Academy journal for Basic and Applied Sciences (AJBAS) Volume 6 issue 3, 2024

Comparative Study of Hydroelectric Power Production between Wadi Ghan Dam and Wadi Majinin Dam in the Western Mountain Region of Libya

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Abstract--This paper presents the study if could design of a hydroelectric power station utilizing dam resources in the Western Mountain region of Libya. Monthly data spanning three years was analyzed for each dam, focusing on energy production comparisons between Wadi Ghan and Wadi Majinin dams from 2010 to 2012. Key factors examined include dam size, height, and water storage capacity, all impacting energy production efficiency. Designed with a targeted production capacity of 30 MW per day, the project incorporates pumps to recycle discharged water, preventing loss and optimizing resources. Data analysis was conducted using Excel. The economic viability of the project is promising, as the station will enhance regional electricity supply while reducing dependence on conventional energy sources. As a renewable and clean source, hydroelectric power minimizes harmful emissions and mitigates negative environmental impacts. Establishing the station is also expected to support local infrastructure, stimulate the economy, and create job opportunities. In the operational phase, hydroelectric power generation is anticipated to have lower costs compared to traditional energy sources.Furthermore, raising the dam's water level is projected to boost energy output by increasing storage capacity and enhancing hydrostatic pressure on the turbines, thus improving turbine efficiency and overall energy generation. These optimizations align with the project's objectives, contributing to increased energy output, economic viability, and the enhanced performance of the hydroelectric power station.

Key words --Wadi Ghan Dam, Wadi Majinin Dam, Maximum water Level height: HL, Outlet Channel height: OL, Outlet Channel diameter: D, Water Level: WL, Area: A, Velocity: V, Flow rate:Q, Power:P, Energy:E and Hydroelectric Power

I. INTRODUCTION

Renewable energy sources provide an essential alternative to meet global energy needs while minimizing the environmental impact of energy production. These alternative sources include solar, wind, hydroelectric, thermal, biomass, and waste energy, all of which help address challenges related to climate change and the depletion of natural resources. Water, as one of the world's most abundant resources, holds vast potential for energy generation through its natural flow. Hydroelectric power harnesses this potential by utilizing the elevation difference between high and low water levels to drive turbines and produce electricity through the flow's kinetic energy.

Hydropower has been widely utilized for centuries. Ancient Greek farmers used water wheels to grind grain, and this form of energy saw significant development in the late 19th century. The first hydroelectric station was constructed at Niagara Falls between 1879 and 1881, followed by the first U.S. station in Appleton, Wisconsin, in 1882. By the 20th century, hydropower was generating about one-fifth of the world's electricity, with China, Canada, Brazil, the United States, and Russia emerging as the leading producers [1][2].

Hydroelectric stations are among the most cost-effective means of electricity generation, as they rely on renewable fuel sources—rain and snowfall—which are naturally replenished annually. This approach enables engineers to control electricity production based on demand. Hydropower facilities are diverse, encompassing river-based power, storage hydroelectricity, marine hydropower, and pumped-storage systems, which allow flexibility to meet daily energy needs [3].

II. LITERATURE REVIEW

- Using Artificial Neural Networks for Optimal Long-term Operation of Hydropower Stations, Saleh Al-Hafez, 2011: Load distribution in a system containing thermal and hydropower generation is known as optimal load distribution, aiming to reduce the total electricity generation cost while considering electrical and hydrological constraints. This distribution occurs in two steps: finding the hydropower generation part, then the thermal generation part. The study focuses on the first part, using artificial neural network technology to find the optimal water distribution over the months of the year, taking the main Mosul Dam as an example. Six inputs were selected as network input variables[4]. This study provides a good method for calculating the cost of electricity generated from the station and the value of the artificial neural network for optimal distribution.
- Turkish Water Projects in the Tigris and Euphrates Basins, Hamid Abid Haddad, 2012: Turkey initiated its

water projects in the 1980s, starting with the Southeastern Anatolia Project (GAP), one of the world's largest and most ambitious projects, conceived by former Prime Minister and President Süleyman Demirel. The project's idea matured in the late 1970s, even though plans for the Keban Dam on the Euphrates in Turkey existed much earlier. The GAP includes 13 major projects, with seven in the Euphrates Basin and six in the Tigris Basin, involving the construction of 22 dams and 19 hydroelectric stations. Following the GAP, Turkey planned the "Peace Water Pipes" project in 1986, aiming to divert part of Turkey's water to Middle Eastern and Gulf countries via two pipelines. This project has faced many challenges and obstacles, preventing its implementation. Turkey's water projects aim to achieve economic, political, security, and strategic goals, striving to become an economic and political power at the expense of the riparian countries[5]. This study helps in evaluating the success of irrigation channels and the efficiency of water flow in operating the hydroelectric station.

- Mathematical Algorithm for Stabilizing the Power System through Controlling Hydropower Plant Parameters, Ziad Hermosh, 2012: In Syria, a hydroelectric power plant on the Euphrates Dam is operational. This research highlights the potential to enhance the stability of the electrical power system by developing a mathematical algorithm to control the power generated by such plants, which are primarily used to support peak loads due to their smooth and rapid start-up. The algorithm focuses on studying the control system of the massive turbines to improve the dynamic stability of the power system during significant short circuits, ensuring turbine power restriction for increased static stability during the disconnection of power transmission lines, damping transient electrodynamics states[11]. This topic is crucial for the study of dams in terms of estimating and calculating the power and capacity of stations providing dynamic stability for hydropower plants, making it easier to determine the study's success or failure.
- Study and Design of a Hydropower Station on the 16 Tishreen Dam in Latakia, Jouni Tekla, 2015: The researcher chose the 16 Tishreen Dam on the Al-Kabir Al-Shamali River to build a hydropower station. He conducted a comprehensive study of numerous such stations, their components, and operations, identified all types of turbines used, and carried out a computational study for the hydropower project. After thoroughly studying the collected data about the dam and its waterways, he selected the appropriate channel and designed the dimensions of the Kaplan turbine. The design ensured that the hydropower station's establishment did not affect irrigation works or other projects on the dam, using necessary engineering programs for automation and creating required curves and diagrams[6]. This study is closely related to ours in terms of calculating the amount of electricity generated from flowing dam water and selecting engineering programs for automation.
- The Renaissance Dam Crisis and Its Impact on Egyptian-Ethiopian Relations, Azar Abd Khlifa, 2021: Formerly known as the Millennium Dam, it is a gravity dam under construction on the Blue Nile, about 40 km east of Sudan, in the Benishangul- Gumuz region, Ethiopia, with a capacity of 6,000 MW.

