Hadi Arbabi

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Hadi's work and research interests sit at the interface of data-driven urban analytics and planning. hadi's overall body of research focuses on the challenges relating to resource consumption and productivity in urban systems often in the context of planetary resource capacity and extreme climate change. Their previous work has focused on a spatially multi-scale examination of urban systems and the extent to which their performance is influenced by their embedded physical infrastructure. Hadi's broader research activity and interests include but are not limited to practical uses of **urban scaling** and **allometry**, city morphology, infrastructure planning for **agglomeration**, **network analysis** of intra- and inter-city urban flows, and building stocks and **urban metabolism**. As of July 2025, Hadi has over 300 citations and an h-index of 11 on Google Scholars.

Academic Positions

The University of Sheffield

Lecturer in the Built Environment   August 2020 – Present
Resources, Infrastructure Systems, & built-Environments Research Group

Research Associate   April 2019 – July 2020
Digital Urban Characterization [EP/S016627/1, EP/V012053/1]

Part-Time Research Associate   November 2018 – February 2019
Engineering Complexity Resilience Network Plus [EP/N010019/1]

Education

The University of Sheffield

PGCert   2021 – 2024
Teaching for Learning in Higher Education,

- Project Title:
  Cruel Intentions: Outcomes & Assessments

PhD   2015 – 2019
Resources, Infrastructure Systems, & built-Environments,

- Thesis Title:
  Urban Productivity & Spatial Patterns Across Scales–
  A Multi-Scale Exploration of Urban Networks and Their Hierarchical Configurations

MEng   2011 – 2015
Architectural Engineering (First-Class Honors),

- Dissertation Title:
  Influence of Anthropic and Spatial Characteristics of Cities upon Their Energy Metabolism

| Selected Research Articles | J23. | An Emergent Optimal Resource Allocation for Climate Resilience of Transport Infrastructure Networks. *Royal Society Proceedings A*, , - (2025), with Q. Li, & G. Punzo. doi:10.1098/rspa.2025.0084 |

J23. An Emergent Optimal Resource Allocation for Climate Resilience of Transport Infrastructure Networks. *Royal Society Proceedings A*, , - (2025), with Q. Li, & G. Punzo. doi:10.1098/rspa.2025.0084

J22. Parametric Contribution of Building Form to Whole Life Carbon Decision Making. *Royal Society Open Science*, , - (2025), with D. Abbey, & D. Densley Tingley. doi:10.1098/rsos.241953

J21. Learning from Other Cities: Transfer Learning Based Multimodal Residential Energy Prediction for Cities with Limited Existing Data. *Energy and Buildings*, **338**,115723 (2025), with Y. Sheng, W. Ward, & M. Mayfield. doi:10.1016/j.enbuild.2025.115723

J20. Building Geodemographic Regions: Commuting, Productivity and Uneven Spatial Development in England and Wales. *Regional Studies*, **59**, - (2025), with S. Hincks, & R. Hamilton. doi:10.1080/00343404.2025.2485132

J19. City-Scale Residential Energy Consumption Prediction with a Multimodal Approach. *Scientific Reports*, **15**, 5313 (2025), with Y. Sheng, W. Ward, M. Álvarez & M. Mayfield. doi:10.1038/s41598-025-88603-2

J18. Built Environment Stocks in the Context of a Master Planned City: A Case Study of Chandigarh, India. *Journal of Industrial Ecology*, **28**(3), 573-588 (2024), with W. Mihkelson, S. Hincks, & D. Densley Tingley. doi:10.1111/jiec.13466

J17. Component-Level Residential Building Material Stock Characterization Using Computer Vision Techniques. *Environment Science & Technology*, **58**(7), 3224-3234 (2024), with M. Dai, J. Jurczyk, R. Mao, W. O. C. Ward, M. Mayfield, G. Liu, & D. Densley Tingley. doi:10.1021/acs.est.3c09207

