

GUIDELINES FOR FIRST-STAGE RESEARCH OF DRY VALLEYS AND THEIR MANAGEMENT IN THE DRY VALLEYS OF THE HENGDUAN MOUNTAINS

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INTRODUCTION

A multidisciplinary reconnaissance was carried out in 1984 throughout the dry valleys of the Hengduan Mountains, by the Commission for Integrated Survey of Natural Resources. A number of natural scientists participated including physical geographers, pedologists, plant ecologists, geomorphologists, ecologists, climatologists and soil scientists. We were asked to offer a general assessment with research guidelines for further investigating concerning the management of the dry valleys which are considered to be a special kind of watershed in their particular vegetational and soil conditions.

The dry valleys within the Hengduan area along the three gorges of Nujiang (Salween), Lancangjiang (Mekong) and the upper reaches of Changjiang (Yangtze) and its tributaries (the Jinshajiang, Taiduhe and Miajiang), and the Yunnan Plateau in the southern Yunnan. They are not only of academic interest but also of great importance to agriculture due to the better water resources and the concentrated fertile farmland there which hold about 5% of the total farmland, and are the most populated settlement of the area.

According to Waggoner's study of the local rainfalls (1932) and Turner's study of local wind systems (1944), Schindler (1981) pointed out that the phenomenon of "Local dryness" in the valley bottoms observed in the Hengduan region was comparable to what had been reported from some parts of the Himalayas. In the Hengduan, they were developed on a much grander scale. The vegetation belts had been drawn out through almost all the gorges from about 34°N to about 22°N at the south border (Wu, 1980). In most of the valleys, the farmland suffers frequently from water shortages because of the climate and other environmental conditions as well as a drastic, unfulfilled irrigation requirement. It seems somewhat

of an oversimplification to treat the dry valleys as a single type of landscape because the great latitudinal and longitudinal breadth of their development gives considerably variation in regional environment as well as in agricultural systems.

DRY VALLEYS

Classification

For the purpose of dry valley management, it is necessary to identify them on the basis of climatic criteria. Using the Köppen index of Penman (1948) as the basis of meteorological and hydrological analysis was analysed and the types of dry valleys of the Hengduan Mountains were divided into arid category and the semiarid category. The dryness was measured by the annual semihumid surface air temperature, the temperature range, the number of days for the ground temperature at 5 cm scale. The combination of the climatic indices give three types: warm-dry and semiarid-dry, and cold-dry. However, the study of the dryness was not only on the basis of climate but also on the basis of vegetation and soil conditions. The vegetation and soil conditions were analysed by the vegetation index and soil index. The vegetation index was calculated by the vegetation index of the Hengduan Mountains (Wu, 1980).

Management

There are several serious problems in the management of the dry valleys. The first is the water shortage. The second is the soil erosion. The third is the land use. The fourth is the vegetation and soil management. It is not suggested that the study is not in agreement with the present vegetation map which is used in the

GUIDELINES FOR FIRST-STAGE RESEARCH OF WATERSHED MANAGEMENT IN THE DRY VALLEYS OF THE HENGDUAN REGION

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INTRODUCTION

A multidisciplinary reconnaissance was carried out in 1984 throughout the dry valleys of the Hengduan Mountains, by the Commission for Integrated Survey of Natural Resources. A number of natural scientists participated including physical geographers, pedologists, plant ecologists, geomorphologists, hydrologists, climatologists and one economist. We were asked to offer a general comment with research guidelines for further investigation concerning the management of the dry valleys which are considered to be a special kind of watershed in these particular areas.

The dry valleys within the Hengduan area along the three gorges of Nujiang (Salween), Lancangjiang (Mekong) and the upper reaches of Changjiang (Yangtze) and its tributaries (the Jinshajiang, Taiduhe and Minjiang), and the Yuanjiang (Red) in the southern Yunnan. They are not only of academic interest but also of great importance to agriculture due to the better water resources and the concentrated terrace farmland there which hold about 90% of the total farmland, and are the most populated settlements of the area.

