

A large-scale water project built in ancient China and used up to now. It can be divided into two systems: the irrigation head and the irrigation water network.

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Figure 1: Linpan settlements on the downstream.

Context.

Location: Dujiangyan, Chengdu, Sichuan, China.

Landscape Type: Alluvial-proluvial Fan Plain Area: 9822.000 ha (originally).

Function: Flood control and sand removal, water transportation, urban water supply.

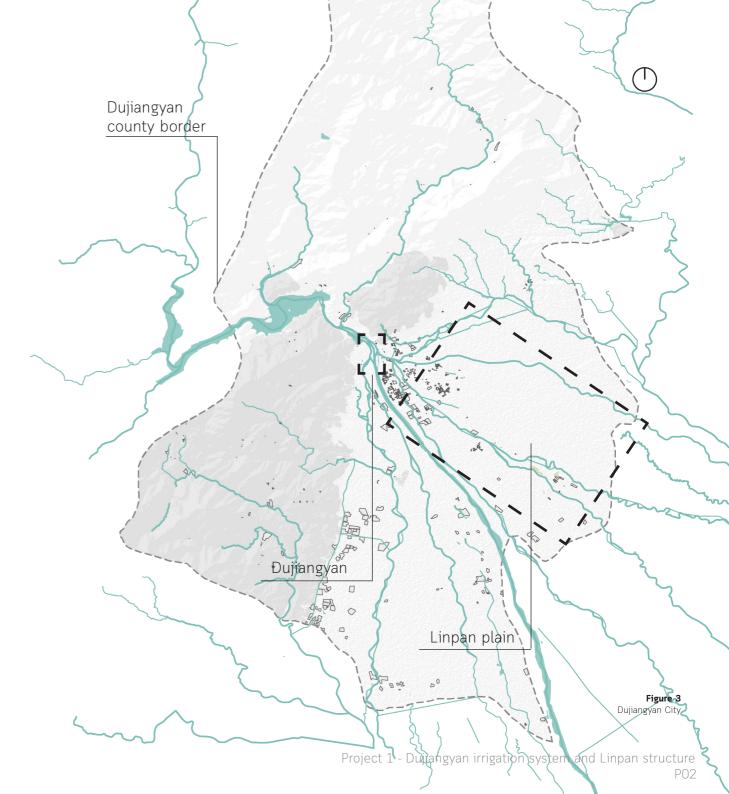
Components: Dam, water inlet, irrigation ditch

Dujiangyan system is a large-scale water conservancy project built in ancient China and used up to now. It is located in the west of Dujiangyan City, Sichuan Province, 340 kilometers upstream of the Minjiang River. According to legend, Dujiangyan was built from about 256 BC to 251 BC. After successive renovations, it has played a huge role for more than two thousand years.

Without destroying natural resources and with making full use of natural resources to serve human beings, the project turned harm into benefit and made a high degree of harmony among people, land and water, which is also a great "ecological project" in the world.



Figure 2
Site location



Climate.

Subtropical Climate zone:

Central subtropical monsoon humid climate zone Sub-climate:

Climate & Weather Averages

High tº: 28°C Low to: 7°C Humidity: 80% Dew point: 6°C Frost-free period: 10 km/h Pressure: 1019 mbar Mean to: 15.5°C Precipitation: 1117.0 mm

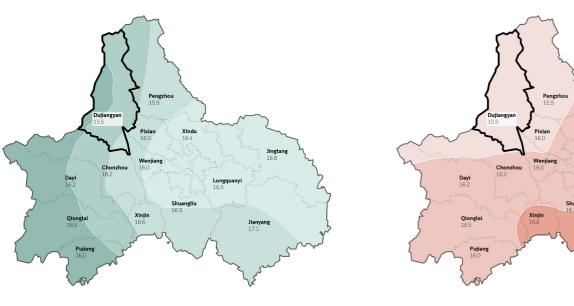




Figure 5



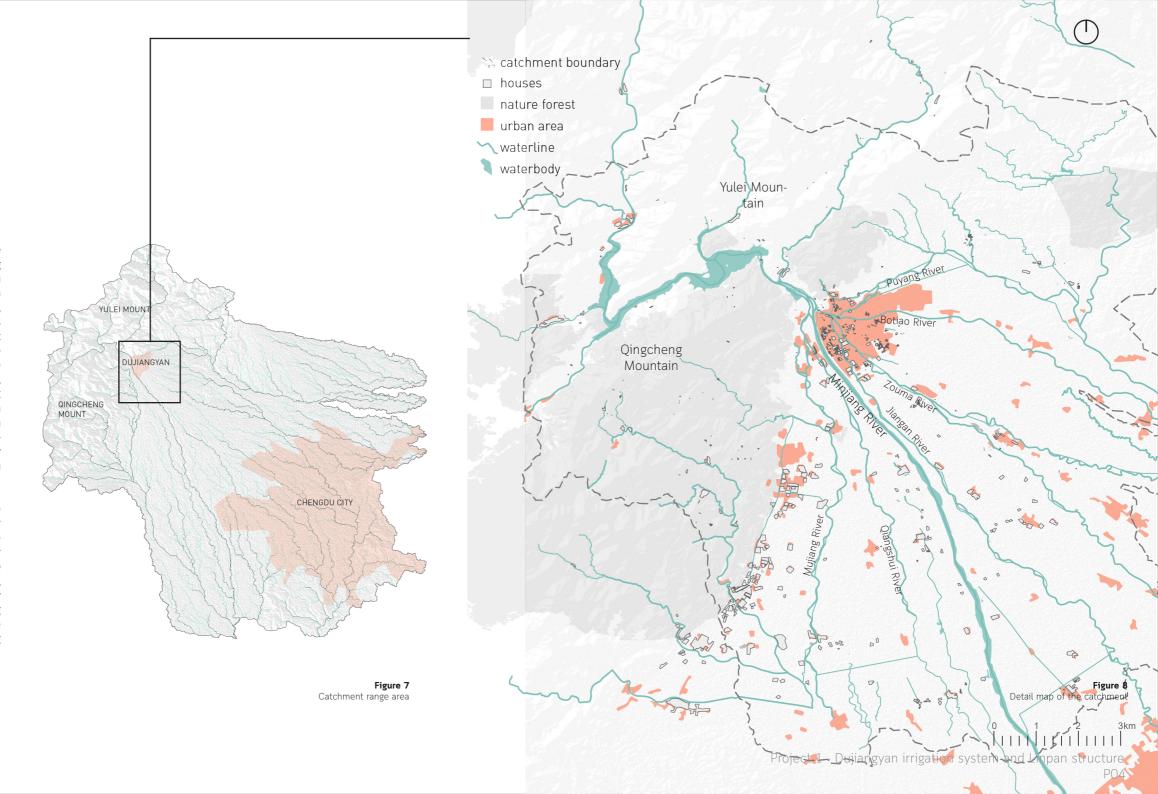
Figure 6 Temperarture and amount of rainfall

