



# Water Dams and Their Economic Role in Sustainable Development of the Agricultural and Energy Sectors in India

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## ABSTRACT

A dam is defined as a barrier that divides water, and dams generally serve the primary purpose of retaining water. India has the largest number of water dams in the world after the United States of America and China. It has two of the top ten dams in the world: the Tehri Dam 261m and Keshaw Dam 253m. Efforts have been combined to preserve water resources, and provide what would ensure life on the surface of the earth through the construction of dam projects and making maximum use of them. Dams aim to store water for irrigation and drinking, to face drought crises in some years, and to reduce the risk of floods. Water dams play a major role in sustainable development in the agriculture and energy sectors, given that water is the basis on which agriculture and energy are based. The development of agriculture and energy inevitably leads to the recovery of the economy as a whole.

**Keywords:** Water dams, Economy, agriculture, energy, sustainable development.

## Introduction

Water is a manifestation and source of life and blessings, but at the same time it carries fears, raises ambitions and disputes, and warns of dangers. The multiple and necessary functions of water have turned it into an important source, and it is of interest to all mankind. The importance of water and ensuring water security remains the focus of attention of researchers, decision-makers and those interested in the issue of water to avoid falling into destructive wars for all parties, by searching for the best ways to manage water and make optimal use of it, and accordingly leading to sustainable development in various sectors, benefiting and increasing incomes for peoples. Under the pressures of population and economic activities, the demand for water is increasing and the water sector will increasingly face the challenge of bridging the gap between supply and demand.

Water dam projects are built to achieve the maximum benefit and optimal utilization of water, water storage for irrigation and drinking, facing drought crises, protecting the country from the dangers of floods, and multiple other uses. India is one of the countries that uses

dams with high storage efficiency so as to provide irrigation water for its agricultural projects, which are responsible for about 22% of the GDP and employ about 70% of the country's workforce (Abd al-Rahman, 2013).

The study aims to identify the economic effects of water dams and their role in sustainable development in India. In addition, it aims at building a database that contains an inventory and classification of dams in India, and attempting to identify the most important problems of their exploitation.

To achieve the aim of the study, this research is divided into the following topics:

First: the General Characteristics of the Study Area.

Second: The Concept, Goals and Indicators of Sustainable Development.

Third: The General Characteristics of Water Dams.

Fourth: The Role of Water Dams in Sustainable Development.

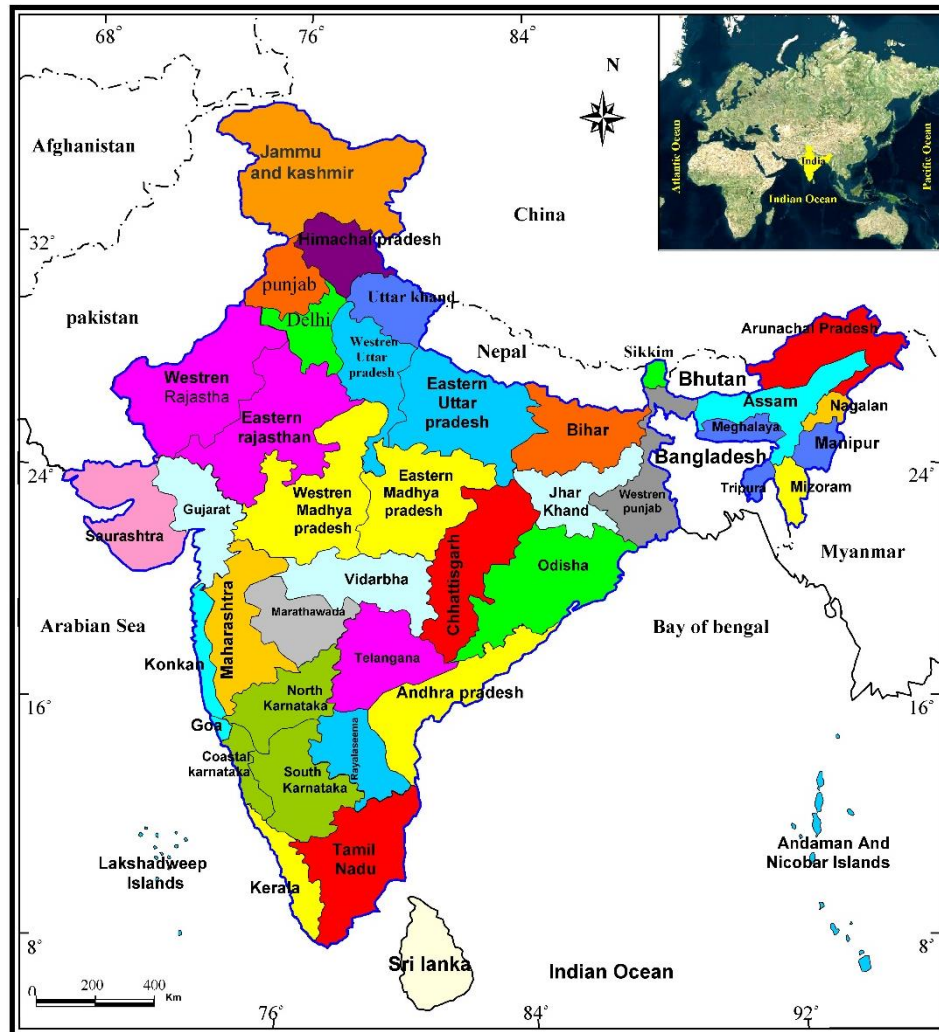
What follows is a detailed study of these topics:

### **First: The General Characteristics of the Study Area**

**1. Location and area:** India is located in the southern part of the continent of Asia, and it includes most of the lands of the Indian subcontinent. It is bordered to the north by China, Nepal, and Bhutan, to the northwest by Pakistan, and to the east by Bangladesh, and Myanmar (formerly Burma), Fig. 1. It occupies a vast area of South Asia, reaching 3.2 million km<sup>2</sup> with a percentage of 6.9% of the total area of the continent, and thus it is the second Asian country in area after China (Ghareeb, 2005).

India has land borders with a length of 14,103 km, separating it from Bangladesh by 4,053 km, Bhutan by 605 km, Myanmar by 1,463 km, Nepal by 1,690 km, China by 3380 km, and Pakistan by 2,912 km. It has a coastline of 7,000 km. (Youssef, 2013).

The southern tip of the Indian subcontinent known as Cape Comorin, located at latitude 8° north of the equator, represents the maximum extension of the Indian lands without the islands to the south. However, the territory of the city of Champa represents the maximum extension of the lands of India in the north, located on the foothills of the Himalayas at latitude 33° north, Fig. 1. Thus, the state's territory extends in latitudes about 25° in the northern hemisphere; that is, it extends for a distance of 2900 km between north and south. Moreover, it extends between longitudes 68° east and 98° east; that is, it goes for a distance of more than 3000 km between east and west (Al-Zawka, 2004).



Source: <https://ar.wikipedia.org/wiki/%D8%A7%D9%84%D9%87%D9%86%D8%AF>

**Fig. 1: Geographical Location of India**

## 2. Population:

India gained independence in 1947. Its population was about 345 million, and the number rose to 1.21 billion, according to estimates in 2011. The rate of natural increase of the population reached 1.6% during the period between 2009 and 2011. According to the World Bank estimates in 2014, the population in India was 1.29 billion people, has reached about 1.38 billion people in the year 2020, and is expected that it will reach 1.52 billion people in 2030 (Ibrahim, 2015).

India is the second most populous country in the world after China, according to the estimates of the World Bank in 2020. Most of India's population works in agriculture (Ghareeb, 2005).

**3. Local division:** India is divided into 28 states and eight union regions, including the city of Delhi. The capital of India is New Delhi, and the major cities are Bombay, Delhi, Madras and Hyderabad (Fig. 1). One of the largest states is Rajasthan, followed by Madhya Pradesh, while the smallest Indian state is Goa. (<https://ar.wikipedia.org/wiki/%D8%A7%D9%84%>)

## **Second: The Concept, Goals and Indicators of Sustainable Development**

### **1. The Concept of Sustainable Development:**

Sustainable development is the development that ensures an increase in the welfare of the present generation, without leading to a decrease in the welfare of the next one. This means equality between generations and guarantees that social welfare will never decrease in time.

