TABLE OF CONTENTS

Acknowledgements 03
Glossary 04
Executive Summary 06
Introduction to Climate Data Management 10
Objectives of the Climate Data Management Framework 14
Scope of Application 16
Structure of the Framework 18
1. Theme 1: Data Management Strategy 22
2. Theme 2: Data Quality and Assurance 32
3. Theme 3: Leadership and Governance 44
4. Theme 4: Technology and Systems 54
5. Theme 5: Data Use and Decision-Making 66
References 76

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The Children’s Investment Fund Foundation (CIFF) is an independent, philanthropic organisation. Our staff and Trustees combine the best of business and the best of development, bringing a wealth of experience from both sectors to CIFF’s work. We aim to demonstrably improve the lives of children in developing countries by achieving large-scale, sustainable impact. We believe that every child deserves to survive, thrive and mature into adulthood in a supportive and safe environment. However, climate change disproportionately affects children living in poverty in developing countries. A key focus for CIFF is climate-smart urbanisation.

C40 Cities connects more than 90 of the world’s greatest cities, representing 650+ million people and one quarter of the global economy. Created and led by cities, C40 is focused on tackling climate change and driving urban action that reduces greenhouse gas emissions and climate risks, while increasing the health, wellbeing and economic opportunities of urban citizens.

C40 engaged EY to support the development of this City Climate Data Management Framework and the corresponding Maturity Assessment Tool. EY is a global leader in assurance, tax, transaction and advisory services. The insights and quality services we deliver help build trust and confidence in the capital markets and in economies the world over. We develop outstanding leaders who team to deliver on our promises to all of our stakeholders. In so doing, we play a critical role in building a better working world for our people, for our clients and for our communities.

Organisations that seek to embed sustainability and climate change into core business activities have an advantage with real benefits. We help organisations identify, develop and deliver strategies that address risk and opportunity while measuring their effectiveness. Whatever your sustainability or climate change challenges are, we’re here to help you.
Cities need to respond to the challenge of climate change by reducing emissions (mitigation action) and improving resilience to the impacts of climate change (adaptation action). This response is often set out in a long-term climate change strategy and action plan. This City Climate Data Management Framework focuses on climate change mitigation data although many of the themes and elements described in the Framework could be applied to other types of data relevant to the climate change strategy and action plan, such as climate risk and adaptation data and other datasets relating to the socio-economic context of the city.

A term used to summarise the cycle of climate change strategy development from establishing a baseline, designing the strategy, developing actions to deliver the strategy, evaluating progress, updating the baseline, refining the strategy and so on. Data needs throughout the cycle may vary and should be considered as part of a climate data management strategy.

Data relating to the city’s greenhouse gas (GHG) emissions inventory and the monitoring of actions to mitigation or adapt to climate change. This includes activity data associated with an activity that consumes energy and/or produces GHG emissions. It could also refer to environmental data relating to the climate or economic and social data. Climate data may be used for a range of purposes throughout the climate action lifecycle including setting a baseline emissions inventory, developing a climate change strategy and action plan, and monitoring, reporting and evaluation. Climate data may be produced by cities and/or by third-parties.

A Maturity Assessment Tool, aligned with this City Climate Data Management Framework, has been provided to assist cities in understanding their current level of data management. The results of the self-assessment will inform a city’s journey to improve climate data management practices. An Action Plan is included in the Tool, presenting an opportunity to reflect on the current maturity level, set a target maturity level, and develop actions to work towards achieving it.

The process of obtaining, assessing, validating, storing, protecting, analysing, approving, and communicating data.

The Framework is organised into five climate data management themes:
- Data Management Strategy
- Data Quality and Assurance
- Leadership and Governance
- Technology and Systems
- Data Use and Decision-Making

Each of the themes contain multiple elements which provide further details on the theme in the Framework.

‘Sustainability department’ has been used in this document as a general term to refer to the city department(s) covering sustainability, environment, asset management, smart city programs, or other city departments in charge of climate data management within the organisation.
EXECUTIVE SUMMARY

WHY CLIMATE DATA MANAGEMENT?

If we are to successfully deliver on aims of the Paris Agreement, to limit global warming temperature increase to well below 2°C and pursue efforts to limit temperature increase to 1.5°C, then action in cities to mitigate and adapt to climate change is crucial. But first we need to understand where we stand. Climate data is key to understanding how cities are contributing to rising emissions so that we can appropriately respond and prioritise actions that will deliver the greatest impact.

Cities use a range of climate data to do this. However, many cities do not yet have access to high quality climate data required to develop effective climate change strategies, and there are also opportunities to support cities in establishing internal processes and procedures to consistently meet existing and new reporting and analysis requirements. Good climate data management is needed so that data can inform and improve climate policy design and implementation.

Whilst reporting standards exist, they do not set out the practicalities of data management at the city department level. This Framework serves as an overarching guidance document for cities to assist them in building their capability in relation to climate data management.

WHO IS IT FOR?

This Framework has been designed to support cities of all sizes to implement sound data management practices that will strengthen the city’s understanding of the current situation, drive continuous improvement and, achieve its climate mitigation ambitions.

Assessment against this Framework in conjunction with the corresponding Maturity Assessment Tool will assist cities in understanding the current challenges and gaps in their existing climate data management policies, practices, systems and processes, identifying areas for improvement and setting action plans to move up the maturity curve.

Many cities do not yet have access to high quality climate data required to develop effective climate change strategies, and there are also opportunities to support cities in establishing internal processes and procedures to consistently meet existing and new reporting and analysis requirements.
WHAT IS IT?
The Framework is organised into five climate data management themes, each broken down into multiple elements. The themes are summarised below.

1. DATA MANAGEMENT STRATEGY
Data management strategy is related to the city’s consideration of how high-quality data will shape decision making and drive the achievement of the city’s broader climate change mitigation strategy, including alignment with the other data management initiatives set by the city. Refer to page 22-31 for additional information and case studies relating to the data management theme.

2. DATA QUALITY AND ASSURANCE
The data quality and assurance theme refers to the process of identifying and minimising risks to the accuracy, completeness, and relevance of the activity data required, and indicators in use, by implementing data quality controls. Refer to page 32-43 for additional information and case studies relating to the data quality and assurance theme.

3. LEADERSHIP AND GOVERNANCE
Leadership and governance relates to the ‘human element’ of climate data management. An organisational culture of data-driven decision-making can manifest at all levels of the organisation, but is often led by executives that demand evidence-based justification of the city’s actions and investments. This is complemented by an understanding of the skills and capacity requirements needed to implement the city’s data management strategy and the expectation and support for data management improvements. Governance arrangements refers to the relationships established with data owners and the extent to which the roles and responsibilities of everyone involved in the city’s data management are defined. Refer to page 44-53 for additional information and case studies relating to the leadership and governance theme.

4. TECHNOLOGY AND SYSTEMS
Technology and systems refers to the hardware, software, and processes involved in climate data management. Refer to page 54-65 for additional information and case studies relating to the technology and systems theme.

5. DATA USE AND DECISION-MAKING
The data use and decision-making theme relates to how the city is using data to inform evidence-based climate action and the ways in which information is communicated to multiple audiences. Refer to page 66-75 for additional information and case studies relating to the data use and decision-making theme.

For each of the Framework themes, case studies have been provided to illustrate how some cities have responded to these data management challenges, offering an opportunity to learn from peers and explore different approaches to climate data management.

This Framework has been designed to support city self-assessment of climate data management processes and identification of potential areas for improving using the Climate Data Management Maturity Assessment Tool.
As a growing proportion of the global population live and work in cities, cities are increasingly becoming the key agents supporting the transition to a sustainable future. Cities currently consume more than two-thirds of the world’s energy and account for more than 70% of global CO₂ emissions. Cities also have a lot to lose from climate change due to the potential of changing weather patterns and extreme events to erode the resilience of cities and their communities. If we are to successfully deliver on aims of the Paris Agreement, to limit global warming temperature increase to well below 2°C and pursue efforts to limit temperature increase to 1.5°C, then action in cities to mitigate and adapt to climate change is crucial.

But first we need to understand where we stand. Climate data is key to understanding how cities are contributing to rising emissions so that we can prepare and deliver evidence-based climate change strategies that prioritise actions that will deliver the greatest impact.

This starts with the community-scale emissions inventory and extends to other types of data relating to cities’ climate change strategies. Every year cities around the world need to collect and use climate data as part of the preparation of their greenhouse gas (GHG) emissions inventory. This supports a range of evidence-based responses, including: the development of climate mitigation, carbon neutral or net zero strategies, the setting of emissions reduction targets and the assessment of the benefits of climate mitigation actions for their local communities. By the end of 2018, fifty-five C40 cities have reported their emissions inventory using the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). Similarly, a growing number of cities have committed to develop climate action plans before the end of 2020, which will deliver the scale of action aligned with the goals of the Paris Agreement.

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“\[If you can’t measure it, you can’t manage it and you can’t fix it.\]”

Michael Bloomberg

C40 Cities Climate Leadership Group, President of the Board

Mayor of New York City (2002-2013)

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3  C40 Cities, City Greenhouse gas emissions interactive (accessed via https://www.c40.org/other/gpc-dashboard)


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INTRODUCTION TO CLIMATE DATA MANAGEMENT
Cities use a range of climate data to support evidence-based decision-making that will deliver the action required to effectively reduce emissions and improve resilience in response to the impacts of climate change. These climate data include activity data, socio-economic data, and environmental data produced by the cities and third-parties that are typically in relation to energy, buildings, transport and, waste.\(^1\) **C40** has identified opportunities to improve data management in cities. Many cities do not yet have the datasets required to develop effective climate change strategies, and there are also opportunities to support cities in establishing internal processes and procedures to consistently meet existing and new reporting and analysis requirements. Good climate data management is needed so that data can inform and improve climate policy design and implementation.

Whilst reporting standards exist, they do not set out the practicalities of data management at the city department level. The GPC outlines the requirements for city level emissions reporting. This Framework supports, but does not duplicate, the GPC standard. This Framework serves as an overarching guidance document for cities using standards such as the GPC to assist them in building their capability in relation to climate data management.