Catchment area.

Part of the Minjiang River Catchment in the Chengdu Plain.

The Minjiang River Basin is located on the southwestern edge of the Sichuan Basin, with a terrain high in the west and low in the east, covering an area of about 133,000 square kilometers. The population of the basin is 17.894 million, of which 7.103 million are non-agricultural. Dujiangyan and Chengdu Plain are located in the middle reaches of the Minjiang River, which is from Dujiangyan to Leshan. This part is about 216 kilometers long. It has been called the "golden waterway" of Sichuan since ancient times. It mainly flows through the Chengdu Plain and hills with an altitude of less than 800 meters. It belongs to the subtropical climate zone. The middle reaches of the Minjiang River is a zone of steep change in geology, landform and climate in western China, densely populated with ancient towns and rich in cultural heritage. The west of the catchment's terrain belongs to the edge mountains of the Sichuan Basin in the southern section of Longmen Mountains. It is composed of a series of northeastsouthwest mountains. The terrain is high and the mountains are below 3,000 meters above sea level. The eastern part belongs to the Chengdu Plain, with flat terrain. The altitude is generally below 720 meters.

The middle reaches of the Minjiang River were divided into two by the Dujiangyan Project, forming two waterways, the Outer River and the Inner River, of which the Outer River is the main stream. The section of the Outer River from Dujiangyan to Xinjin is called the Jinma River, and after the confluence of the Xinjin River and the Xihe River, it is called the Minjiang River again. The Inner River is divided into the Puyang River, Baitiao River, and Zuoma River, and continues to branch out into many rivers to irrigate the Chengdu Plain and communicate with the Tuojiang River system. Among them, the branches of the Baitiao River and the Zouma River entering the urban area of Chengdu are called the Jinjiang River.



Water system: Plan.

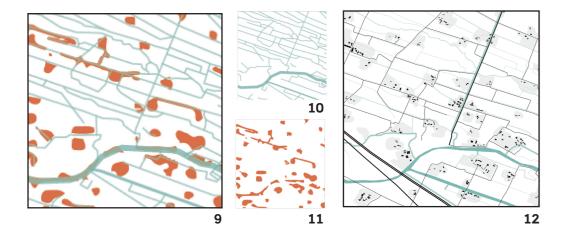
Seasonal rainfall makes the lower-reach-places very dependent on the upstream Minjiang River water source. As a unique agricultural and rural landscape, Dujiangyan Project had a profound influence on the production and life of downstream residents, as well as the shaping of the Chengdu Plain in terms of spatial form. This downstream map shows the pattern and textures of the plain, which also explain the inner relationship between water system, function, spatial form, etc.

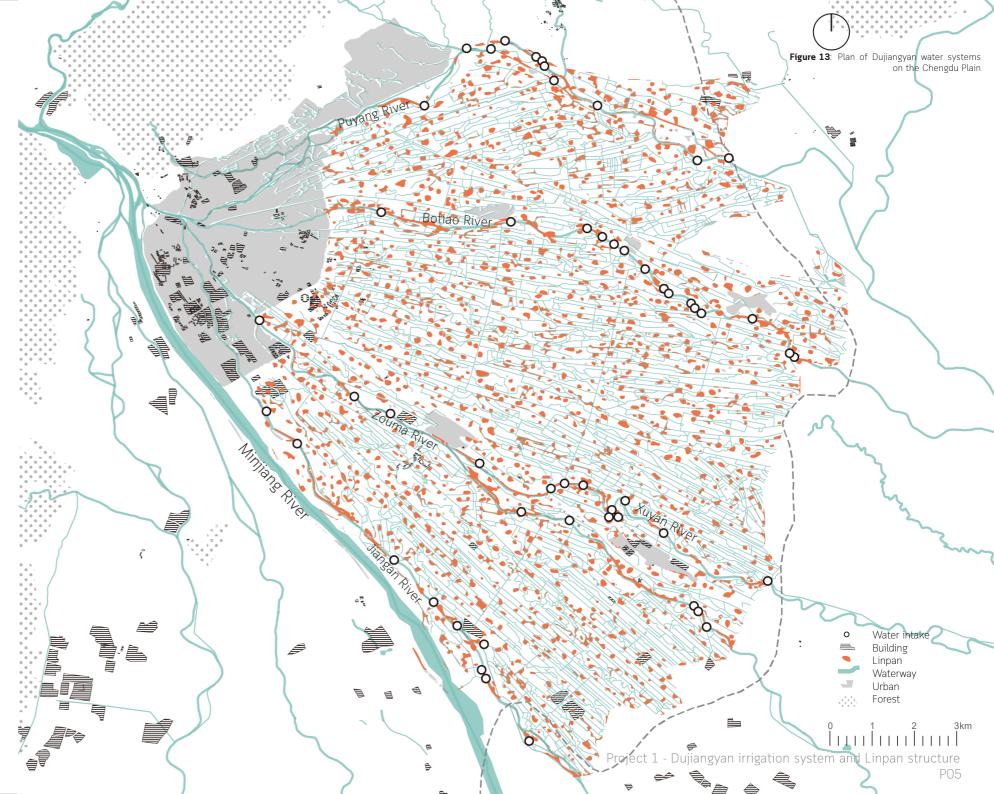
If we zoom in a liitle bit, the basic pattern of this plain will become more clear, which is consist of lines and blocks. The line is the waterway and the block is linpan settlement. It looks just like the blood structure of the human body, oxygen is transported to every cell structure through arteries, veins, and capillaries.

