Curriculum Vitae

Xuehang Song

September 12, 2020

General Information

Address: Hydrology Technical Group
Energy and Environment Directorate
Environmental Technology Building (ETB)
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Professional Preparation

2014 Ph.D. in Hydrology & Water Resources Engineering, Wuhan University.
Supervisor: Jinzhong Yang, Liangsheng Shi.

Song, Xuehang. (2014). *Data Assimilation Application to the Saturated-unsaturated Flow*. Doctoral dissertation, Wuhan University.

2009 B.E. in Hydrology & Water Resources Engineering, Wuhan University.

Nondegree Education and Training

2015–2018 Post-doc, Atmospheric Sciences & Global Change, Earth and Biological Sciences Directorate, Pacific Northwest National Laboratory.

2014–2015 Post-doc, Department of Scientific Computing, Florida State University.

Professional Experience

2018–present Earth Scientist, Hydrology Technical Group, Energy and Environment Directorate, Pacific Northwest National Laboratory. Responsible research in the field of computational subsurface hydrology, reactive transport modeling, Bayesian data assimilation and geostatistics.

Current Membership in Professional Organizations

American Geophysical Union
Geochemical Society

Publications

Refereed Journal Articles

2020~present

Rizzoa, C. B., **Song, X**., de Barrosa, F. P., and Chen, X.. (2020). Temporal Flow Variations Interact With Spatial Physical Heterogeneity to Impact Solute Transport in Managed River Corridors. Submitted to *Journal of Contaminant Hydrology*. https://doi.org/10.1016/j.jconhyd.2020.103713

Song X., Chen, X., Zachara, J.M., Gomez-Velez, J., Shuai, P., Ren, H., and Hammond, G.. (2020). "River Dynamics Control Transit Time Distributions and Biogeochemical Reactions in a Dam-Regulated River Corridor." *Water Resources Research*, e2019WR026470. https://doi.org/10.1029/2019WR026470.

Tso C., Johnson, T.C., **Song, X**., Chen, X., Kuras, O., Wilkinson, P., Uhlemann, S., et al. (2020). "Integrated hydrogeophysical modelling and data assimilation for geoelectrical leak detection." *Journal of Contaminant Hydrology*. https://doi.org/10.1016/j.jconhyd.2020.103679.

Zachara, J., Chen, X., **Song, X**., Shuai, P., Murray, C., and Resch, C., (2020). Kilometer-Scale Hydrologic Exchange Flows in a Gravel Bed River Corridor and Their Implications to Solute Migration. *Water Resources Research,* e2019WR025258. *https://doi.org/10.1029/2019WR025258*

Rockhold, M., Robinson, J., Parajuli, K., **Song, X.**, Zhang, F., and Johnson, T. (2020). Characterization and Monitoring of a Complex Industrial Waste Site Using Electrical Resistivity Imaging. *Hydrogeology Journal*. *https://doi.org/10.1007/s10040-020-02167-1*

Asmussen R.M., Fang, Y., **Song, X.**, Tartakovsky, G.D., Westsik, J.H., Smith, G.L., Brown E.E., et al.. Defining a Metric to Assess Leachability of Contaminants from Cementitious Waste Forms in Lab. Conference Proceedings of *WM Symposium 2020*

2019~2020

Song, X., Chen, X., Ye, M., Dai, Z., Hammond, G., and Zachara, J. M. (2019). Delineating Facies Spatial Distribution by Integrating Ensemble Data Assimilationand Indicator Geostatistics With Level-Set Transformation. *Water Resources Research*, (509), 2018WR023262. https://doi.org/10.1029/2018WR023262

Shuai, P., Chen, X., **Song, X.**, Hammond, G. E., Zachara, J., Royer, P., et al. (2019). Dam Operations and Subsurface Hydrogeology Control Dynamics of Hydrologic Exchange Flows in a Regulated River Reach. *Water Resources Research*, 2018WR024193. https://doi.org/10.1029/2018WR024193

