

# **Sustainable irrigation in South China: a case study of the Chengyang valley**

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## **Abstract**

In South China, in the rural Chengyang area, large rice fields crossed by the Linxi River are still irrigated by the river water raised by bamboo water-wheels. These water-wheels represent a viable and elegant example of a sustainable irrigation system, whose functional aspects are successfully combined with their aesthetic characteristics. The advantages provided by the material, which is easily available in the area, and the morphological characteristics of the land, have allowed the construction of numerous examples of this system of irrigation. It has a simple assembly, is efficient and has low operational and maintenance costs and enables irrigation requiring no petrol or oil.

This paper analyses the device focusing on its architectural and constructive aspects, on the important role played by the material, and on its advantages and disadvantages.

*Keywords: bamboo construction, irrigation, eco-architecture, China.*

## **1 Introduction**

Bamboo has a long and well-established tradition as a building material throughout the world's tropical and sub-tropical regions. Bamboo is a renewable and versatile resource, characterized by straightness, lightness, hardness, high fibre content and easy workability. These particular qualities of bamboo make it ideal for different technological purposes.

Located in South East China, in the sub-tropical humid monsoon climate region, Guangxi has a good climate for bamboo plantations and, at the same time, people there have experience in selected seed cultivation and planting techniques.



In the area of the Linxi River, near the village of Chengyang, irrigation of large fields is guaranteed by numerous bamboo water-wheels, which, moved by the river current, raise water from the river itself to the banks. The fields are between 3-4 metres to 7-8 metres above normal river level.

## 2 Structure characteristics

The construction methods of the water-wheels on the Linxi river are representative of the numerous bamboo machines which are still in use for irrigation in other regions of China and several countries of Southeast Asia, like Cambodia, Burma, Thailand, Vietnam and Indonesia. The origin of these bamboo water-wheels is unknown, but existing records show that it was already in use in China in the 14<sup>th</sup> century.

Apart from the horizontal axis which is made of a timber trunk, all the components of the machines are made of bamboo canes with different dimensions and diameters which range between a few centimetres and about 15 centimetres. The bamboo canes are not shaped, but retain their natural appearance. For spokes and rims, canes with a diameter of 3-5 centimetres are used, while buckets and aqueduct channels are made of bamboo timbers which can have a diameter of more than 10 centimetres.

The wheel consists of two parallel external rims, and two internal rims close to each other. They are connected by bamboo paddles on which the river current pushes causing the rotation of the wheel. The paddles consist of a sequence of half bamboo canes or wooden plates.

Containers made of segments of bamboo canes with a diameter of about 10 centimetres are tied to the two external rims. During the rotation they fill with water as they become submerged when the wheel turns round. They are subsequently discharged at the top of the wheel into a wooden or bamboo channel from which water is transported into the irrigation network.



Figure 1: Rice fields on the Linxi River.



Figure 2: A water-wheel for irrigation.



Figure 3: Water pouring in the channel.

The network of channels is made of bamboo canes with a diameter of about 10-15 centimetres. In order to evacuate the redundant quantity of water, the irrigation channels are opened on the upper part at regular intervals.

The strength of the wheel is guaranteed by numerous pairs of radial spokes. Each pair of spokes connects one of the ends of the horizontal axis supporting the wheel to a paddle on the opposite rim. The two spokes cross each other creating a brace to the structure. The internal rims sit either side of where the spokes cross and thus give more strength to the structure.

The diameter of the wheels depends on the height of the banks. It can reach about 8 metres.

The central axis of the wheel is supported by wooden poles which lie on the bed and on the banks of the river. Because of its lightness and flexibility, the structure can be moved to wherever needed along the river banks.

These water-wheels are easily replaced and repaired due to their extremely simple assembly and the lightness and availability of the bamboo used in their construction. Untreated bamboo, like that used to build these structures, has an average life of only few years when it is directly exposed to soil and the atmosphere and so frequent replacement and reconstruction are necessary.

In order to raise more water it is possible to find groups of consecutive water-wheels whose close disposition is allowed by a river current which is not particularly strong and where there is no risk of turbulence which could interfere with the smooth running of the wheels.

Bamboo pots, during the circular motion, gradually change position depending on the volume of water carried in the pot. In fact, at the river level, when they fill, due to the weight of water, they are in a vertical position, with the base at the bottom. Going up, between the river level and the top of the wheel, they are in an oblique position, which becomes horizontal at the top. Here, during the transfer of water to the channel, they are parallel to each other. Going down, between the top of the wheel and the river level, they are again oblique, but with the base at the top. At the river level they return to a vertical position due to gravity.

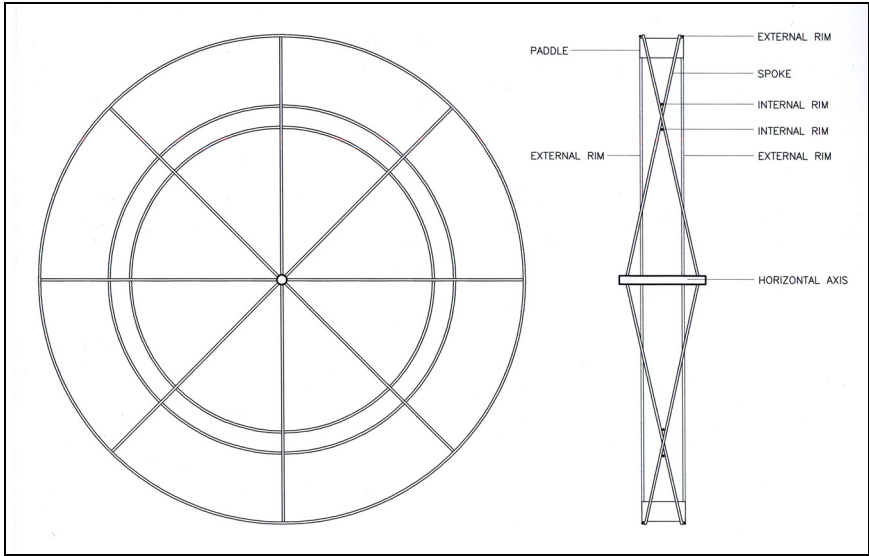


Figure 4: Schematic elevation and section of the wheel.



Figure 5: Detail of the wheel.



Figure 6: An irrigation channel.

### 3 Continuity of sustainable irrigation

These structures represent a clean technology for the environment, allowing irrigation fully exploiting the power of the river, without the use of petrol or oil. They do not present a risk of provoking environmental damage. In the eventuality of small floods, these are not dangerous to the wheel. In fact the embankments where these structures are located, always considerably exceed the river level in height. The easy availability of the material in the area, the simple



assembly and re-assembly of the components of the structures, together with the favourable morphological characteristics of the river, continue to guarantee the use of this ancient irrigation method which is strictly integrated into the ecological system of the area and, because of the lightness of the structure of the wheels, often makes them appear part of the natural landscape.

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