

Training Course on the CATHY (CATchment HYdrology) Model
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Lecturers

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Bibliography of CATHY-related papers

Model development

- M. Camporese, C. Paniconi, M. Putti, and S. Orlandini, “Surface–subsurface flow modeling with path-based runoff routing, boundary condition-based coupling, and assimilation of multisource observation data,” *Water Resour. Res.*, 46, W02512, doi:10.1029/2008WR007536, 2010
- S. Orlandini and R. Rosso, “Parameterization of stream channel geometry in the distributed modeling of catchment dynamics,” *Water Resour. Res.*, 34(8), 1971–1985, 1998
- S. Orlandini and R. Rosso, “Diffusion wave modeling of distributed catchment dynamics,” *J. Hydrologic Engrg., ASCE*, 1(3), 103–113, 1996
- C. Paniconi and E. F. Wood, “A detailed model for simulation of catchment scale subsurface hydrologic processes,” *Water Resour. Res.*, 29(6), 1601–1620, 1993

Drainage basin delineation

- S. Orlandini, G. Moretti, M. A. Corticelli, P. E. Santangelo, A. Capra, R. Rivola, and J. D. Albertson, “Evaluation of flow direction methods against field observations of overland flow dispersion,” *Water Resour. Res.*, 2012 (submitted)
- S. Orlandini, P. Tarolli, G. Moretti, and G. Dalla Fontana, “On the prediction of channel heads in a complex alpine terrain using gridded elevation data,” *Water Resour. Res.*, 47(2), W02538, doi:10.1029/2010WR009648, 2011
- S. Orlandini and G. Moretti, “Comment on ‘Global search algorithm for nondispersive flow path extraction’ by Kyungrock Paik,” *J. Geophys. Res.*, 114(10), F04004, doi:10.1029/2008JF001193, 2009
- S. Orlandini and G. Moretti, “Determination of surface flow paths from gridded elevation data,” *Water Resour. Res.*, 45, W03417, doi:10.1029/2008WR007099, 2009
- S. Orlandini, G. Moretti, M. Franchini, B. Aldighieri, and B. Testa, “Path-based methods for the determination of nondispersive drainage directions in grid-based digital elevation models,” *Water Resour. Res.*, 39(6), 1144, doi:10.1029/2002WR001639, 2003

Numerical algorithms

- A. Mazzia, G. Manzini, and M. Putti, “Bad behavior of Godunov mixed methods for strongly anisotropic advection-dispersion equations,” *J. Comput. Phys.*, 230, 8410–8426, 2011
- M. Putti and F. Sartoretto, “Linear Galerkin vs mixed finite element 2D flow fields,” *Int. J. Numer. Meth. Fluids*, 60, 1011–1031, 2009
- A. Mazzia and M. Putti, “Three dimensional Mixed Finite Element-Finite Volume approach for the solution of density dependent flow in porous media,” *J. Comput. Appl. Math.*, 185, 347–359, 2006
- L. Bergamaschi, R. Bru, A. Martinez, and M. Putti, “Quasi-Newton preconditioners for the inexact Newton method,” *Electronic Trans. Num. Anal.*, 23, 76–87, 2006
- A. Mazzia and M. Putti, “High order Godunov mixed methods on tetrahedral meshes for density driven flow simulations in porous media,” *J. Comp. Phys.*, 208, 154–174, 2005
- A. Mazzia, L. Bergamaschi, C. N. Dawson, and M. Putti, “Godunov mixed methods on triangular grids for advection-dispersion equations,” *Comput. Geosci.*, 6(2), 123–139, 2002
- C. Cordes and M. Putti, “Accuracy of Galerkin finite elements for the groundwater flow equation in two and three dimensional triangulations,” *Int. J. Numer. Methods Eng.*, 52, 371–387, 2001
- A. Mazzia, L. Bergamaschi, and M. Putti, “On the reliability of numerical solutions for density dependent flow and transport in groundwater,” *Transp. Porous Media*, 43(1), 65–86, 2001
- A. Mazzia, L. Bergamaschi, and M. Putti, “A time-splitting technique for advection-dispersion equation in groundwater,” *J. Comp. Phys.*, 157(1), 181–198, 2000

- L. Bergamaschi and M. Putti, "Mixed finite elements and Newton-type linearizations for the solution of Richards' equation," *Int. J. Numer. Meth. Engng.*, 45, 1025-1046, 1999
- M. Putti and C. Cordes, "Finite element approximation of the diffusion operator on tetrahedra," *SIAM J. Sci. Comput.*, 19, 1154-1168, 1998
- M. Putti and C. Paniconi, "Picard and Newton linearization for the coupled model of saltwater intrusion in aquifers," *Adv. Water Resour.*, 18(3), 159-170, 1995
- C. Paniconi and M. Putti, "A comparison of Picard and Newton iteration in the numerical solution of multidimensional variably saturated flow problems," *Water Resour. Res.*, 30(12), 3357-3374, 1994

Model testing

- C. Dagès, C. Paniconi, and M. Sulis, "Analysis of coupling errors in a physically-based integrated surface water-groundwater model," *Adv. Water Resour.*, 2012 (in press)
- M. Sulis, C. Paniconi, and M. Camporese, "Impact of grid resolution on the integrated and distributed response of a coupled surface-subsurface hydrological model for the des Anglais catchment, Quebec," *Hydrol. Process.*, 25(12), 1853-1865, doi:10.1002/hyp.7941, 2011
- M. Sulis, S. B. Meyerhoff, C. Paniconi, R. M. Maxwell, M. Putti, and S. J. Kollet, "A comparison of two physics-based numerical models for simulating surface water-groundwater interactions," *Adv. Water Resour.*, 33(4), 456-467, doi:10.1016/j.advwatres.2010.01.010, 2010
- C. M. F. D'Haese, M. Putti, C. Paniconi, and N. E. C. Verhoest, "Assessment of adaptive and heuristic time stepping for variably saturated flow," *Int. J. Numer. Meth. Fluids*, 53(7), 1173-1193, 2007
- S. Orlandini, "On the spatial variation of resistance to flow in upland channel networks," *Water Resour. Res.*, 38(10), 1197, doi:10.1029/2001WR001187, 2002

