

Reconstruction of Infrastructure After Disasters in the Disaster Areas Suffered from Heavy Earthquakes

Taking Dujiangyan as an Example

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Abstract—As one of the greatest natural disasters to humanity, the earthquake is devastating to a region, and post-disaster reconstruction is urgent and arduous. In the current research field, there is a lack of detailed and in-depth research on the post-disaster reconstruction work of the heavily affected areas. In order to make the theoretical support for the post-disaster reconstruction and development work in the severely affected areas, the author has carried out this research. This paper selects the major disaster-affected area, Dujiangyan City, as an entry point, and conducts an in-depth study on the status quo of infrastructure reconstruction work after 10 years of disaster. According to the analysis of Dujiangyan, the experience of infrastructure reconstruction after the disaster is summarized.

Keywords—heavy disaster area; Wenchuan earthquake; infrastructure reconstruction

I. INTRODUCTION

After the earthquake, the city has been hit hard, and it is imperative to rebuild the work. How to organize and carry out the restoration and reconstruction of the disaster area in an efficient and orderly manner has always been a common problem faced by all countries in the world, and it is also a hot spot of concern in the academic circles. According to the development of post-disaster reconstruction work in the severely affected areas in recent years, reconstruction is extremely complicated and needs to be coordinated by many parties. [1] [2] [3] For the reconstruction of a city, infrastructure reconstruction is the foundation of the entire urban reconstruction work. The breakdown of infrastructure is undoubtedly aggravating the post-disaster reconstruction work.

As a major disaster-stricken area in the Wenchuan earthquake, Dujiangyan City suffered huge losses. As a tourist city, Dujiangyan is rich in water resources and has a high dependence on infrastructure. This paper selects Dujiangyan, and hopes to analyze and summarize some empirical inspirations through the research on the reconstruction of infrastructure in the past ten years, and provide theoretical references for the reconstruction of other disaster-stricken areas.

In order to more objectively and accurately understand the current situation of the reconstruction and development of infrastructure in the Dujiangyan area after the Wenchuan earthquake, data collection was carried out through the issuance of questionnaires, key figures and organizational interviews and literature references. A total of 1,402 resident samples were involved (including 1,344 valid samples, 58 invalid samples, 95.86% effective rate), 5 key individuals and organizations, and some objective indicators and assessment points could not be found in the document. The information disclosure channel is submitted to relevant departments for disclosure and collection.

II. DUJIANGYAN DISASTER SITUATION

On May 12, 2008, a large earthquake of 8.0 Ms occurred in Wenchuan County with a moment magnitude of 8.3 Ms and an earthquake intensity of 11 degrees. As of 12:00 on September 18 of that year, the Wenchuan Earthquake caused a total of 69,227 deaths, 374,643 injuries, and 17,923 missing. The direct economic losses amounted to 845.215 billion Yuan [4], the most destructive earthquake since the founding of the People's Republic of China. It was also the most serious earthquake after the Tangshan earthquake [5].

Dujiangyan, a historical and cultural tourist city 23 kilometers from the earthquake center, is one of the ten most severely affected areas. More than 80% of the houses in the urban area have been damaged to varying degrees. Dujiangyan City is a historical and cultural city with a history of more than two thousand years of city construction and rising from the water. Tourism is its pillar industry [6], and its contribution to the economy has exceeded 10%. However, after the earthquake, all scenic spots in Dujiangyan were severely damaged, which had a huge impact on the tourism industry in Dujiangyan City, causing countless losses.

III. DUJIANGYAN INFRASTRUCTURE RECONSTRUCTION STATUS

Combined with the situation of Dujiangyan and the damage caused by earthquakes, this paper selects transportation, energy and other basic equipment as the first-level indicators, paving mileage, number of bridges, per capita road area, total railway mileage, total supply of liquefied petroleum gas, and groundwater. Pipeline, gas penetration rate, number of public toilets owned by 10,000 people, sewage treatment rate, sanitation special vehicle equipment, and water supply pipeline length as secondary indicators (11 in total).

A. Traffic

1) *Road paving mileage:* The Wenchuan earthquake severely damaged the original road traffic, and the highways

suffered from various degrees of damage. The Hongkou Tourist Road and the Duwen Expressway were all damaged during the earthquake, and the original road damage rate reached 60.96% [7]. Post-disaster reconstruction has gradually restored the traffic order and the traffic construction industry has developed rapidly. From 2008 to 2011, the construction of the main road projects started. The city's 265 and 382.4 km rural roads and resettlement roads were fully implemented; the construction of the main lines such as Guanwen Road, Longchi Connection Line, It Avenue and Chongyi Overpass was completed.

