Project Title: Climate Resilient and Just Cities: Data for Research and Practice

Summary Description:

Provide a brief (300-word) description of your project

This project will develop and make available new standardised and integrated data layers that comprehensively depict urban climate variability, impact, and justice in major Australian cities and regional townships. It will expand available urban datasets in AURIN by integrating three critical data layers: 1) updated quality-controlled environmental and meteorological variables (obtained from established and crowdsourced monitoring campaigns), 2) high-resolution data on urban form and fabric relevant to micro and mesoscale climate, and 3) consolidated socioeconomic, demographic and housing data required for assessing sensitivity and vulnerability to environmental stresses. The datasets will be accessible through the AURIN data portal, and different end-users (including researchers, policymakers, planners, and the AURIN community) will be able to extract a subset of parameters at different scales that are relevant to their needs. The final product will be presented via two use cases that demonstrate the capabilities of the data layer to inform urban climate resilience, in addition to providing design and policy interventions.

This project will provide the first integrated dataset for informing research in urban climate resilience, and more importantly, enabling planning and policy interventions in the face of increasing climate challenges. The final product will complement existing national datasets and can be embedded in scenario planning tools for climate impact mitigation, enabling us to holistically quantify effectiveness and equity in climate change adaptation plans in cities. Further, the integrated data layers will identify any gaps in monitoring campaigns and analyses that can be addressed in subsequent data integrations.

Project Lead

Dr Negin Nazarian, UNSW, Scientia Senior Lecturer (Career stage: Early Career)

1. Outputs (criteria one)

Briefly (300 words) describe the new datasets, derived datasets and/or new tools/services/methodologies that will be generated and shared with and re-used by the AURIN Community.

Proposed outputs are twofold: a) creation of high-resolution urban datasets for AURIN and decision support tools focused on climate impact mitigation, and b) documentation of use cases for integrated data analyses in research and application.

Three data outputs are proposed:

i. Data from a network of established environmental sensors will be consolidated, compared with reference sensors to automate quality control, and processed to obtain time-averaged maps of heat and air quality. This network includes crowdsourced environmental monitors as well as scientific-grade sensors accessible through APIs or web-scraping.

ii. Data layers that holistically depict urban form and fabric influencing urban climates. Two maps will be processed: 1) **Local Climate Zone (LCZ)** maps at 100m resolution obtained through the World Urban Database and Access Portal Tools. LCZ maps are a universal classification for urban landscapes considering micro-scale land-cover and associated physical properties. LCZ maps of three major Australian cities are currently being evaluated. This will be extended to major Australian cities and townships. 2) Processed data outputs (100-500m resolution) of land-cover and building characteristics derived from 3D building models (such as Geoscape or Metromap). These maps will provide a comprehensive representation of built environments, covering variables such as street aspect-ratio and impervious fractions at resolutions relevant for urban climate observation and modelling studies.

iii. Digital data on socio-economic status, demographics, and housing (including rental bond board and land valuation data obtained through the Australian Housing Data Analytics Platform) will be consolidated to comprehensively characterize the exposure, sensitivity, and vulnerability to various environmental stressors.

Additionally, two data analysis use cases will be developed, documented, and shared publicly. The first use case will focus on quantifying urban climate injustice in Sydney with critical design and policy implications, while the second will explore how integrated datasets can inform, validate, and translate the results of climate models.

Please indicate whether the outputs are:

Unique	**Yes**	No	N/A
Nationally important	**Yes**	No	N/A
Of national scale	**Yes**	No	N/A
Of statewide scale	**Yes**	No	N/A
Strongly linked to other AURIN projects	**Yes**	No	N/A
Strongly linked to an ARC or NHMRC funded project	Yes	**No**	N/A

Data that will be used in this project - please provide as much information as possible

