The Application of Solar Irrigation Pump Technology in the Ecological Restoration of the Dry-hot Valley of Jinsha River

Wei CHEN¹,a,* , Chun-Lin BIAN², Gang WANG¹
¹Panzhihua University, Panzhihua Sichuan, 617000, China
²School of Agricultural Sciences of Xichang College, Xichang Sichuan, 615013, China
¹cw315000@163.com
*Corresponding author

KeyWords: The Dry-hot Valley, Ecological Restoration, Solar Irrigation Pump, Remote Sensing Analysis.

Abstract. The Dry-hot Valley of Jinsha River is the severe ecological degradation region in the Yangtze River economic belt and also the main sediment yield area of the Yangtze River. This paper describes the ecological conditions of the Dry-Hot Valley of Jinsha River, and puts forward the solar irrigation pump technology to intake water to support landscape revegetation and restore ecological environment. Combined with the actual case, this paper sums up the achievements of existing work, showing that the use of new energy sources, especially solar energy technology, can effectively change the eco-environment of the Dry-hot Valley, and the application should be vigorously promoted.

Concept of the Dry-hot Valley

The Dry-hot Valleys of Jinsha River are mainly located in the middle and lower reaches of the Jinsha River region, with a total area of 29,037.7 square kilometers, of which there is 15,096.0 square kilometers in Yunnan Province, and Sichuan Province has 13,941.7 square kilometers. The Dry-hot Valleys in Panzhihua region are mainly distributed over the valley slopes at the altitude of 1,000 to 1,500 meters of Jinsha River, Yalong River and Anning River, with a total area of over 160,000 mu. The ecological problems of the Dry-hot Valley of Jinsha River mainly represent in the following five aspects: drought, high temperature damage and low temperature freeze injuries, poor soils and severe land degradation, soil erosion and serious mudslides and landslides, and low vegetation coverage. These five environmental issues interact with each other, resulting in the deaths of a large number of protophytes in the region, and new plants are difficult to survive. On the other hand, soil erosion is serious, and land aridity and degradation intensifies. The situations of semi-desert, desertification, rocky desertification are growing severely. Landslides, mudslides and droughts and floods frequently take place. All of these not only threaten the safety of residents in the Dry-hot Valley of Jinsha River, but also have a huge impact on the environment of the middle and lower reaches of the Yangtze River region. Fragile ecological environment has continuously restricted the agricultural development and has become a bottleneck of local economic development.

The climate of the Dry-hot Valley region is formed due to the combined effects of complex geographical environment and local microclimate. The ecological environment of the Dry-hot Valley of Jinsha River is extremely fragile, but there are many superior resources in this vast
land: abundant water, adequate light and heat, complex terrain environment, uncontaminated soil, prominent microclimate, and large diurnal temperature range. These have provided conditions and basis for biological diversity and the improvement of yield and quality of agricultural products, letting the region become a hot rare treasure.

The Dry-hot Valleys in Panzhihua region are mainly distributed over the valley slopes at the altitude of 1,000 to 1,500 meters of Jinsha River, Yalong River and Anning River, with a total area of over 160,000 mu. The soil is infertile, and the content of organic matter in the soil is extremely low. Excessive concentration of rainfall makes phosphorus, potassium and other active elements in the soil leach and lose seriously. The nutrients in the soil are poor. The climate is mainly characterized by hot and dry. Rainfall is concentrated. Wet and dry seasons are distinct. Every year, the dry season is from October to May in next year, up to more than 8 months; the average annual temperature in the region is 20.3 °C. Annual sunshine hours is 2695 hours, with an average annual rainfall of about 800mm, and annual evaporation amount of 1877--2697mm. The monthly amount of evaporation in April and May is 20 times the monthly rainfall, and strong sunlight makes the temperature of bare land surface reach up to 70 °C. The moisture in the topsoil within 40cm is close to zero. The foehn effect in valley regions is remarkable, making it become an islet of sub-type arid in South Asian tropics in the western part of subtropics in China.