In 1980, a report on the international strategy for the conservation of the environment proposed the term "sustainable development", which became a concept familiar to the public in the report "Our Common Future" published by the World Commission on Environment and Development in 1987. In the report, also known as the Brundtland Report of 1987, sustainable development was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Sustainable development is an integrated concept of the three pillars: environmental, economic and social. Accordingly, education for sustainable development addresses sustainable development issues, which are not only environmental problems, but social and economic problems as well. It defines the sustainable environment as the preservation of natural resources, which ensures the natural function of local ecosystems and nature in general; social sustainable development as solidarity and cooperation with other societies; and sustainable economic development as the development ensuring the quality of life through economic self-determination and self-development of both individuals and societies.

The publication of the United Nations "Transforming Our World: Agenda for Sustainable Development 2030" contains seventeen sustainable development goals, which according to the agenda are "integral and indivisible and balance the three dimensions of sustainable development: economic, social and environmental" (**United Nations, 2015**).

Sustainability is considered the need for a balance between economic growth and environmental preservation. It also refers to "meeting the needs of the present generation without compromising the needs of future generations" (Todaro & Smith, 2012).

Sustainable development refers to "a process of change in which resources are exploited, and investments, technological development and institutional change are directed in line with the future." It embraces the challenging mission of achieving economic improvement, equity and environmental integrity across generations in an integrated manner (Rahman, et. al.,

2016).

The third principle, which was established at the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, defined sustainable development as “the necessity of realizing the right to development” so that the developmental and environmental needs of present and future generations are equally fulfilled. The fourth principle approved by the conference indicated that "in order to achieve sustainable development, environmental protection must be an integral part of the development process and cannot be thought of in isolation from it" (**Muschet, 2000**).

The Indian Ministry of Planning and Development has defined sustainable development as a development that improves living conditions in the present without compromising the resources of future generations. Development is not sustainable when we spend or use all our resources now, leaving future generations with nothing.

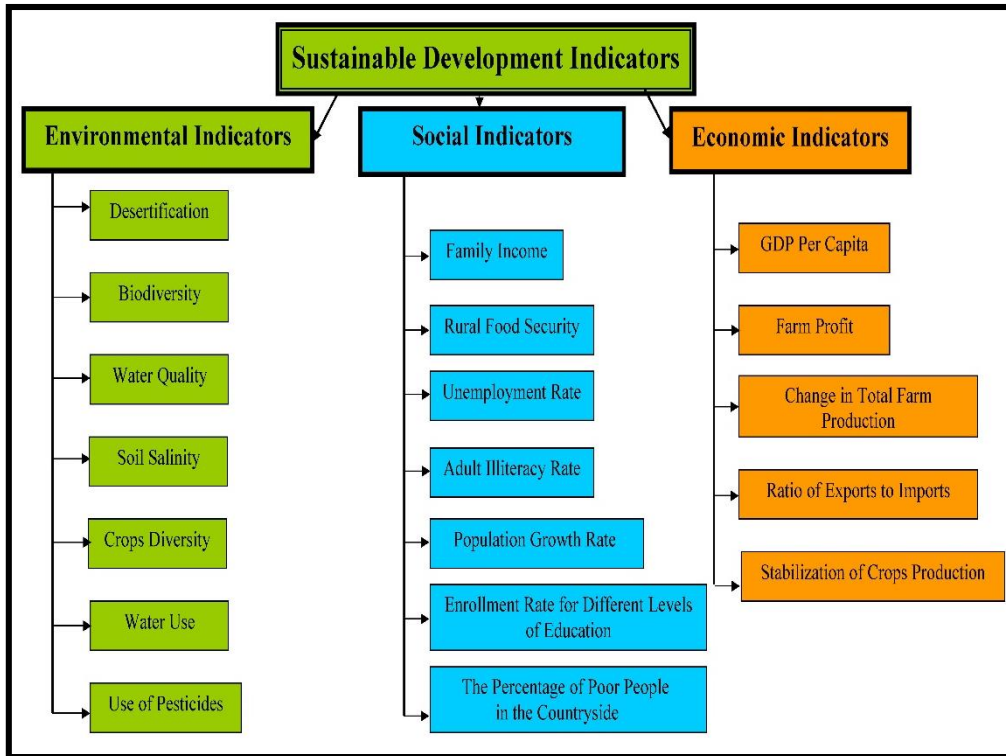
## **2. The Sustainable Development Goals:**

The sustainable development goals set by the United Nations Economic and Social Council in the report issued on May 10, 2018, related to water resources, are reviewed. The most important of which are:

1. Ending hunger, achieving food security, improving nutrition and promoting sustainable agriculture.
2. Ensuring availability and sustainable management of water and sanitation for all.
3. Ensuring access to modern, reliable and sustainable energy for all.