  It will become Africa's largest hydropower station upon completion, ranking 13th or 14th globally, alongside the Krasnoyarsk Dam. The dam's reservoir will have a capacity of 63 billion cubic meters, making it one of the largest reservoirs in Africa. The dam's primary purpose is electricity generation, with water returning to its course to downstream countries (Sudan and Egypt) after electricity generation, without consumption for irrigation [12]. This study can help in understanding how to store water at a certain height, converting the potential energy of water held by the dam into kinetic energy due to gravity when a waterway is opened at a lower level, and using the flowing water's speed to operate the station.

III. Problem Statement

Is it possible to obtain a good hydroelectric power system as same as in Dukan Dam that is used in Iraq as shown in Figure .5 and 6, when applied to the Wadi Ghan Dam and the Wadi Imjinen Dam, by using Grundfos pumps ?.

IV. Methodology

This study evaluates the feasibility and design requirements for a hydroelectric power station in the western mountainous region of Libya, specifically focusing on the Wadi Ghan and Wadi Majinin dams. The methodology involves a comprehensive analysis of the study area, assessment of hydrological and geographical characteristics, and an adaptation of the Dukan Hydroelectric Power Station design for optimal implementation. The steps involved in this methodology are as follows:

The methodology employed in the study includes:

Case study

A. Study Area and Hydrological Assessment

- The study area, as shown in Fig. 1. located in Libya's western mountainous region, was assessed for its suitability for hydroelectric power generation. As shown in Figure.1, this region, characterized by mountainous terrain and significant rainfall, provides a favorable setting for hydropower development.
- The dams in this region, including Wadi Ghan and Wadi Majinin, are examined based on location, rainfall patterns, and water resource potential to support efficient electricity generation.
- A detailed review of existing dams in the area, specifically Wadi Ghan and Wadi Majinin, including assessments of structural specifications, catchment areas, and reservoir capacities, illustrated in Fig. 2. and 3, respectively. [7]
- Grundfos is the largest pump manufacturer in the world, based in Denmark, with more than 19,000 employees globally. The annual production of more than 16 million pump units, circulator pumps, submersible pumps, and centrifugal pumps as shown in Figure.4

DOI: 10.5281/zenodo.14339457

- Study Area Assessment: Evaluating the geographical and hydrological characteristics of the Western Mountain region.
- Data Collection: Analyzing monthly energy production data from Wadi Ghan and Wadi Majinin dams over three years.
- Comparative Analysis: Examining energy output, efficiency, and economic viability of both dams.
- Design Adaptation: Adapting the successful design of the Dukan Hydroelectric Power Station in Iraq to fit the local conditions of the Libyan dams.
- Water Management Design: Implementing a pumping system to optimize water storage and maintain operational continuity.

A. *Water Pumping System*

- Since Wadi Ghan and Wadi Majinin dams are not located on flowing rivers, a system for returning water to the dam was designed to optimize storage and maintain consistent operation. This system includes a network of pumps to prevent water loss by collecting runoff into a basin near the dam and returning it to the reservoir.

- Pump specifications include a water flow rate of 22 cubic meters per hour, pumping height of 53 meters, and efficiency of 70%. Calculations determined that approximately 99 pumps, each consuming 4.54 kW, would be required, resulting in a total power consumption of 454 kW per hour.

Fig. 1. Shows a map of Libya, indicating the location of the Western Mountain and the area it occupies[8]

Fig. 2. Shows a satellite image of Wadi Ghan Dam[9]

DOI: 10.5281/zenodo.14339457

Fig. 3. Shows a satellite image of Wadi Majinin Dam[10]

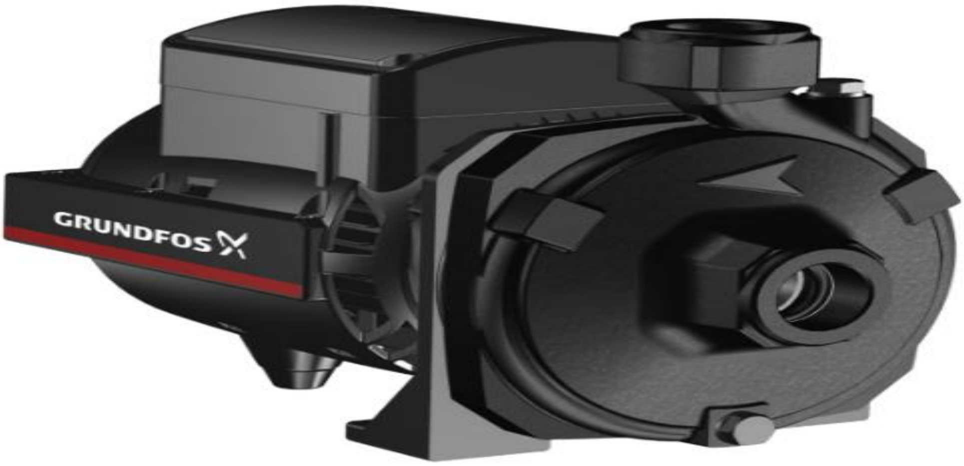

Fig.4. Shows a Grundfos pump[11]

