ASSESSMENT OF HYDROPOWER POTENTIAL OF NEELUM RIVER USING REMOTE SENSING AND GIS TECHNIQUES

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ABSTRACT: The expanding energy interest, because of the quickly expanding populace, and the subsequent strain on our traditional fuel sources, has demonstrated the advantages of environmentally friendly power sources as an essential for practical financial development. Hydropower is one such source that is both inexhaustible and maintainable as well as being climate agreeable. In spite of the fact that Pakistan depends fundamentally upon hydropower, yet a significant part of the nation experiences monstrous force deficiencies inferable from the huge hole among market interest, notwithstanding having gigantic hydropower potential in the Indus and the Jhelum streams of Pakistan, a large portion of which actually stays un-tapped. Late headways have made conceivable the administration and handling of spatial information utilizing a Geographic Information System (GIS) based climate. The investigation centers around surveying the relative assessment of hydropower potential of bowls, the Indus and the Jhelum of Pakistan, utilizing geographical information, gotten through far off detecting as an advanced rise model, and neighborhood stream datasets. The information was then handled utilizing the different spatial analysis apparatuses, accessible in ArcGIS, to distinguish the likely areas for creating hydropower plants and to assess the hydropower potential related with these spaces. In Jhelum Basin, absolute length of Jhelum River alongside minor waterways is 628 Km of waterway overflow has been assessed to distinguish expected destinations for setting hydropower plans. In Jhelum Basin, 102 No of destinations are assessed with hydropower capability of 10,100 MW. The consequences of this investigation can help increment mindfulness among the dynamic specialists about the tremendous environmentally friendly power capability of the Jhelum River, as hydropower, which is as yet undiscovered. Keeping in view the flow monetary circumstance and setback of electricity being looked by country as a main priority promptly 50 destinations suggested through which 31,900 MW can be produced by introducing hydropower plans. This examination will thusly help the experts in taking astute ruling for a supportable future and beat the energy emergency being confronted today by Pakistan.

Keywords: *Hydropower, GIS, Runoff, Dam Suitability*

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INTRODUCTION

Early investigations of stream networks demonstrated that simply irregular cycles could create fluvial frameworks with topological properties like normal frameworks (Shreve, (1975); Smart, (1968). Such irregular model reasoning has been amazingly persuasive in channel network examines.

Nonetheless, later exploration distinguished various consistencies in stream network geography. These deliberate varieties seem, by all accounts, to be a consequence of different components, including the requirement for lower-request bowls to fit together, the sinuosity of valleys and the movement of valley twists downstream, and the length and steepness of valley sides. These components are more articulated in enormous bowls, yet they are available in little catchments.

A dam is a hindrance built across a characteristic stream (waterway, stream and so forth) to make a capacity, which is by and large called a lake or a repository (Raheem and Khan, (2002)).

Nonetheless, the term repository in water assets designing is utilized from a limited perspective for a similarly huge waterway put away on the upstream of a dam built for this reason. The release in a stream for the most part shifts extensively during various times of a year.

GIS and RS have singled out huge consideration for finding the appropriate hydropower destinations in the new history (Ahmad and Lakhan, (2012); Thara et al., (1993); El-Awar et al., (2000); Shankar and Mohan (2005)). Various boundaries establish the plan of the dam that incorporates the stream qualities, records of stream attributes. Past examinations zeroed in on individual lists like mean day by day stream, consistency and skewness of stream, top dis charge, mean day by day stream, normal stream, flood recurrence, and so forth, while today contemplates zeroed in on multivariate methodology (Hughes and James, (1989); Richter et al., (1996), Richter et al., (1998); Clausen and Biggs, (2000); Extence et al., (1999); Pettit et a l., (2001).

Limitation and grouping of spatial zones dependent on precised spatial and non-spatial rules is the most troublesome issues in the field of an area the executives (TikNiouine, et al., 2006).

Silt and volcanic rocks are uncovered around the pinnacle of Hazara-Kashmir Syntaxis which were portrayed as Panjal System by Lydekker (1878). Landscape geomorphology, subsurface geographical boundaries and region the executives assume key job in the strength; supportability and cost-adequacy of basic designing activities incorporate Dams, Tunnels, Roads, Bridges and so on (Chan et al., 2007) which give mention of development of hydropower dam in interlocking spikes.

