

# IS THE KALABAGH DAM SUSTAINABLE? AN INVESTIGATION OF ENVIRONMENTAL IMPACTS.

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**ABSTRACT:** *Kalabagh dam is a largescale project that may be the answer to power shortages, however it is imperative to identify the environmental impacts and necessitate towards making this project environmentally sustainable. There is scarce data available on the environmental studies of Kalabagh dam. This study attempts to investigate the environmental effects by comparing the EIA studies and data collected on Three Gorges dam, Aswan dam and Tarbela dam. It attempts to consolidate the data already available and the impacts of the dam generated in the three case studies. The results indicate that the dam has a potential to have large scale ecological impact however these impacts can be mitigated by adopting appropriate mitigation. The EIA process has enormous potential for improving the sustainability of hydro development, however this can only be considered if strong institutional changes are made and implemented.*

**KEYWORDS:** EIA, Kalabgh dam, impact identification.

## 1. INTRODUCTION:

The construction of large dams results in advantages as well as irrevocable and unfavorable impacts on the environment. The aquatic ecosystems are completely altered as a result of damming a river thus affecting the migration of aquatic organisms. Sedimentation as a result of reservoir impoundment stimulates erosion downstream which causes disruptions in the aquatic food chain. Dams also affect the temperature. The change in temperature alters the reproduction patterns and affects the population of aquatic animals. The most important environmental impacts mainly include altered flooding and hydrology patterns, sedimentation and siltation, seismic activity and land sliding and variation in biodiversity (affecting flora and fauna)[1,2,3,4]. These environmental impacts are identified and mitigated through environmental impact assessment. The current study aims to assess these impacts on Kalabagh dam.

The concept of environmental impact assessment is not too alien for developed countries like US, England, Canada and China. However, this concept still needs to be accepted and thoroughly understood in developing countries like Pakistan so that more focus can be laid on sustainable development. In Pakistan, the basic concept of environmental protection and impact assessment was induced vide Environment Protection Ordinance in 1983 and EIA was legally recognized after promulgation of the Pakistan Environment Protection Act, in 1997. Section (12) of the Act requires that all large scale developmental projects must file an EIA report to EPAs for obtaining environmental approval [\*]. This made a remarkable increase in the number of EIA reports submitted to Environmental Protection Agency with a total number of 347 reports being submitted within 3 years. [5,6]. The benefits of performing an EIA are that the process not only judges the impacts on environment but binds together social and economic impacts of any developmental project in the present and future. If performed correctly in Pakistan, much of the developmental projects will have far endearing benefits than one can imagine.

Pakistan is still considered to be a third world country where problems like power shortage and less availability of water are in dire need have taken care of. In present day and age, to over-come these problems and to strengthen the economy it

becomes imperative for Pakistan to build multi-purpose dams like Kalabagh. This project is riddled with political controversies and has for a long time been neglected when it comes to making informed and well intentioned decisions. When it comes to making informed decisions, there are meagre studies conducted that actually highlight the positive impacts of such a project. The last research conducted over the project was back in 1999 which included the political interface of the project and the controversies created by all the four provinces along-with their apprehensions. [7, 8]. Many of the water projects and major constructions in Pakistan have been conducted without their EIA's been taken into account. However, the construction of Mangla dam was an exception. The EIA conducted showed that the dam will start losing its designed storage capacity after 4-50 years of its construction due to excessive sedimentation. The EIA helped in the design years of the dam and on the basis of that now Mangla dam has been successfully raised to increase the storage capacity and minimize the effects of sedimentation. The importance of EIA can never be denied at any phase of construction.[9, 10].

The main objective of this paper is to describe the the environmental impacts of Kalabagh dam and discusses the positive and negative impacts based on the probability of their occurrence and their severity. The focus is just on discussing the impacts without discussing the mitigation measures and how to quantify the impacts in terms of indices through multi-criteria decision matrices. This paper aims to highlight the positive and negative environmental impacts of Kalabagh Dam, a multipurpose project, proposed in Khayber-Pahtunkhaw province of Pakistan.

The present study has been done by a detailed study of environmental impacts of three different dams, Tarbela (Pakistan), Aswan (Egypt) and Three Gorges Dam (China) and the comparative analysis of before and after construction scenario of the dams has been conducted. These dams have been chosen for comparison on the basis of similarities to Kalabagh dam with respect to social aspects, geological location and economic implications. Moreover, all the dams were built for hydro-power generation and irrigation

purposes. The impact projection is then applied on the proposed Kalabagh Dam.

