Building a Dam and Irrigation System to Help Farmers in Isabela, the Philippines, Adapt to Climate Change, 2011–18

Korea Program FOR Operational Knowledge

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PROJECT DATA

IMPLEMENTING AGENCY:
Korea International Cooperation Agency (KOICA)

DEVELOPMENT CHALLENGE:
Climate Change–Resilient Agriculture

DELIVERY CHALLENGES:
Natural Disasters; Coordination and Engagement; Organizational Capacity; Civil Unrest and Armed Conflict; Market Deterioration

SECTOR:
Climate Change, Agriculture, Water

COUNTRY:
The Philippines

REGION:
Southeast Asia

IMPLEMENTATION YEARS:
2011–18

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Executive Summary

Farmers in Isabela, a province in the Philippines, have long suffered from natural disasters such as flooding and drought, and climate change has made farming even more difficult. In the 1990s and 2000s, droughts lasted longer, typhoons became more frequent, and the timing of seasons varied unexpectedly, making it difficult for farmers to predict rainfall. Most farmers in the region depended solely on rainfall to cultivate crops, which meant they could harvest only once a year. As a consequence, farms had low productivity, and many farmers struggled to get by.

To reduce the impact of extreme weather, the government of the Philippines in 2011 launched the Pasa Dam project to build a dam, construct irrigation infrastructure, and improve management of the watershed, the land area that soaks up rainfall and channels it and underlying groundwater into rivers and lakes. Ultimately, the government aimed to increase agricultural production through a consistent supply of irrigated water.

The project team faced several challenges in their efforts to build the dam, including typhoons, bankruptcy of the main construction contractor, and deforestation of the watershed area. To deal with the challenges, the team had to maintain strong relations with the local community and frequently adapt the construction plans.

The dam and irrigation infrastructure were finally completed in 2018. In 2019, it was still too early to evaluate the project's impact, but signs were encouraging. There was no flood or drought damage in the area in 2018 and 2019, and the dam was able to withstand two typhoons. Moreover, crop yield in the 2019 dry

Sooyoung Choi authored this case study on the basis of interviews conducted in July 2019. This research was supported by the Korea Program for Operational Knowledge, a partnership between the Ministry of Economy and Finance of the Republic of Korea and the World Bank Group.

season was twice as high as it had been previously, and some farmers had begun harvesting twice per year.

Introduction

The Philippines has long suffered economic damage and decreased agricultural productivity as a result of frequent typhoons, droughts, and floods. This phenomenon has intensified in recent years because of climate change. The agriculture sector, which in 2009 employed about one-third of the country's work force, is the most vulnerable sector of the economy in regard to climate change (Philippine Statistics Authority 2010). In areas where temperature or rain patterns fluctuate, or where extreme events such as floods or droughts happen more often, production of grain and other agricultural produce can suffer. Increased frequency of tropical cyclones, in particular, can put pressure on agricultural production.

In response to these challenges, in 2010, the government of the Philippines asked the Republic of Korea to provide support to areas in the Philippines suffering the effects of climate change. The government wanted to build irrigation structures and better manage watersheds, the areas of land that drain or "shed" water into rivers and lakes, in an effort to prevent flooding and provide farmers with a more consistent water supply. Irrigation structures can effectively impound and store excess water to be used for agriculture or domestic purposes.

In 2009, the Korean government had initiated the Green Growth Strategy, which aimed to shift the development paradigm from fossil fuel–dependent growth to more environmentally friendly alternatives using low-carbon and renewable energy resources. In 2008, prior to this policy, the Korea International Cooperation Agency (KOICA), Korea's international aid organization, had launched the East Asia Climate Partnership (EACP).[1] The Philippines requested Korea's support through the climate partnership to build two irrigation structures: one in Bukidnon, a landlocked province in the Philippines located in the Northern Mindanao region, and one in Isabela, the largest province on the island of Luzon.

In 2011, KOICA put together a research team, consisting of dam construction engineers, rural development specialists, KOICA headquarters staff, and staff from KOICA's Philippines country office, to visit Bukidnon and Isabela. To accompany the group from Korea, the Philippine government sent officials from the Bureau of Soils and Water Management, a government agency; the National Irrigation Administration (NIA), a government-owned and government-controlled corporation primarily responsible for irrigation development and management; and the local governments of Bukidnon and Isabela.

The research team encountered several obstacles in the Bukidnon area. The main issue was that NIA officials could not agree with the local community on compensation for the submerged area. Because the dam would involve flooding a certain area, the project had to pay people who lost their land. In Isabela, project officials negotiated compensation that both sides were happy with, but in Bukidnon, political interference hindered negotiations, and the two sides were unable to reach an agreement. Furthermore, the research team found that a local college owned most of the land surrounding the proposed Bukidnon site, which meant few local farmers would benefit from a new irrigation system.

The feasibility research team also determined that the allocated project budget and time period were not sufficient to cover two separate sites. So in light of the difficulties in Bukidnon, the Philippine government and KOICA decided to have just one project site: Isabela province. KOICA reallocated the budget for the Bukidnon site to Isabela and redesigned the project outline to account for the new focus on just one area.

Coming to that decision was a lengthy process that included many discussions with government officials in the Philippines and Korea and with the two local governments in Bukidnon and Isabela. By the time the proposed site in Isabela was confirmed, the project was behind schedule, and the Korean government put pressure on the team to move ahead quickly with implementation.

