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Water Resource Management and Dams Construction for Sustainable Development of Pakistan

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ABSTRACT For human survival, electricity needs, flooding control, water resources management, and the construction of dams are very important. The purpose of this study is to undertake a sustainability evaluation of water resources management and dam construction in Pakistan. The findings demonstrated that the economic dimension of dams is the most significant for sustainable development in Pakistan. Need for the electricity has increased dramatically so hydroelectric projects play a vital role because of their technological and environmental advantages. This study will be helpful in dealing with the measures to fulfill Pakistan's energy and power demand for sustainable development. About 33 % of electricity generation in Pakistan is done by hydropower, but Pakistan needs to increase the production; hydro power is considered as a symbol of praise in the production of energy and it is also a fundamental source of storage of the water. The recent flood condition in Pakistan affected the economy and it diverts the focus of government towards the destruction recovery. Hydropower reservoirs are fundamentally used in the electricity generation in summer and water reservoirs are used in crop irrigation during the winter and these reservoirs filled in the moon soon season.

Keywords:

Water Resource Management, Sustainable Development, Hydropower Projects, Dams Construction

1. Introduction

For economic and social development and improved facilities for the life the most essential component is energy nowadays; the methods through which we are producing energy are not constant and sustainable [1]. In order to control the emission of greenhouse gases and other pollutants; efficiency in the production of energy and use of energy are essential [2]. One fifth of power generation in the world is done by hydropower plants. Hydropower plant is used for domestic energy generation in many countries [3] and it is the most constant and sustainable

energy production resource. In coming decades, about 95% people will search for the sustainable source of energy; the ability to plan generating is one of the main benefits of hydropower, depending upon the storage capacity involved [4] and to provide continuous base load generation hydropower built on the run of river; this scheme can optimize the generation of energy when it is needed [5]. Reservoir in this scheme helps to store potential energy for the generation for the highest demand, when reservoir is not available then the pump storage is used for potential energy production [6]. The efficiency in mixed power generation can be sustained by the hydropower and it will also decrease the fossil-fuel power plant use and backing the wind power plant. Dams are crucial for the prevention of flooding, the production of electricity, transporting goods, and water supply, as well as for easing the global energy crisis and lowering the danger of climate change [7]. But because so much water is being stored, significant potential energy is created, which poses a serious threat to the downstream. Several destructive floods are caused by dam breaks, which also have a significant negative effect on the environment and ecosystem, as well as on the economy. The focus given to the environmental damage caused by dam failure increased comparatively later in comparison to concerns surrounding the loss of lives and the economy [8]. The reason presented in favor of dam construction is that the economic advantages of the dam exceed its expenses, but the construction of a dam also causes harmful biophysical and geopolitical effects, moreover, it also sometimes causes the complete loss of ecological services by the aquatic system [9]. This also has an impact on the life of those people who completely depend upon the river for livelihood. In this assessment [10], we study the construction efforts made by developed to developing countries like China, the USA, and Southeast Asia. We come to the conclusion that certain element related to the development has link between the policies, governed and the cost reduction of dam socially and environmentally. The need is to emerge environmental activism to play a vital role in sustainable development as an individual play a role in influencing the political resolution behind the dam construction [11]. The discussion about the huge dams is fundamental and complicated; it involved many political, environmental and social decisions regarding to human growth and wellbeing. The design, building and operation of dam are included in decision.

Need for the electricity is increased dramatically so Hydroelectric power will play a significant role in the future of global energy mix because of its technological and environmental advantages. This study is helpful to deal with the measure to fulfill Pakistan's energy and power

demand for the development of sustainable energy. The total hydropower production in Pakistan is 10,635 Megawatts whereas more than 14,600 megawatts projects are under construction.