**2. LITERATURE REVIEW:**

The aim of an EIA is to identify the significant environmental and social impacts of any project and then propose mitigations to make the project sustainable. The following dams highlight the important environmental impacts of the three major dams in the world.

**2.1 Environmental Impacts of Tarbela Dam:**

Considering the environmental impacts, at the time of constructing of Tarbela dam the environmental impacts were not given much of importance, hence there was lack of data. Also, studies have revealed that the construction of Tarbela dam has no particular impact on plants and animal species present in the vicinity of the reservoir because there were already two barrages constructed before that dam and the changes might have been due to those barrages. [11,12,13].

**2.2 Environmental Impacts of Aswan Dam:**

Dam seems to affect the amount of fisheries present in the river near the vicinity of Aswan Dam. Apart from effect on fisheries the sedimentation rate was lower than expected and

**2.3 Environmental Impacts of Three Gorges Dam:**

The estimated amount of sedimentation was 530 million ton there was no other species of plants and animals which were observed to be affected as a result of construction of dam.[14].

in the reservoir at Three Gorges. However, the observed sediment load is 200 million tons and is actually less than the predicted value. According to CYJV, 6-105 it was stated that there would be no direct impact on the vegetation. Chen et al., 1997 states that 34 local plant communities will be inundated. Important fern species such as *Adiantum Reniforme var.sinense* are expected to be submerged. [15]. It was predicted that *Myricaria Laxiflora* another flora will also be affected. The observation after the construction has shown that *Myricaria Laxiflora* is not extinct due to habitat loss. [16]. It was predicted that almost 172 fish species that reside in Yangtze river will be affected out of which 25 species are caught by villagers for food and earnings.[17]. The observation after the construction shows that there is no impact on endangered and rare species.

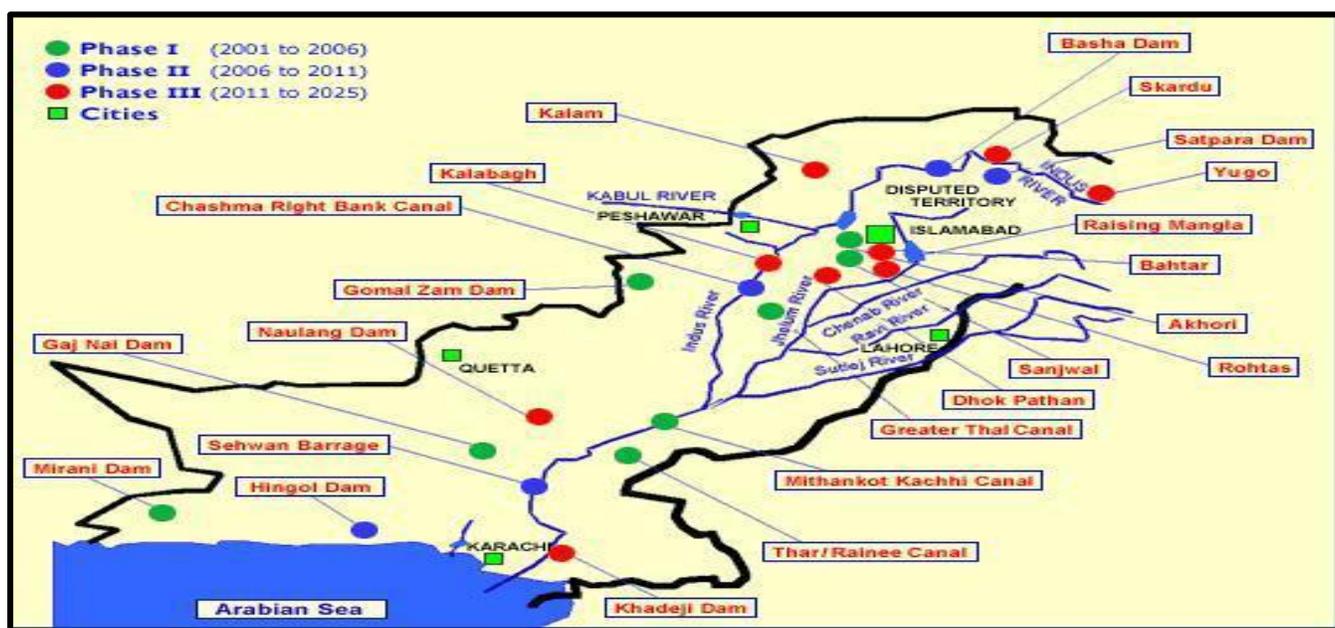


Figure 1 Proposed Kalabagh Dam [6]

Table 1 Plant Species available in vicinity of the dam [5].

