

An Analysis of Ferry System and its Accidents

In Guizhou Province, China

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Abstract

Guizhou Province is the archetype of Southwestern Mountain Areas in China—there are variegated rivers on which many dams are built. These dams lead to the form of deep reservoir areas, increasing people's reliance on water transport. Unfortunately, many risk factors in Guizhou ferry system resulted in six accidents since 2002. This paper provides causation analysis and detailed description of ferry accidents in Guizhou Province. Subsequently, it identifies four high-risk factors existing in Guizhou ferry system. In addition, the paper describes the characteristics of the ferry system, including ferry service characteristics, conditions of waterways, vessel and terminal characteristics, crew and management. Finally, countermeasures are proposed to improve ferry safety in Guizhou and Southwestern Mountain Areas in China.

Key words: Guizhou ferry system, accidents analysis, high-risk factors, situation analysis

Introduction

Ferry safety is given high attention in urban areas where population density is high. However, ferry transport is widely used in rural areas of developing countries and its safety conditions incur high challenges. Rural areas in China Southwestern Mountain Areas have a dense network of rivers. Because of the technical and financial difficulties to build roads in mountain areas and the risks of landslides, villagers traditionally rely on water transport. In recent years, their reliance on water transport has increased since many hydropower stations were built under the national policy of “electricity transmission from western to eastern area”. Guizhou Province is a typical mountainous area in Southwestern China , with a population of 34.75 million and an area of 176,167 square kilometers. The Province is interspersed with variegated rivers and hydropower stations. There are 93 rivers more than 50 km long.



Figure 1: Location of Guizhou Province in China

Rivers in Guizhou belong to two major river systems—Chishui River, Wujiang River, Jinjiang River and Qingshui River are tributaries of the Changjiang River; Nanpan River, Beipan River, Hongshui River and Dulu River are tributaries of the Zhujiang River. Each of the rivers has their own branches, flowing through 70% of the whole province area.

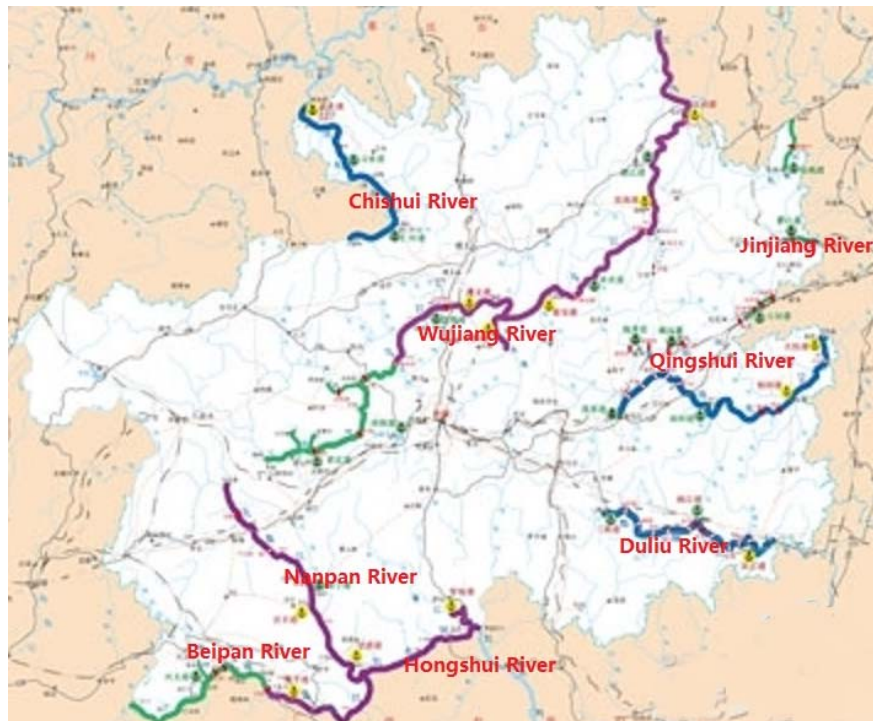


Figure 2: Rivers in Guizhou Province

There are about 25 large hydropower stations in Guizhou by now; in addition, three hydropower stations are under construction. The following table lists the stations in Guizhou.