Development Challenge

Climate change, population growth, declining land area, high cost of inputs, poor drainage, and inadequate irrigation are the major constraints to agricultural production in the Philippines (World Bank and GFDRR 2011). Some of these constraints are interrelated. Climate change and crops' vulnerability to drought and heavy rainfall, especially during the typhoon season, severely

1 The EACP was launched at the Group of Eight Extended Summit in June 2008. Korea committed US$200 million to the fund to help developing countries in Asia fight climate change and promote green growth. More information can be found at http://17greengrowth.pa.go.kr/?page_id=42459.

affect production. The Philippines bears the brunt of typhoons coming in from the Pacific Ocean, with heavy rains causing drainage problems in the rice fields, resulting in a reduction in the rice yield and quality.

Sometimes both droughts and floods affect farms during the same season. In the Philippines, severe droughts are associated with El Niño, the climate phenomenon that causes changes in ocean temperatures and rainfall, affecting agriculture and fishing in the countries bordering the Pacific Ocean (CAD 2011). During El Niño, low rainfall places significant pressure on the country's water resources. Climate change projections suggest that El Niño may intensify, creating profound implications for agricultural production (REECS 2010). In the 1990s and 2000s, the Philippines experienced several drought episodes that caused crop damage and economic decline, especially in El Niño years (CAD 2011). Droughts in 1997 and 1998 caused widespread crop failures, water shortages, and forest fires across the Philippines and dried out 20 percent of the country's fish farms, which led to a 6.6 percent drop in agricultural production (CAD 2011).

Intervention

The Pasa Dam project consisted of four core interventions: construction of the dam and irrigation infrastructure, construction of roads, introduction of better management practices in the watershed for sustainable water conservation, and training of Philippine government officials and farmers. The goal was to protect cropland from disasters, such as floods and droughts, and increase agricultural production through a stable supply of irrigation water. With increased agricultural productivity, members of the local community could expect to generate additional income.

KOICA contracted the Korea Rural Community Corporation (KRC), a government corporation that specializes in water resource management for agriculture and fisheries, to supervise all construction activities in the field. KOICA opened the bidding to select a construction company and settled on two contractors: Halla, a Korean company that provides contractor services for industrial facilities and civil construction engineering, as the primary construction company, and Gumgwang, a Korean construction and engineering company that specializes in dams, bridges, and tunnels, as the assistant contractor. NIA, the main project partner in the Philippines, was in charge of watershed management and general administrative support, along with the local government and the Department of Environment and Natural Resources, a government ministry.

The four core interventions are outlined below:

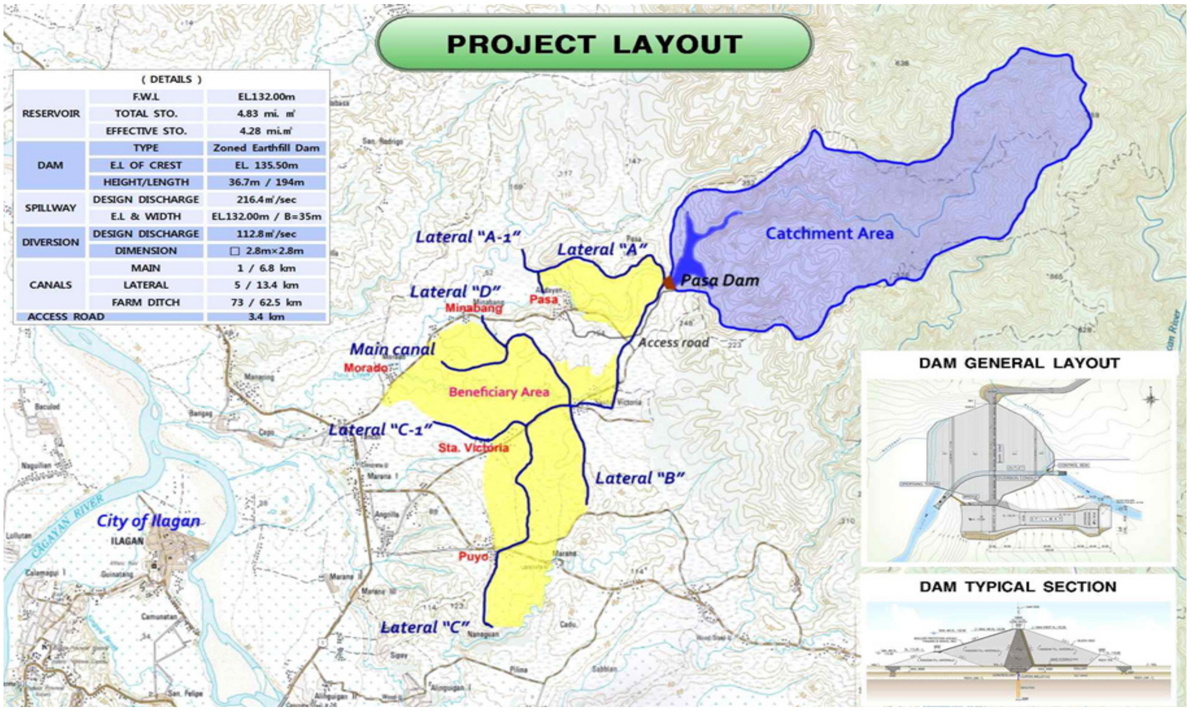
- *Road construction*. The roads to the construction site were narrow and unpaved, which made it difficult for vehicles to access the site. The construction contractor planned to build a 3.2-kilometer-long access road, as well as other roads, so that vehicles could access the area and construction equipment could be delivered. Local communities could use the roads during and after the project.
- *Construction of dam and irrigation infrastructure*. KRC and the construction contractor planned to build a dam 36.7 meters high and 194 meters long (see map 1). The dam would be made of compacted earth with a concrete core and have a 35-meter-wide spillway to release any surplus water that exceeded the dam's storage capacity (see annex A). To supply water from the dam to local farms, a 19.38 kilometer canal was designed, with one main line and six laterals, as well as 38.72 kilometers of ditches.
- *Watershed management.* NIA and the local government of Isabela planned four activities in the watershed area: reforestation, enrichment, agroforestry, and riparian reforestation. NIA and the local government determined the areas for each activity according to the condition of the watershed. NIA developed the specific plan for each activity with Byeongil Yoo, an afforestation specialist from Korea's Forest Service. In total, 300 hectares of watershed development were planned (see map 2).
- *Training of government officials and farmers.* KOICA and KRC planned trainings on dam safety, operation, and maintenance and on watershed management for government officials from relevant departments. In addition, KOICA and NIA planned to hold a workshop for local farmers to improve their understanding of irrigation systems and efficient water management and to provide them with knowledge about watershed area management.