Collection/dataset title	Unique ID	Custodian	Origin	Is this open data?	License type/description	Access arrangements	Currency	Format	Aggregation / resolution	Geographic extent	Metadata
		Who owns this data?	Who collected this data?	Yes/No	E.g. CC	Describe who can/cant access this data and how?	Describe the currency of the data,	E.g. vector, real-time	E.g. MB, SA2, S/T, SA1-SA4	E.g. National, Northern Beaches NSW, Queensland	Describe the metadata availability
Integrated and processed environmental data from sensor networks	N/A	Research project team at UNSW (https://ror.org/03r8z3t63) and University of Melbourne (https://ror.org/01ej9dk98)	Data layer is consolidated from different data sources. Crowdsourced sensor networks are collected by citizens and real-time data is shared publicly on the Netatmo weather map (https://weathermap.netatmo.com/). Web-scraping will be done and automated by the research team (pilot done in doi.org/10.3389/fenvs.2021.720323). Additional data from reference sensors (such as Schools Weather and Air Quality network: https://www.swaq.org.au/) are collected by research institutes (such as UNSW, DPIE, and BoM) and are shared publicly via an API.	Yes	Creative Commons Attribution License (CC-BY)	Permission is granted, free of charge, to any person obtaining a copy of this data and associated documentation files through the CityData and AURIN platform on the condition that the creator is appropriately credited.	This dataset is gathered in real-time and the historic dataset will be available through web-scraping and API access. The processed environmental data map will be updated frequently and therefore will the latest version.	Space-time vector data + rasterized time-averaged maps	Depending on sensor availability, data maps will be processed at 300m to 1km resolution	Greater metropolitan regions of major Australian cities and several regional townships (selected based on vulnerability to heat and air quality and data availability).	Metadata for the processed environmental maps and Netatmo data will be made available through this project. Metadata for the reference stations are already available (SWAQ network is published and freely available on TERN, while BoM and DPIE provide detailed metadata shared publicly). Metadata materials for used sensors will be consolidated in this project.
Local Climate Zone maps of Australian cities and regional townships	N/A	Research project team at UNSW (https://ror.org/03r8z3t63) and University of Melbourne (https://ror.org/01ej9dk98)	Obtained through satellite imagery and machine learning algorithms. The training areas and resultant maps will be developed by the project team. Example of Sydney map developed is found here https://bit.ly/3avp8cx	Yes	Open data distributed under the CC BY-SA 4.0 license	Permission is granted, free of charge, to any person obtaining a copy of this data and associated documentation files, to copy and redistribute the material in any medium or format, and to remix, transform, and build upon the material for any purpose, even commercially	The data will be created using the latest satellite imagery and therefore is the latest version (2021-2022). It is recommended that the maps are updated every 5 years. Future updates will be provided by the project team.	Raster data	100m	Greater metropolitan regions of major Australian cities and several regional townships (selected based on vulnerability to heat and air	Metadata is available through the WUDAPT project and will be consolidated in this project.

										quality and data availability).	
Land-cover and building characteristics maps	N/A	These maps are derived from 3D building raw data, which is owned by Geoscape/Metromap (and thus not shared). The raw data is licensed to the research team to derive surface maps relevant for urban climate modeling and observation. The processing technique is owned by the project team at UNSW (https://ror.org/03r8z3t63) and University of Melbourne (https://ror.org/01ej9dk98) and the derived data will be shared publicly using the CC-BY license.	3D building data is collected by Geoscape and Metromap, but processed previously by team members at UNSW and Melbourne University through research agreement. Processed maps of land cover data is made available to AURIN users and published openly for non-commercial use.	The processed maps will be searchable and accessible to users with accounts in CityData and AURIN but the 3D building data is proprietary and not accessible.	Creative Commons Attribution License (CC-BY)	Permission is granted, free of charge, to any person obtaining a copy of this data and associated documentation files through the CityData and AURIN platform on the condition that the creator is appropriately credited.	The data is created using the latest Geoscape and Metromap 3D models (2021) and will be the latest version. Future updates require further agreements and data availability.	Raster data	100-500m	Greater regions of major Australian cities	Metadata will be made available through this project.
An integrated map of climate sensitivity and vulnerability for different environmental stressors	NA		Different datasets are obtained through different sources and made available through the Australian Housing Data Analytics Platform (AHDAP). For instance, the SES and demographics data are collected by ABS, housing stress and affordability is collected by the Australian Institute of Health and Welfare, Rental Bond Board data is collected by NSW Fair Trading, and land valuation is collected by Valuer General NSW.	Open (Many of the sources noted here are open access for NSW. AHDAP is extending the access to national datasets, which will be leveraged here)	Creative Commons Attribution License (CC-BY)	Permission is granted, free of charge, to any person obtaining a copy of this data and associated documentation files through the CityData and AURIN platform on the condition that the creator is appropriately credited.	The exposure sensitivity maps will be generated using the latest version of data layers. It is recommended that the maps are updated every 3 years. Future updates can be provided by the project team.	Raster data	Raster data at resolutions relevant for urban climate models and observations (300m-1km) will be made available.	Greater regions of Australian cities	Metadata will be made available through this project.

1.1. Please provide output software/tool info:

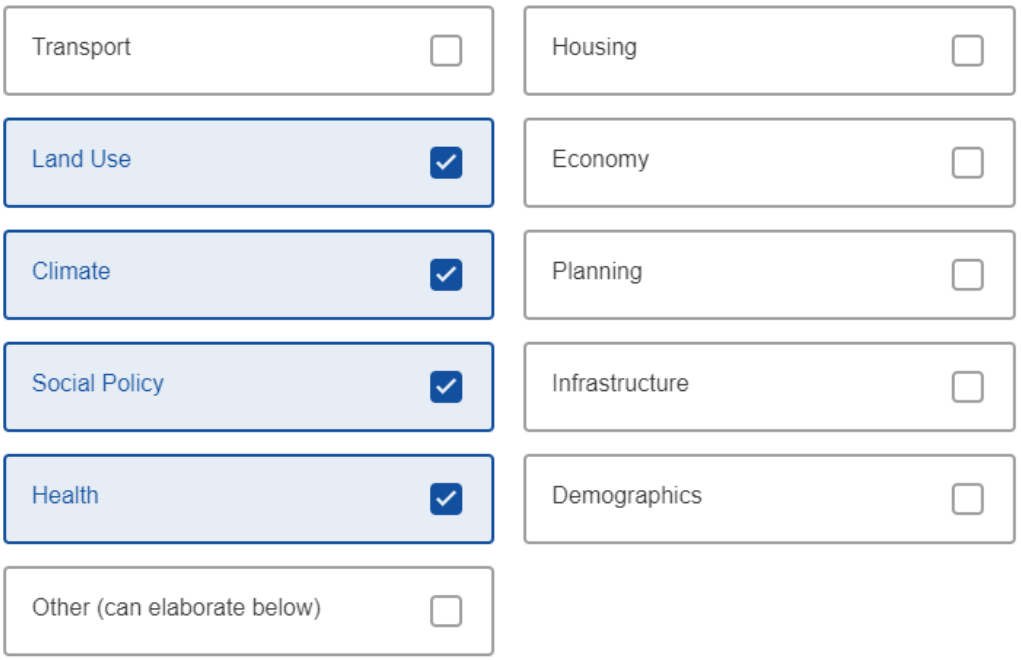
For each tool, script, software application, methodological process document, or other pieces of IP that will be created as a result of this project – please provide as much information as possible using the IP template attached. For multiple pieces of IP, please duplicate the details in the template as required before uploading.