J16. A Systematic Approach to Climate Resilience Assessment of Infrastructure Networks. *IEEE Sytems Journal*, **18**(1), 24-35 (2024), with Q. Li, C. Robson, G. Punzo, & M. Mayfield. doi:10.1109/jsyst.2023.3329765

J15. Regional Economic Resilience, Trophic Characteristics, and Ecological Analogies. *Papers in Regional Science*, **102**(6), 1127-1145 (2023), with G. Punzo. doi:10.1111/pirs.12766

J14. Towards an automated workflow for large-scale housing retrofit. *Environmental Research Letters*, **18**(6), 061006 (2023), with L. M. Tan, W. O. C. Ward, X. Li, D. Densley Tingley, A. Khan, & M. Mayfield. doi:10.1088/1748-9326/acd797

J13. Estimating Energy Consumption of Residential Buildings at Scale with Drive-by Image Capture. *Building and Environment*, **234**, 110188 (2023), with W. O. C. Ward, X. Li, Y. Sun, M. Dai, D. Densley Tingley, & M. Mayfield. doi:10.1016/j.buildenv.2023.110188

J12. The Intrinsic Cybernetics of Large Complex Systems and How Droughts Turn into Floods. *Science of the Total Environment*, **859**(2), 159979 (2023), with G. Punzo. doi:10.1016/j.scitotenv.2022.159979

J11. Scalable Residential Building Geometry Characterisation Using Vehicle-Mounted Camera System. *Energies*, **15**(16), 6090 (2022), with M. Dai, W. O. C. Ward, D. Densley Tingley, & M. Mayfield. doi:10.3390/en15166090

J10. Net Zero by 2050: Investigating Carbon-Budget Compliant Retrofit Measures for the English Housing Stock. *Renewable and Sustainable Energy Reviews*, **161**, 112384 (2022), with X. Li, G. Bennett, T. Oreszczyn, & D. Densley Tingley. doi:10.1016/j.rser.2022.112384

J9. A Scalable Data Collection, Characterization, and Accounting Framework for Urban Material Stocks. *Journal of Industrial Ecology*, **26**(1), 58-71 (2021), with M. Lanau, X. Li, G. Meyers, M. Dai, M. Mayfield, & D. Densley Tingley. doi:10.1111/jiec.13198

J8. Mapping Resource Effectiveness across Urban Systems. *npj Urban Sustainability*, **1**, 20 (2021), with L. M. Tan, P. Brockway, D. Densley Tingley, & M. Mayfield. doi:10.1038/s42949-020-00009-3

J7. On the Use of Random Graphs in Analysing Resource Utilization in Urban Systems. *Royal Society Open Science*, **7**, 200087 (2020), with G. Punzo, G. Meyers, L. M. Tan, Q. Li, D. Densley Tingley, & M. Mayfield. doi:10.1098/rsos.200087

J6. Productivity, Infrastructure, and Urban Density – an Allometric Comparison of Three European City-Regions across Scales. *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, **183**(1), 211-228 (2020), with M. Mayfield & P. McCann. doi:10.1111/rssa.12490

J5. On Development Logic of City-Regions: Inter- Versus Intra-City Mobility in England and Wales. *Spatial Economic Analysis*, **14**(3), 301-320 (2019), with M. Mayfield & P. McCann. doi:10.1080/17421772.2019.1569762

J4. Urban Performance at Different Boundaries in England and Wales through the Settlement Scaling Theory. *Regional Studies*, **53**(6), 887-899 (2019), with M. Mayfield & G. Dabinett. doi:10.1080/00343404.2018.1490501

J3. An Ecological Thermodynamic Approach in Urban Metabolism: Measuring Resource Utilization with Open System Network Effectiveness Analysis. *Applied Energy*, **254**, 113618 (2019), with L. M. Tan, P. E. Brockway, D. Densley Tingley, & M. Mayfield. doi:10.1016/j.apenergy.2019.113618

