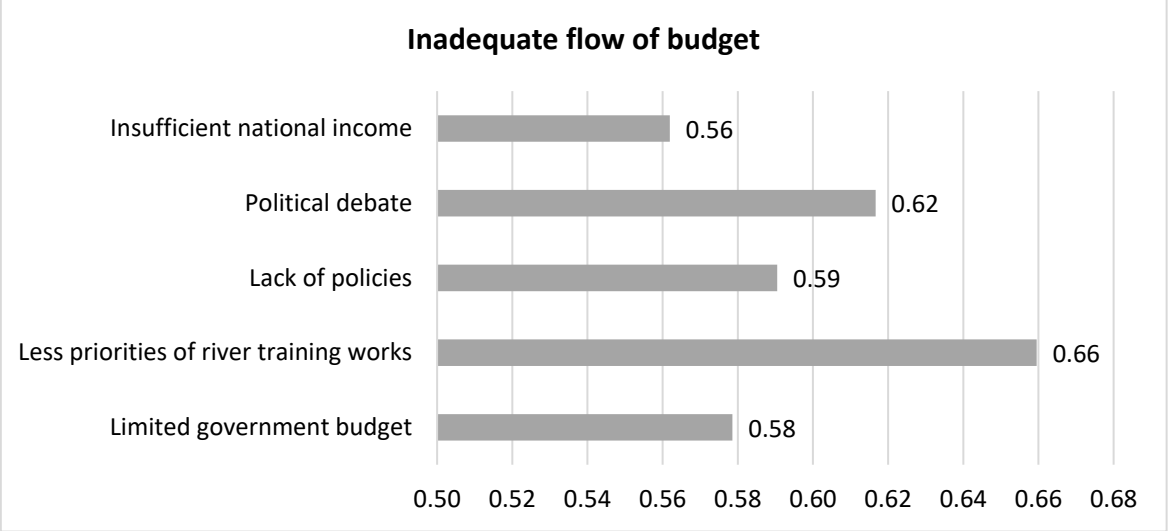

Fig 16: Causes of Inadequate Flow of Budget

From KII and FGD it is seen that, generally the agencies prefer to do the works in the sectors such as health, education. Even the planners are unaware of real scenario and plans on the general constructional works. Because of this, the less priorities are given on river training works and thus becomes a cause of inadequate flow of budget.

5.10 Respondent's analysis on effect of inadequate co-ordination between line agencies:

There were 5 major effect listed related inadequate co-ordination between line agencies. It was ranked delay in works as the major one (RII= 0.66) and duplication as the minor one (RII=0.61). All options and their respective values are presented in figure 17.