The Dry-hot Valleys in Panzhihua region mainly concentrate on the coasts of Jinsha River, with a total area of 160,000 mu. Makan area is the most typical section of the Dry-hot Valleys in Panzhihua City. It is also a difficult afforestation area. Because of poor site conditions, steep slope, barren soil, and low ability of soil in retaining water and fertilizer, almost nothing grows in this region. After years of efforts, some drought-tolerant plants, such as sisal have been planted, and vegetation was restored (Fig. 1).

![Figure 1. The restore situation of Earth's surface vegetation.](image-url)
Satellite Remote Sensing Analysis of the Built-up Area of Panzhihua City

According to the requirements of the National Garden City Standards [1] and National Garden City Remote Sensing Survey and Test Requirements [2] released by Ministry of Housing and Urban-Rural Development of the People’s Republic of China (Mohurd), the investigation and interpretation of remote sensing work in garden cities have been completed, along with statistical analysis of various indicators.

This research takes the built-up area of 87.48 square kilometers of Panzhihua City, provided by Panzhihua Housing and Urban-Rural Planning and Construction Bureau as the spatial boundaries for the study. It is registered in the GIS platform, and the remote sensing images are abstracted by using Landsat 8 (Fig. 2). Shooting time is 2015-01-27T03:40:43.0163584Z. Cloud over is 0.11%. Resolution is 30 m, and number of wavelengths is 7. Remote sensing analysis is conducted based on the above data (Tab. 1). According to the standards in Urban Landscape Remote Sensing Test Technical Specification issued by Mohurd, greening rate of the built-up area (%) = (acreage of all types of green areas / acreage of built-up area) × 100%, and relevant datas were calculated. Remote sensing interpretation work is proceeded in ENVI platform. It has in succession conducted atmospheric correction, geometric registration, supervised classification, post-classification processing and so on.

The results show that green space rate in the built-up area of Panzhihua City is about 25.61%. Among them, patches on the mountains and other greenspaces in view are primarily arid and semi-arid alpine meadow regions. Panzhihua region belongs to the subtropical dry-hot valley climate zones, so the mountain and forest coverage is low within the viewing area. Resolution of remote sensing image is 30 * 30 meters, that is there are some errors in the recognition of green patches below 900 square meters.

Figure 2. Classification results of remote sensing interpretation of built-up area in Panzhihua region.
Table 1. Interpreting results of various types of land use.

<table>
<thead>
<tr>
<th>Number</th>
<th>Types of land use</th>
<th>Area (Square kilometers)</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Semi-arid meadow region</td>
<td>3.1226</td>
<td>3.57%</td>
</tr>
<tr>
<td>2</td>
<td>Arid meadow region</td>
<td>9.1493</td>
<td>10.46%</td>
</tr>
<tr>
<td>3</td>
<td>Industrial and mining areas</td>
<td>3.0105</td>
<td>3.44%</td>
</tr>
<tr>
<td>4</td>
<td>Industrial area</td>
<td>16.1669</td>
<td>18.48%</td>
</tr>
<tr>
<td>5</td>
<td>Residential area</td>
<td>32.1551</td>
<td>36.76%</td>
</tr>
<tr>
<td>6</td>
<td>Bare area</td>
<td>4.7941</td>
<td>5.48%</td>
</tr>
<tr>
<td>7</td>
<td>Farmland</td>
<td>1.591</td>
<td>1.82%</td>
</tr>
<tr>
<td>8</td>
<td>Forested region</td>
<td>9.0337</td>
<td>10.33%</td>
</tr>
<tr>
<td>9</td>
<td>Sand</td>
<td>3.6401</td>
<td>4.16%</td>
</tr>
<tr>
<td>10</td>
<td>Water</td>
<td>4.8171</td>
<td>5.51%</td>
</tr>
<tr>
<td>11</td>
<td>Total</td>
<td>87.4804</td>
<td>100%</td>
</tr>
</tbody>
</table>

Developmental Advantages of Solar Energy of the Dry-hot Valley of Jinsha River in Panzhihua Region

The Dry-hot Valley of Jinsha River has diverse microclimate and sufficient water and light, so the region is suitable for the cultivation and production of navel oranges and other crops, breeding a number of characteristic drug resources, which have the excellent value of development and utilization. Panzhihua has abundant light and heat resources. According to statistical analysis of meteorological data of Panzhihua City, the annual amount of radiation is a high-value area of Sichuan solar radiation. The total annual radiation is 5600 ~ 6300MJ/m², and the total amount of direct radiation is 3100 ~ 4100MJ/ m². Photosynthetically active radiation is 2300 ~ 2700 MJ/ m²; annual sunshine hours range from 2300 to 2700 hours, the equivalent of 3 to 5 times of the Chengdu Plain; the annual average number of days of sunshine duration (≥6 hours) is more than 260 days; the percentage of sunshine changes between 53 to 61%; annual number of sunny days is 106 to 152 days, thus it is exceptionally rich in solar energy resources.

