

TAKAHIRO YABE

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EDUCATION

Doctor of Philosophy (PhD) 2021 (expected)
Purdue University West Lafayette, IN

Dissertation: *Resilience of Coupled Urban Socio-Physical Systems to Disasters*

Advisors: Dr. Satish V. Ukkusuri (co-chair), Dr. Seungyoon Lee (co-chair), Dr. P. Suresh C. Rao, Dr. David R. Johnson

Master's Degree (Civil Engineering) 2017
University of Tokyo Tokyo, Japan

Dissertation: *Modelling Evacuation Behavior after Disasters using Mobile Phone Data*

Advisors: Dr. Yoshihide Sekimoto (chair), Dr. Muneo Hori

Bachelor of Engineering 2015
University of Tokyo Tokyo, Japan

Dissertation: *Real-Time Urban Mobility Predictions after Disasters using Mobility Data*

Advisor: Dr. Yoshihide Sekimoto

RESEARCH INTERESTS

Resilience of Coupled Socio-Physical Systems

- Inferring the inter-dependencies between urban social and physical systems, and how they affect the resilience of cities.
- Prescriptive modeling to guide policies for resilient and sustainable urban growth.

Location Big Data Analytics for Disaster Response

- Analysis of population displacement and recovery after shocks (e.g. disasters, pandemics) using mobile phone location datasets.
- Causal impact estimation of shocks on business performances using mobility data.

Artificial Intelligence for Urban Science

- Deep learning-based methods to understand urban functionality, hierarchical structures, and similarities between cities using dynamic trajectory data.

PROFESSIONAL EXPERIENCE

Data Science Consultant 5/2020 – Present
Global Facility for Disaster Reduction and Recovery, The World Bank Washington D.C.

- Conducted analysis of large-scale mobile phone GPS data to assess the impacts of the Puebla Earthquake in Mexico.
- Developed open-source codes and tools to analyze population displacement and recovery patterns (<https://github.com/takayabe0505/>).
- Planned and provided tutorials and capacity building sessions for World Bank Group staff on location data analytics for disaster resilience.

- Graduate Research Assistant** 7/2017 – Present
Purdue University West Lafayette, IN
- Student lead in the NSF funded project “*CRISP Type 2: Critical Transitions in the Resilience and Recovery of Interdependent Social and Physical Networks*” (PI: Dr. Satish V. Ukkusuri).
 - Developing methods to infer the recovery of communities after severe disasters using large scale mobility datasets (e.g. mobile phone CDR, GPS, social media, web search).
- Doctoral Research Fellow** 8/2018 – 5/2020
Purdue Systems Collaboratory West Lafayette, IN
- Selected as one of the three inaugural research fellows in the university.
 - Conducted research on the disaster resilience of cities with an interdisciplinary team of collaborators, including public policy specialists, social scientists, and engineers.
 - Served as guest lecturer for graduate/undergraduate students interested in systems research.
- Research Consultant** 5/2020 – 7/2020
Asian Development Bank Institute Tokyo, Japan
- Assisted the operations of ADBI and planning of the *Purdue – ADBI – UTokyo virtual workshop*.
 - Co-authored a policy brief paper related to COVID-19 and urban mobility patterns.
- Research Assistant** 4/2014 – 3/2017
University of Tokyo Tokyo, Japan
- Developed data assimilation framework to integrate multi-agent simulations and real time observation data to predict city-scale human mobility with Dr. Shibasaki and Dr. Sekimoto.
 - Delivered evacuation mobility analysis results to local governments just after Kumamoto earthquake (2016 April) to assist developing shelter allocation strategies.
- Research Intern** 8/2015 – 11/2015
Yahoo! Japan Research Tokyo, Japan
- Developed methods to measure the fragility of urban transportation systems using large scale mobility dataset.
 - Collaborated with researchers in private firms and local government officials.
- Consultant Intern** 7/2016 – 9/2016
Japan International Cooperation Agency Manila, the Philippines
- Conducted interviews and surveys to local government agencies to investigate disaster preparedness of people living in vulnerable areas.
 - Inspected disaster risk analysis of informal residential areas near Manila using GIS software.