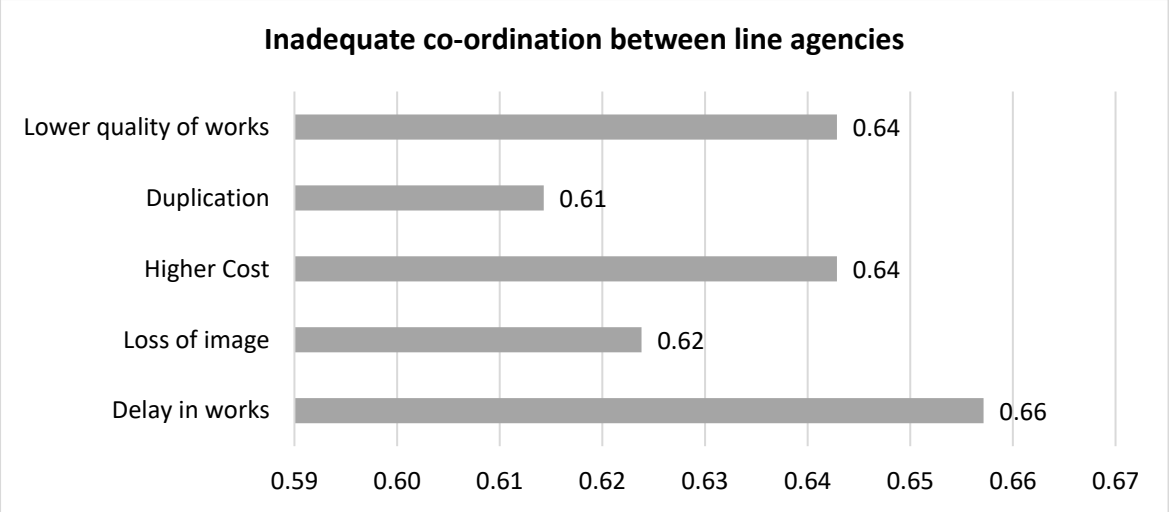

Fig. 17: Effect of Inadequate Co-ordination between Line Agencies

5.11 Respondent's Analysis on Effect of River Encroachment:

There were 5 major effect listed related river encroachment. However, it was ranked land inundation as the major one (RII= 0.76) and increased depth of river as the minor one (RII=0.45). All options and their respective values are presented in figure 18.

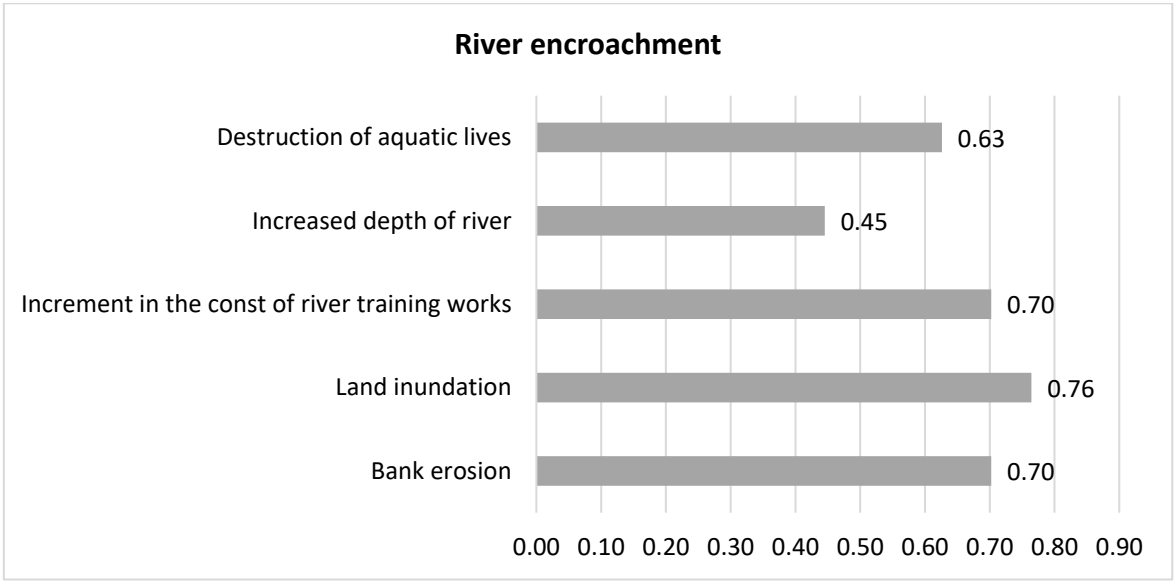

Fig. 18: Effect of river Encroachment

5. 12 Respondent's Analysis on Effect of Inadequate Monitoring and Evaluation:

There were 5 major effect listed related inadequate monitoring and evaluation. However, it was ranked low quality of work as the major one (RII= 0.70) and difficult in policy making as the minor one (RII=0.62) and increment of cost and project delay were having same RII with 0.63.

5.13 Respondent's analysis on effect of inadequate maintenance of built structure:

There were 5 major effect listed related inadequate maintenance of built structure. However, it was ranked life of structure decreased was the major one (RII= 0.71) and image loss was the minor one (RII=0.58). All options and their respective values are presented in figure 19.