According to Wagner's theory of Berg-und Talwinde (1932) and Flohn's review of local wind system (1968), Schweinfurth (1981) pointed out that the phenomena of "Local dryness" in the valley bottoms observed in the Hengduan region were comparable to what had been reported from parts of the Himalayas. In the Hengduan, they were developed on a much grander scale. The vegetation area has been drawn out through almost all the gorges from about 31°N to about 22°30'N at the south border (Wu, 1980). In most of the valleys, the farmland suffers frequently from water shortages because of the climate and other environmental conditions as well as a drastic, unfulfilled irrigation requirement. It seems somewhat

of an oversimplification to treat the dry valleys as a single type of landform because the great latitudinal and longitudinal breadth of their distribution gives considerable variation in physical environment as well as in agriculture systems.

DRY VALLEYS

Classification:

For the purpose of dry valley management, it is necessary to identify them on the basis of climatic criteria. Using the aridity index of Penman (1962), the data from 58 meteorological and hydrological stations, was analysed and the result shows that the dry valleys of the area belong to the semi-arid category and can be subdivided into three patterns according to the degree of dryness which varies locally, e.g. tending to semihumid, normal or arid. The temperature index is taken as the criterion for the climatic regionalization on a large scale. The combination of the two climatic indices give three major types: hot-dry, warm-dry and temperate-dry; and seven subtypes illustrate the vegetation diversity and the regional variety of farming in general (See Table 1). Furthermore, each type and subtype is characterized by distinct upper natural zones of predominantly wet vegetation.

Distribution

There are nineteen sections corresponding to the semi-arid climatic type, in the seven rivers mentioned above. They are distributed discontinuously and occupy about 11,403 km² in total. The most widespread type is the hot-dry followed by the warm-dry and the temperate-dry (Fig. 1). It is not surprising that this result is not in agreement with the previous vegetation map which is based on the

Table 1: Criteria for the Classification of Dry Valleys in Hengduan Area

	Annual T. July T. Jan. T.	Aridity (Semiarid)	Annual rainfall (mm)	Extant Vegetation (Original vegetation)	Cropping	Yield without irrigation
Dry-hot	20°	Tending Semi-humid ¹	800-900	Shrub-grass with trees scattered (Dry monsoon forest)	3	rather good(I)
	24°-28°	1.5-2.0(2.2)		Small-leaved mesoshrub (Pine or oak forest)		not bad(II)
	12°-7°	Normal (II) 2.0(2.2)-3.4	800			
Dry-warm	14°	(I)	800-900	Shrub-grass with trees (Pine or oak forest)		(I)
	22°-24°			Small-leaved deciduous shrub (Pine or oak forest)	2	(II)
	5°-7°	(II)	600-700			
Dry Temperate	10°	(I)	600-700	Broad-leaved deciduous shrub (Pine or oak forest)	2 almost	(I)
	18°	(II)	500-600	Small-leaved thornlet shrub (Pine Juniper forest)		(II)
	0°	Tending arid (III)	300-450	Small-leaved thornlet shrub (Open pine-Juniper forest)		unstable (III)

1 Flohn, 1968

extant vegetation only, because without the help of climatic data, it is difficult to distinguish the natural vegetation forms from the secondary savanna-like grasswood in such an environment degraded by long-term human activities. In the great mountain chains ranging in different geographical positions and with abrupt and complex topography, there are enormous regional and local changes of such dry areas. Nevertheless, the valley bottoms of the gorges can never be replaced by the wetter vegetation which appears constantly at a certain altitude above.

It is interesting to point out that most of the dry valley sections are located within the regional centres of lowest rainfall. These centres are situated in geographical positions that are subjected to the effects of rain-shadow in the area. It is reasonable to suggest that the local dry phenomena occurring on such a scale may be the result of the interaction of climatological factors,

although the local wind system could play the most important role, including those of the circulation system, regional climatic system and local current system. All the factors may strengthen or weaken the development of valley dryness in a given period of time, as shown in Fig. 2.

MANAGEMENT OF DRY VALLEYS

The classification of dry valleys may contribute as an indicator to show the possible potential for environmental improvement and agriculture development in different sections unclassified areas with aridity indices less than 1.5, are known by the local people as a kind of dry valley with scant vegetation, serious soil erosion and irrigation shortage. But, those sections are better characterized by climatic conditions when they show a surprising potential for tree growth and incidentally provide evidence that most of

those sections must once have been natural forests of subtropical evergreen trees.