J2. Ecological Network Analysis on Intra-city Metabolism of Functional Urban Areas in England and Wales. *Resources, Conservation & Recycling*, **138**, 172-182 (2018), with L. M. Tan, Q. Li, Y. Sheng, D. Densley Tingley, M. Mayfield, & D. Coca. doi:10.1016/j.resconrec.2018.06.010

J1. Urban and Rural — Population and Energy Consumption Dynamics in Local Authorities within England and Wales. *Buildings*, **6**(3), 34 (2016), with M. Mayfield. doi:10.3390/buildings6030034

Chapters & Reports

R4. Support Place-Based and Inclusive Supply Chain, Employment and Skills Strategies for Housing-Energy Retrofit. In A. Crowther, C. Foulds, R. Robison, & G. Gladkykh (Eds.) *Strengthening European Energy Policy: Governance Recommendations From Innovative Interdisciplinary Collaborations*, Cham: Palgrave Macmillan, (2024), with R. Macrorie, W. Eadson, R. Hanna, K. Camacho McCluskey, K. Simpson, & F. Wade. doi:10.1007/978-3-031-66481-6_6

R3. Report on Intra- and Inter-Generated Traffic in South Yorkshire. *South Yorkshire Sustainability Centre*, (2024), with S. Ivings, & G. Punzo. doi:10.15131/shef.data.27868524.v1

R2. Resource Effectiveness in and across Urban Systems. In R. C. Brears (Ed.) *The Palgrave Encyclopedia of Urban and Regional Futures*, Cham: Palgrave Macmillan, (2021), with L. M. Tan. doi:10.1007/978-3-030-51812-7_202-1

R1. Quantifying Agglomeration Productivity Potential in Long-Term Infrastructure Planning (PIN – Productivity Projects Fund). *Productivity Insights Network*, (2020), with J. Pannell, S. Hincks, & G. Punzo. doi: available here

Others

O7. New Towns: Practical Delivery, Written Evidence Submitted to the Built Environment Committee. *UK Parliament*, (2025), with D. Densley Tingley, H. Fairclough, J. Giesekam, C. Gillott, M Graham, K. Hobson, S. Maharjan, R. Lupton, & M. Sharmina. doi: available here

O6. Environmental Sustainability and Housing Growth, Written Evidence Submitted to the Environmental Audit Committee. *UK Parliament*, (2024), with C. Gillott, D. Densley Tingley, D. Abbey, M Graham, & S. Hincks. doi: available here

O5. The Grey Belt, Written Evidence Submitted to the Built Environment Committee. *UK Parliament*, (2024), with D. Abbey, C. Gillott, & D. Densley Tingley. doi: available here

O4. Government Resilience: Extreme Weather, Written Evidence Submitted to the Public Accounts Committee. *UK Parliament*, (2024), with T. Wood, S. Sadati, G. Punzo, & M. Mayfield. doi: available here

O3. Heating Our Homes, Written Evidence Submitted to the Energy Security and Net Zero Committee. *UK Parliament*, (2023), with R. Macrorie, M. Zune, D. Witherley, R. Sulley, W. Eadson, & D. Densley Tingley. doi: available here

O2. Comments on Bettignies et al., 'The Scale-Dependent Behaviour of Cities: A Cross-Cities Multiscale Driver Analysis of Urban Energy Use' Sustainability 2019, 11, 3246. *Sustainability*, **14**, 4230 (2022), with G. Meyers, L. M. Tan, & M. Mayfield. doi:10.3390/su14074230

O1. Comments on 'A Multi-Level Framework for Metabolism in Urban Energy Systems from an Ecological Perspective' by Barrera et al. (2018). *Resources, Conservation & Recycling*, **136**, 463-465 (2018), with L. M. Tan & M. Mayfield. doi:10.1016/j.resconrec.2018.04.028

Invited Talks

T4. Regions at Risk: Extreme Climate Change, Population & Displacement. In *Adapting to climate change: Local, national and international perspectives*. Grantham Centre for Sustainable Futures: Annual Symposium 2023, UK: 11 October 2023.

