TPG

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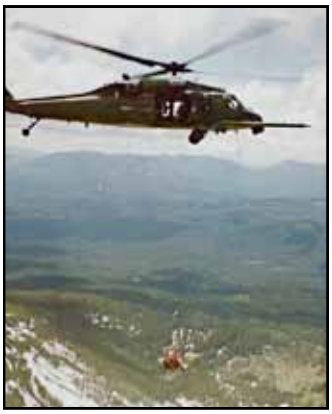

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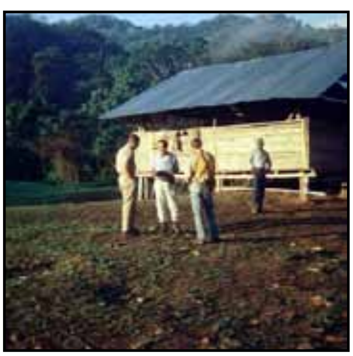

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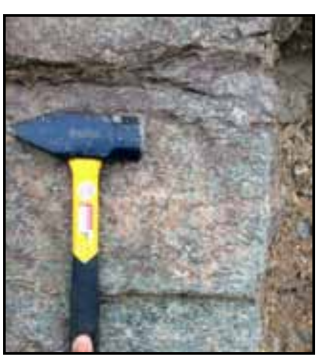

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Cover: Victoria Falls, Zambia/Zimbabwe. Photo was taken looking east from half-way down the falls at the Zimbabwe end. The falls are located at 17:55:28S, 25:51:24 E and are 355 feet high and 1708M (5605 feet) wide. The average volume of water going over them is 1088m3/s, or 38,430cfs, but it varies during the year from 3,000 cfs to 105,000 cfs. By John Berry, CPG-04032.

FEATURES

Development of an Earthen Dam Break Data Base

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STUDENT ARTICLE

Introduction:

A frequently used approach in the assessment of earthen dam-break outcomes is to use regression equations that are developed from data collected following various dam-break events. Several regression equations have been reported in the literature, and the resulting equations are not necessarily developed from the same dam-break data sets. Furthermore, data corresponding to a dam-break not already part of the data base may not fit well within the selected regression equation. Because dam-breaks and the ensuing floodplain inundation are a significant influence on many other water resources related factors, such as landslides, sediment transport, flooding, and mud flood propagation, providing another tool to aid in the assessment of the applicability of a particular dam-break regression equation may be a valuable contribution towards better understanding the connectivity between the various related water resources factors.

Objective of the Project:

Our project is an ongoing assembly of earthen dam break event measurements into a comprehensive data base of 146 earthen dam failure events with relevant measurements related to the regression equations of the in-situ situation. These measurements consists of over 23 different parameters as seen in Figures 2 and 3. In addition, a web based application is under construction that provides two-dimensional "slices" of the multi-dimensional data base, in order to visualize 2-dimensions of the selected parameters in the data base. For instance, a graph of dam height can be measured against the peak outflow.

Description of the Project:

Because the data base is intended to evolve over time, some of the data point entries do not have values and consequently those particular events will not appear in the respective marginal distribution scatter plots. The various marginal distributions can be used to examine the positioning of test case data against the measured data contained in the data base. Such a visualization may be useful to indicate the relevance of the data base with respect to the test case under examination, and therefore indicate the possible applicability of the published corresponding regression equations. Sources of the earthen dam break data include reports from the U.S. Department of the Interior Bureau of Reclamation Dam Safety Office, articles published in the Journal of Geotechnical and Geoenvironmental (©ASCE) and Journal of Hydraulic Engineering (©ASCE), and reports submitted to the National Dam Safety Review Board. The data collected is as recent as 1996. Contributors to the data base include Dr. Tony Wahl, Dr. Steven Abt, and Dr. Limin Zhang who are foundational in the literature in the development of earthen dam break assessment methodology and data compilations. The data base will be downloadable from the web page.