Technical outputs such as tools, scripts, etc that will be created as a result of this project - please provide as much information as possible						
Description of tool, software or library	**URL**	**Unique ID (if available)**	**License type/description**	**Use and copy arrangements**	**Source code format**	**Operating system**
			Opensource	Who can use/copy/edit this IP and how?	E.g. R, Python	
N/A						

2. Relevance to AURIN community (criteria two)

This criterion relates directly to the second objective of the program: Demonstrate the value and potential of the AURIN infrastructure. It is a measure of the extent to which the project is aligned with AURIN strategy, such as alignment with AURIN's Key Thematic priority areas (Transport, Housing, Land Use, Economy, Climate, Planning, Social Policy, Infrastructure, Health, Demographics); and/or technology focus areas (Digital Twins/real-time data); and/or projects currently supported by AURIN.

Check any AURIN strategic thematic priorities that the proposed project is closely aligned with, or describe how the proposed project is aligned with AURIN's strategic priorities in the text box below.



2.1. Other/more information

Briefly (300 words) describe how the proposed project is aligned with AURIN's strategic priorities, including technology focus areas (Digital Twins/real-time data) if appropriate. You should consider AURIN's Strategic Plan and how your proposal is aligned with it.

Case studies of individual cities suggest that environmental stressors (such as urban heat and air quality) are unequally distributed across income groups, socioeconomic status, and urban resources. To quantify this disparity for Australian cities and townships, and more importantly, propose effective interventions in urban design and policy, a holistic analysis involving multiple data layers is required. Responding to this complexity, this project aims to take full advantage of capabilities in emerging technologies (such as Internet of Things and crowdsourced monitoring), robust, universal, and comprehensive datasets (such as local climate zone maps), and data infrastructures available in Australia, which is closely aligned with the AURIN 2023 strategy.

The proposed project will empower cutting-edge and multidisciplinary research in urban climate, climate justice, and urban climate informatics by providing timely and relevant spatial datasets and visualizations. Using integrated data and analytical environments, it supports several AURIN research priorities (including urban planning, population health, liveability, and sustainability) such that we holistically quantify and

address pressing environmental challenges faced in Australia. Furthermore, it strengthens AURIN's reputation as a leader in integrated spatial data and urban informatics for addressing real-world challenges.

The proposed integrated data layers assist us in moving beyond traditional climate analyses - often solely focused on environmental data - to incorporate the drivers and trends shaping our ever-changing cities. For instance, the availability of high-resolution datasets on urban form and fabric can directly inform urban climate modelling, while the environmental data maps provide a robust basis for model validation and calibration. Furthermore, data on socioeconomic status across the city, combined with model results, can accurately identify areas with the most exposure, sensitivity, and vulnerability to environmental stressors. Together, multi-disciplinary data analyses and scenario planning can inform interventions in both climatological observations and policies for addressing environmental inequalities in Australian cities.

2.2. Fields of Research

Thinking about those who will use the outputs of your project in the future, select the top three Fields of Research you expect they will come from.

- ☐ 30 AGRICULTURAL, VETERINARY AND FOOD SCIENCES
- ☐ 31 BIOLOGICAL SCIENCES
- ☐ 32 BIOMEDICAL AND CLINICAL SCIENCES
- ☑ 33 BUILT ENVIRONMENT AND DESIGN
- ☐ 34 CHEMICAL SCIENCES
- ☐ 35 COMMERCE, MANAGEMENT, TOURISM AND SERVICES
- ☐ 36 CREATIVE ARTS AND WRITING
- ☐ 37 EARTH SCIENCES
- ☐ 38 ECONOMICS
- ☐ 39 EDUCATION
- ☐ 40 ENGINEERING
- ☑ 41 ENVIRONMENTAL SCIENCES
- ☑ 42 HEALTH SCIENCES
- ☐ 43 HISTORY, HERITAGE AND ARCHAEOLOGY
- ☐ 44 HUMAN SOCIETY
- ☐ 45 INDIGENOUS STUDIES
- ☐ 46 INFORMATION AND COMPUTING SCIENCES
- ☐ 47 LANGUAGE, COMMUNICATION AND CULTURE
- ☐ 48 LAW AND LEGAL STUDIES
- ☐ 49 MATHEMATICAL SCIENCES
- ☐ 50 PHILOSOPHY AND RELIGIOUS STUDIES
- ☐ 51 PHYSICAL SCIENCES
- ☐ 52 PSYCHOLOGY
- ☐ None, please explain e.g. these outputs are for industrial use only

2.3. Engagement with industry or commercial entities

If industry or commercial entities will use the outputs of your project in the future, select the top three industries you expect they will come from.

