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10 December, 2016

Opportunities and Challenges with the Development of Hydropower in Various Countries

The sixties were a time of major population and economic growth in Brazil. With a count at 70 million, it was expecting another 100 million in a short three decades. This boom meant that energy sources had to expand. Still not exactly wealthy, Brazil did not have enough money for oil imports. Therefore, they decided to utilize the one resource they did own: water. About ten percent of the Earth's freshwater is found in Brazil. Hydroelectric power seemed like the obvious and most resourceful option for the expanding country. This would be no easy task. First off, they needed to find a proper and safe site through 40,000 km of river. On top of this, authorities preferred one massive dam to create a large fraction of energy for Brazil. In this case, the river of choice had to have enough volume, with sturdy and narrow bedrock. The only option were sites in the Piranha River, the seventh largest in the world. Flowing through a deep underwater gorge, the bedrock proved to be strong enough. However, it sits right between Paraguay and Brazil. Paraguay, an old enemy, fought in a bitter war with Brazil, losing half of its territory and population. It was so traumatic that even more than 100 year later, there was still distrust between the countries. Finally, in 1973, they signed a treaty in agreement over the building of the Itaipu Dam and its energy use.

In order to produce the most hydroelectric power, it had to spread seven kilometers across since the chosen site is only fifty meters deep. To begin, workers had to carve the biggest water diversion channel ever attempted. This task itself took about three years, creating a pile of unwanted rock larger than Sugar Loaf Mountain in Rio. Once flowing through the new channel, cofferdams were built to keep water from the building site. Luckily, with no issue regarding

these temporary dams, the Itaipu Dam went under construction. In 1979, after much uninterrupted progress, the building hit a standstill. There was a weak area of bedrock about twenty meters under the surface, flat and running right across the dam's foundations. Taking a few months, workers replaced it with concrete, solidifying Itaipu foundations.

Using mainly concrete, the Itaipu Dam was built to be heavy and somewhat cheap. With very thick walls and hollow middles, the dam is sturdy and houses the powerhouse equipment within. In order to move the masses of concrete used in construction all 61 billion tons of it, massive steel structures needed to be built. There was much work put into this dam, which is why work went on around the clock, 365 days a year. Because there were so many hours put in and so many people involved, there was a whole community built for the laborers. The nearest city, 1,000km away, did not allow the workers a practical life. Therefore, a chunk of the dam's budget went into building houses, schools, and other communal necessities.

Seven years after the start of construction, the divergent channel was closed off. Stakes were high. There is no rehearsal, only a moment of truth. If the dam had failed, a wave would cause detrimental flash floods. Thankfully, it proved successful as the reservoir filled 100m. over the course of a few days. To stop water from flowing over the dam, a spillway was built. Larger than Niagara Falls, it was the largest manmade waterfall. This too had no rehearsal, but was a success. The next question was whether or not spillway flow damaged the dam or downstream riverbed. Although there was a bit of erosion, the water's energy is dissipated from a ramp structure. It was to enough to be destructive, so they continually check for more erosion. With the walls of the dam completed and functioning, the power technology went into the workings. Nine years later, in 1984 poured through, spun the turbines and generated electricity from the Itaipu Dam for the first time.

The Itaipu Dam is the most powerful hydroelectric plant in the world, feeding thousands of people. However, a majority of these people live kilometers away, making power lines necessary. In 2002, Brazil realized just how much of the country relies on the Piranha River's power. Due to a failing power line, thirteen turbines came to a halt, cutting power to Rio de Janeiro and Sao Paulo. Subways, elevators, and everything in between were temporarily useless in the dark cities. After this black out, money was put into energy transmission.

This type of reliance does not come without a price. Many people and animals are relocated, and there is major habitat destruction and alteration. Even around 145 people lost their lives in construction. On Brazil's side of the Piranha River were agriculture and communities. The country had to sacrifice many acres of farmland and relocate nearly 40,000 people. Albert Fraise was the man who conducted real estate evaluations on many of these properties. He sent people out to photograph everything included on peoples' properties. People were given money and some were given new land. A majority of the citizens accepted the offers, but a few wrestled in court. On the Paraguayan side laid precious Amazon Rainforest. Environmental consultants came during construction to create a major rescue plan. The team, over years, searched for animals, documenting 129 bird species, thirty-two mammal species, and nine reptile species they hoped to track, remove, and relocate. However, it was understood that thousands of living things would perish and possibly go extinct. When the waters were released, a team of over 300 conservationists set out to save the animals they missed during relocation. This painfully went on for many days, but the land was just too big to completely cover. On the plus side, millions of new trees were planted to replace the many submerged in the reservoir. During the eighties, this was a significant and unusual accomplishment.