Figure 9: Enlarged view of Linpan pattern.

Figure 10: Waterline network of Linpan pattern.
Figure 11: Linpan blocks of Linpan pattern.

Figure 12: Detail view of Linpan pattern.





Water system and Mechanism.

The upstream watersystem consists of three main constructions that work in harmony with one another to ensure against flooding and keep the fields well supplied with water:

The Fish Mouth Levee, named for its head resembling the mouth of a fish, is the key part of the construction. The inner stream is deep and narrow, while the outer stream is relatively shallow but wide. This special structure ensures that the inner stream carries approximately 60% of the river's flow into the irrigation system during dry season. While during flood, this amount decreases to 40% to protect the people from flooding. The outer stream drains away the rest, flushing out much of the silt and sediment.

The Flying Sand Weir has a 200-meter-wide opening that connects the

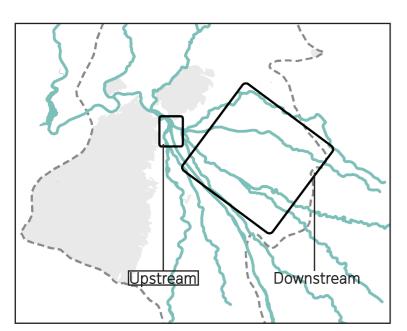


Figure 14: Dujiangyan floor plan.

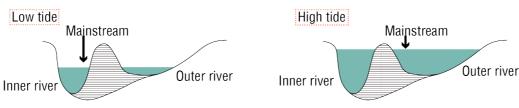
inner and outer streams. This ensures against flooding by allowing the natural swirling flow of the water to drain out excess water from the inner to the outer stream. The swirl also drains out silt and sediment that failed to go into the outer stream. A modern reinforced concrete weir has replaced the original weighted bamboo baskets.

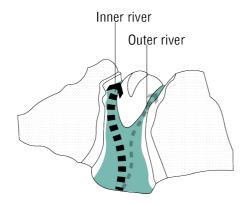
The Bottle-Neck Channel, which was gouged through the mountain, is the final part of the system. The channel distributes the water to the farmlands in the Chengdu Plain, whilst the narrow entrance, that gives it its name, works as a check gate, creating the whirlpool flow that carries away the excess water over Flying Sand Fence, to ensure against flooding.

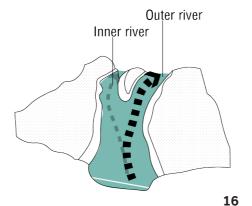
Figure 15: Photo of Dujiangyan upstream water system.

Figure 16: Working mechanism of the Fish Mouth Levee.

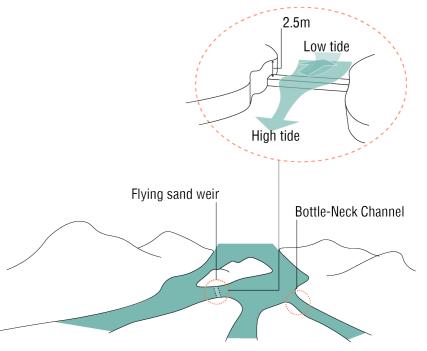
Figure 17: Working mechanism of the Flying Sand Weir.











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Project 1 - Dujiangyan irrigation system and Linpan structure

Water system and Mechanism.

The lower reaches mainly consist of diversion channels at all levels of the irrigation district, roughly divided into four levels, using the height difference to divert water to complete irrigation, while many facilities to assist in the control of irrigation.

Water from the river flows through the inlet sluice, entered the irrigation canals, which basically have four to five levels. The first-level canal is called branch canal, which is the widest and shallowest, and the last-level canal is called net canal, which is the narrowest and deepest. The overall terrain trend of the Dujiangyan Plain is high in the northwest and low in the southeast. In ancient times, people use the original micro-topography and the artificially-created height difference to guide the water flow to the fields and houses level by level. The water finally flows into the drainage

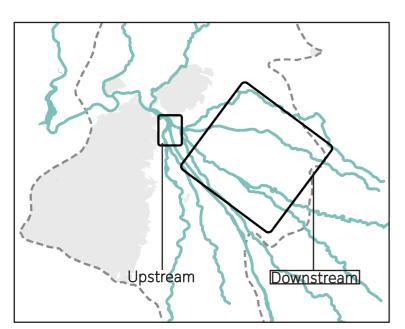


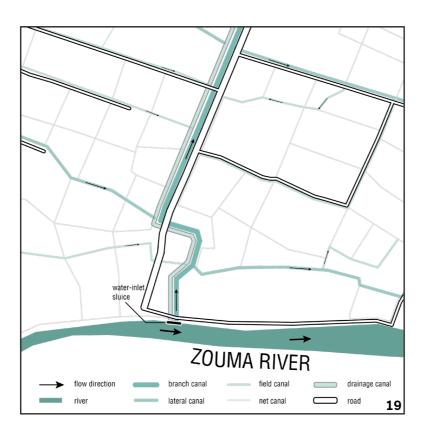
Figure 14: Dujiangyan floor plan.

channel, and then back into the river. After generations of updating and repairing the canals, the water reaches the each Linpan residents and farmlands through the net canal and the field canal, weaving into a dense water system network, which makes it more convenient and direct to obtain domestic water and agricultural water.