Table 1: Hydropower stations in Guizhou Province

River system	Tributary	List of hydropower stations	Total
Changjiang River	Wujiang River	Dongfeng, Suofengying, Wujiangdu, Goupitan, Silin, Shatuo, Yinzidu, Hongjiadu, Suoshai	9
	Qingshui River	Sanbanxi, Guazhi, Baishi	3
Zhujiang River	Nanpan River	Tianshengqiao I, Tianshengqiao II, Pingban	3
	Beipan River	Guangzhao, Dongqing, Mamaya I	2+1(under construction)
	Hongshui River	Longtan, Yantan, Dahua, Bailongtan, Letan, Qiaogong	6
	Duliu River	Hongyan, Yongfu, Congjiang, Darong	2+2(under construction)

Hydropower station backwater submerged the low-lying areas and streams, changing shallow waterways to deep reservoirs. People living around the reservoir areas mainly travel by ferries. In our research, about 46.1% of the respondents said their farmlands were on the other side of the reservoirs, so they have to go to the field by ferries. Besides, they take ferries to visit their friends and relatives, or to go to a village fair; students also go to school by ferries. As a result, ferries and terminals sprung up in Guizhou, especially in rural areas.

However, the complicated navigation environment in reservoir areas, the simple and crude ferry infrastructure, the crew lacking in skills, and the inefficient management result in the high rate of ferry accidents in Guizhou. Since the new millennium, six accidents have been reported to happen, not to mention that concealed and false reports of accidents cannot be ruled out. It can be seen that as a high-risk area of water transportation and a typical example of Southwestern Mountain Areas in China, the Guizhou ferry system deserves attention.

Literature review

The study direction of ferry safety is divided into three parts:

1. Safety analysis of certain ferry system

In China, research about ferry safety mainly concentrates on the main channel of the Changjiang River and the Three Gorges Reservoir. These publications discuss the

overall problems of ferry system instead of analyzing the ferry accidents in detail.

2. Ferry safety assessment criteria

Other literature reviewed identify crucial safety assessment criteria for enhancing ferry safety. In a survey about ferry safety of Yangtze River, it was indicated that the risks in the Yangtze ferry system can be identified from four perspectives: human beings, ferries, climate and management. In addition, Chin-Shan Lu and Po-Hsing Tseng (2012) identify six dimensions of safety assessment: safety equipment, ship structure, ship documentation inspection, safety instructions, navigation and communication, and crew members' ability.

3. Inland shipping development in Guizhou

There are publications about the shipping system in Guizhou Province, describing the condition of inland water transportation in Guizhou and proposing measures to accelerate its development. These papers describe passenger and cargo transportation as a whole and mainly focus on the economic issues. However, there are few papers concentrating on the ferry system in Guizhou and its safety problems.

It is imperative to analyze the ferry accidents and find countermeasures to improve water traffic safety in Guizhou.

Research methodologies

1. Survey. This consists of interviews, field investigation, questionnaire survey and collection of information from literatures.

With the support of Guizhou Water Transport Management Bureau and Marine Bureau, interviews with government officials were carried out to know about the status quo of ferry system in Guizhou and get detailed information about management and infrastructure condition. Interviews with ferry enterprises were made to get operation information and their concerns about the ferry safety issues. In addition, field investigation was conducted to get information and images of the waterway environment and affiliated infrastructure. A questionnaire was designed to learn about the residents' travel information and their opinions on the ferry system.

Statistics about the accidents are collected by searching media reports in China. In addition, the researchers also tried to get data about ferry accidents from government agencies and update the initial reports. To analyze the causation of accidents, the researchers searched for relevant information as much as possible.

2. Hazard analysis and risk identification. By analyzing the characteristics of the ferry accidents, the paper identifies the high-risk factors existing in Guizhou ferry system.

3. System analysis. By analyzing the main factors in the ferry system, the paper puts forward some countermeasures that reduce the risks in Guizhou.