Delivery Challenges

Natural Disasters: Heavy Rain and Typhoons

Typhoons strike the Philippines regularly, and Isabela usually suffers from typhoons at least twice per year.

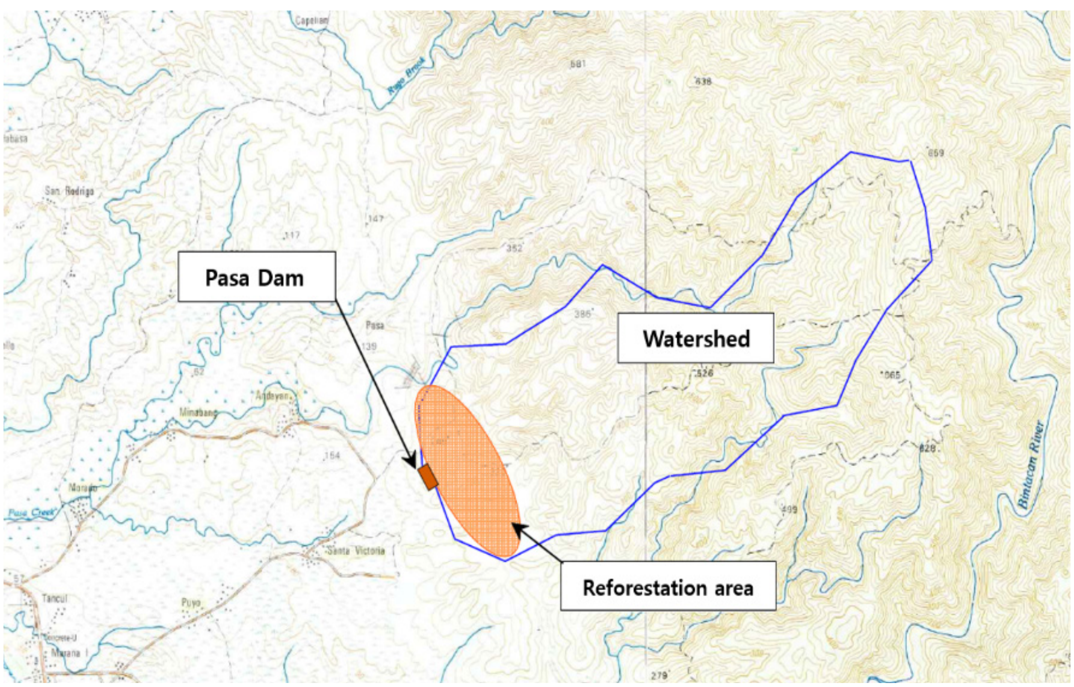
MAP 1. LOCATIONS OF THE WATERSHED, DAM, AND IRRIGATION CANALS



Map shows the planned irrigation system: the Pasa Dam construction site, the watershed (labeled "Catchment Area"), and the irrigation canals (main canal and six laterals). The service area of irrigation (labeled "Beneficiary Area") is shaded in yellow.

Source: KOICA 2018.

