

GEORGE BWALYA MATANGA

CURRENT POSITIONS

Civil Engineer (hydrology and water resources)
MP Coordinator, Science & Technology Program

Division of Planning, Mid-Pacific Region
Bureau of Reclamation
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EDUCATION

Post-Doctoral Fellowship, Earth Sciences, University of Waterloo, Canada (1982)
Ph.D., Civil Engineering, University of California, Davis, California (1978)
M.S., Civil Engineering, University of California, Berkeley, California (1973)
B.S., Civil Engineering, California State University, Sacramento, California (1971)

PROFESSIONAL REGISTRATIONS/CERTIFICATIONS

Professional Engineer, State of California

LETTER OF APPRECIATION (from U.S. Department of Energy)

In April 2008, you participated in an expert panel of scientists from academia and industry to provide observations and suggestions intended to improve the current understanding of groundwater-surface water interactions in the 100 Areas of the U.S. Department of Energy Hanford Site. The U.S. Department of Energy, Richland Operations Office (RL) would like to thank you for your valuable contribution to the panel and subsequent report "Technical Evaluation of the Interaction of groundwater with the Columbia River at the U.S. Department of Energy Hanford Site, 100-D Area, SGW-39305, Revision 0." RL recognizes the considerable time and effort extended by you and other members of the panel. Your observations and suggestions have provided significant insight in the development and implementation of the remedial investigation efforts.

Again, thank you very much for your time, effort, and expertise in support of the 100 Area cleanup effort at the Hanford Site.

EXPERIENCE

1999 – present: Civil Engineer
Science & Technology Program Coordinator, MP Region

Department of the Interior, Reclamation, Mid-Pacific Region, Sacramento,
California

Duties

- Providing leadership in application of numerical tools for impact analysis of climate change on groundwater resources in the Central Valley of California.
- Performing impact analysis of land subsidence caused by the additional groundwater withdrawal due to on-going Californian drought.
- Developing and applying numerical tools for analyses of issues related to water-supply reliability, water quality and ecosystem health in an integrated manner for California's Bay Delta Conservation Plan. The Delta, located east of San Francisco, is a major source of water supply for California's agriculture and more than twenty-five million Californians.
- Leading a technical team that is applying HydroGeoSphere to evaluate effectiveness of a sequential drainage water re-use system known as "Integrated on-Farm Drainage Management (IFDM) system" to control drainage water and salinity in California's San Joaquin Valley. The task involves analysis of flow and transport processes taking place within the IFDM system and surface/subsurface water regimes. Results of the evaluation and analysis will be valuable in optimal design and management of IFDM systems in arid agricultural lands of the world.
- Leading a technical team that is applying HydroGeoSphere in a feasibility study of a proposed off-stream storage reservoir in Upper Klamath River Basin of California and Oregon.
- Applying HydroGeoSphere to evaluate flooding and water banking/conjunctive use in Sacramento River Basin. This project is related to feasibility study of Shasta Dam and Reservoir Enlargement by Reclamation for the purpose of enhancing water supply reliability.
- Providing hydrology and modeling support to joint California State Water Project (SWP) and Federal Central Valley Project (CVP) in California's Central Valley.
- Coordinating research activities of Reclamation's Science & Technology Program in the Mid-Pacific Region Reclamation.

Research and Development

- Developing an approach for evaluating stream functions in three-dimensional groundwater flow systems with wells.
- Developing software for visualization of flow and transport processes in three-dimensional flow systems with wells. This will be a valuable tool in

control and remediation of groundwater contamination, and design of drinking-water well fields.

1991 – 1999: Senior Staff Engineer, Radian International, Sacramento, California

Duties

- Supervised a technical team responsible for design and implementation of a groundwater remediation system at Reese Air Force Base, Texas. Developed numerical models and scripts that were used in design of the system. Economic analysis of various designs was undertaken in order to arrive at a cost-effective design by minimizing pumping and operational costs. An optimization model, MODMAN, was applied to minimize the number of extraction and injection wells. Received a Certificate of Appreciation jointly from the United States Army Corps of Engineers, Tulsa, and Reese Air Force Base.
- Undertook task leadership in groundwater modeling for numerous projects.
- Supervised and mentored Radian staff in application of numerical models for analysis of groundwater flow and transport, evaluation of hydraulic connection between groundwater and surface-water bodies, and design of groundwater remediation systems.
- Provided modeling expertise to project managers.
- Displayed extensive experience in application and modification of existing finite-difference and finite-element codes, development of state-of-the-art computer codes, and development of differential equations describing flow and transport processes.
- Modified a finite element flow and transport model SALT developed at University of Waterloo to incorporate capability to handle complex flow and boundary conditions. This model was applied to evaluate groundwater flow and contaminant transport at Elmendorf Air Force Base, Anchorage, Alaska.
- Developed a pre-processor for University of Waterloo VAPOUR-T model in order to facilitate application of the model by users with limited knowledge of the finite element method. VAPOUR-T has been applied extensively by Radian in analysis of vadose-zone vapor transport in Central California.
- Performed modeling procedures such as: data evaluation, development of conceptual models, model selection, model calibration, sensitivity analysis, application of numerical models in solution of real problems, and reporting of model results and recommendations.

