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CASE STUDY

A Clean Solution for Moving People and Goods

Transporting passengers and cargo over navigable rivers and canals reduces road and rail congestion, road crashes, pollution, emissions, and energy consumption.

Overview

Inland waterway transport can be an efficient, cost-effective, and environment-friendly option to move people and bulk commodities over long distances. Transporting people and goods over navigable rivers and canals reduces road and rail congestion, road crashes, pollution, emissions, and energy consumption.

The People's Republic of China (PRC) has the world's largest inland waterway network, both in terms of length and freight volume. However, investments for the maintenance and modernization of the infrastructure have been overtaken by investments for highways and rail. Many ports are outdated, with no specialized berths and modern handling equipment. This has kept inland waterway transport in the country from reaching its full potential. However, in recent years, the PRC has given inland waterways renewed priority investment, recognizing it as an essential part of its transport system.

The province of Hunan, which has one of the biggest inland waterway networks in the country, has been deeply involved in efforts to improve inland waterway infrastructure in the PRC. It is a landlocked province with around 68.4 million residents. The Xiang River, one of the largest tributaries of the Yangtze River, flows through six cities in the province. It is 969 kilometers long with 773 km passing

through Hunan, making it the province's biggest river. Xiang forms part of an intricate inland waterway network in the PRC, which has over 11,495 km of waterways, 107 ports, and 1,880 berths.

The Asian Development Bank (ADB) is helping improve the inland waterway transport system in Hunan. The project will make the Xiang River more navigable for larger vessels, improve cargo terminals along the river, and provide landing berths for rural communities. It will also tap the river's hydropower potential to provide clean energy to the province. This initiative will improve access to markets, reduce road and freight transport congestion, and cut down greenhouse gas emissions and pollution.

This case study was originally published in Lessons from ADB Transport Projects: Moving Goods, Connecting People, and Disseminating Knowledge.

Project snapshot

Dates	• **December 2012:** Approval Date • **2017:** Completion Date
Cost	• **$393.32 million:** Total project cost estimate • **$150 million:** ADB Loan • **$65.40 million:** China Construction Bank Loan
Institutions and Stakeholders	**Executing agency** • Hunan Provincial Department of Transport **Financing** • Asian Development Bank • China Construction Bank

Challenges

Hunan's inland waterway infrastructure needed vast improvement. Only 6% of its waterways and berths can accommodate vessels with a carrying capacity of 1,000 tons. The limited depth of the Xiang River and its long rocky shoals have prevented safe year-round access by larger vessels. Traffic growth is also constrained by obsolete and insufficient infrastructure and loading facilities in the river's ports. In 2009, the network carried only 10% of the overall freight transported in the province in terms of ton-kilometers.

To address these constraints, the PRC prepared the Xiang River Network Master Plan, which emphasizes infrastructure development. Hunan has already executed several improvements in line with the master plan to gradually make the Xiang River navigable year-round for barges of up to 1,000

deadweight tons in its middle and upper reaches and for barges of up to 2,000 deadweight tons in its lower reaches. Once the plan is fully implemented, the Xiang River will become one of the most important freight corridors in Hunan.

Solutions

In 2011, the PRC sought ADB's assistance in achieving its vision for the inland waterway network in Hunan. Together, they initiated a project that aimed to construct the Tugutang Navigation Complex with a ship lock capacity that can accommodate Class III vessels, which can carry 1,000 deadweight tons; a run-of-the-river barrage to regulate river levels and flows; and an associated hydropower plant with a capacity of 90 megawatts. It will also construct cargo terminal berths and improve public landing stages, which will provide rural communities with improved access to river transport to different parts of the province and maximize the potential of industrial sites in the area.

The project is an important element of the Xiang River Network Master Plan. Without the Tugutang Navigation Complex, prior investments given to enhance inland waterway transport facilities upstream of the river will be less beneficial.

Barrage design and construction

A barrage is a structure that controls river level and flow. In this project, the barrage design considered several important dimensions. First, its design aims to raise water levels in the river so that class III vessels can navigate through it. Second, its design will integrate a hydropower plant with a total installed capacity of 90 megawatts. It was essential for the project to choose the best location for the barrage given its multipurpose nature. Geography, geology, river navigation, adjacent developments, and ease of construction were considered.

