Futures 67 (2015) 22–25

Contents lists available at ScienceDirect

Futures

journal homepage: www.elsevier.com/locate/futures

Trajectories

The future of India's obsolete dams: Time to review their safety and structural integrity

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ARTICLE INFO

Article history:
Available online 11 February 2015

Keywords:
Dam
Decommission
Structural integrity
Safety
Community
India

ABSTRACT

India has built over 5000 large dams till date to boost electric power and to enhance irrigated agriculture. In spite of this big dam building venture, India lacks expertise in decommissioning old dams. As a matter of fact, India has more than 500 large dams that were built 50 years ago, and 100 of them have passed over a century. This article analyses the existing facts on India's outdated dams, their safety matters and recommends future strategies to safeguard the large dams from potential future threats.

Dam building is not new and it has been an Indian tradition for millennia (Maira, 2009). Historical records from the Indus valley civilization show that villages had reservoirs then known as the source of fertility. Ancient Hindu scriptures highlight the sacredness of water in society and they also reveal sophisticated methods of building aqueducts and dams. During a visit to the Dholavira archeological site, I was amazed to see an inspiring pre-historic city with several reservoirs to harvest rainwater connected by an intricate network of aqueducts (Maira, 2009).

India has built numerous large dams to harvest hydro-electric power and to support rural agriculture through canal irrigation. Despite this mega-dam building venture, it does not have the know-how to decommission dams, which is similar to many developing nations. But the fact is, India has over 500 large dams that were built 50 years ago, and 100 of them were built a century ago (Sharma, 2011). So I wonder whether these outdated dams can withstand massive flash floods influenced by rapidly changing climate and high-impact earthquakes. In this article, I have analyzed the existing facts on India's outdated dams, their safety concerns and also presented appropriate future strategies to safeguard India's large dams from potential threats.

1. Everlasting exemplar of Asia's ancient dams

India's ancient check dam, the Grand Anicut is only 4.5 m tall and 300 m long, and it is considered as one of the oldest dams in human history. It continues to irrigate the Cauvery delta of Tamil Nadu state of southern India for over two millennia (Agoramoorthy, 2009). Built on the holy river Cauvery, the Grant Anicut, locally known as *Kallanai* or stone dam in Tamil language, currently supports about four million farmers with irrigation water. The Anicut has been attributed to the 2nd Century AD Chola dynasty's King, Karikalan. But the name of the engineer who designed the dam has not been mentioned in records depicting the fact that native cultural richness may not necessarily depend only on historic writings (Agoramoorthy, 2009).

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http://dx.doi.org/10.1016/j.futures.2015.02.001
0016-3287/

Two British engineers who contributed greatly to irrigation technology during India's colonial era were Proby Cautley, who designed the Ganges Canal, and Arthur Cotton, who renovated the Grand Anicut on the Cauvery. When the British East India Company started to manage the Cauvery delta in 1799, it had difficulty to control the rising river due to silt backed up against the dam. British engineers struggled for a quarter century and at last, using traditional methods, Arthur Cotton was able to resolve the crisis. He later admitted in writing that he learnt more about the art of ingenious technology to anchor foundation in fast flowing river covered with loose sand at the bottom only after renovating the primordial Anicut (Cotton, 1874). Statues of Arthur Cotton and King Karikalan erected on the Anicut to recognize their contributions to irrigation in Tamil Nadu can still be seen.

According to the International Commission on Large Dams, any structure taller than 15 m is considered as 'large dam', and when it exceeds 150 m, it becomes a 'major dam'. So check dams are smaller than 15 m. India's largest check dam built by Sadguru Foundation (a non-profit agency based in Dahod, Gujarat) with government support, located at Baneshwardham in Rajasthan, stands at 7.25 m (Agoramoorthy, 2009).

