第 21 卷第 8 期
2001 年 8 月

生 态 学 报
ACTA ECOLOGICA SINICA

Vol. 21, No. 8
Aug., 2001

河北太行山区河谷土地空间分异规律研究

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摘要: 河谷是集自然的精华与众多的人文景观于一体的带状地域, 在山丘区的可持续发展战略中具有举足轻重的地位。在山丘区退化河流生态系统的恢复和洪水过后的灾后重建过程中, 河谷土地的空间分异特征以及洪水干扰对河谷景观安全的制约作用, 是确定河谷土地利用策略和指导河岸植被带建设的重要依据。本文以景观生态学原理为指导, 调查了河北太行山地区的 7 条河流, 在全面分析主流河谷土地利用格局及 96.8 洪灾格局的基础上, 深入研究了太行山地区河谷土地的空间分异规律。以洪水干扰为主导因素, 提出由上至下在纵向上把河谷划分为 5 个区段, 即上游侵蚀区, 上中游侵蚀-堆积区, 中游侵蚀堆积区, 中下游堆积-侵蚀区, 下游堆积区; 由河道向两侧山体在横向上把河谷土地划分为弹性利用带、脆弱利用带和稳定利用带 3 条土地带, 同时阐明了每种土地带的空间范围和确定方法。

关键词: 太行山地区; 河谷土地; 空间分异; 土地利用带

Study on the spatial differentiation of valley lands in Taihang mountain areas in Hebei Province

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Abstract: River valley is a strip of zone in which the natural cream and numerous human landscapes are congregated. In Taihang mountain areas of Hebei province, river valley occupies only about 10 percent of the total area of mountain and hill region, but it gathers almost all the inhabitant construction land and farmland with the highest productivity level. River valley holds the key position in sustainable development strategy in the areas. On 4th and 5th August 1996, a great flooding rarely in the local history occurred in Tainhang mountain area in Hebei province. The losses from the flooding were serious in the riverine area. The comprehensive human activities led to the degradation of watershed environment and became the cause for the frequency flood. So the foundation of flood control and river ecological restoration is predicated on the scientific recognition to the rules of flood disaster and the spatial differentiation of valley lands, and also based on the establishment of adaptive policy. The core of the policy was to using lands reasonably to make the land-use patterns adapt the spatial differentiation of valley lands and possible flood in the area. In this paper, using landscape theories and methods, the problem was studied.

The outside inverstigation was performed from June to July in 1997 and May to June in 1998. Based on a case study of the 96.8 flood, the cahnges of valley lana-use patterns were investigated completely. The main valleys of 7 rivers-Yanzhi, Dasha, Beiliu, Banyu and Yaozi located in Fuping county, Beisha and Zhulong located in Yuanshi county, were selected to be the typical research locations. Walking down from headstream along the river, the status of land-use and 96.8% flood disaster were surveyed by interviewing with local people who experienced the event. The status of land-use was described by 4 phases of pre-flood, during flood, after flood and present. Meanwhile the changes of land-use patches, river characteristics and the range of land affected by flood were evaluated by land measuring and drawing on the present land-

基金项目: 国家科技部农业专项研究(98-11-10)和河北省林业厅资助项目

收稿日期: 1999-11-15; **修订日期**: 2000-05-12

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use status map. We used the reach as the basic researching unit. In order to compare the differences between regions and rivers, classification was carried out according to the practical situations of land-use before 1996 and after 96.8 flood disaster in valley of Taihang mountain areas. The land-use patch was classified into seven types-farmland, village, forest land, orchard, reservoir or pond, barren sands or beach, and reed field; while the 96.8 flood disaster was classified into three types-destroyed, flooded and sedimentated patch.

Using the corridor analyzing method of landscape ecology, the river corridor was to divide into three sections of matrix, patch and corridor. Based on comprehensive analysis of land-use and flood patterns in main river valleys of 7 rivers, and emphasized Yanzhi river for a case study, the spatial differentiation of valley lands were studied in longitudinal and cross direction. The results were as follows:

1. The whole trends of valley characteristics in longitudinal direction were that: along with the extending of river from headstream to downstream, the grain composition of riverbed matrix reduced, valley landform tended to gentle and valley gradually widened in steps, and this process was usually related to branch converge and swerve. The erosion process gradually weakened while deposition process enhanced. Valley lands are disturbed exitensively by human being actions because of being the central zone for producing and living. Artificial landscape types took up the main parts of the valley landscape except the residual natural landscape types occurred in upstream valley. The proportion of artificial land-use area increased from headstream to downstream, the human disturbance index was 55.48%, and the reserved watercourse 20.88%. Besides the influence of landforms, we could also obtained the same result from the changes of other 6 river valleys.