2) *Number of bridges and per capita road area:* The Wenchuan earthquake caused a large number of bridges in Dujiangyan City to be damaged, road collapses, serious damage to transportation infrastructure, and the number of bridges and per capita roads fell to a low level. During the three years following the earthquake, the normal movement of regional personnel and materials was affected. The post-disaster reconstruction has gradually restored the traffic order in the region, and the traffic construction industry has developed rapidly. The bridges such as the Miaozipingte Bridge have been reset overall, and the number of bridges has generally increased.

In the past four years, the per capita road area of Dujiangyan City has grown rapidly with the restoration and reconstruction of transportation infrastructure. From 2010 to 2013, the passenger traffic and freight turnover of the city also increased rapidly (see "Fig. 1" and "Fig. 2").

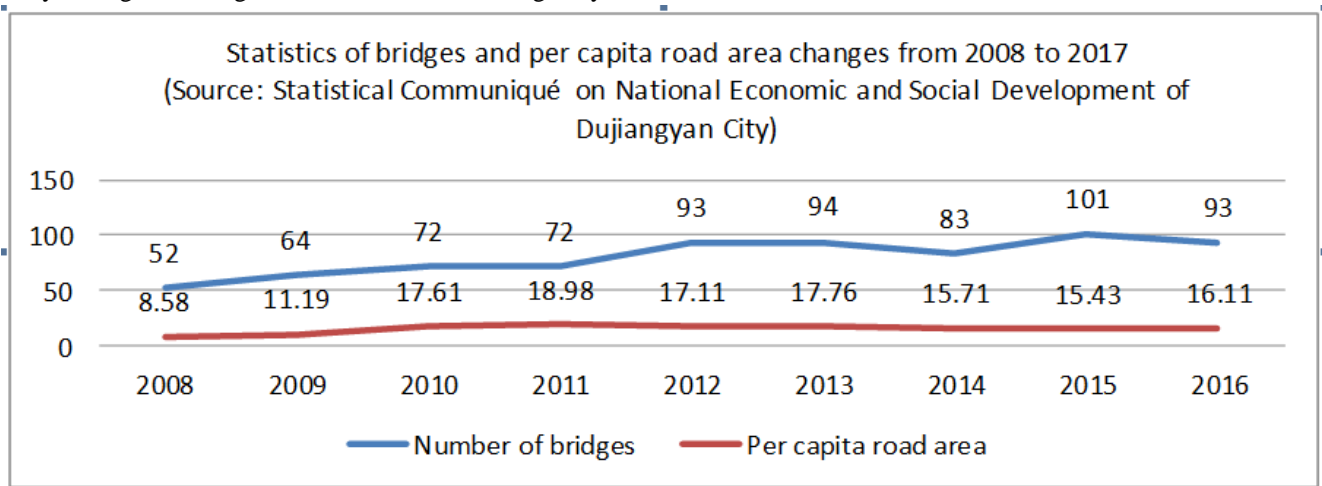


Fig. 1. Statistical graph of changes in the number of bridges and per capita road area from 2008 to 2017.

