FRACTAL annual meeting

Monkey Valley, Cape Town
12-15 February 2019

Context of this document

Future Resilience for African Cities and Lands (FRACTAL) is a transdisciplinary project, aiming to contribute to climate resilient development planning in southern African cities. To achieve this, three explicit objectives drive FRACTAL activities, namely: i) deepen understanding of city specific contexts, asking what the urban climate change risks and impacts are, how resilient the cities currently are and what decisions are being taken for adaptation and development; ii) explore the decision-making space in the FRACTAL cities and look for opportunities to better incorporate climate information/knowledge into local decision-making contexts; and ii) advance understanding of physical climate processes that govern the regional system (observed and simulated) and develop robust and scale relevant climate information. These three objectives are inextricably linked and work has been guided by transdisciplinary co-production principles, which support collaboration across geographic areas, organisations and agendas.

FRACTAL is in its fourth and final year; the last annual meeting was held from 13-15 February with the overarching objectives to:

1. Collaboratively articulate a big picture of FRACTAL work that has been undertaken during the project;
2. Unpack the FRACTAL-related impacts in cities and the frontiers in science; and
   Collate recommendations from team members for carrying FRACTAL work forward at an individual, institutional and community level.
3. As per recommendations from team members at the last annual meeting (2017), more city representatives have been invited to the meeting to contribute to the conversations related to city impacts.

The information presented in this document has been collated from the inputs and discussions at the FRACTAL annual meeting. See Annex A for an overview of the programme.

Contents

COMIC meeting and bilateral meetings/focused writing sessions

CoOrdination, Management and Integration Committee (COMIC) meeting

On 12 February the COMIC met to discuss strategic priorities for the last year, including those listed below. For more information, see the notes of the COMIC meeting.

1. Review of FRACTAL overall progress and overall achievements
2. Review core FRACTAL budget
3. Discuss upcoming strategic events and engagement of FRACTAL in the final months (e.g. Lusaka Conference, Mayors meeting etc), as well as important events coming up and FRACTAL engagement
4. Consider funding priorities and strategic plan on how to proceed sourcing funding for FRACTAL next
5. Strategic priorities for the last months of FRACTAL and legacy

Parallel meetings

In the afternoon, team members from the Blantyre/Harare SOG met to discuss progress and way forward. See notes here.

Day 1: unpacking impacts in cities

Opening

The first day kicked off with a welcome and presentation by Bruce Hewitson, FRACTAL PI. He shared his thoughts about why the team was there, to: i) bring the strands of FRACTAL together and articulate a big picture; ii) take a closer look at the FRACTAL-related impacts in cities and frontiers in science; iii) prepare for closing months to achieve an optimal conclusion (leaving good "children"); and iv) look to the future for carrying the unique value of the "FRACTAL process" forward at an individual, institutional and community level. He also spoke about the different people at the meeting, namely the team (individuals), external observers (Bill Gutowski, Jon Padgham and Rosalind West) and COMIC. Bruce presented some key discussion points from the COMIC meeting, which took place on 12 February. These points are presented below.

- We are generally in good financial shape and have enough to achieve the completion of the project.
- Tangible impacts and reporting: we are all aware of how some of the impacts from FRACTAL are major but not all amenable to formal reporting processes.
- We believe we have developed something new/unique, which is the FRACTAL paradigm/process. We need to capture this in a high-level document.
- The annual meeting will likely be generative and spark new ideas related to what could or should be done in remaining months. We need to remain pragmatically focused and not take on more than we can handle.
- We have much to contribute to AR6 - journal paper submission deadlines are firm and unalterable.
- There are several strategic opportunities in the year where FRACTAL could/should have high visibility.
- With regards to looking forward, we should focus on two dimensions: i) maintaining momentum of the capacity and community; and ii) being prepared to leverage emerging opportunities for new funding.

Interactive introduction

After the introduction by Bruce, an interactive exercise was run by Sukaina for all participants to get to know one another better. Participants were requested to team up with someone that they were not very familiar with and tell them a bit about themselves. This happened a few times over to create a relaxed and friendly atmosphere. For a full list of participants, see Annex B.

FRACTAL framing

To provide a framing for FRACTAL and the meeting, Alice posed the question to participants; *how do all the different parts of FRACTAL add up?*

She described how she had been battling during the weeks leading up to the annual meeting to think of a way to adequately represent all the different elements of FRACTAL adequately. She had interrogated framings, theories, activities, processes, outcomes and places relevant to the project and briefly touched on each of these elements with participants.

In terms of the FRACTAL **framing**, she presented the overarching objective (as written in the proposal):

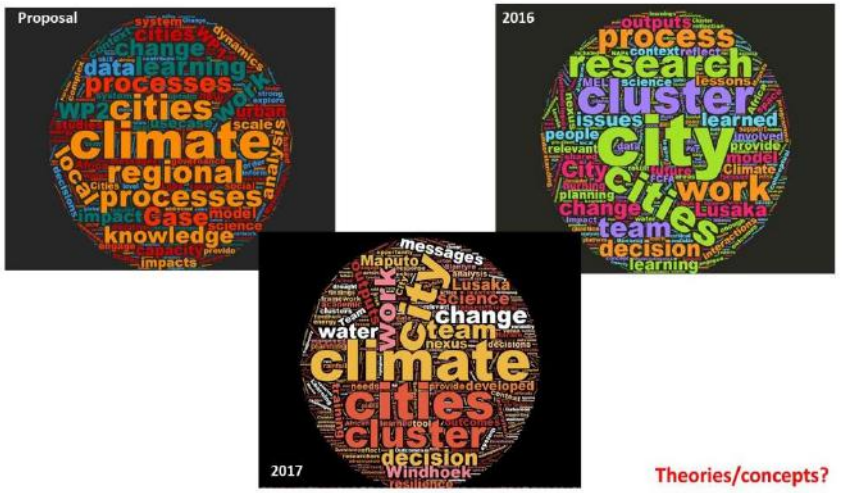
FRACTAL aims to advance scientific knowledge about regional climate responses to anthropogenic forcings, and to enhance the integration of this knowledge into medium to long-term decision making at the co-dependent city-region scale that responsibly contributes to resilient development pathways. This is addressed through an iterative, transdisciplinary co-exploration/ co-production approach, worked through a set of deep-focus case studies

She reflected on the fact that even though this objective is well articulated, it doesn't really do justice to what has occurred during the past three years of the project; we've learned a whole lot more that is not represented in this statement.

Alice then showed three Theories of Change (ToCs), within which the impacts of FRACTAL might be mapped; the FCFA ToC, FRACTAL ToC 1 (2016) and FRACTAL ToC 2 (2017). She suggested that although these images are extremely helpful, they don't adequately capture the essence of FRACTAL.

She then explored the questions that were developed to guide research near the beginning of the project, that have been iterated over time. These are presented in project update that was distributed to participants before the meeting (Annex C). To her mind, these questions did quite a good job of capturing the range of work that has been integrated into FRACTAL… but still don't quite capture what FRACTAL was all about.

Alice then briefly spoke about some of the main **theories/concepts** that were included in the proposal, and/or that have been developed over time. To do this, she built word clouds from three documents; the FRACTAL proposal, as well as reports from the 2016 and 2017 annual meetings. These word clouds are presented below. She noted that some concepts/words have remained important throughout (e.g. climate) but that some words have become important over time and at particular periods in the project (e.g. water).



Alice then tried to sow the many **activities** that have been implemented in FRACTAL, emphasising the fact that there are, in fact, too many to map on one image or timeline. She also showed images of the many **processes** that have been implemented during the project, which have been extremely important for achieving the outcomes and outputs of the project. The FRACTAL **outputs** were also shown to participants, according to particular groupings. Bearing in mind that not all outputs have been finalised and the lists presented are not exhaustive, the team has already produced an impressive number of journal articles (9), working papers (8), tools and decision support products (16), concept notes, briefing papers and think pieces (8), as well as seminar and conference contributions (9) (50 in total).

Alice spoke about the **places** in which FRACTAL has happened, and how important the teams in and across the cities have been. She mentioned that fact that theoretical developments have been rooted in the nine southern African cities in which FRACTAL has been working.

After presenting these different elements, Alice showed one of the few attempts that has been made to depict FRACTAL in its entirety; the infographic (see below). She alluded to the fact that although this infographic is useful to imagine how all the different FRACTAL elements add up, it requires a lot more discussion and time for unpacking. It should probably have been used more widely during FRACTAL, with associated discussions.

Alice explained that while interrogating all these elements in the weeks leading up to the 2019 annual meeting, she felt overwhelmed by the enormity of FRACTAL, and that no interrogation of any of the elements had left her feeling satisfied with an adequate representation of FRACTAL in its entirety.

She then stumbled across a podcast on creative differences: the benefits of reaching out to people unlike ourselves. The points being made in the podcast really resonated with her as she thought about all of the very different elements of FRACTAL and how they have added up to become something so much more through creative processes. One of the projects that was featured on the podcast was the Silk Road Collective (SRC): *Yo-Yo Ma conceived Silkroad in 1998 as a reminder that even as rapid globalization resulted in division, it brought extraordinary possibilities for working together. Seeking to understand this dynamic, he began to learn about the historical Silk Road, recognizing in it a model for productive cultural collaboration, for the exchange of ideas and tradition alongside commerce and innovation. And in a radical experiment, he brought together musicians from the lands of the Silk Road to co-create a new artistic idiom, a musical language founded in difference, a metaphor for the benefits of a more connected world* (https://www.silkroad.org/about)

The ethic of the project really stuck with Alice; how the whole is much greater than the sum of the very many different parts; how the individual instruments provide support for the much bigger sounds; how each of these instruments might sound louder at some times and at other times, there is a completely different sound as all the instruments add up; how the very different musicians came together around a common objective and seemed to be having fun while doing so. She ended off her framing session by showing a video of the SRC as a hopefully inspiring metaphor for FRACTAL.

Process discussion

Sue Soal introduced the process discussion, describing how the next three days would be run, as well as the role that different people would play. Bruce had already alluded to the fact that COMIC should play a strong role in the meeting. Sue introduced herself as the co-process designer (with Alice) and explained that she had been working closely with Alice to design the programme. She would continue to support with process design and help articulate the key learnings from FRACTAL. She mentioned that she worked with the Mistra Urban Futures to do the same.

Learning lab journey

Bettina facilitated a learning lab journey session, during which participants split into different groups to discuss the learning lab processes that have taken place in Lusaka, Maputo and Windhoek. To kick off the session, a talk show style exercise was used to compare expectations of the learning labs (initially) with what the team has learned. A few people who have been core to the learning lab processes in different cities were interviewed 'before' and 'after' to collate key messages about expectations and learnings. Thereafter, participants split into city groups to discuss three main questions: i) what was good about the journey; ii) what was not so good about the journey; and iii) what lessons might we share with other groups who are keen to undertake similar work? Reflections on these questions were hung in the room for all to read during the course of the meeting.

