Agricultural Research Service

United States Department of Agriculture

National Sedimentation Laboratory

Preliminary Watershed Characterization Hotophia Creek Demonstration Erosion Control Project

E.H. Grissinger, R.W. Darden,
and W.A. Blackmarr

Technology Applications Project Report No. 9

Not an official Publication

May 1990

P.C. # ~~7843~~ 7841

Preliminary
Watershed Characterization
Hotophia Creek
Demonstration Erosion Control Project

Submitted to the DEC Task Force

by

E. H. Grissinger, R. W. Darden, and W. A. Blackmarr

National Sedimentation Laboratory

Agricultural Research Service

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Preliminary Watershed Characterization Hotophia Creek Demonstration Erosion Control Project 1990 [1] [2]

E. H. Grissinger, R. W. Darden, and W. A. Blackmarr[3]

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[1]Contribution of the National Sedimentation Laboratory, Agricultural Research Service, U. S. Department of Agriculture, Oxford, MS.

[2]Report submitted to Demonstration Erosion Control Task Force

[3]Soil Scientist, Supvry. Mathematician, and Hydrologist, U. S. Department of Agriculture, Agricultural Research Service, National Sedimentation Laboratory, Oxford, MS 38655.

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May 30, 1990

Mr. L. Pete Heard
State Conservationist
USDA-SCS
Suite 1321, Federal Building
100 West Capitol Street
Jackson, MS 39269

Dear Pete:

Enclosed is a copy of "Preliminary Watershed Characterization - Hotophia Creek - Demonstration Erosion Control Project." This TAP Report No. 9 illustrates technology developed at the National Sedimentation Laboratory for use of a Geographic Information System in watershed research.

Three other copies will be distributed at the next DEC Task Force meeting currently scheduled for June 7, 1990.

Sincerely,

Cal

C. K. MUTCHLER
Laboratory Director

Enclosure

cc:
David A. Farrell, w/encl.

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Agricultural Research Service
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National Sedimentation Laboratory
Airport Road
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May 30, 1990

Col. Francis R. Skidmore
Commander & District Engineer
DOD-COE, Vicksburg District
CELMK-ED-H
P. O. Box 60
Vicksburg, MS 39180

Dear Col. Skidmore:

Enclosed is a copy of "Preliminary Watershed Characterization - Hotophia Creek - Demonstration Erosion Control Project." This TAP Report No. 9 illustrates technology developed at the National Sedimentation Laboratory for use of a Geographic Information System in watershed research.

Three other copies will be distributed at the next DEC Task Force meeting currently scheduled for June 7, 1990.

Sincerely,

Cal

C. K. MUTCHLER
Laboratory Director

Enclosure

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David A. Farrell, w/encl.

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Abstract

Readily available data for Hotophia Creek Watershed have been organized in a Geographic Information System to illustrate the utility of this procedure for watershed characterization and for initial watershed problem evaluation. These presentations were selected to illustrate procedural capabilities, particularly with respect to variables significant to watershed hydrologic conditions and with respect to possible locations of excessive sediment production. Hydrologic related variables addressed herein include slope and aspect topographic conditions, hydrologic soil class, and land use. Identification of possible locations of excessive sediment production are based on land use in relation to soil capability class. Obviously, numerous comparable presentations are possible. For efficient and effective routine presentation of results, we need to address all pertinent action agency needs and hence would appreciate feedback from the action agencies concerning their specific data needs.

Introduction

Background

The Demonstration Erosion Control (DEC) Project in the Yazoo Basin was proposed by the U. S. Congress in 1984 in response to continuing sedimentation problems. The DEC project was organized as an interagency effort to combine technology and resources of research and action agencies, producing a watershed systems approach for better land and water resource management.

Congress directed the U. S. Army Corps of Engineers and the USDA Soil Conservation Service to develop six demonstration watersheds where systematic watershed and flood control programs could be developed. Other research or service agencies, including the Agricultural Research Service, U. S. Army Engineers Waterways Experiment Station and the U. S. Geological Survey, were requested to participate in the project in various capacities. The USDA-ARS National Sedimentation Laboratory is participating in DEC by documenting system properties and conditions, evaluating the efficiency of specific watershed management practices and structural measures, and documenting project progress.

Report Purpose

Specific problems identified and prioritized in each of the DEC Watersheds included:

1. Erosion of hill lands,
2. Bank erosion and caving,
3. Channel filling and obstruction,
4. Sedimentation of agricultural lands,
5. Agricultural and urban land flooding.

Obviously, these individual problems are differing expressions of a singular (watershed) system involving runoff, erosion, and sediment transport. The purpose of this report is to illustrate the utility of organizing routinely available data in a Geographic Information System (GIS) for use in initial watershed (system) characterization and preliminary problem evaluation. Stream channel characterization and problem evaluation are not addressed in this report. Due to the recurring (approximately biennial) reconnaissance of the study channels, each channel evaluation will be reported separately. Results presented herein are based on data from Landsat imagery, county soil survey reports, and digital elevation models (DEM). All data are scaled to a 30 meter grid.

These presentations were selected to illustrate procedural capabilities, particularly with respect to variables significant to watershed hydrologic conditions and with respect to possible locations of excessive sediment production. Hydrologic related variables include slope and aspects, hydrologic soil class, and land use. Identification of possible locations of excessive sediment production are based on land use in relation to soil capability class. Obviously, numerous comparable presentations are possible. We solicit feedback from action agency personnel concerning specific needs not fully satisfied in this preliminary report. Comments and suggestions about presentations to meet such needs will be appreciated.

Results

Geographic features of Hotophia Creek are shown on Fig. 1. This type of figure was prepared with a roll-type plotter. Maximum possible size is 36 inches wide. All other figures were prepared using a color printer with a maximum size of 14 inches interfaced to the GIS.

Figures 2 through 5 were prepared from DEM data. The basic elevation data (Figure 2) can be used for direct comparison between watersheds or subwatersheds by statistical procedures such as the Smirnov test. More significantly, the DEM data is used to compute both slopes and aspects (Figures 3 and 4, respectively). Slope is one of the primary hydrologic variables and together with aspect can be used in a standard topographic analysis to develop overland flow routing networks. The Hotophia relief map (Figure 5) has cosmetic advantages over the basic elevation map but carries no additional information.

Land use for Hotophia Creek Watershed (Figure 6) was accomplished using a supervised classification on Landsat imagery dated 7/27/87. This is seven band imagery. The supervised classification was developed for Goodwin Creek Watershed, an adjacent watershed using bands 2, 4, and 5 and field-documented land use. Soil hydrologic units (Figure 7) and capability classes (Figure 8) were input to the GIS via digitizing the watershed area from the Panola County Soil Survey.

Various standard GIS procedures can be used to optimize information extraction from these basic data sets. Matrixing can be used to quantify variable interactions. Table 1 illustrates this capability. This matrix of land use versus soil capability class quantifies the occurrence of all variable (simple) interactions. Interactions of interest can then be weighted, and the non-zero weighted variables plotted to identify where the interactions of interest are located. Figures 9 and 10 illustrate this capability, using the interactions of land use with IVe, VIe and VIIe soils as an indication of potential erosion problems. Potential erosion problems associated with cotton and soybean production are shown in Figure 9. A second generation matrix is presented in Table 2, further subdividing the land use on IVe, VIe, and VIIe subset on the basis of slope. Again by using appropriate weighing techniques, subset elements with slopes less than 9% and greater than 9% can be located within the study area (Figure 10). The grid overlay on these figures has been added as an aid to location identification.

Subareas within a given watershed can be easily quantified. Subwatersheds of Hotophia Creek Watershed illustrate this capability (Figure 11), and all subareas (subwatersheds) can be characterized in like manner to that for the whole. Figures 12 through 17 present elevations, slopes, aspects, land uses, and soil hydrologic units and capability classes respectively for Harris, Mill and Marcum subwatersheds. Results are summarized in Table 3 for these subwatersheds.

Discussion

The preceding results have been presented to illustrate the range of readily-available data, the capabilities for identifying and quantifying interactions of specific variables, and the capabilities for subsetting areas of interest within a given watershed. These examples were selected due to their significance with respect to watershed hydrology and sediment production problems. Potential erosion problem areas (in this example estimated by the mismatch between actual land use and soil capability class) could be subset by land owner, by beat, or in an extreme case by individual field. Similarly, expected spatial variation in watershed hydrologic conditions can be estimated by appropriate subsetting. This subsetting could be by tributary, by area upstream of impoundments, or by a specified design criteria. Obviously, additional variables could be addressed in this type of information extraction procedure.