## **3. Indicators of Sustainable Development:**

Development is no longer economic numbers and indicators, but rather social changes, the consolidation of correct concepts and values, and the participation of individuals in decision-making, in addition to a clean environment free of pollution factors. It is also the spread of education and the adoption of knowledge in order to keep pace with scientific and technological progress, as illustrated in Fig. 2:



Source: Farhad Zulfiqa, 2017.

**Fig. 2: Sustainable Development Indicators**

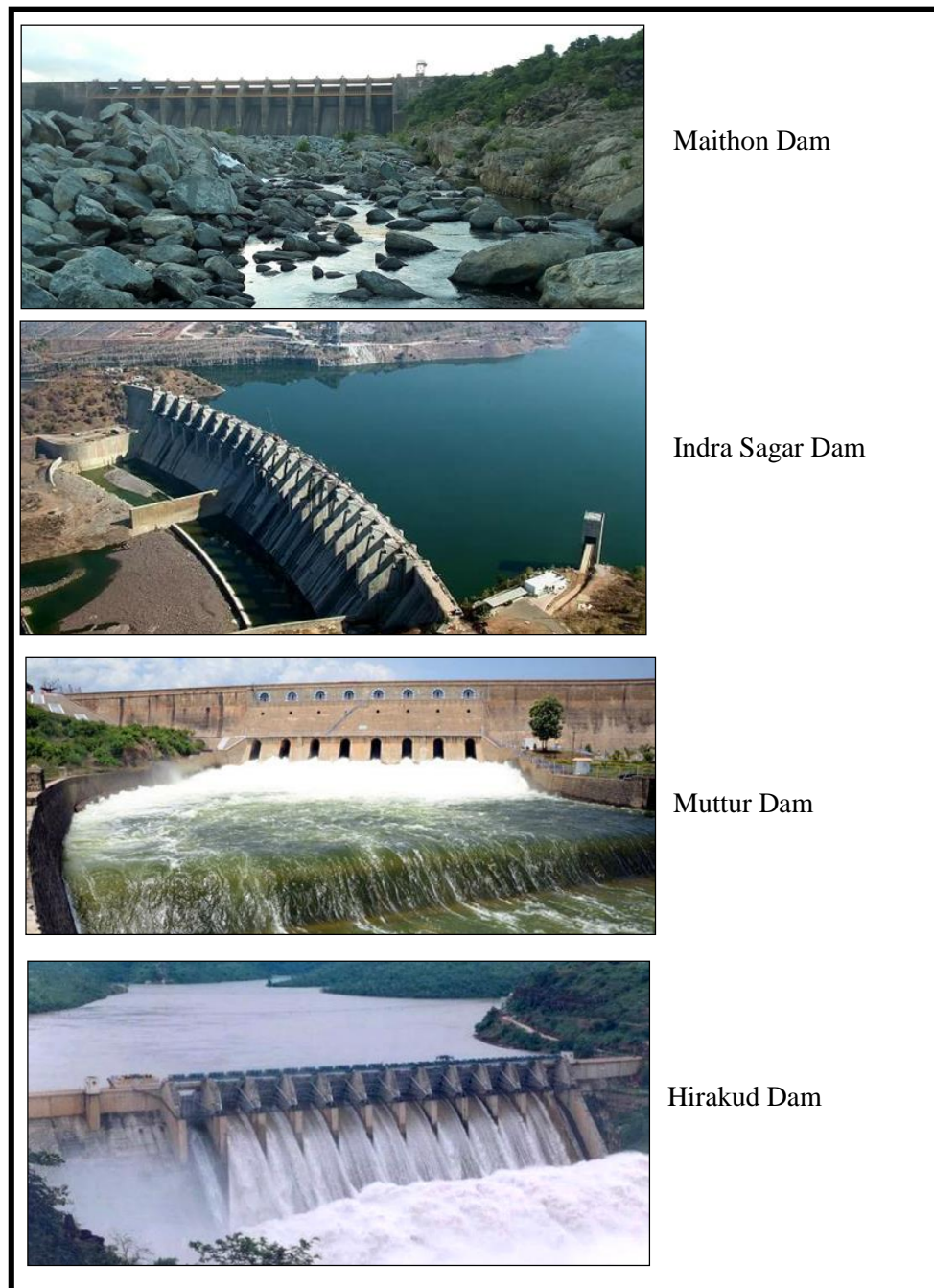
### Third: Water Dams in India

India has the largest number of water dams in the world after the United States of America and China. It has two of the top ten dams in the world: Tehri Dam 261 m and Keshaw Dam 253 m. In terms of storage capacity, the largest dam in India is the Upper Wiganga Dam, with a storage capacity of 507 km<sup>3</sup>.

At independence in 1947, India had less than 300 large dams, and by the year 2000 the number of large dams had reached more than 4000, and half of these dams were built between 1971 and 1989. Accordingly, India ranks third in the world in building dams after the United States of America and China (Youssef, 2013).

The following is a study of the most important water dams in India, as follows: (Figure 3)





Google Earth Pro, 2022.

**Fig. 3: The most Important Water Dams in India**

- **Bhakra and Tangal Dam:** It is a Bhakra dam and barrage at Tangal, and the distance between them is 13 km. Its storage is annual, and its height is 222 m. It was built on the Stilj River, one of the tributaries of the Indus River (Ghareeb, 2005).
- **Tongabhadra Dam:** It is 2 km long and 50 m high. It is located on the Tungabhadra River, a tributary of the Krishna River, and was established in 1953.
- **Damodar Valley Dam:** It is located on the Damodar River, a tributary of the Ganges River. This project consists of four dams based on four tributaries of the Damodar River, which were established in 1957.

- **Hirakud Dam:** It is located on the Mahandi River and is the longest dam in the world, with a length of about 4.5 km. It was built in 1960.
- **Gandhi Sagar Dam and Kutah Barrage:** It is located on the Chambal River, which lies between Rajasthan and Mahayapradesh, and is connected to the Jamna River from the west. Work on the project began in 1960 and was completed in 1964.
