

# HYDRAULIC PROCESSES ON ALLUVIAL FANS

**R.H. FRENCH**

*Water Resources Centre, University of Nevada System,  
2505 Chandler Avenue, Suite 1, Las Vegas, NV 89120, U.S.A.*



**ELSEVIER**

**Amsterdam — Oxford — New York — Tokyo 1987**

## TABLE OF CONTENTS

1	INTRODUCTION	1
1.1	Scope and Importance of Problem, 1	
1.2	Initial Concepts and Definitions, 17	
1.3	Conclusion, 24	
2	BASIC GEOLOGIC CONCEPTS	28
2.1	Introduction, 28	
2.2	Competing Geologic Doctrines, 28	
2.3	Alluvial Fan Systems: General Morphometric Characteristics, 32	
2.4	Conditions Favoring the Development and Modification of Alluvial Fans, 43	
2.4.1	Vegative Cover/Precipitation/ Sediment Yield, 43	
2.5	Fanhead Entrenchment, 61	
2.6	Conditions Favorable to the Formation of Debris and Mud-Flows, 65	
2.6.1	Precipitation, 69	
2.6.2	Lithology, 72	
2.6.3	Topography, 72	
2.6.4	Land Use, 73	
2.7	Characteristics of Flows in Ephemeral Streams, 73	
3	BASIC PRINCIPLES OF OPEN CHANNEL HYDRAULICS	82
3.1	Introduction, 82	
3.2	Specific Energy, 82	
3.3	Uniform/Normal Flow, 87	
3.4	Alluvial Channel Stability, 90	
3.5	Debris Flow Mechanics, 106	
3.5.1	Fluid Types, 109	
3.5.2	Analytic Results for Debris Flows, 114	
3.6	Hydraulic/Physical Models, 123	
3.6.1	Froude Law Models, 124	
3.6.2	Moveable Bed Models, 125	
3.6.3	Theoretical Techniques, 126	
3.6.4	Empirical, 130	
3.7	Conclusion, 131	

4	MODELS OF HYDRAULIC PROCESSES ON ALLUVIAL FANS	136
4.1	Introduction, 136	
4.2	Numerical Model, Geologic Time Scale:	
	Price (1972,1974), 136	
4.2.1	Initial and Boundary Conditions, 137	
4.2.2	Co-ordinate System, 138	
4.2.3	Input Variables and Parameters, 138	
4.2.4	Process: Uplift/Relief Development, 139	
4.2.5	Process: Weathering and Accumulation of Material in the Drainage Basin, 143	
4.2.6	Process: Flow, 144	
4.2.7	Calibration/Verification/Validation, 152	
4.2.8	Summary, 152	
4.3	Physical Model, Geologic Time Scale: Hooke (1965,1967,1968), 154	
4.3.1	Experimental Apparatus, 154	
4.3.2	Experimental Procedures, 155	
4.3.3	Verification, 155	
4.3.4	Results, 155	
4.3.5	Summary, 158	
4.4	Numerical/Physical Model, Engineering Time Scale: Anon. (1981a), 159	
4.4.1	Experimental Apparatus, 160	
4.4.2	Theoretical Assumptions and Development, 160	
4.4.3	Results, 167	
4.4.4	Summary, 173	
4.5	Numerical Models of Debris Flows in Channels: DeLeon and Jeppson (1982) and Jeppson and Rodriguez (1983), 174	
4.5.1	Debris Flow Relative to Water Flow Depths, 175	
4.5.2	Results, 178	
4.5.3	Discussion, 178	
4.6	Conclusion, 179	
5	METHODS OF FLOOD HAZARD ASSESSMENT ON ALLUVIAL FANS	183
5.1	Introduction, 183	
5.2	FEMA Methodology for Alluvial Fan	

Studies, 183	
5.2.1 FEMA Assumptions Explicit and Implicit, 183	
5.2.2 Implementation, 185	
5.2.3 Discussion, 191	
5.3 Alternative Methodology for Alluvial Fan Studies, 195	
5.3.1 Discussion, 196	
5.4 Proposed Modification of the FEMA Methodology, 199	
5.4.1 Proposed Modifications to the FEMA Methodology, 201	
5.4.2 Discussion, 203	
5.5 Conclusion, 206	
6 CONCLUSION	214
6.1 Introduction, 214	
6.2 Socio-Economic and Institutional Problems, 214	
6.3 Research Needs, 216	
6.3.1 Prognosis, 219	
GLOSSARY	222
AUTHOR INDEX	228
INDEX	234