Under a semiarid climate, dry agriculture can exist, so in the mind of local farmers and even officers of the local governments, the land of dry valley has high potential. During the past decades, the policy of the government has prompted the farmers to enlarge cereal crops to increase food production. Because of that the limited terraces in the valleys have been farmed exhaustively; expansion of cultivation could only be onto the steep slopes. This led to accelerated forest clearing and soil erosion, damaging downstreams and reservoirs. In addition, the deforestation on the high slopes, regular removal of firewood near the settlements, and road cuts or other misplanned construction in the area have facilitated slope instabilization, sometimes with cataclysmic results.

The deforestation in the dry valleys produced a vast range of pasture which can only support poor grazing of goats because of the adaptability of the goats to low quality feed, drought and rugged terrain. A misleading policy was established in the last decades to promote goat pasture which resulted in overgrazing, especially preventing growth of plants and compacting the soil, despite the limited economic value of goats products on the market.

Man-made factors intensified the deterioration of the ecological environment in the dry valleys. It is almost impossible to find any ecosystem without intensive and direct human influence in the whole area, but, many people attribute the deterioration to unchangable natural factors. So, making a scheme to show the whole picture including all the factors and their interrelationship may generate further understanding (Fig. 2).

With the practise of Four Modernizations, a basic principle of the policy for mountain agro-system reform is to emphasize increasing the income of the local farmers and in the meanwhile to improve the degraded ecological environment. For a long time people know that the diversity of the mountains environment has resulted in a wide range of subsistance resources. This

is considered to be a strong support for the strategy of reform to develop a multiple cropping-system, replacing the former single-cropping of cereal, based upon the discussion above, and taking a more realistic attitude, the first step in the management of the dry valleys should focus on the conversion of the misused lands, especially the steep slope farmland, to land available to plant perennial, noncereal crops or to abandon for greening in order to minimize, at least by degrees, the serious extent of ecological deterioration. For that further investigation should be concentrated on the following:

- a. Analysis of basic data provided by the local government (environment and its vertical variation, landuse patterns and their distribution, the dynamics of shifting cultivation in the hot-dry areas, local economic activities, national economic priorities).
- b. Assessment of the extent of landuse
 - classification of actual misuse of agriculture land based on standard criteria (slope gradient, soil quality)
 - quality of grazing slope (vegetation cover, abundance of palatable plants, soil)
 - habitat of silviculturing slope (soil, microtopography available and its plant percent)
- c. Suggestion of farmland conversion and land protection.
 - the sites for conversion, based upon the degree of their deterioration.
 - alternative uses of the converted land (following crops or the kinds of greening)
 - the land which should be prohibited from goat-grazing
 - which forest should be prohibited from cutting.
- d. Based on the experiences of dry valley management of the local governments, to

develop the three types of dry valleys respectively.

All the studies suggested above should be paralleled by studies of socio-economic aspects of the minority. The best way is to organize integrated research with the participation of experts of natural, social, and economic sciences and the officials concerned from the local governments, because the primary and final objective of watershed management in the dry valleys should not only benefit the local people but also contribute the resources to national modernization, and minimize the negative effect downstream. The government should pay attention to the management and make an effort to get a compromise between national or regional priorities and the local goals, although, to reach a compromise in some cases might be difficult; for example, the forestation

needed by the national government in certain places would be unacceptable in terms of the interest of local people.

For the first stage of dry valley management, the decision makers of the local government must consider relying on national and regional policy and common engineering works to promote reform on the one hand, and to fit the development of the so-called third and fourth industries, inside or outside, on the other hand, which may be a decisive influence on the reform undertaking. Figure 3 shows the three major systems (Administrative, Agro-ecological, Economic) in the overall framework of the dry valley management. It is not a working model but gives comprehensive concepts for the decision makers and is a scheme for the continued refinement of further research projects.