Data assimilation

- D. Pasetto, M. Camporese, and M. Putti, "Ensemble Kalman filter versus particle filter for a physically-based coupled surface-subsurface model," *Adv. Water Resour.*, 47, 1-13, 2012.
- M. Camporese, C. Paniconi, M. Putti, and P. Salandin, "Ensemble Kalman filter data assimilation for a process-based catchment scale model of surface and subsurface flow," *Water Resour. Res.*, 45, W10421, doi:10.1029/2008WR007031, 2009
- M. Camporese, C. Paniconi, M. Putti, and P. Salandin, "Comparison of data assimilation techniques for a coupled model of surface and subsurface flow," *Vadose Zone J.*, 8(4), 837-845, doi:10.2136/vzj2009.0018, 2009
- R. Hurkmans, C. Paniconi, and P. A. Troch, "Numerical assessment of a dynamical relaxation data assimilation scheme for a catchment hydrological model," *Hydrol. Process.*, 20(3), 549-563, 2006
- C. Paniconi, M. Marrocu, M. Putti, and M. Verbunt, "Newtonian nudging for a Richards equation-based distributed hydrological model," *Adv. Water Resour.*, 26(2), 161-178, 2003

CATHY model extensions (integration of other processes)

- G.-Y. Niu, C. Paniconi, P. A. Troch, R. L. Scott, M. Durcik, X. Zeng, T. Huxman, and D. C. Goodrich, "An integrated model of catchment-scale ecohydrological processes: 1. Model description and tests over an energy-limited watershed," *Ecohydrology*, 2012 (submitted)
- M. Camporese, S. Ferraris, M. Putti, P. Salandin, and P. Teatini, "Hydrological modeling in swelling/shrinking peat soils," *Water Resour. Res.*, 42, W06420, doi:10.1029/2005WR004495, 2006

Transport and CODESA model development and application

- S. Weill, A. Mazzia, M. Putti, and C. Paniconi, "Coupling water flow and solute transport into a physically-based surface-subsurface hydrological model," *Adv. Water Resour.*, 34(1), 128-136, 2011
- C. Paniconi, I. Khlaifi, G. Lecca, A. Giacomelli, and J. Tarhouni, "Modeling and analysis of seawater intrusion in the coastal aquifer of eastern Cap-Bon, Tunisia," *Transport in Porous Media*, 43(1), 3-28, 2001
- G. Gambolati, M. Putti, and C. Paniconi, "Three-dimensional model of coupled density-dependent flow and miscible salt transport," in *Seawater Intrusion in Coastal Aquifers – Concepts, Methods and Practices* (J. Bear, A. H.-D. Cheng, et al., eds.), ch. 10, pp. 315-362, Kluwer Academic, Dordrecht, The Netherlands, 1999

CATHY model applications

- C. Guay, M. Nastev, C. Paniconi, and M. Sulis, "Comparison of two modeling approaches for groundwater-surface water interactions," *Hydrol. Process.*, 2012 (in press)

- G. Passadore, M. Monego, L. Altissimo, A. Sottani, M. Putti, and A. Rinaldo, "Alternative conceptual models and the robustness of groundwater management scenarios in the multi-aquifer system of the Central Veneto Basin, Italy," *Hydrogeol. J.*, 20, 419-433, 2012
- S. Broda, C. Paniconi, and M. Larocque, "Numerical investigation of leakage in sloping aquifers," *J. Hydrol.*, 409, 49-61, doi:10.1016/j.jhydrol.2011.07.035, 2011
- M. Sulis, C. Paniconi, C. Rivard, R. Harvey, and D. Chaumont, "Assessment of climate change impacts at the catchment scale with a detailed hydrological model of surface–subsurface interactions and comparison with a land surface model," *Water Resour. Res.*, 47, W01513, 2011
- F. Zanello, P. Teatini, M. Putti, and G. Gambolati, "Long term peatland subsidence: experimental study and modeling scenarios in the Venice coastland," *J. Geophys. Res.*, 116, F04002, 2011
- M.-J. Gauthier, M. Camporese, C. Rivard, C. Paniconi, and M. Larocque, "A modeling study of heterogeneity and surface water–groundwater interactions in the Thomas Brook catchment, Annapolis Valley (Nova Scotia, Canada)," *Hydrol. Earth Syst. Sci.*, 13, 1583-1596, 2009
- C. Paniconi, P. A. Troch, E. E. van Loon, and A. G. J. Hilberts, "Hillslope-storage Boussinesq model for subsurface flow and variable source areas along complex hillslopes: 2. Intercomparison with a three-dimensional Richards equation model," *Water Resour. Res.*, 39(11), 1317, doi:10.1029/2002WR001730, 2003
- A. C. Bixio, G. Gambolati, C. Paniconi, M. Putti, V. M. Shestopalov, V. N. Bublias, A. S. Bohuslavsky, N. B. Kastelteseva, and Y. F. Rudenko, "Modeling groundwater–surface water interactions including effects of morphogenetic depressions in the Chernobyl exclusion zone," *Environ. Geol.*, 42(2–3), 162-177, 2002