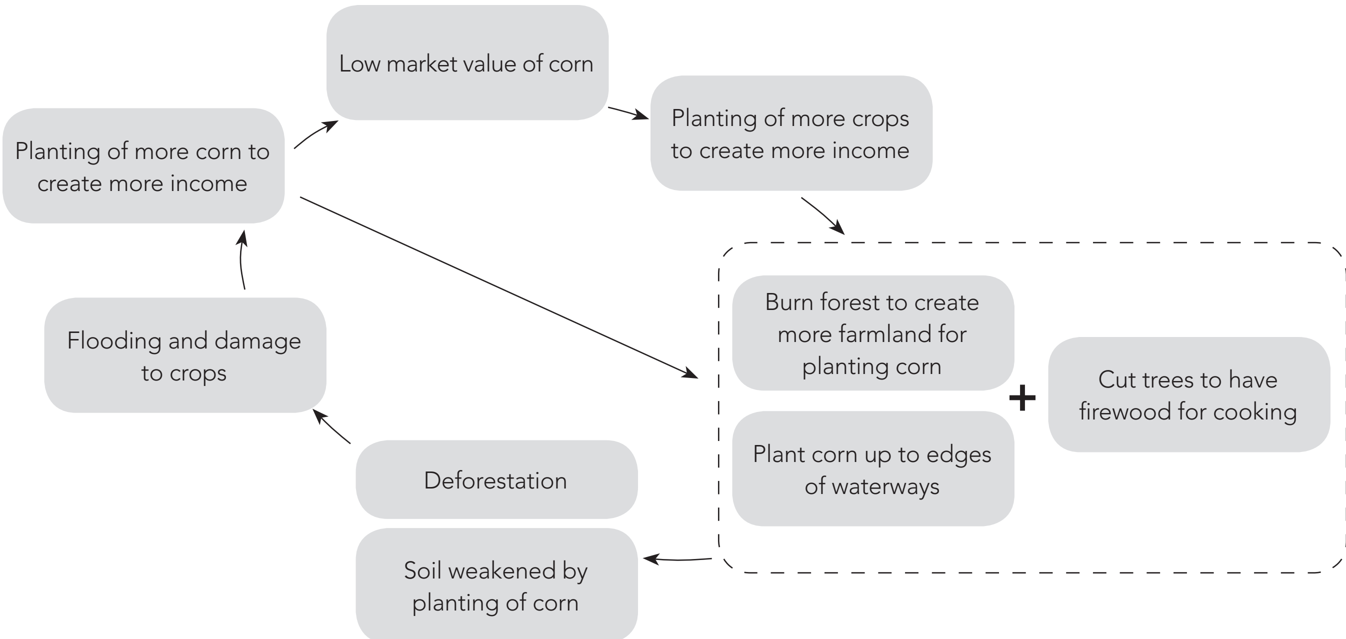
MAP 2. APPROXIMATE LOCATION OF WATERSHED MANAGEMENT ACTIVITIES



Map shows the watershed area. The area shaded in orange shows the approximate location of reforestation activities.

Source: KOICA 2018.

FIGURE 1. FLOODING DRIVERS



Source: Author configured diagram based on interviews with project staff and farmers in Isabela.

With the additional challenge of variable rainfall caused by a changing climate, the project team was concerned that extreme weather could affect the whole construction schedule and quality. To construct the dam, the contractors needed enough days to dry the soil and cement foundation so that the dam would have a solid foundation. Construction had to be halted if there was rainfall of more than 1 millimeter, so if there were too many rainy days, the project would be significantly delayed.

To cope with the risk, the project implementation stakeholders reviewed and analyzed the annual rain days of previous years and planned the construction schedule to avoid the rainy season. In addition, the construction company prepared a natural disaster management manual to minimize the damages from natural disasters during construction.

Lack of Awareness of Flooding Drivers

Unsustainable farming practices were one of the leading causes of flooding and soil erosion in the Isabela region. Most farmers grew corn because it could survive with low and irregular amounts of rainfall. However, corn had a low yield per hectare and low market value, so to earn enough income, farmers had to plant large areas of corn. Sometimes farmers resorted to planting corn right up to the edge of waterways or even burning forestland to open up more space to plant crops. These practices led to soil erosion and flooding (see figure 1). Although experts have long agreed on the link between deforestation and soil erosion, most farmers were unaware of the damage their actions caused.

As well as hurting agricultural production, unsustainable farming practices also hindered the irrigation system, because erosion of weak soil could easily block the canals. The root systems and foliage of trees next to waterways could strengthen slopes and reduce the effects of erosive forces. For the dam and irrigation canals to be sustainable, project staff had to convince farmers to protect the areas next to waterways and prevent deforestation in the watershed.

Lack of Coordination among Stakeholders

Coordination was particularly difficult since the main organizations involved did not have experience working together or in the region. KOICA and NIA were working together for the first time, and each team had to become familiar with the other's procedures. In addition, the construction contractors had to learn how to operate in the Philippines. The contractors had extensive experience

MAP 3. MAP OF ISABELA PROVINCE AND ILAGAN CITY

a. Location of Isabela in the Philippines

b. Location of Ilagan in Isabela

Source: KOICA 2018.

in irrigation facility construction in Korea but had never worked overseas.

To ensure effective communication among stakeholders, KOICA requested that KRC oversee project operations and provide technical supervision in the field. KRC was Korea's most experienced agency in irrigation system construction, and it also had experience in international agriculture projects. KRC designated Incheol Hwang as the field project manager to take the liaison role among stakeholders. Hwang, an agricultural engineer, had extensive experience working on agricultural projects for KRC and specialized in construction of water-related facilities (such as dams and canals). In addition, Hwang had experience working in several Southeast Asian countries, including the Philippines.

Organizational Capacity

Ensuring proper maintenance of the dam and canals was critical to ensure the sustainability of the irrigation system. After completion of the facility, the Irrigation Association, a voluntary community organization of about 600 farmers, would be responsible for resolving any blockages in the canal. However, the association did not have funding for maintenance work. Furthermore, NIA had never before worked with an automatically operated irrigation facility, and the NIA officials who would be in charge of the dam did not have the technical expertise to operate and maintain it. Ensuring that each group had the financial resources and expertise to take on their new responsibilities was critical to the project's success.