Reflection	Maputo	Lusaka	Windhoek
Good	• Learning labs provided the space for city stakeholders to openly share their concerns • Facilitation style makes participants feel freer. Learning labs have no pre-established agenda, no politics • Having to use translators gave facilitators less power to steer the direction/conversation	• Can see the development of the process between learning labs (continuity) • In-depth analysis and looking at critical issues with a social bearing • Informality of labs made it comfortable to listen, engage and learn • Took people out of their usual work spaces • People making recommendations for others to join and the creation of professional networks outside of learning labs • Support from the wider FRACTAL team. There was teamwork and consistency • Great learning from exchange visits • Learning lab was a first and we were motivated to address things relevant to our community – FRACTAL bringing is together • Good venue for first learning lab. People felt free to speak and express opinion without fear	• Great teamwork – creative and holistic process of the learning labs process • Shared lessons with city's sister-towns • Facilitation and support from clusters • Political leadership support (e.g. Mayor and MP) and city high level management (e.g. CEO and SE's) • Funding opportunities to address city burning issues e.g. SOG • Great facilitation process – games, discussions etc. • Great mix of stakeholders i.e. academia, city officials, NGO's etc. • Strengthen vertical linkages especially with national ministries responsible for finance, urban, climate • Protocol – who invites participants is important – learn that commitment from the CEO is critical

Reflection	Maputo	Lusaka	Windhoek
Not so good	• People not taking the opportunity to really collaborate – institutional constraints • People who have been in the water space for many years becoming defensive/less open to critically discuss	• Perceptions of a lack of preparation? • Raising expectations of the stakeholders • Lack of clarity of the journey going forward • Full steam ahead which did not allow for constant learning from other labs in other cities • People shying away from topics when their bosses were present (LL4) • Some venues were not up to participant standards • Situations where there was not enough thought put in • People working in silos in the early learning labs	• It took time to win trust – "it took time to put our foot into the city" • At the start we were only engaging lower ranks of city people, not the senior decision makers • Restructuring of the city, shifts in city management – some participants were nervous to engage (importance of the timing of engagements) • Getting people to stay e.g. after lunch. Venue is important (in the city people are tempted to return to work) • Organising at short notice (e.g. getting facilitators, getting good attendance) • Challenge of bringing two worlds together – a lot of iteration to ask questions of each other • Different people attending different labs- disruptions to continuity with different people • Overambitious with the programme

Reflection	Maputo	Lusaka	Windhoek
Recommendations	• Use the language difference as a positive – translators detaching facilitators from the group • Use the same translator for various events • Explain co-production through doing- set the scene explicitly, no one party is here to teach anyone, here to learn together • Take people away from the city/distractions	• Developing a process for transfer of information and building capacity for those who go through the entire process • Accepting that there will be differences in opinions. Creating respect for what everyone brings to the table • Embedded researchers are fundamental to the process • Finding a golden thread between the labs • Passing on of skills developed in the labs	• Engage city partners early in the process to gain buy-in and right get the right people and senior level people in the room from the start • Terminology/language important to consider from the beginning e.g. resilience vs sustainability • Link labs to implementation action more clearly by having more implementation partners involved in labs • Have a dedicated person / team to drive the learning labs process (e.g. ER's, city government champion, facilitators, task team) • Do not over pack the programme. Get a good balance between presentations in engagements and discussions • Use a venue out of the town so that people stay and are fully involved

In terms of aspects that were good, common themes across cities is the environment that the labs create; informal and comfortable so that people feel welcome to share their ideas. This was supported by the facilitation styles and techniques in all cities. In terms of aspects that were not so good, there is a theme across cities of some people perhaps not fully taking the opportunity to share and collaborate across sectors, perhaps because of institutional constraints. Lessons that several city teams put forward include choosing a venue outside of the city to be sure people are not called for work, as well as doing justice to the co-production process by valuing different knowledge types and opinions.

The information generated during this session will contribute to the final FRACTAL learning lab output (contact Bettina: Koelle@climatecentre.org).

FRACTAL city impacts sessions

The remainder of Day 1 focused on hearing impact stories or inputs from all FRACTAL cities. City teams presented their feedback but every workshop participant was also prescribed a 'city group', in which they would sketch out an impact story at the end of the day. Feedback that was shared by city teams in various formats is presented below.

Lusaka

Brenda, the Embedded Researcher (ER) from Lusaka showed a slide show and some videos from the Lusaka team. Key points raised through these were:

- In terms of planning for climate change, the focus has been on agriculture as this is what drives economy. Previously, there was no collaboration across sectors to share information. An unexpected change from the learning lab process is the informal interactions that have been created; people feel comfortable to now pick up the phone to get information from someone else; the large bureaucratic barriers have been overcome. Furthermore, climate narratives have been integrated into city decision making.
- The knowledge co-production process was extremely important as everyone was asked to contribute, they did not simply receive information. Through the learning labs, city exchanges etc., people learned a lot with one another and framed problems together. This resulted in more thought about climate change in planning and 'integration of narratives in planning'. It also supported greater ability to engage with/interact with data sources and resources, proactive planning, as well as applied use of research outputs.
- Learning labs have led to the co-production of policy briefs on 4 identified burning issues. These have gone to the ministry of water, and recommendations are being implemented. The climate information that is used is primarily focused around a 5 year timescale. Other outputs have been 1) increased awareness of the impact of climate on water supply, 2) Request for climate narratives, 3) Network creation – and subsequent enhanced demand for climate information, 4) Learnt that they can request data from MET, 5) CADD training.
- There is an appetite for continuing similar experiences in Lusaka on account of the value already delivered, which is direct/easier access to resources including knowledge and finances, at regional and global scales.

Durban

Lulu, the ER in Durban presented their impact story, accompanied by Smiso Bhengu who works in the Environmental Planning and Climate Protection Branch (EPCPD) in the eThekwini Municipality. Lulu mentioned that Durban was lucky: they were self-funded, which means they could choose how to implement the ER process of FRACTAL. Because of this, the FRACTAL emphasis has been on integrating climate change information into biodiversity planning for the city. The ER approach was appealing to the Durban team as it was an opportunity to experiment with another transdisciplinary method. The flexibility to tailor this method to support the needs of biodiversity was important, otherwise it might not have worked. The ER latched onto the biodiversity strategy that was in development and set out to develop climate and biodiversity information; trying to find entry points while building 'receptivity' (see session on day 2). Lulu noticed that spending time at the city was a huge factor in the success of creating receptivity.

In terms of planning in Durban, climate has always operated at a higher level while biodiversity operates at the implementation level. The ER was effective as a boundary spanner; she helped with building relationships for data sharing and to understand potential use of these data. The fact that the ER is not an outsourced service provider also allowed for extra flexibility and exploration within FRACTAL work. To carry this type of approach forward, cost will always be an issue so building partnerships to support with funding (e.g. with UKZN) is a necessity.

Lulu also shared a reflection on 'being in the right place at the right time' as an ER, spanning different work spaces. Through an informal discussion with a Branch Manager in the Development Planning Department , momentum was sparked to join forces with the Durban botanical trust education officers, the strategic planning branch, the climate protection branch and the Municipal Institute for Learning to pilot leadership training on climate change. If successful, the training will be rolled out across the city. Lulu is confident that this occurred through connecting the dots, having enough receptivity created and providing a bridging function between stakeholders. In her words; "sometimes everything is in place but you just need a catalyst for action".

Blantyre

Burnet Mkandawire, the local PI for Blantyre, discussed the FRACTAL work that has taken place in his home city. He mentioned that before FRACTAL, there was limited coordination across the departments, although some of the departments were potentially concerned with climate change. He mentioned that climate information was available but that it was not effectively applied to support decision making. There was also a lack in continuity in thinking with regards to who sets the climate change agenda.

Several expected impacts were presented including:

- increased understanding of stakeholders and decisions;
- mapping out stakeholders;
- co-exploring and co-produce climate knowledge with various stakeholders in the City; and
- establishing key/burning issues that relate to climate, as well as barriers that hamper uptake of climate information in decision making.

Burnet mentioned that FRACTAL had resulted in several unexpected benefits, including decision makers in the city talking about and defining the term 'resilience' through the CDKN innovation fund think tanks. Also through these think tanks, the team explored the values and perspectives that drive urban development to find that the loudest voices typically have regulatory functions in their sectors. FRACTAL approaches initiated discussions about the broader context of climate change with other problems such as energy, water, food, health and waste management. The narratives project was particularly useful for initiating such conversations. Those who were part of the FRACTAL engagements were amazed at how little they knew about the mandates and responsibilities of other organisations before these engagements.

Maputo

Genito, the local PI in Maputo, shared the story of one of the main FRACTAL impacts in Maputo; the development of an improved early warning tool for climate-induced vector- and water-borne diseases. At the first learning lab in March 2017, burning issues and associated questions were identified for Maputo, one of which was incorporating climate information into municipal planning. These engagements and interrogation inspired the development of a Small Opportunity Grant (SOG) project for "Engaging researchers and decision makers in

co-designing and establishing an improved early-warning tool for climate-induced vector-borne and water-borne diseases within Maputo City Municipality." SOG funding was ringfenced in the core FRACTAL budget for city partners to develop city-specific research proposals stemming from contextual needs; this impact story is therefore a good example of the SOG function. Through this SOG, a web-based tool has been developed for estimating risk of vector-/water-borne diseases as a function of climate variables. This tool should help enhance understanding for stakeholders in Maputo of how vector-/water-borne diseases relate to climate variables, and how relevant stakeholders are prepared to trigger adequate actions that favour early adaptation to climate risk within the Municipality. The tool itself will aid decision making by providing an interactive platform/tool, while the development of the platform was a learning processes; multiple, different stakeholders came together to share ideas and knowledge.

Windhoek

The Windhoek team presented their impact story through 'Tupopyeni FRACTAL' (let's talk FRACTAL); a talkshow style that has been used in various annual meeting and learning lab settings. The team explained that the main impact in Windhoek has been the collaborative development on the Integrated Climate Change Strategy and Action Plan (ICCSAP), which had previously been relatively ad hoc. The development of the ICCSAP, with FRACTAL support, has supported a different approach to policy development. For example, councilors are more aware of policies as they emerge. There is also political involvement and participation of leadership in these processes (e.g. the deputy mayor was present at the opening). Councillors have been sensitized through training (the transformational leadership training on climate change) and buy-in from senior officials has been noticed. Windhoek has also made connections with other Namibian municipalities (cities offering direction to other local authorities). The next steps will be finalising recommendations to the plan before presenting to the City of Windhoek. This presentation is no longer a large job as it previously may have been; climate change issues now have high priority with councillors. Climate information has been integrated using narratives and infographics, this allows the integration of risk into strategic plans. There has been interaction with the national climate change unit and planning is underway to create a City of Windhoek climate change steering committee. The next challenge will be to take lessons from sustainable eco-villages of sewage, water and electricity into informal settlements.

In the first LL (March 2017) burning issues were identified with the involvement of stakeholders from the energy and water sectors. There was also a councillor workshop with the aim of spreading awareness of climate change and what it is. These processes meant the work started with participation and ensured stakeholder buy-in from the start. Connections have been made between researchers and the city, where pervious no communication took place. This has led to research that is relevant with application. University has had access to a START GEC which is being used to look at the burning issue of drought and water security.

There has been a city exchange with Lusaka, during which important networks were built and lessons shared. This has been a critical aspect of the project. Windhoek is now partnered with its sister city Bremen, Germany.

As a means to give participants a break and re-energise the conversation, ICLEI Africa ran a session where participants co-developed word clouds for two important questions; what is the magic of FRACTAL (Figure 1) and what are the next steps for FRACTAL (Figure 2).

Figure 1: What is the magic of FRACTAL?

Figure 2: What are the next steps for FRACTAL?

Harare

Rudo, the ER in Harare, presented their impact story. She mentioned that previously, climate scientists used to go into institutions, extract data, and leave to write up, having little developmental impact. FRACTAL has changed this by working with stakeholders (city council and water authorities). These stakeholders were initially sceptical as they could not connect the dots between the relevance of climate change with city planning, and the trust was not there between researchers and cities, which resulted in slow initial progress in the first two months.

Acknowledging the limitations of being a Tier 2 city (with less funding available from the core budget), researchers in Harare have capitalised on other funding opportunities made available through FRACTAL such as the NERC narratives project, the CDKN innovation think tanks and SOG funding. Through one of these mechanisms, stakeholders were gathered at an inception meeting, introduced to FRACTAL and burning issues were co-identified. Over the first 6 months, two Early Career Researchers (ECRs) undertook day-to-day activities in the city and interviews key informants to produce a stakeholder network map. Research on the burning issues was undertaken and co-produced results were shared with stakeholders. This process built trust and relations, and also allowed for progress in non-FRACTAL projects. It has led to better understanding of the issues faced by decision makers.

Narratives on the future of water in Harare were co-produced using climate projections. This setup allowed different stakeholders to talk without tensions, focused on the same aim. Through FRACTAL, awareness of how climate change might affect the city and planning has created demand for climate information, where before the role of climate change was overshadowed by short-term issues. Long lasting benefits can be gained from trust between researchers and stakeholders, and Rudo warned about the “danger of the single story” (see Ted Talk here by Chimamanda Ngozi Adichi); a phrase that everyone resonated with as FRACTAL has supported the visualization of multiple stories.

The team feels that the learning derived from this case can be summarised as:

- The value of co-production in climate change adaptation and building sustainable cities
- The importance of understanding the context before recommending solutions

- The importance of building relationships and trust with stakeholders as researchers

Gaborone

Lapogang also expressed the challenges they faced as a "Tier 2" city with limited funds but explained how the narratives process has introduced a 'humble' science, with which stakeholders can easily engage. The stakeholders who engage with these narratives feel that the narratives are about them.

As with many other cities, Lapo described how FRACTAL has supported building connections across silos that usually work alone, which she believes supports changes in city practices. Because of these connections, the following impacts have been supported:

- greater confidence in analysis;
- city willingness to tackle climate change;
- networking and cooperation;
- city is now reaching out to other departments;
- University of Botswana (UB) now working with City on MoU; and
- more immediate and closer access to climate information.

Cape Town

Cape Town has been a self-funded city and has not been integrally involved in FRACTAL. However, the local contact point from the City of Cape Town (Amy Davison), provided some feedback on lessons related to climate information for cities, which is included below.