Scientific Name	Local name	Common name	Commercial use
<i>Prosopis cineraria</i>	Jandi	Chhenkur	Wood is of construction class and is used for house-building.
<i>Capparis aphylla</i>	Karir	Karir	Used for charcoal and firewood.
<i>Acacia nilotica</i>	Kikar	Thorn Mimosa	Drought resistant and occurs in plain, flat or gently, undulating ground and ravines. Timber resists insects and water, and is used for boat making, water pipes, well planking and carts etc.

**Table 2 Environmental Impacts of KalaBagh Dam [8]**

Environmental Impacts	Impact Description	Comments
<b>Sedimentation</b>	The sediment rate in Kalabagh dam will be more than Tarbela as it is on the downstream of Tarbela, the entire sediment load will flow downstream to Kalabagh Dam reservoir resulting in the inundation of reservoir. It is also feared that the sedimentation will begin near Noshehra thus causing the town to undergo heavy flooding. [8]	This will reduce the life of dam as sediment deposition will be trapped in the reservoir and will increase the risk of high floods.
<b>Biodiversity</b>	The Mangroves will be affected as a result of construction of dam. Other species present in that area are Avicennia Marina, Rhizophora Mucronata and Ceriops Taga which are important for avoiding salination.	The Mangrove forests depend on silt coming from Indus Delta for their survival. As a result of silt accumulation in Kalabagh reservoir their survival would be difficult. Moreover, the other animal species like bears, fisheries e.g. prawns and dolphins depend on Mangroves. The destruction of the forests will have indirect effect on the fauna as well. The mangroves are a source of timber, deforestation of Mangroves will affect the livelihood of people living in coastal areas who are dependent on timber for wood and fuel resource. [8].
<b>Seismicity</b>	The geographical study of the site shows that there are two fault lines in that area, which are quiet active.	Constructing a dam may lead to serious consequences of life and property loss. [8].

### 3. MATERIAL & METHODS:

#### 3.1 Study area and site location:

Kalabagh dam is intended to be constructed in Punjab province of Pakistan on River Indus with the reservoir area in KhyberPakhtunKhaw and Power plant in Punjab.. River Indus is one of the largest rivers in the world. Its height from mean sea level is 5183 m, length is 3000 km and it comprises of catchment area of 940000 Km<sup>2</sup>. [20]. Figure 1 depicts the main and distributing trajectories of the river Indus and the proposed and existing dams on River Indus along with the location of proposed Kalabagh dam.

This paper has been written by conducting immense research regarding positive and negative impacts of constructing large dams and how they should be mitigated. The base line studies have been conducted and discussed keeping the environmental sustainability in view.

#### Data collection:

The data has been collected from past researches and baseline studies conducting for Tarbela dam since the environmental impacts of Tarbela and Kalabagh dam are more or less similar because of their similar geographical location.

#### 4. METHODOLOGY:

The research has been conducted by considering three different dams, Tarbela in Pakistan, Aswan in Egypt and Three Gorges Dam in China and the comparative analysis of before and after construction scenario of the dams has been made. These dams have been chosen for comparison on the

basis of similarities to Kalabagh dam with respect to social aspects, geological location and controversies. Moreover, all the dams were built for hydro-power generation and irrigation purposes. Their projection is then applied on proposed Kalabagh Dam.

The impacts have been ranked on the basis of their probability of occurrence and their severity. The method chosen for this ranking is Analytical hierarchy method and multi-criteria decision matrix. This method is completely based on the probability and any error can be expected. Furthermore, the sensitivity analyses have been carried to check the results

### 5 RESULTS AND DISCUSSION:

#### Environmental Impacts of Kalabagh Dam

The proposed dam site falls in the salt range which is composed of sand-stones and silt stones and there are five oil fields near the proposed dam site. The sand stones and silt stones are hard rocks which are capable of bearing shear pressure of 8 tonnes/ sq. ft.[7]. The dam site is located in the area which has the ability of sediment sluicing which results in the longer life span of dam. However, to efficiently clear the deposited sediment from the reservoir the dam is proposed to have an orifice spillway.