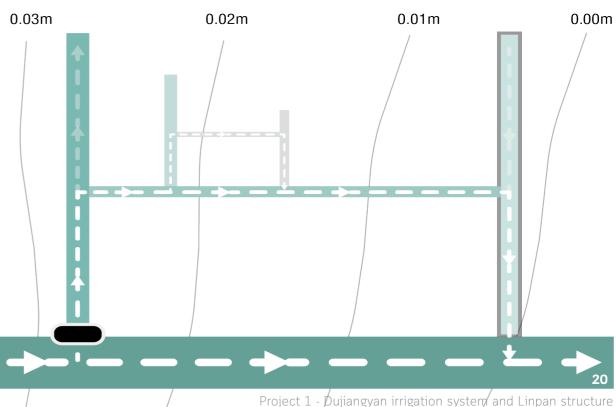
Figure 18: Photo of Dujiangyan downstream water system.

Figure 19: Detail plan of downstream irrigation network.

Figure 20: Working mechanism of downstream irrigation network.







Landscape transformation.

During the origin period, the embryonic form of the water system in the Chengdu Plain is emerging, however the main rivers are in a disorderly radial pattern and changed frequently. The tributaries didn't form fixed and stable waterways, bringing several floods and droughts.

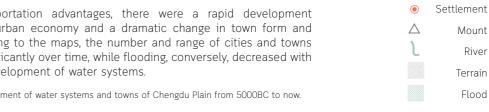
Since 260BC, the construction of the Dujiangyan Water Conservancy Project completely changed the water control environment in the Chengdu

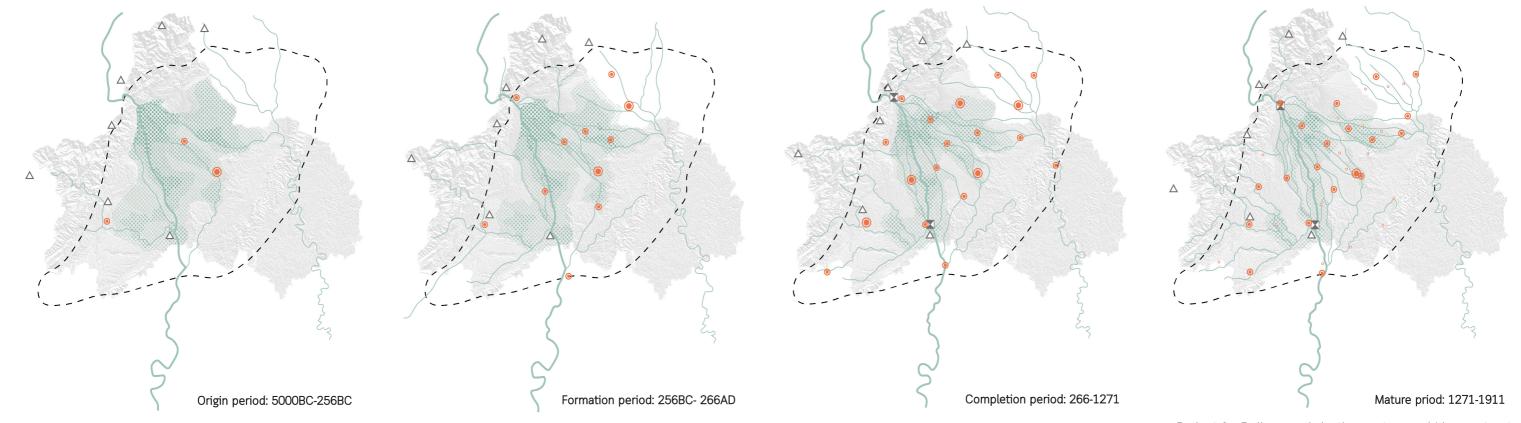
Plain, significantly reducing floods frequency and severity, and improving agricultural irrigation efficiency. The water system in the Chengdu Plain mainly expands to the east, and the channels gradually became fixed and clear with the maintanence of residents. The overall shape of water systems gradually becomes a dendritic water network.

The open up of inner and outer rivers provided sufficient water resources for the construction and economic development of Chengdu city. With

obvious transportation advantages, there were a rapid development of Chengdu's urban economy and a dramatic change in town form and layout. According to the maps, the number and range of cities and towns increased significantly over time, while flooding, conversely, decreased with the gradual development of water systems.

Figure 21: Development of water systems and towns of Chengdu Plain from 5000BC to now.





Project 1 - Dujiangyan irrigation system and Linpan structure

Human Interactions.

The human activities in the upper and lower reaches of Dujiangyan present different features because of having different main functions. At the head of Dujiangyan Project, surrounded by green mountains and green waters, the superior ecological environment and historical sites make it a leisure and tourist attraction in addition to undertaking the function of water conservancy regulation.

Downstream, a vast irrigation system spreads out, and in symbiosis with it is a system of woodland settlements created by indigenous people over thousands of years using water and in situ conditions. People live near the water, get their food from the water, rely on the water as a means of transportation, and relax and socialize by the water.