Based on those characteristics, we could divided a valley into five zones in longitudinal direction: (1) upstream erosion section in which the role of runing water was to erode down, (2)up-midstream section in which the role of running water was to erode down and side, (3)midstream section in which the erosion process was correspond to accumulation, (4)middle-downstream in which the accumulation was the main process while the erosion was second, and (5) downstream in which the accumulation was the main process.

2. Although the appearance of valley landscape tended to homogeneity because of the long-term influenced by human activities, the heterogeneity of valley land attributes was reflected by the distribution patterns of land-use types in cross direction. In the mountain and hill area, the most typical landscape characteristics were that: changing from channel to hillside, the land-use types showed seasonal channel→riparian forest belt which was continuous or discontinuous→artificial river bank with forest belt or scattered trees →irrigable lands usually were farmlands or orchards→roads with forest belt in both side→village surround with forest belt→sloping field which often were dry farmlands or irrigable lands→barren lands or low density forest lands. The landscapes of channel in the plain section were some different and the typical model was that: seasonal channel which was occupied mostly by farmlands, occasionally distributed by brickyard →natural soil river bank with scattered trees→large-area farmland, occasionally orchards→village and road surround with forest belt.

Based on the analyzing on the width of water flow, flooded and destroyed range in fore-and-aft 96.8 flood, the influence range of flood in cross direction, an the types of disaster, a valley was divided into three zones-fragile use zone, stable use zone and elastic use zone. The spatial range of and evaluation method for each zone were illustrated as follows:

(1)fragile use zone referred to those river beach lands, in which threre were no water in common period, but during the flooding season those lands were easy to be destroyed. Usually the lands were very thin,

mainly composed of sand, mixed few sedimentated soil and often located in watercourse. For artiificial utilization, the main type was beach farmland, also included some watercourse farmlands which were built by carrying soil from other place or accumulating from the water. According to the duration of utilization, this kind of lands were also could be classified into two kinds——seasonal temporary use zone which could be used in spring and autumn and annual short term use zone which could be used in whole year during common year. The evaluation method for both zones were as follows:

Width of elastic use zone = watercourse width after flood-average width of watercourse in common year

i. Width of seasonal temporary use zone = maximum width of watercourse in normal year-average width of watercourse in common year

ii. Width of annual short term use zone = width of watercourse after flood-maximum width of watercourse in normal year

(2)fragile use zone referred to those riverside lands, for which the lands were easy to be flooded and sedimentated during flooding, but basically were not destroyed. Usually the layer of soil was relatively deep, but content of sand was high, and often located on the riverbank. This kind of land mainly included the ranges between riverbank and village or road. For artificial utilization, the main types were producing lands such as farmland, orchards et al., mostly composed of terraces, and also included some watercourse farmlands. This part of lands were main land resources for the residents to make living. in whole year during common year. The evaluation method was as follow.

Width of fragile use zone = width of flooded valley-maximum width of watercourse in normal year

(3)stable use zone referred to those riverside lands, for which the lands were not easy to be flooded even during flooding. Usually the layer of soil was relatively deep, mainly composed of slope accumulation materials, mixed partly sedimentated materials, and often located near the bottom of hill in valley. For artificial utilization, the main types were villages, farmlands and roads, mostly composed of terraces. This part of lands was main place for the residents to build their houses. Those lands showed a lot of advantages in landscape security, climate situation and other aspects. The evaluation method was as follow:

Width of stable use zone = width of valley-width of flooded valley

The spatial differentiation of valley land is universally existent in longitudinal and cross direction. So according to the above-mentioned methods, we can analysis the spatial differentiation characteristics of other rivers in Taihang mountain area. At present, the management core of most river eco-system is to keep the ecological integrality of river eco-system, but valley lands and flooding plain have been being used for a long time, it was unpractical to retreat from using those lands. We must search for land-use way to live with river and flood. The results are helpful for the restoration of disaster in Taihang mountain and even other regions, accelerating the establishment of riparian vegetation which mainly composed of trees, consequentially enhancing the resistance of riverine landscape to flood disturbance, and progreeively carrying out the restoration of the degenerated river ecological system.

