

**Bernard A. Engel, Ph.D., P.E.**

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**Education**

Ph.D. 1988, Purdue University, Department of Agricultural Engineering. Dissertation: *An artificial intelligence approach to soil erosion modeling.*  
M.S. 1985, University of Illinois, Department of Agricultural Engineering. Thesis: *Crop coefficients for irrigation scheduling in Illinois.*  
B.S. 1984, University of Illinois, Department of Agricultural Engineering.

**Professional Positions**

Founding Director, Purdue University Discovery Park Center for the Environment (July 2005-September 2006)  
Head of ABE, Purdue University (May 2005-present)  
Interim Head of ABE, Purdue University (August 2004-May 2005)  
Professor, Purdue University (1996-present)  
Research Engineer, Sabbatical Leave at NASA Kennedy Space Center (KSC), KSC, FL and US Army Construction Engineering Research Laboratory, Champaign, IL (1994-95)  
Associate Professor, Purdue University (1992-1996)  
Assistant Professor, Purdue University (1988-1992)

**Awards and Honors**

State Scholarship, Illinois, 1980-1984  
Johnathan Baldwin Turner Scholarship, 1980-1984  
School of Agriculture Fellowship, University of Illinois, 1984-1985  
USDA National Needs Fellow, 1985-1988  
ASAE Educational Aids Blue Ribbon Award, *Dam Site Selection Expert System*, 1987  
ASEE NASA Summer Fellow, Kennedy Space Center, Florida, 1992-1993  
Professional Engineer (PE) (Indiana), 1995-present  
ESCOP/ACOP Leadership Fellow, 1996-1997  
Engineering Best Teacher Award, Purdue University, 1996  
School of Agriculture Outstanding Researcher, Purdue University, 1998  
University Scholar, Purdue University, 1999-2003  
ASAE Outstanding Young Researcher Award, 1999  
Horwood Critique Honorable Mention Prize for 1999, 2001 and 2002 from the Urban and Regional Information Systems Association (URISA) for GIS and Hydrologic/Water Quality Modeling Papers  
Outstanding Graduate Educator, College of Agriculture, 2006  
Food Systems Leadership Institute Fellow, 2012  
ASABE Fellow, 2014  
Recognized among the 8 most productive authors globally in nonpoint source pollution modeling research (Li et al. 2014, JSWC 69(4), doi:10.2489/jswc.69.4.121A).  
Gilley Academic Leadership Award, ASABE, 2016

## **Relevant Activities**

US EPA Food Quality Protection Act (FQPA) Board Member and Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) SAP participant, 1999-present.

- 1999 - Use of Watershed-derived Percent Crop Areas as a Refinement Tool in FQPA Drinking Water Exposure Assessments for Tolerance Reassessment
- 2000 - Consultation on Development and Use of Distributions of Pesticide Concentrations in Drinking Water for FQPA Assessments
- 2004 - A Model Comparison: Dietary and Aggregate Exposure in Calendex, CARES, and Lifeline
- 2011 - Two-dimensional Exposure Rainfall-Runoff Assessment (TERRA) Watershed Model and its Use in the FIFRA Ecological Risk Assessment for Antimicrobial Uses of Copper
- 2012 - Problem Formulation for the Reassessment of Ecological Risks from the Use of Atrazine
- 2015 - Development of a Spatial Aquatic Model (SAM) for Pesticide Risk Assessment

## **EXCELLENCE IN RESEARCH**

### **Statement of Research Contribution**

Dr. Engel has attained national and international stature in the field of information systems, focusing on the use of geographic information systems (GIS), expert systems, artificial intelligence and simulation to study and control agricultural non-point source pollution of surface and ground water. Dr. Engel was among the first to seize the opportunity presented by affordable workstation computers capable of displaying high resolution images and powerful enough to quickly model large land areas. He realized that the integration of the two fields (information systems and hydrologic/water quality modeling) offered enormous potential, both in the laboratory and in the field to greatly improve the decision-making that affects our water resources. Previously, investigators were forced to spend a great deal of time, money and effort in preparing the input spatial data sets needed for a single run of a large model; consequently, these valuable models were largely unused. Dr. Engel has been a leader in the national effort to integrate GIS and information technologies with watershed modeling to produce very usable, very powerful tools that dramatically reduce preparation time from weeks and months to a matter of minutes. This has made these complex models practical for the first time in evaluating a research hypothesis, or a design decision. The work performed by Dr. Engel and his students has helped to shape an entirely new approach to water quality modeling, that of developing water quality models within the context of a GIS setting. This has enabled "basin-level" water quality modeling (such as with SWAT), which can help not only to prevent costly, ineffective regulations, but more importantly, target stringent protection toward the most vulnerable areas.

