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OYOS AND IRONMENTAL CHANGE

MERICAN SOUTH-WEST

COOKE AND RICHARD W. REEVES

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Arroyos and Environmental Change in the American South-West

Ronald U. Cooke
Bedford College, University of London

and

Richard W. Reeves
University of Arizona, Tucson

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SRP10568

EDITORIAL PREFACE

The word arroyo, according to the *O.E.D.* is found as early as 775 in Old Spanish, but is of uncertain origin. It was usually translated into English as a small stream, water-course or similar feature but is now used to describe gullies characterised by steeply sloping or vertical walls in cohesive, fine sediments and by flat and generally sandy floors. Arroyos are found in several arid or semi-arid parts of the world, including the south-western United States, parts of India, South Africa and around the Mediterranean. Their occurrence and development are sometimes spectacular and have often received comment.

The authors have worked mainly in Arizona and California, and they have been able to obtain and assess a great deal of field evidence. In several places they have also been able to correlate this with early surveys made when the first farmers and pastoralists settled in the region. Perhaps the most interesting feature of their study is that they have shown how physiography and geology, archaeology, climatology, and land management have had to be taken into account in explaining arroyos. Those in the United States have possibly all developed since 1850. Many were started by white settlers in their transformation of the original landscape into one considered, at the time, more suitable for agriculture or pastoral use. The destruction of the original vegetation often led to the cutting of small runnels in storms; it was only a matter of time before these became true arroyos. The Indians, too, may well have played a similar, but less effective, part. On the other hand, some may well have originated from natural causes.

Whatever their origin arroyos are now a major feature in many landscapes and the authors of this volume are to be congratulated on studying them so comprehensively in two major regions. They have not only made an important contribution to geomorphology, but have also given both the student and the general reader a convincing account of the development of these channels.

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J.G. J.A.S.
F.V.E. C.D.H.

SRP10569

PREFACE

The folklore of the American South-West is dominated by conflicts, such as the familiar struggles between cowboys and Indians, and farmers and pastoralists. Behind these dramas lies the more persistent struggle between the inhabitants and their natural environment. It was fought by groups as diverse as Mormons, Texans, and Papago Indians, using barbed wire, windmills, irrigation ditches, and other weapons against forces that included fire, flood, and drought. In this study we examine an important aspect of environmental transformation that arose during the struggle since about 1850: the formation of arroyos in some of the major alluvial valley floors in southern Arizona and coastal California.

The nature and causes of arroyo formation have been a matter of concern and debate for many years among interested individuals in such disparate fields as geology, range management, archaeology, and climatology. Much of the interest lies in the related possibilities of explaining arroyos in terms of contemporaneous environmental changes, and of controlling arroyo cutting and the soil erosion accompanying it. We would hesitate to enter the debate if it were not for two rather surprising facts. In the first place, although many studies imply the widespread occurrence of arroyos and many explanations invoke regional environmental changes, there have been remarkably few attempts to study arroyo distribution. Thus we find that arroyos are much more numerous in California than previous observers have indicated, and arroyos are not quite as common in southern Arizona as we had been led to believe. A second, even more important fact is that in southern Arizona and coastal California much of the extensive body of historical evidence relevant to a study of arroyos and environmental change has not previously been analysed.

Our approach has been to create a generalized explanatory model of arroyo formation and to test a number of hypotheses within it in the context of a wide range of field and historical evidence. Our inquiry leads us into the under-developed, but potentially fertile, territory on the frontiers between historical research and scientific analysis of environmental change. We recognise at the outset that the fragmentary historical record makes impossible a perfect explanation of arroyos and the environmental changes related to them: the best that we can hope to do is to narrow the area of speculation and uncertainty, and to make progress towards identifying the most probable explanations. We hope that this attempt to join the equation with the archive contributes to the environmental debate in the American South-West, and that the results are also relevant to the discussion of similar problems in semi-arid lands elsewhere.