The inherent multitude of possible relations coupled with the need to evaluate reliability of results for each estimation precludes analysis of all possibilities. Rather, for maximum utility of effort, we need to restrict the analyses to relations of most value. For this purpose, we request that the appropriate action agency personnel critique applicability of such relations to their needs.

Acknowledgements

The authors wish to thank Dr. W. C. Little, Glenn Herring, Joe Willis, Joe Murphey, and Johnny Walker for their technical assistance. This report was prepared as a part of research under the Technology Applications Project (TAP), USDA National Sedimentation Laboratory, Agricultural Research Service, Oxford, Mississippi in cooperation with the Demonstration Erosion Control (DEC) Project in the Yazoo Basin.

Estimated average annual erosion on all nonfederal cropland, by land capability class and subclass, 1982.

Class and subclass		Sheet and rill erosion		
		1,000 tons	1,000 acres	Tons per acre
	I	1,529.0	317.8	4.8
	IIe	7,428.9	824.6	9.0
	IIw	9,615.0	2,248.0	4.3
	IIs	248.8	59.6	4.2
All	II	17,292.3	3,132.2	5.5
	IIIe	9,472.6	620.0	15.3
	IIIw	7,514.3	1,916.2	3.9
	IIIs	94.5	35.3	2.7
All	III	17,081.4	2,571.5	6.6
	IVe	6,018.0	243.8	24.7
	IVw	2,227.0	644.8	3.5
	IVs	79.2	12.5	6.3
All	IV	8,324.2	901.1	9.2
	V	690.9	192.9	3.6
	VIe	6,766.6	203.0	33.3
	VIw	6.0	2.4	2.5
	VIs	11.7	2.8	4.2
All	VI	6,784.3	208.2	32.6
	VIIe	3,530.6	90.4	39.1
	VIIw	--	0.0	--
	VIIs	35.4	1.2	29.5
All	VII	3,566.0	91.6	38.9
	VIII	--	0.0	--
TOTAL		55,268.1	7,415.3	7.5

Reference

Mississippi Nonfederal Land Resources, USDA Soil Conservation Service, Jackson, Mississippi, 1982.

Table 1.

LAND USE VS SOIL CAPABILITY

-LAND USE--	SOIL CAPABILITY CLASSES 4,6&7 E	2 W	2 E	3 E	4&5 W	2&3 W	GP	TOTALS
COTTON	0.18	2.53	1.15	0.12	0.08	0.59	0.00	4.65
SOYBEANS	0.66	2.32	0.28	0.10	0.00	0.04	0.00	3.40
WATER	1.43	0.63	0.04	0.04	0.09	0.00	0.12	2.35
IDLE LAND	11.51	3.04	0.89	0.53	0.16	0.04	0.06	16.23
FOREST	39.88	6.25	0.71	1.52	0.72	0.02	0.27	49.37
PASTURE	15.35	5.23	2.08	0.73	0.12	0.10	0.07	23.68
GRAVEL PITS	0.17	0.01	0.00	0.00	0.00	0.00	0.14	0.32
TOTALS	69.18	20.01	5.15	3.04	1.17	0.79	0.66	100.00

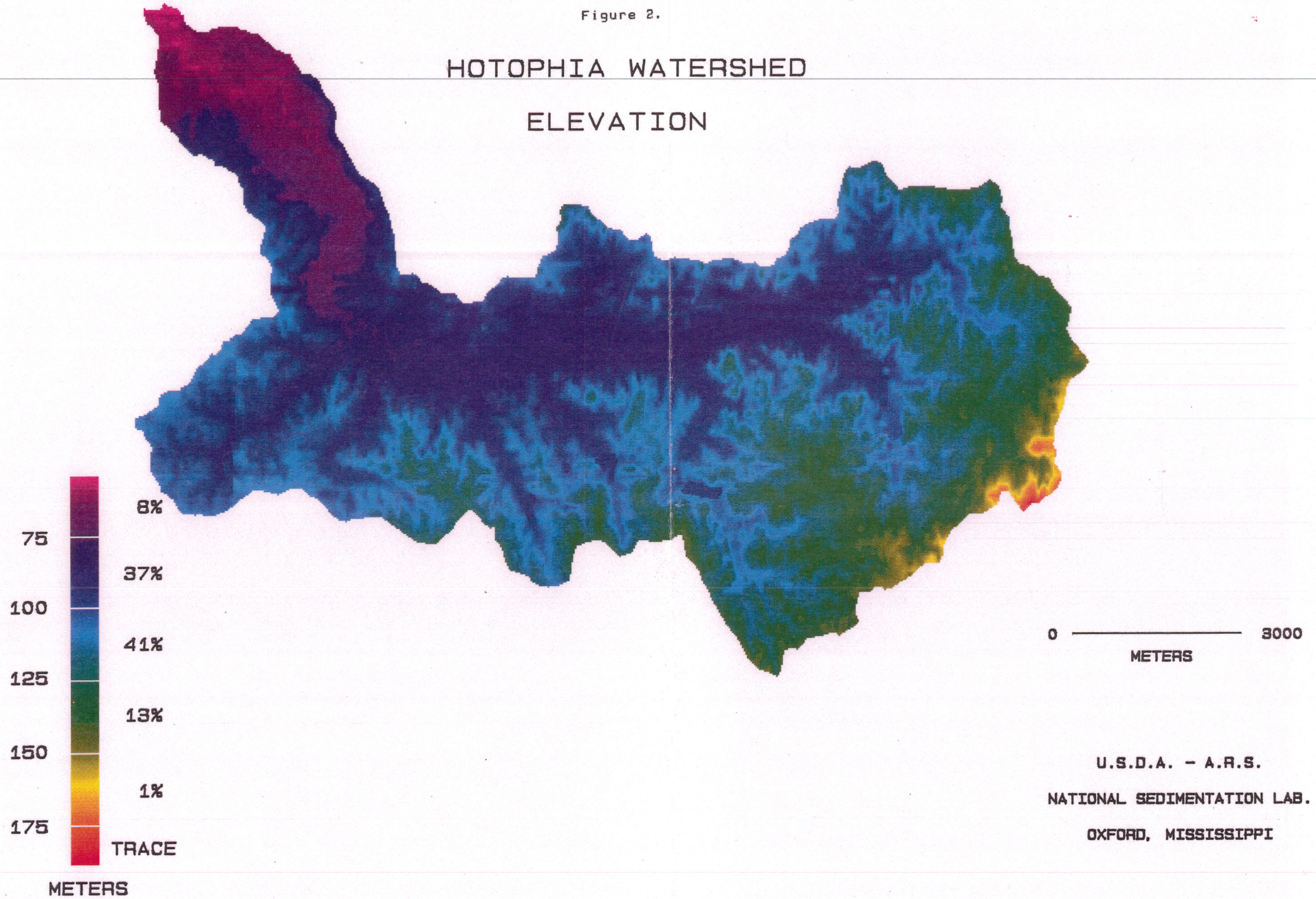
Table 2. Hotophia Watershed
Land Use on 4E,6E, and 7E Soils VS Slope %

	Slope						
Land Use	0-2%	3-5%	6-8%	9-12%	13-17%	>17%	Total
Cotton	0.16	0.09	0.01	0.00	0.00	0.00	0.26
soybean	0.36	0.39	0.16	0.04	trace	0.00	0.95
Water	0.53	0.72	0.53	0.20	0.06	0.03	2.07
Idle	3.53	5.95	4.93	1.68	0.48	0.09	16.66
Forest	9.65	18.45	17.96	8.40	2.88	0.32	57.66
Pasture	6.24	8.45	5.46	1.59	0.36	0.06	22.16
Gravel pits	0.01	0.13	0.07	0.03	trace	trace	0.24
Total	20.48	34.18	29.12	11.94	3.78	0.50	100.00

Table 3. Comparison of Selected Subwatersheds to Hotophia Watershed

		Harris	Mill	Marcum	Hotophia
Land Use					
	Cotton	1	Trace	Trace	5
	Soybean	1	2	4	3
	Water	4	2	3	2
	Idle Land	22	16	11	16
	Forest	40	57	70	50
	Pasture	30	23	12	24
	Gravel Pits	2	0	0	Trace
Slope					
	0- 2%	39	22	20	32
	3- 5%	39	33	30	33
	6- 8%	18	31	29	23
	9-12%	3	12	15	9
	13-17%	1	2	5	3
	>17%	Trace	Trace	1	Trace
Soil Capability					
	6E,7E -Gullied	26	35	30	29
	6E,7E -Not Gullied	18	30	34	23
	2W -Floodplain	13	10	15	20
	4E	23	21	18	17
	2E	17	2	1	5
	3E	2	2	1	3
	4W,5W -Floodplain	0	0	1	1
	2W,3W -Terrace	0	0	0	1
	Gravel Pits	1	0	0	1
Hydrologic Soils					
	Group C	55	29	29	42
	Group B -Gullied	35	36	31	31
	Group B -Not Gullied	8	35	40	24
	Group D	1	0	0	3
	Gravel Pits	1	0	0	Trace

Figure 2.



