

Utilization potential evaluation of plant resources in the dry-hot valley of Jinsha River

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Abstract. Plant resources in the dry-hot valley of Jinsha River are endemic to a class of district. The article adopts the analytic hierarchy process method to evaluate the exploitation and utilization potential of plant resources of thirty typical plant resources on the basis of their characteristics in the dry-hot valley of Jinsha River, which provide scientific evidence for quantitative evaluation of regional plant resources, and we also suggest pathways offering protection and development.

1. Introduction

The definition of plant resources is as follows: the sum of plants proving to be useful to humans either directly or indirectly in any of the following settings: a certain period of time, space, humanism background and economic and technological conditions^[1]. Plant resources are classified into two types: wild plant resources and cultivated plant resources. Wild plant resources include the sum of wild plants that either immediately or indirectly impact human production, living beings and nature in a certain space pattern^[2].

In China, the dry-hot valley is found mainly in the lower part of the canyon mountains, which are located in southwest of Jinsha River, Yuan River, Nu River. The modern ecological environment is influenced by the presence of canyon landform in a special geographical position. Herein both its regional climate and vegetation are non-zonality of subtropical zonal type^[3], and composition of the flora is also different from the zonal area. The vegetation in this region does not include any of the primitive types, such as river valley monsoon forest and savanna forest. The regional vegetation includes more stable secondary semi-savanna vegetation^[4], which is composed of a unique community of plants with distinct floristic composition. In this case, we came across a particular kind of vegetation in the river region located southwest of our country. The regional vegetation of the valley is a representative example of the remnants of savanna vegetation as well as a rare and endangered vegetation type^[5]. Plant species of the plant communities in the dry-hot valley are the dominant species in this region; but they are very rare in other regions of our country.

Presently, resource studies investigating plant resources in the dry-hot valley of Jinsha River are mainly focused on plant flora, plant types, endemic plants and experimental study of exploitation and utilization of specific plants etc. In earlier times, for example, Yude Chen, has described the exploitation and utilization of unique natural plants, such as *Ziziphus mauritana*, *Cajanus caja* and



Phylanthus emblica in the dry-hot valley of Jinsha River^[6]. Xiaokun Ou, etc, presents a comprehensive research on the plant flora of dry-hot valley of Jinsha River, The research study is an elaborate investigation of the vegetation and plant resources in the dry-hot valley of Jinsha River^{[7][8]}. Later,Zhouyuan also made further supplements to this research study^[9]. To determine the exploitation and utilization of plant resources in the dry-hot valley area, researchers primarily laid heavy emphasis on the use of a certain kind of plant resources. They also assessed the economic and ecological value of these plant resources. All these approaches served the purpose of evaluation and application of the plant resources. Since the late 1990s, research achievements of scholars, such as Huiying, Long, Lu He, Guangheng Feng, Yulan Lv and scholar Laibin Zhang^{[10][11][12][13][14]} etc. To the best of our knowledge, previous studies have never focused on the potential utilization of plant resources in the dry-hot valley, especially in the dry-hot valley of Jinsha River. This study was conducted on the basis of years of plant resources investigation in the reservoir area of Wudongde Hydropower station of Jinsha River. In this study, we selected 30 typical plant species in the region. Then, we evaluated these plant species to determine their utilization potential. The entire research study was performed in the premises of the dry-hot valley of Jinsha River region to define a comprehensive value of the existing plant resources. Thereafter, we provided further measures for the exploitation and utilization of plant resources in this area.

2. Overview of the study area

Jinsha River Valley, which is divided into Tongtian river and Tuotuo river, is situated on the western edge of the Qinghai-Xizang Plateau, the Yunnan-Guizhou Plateau and Sichuan basins. Its exact location is defined as follows: longitude is between 90°23'E and 104°37'E,latitude is between 24'28' and 35'46'.In summery, it spreads across Qinghai province, Tibet autonomous region, Sichuan province, Yunnan province and Guizhou province, with its catchment area spreading over 500,000 square kilometers. WuDongde hydropower station is located on the boundary river downstream of the Jinsha river in Sichuan province and Yunnan province. It is the first station among the four hydropower cascades extending from the middle Jinsha River to the downstream cascade of Guanyin rock hydropower station that is located 253km apart from the crane lying 180km under Letan Hydropower Station.

