

# IMPACTS OF ATTABAD LAKE (PAKISTAN) AND ITS FUTURE OUTLOOK

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## Abstract

Due to geological, hydrological and anthropogenic variations in Northern Areas of Pakistan, the possibility of hazards like earthquake, flash floods, landslide and Glacial Lake Outburst Flood (GLOF) have increased manifolds. The incident of Attabad landslide on 4th January 2010 blocking the Hunza River and resulting in the formation of huge lake as a sequel to Astore earthquake in 2002 and Kashmir earthquake in 2005 is a testimony to the fact hazards turn into disasters causing loss and damage to lives, properties, assets and environment. There are multiple reasons ranging from global warming, deforestation, unplanned settlements, population growth, aggressive farming and host of other man induced activities which have made the Northern Areas of Pakistan hazards prone and are likely to pose continuous threat if requisite preparation and response options are not considered well in advance.

In case of Attabad landslide, viewing from the prism of disaster risk management the response of Gilgit-Baltistan and Federal Governments has though not been up to the mark yet mobilization of resources and opinion to manage the disaster leaves a promising environment of hope and capacity which can be further developed to more resilient respondent provided little extra deliberations are done and attention is paid. The solution to Attabad landslide dam crisis lies in reducing the risk by either draining out the lake completely or making a reliable structure with proper design for flow of the water from the lake.

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**Keywords:** Hazard, disaster, capacity, exposure, vulnerability, risk, Northern Areas, landslide dam, spillway, inundation, overtopping, inflow and outflow, GLOF

## Introduction

'Northern Areas' of Pakistan is unique in its geographical configuration and layout which houses confluence of three major mountain ranges like Hindukash, Karakorum and Himalayas and 5 out of 14 peaks exceeding 8000 meters height. These mountain ranges are characterized for their slope instability due to the inherent topographic, geological, geomorphological, seismological, hydrological and anthropogenic reasons. Consequently hazards like earthquakes, landslides, mud slides, debris slides, rock avalanches, erosions, glaciated drifts and glaciated lake outburst floods (GLOF) are common phenomena. Water channels like rivers, nullahs and streams, lines of communication like highways, roads and tracks and built up areas like towns, villages, hutments and isolated houses, agriculture farms and orchards etcetera remain exposed to these hazards with variable level of vulnerability. The interaction between hazard and vulnerability leads to disaster in the form of blocking water channels like rivers, disrupting line of communications and washing away farms and orchards causing physical, social, psychological, political, economic and environmental impacts on those communities and people along with their infrastructure who suffer from these events.

4th January 2010 is a day which witnessed a landslide hazard meeting with the vulnerabilities of Attabad and Sarat Villages, 109 kilometers north-east of Gilgit and 20 kilometers upstream from Karimabad in Hunza Valley, their farms and orchards, the River and Karakorum Highways resulting into a historical event of creation of huge lakes subsequently engulfing most parts of the villages like Ainabad, Sheshkat, Gulmit, Gulkin and Hussaini into its fold. Although since the day of incidence, planners, researchers, academicians, experts, social workers and philanthropists have visited the site and documented their thought processes in the form of assessments, analyses, comparative studies and management proposals yet an insight from a disaster risk manager's point of view seemed wanting which this paper is intended to address.

Following a typical disaster risk management cycle comprising three distinct stages of pre, during and post disaster activities, Attabad Lake incidence will be viewed for each activity starting from the preventive, mitigation, preparedness, early warning, evacuation, search and rescue, relief, rehabilitation to reconstruction. Impact of this event will be seen from the prism of a disaster manager in physical, social, economic and environmental domains thereby reconstructing its future outlook with a view to suggest measures for managing newly transformed landslide dam in a cost effective and productive manner.