Tracing the Implementation Process

Constructing the Dam

Before dam construction could begin, access roads had to be completed so that equipment to build the dam could be brought in. Originally, KOICA was in charge of dam construction and training, and NIA was supposed to build the canals and access roads. However, it was uncertain when NIA could arrange the financial resources to construct the roads. According to NIA regional office staff, the access road from the community needed expanding and paving for a long time.[2] NIA's regional office tried to obtain government funding to conduct the work but was unsuccessful. Because the access road was critical for the project to move forward and NIA was unable to complete the installation on time, KOICA decided to take responsibility for all construction activities. NIA remained responsible for watershed management and administrative support. In 2012, KRC and the construction contractor built a 3.2-kilometer-long dirt road to provide access to the proposed area.

2 Author interview with staff members at NIA regional office, field site in Isabela, July 2, 2019.

The proposed site was in Ilagan, the capital of Isabela province (see map 3). In the Philippines, each city is divided into barangays, which are administrative divisions similar to villages. The proposed project area covered five rural barangays in Ilagan: Pasa, Santa Victoria, Minabang, Morado, and Fuyo. The five barangays were in an upland area that suffered from water shortages, especially during the summer period.

In May and June 2013, to help decide on a specific site to construct the dam, the implementation team conducted a baseline survey, collecting data from farmers in the five barangays using surveys and interviews.

Following the baseline survey, the team decided that the barangay Pasa had the most suitable land for a dam because it was surrounded by rolling hills, was located downstream of Cagayan valley, and had reasonably solid bedrock for the dam construction.

At about the same time the survey began, Halla, the main construction contractor, went bankrupt. This development demoralized everyone involved in the project and created a huge challenge for the implementation team, which was already under pressure to begin construction quickly. To resolve the crisis, KOICA and KRC asked the second construction contractor, Gumgwang, to take over all of the construction work. Fortunately, Gumgwang accepted the offer. While Gumgwang procured construction equipment for the task, KOICA obtained necessary approvals for the construction plan from NIA and from the National Economic and Development Authority, an independent agency responsible for economic development in the Philippines.

In October 2013, Gumgwang began dam construction, which consisted of five phases: bed excavation, concrete work to form the diversion conduit, spillway excavation, dam embankment, and valve chest construction. The first phase, bed excavation, was conducted using backhoe equipment and boring tools. During excavation, the bedding was partially compacted and properly spread to maintain uniform thickness. In November 2014, after the bed excavation stage, Gumgwang began the grouting procedure, which involved pouring a thick slurry mix of cement and water into any cracks and fissures to create a mostly flat surface.

Gumgwang completed the spillway construction in one dry season and the embankment in the next. The spillway allowed the release of surplus water that could not be contained in the allotted storage space. This work was accompanied by the diversion conduit construction, the installment under the dam to control excess river flow during construction. The final step was valve chest construction, which was the dam control operation space.

Throughout construction, Hwang, the project manager, regularly conducted cross-section inspections to examine the embankment's strength and geological features, such as the existence of limestone, that could cause water leakage.

While the dam was being constructed, KOICA and KRC conducted trainings on dam safety, operation, and maintenance for NIA's working-level officials. For one of those trainings, KOICA and KRC invited 12 NIA officials to Korea for 10 days. The officials visited a Korean dam and irrigation system that was similar to what the Pasa Dam would be, and they saw how the dam was operated and maintained. The training participants also learned about the irrigation operating system and attended a lecture on water supply systems and waste management from Korean experts. After discovering that the Korean dam had become a tourist attraction, the Philippine officials became interested in the possibility that the Pasa Dam could attract tourists when it was completed.

The dam construction kept facing setbacks, however. The construction plan had allowed for an average of eight rain days per month—the average number of rain days per month in the area from 2003 to 2012. But from September 2013 to November 2015, rainfall halted construction on 279 days—63 more days than had been planned for. To cope with the higher than expected rainfall, the construction company extended the daily working time during the dry period. As a result, although construction progressed much slower than expected, more than 80 percent of construction was completed by mid-2016. Farmers were expecting to be able to use water from the dam for irrigation beginning in 2017.

But the worst weather was yet to come. In October 2016, Typhoon Haima (called Super Typhoon Lawin in the Philippines) hit Isabela, causing extensive damage to the almost-completed dam (see figure 2). The project team had prepared for typhoons and had emergency protocol procedures in place, but the typhoon hit with far more strength than anyone had anticipated. "We were expecting to use the irrigated water for farming soon by that time because the construction was being finalized," said one farmer from Pasa. "The typhoon delayed construction and caused us great distress." It took more than four months to repair the damages and cost nearly US$1 million.

FIGURE 2. DAM CONSTRUCTION BEFORE AND AFTER TYPHOON HAIMA

a. Before (Dam body-center filled part)

a-1. After (Dam body-center filled part)

b. Before (Spillways slope)

b-1. After (Spillways slope)

The dam body and spillway slope swept away because of the excessive overflows, although the construction team installed additional drainage along with the planned emergency installations for typhoon and flooding.

Source: KOICA 2018.

Constructing the Canal and Ditches for the Irrigation System

The project team wanted to ensure that the canals and ditches for irrigation were ready by the time the dam was completed so that farmers could use the water immediately. The team hired local residents for construction work, which helped improve the community's understanding of the project and built a strong relationship between the project team and the community. It also created extra income for community members who worked on the construction.

Throughout the construction period, the project team changed the canal and ditch layouts several times to provide more benefits to farmers in terms of access to water. Hwang said that this kind of construction often causes conflict between a project team and a local community because some people benefit more than others. For example, the layout of the canals and the roads bring more benefits, such as convenient water access, to people who live nearby. However, this project didn't have that kind of conflict during the implementation, Hwang said, partly because of the strong trust built between the project staff and the community members.