2. Hydropower Projects for Sustainability

There are uncountable benefits of the rivers like irrigation, drinking water and energy navigation and it also increase the beauty of the landscape [12]. For centuries people tried to ensure the benefit of river by harnessing water and by constructing dam; dams usually change the natural regime flow of the water and consequently it effect the whole natural life in rivers [13]. It also effects the reproduction of fishes, aquatic habitat and quality of water; for example, there is loss of water in reservoir due stream laden with the sediments and in arid environment the loss of water is done by the evaporation. Dams also affect the owner economically; decision-makers must continue looking for sustainable water sources and usage strategies that may meet both human and environmental needs as communities experience a growing strain on their water supplies. Water conservation, infiltration galleries, and desalination plants are a few alternatives your community can implement to reduce demand and secure water supplies in less harmful ways if there is a water supply dam or diversion causing unjustified harm to the river ecosystem in your community or a new storage facility is being planned; alternatives with lower impact cannot be used to replace water supply structures in any case [14]. In 1993, the USA made many dams for water storage and to protect the people from flooding; due to the dynamic nature of the river ecosystem, many species of fish and aquatic animals reproduce on this basis of drought and floods even species migrate, but flood causes damage to human wealth and property. In the USA damage from floods increased from 40 billion dollars in recent five years [15]; this is all due to people's carelessness and many people lost their life. There are two ways of managing this: 1. the first way is that we should understand the frequency and magnitude of the flood and protect the people's life. 2. Second is the traditional way of making dams and other structural flood-managing structures. Hydropower has great relation with the water management and renewable energy production [16]. So, it will play significant role in contributing to sustainable development in world where billion of people do not have facilities of drinking safe water. In this world about 1.6 billion people do not have electricity supply while 1.1 billion people do not have adequate drinking water facilities. But still there a number of hydropower sources in world; Hydropower exists in 150 countries and 70% helpful in generating electricity in developed countries [17]. Hydropower preserves the precious water source [18] by not polluting, over

consuming and wastage; the money obtains from water resources by selling the energy can be used in the welfare of the society; these include the irrigation facilities, navigation and ecotourism. As we know life depend upon the water and unfortunately there is less water sources in many countries and even some countries face drought condition; the water sources are unequally distributed in the world. Flood also effect the major part of the world but Dams are used to store water and also used for generating energy and for the storage of water for cultivation, irrigation. Hydropower has little greenhouse gases emission as compared to the other big sources but it also helps in the storage of water and prevents from the flood and drought condition. It also assets and helps in saving the people life. Dams have very little environmental effects and it does not cause acid rain or any atmospheric pollution. In this world there is no cleaner way to get energy; there must be little pollution by every energy source. Stakeholders have to make guidelines and follow them to get a sustainable energy source [19]. More than 20% of the world electricity generation is done by hydropower plants; in Europe there is about more than 33% of electricity generation done by hydropower plant and in North America more than 20% of electricity generation this means. People also use small hydropower to fulfill their needs; about 300 million people in china use this method for energy generation; the hydro capacity in worldwide is 700GW [20]. The world gross production is 40000TWh/year and this is theoretical value; about 14000TWh/year is used for the development while 7000TWh/year for economic use. The hydropower plant generates about 65% of the electricity in developing countries. In developing countries it will be the main of source of electricity generation in future [21].

3. Hydropower Projects in Pakistan

Energy is essential to economic and social development and improved quality of life in Pakistan as in other countries. On the other hand, electricity supply infrastructures in Pakistan, as in many developing countries, are being rapidly expanded as policymakers and investors around the world increasingly recognize electricity's pivotal role in improving living standards and sustaining economic growth. On the contrary, in the coming decades, global environmental issues could significantly affect patterns of energy use around the world as in Pakistan. Pakistan is full of the natural resource, which are very helpful in producing electricity. In Pakistan, the production of electricity depends on different resources like oil, gas, hydro and others as table 1 is showing following;

Table 1: Percentage of Electricity Production by Sources

No	Type	Percentage
1	Fossil Fuels	59
2	Hydroelectricity	33
3	Non-Hydroelectric	1
4	Wind	1
5	Solar	1
6	Nuclear	5