These discoveries are now used by many researchers around the world and have been extended by other scientists to create modeling and decision support systems which are being used to evaluate water resources and water quality issues for the entire US. His methodologies are widely used by other universities, by local, state and federal government agencies, including NASA's Kennedy Space Center, the US Army (Ft. Chaffee, Camp Shelby, Ft. Bragg, Ft. Campbell, Ft. Stewart, and Ft. Leonardwood), the USDA Natural Resources Conservation Service (NRCS), and the US EPA to improve and protect water resources. Within Indiana, his research results are routinely used to protect water resources by the NRCS, the Office of the

Indiana State Chemist (OISC), Indiana Department of Natural Resources (IDNR), and Indiana Department of Environmental Management (IDEM). His programs are in use around the world, including Jamaica, Portugal, the Netherlands, Germany, India, England, Australia and Indonesia. In addition, personnel trained by Dr. Engel in Jamaica and Portugal are continuing the development of more site specific systems.

Dr. Engel is an active project leader and key contributor to multi-disciplinary research within the Colleges of Agriculture and Engineering, and Purdue University. He and his co-investigators have leveraged Purdue's investment in this research, obtaining more than \$26.6 million in external support during the past 28 years. His cross-disciplinary collaborations have been most significant with faculty from Agricultural Economics, Forestry and Natural Resources, Agronomy, Civil Engineering, Earth and Atmospheric Science, and Veterinary Medicine. Dr. Engel led the development of the geographic information systems (GIS) database for the interdisciplinary Indian Pine Natural Resources Field Station. Building on this success, he initiated an effort (Center for Advanced Applications of GIS - CAAGIS) to promote multi-disciplinary research, teaching and outreach using spatial (GIS) data.

Dr. Engel has created numerous environmental decision support systems and in the past 18 years has created web-based watershed and water quality decision support systems by integrating GIS and natural resources modeling tools (many of which were developed by Dr. Engel and his students). For example, the Long-Term Hydrologic Impact Assessment (L-THIA) model ([www.ecosystemtools.org](http://www.ecosystemtools.org)) is widely used throughout the US and has been adopted by the International City/County Management Association (ICMA). The L-THIA system with WWW GIS and watershed delineation capabilities is widely used with US EPA Region 5 and is being increasingly used in TMDL analysis. Recent extensions of the model have added representation of Low Impact Development and Best Management Practices and the optimal selection and placement of these practices. The National Agricultural Pesticide Risk Analysis (NAPRA) system ([www.ecosystemtools.org](http://www.ecosystemtools.org)) is used within Indiana and the Midwest to create pesticide and nutrient management plans for agricultural watersheds. A hydrograph separation tool called WHAT (Web-based Hydrograph Analysis Tool) automates access to USGS stream flow sites and performs baseflow separation on the data (<http://engineering.purdue.edu/~what/>). The Flow and Load Duration Curve tool (<http://engineering.purdue.edu/~ldc>) flow and water quality data from USGS gauging stations and from USEPA water quality databases to create flow duration curves and load duration curves that are useful in TMDL analyses and in creating watershed management plans. These and other web-based watershed and water quality decision support tools developed by Dr. Engel are used hundreds of times daily by a range of users in government and the private sector. More recently, he has provided co-leadership in the development of a sensitive crops and sites registry to protect them from pesticide spray drift ([www.driftwatch.org](http://www.driftwatch.org)).

Professor Engel's research has provided significant benefits to Indiana, the US, and internationally. One of the major sources of ground water pollution within Indiana, and within the Midwest US, is nonpoint source (NPS) pollution resulting from agricultural production. Dr. Engel's efforts in modeling the vulnerability of ground water to potential pollutants have created a series of ground water vulnerability maps that are being used within the State's ground water protection State Management Plan. He developed and validated a unique technique that used models integrated with GIS to determine ground water vulnerability to agricultural NPS

pollution. The results were evaluated using observed nitrate and pesticide contamination in well water data and were found to be far more accurate than previously accepted techniques. These maps estimated that approximately 25% of the State is highly susceptible to contaminants reaching ground water with over 75% of pesticide and elevated nitrate detections located within the portions of the State predicted to be most susceptible. As a result, the State's ground water monitoring effort was designed to place greater numbers of monitoring wells within the State's most susceptible areas and the numbers of wells in less vulnerable areas were reduced. This provided improved protection for the State's ground water and resulted in substantial savings to the State since the overall number of monitoring wells could be safely reduced. The ground water vulnerability maps are also being used within the State Management Plan to target ground water educational efforts to areas with the most sensitive ground water. As a result of this pioneering research, regulations banning the use of certain pesticides within the State were not necessary. It also permitted the continued use of agronomic practices that maintain high levels of agricultural productivity in the less sensitive areas.