- Developed a statistical code RISAC (Radian International Statistical Analysis Code) for health risk assessment.

Research and Development

- Developed a partial-differential equation for evaluation of spatial distribution of pseudopotential function in anisotropic groundwater flow systems.
- Developed two partial-differential equations for evaluating spatial distributions of stream functions in three-dimensional groundwater systems. Pseudopotential and stream functions are valuable in visualization of flow and transport processes in three-dimensional flow systems.
- Developed a visualization code, visualFAT (visual Flow And Transport). This code has capabilities for plume animation and process visualization by displaying hydraulic and transport parameters on pseudopotential and stream function surfaces, resulting in accurate evaluation of flow and transport processes. The visualFAT code is based on C, OpenGL and win32 Windows programming.
- Developed a finite element flow and transport code (flowTran) for evaluation of flow and transport parameters required by visualFAT. The code flowTran is written in FORTRAN.

1996 – 1999: Consultant, United Nations Children Fund (UNICEF)

- Provided advice to UNICEF on use of groundwater resources in water supply and sanitation in South Africa.
- Provided training in groundwater hydrology and groundwater modeling to South African professionals from government, industry, and academia.
- Developed a computer code that could be applied by non-technical staff to acquire an understanding of groundwater flow and transport processes.
- Provided technical advice to South African Department of Water Affairs and Forestry, and National Community Water Supply and Sanitation Training Institute.

1994 – 1995: Lecturer, Civil and Environmental Engineering, University of California, Davis

- Taught Advanced Groundwater Hydrology: (A) groundwater flow and contaminant transport processes and (B) finite-element modeling of three-dimensional flow and transport.

1986 – 1991: Supervising Engineer, McLaren/Hart, Rancho Cordova, California

- Evaluated groundwater flow and chemical migration in an aquifer under tidal influence for an aerospace company.
- Applied air models for AB 2588 compliance services to a number of companies in Southern California.
- Applied numerical models to design remediation systems at Lockheed and Ford sites in the San Francisco Bay area.

- Applied hydraulic-head and stream-function numerical model to determine possible sources of groundwater contamination in San Gabriel Basin in Southern California for an aerospace client.
- Analyzed pumping-test data and developed zones of capture using a finite element model for an international electronics manufacturing company.

1986 – 1987: Contractor, Bureau of Reclamation, Sacramento

- Evaluation of the long-term viability of groundwater pumping in the western San Joaquin Valley was essential to the plan formulation and evaluation activities of the San Joaquin Valley Drainage Program. The San Joaquin Valley Drainage Program had a mandate by the US Congress and the California Legislature to develop long range plans for management of salt and selenium contaminated drainage water in the San Joaquin Valley of California. Developed a unique finite element groundwater model that was ideally suited to perform the analysis required for evaluation of salt and selenium conditions. The model was based on the theory of dual application of stream functions and hydraulic head that Professor Frind and I developed at University of Waterloo in Canada. The Drainage Program performed an analysis of several preliminary scenarios with this model during the fiscal year 1988.

1984 – 1986: Visiting Professor, Oregon State University, Corvallis, Oregon

- Taught: (A) finite-element modeling of groundwater flow and physical transport processes and (B) Computer Applications in Agricultural Systems - FORTRAN PROGRAMMING.
- Continued with research in groundwater flow and transport.

1983 – 1984: Research Scientist, University of California, Davis

- Tested the new theory of pseudopotential functions in anisotropic porous media.
- Applied economic analysis, stochastic processes and stochastic dynamic programming to develop optimal irrigation plans in terms of leaching and seasonal irrigation depths.

1982 – 1983: Senior Research Fellow, University of Zimbabwe, Harare, Zimbabwe

- Taught undergraduate courses and initiated research work leading to development of the theory of pseudopotential functions in anisotropic porous media.