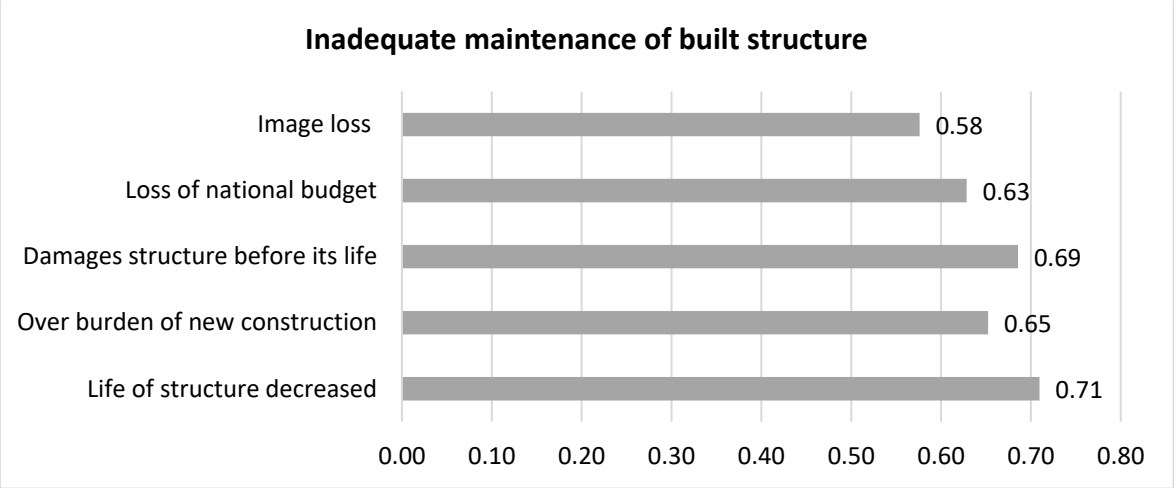

Fig. 19: Effect of Inadequate Maintenance of Built Structure

1.14 Respondent's Analysis on Effect of Unmanaged Upper Catchment Area:

There were 6 major effect listed related unmanaged upper catchment area. However, it was ranked inundation in lower catchment area and increases flood frequency as the major one (RII= 0.79) and increased land slide as the minor one (RII=0.58). All options and their respective values are presented in figure 20.