## 2 TRACING THE ORIGIN

Oldest linkage of Attabad landslide is traced back to 1858 landslide , which erupted at Salmanabad, 3 kilometers downstream of present site where also the landslide had followed almost the same pattern of flow in which debris flowed in three directions, straight in front across the river hitting the opposite ridge then falling in reverse, upstream and downstream. Like many other settlements in mountainous valleys which are made on deposits of landslides mainly for the reasons of availability of relatively more leveled ground and water as slides mostly flow along water channels, Attabad and Sarat Village were also on such floor mainly consisting of river gravel overlaying silty - clay bed.

Tectonically or seismically, the area is sandwiched between Main Karakorum Thrust (MKT) zone and Main Mantle Thrust (MMT) zone; therefore it keeps experiencing shocks due to plates movement. Next linkage of the incident is traced back to 2002, where an earthquake measuring 6.3 on Richter scale had jolted Gilgit - Baltistan due to which the area around the site had developed fissures and fractures which were even visible on terraces where farming was being done in routine though later the farmers had become little conscious of the fact. Next in the chain was Earthquake 2005 which measured 7.6 on Richter scale resulted into over 78000 fatalities, had sent tremors across almost complete area of Azad Kashmir and Gilgit - Baltistan. This even had deepened the scars on face of the earth in eastern part of Attabad Village as well but the routine went on as usual.

According to report by Northern Areas Conservation Strategy (NACS -2001), hydrological profile of northern areas has been affected due to rise in the average precipitation in the region in last 50 years. Whereas according to NACS 2012, annual average precipitation rise has been from 129 mm in 2001 to 150 mm in 2012. Accumulatively with 2-3 feet snow in Hunza Valley, in winters the hydrological pressure increases which causes downward movement of landmass resulting into slides, mud flows and avalanches.

Topographically, Hunza Valley has most varying relief compared with any other part of the world. Valley cuts Karakorum Range, with extremely high vertical to horizontal ratio. It rises from 1850 meters to 7788 meters attaining a vertical height of 6 kilometers. This is the reason Karakorum Highways (KKH) is considered the highest metalled road in the World and World's eight wonder as well. This makes the slopes in the Valley very steep and renders the area most hazards prone from slides point of view. Similarly the geomorphology of Hunza Valley is also of several types which due to slope instability, porosity and inhomogeneous nature make it more slides prone. This is the main reason that keeping KKH open even in fair weather is a great challenge.

Anthropogenically as well, Hunza Valley is no exception. Starting from deforestation, terrace farming, zigzag water channeling, unplanned settlements to intensive blasting as a result of construction of KKH and subsequent maintenance effort resulting into slope cutting and toe excavations, all are man induced activities which have exacerbated the sliding process in the area.

There may not be a single cause or reason to which the Attabad landslide be attributed rather it is fair to say that it is result of a combination of all factors though with varying degree which are instrumental in causing this slide. The synthesis of various contributory factors which has been done here shall lead to suggest preventive or mitigation measures for providing adequate protection level from such hazards to exposed communities and infrastructures in future.

### **3 WARNING BEFORE THE FURY**

All over the world, natural hazards are preceded by some kind of natural warning which if picked up correctly and timely can save precious lives through eliminating or reducing their exposure and vulnerability. Recent example of natural warning being picked up by an intelligent viewer before a disaster is that of Indian Ocean Tsunami 2004. Tilley Smith a 10 years old girl was on a trip with her family in Thailand, she recognized the receding water and frothing bubbles on the surface of the water as a sign that a tsunami was on its way and alarmed people around her through her parents and saved the lives of dozens of tourists.

Similarly after Astore earthquake 2002, fractures and fissures on the back slope of Attabad Village had developed which traveled longitudinally and transversely into the cultivated fields and surrounding inhabited areas in 2004. After Kashmir earthquake in 2005, the failure conditions and networks of crack had aggravated causing damage to infrastructure. Geological Survey of Pakistan (GSP) on behalf of National Disaster Management Authority (NDMA) had studied the area in 2009 and predicted a large scale landslide that could block Hunza River.