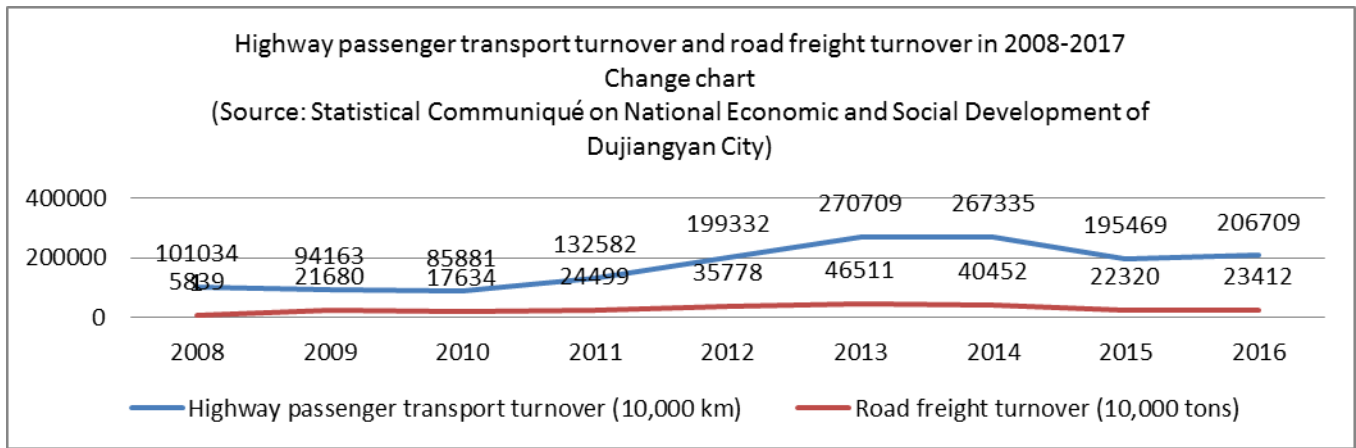


Fig. 2. Statistical chart of highway passenger traffic turnover and road freight turnover in 2008-2017.

3) *Total mileage of the railway:* The construction of the road and grid bureau with the core of "five verticals, five horizontals, one rail and one belt" has been gradually promoted. The construction of the express railway is fast, the construction of the backbone roads such as Dujiangyan

section, Juqing line and Pengqing line on the Shaxi line is completed, and the traffic network is improving day by day. From 2008 to 2016, the transportation industry in the city has developed rapidly. (see "Fig. 3")

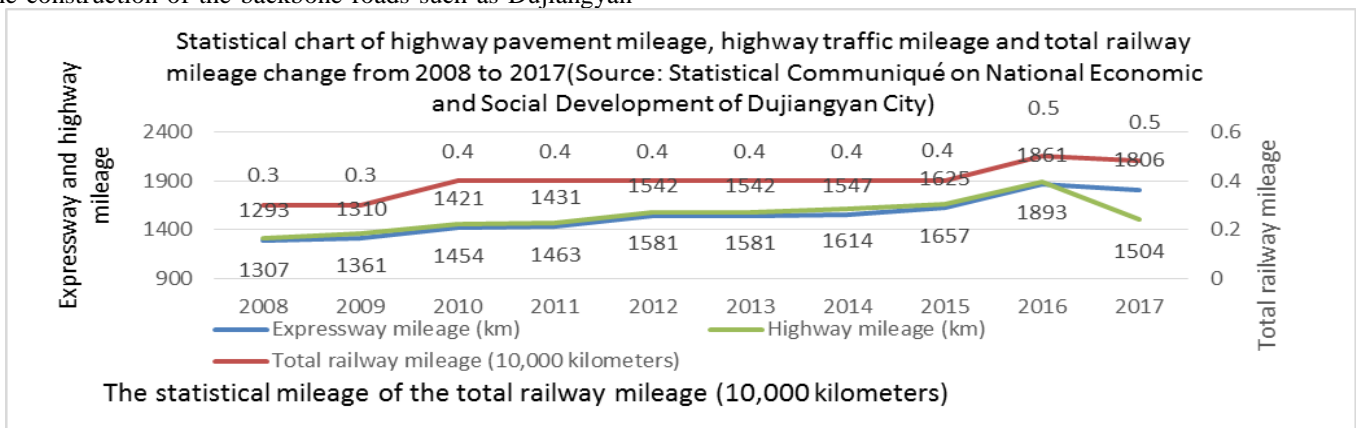


Fig. 3. Statistical chart of highway pavement mileage, highway mileage, and total railway mileage from 2008 to 2017.

4) *Residents' traffic recognition:* The transportation restoration and reconstruction in the past ten years has achieved good results, and the city's transportation network has been continuously improved, bringing great convenience to the lives of local residents. By issuing questionnaires to residents, the survey results show that the proportion of residents who agree with the "convenience of transportation" is over 90%. Residents widely recognize the achievements of traffic recovery and development in Dujiangyan City, and can understand the convenience brought by regional transportation development.

B. Energy

1) *Energy use structure is optimized:* Under the strong leadership of the Party Central Committee, the State Council, the provincial party committee, the provincial government, and the selfless assistance of the people of the whole country [8], the economy of Dujiangyan City has gradually

recovered and the government has paid more and more attention to environmental protection, and the energy and water resources in the city. The structure is continuously optimized.