HOTOPHIA WATERSHED
ELEVATION
75
100
125
150
175
METERS
8%
37%
41%
13%
1%
TRACE
0
3000
METERS
U.S.D.A. - A.R.S.
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OXFORD, MISSISSIPPI

Figure 1.

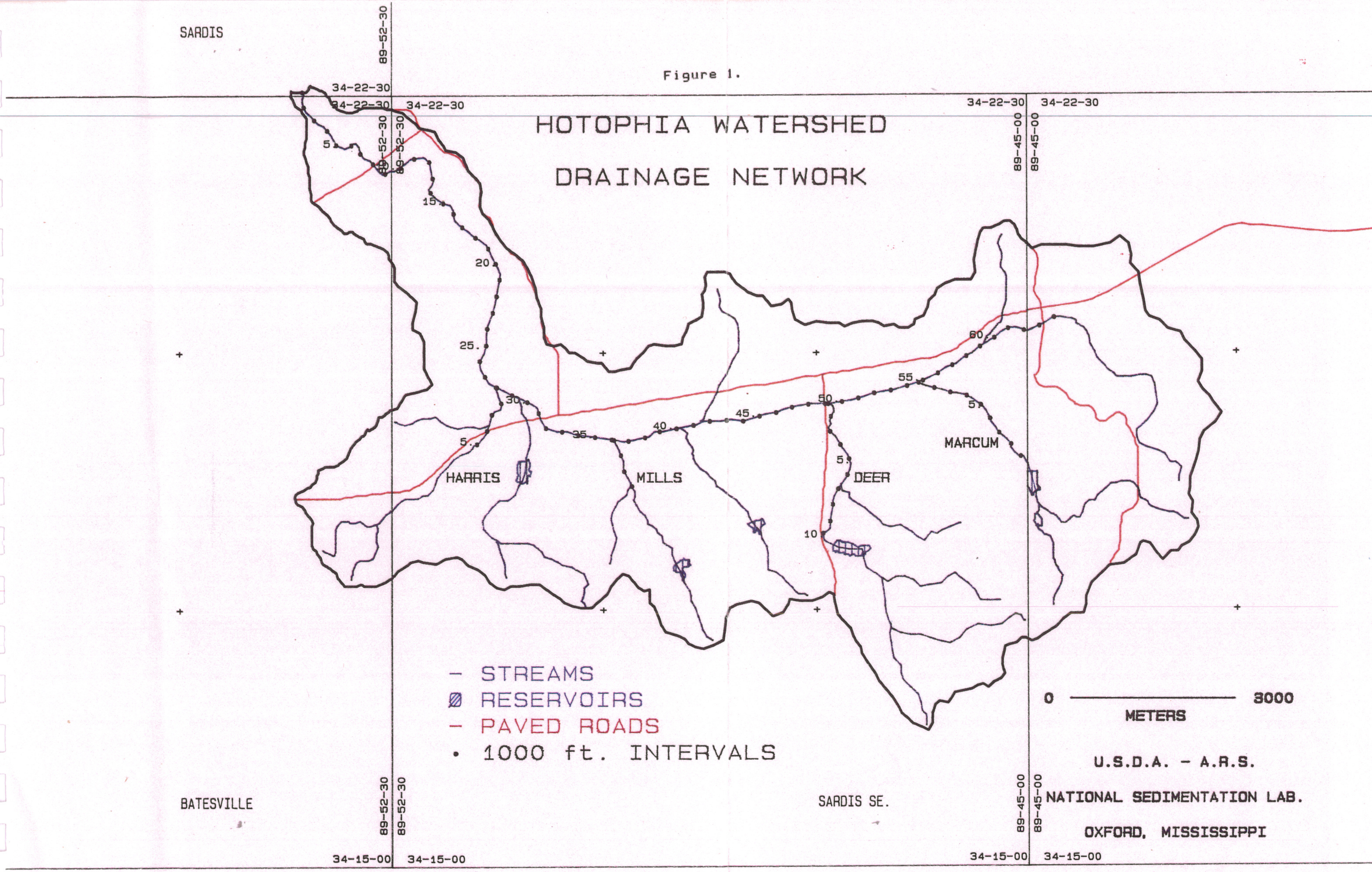
HOTOPHIA WATERSHED
DRAINAGE NETWORK
SARDIS
BATESVILLE
SARDIS SE.
34-22-30
89-52-30
89-45-00
34-15-00
HARRIS
MILLS
DEER
MARCUM
5.
15.
20
25.
30
35
40
45.
50
55
60
10
— STREAMS
RESERVOIRS
— PAVED ROADS
• 1000 ft. INTERVALS
0
3000
METERS
U.S.D.A. - A.R.S.
NATIONAL SEDIMENTATION LAB.
OXFORD, MISSISSIPPI

Figure 3.

HOTOPHIA WATERSHED

SLOPE

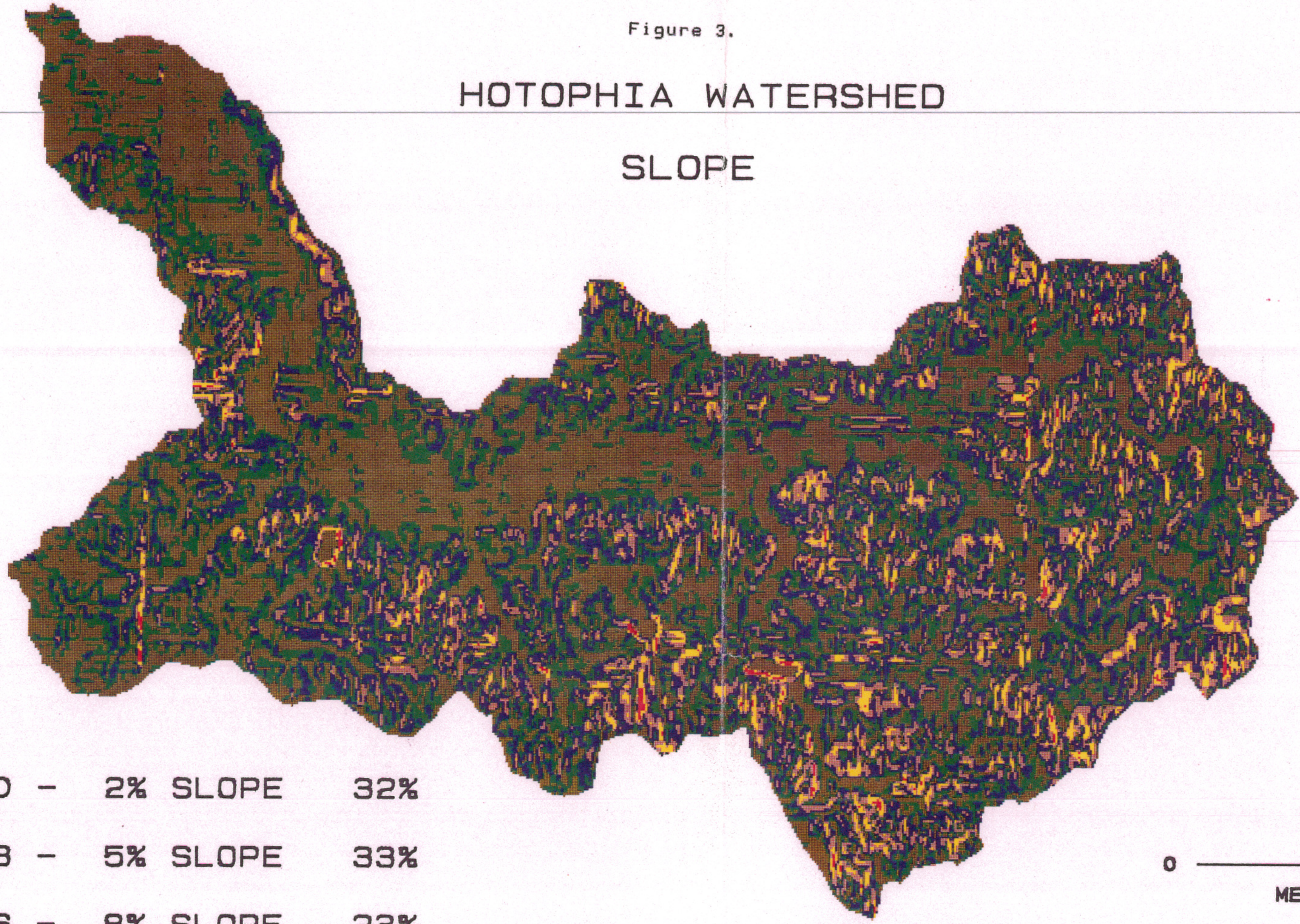

Figure 4.