This Framework has been designed to support cities of all sizes to implement sound data management practices that will strengthen the city's understanding of the current situation, drive continuous improvement and, achieve its climate mitigation ambitions. Implementing this Framework will assist city sustainability departments in designing and implementing adequate processes, policies, and procedures to effectively and efficiently manage and use the climate data.

Assessment against this Framework in conjunction with the corresponding Maturity Assessment Tool will assist cities in understanding the current challenges and gaps in their existing climate data management policies, practices, systems and processes, identifying areas for improvement and setting action plans to move up the maturity curve.

For each of the Framework themes, case studies have been provided to illustrate how some cities have responded to these data management challenges, offering an opportunity to learn from peers and explore different approaches to climate data management.

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**CLIMATE DATA MANAGEMENT AND CLIMATE ACTION PLANNING**

A climate change strategy and action plan lays out a plan, including specific measures, to reduce GHG emissions and adapt to the impacts of climate change. C40 supports cities to update and/or develop climate action plans. The C40 Climate Action Planning Framework\(^2\) outlines a set of criteria which describes what good climate action planning looks like. It encourages cities globally to develop pathways to emissions neutrality by 2050.

Climate data and the need for climate data management is referenced throughout the C40 Climate Action Planning Framework. For example, the need to engage with stakeholders to collate appropriate and comprehensive data and information is acknowledged, as well as the need to base climate actions on relevant contextual data including social and economic indicators. The Climate Action Planning Framework also emphasises the importance of an up-to-date emissions inventory and the development of emissions trajectories, which should be accompanied by a description of the methodology, data sources and assumptions. As part of monitoring, evaluation, reporting and revision, the C40 Climate Action Planning Framework suggests that a public data and reporting platform may be used by the city to communicate progress against the plan.

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1. The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) BASIC+ reporting level also includes data relating to Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFLOU), and transboundary transport. The GPC acknowledges that the data collection and calculation processes for these activities is relatively more challenging to undertake. For more information relating to the GPC refer to World Resources Institute, 2014, Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities (accessed via https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities, 11 March 2019).

As cities seek to develop evidence-based climate action plans additional data must be obtained. It can be challenging to acquire timely and accurate data to complete emissions inventories and maintain them to keep them up-to-date. Modelling different types of emissions reduction actions can also require new and different types of climate, economic and scientific data. Many of these data needs can be met by re-purposing existing datasets, which are increasingly available via open data platforms. However, some will require establishing new relationships with new data owners.

A standardised approach to climate data management can help cities (and organisations of all types) to better manage their data needs and support data quality improvements.

This Climate Data Management Framework will help cities to put in place adequate processes, policies, and procedures to effectively and efficiently manage and use climate data. This will improve the reliability of data and enable cities to monitor performance and drive continuous improvement.

This Climate Data Management Framework and corresponding Maturity Assessment Tool has been designed to assist cities to:

- Identify and evaluate climate data management issues in cities (for example, inefficiencies in the climate data management process, inadequacy of the climate data against the data needs to support the emissions inventory preparation, climate mitigation, carbon neutral or net zero strategy development, emissions reduction targets settings and the assessment of the benefits of climate mitigations actions for local communities).
- Adopt a data management action plan to address climate data management issues and build cities’ capability to set their own ambition and develop a climate data management strategy to support the achievement of their climate mitigation ambitions.
- Promote improved climate data management performance of cities through the effective use of this Framework and corresponding Maturity Assessment Tool.
- Ensure that climate data management policies, practices, systems and processes from cities are managed appropriately to meet increasing demands from internal and external stakeholders.
- Promote and provide means for adequate engagement with climate data owners (internal and external) to establish and maintain relevant governance structures.
The Framework has been designed to be relevant and applicable to cities of all sizes and experience. It focuses on climate change mitigation data although many of the themes and elements described in the Framework could be applied to other types of data, such as climate change adaptation data and other datasets relating to the socio-economic context of the city.

This Framework has been designed for:

- Cities of any size, type, or region.
- City departments covering sustainability, environment, asset management, Smart City programs, or other city departments in charge of climate data management within the organisation.
- Cities that are relatively inexperienced in relation to climate data (for example, cities that have recently adopted the GPC standard to report their emissions inventory) or relatively experienced cities in relation to climate data (for example, cities with long standing GHG emissions reporting practices). Whatever your level of experience, this Framework and corresponding Maturity Assessment Tool offers opportunities to further improve climate data management.
- Cities that report on GHG emissions relating to any of the GPC sectors (stationary energy, transportation, waste, industrial processes and product use (IPUU), agriculture, forestry and other land use (AFOLU)). The Framework has been developed with community-scale emissions related data as its focus. However, the principles of data management outlined in the Framework would also be relevant to cities’ corporate emissions monitoring, as well as other measurement and reporting standards.
- Climate data including activity data, environmental data, economic data, social data, produced by the cities and/or by third-parties.

The City Climate Data Management Framework applies across all aspects of a Data Management System, set out in the diagram below.

### Scope of application

<table>
<thead>
<tr>
<th>Scope of application</th>
<th>Activity data</th>
<th>Data processing</th>
<th>Data visualisation</th>
</tr>
</thead>
</table>
| Various types of climate data may be collected by the city.  
For example, activity data relating to energy consumption, transport, waste. | Different types of tools may be used to process climate data to extract meaningful insights.  
For example, the city may use an Excel-based or bespoke software system to set a baseline emissions inventory, develop a climate change strategy and action plan, or monitor, report and evaluate climate actions. | Different audiences demand different types of information and visualisation of the city's climate data.  
For example, citizens may use interactive, online dashboards to interrogate the city's climate change strategy. |
The Framework is organised into five climate data management themes, each containing multiple elements as presented in Figure 1:

<table>
<thead>
<tr>
<th>Theme</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Management Strategy</td>
<td>Documented climate data strategy, Data objectives, Alignment with other data initiatives, Supporting the climate strategy</td>
</tr>
<tr>
<td>Data Quality and Assurance</td>
<td>Data collection purpose, Data use and re-use, Industry standards, Reporting boundary, External reporting requirements</td>
</tr>
<tr>
<td>Leadership and Governance</td>
<td>Culture, Leadership endorsement, Skills and training, Capacity, Reporting boundary, Governance arrangements</td>
</tr>
<tr>
<td>Technology and Systems</td>
<td>Capacity and features of system, Data processing and calculation, Integration with other systems, Integration with other systems</td>
</tr>
<tr>
<td>Data Use and Decision-Making</td>
<td>Data trend analysis, Climate strategy design and evaluation, Transparency and open data, Business cases, Project-based abatement</td>
</tr>
</tbody>
</table>

CITY CLIMATE DATA MANAGEMENT FRAMEWORK

The Framework is organised into five climate data management themes, each containing multiple elements as presented in Figure 1.
Across each of the themes and elements in the Framework, cities are likely to exhibit various levels of ‘maturity’, with some just starting their data management journey and others at a more advanced stage of data management practice. Similarly, while some cities may demonstrate leading practice for some of the elements there will likely be other areas of the framework that represent opportunities to improve.

To assist cities in assessing their maturity level for each of the themes and elements of the Framework, the Maturity Assessment Tool guides cities through a self-assessment questionnaire.

For each of the elements within the framework, three levels of maturity are described: developing, established, and leading.

At this stage, it is not anticipated that even the most advanced cities will view themselves as “leading” across all aspects of the Climate Data Management Framework. It is likely that all cities will have areas of the Framework to improve upon. It is also acknowledged that not all data, across all departments, will fall into the same level of maturity. A process of continuous improvement in data management practices is recommended.

Acting on the improvement areas identified through using the Framework and associated action plans will require ongoing leadership by the cities. C40 believes that cities should consider a two to three-year time frame for cities to act on their climate data management following the initial maturity assessment.

The results of the Maturity Assessment Tool can be used by the city to determine which areas to focus on and improve its climate data management.
**THEME I: DATA MANAGEMENT STRATEGY**

Data Management Strategy is related to the city's consideration of how high-quality data will shape decision making and drive the achievement of the city's broader climate change mitigation strategy, including alignment with the other data management initiatives set by the city.

In an increasingly digital and connected world, the amount of data generated is proliferating. It is therefore becoming increasingly important to think strategically about data needs to enable organisations to thrive in a world of information overload. Thinking strategically about the city's data needs now and in the future, will enable the city to extract value from its data.

A climate data management strategy should outline why data management is important and reference other elements of good data management described in this Framework, including identification of gaps between the current state and the desired future state. The overall priorities and strategy for the city will drive the climate data management strategy to ensure the city has the data it needs to make informed decisions.

The climate data management strategy sets out and documents the vision of the city so that everyone involved is clear on the future direction. It should be approved by all relevant stakeholders and spearheaded by an executive to emphasise the importance of good data management to the city and the principle of evidenced-based decision making. Feedback from these key stakeholders will be important to gain buy-in to the climate change strategy and the corresponding climate data requirements.

A climate data management strategy will only be successful if it is aligned with the broader business strategy. For cities, this means that the climate data management strategy should be linked to the city's overarching priorities and the objectives of the climate change strategy and action plan. It should also complement other city processes, for example smart cities plans or centralised information management offices.

The climate data management strategy will set out the data needs at all phases of the climate action lifecycle.

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**EVALUATION:** How will we know if our actions have delivered the expected results? What data do we need to measure success?

**BASELINE:** What data do we need to develop the community-scale emissions inventory?

**CLIMATE ACTION PLANNING:** How will we know which interventions will make the biggest difference to the city's emissions profile?

**STRATEGY DESIGN:** What data do we need to support our climate change mitigation strategy?

---

Rather than viewing data as an optional extra, careful consideration of what, when and how to implement data for the best, strategy-aligned results will allow organisations to develop value-creating, big picture insights. This can help cities navigate the ever-increasing volume of data during a time of unprecedented growth in data sources, processes and systems. Organisations globally, including cities, are trying to capture and store everything, without first establishing the data's business utility. Developing a climate data management strategy will help cities extract valuable insights to deliver effective climate action.

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The four elements that describe this theme of the Framework are detailed in the following sections.