Ferry accidents analysis

According to reports in China, between December 2002 and January 2012, 26 people died and 30 people went missing in six separate incidents. However, accident reports lack transparency in China, making it hard for the international organizations to know what happened in Guizhou. The following table lists the ferry disasters which took place in Guizhou Province since 2002, and some of them were not reported publicly.

Table 2: Ferry fatality statistic and causation

Date	Location	Fatalities	Missing	Vessel's name	Vessel's ownership	Cause
2002-12-2	Sinan County, Liuchi River	13		Private No.002	Private	Leaking, sank
2003-6-7	Jianhe County, Qingshui River		15	"Qian-Jianhe Ferry" No.00178	Public(without business certificate)	Mechanical failure, mishandling, stranding
2003-12-13	Tianzhu County, Qingshui River	8		"Qian-Baishi Ferry" No.00311	Public	Stranding, capsizing
2004-7-26	Xishui County, Chishui River	2	2	Unknown	Unknown	Sank
2009-3-3	Jianhe County, Qingshui River		10	"Qian-Dongnan Ferry" No.0181	Public	Stranding, Sank
2012-1-20	Jinsha County, Yutang River	4	3	"Qian-Bijie Ferry" No.4001	Public	Collison, rolling over
Total		27	30			

Detailed information and causation analysis of accidents

2002-12-2

On December 2, 2002, a private agriculture ferry carrying sixteen people sank in Liuchi River, resulting in thirteen people's deaths. The causation of the accident was the influx of water in the nose of the ferry as a result of hull cracking.

Actually, this accident reveals a key problem in Guizhou ferry system that the private vessels carry passengers without permission. It is very dangerous because the private vessels are not equipped with sufficient life-saving equipment and qualified operators.

2003-6-7

On June 7, 2003, an accident took place when a motor ferry pushing against the torrential current in Qingshui River, causing fifteen people missing and 20 people injured. The ferry "Qian-Jianhe Ferry" No.00178 carried sixty students and two operators, while the loading limit is 35. The causation of the accident was mechanical failure. The subsequent mishandling led to the flameout of the engine. The vessel went out of control, broke up on a rock and sank eventually.

About twenty days before the accident, the ferry was inspected by the maritime department. It failed to get the business certificate because of deficient life-saving equipment. After that, the former shipowner sold the vessel to the operator who even did not own a navigation certificate.

2003-12-13

Not very long after the accident in June, another ferry accident happened on December 13 the same year. This time eight people died tragically. There were more than 40 passengers on the ferry which was allowed to carry 28 passengers. The precipitating factor was the foggy weather. Under the poor visibility condition, the ferry struck on a rock when avoiding another ship. All the passengers fell into the water with the capsizing of the waterlogged ferry.

2004-7-26

On July 26, 2004, a ferry with 18 people sank during its voyage between two towns. There were two people losing their lives and two people missing. However, the report about this accident was limited, so it's difficult to analyze the causation.

2009-3-3

On March 3, 2009, the local market day, a short-distance ferry named "Qian-Dongnan Ferry" No.0181 wrecked on a rock in Qingshui River. It was reported that the ship sank quickly after striking the rock, claiming 10 people's lives.

The disaster was attributed to the massive overloading and poor waterway characteristics. The ferry is a small steel passenger ship that is supposed to carry less than eighteen passengers. However, there were 46 people on the ferry, including 44 passengers, an operator and a ticket seller. The location is in SanBanXi reservoir. The depth of water is 20 meters. Also, the water is turbulent with many reefs. On the day when the accident happened, the water was turbid as the result of reservoir swelling, adding to the difficulty of rescue.

There are two shipping companies—SanBanXi Shipping Co., LTD and Coastal Water Transportation Co., LTD—with about 60 ferries in SanBanXi reservoir. Sixty ferries were under the supervision of only one maritime management official and two assistants. The sunken ferry belonged to one of the shipping companies, and the operator had a driving certificate. The government said that the operator ignored the warning by his assistant.

After this accident, the Guizhou Province carried out a water transportation safety inspection to restrain overcrowding and illegal operation.