Few days before the incidence, the people in the area were ripped by the fear of uncertainty and mysterious projection of landslide since the cracks had developed alarmingly wide and deep and cracking sounds could also be heard at the time of calm. General feeling of people about a fury to unleash was wide spread. As a result of work by NDMA and a local NGO by the name of FOCUS, population from eastern part of Attabad Village deemed at risk was evacuated from the area three days before the start of the landslide. Nature had played its role by showing the signs before a hazard could occur. The warning was correctly and timely picked up and hundreds of lives were saved. Only those particularly from adjacently low lying Sarat

Village and who did not pay heed to the warning died, count of which did not exceed 20.

#### **4 LANDSLIDE AND LAKE PROFILE**

At about 1130 hours on 4th January 2010, finally the fury unleashed in the form of a huge landslide approximately 10 kilometers downstream of Gulmit Town. The landslide comprised 60 - 70% huge rock boulders and 30-40% fine matrix of predominantly clay and silt. It measured an average of 600 meters in length, 400 meters in width and 60 meters in depth which detached itself from the base. It swung wiping Sarat Village, across Hunza River and hit the opposing rocks. Completely blocking the water channel, the slip mass reversed its swing in a pendulum movement thickening the slip mass further, triggering more slides and accentuating the fanning process of debris and mud flow upstream as well as downstream covering an area of approximately 1.5 - 2 kilometers along the River.

Where the landslide occurred, Hunza River is curved which had now been completely covered by the slip mass blocking the water resulting into formation of upstream lake. Although it was peak winter season yet there was an inflow of about 300 cusecs with which the lake slowly and gradually started rising. The land mass which had blocked the river was massive. Its transversal (350-400 m), longitudinal (1.5-2 km) and vertical (130-200 m) spread along the river measuring volume of over 50 million cum (1.7 billion cft) was so thick that the possibility of water seeping downstream without deliberate effort was not possible.

KKH at landslide site was at the elevation of 2330 m and the bed level was at the elevation of 2290 m. The lake was a reality and on every passing day the lake was expanding upstream engulfing KKH and the outskirts or the lower parts of villages like Ainabad, Sheshkat, Gulmit, Gulkin and Hussaini were to become lake's subsequent part as it was initially rising by 4 m per day but was subsequently reduced to 1 m per day due to relatively open area upstream (Figure 3). On 29 May 2010, when the water had started flowing through the spill way, the lake was having width of 300-700m, maximum depth of 106 m and length of 22 kilometers with an inflow of about 26000 cusecs having total volume of approximately 408 million cum (330,000 Acre ft).

#### **5 IMPACT OF THE CATASTROPHE**

Impact of disasters relate to the hazard, exposure and vulnerability. Dimensions of each element accumulatively become the dimensions and range of the impact. Impact of a hazard can be further subdivided into the hazard itself and the secondary hazards which are either prelude or sequel to the main hazard. In case of Attabad landslide, all three domains will be

critically viewed for gauging the impacts. As far as prelude to Attabad landslide is concerned, it can be traced back to Astore Earthquake in 2002. With the development of fractures, fissures and cracks in the surrounding areas of Attabad, physical, economic and environmental impact had already started. Although socially it might have not developed any scar on the facade of the community yet the uncertainty and fear of unknown loomed around them. Impacts of secondary hazards like Attabad Lake will keep hounding the present as well as coming generations till the time it is either appropriately addressed or eliminated. In succeeding paragraphs, impacts of Attabad landslide and lake shall be discussed from multifaceted dimensions with a view to draw relevant conclusions to assess the correct outlook of this newly transformed hazard.

### **5.1 Physical Impact**

As a prelude to landslide, people of eastern part of Attabad Village were evacuated and displaced abandoning their properties, assets and some of their livestock. As a direct impact, the landslide washed away a low lying Sarat village including its hutment, farmland, orchards and related infrastructure comprising public as well as private properties. The massive landslide filled about 2 kilometers of Hunza River with slip mass and completely blocked the water. Approximately 2 kilometers of KKH came under the thick land mass and got buried dozens of meters deep, disrupting line of communication between Pakistan and China. Due to splitting of the area with landslide, upstream and downstream communities got isolated.