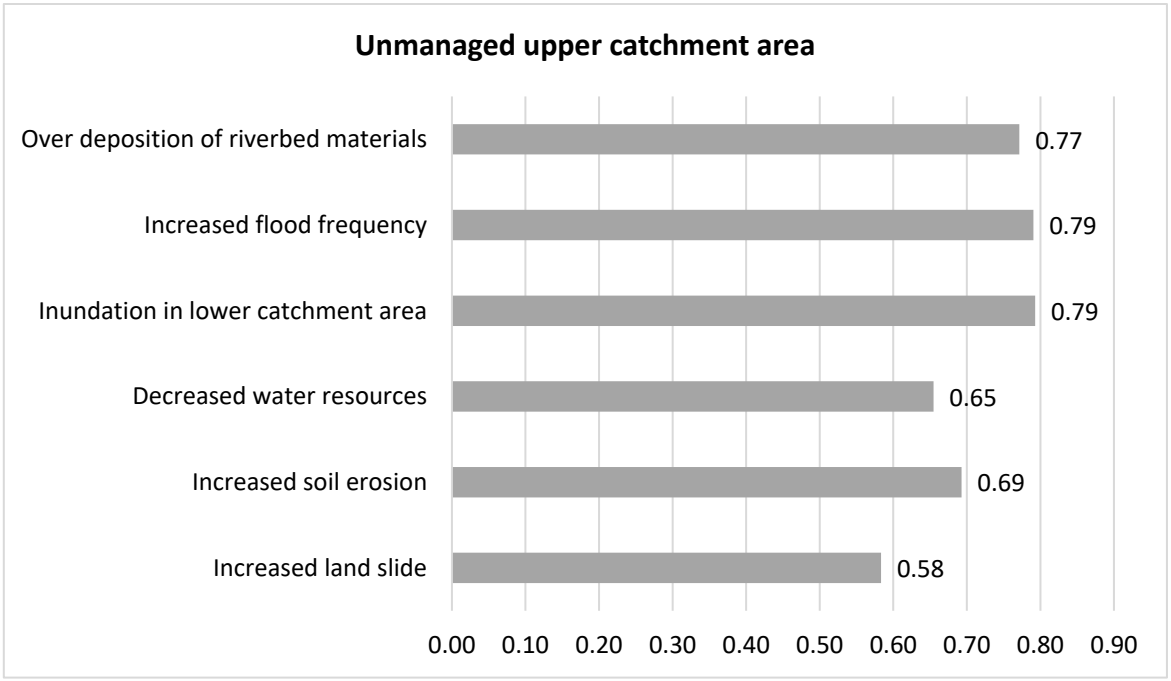

Fig. 20: Effect of Unmanaged Upper Catchment Area

5.15 Respondent's Analysis on Effect of Inadequate of People's Awareness:

There were 6 major effects listed related inadequate of people's awareness. However, it was ranked increase's chance of corruption as the major one (RII=0.68) and increase cost as the minor one (RII=0.59). All options and their respective values are presented in figure 21.

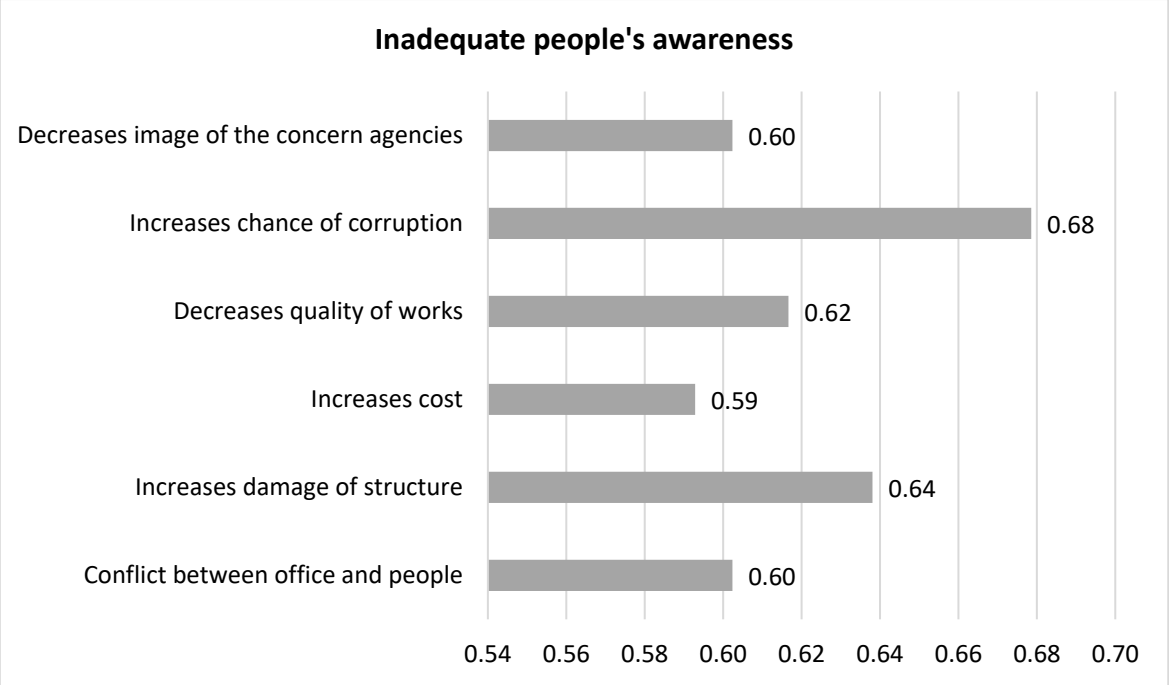

Fig. 21: Effect of Inadequate of People's Awareness

5.16 Respondent's Analysis on Effect of Lack of Early Warning SYSTEM:

There were 3 major effect listed related lack of early warning system. However, it was ranked difficult in flood forecasting as the major one (RII= 0.67) and environmental degradation as the minor one (RII=0.63) in between that loss of life and property with RII 0.66.

5.17 Respondent's Analysis on Effect over Extraction of Riverbed Materials:

There were 5 major effects listed related over extraction of riverbed materials. However, it was ranked fast meandering as the major one (RII= 0.71) and depth of riverbed increases as the minor one (RII=0.48). All options and their respective values are presented in figure 22.