2012-1-20

The latest reported ferry accident in Guizhou Province occurred on January 18, 2012. A manually-operated ferry named "Qian-Bijie Ferry" No.4001 rolled over with nine people and two motorcycles. Four people died and three people are missing in this accident. According to the report, the man who was punting the vessel was worn out

because of the rushing water. As a result, the ferry bumped on a bridge pier under construction and then rolled over.

The illegal stowage of motorcycles mainly contributed to this tragedy. It not only increased the burden of the ferry but also created imbalance. In addition, the backward man-powered vessel was another contributing factor. Man power is unreliable in such rough waterway environment.

Identification of high risk factors

By analyzing the ferry accidents in Guizhou, we see that there are four high risk factors in Guizhou ferry system, as described below.

1. Conditions of waterways—among all the accidents happened since 2000, there are three accidents involved in stranding (happened on 2003-6-7, 2003-12-13, 2009-3-3). Besides, rushing water became the contributing factor in two accidents (happened on 2003-6-7, 2012-1-20).

2. Quality of ferries—accidents on 2002-12-2 and 2003-6-7 were directly caused by poor quality of ferries. The accident on 2012-1-20 was indirectly caused by the quality of ferry, because the man-powered vessel exhausted the operator.

3. Illegal operations—strictly, each accident was involved in illegal operations. Overloading is the most serious problem, which happened in three accidents. Another illegal operation is that private vessels carried passengers without permission. In addition, fog sailing and improper stowage of cargo respectively contributed to accidents on 2003-12-13 and 2012-1-20.

4. Quality of crew—the operator's mishandling contributed to the accident happening on 2003-6-7. Actually, operators should be blamed for most of the accidents since their illegal operations put the ferry in danger.

Situation analysis of Guizhou ferry system

Ferry service characteristics

According to the official statistics, the ferries in Guizhou carried 24.53 million passengers in 2012, which increased by 12.08% compared with the previous year. The ferry routes can be divided into four types: (1) across the reservoirs (2) along the bank line of reservoirs (3) between different reservoirs (4) along the bank line of rivers outside the reservoirs. In reality, because of the obstruction of dams and lack of facilities for ship passing, the majority of the water traffic in Guizhou is within the reservoir areas.

There are both regular and irregular service. For example a shipping company in Jianhe County, on usual days, it arranges six ferries to carry out twelve fixed voyages; on local market days, the ferries carry passengers along the route without centralized scheduling. In addition to formal ferry service, some farmers use private vessels to carry passengers randomly, which is usually irregular and also illegal.

Most ferry operators collect ticket fees to maintain operations and make profits. But there are exceptions. Some villagers provide free ferry service for acquaintances in a small area; though the villagers are very kind to do so, the free ferries are more likely to have safety problems because of disrepair.

Conditions of waterways

The grade of waterways in Guizhou are low—270 km of level 4, 336 km of level 5, 1025 km of level 6, 670 km of level 7, 1262 km of substandard level (higher number represents poorer quality). In China, low level waterways are not well-funded by the government, thus restricting the infrastructure construction of these waterways.

In reservoirs, the huge expanse of water brings convenience to vessel navigation. However, there are also many potential safety hazards. The original routes cannot be identified because of the expansion of rivers. Under the water are those submerged hills, rocks and trees, becoming new risks. Besides, the water level in the reservoirs varies in a large range, which makes the condition of waterways more complicated. For example, the water level in Sanbanxi reservoir has a drop of 50 meters (from 475m to 425m). On the other hand, the downstream channels of the reservoirs also face changing water levels, as well as rushing flows, dangerous reefs and sharp turns.

Another threat to the ferries is the presence of nets and cages in the reservoirs. The backwaters of the hydropower stations inundated much farming land. As a consequence, many villagers take up aquaculture since the reservoirs are good for aquaculture. The result of our questionnaire survey shows that about 24.3% villagers depend on aquaculture for regular income. According to incomplete statistics, there are 3585 nets and cages in Guizhou reservoirs. These nets and cages scatter over the reservoirs and even extend to the middle of the waterways, seriously affecting the safety of the ferries. What's worse, the fodder of the aquaculture results in eutrophication. The blooming alga become another safety risk.