In the past ten years, with the steady growth of the number of permanent residents in Dujiangyan City, the production and living water has increased, and the total amount of social water supply has progressed steadily. The municipal government implemented an air pollution prevention and control action plan to strengthen comprehensive ecological management and continuously improve environmental quality [8]. As a substitute for traditional energy coal, natural gas, while reducing the consumption of non-renewable energy, the demand for natural gas in the city has increased substantially, and the gas supply rate of natural gas has generally increased. The popularity of natural gas-based gas has also increased. (see "Fig. 4" and "Fig. 5")

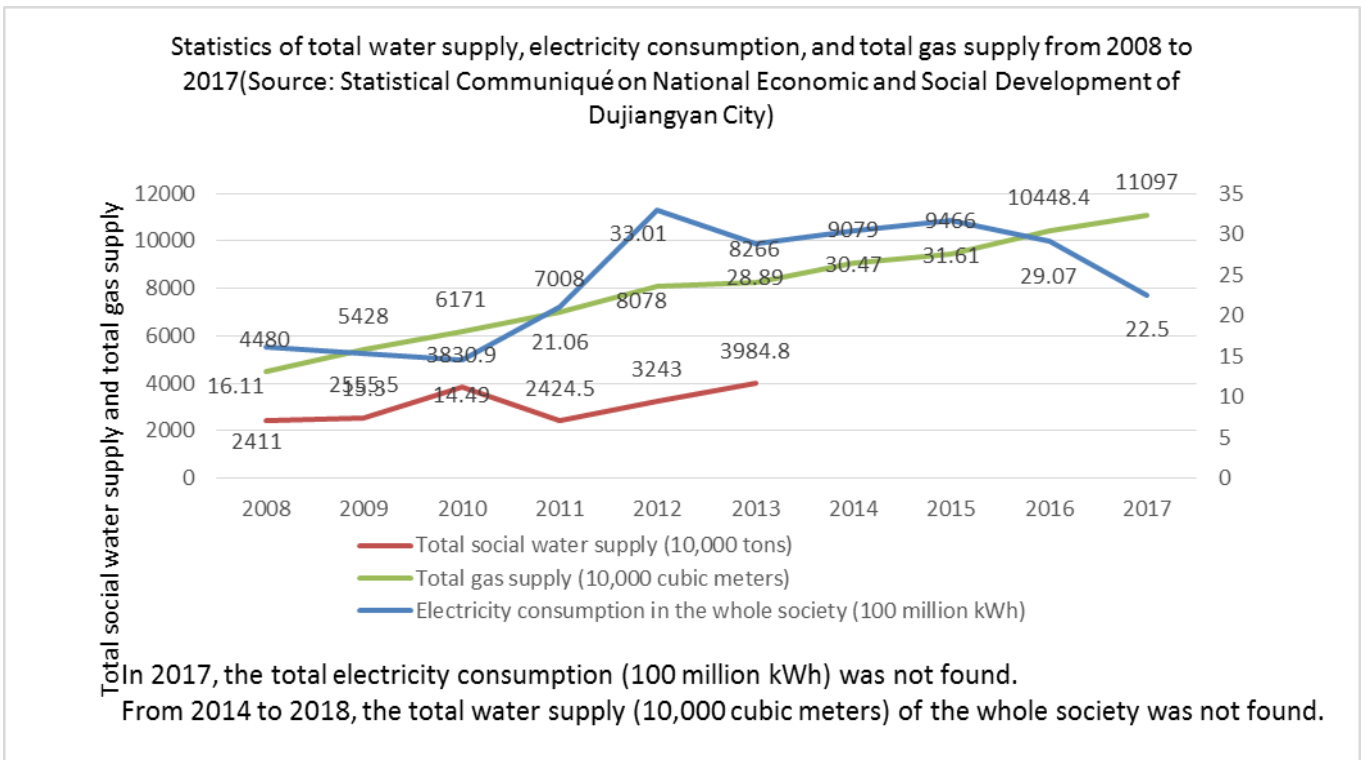


Fig. 4. Statistical graph of total water supply, electricity consumption, and total gas supply in 2008-2017.