Geographic Information Systems (GIS) have demonstrated to be a productive instrument in the recognizable proof of possible destinations for hydropower improvement. Such devices can enhance or now and again totally supplant the on-ground studies, fundamental for distinguishing reasonable locales for hydropower improvement, due the geological detachment. Various examinations and exploration have been done in different pieces of the globe on the use of GIS for recognizing possible destinations for affordable hydropower projects.

Energy is quite possibly the main assets of a nation. It is the foundation of the financial advancement of a nation. The whole modern and private area relies on it. With the presentation of motorized horticulture, the farming area additionally depends generally upon these energy assets likewise alluded to as power. Power illuminates our homes, runs a wide range of apparatus in modern offices and assumes an indispensable job in making our lives agreeable.

Nonetheless, at present Pakistan experiences one more significant threat Energy Crisis'. The expanding populace and modern advancement in the nation has made it unthinkable for it to adapt to the expanded energy requests, the outcome is an energy emergency for a gigantic scope. Extended periods of intensity blackouts have become a serious regular sight in the nation. This is hampering Pakistan from gaining any huge ground in the financial area.

Hydropower has been being used in Pakistan for a long while and is one of the significant supporters of the energy area of the nation. Considering the environmental change issues examined above, it would be generally astute for Pakistan to depend upon greater climate benevolent and reasonably energy arrangements as opposed to depending upon petroleum products for power age. Hydropower is one such arrangement which is very reasonable for Pakistan's circumstance, which being a non-industrial nation, isn't in a situation to manage the cost of immense atomic force plants or tremendous regions of land and costly gear for wind and sun-based ranches. Luckily, nature has invested Pakistan with huge assets of hydropower, an enormous piece of which actually stays undiscovered. This may simply be one of the answers for Pakistan's energy emergency circumstance.

MATERIALS AND METHODS

The study area is the Neelum River, upper Jhelum Basin (UJB), the longitudes of $73^0$00'00"E to $76^0$00'00"E and latitudes of $33^0$00'00"N to $35^0$15'00"N situated in the (N-E) of Pakistan, a highly elevated area. The major streams of the Jhelum River, drain the northern slope of the Pir Punjal Mountains and the southern slope of the Greater Himalayas located in Jammu and Kashmir. The elevation of the basin ranges between 200m to 6248m and the total area of the basin is about 17,484 km^2.The basin is basically the catchment area of the Jhelum River, upstream of the Mangla reservoir which is the country's second largest reservoir.

Points are generated over the stream at a specified interval followed by the interpolation of point average annual stream flow data to obtain the stream flow values at these points. The interpolation of stream flow data is accomplished using ratio proportion technique in GIS. The elevation values at these points are extracted from the DEM to get the hydraulic head. Knowing the average annual stream and hydraulic head, the theoretical hydropower potential at these previously defined points can be easily evaluated.

The previously mentioned checking stations were then situated inside the investigation territories with normal yearly overflow in cumecs as the quality worth. The focuses were situated in the investigation zones utilizing their geographic directions acquired from Google and Data given by WAPDA.

To plot these focuses in ArcGIS, a dominate sheet was readied containing the above information and it was saved as a .csv record. By utilizing Add Data work this document is added to ArcGIS. The focuses were then plotted in ArcGIS. These ascribes relate to the snapped directions of the stations. These snapped organizes will be alluded to as the directions of the checking stations.

Spillover was interjected absurd catchment territory viable by utilizing proportion extent procedure in ArcGIS. As the release esteems are needed at each proposed area along the stream where we need to ascertain the hydropower potential. The release at obscure areas is determined by introduced the given release at different checking stations (Jha, 2011). To clarify it further accept "1" and "2" as two measures introduced in a stream with Q_1 and Q_2. Check "1" is introduced at an upstream area in the watershed, though, measure "2" is situated at the downstream point. The individual sub-seepage spaces of "1" and "2" are "A_1" and "A_2" separately. Let there are two additional focuses "X_1" and "X_2" found upstream and downstream of measure "1" where stream is should have been assessed. Likewise, the sub catchment spaces of "X_1" and "X_2" are "AX_1" and "AX_2" individually. The stream QX_1 and QX_2 at ungauged area utilizing conditions 3.1 and 3.2.

