

The canal that thinks and saves water

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China has opened the Pinglu Canal, creating a new river-to-sea route from its inland southwest to the South China Sea and linking its western manufacturing regions more directly with Southeast Asia (Figure 1). Opened on September 16, 2026, the canal forms a gateway from Guangxi's Pingtang River to Beibu Gulf in the northwestern South China Sea, four years after construction began. The 134.2-kilometre waterway, designed for 5,000-tonne vessels, crosses a cumulative 65-metre elevation difference through the Madao, Qishi and Qingnian hubs, at a reported total investment of about 72.7 billion yuan (US\$10.2 billion).¹ Combining high-head water-saving locks, digital control and ecological engineering, the project is an important test of whether modern canals can expand trade links while managing water and environmental risks.

Can the canal maintain reliable traffic while allocating scarce freshwater, managing extreme weather and protecting an altered river corridor?

WATER-SAVING LOCK DESIGN

Locks raise or lower vessels by changing chamber water levels as water moves through the filling-and-emptying system under differences in hydraulic head. In a conventional cycle, part of the chamber water is released downstream. At Pinglu, the problem is magnified by 29.6-metre maximum operating head at the Madao hub, among the highest for an inland navigation lock.^{2,3} Heavy traffic could make repeated lockages a major claim on a region where water must also support cities, farms and river habitats.

The project's answer is to recycle part of each chamberful. Madao and Qishi use three-level saving basins: during emptying, water enters adjacent basins and returns to the chamber before additional water is drawn from the upper reach in the next filling cycle. Their compact layout overlaps the first and third basin levels in plan, while the intermediate level is arranged separately. Qingnian instead transfers water between parallel chambers, so savings depend on paired traffic and operating sequence. Under design conditions, the project estimates a water-saving rate above 60% per lockage^{2,3} and annual savings of about one billion cubic metres.⁴ Both figures are forecasts; traffic, scheduling, leakage, evaporation and river conditions will determine actual performance.

International practice shows that no single solution fits every high-head canal. The expanded Panama Canal uses three lateral saving basins for each chamber and recycles about 60% of lockage water.⁵ High lifts can also be divided among lock flights, served by counterweighted ship lifts, or supported by back-pumping from a lower reach. Ship lifts sharply reduce lockage water but impose vessel-size, mechanical-reliability and capital constraints, while pumping increases energy demand and conventional side-by-side basins occupy land. Pinglu's compact basins and cross-filling address space and water use but add hydraulic and scheduling complexity. Their comparative value must be tested through verified water balances, energy use, maintenance demand and vessel-throughput data.

Scale creates another challenge: moving large water volumes rapidly without destructive waves, cavitation or unsafe forces on moored vessels. Designers conducted more than 1,000 lock-model tests and over 5,000 tests of a labyrinth-type energy-dissipation device.² The resulting filling-and-emptying system uses fast-acting valves and distributed flow paths to tame this turbulence—a less visible engineering achievement than the locks themselves, but just as central to the canal's innovation. Its real benchmark will be repeated operation under mixed vessel sizes, peak demand and extreme rainfall.

DIGITAL OPERATION AND HUMAN OVERSIGHT

Pinglu was designed not simply as a channel but as an instrumented system. A network combining BeiDou satellite positioning, cloud computing, artificial intelligence and sensors observes the canal from water, land, air and

space.¹ Water levels, currents, turbidity and structural behaviour can be monitored continuously, and operators can adjust the three hubs as a connected hydraulic system rather than as isolated gates.

This matters because navigation canals are dynamic: a delay at one lock can propagate into queues upstream, a sudden storm changes inflow and visibility, and equipment failure can close a route whose value depends on reliability. Automatic hydrological and water-quality stations reportedly transmit measurements every 15 minutes, and forecasts let operators simulate the next 24 hours and adjust flows accordingly.