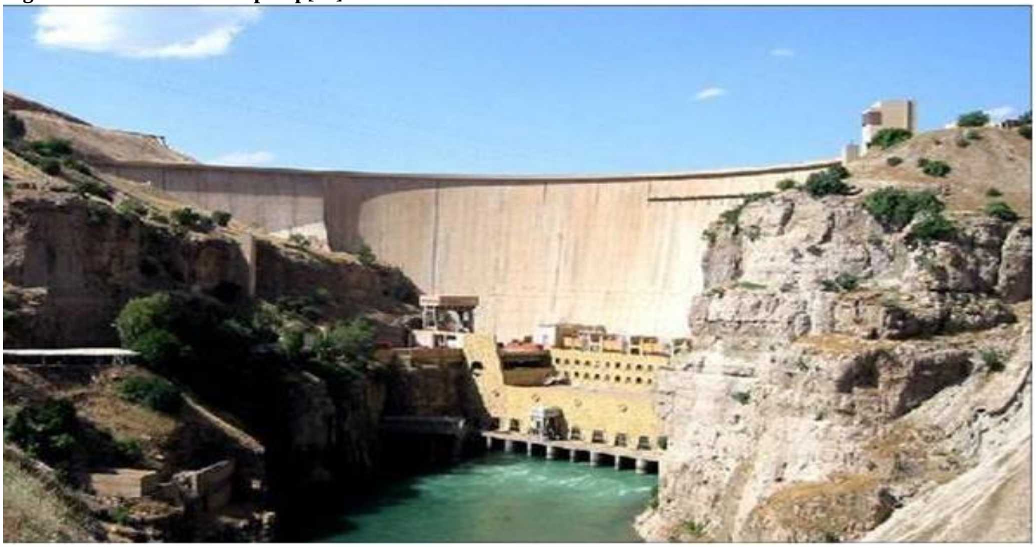

Fig.5. Shows the hydroelectric power station built on the Dukan Dam[4]

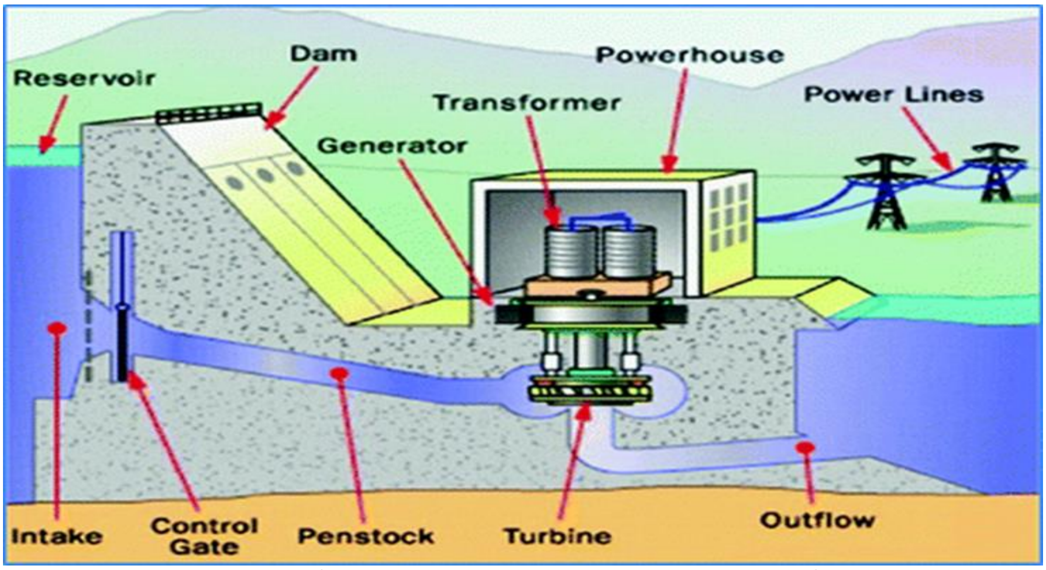

Fig.6. Illustrates the components of the hydroelectric power station and the mechanism of turbine rotation[4]

B. Theoretical Calculation

Water Flow Rate: 22 cubic meters per hour (equivalent to 0.0061cubic meters per second).

- Pumping Height: 53 meters.
- Pump Efficiency: 70% (0.7).
- Water Density:1000 kg/m3[11].
- The required power for the pump can be
- calculated as follows:

RequiredPower(kW)=
$\text{Flow Rate} * \text{Water Density} * \text{Gravity} * \text{Heigh}/E\text{fficiency}$

Required Power (kW) =$0.0061 * 1000 * 9.81 * 53/0.7$
Required Power (kW) = 4.54kw
A pump with a power of 4.54 kW will consume 4.54 kWh of electrical energy for each hour it operates.

Determining the Number of Pumps Required: Due to the large volume of water from the discharge channel, multiple pumps will be necessary.
The number of pumps can be determined based on the desired flow rate. - Calculation of Required Number of Pumps: Given that each pump handles a flow rate of 22 cubic meters per hour, the total number of pumps needed is:

Number of Pumps = $\frac{Total\ Water\ Flow\ Rate}{Flow\ Rate\ of\ One\ Pump}$

Number of Pumps = $\frac{22}{0.22}$ = 99

To operate approximately 100 pumps, each consuming 4.54 kW, the total power consumption is calculated as follows:
Total Power Consumption (kW) = Power per pump * Number of Pumps Total Power

Consumption (kW) = 4.54 kw * 100 = 454 kw

The total energy consumption required to operate 100 pumps is approximately 454 kW per hour.
Thus, approximately 99 pumps would be needed to ensure all the water is effectively returned to the dam.

C. Monthly Data Analysis Using Excel:

- Data covering water levels, outlet characteristics, flow rates, and generated power for Wadi Ghan and Wadi Majinin dams from 2010 to 2012 were collected from the General Water Authority of Libya. This data, shown in fig. 7 , 8 and Table.I and II a start and end calculation by exceel. that was analyzed monthly to calculate parameters including water velocity, flow rate, and daily energy production.

- The analysis tables utilize the following symbols: HL (maximum water level height), OL (outlet channel height), D (outlet channel diameter), WL (water level), A (area), V (velocity), Q (flow rate), P (power), and E (energy).[9]

- Determining the Number of Pumps Required:

- Due to the large volume of water from the discharge channel, multiple pumps will be necessary. The number of pumps can be determined based on the desired flow rate.

In this study, the data were obtained from the General Water Authority in Libya, covering the period from 2010 to 2012.
The data were collected monthly for each of these years and focused on the following hydraulic parameters:
1- Water level: Monthly measurements of water levels in the dams.
2- Water outlet height: The height of the water outlet for each dam.
3- Outlet diameter: Data on the diameter of the water outlet in the dams.