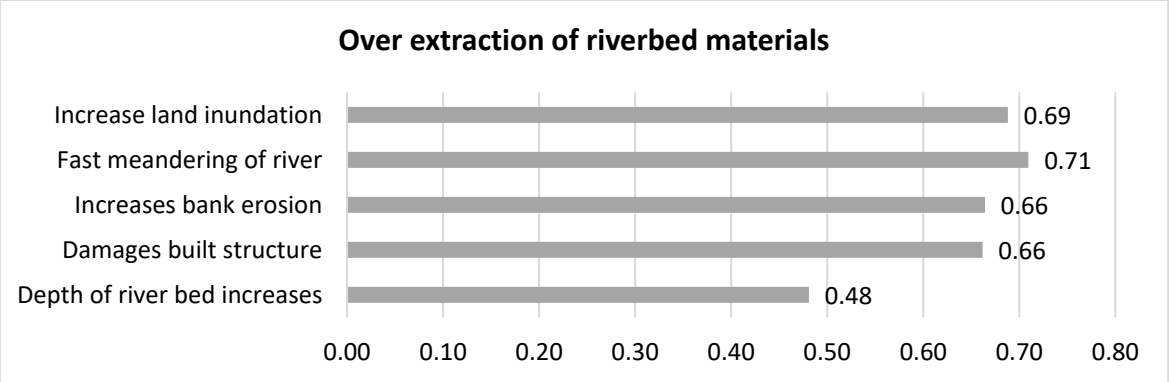

Fig. 22: Effect over Extraction of Riverbed Materials

5.18 Respondent's analysis on effect of lack of social participation:

There were 5 major effect listed related lack of social participation. However, it was ranked chances of corruption, creates conflict between people and decrease quality of work as the major one (RII= 0.65) and unsustainable development as the minor one (RII=0.58). All options and their respective values are presented in figure 23.

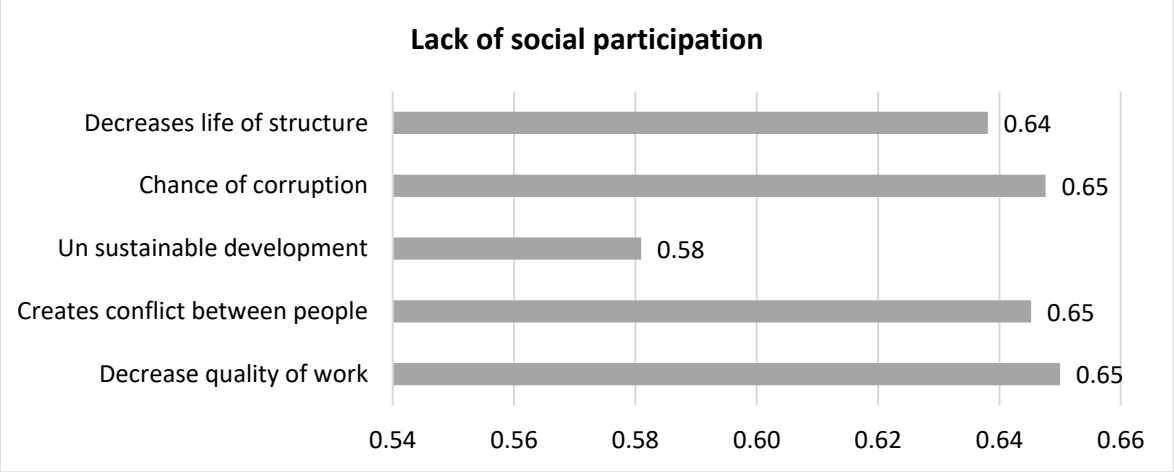

Fig. 23: Effect of Lack of Social Participation

5.19 Respondent's analysis on effect of socio-political pressure:

It was ranked imbalanced development as the major one (RII= 0.65) and conflict and quarrel as the minor one (RII=0.57) whereas defective work (0.65) and project delay (0.62) and cost increase (0.62) were equal in RII. Similarly, Respondent's Analysis on Effect of Lack of Enforcement of Law and Policies ranked haphazard construction (0.63) and creates violence (0.63) as the major one (RII= 0.63) and conflicts and quarrel as the minor one (RII=0.59) whereas increased disorder (0.63), and uncertainty in work (0.60) were other options. Furthermore, Respondent's Analysis on Effect of Inadequate Flow of Budget ranked increase flood and damage of structure as the major ones (RII= 0.66) and conflict between office and contractor was the minor ones (RII=0.54) whereas defective staffs (0.59), Cost increases (0.62) and project delay (0.63) were other options.