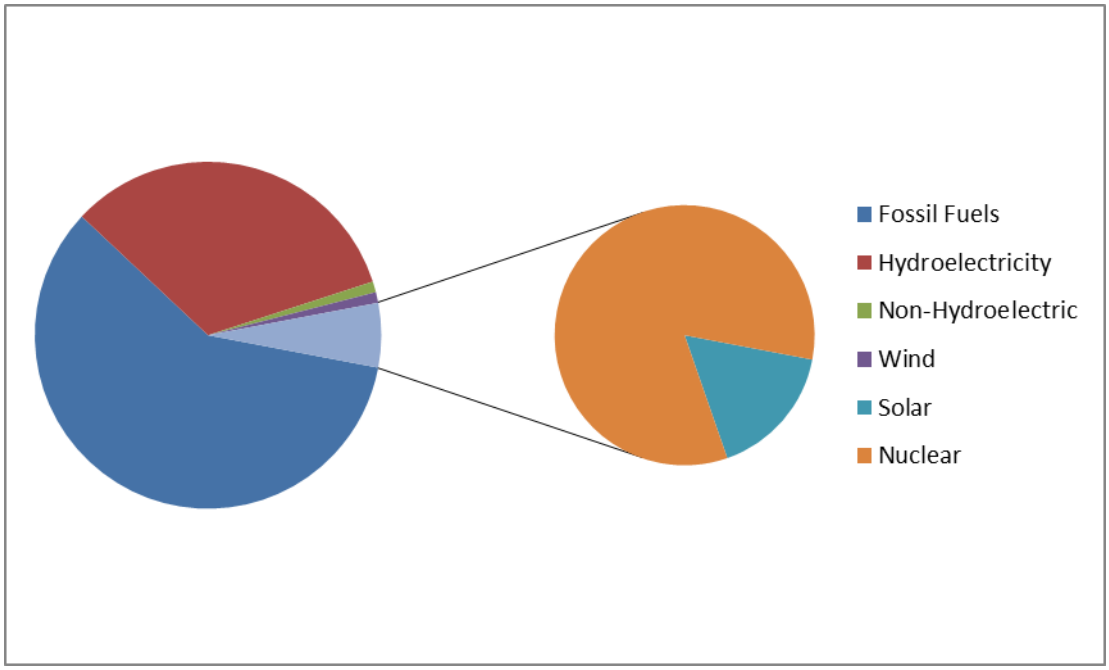

Fig. 1: Percentage of Electricity Production by Sources

As per the report of National Electric Power Regulatory Authority, following are the hydropower projects working in Pakistan. The total capacity of working HPP is 10,635 Megawatts as shown in table 2.

Following is the list of under construction HPP, the total capacity of these projects more than 14,600 megawatts, as shown in table 3;

Table 2: Working Hydropower project's Electricity production capacity

Station	Location	Type	Capacity
Allai Khwar	Mansehra, KPK	Reservoir	121
Chashma	Chashma, Punjab	Run of River	184
Chichonki Malian	Sheikhupura, Punjab	Run of Canal	13
Chitral	Chitral, KPK	Run of Canal	1
Daral Khwar	Swat District, KPK	Run of River	37
Dargai	Malakand, KPK	Run of Canal	20
Duber Khwar	Kohistan, KPK	Reservoir	130
Garam Chashma	Chitral, KPK	Hydro	1
Ghazi-Barotha	Attock, Punjab	Run of River	1,450
Golen Gol	Chitral, KPK	Run of River	108
Gomal Zam	South Waziristan	Reservoir	17
Gulpur Hydropower Plant, Barali	Kotli, Azad Kashmir	Run of River	100
Jagran	Neelum, Azad Kashmir	Hydro	30
Jinnah	Jinnah Barrage, Punjab	Run of River	96
Karot	AJK/Punjab	Run of River	720
Khan Khwar	Shangla, KPK	Reservoir	72
Kurram Garhi	Kurram Garhi, KPK	Run of Canal	4
Laraib Energy	Jhelum River, AJ&K	Hydro	84
Malakand/Jabban	Malakand, KPK	Run of River	22
Malakand-III	Malakand, KPK	Run of River/Canal	84
Mangla	Mirpur, Azad Kashmir	Reservoir	1,000
Marala Hydro (PPDCL)	Sialkot, Punjab	Canal Fall/Run of River	8
Nandipur	Gujranwala, Punjab	Run of Canal	14
Neelum–Jhelum	Muzaffarabad, Azad Kashmir	Run of River	969
Patrind Hydro	Muzaffarabad, Azad Kashmir	Run of River	147
Pehur	Swabi, KPK	Canal Fall/Run of River	18
Ranolia	Kohistan, KPK	High Head	17
Rasul	Mandi Bahauddin, Punjab	Run of Canal	22
Renala	Renala, Punjab	Run of Canal	1
Shadiwal	Shadiwal, Gujrat, Punjab	Run of Canal	14
Tarbela	Tarbela, KPK	Reservoir	3,478
Tarbela 4th Ext.	Tarbela, KPK	Reservoir	1,410
Warsak	Peshawar, KPK	Run of River	243