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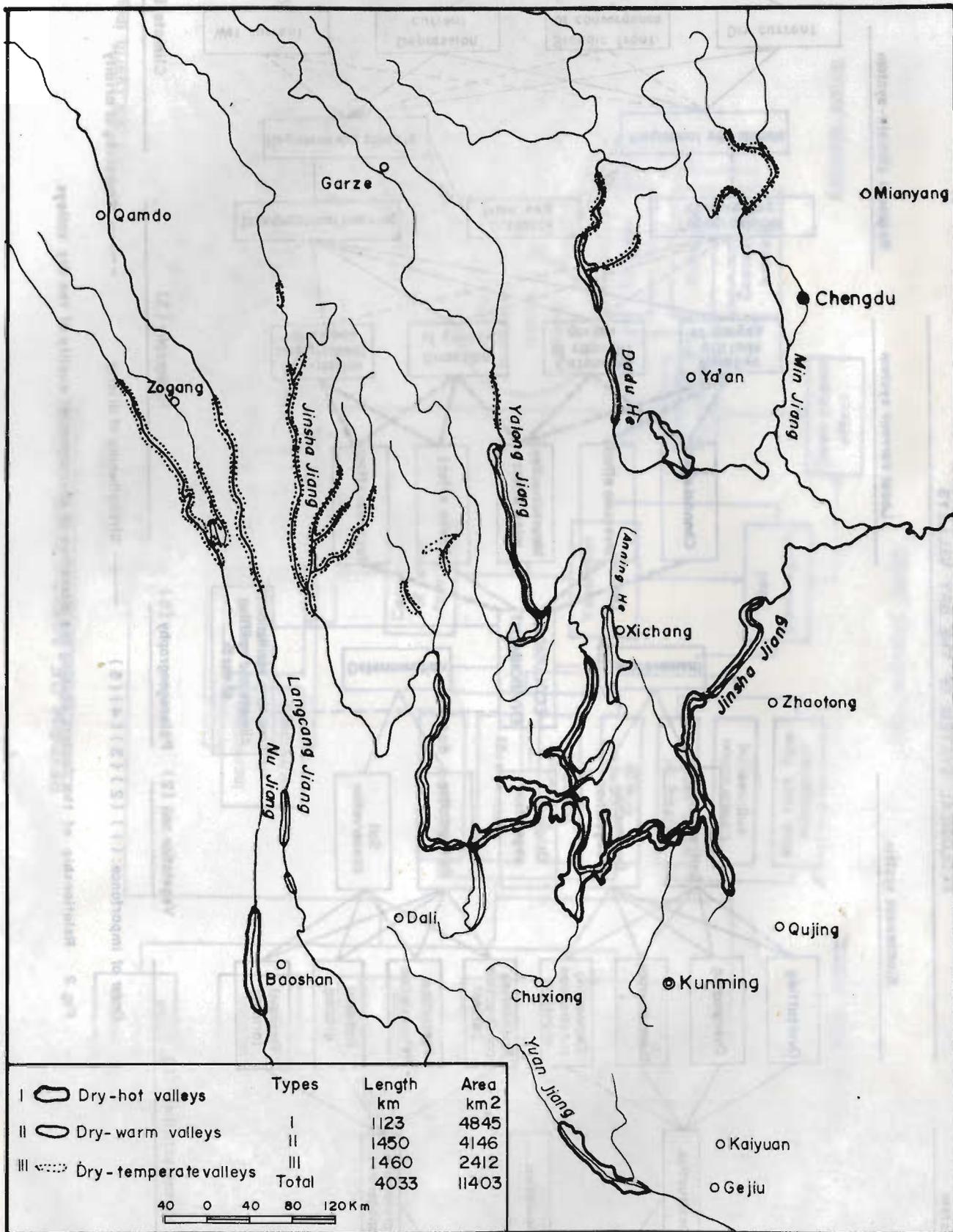


Fig. 1 Types and their distribution of dry valleys in the Hengduan Region (simplified)