Dr. Engel recently developed a decision support tool to estimate the risk of pesticides and nutrients reaching ground and surface water at any location within Indiana, using site specific agronomic management information and extensive databases including GIS datasets. The tool is also unique in that it is WWW accessible allowing users to explore the effects of alternative management practices on the movement of pesticides to ground and surface water. It is currently being used to target water protection efforts within the state.

Dr. Engel has extensive experience with the development and application of watershed hydrologic models including SWAT to address a range of water quality issues at watershed scales. He has extensive experience in modeling pesticide, nutrient, and erosion losses from watersheds.

## **Publications**

### **a. Refereed Journal Papers**

1. Engel, B.A., W.D. Lembke, S.K. Sipp, and W.D. Goetsch. 1989. Irrigation crop coefficients for Illinois corn. *Trans. ASAE*. 32(4):1275-1280.
2. Engel, B.A., D.B. Beasley, and J.R. Barrett. 1990. Integrating multiple knowledge sources. *Trans ASAE*. 33(4):1371-1376.
3. Rewerts, C., B. Engel, J. Rogers, and D. Jones. 1990. An end user interface for CLIPS. *AI Applications in Natural Resources*. 4(2): 57-65.
4. Engel, B.A., D.B. Beasley, and J.R. Barrett. 1990. Integrating expert systems with conventional problem solving techniques using blackboards. *Computers and Electronics in Agriculture*. 4(4):287-302.
5. Motz, D., K. Haghighi, and B. Engel. 1990. A blackboard architecture for multiple knowledge source integration in a design environment. *AI Applications in Natural Resources*. 4(2): 101-109.
6. Engel, B.A., C. Baffaut, J.R. Barrett, J.B. Rogers, D.D. Jones. 1990. Knowledge transformation. *Applied Artificial Intelligence*. 4:67-80.
7. Wright, J.R., S. Benabdallah, and B.A. Engel. 1990. A normalized user interface for complex simulation models. *AI Applications in Natural Resources*. 4(2):11-16.

8. Amin Sichani, S. and B.A. Engel. 1990. Prediction of runoff and sediment from agricultural watersheds by a mathematical model: Watershed simulation. *Iran Agricultural Research* 9(1):1-16.
9. Amin Sichani, S., B.A. Engel, and E.J. Monke. 1990. Prediction of runoff and sediment from agricultural watersheds by a mathematical model: Sediment-bound and soluble phosphorus loadings. *Iran Agricultural Research* 9(2):75-100.
10. Stone, N.D. and B.A. Engel. 1990. Knowledge-based systems in agriculture and natural resources management. *AI Magazine*. 11(3):20-22.
11. Srinivasan, R., B.A. Engel, and G. Paudyal. 1991. Expert system for irrigation management (ESIM). *Computers and Electronics in Agriculture*. 36(3):297-314.
12. Engel, B.A., D.D. Jones, J.R. Wright, and S. Benabdallah. 1991. Selection of an expert system development tool. *AI Applications in Natural Resources*. 5(1):15-22.
13. Engel, B.A. and D.B. Beasley. 1991. DSS: A dam site selector expert system for education. *ASCE Journal of Irrigation and Drainage Engineering*. 117(5):774-783.
14. Zhuang, X., B.A. Engel, M. Baumgardner, and P. Swain. 1991. Improving classification of crop residues using digital land ownership data and Landsat TM imagery. *Photogrammetric Engineering and Remote Sensing*. 57(11):1487-1492.
15. Amin Sichani, S., B.A. Engel, E.J. Monke, J.D. Eigel, and E.J. Kladivko. 1991. Validating GLEAMS with pesticide field data on a Clermont soil. *Trans ASAE* 34(4):1732-1737.
16. Srinivasan, R. and B.A. Engel. 1991. Effect of slope prediction methods on slope and erosion estimates. *Journal of Applied Engineering in Agriculture* 7(6):779-783.
17. Engel, B.A., D.D. Jones, and T.L. Thompson. 1992. Advanced information systems: Integrating expert systems with traditional computer-based problem solving techniques. *AI Applications in Natural Resources* 6(2):5-12.
18. Edan, Y., B.A. Engel, and G.E. Miles. 1993. Intelligent control system simulation of an agricultural robot. *Journal Paper No. 13043. Journal of Intelligent and Robotic Systems* 8:267-284.
19. Mitchell, J.K., B.A. Engel, R. Srinivasan, R.L. Bingner, and S.S.Y. Wang. 1993. Validation of AGNPS for small mild topography watersheds using an integrated AGNPS/GIS. *Advances in Hydro-Sciences and Engineering*. pp. 503-510.
20. Brown, S.J. and B.A. Engel. 1993. A comparison of GIS assisted simulated hydrologic response with actual storm event data. *Advances in Hydro-Sciences and Engineering*. pp. 511-517.
21. Engel, B.A., R. Srinivasan, J. Arnold, C.C. Rewerts, and S.J. Brown. 1993. Nonpoint source (NPS) pollution modeling using models integrated with geographic information systems (GIS). *Water Science and Technology* 28(3-5):685-690.
22. Pritchard, T., J.G. Lee and B.A. Engel. 1993. Reducing agricultural sediment: An economic analysis of filter strips versus micro-targeting. *Water Science and Technology* 28(3-5):561-568.
23. Mitchell, J.K., B.A. Engel, R. Srinivasan, and S.S.Y. Wang. 1993. Validation of AGNPS for small watersheds using an integrated AGNPS/GIS system. *Water Resources Bulletin* 29(5):833-842.
24. Srinivasan, R., and B.A. Engel. 1994. A spatial decision support system for assessing agricultural nonpoint source pollution. *Water Resources Research* 30(3):441-452.