Dai, H., Chen, X., Ye, M., **Song, X.**, Hammond, G., Hu, B., and Zachara, J. M. (2019). Using Bayesian Networks for Sensitivity Analysis of Complex Biogeochemical Models. *Water Resources Research*, 2018WR023589. https://doi.org/10.1029/2018WR023589

Dai, H., Ye, M., Hu, B. X., Niedoroda, A. W., Zhang, X., Chen, X., et al. (2019). Hierarchical sensitivity analysis for simulating barrier island geomorphologic responses to future storms and sea-level rise. *Theoretical and Applied Climatology*, *136*(3–4), 1495–1511. https://doi.org/10.1007/s00704-018-2700-5

Before 2019

Song, X., Chen, X., Stegen, J., Hammond, G., Song, H., Dai, H., et al. (2018). Drought Conditions Maximize the Impact of High-Frequency Flow Variations on Thermal Regimes and Biogeochemical Function in the Hyporheic Zone. *Water Resources Research*, *54*(10), 7361–7382. https://doi.org/10.1029/2018WR022586

Zhou, T., Bao, J., Huang, M., Hou, Z., Arntzen, E., **Song, X.**, et al. (2018). Riverbed Hydrologic Exchange Dynamics in a Large Regulated River Reach. *Water Resources Research*, *54*(4), 2715–2730. https://doi.org/10.1002/2017WR020508

Dai, H., Chen, X., Ye, M., **Song, X.**, and Zachara, J. M. (2017). A geostatistics-informed hierarchical sensitivity analysis method for complex groundwater flow and transport modeling. *Water Resources Research*, *53*(5), 4327–4343. https://doi.org/10.1002/2016WR019756

Song, H.-S., Thomas, D. G., Stegen, J. C., Li, M., Liu, C., **Song, X.**, et al. (2017). Regulation-Structured Dynamic Metabolic Model Provides a Potential Mechanism for Delayed Enzyme Response in Denitrification Process. *Frontiers in Microbiology*, *8*, 1866. https://doi.org/10.3389/fmicb.2017.01866

Zhou, T., Huang, M., Bao, J., Hou, Z., Arntzen, E., Mackley, R., et al. (2017). A New Approach to Quantify Shallow Water Hydrologic Exchanges in a Large Regulated River Reach. *Water*, *9*(9), 703. https://doi.org/10.3390/w9090703

Shi, L., **Song, X.**, Tong, J., Zhu, Y., and Zhang, Q. (2015). Impacts of different types of measurements on estimating unsaturated flow parameters. *Journal of Hydrology*, *524*, 549–561. https://doi.org/10.1016/j.jhydrol.2015.01.078

Shi. L., Zhang, Q., **Song, X.**, and Fang, X. (2015). Application of groundwater level data to data assimilation for unsaturated flow. *Advances in Water Science, 26(3):404-412.* https://10.14042/j.cnki.32.1309.2015.03.011

Song, X., Shi, L., Ye, M., Yang, J., and Navon, I. M. (2014). Numerical Comparison of Iterative Ensemble Kalman Filters for Unsaturated Flow Inverse Modeling. *Vadose Zone Journal*, *13*(2). https://doi.org/10.2136/vzj2013.05.0083

Tan, X. C., Yang, J. Z., **Song, X.**, and Zha, Y. (2013). Estimation of groundwater recharge in North China Plain. Advances in Water Science, 24(1), 73–81. https://doi.org/10.14042/j.cnki.32.1309.2013.01.015

Zha, Y., Yang, J., Shi, L., and **Song, X.** (2013). Simulating One-Dimensional Unsaturated Flow in Heterogeneous Soils with Water Content-Based Richards Equation. Vadose Zone Journal, 12(2), 0. https://doi.org/10.2136/vzj2012.0109

Submitted Journal Articles in revision

Song X., Fang, Y., Bao, J., Perkins, W.A., Ren, H., Zhou, H., and Hou, Z. "Spatial variability of hydrological exchange flows and residence time in a large regulated river." Submitted to *Journal of Hydrology*. (moderate revision)