- ☐ AGRICULTURE, FORESTRY AND FISHING
- ☐ MINING
- ☐ MANUFACTURING
- ☐ ELECTRICITY, GAS, WATER AND WASTE SERVICES
- ☐ CONSTRUCTION
- ☐ WHOLESALE TRADE
- ☐ RETAIL TRADE
- ☐ ACCOMMODATION AND FOOD SERVICES
- ☐ TRANSPORT, POSTAL AND WAREHOUSING
- ☐ INFORMATION MEDIA AND TELECOMMUNICATIONS
- ☐ FINANCIAL AND INSURANCE SERVICES
- ☐ RENTAL, HIRING AND REAL ESTATE SERVICES
- ☑ PROFESSIONAL, SCIENTIFIC AND TECHNICAL SERVICES
- ☐ ADMINISTRATIVE AND SUPPORT SERVICES
- ☑ PUBLIC ADMINISTRATION AND SAFETY
- ☑ EDUCATION AND TRAINING
- ☐ HEALTH CARE AND SOCIAL ASSISTANCE
- ☐ ARTS AND RECREATION SERVICES
- ☐ OTHER SERVICES

2.4. **End users**

Briefly (100 words) describe who you think the future users of your project's outputs will be.

The project's outputs will appeal to the triple helix model of innovation: engaging academia, government, and industry for increased interdisciplinary collaborations, supporting:

a) **Research communities** in urban climate, climate justice, health, and resilience to inform and validate climate models, complement observational analyses, and enable existing scenario planning and "what-if" tools for climate impact mitigation and adaptation,
b) **Government and non-government organisations** (such as Geoscience Australia and local councils) **and private sector** involved in urban design and planning to quantify and address local-scale climate impacts,
c) **Policymakers** to identify hotspots of environmental stressors and priority areas of policy and design intervention.

3. **Impact (criteria three)**

This criterion relates directly to the third objective of the program: Improve our understanding of complex urban and regional planning issues in Australia.

Briefly describe (300 words) the extent to which the project will have impact beyond its scope and completion.

Consider the following:

- Impact beyond research, such as economic, societal wellbeing, or policy impact (you should consider who will benefit (e.g. Which populations/organisations))
- The adoption of novel, innovative approaches to reveal new insights and outputs (e.g., new indicators, datasets, models)
- Impact on future research and the extent to which the project will enable future research by the AURIN community to investigate significant challenges, such as National or State/Territory research priorities

The outputs developed and presented in this project will enable future multidisciplinary collaboration within the AURIN community, particularly between researchers focused on data analytics, urban studies, environmental health, and climate analyses. More importantly, it produces holistic and applicable outputs for addressing environmental challenges, aligning with national research priorities in Environmental Change.

The impact of this project goes beyond enabling world-class research on climate resilience in Australia. First, the project drives innovation as it integrates multiple state-of-the-art technologies (such as crowdsourced monitoring campaigns and Internet of Things sensing) with large-scale datasets (such as satellite imagery) and machine learning algorithms to construct the most comprehensive multi-dimensional spatial datasets for analysing climate impact and resilience.

Second, the outcome of this project directly informs and impacts the design and management of Australia's built environment, which is increasingly faced with environmental challenges such as climate- and urban-induced excess temperatures, and poor air quality from bushfires or hazard reduction burns.. Making comprehensive data layers available in major cities and townships faced with increased heat and air quality exposure enables us in quantifying climate impact, deriving most suitable indicators for vulnerability, and mapping out the most effective and equitable outcomes.

The knowledge generated from integrating these data layers further contributes to Australia's economy, as heat and air quality kill more Australians than any other natural disaster, and has substantial implications on citizen's wellbeing and health in the current and projected climate.

List (100 words) the primary National or State research priorities that the project is strongly aligned with.

The project will place Australia at the forefront of data analytics for climate-resilient cities. It is strongly aligned with the national research priorities in Environmental Change ("Improved accuracy and precision in measuring the impact of environmental changes caused by climate and local factors"). It will improve Australia's ability to mitigate the impact of environmental stressors - such as heat and air quality - by integrating microclimate datasets with detailed urban land classification and social factors. This knowledge will transform the way we design to minimise environmental stressors, which is critical for productivity and wellbeing in highly-urbanised Australian cities with aging populations.

Projects will be required to generate at least one novel, high impact case study and related media and communications content.

Briefly (300 words) describe the case studies, publications, media, presentations and communication approaches that will be employed to disseminate the project findings and outcomes.