Figure 22: Tourists cross a bridge in Dujiangyan.

Figure 23: Scenic boating on the water.

Figure 24: Downstream residents are fishing and chilling by the water.

Figure 25: Farmer transplanting rice seedlings in rice field.

Figure 26: Fish fry and rice are symbiotic, and they can be caught and marketed before the rice is harvested.

Figure 27: Farmers are relay harvesting crops.



Project 1 - Dujiangyan irrigation system and Linpan structure

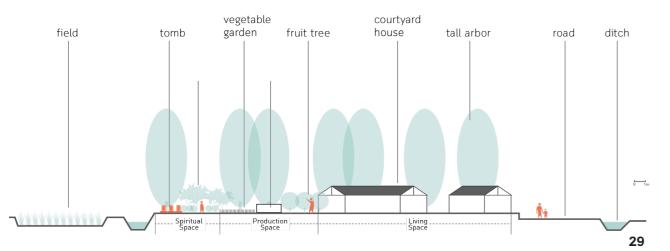
Linpan settlement.

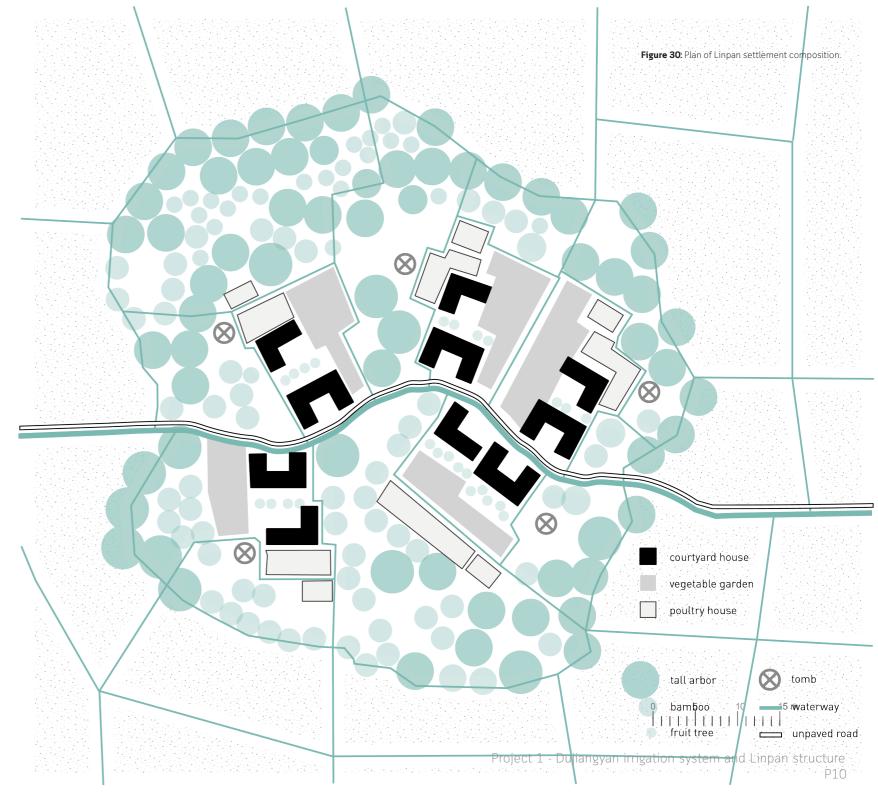
As a unique agricultural and rural landscape, Linpan in Western Sichuan is a settlement form that is integrated with natural geography, which embodies the harmony between human and nature. Linpan is an important resource for the sustainable development of society, economy, and ecology in Western Sichuan, a precious cultural landscape and an important carrier for the indigenous people to maintain their local cultural life and emotions.

Western Sichuan Linpan refers to the organic integration of farmyards and surrounding trees, bamboo woodland, rivers and surrounding cultivated land in the Chengdu Plain area to form a rural residential environment. It is a composite living mode integrating production, life and landscape. This mode of production and life has a long history, and it is in harmony with the farming conditions, traditional farming methods and living needs of the Chengdu Plain.

Figure 28: A zoom-in view of one Linpan in Chengdu Plain. Figure 29: Section of Linpan settlement.







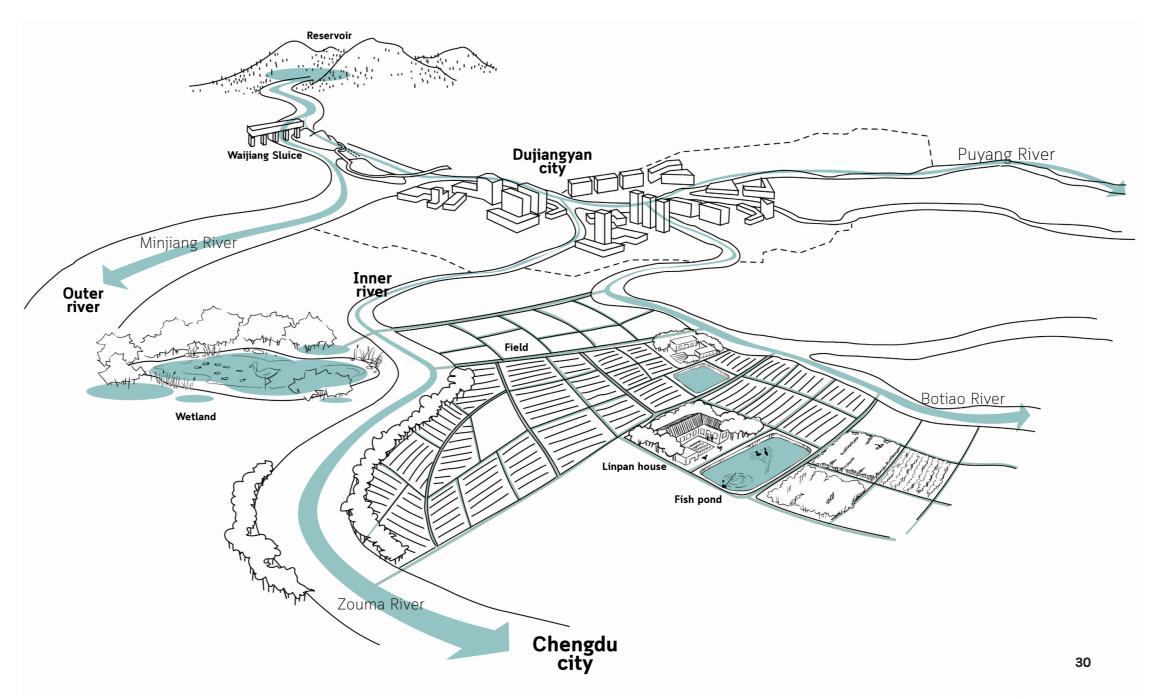
Water system: Circularity.