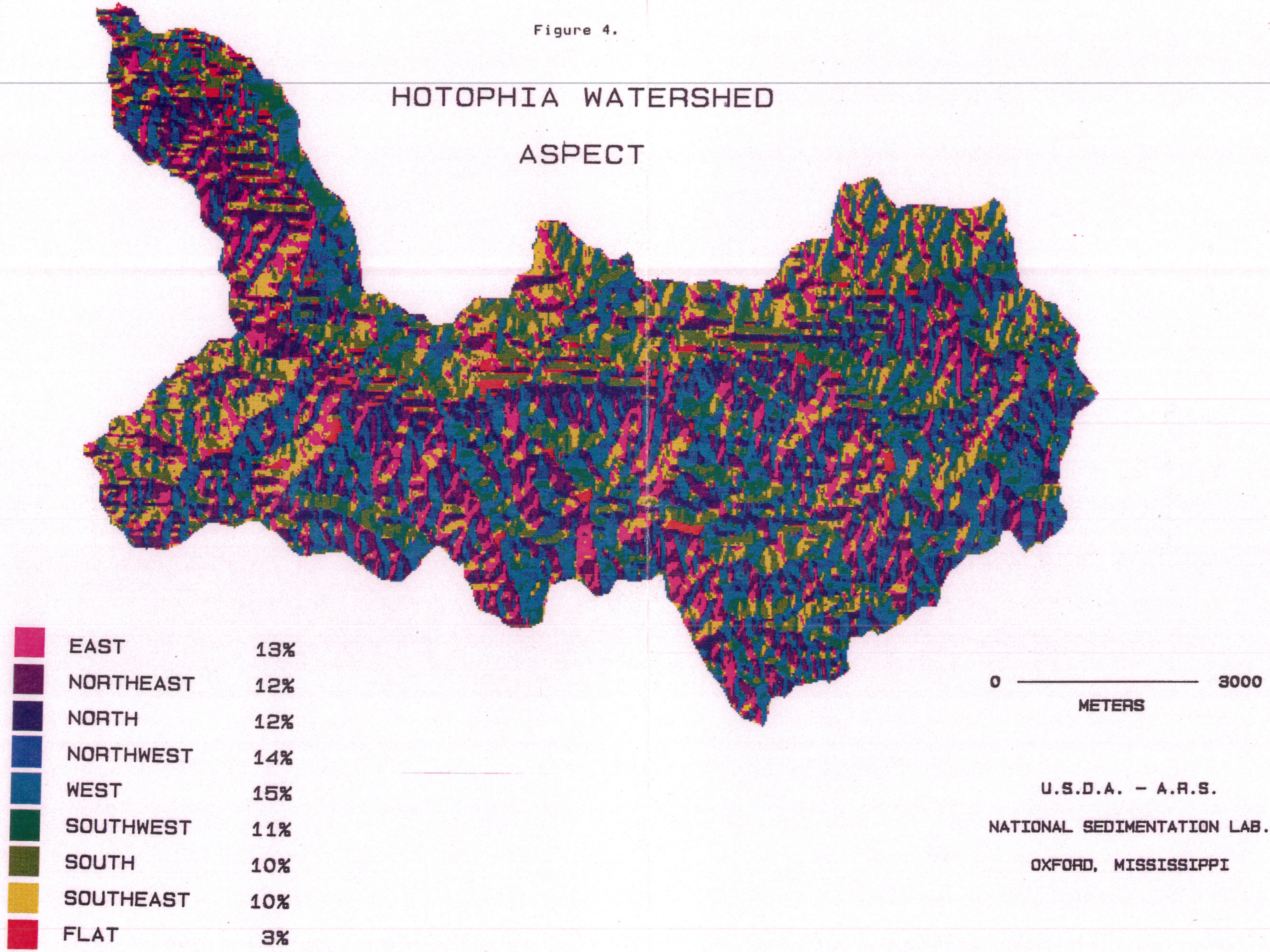
HOTOPHIA WATERSHED
ASPECT
EAST 13%
NORTHEAST 12%
NORTH 12%
NORTHWEST 14%
WEST 15%
SOUTHWEST 11%
SOUTH 10%
SOUTHEAST 10%
FLAT 3%
0 3000
METERS
U.S.D.A. - A.R.S.
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Figure 5.

HOTOPHIA WATERSHED

ELEVATION

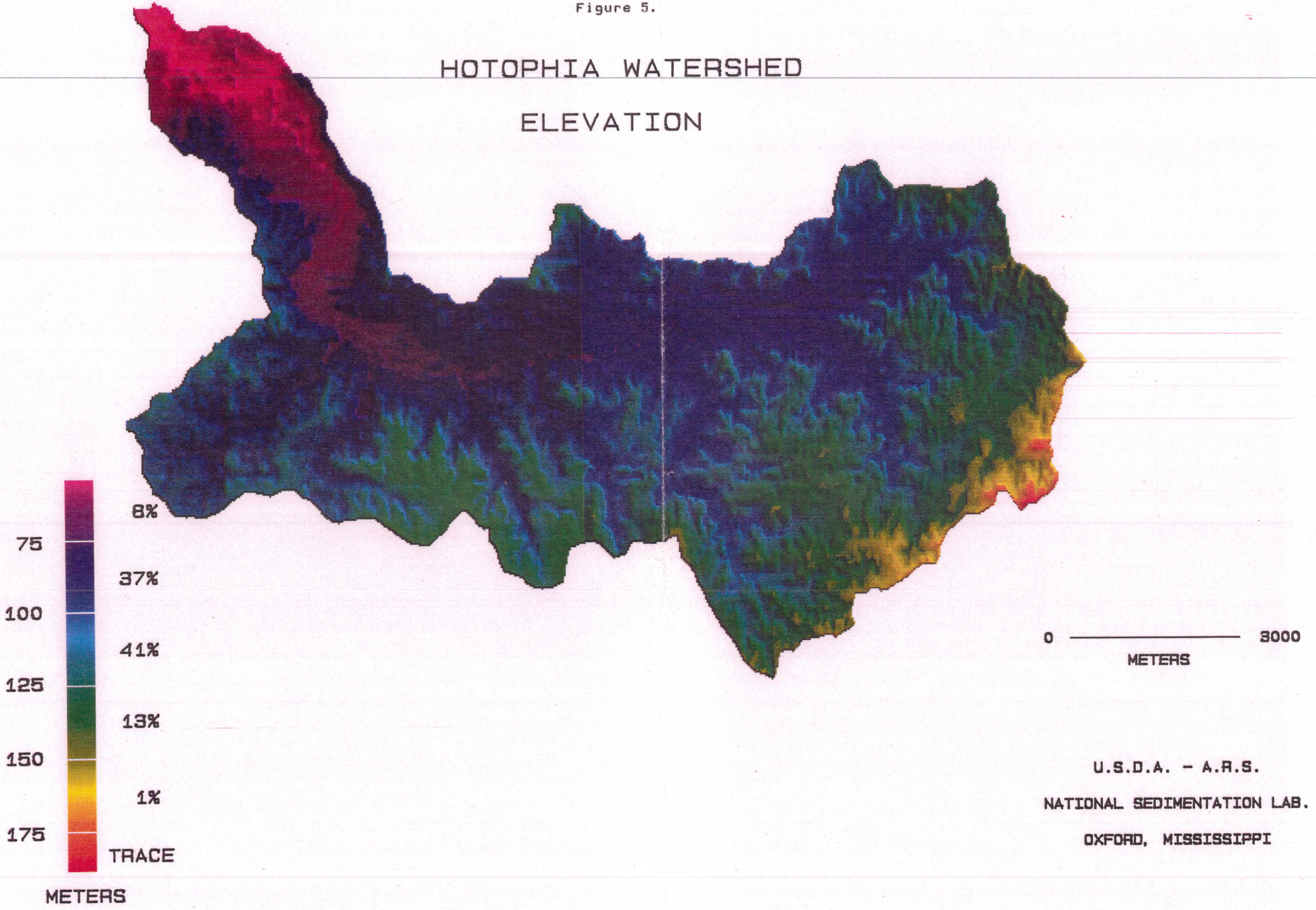

Figure 6.