The following case studies will be developed:

1) **Quantifying urban heat injustice in Australian Cities**: This use case will quantify the disproportionate exposure to urban heat intensity across Sydney. Urban heat stress poses a major risk to the health and wellbeing of urban dwellers, while being unequally distributed across income groups and socioeconomic status. This use case will demonstrate how to quantify this disparity by combining crowdsourced air temperature measurements with high-resolution urban data for vegetation, surface cover, topography, and distance from the coast. Urban heat analyses will then be combined with processed housing and income data to better quantify urban climate injustice embedded in current data gaps. This multidisciplinary data analysis can inform interventions in both environmental observation networks and policies for addressing environmental inequalities.
2) **Informing climate models to create human-centric maps of thermal exposure**: This use case will demonstrate how multiple data layers can be extracted to inform and validate urban climate models across different scales, such that we better understand and address the complex impact of heat in diverse Australian urban areas. The integrated data layers will a) inform the deployment of multi-scale climate models for assessing current and projected heat exposure, b) identify datasets and emerging research outputs that can be integrated into national heat exposure and vulnerability maps, and c) determine integrated (climatic and socioeconomic) outputs needed to support policy and practice in addressing heat exposure. Informing future urban design and policy debate using detailed climatic maps such as these will reduce the negative impacts of heat exposure on the health and wellbeing of Australians and improve the livability of Australian cities and townships.

Results will be disseminated via media releases, scientific publications, presentations to stakeholders and in conferences, and via AURIN and ARC Centre of Excellence for Climate Extremes websites and newsletters.

4. Feasibility (criteria four)

This proposal must demonstrate that the project is technically feasible, including with respect to intellectual property, and that available resources and team expertise is sufficient to ensure that the project can be completed, and deliverables met, within the proposed budget and timeframe.

4.1. Key deliverables

A work package is a task or collection of related tasks that need to be undertaken in order to deliver a related deliverable or milestone						
Work package descriptions may be a list of tasks or text. They must have sufficient detail to demonstrate that the deliverable or milestone can be achieved						
Please identify; relationships between project components, such as other work packages; responsible persons; estimated effort involved in delivery; measures of success						
Examples responses have been included – please remove and replace these as required for your Project.						
Project Start date						1-Jun-22
Work package ID		**Detailed description**	**Months**	**Responsibility**	**Deliverable/s**	**Due date**
1	**Project Management**	Monitoring of progress, reporting, meeting preparation and participation, etc, across the life of the project	1 to 12	Project Lead	Monthly project update meetings with AURIN Ad hoc technical meetings as required	From 1/6/2021 to 31/5/2022
				Project Lead	Complete Project Plan template and submit to AURIN	1-Jul-22
				Project Lead	Complete Mid-term report template and submit to AURIN	1-Jan-23
			12	Project Lead	Complete Final report template and submit to AURIN	1-May-23
				Project Lead	Complete Finance report template and submit to AURIN	Before 30 August annually
2	**Project Promotion**	Presentations at events; including preparation of slides Literature review and writing of case studies and articles for peer-reviewed publication Production of promotional, press and training materials		Project Lead and Research Associate	Presentations at AURIN forums/events or other events agreed with the AURIN team to disseminate the project plans, progress, methods, outcomes, impact and/or other items as agreed with the AURIN team	TBA
		Case study Literature review months 1 & 2 Case study writing month 3	1 to 3	Research Associate	Deliver to AURIN the novel and high impact urban-scale case study described in the project proposal	1-Sep-22
		User guide preparation, review, edit and finalisation	12	Project Lead and Research Associate	Deliver to AURIN the user guide tool	1-Jun-23
		Publication Literature review months 9 & 10 Case study writing months 11 & 12		Project team	Submit publications to academic journals for the two use cases	1-Jun-23
3	**Data delivery**					
		- Preparation and testing of training data local climate zones (LCZ)	1 to 3	Research Associate and	Local Climate Zone maps for major Australian Cities and regional townships	1- Jul-22

		- Deploying LCZ-generator algorithms to obtain LCZ maps. - Correction of training and test data against local insights and datasets - Data hosting on CityData		Software & Cloud Engineer		
		- Processing of historical data (2019-2021) gathered from 870 crowdsourced Netatmo stations in Melbourne, Adelaide, Perth, Sydney, and Brisbane (scraped from https://weathermap.netatmo.com/) to draw insight on automation and quality control (example for Sydney provided in doi.org/10.3389/fenvs.2021.720323) - Automate and consolidate web-scraping for major Australian cities and regional townships - Pull scientific-grade environmental data from established networks (such as SWAQ, BoM, and DPIE) through APIs. - Automate quality control and data cleaning processes - Process time-averaged (daily-to-monthly) environmental maps - Data hosting on CityData	1 to 5	Research Associate and Software & Cloud Engineer	Consolidated environmental data map	1- Sep -22
		- Consolidation of the processed urban surface cover dataset (vegetation fraction, impervious fraction, and urban density)	3 to 7	Research Associate and Software & Cloud Engineer	Processed urban surface cover dataset	1-Nov-22
		- Calculate indicators for climate sensitivity, adaptive capacity, and vulnerability maps for various environmental sensors (such as heat and air quality) from demographic, housing, and SES data. - Data hosting on CityData	7-8	Research Associate and Software & Cloud Engineer	Heat and air quality sensitivity, adaptive capacity, and vulnerability map in major Australian cities	20- Dec-22
4	**Use Case development**	- Developing and documenting the use of integrated datasets for quantifying urban heat injustice in Australian Cities	9-12	Project Lead and Research Associate	Use case (1)	1-Apr-23
		- Developing and documenting the use of integrated datasets for informing climate models to create high-resolution and human-centric maps of thermal exposure	9-12	Project Lead and Research Associate	Use case (2)	1-Apr-23
5	**Documentation delivery**	Code notation throughout the development Preparation, review, edit and finalisation of all documentation	12	Project Lead and Research Associate	Final report, data, metadata	1-Apr-23

4.2. Constraints and dependencies

Briefly (300 words) describe any constraints, assumptions, or dependencies that apply to the proposed project.