Building on this monitoring, the project's smart-dispatch platform assigns vessels to lock chambers, forecasts water supply and demand, and supports predictive maintenance, scheduling vessels before they even reach a lock. Researchers have also built a mathematical scheduling model for the river-sea transition zone at the estuary that shortens total transit time, cuts vessel waiting and resolves traffic conflicts such as overtaking and head-on encounters. In Guangxi, a smart water-transport AI system is being trialled that pairs a general-purpose model with task-specific modules to handle complex scheduling rules quickly.

The system is not designed to replace dispatchers. Machines handle standardised, repetitive tasks such as berth matching and timing calculations, while on-site coordination and special vessel requests remain led by human operators—an explicit human-machine collaboration.

Under extreme rainfall, typhoons, drought or low inflow, a digital twin supports a four-step response used widely in Chinese water management: forecasting, early warning, scenario rehearsal and contingency planning. Operators can simulate alternative gate and reservoir actions before applying them, and a scheduler balances flood safety, navigation queues, water consumption, ecological-flow limits, salinity control, energy use and maintenance rather than maximising throughput alone. If automated control fails, backup modes allow manual hydraulic or mechanical operation, keeping critical lock functions available during power or system outages.

ENGINEERING IN AN ALTERED ECOSYSTEM

A canal of this scale cannot be ecologically neutral. Construction widened, deepened and straightened existing rivers, cut a short land section, relocated communities and changed how water and sediment move between the Xijiang basin and the coast. Its environmental technologies are mitigation of those impacts, not proof they disappear.

During construction, more than 98% of roughly 315 million cubic metres of excavated earth and rock was reused or otherwise beneficially utilised, according to the project's opening-day report.

To preserve wildlife connectivity across the altered corridor, the Qingnian hub includes a 480-metre passage that combines a vertical-slot fishway with a route suited to eels, allowing upstream and downstream movement across a major barrier. The fishway incorporates an intelligent monitoring system with underwater attraction lights and sonar tracking; by mid-2026 it had recorded over 76,000 upstream and 115,000 downstream fish passages across more than ten species, China's People's Daily reported in June 2026. A separate 240-metre vegetated bridge over the canal gives terrestrial animals, including leopard cats and squirrels, a dedicated crossing. Replanted banks and water-quality monitoring form part of a broader ecological corridor.

During construction, the project also used anti-pollution curtains to control suspended particulate matter, with monitoring data showing concentrations in nearby mangrove wetlands remained below the relevant environmental threshold.

For operations, an integrated emergency response framework is planned through the smart canal's "one-click coordinated emergency response" function, which links monitoring alerts to dispatch protocols for acute pollution incidents. However, the project has not publicly detailed specific



Figure 1. China's new Pinglu Canal combines high-head water-saving locks, digital control and ecological engineering to redraw the route between its inland southwest and Southeast Asia.

thresholds or seasonal flow regimes, which will be essential for verifying that habitat connectivity is maintained during low-water periods.

These measures matter only if their outcomes are tracked. Fishways often work unevenly across species and seasons, and wildlife crossings succeed only when animals actually use them and habitat stays connected on both sides. Long-term, independently accessible monitoring of passage rates, water quality and estuarine salinity would make Pinglu more valuable internationally, showing which mitigation designs transfer to other large canals and which need revision.

LESSONS FOR FUTURE CANALS

Pinglu arrives as governments from Central America to Southeast Asia revisit canals and inland waterways under pressure from congested ports, climate risks and fragmented supply chains. Its most exportable lesson is not a single lock design, but the need to integrate hydraulics, automation, material reuse and ecological connectivity from the outset.

The first vessels have now crossed the canal. The more consequential experiment begins after the ceremony: thousands of lock cycles, wet and dry seasons, equipment failures, migrating fish and changing trade flows. If operational evidence confirms its promised water savings, reliability and environmental performance, the canal could become a reference design for more climate-aware inland navigation. If the data reveal shortcomings,

publishing them would be equally valuable. Its international importance ultimately rests not only on the 560 kilometres it removes from the original voyage, but on whether it becomes a measurable, adaptable system rather than just a monumental one.

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DECLARATION OF INTERESTS

The author declares no competing interests.