As an indirect impact, landslide blocked Hunza River leading to the formation of a huge lake which in itself has become a hazard to be reckoned with. As the volume of water in lake increased on day to day basis and it expanded upstream, it started engulfing the built-up areas, KKH, farmlands, orchards, bridges, villages and the land on both sides of the River. As mentioned earlier, till 29 May 2010, the lake had submerged 22 kilometers of KKH, major parts of five villages that is to say Ainabad, Sheskat, Gulmit, Gulkin and Hussaini, had submerged six bridges including Sheskat old and under construction new bridges attaining the width of 300-700 meters rising the depth of the water up to about 100 meters from the original water level. With over 408 million cum water the lake was exerting pressure on the deposited slip mass for gushing water to flow downstream. In succeeding paragraphs physical impact of the landslide will be translated into social, political, economic and environmental terms.

### **5.2 Social Impact**

Social impact of the disaster can be categorized into those who were directly affected by the landslide by suffering loss of lives, property, assets

and environment and those who were indirectly affected or still being affected from the secondary hazards. People of Attabad and Surat Village are the direct affectees who faced evacuation, got displaced, suffered the agony of living with their relatives or in relief camps and have not been able to recover since no worthwhile rehabilitation or reconstruction work could be done for them as piece of land on which they dwelled no more exists. There were few residents of Surat Village who despite clear signs, vivid warnings and social pressures did not leave their homes and got perished in the process. People suffering direct impact have lost their homes, livelihood, properties, land, farms, orchards and societal setups as a result of physical interaction with the hazard.

Second category of indirect affectees, are those who were split apart by the formation of lake upstream and downstream of the landslide. Livelihoods of the people on both sides were adversely affected due to disruption of line of communication, transport and other social activities. In severe weather conditions, people have to ride boats paying very high fare charges and traveling in windy environment on unsafe means and in insecure environment. Schooling and education have also been adversely affected since the school buildings have either got collapsed, inundated, or abandoned and the students got dispersed or unable to reach schools across the lake with teachers also mostly disturbed. Medical facilities have also been compromised as the threat of malnutrition, anemia, scabies, eczema and typhoid mostly prevailed.

The situation gets worsened in winters when the lake freezes and boats stop operating. With freezing of the lake, social life of the people in the area is also frozen. In the absence of any means of transportation, people have been endangering their lives in reaching their abandoned houses walking over the iced surface of the lake resulting into change in social activities and pattern. Since the population in the affected area of Hunza-Nagar District belongs to a particular ethnic group in which communities are homogeneous and well bonded therefore with their mutual support they have been able to sustain the worst effects of the incident quite amenable otherwise at such a far flung and remote area, the support from the government lacked requisite resolve and wherewithal.

### **5.3 Political Impact**

Political situation at tehsil, district, Gilgit - Baltistan and national levels needs to be gleaned through for establishing correct perspective. Following a bottom up approach, the issue will probably become clearer for realistic understanding of political context ensuing Attabad landslide incident. Central Hunza and Gojal are two neighboring tehsils (sub-district) of Hunza- Nagar District. Attabad and Surat are the last villages of

Central Hunza tehsil and the area which got subsequently affected by formation of lake forms part of Gojal tehsil which has tehsil headquarters at Gulmit. Local level politics immediately started when the focus of government restricted itself to Central Hunza tehsil ignoring the projected losses of villages of Gojal tehsil which were in the process of getting engulfed by upstream expanding lake.

Before 2009, Gilgit-Baltistan was named as 'Northern Areas' with no legislative assembly or the government. A federal ministry of Kashmir Affairs and Northern Areas (KANA) would manage it under legislative arrangement of Pakistan though Azad Kashmir had its own assembly and the government then. Taking a strategic decision, Government of Pakistan gave Gilgit-Baltistan a kind of limited self rule status wherein through elections legislative assembly was formed under a chief minister whereas the first Governor (Qamar-u- Zaman Qaira) still remained imported. Pakistan People's Party (PPP) formed the government.