- An extremely valuable outcome of FRACTAL and similar programmes has been to establish and further develop an ongoing working relationship with UCT and various entities within UCT (i.e. CSAG and ACC).
- The occurrence of a climate crisis (2015 – 2017 drought) accelerated the uptake of climate information into the City's decision-making processes, and involved various officials who may otherwise not have had the interest in or opportunity to be involved in a partnership

with an academic institution. This crisis was unpredictable, but has played an important role in "normalizing" the use of scientific information in city planning.

- The use of narratives has been a valuable tool in communicating climate information to decision-makers as it provides a more integrated view of what a projection such as "1.5 degrees hotter" is likely to really mean in practice.
- "Intermediaries" play an important role; City officials who have some understanding of climate information and climate science can help communicate complex climate information to other City officials who don't have the background knowledge or understanding required to interpret climate information themselves.
- How we talk about climate change is extremely important. Terminology is confusing and sometimes contested, new jargon is continuously emerging, and similar terms have different meanings in different professional fields. This can make engaging with climate change matters seem intimidating and inaccessible and can create confusion when working with partners "outside" the climate change "field". Working to establish clear understanding and agreement is an ongoing task and an important part of establishing new partnerships or partnership projects.

Johannesburg

Similar to Cape Town, Johannesburg has been involved in FRACTAL learning events but has not been integrally involved in the project activities. Coleen Vogel has been working in the Global Change Institute (GCI) at the University of Witwatersrand to support the City of Johannesburg with their climate change adaptation plan. She provided reflections on these processes, which have been similar to the FRACTAL learning labs, where data is surfaced, analysed and mirrored back to the practitioner community. However, in her experience, there was a problem with discontinuity so they undertook one-on-one interviews.

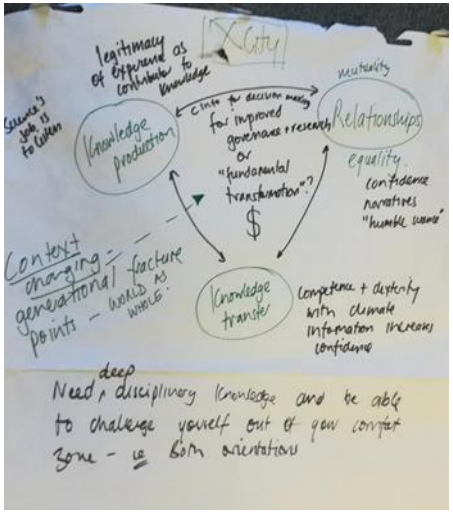
Coleen reminded everyone that bottom-up work that is being done is great but that cities do work with a top-down approach. The Key Performance Indicators (KPIs) according to which everyone is measured make it difficult for cross-sectoral work and collaboration. The issue of power also needs to be seriously considered in this type of work; how do we address or get to the heart of this? One of the biggest challenges is the structural process driving the city, both with regards to formality and informality. Coleen posed the question; could we do a deeper dive into some of the issues that are happening in the cities?

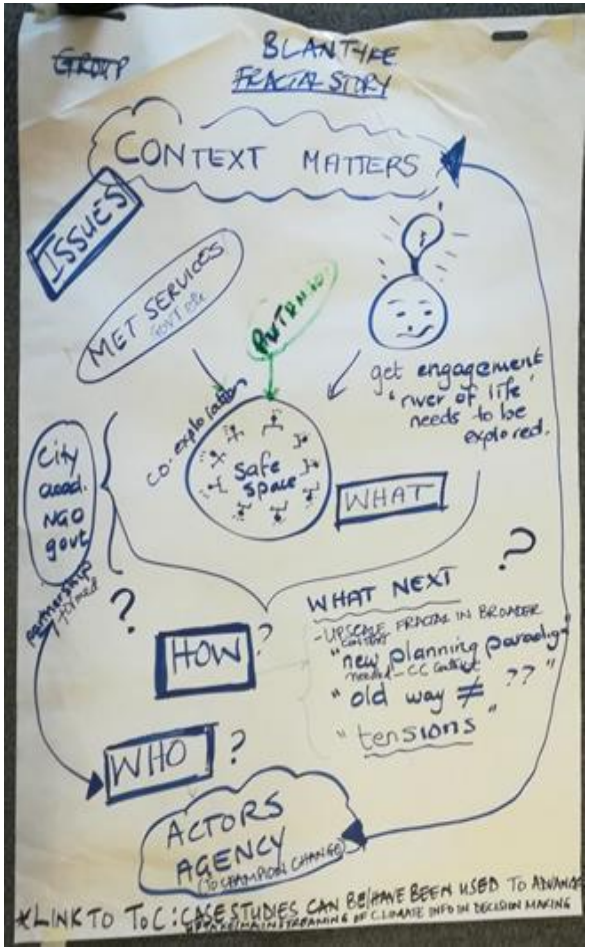
Sketching impact stories

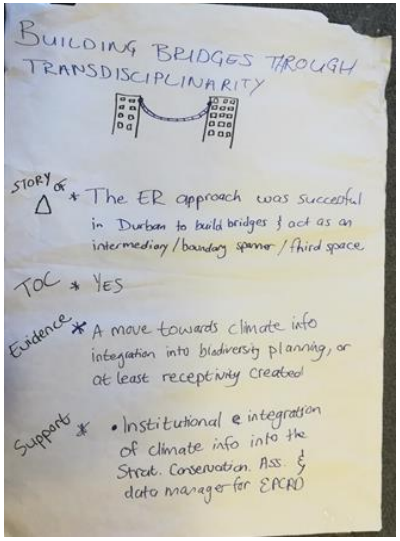
Once all the city teams had presented their impact stories, participants broke away into eight groups to flesh out impact stories for Blantyre, Durban, Gaborone, Harare, Lusaka, Maputo, Windhoek, as well as one cross-cutting group. Each group designed a city impacts poster bearing four important questions in mind;

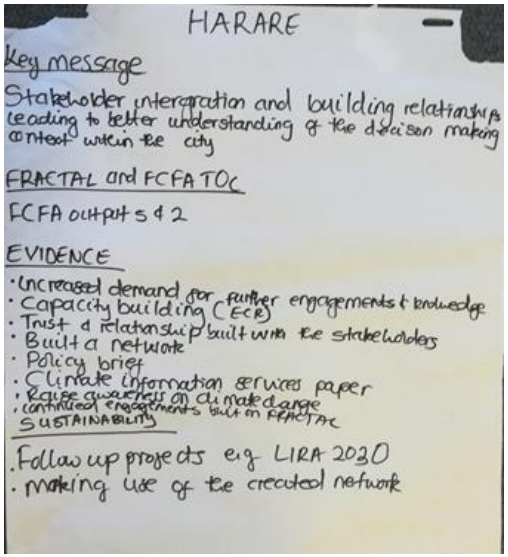
1. What is the key message/story of change?
2. Do these map onto the FRACTAL & FCFA ToC?
3. What is the evidence for this/these changes?
4. How can we support sustainability of these changes?

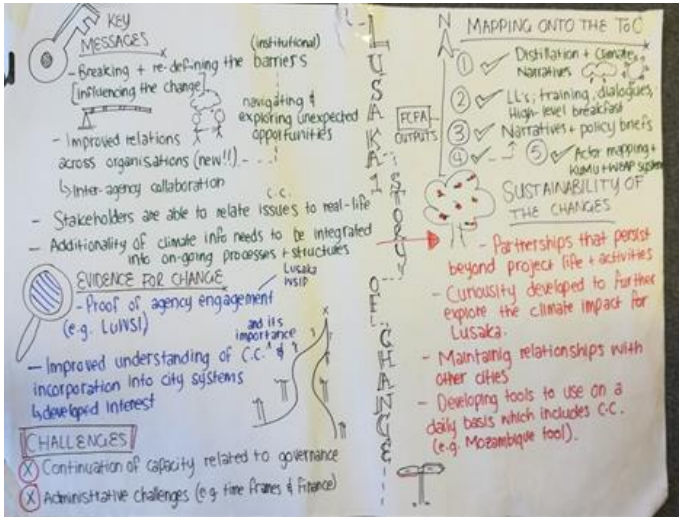
Key messages from these impact stories, as well as posters, are presented below.

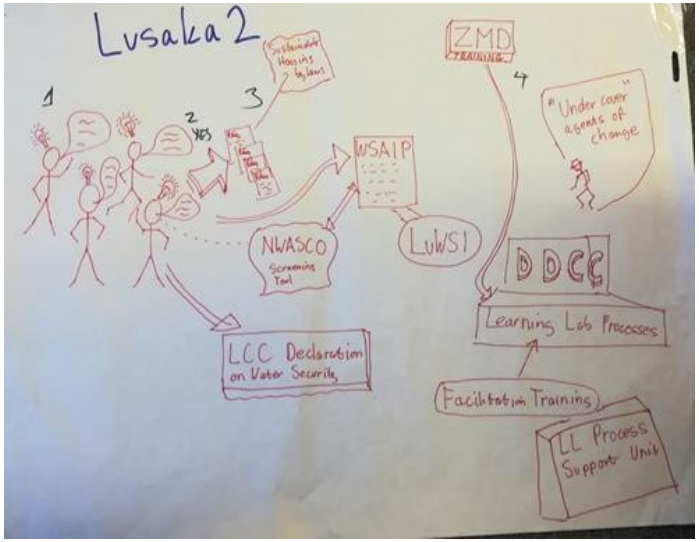
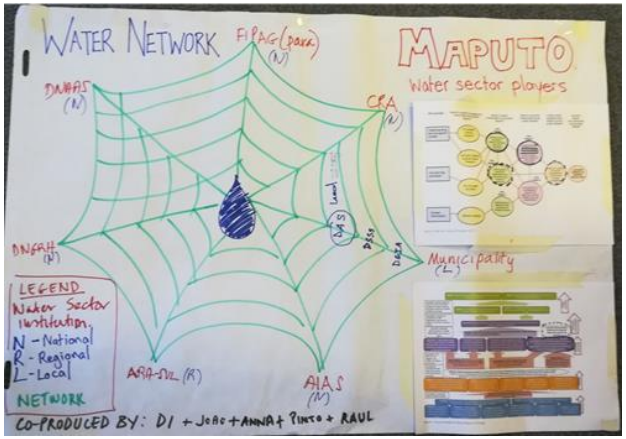
City impact story	Poster
Cross-city impacts Story of change: knowledge/information co-production, learning through sharing knowledge and experiences, developing/enhancing relationships Evidence of change: FRACTAL engagements and processes provided climate information for improved governance and research or "fundamental transformation". Scientists put more energy into listening to provide context specific info relevant to city needs, rather than feeding decision-makers with less useful information. Co-production of narratives was met with more confidence. Competence and dexterity with climate information increased confidence. City contexts are changing. We need deep disciplinary knowledge and be able to challenge yourself out of your comfort zone – i.e. both orientations.	

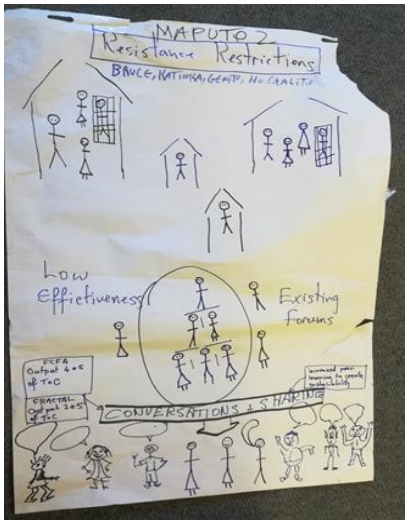
City impact story	Poster
Blantyre Key messages/Story of change: Context matters in order to get the right people/agency together and understand the key issues the city faces. We need to provide a safe space where stakeholders can engage, discuss, network and unpack issues as well as identify opportunities The work in Blantyre has linked to the FCFA ToC related to case studies being used as an effective tool to advance uptake/mainstreaming of climate information into decision making. Evidence of change: i) partnerships formed between government, NGO's etc.; ii) stakeholders understanding the broader context of climate change; iii) stakeholders defining resilience; and iv) the waste to energy project. Supporting sustainability of change: building actors agency to champion change (actors include: MET services, government, private organisations and NGO's) What next: i) upscale FRACTAL in the broader context; ii) "new planning paradigm" needed with climate change context; iii) we need to move away from the old way of doing things...	