Key words: Taihang mountain areas; river valley land; spatial differentiation; land use zone

文章编号:1000-0933(2001)08-1329-10　**中图分类号**:F301.24;X171.4　**文献标识码**:A

河谷土地的利用格局对河流生态系统的空间联接和生态功能有着深刻的影响。在过去,河流生态系统的管理更多的是在未考虑生态系统自然动态的情况下实施的,甚至压制了时空异质性[1~4]。而近些年来为控制洪水而采取的许多措施,多数都是针对防洪工程和集水区的坡地而言的,对近河区景观特别是河谷土地的利用格局关注较少,忽视了包括洪水在内的各种自然干扰事件对河谷景观形成和河流生态系统维持

的重要作用,这种状况已经导致了许多河流生态系统的退化。

流域生态环境的退化也是导致洪水频繁发生的主要原因,随着修复损坏工程成本的不断提高和涉及到的环境问题,人类必须要探索与河流及洪水共存的土地利用方式[5~7]。景观生态学认为土地具有异质性的特点[1~2,8],这种异质性是不同环境因子相互耦合的结果,也是决定潜在景观格局的内在机制。在河谷内,由于存在多条生态交错带[4],加之洪水的干扰和人类活动的深刻影响,河谷土地的空间异质性表现得更为突出。因此,了解河谷土地的空间异质性,对于指导河谷景观现实格局的规划、近河区土地的洪水灾后恢复和山丘区河流防护林带建设的范围和模式都有重要意义。本文以河北省太行山地区的 7 条河流为例,对该问题进行了探讨。

1 研究区自然地理概况

河北太行山区是我国水土流失严重、自然灾害频繁、生态环境比较恶劣的地区之一[9],河谷土地的开发历史久远,河谷内自然植被破坏严重,许多河流断流或干涸[10]。本次研究从太行山地区的整体性和代表性出发,选择阜平县和元氏县为研究靶区。在两个县调查了 7 条河流,阜平县有大沙河、胭脂河、北流河、板峪河和鹞子河(有少量常年流水),元氏县有潴龙河和北沙河(没有常年流水)。

元氏县位于太行山东麓,地处 114°10′~114°39′E 和 37°40′~37°55′N 之间。元氏县属太行山隆起带的东缘,地势西高东低,具有低山、丘陵和山前平原 3 种地貌类型,海拔在 50~500m 之间。全县土地总面积 681km^2,海拔在 100m 以下的地区面积为 34867hm^2,占总面积的 51.12%,100~500m 的丘陵面积为 30134hm^2,占 44.19%。潴龙河、北沙河都发源于本县境内,在栾城县汇入 河,是滏阳河的支流。阜平县地处太行山东麓,位于 113°45~114°32E 和 38°39~39°08N 之间。县境西端为太行山山脊,具有中山、低山和丘陵 3 种地貌类型,海拔在 200~2000m 之间。全县总面积 2527.14km^2,海拔 200~1000m 之间的土地占 77.72%,其中以 200~500m 的面积最大,为 91733hm^2,占总面积的 37.12%。大沙河是阜平县境内的主干河流,发源于山西省灵丘县太白山麓,自西北向东南贯穿阜平全县,在曲阳县纳入磁河后汇入大清河的一条大支流潴龙河。胭脂河、北流河、鹞子河和板峪河是其主要支流。

2 研究方法

于 1997 年 6~7 月份和 1998 年的 5~6 月份对 1996 年洪水前后的河谷土地利用格局变化进行了野外调查。从河流的源头向下游方向徒步行走,边走边进行访问调查,边拍摄土地利用和受灾情况,记录洪水前、洪水期间、洪水后和当前的河谷土地利用情况,并在 1:1 万土地利用现状图上直接绘出土地斑块、河流特征在上述 4 个时期的变化情况,必要时借助测量工具进行辅助定位。调查时以河段为基本描述单位。根据土地利用方式相近、河谷河道特点(宽度、通直度、河岸类型等)相近、地貌类型和自然植被状况相近等河谷及河流的特点,把一条河流分成若干个河段[11]。土地斑块类型划分基本上以国家土地利用现状调查的类型划分为准[12],按当地的土地利用现状图进行调查。

3 太行山地区河谷空间分异规律分析

3.1 太行山地区河谷的纵向分异性

3.1.1 河谷的纵向梯度变化 河流在纵向上是一个贯穿于多种景观的线状连续体。从各个支流的源头到汇入干流的汇入口,以及到干流的入海口,一级一级呈梯度变化,随着河流等级的这种变化,无论是河流两侧的地貌、岩性、土壤、植被,还是河岸附近的土地利用类型、面积、格局,甚至是河流内的各种生物(包括水生生物和陆地生物)及河流的各种属性(河床物质、水流特性等)也随之而呈等级式的梯度变化[13~20]。水流是联接河流上下游的纽带,太行山地区的众多河流受人类活动的长期影响,流量急剧减少,许多已经变成季节性河流。本次调查的阜平县 5 条河流河道内都有常年流水,上下游水流宽度变化在 1~15m 不等,元氏县的 2 条河流为季节性河流。虽然各河流之间略有不同,但从河谷土地的实际利用情况和对河流的影响及依赖程度来看,都具有广泛的共性。这里仅选择阜平县的胭脂河的情况来说明这种变化规律。对于胭脂河,全河共划分了 6 个 1 级河段和 23 个 2 级河段(见表 1)。