1980 – 1982: Post-Doctoral Fellow, University of Waterloo, Waterloo, Ontario, Canada

- Applied numerical models based on 2D stream functions and hydraulic head in analysis of chemical migration in an aquifer underlying an irrigated land in Southern Alberta, Canada.
- Evaluated saturated-unsaturated numerical models that could be applied by Atomic Energy of Canada to study migration of low-level nuclear contaminants.

1978 – 1980: Civil Engineer, Ingenieurburo Dr. Ing. Gerhard Bjornsen, Koblenz, Germany

- Developed a numerical groundwater flow and transport model and analyzed interrelationship between surface and subsurface water in a valley in Southern Germany.

1971 – 1972: Teaching Assistant, Civil Engineering, University of Zambia, Lusaka, Zambia

- Provided assistance in teaching and laboratory work in Fluid Mechanics and Hydraulics.

PROFESSIONAL SOCIETY MEMBERSHIP

- American Geophysical Union
- United States Committee on Irrigation and Drainage
- American Society of Civil Engineers

SERVICE TO PROFESSIONAL PUBLICATIONS

- Since 1995 Journal of Hydrologic Engineering Reviewer
- Since 1993 Journal of Irrigation and Drainage Reviewer
- Since 1982 Water Resources Research Reviewer
- Since 1999 Journal of Hydrology Reviewer

OTHER TRAINING

- Trained in OpenGL (Open Graphics Library) at Silicon Graphics, Inc..
- Participated in a scientific-visualization workshop at Colorado State University, Fort Collins, Colorado, 1994 Groundwater Modeling Conference.
- Self-taught C/C++, win32 Windows programming and three-dimensional computer graphics.

PROFESSIONAL PUBLICATIONS

Refereed Journal Articles

Park, Y-J, E.A. Sudicky, P. Sorab and G.B. Matanga, "Implicit Sub-Time Stepping for Solving the Nonlinear Equations of Flow in an Integrated Surface-Subsurface System", www.vadosezonejournal.org, vol. 8, No. 4, November 2009.

Matanga, G.B., 1996. "Stream and Pseudopotential Functions in Visualization of Groundwater Flow and Transport Processes," *Water Resources Research*, 32(4), 953-957

Matanga, G.B., 1996. "Characteristics in Evaluation of Stream Functions in Groundwater Flow," *ASCE Jour. of Hydrologic Engineering*, 1(1), 49-53.

Matanga, G.B. 1993. "Stream Functions in Three-Dimensional Groundwater Flow", *Water Resources Research*, 29(9), 3125-3133

Matanga, G.B., 1988. "Pseudopotential Functions in Construction of Flow Nets for Contaminant Transport", *Water Resources Research.*, 24(4), 553-560

Frind, E.O. and G.B. Matanga, 1985. "The Dual Formulation of Flow for Contaminant Transport Modeling: 1. Review of Theory and Accuracy

Aspects", *Water Resources Research*, 21(2), 159-169

Frind, E.O., G.B. Matanga, and J.A. Cherry, 1985. "The Dual Formulation of Flow for Contaminant Transport Modeling: 2. The Borden Aquifer", *Water Resources Research*, 21(2), 170-182

Matanga, G.B. and M.A. Marino, 1979. "Irrigation Planning: 1. Cropping Pattern", *Water Resources Research*, 15(3), 672-678

Matanga, G.B. and M.A. Marino, 1979. "Irrigation Planning: 2. Water Allocation for Leaching and Irrigation Purposes", *Water Resources Research*, 15(3), 679-683

Articles in Refereed Conference Proceedings

VanderKwaak, J.E., E.A. Sudicky, R.G. McLaren, G.B. Matanga, L.R. Gessford, K. Buchnoff, C.Y. Jacquemin and J. Diener. 2003. Integrated Hydrologic Modeling of Surface and Subsurface Water Flow and Solute Transport in Irrigated Agriculture: Model Overview, Proceedings, Second International Conference on Irrigation and Drainage, United States Committee on Irrigation and Drainage (USCID), May 12-15, Phoenix, Arizona, USA, p367-376.

Matanga, G.B., L.R. Gessford, K. Buchnoff, C.Y. Jacquemin, J.E. VanderKwaak, E.A. Sudicky, R.G. McLaren and J. Diener. . 2003. Integrated Hydrologic Modeling of Surface and Subsurface Water Flow and Solute Transport in Irrigated Agriculture: Model Application, Proceedings, Second International Conference on Irrigation and Drainage, United States Committee on Irrigation and Drainage (USCID), May 12-15, Phoenix, Arizona, USA, p377-387.