1.1 DOCUMENTED CLIMATE DATA STRATEGY

The climate data management strategy documents how the city is thinking strategically about its climate data needs. It outlines why data is important, what it will be used for, and who is involved. The climate data management strategy references other elements of leading data management described in this Framework.

Documenting the climate data management strategy means that everyone has a reference point, aligned to the sustainability department’s needs and the city’s broader priorities and ambitions. Data privacy and accessibility considerations should be incorporated into the data management strategy documentation.

“Exponential data growth is a fundamental problem that is continuing to overwhelm most businesses, and it is accelerating. New digital business models are increasingly more complex, we are talking about entire ecosystems of data and companies that are able to effectively manage that complexity will clearly maintain a competitive advantage.

Unmanaged, that complexity becomes a barrier to innovation and inhibits our ability to derive meaningful insights and, in fact, becomes a barrier to achieving the automation and efficiency we desire. To seize the full potential of digital, companies must develop data strategies, and better information and data management discipline, and start asking better questions.”

Dave Padmos
EY Global Technology Sector Leader Advisory Services

1.2 DATA MANAGEMENT OBJECTIVES

The city understands the maturity of its current climate data management practices and the desired future state for climate data management. The city has developed a process of improvement and understands the investments needed to reach its desired future state.

Once the strategic climate data needs have been established, an assessment of how the city is currently managing its climate data can uncover opportunities to improve and ensure the data needs are met. By identifying the gaps between the city’s current state of climate data management and the desired future state, the city can determine a programme of work to improve its data management. This includes allocating appropriate budget for on-going data collection, analysis, and improvements to the data management process.

The City Climate Data Management Maturity Assessment Tool, provided alongside this Framework, has been developed to support cities in setting their own climate data management ambitions and developing an action plan to address areas for improvement.

1.3 ALIGNMENT WITH OTHER DATA INITIATIVES

Aligning with smart city plans or the city’s other data initiatives will facilitate efficient data sharing across city departments.

More cities are developing ‘smart city’ plans, embracing new technology to capture new sources of real-time data about the performance and sustainability of cities as urban systems. These plans enable improved understanding of how the city is working and evolving, in turn leading to an enhanced range of city policies, programmes and investments. In some cases, this ‘smart city’ ambition is complemented by a chief information or digital office to manage data flows and support city departments to access data and generate insights to inform policy making.

Whether there exists a ‘smart’ cities programme or not, all cities will have to prepare for the integration of ‘big data’ in their operations. Given the multi-disciplinary and inter-departmental nature of solutions of climate change, alignment with these plans and cross-departmental collaboration is essential.

The climate data management strategy should also aim to align with the requirements of other data policies, such as those that relate to data security and accessibility.

1.4 SUPPORTING THE CLIMATE CHANGE MITIGATION STRATEGY

Ultimately, the city’s climate data management strategy should service its climate change mitigation objectives. The climate data management strategy should be aligned to the objectives and ambition of the climate change strategy and action plan.

A climate change strategy and action plan has a range of data needs to support its development and delivery. These should be covered by the climate data management strategy which articulates the plan for obtaining, using, and improving the data supporting the development of the climate action plan.

The data needs of the climate change strategy may change throughout the climate action lifecycle (refer to Figure 2). The city’s climate data management plan should consider these diverse data needs and include budget allocation to meet the data needs from establishing the baseline, through to monitoring and evaluation of the planned interventions.
CITY OF SYDNEY – Environmental performance targets

The City of Sydney has established clear environmental and performance targets across greenhouse gas emissions, energy consumption, water consumption, waste to landfill, and emissions from transport. The city currently licenses and uses the CCAP City tool to inform its analysis and reporting on these targets. As the city’s data gathering and resource tracking requirements have grown and its analysis needs have become more granular, it required a more transparent, automated, frequent and robust data collection process that aligns to both its internal programs as well as external reporting requirements.

CCAP City is an integrated urban analytics tool designed and developed by Kinesis in collaboration with the Council of the City of Sydney, to aggregate, analyse & report disparate urban data to drive more informed and dynamic decision making. Kinesis manages datasets for the City of Sydney within CCAP City to track and monitor the environmental sustainability performance targets of Sustainable Sydney 2030. These datasets include local government area emissions, energy, water, waste, transportation etc. (disaggregated to finer-grain sectors and geographies), and building-level operational data.

When building the CCAP City platform, the City of Sydney had a methodology developed that:

• Is repeatable and automated,
• Complies with the Global Protocol for Community Scale Emissions (GPC),
• Is formatted to allow for new or altered data sources to be added in the future.

INDICATIVE CONTENTS OF A CITY CLIMATE DATA MANAGEMENT STRATEGY

The table below provides an outline of some of the data management considerations to include within a City Climate Data Management Strategy. It draws on each of the themes and elements with the City Climate Data Management Framework.

<table>
<thead>
<tr>
<th>Scope of the Strategy</th>
<th>Describe the scope of the city’s climate data. What climate data is considered? Does it include mitigation data and/or adaptation data? Does it include corporate climate actions and/or actions for the broader community?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governance of the Strategy</td>
<td>Who is responsible for the climate data? Where does it come from? How frequently does the city obtain data from external data providers? What support is available to those using the city’s climate data?</td>
</tr>
<tr>
<td>Procedures</td>
<td>What controls are in place to support the quality of climate data used in decision making? What systems are used to collect, store, analyse, and report data?</td>
</tr>
<tr>
<td>References</td>
<td>Where can city staff and/or citizens find more information on how the city’s climate data is being used?</td>
</tr>
</tbody>
</table>

10 This case study was provided by the City of Sydney.
1.6 DATA MANAGEMENT STRATEGY: MATURITY LEVELS

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>CITY CLIMATE DATA MANAGEMENT MATURITY MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documented climate data strategy</td>
<td>Developing</td>
</tr>
<tr>
<td></td>
<td>Established</td>
</tr>
<tr>
<td></td>
<td>Leading</td>
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<tr>
<td>Data management objectives</td>
<td>Developing</td>
</tr>
<tr>
<td></td>
<td>Established</td>
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<td></td>
<td>Leading</td>
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<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>CITY CLIMATE DATA MANAGEMENT MATURITY MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment with other data initiatives</td>
<td>Developing</td>
</tr>
<tr>
<td></td>
<td>Established</td>
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<tr>
<td></td>
<td>Leading</td>
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</tbody>
</table>

Supporting the climate change mitigation strategy

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>CITY CLIMATE DATA MANAGEMENT MATURITY MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing</td>
<td>The city’s climate change strategy and action plan is yet to be developed, or has been developed in isolation without consideration of the availability or quality of supporting data or reference to a leading practice standard, such as the GPC. Climate data is obtained on an ad hoc basis, based on what is already available to the city.</td>
</tr>
<tr>
<td>Established</td>
<td>Data requirements for the city’s climate strategy and action plan have been identified; however, limited data is available for this purpose. Data gaps may have been filled with estimates that have not been validated.</td>
</tr>
<tr>
<td>Leading</td>
<td>Climate data needs across the whole climate action lifecycle are identified and addressed (including through the allocation of sufficient budget for data management). For example, including climate data required for: • Baseline: Annual emissions inventory or baseline emissions inventory • Climate strategy development: Climate action plan and emissions reduction trajectory (for example, a carbon neutral, net zero emissions strategy) • Climate action planning: Climate abatement programme and/or project justification and evaluation pre- and post-implementation • Evaluation: Monitoring of community-scale emissions through updates to the emissions inventory and monitoring and evaluation of abatement programmes and/or projects versus the expected results.</td>
</tr>
</tbody>
</table>
THEME 2: DATA QUALITY AND ASSURANCE

The data quality and assurance theme refers to the process of identifying and minimising risks to the accuracy, completeness, and relevance of the climate data required by implementing data quality controls. Decisions will only ever be as good as the data that supports them. Therefore, if we want high-quality decisions to shape our approach to climate action then we need high-quality data in our evidence base. There are several aspects that determine the quality of data such as the purpose for which the data was collected, how it is being used, the standards and guidance that have been used in calculations and the level of control over data collected.

Obtaining assurance, or verification, of climate data can provide additional confidence in the data used and reported by the city. Assurance procedures identify the risks to data quality with the overall aim of supporting the city to disclose accurate information and improve the city’s data management in the process.

Definition of quality control and assurance

“Quality Control (QC) is a system of routine technical activities, to measure and control the quality of the inventory as it is being developed. The QC system is designed to: (i) Provide routine and consistent checks to ensure data integrity, correctness, and completeness; (ii) Identify and address errors and omissions; (iii) Document and archive inventory material and record all QC activities. QC activities include general methods such as accuracy checks on data acquisition and calculations and the use of approved standardised procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting. Higher tier QC activities include technical reviews of source categories, activity and emission factor data, and methods.

Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. Reviews, preferably by independent third-parties, should be performed upon a finalised inventory following the implementation of QC procedures. Reviews verify that data quality objectives were met, ensure that the inventory represents the best possible estimates of emissions and sinks given the current state of scientific knowledge and data available, and support the effectiveness of the QC programme.”

IPCC Good Practice Guidance

“The GPC does not require that cities verify their inventory results, but recommends that cities choose the level and type of verification that meets their needs and capacity... Verification involves an assessment of the completeness and accuracy of reported data. Cities may choose to verify their data to demonstrate that their calculations are in accordance with the requirements of the GPC and provide confidence to users that the reported GHG emissions are a fair reflection of a city’s activities. This can be used to increase credibility of publicly reported emissions information with external audiences and increase confidence in the data used to develop climate action plans, set GHG targets and track progress. Verification can be performed by the same organisation that conducted the GPC assessment (self-verification), or by an independent organisation (third-party verification).”

Global Protocol for Community-Scale Greenhouse Gas Emission Inventories

The six elements that describe this theme of the Framework are detailed in the following section.

2.1 DATA COLLECTION PURPOSE

The purpose for which data is collected should be clear as this could have implications for how the data should be used and indicate any limitations.

The data collected by cities can be used for a variety of purposes, such as designing policy initiatives, developing business cases, applying for grants, and reporting to internal and external stakeholders. Multiple stakeholders are often involved in the collection process, including external third-parties who may be the owners of the data required.