Open data sources of accurate and detailed urban morphology are rare and limited in coverage. Commercial sources are becoming available but can be expensive and often available under restrictive licensing. Two such sources are Geoscape and Metromap (Aerometrex) with which the research team has existing usage agreements. This data can also be derived from urban imagery through machine learning, and although the research team has existing experience with these techniques, this will require some investment in computing and processing. The project team have considered 10,000 AUD in contingency funding to purchase data for regional areas that may be outside of the existing usage agreement which can remove time commitment outside of the planned deliverables.

The extension of the environmental data to selected townships will depend on the availability of environmental data (including Netatmo crowdsourced sensors and scientific-grade networks). The project team is involved in a Citizen Science project (Air in Alice Spring) that aims to tackle the gap in data in regional areas that can further leverage and scale urban dataset to selected townships that are vulnerable to heat and air quality.

4.3. Risks

Briefly (300 words) outline the top three (most significant) risks that apply to the proposed project.

While developing LCZ maps is highly feasible (and has been ongoing for three major Australian cities by project members), there is a risk in the lack of local knowledge for obtaining accurate training data in major Australian cities and regional townships. Project members have a background in urban climate, and more importantly, have extensive collective knowledge, and a network of local collaborators, with specialist expertise on Australian cities. Accordingly, the expertise required for obtaining additional local insight for the training data can be obtained through multiple sources.

One of the challenges in using crowdsourced data sets is access to reference stations for robust quality control. The pilot project developed for Sydney (doi.org/10.3389/fenvs.2021.720323) addressed this challenge by exploring multiple reference sensor networks (such as DPIE, BoM, and SWAQ) through various APIs , which is reflected in this proposal.

Employment of suitable personnel - the research associate position will be advertised widely through national avenues to ensure suitably qualified candidates are found.

4.4. Project budget

Personnel costs

Role; Name and affiliation if known E.g. Data analyst; John Citizen, ABC University	Hours over project lifetime E.g. 0.6 FTE / 6 weeks	Total cost E.g. $3,300.00
Research Associate at UNSW (with expertise in data science, machine learning, and urban climate informatics)	0.9 FTE/1yr (Level A-6)	$117,098.81
CityData Software and Cloud Engineer (with expertise in data hosting, compatibility, and interoperability in digital infrastructures)	18 days/1 FTE (Level 9-1)	$12,267.73
Total personnel expenses		$129,366.55

Other costs

Item	Total cost

E.g. software licenses	E.g. $120.00
AWS hosting for consolidated data layers hosted on CityData (UNSW)	$5,000
Graphic design and storyboard/website design for use case result dissemination	$5,000
(Contingency) Metromap data for regional townships	$10,000
Total other expenses	$20,000

Total cash expenses (personnel plus other)	$149,366.55
Total amount requested from AURIN (up to $150,000.00)	$149,366.55

In-kind contributions

Contributor E.g. ABC University	Item E.g. personnel contribution	Value E.g. $16,500.00
University of New South Wales	Dr Negin Nazarian (project lead) 0.15 FTE	$26,625.26
University of New South Wales	Prof Chris Pettit 0.05 FTE	$13,579.89
University of New South Wales	A/Prof Melissa Hart 0.05 FTE	$11,314.39
University of Melbourne	Dr Kerry Nice 0.05 FTE	$7,947.75
University of Melbourne	Dr Sachith Seneviratne 0.05 FTE	$7,412.05
University of New South Wales	Existing Citydata system architecture and infrastructure	$20,000.00
Total in-kind contributions		

4.5. Please provide output data layer:

For datasets/collections that will be created as a result of this project – please provide as much information as possible using the datasets template attached. For multiple datasets, please duplicate the details in the template as required before uploading.

Data that will be used in this project - please provide as much information as possible