Traditionally in the past, complete financial needs of 'Northern Areas' would be sustained by the Federal Government and in present arrangement as well Gilgit-Baltistan looked towards the centre. Virtually after the incident, initially there were feelings of insensitivity and apathy towards the affected people. It was only when against the culture and habit of locals, Gojalis and the opposition parties came on the streets and staged protests, the Governments at Gilgit-Baltistan and federal levels got little moved. Governor and the Chief Minister visited the areas pacified the people by showing sympathy and promising help. Both of them presented cheques to the affectees and their relatives but the response still remained below satisfactory. Relief camps were though established by the Government yet the management of displaced people mainly revolved around NGOs and local community. Due to location and distribution of affected area, local political division and higher political dispensation, the lack of requisite political support and will, has made the management of Attabad lake disaster quite difficult.

#### **5.4 Economic Impact**

Attabad landslide had interacted with the strategic communication link of Pakistan with China which is used as the only land route between two countries. Besides, as a result of direct as well as indirect physical and social impact, the event has generated effects which range from national to local and macro to micro economy levels. After Hunza River was blocked by landslide on 4th January 2010, the trade between Pakistan and China got completely suspended from KKH since the people, traders, planners and executives were uncertain about the future of the lake. No one expected it to last long; everyone feared that even if the lake water did not wash away the



slide, it will over top it when the water level in the lake became higher than the top level of slide. It was only on 29 May 2010, when the water was made to flow through a cut spill way, certain level of confidence had started emerging in the minds of people and planners about the viability of turning lake into a relatively safe route for restoration of trade though temporarily between Pakistan and China. Although the trade activity between two countries has resumed yet its size and magnitude has reduced to less than one fourth due to the inconvenience and high cost involving multiple loading and unloading compulsions and then sailing the goods across the lake through insecure, unsafe, uncertain and expensive means like adhoc boats and rafts being used for the purpose. At micro level also, Government had mad effort to revitalize the business by giving compensatory amounts to affected people, but do overall inconducive business environment, it could not be fully restored.

To restore the line of communication, construction of road on new alignment along the left bank of Hunza River is inevitable. Construction of a new bridge at Sheshkat was already underway which was also submerged in newly formed lake but has now been recovered through lowering of water level. New Sheshkat Bridge will replace the old one which is likely to remain submerged if the water level in the lake is not further lowered. A contract to a Chinese firm has already been awarded for construction of over 20 kilometers of road for linking upstream road through new Sheshkat Bridge which also includes construction of 5.7 kilometers of tunnel across some difficult stretches of Rocky Mountains.

Economic cost of direct impact of landslide resulting from loss of lives, properties like hutments, agricultural lands, cash crops like potatoes farms, fruits like apricot orchards, public infrastructure like road, bridges, schools, hospitals /dispensaries, office buildings and private infrastructures like hotels, restaurants and transport etc is though considerably high. But it will still be lesser than the economic cost of the indirect impact of landslide as a result of formation of a permanent lake which has engulfed five villages along with their economic resources and activities. Besides, posing a potential hazardous threat, the lake will continue to radiate adverse economic effects for present as well as coming generations if not managed appropriately.

## **5.5 Environmental Impact**

What all surrounds a man forms the environment. The interaction between atmosphere, hydrosphere and lithosphere which constitute the biosphere plays the major role in defining our environment. All contributory factors to climate change may not be visible in 'Northern Areas' but the effects of global warming have started manifesting in one form or the other.

Environmental impact related to soil, water, multiple ecosystems and plantation are matter of great concern while undertaking the review for establishing the correct perspective. Extensive deforestation has denuded the mountains in Northern Areas from green cover. Inappropriate land use particularly for making roads and tracks, hutments, agricultural farming and irrigation management has degraded the environment to a dangerous level. Soil degradation, slope instability, water and wind erosion and extensive sedimentation have adversely disturbed the environmental equation in the area.