It is important that the intended purpose(s) of the data being collected is understood by those compiling the data, and to a certain degree by the other stakeholders involved in the data collection process. The data collection purpose provides the context that informs the way the data is cleansed, modified, and organised. If an external data provider (for example, an electricity utility operator) does not have the required context, they may make certain assumptions, aggregations and modifications to the dataset that are inappropriate in the context of the intended purpose of the data. Communication from the city to the data provider of the underlying use cases and purpose of the data being requested can help to mitigate these risks.

The data collection purpose should be outlined in the data management strategy (refer to Theme 1: Data Management Strategy).

2.2 DATA RE-USE

Consideration of multiple uses for underlying data and improving data utility across city departments.

This element of climate data management is linked to data collection purpose. It is likely that data collected in a given year will be useful to the city in future years or will be useful to other stakeholders that the city may share the data with. Considering data re-use early and often is important as it will affect the way in which the city organises, compiles, processes and stores its datasets.

Consider creating a standard template to document key information about each dataset that will be of use when reusing the data. This template could include:

- **Title**
- **Description of the dataset (brief or detailed)**
- **Source(s) of data in the dataset**
- **Temporal information: time period the data relates to, time period over which the data was collected**
- **Existing uses of the dataset, for example any related strategies, publications, reporting**
- **Provider and collector of the dataset**
- **Description of data collection process**
- **Description of data cleansing process**
- **Date of next update / expiration date**
- **File index: listing of files and folders included in the dataset**
- **Contact person/organisation**

The above information can be considered metadata, i.e. data about the data. The city could consider storing this data in machine-readable formats like xml or json files; this is particularly useful if the city has plans to catalogue and host datasets online for public access as it enables others to search for a given dataset easily.

2.3 INDUSTRY STANDARDS AND EXTERNAL REPORTING REQUIREMENTS

The extent to which the city is able to conform to the standards for city-level climate reporting and the level of ease with which the city is able to meet external reporting requirements.

There are currently a range of standards and external reporting demands that a city is requested to meet. Usually these requirements specify a methodology to be used for estimating current and future emissions as well as request additional metrics and information.

Examples of industry standards and external reporting requirements may include:

- Internal reporting to Council and the city executive management team
- Reporting to other tiers of government
- Corporate emissions inventory reporting in accordance with the GHG Protocol Corporate Accounting and Reporting Standard or alternative national standards or equivalent
- Community scale emission inventory reporting in accordance with the Global Protocol for Community-Scale emission inventories (GPC) or equivalent
- CDP Cities program
- City sustainability reporting
- Other international reporting requirements (including through C40 and other networks)
2.4 REPORTING BOUNDARY

Describes the scale and limits of the city’s reporting and the choice of scope for accounting and reporting climate related metrics, such as emissions.

For emissions inventories, the reporting boundary describes the geographic areas, time span, greenhouse gases, and emissions sources included in the inventory. The chosen or required reporting standard will likely specify the requirements for the reporting boundary but may offer flexibility in how to apply the standard, as long as the choice made is clearly disclosed.

The GPC is flexible enough for cities of all sizes to use it, so long as the reporting boundary is specific and clearly defined. This is particularly important to allow for comparisons between cities and monitor progress towards global emissions reductions goals, such as the Paris Agreement’s objectives and other climate related objectives such as the carbon budgets outlined in C40’s Deadline 2020 report. Each city will define the reporting boundary upon which they have certain level of influence over actions to reduce emissions. For example, the London emissions inventory covers the Greater London area comprising 33 local authorities. The City of Melbourne’s emissions inventory defines the boundary as the administrative limits of the city, one of 32 local authorities in the Greater Melbourne area.

2.5 QUALITY CONTROLS AND ASSURANCE

The processes and measures implemented to identify and subsequently control the risks to the integrity of the data. Quality control and assurance involves understanding the various sources of data, making judgments on the reliability of the data sources, and then applying a corresponding level of scrutiny to the data. It also involves acknowledging that errors can occur during analysis of the data and implementing a process of validating assumptions, checking calculations, and obtaining assurance over the outputs of the analysis to ensure the results and underlying data are accurate and fit-for-purpose.

Examples of data quality risks, include:

- Completeness
- Accuracy of measurement of activity data
- Timeliness of the reporting
- Transcription and input error
- Calculation error
- Reasonableness of assumptions or undocumented assumptions

The city can implement quality control and self-verification over its data. However, a second pair of eyes can provide helpful scrutiny over the quality of the climate data. The city could obtain the opinion of a suitably qualified third-party assurance provider to review the reported climate data.

2.6 DATA CLEANSING AND STANDARDISATION

The process of preparing data collected into a consistent, defined, format and removing or correcting erroneous data.

Datasets often have missing or erroneous data that require cleansing. It is important for the city to first identify the issues in the data being collected, categorise these issues, and then develop cleansing and standardisation rules to deal with each issue in a consistent manner. For example, missing values within a given column of data could be categorised as one type of issue. The corresponding rule(s) may be to first contact the data provider and attempt to obtain the missing data, and if unsuccessful to then replace all missing values with the average of the existing values.

Data cleansing and standardisation rules and procedures should be explicitly documented. Importantly, when the rules fundamentally alter the dataset (for example, replacing missing values with averages as in the example above) this should be documented in any work produced from the cleansed data. Implementation of the cleansing rules should be automated where possible, for example by programming the rules into a macro in Excel or other data management tools. This can improve efficiency and reduce potential errors caused by rules being overlooked or being performed in the wrong order.
NEW YORK – Improving building data quality

The Mayor’s Office of Sustainability in the city of New York collects energy consumption data each year for buildings over 25,000 square feet. This data is reported to the city by building owners through the Energy Star Portfolio Manager website. In order to improve the quality of the data reported, the City took the following actions:

1. Established a full-time (9 am - 5pm, Monday - Friday) Energy Benchmarking Help Center that provides on-call assistance to building owners trying to comply with the local law.
2. Worked with local utilities to build automatic data upload tools that send energy consumption data directly to building owners’ Energy Star Portfolio Manager accounts. This eliminates the error introduced by transcribing bill data and makes the reporting process much easier.
3. Began issuing violations through the Department of Buildings for missing or clearly erroneous energy and gross floor area data.

The city also collects detailed energy audit data from buildings larger than 50,000 square feet. These reports include inventories of the lighting, heating, cooling, hot water, building envelope, and conveyance systems in each building. Until recently, this data was collected in Excel forms that lacked data validation and that did not allow users to allocate systems to specific buildings or parts of a building. The result was a dataset that held great value, but which was very difficult to analyse.

The city has worked for several years with the Federal Department of Energy, Pacific Northwest National Labs, and the National Renewable Energy Laboratory to develop a web-based energy audit reporting tool that solves both these problems. This tool was built as an extension of the Department of Energy’s Building Energy Asset Score tool, which issues a rating for the efficiency of a building’s assets. The result is a cleaner, better organized dataset, which also includes a Building Asset Score.15

15 This case study was provided by the City of New York. Additional information on the New York City Benchmarking Help Center (BHC) is available at https://www1.nyc.gov/html/gbee/html/plan/ll84_help_center.shtml. Details of the U.S. Department of Energy's National Building Energy Asset Score is available at https://www.energy.gov/energy/buildings/building-energy-asset-score.
### 2.8 DATA QUALITY AND ASSURANCE: MATURITY LEVELS

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>CITY CLIMATE DATA MANAGEMENT MATURITY MODEL</th>
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<tbody>
<tr>
<td>Documented climate data purpose</td>
<td>Developing Some of the team members involved in compiling the city’s climate data understand the purpose(s) of the data being collected and are familiar with the city’s data collection processes. However, documentation of purpose and process is non-existent or minimal.</td>
</tr>
<tr>
<td></td>
<td>Established Key team members involved in compiling the city’s climate and external data providers understand the purpose(s) and broad use cases of the data being collected. Key requirements are communicated effectively. Documentation of purpose may be minimal.</td>
</tr>
<tr>
<td></td>
<td>Leading Key personnel within the city and external data providers understand the purpose(s) and broad use cases of the data being collected. Key requirements are communicated effectively. Documentation of purpose is extensive. For example, all sources of data are mapped to purposes and use cases. If data used was collected for another (non-climate related) purpose the limitations of the data are understood and the data is treated appropriately.</td>
</tr>
<tr>
<td>Data re-use</td>
<td>Developing Little consideration is given to the potential for data reuse. As such, datasets are not well organised and information about each dataset is not well documented.</td>
</tr>
<tr>
<td></td>
<td>Established Some consideration is given to the potential for data reuse. Datasets are generally well organised and some information about each dataset is documented.</td>
</tr>
<tr>
<td></td>
<td>Leading Extensive consideration is given to the potential for data reuse. Datasets are organised and coherent, with files and folders following logical naming conventions. Documentation is comprehensive to the extent that another user could easily understand key information about the dataset and draw inferences about its properties and limitations.</td>
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<tr>
<th>ELEMENT</th>
<th>CITY CLIMATE DATA MANAGEMENT MATURITY MODEL</th>
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<tbody>
<tr>
<td>Industry standards and external reporting</td>
<td>Developing The city is not currently meeting external reporting requirements. For example, the city has not disclosed a community-scale emissions inventory.</td>
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<tr>
<td></td>
<td>Established A methodology for externally reported metrics is applied and disclosed annually to allow for comparison of data over time. Data quality may be limited with no plans in place to improve data over time.</td>
</tr>
<tr>
<td></td>
<td>Leading A methodology for estimating emissions and measuring other indicators is applied and disclosed annually. The methodology is well understood and areas to improve data have been identified to reduce the level of uncertainty in reported data.</td>
</tr>
<tr>
<td>Documented climate data purpose</td>
<td>Developing The city has limited climate data for activities within the city boundary. For example, the city may have data available and reports on some, but not all Scope 1 and Scope 2 emissions sources, and has data available and reports a few or no Scope 3 emissions sources. This corresponds to an incomplete “BASIC” reporting level as outlined by the GPC.</td>
</tr>
<tr>
<td></td>
<td>Established The city has some climate data for activities within the city boundary. For example, the city reports on all Scope 1 and Scope 2 emissions from stationary energy, transportation, and waste, as well as some Scope 3 emissions sources. This corresponds to a complete “BASIC” reporting level as outlined by the GPC, and possibly also some elements of “BASIC+” reporting.</td>
</tr>
<tr>
<td></td>
<td>Leading The city has climate data for most activities within the city boundary. For example, the city reports on all Scope 1 and Scope 2 emissions from stationary energy, transportation, waste, IPPU, and AFOLU. The city also reports on almost all Scope 3 emissions sources. This corresponds to a complete “BASIC+” reporting level as outlined by the GPC. The sources covered in BASIC+ also align with sources required for national reporting in IPCC Guidelines.</td>
</tr>
<tr>
<td>Data re-use</td>
<td>Developing</td>
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<td>----------------------------------------------------------------------------</td>
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<tr>
<td></td>
<td>Data sources are not formally documented or mapped.</td>
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<tr>
<td></td>
<td>Little to no consideration is given to the reliability of a data source,</td>
</tr>
<tr>
<td></td>
<td>with little to no documentation of risks and controls. Few to no checks</td>
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<tr>
<td></td>
<td>on source data are performed. Data analysis outputs are not subject to</td>
</tr>
<tr>
<td></td>
<td>checks or assurance either internally or externally.</td>
</tr>
<tr>
<td>Industry standards</td>
<td>Developing Datasets are not checked for anomalies or errors and are used</td>
</tr>
<tr>
<td>and external</td>
<td>with little scrutiny. If errors are found, cleansing is performed in an</td>
</tr>
<tr>
<td>reporting</td>
<td>ad-hoc manner and cleansing techniques are applied inconsistently.</td>
</tr>
<tr>
<td></td>
<td>Documentation of data cleansing is non-existent or minimal.</td>
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</table>
THEME 3: DATA QUALITY AND ASSURANCE