- **Rehand Dam:** This dam was built on the Rehand River, one of the tributaries of the Son River, which flows into the Ganges. It is located in the city of Bipri in the Sunhadra district of Uttar Pradesh. The dam is 91.1 meters high and 93.3 meters long. Behind this dam is a giant water storage tank known by the name of Govind Tank Blabah Pant.
- **Kosi Dam:** It is located on the Kozi River, a little distance from Nepal, at the exit of the river from the Himalayas.
- **Cherothi Dam:** It is located on the Cherothi River in the state of Kerala. It is the third highest Indian dam in height, with a height of 138.4 m, and the width and extension of this dam is 701.0 m.
- **Indira Sagar Dam:** It is located on the Narmada River, with a height of 92 m. This dam is located in Kandwa district in the state of Madhya Pradesh. It has the largest water reservoir in India, with a length of 653 m.
- **Krishna Raja Sagar Dam:** It is located on the Kaveri River, one of the most important branches of the Ganges River, near Mysore district in Karnataka. The height of this dam is 38.1 m, and its length is 3.5 km.
- **Mitur Dam:** This dam was built on the Mitur River in the Salim district of Tamil Nadu at a height of 120 feet and a length of 1700 m. This dam is among the highest and oldest dams in India.
- **Bisalpur Dam:** It is located in the Tonk district in the state of Rajasthan, where it is located on the Banas River between the two highest mountains in the district. Its height is 39.6 m, and its length is 573.9 m.
- **Koena Dam:** This dam was built on the Koena River in the Koina Naga district in Maharashtra, with a height of 103.3 m, and a length of 807.1 m.
- **Mithun Dam:** This dam was built on the Parakar River in the Mithun district of Jharkhand district in the Damodar Valley. It is considered one of the largest multi-purpose dams not only in India, but also in Southeast Asia as a whole.
- **Bhavani Sagar Dam:** This dam was built on the Bhavani River, 80 km from the city of Coimbatore in the state of Tamil Nadu. It is one of the most important tourist attractions in Erode County, with a length of 1700 m.
- **Narmada Valley Project:** This project includes 30 large dams, 135 medium dams, and 3000 small dams. It covers a large area of the Narmada River and its surrounding areas.