The dam is located on a geological fault line, there are two fault lines, and one is right lateral fault known as 'Kalabagh Fault' and the other is 'Khariwan Fault'. The fault lines are located at 200 km from the proposed dam site. These plates

are quite active and their movement results in the rise of mountains every year. [8].

The Kalabagh dam will have adverse effects on the environment causing severe damage to Mangroves which are source of timber, thus, resulting in reduced production of timber and fuel. Moreover, the other species of plants available in that area which might get affected as a result of constructing the Kalabagh Dam are summarized in the table below:

The wild life available in the area constitutes of jackal, fox, hare and wild boar. However, the downstream of the dam is lack of habitat thus there are less downstream impacts on the wild life. Other species falling under the category of biodiversity include freshwater turtle, fish and fisheries. These fish are sold locally and are of economic value of around 1.6 million dollars. [5].

As a result of seismic activity, there will be environmental disaster, social disruption and economic loss. The damage to dam structure will lead to property loss and casualties. The probability of occurrence of an earthquake is very little. However the severity is high rendering the downstream areas at high risk of undergoing damages. Considering the case of Tarbela dam, which is located 120 miles upstream of proposed Kalabagh dam and is located on the fault line, there was no damage to dam structure as a result of severe earthquake in October 2008 in Pakistan.

## 6. RESULTS AND DISCUSSION:

The comparative analysis of three dams shows that when Aswan dam and Tarbela dam were constructed, the focus towards sustainable development was not the main objective. The main objectives of constructing those dams were power generation and flood alleviation. The environmental issues were totally undermined. It has been observed that all three dams justified their purpose of construction by controlling heavy floods and saving the properties at risk. The case of Kalabagh dam is not different from those of Three Gorges, Aswan and Tarbela when it comes to dam construction. The sedimentation deposition rate in case of Kalabagh will be more as compared to Tarbela since Kalabagh is at the downstream of Tarbela. However, the sediment deposition at Tarbela is less than its predicted value which means the sediment load flowing towards Kalabagh will be less than the predicted. It can be considered as a best case while applying the projection on construction of Kalabagh Dam. If the case of Aswan Dam is considered, it can be seen that sediment deposition prediction has been different in that situation as well. Nile has been bringing sediment load down to Aswan for ages as a result of which the dam's storing capabilities have been affected but it also has enhanced the life span of dam. Also, the sedimentation rates at Three Gorges have been different since the time of construction. It was observed that Tarbela and Aswan dam have least negative impacts on the ecological conditions around them. The one main reason is that at the time of construction of these dams the term sustainable development was not well-recognized hence their environmental impacts were not well taken into consideration. [14]. Same is the case with Three Gorges dam, at the time of

construction the environmental issues were not considered but only associated costs and benefits of the project because at that time sustainability was not the main consideration in China [15]. This point can be used as an important point while considering the case of Kalabagh Dam.

## 7. CONCLUSION:

If Kalabagh dam is not to be built at all then, natural disasters coupled with power shortages will continue to ravage the present economy. The environmental impacts as discussed above are not that severe that they would lead to stop the construction of the dam. Some of the impacts are extremely high risk but the probability of the occurrence is very rare e.g. the seismic activity. It has a very less probability of occurrence but the impacts will be severe. The mitigation measures are a separate and broader area of research and will be discusses separately. Though Kalabagh dam is not the only answer to the economic woes we can consider the alternatives to the dam. Solar energy can be considered a better option since it has positive impacts on the environment but the cost of installing a photovoltaic cell for solar power generation will take almost 7years to be recovered. Also, the cost of electricity generated by all the other alternatives like coal, gas and nuclear power are expensive and will have adverse impacts on environment. Moreover, gas and coal are non-renewable energy resources; more consumption of these resources will cause depletion of natural resources rendering them unavailable to serve our coming generations.

The results of comparison of three dams show that the stake holders, environmentalists, politicians and engineers, who are concerned with the construction of Kalabagh dam should consider the consequences and outcomes of constructing three big dams in all aspects, socio-economic and environmental. This can help in making a better decision in regard to Kalabagh dam and future of Pakistan.

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