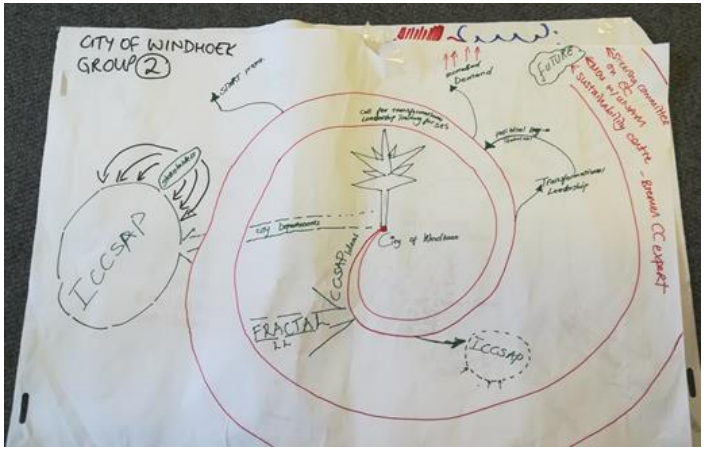
City impact story	Poster
Durban Key message/Story of change: the Embedded Researcher approach was successful to build bridges and act as intermediary/ boundary spanner/ third space Evidence of change: a move towards climate information integration into biodiversity planning or at least receptivity created Supporting sustainability of change: institutional integration of climate information into the strategy, conservation, assessment and data management for Environmental Planning and Community Resilience Division (EPCRD)	
Gaborone Key messages: stakeholder collaboration is important. We need to support ownership of key climate issues, regardless of organisational mandate. It is council intention to include climate solutions in the Urban Development Plan 4 (UDP4) but the city has not yet increased or even reached the resilience point in relation to climate change The Gaborone work maps onto the following impact pathways in the FRACTAL and FCFA ToCs: i) enabling an improved understanding of city systems (FCFA output 5); strengthening decision making processes (FCFA outputs 3 & 4); city issues assessment with a diversity of stakeholders (FCFA outputs 2); improved understanding of regional climate change (FCFA outputs 1); co-production of knowledge for relevant climate related issues (FCFA outputs 4); mid-term review of	

City impact story	Poster
local government project prioritisation (FCFA outputs 3 & 4) Promote sustainability by formulating of the FRACTAL community of practice virtue.	
Harare Key messages: stakeholder integration and building relationships leads to better understanding of the decision making context within the city The work in Harare maps onto the FCFA outputs 5 & 2 Evidence of change: i) increased demand for further engagement and knowledge; ii) capacity building (ECR); iii) trust and relationships built with the stakeholders; iv) a network; v) policy brief; vi) climate information services paper; vii) awareness on climate change; viii) continual engagements built on FRACTAL Supporting sustainability of the changes: i) follow-up projects (e.g. LIRA 2030); making use of the created networks.	

City impact story	Poster
Lusaka (group 1) Key messages: breaking and re-defining the barriers influencing the change (institutional), navigating and exploring unexpected opportunities, improved relations across organisations (inter-agency collaboration) (new!!), stakeholders are able to relate climate change issues to real life, climate information needs to be integrated into ongoing processes and structures The Lusaka work can be mapped onto the following FRACTAL & FCFA ToC impact pathways: i) distillation and climate narratives (FCFA output 1); ii) learning labs, trainings, dialogues, high-level breakfasts (FCFA output 2); iii) narratives and policy briefs (FCFA output 3 and 4); iv) actor mapping + KUMU + WEAP system (FCFA output 5) Evidence of change: proof of agency engagement Lusaka WSIP (e.g. LuWSI), improved understanding of climate change and its importance and incorporation into city systems; developed interest. Supporting sustainability of the changes: i) partnerships that persist beyond the project life and activities; ii) curiosity developed to further explore the climate impact for Lusaka; iii) maintaining relationships with other cities; and iv) developing tools to use on a daily basis which includes climate change (e.g. Mozambique tool) Challenges: continuation of capacity related to governance, as well as administrative challenges (e.g. time frames & finance).	

City impact story	Poster
Lusaka (group 2) Story of change/key messages: FRACTAL engagements, collaboration and co-production processes developed relations and networks/partnerships, enhanced awareness of climate change impacts and provided a space for sharing ideas, knowledge and experience; climate change more integrated in planning Evidence of change: LCC Declaration on Water Security; strategic governance plans/policies were developed (e.g. Sustainable Development Bylaw); NWASCO Screening Tool; Sater Security Action and Investment Plan (WSAIP); Lusaka Water Security Initiative (LuWSI) Supporting sustainability of change: i) "under cover" agents of change; ii) ZMD training; iii) DDC learning labs processes; iv) facilitation training; and v) learning lab support unit.	
Maputo (group 1) Story of change/key messages: developed networks for improved collaboration between water sector institutions The work undertaken in Maputo maps onto the following pathway on the FCFA ToC: outputs 2, 3 & 5 (decision making process strengthened and include climate knowledge) Evidence of change: plans in place to develop and implement water and sanitation department within local government Supporting sustainability of change: enable the newly developed department of	

City impact story	Poster
water and sanitation to lead the forum of water collaboration and facilitate networking between the water sector institutions.	
Maputo (group 2) Story of change: the status quo had institutions and departments working in isolation. There was low effectiveness from existing forums and city processes and services. FRACTAL engagements and processes facilitated collaboration between intuitions, departments and disciplines. The work undertaken in Maputo maps onto the following impact pathways in the FCFA and FRACTAL ToC: i) and FCFA outputs 4 & 5; ii) FRACTAL outputs 2 & 5 Evidence of change: increased peer learning to create sustainability through conversations and knowledge and information sharing	

City impact story	Poster
Windhoek (group 1) Story of change: FRACTAL processes enabled a seed (ICCSAP) to be planted within the decision-making space to mainstream climate change response into city processes. Engagement platforms, technical expertise, climate information, trainings and funding were seen as providing the food, water and energy needed to allow the seed to grow through resource mobilisation, increased political support and building institutional capacity, which resulted in networks being built and a political will to move away from "business as usual". Sustainability of change (garden maintenance): The following are seen as important components to support the sustainability of change: i) ICCSAP steering committee; ii) city management; iii) climate change desk; iv) SIM expert; and v) developing capacity, new knowledge and more champions are seen as a means of identifying and planting new seeds to ensure a sustainable, liveable city	
Windhoek (group 2) Story of change: Through FRACTAL engagements supported the development of an Integrated Climate Change Strategy and Action Plan (ICCSAP) to provide a framework and streamline the city's response to climate change into city processes. Fractal supported a stakeholder workshop for the ICCSAP for discussing and unpacking of climate risks as well as interventions for climate adaptation and mitigation. The workshop highlighted the need for transformational leadership and increased political buy-in. The idea for Transformational Leadership on Climate Change (TLCC) training for strategic executives arose from the FRACTAL learning labs process. A START project was conducted focusing on water security in Windhoek.	

City impact story	Poster
Future: i) City's steering committee on climate change; ii) MOU with the University of Namibia & City of Windhoek; and iii) Sustainability centre - Bremen climate change expert	

Wrap-up of day and side conversations

Sue wrapped up the first day and encouraged participants to have a look at their FRACTAL information packs in the evening. After this wrap-up, city partners met one-on-one with Sharon to discuss finances.

Day 2: Research frontiers related to distillation, receptivity, co-exploration, co-production and transdisciplinarity (cocotrans), capacity development

Exploring FCFA learning framework

The second day kicked off with an introduction to the FCFA learning framework, presented by JP and Julio from CDKN. The objectives of this framework and the learning study, they explained, is to share learning between the FCFA research consortia and generate joint learning outputs. Important in this process, is pulling together key messages to inform donors on improved project design, research priorities etc. The learning agenda has two main components; i) impact case studies; and ii) thematic 'deep dive' questions, which are included below (these might be updated/iterated by the MEL team).

1. What have we learned through FCFA about how best to present or position medium to long term climate information for uptake across scales?
2. To what extent has the design and implementation of FCFA work aligned with the assumption that impactful research in the south requires strong and meaningful southern partnerships (that lead research and engagement)?

3. How has FCFA engagement with NMHS improved the robustness of the science and reach of climate information?
4. How has ongoing consortia learning altered the direction/impact/uptake of consortia research agendas and outputs?
5. How has the CCKE promoted collaborative learning amongst FCFA partners, b) and how has this altered the direction of research and outputs?

Julio and JP described the process for the learning study, which involves several steps, a working group across consortia and an external learning expert. The timeline was also presenting, showing the final learning output being developed by 30 June 2019.

Climate cluster work

Most of the morning on the second day was spent discussing work that has been undertaken within the climate cluster. Chris Jack and Richard Jones (climate cluster co-chairs) presented this work, along with several other members of the cluster. To kick things off, Chris presented the questions that the climate cluster had focused on answering over the past few years, which are included in project update in Annex C alongside the other research questions, as well as below.

What are the relevant baselines and their associated uncertainty in the observations/observation-based products? What are the multi-scale (time and space) atmospheric/lan/ocean drivers, processes, process chains and interactions that drive local scale climate variability and long-term climate change? What are the causal reasons for the range of projections from predictive tools and methods (e.g. GCMs, downscaling methods, spatial disaggregation methods, impacts models)? What is the most informative way for climate scientists to quantify and present the range of estimated future climates to facilitate the co-production of useful climate information for practitioners assessing climate vulnerability and climate change adaptation in the partner cities?

Chris and Richard also mentioned that several questions had been posed by city representatives to the climate cluster at the 2017 annual meeting; see below.

- Harare and Gaborone: can climate scientists give Harare/Gaborone nearer term projections re: rainfall? (30 years or less)
- Maputo: what are the predicted changes in intensity and frequency of heavy rainfall events in Maputo City by 2030?
- Cape Town: what is the likely change in the return period of a similar drought (as is occurring now) in the future? And can we identify the thresholds for action based on climate data?
- Blantyre: how will the Lake Malawi levels be affected by climate change in the next 20 years? (hydrological cycle)
- Windhoek: what will the rainfall pattern be in the next 15/20 years in Khomas (water source for Windhoek)? And, what will the rainfall runoff pattern and distribution in Khomas be in the next 20 years (frequency of below normal and above normal)?

Through discussions about the climate-related work, Chris and Richard hoped to show progress made towards answering the questions presented above.

Firstly, the cluster co-chairs explained the values that have guided the work of the climate cluster, which include: i) not dominating the knowledge process; ii) listening and learning; iii) being humble and ethical; and iv) attempting to step out of their comfort zones. They also presented three overarching concepts that have been explored through FRACTAL climate research:

1. **Added value**: what is it and how do you create/demonstrate it?
2. **Contradictions**: embracing, explaining and *maybe* resolving
3. **Distillation**

The work that has been done undertaken within the cluster was then presented, as described below.

Narratives

In general, FRACTAL aimed to turn the traditional climate-knowledge-into-use approach on its head; science was not supposed to dominate the learning/knowledge process. Instead, scientists hoped to listen and learn what city needs are and how research can contribute to answering these. Chris and others in the cluster were frustrated by the typical narratives found in documents such as the IPCC reports; he believed that these caused confusion because when it came to using words to describe the certainty of climate information (e.g. "likely"), people who read these words have very different interpretations, especially across the scientific and non-scientific communities. This generally leads to misunderstandings and poor communication. From this frustration, the narrative approach was born. They were initially very science-y and people didn't really know what to do with them so they ended up tacked into appendices of documents. They have been explored and iterated through several processes in FRACTAL.

In Lusaka, Maputo and Windhoek (initially labelled Tier 1), narratives were developed by climate scientists reading up on socio-economics. These were then presented in city learning processes with the aim of gathering feedback and integrating knowledge from the cities. Their purpose has evolved over time but they are currently seen as extremely important conversation starters. Narratives have been iterated in various forms including textual, infographics and skits. Infographics produced through FRACTAL have been used in funding applications undertaken by the city. The science in the narratives is very basic; the idea is that city stakeholders build on these. There is now the question of how the novel science produced within FRACTAL can be brought in.

In Blantyre, Gaborone and Harare (initially labelled Tier 2), the narratives were first written by city experts, who produced very rich and complex outputs. The challenge here was how to overlay climate information into these future visions. This process was very useful in identifying what climate information would be useful.

The next generation of narratives will have to consider who or how the initial narrative is written (whether a city expert or climate scientist) as this heavily influences the output. They should aim to include broader issues (e.g. national), and link multiple processes together, as well as link to models.

The take home message is that the benefit of the narratives is in the process, not the product.

Differences between datasets

Through this research, FRACTAL members have been trying to gain clarity on why there are differences between models. The first step was to identify the processes and conditions that lead to rainfall. The large scale processes agree well; where the models have trouble is translating this into local scale rainfall. Climate researchers think that some models do the right thing while others don't; they can gain insight based on model preferences. There is however a consistent message across models for southern Africa of a decrease in rain days, and increase in dry days, a constant mean rainfall, and in increase in the intensity of rainfall.