Based on field investigation of plant resources in Jinsha River basin which is involved with Wudongde Hydropower Station reservoir area during 2006~2010, combined with the systematic rearrangement of the data in flora accumulated over the years, the regional land vascular bundle plants are totally 132 families, 493 genera, and 781 species. Among them, the natural floras (not including cultivated species) are 111 families, 380 genera, and 604 species. There are 10 families, 11 genera, and 16 species of fern, 6 families, 10 genera, and 12 species of gymnosperm, and 116 families, 472 genera, and 753 species of angiosperm^[15]. According to the research, the resource plants which can be exploited are totally 132 families, 489 genera, and 764 species in Wudongde Hydropower Station reservoir area, which accounts for 97.57% of the total regional land vascular bundle plants^[15]. It shows that most plants in this area have the potential for development and utilization.

3. Research Method

In this study, we implement the AHP method to evaluate the utilization potential of plant resources in the dry-hot valley of Jinsha River. The Analytic Hierarchy Process (AHP) is a kind of analysis method based on hierarchy decision. It was put forward by Professor Saaty at the American University of Pittsburgh in the early 1970s. In this method, a multi-objective decision-making approach is adopted to solve simple and complex decision-making problems with multi-criteria or no structural characteristics. The method can classify decision-related elements into goals, standards, programs, and other levels. Based on this preliminary classification of elements, we perform qualitative and quantitative analysis^[16]. Moreover, AHP method has been used to assess the utilization value of wild ornamental plant resources, medicinal plant resources, and edible plant resources. Thus, most domestic

scholars provide an evaluation of biomass resources. The evaluation result of AHP method is more objective and credible compared to those obtained by other methods, such as the early experience judgment method, gray correlation method, and quantitative evaluation method.

On the basis of years of plant investigation in Wudongde Hydropower Station reservoir of Jinsha River, we adopted AHP method and developed a novel evaluation index system and defined the index weight. Furthermore, the AHP method was used to establish the standard for evaluation indicators. Thus, we analyzed and evaluated the potential value of 30 typical species of the price zone that could be associated with the utilization of plant resources.

3.1 Establishment of Index system

This study is made on the fundamental findings of previous studies^{[17][18][19]}, which described the features of plant resources in the dry-hot valley of Jinsha River. Thus, we comprehensively developed a method based on theoretical analysis and expert consultation to compile the evaluation index system. From the top to bottom, we have divided the index system into four levels: the goal layer, the constraints layer, the standard layer, and the bottom layer. A target layer is in the dry-hot valley of Jinsha River, and an evaluation of the utilization potential of plant resources is done in this layer. Constraint layer B consists of use value, biological characteristics, and resources potential index of three classes. Standard C represents the index of each class that consists of three secondary indexes, which present the use value. There are secondary indexes for economic value, ecological value, social value, and biological characteristics. There are secondary indicators for habitat, distribution scope, and the degree of difficulty to breed. The resource potential has secondary indicators for utilization degree, resource quantity, and regeneration. In total, there are nine evaluation indexes.

Table 1. Plant Resource Utilization Potential Evaluation Model in the dry-hot valley of Jinsha River

A. the target layer	B. the constraint layer	C. the standard layer	D. the bottom layer
The utilization potential of plant resource in the dry-hot valley of Jinsha River	B1 utility value	C1 economic value	Plant resource in the dry-hot valley of Jinsha River
		C2 ecological value	
		C3 social value	
		C4 habitat requirements	
	B2 biological characteristics	C5 distributive scope	
		C6 the ease or practicality of fecundity	
		C7 utilization degree	
	B3 resource potential	C8 resource quantity	
		C9 regeneration capacity	

3.2 Determination of index weight

In this study, we used the AHP scaling method^[18] to determine index weight of each layer. Please note that AHP scaling method is a modified form of AHP method, with a scaling ratio of 1 to 9. It utilizes the constraint layer B and standard layer C of the hierarchical model to provide a pairwise comparison judgment matrix, which is also known as the straight reciprocal matrix. We invited five relevant specialists and scholars focused on plant resources; they were asked to comprehensively conceptualize an evaluation index based on subjective experience after processing pairwise comparison judgment. The relative advantages and disadvantages of each evaluation are confirmed on the basis of nine partial ratios, and then we construct a judgment matrix of evaluation index besides processing a consistency check on the judgment matrix. It is customary to assume that the calculation result (CR) of the consistency check of judgment matrix would be less than 0.1, the results indicate that the judgment matrix is having consistency.