Matanga, G. B., C. Jacquemin and D. Demarco. 2003. Simulating Integrated Surface and Subsurface Hydrologic Processes in Irrigated Agriculture. Accepted for oral presentation and conference proceeding, MODFLOW and More: Understanding through Modeling, Conference, Colorado School of Mines, September, 17-19, 20.

Article in a Book

Sudicky, E.A., J.E. VanderKwaak, J.P. Jones, J.P. Keizer, R.G. McLaren and G.B. Matanga. 2003. Fully-Integrated Modeling of Surface and Subsurface Water Flow and Solute Transport: Model Overview and Application, in Proc. of the Dubai Water Resources in the Third Millennium, February 2-6, 2002, Dubai, United Arab Emirates.

Reports

Matanga, G.B. and E.O. Frind, 1981. "An Evaluation of Mathematical Models for Mass

Transport in Saturated-Unsaturated Porous Media", prepared for Atomic Energy of Canada, May

Frind, E.O. and G.B. Matanga, 1981. "Groundwater Flow and Salt Transport in Irrigated Land in the Bow River Irrigation District, Alberta", prepared for Agriculture Alberta, Canada, July

Oral Presentations

Matanga, G.B. 2007. HydroGeoSphere: On-going and Future Model Enhancements, California Water and Environmental Modeling Forum (CWEMF), 2007 Annual Meeting, February 26-28, Asilomar, California

Matanga, G.B. 2007. HydroGeoSphere: Model Applications by Bureau of Reclamation, California Water and Environmental Modeling Forum (CWEMF), 2007 Annual Meeting, February 26-28, Asilomar, California

Matanga, G.B., L. Peltz-Lewis and L. Gessford. 2007. HydroGeoSphere: Model Enhancements and Applications, Hydrologic Science Seminar, University of California, Davis, California.

Matanga, G.B., K. Nelson and L. Gessford. 2006. HydroGeoSphere: Recent and On-going Enhancements, California Water and Environmental Modeling Forum (CWEMF), 2006 Annual Meeting, Asilomar, California.

Matanga, G.B. 2006. Integrated Surface/Subsurface Model for Multiple-scale Hydrologic Systems, Federal Interagency Hydrologic Modeling Conference, April 2-6, 2006, Reno Nevada.

Matanga, G.B. 2006. Integrated Surface/Subsurface Flow and Transport Model for Multi-scale Hydrologic Systems, Federal Interagency Steering Committee on Multimedia Environmental Modeling Meeting, Alexandria, Virginia.

Matanga, G.B. and L. Gessford. 2005. Conjunctive Model for Analysis of Water Supply Reliability, Water Quality and Ecosystem Health, Reclamation Groundwater Workshop, Las Vegas, Nevada

Matanga, G.B. 2005. HydroGeoSphere: A Fully-Coupled Surface/Subsurface Flow and Transport Model, Reclamation, Technical Service Center, Denver, Colorado.

Matanga, G.B. 2004. Some of Reclamation's HydroGeoSphere Applications, HydroGeoSphere Workshop, September 29-30, 2004, Mid Pacific Region, Reclamation, Sacramento, California.

- Matanga, G.B., K. Nelson, L. Gessford and C. Jacquemin. 2004. HydroGeoSphere: A Robust Fully-Coupled Surface-Subsurface Flow Transport Numerical Model, Hydrologic Science Seminar, November 18, 2004, University of California, Davis, California.
- Matanga, G.B. 2004. Developing HydroGeoSphere Model Capabilities, Reclamation, Science & Technology Program Meeting, August 3, 2004, Fort Collins, Colorado
- Matanga, G.B., K.E. Nelson, E. Sudicky, R. Therrien, S. Panday, R. McLaren, D. DeMarco and L. Gessford. 2004. HydroGeoSphere: Fully-Integrated, Surface/Subsurface Numerical Model for Watershed Analysis of Hydrologic, Water Quality and Sedimentation Processes, presented at AGU 2004 Fall Meeting, San Francisco, California
- Matanga, G.B., 2003, "HydroGeoSphere: A Robust Fully-Coupled Surface/Subsurface Flow and Transport Model", Internal USGS Modeling Workshop, invited expert presentation, May 13.
- Matanga, G.B., C. Jacquemin and D. DeMarco. 2003. Simulation of Fully-Coupled Surface and Subsurface Hydrologic Processes in Irrigated Agriculture, MODFLOW 2003 International Conference, September 17, 2003