These data were used in precise calculations, including:

- Water velocity: The velocity of water flow was calculated using the
- water level and outlet characteristics

DOI: 10.5281/zenodo.14339457

- Flow rate: Estimation of the monthly water flow from the dams.
- Power: Calculation of the hydraulic power generated by the water flow.
- Energy produced per hour: Estimation of the amount of energy that
- can be produced in one hour based on flow rate and power.
- Energy produced per day: Calculation of the total energy produced
- daily.
- The use of Excel allowed for an easy analysis of these data and accurate
- visualization of the results, which helps in assessing the performance of
- the dams and their potential for hydropower generation.
- Data for Wadi Ghan Dam :

- Height of the Outlet Channel: 290 meters
- Height of the Maximum Water Level: 343 meters
- Diameter of the Outlet Channel: 3 meters

- Calculations of the Data :

$$(WL) = (HL) – (OL) = 343m – 290m = 53m \quad (1)$$

$$Q = A * V \quad (2)$$

A = Area, V = Water Velocity

$$V = \sqrt{2gh} \quad (3)$$

Where :

h = water level (4)

1. g = acceleration due to gravity (approximately 9.81 m/s
2. Power (P) :

$$P = H * Q * g * \eta * \dot{\rho} \quad (5)$$

3. Energy (E) :

$$E=P*t \quad (6)$$

V. Results and Discussion

A. *Monthly Data Analysis Using Excel:*

Data covering water levels, outlet characteristics, flow rates, and generated power for Wadi Ghan and Wadi Majinin dams from 2010 to 2012 were collected from the General Water Authority of Libya. This data, shown in figures 7 and 8 and Table3 and 4, was analyzed monthly to calculate parameters including water velocity, flow rate, and daily energy production.

B. *Economic Feasibility Study:*

While the financial return may not fully offset initial costs, hydroelectric stations offer significant long-term value in reducing fossil fuel dependency. These facilities supply critical energy to residential and commercial areas, advancing Libya's renewable energy goals and supporting regional sustainability[9].

- Hydroelectric Performance: The analysis revealed stable energy outputs from Wadi Ghan Dam, ranging from 26 MW to 30 MW, indicating reliability and minimal annual fluctuations.
- Energy Distribution: Wadi Ghan Dam can power critical infrastructure, including hospitals and homes, with potential production increases to meet higher demands.
- Seasonal Trends: Seasonal variations significantly impact production, with winter showing the highest outputs due to optimal water levels.
- Comparative Production: Wadi Ghan exhibited higher production capacity compared to Wadi Majinin due to its size and structural advantages.
- Economic Feasibility: While initial costs may not be offset fully by financial returns, the long-term benefits of reduced fossil fuel dependency and enhanced energy security are substantial.
- Recommendations: Future improvements in dam design and seasonal water management are necessary to optimize energy yield and operational stability.

C. *Overview of Hydroelectric Performance at Wadi Ghan and Majinin Dams:*

This section presents the hydraulic analysis results from "The Study and Design of a Hydropower Station Supported by Dams in the Western Region of Libya." Using Excel-based data analysis, insights into the energy output, efficiency, and economic impact of the station were extracted, with a focus on water management systems that enhance operational continuity and reduce losses.

- ***Annual Average Power Generation for 2010-2012:***

- **Wadi Ghan Dam:** As shown in fig.7 and 9 an analysis of monthly averages from 2010 to 2012 shows
- stable energy output, ranging from 26 MW to 30 MW. This consistent performance demonstrates reliability, with minor annual fluctuations.
- **Wadi Majinin Dam:** As shown in fig.8 and 10 a data shows a noticeable seasonal variation, with an increase in production at the start of each year and a gradual decline, ranging between 25 MW and 33 MW. This pattern reflects environmental factors affecting water availability.

- ***Seasonal Power Generation Trends* as shown in figure. 11 and 12*:***

- **Wadi Ghan Dam:**
- **Winter (30%):** Achieved the highest seasonal energy output, attributed to favorable water levels and climatic conditions.
- **Spring and Autumn (24% each):** Moderate output, supported by rain and snowmelt.
- **Summer (22**%): Lower output likely due to higher evaporation and reduced inflow.
- **Wadi Majinin Dam:**
- **Winter (28%):** Highest output season, aligning with optimal water levels.
- **Spring (25%):** Enhanced output due to increased water availability.
- **Summer (24%):** Lower output due to water flow reduction.
- **Autumn (23%):** Declining output as seasonal conditions change

- ***Comparative Analysis of Energy Production (2010-2012):***

As shown in fig.7,8,9,10 and 13, a comparison between a Wadi Ghan and Majinin Dams over 2010-2012, Wadi Ghan Dam displayed higher production capacity, likely due to its structural advantages in size, height (53 meters), and water storage capacity. These design factors contributed to a more stable output and demonstrate the impact of dam specifications on production efficiency.

- ***Economic Feasibility of Hydroelectric Stations:***

While the financial return may not fully offset initial costs, hydroelectric stations offer significant long-term value in reducing fossil fuel dependency. These facilities supply critical energy to residential and commercial areas, advancing Libya's renewable energy goals and supporting regional sustainability.

- ***Distribution of Energy for Community Needs:***

- **Wadi Ghan Dam** (at 29 MW daily) is capable of powering a hospital, a bank, a supermarket, and 500 homes per month. By raising water to the maximum level of 53 meters,

- Wadi Ghan Dam's production increases to 83 MW, enabling it to meet higher demands, such as:

- **Hospitals**: 8 units
- **Banks:** 49 units
- **Supermarkets:** 124 units
- **Homes:** 2490 units
- **WadiMajinin Dam:**provides sufficient energy to support one hospital, 16 banks, 40 supermarkets, and 810 homes monthly. These findings underscore the role of hydroelectric facilities in meeting local energy needs and promoting sustainable development.