Table 3: Under construction Hydropower project's Electricity Production Capacity

Station	Location	Capacity
Azad Pattan Hydropower Project	Sudhanoti, Azad Kashmir	700
Chiniot Dam	Chiniot, Punjab	80
Dasu Dam	Dasu, KPK	4,320
Diamer-Bhasha Dam	Chilas, Gilgit-Baltistan	4,500
Jabori Hydropower Project	Mansehra, KPK	10.8
Jagran-II Hydropower Project	Neelum, Azad Kashmir	48
Karora Hydropower Plant	Shangla, KPK	11.8
Keyal Khwar Hydropower Project	Kohistan, KPK	128
Kohala Hydropower Project	Muzaffarabad, Azad Kashmir	1124
Koto Hydropower Plant	Lower Dir, KPK	40.8
Kurram Tangi Dam- Stage I	North Waziristan, FATA	83.4
Lawi Hydropower Plant	Chitral, KPK	69
Matiltan Hydropower Project	Swat, KPK	84
Mohmand Dam	Mohmand Agency, KPK	800
Nai Gaj Dam	Dadu, Sindh	4.2
Naltar-III Hydropower Project	Naltar, Gilgit-Baltistan	16
Nara Hydropower Project	Nara, Sindh	13.6
Naulong Dam	Jhal Magsi, Balochistan	4.4
Shagarthang Hydropower Project	Skardu, Gilgit-Baltistan	26
Sharmai Hydropower Project	Upper Dir, KPK	150
Shingo Kas Hydropower Project	Dir, KPK	102
Suki Kinari Hydropower Project	Mansehra, KPK	884
Tangir Hydropower Project	Chilas, Gilgit-Baltistan	21
Tarbela Dam Extension-V	Tarbela, KPK	1,530

4. Power Consumption Analysis

Table 4 represents the increasing percentage of electricity consumption in Pakistan. Numerical statistical approaches used in the data analysis are neutrosophic statistical approach; which is used to visualize the data and proposed by Smarandache, F.[22]. Nowadays, the use of this technique has enhanced the capability to suction the data in various spheres. This new method is based on interval data with its indeterminacy to explain the difference of data; old Classical method deals with single value that is unable to indicate indefiniteness and difference [23].

Table 4: Yearly Increasing Percentage of Electricity Consumption

No	Year	Consumption	Increasing %
1	2012	76761	---
2	2013	76789	0.036463556
3	2014	83409	7.936793392
4	2015	85818	2.807103405
5	2016	90431	5.101126826
6	2017	95529	5.336599357
7	2018	106928	10.66044441
8	2019	109461	2.314066197
9	2020	108371	-1.00580414
10	2021	115816	6.428300062
11	2022	133666	13.35418132