Fang Y., **Song, X**., Ren, H., Perkins, W.A., Shuai, P., Richmond, M.C., Hou, Z. et al. 2020. "High-performance simulation of dynamic hydrologic exchange and implications for surrogate flow and reactive transport modeling in a large river corridor." Submitted to *Frontiers in Water*. (moderate revision)

Ren H., Hou, Z., Duan, Z., **Song, X.**, Perkins, W.A., Richmond, M.C., and Scheibe, T.D. 2020. "Mapping Spatially Heterogeneous Riverbed Permeability using Machine Learning." Submitted to *Frontiers in Water*. (minor revision)

Hou Z., Ren, H., Murray, C.J., **Song, X**., Fang, Y., Arntzen, E.V., Chen, X. et al. 2020. "A Novel Construct for Scaling Groundwater-River Interactions Based on Machine-Guided Hydromorphic Classification." Submitted to *Environmental Research Letters*. (moderate revision)

Submitted Journal Articles under review

Chen, K., Chen, X., **Song, X.**, Briggs, M., Jiang, P., Shuai, P., Hammond, G., Zhan H., and Zachara, J.. Using Ensemble Data Assimilation to Estimate Transient Hydrologic Exchange Flow under Highly Dynamic Flow Conditions . Submitted to *Water Resources Research.*

Shuai, P., Chen, X., Hammond G., **Song, X.**, Chen, K., Zachara, J., Perkins, W., Richmond, M., and Nugent, J.. Hydrologic Exchange Flows Alter River Corridor Thermal Regimes in a Dam-regulated River. Submitted to *Water Resources Research.*

Zhu, Y., Johnson, T. C., Thomle, J. N., Strickland, C. E., **Song, X**., and Stegen, J.. Joint hydrogeophysical inversion for monitoring dynamic mass flux at the groundwater-surface water interface. Submitted to *Journal of Hydrology*.

Moghaddam M., Ferre T.P., Chen X., Chen K., **Song X**., and Hammond G.. "Applying Simple Machine Learning Tools to Infer Streambed Flux from Subsurface Pressure and Temperature Observations." Submitted to *Water Resources Research*

Chen Y., Bao, J., Richmond, M.C., Perkins, W.A., Ren, H., Fang, Y., **Song, X**. et al. "Three dimensional computational fluid dynamics modeling of streamflow in a 30 kilometer long reach over a nine year period using OpenFOAM." Submitted to *Water Resources Research*.

Bao J., Chen, Y., Fang, Y., **Song, X**., Perkins, W.A., Duan, Z., Ren, H. et al. "Use of numerical modeling to evaluate the impact of hydrodynamic pressure on hydrologic exchange fluxes and resident time for a large-scale river section over a long-term period." Submitted to *Hydrological Processes*

Wu R., Chen, X. , Hammond, G.E., Bisht, G., **X. Song**, Huang, M., Niu, G. et al. "Coupling Surface Flow with High-performance Subsurface Reactive Flow and Transport Code PFLOTRAN." Submitted to *Environmental Modelling & Software*.

Nonrefereed Reports

Asmussen R.M., Fang, Y., Tartakovsky, G.D., Song, X., Westsik, J.H., and Smith., G.L. 2019. Performance Metric for Cementitious Waste Form Inventory Release in the Integrated Disposal Facility. PNNL-28992. Richland, WA: Pacific Northwest National Laboratory. Performance Metric for Cementitious Waste Form Inventory Release in the Integrated Disposal Facility.

Rockhold M.L., Song, X., Tagestad, J.D., Thorne, P.D., Tartakovsky, G.D., and Chen., X. 2018. Sensitivity Analysis of Contaminant Transport from Vadose Zone Sources to Groundwater. PNNL-28065. Richland, WA: Pacific Northwest National Laboratory.

Yonkofski C., Appriou, D., Song, X., Downs, J.L., Johnson, C.D., and Milbrath, V.C. 2018. Water Application for Dust Control in the Central Plateau: Impacts, Alternatives, and Work Strategies. PNNL-28061. Richland, WA: Pacific Northwest National Laboratory.