T3. Urban Densification: Is This the Future for Our Cities? In *Festival of Debate*. Opus Independents, UK: 10 May 2023.

T2. The Tensions between Density, Mobility, & Economic Output in Long-Term Mobility Planning. In *Northern Evidence Academic Forums*. Transport for the North, UK: 12 May 2021.

T1. On the Development Logic of City-Regions. In *Connect to Collaborate: Accelerating Infrastructure Transitions towards Connected Places*. The University of Bristol, UK: 23 May 2019. (An ESRC co-funded workshop through the Productivity Insights Network)

Conferences

C18. Fabric Energy Efficiency in Housing Retrofit: The Role of Whole-life Operational and Embodied Carbon Emissions. In *37th Passive and Low Energy Architecture Conference: (Re)thinking Resilience*. Wrocław: 2024, with M. Zune, & D. Densley Tingley. doi:10.37190/PLEA_2024

C17. Deviations from Agglomeration Expectations: Accessibility, Density, and Local Characteristics. In *Regional Sciences Association International-British and Irish Section 50th Annual Conference*. Bristol: 2024, with G. Punzo.

C16. Extreme Climate Change Impacts on Urban Infrastructure and Support Systems. In *the EGU General Assembly 2023*. Vienna: 2023, with T. Wood, & M. Mayfield.

C15. Regional Economic Resilience, Trophic Coherence, and Ecological Analogies. In *Regional Sciences Association International-British and Irish Section 48th Annual Conference*. Stirling: 2022, with G. Punzo.

C14. Demolish or Reuse? - The Balance between Operational and Embodied Emissions in the Retrofit of Commercial Buildings. In *Sustainable Built Environment D-A-CH Conference*. Berlin: 2022, with D. Abbey, C., Gillot, W. O. C. Ward, & D. Densley Tingley. doi:10.1088/1755-1315/1078/1/012016

C13. Deep Learning Based Residential Energy Prediction Using EPC and GSV. In *Sustainable Built Environment D-A-CH Conference*. Berlin: 2022, with Y. Sheng, M. Mayfield, M. Àlvarez, & W. O. C. Ward. doi:10.1088/1755-1315/1078/1/012038

C12. Measuring the Cityscape: A Pipeline from Street-Level Capture to Urban Quantification. In *Sustainable Built Environment D-A-CH Conference*. Berlin: 2022, with W. O. C. Ward, M. Dai, Y. Sun, D. Densley Tingley, & M. Mayfield. doi:10.1088/1755-1315/1078/1/012036

C11. Spatial Consistency and Patterns in Agglomeration Elasticities within and across European Urban Systems. In *Regional Science Association International-British and Irish Section 47th Annual Conference*. Cambridge, UK: 2019.

C10. Limiting Factors in Achieving Overall Circular Economic Effectiveness: an Analytical Assessment. In *1st International Conference on Construction Circular Economy*. Manchester, UK: 2019, with G. Punzo, G. Meyers, L. M. Tan, Q. Li, D. Densley Tingley, & M. Mayfield.

C9. Finding Northern Powerhouse, or How to Grow Your Own City Regions. In *Regional Studies Association Winter Conference*. London, UK: 2017, with M. Mayfield & P. McCann.

C8. Ecological Network Analysis on Intra-city Metabolism of Functional Urban Areas in England and Wales. In *Spaces & Flows: Eighth International Conference on Urban and ExtraUrban Studies*. Hull, UK: 2017, with L. M. Tan, Q. Li, Y. Sheng, N. Stanton, T. J. Valentine, & E. B. Fraser.

C7. Ecological Network Analysis of Inter-city Metabolism of Functional Urban Areas in England and Wales. In *Proceedings of the Department of Civil and Structural Engineering*. Sheffield, UK: 2017, with L. M. Tan, N. Stanton, T. J. Valentine, Q. Li, Y. Sheng, & E. B. Fraser.