We are pleased to acknowledge the encouragement and assistance of many friends. In the field we have been helped by J. Haskell, D. Houston, D. Josif,

SRP10570

W. Miller, and W. Sigleo. Archival research was facilitated by the generous co-operation of many organizations, especially the Arizona Historical Society (Tucson), the Bureau of Land Management (Phoenix, Sacramento, and Riverside), the Southern Pacific Transportation Company (San Francisco), the U.S. Geological Survey (Tucson), the National Archives (Washington), the universities of California (Los Angeles) and Arizona (Tucson), and the National Oceanic and Atmospheric Administration (Asheville). Much of the research in southern Arizona was undertaken when Cooke was a Visiting Professor in the Department of Geography and Area Development of the University of Arizona (Tucson). Dr. G.E. Hollis, Dr. R. Bennett, Dr. A. Lavell, and K. Hughes contributed to the task of data analysis, and Valerie Cawley expertly drew the diagrams in the Department of Geography, University College London. Finally, we are grateful to Professor A.H. Clark, Dr. D.R. Harris, Professor L.B. Leopold, and others who have kindly read and commented upon parts of the manuscript. Although they do not necessarily subscribe to our views, they have helped to eliminate errors and clarify our presentation. We are responsible for any remaining shortcomings.

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Ronald U. Cooke
Richard W. Reeves

SRP10571

CONTENTS

List of Figures xi

PART I THE ARROYO PROBLEM 1

Dimensions of the Problem 1

Interest in the Problem 2

Practical aspects: the effects of arroyo cutting 3

Academic aspects: arroyos and environmental change 5

Review: Hypotheses of Arroyo Origin 6

Human land-use changes 6

Secular climatic changes 9

Random frequency-magnitude variations 13

Summary: A Model of Arroyo Formation 15

Erodibility of materials 16

Erosiveness of flows 17

Values of hydraulic variables 18

Evaluating the Model 23

PART II ARROYOS IN SOUTHERN ARIZONA 24

Introduction 24

Context 24

The pattern of arroyos 25

Sources of data 27

Evidence from the Major Valleys 28

Arroyos along the San Simon Valley 28

The Aravaipa Arroyo 35

Whitewater Draw 37

Entrenchment along the San Pedro Valley 41

Arroyos along the Santa Cruz Valley 47

Arroyos in Avra and Altar valleys 55

Arroyos in the Papago country: a speculation 59

Hypotheses of Regional Change 62

Introduction 62

The precipitation record 65

Vegetation changes 79

Climate, vegetation, and valley-floor discharge 86

Hypotheses of Valley-Floor Change 90

Slope change and arroyo development 90

Drainage concentration, related valley-floor changes, and arroyo initiation 94

Conclusions 97

SRP10572

PART III ARROYOS IN COASTAL CALIFORNIA 100

Introduction 100
- Environmental and historical context 101
- The pattern of arroyos 107
- Sources of data 109

Evidence from the Valleys 109
- San Timoteo Creek 111
- Cañada de Los Alamos 118
- Thorn Meadows 125
- Estrella River and Cholame Creek 129
- Panoche Creek 131
- Little Panoche Creek 134
- Arroyo Pasajero 135
- Bitterwater Creek 137

Hypotheses of Regional Change 137
- Introduction 137
- Precipitation trends 139
- Livestock numbers 164
- Vegetation change 170
- Vegetation, soil, and runoff 173

Hypotheses of Valley-Floor Change 176
- Increase of slope 176
- Concentration of flows 177
- Removal of valley-floor vegetation 178
- The relative effects of environmental changes 179