Selected Presentations

Nonrefereed Presentations at Conferences

Shuai P., Chen, X., Song, X., Chen, K., and Hammond, G. (2019). Dam Induced Hydrologic Exchange Flows Alter River Corridor Thermal Regime. In *AGU San Francisco, California*, United States.

Chen Y., Bao, J., Richmond, M.C., Perkins, W.A., Duan, Z., Ren, H., and Fang, Y. et al (2019). Modeling the effects of discharge nonstationarity and bathymetric heterogeneity on streambed resistance and dynamic pressure distribution in streams using OpenFOAM. In *AGU San Francisco, California*, United States.

Bao J., Chen, Y., Fang, Y., Song, X., Perkins, W.A., Duan, Z., and Ren, H. et al. (2019). Three-dimensional OpenFOAM-PFLOTRAN coupled model for large-scale river hydrologic exchange flows over long-term period. In *AGU San Francisco, California*, United States.

Song X., Fang, Y., Bao, J., Perkins, W.A., Ren, H., Zhou, H., and Hou, Z. et al. (2019). Spatial variability of hydrological exchange flows and resident time distributions in a large regulated river. In *AGU San Francisco, California*, United States.

Shuai P., Chen, X., Song, X., and Chen. K., (2019). Boosting Research Reproducibility: Managing High Performance Model Simulation Workflow Using Jupyter Notebook. In *AGU San Francisco, California*, United States

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Ren H., Hou, Z., Song, X., Fang, Y., Perkins, W.A., Duan, Z., and Chen, Y. et al. (2019). Machine Learning Applied to Flux/Residence Times of Hydrological Exchange Flows in the Columbia River. In *AGU San Francisco, California*, United States.

Chen K., Chen, X., Song, X., Briggs, M., Jiang, P., Shuai, P., and Hammond, G.E. (2019). Using Ensemble Data Assimilation to Estimate Transient Hydrologic Exchange Fluxes under Highly Dynamic Flow Conditions. In *AGU San Francisco, California*, United States.

Song, X, Chen, X., Zachara, J. M., Gomez-Velez, J. D., Shuai, P., Ren, H., & Hammond, G. E. (2019). Dynamic River Stage Variations Lead to Multimodal Residence Time Distributions of Hydrological Exchange Flow. In *12th Washington Hydrogeology Symposium,*. Tacoma, WA, United States.

Song, X, Chen, X., Zachara, J. M., Gomez-Velez, J. D., Shuai, P., Ren, H., & Hammond, G. E. (2018). Dynamic River Stage Variations Lead to Multimodal Residence Time Distributions of Hydrologic Exchange Flows. In *AGU Annual Meeting*. Washington DC, United States.

Chen, X., Shuai, P., Song, X., Dai, H., Hammond, G. E., Johnson, T. C., & Zachara, J. M. (2018). Using Sensitivity Analysis and Data Assimilation to Improve Process Understanding of Hydrologic Exchange Flows in Dynamic River Corridors from km-to Reach Scales. In *AGU Annual Meeting*. Washington DC, United States.

Johnson, T. C., Zhu, Y., Strickland, C. E., Thomle, J. N., Stegen, J., Song, X., & Chen, X. (2018). Joint hydrogeophysical inversion: application to dynamic mass flux monitoring at the groundwater/surface water interface. In *AGU Annual Meeting*. Washington DC, United States.

Scheibe, T. D., Stegen, J., Chen, X., Huang, M., Bao, J., Fang, Y., et al. (2018). Merging Process Understanding with Numerical Models across Scales to Predict River Corridor and Watershed Function. In *AGU Annual Meeting*. Washington DC, United States.

Shuai, P., Chen, X., Song, X., Hammond, G. E., Zachara, J. M., Royer, P., & Ren, H. (2018). Hydrogeomorphic Controls on Hydrologic Exchange Flows Dynamics within a Large Regulated River Corridor. In *AGU Annual Meeting*. Washington DC, United States.