Let $'A_{iN}'$ is the neutrosophic numbers having A_{iL} lower values and A_{iU} upper values, so the neutrosophic formula for the ithinterval:

$$A_{iN} = A_{iL} + A_{iU} I_{iN}; I_{iN} \epsilon [I_{iL}, I_{iU}] \quad (1)$$

Here, $I_{iN} \epsilon [I_{iL}, I_{iU}]$ is indeterminacy interval and $A_{iN} \epsilon [A_{iL}, A_{iU}]$is an unsystematically neutrosophic variable having size$n_{iN} \epsilon [n_{iL}, n_{iU}]$. The lower part/value of$A_{iN} \epsilon [A_{iL}, A_{iU}]$is the classical part/value and the upper part/value is the indeterminate part/value. For neutrosophic formula $I_{iL} = 0$ an I_{iU} can be found by using $(A_{iU} - A_{iL}) / A_{iU}$. Similarly, neutrosophic mean $\bar{A}_N \epsilon [\bar{A}_L, \bar{A}_U]$is defined as follows:

$$\bar{A}_N = \bar{A}_L + \bar{A}_U I_N; I_N \epsilon [I_L, I_U] \quad (2)$$

Here $\bar{A}_L = \sum_{i=1}^{nL} \left({}^{A_{iL}}/_{n_L} \right)$ and $\bar{A}_U = \sum_{i=1}^{nU} \left({}^{A_{iU}}/_{n_U} \right)$.

5. **Discussion**

About 33 % of electricity generation in Pakistan is done by hydropower, but Pakistan needs to increase the production for sustainable development[24]. Hydropower is considered as a symbol of praise in production of energy and this is also fundamental source of storage of the water. It seems quite difficult for Pakistan to achieve such production of electricity with problems like severe climate, increase in the cost and delay in the schedule. Recent flood condition in Pakistan effect the economy and it diverts the focus of government towards the destruction recovery. Despite, having a great share in the total power mix of Pakistan, still the store water in the dams

and hydropower are used in the agriculture field. Hydropowers are fundamentally used in the electricity generation in summer and water reservoirs are used in crop irrigation during the winter and these reservoirs fill in moon soon season.

Table 5: Neutrosophic Analysis of Consumption

No	Year	Data Intervals	Neutrosophic Formula
1	2013	[76761, 76789]	$76761+ 76789_N$; $I_N\epsilon[0, 0.0003]$
2	2014	[76789, 83409]	$76789+ 83409_N$; $I_N\epsilon[0, 0.0793]$
3	2015	[83409, 85818]	$83409+ 85818_N$; $I_N\epsilon[0, 0.0280]$
4	2016	[85818, 90431]	$85818+90431_N$; $I_N\epsilon[0, 0.0510]$
5	2017	[90431, 95529]	$90431+ 95529_N$; $I_N\epsilon[0, 0.0533]$
6	2018	[95529, 106928]	$95529+106928_N$; $I_N\epsilon[0, 0.1066]$
7	2019	[106928, 109461]	$106928+ 109461_N$; $I_N\epsilon[0, 0.0231]$
8	2020	[109461, 108371]	$109461+ 108371_N$; $I_N\epsilon[0, -0.0100]$
9	2021	[108371, 115816]	$108371+115816_N$; $I_N\epsilon[0, 0.0642]$
10	2022	[115816, 133666]	$115816+133666_N$; $I_N\epsilon[0, 0.1335]$

6. Conclusion

To conclude, we can say that proper management of water resources and construction of dams is mandatory for sustainable development of Pakistan. Dams are used for many purposes like irrigation, navigation, and flood management and for the production of electricity. Run of river and peaking mode are operated by the hydropower dams. The renewable energy production has a close relation with both water management and hydropower industry. The hydropower industry has great impact on the international community and working for the sustainable development in the world. Hydropower industry has very small effect in global warming because of its low emission of greenhouse gases, but it also help in the storage of water and providing people with cleaning water for drinking purposes and for cultivation. Hydropower plants are proven very efficient in generating energy. These can produces energy up to 95% while on the other hand fossil fuel can produce only 60% of useful energy.

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