Figure 3: Nets and cages in the Sanbanxi Reservoir, surrounded by blooming algae

Vessel characteristics

1. Ownership and operation

There are two types of ferry based on ownership characteristics—public ferry owned by shipping companies and private ferry owned by residents. Public ferries are under the supervision of the official management department. By contrast, private ferries are not completely included in the management scope. There are about 12 thousand vessels owned by local residents—about two thirds of the total number of vessels in Guizhou. These private vessels are limited to be used in agricultural or sideline production. However, it often occurs that private vessels or fishing boats carry passengers without operating license, which not only disturbs the ferry market but also brings ferry safety problems. The disaster happening on December 2, 2002 exactly confirmed the risks of private vessels.

2. Technical condition

In general, the technical condition of ferries in Guizhou is changing for the better, especially the public ferries. The wooden boats are gradually replaced by steel vessels. The capacity of the ferries is larger—there are 260 ferries with 400 capacity in Guizhou. Some single engine ferries have been improved to double engine, which work better in rapids. Moreover, steel ferries are designed to have watertight compartments. The government is engaged in the upgrading and reconstruction of ferries. In 2009, China implemented the policy of rewarding the updating of rural old ferries. In 2012, Guizhou Province raised 10 million Yuan to build 135 standard ferries and arranged them to operate in important waterways. In addition, 110 old ferries in Sanbanxi Reservoir are upgraded with the money collected from operators and the government.

However, many private vessels are still in poor condition. It is a common phenomenon that villagers build private vessels by their own efforts or in illegal shipbuilding workshop. For instance, there are 1450 vessels in Tianshengqiao

Reservoir, 90% of which are built without formal design. These vessels are small and simple without watertight compartment and lifesaving facilities, having weak stability and inadequate reserve buoyancy. In addition, because of the villagers' financial difficulty, the private vessels suffer from chronic lack of maintenance. Consequently, the private vessels are inclined to get involved in accidents.



Figure 4: Public sector ferries in Guizhou



Figure 5: Private ferry

Terminal characteristics

The survey found that the terminals in rural areas are natural slopes, which are slippery. The gangway is a long and narrow boardwalk, which is dangerous especially in peak hours. Questionnaire results show that most villagers are not satisfied with the terminals.





Figure 6: Simple terminal and gangway

Crew

The crew of the ferries in Guizhou usually have low amounts of schooling —most of them received education lower than junior middle school. They care about economic income more than water traffic safety. In addition, they generally lack formal training, thus they are not familiar with navigational knowledge and safety codes. As a result, it is often seen that the operators commit overloading and fog sailing.

Additionally, in rural area, some private vessels are even operated by the aged or by children.

Management

1. Local provincial government management

In recent years, the economic effects of inland water transportation are brought to the forefront. Therefore, the water traffic safety problems are emphasized. A series of policies and regulations have been released since 2000. In 2001, the Transportation Department and Safety Committee jointly issued safety measures for the administration of private vessels, banning profit-making transport of private vessels. In 2007, the people's congress of Guizhou Province agreed on waterway traffic regulations. The regulations refer to the traffic administrative departments at and above the county who are in charge of waterway transportation work within their respective administrative areas; the affiliated shipping and marine management institutions are responsible for specific management and supervision. The regulations also stipulate that ferries should operate according to the schedule and routes approved by shipping management institutions. In 2009, the Guizhou government office issued measures for the administration of large and medium sized reservoirs, clarifying the responsibilities of all departments and all levels of government. A responsibility chain has been formed in Guizhou, including vessel, operator, village committee, township government, county government and shipping and marine management institutions.

In addition, some large reservoirs are shared by Guizhou Province, Guangxi Province

and Yunnan Province, such as Tianshengqiao and Longtan Reservoir. The Marine Bureau of the 3 provinces carried out joint enforcement to punish overloading and illegal operation.

2. Water transportation enterprises management

Many water transportation enterprises are small scale with a loose management system. Some shipowners sign agreements with the enterprise and pay management fees every year. Apparently, the ferry belongs to the enterprise—all kinds of certificates of the ferry (inspection certificate, citizenship certificate and all the warrants) are under the name of the enterprise. It seems that the shipowner is employed by the enterprise. In fact, it's just nominal affiliated relationship. It is difficult for the enterprise to manage these ferries because the independent shipowners often don't obey the management.