Chen, X., Song, X., Shuai, P., Hammond, G. E., Ren, H., & Zachara, J. M. (2017). Quantifying Km-scale Hydrological Exchange Flows under Dynamic Flows and Their Influences on River Corridor Biogeochemistry. In *AGU Annual Meeting*. New Orleans, LA, United States.

Song, Xuehang, Chen, X., Shuai, P., Gomez-Velez, J. D., Ren, H., & Hammond, G. E. (2017). Hyporheic Zone Residence Time Distributions in Regulated River Corridors. In *AGU Annual Meeting*. New Orleans, LA, United States.

Tso, C. H. M., Johnson, T. C., Song, X., Chen, X., & Binley, A. M. (2017). Using coupled hydrogeophysical models and data assimilation to enhance the information content in geoelectrical leak detection. In *AGU Annual Meeting*. New Orleans, LA, United States.

Chen, X., Ren, H., Dai, H., Song, X., Goldman, A. E., Mackley, R., & Zachara, J. M. (2016). Understanding the Spatial and Temporal Variability of Groundwater and Surface Water Interaction Using a Multi-year Multi-sensor Dataset. In *AGU Annual Meeting*. San Francisco, CA, United States.

Song X., Chen, X., Stegen, J., Hammond, G., and Song, H. (2017). Long-term Impact of Dam Operation On Thermal aand Biogeochemical Dynamics in the Hyporheic Zone. In *11th Washington Hydrogeology Symposium,*. Tacoma, WA, United States.

Dai, H., Chen, X., Ye, M., Song, X., & Zachara, J. M. (2016). A Bayesian Network Based Global Sensitivity Analysis Method for Identifying Dominant Processes in a Multi-physics Model. In *AGU Annual Meeting*. San Francisco, CA, United States.

Scheibe, T. D., Yang, X., Song, X., Chen, X., Hammond, G. E., Song, H. S., et al. (2016). A Multiscale Simulation Framework to Investigate Hydrobiogeochemical Processes in the Groundwater-Surface Water Interaction Zone. In *AGU Annual Meeting*. San Francisco, CA, United States.

Song, H. S., Li, M., Qian, W., Song, X., Chen, X., Scheibe, T. D., et al. (2016). Functional enzyme-based modeling approach for dynamic simulation of denitrification process in

hyporheic zone sediments: Genetically structured microbial community model. In *AGU Annual Meeting*. San Francisco, CA, United States.

Song, X, Chen, X., Dai, H., Hammond, G. E., Song, H. S., & Stegen, J. (2016). Quantifying Hydro-biogeochemical Model Sensitivity in Assessment of Climate Change Effect on Hyporheic Zone Processes. In *AGU Annual Meeting*. San Francisco, CA, United States.

Zachara, J. M., Chen, X., Murray, C. J., Shuai, P., Rizzo, C., Song, X., & Dai, H. (2016). Solute Transport Dynamics in a Large Hyporheic Corridor System. In *AGU Annual Meeting*. San Francisco, CA, United States.

Zhou, T., Bao, J., Huang, M., Hou, Z., Arntzen, E., Mackley, R., et al. (2016). Quantifying hyporheic exchange dynamics in a highly regulated large river reach. In *AGU Annual Meeting*. San Francisco, CA, United States.

Song X., X. Chen, M. Ye, Z. Dai, and G. H. (2015). Delineating Facies Spatial Distribution by Integrating Ensemble Data Assimilation and Indicator Geostatistics. In *AGU Annual Meeting*. San Francisco, CA, United States.

Invited Workshops

Song X., and Hammond, G.. (2018, December). PFLOTRAN Reaction Sandbox. Workshop delivered at AGU Fall Meeting 2018, Washington D.C.

The Profession

Guest Reviewer for Refereed Journals

Inverse Problems in Science & Engineering (2016-present).

Soil Science Society of America Journal (2016–present).

Advances in Water Resources (2017–present).

Water Resources Research (2017–present).

Journal of Hydrology (2018–present).

Journal of Hydrologic Engineering (2019–present)

Resources (2019–present)

Water (2019–present)