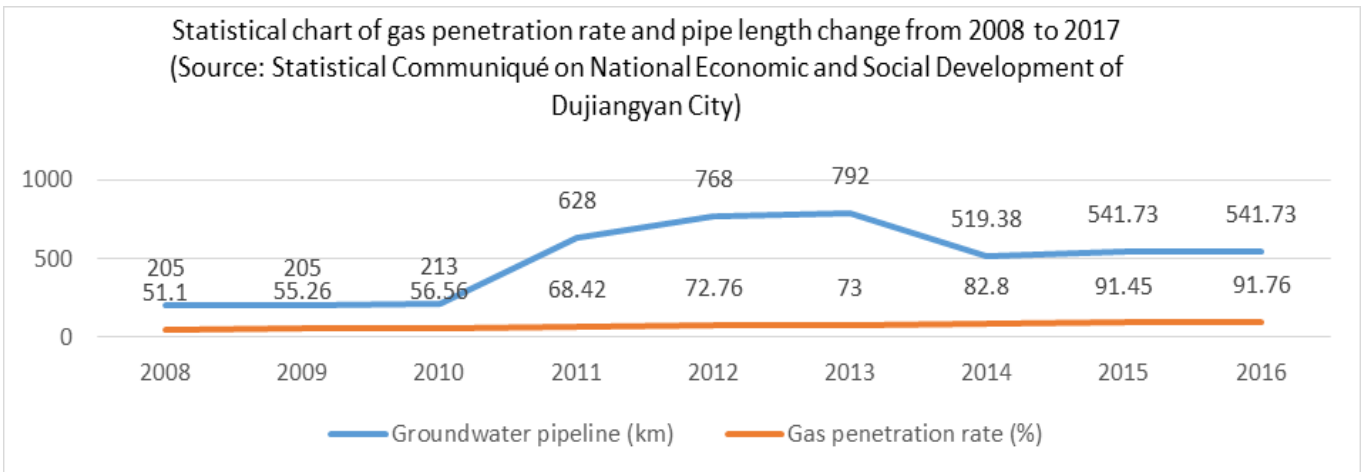


Fig. 5. Statistical graph of gas penetration rate and drain pipe length change from 2008 to 2017.

At the same time, the municipal government attaches great importance to environmental protection work and promotes the increase of clean energy supply. The total supply of liquefied petroleum gas (CLP) which is lower than the cleanliness of natural gas has shown a sharp decline. (see "Fig. 6")