The weight of different evaluation indices is finally confirmed after the model judgment matrix passes the consistency check. After calculating the weighted value of each evaluation index associated with the ratio of C relative to B layer, we combine it with the weight of B layer. Thus, we get the total sort weight of the ratio representing C relative to A in the target layer, that is, the comprehensive weight.

Comprehensive weight can be used in the evaluation of utilization potential of plant resources. The computed results are presented in Table 2.

Table 2. The Index Weight of Each level

Evaluation Index	Index Weight	Comprehensive weight
B1 utility value	0.52	
C1 economic value	0.67	0.3484
C2 ecological value	0.27	0.1404
C3 social value	0.06	0.0312
B2 biological characteristics	0.21	
C4 habitat requirements	0.41	0.0861
C5 distributive scope	0.41	0.0861
C6 the ease or practicality of fecundity	0.18	0.0378
B3 resource potential	0.27	
C7 utilization degree	0.14	0.0378
C8 resource quantity	0.43	0.1161
C9 regeneration capacity	0.43	0.1161

3.3 Determination of index rating criteria

To construct the index rating criteria on a 5-grade marking system, we obtain a specific grading standard of each index of the C layer after defining the exploitation and utilization targets of plant resources in the dry-hot valley of Jinsha River. After referring to the relevant research findings and suggestions of specialists and scholars investigating the plant resources area, we finally compile the specific evaluation standard of C layer. Please check Table 3.

3.4 Evaluation of the utilization potential of plant resources

Invite five specialists and scholars pursuing research interests in plant resources. Ask them to evaluate and score 30 resource plants in the dry-hot valley of Jinsha River by referring to the index rating criteria presented in Table 3. Then, we can arrive at the index evaluation results in the C layer for each plant. The results are multiplied by the comprehensive weight coefficient of each index. Thus, we achieve the comprehensive evaluation results quantifying the utilization potential of each plant (chart 4). In general, the scale commonly ranges from 1 to 5. Higher the evaluation value, greater would be the potential value of the plant in terms of exploitation and utilization.

4. Evaluation results and analysis

As shown in Table 4, we compiled a comprehensive evaluation value of 30 kinds of plants in the dry-hot valley of Jinsha River. The range of the evaluation value was from 4.2614 to 1.9834. There were nine wild plants whose evaluation index had surpassed 3.5, including *Phyllanthus emblica*, *Eulaliopsis binata*, *Atropa cufcas*, *Pinus yunnanensis*, *Pistacia weinmannifolia*, *Scutellaria amoena*, and *Euphorbia royleana*. They possess higher evaluation index in terms of utilization value, biological characteristics, resource potential etc. They are priorities for surrounding areas of the introduction and cultivation of wild plant species, we can vigorously enhance the exploitation and utilization of these plant resources. 13 plants with the evaluation value ranging from 2.5 to 3.5, including *Dodonaea viscosa*, *Heteropogon contortus*, *Tamarindus indica*, *Alnus nepalensis* etc, can be exploited and developed corresponding to actual requirements. The evaluation value of eight wild plants was less than 2.5, with their utilization potential being on the lower side. As a result, there was no need for them to be introduced and cultivated temporarily.

Table 3. Index Score Standard of the C layer

Score	5	4	3	2	1
C1 Economic value	Extremely wide range of use, extremely high economic value	Wide range of use, high economic value	Have certain use, ordinarily economic value	Less usage, low economic value	Substantially no use, extremely low economic value
C2 Ecological value	Extremely high	High	Ordinary	Low	Extremely low
C3 social value	Rich in ethnic, religious, cultural and other social values	Relatively rich in ethnic, religious, cultural, and other social values	Certain national, religious, cultural, and other social values	Low social values	Substantially no social value
C4 Habitat requirements	No request in the habitat, very wide ecological amplitude	Relaxed request in the habitat, wide ecological amplitude	Certain request in the habitat, relatively wide ecological amplitude	Relatively rigorous request in the habitat, relatively narrow ecological amplitude	Rigorous request in the habitat, extremely narrow ecological amplitude
C5 Distributive scope	Extremely wide	Wide	Ordinary	Relatively narrow	Narrow
C6 The ease or practicality of fecundity	Very easy to propagate	Easy to propagate	Relatively difficult to propagate	Difficult to propagate	Very difficult to propagate
C7 Utilization degree	Unutilized	Less utilized	Already utilized	Relatively Widely utilized	Widely utilized
C8 Resource quantity	Abundant	Relative abundant	Ordinary	Relatively less	Rare
C9 Regeneration capacity	Extremely strong, fast growing	Strong, relatively fast growing	Ordinary, ordinary growth	Weak, relatively slow growing	Extremely weak, very slow growing