25. Srinivasan, R., B.A. Engel, J.R. Wright, J.G. Lee, and D.D. Jones. 1994. The impact of GIS-derived topographic attributes on the simulation of erosion using AGNPS. *Applied Engineering in Agriculture* 10(4):561-566.
26. Zhuang, X., B.A. Engel, D.F. Lozano-Garcia, R.N. Fernandez, and C.J. Johannsen. 1994. Optimization of training data required for neuro-classification. *International Journal of Remote Sensing* 15(16):3271-3277.
27. Hetzroni, A., G.E. Miles, B.A. Engel, P.A. Hammer, and R.X. Latin. 1994. Machine vision monitoring of plant health. *Advanced Space Research* 14(11):203-212.
28. Embleton, K., B.A. Engel, and D.D. Jones. 1994. Evaluation of a Farmstead Drinking Water Quality Decision Support System. *Applied Engineering in Agriculture*. 10(6):863-869.
29. Zhuang, X., B.A. Engel, X. Xiong, and C.J. Johannsen. 1995. Analysis of classification results of remotely sensed data and evaluation of classification algorithms. *Photogrammetric Engineering and Remote Sensing*. 61(4):427-433.
30. Savabi, R., D.C. Flanagan, B. Hebel, and B.A. Engel. 1995. Application of WEPP and GIS-GRASS to a small watershed in Indiana. *Journal of Soil and Water Conservation*. 50(5):477-483.
31. Ozer, N., B.A. Engel, and J.E. Simon. 1995. Fusion classification techniques for fruit quality sorting. *Trans. of ASAE* 38(6):1927-1934.
32. Engel B., Randhir T., Lee J. 1995. A distributed parameter/GIS approach to reduce agricultural pollution. *AM J AGR ECON* 77: (5) 1358-1358.
33. McCauley, J.D. and B.A. Engel. 1995. Comparison of scene regenerations: SMAP, ECHO, and Maximum Likelihood. *IEEE Trans. on Image Proc.* 33(6):1313-1316.
34. Engel, B.A., K. Navulur, B. Cooper, and L. Hahn. 1996. Estimating groundwater vulnerability to nonpoint source pollution from nitrates and pesticides on a regional scale. *IAHS Publication No.* 235:521-526.
35. Muttiah, R.S., B.A. Engel, and D.D. Jones. 1996. Waste disposal site selection using GIS-based simulated annealing. *Computers & Geoscience* 22(9):1013-1017.
36. Preston J., Engel B., Lalor G.C. 1996. The application of geographic information systems to geochemical studies in Jamaica. *ENVIRON GEOCHEM HLTH* 18: (3) 99-104.
37. Engel B., Lalor G.C., Vutchkov M.K. 1996. Spatial pattern of arsenic and lead distributions in Jamaican soils. *ENVIRON GEOCHEM HLTH* 18: (3) 105-111.
38. Chang, Y., J.R. Wright, and B.A. Engel. Evidential reasoning for assessing environmental impact. *Civil Engineering Systems* (14):55-77.
39. Embleton, K., D. Jones and B. Engel. 1996. Comparative risk assessment primer. *Environmental Software* 11(4):203-207.
40. McCauley, J.D. and B.A. Engel. 1997. Approximation of noisy bivariate traverse data for precision mapping. *Trans. of ASAE* 40(1):237-245.
41. Montas, H., J. Eigel, B. Engel, and K. Haghighi. 1997. Deterministic modeling of solute transport in soils with preferential flow pathways - Part 1. Model development. *Trans. of ASAE* 40(5):1245-1256.
42. Montas, H., J. Eigel, B. Engel, and K. Haghighi. 1997. Deterministic modeling of solute transport in soils with preferential flow pathways - Part 2. Model validation. *Trans. of ASAE* 40(5):1257-1265.
43. Engel, B.A., H. Manguerra, and J. Smithers. 1997. Hydrologic and water quality modeling of watersheds using SWAT. *Management of Landscapes Disturbed by Channel Incision*.