I. Assessing Flow QX_1 at 'X_1'

Moving upstream from measure '1' release should be deducted comparative with the space of sub catchment X1.

$$QX_1 = \left(\frac{AX_1}{A_1}\right) \times Q_1$$

ii. Assessing Flow QX_2 at 'X_2'

Moving downstream from measure 'a', the total release can be determined for each proposed site utilizing following condition.

$$QX_2 = \left(\frac{AX_2}{A_2}\right) \times Q_2$$

Utilizing the previously mentioned approach the release is determined at the imperative point where the hydropower potential to be assessed. The essential focuses are produced by utilizing order "testing" at the distance of 5 Km along the Jhelum streams and furthermore at minor waterways.

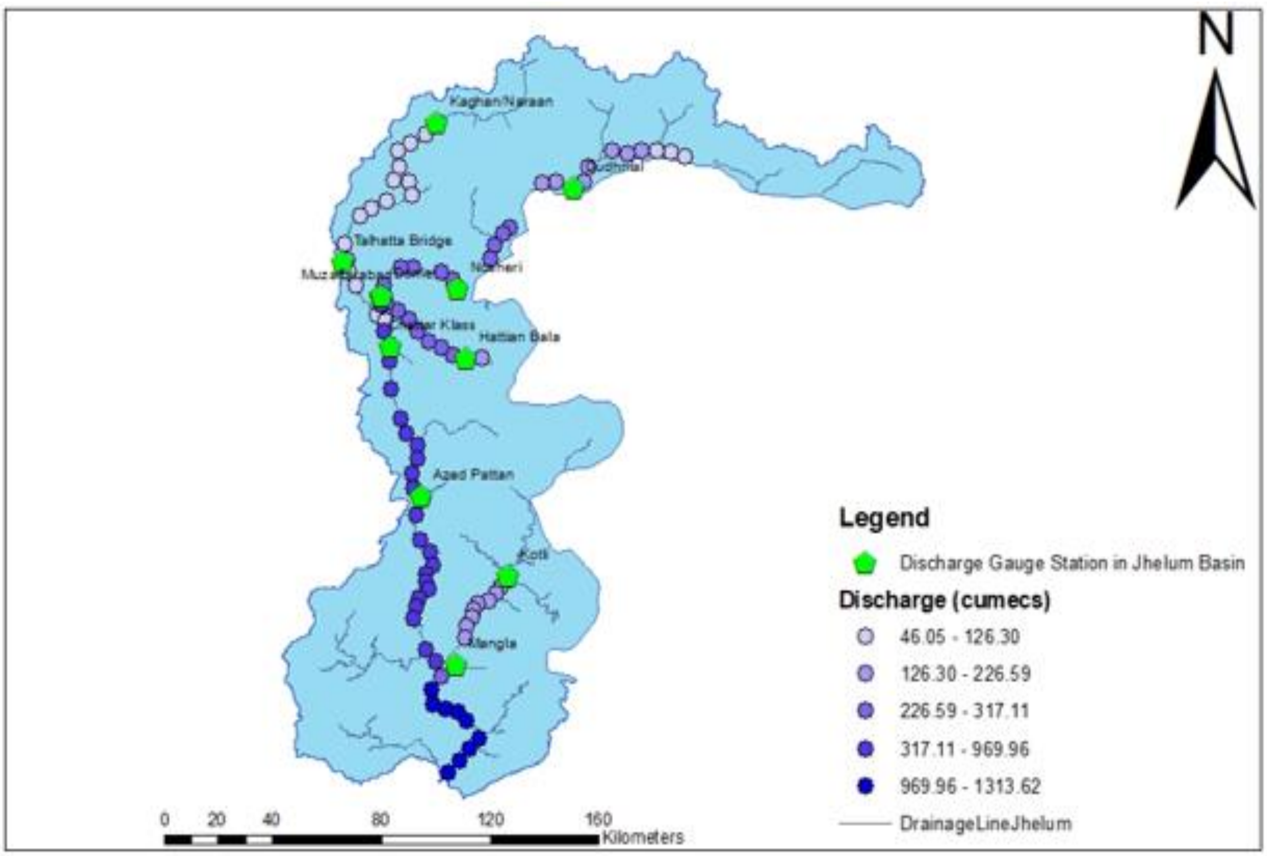


Figure 3.6: Discharge Interpolated over the Jhelum River and its Tributaries

Evaluation of Hydropower Potential: The spillover and rise at Mangla Dam focuses were removed from the DEM and interjected overflow layer, utilizing the "Concentrate Values to Points". Head at each point was then assessed by deducting the height at each point from that of the quickly past point as logical by the accompanying condition,

$$H_n = h_{n-1} - h_n$$

where,

h_n is elevation of the point under consideration, h_{n-1} is elevation of immediate upstream point and H_n is head in terms of height of water column at that point.