It was only when we looked back and sorted out the history that we discovered that there was such a deep and long-standing connection between the development of the Chengdu Plain and water. In the past, people's life and production all depended on the upstream Dujiangyan, and this great water conservancy project has been maintained for more than two thousand years. Everything here revolves around water.

Today's Dujiangyan water system is still in operation. The origin of the water is stored in a reservoir on the Mount Yulei, flowing down to Dujiangyan. After the water conservancy adjustment of Dujiangyan Project, the water flow is divided into Inner river and Outer river to the east and north respectively. After flowing through the main urban area of Dujiangyan, there are two options for the water to flow on the flat Chengdu Plain: to form part of wetland tidal flats in a natural state, or to form vast irrigation canals to irrigate farmland under artificial water conservancy treatment. The first type provides a habitat for many creatures, but the area of these natural wetlands has gradually shrunk, and the second type has developed a unique forest settlement structure and lifestyle through people's labor and wisdom.

Linpan represents ecological settlement units of field green islands formed in semi-natural and semi-constructed wetlands under the influence of the Dujiangyan water conservancy project. These units form a large area of oasis in the periphery of the city and act on the climate regulation of the Chengdu Plain environmental improvement.

Figure 30: A story of circularity of a lifestyle that utilizes water resource as irrigation system in Chengdu Plain.



Project 1 - Dujiangyan irrigation system and Linpan structure

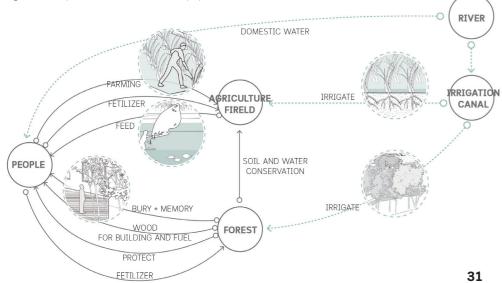
Water system: Circularity.

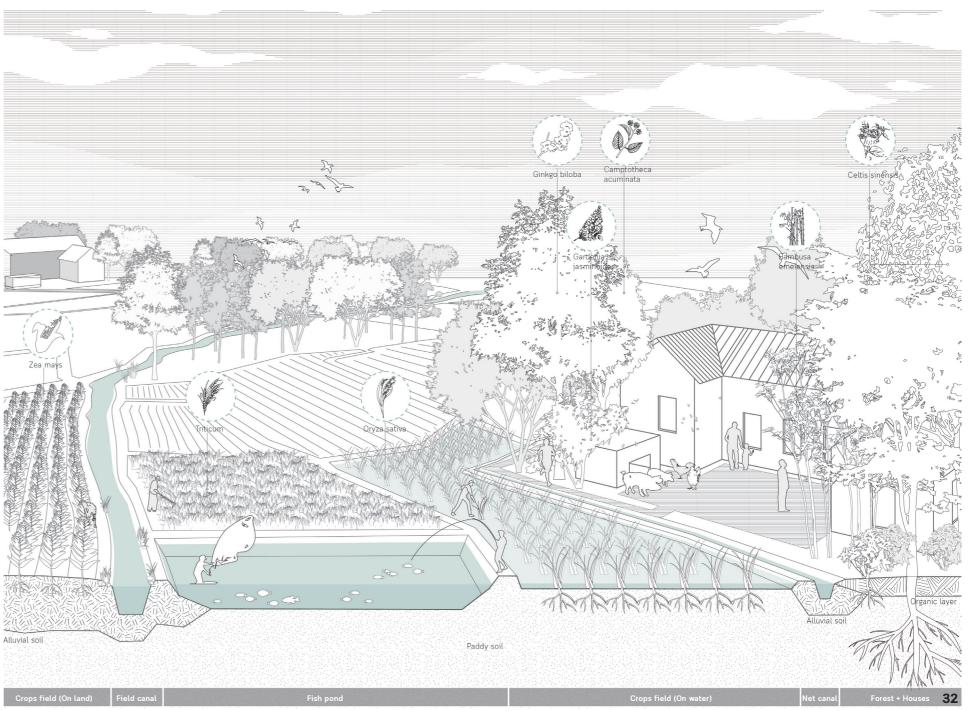
Linpans on the western Sichuan Plain consisting of Dujiangyan irrigation system, agricultural production, family-based lifestyle, is a spatial form that perfectly combines cultural symbols and usage values. It is a sustainbale system that integrates the living, production and ecological environment of the Chengdu Plain.