#### **Fourth: The Role of Dams in the Sustainable Development of the Agriculture and Energy Sectors in India**

The sixth goal of the Sustainable Development Goals to ensure the availability of sustainable use of water for all is a major objective of the sustainable development plan.



Water dams are one of the means or tools to achieve this goal, and its purposes include ensuring an adequate supply of water in the agricultural and energy sectors:

The water dams that are built on rivers are of great benefit, as they are established in order to use the water stored in front of them to provide water for agriculture, industry and population consumption, as well as to generate hydroelectric power, which is clean energy that does not pollute the environment. Table (1) shows the uses of water dams in the agricultural and energy sectors in India.

**Table 1: Uses of Water Dams in the Agricultural and Energy Sectors in India**

No.	The name of the dam	Uses in irrigation	uses in energy
1	Bhakra and Tangal	Irrigation of two million acres	—
2	Tongabhadra Dam	Irrigation	Generate 72 megawatts
3	Damodar Valley Dam	irrigating a million acres	Power generation
4	Hirakud Dam	Hirakud Dam irrigating half a million acres	Power generation
5	Gandhi Sagar Dam and Kutah Barrage	irrigated more than a million acres	Power generation
6	Rehand Dam	Irrigation of a million and a half acres	Generate 300 megawatts
7	kozy dam	Irrigation of one million acres	—
8	Shirothoni Dam	—	Generate 32 megawatts
9	Indira Sagar Dam	—	generating 120 megawatts
10	Krishna Raja Sagar Dam	—	Generate 200 megawatts
11	Metur dam	—	Generate 32 megawatts per day
12	Bisalpur Dam	—	Generate 172 megawatts
13	Quina Dam	—	Generating 1920 megawatts
14	Mithun Dam	—	Generating 60 megawatts
15	Bhavani Sagar Dam	—	Generating 1920 megawatts
16	Narmada Valley Project	irrigating one million acres	Walid 1200 megawatts

Source: Al-Galaly, 2017.

The following is clear from the analysis of Table (1):

- **Bhakra and Tangal Dam:** It is one of the largest irrigation and electricity projects in India. It was used in 1960/59 to irrigate an area of two million acres by means of a group of canals dug in Punjab, India, and Rajasthan, and the two states in which only a little rain falls (Muhammad, 1999).
- **The Tongabhadra Project:** The states of Mysore and Andhra Pradesh benefit from it in irrigation and electricity. In addition, two canals have been dug on both sides of the river for use in irrigating agricultural lands in the two mentioned states. The dam has a power plant that operates with a production capacity of about 72 megawatts, and the Japanese garden adjacent to the dam is one of the largest tourist areas in the region.
- **Hirakud Dam:** The target plan for generating electricity from the dam was 1.524 million units. However, 50 years later, in 2010, only 948,650 units were generated as an annual average which is just 62.24% of the original demand. In terms of irrigation, the target was 10.94.953 acres, but what was achieved is only 6.1 acres irrigated annually at a rate of 55.85% of the target (Nayak, 2010). It irrigates an area of half a million acres in the state of Orissa, and an electric station was established on it to benefit from the power of falling water.
- **Gandhi Sagar Dam and Kutah Barrage:** It consists of a reservoir that irrigates an area of more than one million acres and a power plant. Irrigation canals start at the Kutah Barrage, which is located in the middle of the Chambal River.
- **Rehand Dam:** Behind this dam is a giant water storage tank known as the Govind Balaba Pant reservoir. The dam has a gigantic power plant with a production capacity of about 300 megawatts. The project irrigates an area of one million acres in Uttar Pradesh, and half a million acres in Bihar.
- **Kozy Dam:** The dam irrigates an area of one million acres. It controls the flooding of the Ganges, and it retains a great deal of water at the time of the flood. It is the last major tributary to connect to the Ganges before entering the Ganges delta, which originates in the eastern tip of Nepal.
- **Shirothoni Dam:** This dam generates an electric energy estimated at about 32 megawatts annually (Youssef, 2013).
- **Indira Sagar Dam:** This dam has the largest water reservoir in India, and it produces electric power estimated at 120 megawatts.
- **Krishna Raja Sagar Dam:** This river produces electric power estimated at about 200 megawatts. It is also a tourist attraction due to its being an architectural masterpiece in addition to its proximity to the famous Raja Sagar tourist area with its wonderful gardens.
- **Mitur Dam:** This dam has the largest electric power plant in Tamil Nadu. It produces about 32 megawatts per day.
- **Bisalpur Dam:** It has an electric power plant estimated at 172 megawatts. In addition, the area in which the dam is located is one of the most important areas in eco-tourism,