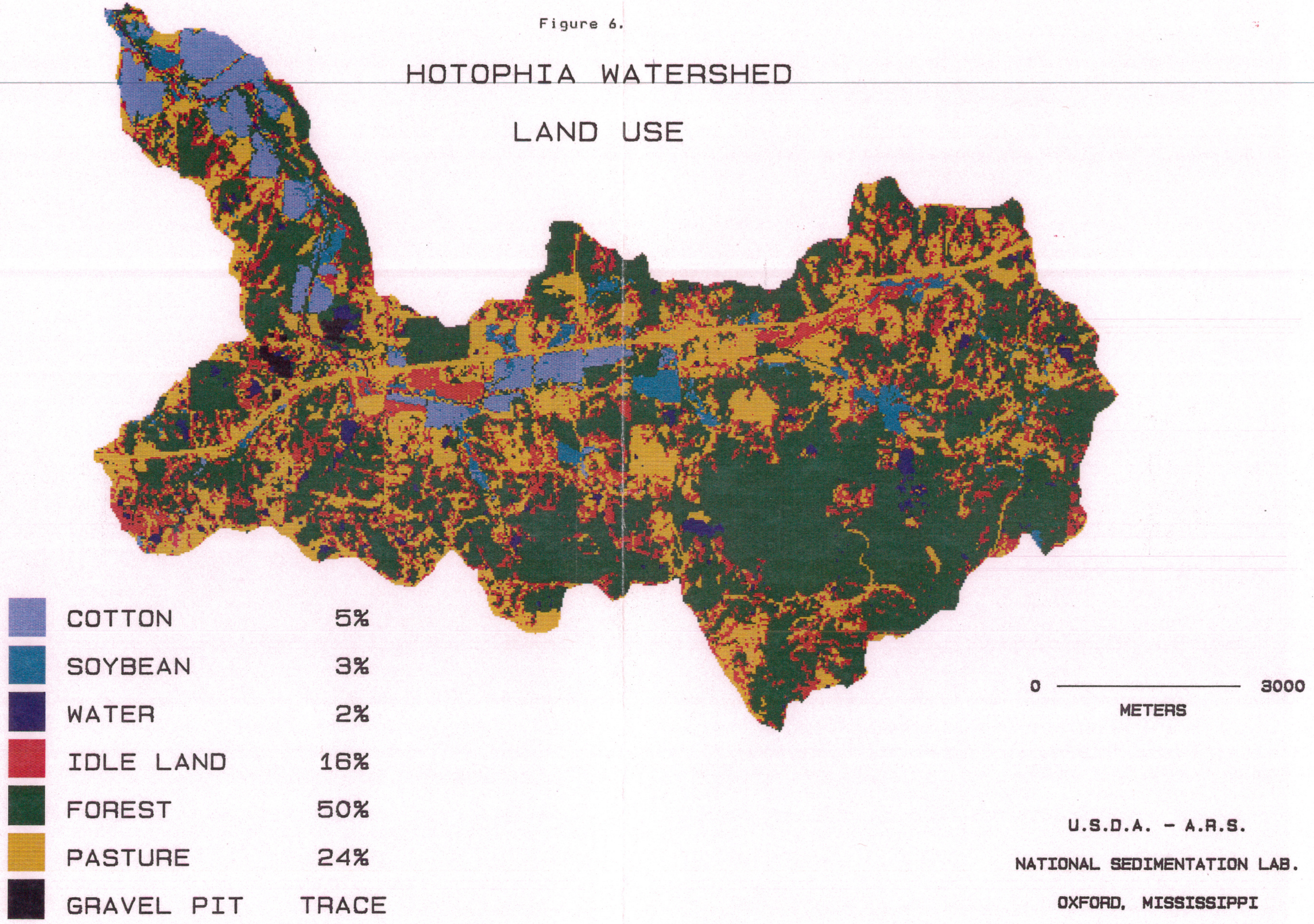
HOTOPHIA WATERSHED
LAND USE
COTTON 5%
SOYBEAN 3%
WATER 2%
IDLE LAND 16%
FOREST 50%
PASTURE 24%
GRAVEL PIT TRACE
0 3000
METERS
U.S.D.A. - A.R.S.
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Figure 7.

HOTOPHIA WATERSHED

HYDROLOGIC SOIL GROUPS

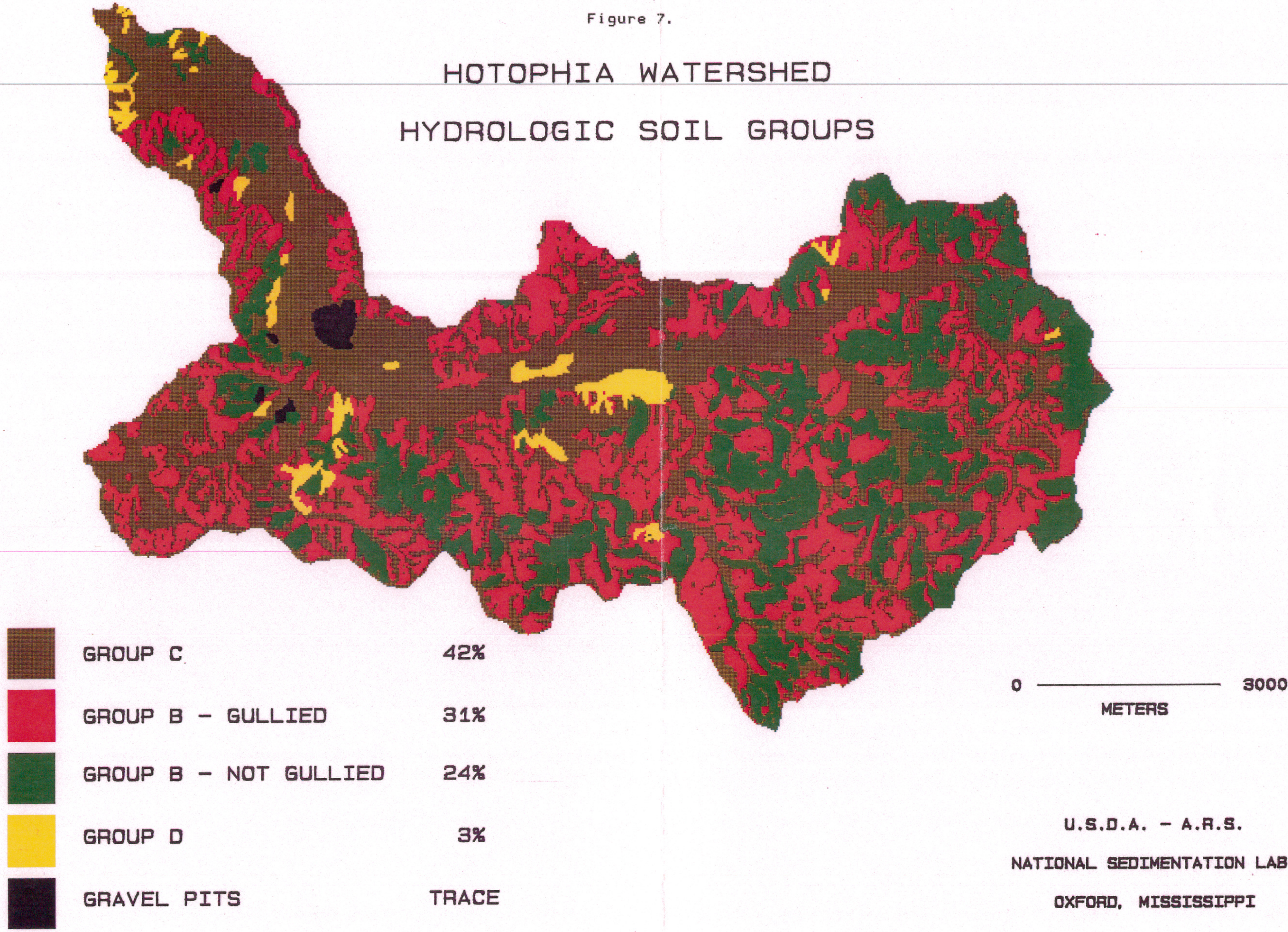

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Figure 8.