The ecological farming pattern is in harmony with the farming conditions, traditional farming methods and living needs of the western Sichuan Plain. The entire West Sichuan Plain irrigated by the Dujiangyan Project is a semi-artificial and semi-natural wetland ecosystem, providing habitat for birds and food base and living space for humans, while the symbiosis of human and forest in the Linpan continues to this day. These spontaneous ecological ways of living are worthy of human inheritance and development. Within the Linpan system, people, field, water and forests are interdependent. For example, people use the wood of forests to make fires and build houses. The forest serves as a barrier and a place for people to rest. Human and livestock manure will in turn fertilize the forest. In this way, Linpan forms a whole circular system of energy, material, (maybe emotion). People can live self-sufficiently in Linpan.

 $\textbf{Figure 31:} \ \ \, \text{Linpan's self-sufficient circulatory framework}.$

Figure 32: Linpan's self-sufficient circulatory system.





Project 4 - The Roman Aqueducts

Conclusion.

Landscape Values - In terms of material, the Dujiangyan water system includes various material elements such as farmland landscape, irrigation canal engineering landscape, and linpan landscape, and carries multiple functions such as ecology, production, and life. In the non-material aspect, the Linpan area has a long history of production and life, carrying important historical and cultural memories.

Heritage values - The core irrigation area of Dujiangyan has a very long history of irrigation and agriculture. The Linpan landscape was gradually formed during the thousands of years of evolution, witnessing the historical changes of the area. The various elements and overall characteristics of the Linpan each play a corresponding witness role in a certain time dimension and evoke the long-term memory of the regional history.

Production values - The Dujiangyan Core Irrigation District has the densest population and distribution density of forests, and the extremely low unit land area bears the production and living needs of residents. The forest-pan economy in the area is an excellent example of the traditional small-scale peasant economy, and the rice farming model of intensive cultivation has had excellent economic benefits for a long time. It has created the continuous high quality and high yield of agriculture in western Sichuan. At present, traditional production methods are still well-preserved in some areas. Although they have received certain impacts in the short term, the sustainable land use and production models behind them, as well as the highly complex field and forest production system, have room for optimization and improvement and the great potential for appreciation

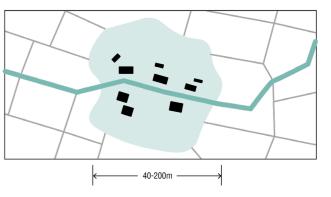
in the future.

Ecological values - From the perspective of regional relations, the core irrigation area gathers the main water systems flowing through the western Sichuan plain and is located upstream, so it has a great impact on the downstream water and soil. The protection of the forest pan landscape in the area plays an important role in maintaining the upstream and the overall water and soil conditions in the area. In addition, it also plays an important role as an ecological barrier. From the inside of the area, traditional forests play an important role in maintaining regional carbon and oxygen balance, purifying air, regulating climate, maintaining soil functions, conserving water sources, and conserving biodiversity.

Ethnographic and identity values - The Dujiangyan water system is an outstanding representative of the long-term adaptive transformation of nature by the residents of the western Sichuan plain. It shows the outstanding interaction between people and land, transforming the western Sichuan region, which is densely covered with lakes and floods, into a place of high agricultural prosperity, and creating a landscape system of Linpan - field - weir and canal in harmony with people and land. The unique spatial forms and lifestyles have become an important feature of the area and one of the sources of people's sense of belonging.

Figure 33: Abstract structure of Linpan.

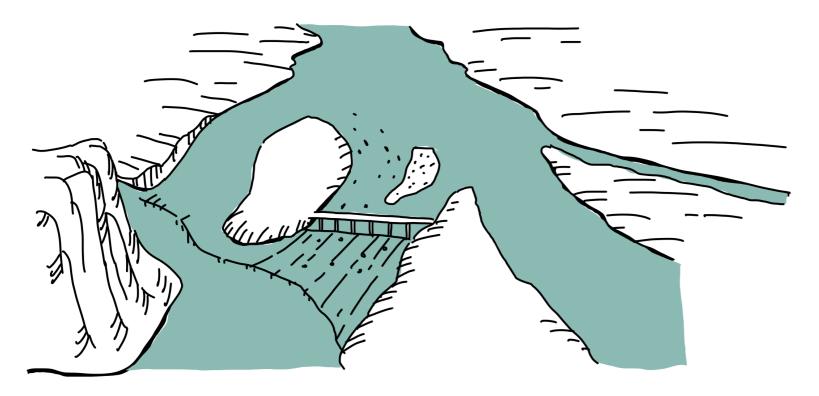
planar structure



vertical structure



Landscape elements.



Flying sand division - 飞沙堰

Flying sand division is the key point for Dujiangyan to protect the Chengdu Plain from floods. Its main functions are adjusting water overflow when the water volume of the Inner River exceeds the upper limit of the Baopingkou flow, and "flying sand" to prevent sand and rocks from flowing down the Inner River to silt up the irrigation area.

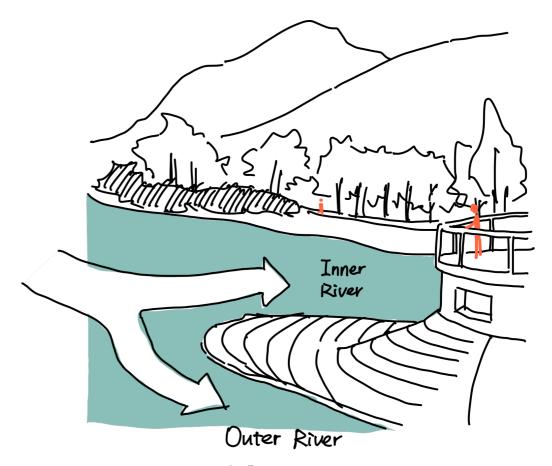
Project: Dujiangyan Water Conservancy System - a water regulation infrastructure in South-western China.