As far as environmental impact of Attabad landslide is concerned, the area has further degraded, soil stability has been further deteriorated, sedimentation has largely increased and ecosystems related to plants, birds, animals, insects and various other creatures have been seriously disturbed. When on 4th January, 2010 the Hunza River landslide occurred and the water got completely blocked, about 100 kilometers of Hunza River got dried up perishing the ecosystems of unique species which were being sustained in a particular environment for centuries. Whereas for upstream as the water started engulfing the ecosystems and disturbed their time old equation. The lake itself is a potential danger if it overtops the spill way due to any reason particularly falling of landslide in the lake and is likely to affect the area approximately 60 meters above the river water line till Tarbela. Depositing of thick sediments over the area recovered from the lake has also changed the profile of land rendering it useless which once used to be arable. Siltation and sedimentation will continue to pose environmental threat till the time the lake water is appropriately managed.

## **6 PEEPING THROUGH PRISM OF DISASTER RISK MANAGEMENT**

Classically disaster risk management cycle starts from prevention, mitigation and preparedness before the hazard strikes followed by evacuation, search and rescue and relief operation during the response stage whereas in recovery stage of the cycle rehabilitation and reconstruction activities sue before it completes the loop through entering into development paradigm. Each stage and activity within each stage is though categorically defined yet overlap with each other having mitigation i.e. structural or non-structural throughout the cycle. At each stage efforts remain at hand to lessen the adverse effects of the disaster and protect lives, properties and assets of the people at risk or affected. Effective disaster risk management leads to effective disaster risk reduction and vice versa, leading to sustainable development for future generations to live in an uncompromised environment.

As it has been discussed in detail in preceding paragraphs that Attabad landslide had started showing its signs right after the earthquake in Astore in 2002 by developing fractures, fissures and cracks in the area around Attabad but no worthwhile preventive or mitigation measures could be taken obviously due to lack of awareness, understanding and to some extent concern and care by those at help of affairs. Earthquake 2005 also passed by, aggravating and pronouncing the signs, yet no measures could be taken to avert the catastrophe. It was not before 2009 when study by Geological Survey of Pakistan led to the projection of huge geologic event in the area. This was the time when the realization had started emerging at the level of National Disaster Management Authority (NDMA) and other NGOs which had started sensitizing people but no concrete preparedness measures could still be taken even when the time was fastly squeezing. Few days before the incident when warning had become very clear, the level of risk became very high and the life appeared extremely insecure and unsafe, the physical evacuation started moving them to the relief camps established by the Government and NGOs or to the relatives according to the convenience or compulsion.

Since people of Attabad and Surat Villages and surrounding areas appeared to be in direct danger, therefore, they were moved first. Whereas people living in those villages which subsequently got engulfed by upstream lake though lived in fear but didn't move and were later evacuated by helicopters after the landslide had occurred. On occurrence of landslide on 4 January 2010, a new situation of washing away Attabad village, blocking of Hunza River and formation of lake upstream developed which had its own dimensions and dynamics and demanded a response from disaster risk management machinery on ground which was neither configured nor prepared. An emergency of extreme danger and crisis of huge magnitude had set in which panicked the policy makers, planners, disaster managers and the community facing the risk of getting drowned and inundated by the rising water in the newly formed lake.

Federal Government had activated Pakistan Armed Forces for evacuation of people entrapped in the affected area. Helicopters were intensively used to take the people out of danger to safer locations. Simultaneously at planning commission, NDMA and Army level, the planning had started to mitigate the adverse impact of huge lake through lowering down the level of water by cutting a spill way through the slide. After completion of rescue operation, the relief operation had started but not with the speed which could satisfy the affectees. Disaster had taken a new turn. A lake had been formed which had accumulated a huge volume of water which could burst or overtop the blocking slip mass and cause catastrophe of unparallel kind along the river till Tarbela Dam. Through

unprecedented commitment, hard work and dedication of Pakistan Army Engineers under the umbrella of Frontier Works Organization (FWO), the water started flowing through the cut spillway on 29 May 2010, providing a sigh of relief to everyone concerned who were looking at the monster intimately.