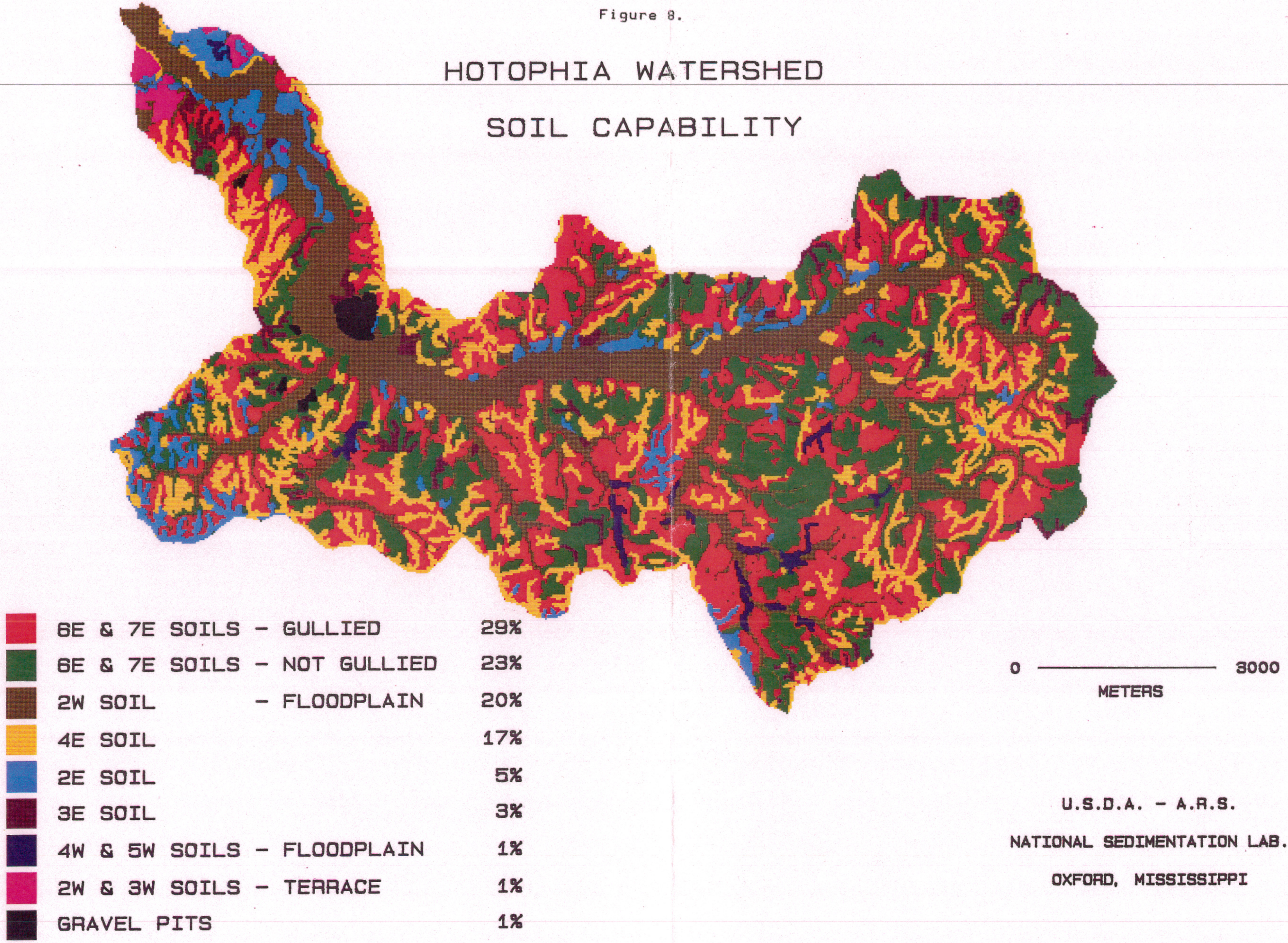
HOTOPHIA WATERSHED
SOIL CAPABILITY
6E & 7E SOILS - GULLIED 29%
6E & 7E SOILS - NOT GULLIED 23%
2W SOIL - FLOODPLAIN 20%
4E SOIL 17%
2E SOIL 5%
3E SOIL 3%
4W & 5W SOILS - FLOODPLAIN 1%
2W & 3W SOILS - TERRACE 1%
GRAVEL PITS 1%
0 3000
METERS
U.S.D.A. - A.R.S.
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Figure 9.

HOTOPHIA WATERSHED
POTENTIAL PROBLEM SITES ON CULTIVATED LANDS

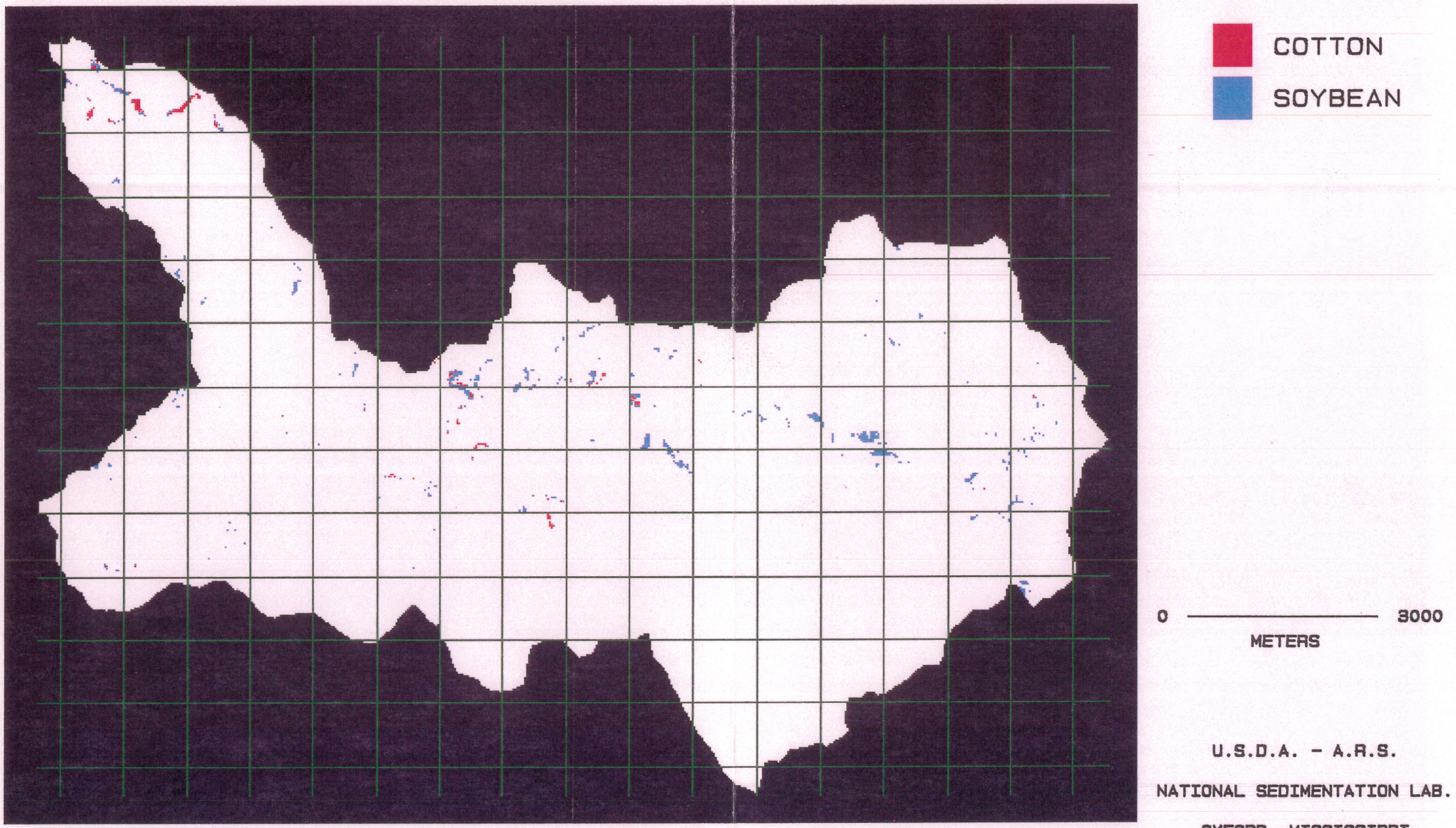

Figure 10.