表 1　胭脂河河谷河段的总体特征

Table 1　The characteristics of reaches in Yanzhi river valley

河段 Reach	河段长度 Length of reach(m)	海拔范围 Range of altitude(m)	河谷宽度 Width of valley(m)	河谷通直度 Straighten degree of valley	洪水前河道宽度 Channel width before flood(m)	人为干扰指数* Index of human disturbance	河道比例 Proportion of channel(%)	河床基质 Characteristics of riverbed substrate
1	4600	2144～980	20	0.94	7	0.00	0.0	以大卵石为主,直径在 1m 左右。It is mainly composed of big stones and their diameters are about 1m
2	1450	980～870	40	0.97	10	20.55	29.8	以大卵石为主,直径 80cm 左右,河沙含量很少。It is mainly composed of big stones of diameters about 80cm. There are a less sands
3	2250	870～720	35	0.88	25	23.73	54.5	
4	2120	720～650	20	0.86	20	66.48	33.5	
5	3030	650～570	40	0.86	30	40.97	42.0	
6	1450	570～550	150	0.99	25	78.31	19.5	以中型卵石为主,直径 20～50 cm 之间。It is mainly composed of middle-size pebbles and their diameters are between 20cm and 50cm
7	770	550～538	200	0.97	30	92.50	22.9	
8	1550	538～515	100	0.94	30	65.73	20.6	
9	1900	515～480	150	0.82	20	76.30	19.8	
10	1050	480～470	320	0.81	30	80.00	18.3	
11	2400	470～420	200	0.83	30	77.64	17.3	
12	2450	420～395	120	0.98	30	68.09	22.6	
13	3950	395～350	80	0.54	25	62.69	33.3	
14	1400	350～340	250	0.82	30	82.10	12.8	以河沙、小砾石为主,直径 20 cm 左右的卵石也有较多分布,在整个河段内变化都不大,比较均一(可能与大型卵石多数被用于居民建筑和垒筑田埂有关)。It is mainly composed of sands and small pebbles. There are many pebbles which diameters are about 20cm. The changes of matrix are not obvious (This is related to that big stones have been used to build house or field ridge)
15	1980	340～320	260	0.90	20	78.29	11.1	
16	1810	320～304	500	0.99	30	91.81	9.0	
17	2230	304～290	400	1.00	30	79.93	8.9	
18	2020	290～276	700	1.00	70	88.49	7.5	
19	1830	276～264	500	1.00	150	58.71	23.9	
20	4080	264～245	450	0.93	150	51.90	33.4	
21	4520	245～225	500	0.75	180	50.34	31.0	河床以沙为主,小卵石和砾石的含量明显减少。It is composed of sands, while the amounts of small peddle and gravel decrease obviously
22	3640	225～209	850	1.00	200	61.78	22.1	
23	6500	209～186	750	1.00	200	31.51	18.1	以细沙为主,含少量淤积土。It is mainly composed of fine-size sands and a little sedimentary soil

* 人为干扰指数——农田与村庄的面积之和与河谷面积的百分比。

(1)源头→香炉石河段(第 1 河段) 从胭脂河的发源地——百草坨,到香炉石村,河谷长 4600m,宽度在 20m 左右,河道宽度 5～10m。这一段海拔在 980m 以上,山高坡陡,河谷多呈 V 字型。两侧山坡上为大片天然林,植被盖度大。河床以巨型卵石为主,河岸为自然的土石,生长着以青杨、桦木为主的阔叶林,河道内基本没有农田,保持着自然风貌。这一河段仅划分为 1 个 2 级河段。

(2)香炉石→口上村河段(第 2 河段) 河谷全长 8850m,宽度 20～40m,河道宽 10～20m,海拔 570～980m,河两侧山坡植被生长良好。河床以大型卵石为主,河谷多呈 V 字型。河道两侧的河岸上也有小块农田出现。有多条 1、2 级支流先后汇入。河岸多为斜坡状的自然山体。这一段根据河谷宽度及土地利用情况的不同又划分为 4 个 2 级河段。

(3)口上村→大岸底河段(第 3 河段) 这一段河谷蜿蜒曲折,河道深切,地势变化比较大,有多条 1、2 级支流汇入。河谷长 15 520m,宽度 80～300m,而河道宽度一般只有 10～20m。海拔 350～570m,河谷也基本上呈陡峭的 V 字型。山坡上植被生长良好。河岸基本上为自然山体,但有许多农田紧靠河岸分布,大多是用河道内的卵石垒成台田状,形成了比较陡峭的半人工垂直河岸。河床以中型卵石为主,直径在 20～50cm 之间。河岸上一般都有树木生长。这一段又可分为 8 个 2 级河段。