Climate process chains; what is driving large scale processes?

For this research, FRACTAL members used the example of El Nino, hoping to answer the following question: *can we use knowledge of this to understand climate model responses to larger scale processes?* They did this by linking the outcome of the processes (eg. Drought) back to a driver. A credible climate model has to be able to do this correctly, so we can use this understanding to interrogate models.

Process co-behaviour

There are other important processes at play; not just ENSO (e.g. currents, high pressure systems, the ITCZ). This aspect of the research aimed to explore how these interact to give an outcome. Researchers used models to test extremes of these processes to investigate their interactions. These research branches have allowed the conversation to be transformed from "we don't know much" to "this is what we do know". The next challenge is how to communicate this…

Distillation

The second half of the morning focused on the concept of distillation, which has been core to FRACTAL work. The concept comes from the realisation that various people can extract different messages from the same data because of their varying backgrounds (involving

prior knowledge of a topic, ethics, norms and values). Considering this, the value of diversity in knowledge and processes in FRACTAL is emphasised as there is no single right interpretation (which related back to the danger of the single story). Decisions need to be made to support climate resilient development and these decisions need to be informed but ethically, climate scientists should not dictate any single right way. The distillation framework provides a set of guiding principles to support engagements for interrogating possible options for constructing climate knowledge, as well as the consequences of choosing one of these options.

The following ideas are core to the distillation concept and framing:

- Framing & Questions: Are all stakeholders (including scientists and decision makers) on the same page?
- Evidence & Contradictions: The multiple perspectives (of models, stakeholders etc.) need to be acknowledged and it should be noted that precise evidence is built on assumptions; are these valid? Who decides these assumptions?
- Uncertainty & Risk: The trade-off between uncertainty and risk should be made explicit. For example, if a scientist delivers a message with little or no uncertainty by focusing on one or a few models, there is a risk that planning for other, plausible climate futures does not happen.

Two case Studies were presented to highlight the framework of distillation, as described below.

Lusaka & extreme rainfall

From the Learning labs in Lusaka, flooding emerged as issue in the rainy season,leading to drainage and sanitation issues. While in many areas, drainage infrastructure does not exist, there are large plans (eg. Evidence-based updates were required to enhance design standards for a >10 yr lifetime. Statistical rainfall extremes for the 5, 20 and 50 year timescales showed that today's (1970-2005) 1 in 50 yr event may be the futures (2030-2066) 1 in 20 yr event. These results are taken back into discussion with city planners at the next learning lab. It doesn’t solve the drainage problem in Lusaka, but it supports the conversation.

A question was raised on the direction of this case study; do we run the risk of forcing the conversation in one direction based on engagements? This is based on the people who are in the room. The response to this is that we must find out where climate information can help and not just force it in. It is one small part of the conversation.

Lusaka & WEAP modelling

This is an example of "decision-scaling", which involves gathering information from stakeholders at an event, linking to regional process, as well as global process. A city water use model for the year 2040 was developed for Lusaka based on information gathered during learning labs to identify water sensitivities and vulnerabilities. The process of developing the WEAP model was extremely helpful as it supported conversations between right people and identified trade-offs and interdependencies. The outputs of the WEAP model illustrated risks associated with different climate futures in Lusaka (shown in green, yellow and red for low, medium and high risk); the focus on numbers was removed. The co-development of this model gave people ownership of the process of producing knowledge, which city stakeholders feel helped to spread messages across their spheres of influence.

An aside… Cape Town Water Crisis

Cape Town was presented as an aside as it was a good example of *how* climate information is provided is important, not necessarily *what* climate information is provided. The impacts of climate change are being felt now in Cape Town, so the messages are not vague and directed at the future. Information that was already produced and available was presented in innovative ways to get messages across to stakeholders.(e.g. input in the media), so that they could be pulled apart and provide insight into contested views. It was a good way to support engagement with science.

Rethinking climate information for cities of the future

Eddie facilitated an interactive session to document ideas about the successes of FRACTAL in terms of producing climate information, as well as how practices could be improved into the future. Participants teamed up to prioritise their responses, which are shown below.

What was done well when using climate information in cities?

- Refreshing that climate scientists were not prescriptive
- Iterative learning and co-development of science
- Understanding of the context
- Understanding of common goal – bring multiple perspectives together
- Increased receptivity of actors
- Found places for climate information to go: policy briefs, strategy plans, risk assessments.

What should we do differently?

- Greater integration of African university partners – capacity building
- Increase engagement speed and travel budgets for learning labs
- Translate narratives into local languages
- Involvement of local met office
- Pre-understanding of information flows
- Engage with local institutions to define priorities
- Have a project coordinator from start
- Bring in an economist
- Earlier definition of climate words – climate literacy first
- Early input of climate information into cities
- Use climate information to predict local vulnerabilities

Unpacking TD, co-production and receptivity

The objective of this session was twofold; i) to introduce receptivity as a new concept developed through FRACTAL; and ii) present conceptual developments related to transdisciplinary co-production and distillation.

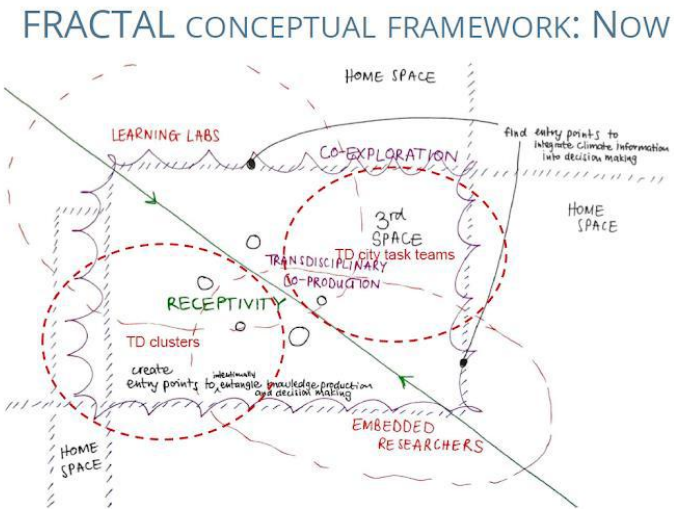
The session started with a presentation about receptivity (from Di) as an openness to new frames of reference. Building receptivity across all stakeholders leads to impartial decisions, allows for innovation, and is key for socio-economic change. It occurs during participatory processes; this is why learning labs were hosts for building receptivity. In some cases, a mindset shift is observed, and other times people get more embedded in a political stance; this is indicative of receptivity. Through this concept, FRACTAL challenges the assumption that people are passive receivers of climate information; rather they are agents and producers of relevant climate information. Understanding the importance of receptivity helps one to think about approaches for introducing climate information into cities and has provided a link between the natural and social sciences. It explains how processes (such as narratives and learning labs) have worked in FRACTAL. A working paper entitled Receptivity and judgement: expanding ways of knowing the climate to strengthen the resilience of cities has been developed and is available on the FRACTAL website.

Importantly, Lulu noted that receptivity does not replace entry points; they go hand in hand. Pre-existing entry points are in fact few and far between, and generally have to be created. These are created in a third space; which is outside the comfort zone of all involved. Time must be invested to create receptivity, and that this can be a tool/motivation as it articulates an early goal. This fed well into the second half of the session, which focused on meta-conceptual developments in FRACTAL.

The meta-conceptual developments presented relate to: i) integrating climate information into decisions that shape resilience in cities; and ii) conceptualising processes of science and decision making with respect to climate related risk.

Anna presented these developments, noting that the project was unique in its approach. Through work undertaken, FRACTAL has transformed the typical binary starting point that so many of these projects adopt, which is the separation of knowledge 'producers' and 'users'. In this original framing, the approach is linear, whereby transdisciplinarity supports 'feeding' climate science into decision making. This approach has been completely transformed by FRACTAL over the last 3 years. The two isolated domains of 'user' and 'producer' no longer exist; instead there is an overlap whereby both parties (and many others) use, produce, and hold data. Building receptivity amongst all stakeholders involved has allowed the borders of these domains to meet during co-exploration processes where a common language is founded and priorities are explored. This receptivity also supports the overlapping of these boundaries, leading to co-production.

Through FRACTAL, we learned that pre-existing entry points for climate information are few and far between; instead these opportunities need to be created, for example in the form of policy briefs and risk assessments. This conceptualisation is illustrated in the image below.

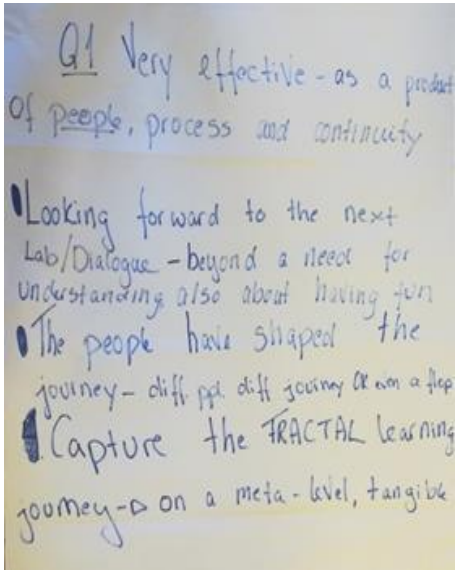


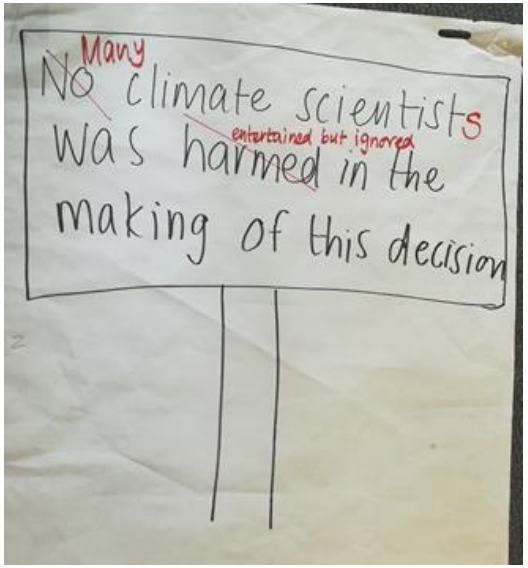
Major shifts in concepts since the FRACTAL project was initiated are described below.

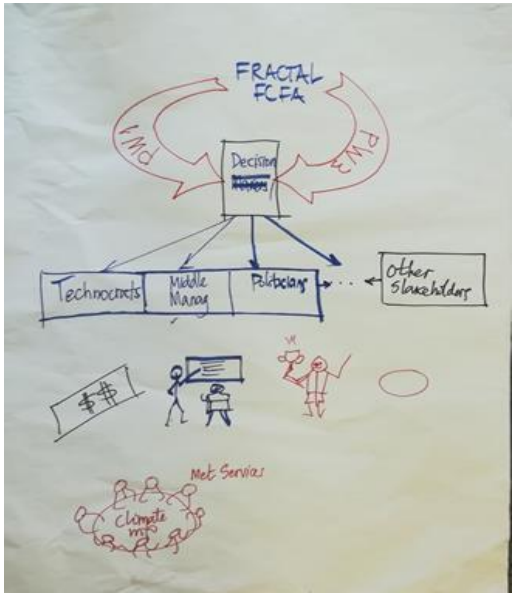
- We moved from thinking about co-exploring to find existing entry points to **co-producing (creating) entry points together** (enhanced receptivity allows us to make this shift).
- We recognised that we need to build **relational agency to intentionally entangle knowledge and decisions** instead of integrating knowledge that is co-produced into decisions once it has been created. This shifts the emphasis from “knowledge is key to changing decisions” to “people are key to changing decisions” and rejects that idea more knowledge always leads to better decisions.
- **Distillation is conceptualised as a process of bringing together knowledge making and decision making** instead of an idea to produce climate information for decision making.