HOTOPHIA WATERSHED
POTENTIAL EROSION SITES ON IDLE LANDS

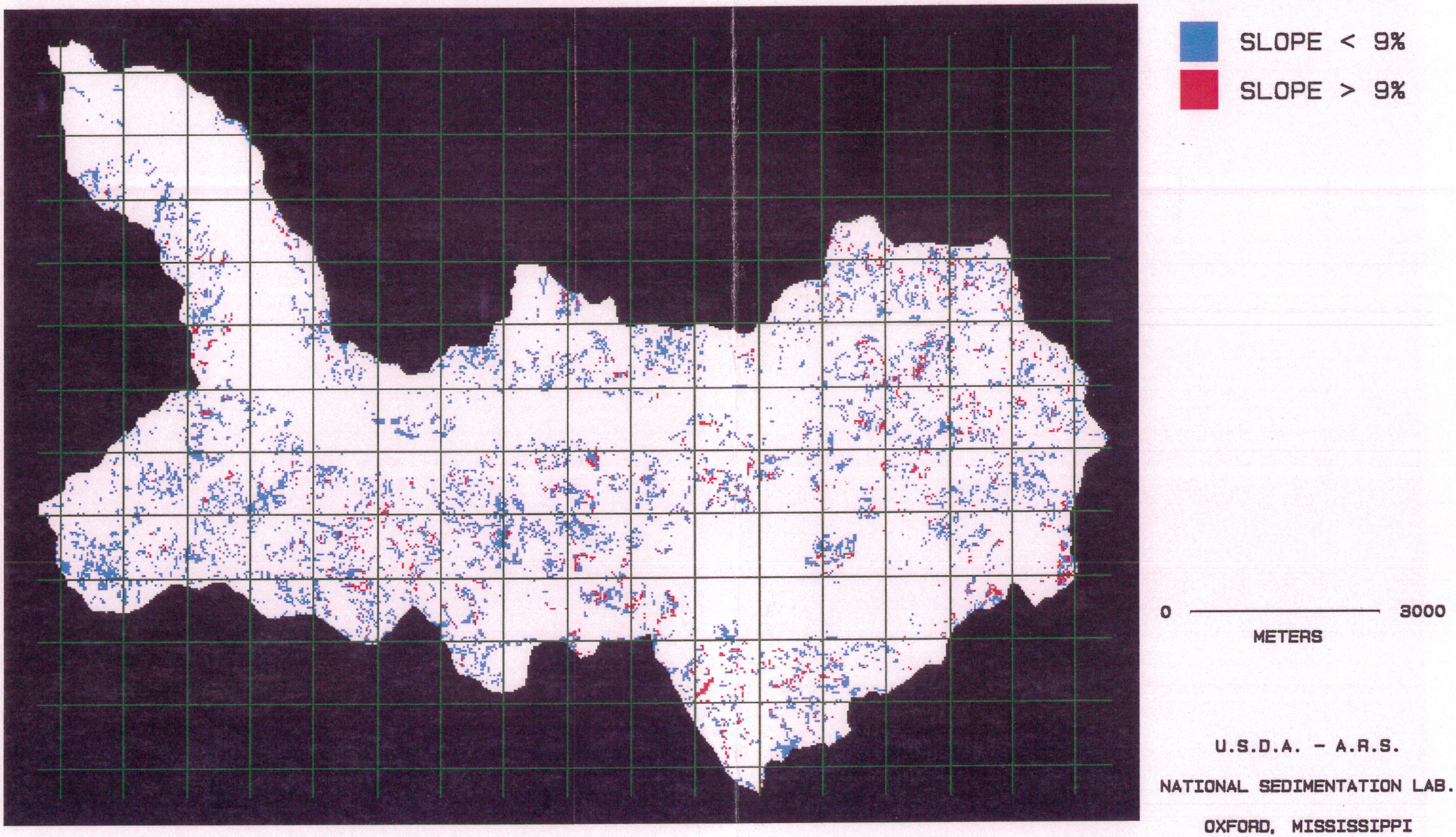

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Figure 11.

HOTOPHIA CREEK SUBWATERSHEDS

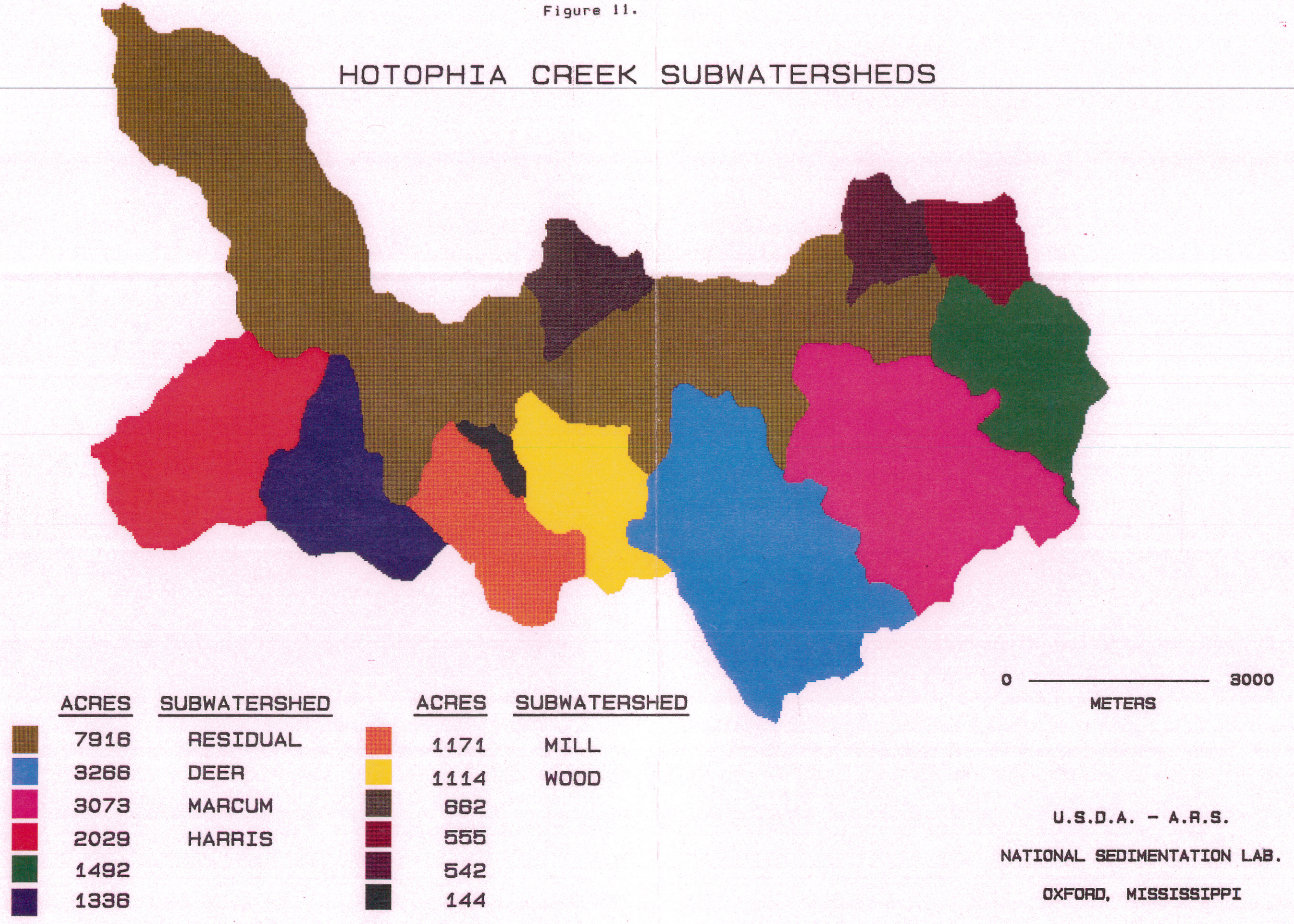
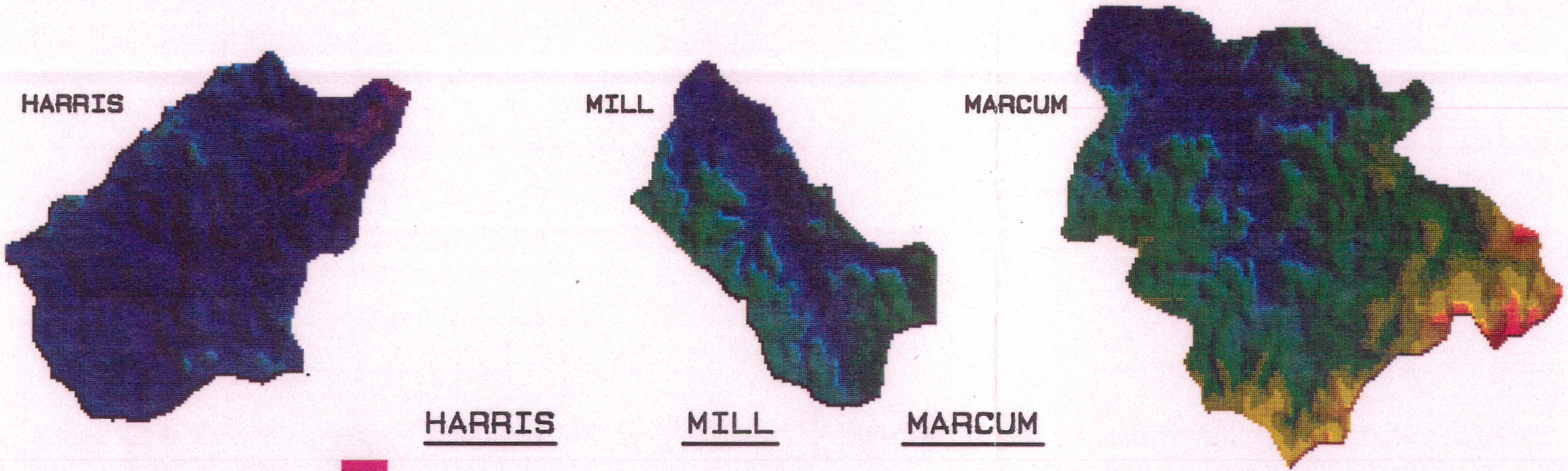
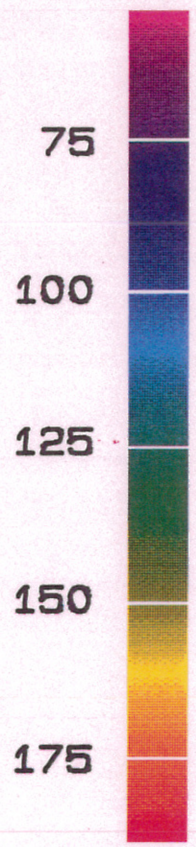