1) Solar photovoltaic power (using industrial and mining wasteland and renting farmers’ land)

Panzhihua is located in the Dry-hot Valleys of Anning River, Yalong River and Jinsha River. The light and heat resources are very rich. The annual sunshine hours is more than 2700 hours, which is one of the best area of development and utilization of solar energy, with a very superior natural conditions on the application of solar energy products.

2) Solar irrigation pump (promoting the pilot project of 20 MW photovoltaic power stations, five to ten square kilometers)

Irrigation pump technology plays an important role in world agriculture, having the characteristics of water-saving and high-yield. Irrigation pump system is generally installed on a large area of farmlands, requiring sophisticated technology and high management level, while subject to the terrain conditions, it is difficult to construct large-area irrigation pump system in
western mountainous areas. Solar irrigation pump station in small-scale is suitable for irrigation requirements of lands in small area of mountain agriculture, forestry and landscaping.

**Example of Solar Irrigation Pump**

Solar irrigation pump station in Wohan Community Xinhua Village He’ai Townlet Yan County (Fig.3). Solar irrigation pump station of Wohan Community is located in Xinhua Village He’ai Townlet Yan County, which is consisted of the pumping stations, photovoltaic solar modules, inverter controllers, dedicated solar pumps and water pipelines. Lift is 113m. Get water from a small brook, and inject water to 200 m$^3$ and 500 m$^3$ pools by using two devices simultaneously. Installed capacity is 18.4kw (9.2 kw * 2). Solar panels are 76 pieces/ 19kw, and the design flow is 20m$^3$/h. The length of water pipelines is 770m, and irrigation area is 800 mu. The main crop is vegetables.

Total investment of constitution is 510,000 yuan. In October 2014, it is completed and put into use. The irrigation pump station achieved the remote control, with the characteristics of high efficiency, low operating cost, easy management, small floor area and so on.

The completion of the irrigation pump station promoted agricultural production and rural economic development.

![Image](image.png)  
**Figure 3.** Solar irrigation pump station in Wohan Community Xinhua Village He’ai Townlet Yan County.

**Conclusions**

(1)The Dry-hot Valley of Jinsha River is the region of economic poverty and backward social development in the economic belt of Yangtze River. Ecological degradation continued to increase. The Dry-hot Valley of Jinsha River is the largest sediment yield area of the Yangtze River basin, so it is a serious threat to the safety of the Three Gorges Reservoir and the entire Yangtze River economic belt.

(2) The ecological environment protection of the Dry-hot Valley of Jinsha River needs to address the following issues: first, harsh natural conditions restrict ecological restoration; the second is the uneven spatial and temporal distribution of water resources. The utility cost is
high, but effective utilization is low; the third is behind and extensive production and management methods; fourth, energy structure is irrational; the fifth is the inadequate investment in ecological construction; sixth, the attention on ecological construction is not greatly enough. The results showed that it is appropriate for the Dry-hot Valley to recover the grass and shrub vegetation, studying the relationship between vegetation and arid sand and making researches on the physiological and ecological characteristics of suitable afforestation tree species, as well as the breeding density characteristics.

(3) Practice shows that solar irrigation pump technology plays an important role in the ecological restoration of the Dry-hot Valley of Jinsha River. Due to low-cost, convenient operation, and good comprehensive benefits, the use of the technology should been vigorously promoted.

(4) Provide energy by the development of solar energy to promote the industrial and mining development, change rural energy structure, and accelerate regional economic and social development and ecological protection. Take a small part of the earnings making from solar power as the local irrigation facilities fund for the construction of local irrigation facilities, thus promoting local rural economic and social development.

References