Leadership and governance relates to the ‘human element’ of climate data management. An organisational culture of data-driven decision-making can manifest at all levels of the organisation, but is often led by executives that demand evidence-based justification of the city’s actions and investments. This is complemented by an understanding of the skills and capacity requirements needed to implement the city’s data management strategy and the expectation and support for data management improvements. Governance arrangements refers to the relationships established with data owners and the extent to which the roles and responsibilities of everyone involved in the city’s data management are defined. A 2016 study of data-driven local governments in the UK found that support from leadership was “a critical component of success.” This finding is not unique to the public sector. Organisations of all types across the world are considering how to remain relevant and improve products and services in an increasingly data-driven world. An EY-Forbes Insights survey of over 1,500 global executives found that “lack of senior leadership support” was considered to be a key barrier or “pain point” hindering the refinement of the business strategy to account for data and analytics. Notably, the survey also highlighted that across the board an organisational culture based more on intuition than data was reported as a significant barrier to improved data management.

A common theme, related to climate data governance, emerged from interviews with a selection of C40 cities during the development of this Framework. The climate data needs of cities frequently extend beyond the datasets collected, owned, and controlled by the city. Cities can struggle to meet data needs where authority over external data owners is lacking. Formalising governance arrangements may support cities to efficiently obtain data from external parties. These formal arrangements between organisations can also mitigate against ‘key-person risk’ if the data required is solely obtained through strong personal relationships with key individuals involved in maintaining the emissions inventory and other climate data.

The five elements that describe this theme of the Framework are detailed in the following section.

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“Data analytics tools and methods have an increasingly important influence on decision-makers’ choices. However, in order to be truly effective, organisations need to consider the ‘human element’ in the adoption of data analytics.”

John Farrelly
Director, Data Analytics EY

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3.1 CULTURE
The need and demand for evidenced-based decision-making leads to data management principles being reflected throughout the attitudes of staff and organisational culture of the city.

The organisational culture of a city can either support or hinder effective climate data management. It can be especially challenging if the majority of the city’s staff are not aware of the benefits of strong data management or are resistant to change. Organisations with strong data management practices are likely to foster collaboration and are driven to justify decisions based on observed trends and high-quality data.

3.2 LEADERSHIP ENDORSEMENT
The extent to which climate data management is driven and supported by the city’s leadership.

City leadership, including Councillors and the executive management teams, are key customers demanding timely data relating to the climate change strategy to support policy and programme and/or project development and evaluation.

3.3 SKILLS AND TRAINING
The extent to which the city has the right skills within its teams to deliver efficient and effective climate data management as outlined in the climate data management strategy.

Meeting the data needs of the climate change strategy and action plan may test the technical capability of city staff. Most city sustainability departments do not have specialist data scientists working within their teams. Recognising these constraints will help cities to define new ways to meet the cities evolving needs. Investment in up-skilling of staff may be required.

Data literacy is a term used to describe an individual’s ability to “identify, locate, interpret and evaluate information and then communicate key insights effectively.”19 Within the public sector there is a growing expectation that most staff will have at least a basic level of data literacy to equip them with the right skills to ask and find answers to the right questions to support evidence-based decision making. In some cases, technical assistance may be outsourced.

3.4 CAPACITY
The extent to which the city has sufficient resources to deliver efficient and effective climate data management as outlined in the data management strategy.

Capacity constraints, i.e. the amount of work for the number of people in the city sustainability teams, was frequently highlighted as a challenge when cities were interviewed during the development of this Climate Data Management Framework. A coherent data management strategy should help cities better organise its data and create opportunities for efficiencies, freeing up time for staff to focus on what matters most. Acknowledging a capacity constraint can help inform the overall data management strategy.

3.5 GOVERNANCE ARRANGEMENTS
The authority and control (planning, monitoring, and enforcement) over the management of data assets and the relationships with data owners.

Establishing clear governance arrangements will clarify what is expected of each of the stakeholders involved in the data collection, analysis, and reporting process.

Most city sustainability departments do not have specialist data scientists working within their teams. Recognising these constraints will help cities to define new ways to meet the cities evolving needs.

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SAN FRANCISCO – Data Academy

The City and County of San Francisco has implemented a training program called the Data Academy. All staff have access to the Academy to ‘explore, refine and enhance their skillsets in data use, data management and process improvement.’ The aim of the program is to transform the way the city utilises and manages data in order to optimise service and outcomes delivery.

The Data Academy was set up in 2014 following the recognition that several departments within the city had staff with a desire to undertake advanced analytics projects; however, there was limited time and resources to enable this. There was a recognised need amongst the staff for data education as well as a culture that sought to empower the use of data. The city sought effective and efficient use of data to augment the operations and services within the city. The Data Academy was developed and embodied the existing culture through training and upskilling all interested staff in enhanced data use and management. There are several types of data management courses available in data usability, project management, Excel, and other programs.

The Data Academy not only has the benefit of educating those less versed in data analytics, but also keeps the advanced analysts and project managers abreast of the latest data techniques and improvements. The Data Academy has also enabled and strengthened inter-departmental relationships; with enhanced knowledge sharing and collaboration across departments which allow for innovations in data use and management. The Data Academy has empowered staff in San Francisco with the capabilities to not only perform their roles, but undertake sophisticated data analytics which creates useful insights and enhanced performance.

20 City and County of San Francisco, Data Academy. (accessed via https://datasf.org/academy/, 19 March 2019)
22 City and County of San Francisco, Data Academy. (accessed via https://datasf.org/about/, 19 March 2019)
25 This case study has been provided by the City and County of San Francisco.
RIO DE JANEIRO – SIURB and Its Data Governance Arrangements

In 2014, the Rio de Janeiro City Government implemented its Municipal Urban Information System (SIURB), a management and planning instrument established under the city’s 2011 Sustainable Urban Development Master Plan.

The purpose of SIURB is to gather, manage, integrate and update data and information on the City of Rio de Janeiro, establishing an efficient communication channel among the departments.

Before the implementation of SIURB, the workflow for data sharing within the City Government was not well defined and this compromised data-driven decision-making. As shown in the figure below, the system came to organize the flow of data and information with integrated and coordinated logistics and procedures.

SIURB is coordinated by Instituto Pereira Passos (IPP), the city’s Institute for Data and Information management. However, it is managed by collective decision-making, including a Steering Committee with representatives from its six main data contributors and quarterly ordinary meetings with all participating entities. While this is a city-led initiative, it also includes external entities, like private utilities and state and federal level organisations.

The daily routine of the work is managed as below, where for each city department two staff are appointed to conduct its data management work, with two other staff at IPP supporting this work with sectorial and data management expertise.26

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26 This case study was provided by the City of Rio de Janeiro. Additional information on SIURB is available at [http://www.rio.rj.gov.br/web/ipp/siurb](http://www.rio.rj.gov.br/web/ipp/siurb)
### 3.7 Leadership and Governance: Maturity Levels