Conclusions 184

PART IV CONCLUDING REMARKS 187

Notes 190

References 194

Index 203

SRP10573

LIST OF FIGURES

I.1	The main areas affected by historic entrenchment in the American South-West	1
I.2	A model of arroyo formation	16
I.3	Relations between flow width and mean flow velocity for various depths and discharges	21
I.4	Relations between discharge and mean flow velocity for various hydraulic radii, Manning *n* values and widths of flow	22
II.1	The pattern of major arroyos in southern Arizona	26
II.2	San Simon Valley: historical data	31
II.3	San Simon Valley: the relations between the valley floor and transportation routes	34
II.4	Aravaipa Valley: historical data	36
II.5	Whitewater Draw: historical data	38
II.6	San Pedro Valley: historical data	43
II.7	San Pedro Arroyo at the Benson railroad bridge	44
II.8	Santa Cruz Valley: historical data	49
II.9	Santa Cruz Valley: data from Olberg and Schanck (1913)	52
II.10	Altar Valley: historical data	56
II.11	Avra Valley arroyo: cross-sections, 1970	58
II.12	Relations between peak discharge and recurrence interval for selected gauging stations in southern Arizona. For explanation, see text. Based on U.S. Geological Survey (1971) data	63
II.13	Ten-year running means comparing mean seasonal precipitation at 18 Arizona and western New Mexico stations (after Sellers, 1960) with mean annual temperatures at 18 Arizona stations (after Hastings and Turner, 1965)	67
II.14	Stations used for the analysis of daily precipitation	68
II.15	Fort Lowell-Tucson: 5-year running means of total annual precipitation, and annual frequency of rainfalls in different categories	70
II.16	Fort Lowell-Tucson: annual total precipitation, and annual frequency of rainfalls in different categories	71
II.17	Fort Lowell-Tucson: seasonal precipitation totals, and seasonal frequency of rainfalls in different categories (summer: June–September; non-summer: October–May)	72
II.18	Secular trends in southern Arizona, represented by regression lines showing precipitation totals and annual and seasonal frequencies of rainfalls in different categories	75
II.19	Vegetation distribution in southern Arizona (modified from Nichol, 1952)	79
II.20	Relations between cumulative forage deficiency and summer rainfall deficiency at Santa Rita (solid line, after Reynolds, 1954), with superimposed cumulative summer rainfall deficiencies at Ford Lowell-Tucson between 1867 and 1966	89

SRP10574

II.21	Longitudinal profiles of valley floors in southern Arizona (for explanation, see text)	92
III.1	Major mountain ranges and alluvial valleys in coastal California	102–3
III.2	Major vegetation types of coastal California (based on Burcham, 1957)	104
III.3	Distribution of arroyos in coastal California	108
III.4	The drainage basin of San Timoteo Creek	110
III.5	The longitudinal profile of San Timoteo arroyo, 1966	112
III.6	Cross-sections of San Timoteo arroyo, 1966 (number in each cross-section refers to distance upstream, as shown on Figure III.5)	113
III.7	San Timoteo arroyo: historical data	116
III.8	Cañada de Los Alamos: historical data	119
III.9	Cañada de Los Alamos: profiles	122
III.10	Thorn Creek: longitudinal profiles	127
III.11	Thorn Creek: cross-sections	128
III.12	Estrella River-Cholame Creek: historical data	130
III.13	Panoche and Little Panoche creeks	132
III.14	Arroyo Pasajero	136
III.15	Bitterwater Creek	138
III.16	Location of climatic stations	140
III.17	The 12-station composite record: annual precipitation	149
III.18	The 12-station composite record: seasonal distribution index	156
III.19	The 12-station composite record: early precipitation	156
III.20	The 11-station composite record: daily precipitation frequency	158
III.21	The 11-station composite record: mean daily precipitation intensity	160
III.22	The 5-station composite record: (a) maximum 24-hour and (b) maximum daily precipitation intensity	161
III.23	Summary of precipitation trends in coastal California	163
III.24	Livestock numbers, 1850–1950 (based on Burcham, 1957)	168
III.25	Livestock numbers in coastal California, 1850–1950 (based on Burcham, 1957)	169
III.26	Relations between discharge and mean flow velocity for two different valley-floor gradients	181
III.27	Relations between discharge and mean flow velocity for two different valley-floor cross-sections	181
III.28	Relations between discharge and mean flow velocity for different vegetal retardances	182
IV.1	Model of arroyo formation: summary of conclusions	188