C6. A Look at Urban Performance Balance across Different Boundaries in England and Wales. In *Regional Science Association International-British and Irish Section 46th Annual Conference*. Harrogate, UK: 2017, with M. Mayfield, & G. Dabinett.

C5. The Importance of Understanding the Material Metabolism of the Built Environment. In *World Sustainable Built Environment Conference*. Hong Kong: 2017, with D. Densley Tingley & M. Durkin.

C4. Too Large and Too Sparse, or Why the UK Northern Powerhouse Does Not Perform to a London Standard. In *Regional Studies Association Student & Early Career Conference 2016*. Newcastle, UK: 2016, with M. Mayfield & G. Dabinett.

C3. Avoiding Reductionism in Disaster Prevention and the Role of Complexity. In *Vestnick of Almaty University of Power Engineering and Telecommunications Special Issue 2016*, 14–22. Almaty, Kazakhstan: 2016, with G. Punzo & M. Mayfield.

C2. Urban and Rural – An Exploratory Look at Population and Energy Consumption in Local Authorities within England and Wales. In *Regional Urbanism in the Era of Globalisation*. Huddersfield, UK: 2016, with M. Mayfield.

C1. Renewable Energy Technologies in Campus-Sized Developments: A Spatial Study. In *CIBSE Technical Symposium 2015*. London, UK: 2015, with B. R. Lazarov & M. Mayfield.

Funding
(**£386k** apportioned)

EPSRC — June 2024
***£6m** – Co-investigator for BuildZero: transforming the UK's buildings for zero material extraction, zero carbon and zero waste – EP/Y530578/1.*

British Academy — March 2024
***£10k** – Principal-investigator for Pump Priming Collaboration between UK and EU Partners – PPHE2400399.*

QR Policy Support Fund — October 2023
***£36k** – Principal-investigator for award to support Transfort for the North investigating the changing profile of climate related transport infrastructure failure in the North.*

Rochdale Boroughwide Housing — January 2023
***£12k** – Co-investigator for research commission on new build versus retrofit for housing in Rochdale.*

MAKE Architects — July 2022
***£20k** – Co-investigator for research commission on new build versus retrofit office development.*

Community Renewal Fund — June 2022
***£42k** – Institutional principal-investigator for research commission awarded by the Doncaster Metropolitan Borough Council on residential retrofit planning.*

RE Development Fund — January 2022
***£4m** – Co-investigator for the housing and infrastructure theme of the South Yorkshire Sustainability Centre funded by RE.*

ATI Towards Turing 2.0 — October 2021
***£755k** – Co-investigator for the energy modelling digital twin of the Digital Twins for High-Value Engineering Applications program.*

ESRC Impact Acceleration Account   October 2021
£19k – Co-investigator for award allocated by the ESRC-funded IAA to support unlocking productivity in the Sheffield City Region through changes to the mobility network

RE Higher Education Innovation Fund   April 2021
£36k – Co-investigator for award allocated by the Research England-funded HEIF to support decarbonization through knowledge exchange partnership with Barnsley Metropolitan Borough Council and South Yorkshire Mayoral Combined Authority

RE Higher Education Innovation Fund   January 2021
£37k – Co-investigator for award allocated by the Research England-funded HEIF to support the development of a regional emissions accounting and budgeting framework in partnership with the South Yorkshire Mayoral Combined Authority

EPSRC Impact Acceleration Account   January 2021
£9k – Principal investigator and project lead for award allocated by the EPSRC-funded IAA to support the trial of an automated residential retrofit assessment in partnership with Barnsley Metropolitan Borough Council

Productivity Insights Network Productivity Project Funding   March 2020
£9k – Principal investigator and project lead for award allocated by the ESRC-funded Productivity Insights Network to support new and ambitious interdisciplinary directions in productivity research across the social sciences that engage partners and deliver impact on Quantifying Agglomeration Productivity Potential in Long-Term Infrastructure Planning — (Report R1)

Productivity Insights Network Early Career Seed Funding   November 2019
£500 – Award allocated by the ESRC-funded Productivity Insights Network to further develop a research idea presented at the network's early career sandpit event
315