Dam and Location		Built	Failed	Failure Mode	Construction
1	Apishapa, Colorado	1920	1923	Piping	Homogeneous earthfill, fine sand
2	Baimiku, China			Overtopping	
3	Baldwin Hills, California	1951	1963	Piping	Homogeneous earthfill
4	Banqiao, China			Overtopping	
5	Bayi, China			Piping	
6	Bearwallow Lake, North Carolina	1963	1976	Sliding	Homogeneous earthfill
7	Big Bay Dam,USA			Piping	
8	Bradfield, England	1863	1864	Piping	Rockfill/earthfill
9	Break Neck Run, USA	1877	1902		
10	Buckhaven No. 2, Tennessee			Overtopping	
11	Buffalo Creek, West Virginia	1972	1972	Seepage	Homogeneous fill, coal waste

Figure 1. Illustration of the data base

Embankment Dimensions								Hydraulic Characteristics					
Dam Height	Crest Width	Base width	Average width	Upstream slope	Downstream Slope	Length	Peak Outflow		Reservoir Storage	Surface area	Volume stored above breach invert	Depth above breach	Breach Formation Factor
h_d	W_c	W_b	W	$Z_{e/u}$	$Z_{e/d}$	L	Q_p		S	A	V_w	h_w	$V_w h_w$
m	m	m	m	Z:1(h:1)	Z:1 (h:v)	m	m^3/s	Method of Determining Peak Outflow	m^3	m^2	m^3	m	m^4

Figure 2. Assembled embankment dimensions and hydraulic characteristics used in the data base

Breach Characteristics							Time Parameters			
								Maximum		
	Height	Top width	Bottom width	Average width	Average side slopes	Eroded volume	Formation Time	Failure Time	Development Time	Breach and empty Time
	h_b	B_{top}	B_{bottom}	B	Z	V_{er}	t_f	t_f	t_f	t_f
Breach Shape	m	m	m	m	Z:1(h:v)	m^3	hr	hr	hr	hr

Figure 3. Assembled Breach characteristics and time parameters used in the data base

The web application depicts the data base as a set of two-dimensional scatter plots, including a scatter plot display for each possible two-dimensional selection of data base variables, and highlights the positioning of the test prototype data. These displays will demonstrate the possible appropriateness of the global data base in enveloping the test data situation. A common problem in the use of published regression equations can be the lack of a clear depiction as to how well the data used to develop the considered regression equation fits the situation of the test data point. This web application will provide such a demonstration and may be another useful tool for aiding evaluation of earthen dam break assessment.

The project is evolving with the addition of data over time and modification of data base entries if required.

References

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LTC Randy Boucher is an Assistant Professor and Senior Analyst at the United States Military Academy at West Point where he serves as the Program Director for the Advanced Mathematics Program in the Department of Mathematical Sciences. He holds an M.S. from the University of Washington and a Ph.D. from the Naval Postgraduate School. His research involves optimal control, computational mathematics, and dynamical systems.

Karoline M. Hood is a Captain in the Army and an Instructor in the Department of Mathematical Sciences at the United States Military Academy. She has served in operational assignments around the world to include deployments to Iraq and Afghanistan. She graduated from the United States Military Academy with a B.S. in Environmental Engineering and also holds a M.S. from the University of Missouri Science and Technology in Rolla, MO in Environmental Engineering and a M.S. from the Naval Post Graduate School in Monterey, CA in Applied Mathematics. She is a licensed P.E., Project Management Professional, and LEED AP BD&C.

Dr. Theodore V. Hromadka, II is a Professor of Mathematics at the Department of Mathematical-Sciences at the United States Military Academy, West Point, New York. He has been Principal Engineer and Hydrologist for nearly 15 years at the consulting firm Hromadka & Associates in Rancho Santa Margarita, California. He holds several professional licenses, including Civil Engineer, Geoscientist, Geologist, and holds professional certifications as a Hydrologist for both surface water and groundwater. He has over 40 years of professional engineering experience and has served in various academic and research positions for over 35 years. His publications record includes 375 papers and over 20 books. He has authored more than 30 monographs that have been published by governmental agencies and he has prepared or directed the preparation of project reports and studies for over 1000 studies. He has served as Expert Witness in over 500 Superior Court matters, appearing in over 60 Court trials. He is a Diplomate of the American Academy of Water Resources Engineers and serves on the Board of Directors of the Wessex Institute of Technology in Great Britain. Dr. Hromadka also serves on the Advisory Board of the Department of Civil Engineering at the United States Military Academy at West Point. He is Professor Emeritus at the California State University, having served in the Departments of Mathematics, Environmental Studies and Geological Sciences. He is also an Associate member of AIPG.

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Bryce D. Wilkins is a Cadet at the United States Military Academy. He is majoring in Mathematical Sciences with Honors and has a minor in Network Science. Bryce has worked with the other authors in advancing research related to the Complex Variable Boundary Element Method (CVBEM) for solving problems governed by Laplace's partial differential equation. Recently, his work has explored the use of other basis functions in the CVBEM approximation function and has explored modeling problems governed by the transient Laplace equation.