The estimation of the hypothetical hydropower potential depended on the accompanying fundamental condition,

$$Power\ Output = P = \rho \times Q \times g \times H$$

where, P is power output in watts, ρ is the density of water (1000kg/m^3), Q river discharge (m^3/s), g acceleration due to gravity (9.81 m^3/s), H is available head (m).

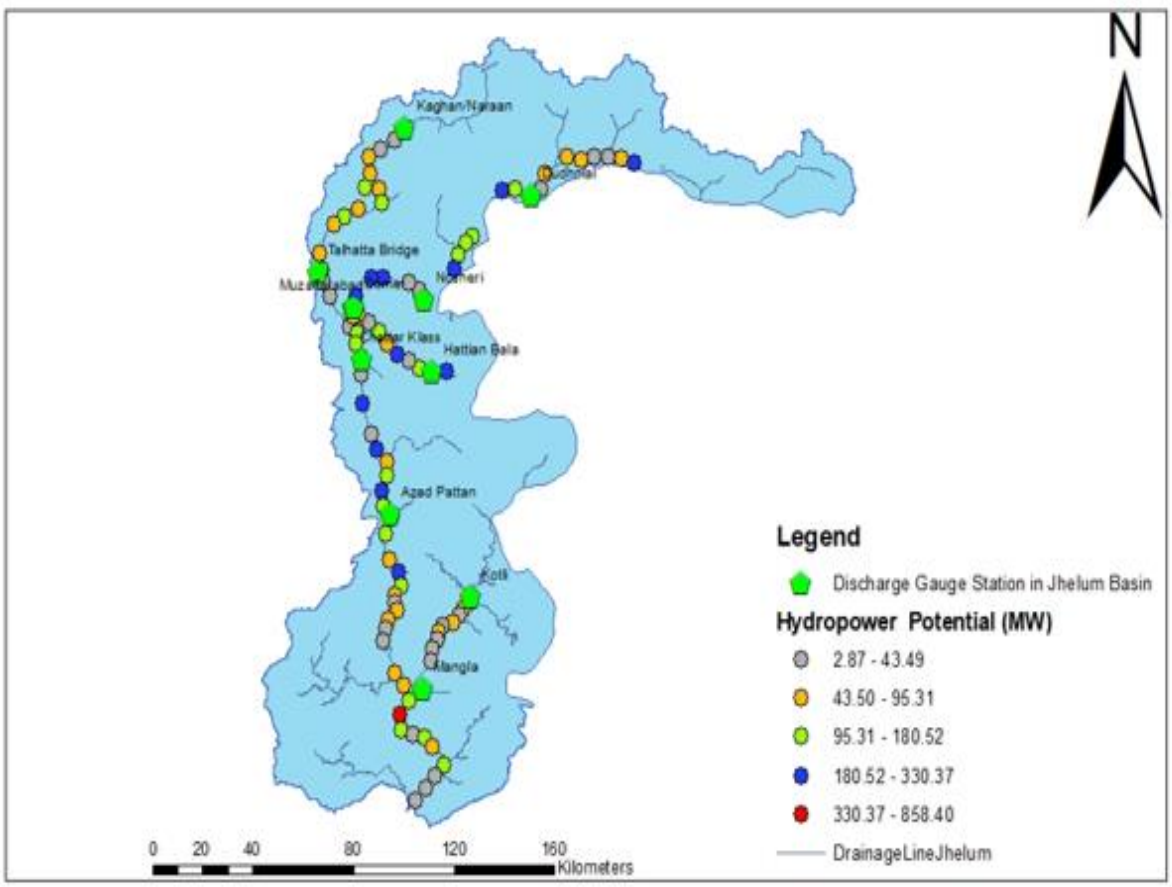
The thickness of water and speed increase because of gravity has been thought to be steady. The solitary two factors in condition (3.4) are stream release and accessible head, which fluctuate along the length of the waterways and have effectively been assessed utilizing ArcGIS. So, the force yield can be handily assessed.