5.22 Respondent Analysis on the Solution of River Training Problem in Mohana River:

It was ranked the higher priories for Co-ordination between line agencies should be maintained smoothly (RII= 0.7). And Socio-political pressure should be minimized at all stages of the project as the minor one (RII=0.57). All options and their respective values are presented in figure 24. There are different government line agencies such as Department of Water Induced Disaster Management, Local Level Offices are mainly responsible for construction of mega structures and the non-government organizations such as different NGOs, INGOs, Red Cross etc are involved in construction of low-cost riverbank protection works. Generally, the river training works that are of low cost are executed without any planning but in actual need at the time of emergency conditions. In case of the mega structure, there is step by step planning before its execution. The low-cost riverbank protection works are practiced at the time of emergency, so no serious concerns are given on the technical parameters Whereas in case of the mega structure, this is just opposite. In case of low-cost protection works, majority of the raw materials are available locally and are much cheaper in comparison to the mega structure construction works. Also, there are seen more practice of low-cost riverbank protection works during both construction of new and repair as well. There are some of the problems seen in regard to the low-cost river protection works, such as less budget in the sector, political pressure and influence, lack of awareness, inadequate coordination between line agencies, inadequate monitoring, over extraction of river bed materials. The solution of the river training problems from the study are seen as allocating sufficient budget, increasing people awareness, and performing regular monitoring and evaluation. The reason why people might be interested in low-cost river protection works is that this method is cheaper, easier to implement and can be easily executed at the time of emergency. Use of bamboo bundling structures will be very much effective for the riverbank erosion protection. It can also be concluded that the bandals are working as a riverbank erosion protection structure (Md. L Rahman and Md. S Osman) [20-23]. The constructed bamboo bundling structure near the Shaheed Salahuddin Cantonment at the upstream of the Bangabandhu Bridge East Guide Bund, Bhuapur, Tangail are functioned well to the riverbank erosion protection by stabilizing the river course through near bank sedimentation.