On July 5, 2018, one main canal and six lateral canals were built, covering 19.38 kilometers in total. In addition, 38.72 kilometers of ditches were built to make the water easier for local farmers to access.

The Irrigation Association assigned each lateral canal a canal officer, who was in charge of the irrigated water supply schedule and the collection of fines and fees. According to Philippine law, individual farmers could not own more than seven hectares, and the government did not charge farms of less than eight hectares any fees to use irrigated water. Thus, farmers could irrigate their crops for free. However, if a farmer wanted to use irrigated water for fish farming, the NIA regional office charged a usage fee of ₱1,000 (about US$20) per hectare. If someone broke the schedule and stole water, the Irrigation Association charged a fine of ₱200 (about US$4). The canal officers were responsible for collecting these amounts.

Reforesting and Enriching the Watershed

NIA worked with the Department of Environment and Natural Resources to conduct the watershed management activities. KOICA helped plan the activities by dispatching a Korean forestry specialist to assess the watershed area in December 2015. On the basis of the forestry specialist's research, NIA and the Department of Environment and Natural Resources decided to conduct four activities in the watershed area: reforestation, enrichment, agroforestry, and riparian reforestation.

Reforestation involved planting trees in areas with severe deforestation, whereas enrichment involved planting trees in partly deforested areas to strengthen the density of vegetation. Agroforestry involved planting fruit trees that the local community could earn income from, and riparian reforestation involved planting trees next to waterways.

NIA and the Department of Environment and Natural Resources waited until the dam construction was well under way to start watershed management, so that they had a clear outline of where to work. NIA hired around 90 people from the community to plant seedlings, with a forestry officer from NIA monitoring their work. In riparian areas, workers planted bamboo seedlings. In the enrichment area, workers planted mahogany and other woody plant seedlings.

NIA purchased more than 150,000 seedlings for the area between 2016 and 2018. However, NIA estimated that one-sixth or more withered away. To prevent withering, NIA installed an automatic water spray machine that watered the seedlings (similar to a sprinkler), and NIA members regularly monitored their growth. NIA and KOICA had originally planned around 300 hectares of watershed management activities but had to reduce that figure by about half because of time and budget constraints. By the end of the planting, just over 150 hectares of the 1,900-hectares watershed area was covered.

The watershed area had been designated a protected area by the National Integrated Protected Areas System Act of 1992, but the legislation failed to stop local community members from cutting down trees to get firewood and create farmland. To prevent deforestation and restrict land encroachers, officials from the Department of Environment and Natural Resources patrolled the watershed area and imposed fines on anyone caught cutting down trees.

Additionally, KRC and NIA conducted two workshops in Isabela with regional officials and farmers to improve awareness of the importance of watershed management. The first workshop, in April 2017, consisted of two courses, one for irrigation specialists and another for government officials. More than 100 people attended, and Korean and Philippine participants gave presentations on their country's watershed management program with sample cases. Many ideas to prevent deforestation were shared during the workshop, and all participants agreed that it was important to work together to protect the watershed.

In May 2017, KRC and NIA held a second workshop targeting local communities, which was attended by nearly 500 people. Watershed management specialists from the Philippines gave a presentation on the watershed management approaches of Pasa Dam, on ways to control forest fires, and on the role of local communities in watershed management.

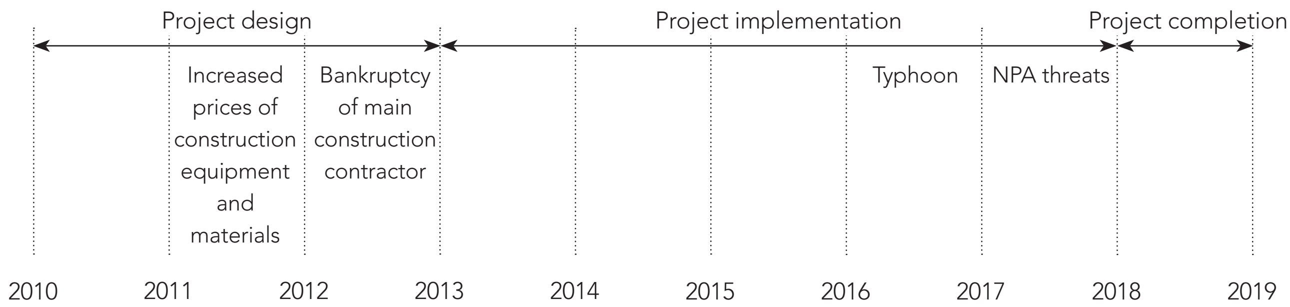
Overcoming Unexpected Obstacles

Aside from the original construction company going bankrupt and the damage caused by Typhoon Haima, the project faced two further unexpected obstacles: market conditions that drove up costs and the intrusion of an armed rebel group (figure 3).

At the time the project got under way, two big rural infrastructure projects were happening in the Philippines. The massive demand for construction materials and equipment caused market prices to increase. The Philippine government and KOICA had made a procurement plan in 2011 (KOICA 2011), but they were not ready to begin procuring materials for another two years. By that time, the market price had increased more than the inflation rate, and the construction work had to wait until the budget could be reallocated.