RESULTS AND DISCUSSION

The hydropower potential is low close to the upstream finish of the Jhelum River where it enters Pakistan, trailed by an ensuing increment as it is joined by a few minor waterways for example Neelum River, Kunhar River, Poonch River and so forth and a few minor feeders downstream. Figure 4.2 shows an enormous hydropower potential close to the intersection of the Neelum River and Kunhar River with Jhelum River nearby Mangla dam with values as high as 858.403 MW. Additionally, for the Neelum River it is obvious from figure that it begins from Pakistan limit and approx. after 65Km it enters in Indian Held Kashmir tertiary so it become less successful in Jhelum Basin. While the complete 22 focuses created at Neelum River with net Hydropower age of 2844.41MW and most extreme and least hydropower capability of 330.37 MW and 2.87 MW separately, and a normal hydropower capability of 129.28MW. The gross hydropower potential in the Kunhar River is 1512.322MW and most extreme and least hydropower potential is 159.196 MW and 9.036 MW separately, and a normal hydropower capability of 75.616 MW. The Poonch River additionally unequivocal the hydropower capability of gross hydropower age of 609.34MW, and most extreme and least hydropower age potential is 180.522 MW and 13.094 MW individually, and a normal hydropower age potential from Run-Off-River is 55.397 MW. The join hydropower potential from previously mentioned three Run-Off-River is 4965.802MW. The net age of hydropower from Run-Off-River Jhelum is 5144.063 MW and a normal hydropower age from stream run off is 119.629 MW. The net hydropower potential over the whole Jhelum Basin through stream run off at the time period Km at 102 unique focuses is 10109.85MW with greatest and least 858.40 MW and 2.87 MW separately, with a normal hydropower age is 105.31 MW.

The outcomes for the spatial dispersion of the hydropower potential in the Jhelum bowl territory are appeared in Table. The yellow featured focuses are addressing the above 50MW and sub optimal for example 105.311MW hydropower expected focuses. The qualities featured in red relating to a hydropower potential more noteworthy than normal hydropower potential in the area for example 105.311 MW and beneath 500MW and these focuses are bound to be reasonable for the improvement of a hydropower conspire. The worth heighted with green comparing to most elevated Run-Off-River potential point for example 854.403 MW.

Sr No	Longitude (DMS)	Latitude (DMS)	Elevation Above Mean Sea level (AMSl) (m)	Elevation above Mean sea level (AMSL) of upstream end (m)	Head (m)	Discharge (cumecs)	Hydropower Potential (MW)	Hydroelectricity (x10^10 Whyr)	Remarks
				(a) Neelum River					
1	74°31'11"E	34°47'18"N	2365	-	-	89.07	-	-	
2	74°28'14"E	34°48'9"N	2095	2365	270	93.97	248.91	218.04	
3	74°25'32"E	34°48'55"N	2044	2095	51	97.22	48.64	42.61	
4	74°22'35"E	34°49'23"N	2007	2044	37	98.96	35.92	31.46	
5	74°19'46"E	34°49'11"N	1983	2007	24	148.55	34.97	30.64	
6	74°16'45"E	34°48'44"N	1921	1983	62	151.79	92.32	80.87	
7	74°13'53"E	34°49'24"N	1874	1921	47	155.26	71.59	62.71	
8	74°8'56"E	34°46'20"N	1836	1874	38	205.01	76.42	66.95	
9	74°8'13"E	34°43'21"N	1818	1836	18	206.97	36.55	32.01	
10	74°2'42"E	34°43'23"N	1737	1818	81	216.86	172.32	150.95	
11	73°59'58"E	34°43'12"N	1608	1737	129	226.59	286.75	251.19	
12	73°55'43"E	34°36'28"N	1416	-	-	245.24			