Figure 12.

HOTOPHIA CREEK SUBWATERSHEDS

ELEVATION





HARRIS	MILL	MARCUM
TRACE	0%	0%
59%	23%	12%
41%	72%	50%
0%	5%	30%
0%	0%	7%
0%	0%	1%

0 — 3000
METERS

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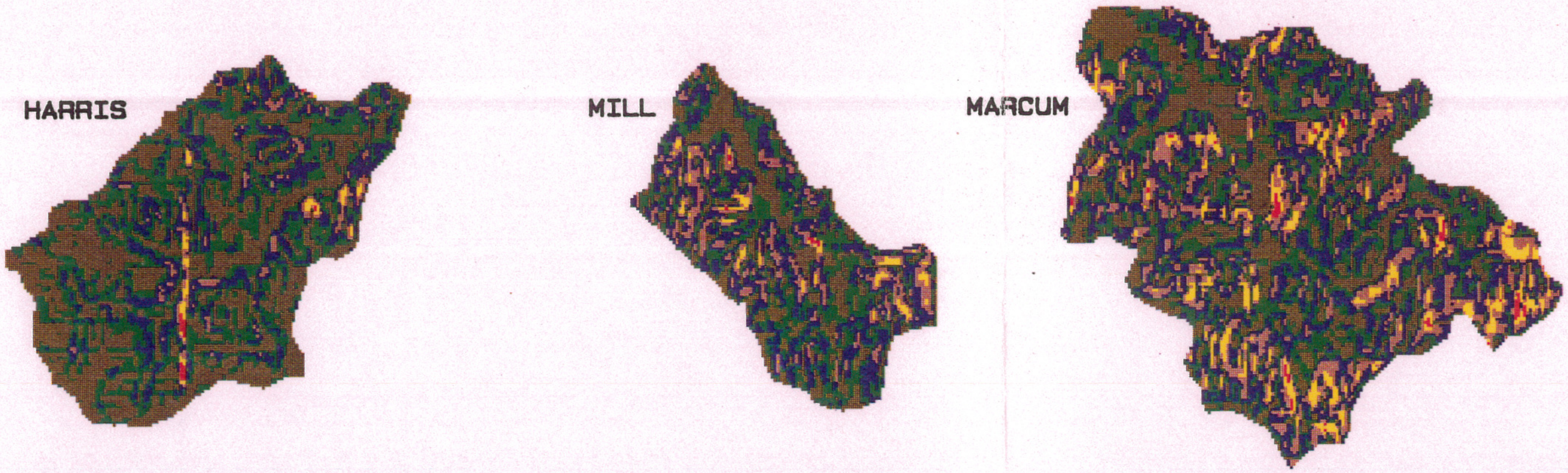
Figure 13.

HOTOPHIA CREEK SUBWATERSHEDS

SLOPE



	HARRIS	MILL	MARCUM
0 - 2% SLOPE	39%	22%	20%
3 - 5% SLOPE	39%	33%	30%
6 - 8% SLOPE	18%	31%	29%
9 - 12% SLOPE	3%	12%	15%
13 - 17% SLOPE	1%	2%	5%
18 - % SLOPE	TRACE	TRACE	1%

0 —— 3000
METERS

U.S.D.A. - A.R.S.
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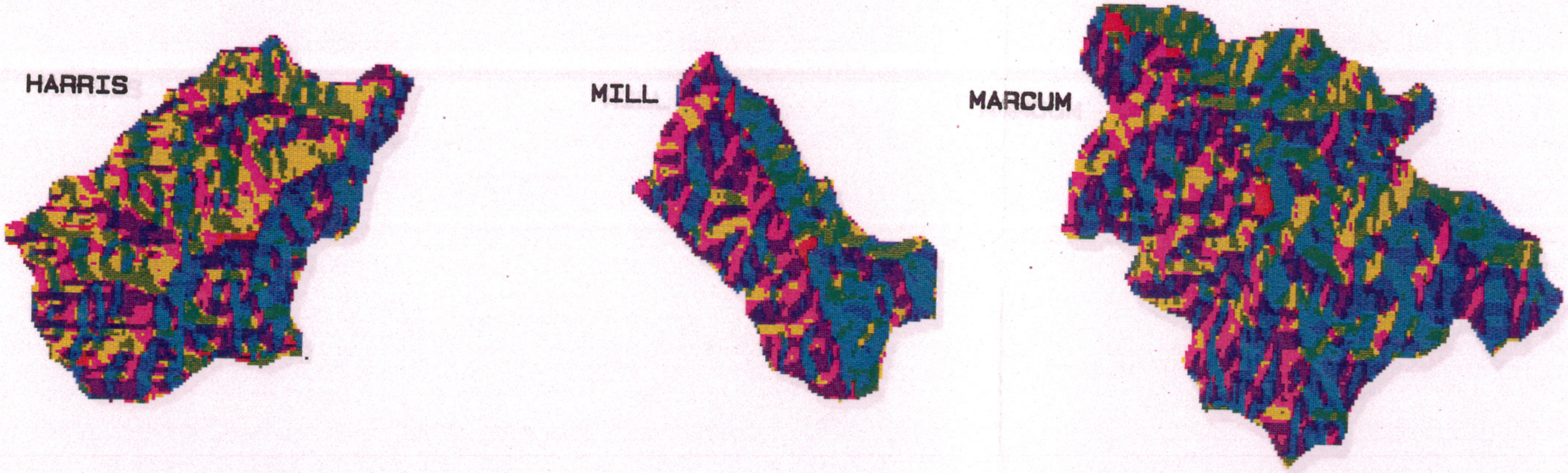
Figure 14.

HOTOPHIA CREEK SUBWATERSHEDS

ASPECT



	HARRIS	MILL	MARCUM
EAST	15%	17%	12%
NORTHEAST	13%	18%	12%
NORTH	11%	9%	12%
NORTHWEST	12%	12%	18%
WEST	10%	20%	18%
SOUTHWEST	9%	10%	11%
SOUTH	12%	5%	7%
SOUTHEAST	16%	7%	9%
FLAT	2%	2%	1%

0 ——— 3000
METERS

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