The project chose from among three options: at the upper portion of the river in Hengnan County in Hunan, at a lower portion of the river in Chejiang Town, and at a middle site about 8.8 kilometers downstream from the upper portion of the river in Hengnan. The site in the upper portion of the river in Hengnan was ultimately chosen. In this area, the river channel is straight, providing ships adequate space to maneuver. The area is highly rural and has no environmentally sensitive sites, thus social and environmental impacts are minimized.

The project's barrage which forms part of the navigation complex, will have 17 sluice gates. Each gate will be 20 meters wide. A sluice gate serves as the barrage's "doors" that can be opened or closed to control river flow. Each bay or opening will have metal radial sluice gates, which can be lowered or raised by pistons supported by bearings fixed to the pier walls. Each gate will be provided with an alternative source of power for backup in the event of main electricity supply failure.

The gates will be controlled and operated automatically, but will have a manual override option. Moreover, the barrage was designed to discharge a flow with a 1:50 year return period and verified as structurally able to withstand a catastrophic flood with a 1:500 year return period.

The barrage will include a run-of-the-river hydropower generation plant with a total installed capacity of 90 megawatts and normal annual energy output of 358.2 million kilowatt–hours. The plant will have four turbine units, a power house, tailrace, transformer yard, and transmission lines to connect to the regional electricity grid on the west side of the barrage.

The construction of the hydropower plant was not a mere afterthought. Rather, the barrage was designed to be multipurpose, with hydroelectricity generation providing a revenue that would help the province recover the investment cost.

Ship lock

For vessels to pass the barrage, they go through a ship lock which is a chamber with gates at each end. Ship locks enable vessels to navigate through steep changes in the level of the river. The project's ship lock is located on one side of the river, and was designed to hold up to four 1,000-ton vessels. To fill the chamber, the ship lock has three inlet conduits where water regulated by the gates will flow. The chamber's walls were treated with manifold arrangement to minimize the whipping of turbulent waters on ships within the lock.

Ports development

As the navigation complex is projected to attract more freight traffic, ports in Hunan must also be enhanced. Cargo terminals in the project site only had main moorings and loading ramps for small vessels, with the biggest berth capable of receiving vessels with capacities of only 300 tons. The project sought to increase the port capacity of the province's inland waterway network. Engineering designs for two cargo terminals, each with a 100-meter concrete berth, have been completed. The project will expand and improve the berths so that they can handle vessels of up to 1,000 tons. Aside from improving the berths, facilities will be added to the terminals, such as open cargo storage areas, warehouses, and workshops.

Fish pass

The project incorporated a fish pass into its design, to ensure that no fish and other aquatic animals will be carried into the hydropower turbines. The fish pass will be 774 meters long, and will provide a channel where aquatic animals can pass. In addition, important fish habitats will be identified and protected.

Institutional development

Alongside infrastructure development, reforms were also introduced in the institutions involved in inland waterway transport in the province.

First, to improve coordination among the many institutions with responsibilities concerning the waterway, the province set up the Water Transport Development Committee.

Through the project, the province started introducing modern inland waterway transport management

and support systems and provided training in monitoring, inspection, and emergency response to the Hunan provincial department of transport, the Hunan Maritime Affairs Bureau, and the Hunan Xiangjiang Navigation Construction and Development Company.

The project has helped establish an enterprise that will construct, develop, operate, and maintain inland waterway channels and associated assets in Hunan.

The province, through the project, has also formulated an action plan for waterway promotion. This action plan includes setting incentives to encourage vessel modernization, shift from road to inland waterway transport, and waste management.

Results

When the complex is completed in 2017, Hunan will have the modern Tugutang navigation-cum-hydropower complex. This modern infrastructure will improve transport efficiency along the river as the navigation complex will be able to receive class III vessels, with a ship lock operation lasting no more than 50 minutes. This complex will be supported by 72 enhanced landing stations and two cargo terminals with wider berths, ready to receive more and larger vessels.

The navigation complex features a run-of-the-river barrage that regulates river levels and flows and a 90-megawatt hydropower plant. This additional energy can help the province meet its energy demand through its yearly power output of 363 gigawatt-hours of clean energy by 2017. This increased power supply through renewable energy will meet the electricity needs of about 300,000 households.

By producing clean energy, the project can help reduce greenhouse gas emissions. The project will help avoid approximately 290,000 tons of carbon dioxide by generating electricity through hydropower rather than fossil fuels. It will further cut down emissions and pollution by reducing highway traffic congestion when cargo road transport shifts to inland waterway transport.