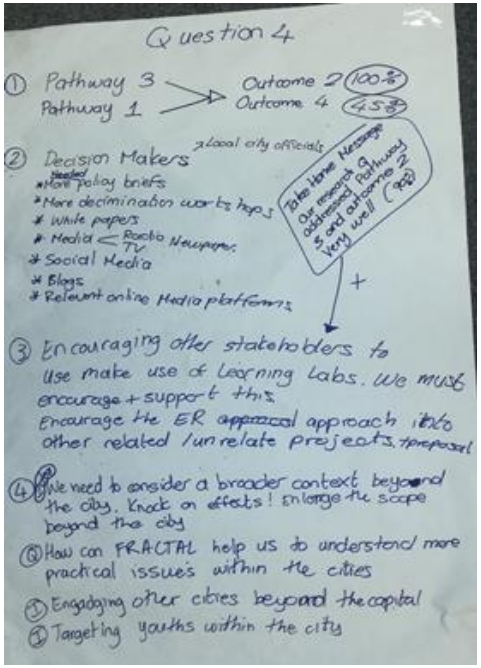
Answering research questions

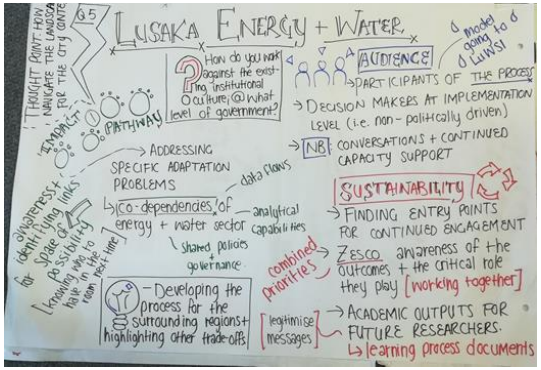
In an attempt to generate knowledge about how the different elements of FRACTAL added up, an exercise was facilitated during which participants reflected on the 12 overarching research questions. Groups of participants discussed progress made towards answering research questions, guided by four questions: i) which FCFA and FRACTAL pathway to impact does this work talk to? How far along these pathways have we come?; ii) who was the intended audience for these outputs (research community, government etc.)? What needs to happen to be sure key messages reach target audience before FRACTAL ends? iii) what can we do as a team to support sustainability of this work/knowledge?; and iv) what ideas or questions have arisen from work undertaken within the realm of this research question that should be taken forward in follow on work? Groups also produced posters based on these reflections, which are presented below.

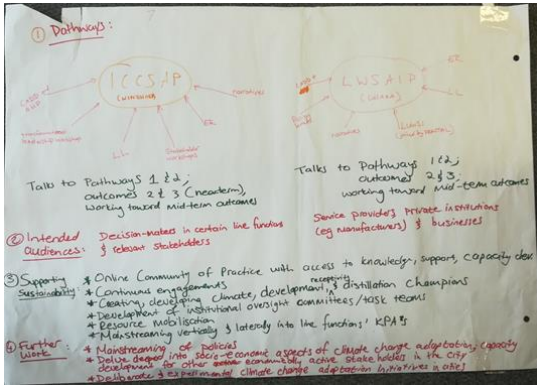
Research question	Poster
Question 1: How effective are the various transdisciplinary knowledge co-exploration/ co-production methods? Very effective; as a product of people, process and continuity. Teams are always looking forward to the next lab/dialogue beyond a need for understanding, also about having fun. The people involved in different processes have shaped the journey: city government and teams have created different pathways. We need to be sure we capture the FRACTAL learning journey on a meta-level in a tangible way.	

Research question	Poster
Question 2: What are the relative strengths and weaknesses of various decision support methods and tools for use in medium-term climate sensitive decision-making in southern African city regions? The main hindrance/opportunity for incorporating climate information into decision-making processes and ultimately governance documents is the lack of collaboration/disconnect between decision-makers and scientists. We therefore need information dissemination processes to help decision-makers understand what scientists are finding/saying, engagement platforms where co-production of relevant information specific to identified needs can be discussed, as well as a sense of inclusiveness, transparency and trust to build networks and partnerships for continued engagement and access to context specific information/ relevant data. The image (poster) depicts the disparate nature between information generators/providers and decision-makers, each perhaps with their own agendas and no clear links in the absence of collaborative efforts. As a result either decision-makers do not include climate information into their decisions or for the sake of results driven decision-making, scientists are entertained but ignored. FRACTAL perhaps highlights the importance of identifying and having the right mix of stakeholders in a room to maximise the benefits of various decision support methods and tools.	

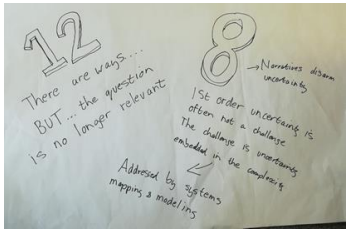
Research question	Poster
Question 3: How has decision making [rather than specific decisions] changed, if at all, as a result of FRACTAL engagements and/or the knowledge produced within the FRACTAL project? OR Is there any evidence of decision-making being in the process of changing that FRACTAL has contributed to? Work undertaken to answer this research question in in line with FCFA impact pathways 1 (targeted engagements through case studies, with focus on specific adaptation problems and groups of stakeholders) and 3 (engagement with users and key decision-makers at regional and pan-African level utilising FCFA generic products and tools) The intended audience for key messages are technocrats, middle management, politicians etc. Sustainability would be supported by: i) increased access to finance, ii) training and capacity development, iii) supporting the development of champions; iv) strengthening/establishing collaboration platforms; and v) including representatives from meteorological services in processes to provide useful climate information.	

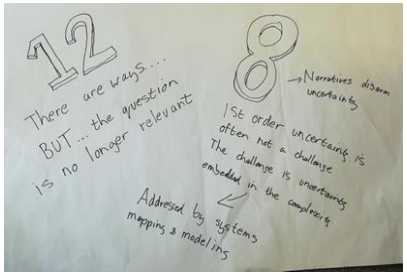
Research question	Poster
Question 4: What are the strengths and weaknesses of real world city case studies (learning labs?) as a method for analyzing [and improving] the use of climate information (Old question - how does climate change and climate change information factor into city decision-making, accounting for the urban-regional multi-sectoral dependencies?) Through work focused on this research questions, we have contributed to impact pathways 3 (engagement with users and key decision-makers utilising FCFA generic products and tools) & 1 (targeted engagements through case studies). The work has also contributed to Outcome 2 (decision makers and affected communities empowered with greater awareness of climate risks and the value of climate information for decision making. Increased skill of users to apply products in practice) and Outcome 4 (Greater capacity in in scientific community to deliver demand-led, relevant and actionable information; stronger multidisciplinary and international collaboration; and greater capacity of African scientists) Intended audience for messages about this approach: decision makers (local city/municipal officials) through more policy briefs, dissemination workshops, white papers, media (i.e. newspaper articles, radio and television broadcasts etc.), social media, blogs and relevant online platforms. We can supporting sustainability by encouraging and supporting other stakeholders to make use of learning labs, as well as embedded researchers in their approach to related/unrelated projects and proposals. Further work: ● We need to consider a broader context beyond the city. The ripple/knock-on effect of climate issues affecting regions beyond the urban context. ● How can FRACTAL help us to understand more practical issues within the cities?	

Research question	Poster
• Engaging other cities beyond the capital • Targeting youth within the cities (awareness raising and development programmes to help understand/identify issues and opportunities)	
Question 5: What is the structure/form of each city region's (electricity and other) and water (supply, waste, stormwater) system (physical and institutional) and what are the associated regional linkages/dependencies? This was only really answered for Lusaka Energy and Water The work undertaken to answer this research question contributed to impact pathway 1 (Targeted engagement through case studies, with focus on specific adaptation problems and groups of stakeholders) by addressing specific adaptation problems, understanding co-dependencies of energy and water sectors, data flows, analytical capabilities, shared policies and governance as well as awareness raising and identifying links for space of possibilities (knowing who to have in the room next time) The intended audience for sharing this work are: i) participants of the process; and ii) decision makers at implementation level (i.e. non-politically driven). We need to be sure messages reach these stakeholders through ongoing conversations and continued capacity support. Sustainability would be supported by: i) finding entry points for continued engagement; ii) increasing awareness among ZESCO (combined priorities) with regards to the potential outcomes and the critical role they play (working together); iii) developing academic outputs for future researchers; and iv) supporting learning process documents.	

Research question	Poster
Question 6: What is the current urban policy and socio-institutional governance landscape with specific relevance to the climate change, water and energy sectors? The work undertaken to contribute to answering this research question maps onto the FRACTAL Impact pathways to understand the city specific context and city-learning processes, as well as FCFA research output 5 (understanding of city players, systems, challenges and critical thresholds increased) & 2 (learning with a diversity of stakeholders from cities and science initiated or enhanced) The intended audience for delivering key messages about this work are national government, city officials and councillors, non-state actors, as well as others at the FRACTAL mini conference - refine who can 'hear' based on modalities/moralities Sustainability would be supported by helping to figure out correct modalities for the target audience then developing the appropriate output Future work: this needs to be refined and focus on which target audience and which modalities to communicate this to, in response to learning lab suggestions.	
Question 7: What city-region decision pathways can be identified for the uptake of increasingly detailed climate information? Integrated Climate Change Strategy and Action Plan (ICCSAP) in Windhoek. Activities and processes that contributed to this included: i) CADD and AHP training; ii) Transformational leadership workshops/training; iii) learning labs; iv) Stakeholder workshops; v) embedded researchers; and v) narratives. Work undertaken in line with this research question links to FCFA: i) pathways 1 (targeted engagements through case studies) & 2 (securing long-term legacy through improvements in	

Research question	Poster
knowledge base, models, data and capacity); ii) Outcome 2 (Decision makers and affected communities empowered with greater awareness of climate risks and the value of climate information for decision making. Increased skill of users to apply products in practice); iii) Outcome 3: improved scientific knowledge and tools have co-benefits for other areas. Lusaka Water Security Action and Investment Plan (LuWSAIP). Activities and processes that contributed to this include: i) CADD; policy briefs; iii) narratives; iv) LuWSI (joined by FRACTAL); v) learning labs; vi) embedded researcher Work undertaken in line with this research question links to FCFA pathways 1 & 2 and Outcomes 2 & 3 Audiences intended for this key message include: i) decision-makers in certain line functions and relevant stakeholders; and ii) service providers, private institutions (e.g. manufacturers) and businesses. Sustainability could be supported by: i) an online community of practice with access to knowledge, support and capacity development; ii) continuous engagements; iii) developing climate, development receptivity and distillation champions; iv) development of institutional oversite committees/ task team; v) resource mobilisation; and vi) mainstreaming vertically and laterally into line functions and KPA's Further work: ● Mainstreaming of policies ● Delve deeper into socio-economic aspects of climate change adaptation ● Capacity development for other economically active stakeholders in the city ● Deliberate and experimental climate change adaptation initiatives in the city	

Research question	Poster
Question 8: How are cities/city regions accounting for and dealing with uncertainty in their medium-term decision making? ● Narratives disarm uncertainty ● First order uncertainty is often not a challenge, the challenge is uncertainty embedded in the complexity… This is addressed by systems mapping and modelling	
Question 9: What are the relevant baselines and their associated uncertainty in the observations/observation-based products? (Both climate and non-climate) ● Focus on understanding contradictions in observational datasets ● Trying to reduce and describe observational uncertainties ● Encourage open data policies	N/A
Question 10: What are the multi-scale (time and space) atmospheric/land/ocean drivers, processes, process chains, and interactions that drive local scale climate variability and long-term climate change? This research question addresses Problems 1 and 2 in identified gaps in knowledge by the FRACTAL project. It seeks to improve knowledge while enhancing the prediction of the African climate through capacity building, of much interest is model and model development. In the long run, we envisage the accessibility of robust, high quality and relevant climate information in decision making. The target of this research question is mainly the scientific research community through publications as well as end users such as city managers/policy makers.	N/A

Research question	Poster
While there is the need to do more basic science, there should be much focus on need-based research.	
Question 11: What are the causal reasons for the range of projections from predictive tools and methods (e.g. GCMs, downscaling methods, spatial disaggregation methods, impacts models)? In going forward, undertaking fundamental research is essential to understanding and improving predictive tools such as models (parameterisation, boundary condition agreements etc), downscaling methods to reduce uncertainty	Very similar outputs for 10
Question 12: What is the most informative way for climate scientists to quantify and present the range of estimated future climates to facilitate the co-production of useful climate information for practitioners assessing climate vulnerability and climate change adaptation in the partner cities. This question is no longer relevant	

Wrap-up of day 2 and looking ahead

At the end of Day 2, the team reflected on how what had been discussed on Day 1 and 2 might feed into Day 3 (looking forward). This was followed by a "Urban Resilience caucus" meeting, drinks and a project dinner.

Day 3: Learning and looking forward

Jungle walk

The last day started off with a fun activity called the jungle walk, which involved two volunteers closing their eyes and walking around the room while the rest of the participants made jungle sounds (e.g. birds, roaring tigers, plants). As each participant was touched by the jungle walkers (i.e. volunteers), who located the other participants using their hearing, they stopped their jungle sound. The room got quieter and quieter until eventually it was silent. The team reflected on this activity, relating it back to teamwork or experiences they have had working in FRACTAL.