Mitigation measures

Some suggestions that are helpful to improve ferry safety in Guizhou and Southwestern Mountain Areas in China are proposed below.

1. Accelerate construction of navigation channel—on one hand, more capital should be invested in the improvement of waterway infrastructure. Navigation aids should be set to help ferries avoid reefs and rapids. On the other hand, the contradictory between aquaculture in reservoirs and shipping should be reconciled. It is essential to prohibit nets and cages from occupying navigation channel.

2. Accelerate upgrading of vessels—the quality of vessels is one of the major risks in Guizhou ferry system. Because of the poor financial condition in Southwestern Mountain Areas, the villagers need subsidies to upgrade their vessels. Though it is important to remove superannuated vessels, the most fundamental method is to ban illegal shipbuilding and standardize the vessel design.

3. Strengthen the crew training—crew play a key role in the ferry system. The crew should be trained to learn navigational skills and regulations. Besides, they should be familiar with the environment of the waterway, so as to avoid risk factors in navigation. It should be guaranteed that the ferry operators have effective navigation certificate.

4. Strengthen supervision and inspection—the regulatory power of marine institutions needs to be strengthened, so as to ensure lasting effective implementation of the regulations. Illegal operations such as overloading, fog sailing, night travel should be

banned and enforced against. What is more important is to prevent private vessels from carrying passengers. To achieve this, not only the operators should be punished for private operation but also the villagers should be educated not to take private vessels.

Concluding remarks

Establishing a safe and well-organized ferry system in Guizhou Province needs active participation of different institutions. The government of Guizhou is supposed to build an efficient management system. Funding is of great importance to construct infrastructure, upgrade vessels and train crew in Guizhou. Advanced experience is needed to deal with safety challenges. In addition, the more fundamental problem in Guizhou is education and employment. Education helps to improve villagers' awareness of safety and law; employment helps to prevent villagers from operating illegally to earn their bread.

It's good news for Guizhou and other Southwestern Mountain Areas in China that the WFSA, Interferry and IMO are concentrating on the ferry safety problems in developing countries. We hope that with efforts of both national and international organizations, ferry systems in these areas will reduce ferry accidents in the future.

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Appendix: Summary of recent accident reports - Guangxi and Hunan Provinces

1. Accident in Xunjiang River, Guangxi Province

On March 11, 2012, a collision accident happened between a ferry and a cargo vessel, causing twenty deaths. The ferry is named “Shiju Ferry” No.035. While the vessel was allowed to carry 30 passengers, it carried 50 people, including 48 passengers and two mariners. The collision happened because of misjudgment of the operator. He thought that the other cargo vessel would avoid it, so he didn’t take action until the distance was only 50m.

The ferry was a self-built steel vessel built in 1995 ($L_{oa} * B * D = 17.5 * 3 * 1$ m) with

complete license--Individual industrial and commercial business license (issued by City Administration for Industry and Commerce), Water Transportation License and Marine Transportation Operating License (both issued by Transport Department in city level). The vessel was equipped with two life buoys, 33 life jackets, one trichromatic lamp, one set of signal flag, and one whistle.

http://www.gxajj.com/html_notice/9822.html

2. Accident in Yuanjiang River, Hunan Province

On October 5, 2012, a collision accident happened between a private ferry and a cargo vessel, causing twelve deaths. There were 22 people on the ferry, including twenty passengers and two mariners, who were husband and wife. And both of them don't have navigation certificate. The lack of signal equipment contributed to the collision. In addition, the navigation vision was limited because the rain shed and curtain before the cab.

The ferry was a steel vessel built in 2008 ($L_{oa} * L * B * D = 16.5 * 13 * 2.4 * 0.62m$) and had no license. There were ten life jackets on the vessel.

The report also refers to that it's a perennial problem in this water area that private vessels without license carrying passengers illegally.

http://www.hunan.gov.cn/zwgk/zdlyxxgk_37476/scaq/sgdcbg/201401/t20140124_1025932.html