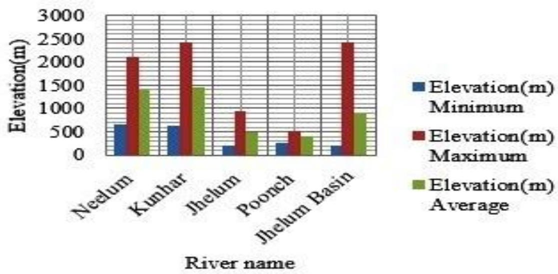


Figure a: Comparison of elevations of Jhelum Basin

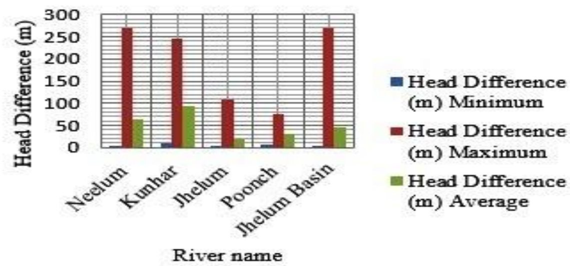


Figure b: Comparison of Head Difference of Jhelum Basin

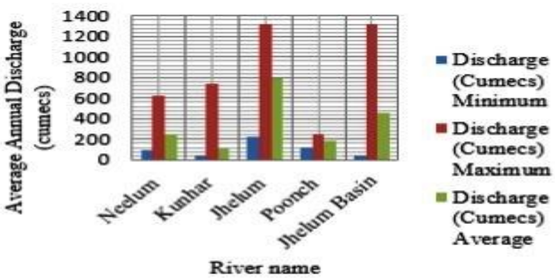


Figure c: Comparison of Discharge of Jhelum Basin

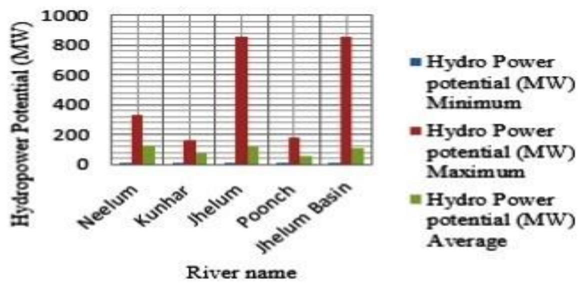


Figure d: Comparison of Hydropower Potential of Jhelum Basin

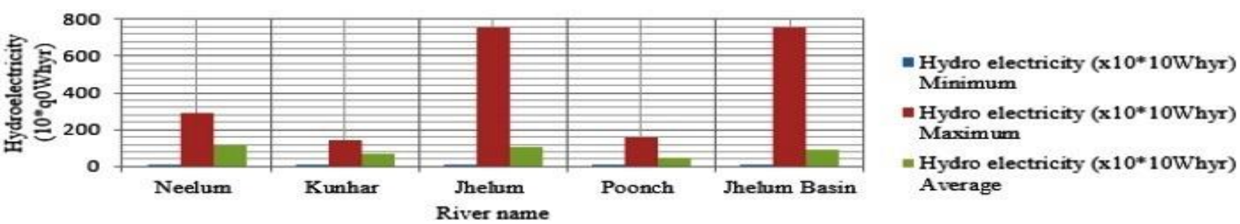


Figure e: Comparison of hydroelectricity of Jhelum Basin

The outcome investigation shows that there is a tremendous hydropower potential in Jhelum bowls that can be created by raising Run-Off-River plans.

It is obvious from underneath realistic portrayal of boundaries. The greatest elevation esteem in Jhelum bowl is 6285m. Additionally, the base worth in Jhelum bowl is 214 m. Essentially investigation of release shows that greatest yearly normal release in Jhelum bowl is 795.99 cumecs at Azad Pattan release check station. It will be prudent to introduce a few marks of hydropower plot with normal Power Station.

Conclusion: The study concludes the following testimonials:

i. The absolute hydropower capability of the Upper Jhelum Basin adds up to 10,100 MW, in light of the 5km stretch at 102 focuses set up with the end goal of this examination.
ii. The scope of hydropower limit will run between 2,056.493 MW and 273.308 MW.
iii. 2,101 MW can be created by setting 5 hydropower plots in Jhelum Basin.

Subsequently making an admirably strides by raising hydropower plans at the previously mentioned 50 locales the gross hypothetically hydropower potential approx. 31,990 MW can be created and as of now examined net normal interest is 21,000 MW and henceforth presently whole interest can be met through hydropower and in this way financial area of nation can be support by depending least on petroleum derivative worked plants.

This investigation can help the dynamic specialists like Water and Power Development Authority (WAPDA) of Pakistan to settle on fast and steady choices to the greatest advantage of the nation's economy and revealed some insight into the huge stores of sustainable power accessible in much disregarded Jhelum Basin spaces of Pakistan.

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