Reflections

The team was guided through a reflection session on the whole FRACTAL project, starting off with thinking about how feedback is a gift and offering good feedback to people in the room. Thereafter, participants took 20 minutes to fill out a reflective survey, which included the following questions; i) what have you liked about FRACTAL? Why? ii) What was challenging about FRACTAL? iii) What would you change for another, similar project? How might this project be designed in a different, better way? iv) Has FRACTAL changed the way you approach issues of climate change? If so, can you provide an example? v) "I wonder…"

Data collected through this reflective exercise will be included in the learning study (see framing for FRACTAL learning study)

Priority setting; urban caucus and other tasks

After the reflection session, the team took some time to discuss the urban caucus and map out priorities for the last few months of FRACTAL 1. Initially, Gilbert explained that the Urban caucus will take place in Lusaka in May or June 2019, aimed at sharing FRACTAL experiences and potentially including a Meeting of Mayors (MoM). He mentioned that representatives from all cities should be present at this meeting and that the Lusaka core team is currently driving this activity. Any other interested person is welcome to join the team.

After the discussion about the caucus, team members developed a joint timeline of activities, processes and outputs up until June 2019 by writing down their commitments, announcing these and sticking them on a timeline on the floor (see example below). The list of commitments is included in Annex D.

Photo courtesy of Kate Kloppers

Feedback from Participating Advisory Panel (PAT)

Each year, representatives from organisations not involved in FRACTAL provide input to the annual meeting from an external perspective. At the 2019 meeting, Bill Gutwoski attended from Iowa State University, Jon Padgham from START, as well as Rosalind West from DFID. Each of these representatives provided feedback on the last day. Some of the key messages from this feedback are presented below. For more extensive versions, see the formal feedback shared by Bill and Jon.

Bill

- Have observed impact in so many ways, throughout the AGMs have seen a progression from initial excitement, into experiences, and now impacts.
- The question now is how to sustain this?
- It is important that everything is documented – don't want to be shunted as an oddity.
- Have seen a change in leadership of meetings from academics to the people that are involved on the ground.
- Interested to learn more about the learning lab process – this is how things should be done – no formal training.

Jon

- Emergence of new concepts: receptivity and distillation
- Experiential learning and trust building are inherently linked to capacity development
- Focus in learning, and then training followed when it fitted in. There was no focus on any assumed knowledge deficit.
- START funded SOGs were important in connecting cities

Rosalind

- Everyone here should be very proud of what they have managed to achieve.

- Fundamental breakthrough in how things should be done, how to actually have impact, something that has seemed like a brick wall for a long time now.
- What has really been key are the connections that have formed between people of different expertise, and that it takes time to listen.
- A focus now is what can we take from FRACTAL to move forward.

FRACTAL next

The last part of the third day was spent thinking about moving FRACTAL forward. This session built on the draft FRACTAL next proposal, which included five ideas for moving the work forward, namely: i) from seasonal to near term climate risk; ii) beyond mainstreaming adaptation; iii) urban climate resilience knowledge and inspiration (network); iv) information distillation platform; and v) urban deep dives. Participants voluntarily split into groups according to these themes to discuss further. Bullet points and key ideas from these discussions are recorded below.

From seasonal to near term climate risk
There is a need for extending seasonal to longer term We need a hydrological outlook Attribution forecasts for communicate changing risks? Three temporal contexts: ● Response ● Planning ● Longer term adaptation, education and awareness Defining risks, particularly “downstream” Focus on the generation of seasonal information by means of:

- Improvement of traditional numerical forecast (basic science)
- Alternative/non-traditional approaches- bespoke/creative/exploratory/need-driven
- Complexity vs simplicity

Aspects of communication: how? To what audience?
Management response: how to interpret?
Societal response

Beyond mainstreaming adaptation

- Focusing on spatial development policies and frameworks; how do the different plans overlap and how can climate be integrated?
- Engagement with stakeholders from planning through to ground level (sosatie stick – all different stakeholders and governance types on one 'stick')
- Explore who or what is driving development (in Cape Town, there is an internal working group that discusses development)
- Look at the constellation of actors, who is influential and why this is so
- NB in an African context; acknowledging informality and various planning/land tenure processes (informal, traditional, protected etc.) - systemic challenges
- Integrating climate

Urban climate resilience knowledge and inspiration (network)

Resilience should be understood to relate to climate change, yes, but also the broader frame of reference that is relevant to city stakeholders, tied to what their mandate is, and what makes them tick (e.g. a Councillor is motivated by winning votes), and the need to link any work done in cities to stakeholder agendas, goals and mandates, to ensure sustainability and buy-in.

Perhaps a better word than 'network' is 'community of practice', as the goal would not be to add to the plethora of networks 'out there', but up and out-scale the processes and principles of FRACTAL more than attempt to apply outputs in different contexts (i.e. not a cookie-

cutter approach). Linked to this point, is the idea of linking the right stakeholders on the right issues for 'inspiration'. Perhaps we could find a way, if we go with an online presence for this, of people being able to click on a logo related to a certain problem, opportunity or solution, to link stakeholders thinking about a certain issue together, e.g. informality?

The idea would be that we would expand the FRACTAL network at multiple scales:

- Scale 1a: Deepen and seek to institutionalise existing FRACTAL unearthed/ engaged/ initiated networks, so that they are not solely based on personal relationships, which makes these networks open to collapse if key individuals leave their respective organisations.
- Scale 1b: Within the current FRACTAL cities (may want to say city region to better reflect urban-rural continuum in African cities, e.g. pockets of rural in urban), expand to stakeholders not engaged with regularly during FRACTAL, e.g. the private sector, communities/ civil society.
- Scale 2: Within the current FRACTAL countries – enable better coordination and collaboration between local and national government (vertical integration/ multi-level governance), especially due to the fact that national government holds a lot of the mandates relevant to resilience.
- Scale 3: Regional network – between cities. We would have to think through the modalities of this – on-line platform, city-to-city exchanges, conferences – perhaps having regional hubs where there is appetite, e.g. one for Southern, Eastern, West and perhaps (although very different contextually) North Africa.
- Scale 4: Global influence – communicating and influencing global discourse – African cities as trailblazers. Via for example ICLEI's role as LGMA focal point to the UN processes, multiple IPCC authors involved in FRACTAL etc.

The aim would be to build on/ harness existing networks/ structures if at all possible. For example, in relation to Scale 2, we would build on the fact that Windhoek is part of the National Climate Change Committee, and maybe we could try and get other cities to join this committee, or harness one of Namibia's local government associations, who then sit on the committee and represent a broader set of local governments.

Steps to take this forward (from the group):

- Map existing networks and communities of practice at all 4 scales, for relevance.

- Assess, via remaining FRACTAL engagements, as well as others that consortium members are involved in, appetite for such a network and how it can serve city stakeholders needs in a tangible way.

Information distillation platform

Fynbos example

- Rapid updating
- Integrating "CIP"
- Contributing city knowledge
- Critical mass
- Include National Perspective
- Co-design it!
- Document "library"
- Public and private/safe spaces
- Languages?
- Offline function?

Urban deep dives

Include vertical integration due to national government mandate and important role. Also close feedback loop to what cities are doing to feed back into national mandate.

Emphasis on "implementation science"

Emphasis on mind-set as well as behaviour change (e.g. Gaborone interested in developing climate change strategy and action plan – developing a process and test driving).

Taking current processes forward and going deeper in other cities (deeper into new city based on old processes i.e. duplicate other processes) BUT would like a real product at the end. For example, application of FRACTAL processes, tools etc. applied to get to a city while i.e. not limited to a research question but a city identified need rather (reframing from question to addressing a need through application of FRACTAL learnings). Specific product demands from the city councils should be met. This could be climate change plans, more stakeholders on-board to develop relational agencies, transformational leadership training, city to city exchanges, CADD training, capacity development (true and deep not just learnings), access to flows of "information" improvement.
Climate scientist know the processes for climate information provision and therefore can be replicated

Development of water security

- Application and investment plan
- Training and engagement with MET
- Legacy capacity building (so that processes and activities can continue without FRACTAL)

"FRACTALISING" the city

- Ability to carry the whole process – based on relevance of your cities exposure
- Specific focused climate change training to the department or sector i.e. tailored to energy, tailored to environment etc.
- Engaging more stakeholders – platform (learning and reflecting space) that city takes forward- to be capacitated to do it
- "checklist"/guidance- as develop capacity also develop "process roadmap" – which level should be communicated etc.
- How do we influence by-laws and city governance documents – policy reforms (and plans) especially in Lusaka

-

Deep dive on engagement process – how to hold learning labs, training and facilitation

The FRACTAL next proposal will be iterated based on these inputs and shared with the broader team.

Thanks and closing

In the last session, Alice and Bruce gave their thanks to the team members and wrapped up the meeting. This was followed by a goodbye exercise, during which team members passed around an imaginary gift of gratitude.

Annexes

Annex A: Annual meeting programme

Time	Facilitator	Session purpose and structure	Outcome/output	Comments/notes
Tuesday 12 February **COMIC meeting and bilateral meetings/focused writing sessions**				
COordination, Management & Integration Committee (COMIC)				A small meeting room has been made available for these events. Team members are expected to organise their own bilateral meetings/focused writing sessions in the afternoon.
09h00-12h30	Bruce	COordination, Management & Integration Committee (COMIC) to meet and discuss progress and strategic objectives for the next six months.	Strategic objectives and partner responsibilities for the last six months	
Bilateral meetings				
12h30-18h00	N/A	Bilateral meetings for team members who have travelled to Monkey Valley. This time can also be used for focused writing sessions.	Dependent on teams meeting	
19h00: Dinner				
Annual meeting day 1 (Wednesday 13 February); unpacking impacts in cities				
08h40: registration at venue				
Opening				
09h00-09h20	Bruce	Opening of the meeting by Bruce (PI) to set the scene and present overarching objectives.	Participants understand the objectives of the team meeting	N/A
Interactive introduction				
09h20-09h40	Sukaina	Team members have the opportunity to learn a bit more about one another and the 'bigger picture' FRACTAL project	Participants know each other better, especially those who are new to FRACTAL	N/A
FRACTAL framing				
09h40-10h10	Alice	Participants are provided a brief overview of FRACTAL's initial objectives and research questions, as well as how important concepts have been operationalised. An exercise is introduced to explore the progress that has been made through FRACTAL and what this means for future work. Small groups will work on this exercise over the next two days, with feedback on day 3.	Participants are reminded of the bigger picture objectives and have a clear idea about how to unpack progress towards these objectives with their team mates during the meeting	Participants are expected to read the project brief before the meeting. Other informative materials will also be provided during this session.

Process discussion				
10h10-10h30	Sue	The process of the annual meeting is discussed including introduction to the core process team, design objectives, what people might expect etc. The link between contents and process will also be discussed with participants.	Participants know how the meeting will be run and who they can approach if they are unsure of process	N/A
10h30-11h00	Tea			
Learning lab journey				
11h00-12h00	Bettina	Through a creative exercise, participants gain insight into the learning lab journeys that have taken place in FRACTAL cities	Participants have a greater understanding of learning processes in FRACTAL cities	N/A
FRACTAL city impacts session #1				
12h00-13h05	Anna T & Alice	An overview of the FRACTAL city impacts sessions is presented including: i) the structure of feedback (subject to change from the lists below); ii) expectations of listening participants; and iii) outputs from the session (5 mins) Thereafter, feedback is provided by: ● Lusaka (30 mins) ● Durban (15 mins) ● Blantyre (15 mins)	Participants have a greater understanding of the impacts that have (or have not) been realised in cities as a result of FRACTAL work.	Preparation from city teams beforehand Guided by the impact story architecture (city teams posed questions and record their thoughts for impact stories)
13h05-14h00	Lunch			
FRACTAL city impacts session #2				
14h00-15h30	Meggan & Jess	Feedback is provided by: ● Windhoek (30 mins) ● Harare (15 mins) *Energiser* ● Cape Town (10 mins) ● Maputo (30 mins)	Participants have a greater understanding of the impacts that have (or have not) been realised in cities as a result of FRACTAL work.	Preparation from city teams beforehand Guided by the impact story architecture (city teams posed questions and record their thoughts for impact stories)
15h30-16h00	Tea			
FRACTAL city session #3				
16h00-16h20	Anna S (& Alice)	● Gaborone (15 mins) ● Johannesburg (10 mins)	Participants have a greater understanding of the impacts that have (or have not) been	Preparation from city teams beforehand

			realised in cities as a result of FRACTAL work.	Guided by the impact story architecture (city teams posed questions and record their thoughts for impact stories)
16h20-17h00		**Sketching FRACTAL impact stories**		
16h20-17h00		In groups, team members discuss the cases that have been presented and sketch out impact stories by responding to a set of questions together. ● What is the key message/story of change? ● Do these map onto the FRACTAL & FCFA ToC? ● What is the evidence for this/these changes? ● How can we support sustainability of these changes?	FRACTAL impact stories (for DFID) reporting co-produced Impact videos	Participants are expected to read the project brief before the meeting, which includes an overview of work that has taken place in cities.
Overview of Day 1 and looking forward to day 2				
17h00-17h30	Sue	Participants are provided the opportunity to reflect on the day and provide input for how this will flow into day 2, during which FRACTAL research frontiers will be explored.	Participants feel comfortable with the flow from day 1 into day 2	N/A
Side conversations				
17h30-19h00	Sharon	Time for bilateral discussions and meetings ● FRACTAL finances (Sharon) ● Ownership of publications & authorship ● Writing/planning sessions for outputs (team leads) ● Others arising from the day	Depending on side conversation	N/A
19h00: Group supper				
Annual meeting day 2 (Thursday 14 February): Research frontiers related to distillation, receptivity, co-exploration, co-production and transdisciplinarity (cocotrans), capacity development				
07h00-07h30	Voluntary slow session - beach walk			
Exploring FCFA learning framework				
08h45-09h00	CDKN	Exploring FCFA learning framework	Participants are introduced to the FCFA learning objectives and framework	N/A
Unpacking climate science work				
09h00-10h30	Climate cluster	The climate cluster unpacks the work that they've been doing in depth to answer questions including *inter alia* those below. ● What did we set out to do? ● What has guided us?	Participants have a deep understanding of the climate cluster work	