44. Engel, B.A., H. Manguerra, J. Lee, and T. Randhir. 1997. A WWW-based water quality decision support system. *Management of Landscapes Disturbed by Channel Incision*.
45. Manguerra, H.B. and B.A. Engel. 1998. Hydrologic parameterization of watersheds for runoff prediction using SWAT. *Journal of the American Water Resources Association* 34(5):1149-1162.
46. Navulur, K.C., and B.A. Engel. 1998. Groundwater vulnerability assessment to nonpoint source nitrate pollution on a regional scale using GIS. *Trans of ASAE* 41(6):1671-1678.
47. Ozer, N., B. Engel and J. Simon. 1998. A Multiple Impact Approach for Non-Destructive Measurement of Fruit Firmness and Maturity. *Trans. ASAE* 41(3):871-876.
48. Berg, E., B. Engel, and J. Forrest. 1998. Pork carcass composition derived from neural network systems' analysis of electromagnetic scans. *Journal of Animal Sciences* 76:18-22.
49. Grove M. and Harbor J., and B. Engel. 1998. Composite versus distributed curve numbers: effects on estimates of storm runoff depths. *Journal of the American Water Resources Association* 34(4):1015-1023.
50. Kim, S., J. Delleur, J.K. Mitchell, B.A. Engel, and S. Walker. 1999. Simulation of runoff in agricultural watersheds with tile drainage using an extended TOPMODEL. *TRANS of ASAE*.
51. Pandey, S. S. Muthukrishnan, B. Engel and J. Harbor. 1999. Assessing the long-term impact of urban sprawl on runoff and non-point source pollution - a practical Geographical Information Systems (GIS) based method. *URISA Proceedings*. Horwood Critique Honorable Mention Prize for 1999 from the Urban and Regional Information Systems Association (URISA).
52. Pandey, S., R. Gunn, K.J. Lim, B.A. Engel, and J. Harbor. 2000. Developing Web-based Tool to Assess Long-term Hydrologic Impacts of Land use Change: Information Technology Issues and a Case Study. *Journal of Urban and Regional Information System Association (URISA)*. 12(4): 5-17.
53. Mohtar, R. and B. Engel. 2000. WWW based water quality modeling system to enhance student learning. *Journal of Eng Education*. January 2000:89-94.
54. Bhaduri, B., J. Harbor, B. Engel, M. Grove. 2000. Assessing watershed-scale, long-term hydrologic impacts of land-use change using a GIS-NPS model. *Environmental Management* 26(6):643-658.
55. Montas, H. J.; Shirmohammadi, A.; Haghighi, K.; and Engel, B. 2000. Equivalence of bicontinuum and second-order transport in heterogeneous soils and aquifers. *Water Resour. Res.* Vol. 36 , No. 12 , p. 3427-3438 (2000WR900251)
56. Randhir, T.O., J.G. Lee, and B. Engel. 2000. Multiple criteria dynamic spatial optimization to manage water quality on a watershed scale. *TRANS ASAE* 43(2):291-299.
57. Lovejoy, S. and B.A. Engel. 2000. Environmental decision-making: How will locals merge watersheds?" *Journal of Soil and Water Conservation* 55(4):434-439.
58. Grove, M., Harbor, J., Engel, B. and Muthukrishnan, S. 2001. Impacts of Urbanization on Surface Hydrology, Little Eagle Creek, Indiana, and Analysis of LTHIA Model Sensitivity to Data Resolution. *Physical Geography*, 22, p.135-153.
59. Pandey, S., Harbor, J., and Engel, B., 2001, Internet based geographic information systems and decision support tools. *Urban and Regional Information Systems Quick Study Guide*.
60. Pandey S., Lim K.J., Harbor J., Engel B., 2001, Assessing the long-term hydrologic impact of land use change – A practical Geographic Information System (GIS) based approach. In:

- Singh, R. (Ed.), Urban sustainability in the context of Global Change. Science Publishers, Inc., Enfield, New Hampshire. pp. 247-259.
61. Homes, M., J.R. Frankenberger, and B.A. Engel, 2001, Susceptibility of Indiana watersheds to herbicide contamination. *Journal of the American Water Resources Association* 37(4):987-1000.
  62. Choi, K.J., J.D. Choi, K.J. Lim, and B.A. Engel. 2001. Nonpoint pollution potential assessment in Soyand-dam watershed. *Korean National Committee on Irrigation and Drainage Journal* 8(2):27-34.
  63. Kim, Y., Engel, B., Lim, K., Larson, V., and Duncan B., 2002 Runoff Impacts of Land-Use Change in Indian River Lagoon Watershed, *Journal of Hydrological Engineering*, 7(3):245-251.
  64. Choi, J.Y., B.A. Engel, H.W. Chung. 2002. Daily streamflow modeling and assessment based on the curve-number technique. *Hydrological Processes* 16:3131-3150.
  65. O'Neal, M.R., B.A. Engel, D.R. Ess, J.R. Frankenberger. 2002. Neural network prediction of maize yield using alternative data coding algorithms. *Biosystems engineering* 83(10):31-45.
  66. Miller, P.S., J. K. Mitchell, R. A. Cooke, B. A. Engel. 2002. A wetland to improve agricultural subsurface drainage water quality. *Transactions of the ASAE*(45)5:1305-1317.
  67. Gunn, R.L, R.H. Mohtar, and B.A. Engel. 2002. World-wide-web-based soil and water quality modeling in undergraduate education. *J. Nat. Resour. Life Sci. Educ.* 31:141-147.
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  69. Renschler, C.S., D.C. Flanagan, B.A. Engel, L.A. Kramer, K.A. Sudduth. 2003. Site-specific decision-making based on RTK GPS survey and six alternative elevation data sources: I. Watershed topography and delineation. *Transactions of the ASAE* 45(6):1883-1896.
  70. Lim, K.J. and B.A. Engel. 2003. Extension and enhancement of national agricultural pesticide risk analysis WWW decision support system to include nutrients. *Computers and Electronics in Agriculture* 38(2003):227-236.
  71. Choi, J.Y. and B.A. Engel. 2003. Real time watershed delineation system using web-GIS. *Journal of Computing in Civil Engineering* 17(3):189-196.
  72. Engel, B.A., J.Y. Choi, J. Harbor, and S. Pandey. 2003. Web-based DSS for hydrologic impact evaluation of small watershed land use changes. *Computers and Electronics in Agriculture* 39 (2003):241-249.
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  74. Rochon, G.L., C.J. Johannsen, D.A. Landgrebe, B.A. Engel, J.M. Harbor, S. Majumder, and L.L. Biehl. 2003. Remote sensing as a tool for achieving and monitoring progress toward sustainability. *Clean Techn Environ Policy* 5(2003):310-316.
  75. Laflen, J.M., D.C. Flanagan, and B.A. Engel. 2004. Soil erosion and sediment yield prediction accuracy using WEPP. *Journal of the American Water Resources Association (JAWRA)* 40(2):289-297.
  76. Bracmort, K.S., B.A. Engel, and J.R. Frankenberger. 2004. Evaluation of structural best management practices 20 years after installation: Black Creek Watershed, Indiana. *Journal of Soil and Water Conservation* 191-196.

77. Tang, Z., B. A. Engel, J. Choi, K. Sullivan, M. Sharif, K. J. Lim. 2004. A Web-based DSS for erosion control structure planning. *Applied Engineering in Agriculture* 20(5):707-714.
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79. Choi, J-Y, B. A. Engel, and R. Farnsworth. 2005. Web-based GIS and spatial decision support system for watershed management. *Journal of Hydroinformatics* 7(3):165-174.
80. Frimpong, E.A., T. M. Sutton, K.J. Lim, P. J. Hrodey, B. A. Engel, T. P. Simon, J. G. Lee, and D.C. Le Master. 2005. Determination of optimal riparian forest buffer dimensions for stream biota–landscape association models using multimetric and multivariate responses. *Can. J. Fish. Aquat. Sci.* 62: 1–6 (2005).
81. Vazquez-Amabile, G.G., and B.A. Engel. 2005. Use of SWAT to Compute Groundwater Table Depth and Streamflow in the Muscatatuck River Watershed. *Transactions of the ASAE* 48(3):991-1003.
82. Tang, Z., B.A. Engel, B.C. Pijanowski, K.J. Lim. 2005. Forecasting land use change and its environmental impact at a watershed scale. *Journal of Environmental Management* 76(1):35-45.
83. Saxton G. and B. Engel. 2005. A Survey of Soil Sample Handling Procedures of State Pesticide Regulatory Agencies. *Journal of Environmental Forensics* 6(2):105-108.
84. Mitchell Adeuya, R. K., K. J. Lim, B. A. Engel, M. A. Thomas. 2005. Modeling the average annual nutrient losses of two watersheds in Indiana using GLEAMS-NAPRA. *Transactions of the ASAE* Vol. 48(5): 1739–1749.
85. Saxton, G. and B. Engel. 2005. Permethrin Insecticide and Soil Sample Handling Techniques of State Regulatory Agencies. *Environmental Forensics* 6(4):327-333.
86. Frimpong, E., T. Sutton, B. Engel, T. Simon. 2005. Spatial-Scale Effects on Relative Importance of Physical Habitat Predictors of Stream Health. *Environmental Management* 36(6):899-917.
87. Lim, K.J., B.A. Engel, Z. Tang, S. Muthukrishnan, J. Choi, K. Kim. 2006. Effects of calibration on L-THIA GIS runoff and pollutant estimation. *Journal of Environmental Management*. 78:(1):35-43.
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#### **b. Refereed Book Chapters**

