

黄土丘陵沟壑区第二副区裸地降雨因子 影响产流和产沙的研究

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摘要: 坡面产流和产沙受多种因素的影响。对于裸地而言, 降雨量与雨强是两个最重要的因素。对黄土丘陵区第二副区, 5 年的裸地降雨量和降雨强度与产沙产流数据资料进行相关分析, 总结出三个相应的模型。
关键词: 黄土丘陵区第二副区; 降雨强度; 降雨量; 模型
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Effect of Rainfall Factor of Bare Land on Runoff and Sediment Yield in Loess Hilly-gully Region

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Abstract: The runoff and sediment yield produced on slope are influenced by many factors. For bare land, rainfall amount and rainfall intensity are the two most important factors. Three corresponding models were summed up by analyzing the data in five years about rainfall amount and rainfall intensity, runoff and sediment yield in bare land of loess hilly-gully region.
Key words: the 2nd sub-region in loess hilly area; rainfall intensity; rainfall amount; model

1 试验小区概况及研究方法

试验小区位于延安市宝塔区万花乡向阳沟, 东经 109° 26' 40", 北纬 36° 23' 20", 海拔 1 392 m, 土壤为黄绵土。多年平均降雨量 552.6 mm, 多年平均蒸发量 1 100 mm, 多年平均气温 9.4℃。年径流模数为 32 000 m³/km², 年侵蚀模数为 6 017 t/km²。属黄土丘陵沟壑区第二副区。

研究方法采用径流小区法, 小区坡度 15°, 面积 100 m² (20 m × 5 m), 径流池 5 m × 1.2 m × 1.0 m, 小区常年裸露。通过对 5 年实测降雨、径流资料, 进行相关分析, 归纳出产流与降雨因子、产沙与降雨因子的五种不同的模型关系式。

2 获取数据资料

本研究从 1996 年到 2000 年底, 采集数据, 共 5 年, 22 次(见表 1)。

3 相关分析研究

3.1 模型

$$R = AP^{b_1}I^{b_2}$$

经相关分析 $A = 0.288, b_1 = 0.44, b_2 = 0.72, r = 0.677 0$
即: $R = 0.288P^{0.44}I^{0.72}$

3.2 模型

经相关分析 $A = 0.336, b_1 = 0.63, b_2 = 0.58, r = 0.858 8$
即: $R = 0.336(P - 6)^{0.63}(I - 2)^{0.58}$

根据多年实测资料, 当降雨量小于 6 mm, 降雨强度小于 2 mm/h 时不产生径流。故用 $P - 6$ 表示有效降雨量, $I - 2$ 表示有效雨强。

3.3 模型

$$f = AI^B$$

经相关分析 $A = 0.017, B = 1.154, r = 0.817 0$
即: $f = 0.017I^{1.154}$

3.4 模型

$$f = A(I - 2)^B$$

经相关分析 $A = 0.066, B = 0.703, r = 0.874 3$
即: $f = 0.066(I - 2)^{0.703}$

3.5 模型

$$M_s = a_0P^{b_1}I^{b_2}$$

经相关分析 $a_0 = 50, b_1 = -1.57, b_2 = 2.86, r = 0.848 9$
即: $M_s = 50P^{-1.57}I^{2.86}$

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表 1 暴雨产沙产流资料

| 降雨量 /mm | 降雨强度/ (mm·h) | 径流深 /mm | 径流系数 /% | 冲刷量/ (t·km ⁻²) |
|------------|-----------------|------------|------------|-------------------------------|
| 34.2 | 14.7 | 21.70 | 0.635 | 18617 |
| 82.1 | 7.2 | 22.00 | 0.268 | 7817 |
| 28 | 33.6 | 10.30 | 0.368 | 1212 |
| 16.5 | 6.6 | 1.86 | 0.113 | 557 |
| 24.7 | 10.8 | 5.72 | 0.347 | 1410 |
| 42.2 | 3.98 | 1.07 | 0.025 | 120 |
| 45.6 | 2.78 | 2.17 | 0.048 | 27.4 |
| 16.5 | 5.5 | 2.62 | 0.159 | 208 |
| 18.2 | 5.3 | 1.79 | 0.108 | 53.6 |
| 19.9 | 2.1 | 0.62 | 0.01 | 10.8 |
| 12 | 2.4 | 0.97 | 0.081 | 73.1 |
| 11 | 10.2 | 6.00 | 0.545 | 89.1 |
| 20.8 | 31.2 | 10.70 | 0.514 | 355 |
| 16 | 0.32 | 7.70 | 0.481 | 102 |
| 17 | 5.7 | 5.10 | 0.3 | 75 |
| 10.5 | 7.9 | 1.27 | 0.121 | 0 |
| 68 | 5.7 | 14.20 | 0.209 | 10.8 |
| 20.7 | 17.7 | 15.30 | 0.739 | 307 |
| 23.6 | 9.5 | 9.40 | 0.398 | 262.4 |
| 20 | 16 | 9.10 | 0.455 | 220.3 |
| 25.6 | 8.5 | 9.80 | 0.383 | 298.3 |
| 19.5 | 19.5 | 14.70 | 0.754 | 577.4 |

3.6 模型

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$$Ms = a_0(P - 6)^{b_1}(I - 2)^{b_2}$$

经相关分析 $a_0 = 2.28, b_1 = 1.15, b_2 = 0.71, r = 0.599 0$ 。
即: $Ms = 2.28(P - 6)^{-1.57}(I - 2)^{0.71}$

4 几种模型的比较

4.1 径流深与降雨量、降雨强度的关系

采用模型 $R = 0.336(P - 6)^{0.63}(I - 2)^{0.58}$ ($r = 0.858 8$), 经相关分析 R 与 $(P - 6)$ 、 $(I - 2)$ 显著相关。是较理想的模型。

4.2 径流系数与降雨强度的关系

采用模型 $f = 0.066(I - 2)^{0.70}$ ($r = 0.874 3$), 经相关分析 f 与 $(I - 2)$ 显著相关。是较理想模型。

4.3 产沙量与降雨量、降雨强度的关系

采用模型 $M_s = 50P^{-1.57}I^{2.86}$ ($r = 0.848 9$), 经相关分析 M_s 与 P 、 I 显著相关, 是较理想模型。

降雨量与降雨强度对产流产沙的影响比较复杂, 一般地对某一地区而言降雨强度和降雨量都有一定的范围, 即: 产流、降雨量、雨强都不可能无限大, 其最小值为 0。对于常规条件下的暴雨, 在延安地区利用上述三个公式来推求产流量、产沙量, 完全能够满足精度要求。对于较复杂的下垫面下的产流产沙公式有待进一步研究, 总结出其他关系式。

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