Collection/dataset title	**Unique ID**	**Custodian**	**Origin**	**open data?**	**License type/description**	**Access arrangements**	**Currency**	**Format**	**Aggregation / resolution**	**Geographic extent**	**Metadata**
		Who owns this data?	Who collected this data?	Yes /No	E.g. CC	Describe who can/cant access this data and how?	Describe the currency of the data,	E.g. vector, real-time	E.g. MB, SA2, S/T, SA1-SA4	E.g. National, Northern Beaches NSW, Queensland	Describe the metadata availability
Netatmo weather data in major Australian cities and regional townships	N/A	Netatmo	Crowdsourced sensor networks are collected by citizens and real-time data is shared publicly on the Netatmo weather map (https://weathermap.netatmo.com/). Web-scraping will be done and automated by the research team (pilot done in doi.org/10.3389/fenvs.2021.720323).	Yes	Netatmo grants a limited, non-exclusive, revocable, non-sublicensable, non-transferable license to use the Netatmo Weather API in order to develop and distribute applications. Only non-commercial uses of the Netatmo Weather API are acceptable.	Access to the real-time Netatmo weather map is granted, free of charge, to any person.	This dataset is gathered in real-time (and the historic dataset will be available through web-scraping and API access) therefore will be the latest version and does not require update.	Space-time vector data	N/A (point measurements)	The sensor network covers all major cities and townships in Australia.	Metadata for the processed environmental maps and Netatmo data will be made available through this project.
Reference weather and air quality stations (found from BoM, DPIE, and SWAQ networks based on availability in the region)	SWAQ: https://doi.org/10.5281/zenodo.5016296 BoM and DPIE ID not available	SWAQ data is owned by UNSW (https://ror.org/03r8z3t63) while BoM and DPIE own the data from representative weather and air quality stations	SWAQ data is collected by UNSW (https://ror.org/03r8z3t63) and BoM and DPIE have been responsible for the collection of representative weather and air quality stations	Yes	These are licensed under the Creative Commons Attribution 4.0 International (CC BY 4.0), subject to the State of New South Wales Crown requirements.	Data from all networks are openly accessible and do not require registration or a subscription key.	This dataset is gathered in real-time (and the historic dataset will be available through API access) therefore will be the latest version and does not require update.	Space-time vector data	N/A (point measurements)	The collective sensor networks covers all major cities and townships in Australia.	Metadata for the reference stations are already available (SWAQ network is published and freely available on TERN, while BoM and DPIE provide detailed metadata shared publicly) and will be consolidated in this project.
Training data for Local Climate Zone maps of Australian cities and	N/A	Research project team at UNSW (https://ror.org/03r8z3t63)	The trainips maps will be collected by the research team and used to obtain LCZ maps through satellite imagery and machine	Yes	Open data distributed under the CC BY-SA 4.0 license	Permission is granted, free of charge, to any person obtaining a copy of this data and associated documentation files, to copy and redistribute the	The data will be created using the latest satellite imagery and therefore is the latest version (2021-2022).	Raster data	100m	Greater regions of Australian cities and regional townships	Metadata is available through the WUDAPT project and will be consolidated in this project.

regional townships		and University of Melbourne (https://ror.org/01ej9dk98)	learning algorithms. The training areas and resultant maps will be developed by the project team. Examples of training data for Sydney are found here bitly.is/3aod9gX.			material in any medium or format, and to remix, transform, and build upon the material for any purpose, even commercially	It is recommended that the maps are updated every 5 years. Future updates can be provided by the project team.				
3D Building characteristic data	N/A	The raw 3D building data is owned by Geoscape/Metromap and is licensed to the research team to derive surface maps relevant for urban climate modeling and observation.	3D building data is collected by Geoscape and Metromap, but processed previously by team members at UNSW and Melbourne University. Processed maps of Geoscape data is made available to AURIN users and published openly for non-commercial use	No	Research agreement	Only the research team can access the raw data	The data is the latest Geoscape and Metromap 3D models (2021) and will be the latest version. Future updates require further agreements and data availability.	vector	2m	Greater regions of major Australian cities	Metadata is available through data providers.
Socioeconomic status and demographic	NA	Australian Bureau of Statistics (https://ror.org/00ve6e186)	Australian Bureau of Statistics (https://ror.org/00ve6e186)	Yes	Creative Commons Attribution License (CC-BY)	Permission is granted, free of charge, to any person obtaining a copy of this data and associated documentation on the condition that the creator is appropriately credited.	The latest SEIFA dataset was released in 2011 and is expected to be updated in 2022. Demographics data was updated in 2021 and is the latest version	Vector	SA1/SA2	nationally	Metadata is available through ABS.
Housing stress, affordability, and ownership	NA	Australian Bureau of Statistics (https://ror.org/00ve6e186) and Australian Institute of Health and Welfare (https://ror.org/01972fe66)	Australian Bureau of Statistics (https://ror.org/00ve6e186) and Australian Institute of Health and Welfare (https://ror.org/01972fe66)	Yes	Creative Commons Attribution License (CC-BY)	Permission is granted, free of charge, to any person obtaining a copy of this data and associated documentation on the condition that the creator is appropriately credited.	The dataset was released in 2016 and is the latest version.	Vector	SA1/SA2	nationally	Metadata is available through ABS and AIHW.
Building level land valuation and rental bond data	NA	NSW Fair Trading and Valuer General NSW.	NSW Fair Trading and Valuer General NSW.	No	Research agreement with AHDAP (led by project parner Prof Chris Pettit)	Only the AHDAP research team can access the raw data	The dataset was released in 2020 and is the latest version.	point data	SA1/SA2	NSW and ongoing initiative to extend nationally.	Metadata is available to the research team.

4.6. Please provide input software/tool info:

For existing tools, software, libraries etc. that this project is dependent on, please provide as much information as possible using the template attached.