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>CITY CLIMATE DATA MANAGEMENT MATURITY MODEL</th>
</tr>
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<tbody>
<tr>
<td><strong>Culture</strong></td>
<td>Developing Limited awareness amongst city staff relating to how data can be used to improve the effectiveness of the climate change strategy and action plan.</td>
</tr>
<tr>
<td></td>
<td>Established Most staff are aware of the importance of data to inform policy decisions. Available data is used to support decision making however there is limited engagement or scrutiny from senior management on the limitations of the data used.</td>
</tr>
<tr>
<td></td>
<td>Leading All relevant staff understand the importance of data to inform better decision making. Senior leaders expect data to underpin all recommendations and implementation decisions. The limitations of the current data are understood and leaders support efforts to improve data management.</td>
</tr>
<tr>
<td>Leadership endorsement</td>
<td>Developing Leadership is not involved in the development of a data management strategy, if one exists. Rudimentary data management is undertaken by working level staff only.</td>
</tr>
<tr>
<td></td>
<td>Established Leadership at departmental level is generally supportive but there is no coordinated approach to climate change data or data management more broadly.</td>
</tr>
<tr>
<td></td>
<td>Leading A coordinated approach to data management is led from the top. City leaders demand that all decisions should be made in reference to supporting data analytics outlining the implications of the recommended policy options.</td>
</tr>
<tr>
<td>Skills and training</td>
<td>Developing The teams involved in climate data management can use basic software to compile data and perform simple analytics. Data literacy is patchy.</td>
</tr>
<tr>
<td></td>
<td>Established Some relevant staff have good data literacy, although the level of skill varies. Improving data literacy and data management is not a priority skill for city staff.</td>
</tr>
<tr>
<td></td>
<td>Leading All relevant staff have sufficient capability and data literacy to perform their role. Sophisticated data analytics is undertaken to derive relevant information from data as required by the city. The city has prioritised data management as an area of improvement for all city staff to prepare the city for the future.</td>
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<tr>
<th>ELEMENT</th>
<th>CITY CLIMATE DATA MANAGEMENT MATURITY MODEL</th>
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</thead>
<tbody>
<tr>
<td><strong>Capacity</strong></td>
<td>Developing The city has insufficient capacity (staff numbers) to deliver climate data management. This may result in difficulty meeting internal and external reporting deadlines.</td>
</tr>
<tr>
<td></td>
<td>Established The city has insufficient long-term capacity (staff numbers) to deliver climate data management. Short-term solutions such as use of interns to update the emissions inventory may be employed to manage peaks in workload. No analysis has been undertaken to determine efficiencies in the process to reduce peak work load.</td>
</tr>
<tr>
<td></td>
<td>Leading The required resources are outlined in the data management strategy. Where a capacity gap exists, there is a plan to address this. The process has been reviewed to identify efficiencies. Resources are shared efficiently across departments including the option to draw on centralised data management resources to support the sustainability department where appropriate and peak periods are managed.</td>
</tr>
<tr>
<td>Governance arrangements</td>
<td>Developing No formal arrangements with data owners exist. Data is obtained on an ad hoc basis and generally relies on personal relationships between key persons in the sustainability department and data owners. Stakeholder mapping has not been undertaken, roles and responsibilities are unclear.</td>
</tr>
<tr>
<td></td>
<td>Established The sustainability department has a record of data sources and owners and an informal plan for contacting data owners. However, no formal arrangements exist as the roles and responsibilities of each organisation have not been agreed. Data collection generally relies on personal relationships between key persons in the sustainability department and data owners.</td>
</tr>
<tr>
<td></td>
<td>Leading The city has formal arrangements in place to obtain the data it needs in a timely manner in the most suitable format.</td>
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</tbody>
</table>
Technology and systems refers to the hardware, software, and processes involved in climate data management. There are a range of tools available to support data management practices. The best tool will be one that has the features that meet the city's needs. The best data management system is not necessarily the most expensive or advanced. Good data management is possible using off-the-shelf software, such as Microsoft Excel; bad data management is possible with bespoke data management systems without consideration of the technology and systems requirements.

Mapping of data flows throughout the system is important to document where data has come from (linked to data quality), who it has come from (linked to governance arrangements) and what systems are used (linked to all elements of the technology and systems theme). Clearly outlining the step-by-step procedures from start to finish will also enable potential efficiencies in the process to be identified.

The six elements that describe this theme of the Framework are detailed in the following section.

4.1 CAPACITY AND FEATURES OF SYSTEM
The appropriateness of the technology and systems used to manage climate data.

The organisational culture of a city can either support or hinder effective climate data management. It can be especially challenging if the majority of the city's staff are not aware of the benefits of strong data management or are resistant to change. Organisations with strong data management practices are likely to foster collaboration and are driven to justify decisions based on observed trends and high-quality data.

This includes capacity and features of the system for:
- Data collection (input)
- Data analysis (process)
- Insight presentation/data visualisation (output)
- Data storage (archiving)

The requirements of a data management system will be shaped by the specific data requirements outlined in a climate data management strategy (refer to Theme 1: Data Management Strategy). There are several ways that these requirements could be met.

4.2 DATA MEASUREMENT
The range of tools used to measure and capture climate data.

As cities become smarter, the ability and opportunities to measure and create new datasets supporting climate change action will increase. Digital innovation is just one of many global megatrends and disruptions, alongside climate change, that is shaping the future of cities. These new sources of data provide opportunities to access real-time insights into a city's emissions profile. For example, the Global Covenant of Mayors has established a partnership with Google to provide cities with access to Google Maps. Providing data on how people move about the city to estimate emissions from transport, and using satellite imagery to map buildings types or footprints to estimate energy consumption.27

Digital innovation is just one of many global megatrends and disruptions, alongside climate change, that is shaping the future of cities.

This element refers to climate data that a city collects itself and that provided by third-parties. Where possible, it is generally best to collect activity data in units that can be directly multiplied by an emissions factor to give the quantity of GHG emissions, for example mass (tonnes of waste) or volume (m³ of water, L of fuel). However, in many cases activity data does not take this form. For example, public transport activity data often takes the form of tickets bought/cards swiped and assumptions are required. An appreciation of the way in which the data was obtained will help inform and validate these assumptions.

4.3 DATA PROCESSING AND CALCULATION
Processing of activity and emissions data to generate new data and insights.

The most common calculation used by cities is to derive a quantum of emissions from the activity data collected. Often some amount of modelling is needed. For example, to estimate fuel use attributable to transport within the city it may first be necessary to estimate the average number of kilometres driven per vehicle trip, the average fuel efficiency of vehicle types used, and the total number of trips before the total fuel use can be calculated. Where this kind of modelling is required, it is critical that there is transparency over the estimation techniques applied.

4.4 DATA VISUALISATION TOOLS
The software used to interpret and communicate datasets and draw meaning from the data.

Data visualisation and analytical tools can assist the city to interpret large datasets. To do this efficiently, the way in which these tools are integrated with the underlying data should be considered. The most important factor is understanding what information you need and what questions the city’s data can help you to answer. This will inform the types of visualisation generated. For example, data visualisations could be used to undertake historical trend analysis, to evaluate the impact of a particular programme, or used as part of the data quality control process to detect anomalies in the data. Cities that demonstrate leading practice in this element, use data visualisation tools as one of the primary methods to investigate the data.

4.5 INTEGRATION WITH OTHER SYSTEMS
The efficiency with which data is harmonised between systems and processes.

This element refers to how easily data is pulled from third-party providers (such as utility companies providing energy consumption data) or other data collection sources. For example, integration via an API (that enables two software systems to interact) may be used to reduce the amount of manual data manipulation required.

4.6 PROCEDURES AND DOCUMENTATION
The extent to which procedures for all aspects of the climate data processing cycles are documented.

Mapping of data flows can help to understand where data has come from (linked to data quality), who it has come from (linked to governance arrangements) and what systems are used. Clearly outlining the procedures from start to finish will reduce key-person risk if the tasks performed by an individual are described and can be performed in their absence. Mapping the data flow enables potential efficiencies in the process to be identified.
The City of Cape Town has implemented energy efficiency projects in municipal facilities since 2009. In accordance with the grant funds used for these projects, the city is required to conduct detailed measuring and verification assessments to verify electricity savings post-implementation. In order to make the case for additional funds and enable monitoring across all facilities, the city initiated the roll out of a smart electricity metering programme in partnership with the electricity department. The city has about 1,300 immovable property assets registered and by 2015, the city had installed about 500 smart electricity meters within municipal facilities, but found it challenging to manually extract, analyse and monitor all the data from these meters on a monthly basis for reporting purposes. Through a partnership with several internal departments the city identified isolated sub-systems within the City’s IT infrastructure that needed to be integrated and automated for intelligent data analysis and interpretation. A web based data application, called SmartFacility, was developed that integrates all required data related to municipal facilities and their consumption. This application interprets the facility’s electricity consumption data in a friendly, accessible manner, illustrating the data on several dashboards easily accessible to facility managers and management staff for proactive monitoring and management of municipal facilities consumption.

The purpose of this project was to develop a data-driven online application that could assist with automating the data analytics required for various purposes:

• Monitoring the performance of municipal facilities
• Tracking and monitoring electricity savings achieved through implementation of energy efficiency and renewable energy interventions
• Using the electricity savings data to further motivate for additional funds to continue with implementing these interventions
• Using the facility performance data to prioritise energy optimisation projects
• Tracking building project performance against service delivery contracts
• Automating data collection for annual emissions inventory reporting and related carbon research
• Summarising data required to drive evidence based decision making, policy and strategy development

The purpose of the project was also to align with existing municipal strategies, such as:

• Digital City Strategy (2016 draft) which advocates the use of information and communications technology to promote organisational change. The city’s leadership has committed itself to making the CCT the first truly digital city in our region and to becoming the leading digital city on the African continent.

• Climate Change Policy (2017): ‘Having a clear climate change policy enables the City to understand how to reduce and prepare for these risks (adaptation). The policy also enables all in the City to understand how Cape Town’s GHG emissions can be reduced (mitigation) in order to help slow down global climate change, while also benefitting from the consequent outcomes of improved air quality, reduced costs, energy security and improved health.’

• Data Strategy (2018): ‘The city to be forward looking, resource efficient and integrated city that delivers quality services to its residents. Data plays a critical role in how evidence based decisions are made, and how evidence based policies, strategies, plans and implementation programmes are developed. Data needs to be readily available and appropriately packaged so that it is easy to understand and fit for its purpose.’

The benefits of this application creation and deployment include:

• Reduced human capacity required to manually extract, manipulate and analyse data constantly for various reporting platforms
• Shorter lead times for accurate data simulation of required statistics for reporting
• A tool accessible to all end users without complicated access restrictions
• Fun interactive tool that end users are excited and want to use
• Verified electricity savings tracked from the metering devices from all energy efficiency and renewable energy projects that has saved the city, from 2009-2016, over 170,000 MWh, which translates to savings of R143 million and 170,000 metric tonnes of carbon dioxide equivalent.

The tool has realised significant benefits which enables the city to identify energy efficiency opportunities, ranking and benchmarking facilities in the public sector and supporting data led, evidence based project and programme development and implemented, policy and strategy development to align with climate mitigation goals and targets.28

28 This case study was provided by the City of Cape Town
WELLINGTON – Smart Wellington framework

Wellington is amongst Australasia’s lowest carbon cities and is setting course towards being a zero-carbon capital. An important part of this journey to zero is leveraging Wellington City Council’s Smart City capabilities into the city’s everyday activity to mobilise the organisation and work with citizens to achieve this goal. Wellington’s Smart City approach focuses on generating change in the city through using a data approach of fusing the digital and physical city together to better understand, collaborate and drive changes.