Ancient dams can also be seen in China and the best one I have seen is the Dujiangyan irrigation system in Sichuan Province near Chengdu city. This dam belongs to the Warring States period dating back two millennia. The Min river then was facing frequent floods so the provincial governor, Li Bing studied the landscape associated with fast moving upstream originating from nearby mountain and silted downstream that triggered the shallow banks to burst repeatedly. Subsequently, he came up with a creative idea to build an embankment that looks like a fish mouth that divided the river flow into a deep and narrow inner tributary and a wide and shallow outer tributary. The dam enabled the inner one to take water for irrigation through a canal system. During rainy season, intake reduces to minimize flooding while the outer one drains away flood water loaded with sediments. The local temple has a statue of Li Bing and people still revere him. Both Dujiangyan and Grant Anicut were flawlessly created by great ancient engineers with simple tools and technology amicably harmonizing alongside nature and not against it – this could be the secret for their longevity (Agoramoorthy, 2009).

2. India's large dam dilemma

Historically prior to 1900, there were only 40 large reservoirs worldwide that held total volumes greater than 25 billion gallons. But today, there are over 3000 reservoirs globally holding over 1500 cubic miles of water. It is large enough to flood 120 million acres of land or greater than the combined land areas of Uttar Pradesh, Gujarat and Haryana states of India. The global water usage has also exceeded by six times during the last century. Thus many countries have met this acute demand by building bigger dams. Dam proponents argue that bigger the better since they reduce floods, increase irrigation, develop economy and supply hydropower. But opponents on the other hand argue that they cause extensive environmental damage and displace millions from their homeland. Yet, the standoff among these conflicting schools of thoughts may go on into the future (Agoramoorthy, 2009).

It is well known that India is the third dynamic dam builder in the world. It closely follows China and the United States in holding the record for completed large dams. It has a total of 5193 large dams of which 4846 have been completed while 347 are under completion. Three states namely Maharashtra, Madhya Pradesh and Gujarat are the major stakeholders in this dam race and they hold over 60% of all big dams while the rest spread out in other parts of the nation. These three states alone manage a total of 1845, 905 and 666 large dams, respectively. The dams boost hydropower as well as canal irrigation to enrich agriculture – the lifeline for millions of rural folks.

Unlike the small check dams that are not managed by government, all large and major dams are monitored by the government. The most contested dam debate in history of modern India involves the Sardar Sarovar dam built on the holy river Narmada. Irrespective of ideological differences between anti-dam activists and dam enthusiasts, India's government maintains the status quo of not only building more big dams but also starting a brand new 15,000 km long network of canal system to link India's major rivers with a price tag reaching USD 168 billion. This mega-engineering project is projected to transfer 174 billion cubic meters of water each year, from flooded rivers to drylands, with the sole objective to enhance irrigated agriculture (Bagla, 2014).

Nevertheless, there is an inherent problem involving the existing large dams – aging. The South Asia Network on Dams, Rivers and People (http://sandrp.in/) states that over 500 large dams across India have passed over 50 years, and 100 of them have reached over 100 years (Sharma, 2011). But records on these dams' structural integrity and safety in case of rupture are not available in government records for public scrutiny. So the question is – what will happen when an old dam gives up abruptly? A closer look at the past dam collapse cases may shed some answers.

3. The chilling consequences of collapsed dams

When the technological marvel of Hoover Dam in the Mojave Desert came into reality in 1936, it was the world's largest dam, standing 221 m tall. Without it, there would be no glamorous cities such as Las Vegas and Los Angeles. There is no doubt that the United States has idealized the dam building saga globally to promote economic power. But it has likewise recorded one of the worst disasters in its history when the St. Francis dam near Los Angeles collapsed in 1928 killing 600 people. Later investigations found three major factors contributing to the breakdown: (i) weak foundation based on instable landslide material, (ii) additionally increased dam's height weakened structural integrity, and (iii) construction was supervised by only one expert (David Rogers, 1992). Dams also collapsed in India and the notable case was the Machchu-2 that flooded