DOI: 10.5281/zenodo.14339457

TABLE.I MONTHLY DATE FOR WADI GHAN DAM IN JANUARY YEAR2010

Date	HL(m)	OL (m)	D (m)	WL(m)	A(m^2)	V (m/s)	Q (m^3)	P(kw)	E kw.h	Enet (kw.h)	E (kw.day)
01/01/2010	313.4	290	3	23.4	7.0714	21.43	151.5	24.3	24.3	23.89	573.43
02/01/2010	313.38	290	3	23.38	7.0714	21.42	151.5	24.3	24.3	23.86	572.69
03/01/2010	313.36	290	3	23.36	7.0714	21.41	151.4	24.3	24.3	23.83	571.94
03/01/2010	313.36	290	3	23.36	7.0714	21.41	151.4	24.3	24.3	23.83	571.94
04/01/2010	313.34	290	3	23.34	7.0714	21.4	151.3	24.3	24.3	23.8	571.19
05/01/2010	313.32	290	3	23.32	7.0714	21.39	151.3	24.2	24.2	23.77	570.44
06/01/2010	313.3	290	3	23.3	7.0714	21.38	151.2	24.2	24.2	23.74	569.69
07/01/2010	313.28	290	3	23.28	7.0714	21.37	151.1	24.2	24.2	23.71	568.95
08/01/2010	313.26	290	3	23.26	7.0714	21.36	151.1	24.1	24.1	23.67	568.2
09/01/2010	313.25	290	3	23.25	7.0714	21.36	151	24.1	24.1	23.66	567.83
10/01/2010	313.24	290	3	23.24	7.0714	21.35	151	24.1	24.1	23.64	567.45
11/01/2010	313.23	290	3	23.23	7.0714	21.35	151	24.1	24.1	23.63	567.08
12/01/2010	313.22	290	3	23.22	7.0714	21.34	150.9	24.1	24.1	23.61	566.71
13/01/2010	313.21	290	3	23.21	7.0714	21.34	150.9	24.1	24.1	23.6	566.33
14/01/2010	313.2	290	3	23.2	7.0714	21.34	150.9	24	24	23.58	565.96
15/01/2010	313.19	290	3	23.19	7.0714	21.33	150.8	24	24	23.57	565.59
16/01/2010	315.18	290	3	25.18	7.0714	22.23	157.2	27.2	27.2	26.72	641.36
17/01/2010	319	290	3	29	7.0714	23.85	168.7	33.6	33.6	33.14	795.28
19/01/2010	318.96	290	3	28.96	7.0714	23.84	168.6	33.5	33.5	33.07	793.62
20/01/2010	318.86	290	3	28.86	7.0714	23.8	168.3	33.3	33.3	32.89	789.45
21/01/2010	318.77	290	3	28.77	7.0714	23.76	168	33.2	33.2	32.74	785.71
22/01/2010	318.68	290	3	28.68	7.0714	23.72	167.7	33	33	32.58	781.98
23/01/2010	318.6	290	3	28.6	7.0714	23.69	167.5	32.9	32.9	32.44	778.66
24/01/2010	318.52	290	3	28.52	7.0714	23.66	167.3	32.8	32.8	32.31	775.35
25/01/2010	318.45	290	3	28.45	7.0714	23.63	167.1	32.6	32.6	32.19	772.46
26/01/2010	318.38	290	3	28.38	7.0714	23.6	166.9	32.5	32.5	32.07	769.57
27/01/2010	318.32	290	3	28.32	7.0714	23.57	166.7	32.4	32.4	31.96	767.1
28/01/2010	318.26	290	3	28.26	7.0714	23.55	166.5	32.3	32.3	31.86	764.62
29/01/2010	318.2	290	3	28.2	7.0714	23.52	166.3	32.2	32.2	31.76	762.16
30/01/2010	318.14	290	3	28.14	7.0714	23.5	166.2	32.1	32.1	31.65	759.69
31/01/2010	318.08	290	3	28.08	7.0714	23.47	166	32	32	31.55	757.23

DOI: 10.5281/zenodo.14339457

TABLE .II MONTHLY DATE FOR WADI MJENIN DAM IN DECEMBER YEAR2012

Date	HL(m)	OL (m)	D (m)	WL(m)	A(m^2)	V (m/s)	Q (m^3)	P(kw)	E kw.h	Enet (kw.h)	E (kw.day)
01/12/2012	264.33	240	3	24.33	7.0714	21.85	154.5	25.8	25.8	25.36	608.61
02/12/2012	264.32	240	3	24.32	7.0714	21.84	154.5	25.8	25.8	25.34	608.23
03/12/2012	264.31	240	3	24.31	7.0714	21.84	154.4	25.8	25.8	25.33	607.85
04/12/2012	264.3	240	3	24.3	7.0714	21.83	154.4	25.8	25.8	25.31	607.47
05/12/2012	264.29	240	3	24.29	7.0714	21.83	154.4	25.7	25.7	25.3	607.09
06/12/2012	264.28	240	3	24.28	7.0714	21.83	154.3	25.7	25.7	25.28	606.7
07/12/2012	264.27	240	3	24.27	7.0714	21.82	154.3	25.7	25.7	25.26	606.32
08/12/2012	264.26	240	3	24.26	7.0714	21.82	154.3	25.7	25.7	25.25	605.94
09/12/2012	264.25	240	3	24.25	7.0714	21.81	154.2	25.7	25.7	25.23	605.56
10/12/2012	264.24	240	3	24.24	7.0714	21.81	154.2	25.7	25.7	25.22	605.18
11/12/2012	264.23	240	3	24.23	7.0714	21.8	154.2	25.7	25.7	25.2	604.8
12/12/2012	264.22	240	3	24.22	7.0714	21.8	154.2	25.6	25.6	25.18	604.42
13/12/2012	264.21	240	3	24.21	7.0714	21.79	154.1	25.6	25.6	25.17	604.04
14/12/2012	264.2	240	3	24.2	7.0714	21.79	154.1	25.6	25.6	25.15	603.66
15/12/2012	264.19	240	3	24.19	7.0714	21.79	154.1	25.6	25.6	25.14	603.27
16/12/2012	264.18	240	3	24.18	7.0714	21.78	154	25.6	25.6	25.12	602.89
17/12/2012	264.17	240	3	24.17	7.0714	21.78	154	25.6	25.6	25.1	602.51
18/12/2012	264.16	240	3	24.16	7.0714	21.77	154	25.5	25.5	25.09	602.13
19/12/2012	264.15	240	3	24.15	7.0714	21.77	153.9	25.5	25.5	25.07	601.75
20/12/2012	264.14	240	3	24.14	7.0714	21.76	153.9	25.5	25.5	25.06	601.37
21/12/2012	264.13	240	3	24.13	7.0714	21.76	153.9	25.5	25.5	25.04	600.99
22/12/2012	264.12	240	3	24.12	7.0714	21.75	153.8	25.5	25.5	25.03	600.61
23/12/2012	264.12	240	3	24.12	7.0714	21.75	153.8	25.5	25.5	25.03	600.61
24/12/2012	264.11	240	3	24.11	7.0714	21.75	153.8	25.5	25.5	25.01	600.23
25/12/2012	264.1	240	3	24.1	7.0714	21.74	153.8	25.4	25.4	24.99	599.85
26/12/2012	264.1	240	3	24.1	7.0714	21.74	153.8	25.4	25.4	24.99	599.85
27/12/2012	264.09	240	3	24.09	7.0714	21.74	153.7	25.4	25.4	24.98	599.47
28/12/2012	264.08	240	3	24.08	7.0714	21.74	153.7	25.4	25.4	24.96	599.09
29/12/2012	264.08	240	3	24.08	7.0714	21.74	153.7	25.4	25.4	24.96	599.09
30/12/2012	264.07	240	3	24.07	7.0714	21.73	153.7	25.4	25.4	24.95	598.71
31/12/2012	264.06	240	3	24.06	7.0714	21.73	153.6	25.4	25.4	24.93	598.33