Table4. Evaluation of utilization potential of plant resources in the dry-hot valley of Jinsha River

NO.	Latin name	Common character	Comprehensive evaluation value
1	<i>Phyllanthus emblica</i>	Dungarunga	4.2614
2	<i>Eulaliopsis binata</i>	Perennial caespitose herb	4.1464
3	<i>Jatropha cufcas</i>	Evergreen shrubs or dungarunga	4.1386
4	<i>Cajanus cajan</i>	Evergreen shrubs	4.0225
5	<i>Pinus yunnanensis</i>	Evergreen arbors	3.9847
6	<i>Ziziphus mauritiana</i>	Deciduous shrubs	3.9605
7	<i>Pistacia weinmannifolia</i>	Evergreen shrubs or dungarunga	3.7831
8	<i>Scutellaria amoena</i>	Perennial herbs	3.6545
9	<i>Euphorbia royleana</i>	Clustered succulent shrub	3.5142
10	<i>Dodonaea viscosa</i>	Shrub	3.4802
11	<i>Heteropogon contortus</i>	Clump-forming perennial herbs	3.4802
12	<i>Tamarindus indica</i>	Evergreen arbors	3.4379
13	<i>Bombax malabaricum</i>	Deciduous arbors	3.4204
14	<i>Cyclobalanopsis glaucoides</i>	Evergreen arbors	3.2319
15	<i>Alnus nepalensis</i>	Deciduous arbors	3.1609
16	<i>Elsholtzia cypriani var. angustifolia</i>	Annual herbs	3.1522

17	<i>Rumex hastatus</i>	Shrubs	3.0698
18	<i>Quercus franchetii</i>	Evergreen arbors	3.0498
19	<i>Ficus virens var. sublancoolata</i>	Evergreen arbors	2.6888
20	<i>Barleria cristata</i>	Subshrubs	2.5958
21	<i>Laggera pterodonta</i>	Perennial herb	2.5795
22	<i>Cirsium chlorolepis</i>	Perennial herb	2.5254
23	<i>Toona ciliata</i>	Deciduous arbors	2.4722
24	<i>Tephrosia purpurea</i>	Shrubby herb	2.2609
25	<i>Terminalia franchetii var. glabra</i>	Deciduous arbors	2.1671
26	<i>Osteomeles schwerinae</i>	Deciduous or semi evergreen shrubs	2.107
27	<i>Bletilla ochracea</i>	Perennial herbs	2.0993
28	<i>Campylotropis delavayi</i>	deciduous subshrubs	2.0209
29	<i>Nouelia insignis</i>	Deciduous arbors or dungarunga	2.0132
30	<i>Urochloa yuanmaoensis</i>	Annual herb	1.9834

5. Conclusion

Both vegetation types and plant flora possess significant differences within the zonal areas of dry-hot valley of Jinsha River because they are heavily influenced by myriad factors, such as special landforms, climate, ecological environment, and complex historical factors of the area. The plants resources in this area have the following defining traits: rich utilization ways, strong regional characteristics, abundant endemism, less reserve volume, characteristics of plant resources specific to certain nationalities, etc. In this study, we have referred to the findings and results of previous studies before developing a novel evaluation method for the exploitation and utilization potential of plant resources in a research setting. To achieve the aforementioned objective, we have developed the following parameters: three subsystems (utility value, biological characteristics, resource potential) and nine evaluation index models. With the help of these parameters, we have made a systematic evaluation of the utilization potential of plant resources in the dry-hot valley of Jinsha River. The evaluation results are actually in good agreement with the real frame of reference. Thus, the results of this paper have a certain reference value and objectivity.

Subject to the depth of actual investigation, the degree of mastering materials and data, and the subjective experience of evaluators, some moot points have not been addressed in this study. Therefore, all these drawbacks need to be further investigated in future studies.

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