(4)大岸底→石猴大桥河段(第四河段) 先后有 3 条 3 级支流汇入主河道,河谷开始变得开阔,地势相对平缓,农田也急剧增多。河谷长 15350m,宽度 250～500m,河道宽 20～150m。海拔高度为 245～350m。两侧山坡上的植被明显退化,以散生的刺槐和荆条等灌木为主。河床物质变化不大,以粗河沙为主,散布有直径 20cm 的卵石和砾石,比较平坦。河床中原有的卵石大多被用于垒砌河岸和田坎,从而使河床物质变得较为均一。河左岸基本上以人工垒的石墙为主,而右岸是自然山体。河岸林很少,以散生的杨树为主,在村庄和桥梁附近大多有片林分布。这一段又分成 7 个 2 级河段。

(5)石猴大桥→北果园大桥河段(第 5 河段) 河段全长 8160m,河谷宽 500～850m。河道宽 180～200m,河床基质以沙为主,海拔 209～245m,河谷进一步加宽,河谷内地势比较平坦,两侧山体坡度平缓。河岸以人工垒石和沙堤为主,河两岸都有保存较好的林带,但都与农田混交。河漫滩有很大一部分被利用为农田,种植的作物有红薯、玉米和小麦等。河谷两侧山体的植被以灌木为主,在支沟的沟道内有枣树分布,但植被的整体状况明显不如上一个河段。这个河段又可以分成 2 个 2 级河段。

(6)北果园大桥→王快水库河段(第 6 河段) 这一河段是王快水库的库前区,河谷宽阔而平坦,有成片芦苇分布。河谷全长为 6500m,宽度为 750m,海拔 186～209m。河岸基本上为两侧的山体,仅在开始一段为人工沙堤和垒石岸。河道宽度为 200m,河床以细沙为主,河两岸有散生的杨树。两侧山坡及支沟内分布着多个村庄,山坡植被很少,在沟道内有枣园。水库前的大片滩涂被开发为临时农田。

胭脂河河谷特征纵向变化总的趋势是:随着河流从源头向下游方向的逐步延伸,河床基质的粒级组成不断降低,河谷地势趋于平缓,河谷宽度呈等级逐渐加宽,变化的位置一般是支流汇入、河流转弯的地方;河谷内侵蚀作用逐渐减弱而堆积作用不断增强,人为利用土地面积比例不断增大,全河人为干扰指数为 55.48%,保留河道比例为 20.88%。从其它 6 条河流主流河谷特征的变化来看,除了受地形、地貌等因素的影响以外,基本上也表现出这种总体的变化规律。因此,河谷及河谷土地在纵向的空间分异性十分明显,在太行山地区的河流中是普遍存在的。

3.1.2 河谷的纵向分异 根据以上分析,河谷在纵向上的变化梯度,主要表现在海拔不断降低、河谷拓宽、自然景观减少、人为景观增加等方面。据此,可以将河谷在纵向上划分成 5 个部分。

(1)河流源头部分 这部分河床流水的作用为向下侵蚀作用。河谷两侧整个集水区自然植被保存的比较完好,河道较深,河床比降较大,河水湍急,河床基岩外露。河道内没有农田和村落分布,有的河有河岸林连续分布。洪水基本在河道内。由于农田和村落基本分布于在河道以外,所以洪水危害较轻。

(2)上中游部分 河谷以向下和侧方侵蚀作用为主,在局部有堆积现象。河谷内自然植被仍然占主体,河谷仍然比较陡峭,但在河流转弯和支流汇入等较宽阔的局部地段有堆积现象,发育有冲积洪积扇,坡度在 5～10 度之间,这里多是村落和农田所在地。洪水发生时,可对河道内的小块农田造成毁坏。

(3)河谷中游部分 河谷内侵蚀和堆积过程相当。这部分河谷地形变化较大,经常弯曲。由于河谷曲

折,两侧水流差别明显,从而造成河流一侧以侵蚀为主,而另一侧则产生堆积。从整个河道来说,则是侵蚀和堆积交替发生,凡侵蚀强烈处,则侧方为岩石,凡堆积强烈处,则有阶地出现。河床仍然多有基岩外露,河岸上散生有树木。农田面积增加,人工堆垫和改河造地的现象比较普遍。村庄数量增多,面积也增大。洪水冲毁了部分人工堆垫的河道地,而且在局部地段还比较突出。

(4)河谷中下游部分　这部分河谷表现出以堆积为主,以侵蚀为附的特点。由于支流汇入多,河谷宽度增大,河水对河谷地貌的影响以堆积作用为主,河床很少有基岩外露,基本被卵石和河沙所覆盖。河道经过人工整治变得非常规整,河岸防护林带和堤坝建设比较普遍。河谷中的农田面积急剧增加,河谷中的村庄面积也进一步增大且分布集中。被洪水淹没和冲毁的农田集中连片,特别是在支流汇入附近通常有大面积的农田被冲毁,受灾的土地类型也增多,其中林地也占有一定的比例。