The project will further provide benefits to the people, especially the marginalized, as the extended cargo services can generate more jobs while improving access to markets for the province, which has about 637,000 poor rural residents and 273,000 poor urban dwellers. According to local officials, the project will create 50,000 jobs during its implementation. Women will also benefit from this, as at least 20% of employment generated during construction and operation will be allotted to them.

Lessons

Using inland waterways as a transport option

When it comes to transport, roads and highways would often be the default responses to the need for connectivity. However, inland waterways, as proven by this project, can be an efficient, cost-effective green transport alternative, especially for cargo services. Through a well-developed network, people and businesses will have a more reliable option to transport their goods.

When using inland waterways, opportunities for interconnection can also be maximized, as shown in this project. Although the PRC already has an extensive network, it recognized the need to modernize and extend its system. This project is part of a bigger network that starts at the Yangtze River, from which the Xiang River flows. To make its inland waterways more efficient, the country also developed the infrastructure of Xiang River and further extended it to remote villages.

It is also important for inland waterways to connect to road and rail transport. Inland waterway transport can be an integral link in countries' logistics chain. An inland waterway network, when combined with a well-connected and efficient multi-modal transport network, will boost economic growth since it will enable comprehensive connectivity. Interconnection, however, requires detailed planning and interface arrangement. The project is currently studying port development options to ensure that access roads are wide enough, and will not run through densely populated areas to ensure safety and efficiency.

Optimal inland waterway transport design

Rivers and canals do not usually have uniform levels of depth and topography. In the case of the Xiang River, parts of it were too shallow and its shoals were rocky. This situation poses a big challenge to inland waterway transport since it limits the size and number of vessels that can be accommodated. This project overcame this hurdle. Instead of dredging the river to make it deeper, it raised the water level by building a barrage, with an added power plant component that will harness hydro energy. The barrage and reservoir ensure that river depth will be sufficient for vessel navigation even during dry season; and during the rainy season, they also act as a flood control mechanism since the barrage controls water level.

Institutional development

One neglected aspect in infrastructure development is the need for parallel activities for institutional development. The capacities of the multiple institutions must be expanded and upgraded so that they can easily handle the changes in infrastructure and the consequent results of these changes, such as increased traffic volume and increased demand for resources. Key activities in institutional reforms may include the establishment of a unit or interagency committee to oversee implementation, the creation of a conducive policy environment , the upgrading of specific staff capacities and skills, and the creation of incentives to foster inland waterway transport.

Institutional development was made an integral part of this project. First, a committee was established in 2012 to promote this mode of transport. An inland waterway transport development policy was also prepared, to be reviewed by the provincial government. In addition, the staff are currently being trained in vessel inspection and emergency response.

Importance of project preparatory studies and policy dialogue

Pressure from local or national government can sometimes induce hasty construction, without the benefit of a sound basis that extensive design, preparatory studies, and policy dialogue can give. Particularly when ADB is entering a new field or subsector, initial sector studies play a key role in

ensuring that ADB arrives at a sound basis for its eventual investment support.

The project used a two-stage project preparatory technical assistance where the first phase covered sector assessment and identification of sector policy and institutional issues, and second phase covered project preparation. Phase 1 included workshops that facilitated consultation and policy dialogue between the government and ADB. Results from these activities highly influenced project design and implementation. The government initially wanted only a barrage to control water levels. Drawing on the findings of the project preparatory technical assistance and policy dialogue, port and rural access were added, extending the project's benefits to more rural households.

Resources

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Related links

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Meet the experts

Tyrrell Duncan
Technical Advisor (Transport), Asian Development Bank

Tyrrell Duncan leads ADB's work on transport, which accounts for about a third of ADB lending. Previously he was transport director for East Asia, and bank-wide practice leader responsible for formulating ADB's sector strategy for transport, the Sustainable Transport Initiative. He has degrees in economics and public policy.

Ki-Joon Kim
Principal Transport Specialist, Asian Development Bank

Ki-Joon Kim has over 25 years of professional experience and academic research in the transport sector. He studied urban planning and transport in the Republic of Korea, United States, and United Kingdom. He has worked with many developing countries on various transport projects, including sustainable urban transport, intelligent transport systems, and road safety.

Li Dongxiang
Lead Regional Cooperation Specialist, South Asia Department, Asian Development Bank

Li Dongxiang has more than 30 years of experience in development finance, project management, regional cooperation and integration, public-private partnership, and research and knowledge management. He has developed methodologies for cross-project learning, and published prototype knowledge products. He was director of the ADB Division in the PRC Ministry of Finance, and advisor in the World Bank's PRC Office.

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