HONORS AND AWARDS

- STV Civil Engineering Graduate Assistantship Endowment** 2020
Lyles School of Civil Engineering, Purdue University
- Student Registration Award** 2020
ACM KDD Conference 2020
- UJA Best Presenter Award** 2020
Japan XR Science Forum 2020
- EISG Student Merit Award Finalist** 2019
Engineering and Infrastructure Specialty Group, Society for Risk Analysis

Travel Award Society for Risk Analysis, for the 2019 Annual Meeting	2019
Student Travel Award ACM SIGSPATIAL International Conference on Advances in GIS 2019	2019
Poster Competition 2nd Prize The main conference on the scientific analysis of mobile phone datasets (NetMob 2019)	2019
Outstanding Speaker Award Purdue Institute of Transportation Engineers (ITE)	2019
Best Presentation Award Annual Conference of GIS Association of Japan	2016

GRANTS AND FELLOWSHIPS

Doctoral “Systems” Fellowship Purdue Systems Collaboratory, Purdue University	2018 – 2020
Research Fellowship for Young Scientists (JSPS DC1) Japan Society for the Promotion of Science, total of \$72,000 over 3 years	2017
Doctoral Student Research Fellowship Department of Engineering, University of Tokyo, \$3,000	2016
Student Travel Grant for Overseas Study Department of Engineering, University of Tokyo, \$4,000	2016

PROJECT EXPERIENCE

NSF CRISP (Purdue University) <i>Critical transitions in the resilience and recovery of interdependent social and physical networks</i> ; Resulted in 7 journal and conference papers (3 under review); <u>Student Lead</u> .	2017 – Present
World Bank Project (Purdue University) Usage of smartphone location data for disaster resilience and urban planning; Resulted in working paper and coding toolkit with tutorials; <u>Student Lead</u> .	2020 – Present
Yahoo Japan Joint Research Collaboration (Purdue University) Machine learning and artificial intelligence for urban computing; Resulted in 5 journal and conference papers (2 under review); <u>Student Lead</u> .	2017 – Present
Asian Development Bank Institute Project (Purdue University) Usage of mobility data for disaster resilience and pandemic response; Resulted in policy brief paper and virtual conference; <u>Student Lead</u> .	2020
Ford Motor Project (Purdue University) Resilience applications of social media data; Resulted in academic presentation; <u>Student Lead</u> .	2018
Disaster Mobility Simulation Project (University of Tokyo) Disaster simulation for Ministry of Internal Affairs and Communications of Japan; Resulted in 4 journal and conference papers.	2015 – 2017

TEACHING EXPERIENCE

Mentorship

- Lead of the working group in “mobility analysis for COVID-19 pandemic” in the Urban Mobility, Networks and Intelligence Lab, Purdue University, 2020 – Present
 - Team of 8 students (4 PhD, 2 Master, 2 Undergraduate) working on problems related to COVID-19, including mobility analysis, behavior modeling, and inequality.
- Shagun Mittal (Master Student), 2019 – Present
 - Research topic: impacts of infrastructure development on business entry using large-scale business survey data; Resulted in one journal publication (currently under review).
- Daniel Hooks (Undergraduate Student), 2020 – Present
 - Supervised collection and analysis of data on business closures after disasters.
 - Research topic: modeling hospital choice behavior during the COVID-19 pandemic.
- Chengyuan Yang (Undergraduate Student), 2020 Summer
 - Research topic: understanding the income inequality in mobility patterns during the COVID-19 pandemic; Summer Undergraduate Research Fellowship Program.

Teaching Assistant: “Computational Methods for Urban Resilience” 2021 (planned)

- Designed outline of lectures and preparation of material.
- Covers i) resilience concepts, ii) big data analytics, and iii) system dynamics modeling.

Guest Lecturer: “Ecological Sciences and Engineering Colloquium” (CE597) 2020

- Human mobility analysis during and after natural hazards.
- Exercise on understanding and fitting probability density functions to empirical data.

Guest Lecturer: “Disaster Resilience” (HONR 399) 2019

- Methods and techniques to model human mobility and behavior using large scale location datasets.

Guest Lecturer: “Disaster Resilience and Society” (CE497) 2019

- Evacuation modeling and analysis using household survey data and big data sources.

PUBLICATIONS

Articles under review / in preparation:

- [R7] **Yabe, T.**, Tsubouchi, K., Sekimoto, Y., & Ukkusuri, S. V. Exposure to COVID-19 Infodemic Decreases Compliance to Mobility Restrictions. In preparation.
- [R6] **Yabe, T.**, Jones., N. K., & Ukkusuri, S. V. *DisasterMob*: Post-disaster assessment using large-scale mobility data. In preparation.
- [R5] **Yabe, T.**, Jones., N. K., & Ukkusuri, S. V. Smartphone location data analytics for disaster resilience. In preparation.
- [R4] **Yabe, T.**, Rao, P. S. C., & Ukkusuri, S. V. Maintaining Self-Reliance is Key to Resilient Urban Growth. Under review in *Nature Sustainability*
- [R3] **Yabe, T.**, Tsubouchi, K., & Ukkusuri, S. V. Early Warning of COVID-19 Hotspots using Mobility of High-Risk Users from Web Search Queries. Under review in *The Web Conference 2021*.