Studentships

EPSRC ECR DTP Studentship   October 2023
£76,445 – Scholarship awarded by the University of Sheffield as part of a EPSRC DTP paying UKRI fees and stipend for up to 3.5 years – (Student P8)

Sheffield Undergraduate Research Experience Award
£12,060 – Scholarship awarded by the Department of Civil & Structural Engineering for a six-week research project — (Papers C7, C8, and J2)

Elanor Stonebridge	June 2023
Hasan Shwaish	June 2022
Carmen Truong	June 2021
Chloe Quinn	June 2019
Qianqian Li, Yulan Sheng, Nathaniel Stanton,	June 2017
Thamira Joy Valentine, Elspeth Fraser	
Han Ding	June 2016

Undergraduate Summer Research Award   June 2014
£1,080 – Scholarship awarded by the Department of Civil & Structural Engineering for a six-week research project — (Paper C1)

Grant Support

Contributions to Funded Research

Multi-scale, circular economic potential of non-residential building stock   2020 – 2022
Danielle Densley Tingley (PI)
EPSRC [EP/S029273/1], £381,024
Role: Named Researcher, contributed to development of work packages and writing the initial proposal draft.

Active Building Centre   2018 – 2022
Ahsan Khan (PI), Martin Mayfield (Institutional Co-I)

Doctoral Supervision

The University of Sheffield

P8. Margo Sulek   2024 – Present
A Risky Road: How Does Urban Morphology Change Cities' Risk Levels for Urban Explosions?

P7. Anna Fedotova (FT)   2024 – Present
Threats to, and Opportunities for, Global Building Stocks under Extreme Climate Change

P6. Ben Johnstone Bray (FT)   2023 – Present
Extreme Climate Change Compatible Residential Energy Retrofit

P5. Ioana Jelea (FT)   2023 – Present
Primary Supervisor: Giuliano Punzo
Complexity and Urban Systems

P4. Marcel Fehr (PT), Primary Supervisor.   2021 – Present
Climate Change and Credit Risk for Mortgage Portfolios

P3. Danielle Abbey (FT)   2021 – 2025
Primary Supervisor: Danielle Densley Tingley
Methods to understand the whole life carbon implications of school retrofit at scale

P2. Yulan Sheng (FT)   2020 – 2024
Primary Supervisor: Martin Mayfield
Deep Learning for Urban Thermal Energy Analysis

P1. Will Mihkelson (FT)   2019 – 2023
Primary Supervisor: Danielle Densley Tingley
Understanding the Relationship Between Resource Consumption and Development Levels

Teaching Activities

Program Lead, the University of Sheffield
  MEng Architectural Engineering   2022 – Present
Module Convenor, the University of Sheffield
  CIV4025 – Thermodynamics for Buildings   2020 – 2021
  CIV4017 – Computational Fluid Dynamics   2020 – 2025
  MAC451 – Computational Fluid Dynamics   2025 – Present
  CIV201 – Sustainable Buildings   2022 – 2025
  CIV204 – Sustainable Buildings   2023 – 2025
  MAC217 – Sustainable Buildings   2025 – Present
Module Contributor, the University of Sheffield
  GEE301 – Interdisciplinary Group Design Project   2022 – Present

Graduate Teaching Assistant, the University of Sheffield   2015 – 2019
  CIV201 – Sustainable Buildings (Lecture & Tutorial Delivery and Assessment)
  CIV173 – Engineering Sustainability (Lecture & Tutorial Delivery and Assessment)
  MEC162 – Engineering Solids, Liquids and Gases (Tutorial Delivery)
  ARC6818 – Elements of Computational Design I (Tutorial Delivery)
  CIV6014 – Computational Fluid Dynamics (Tutorial Delivery and Assessment)
  CIV6012 – Thermodynamics for Buildings (Lecture & Tutorial Delivery and Assessment)

Classroom Assistant, Sheffield International College   2012 – 2014