Existing tools, software, libraries, etc that this project is dependent on - please provide as much information as possible									
Description of tool, software or library	**Version no. / date**	**URL**	**Unique ID (if availabl e)**	**Custodian**	**Origin**	**Licens e type/ descri ption**	**Use and copy arrangement s**	**User guides /**	**Source code format**
Codes developed for Netatmo web scraping	1.0	NA	NA	Research project team at UNSW (https://ror.org/03r8z3t63) and University of Melbourne (https://ror.org/01ej9dk98)	Created by the UNSW and Melbourne Uni team using the APIs and scripts available online.	Not licensed	The research team can use, copy, and edit this code at this point. The final code will be made available freely through the CLEX Code Collection on Zenodo.	No user guide is available. However, since the process will be automated in this project, documentations will also be devised.	Python
Codes developed for identifying nearing reference stations and quality control	1.0	NA	NA	Research project team at UNSW (https://ror.org/03r8z3t63) and University of Melbourne (https://ror.org/01ej9dk98)	Research project team at UNSW (https://ror.org/03r8z3t63) and University of Melbourne (https://ror.org/01ej9dk98)	Not licensed	The research team can use, copy, and edit this code at this point. The final code will be made available freely through the CLEX Code Collection on Zenodo.	No user guide is available. However, since the process will be automated in this project, documentations will also be devised.	Python
Codes developed for deriving surface cover maps from 3D building data	1.0	NA	NA	Research project team at UNSW (https://ror.org/03r8z3t63) and University of Melbourne (https://ror.org/01ej9dk98)	Research project team at UNSW (https://ror.org/03r8z3t63) and University of Melbourne (https://ror.org/01ej9dk98)	Not licensed	Only the research team can use, copy, and edit this code at this point.	No user guide is available.	Python

LCZ Generator	1.0	https://lcz-generator.rub.de/	https://doi.org/10.3389/fenvs.2021.637455	Owned by authors and their institutes(Demuzere et al https://doi.org/10.3389/fenvs.2021.637455)	Created by authors (Demuzere et al https://doi.org/10.3389/fenvs.2021.637455)	Not licensed	The algorithm is not available for copy.	User guide is available through https://lcz-generator.rub.de/	Javascript

5. Collaboration (criteria five)

The extent to which the project or its outcomes will enhance collaboration between the project participants, AURIN and/or other organisations in research, government or industry, both within Australia and internationally**.**
Please list Project partners/participants (if more than one, use the template and upload).

5.1. Partner list

Title & name	Organisation	Role (w/Org) – including expertise and project role	Email	Phone
Prof Chris Pettit	City Futures Research Centre	Director, Professor of Urban Studies	c.pettit@unsw.edu.au	
A/Prof Melissa Hart	ARC Centre of Excellence for Climate Extremes	Graduate Director	melissa.hart@unsw.edu.au	02 93856263
Dr. Kerry Nice	University of Melbourne	Research Fellow	kerry.nice@unimelb.edu.au	(03) 834 41756
Dr Mathew Lipson	University of New South Wales / Bureau of Meteorology	Research Fellow	m.lipson@unsw.edu.au	0411100031
Dr Sachith Seneviratne	University of Melbourne	Research Fellow	sachith.seneviratne@unimelb.edu.au	0413626450

5.2. Collaboration

Very briefly (100 words) add any comment you would like to, regarding the project's ability to enhance collaboration between the project participants, AURIN and/or other organisations in research, government or industry, both within Australia and internationally.
The vulnerability of cities to local- and global-scale climate change, and conversely the opportunities for cities to mitigate these issues, is widely recognised as highlighted in the recent IPCC report. This is a wicked problem that is evaluated not just in the academic sector, but also across all levels of government, the Bureau of Meteorology, CSIRO, and many others. The vital data layers produced via this project paves the way for more multidisciplinary collaboration between research communities focused on data analytics, urban studies, environmental health, and climate analyses. More importantly, it produces holistic and applicable outputs for addressing environmental challenges.

6. Scalability, extensibility and sustainability (criteria six)

Briefly (300 words) describe the ability of the project to be applied to larger datasets, greater spatio-temporal extents or to other regions across Australia or nationally; the potential for the project to lead to a larger project proposal to be funded by the ARC, NHMRC, ARDC, CRC, State or Commonwealth Governments or other funding programs; and how the outcomes will be supported and maintained beyond the project's lifetime.

The dataset developed in this project is vital for ongoing urban climate research in Australia, and will continue to be used and developed by the wider community well beyond the duration of this project.

The main objectives of this project is indeed to scale, consolidate, and automate existing initiatives, datasets, and analysis workflows in different research groups, and in doing so, extend the pilot

projects conducted in Sydney or Melbourne to all major Australian cities as well as some regional townships and communities. This integration provides a great value-add in making data and analytics available to a wide range of end-users, which would not be otherwise possible beyond academic publications. Furthermore the methods used can be applied to international cities, making Australia a forefront of data analytics for urban climate justice and resilience.

Furthermore, these datasets are of use across spatial scales from neighbourhood to whole of the city, resulting in opportunities to explore funding from all levels of government. The outputs can complement the data aggregation efforts (such as AHDAP and Colouring Cities project conducted in collaboration with AURIN) as well as scenario planning tools for climate impact mitigation. Therefore, the project outputs can enable development of future proposals for ARC Discovery or Linkage Projects with partners such as Geoscience Australia and FrontierSI, such that complex interactions between urban microclimate and design factors, as well as policy interventions to increase climate adaptability, are assessed through engagement of different stakeholders.