DOI: 10.5281/zenodo.14339457

TABLE.III THE ECONOMIC FEASIBILITY OF WADI GHAN DAM

Month	2010y	2011y	2012y
1	33	26	35
2	31	30	33
3	29	32	32
4	28	34	31
5	28	31	30
6	27	29	28
7	26	28	26
8	25	27	25
9	28	36	25
10	28	34	26
11	27	33	27
12	26	32	29
Total	336	372	347

TABLE.VI THE ECONOMIC FEASIBILITY OF WADI MAJININ DAM

Month	2010	2011	2012
1	30	29	33
2	29	31	32
3	28	30	31
4	27	30	30
5	28	29	28
6	27	28	27
7	26	27	27
8	25	27	26
9	33	27	27
10	32	30	26
11	30	29	28
12	29	29	27
Total	344	346	342

DOI: 10.5281/zenodo.14339457

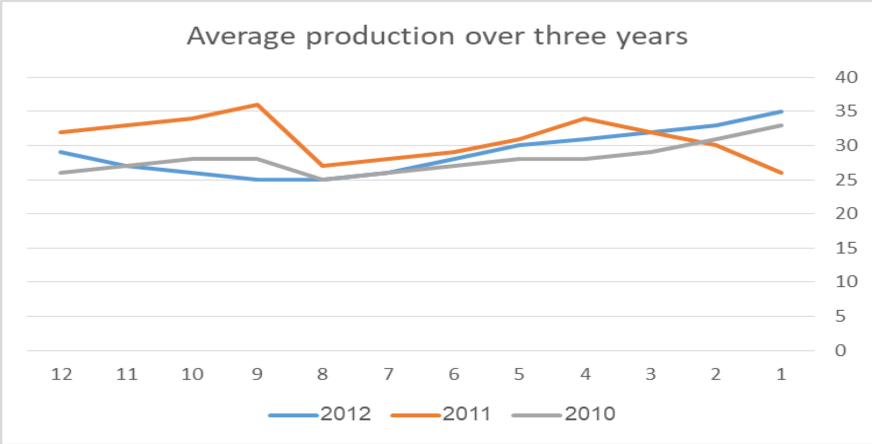

Fig. 7. **Monthly Average electric power generating for the years 2010-2011-2012 at Wadi Ghan Dam, ranging from 26 MW to 30 MW**

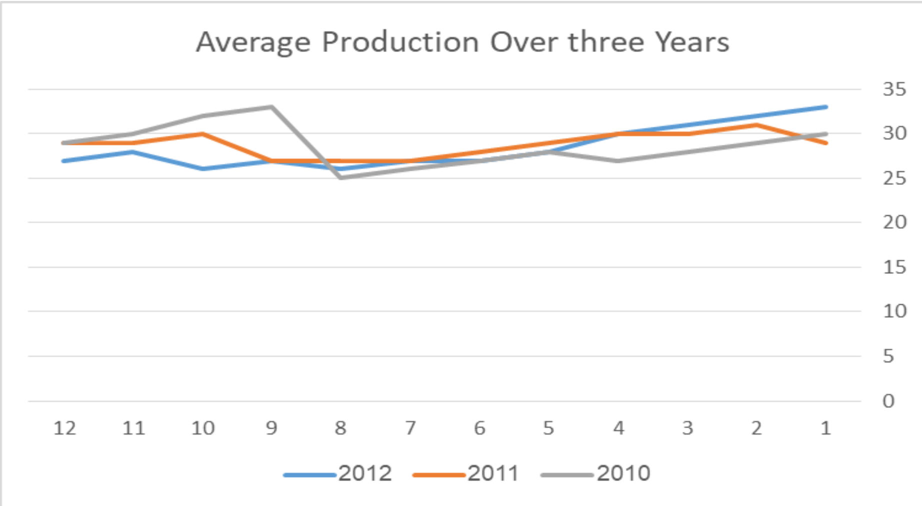

Fig. 8. **Monthly Average Electric Power Generation for the Years 2010, 2011, and 2012 at the Majinin Dam**

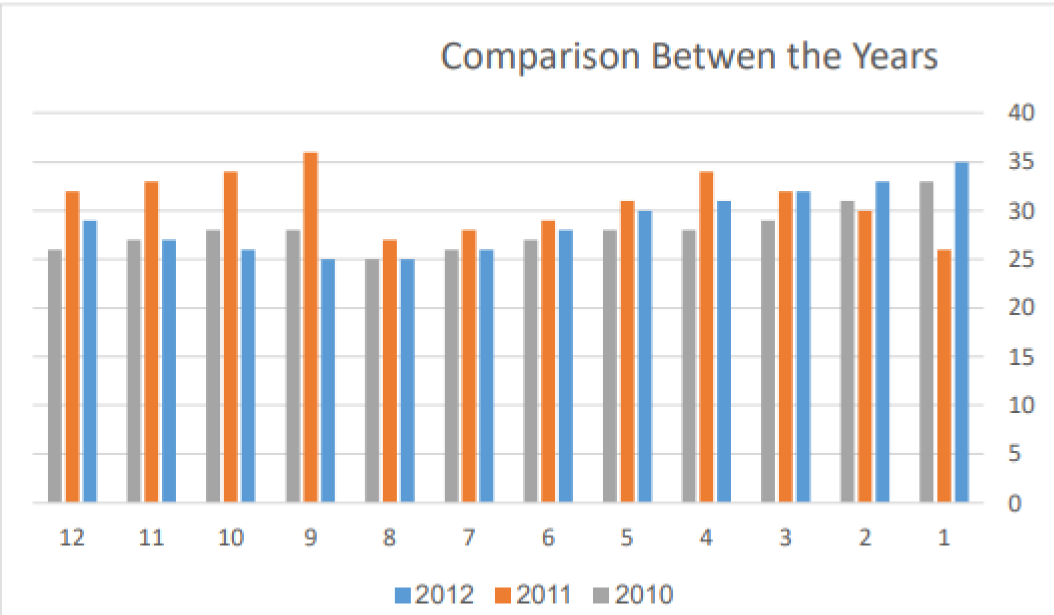

Fig. 9 **Comparison of Electric Power Generation for the Years 2010, 2011, and 2012 at the Ghan Dam**