To overcome this financial burden, KOICA and KRC tried to divide the construction process into segments, so that they could review the unit prices of the materials separately. The construction team sorted the necessary materials, such as cement and rebar, and specified the

FIGURE 3. UNEXPECTED CHALLENGES DURING PROJECT IMPLEMENTATION



Source: Author reconfigured diagram based on interviews with project staff.

procurement schedule. KOICA still had to revise the budget plan to meet the increased procurement cost, but it was better able to cope with this risk using the systematic financial breakdown.

The other major obstacle was that the New People's Army (NPA), an armed wing of the Communist Party of the Philippines that is based primarily in the Philippine countryside, began sending threats to the construction field office in November 2017. The threats were unexpected because the NPA usually sent threats at the beginning phase of construction projects, not at the closing phase. In addition, the NPA usually targeted private businesses, not government projects. KOICA ordered the withdrawal of all Korean personnel, except for the project manager and construction manager, who remained in the field to guard the project equipment and look after the construction site. KOICA requested confirmation from the military of the legitimacy of the threat and organized an emergency meeting for all project stakeholders. The threat was verified as legitimate, and the project ceased operations until a security plan was established. At the end of January 2018, the construction project resumed, with military force stationed around the project site.

Outcomes

In May 2018, the Pasa Dam was finally completed (see figure 4). The project team conducted a final inspection, performed a trial operation, and held a completion ceremony. To prepare the handover of the facilities to NIA, KRC prepared a document with guidelines on security and maintenance, as well as an operation manual.

Although NIA took over the general facility operations, community farmers had to take care of canal maintenance and watershed management. To encourage commitment from the farmers, the Irrigation Association held regular meetings to discuss canal maintenance, group action for farmland development, watershed monitoring, and other relevant topics.

The Pasa Dam was expected to mitigate floods that would affect 434 houses and 465 hectares of agricultural lands in the area, according to estimates from the NIA regional office. It was also expected to alleviate a national rice shortage by supporting an additional 766 hectares of rice fields that would increase rice production by 8,629.20 metric tons annually, according to projections in the final project report in 2018 (KOICA 2018). According to that report, it would take a further two to three years for farmers' incomes to increase as the irrigated water allowed them to convert to more profitable crops and harvest more often.

Although as of 2019 it was still too early to see significant economic benefits from the dam and irrigation system, there were encouraging signs that the dam was sustainable and that the irrigation system would benefit farmers.

First, the dam proved able to handle extreme weather. Shortly after construction was completed, two typhoons hit the Isabela area. Typhoon Mangkhut, known in the Philippines as Typhoon Ompong, hit in September 2018 and Typhoon Yutu, known in the Philippines as Typhoon Rosita, hit one month later. The dam weathered the storms, and the typhoons did not cause any major damage, suggesting that the construction is sturdy enough to withstand future extreme weather events.

With a sustainable supply of irrigation water, some farmers in the five barangays surrounding the dam began to replace corn with rice and other more profitable crops. Moreover, local farmers were able to start other businesses in addition to rice and corn farming. For example, to generate extra income, some farmers built fish farms that use irrigated water. To promote such activities, the Department of Agriculture assisted by providing young fish for fish farming.

A steady supply of water also meant some farmers could begin cultivating two crops per year. Previously, when they relied on rainfall, they could only cultivate one crop per year. The irrigation facilities supplied water to 322 hectares of rice fields during the dry season of December 2018. NIA's 2018 annual report said that the irrigation service area in five barangays of Isabela had increased by more than fivefold compared with 2017. The rice field area increased by two and one-half times during the rainy season. The rice yield in the dry season increased 70 percent, from 2.7 metric tons per hectare to 4.6 metric tons per hectare, and the production of rice overall increased by more than 10 times across the five barangays (see table 1). The increased rice production was especially significant because the Philippines experienced a shortage in domestic rice supply from 2017 to 2019. The shortage was expected to continue as more agricultural land was converted to residential, commercial, and industrial uses across the country.

In 2018, Faustino Dy III, Isabela's governor at the time, said during an interview: "Considering that northern Isabela is prone to floods, especially during the rainy season, the Pasa Dam flood control system features are very timely" (Mapa 2016). He added that the Pasa Dam project would further fortify Isabela as the country's leading agriculture province.

TABLE 1. TRANSITION OF RICE CULTIVATION AREA AND PRODUCTIVITY IN THE IRRIGATION SERVICE AREA

Categories	2018 dry season	2019 dry season
Cultivated area (hectares)	50	322
Metric tons of rice per hectare	2.7	4.6
Aggregate output (metric tons)	135	1,481

Since operation of the irrigation system began in July 2018, the dam has been benefitting the communities in the service area, especially with rice cultivation. The 2019 yield has been increased more than 10 times compared to 2018's aggregated output.

Source: KOICA 2018.

Environmental training and increased monitoring brought positive behavioral changes. According to a forestry officer hired by NIA in 2017 to monitor the watershed area, deforestation by farmers had decreased, and he had not seen any evidence of recent deforestation in the area. The Department of Environment and Natural Resources, in partnership with the local community and the Irrigation Association, also monitored deforestation in the watershed area through regular field visits.

Despite initial signs of success, challenges to the sustainability of the intervention remained. After the handover of the project to the government of the Philippines, the Irrigation Association was put in charge of the maintenance of the canals, and the local government and NIA regional office were to provide additional support in terms of human and financial resources. Although the 2019 typhoons had not damaged the dam itself, they had caused damage to some of the lateral canals. Members of the Irrigation Association said that the damage could be repaired with the necessary financial resources and technical capacity, but they claimed that NIA and the local government had not provided sufficient support. Officials at the regional NIA office said they were awaiting budget assistance from the national NIA office and the local government in order to support the Irrigation Association.