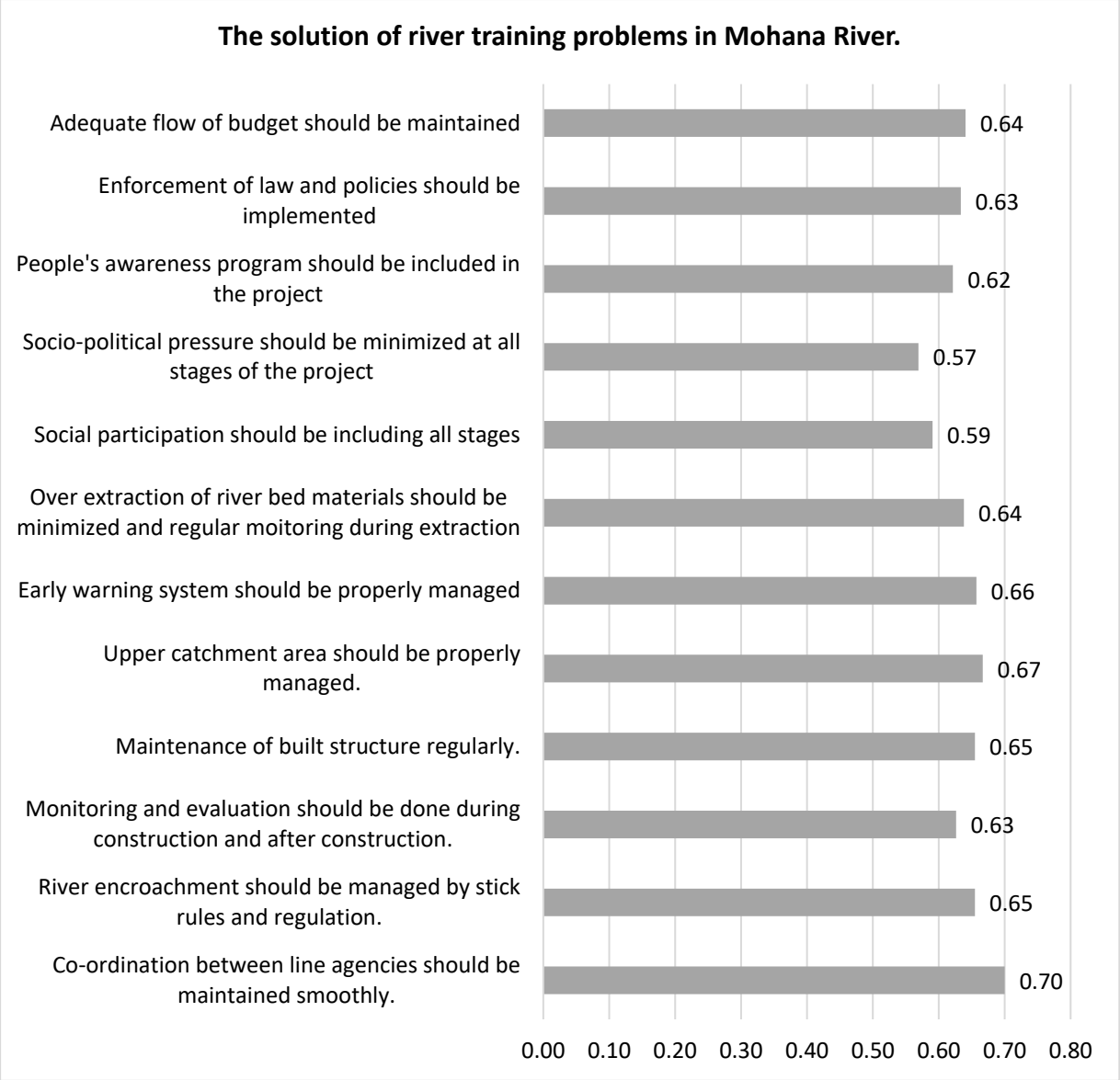

Fig. 24: Solution of River Training Problem in Mohana River.

There is about more than 30 m sedimentation towards the horizontal direction and about more than 3m sedimentation in the vertical direction near the riverbank from at the middle 0.70 km river bending reach. At the upstream 0.30 km river reach there is less sedimentation due beginning thrust of flowing water pressure, but there is a riverbank erosion protection. This position will be improved if bamboo bundling structures are constructed in further upstream of this reach. At the remaining downstream 0.50 km river reach, there is also less sedimentation due to direct impact of the flowing water trust, but riverbank erosion protection. While comparing with the similar kind of works executed globally, different reviews conclude that this low-cost methodology seems very effective in its functioning and well accepted by the local level people who are in extreme emergency conditions [21-27]. In context of the developing nation like Nepal this technology might be feasible solution to coop with the emergency situation as well as this will be a nature-based solution for protecting the riverbank protection further supported as cost effective and environmental approaches [28-30].

6. CONCLUSION :

There is different government line mainly responsible for construction of mega structures and the non-government organizations are involved in construction of low-cost riverbank protection works. The low-cost riverbank protection works are practiced at the time of emergency, so no serious concerns are given on the technical parameters. Whereas in case of the mega structure, this is just opposite. In case

of low-cost protection works, majority of the raw materials are available locally and are much cheaper in comparison to the mega structure construction works. Also, there are seen more practice of low-cost riverbank protection works during both construction of new and repair as well. There are some of the problems seen in regard to the low-cost river protection works, such as fewer budgets in the sector, political pressure and influence, lack of awareness, inadequate coordination between line agencies, inadequate monitoring, over extraction of river bed materials. The solution of the river training problems from the study are seen as allocating sufficient budget, increasing people awareness, and performing regular monitoring and evaluation. The reason why people might be interested in low-cost river protection works is that this method is cheaper, easier to implement and can be easily executed at the time of emergency. While comparing with the similar kind of works executed globally, different reviews conclude that this low-cost methodology seems very effective in its functioning and well accepted by the local level people who are in extreme emergency conditions.

7. ACKNOWLEDGEMENT :

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