Under the Smart City approach the Council has continued to develop a three-dimensional copy of the city, and used this core dataset to deliver metropolitan scale VR systems allowing citizens to understand sea level rise, natural hazards and planning information from the city scale all the way down to their home, commute to work and neighbourhoods. By having a geospatial data model which brings together information from the Internet of Things, Machine Consumable Regulation, Asset and Cultural Data the Council ensures that there is both a system of record, but also a system that can be used to understand and engage with partners and communities. To enable this journey Council has used ‘privacy by design’ principles and a strong system of social licences to allow the proactive collection and use of data over time. This has allowed Council to pursue partnerships with Government and Private Sector Agencies, and embrace newer technologies such as cloud, machine learning and virtual reality to achieve the city’s vision.

Examples of some of the initiatives enabled by these approaches are:

- A carbon calculator\(^{29}\) assisting people to create their own energy pathways for the city
- Freely available data on sea level rise and its challenges\(^{30}\)
- A Plan for Makara which has leveraged geospatial technologies to visualise and open data to empower the community of Makara to create a plan for infrastructure investment in light of sea-level rise and resilience challenges\(^{31}\)
- The FutureFit (Consumption-based personal calculator)\(^{32}\)

\(^{29}\) Wellington City Council, 2050 Climate Calculator (accessed via http://www.climatecalculator.org.nz/#/home, 26 June 2019)
\(^{30}\) Wellington City Council, 2018, Wellington Sea Level Tool (accessed via https://www.arcgis.com/home/item.html?id=5f9b66887e4740c0848cf16f691986d4, 26 June 2019)
\(^{32}\) Wellington City Council, Auckland City Council, Future Fit NZ (accessed via https://www.futurefit.nz/, 26 June 2019)

Wellington is unusual in not having a Smart City Strategy—rather the Smart Wellington approach is infused into the way the city achieves its 2040 and Resilience Strategies\(^{33}\), and the way it operates each day. The city is now developing its second generation of smart city capabilities, and developing its converging Sensing, machine learning, machine consumable legislation and visualisation capabilities into a more complete digital twin, capable of supporting better outcomes and sustaining the relationships and engagements needed to achieve them.\(^{34}\)
### 4.8 TECHNOLOGY AND SYSTEMS: MATURITY LEVELS

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>CITY CLIMATE DATA MANAGEMENT MATURITY MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity and features of system</td>
<td><strong>Developing</strong> No system in place for managing climate data. New tools are developed on an ad hoc basis. For example, spreadsheets are used only once and not re-used or updated in future. Multiple tools (such as different spreadsheets, databases, dashboards) may not be well integrated and a lot of manual changes (such as transcription or reformatting) is required to move data between tools. Climate data is generally not well managed, with potential for data storage, security and privacy risks.</td>
</tr>
<tr>
<td></td>
<td><strong>Established</strong> A system has been established to manage climate data. It is used consistently and generally considered to be reliable. Staff using the system feel as though it meets their needs. However, process and system improvements have not been considered. Some aspects of the system are automated; staff do not need to spend a lot of time making manual changes to data (such as transcription or reformatting) to move data between tools. Climate data is generally well managed, but controls around data privacy and security have not been tested. The system captures, processes and reports climate data, however ad hoc or real-time reporting, and advanced analytics remain challenging.</td>
</tr>
<tr>
<td></td>
<td><strong>Leading</strong> A system has been established to manage climate data. It is used consistently and considered to be reliable. Staff using the system feel as though it meets their needs. Process and system improvements have been considered, and upgrades to the system have been made. Staff beyond the sustainability department are also confident in using the system where necessary. The city has an integrated approach to managing climate data, including data privacy and security. The climate data management system allows for reliable, real-time dashboard reporting and analytics.</td>
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<tr>
<th>ELEMENT</th>
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<tbody>
<tr>
<td>Data measurement</td>
<td><strong>Developing</strong> No understanding of the measurement of climate data provided by third-parties. The city does not directly capture any data.</td>
</tr>
<tr>
<td></td>
<td><strong>Established</strong> The city understands how most of the climate data is collected (by the city and by third-parties) but has not investigated the limitations of data measurement techniques.</td>
</tr>
<tr>
<td></td>
<td><strong>Leading</strong> The way in which source data was obtained and reported is understood by the city departments using the data, and assumptions have been tested. Some climate data may be directly measured by the city, for example by using sensors.</td>
</tr>
<tr>
<td>Data processing and calculation</td>
<td><strong>Developing</strong> Calculations are performed on an ad hoc basis. For example, the calculations are set up every time the emissions inventory or trajectories are developed or updated.</td>
</tr>
<tr>
<td></td>
<td><strong>Established</strong> A standard calculation has been prepared and is used to update the emissions inventory and trajectories. Assumptions are embedded into the calculations and not confirmed each time the calculations are made.</td>
</tr>
<tr>
<td></td>
<td><strong>Leading</strong> The data system includes a standardised approach to calculations, such as with reference to an international or national standard for emissions reporting. Assumptions are documented and easily updated if better data becomes available.</td>
</tr>
<tr>
<td>Data visualisation tools</td>
<td><strong>Developing</strong> No analysis is performed over the climate data.</td>
</tr>
<tr>
<td></td>
<td><strong>Established</strong> Limited analysis is performed over the climate data. Visualisations used may include a limited number of chart outputs that are not always aligned to the key questions driving policy design.</td>
</tr>
<tr>
<td></td>
<td><strong>Leading</strong> The system used generates the outputs required in a suitable format. The visualisations prepared are designed to provide meaning to data to support decisions. Data visualisations may also be generated to assess the quality of the data (refer to quality controls and assurance element of the data quality and assurance theme).</td>
</tr>
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</table>
## City Climate Data Management Framework

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>CITY CLIMATE DATA MANAGEMENT MATURITY MODEL</th>
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</thead>
<tbody>
<tr>
<td>Integration with other systems</td>
<td><strong>Developing</strong> A significant amount of manual data manipulation is required to convert raw data into compatible system outputs.</td>
</tr>
<tr>
<td></td>
<td><strong>Established</strong> Systems work together but require some manual data manipulation to achieve desired outputs. A significant proportion of time is spent formatting data obtained from various sources.</td>
</tr>
<tr>
<td></td>
<td><strong>Leading</strong> Process is mapped providing clarity over the input/process/outputs of the system. Data is provided across the climate action lifecycle in compatible formats with the fewest possible touch points, such as with automated connection and communication with data sources.</td>
</tr>
<tr>
<td>Procedures and documentation</td>
<td><strong>Developing</strong> The city’s climate data processes are not supported by any procedural documentation.</td>
</tr>
<tr>
<td></td>
<td><strong>Established</strong> The city’s climate data processes are supported by some procedural documentation prepared by key individuals. However, this may not be maintained or shared across the organisation and may be documented in personal notes creating key person risk.</td>
</tr>
<tr>
<td></td>
<td><strong>Leading</strong> The city’s climate data processes are supported by a set of procedures outlining the steps involved in collecting, processing, reviewing the climate data. Data flows, risks and controls have been mapped. For example, with simple flow charts or process descriptions. Procedures are maintained and documented so that they are replicable, mitigating key person risk. Potential for process improvement and efficiency gains are highlighted and a process of continuous improvement is implemented.</td>
</tr>
</tbody>
</table>
THEME 5:
DATA USE AND DECISION-MAKING

The data use and decision-making theme relates to how the city is using data to inform evidence-based climate action and the ways in which information is communicated to multiple audiences.

Climate data can be used for many purposes. Different stakeholders can demand different types of information. For example:

- The city’s sustainability department intends to use climate data to support the development and delivery of its climate change strategy and action plan
- The city’s sustainability department may also use data analytics to support the implementation of data quality controls
- Decision-makers within the city will ask different questions of the evidence
- Citizens may also wish to interrogate the city’s climate data to hold the city accountable.

Having data to support the rationale for investments can also support sustainability departments’ bids for budget to support projects, systems, and resources.

Data uses should be linked to the data management strategy which sets out the data needs. The way that data is communicated will vary based on the needs and preferences of different target audiences.

The six elements that describe this theme of the Framework are detailed in the following section.

5.1 DATA TREND ANALYSIS

Analysis is undertaken on the climate data to better understand the historical trends, regional trends, and projections.

This can be incorporated into project evaluation to monitor the impact of interventions. Trend analysis can also be used to implement data quality controls. For example, year-on-year comparisons of data could be undertaken on emissions data or the underlying activity data to better understand how things in the city are (or aren’t) changing.

5.2 CLIMATE POLICY DESIGN AND EVALUATION

Climate data is central to evidenced-based climate change policy design and evaluation.

To deliver the transformational change needed to achieve emissions neutral and climate resilient cities, climate actions should be developed with reference to the evidence base.

5.3 TRANSPARENCY AND OPEN DATA

The extent to which the city’s climate data is communicated and made available to citizens and the general public.

Open data means that datasets can be “freely accessed, used, modified and shared by anyone for any purpose.”

The open data agenda is driven by the belief that making datasets, in particular those generated by the public sector, available to the general public will help solve problems and provide citizens with rights to access, use, and interrogate the data to make decisions.

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5.4 EXTERNAL REPORTING

Climate data is communicated externally in line with stakeholders’ expectations and industry standards.

As covered in the Data Quality and Assurance Theme, there are a number of reporting demands placed on cities relating to climate change data and performance. In some cases, the content and format of external reporting differs. Consideration of external reporting requirements as a climate data use will help cities to design climate data management strategies that can meet these diverse requirements. The more advanced a city is in data management the easier this becomes.

5.5 BUSINESS CASES

Climate data is used to support the justification of the city’s climate change strategy, projects, systems, and resources. Data can be harnessed to demonstrate value for money of a range of city initiatives. Observed cases include, supporting decision making relating to:

- Policy decisions such as the direction and ambition of the climate change mitigation strategy
- Specific projects developed to support climate actions
- System upgrades to support the city’s data management ambitions
- Resourcing for the team including budgets for staff and data

5.6 PROJECT-BASED ABATEMENT

There is provision for data relating to the on-going monitoring and evaluation of abatement programmes and/or projects.