Lessons Learned

Assessing the Importance of Watershed Management

The impact of climate-related events in the Philippines is aggravated by the deteriorating condition of watersheds in the country. Several people who worked on the project said that, while it was impossible to fully prevent damage from natural disasters such as typhoons, the scale of the risk could be reduced by long-term preparation in the form of watershed management.

Watershed management activities help foster natural-disaster resilience by preventing soil loss and controlling stormwater flow (World Bank 2008). Furthermore, sustaining the watershed helps maintain sufficient water levels for irrigation use. The most vulnerable people are upland farmers, who rely on rain as the primary source of water for farming and domestic use. By improving how watersheds are managed, local communities can ensure that they continue to deliver important environmental services such as conservation and purification of water supplies and can minimize the vulnerability of upland farmers to climate change.

Although the government and experts on the impact of climate change in the Philippines have been aware of the importance of watershed management for many years, the Pasa Dam initiative was the first international development project in the Philippines to include watershed-management activities. The project was indicative of a wider shift across the country to place more importance on managing watersheds sustainably. For example, in an effort to improve the sustainability of hydroelectric power, beginning in 2008 the National Power Corporation of the Philippines, a government-owned and government-controlled corporation, became actively involved in operating watershed management facilities for 11 areas in Luzon Island that had existing reservoirs and dams (NPC 2016).

As of 2019, it was too early to see any long-term impacts from the watershed-management activities around the Pasa Dam, although NIA and KOICA experts expected the region to have improved water supply, water quality, drainage, and stormwater runoff through better planning and use of watersheds. These results could help prevent crop damage from natural disasters and increase incomes through higher agricultural productivity.

Finding Synergies between Climate Adaptation and Economic Development

Although its main goal was to reduce the impact of extreme weather events by reducing soil erosion and flooding, the project was able to build local support (from the government and the community) because it promised to boost economic development in the area. The local community began to benefit from the project when construction began. The project team hired community members for construction work, creating extra income for those workers in addition to their agricultural activities. Also, the access road made it easier for farmers to transport harvested crops and farm equipment, which increased their work efficiency and productivity. Those benefits for the local community helped the project maintain local support through the long construction process.

After the irrigation system became operational, rice yields increased, thereby boosting farmers' incomes and strengthening the local economy. In addition, as of 2019, local government and NIA officials were planning to start promoting ecotourism at the new reservoir. According to NIA's principal engineer, people from other towns came to see the newly built dam, and small kiosks opened to sell snacks and other goods. The area received greater exposure to potential tourists through videos of Pasa Dam tours that were uploaded to the video-sharing website YouTube.

Sustaining Stakeholder Engagement by Ensuring Consistent Project Personnel

The key to overcoming the numerous implementation challenges was active stakeholder engagement, which was led by Hwang, the project manager. It is often challenging to maintain consistent staff over a project's life cycle, and many people involved in the Pasa Dam project were replaced during implementation. Hwang, however, managed the project from design to completion. Hwang emphasized the importance of consistency of project management personnel, especially regarding construction components, which often require project period extension. Strong and consistent leadership throughout meant the project team was able to overcome a series of setbacks by maintaining good relations with the community and understanding between project stakeholders.

FIGURE 4. PHOTOGRAPH OF THE COMPLETED PASA DAM

Source: KOICA 2018.

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Annex. Irrigation System Construction Layout

Dam composition		
Dam	**Spillway**	**Diversion conduit**
■ Type: Zoned earth-filled dam[a] ■ Crest elevation: El. 135.5 meters ■ Height: 36.7 meters ■ Length: 194.0 meters ■ Width of crest: 10.0 meters ■ Slope, upstream: 1.0:2.8 ■ Slope, downstream 1.0:2.5	■ Type: Ogee (without gate)[b] ■ Design discharge: 216.4 cubic meters per second ■ Elevation : 132.0 meters ■ Width: 35.0 meters ■ Dissipation type: Stilling Basin TypeⅢ	■ Type: Culvert ■ Design discharge: 112.8 cubic meters per second ■ Cofferdam design elevation, upstream: 113.5 meters ■ Cofferdam design elevation, downstream: 110.0 meters ■ Dimension: 2.8 meters × 2.8 meters ■ Design elevation, inlet elevation: 101.0 meters ■ Design elevation, outlet: 96.0 meters

a. Zoned earth-filled dams are those constructed with the central portions, called core or hearting, made from materials that are relatively impervious. The core wall is made sufficiently thick to prevent leakage of water through the body of the dam.

b. A spillway is a common and basic design that transfers excess water from behind the dam down a smooth decline into the river below. Spillways are usually designed following an ogee curve. Most often, they are lined on the bottom and sides with concrete to protect the dam and topography.

	Canal		
	Length (meters)	**Width (meters)**	**Height (meters)**
Main canal	6,810	1.9~0.6	1.3~0.6
Lateral A	3,180	1.0~0.8	0.8~0.7
Lateral A1	256	0.6~0.5	0.6
Lateral B	1,537	0.8~0.6	0.7~0.6
Lateral C	5,177	1.5~0.9	1.1~0.7
Lateral C1	1,560	1.0~0.5	0.9~0.6
Lateral D	640	0.6~0.5	0.6