(5)河谷下游部分　这部分河谷以堆积过程为主。河谷宽阔平坦,河床以冲积淤积的河沙为主,河漫滩的面积增多。河谷内的农田面积进一步增多,保留的河道都人工修建了石坝或沙堤,堤坝两侧通常有 1～2 行林带保护。洪水冲毁的面积减少,淹没面积显著增加,并有很大一部分受泥沙淤地的危害。

河谷的这种纵向分异规律,是调整土地利用格局,确定不同管理对策的基础。

3.2　太行山地区河谷的横向分异性

3.2.1　河谷的横向梯度变化　从河谷的横向来看,随着由河道向两侧坡地或山体距离的增加,陆地在土壤、水分条件、坡度、高度等方面发生连续的梯度变化,而作为这些内在变化的外观体现,无论是自然植被类型[13～16, 20],还是人为土地利用类型,以及洪水的波及范围和影响后果也都随之而呈梯度式变化。

(1)河谷内的土地虽然经过长期的人类活动影响,在景观外貌特征上趋于同质化,但土地属性内在横向的异质性仍然可以从土地利用类型的空间配置格局体现出来。在山区或丘陵区,最具有代表性的景观特征是:随着从河道向山坡的过渡,土地类型表现为季节性河道→河岸林带(连续或间断的)→人工河岸(有林带或散生的树)→水浇地(农田或果园)→道路(两边有林带)→村庄(四周有林带)→坡地(旱田或水浇地)→荒草地或疏林地。而在平原区的河道及其附近的景观则有所不同,典型的表现为:季节性河道(大部分被利用为农田,间或有砖厂分布)→自然土岸(上面散生有树木)→大片的农田(间或有果园分布)→村庄及公路(有林带包围其周)。

(2)洪水是河谷内频繁出现的干扰事件,是河谷景观形成和发展主要自然动力[1, 17, 22],对河谷景观要素的干扰形式也是多样的,并在范围上表现出明显的梯度分异。本次对 7 条河流在 96.8 洪水前后的水流宽度、洪水水淹宽度和冲毁宽度变化的调查表明,洪水在河谷内横向的波及范围对于不同的洪灾类型来说是不一样的。以胭脂河为例,洪水干扰类型和范围是呈带状分布的(见表 2)。

从胭脂河河谷宽度和洪水淹没宽度的变化来看,虽然不同河段的范围不同,而且都表现出从上游向下游逐渐增加的趋势,但洪水的淹没范围通常不会达及整个河谷,在许多河段都或多或少地保留一定宽度的未受洪水影响的安全地带。这种地带在河流的中游前后河段出现较多,而在源头和下游河段相对较少。洪水后的河道宽度和洪水前的河道宽度的差异也表现出这种特点。而这种基于洪水干扰波及类型和范围变化所表现的河谷土地这种横向分异性,在上述河谷纵向上的 5 个部分都是普遍存在的。不管是在自然状态下的河谷内,还是在农田、村镇等人工土地利用类型已经占据河谷景观的主体的河谷内,洪水是不可避免的干扰事件,仍然是河谷景观的最大扰动因素[14, 22, 23]。因此,河谷土地利用规划以及河流的生态恢复,都必须把洪水作为首要问题来考虑。

3.2.2　河谷的横向分异　根据以上分析,从河谷土地在洪水期的安全性角度出发,沿河道向两侧山体,可以将河谷土地在纵向上划分成 3 条土地利用带。

(1)弹性利用带　是指在平水期没有流水而在洪水期容易淹没并冲毁的河滩地,一般土层极薄,大多以沙为主,混有少量的淤积土,通常处于河道内。从人工利用的角度看,主要是临时河滩田,也包括部分人工堆垫的河道地。又可以根据利用的持续时间分成两种:季节性临时利用带(可在春季或秋季利用)和年际性短期利用带(可在平水年的全年利用)。具体确定方法如下:

表 2 胭脂河不同河段 96.8 洪水波及范围调查(m)
Table 2 Investigation of range affected by flood in different reaches in August 1996

河段 Reach	河谷宽度 Valley width	1998 年调查时的水道宽度 Channel width when investigation in 1998	96.8 洪水时的水淹宽度 Flood width in August 96.8	96.8 洪水前河道宽度 Channel width before 96.8 flood	96.8 洪水后河道宽度 Channel width after 96.8 flood
1	15	3	10	7	7
2	40	3	15	10	10
3	35	15	25	25	25
4	20	10	20	20	20
5	40	10	30	30	30
6	150	15	80	25	37
7	200	10	40	30	30
8	100	15	50	30	30
9	150	10	40	20	20
10	320	15	50	30	50
11	200	15	50	30	30
12	120	20	45	30	30
13	80	10	30	25	25
14	250	20	80	30	60
15	260	10	90	20	50
16	500	10	300	30	70
17	400	5	400	30	80
18	700	10	100	70	70
19	500	20	450	150	200
20	450	20	450	150	200
21	500	30	480	180	220
22	850	30	600	200	200
23	750	30	750	200	200