After the release of water from the lake which still formed part of response stage of disaster risk management cycle, the process of recovery had to start initially through rehabilitating the affectees by restoring their routine functioning and then reconstructing their abodes at safer locations so as to make their stay sustainable for times to come but then followed a different story than what people had expected. Against the expectations of affectees and tall claims and political rhetorics by leaders of the elected government, the affected people were to suffer for longer and are still looking towards the power centers with hope though in a state of despair and despondency that someone may realize their agony and come for their help.

As a token of sympathy affectees and relatives of deceased were given cheques as compensation. Except for monetary compensation to affectees for their self-settlement, no formal, planned, organized recovery process has been undertaken by the Government. Physical rehabilitation was left to people themselves and they at their own restored their routine functioning where they could manage and where it was beyond them the state remained the same which had developed as the result of the disaster. There has been no planned reconstruction effort launched by the Government. Houses got washed away by the slide still remain collapsed under the soil mass and those which were subsequently inundated by the lake though have some been reclaimed yet with their roofs gone are filled with sand deposits. Although NDMA had made efforts initially to respond to the challenge during response stage but for recovery stage the resources, wherewithal and resolve seems wanting.

## **7 FUTURE OUTLOOK**

Attabad Landslide Lake is a reality. With cutting a 30 meters deep spill way across the deposited land mass, over 50 percent inundated area has been reclaimed but still 11 kilometers long, 100 meters deep and 500-600 meters wide lake still exists with a tendency to recoil upstream during summer when the inflow becomes 10-15 times more than what is experienced in the winter. Chinese are making road on left bank which is expected to restore line of communication between two countries by passing over new Sheshkat Bridge and linking old KKH around Gulmit. Recent visit of Prime Minister Nawaz Sharif to China and the announcement for establishing road and rail link between Kashgar and Gwadar is yet another dimension where future plans will hopefully address the Attabad lake issue

in totality but for time being it is a potential hazard. This inherits a danger of overtopping or out flowing in case of more inflow than outflow or by falling a rock/landslide in the lake from either of the banks creating a ripple which would not stop short of crossing the land mass causing catastrophe along the river till Tarbela Dam.

The solution lies in making an arrangement where the outflow increases the inflow around the year. This will only be possible if the spillway is widened as well as deepened. This arrangement in present form has a serious implication of soil erosion. Through widened and deepened spill way more amount of water with more speed will move downward which will have more chances of eroding the sides of spillway and making it a dangerous preposition of overflowing. This can only be addressed if either the spillway is deepened (estimated depth of 86 meters) and widened (according to the depth with gradient of 1:1) to that level where in complete water is drained out from the lake or alternatively deepening the spillway by another 5-10 meters and developing a concrete structure for retention of the soil contents and stability during flow of the gushing water from the lake. Federal and Gilgit - Baltistan Governments should do this with requisite political resolve so as to prevent or mitigate the adverse effects. Only then the real recovery stage of disaster risk management will complete which will lead to the sustainable development of the area.

## **8 CONCLUSION**

'Northern Areas' with peculiar characteristics of lofty mountains, relatively young geological structures, disturbed hydrological setting and unplanned anthropogenic activities under the climate change environment as a result of global warming will remain exposed and vulnerable to hazards like earthquakes, landslides, GLOFs and flash floods. Gilgit-Baltistan has attained a self rule status though limited in reach and outlook yet needs to step up its own legal, organizational and implementation framework for disaster risk management on the lines of PDMA's and DDMA's in other provinces in collaboration with Ministry of Climate Change (NDMA) to be autonomous in handling the Attabad landslide Dam and all anticipated hazards in future. Federal Government should enable the Government of Gilgit-Baltistan to stand on its feet with confidence by providing full political and financial support to prepare for and respond to future threats otherwise the response will remain knee jerked as has been experienced in case of managing Attabad landslide.

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