As the climate change strategy and action plan is developed, the abatement impacts of specific interventions and projects should be forecast. Climate data used in forecasting the estimated impacts should be available on an on-going basis. This will allow the impact of the programme and/or project to be tracked as part of monitoring and evaluation of the programme and/or project throughout the project life.
CITY OF VANCOUVER – Data visualisation to drive policymaking

In 2018, the Green Building team within the City of Vancouver’s Sustainability Group began trialling the use of Tableau as a quick-turnaround trend analysis and communication tool for internal policymakers and stakeholders. The Tableau pilot involved data-gathering, cleansing, import and analysis of multi-year of natural gas and electricity-use data within a sample of single-family houses. This helped to reveal the real-world impact of building-code changes, and helped pinpoint areas of the city where greater rates of new-building development were taking place, indicating potential target neighbourhoods for retrofit incentives.

The City of Vancouver has been using GIS systems for some time, historically in departments where spatial data-analysis and decision-making has been a critical enabler of service delivery (e.g., planning; permitting; social policy). The City is in the middle of an upgrade to its internal and public-mapping tools, shifting to an ArcGIS-based platform. Within the Sustainability group, ArcGIS has been used so far to map electric-vehicle charging infrastructure deployment and help determine siting for future installations.

Using technology to engage residents in citizen science

Externally, City of Vancouver has used the StoryMaps component of ArcGIS as a public engagement tool around sea level rise. This has been a very successful program over the last two winters, activating and enabling “citizen scientists” by asking the public to photograph instances of King tide-related flooding during specific dates and times. The aim is to use the data gathered to help calibrate our flood-risk models.37

CASE STUDY

City of Vancouver Sea Level Rise Story Map38

37 This case study has been provided by the City of Vancouver.
38 City of Vancouver Sea Level Rise Story Map, accessed via https://vancouver.bc.maps.arcgis.com/apps/StoryMapCrowdsource/index.html?appid=eb0a7a32e6954f77a5cd33dbb582ab20 (28 May 2019)
Barcelona – Climate data and decision making

Data can be harnessed to demonstrate value for money of a range of city initiatives. Observed cases include, supporting decision making relating to:

- These projections have concluded, with respect to temperature, that under the committed scenario an increase of 1.6°C in average annual temperature is expected in the middle of the century and 1.7°C at the end of the century. Under the passive scenario, this increases to 2°C in the middle of the century and 3°C at the end of the century. An increase in warm, tropical and hot days and nights is also expected.

- With regard to rainfall, an increase in the frequency of dry periods is expected and a tendency to decrease precipitation by 14% at the end of the century in the committed scenario, and 26% in the passive scenario. The intensity of the rains will be greater and it is expected that there will be a concentration of the extreme episodes.

Based on the results of these climate projections, the city analysed how climate change will affect different sectors that have been considered priorities for the future development of the city. Specifically, the effect of heat island, heat waves, urban flood, maritime flood, biodiversity, forest fires, air quality, water cycle, energy flows and infrastructures have been studied. These studies identified potential impacts and major trends that will affect the city. For example: forecast. Climate data used in forecasting the estimated impacts should be available on an ongoing basis. This will allow the impact of the programme and/or project to be tracked as part of monitoring and evaluation of the city. For example: forecast. Climate data used in forecasting the estimated impacts should be available on an ongoing basis. This will allow the impact of the programme and/or project to be tracked as part of monitoring and evaluation of the programme and/or project throughout the project life.

- By 2050 the city will need an additional 18 hm³/year of drinking water.
- Risk of flood increases; it is expected that variations in rainfall will generate overflows in some points of the city.
- In reference to the increase in sea level, it has been estimated that there will be a loss of useful surface of sand on most beaches and extreme maritime events will be more frequent.

Barcelona – Energy observatory

Barcelona has, for several years now, an Energy Observatory, managed by the Energy Agency of Barcelona. The mission of this observatory is to keep the energy and greenhouse gas emissions information of the city up-to-date, as well as to analyse the energy performance, both at the city level and at the municipal level, through sectoral analysis, as from energy sources used, and with a territorial approach.

The objective is to have an accurate understanding of energy at the city-level, to report on it and, based on its analysis, to be able to define and promote lines of action, both at the city-level and at the municipal-level to improve the energy-use behaviour of the city, with the consequent reduction of emissions. The main actions that are carried out are:

- The Balance of Energy and greenhouse gases of Barcelona: It is an inventory of energy consumption and greenhouse gas emissions with its own methodology. This methodology includes all aspects related to stationary energy, mobility and, in the case of the emissions inventory, it also includes waste treatment, the port and the airport.
- Territorialisation of results: Lately an effort has been made to territorialize energy consumption and greenhouse gas emissions by district and neighbourhood, taking into account the different energy sources and economic sectors.39

Based on this new information, the Climate Plan, in addition to establishing GHG emission reduction objectives (carbon neutrality in 2050), also establishes quantitative adaptation objectives, such as an increase of 1.6 km² in green surface area, achieve a consumption of domestic drinking water of 100 l/inhabitant/day or provide them 18 hm³ of water that will be missing, among others.

This new information of a scientific nature has also served as a basis for planning some of the actions of the Climate Plan (which in total has 242 measures). For example:

- In terms of heat, it is planned to revise the Action Plan to prevent the effects of heat waves on health, incorporating new parameters other than the heat wave such as tropical or torrid nights or identifying climate refuge spaces that can provide thermal comfort.
- In terms of water, it is expected to increase the permeability of the soil through a strategy of sustainable urban drainage, incorporate climate projections in future reviews of the Drought Protocol and in the Alternative Water Resources Plan or carry out communication campaigns to promote the Water saving domestic scale.
- From the point of view of coastal protection, it is foreseen to establish measures that guarantee the conservation of sediments.39

39 This case study was provided by the City of Barcelona. More information is available at http://lameva.barcelona.cat/barcelona-pel-clima/en/climate-plan/resilience-and-adaptation
40 This case study was provided by the City of Barcelona. Additional information is available at http://energia.barcelona/en/energy-observatory
5.8 DATA USE AND DECISION-MAKING – MATURITY LEVELS

<table>
<thead>
<tr>
<th>ELEMENT</th>
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</thead>
<tbody>
<tr>
<td>Data trend analysis</td>
<td></td>
</tr>
<tr>
<td>Developing</td>
<td>Manually collected climate data informs some operational-level management decisions. Limited analysis.</td>
</tr>
<tr>
<td>Established</td>
<td>A combination of automated and manually collected climate data informs a significant proportion of management activities. Predominately using simple analytics (for example, historical analysis, year-on-year trend analysis).</td>
</tr>
<tr>
<td>Leading</td>
<td>Efficiently collected climate data informs the majority of management decisions and climate change strategy, using simple and advanced analytics, including instances of predictive analytics (for example, scenario analysis).</td>
</tr>
<tr>
<td>Climate policy design and evaluation</td>
<td></td>
</tr>
<tr>
<td>Developing</td>
<td>The city’s climate change strategy and action plan is not supported by sufficient and appropriate data.</td>
</tr>
<tr>
<td>Established</td>
<td>Data is used on an ad hoc basis to support decisions relating to the climate change strategy and action plan, but this is driven by the available data and not the other way around.</td>
</tr>
<tr>
<td>Leading</td>
<td>Data is central to justifying the business case for policy design. A plan and budget to satisfy on-going monitoring and evaluation data needs has been established at the outset.</td>
</tr>
<tr>
<td>Transparency and open data</td>
<td></td>
</tr>
<tr>
<td>Developing</td>
<td>Climate data is infrequently disclosed to the public.</td>
</tr>
<tr>
<td>Established</td>
<td>Climate data is disclosed on a regular basis however the underlying data is not.</td>
</tr>
<tr>
<td>Leading</td>
<td>Climate data and underlying datasets are publicly available via an open data platform and maintained on a regular basis.</td>
</tr>
<tr>
<td>External reporting</td>
<td></td>
</tr>
<tr>
<td>Developing</td>
<td>The city is unable to disclose climate data in multiple reporting formats, sometimes failing to address the demands of internal and external stakeholders.</td>
</tr>
<tr>
<td>Established</td>
<td>The city discloses climate data to all required reporting platforms but it takes a significant amount of time to compile the data and extract the required information to meet the expectations of internal and external stakeholders.</td>
</tr>
<tr>
<td>Leading</td>
<td>Reporting and disclosure demands from internal and external stakeholders are easily met. It is quick and easy to convert outputs into the required formats of indicators.</td>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Business cases</td>
<td></td>
</tr>
<tr>
<td>Developing</td>
<td>Decisions relating to the climate change action plan are not supported by data.</td>
</tr>
<tr>
<td>Established</td>
<td>Data is used on an ad hoc basis to support investment decisions but this is driven by the available data and not the other way around.</td>
</tr>
<tr>
<td>Leading</td>
<td>Data is central to justifying the business case for emission reduction activities.</td>
</tr>
<tr>
<td>Project-based abatement</td>
<td></td>
</tr>
<tr>
<td>Developing</td>
<td>Climate data is not collected on an on-going basis and is unavailable to support monitoring and evaluation of emissions abatement projects implemented by the city.</td>
</tr>
<tr>
<td>Established</td>
<td>Monitoring and evaluation is undertaken on an ad hoc basis utilising available data. On-going data needs are not established at commencement of emissions abatement projects.</td>
</tr>
<tr>
<td>Leading</td>
<td>Monitoring and evaluation data needs related to emissions abatement projects are included as an important data use for the city. Plans are in place to meet the monitoring and evaluation needs on an on-going basis.</td>
</tr>
</tbody>
</table>
REFERENCES

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The Makara Beach Project (accessed via https://wcc.maps.arcgis.com/apps/MapSeries/index.html?appid=57e797777a96430c8074182984622a6a, 26 June 2019)


Wellington City Council, Auckland City Council, Future Fit NZ (accessed via https://www.futurefit.nz/, 26 June 2019)