Although the Itaipu Dam has the capacity to generate the most hydroelectric power in the world, the Three Gorges Dam is the largest. Sixty stories tall, the Chinese took concrete construction to new heights on the Yangtze River. Concrete is a stable and cheap way to build a dam, however, it must set correctly in order to create sturdy foundations. In Brazil, setting the concrete was an issue due to high temperatures. While surrounding areas of giant slabs cool, the inner areas hold heat, creating cracks in the concrete. For the Itaipu Dam, the concrete was washed with freezing water and cold air, reaching only seven degrees by the time they were pouring into molds. For the builders in China, this was not so much of an issue. The bigger issue was a sturdy bedrock: without strong bedrock, the concrete barely makes a difference. In order to stabilize their cracking bedrock, they used vertical tubes to fill open spaces with very strong grout. This reinforced stabilization for the dam and confidence in the engineers to begin building.

180 meters tall and two kilometers long, the Three Gorges Dam took 40,000 laborers and more than seventeen years to complete. Just like with the Itaipu Dam, diverging the river water for construction of the main dam was of the most difficult tasks. Using stone cofferdams, they had to divert the two kilometers of Yangtze River flow. Along with this hefty operation, they had to relocate over one million people. When the dam was completed, they used dynamite to blow away the cofferdams. With China being one of the fastest growing economies on earth, the accomplishment of the Three Gorges Dam was necessary. The dam has thirty-two generators, which is enough to generate power for sixty million people.

The Yangtze, being one of the busiest rivers in Asia, ran into a traffic issue with the Three Gorges Dam. Because it carries eighteen million tons of freight a year, it was necessary to build the biggest ship lock on Earth. With this five levels to get to the top, it can take up to four hours for ships to reach the other side of the dam. Therefore, a ship-lift system was built. This

functions similarly to an elevator and uses counter weights to lift the ship and the water its floating in. Another big issue the Three Gorges Dam had to deal with was that of sediment. The area around the dam has one major flood every ten years. Although the dam helps to control the issue, the reservoir locks away many important nutrients that would normally be flowing downstream. Flood waters were beneficial because they carried nutrients to the surrounding land, which is used in agriculture. After the dam was built, agricultural production within the flood plain and hundreds of miles downstream declined. Also, all of the silt settling within the reservoir could interfere with the turbines and disturb the structure of the dam. To deal with these issues, huge slough gates were installed, allowing flood water and nutrients to pass. However, the true flow of nutrients cannot be reached with the Three Gorges Dam in place, but authorities believe its consequences are a price worth paying.

The Grand Coulee Dam's main purpose, unlike the previously noted dams, was irrigation. It provides water for over 10,000 farms each day. This dam, on the Columbia River, also produces large amounts of hydroelectric power. When its construction was completed in 1942, it was a powerhouse for war as it fueled aluminum plants for ship building and other war tools. After its completion, a third power station was added, making it the largest electric power producing facility in the United States. Build with cement, it is 550 feet tall and 5,280 feet wide (only sixty feet short of a mile) with a 350-foot-tall spillway.

These dams have been regarded as additional wonders of the world. To me, it is no surprise as to why. Understanding a bit more about what goes into the preparation and the building of dams was humbling. First of all, I never knew how much space was needed in order to allow the filling of a reservoir. In some cases, even more than a million people are displaced in preparation. Also, depending on what exists in the reservoir space, delicate ecology is at risk. I

am troubled by the amount of distressed and displaced animals there were, since they aren't exactly given a chance to move, like humans are. Also, the details in building and the solutions the engineers work out are brilliant. It amazes me how people, so small, are able to manipulate such massive natural structures. One of the documentaries said that the damming of the Three Gorges Dam actually tripped the Earth's spin for a fractional second. The cofferdams and the enormous use of cement are not easy tasks. However, almost anything is possible when in need. The electricity produced by these dams give power millions of people. I believe that the consequences of dams can be worth the power produced. However, powering a whole world with dams would not be a decent solution, because there would be too many acres lost to these huge structures.