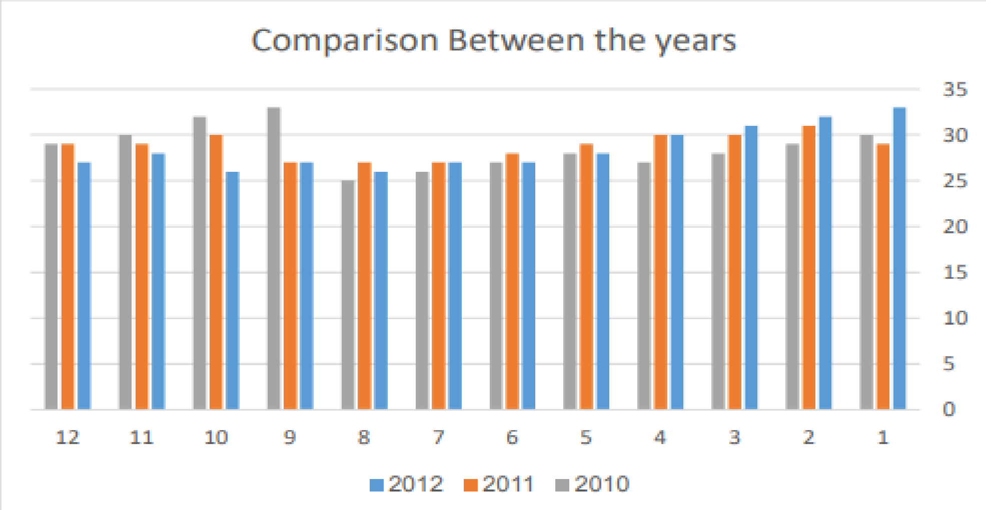

Fig. 10 Comparison of Electric Power Generation for the Years 2010, 2011, and 2012 at the Majinin Dam