弹性利用带 = 冲后河道宽度 − 常年平均水道宽度

①季节性临时利用带 = 平水年最大水道宽度 − 常年平均水道宽度

②年际性短期利用带 = 冲后河道宽度 − 平水年最大水道宽度

式中,冲后河道宽度指洪水过后没有经过人为恢复时的河道宽度;常年平均水道宽度指多年平均的水流宽度;平水年最大水道宽度指平水年河水流量最大时的水流宽度。

(2)脆弱利用带 是指在洪水期容易淹没淤地但基本不会被冲毁的河岸土地,一般土层较厚,但土壤中沙粒含量较高,通常处于河岸之上,在空间上主要包括河岸与村庄、道路之间的土地。从人工利用的角度看,主要是农田、果园等生产性用地,以阶地为主,其中也包括部分人工堆垫的河道地,是河谷内居民维持生活的主要土地资源。具体确定方法如下:

脆弱利用带 = 洪水淹没宽度 − 冲后河道宽度

(3)稳定利用带 是指在洪水期一般也不会被淹没的土地带,一般土层较厚,主要以坡积物为主,混有部分淤积土,通常处于河内的坡脚处。从人工利用的角度看,这一地带主要是村庄、农田以及交通用地。主要是经过平整的阶地,是河谷内居民房屋建筑的主要场所,在景观安全、气候条件等方面具有很大的优越性。具体确定方法如下:

稳定利用带 = 河谷宽度 − 洪水淹没宽度

根据以上河谷内土地带的计算方法,以阜平县胭脂河 96.8 洪水的实际情况为例,确定了不同河段 3 类土地带的宽度(见表 3)。

由表 3 可知,随着河谷的加宽,胭脂河河谷内 3 种土地带的宽度也呈现增加的趋势。对于弹性利用带来说,虽然宽度变化很大,但在河流的各个河段都是普遍存在的,其中季节性临时利用带的宽度不大,而年际短期利用带在中下游河段的宽度很大,这是河谷内围绕河道利用而产生人与水争地的主要地带;在河流的中上游河段稳定利用带的宽度要大于脆弱利用带,而在下游河段以脆弱利用带居多,这种分布格局与河谷地形的关系很大,同时也受支流汇入、河流转弯等因素的影响。

可以说,河谷和河谷土地在横向和纵向上的这种分异是普遍存在的。所以,按照上述方法,可以对太行山地区的其它河流进行纵向和横向分异特征的解析,对世界上任何一条河流也可以进行这种划分。当然,以上这种计算是针对太行山地区 96.8 洪水的干扰范围而言的。从暴雨强度和洪峰流量考虑,太行山地区 96.8 暴雨洪水是 50a 一遇,是继本地区 63.8 暴雨洪水后最大的一次。从洪水的波及范围和发生过程看,这两次洪水极为相似[24]。因此,从河谷内土地利用持续的时间、经济收益以及农民在心理上可承受能力方面考虑,以本次洪水的波及范围确定土地利用带的空间界线,在实际应用时也是可以接受的。

表 3　胭脂河河谷内不同河段的土地利用带的宽度*(m)

Table 3　Width of land-use zones of different reaches in Yanzhi river valley

河段 Reach	弹性利用带 Elastic use zone			脆弱利用带 Fragile use zone	稳定利用带 Stable use zone
	季节性临时利用带 Seasonal temporary use zone	年际性短期利用带 Annual short-term use zone	合计 Total		
1	1.5	1.0	2.5	3.0	5.0
2	1.5	4.0	5.5	5.0	25.0
3	7.5	−5.0	2.5	0.0	10.0
4	5.0	0.0	5.0	0.0	0.0
5	5.0	10.0	15.0	0.0	10.0
6	7.5	7.0	14.5	4.3	70.0
7	5.0	10.0	15.0	10.0	160.0
8	7.5	0.0	7.5	20.0	50.0
9	5.0	0.0	5.0	20.0	110.0
10	2.5	20.0	22.5	0.0	270.0
11	7.5	0.0	7.5	20.0	150.0
12	10.0	−10.0	0.0	15.0	75.0
13	5.0	5.0	10.0	5.0	50.0
14	10.0	20.0	30.0	20.0	170.0
15	5.0	30.0	35.0	40.0	170.0
16	5.0	50.0	55.0	230.0	200.0
17	5.0	60.0	65.0	320.0	0.0
18	5.0	50.0	55.0	30.0	600.0
19	10.0	160.0	170.0	250.0	50.0
20	10.0	160.0	170.0	250.0	0.0
21	15.0	160.0	175.0	260.0	20.0
22	15.0	140.0	155.0	400.0	200.0
23	15.0	140.0	155.0	550.0	0.0