as there are many rare species of birds as a result of its location in the path of migration of these species.

- **Kwena Dam:** There is a power plant in the dam that operates with a production capacity of about 1920 megawatts. The dam is located at the mouth of the river with Lake Shivaji. The dam area is one of the tourist areas in the region due to the presence of the beautiful and picturesque Sahyadri mountain range.
- **Mithun Dam:** This dam is one of the largest multi-purpose dams not only in India but also in Southeast Asia as a whole. This dam was built primarily to store water for use in irrigation. It has an electric power plant with a production capacity of 60 megawatts.
- **Bhavani Sagar Dam:** It has an electric power plant with a capacity of about 1920 megawatts.
- **Narmada Valley Project:** The main dam of Sardar Sarovar was designed to provide water for 40 million people, to provide electric power estimated at 1200 megawatts, and to irrigate 1.8 million hectares (Al-Ashram, 2008).

The following is clear from the previous analysis:

Most of India's irrigation dams are water storage dams, and this is considered as groundwater recharge. India's production of food grains increased fourfold between 1951 and 2000, from 51 million tons to 200 million tons. Two-thirds of this increase was in the irrigated lands, and by the year 2000 the dams irrigated areas constitute 35% of the irrigated lands in India. Most optimistic estimates estimate the increase in the productivity of food grains by about 25% of the irrigated lands from water dams. In fact, large dams have led to an increase in agricultural productivity (Al-Galaly, 2017).

India ranks fifth in the world in terms of the volume of hydropower production, which is estimated at 46000 megawatts as of March 31, 2020. In addition, the potential for hydroelectric power production in India is estimated at 148,700 megawatts, and the total hydroelectric power generated in India reached 156 million megawatt/hour in 2019/2020.)([https://en.wikipedia.org/wiki/Hydroelectricpower\\_in\\_India](https://en.wikipedia.org/wiki/Hydroelectricpower_in_India)

## Results and Recommendations

### First: The Results

1. The development process requires the provision of water resources that are equivalent to the increase in demand for them, whether as a result of population increase or increase in national income, which is representative of the various sectors of the national economy. This, in turn, shows the importance of water resources in the development of the state of India.
2. The Indian government made optimal use of the available potentials of surface water, as it was able to increase irrigation projects, particularly water dams, over the course of the five-year plans.

3. The agricultural sector is one of the most important productive sectors in India. This importance comes from the food it provides to satisfy the growing needs of the population, and from the job opportunities it provides for a large segment of the population.
4. Electricity is the pillar of economic development and an essential element for the optimal utilization of water resources, including water dams.

### **Second: The Recommendations**

1. India should pay attention to how to reduce and rationalize the water directed to the agricultural sector without reducing production, by using modern irrigation techniques.
2. Following the methods of rationalizing water use by all methods by preparing water legislation, and protecting water from pollution, as well as raising awareness through education and the media by highlighting the importance of water resources as a national wealth that must be preserved.
3. Encouraging research and development operations in the field of water, as well as seeking the assistance of universities and research centers in order to develop methods of managing water resources, and finding solutions to the dangers, problems and threats facing these resources.
4. Working to educate all residents about the real value of water and the need to preserve it and rationally use it, in a manner that ensures its immediate and future sustainability, and helps to ensure its use and benefit.
5. India and its neighboring countries should stand side by side in facing the dangers of floods, by constructing dams with different storage capacities.
6. India and its neighboring countries should participate and consult in case of building dams on shared rivers to prevent any problems arising in the future.
7. Basic points must be taken into account when designing irrigation projects, the most important of which is ensuring the quality of returns (irrigation benefits, public health, domestic uses of water) and costs (environmental negatives, resettlement costs, compensation for the displaced, and others).