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2. Rhykerd, R.L., L.M. Rhykerd, B.A. Engel, C.L. Rhykerd Jr., and C.L. Rhykerd. 1991. Knowledge engineering for management of *Medicago sativa L.* In: *Advances in Agronomy*. Compilers International. Trivandrum, India, pp. 61-70.
3. Engel, B.A., R. Srinivasan, and C. Rewerts. 1993. A Spatial Decision Support System for Modeling and Managing Agricultural Non-Point Source Pollution. In: *Environmental Modeling with GIS*, M.F. Goodchild, B.O. Parks, and L.T. Steyart (Eds.), Oxford University Press, New York, NY, pp. 231-237.
4. Engel, B.A. and K. Navulur. 1997. The Role of Geographical Information Systems in Groundwater Engineering. In: *Groundwater Engineering*, J. Delleur (Ed.), McGraw Hill. pp. 21-1 – 21-16.
5. Pandey, S., J. Harbor and B. Engel. 2000. *Internet Based Geographic Information Systems and Decision Support Tools*. URISA, Park Ridge, IL, 36 p.
6. Mohtar, R.H. T. Zhai, J-Y Choi, and B. Engel. 2005. Web-based GIS Hydrologic Modeling for Siting Water Harvesting Reservoir. In: *Watershed Management in Dry Areas, Challenges and Opportunities*. Eds. Bruggeman, A., M. Ouessar, and R. H. Mohtar. ICARDA Press. Aleppo Syria.
7. Engel, B.A., K.J. Lim and K. Navulur. 2006. The Role of Geographical Information Systems in Groundwater Engineering. In: *Groundwater Engineering*, J. Delleur (Ed.), Second Edition. CRC. pp. 30-1 – 30-17.
8. Lim, K.J., Y. S. Park, B. A. Engel and N. W. Kim. 2012. SATEEC GIS System for Spatiotemporal Analysis of Soil Erosion and Sediment Yield. In *Soil Erosion Studies*, D. Godone and S. Stanchi, InTech, Chapter 13. p. 253-280.

#### **c. Conference Proceedings**

Professor Engel has authored or co-authored 85 papers for the proceedings of 51 national and international conferences.

#### **d. Research Papers Distributed and Presented at National and International Meetings**

Professor Engel has authored or co-authored more than 195 papers that have been presented and distributed at national and international meetings.

#### **Graduate Students Advised**

Professor Engel has served as major professor for 45 graduate students and currently serves as major professor for 8 graduate students. His former students hold various positions including research engineers in federal laboratories, engineers in consulting firms, research scientists/engineers in industry, manager of a watershed management district and professors at universities. He has also significantly influenced the graduate education of many other graduate students having served on more than 115 graduate advisory committees. Professor Engel has

served on graduate advisory committees for students from Agronomy, Forestry and Natural Resources, Agricultural Economics, Animal Science, Entomology, Horticulture, Civil Engineering, and Earth and Atmospheric Sciences.

### **Research Grants**

Professor Engel and his co-investigators have obtained more than \$26.6 million in support of his research efforts in the past 28 years through more than 140 grants. He has been especially successful in obtaining support from federal agencies including US EPA, USDA, NSF, DOE, USGS and NASA.

### **EXCELLENCE IN TEACHING**

Dr. Engel's teaching contributions have been very significant, both on- and off-campus: he has updated and revised existing courses, developed new courses, and taught special topics courses and workshops. Much of his impact has been in GIS science, expert systems, modeling and teaching how to apply such knowledge to solving natural resources and environmental problems. Not only is he introducing state-of-the-art subject materials to undergraduate, graduate and adult students, he is also developing new pedagogical techniques, e.g., interactive digital multi-media learning modules. While on sabbatical leave at the NASA Kennedy Space Center in 1994, he taught his ABE 565 (Agricultural Systems Engineering) class over the Internet. In 2000, 2001, and 2002 he taught ABE 526 (Watershed Systems Design) through Web-based materials to students in Europe. He has developed Web-based environmental modeling tools that have proven very effective for educational uses.

Dr. Engel has developed or assisted with the development of more than 75 computer-based multimedia programs for educational use primarily in the areas of environmental and soil and water resources protection (see <http://www.epa.gov/glnpo/seahome>) that have been used in more than 1.5 million sessions annually in each of the past 5 years. The hypermedia paradigm for these programs enables them to be used by federal and state agencies, for college classes and for students in junior and senior high school. Many of the multimedia/hypermedia programs have been used to teach ASM 336, Environmental Systems Management, a new course developed by Dr. Engel. Approximately one-half the course lectures in this class were replaced by programs developed by Dr. Engel. Testing of these multimedia programs by Dr. Engel has shown that they are as effective as lectures and that such programs maintain their effectiveness even when extensive use of such modules is made, such as in ASM 336.