- [R2] Mittal, S., **Yabe, T.**, & Ukkusuri, S. V. Cross-sectoral relationships in business entry dynamics around a highway corridor. Under review in *Applied Geography*
- [R1] **Yabe, T.**, Zhang, Y., & Ukkusuri, S. V. Quantifying the Economic Impact of Disasters on Businesses using Human Mobility Data: a Bayesian Causal Inference Approach. Under review in *EPJ Data Science* (2nd round)

Articles in Peer Reviewed Journals:

- [J12] **Yabe, T.**, Rao, P. S. C., & Ukkusuri, S. V. Regional Differences in Resilience of Social and Physical Systems: Case Study of Hurricane Maria. To appear in *Environment and Planning B: Urban Analytics and City Science* (2020)
- [J11] **Yabe, T.**, Tsubouchi, K., Fujiwara, N., Wada, T., Sekimoto, Y., & Ukkusuri, S. V. Non-compulsory measures sufficiently reduced human mobility in Tokyo during the COVID-19 epidemic. *Scientific Reports*, 10(1), 1-9. (2020)
- [J10] Ukkusuri, S. V., **Yabe, T.**, Seetharam, K. E. Non-Pharmaceutical Interventions for COVID-19: Evidence from Large-Scale Mobility Data in Tokyo. *Asian Development Bank Policy Briefs*, 10(6). (2020)
- [J9] **Yabe, T.**, Tsubouchi, K., Fujiwara, N., Sekimoto, Y., Ukkusuri, S. V. Understanding post-disaster population recovery patterns. *Journal of the Royal Society Interface*, Vol. 17, Issue 163, 20190532. (2020)
- [J8] **Yabe, T.**, Ukkusuri, S. V. Effects of Income Inequality on Evacuation, Reentry and Segregation after Disasters. *Transportation Research Part D: Transport and Environment*, 102260. (2020)
- [J7] Pang, Y., Kashiyama, T., **Yabe, T.**, Sekimoto, Y., Tsubouchi, K. Development of a people mass movement simulation framework based on reinforcement learning. *Transportation Research Part C: Emerging Technologies*, 117, 102260. (2020)
- [J6] **Yabe, T.**, Ukkusuri, S. V., Rao, P. S. C. Mobile Phone Data Reveals the Importance of Inter-City Social Connectivity for Recovery after Hurricane Maria. *Applied Network Science*, Vol. 4, Issue 1, 98. (2019)
- [J5] **Yabe, T.**, Ukkusuri, S. V. Integrating Information from Heterogeneous Networks on Social Media to Predict Post-Disaster Returning Behavior. *Journal of Computational Science*, Vol. 32, pp. 12-20. (2019)
- [J4] **Yabe, T.**, Sekimoto, Y., Tsubouchi, K., Ikemoto, S. Cross-comparative analysis of evacuation behavior after earthquakes using mobile phone data. *PLoS ONE*, Vol. 14, Issue 2, e0211375 (2019)
- [J3] **Yabe, T.**, Tsubouchi, K., Sekimoto, Y. CityFlowFragility: Measuring the Fragility of People Flow in Cities to Disasters using GPS Data Collected from Smartphones. *Interactive, Mobile, Wearable and Ubiquitous Technologies*, 1(3), 117. (2017)
- [J2] **Yabe, T.**, Tsubouchi, K., Sudo, A., Sekimoto, Y. Predicting Delay of Commuting Activities Following Frequently Occurring Disasters Using Location Data from Smartphones. *Journal of Disaster Research*, Vol. 12, No.2, pp. 287-295. (2017)

- [J1] **Yabe, T.**, Sekimoto, Y., Kashiyama, T., Kanasugi, H., Sudo, A. Real time movement prediction after natural disasters using data assimilation. (in Japanese). *Journal of the Japanese Society for Transportation Engineering, Vol. 2 No. 2, pp. 19-27. (2016)*

Articles in Peer Reviewed Conference Proceedings:

- [C13] **Yabe, T.**, Tsubouchi, K., Shimizu, T., Sekimoto, Y., Ukkusuri, S. V. Unsupervised Translation via Hierarchical Anchoring: Functional Mapping of Places across Cities. *Proceedings of the 26th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining. ACM. (2020) (acceptance rate: 14%)*
- [C12] Shimizu, T., **Yabe, T.**, Tsubouchi, K. Enabling Finer Grained Place Embeddings using Spatial Hierarchy from Human Mobility Trajectories. *Proceedings of the 28th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems. (2020) (acceptance rate: 20%)*
- [C11] Pang, Y., Tsubouchi, K., **Yabe, T.**, & Sekimoto, Y. Intercity Simulation of Human Mobility at Rare Events via Reinforcement Learning. *Proceedings of the 28th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (2020). (acceptance rate: 20%)*
- [C10] **Yabe, T.**, Tsubouchi, K., Shimizu, T., Sekimoto, Y., Ukkusuri, S. V. City2City: Translating Place Representations across Cities. *Proceedings of the 27th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems. (2019) (acceptance rate: 21%)*
- [C9] **Yabe, T.**, Tsubouchi, K., Shimizu, T., Sekimoto, Y., Ukkusuri, S. V. Predicting Evacuation Decisions using Representations of Individuals' Pre-Disaster Web Search Behavior. *Proceedings of the 25th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining. ACM. (2019) (acceptance rate: 17%)*
- [C8] **Yabe, T.**, Tsubouchi, K., Sekimoto, Y. Fusion of Terrain Information and Mobile Phone Location Data for Flood Area Detection in Rural Areas. *Proceedings of the 2018 IEEE International Conference on Big Data. IEEE. (2018) (acceptance rate: 20%)*
- [C7] Kumar, D., **Yabe, T.**, Ukkusuri, S.V. Social-Media aided Hyperlocal Help-Network Matching & Routing during Emergencies. *Proceedings of the 2018 IEEE International Conference on Big Data. IEEE. (2018) (acceptance rate: 20%)*
- [C6] Pang, Y., Tsubouchi, K., **Yabe, T.**, Sekimoto, Y. Replicating Urban Dynamics by Generating Human-like Agents from Smartphone GPS Data. *Proceedings of the 26th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems. (2018) (acceptance rate: 20%)*
- [C5] Pang, Y., Tsubouchi, K., **Yabe, T.**, Sekimoto, Y. Modeling and reproducing human daily travel behavior from GPS data: A Markov Decision Process approach. *Proceedings of the 1st Workshop on Prediction of Human Mobility. (2017)*
- [C4] **Yabe, T.**, Tsubouchi, K., Sudo, A., Sekimoto, Y. Predicting Irregular Individual Movement following Frequent Mid-Level Disasters using Location Data from Smartphones. *Proceedings of the 24th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems. (2016) (acceptance rate: 19%)*

- [C3] **Yabe, T.**, Tsubouchi, K., Sudo, A., Sekimoto, Y. A Framework for Evacuation Hotspot Detection after Large Scale Disasters using Location Data from Smartphones: Case Study of Kumamoto Earthquake. *Proceedings of the 24th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems*. (2016) **(acceptance rate: 19%)**
- [C2] Sudo, A., Kashiya, T., **Yabe, T.**, Kanasugi, H., Song, X., Higuchi, T., Nakano, S., Saito, M., Sekimoto, Y. Particle Filter for Real-time Human Mobility Prediction following Unprecedented Disaster. *Proceedings of the 24th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems*. (2016) **(acceptance rate: 19%)**
- [C1] **Yabe, T.**, Sekimoto, Y., Kanasugi, Y., Kashiya, T. Making Real-Time Predictions of People's Irregular Movement in a Metropolitan Scale under Disaster Situations. *14th International Conference on Computers in Urban Planning and Urban Management (CUPUM)*. (2015)

Other Major Conference Presentations:

- [P13] “Regional Differences in Resilience of Social and Physical Systems: Case Study of Hurricane Maria”, *ADBI – Purdue University – University of Tokyo: Virtual Workshop on Resilience of Cities to External Shocks: Analysis, Modeling and Economic Impacts (virtual)*. October 27th – 28th, 2020.
- [P12] “The relationship between social contact reduction and COVID-19 spread using mobility data”, *Bridging Transportation Researchers (BTR) Online Conference*. August 11th, 2020.
- [P11] “How Can Cities Become More Resilient to Natural Disasters?”, Invited Talk at the *Purdue Systems Thinkers Colloquium, West Lafayette, Indiana, USA*. March 5th, 2020.
- [P10] “Modeling the Dynamics of Spatial Segregation after Disasters using Mobile Phone Data”, *Transportation Research Board Annual Meeting, Washington D.C., USA*. January 12th-16th, 2020.
- [P9] “Modeling the Influence of Online Social Media Information on Post-Disaster Mobility Decisions” (poster presentation), *Transportation Research Board Annual Meeting, Washington D.C., USA*. January 12th-16th, 2020.
- [P8] “Understanding Population Recovery Patterns after Disasters from Mobile Phone Data”, *Society for Risk Analysis Annual Meeting 2019, Arlington, Virginia, USA*. December 9th-12th, 2019.
- [P7] “Critical Transitions in the Resilience and Recovery of Interdependent Social and Physical Networks”, *44th Annual Natural Hazards Workshop, Denver, Colorado, USA*. July 17th-18th, 2019. (Plenary talk)
- [P6] “Understanding Post-Disaster Population Recovery Patterns” (poster presentation), *The main conference on the scientific analysis of mobile phone datasets (NetMob), Oxford, UK*. July 8th-10th, 2019.
- [P5] “Mobile phone data reveals the importance of inter-city social connectivity for recovery after Hurricane Maria” (poster presentation), *Complex Systems Conference, Purdue University, Indiana, USA*. May 13th-17th, 2019.

- [P4] “Population Recovery Modeling with Mobile Phones”, *National Science Foundation CRISP Grantees Meeting, George Mason University, Virginia, USA. December 5th-6th, 2018.*
- [P3] “CityFlowFragility: Measuring the Fragility of People Flow in Cities to Disasters using GPS Data Collected from Smartphones”, *2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp 2017), Maui, Hawaii, USA. September 11th-15th, 2017.*
- [P2] “A Framework for Evacuation Hotspot Detection after Large Scale Disasters using Mobile Phone Location Data”, *The main conference on the scientific analysis of mobile phone datasets (NetMob), Milan, Italy. April 5th-7th, 2017.*
- [P1] “Estimating Evacuation Hotspots using GPS data: What happened after the large earthquakes in Kumamoto, Japan?”, *5th International Workshop on Urban Computing (UrbComp), held in conjunction with ACM KDD, San Francisco, CA, USA. August 14th, 2016.*

MEDIA COVERAGE

- “Tokyo’s Voluntary Standstill May Have Stopped COVID-19 in its Tracks”, *Asia Research News. November 5th, 2020.*
- “Mobile phone data shows how Japan averted large-scale outbreaks of COVID-19”, *News Medical, November 6th, 2020.*
- “Life-saving information technology: Predicting disasters using IoT”, *Nikkei Newspaper (Industrial). August 25th, 2016.*

SERVICES

Organizing Conferences/Workshops

- **International Workshop on Prediction of Human Mobility (PredictGIS)**, held in conjunction with ACM SIGSPATIAL conference; **Steering Committee Member**
 - 2017 edition held at Los Angeles, CA, USA (November 7th, 2017)
 - 2018 edition held at Seattle, WA, USA (November 6th, 2018)
 - 2019 edition held at Chicago, IL, USA (November 5th, 2019)
- **Purdue – ABDI – UTokyo Virtual Workshop on Resilience of Cities; Assistant Organizer** (October 27th – 28th, 2020)

Student Organizations

- **Event Coordinator** of *Purdue Institute of Transportation Engineers (ITE) Student Chapter*
- **Student Member** of *Indy Tomorrow*, a network of Japanese researchers based in the Midwest.

Reviewer for Journals / Conferences

- PLoS ONE
- AAAI Conference on Artificial Intelligence
- International Journal of Disaster Risk Reduction
- Environment and Planning B: Urban Analytics and City Science
- The Lancet Public Health
- BMC Public Health
- International Journal of Health Policy and Management
- Frontiers in Built Environment

SKILLS

Computational Expertise

- Large scale (network) data analysis and machine learning methods using **Python, R**.
- Bayesian computation and MCMC sampling using **stan**.
- Multi agent simulation for urban-scale mobility using **Java**.
- Visualization and analysis of networks using **Gephi, NetworkX, iGraph**.
- Geospatial data analysis using **GeoPandas, QGIS, ArcGIS**.
- Parallel computing using **PySpark, Dask**.

Work Experience with Heterogeneous Data

- Spatial data: GPS trajectory data, mobile phone call detail records, point-of-interest data
- Social Media data: Twitter, Facebook
- Web search query data
- Survey data: American Community Survey data

Languages and International Experience

- English (TOEFL 113/120, IELTS 8.5/9.0), Japanese (native language).
- Lived in Great Britain (1998-2001), Canada (2005-2008), US (2017-Present).

REFERENCES

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