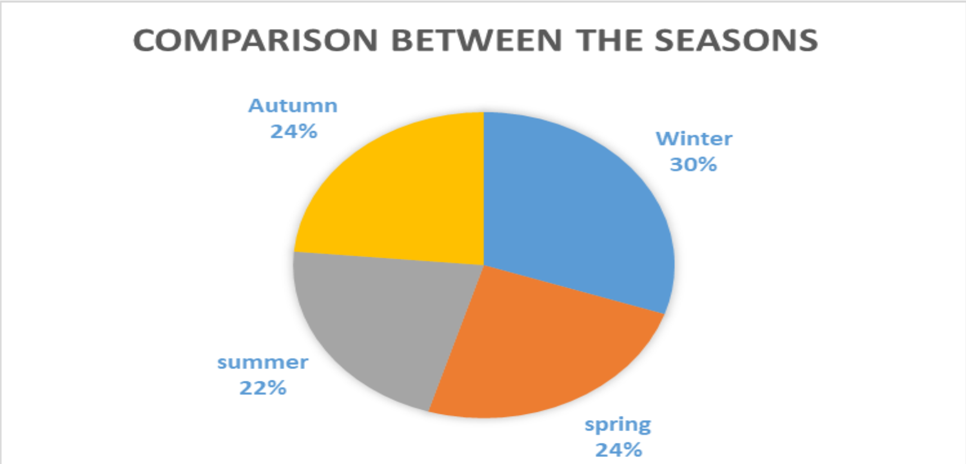

Fig. 11. Ratio of energy output in each season Wadi Ghan Dam

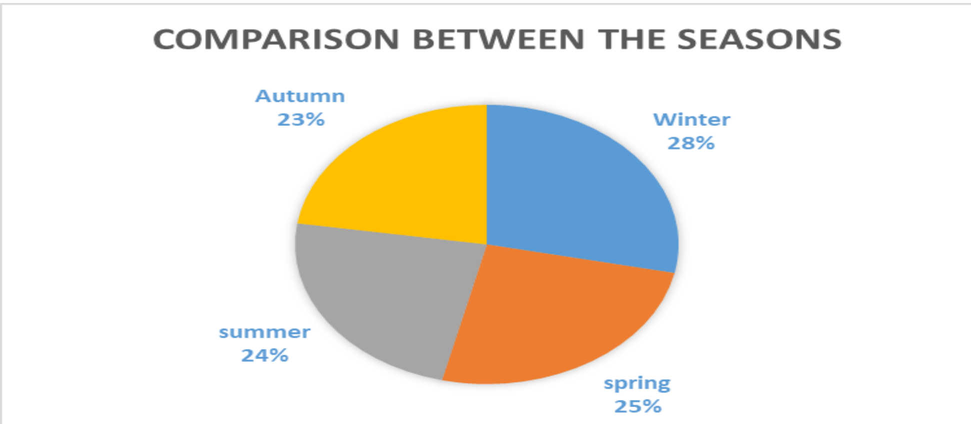

Fig. 12. Ratio of energy output in each season Wadi Majinin Dam

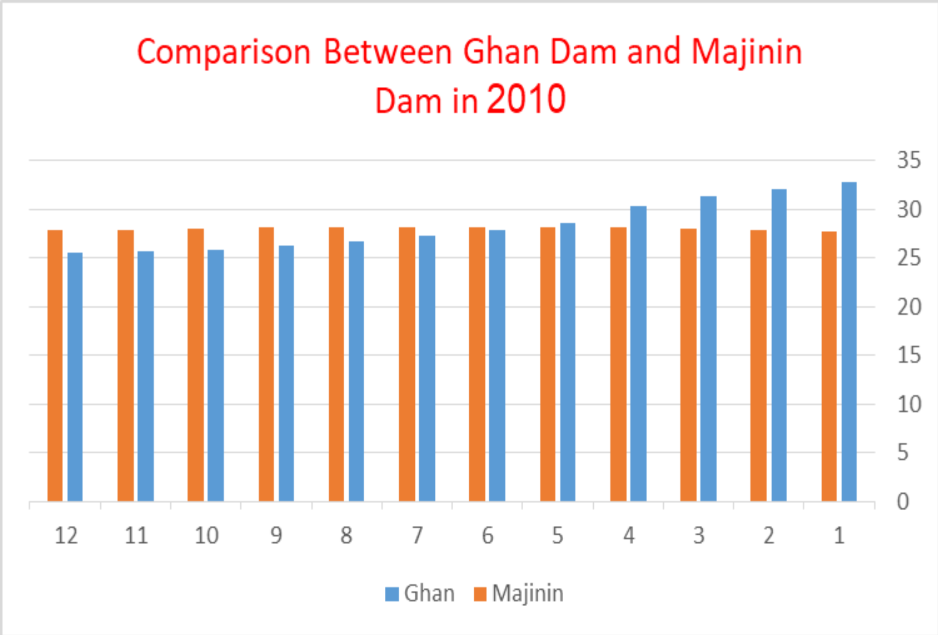

Fig. 13. ComparisonofEnergyProductionBetweenWadiGhanDamand Wadi Majinin Dam During the Year 2010

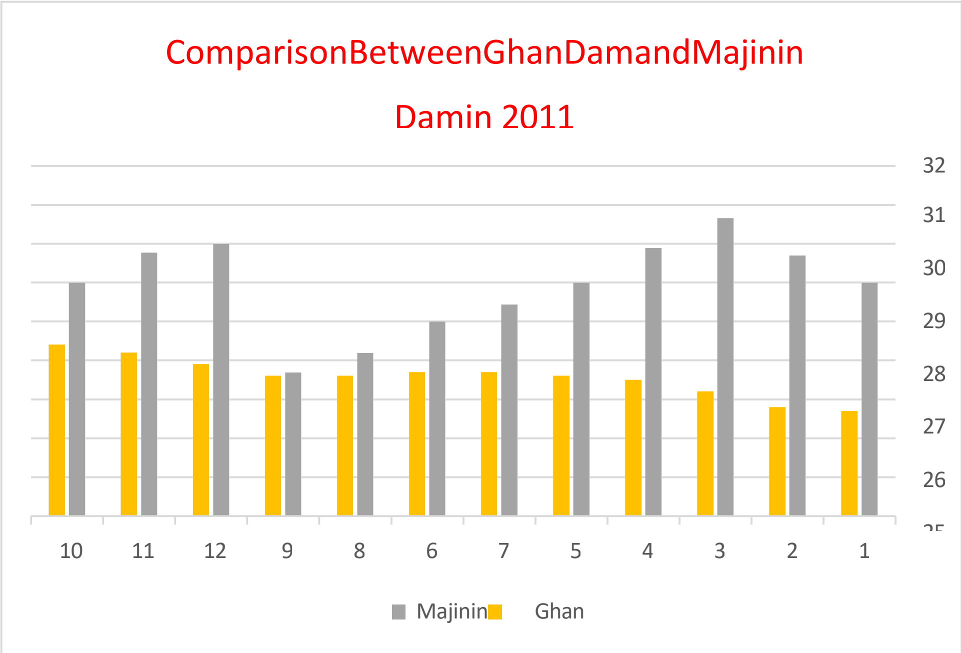

Fig. 14 Comparison of EnergyProductionBetweenWadiGhanDamand Wadi Majinin Dam During the Year 2011

DOI: 10.5281/zenodo.14339457

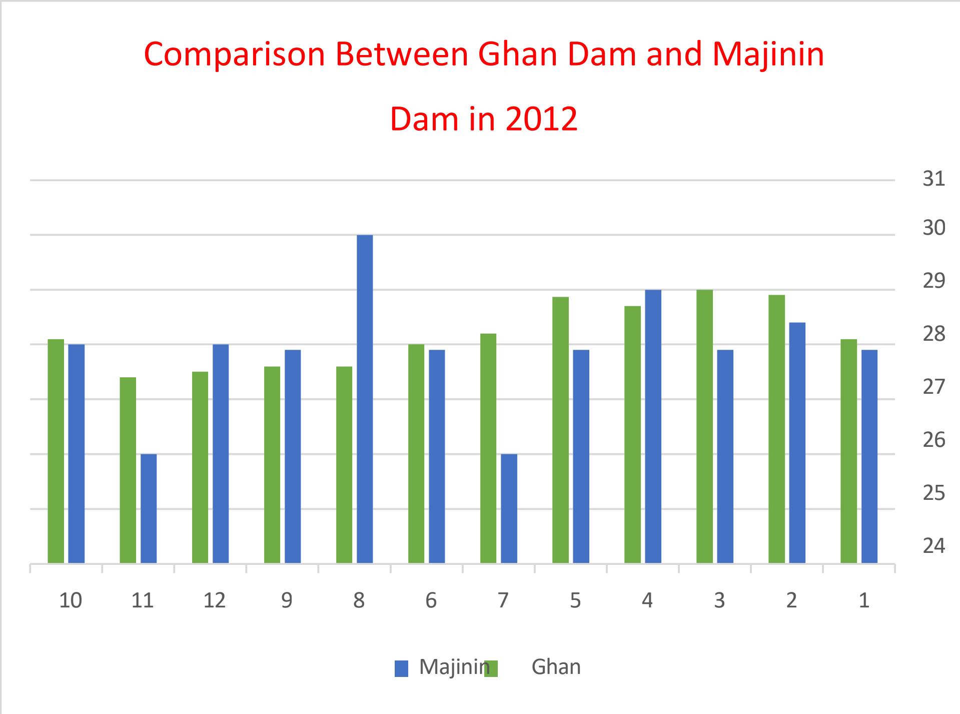

Fig. 15 Comparison of EnergyProductionBetweenWadiGhanDamand Wadi Majinin Dam During the Year 2012

VI. CONCLUSION

This analysis highlights the efficiency and operational stability of Wadi Ghan and Majinin Dams, with structural and seasonal factors significantly impacting energy output. Future improvements to dam design and seasonal water management are recommended to optimize energy yield.

Future initiatives could focus on enhancing the design and management of these hydroelectric facilities to maximize their potential in supporting community energy needs and contributing to sustainable development. The findings reinforce the critical role of hydroelectric power in advancing Libya's energy independence and environmental goals.

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