Dr. Engel has taught several workshops on the development of multimedia applications and computer-assisted instruction including two one-week workshops in Indonesia and a one-week workshop in Puerto Rico. He currently serves on the advisory board for a European effort to develop extensive distance education materials related to geographic information systems (GIS).

### **Courses Taught in Last Three Years**

The courses that Dr. Engel has taught in recent years are briefly described below. In prior years he taught Soil and Water Conservation Engineering (design of grassed waterways, terraces, surface and subsurface drainage systems, and irrigation systems), Soil and Water Management,

Agricultural Systems Engineering, Environmental Systems Management, Introduction to Surveying (3 credit version), GIS, Graduate Seminar, and Watershed Systems Design.

ASM 216 Introduction to Surveying, 5 weeks, Class 2, Laboratory 3, cr. 1. Spring semesters since 2012.

EPICS Engineering Projects In Community Service, Laboratory 2, cr. 1. Each semester since Fall 2009.

ABE 484 and 486 Engineering Design and ASM 494 and 495 Agricultural Systems Management Capstone. Class 1, Laboratory 8, cr. 4, Fall and spring semesters since 2011. Co-taught with Dr. Bob Stwalley since 2013.

### **EXCELLENCE IN ENGAGEMENT AND SERVICE**

Professor Engel makes numerous outreach presentations and has conducted numerous workshops related to the application of environmental education software and decision support systems (described briefly in the research section of this document). In the last three years, he has made more than 10 outreach presentations on the application of web-based decision support tools including the L-THIA (Long-Term Hydrologic Impact Assessment) model, web-based watershed delineation, SEDSPEC, and NAPRA (National Agricultural Pesticide Risk Assessment). A significant base of users has been established for these tools; for example, L-THIA averages more than 2,500 user sessions per month.

### **University Service**

Professor Engel has provided service to the university beyond that as Head of Agricultural and Biological Engineering. For example, in the past 5 years he has served as:

- Forestry and Natural Resources Head Search Chair
- University Accreditation Criterion 1 committee co-chair
- University COACH Committee
- College of Agriculture strategic planning committee

### **Memberships in Professional Societies and Organizations**

- American Society of Agricultural and Biological Engineers (ASABE), 1987-present.
- National Society of Professional Engineers (NSPE), 1987-present.
- Soil and Water Conservation Society (SWCS), 1988-present.
- American Society of Civil Engineers (ASCE), 1988-present.
- Sigma Xi (honor society, scientific research), 1986.
- Phi Kappa Phi (national scholastic honor society), 1986.
- Alpha Epsilon (honor society, agricultural engineering), 1987.
- Gamma Sigma Delta (honor society, agriculture), 1986.
- Alpha Mu (honor society, agricultural systems management), 2003

### **Professional Service Activities**

1. American Society of Agricultural Engineers (ASAE) KS-14: Knowledge Engineering Committee, 1987-90, 1992-present, Vice-Chair in 1989-90, Chair in 1990-91.
2. American Society of Agricultural Engineers KS-15: Simulation Committee, 1988-90.

3. American Society of Agricultural Engineers (ASAE) KS-16: Geographic Information Systems Committee, 1990-present, provided leadership in establishment of this new committee. Secretary 1992-93, Vice-Chair 1993-1994, chair 1995-1996.
4. American Society of Agricultural Engineers (ASAE) SW-215: Hydrologic Systems Committee, 1988-present.
5. American Society of Agricultural Engineers (ASAE) SW-225: Conservation Systems Committee, 1987-89.
6. S-211: Hydrologic/Water Quality Modeling of Sediment and Chemical Movement, Southern Region USDA Committee, 1988-91.
7. S-249: Hydrologic and Water Quality Modeling, Southern Region USDA Committee, 1992-1996, Co-wrote proposal to form committee.
8. S-273 Ecological and Water Quality Modeling, Southern Region USDA Committee, 1997-2002.
9. US EPA National Land Use Change Committee 1998-2000.
10. MUTATE GIS Distance Education Advisory Board, European Union, 1998-2002.
11. Global Livestock Collaborative Research and Support Projects Program Advisory Committee, 2000-2005.
12. ASABE ED210 Agricultural and Biological Engineering Academic Heads, 2009-2010, Vice Chair, 2010-2011 Chair.
13. NCAC 016 North Central Agricultural and Biological Engineering Academic Programs Regional Committee. Chair 2011.
14. DOE Oak Ridge Biofuels Advisory Committee. 2008-2013.
15. BARD Technical Advisory Committee 2010-2013.
16. FieldWatch Board Member, 2012-present