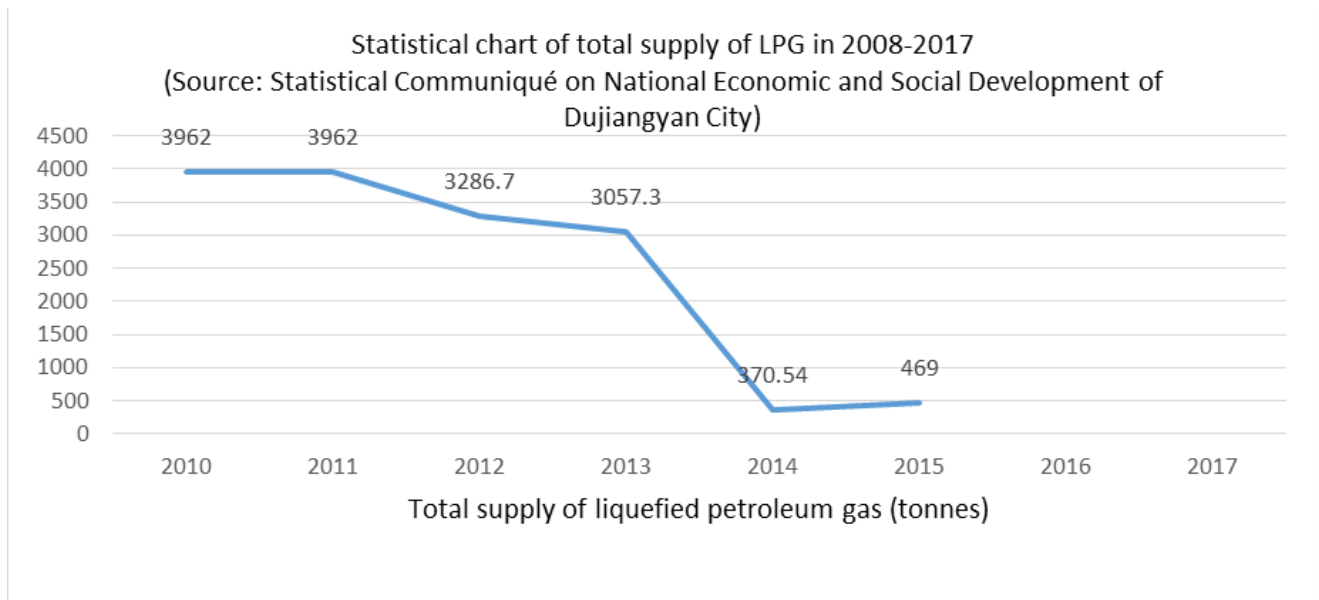


Fig. 6. Statistical chart of total supply of LPG in 2008-2017.

2) *Problems with energy supply still exist:* The supply of water, electricity and gas in Dujiangyan City has shown an overall growth trend, and the construction of the corresponding energy supply infrastructure is still in the process of being completed. In 2017, the water pressure in tap water in Dujiangyan District was insufficient, resulting in the high-floor residents in the Happy Business City area being available in summer. [9]; On November 23, 2017, the two districts of Chongyi and Juyuan in Dujiangyan City were blacked out. Residents have a certain impact on daily life [10].

3) *Residents' recognition of energy recovery:* According to the results of the effective questionnaire survey, it is

obvious that the residents of Dujiangyan City have a higher overall recognition of the regional energy supply. The proportion of "energetic energy" is "very agreeable" and "approved", but there are still quite a few residents. For Dujiangyan City, "energy is sufficient" to "disagree" or "very disagree". It can be seen that the energy supply in the city needs further optimization.

C. *Other Basic Equipment*

The construction of various infrastructures in Dujiangyan City has been gradually improved. (see "Fig. 7")

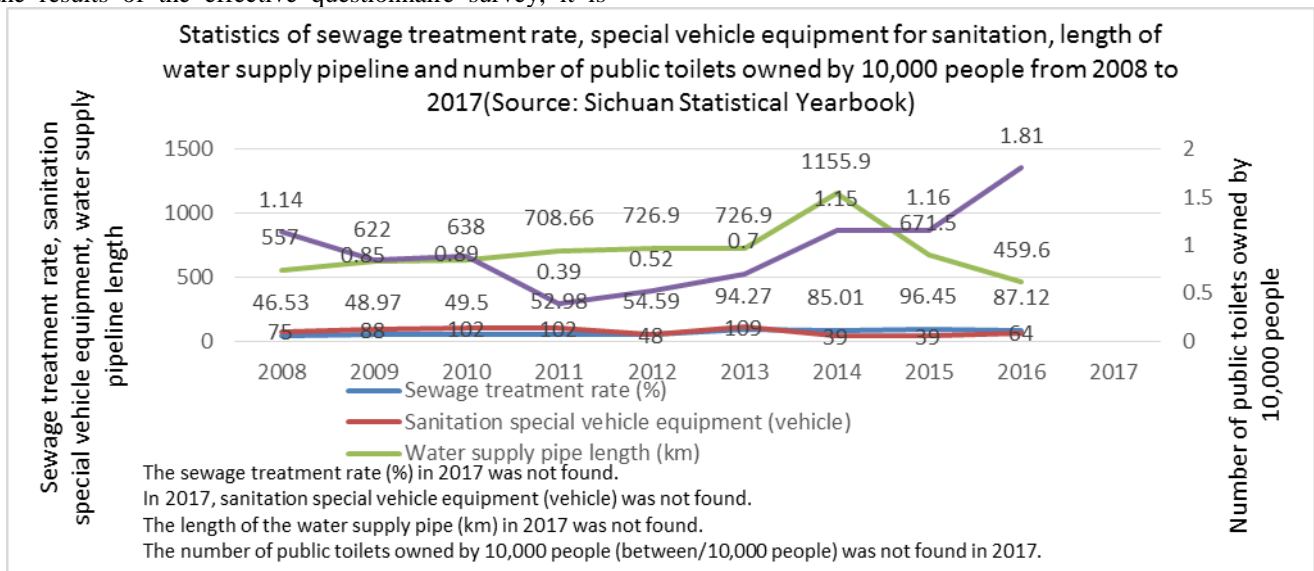


Fig. 7. Statistics of sewage treatment rate, sanitation special vehicle equipment, length of water supply pipeline and number of public toilets owned by 10,000 people from 2008 to 2017.

