*Prior NSF Support - Co-PI Shashi Shekhar:*

(1) **PI for NSF 1541876 (2015, $50,000): FEW: A Workshop** to Identify Interdisciplinary Data Science Approaches and Challenges to Enhance Understanding of Interactions of Food Systems and Water Systems. Broader impacts: The workshop brought the FEWS and BD communities together to identify data and data science needs. For example, participants underscored the need for community infrastructure (shared data sets, evaluation metrics, models, tools), and the training of a new generation of scientists with the requisite training in the Data Sciences and the FEWS sciences to facilitate progress at their interface. Related publications include [1], [2].

(2) Shekhar is also the **Co-PI for NSF 1029711 (2010-2015, $6M approximate.):** Expedition: Understanding Climate Change: A Data Driven Approach. Intellectual merit: The project developed computationally efficient algorithms for spatiotemporal change interval footprint detection, as well as a novel spatial classification model called focal-test-based spatial decision tree for earth observation imagery data. Results have been published in [3]-[16]. Broader Impact: The proposed techniques can potentially help climate scientists study regions with abrupt changes, and help climate scientists estimate methane emissions based on wetland maps created from earth observation images towards understanding climate change. Two Ph.D. students and two HBCU undergraduate students were mentored.

**Related Publications**

[1] S. Shekhar and D. Mulla, NSF workshop on Identifying Interdisciplinary Data Science Approaches and Challenges to Enhance Understanding of Interactions of Food Systems with Energy and Water Systems. October, 2015, Washington DC, Workshop Report Draft at: http://www.spatial.cs.umn.edu/few/INFEWS\_DS\_Workshop\_report.pdf.

[2] E. Eftelioglu, Z. Jiang, R. Ali, and S. Shekhar, “Spatial computing perspective on food energy and water nexus,” *Journal of Environal Studies and Sciences*, pp. 1–15, 2016. Springer.

[3] M. R. Evans, D. Oliver, K. Yang, X. Zhou, and S. Shekhar, “Enabling Spatial Big Data via CyberGIS: Challenges and Opportunities,” A book chapter in *CyberGIS Foster. a New Wave Geospatial Innov. Discov.* In press, Springer. 2014.

[4] X. Zhou, S. Shekhar, and P. Mohan, “Spatiotemporal change pattern mining: A multi-disciplinary perspective,” in *Space-Time Integration in Geography and GIScience: Research Frontiers in the US and China*, Springer, 2015, pp. 301–326.

[5] S. K. Prasad, M. McDermott, S. Puri, D. Shah, D. Aghajarian, S. Shekhar, and X. Zhou, “A Vision for GPU-accelerated Parallel Computation on Geo-spatial Datasets,” in Proceedings of ACM *Special Interest Group on Spatial Information Special.*, vol. 6, no. 3, pp. 19–26, 2015.

[6] X. Zhou, S. Shekhar, and D. Oliver, “Discovering persistent change windows in spatiotemporal datasets,” in *Proceedings of the 2nd* ACM *Special Interest Group on Spatial Information International Workshop on Analytics for Big Geospatial Data - BigSpatial ’13*, 2013, pp. 37–46.

[7] S. K. Prasad, S. Shekhar, M. McDermott, X. Zhou, M. Evans, and S. Puri, “GPGPU-accelerated interesting interval discovery and other computations on GeoSpatial datasets - A summary of results,” in *Proceedings of the 2nd ACM Special Interest Group on Spatial Information International Workshop on Analytics for Big Geospatial Data, BigSpatial 2013*, 2013, p. 7.

[8] A. Karpatne, V. Mithal, X. Chen, A. Khandelwal, G. Nayak, J. H. Faghmous, and V. Kumar, “Monitoring Land Cover Changes using Remote Sensing Data: A Machine Learning Perspective,” *IEEE Geosci. Remote Sens.*, 2015.

[9] S. Shekhar, Z. Jiang, R. Ali, E. Eftelioglu, X. Tang, V. Gunturi, and X. Zhou, “Spatiotemporal Data Mining: A Computational Perspective,” *ISPRS Int. J. Geo-Information*, vol. 4, no. 4, pp. 2306–2338, 2015. MDPI.

[10] X. Zhou, S. Shekhar, P. Mohan, S. Liess, and P. K. Snyder, “Discovering interesting sub-paths in spatiotemporal datasets: a summary of results,” In Proceedings of ACM *Special Interest Group on Spatial Information 2011*. ACM, pp. 44–53, 2011.

[11] Z. Jiang, S. Shekhar, P. Mohan, J. Knight, and J. Corcoran, “Learning spatial decision tree for geographical classification: a summary of results,” in Proceedings of ACM *Special Interest Group on Spatial Information*, 2012, pp. 390–393.

[12] Z. Jiang, S. Member, and S. Shekhar, “Focal-Test-Based Spatial Decision Tree Learning,” IEEE Transaction on *Knowledge and Data Engineering*, vol. 27, no. 6, pp. 1547–1559, 2015.

[13] Z. Jiang, S. Shekhar, A. Kamzin, and J. Knight, “Learning a Spatial Ensemble of Classifiers for Raster Classification: A Summary of Results,” *in Proceedings of IEEE International Conference on Data Mining Workshop (ICDMW),* 2014, pp. 15–18.

[14] Z. Jiang, S. Shekhar, X. Zhou, J. Knight, and J. Corcoran, “Focal-Test-Based Spatial Decision Tree Learning: A Summary of Results,” *in Proceedings of IEEE International Conference on Data Mining*, 2013, pp. 320–329.

[15] P. Mohan, X. Zhou, and S. Shekhar, “Quantifying resolution sensitivity of spatial autocorrelation: A resolution correlogram approach,” in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2012, vol. 7478 LNCS, pp. 132–145. Springer.

[16] X. Zhou, S. Shekhar, and R. Y. Ali, “Spatiotemporal change footprint pattern discovery: An inter-disciplinary survey,” *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, vol. 4, no. 1, pp. 1–23, 2014. Wiley.