ECOLOGICAL SYSTEM OF THE DRY VALLEYS

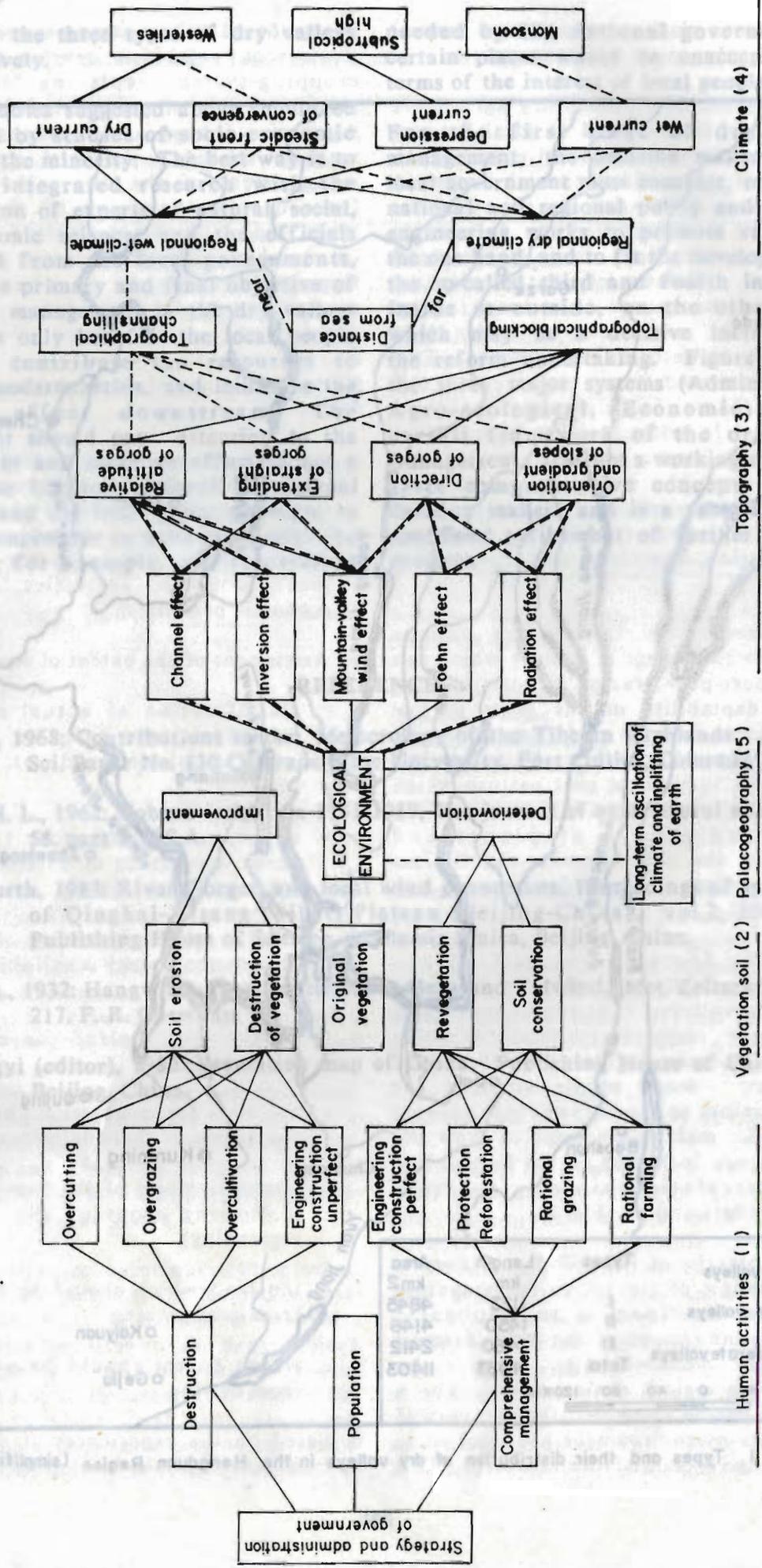
Social system

Bioecoenose system

Local current system

Regional climate-system

Circulation system



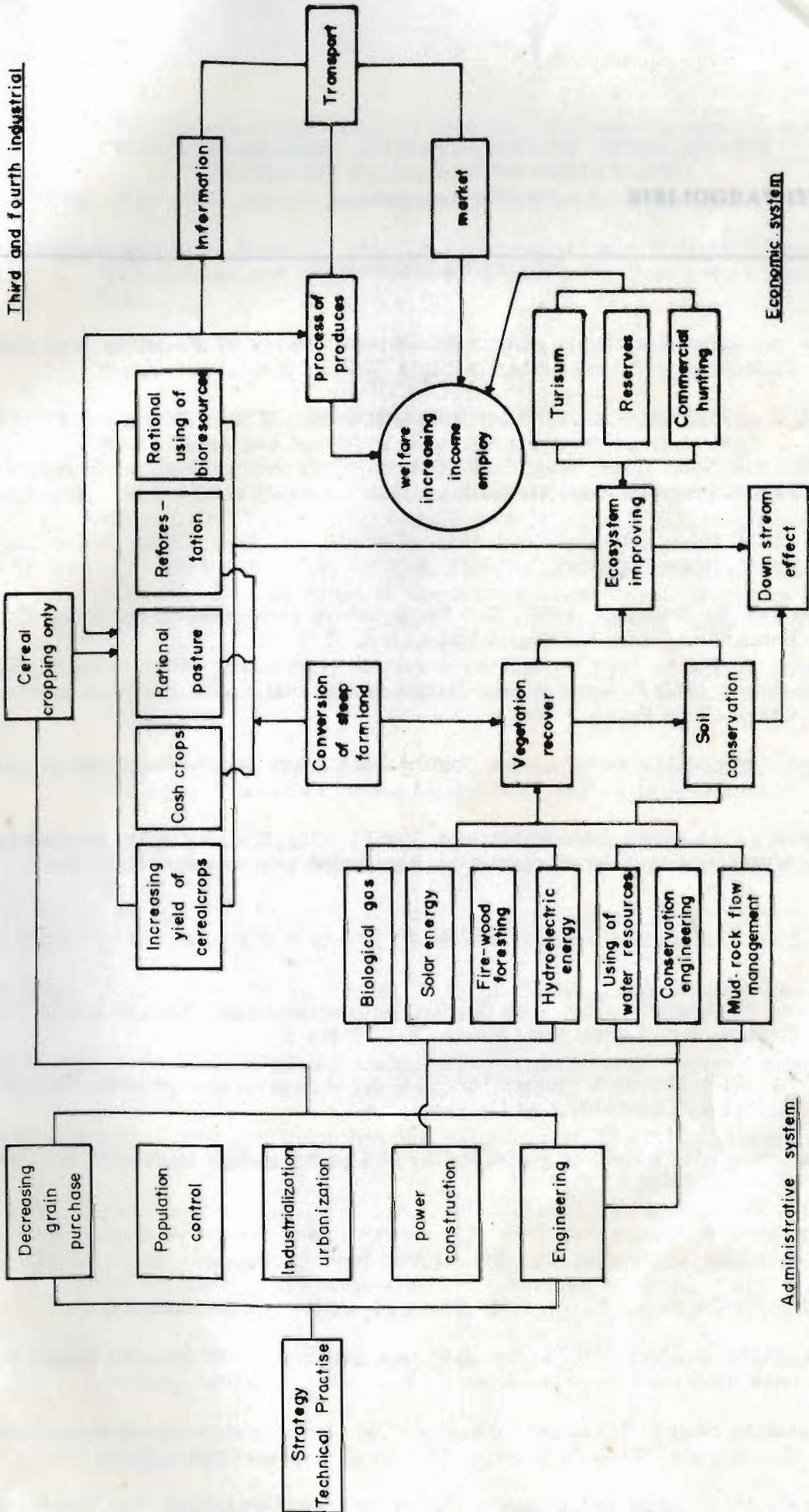
Order of imporfance: (1) (2) (3) (4) (5)

— Strengthening of aridity

----- Weakening of aridity

Fig. 2 Relationship of the factors causing the alteration of environmental quality of the dry valleys.

REFORM OF AGRICULTURE SYSTEM



Agro-ecological system

Administrative system

Economic system

Third and fourth industrial

Fig. 3 A general scheme for comprehensive management of the dry valleys in Hengduan region