### **References**

- Al-Galaly, I. A. (2017). *The economics of water resources and its effects on economic development in India* (A master's thesis). Asian Institute, Zagazig University.
- Al-Zawka, M. K. (2004). *Asia: A study in regional geography*. Alexandria: University Knowledge House.
- Douglas, M. (2000). *Principles of Sustainable Development*, (translated by Bahaa Shaheen). Egypt: International House for Cultural Investments.
- Ghareeb, S. R. (2005). *The role of Agrarian reform in economic development in India* (A

- master's Thesis). Asian Institute, Zagazig University.
- Ibrahim, A., & Abdel Wahed, M. (2015). *The Indian experience in Africa*. Lebanon: Arab House of Science Publishers,
- Mahmoud A. (2008). *Water economics in the Arab world and the world*. Lebanon: Center for Arab Unity Studies
- Muhammad, K. A. (1999). *The development of the Indian agricultural economy from shortage to abundance* (A master's thesis). Asian Institute, Zagazig University.
- Nayak, A. k. (January 9-15, 2010). Big dams and protests in india: A study of hirakud dam. *Economic and Political Weekly*, 45 (2), pp. 69-73.
- Osama, A. (2013). *Dams and the first spark in the water war*. Cairo: Dar Al-Fursan Publishing and Distribution.
- Rahman, M. (2016). *Transformation in development planning frameworks for promotion of sustainable development of agriculture in Bangladesh* (A PhD thesis). School of Law, Western Sydney University, Australia.
- Todaro, M. P. & Smith, S. C. (2012). Economic development.
- United Nations, 2015, paras. 2, 5, 18, 55
- Youssef, H. E. (2010). *Water resources and their impact on agricultural production in India* (A master's thesis), Asian Institute, Zagazig University.
- Youssef, H. E. (2013). *The impact of water resources on agriculture and tourism in the republic of India* (A PhD thesis). Asian Institute, Zagazig University.
- Zulfiqua, F., & Thapa, G. B. (2017) Agricultural sustainability assessment at provincial level in Pakistan, *Land Use Policy*, 68 492–502.

### Websites

<https://ar.wikipedia.org/wiki/%D8%A7%D9%84%D9%87>

[https://en.wikipedia.org/wiki/Hydroelectric\\_power\\_in\\_India](https://en.wikipedia.org/wiki/Hydroelectric_power_in_India)



## السدود المائية ودورها الاقتصادي في التنمية المستدامة

### لقطاعي الزراعة والطاقة في الهند

#### مستخلص

يعرف السد بأنه الحاجز الذي يقسم المياه، والسدود عموماً تخدم الغرض الأساسي وهو الاحتفاظ بالمياه، ويوجد بالهند أكبر عدد من السدود المائية في العالم بعد الولايات المتحدة الأمريكية والصين، وتمتلك الهند اثنان من أعلى عشرة سدود في العالم وهما : سد تهري 261 م وكيشاو 253م،، ولقد تضافت الجهود للمحافظة علي الموارد المائية، وتوفير ما من شأنه ضمان الحياة علي سطح الأرض وذلك من خلال إقامة مشاريع السدود وتحقيق الاستفادة القصوى منها وتهدف السدود إلي تخزين المياه للري والشرب ولمواجهة أزمات الجفاف في بعض السنوات والحد من خطورة الفيضانات، وتلعب السدود المائية دوراً كبيراً في التنمية المستدامة في قطاعي الزراعة والطاقة بإعتبار أن المياه هي الأساس الذي تقوم عليه الزراعة والطاقة، وتنمية الزراعة والطاقة يؤدي حتماً إلي انتعاش الاقتصاد ككل.

**الكلمات المفتاحية:** السدود المائية، الاقتصاد، الزراعة، الطاقة، التنمية المستدامة.