Climate: Central subtropical monsoon humid climate

Year: 256BC till now

Landscape: River landscape Material: Sand, stone and bamboo

Use or Function: Water regulation and management



Fish Mouth Levee - 鱼嘴

Fish mouth levee is a water diversion dam built in the middle of the river, which divides the raging Minjiang River into the Outer River and the Inner River.

Project: Dujiangyan Water Conservancy System - a water regulation infrastructure in South-western China.

Climate: Central subtropical monsoon humid climate

Year: 256BC till now

Landscape: River landscape

Material: Sand, stone and bamboo

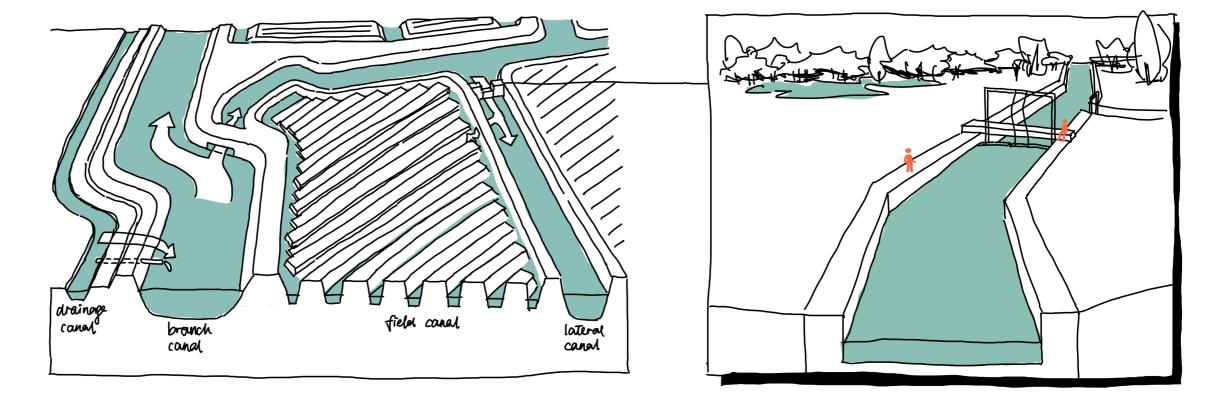
Use or Function: Water division and deceleration

Water works.

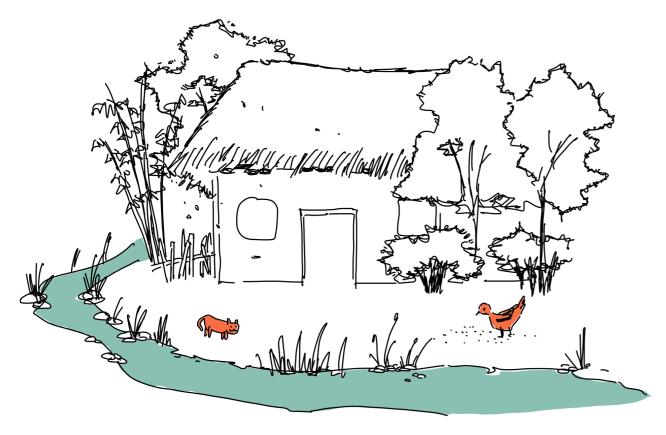
Canals

Water from the river flows through the inlet sluice, entered the irrigation canals, which basically have four to five levels. The first-level canal is called branch canal, which is the widest and shallowest, and the last-level canal is called net canal, which is the narrowest and deepest. People use the original micro-topography and the artificially-created height difference to guide the water flow to the fields and houses level by level. The water finally flows into the drainage channel, and then back into the river.

Project: Dujiangyan Irrigation System.
Climate: Central subtropical monsoon humid climate
Year: 1700 till now
Landscape: Canal landscape
Material: Sand and stone
Use or Function: irrigation and drainage



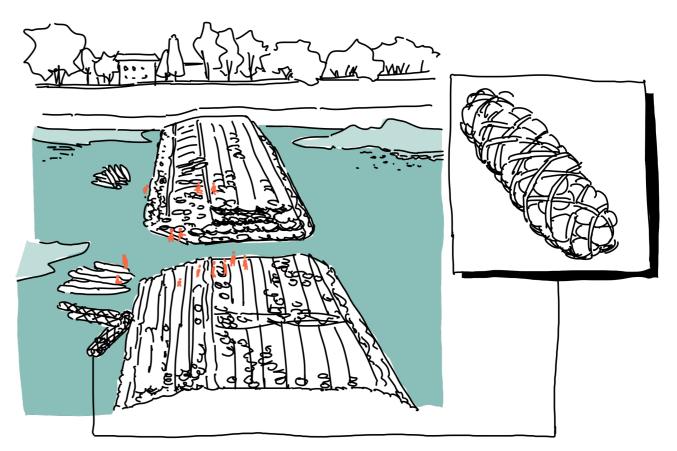
Water stories.



Linpan - 林盘

Linpan is a traditional rural settlement type and an organic integration of farmyards and surrounding trees, bamboo woodland, canals and surrounding cultivated land.

Project: Dujiangyan Irrigation System. Landscape: Rural landscape Material: Sand, stone, wood and bamboo Use or Function: dwell



Water-release festival - 清明放水节

The Qingming Water Release Festival not only holds the ceremony of offering sacrifices to Li Bing and releasing the water, but also integrates festivals, rural fairs, business activities, etc.

Project: Dujiangyan Water Conservancy System - a water regulation infrastructure in South-western China. Landscape: River landscape Material: Stone and bamboo

Use or Function: Water block and release, fair and business.

Project 1 - Dujiangyan irrigation system and Linpan structure