* 由于本次野外调查时间是在 1998 年 5～7 月间,太行山地区刚刚进入雨季,因此调查的水道宽度并不是 1998 年胭脂河最大的水道宽度;同时,考虑到不同河段、不同年代的差异,本文采用调查时水道宽度的 1.5 倍作为常年平均水道宽度,以水道宽度的 2 倍作为平水年最大水道宽度。在实际确定具体河段的水道宽度时可根据当地多年的经验适当修改之。表中计算的各土地利用带的宽度中,负值和零表示不存在这类土地利用带,而宽度值是整个河谷内这种土地利用带的宽度,若考虑到河流是分左右岸的特点,取值应该是这个值的二分之一,但实际当中河流并不是正好处于河谷中央,有时一侧紧靠山体,可利用的土地全部集中在另一侧。因此,在实际应用时可以根据实际情况进行一下调整。

4　小结与讨论

河流是河谷景观形成的基本动力,而洪水则是对河流及河谷景观影响最为强烈的自然干扰事件,由此而产生的河谷景观的潜在格局是复杂多样的。在多数地区,河谷本身就是一个镶嵌体,是由叠加在河流各类因子变化梯度之上的各种镶嵌体构成的一个河谷镶嵌体(Valley mosaics),具有高度的异质性[1]。但是,河谷景观的这种自然属性由于受到人类活动广泛而深刻的影响[23],已经发生了极大的改变,并导致多数河流生态系统的退化。因此,人为干扰形成的现实格局与河谷景观的潜在格局存在巨大的差别,河谷内人力维持的景观外貌和格局通常抹杀了河谷土地内在的空间异质性,是人为的同质化过程。人类对于河流本身及近河区景观(Riverine landscapes)的影响,不仅割裂了自然干扰系列,降低了河谷生境的空间异质性,切断了物质、能量、物种交互流动的途径,使河谷生境趋于破碎化,破坏了河流生态系统的整体性,而且降低了河谷景观抗洪水干扰的能力,加剧了洪水给河谷景观造成的损失[1,13]。因此,对于防洪减灾和河流生态系统的恢复,不仅要注意河流集水区内坡地的生态建设,还必须在充分认识河谷景观的空间分异规律的基础上,注意河谷特别是近河区景观格局的调整。

目前,多数河流生态系统管理的目标主要是针对 3 种情况进行:沿着河谷的横向、纵向和垂直三个方向跨越一系列尺度的环境梯度的重建;景观要素之间生态联接(Ecological connectivity)关系的重建;一些自然动态准平衡状态的重建[1, 13, 21],其核心是要保持河流生态系统的生态整体性[3, 15, 25]。从河流生态系统恢复的范围来看,由于河谷土地及洪泛平原已经长期被人类利用,完全退出是不现实的,也不可能实现。河谷地区的发展历史说明,保持河流的生态整体性与连续性,是和满足流域内居民的基本生活需要密切相关的,靠贫穷维持河流生态环境的稳定难以实现,靠环境退化达到使河谷内居民脱贫也不能长久。同时,洪水作为河流的一种自然属性,它对于河谷景观的威胁是永远也无法消除的。因此,防洪减灾和河流生态恢复的关键,是如何确定合理的河谷土地利用策略,特别是要考虑对于洪水的安全问题。

本文根据河谷环境的空间分异性,并结合太行山地区 96.8 洪水在河谷内的成灾范围和分布格局,以恢复河流生态系统的空间生态联接和保证河谷景观的生态安全为目的,把河谷和河谷土地在纵向上由上向下划分为 5 个部分,即上游侵蚀为主区,上中游侵蚀为主局部堆积区,中游侵蚀和堆积过程相当区,中下游堆积为主侵蚀为附区,下游堆积为主区;在河谷的横向上由河道向两侧山体依次划分成弹性利用带、脆弱利用带和稳定利用带 3 条土地带。这种划分方法和研究视角,不仅反映了河谷景观异质性的梯度变化规律,也体现了河谷景观基于洪水干扰影响的空间分异规律。因此,本项研究为基于洪水安全的土地利用调整策略提供了理论依据,对于指导太行山区乃至其它地区的洪水灾后重建,加快以林木为主体的河岸植被带的建立和完善,促进中国森林生态网络体系建设中河流沿线的绿化工作,从而增强近河区景观抗洪水干扰的能力,逐步实现退化河流生态系统的恢复,都有重要的现实和长远意义。

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