1) *Length of water supply pipe and public toilet:* From 2008 to 2013, the total water supply in Dujiangyan City fluctuated, the water supply facilities were gradually improved, and the length of water supply pipelines grew steadily. In 2014, the number of kilometers of water supply pipelines in Dujiangyan City increased rapidly and reached its peak. From 2014 to 2017, the number has decreased.

As a tourist city, Dujiangyan pays attention to the perceived experience of tourists and citizens in the construction of public facilities. In 2009, the tourism industry recovered strongly and surpassed the pre-earthquake level. From 2008 to 2017, total tourism revenue continued to grow. Stimulated by the rapid development of tourism, Dujiangyan City continued to promote the reconstruction of public toilets in the city. From 2008 to 2011, the number of public toilets owned by 10,000 people declined. From 2011 to 2016, the number began to rise rapidly.

2) *Sewage treatment rate and sanitation special vehicle equipment:* From 2010 to 2015, the sewage treatment rate in Dujiangyan City increased steadily. From 2010 to 2014, the number of special vehicles for sanitation in Dujiangyan City has generally decreased, and the number of equipment has rebounded since 2015. At the same stage, Dujiangyan City firmly grasped environmental protection work, promoted the creation of a provincial-level environmental protection model city, and advocated water conservation and scientific water control. In the past five years, the sewage treatment rate has been generally improved steadily, and sewage treatment engineering facilities have been continuously improved.

3) *Residents' recognition of infrastructure equipment recovery:* According to the statistical chart of residents' approval, the residents who have the "consent" or "very agree" attitude towards "complete infrastructure" in Dujiangyan City occupy the vast majority, and the residents who have a "very disagree" attitude towards the formulation are extremely Less, it can be seen that the residents of Dujiangyan City have a higher overall satisfaction with the urban infrastructure construction. The restoration and construction of the infrastructure in Dujiangyan City has been widely recognized by the residents.

The continuous improvement of infrastructure construction in Dujiangyan City has promoted the continuous improvement of residents' quality of life, and the quality of public services enjoyed by residents has improved and daily life has become more convenient. According to the survey results, the majority of residents agree that the infrastructure is perfect and the overall satisfaction with urban infrastructure construction is high.

IV. THE RECONSTRUCTION OF THE SEVERELY DEVASTATED AREA REPRESENTED BY DUJIANGYAN

Dujiangyan City's transportation industry has achieved remarkable results in its recovery and development. The city's road network construction has made breakthrough progress, the energy and water resources utilization structure

has been continuously optimized, and the infrastructure construction has been gradually improved. Residents expressed overall satisfaction with the results of transportation development and public infrastructure construction in the region, but believed that there are still problems in the supply of energy and water resources in Dujiangyan City. The municipal government should actively explore new models, innovate and optimize infrastructure construction and energy supply systems, guarantee the basic living needs of residents, and provide a good industrial environment to promote the stable and healthy development of the regional economy.

In the construction of infrastructure in major disaster-stricken areas, the basic construction of transportation can be carried out in combination with geographical conditions and disasters. The principle of first-class disaster-stricken areas and dense areas can be followed, and life channels for rescue and reconstruction can be opened as soon as possible. In terms of energy construction, it is necessary to ensure those residents' living needs energy is met as soon as possible, and that frequent blackouts and water cuts in the districts are reduced. In terms of infrastructure, it is necessary to comply with the local development status and pay attention to the investment in basic security equipment such as culture and environment. In addition, the development and utilization of local disaster-stricken resources is of great value not only for the publicity and scientific research of seismic science, but also a very valuable new tourism resource. [11]

V. CONCLUSION

The infrastructure development of Dujiangyan has been generally good, and the recovery of the transportation industry has been particularly effective. The restoration of infrastructure plays a supporting role in the overall reconstruction and restoration of Dujiangyan. After the disaster in Dujiangyan disaster, the infrastructure was not only restored in a short period of time, but also continued to develop, surpassing the original level and achieving great success. Behind the success of the restoration and reconstruction of infrastructure equipment after the disaster, it is the country's strong support, the assistance of other provinces and cities, the continuous help of all sectors of society, the participation of the people in the disaster areas. And the rich experience of infrastructure restoration in the decade after the disaster, other major disaster areas can be comprehensively combined with the actual situation of the disaster area.

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