		• What have we actually done? Including answering questions from the cities and the "auction" • What have been the main challenges? • What mistakes have we made? • What were the highlights and successes? • Where to from here?		
10h30-11h00	Tea			
Unpacking distillation in cities				
11h00-12h30	Chris	The distillation framework is discussed and applied to FRACTAL cases • A brief but deep overview of the distillation framework • Taking the opportunity of having many knowledge holders in the same space, the distillation framework is used to reflect on how information distillation has taken place in each of the Tier 1 cities.	Participants understand the meaning of distillation and how this process has occurred in different cities during FRACTAL (i.e. the sequence of steps, who has been involved etc.) Outputs for DFID reporting	N/A
Rethinking climate information for Cities of the future #1				
12h30-13h00	Eddie	Exercise to pull out some high-level, transferrable messages about climate information/knowledge for decision making in African cities	Key messages are collated for further development into a transferability product	N/A
13h00-14h00	Group photo & lunch			
Rethinking climate information for Cities of the future #2				
14h00-14h30	Eddie	Exercise to pull out some high-level, transferrable messages about climate information/knowledge for decision making in African cities	Key messages are collated for further development into a transferability product	N/A
Unpacking receptivity & transdisciplinary co-production in cities				
14h30-15h30	Di & Anna T	Explore how specific FRACTAL activities have enhanced receptivity and thereby the capacity to co-produce, relating this back to the ideas of entry points and 3rd space and the overarching FRACTAL and FCFA aim of bridging science and society to enhance the climate resilience of cities	Participants understand notions of receptivity and transdisciplinary co-production, as well as how these terms related to building climate resilience in cities through FRACTAL cases.	N/A
15h30-16h00	Tea			

Overview of Day 2 and looking forward to day 3				
16h00-17h00	Sue	Session used to reflect on discussions, lessons and key messages thus far, as well as how some of the lessons might be carried to Day 3: looking forward to the last 6 months and beyond. Groups working on research questions are provided time to unpack their assigned research questions further and develop their poster.	Participants feel comfortable with the flow from day 2 into day 3 and prepared for forward-looking discussions.	
17h00-19h00	Bettina & Richard	Philosophical climate sundowner		
19h00: FRACTAL team valentines supper				
Annual meeting day 3 (Friday 15 February): Learning & looking forward				
Reflection & learning session				
08h30-09h30	Alice, Bettina & Sue	**Reflection & learning** Session kicks off with a short overview of FRACTAL's approach to learning, particularly with regards to how learning assessments and reflections will be used in the process of formally evaluating, capturing and communicating the learning from FRACTAL as a whole Participants then have an opportunity to view posters that have been developed by groups to consider the work that has been done within FRACTAL (relevant to research questions) and what this work means. Using knowledge gained from the posters, as well as other knowledge shared during the meeting, team members reflection on what they've learned in their personal, institutional and/or community capacity through FRACTAL.	Input to FRACTAL learning working paper and approach (from team) Consolidated ideas about lessons learned through FRACTAL	
Feedback from advisory team				
09h30-10h00	Bruce	Advisory team provide feedback to the FRACTAL team in response to what they've heard over the past few days. This will include feedback from: • Bill Gutowski: Department of Geological and Atmospheric Sciences, University of Iowa;	Team members understand how FRACTAL work fits in within the broader community/funding context	N/A

		• Jon Padgham: START/Future Earth; and • Rosalind West: DFID		
What's happening next? (including working tea)				
10h00-12h00	Alice, Bruce, Chris & Sue	The structure of this session will depend on the discussions in previous days. However, the following overarching themes will be included: • Opportunities mapping (individual, institution and collective) • Brainstorming ways to maintain momentum and networks • Understanding needs in cities to carry FRACTAL-related work forward and thinking about how to support these. • Updating the FRACTAL next concept	Team members are provided time to steer the future of similar work	N/A
Closing				
12h00-12h30	Bruce	The PI will close the meeting by describing some immediate next steps and sharing last messages with the team	TBC	N/A

Annex B: List of participants (and assigned groupings)

Name	City grouping	Research Question grouping
Alice McClure	Cross-city	4
Amy Davison	Durban	Observer
Anna Steynor	Maputo 1	1
Anna Taylor	Windhoek 1	2
Becca Cullis	Media	Observer
Beth Mackay	Media	Observer
Bettina Koelle	Lusaka 1	1
Bill Gutowski	Cross-city	Observer
Brenda Mwalukanga	Media	3
Bruce Hewitson	Maputo 2	12
Burnet Mkandawire	Blantyre	4
Chipo Plaxedes Mubaya	Harare	7
Chris Jack	Lusaka 2	8
Coleen Vogel	Blantyre	Observer
Dianne Scott	Maputo 1	6
Eddie Jjemba	Windhoek 2	4
Emmanual Shadreck Kanjunjunju	Blantyre	Observer

Name	City grouping	Research Question grouping
Filimon Hambuda	Windhoek 1	Observer
Genito Maure	Maputo 2	3
Gilbert Siame	Lusaka 1	3
Grigory Nikulin	Gaborone	9
Hecrálito Mucavele	Maputo 2	6
Izidine Pinto	Maputo 1	11
James Cullis	Blantyre	5
Jean-Pierre Roux	Media	Observer
Jess Kavonic	Gaborone	6
Joao da Costa	Maputo 1	Observer
John Mfune	Windhoek 2	3
Jon Padgham	Cross-city	Observer
Jonathan Mwanza	Lusaka 2	3
Julio Araujo	Blantyre	Observer
Kasenga Hara	Lusaka 1	1
Kate Kloppers	Cross-city	4
Katinka Lund Waagsaether	Maputo 2	1
Kornelia Iipinge	Windhoek 1	3

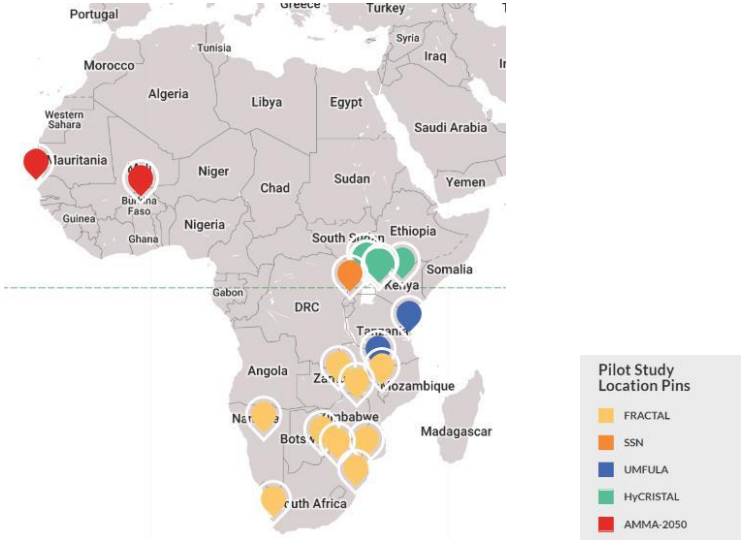
Name	City grouping	Research Question grouping
Kwesi Quagraine	Durban	10
Lapologang Magole	Gaborone	7
Liz Daniels	Windhoek 2	2
Lulu van Rooyen	Durban	7
Mavhungu	Harare	11
Meggan Spires	Durban	6
Molebogi David Ramatlhare	Gaborone	Observer
Muchimba Muvombo	Lusaka 2	3
Mununguu Mungalo	Lusaka 1	7
Mzime Ndebele-Murisa	Harare	4
Olavi Makuti	Windhoek 1	7
Piotr Wolski	Lusaka 2	5
Rachael Shuttleworth	Windhoek 1	Observer
Raul Chilaule	Maputo 1	7
Rebecca Ilunga	Lusaka 1	5
Richard Jones	Lusaka 2	12
Rosalind West	Media	Observer
Rudo Mamombe	Harare	1

Name	City grouping	Research Question grouping
Saima N Haukelo	Windhoek 2	7
Simon Dadson	Gaborone	5
Smiso Bhengu	Durban	Observer
Sukaina Bharwani	Windhoek 1	7
Waarith Abrahams	Cross-city	Observer
Wilma Nchito	Lusaka 1	4

Annex C: Project update (January 2019)

Overview

Future Resilience of African CiTies and Lands (FRACTAL) is a four-year consortium that started in June 2015, funded by DFID and NERC. The project is part of a larger programme entitled Future Climate For Africa (FCFA), which aims to generate fundamentally new climate science focused on Africa, and to ensure that this science has an impact on human development across the continent. The other consortia within FCFA are: i) the African monsoon multidisciplinary analysis 2050 (AMMA-2050); ii) Integrating hydro-climate science into policy decision for climate-resilient infrastructure and livelihoods in east Africa (Hycristal); iii) Improving model processes for African climate (IMPALA); and iv) Uncertainty reduction in models for understanding development applications (UMFULA). The Coordination, capacity development and knowledge exchange unit (CCKE) performs a coordination and knowledge management role to support FCFA. The five consortia within FCFA are working in different areas across Africa, as illustrated in the map below.



FRACTAL is the only consortium that is explicitly focused on climate resilience of cities. Three explicit objectives drive FRACTAL activities, namely: i) understand city specific contexts, asking what the urban climate change risks and impacts are, how resilient the cities are and what decisions are being taken for adaptation and development?; ii) understand the decision-making space in the FRACTAL cities and look for opportunities to better incorporate climate information into local decision-making contexts; and ii) advance understanding of physical climate processes that govern the regional system (observed and simulated) and develop robust and scale relevant climate information. These three objectives are inextricably linked and work has been guided by transdisciplinary co-production principles, which support collaboration across geographic areas, different types of organisations and agendas. For a full list of project partners, see the FRACTAL website: www.fractal.org.za/partners/

FRACTAL partners, grouped into "clusters of collaboration" (city learning, climate, decision making, nexus and cross-cutting) work towards answering 12 questions in an attempt to meet the objectives described above. The questions are listed below.

1. How effective are various transdisciplinary knowledge co-exploration/ co-production (CE/CP) methods (e.g. Learning Labs, embedded research, learning exchanges, competency groups) for fostering collaborative research, and learning at the city, project and broader community scale? and evidence-based decision-making relating to climate sensitivities, within and between city regions?
2. What are the relative strengths and weaknesses of various decision support methods and tools (e.g. participatory scenario building, gaming, the facilitation of competency groups, data visualizations, Real Options Analysis, Robust Decision Making, Portfolio Analysis, Analytical Hierarchy Process, multi-criteria analysis, etc.) for use in medium-term climate sensitive decision-making in southern African city regions?
3. How has decision making [rather than specific decisions] changed, if at all, as a result of FRACTAL engagements and/or the knowledge produced within the FRACTAL project? OR Is there any evidence of decision-making being in the process of changing that FRACTAL has contributed to?
4. What are the strengths and weaknesses of real world city case studies (learning labs?) as a method for analyzing [and improving] the use of climate information (Old question - how does climate change and climate change information factor into city decision-making, accounting for the urban-regional multi-sectoral dependencies?)
5. What is the structure/form of each city region's energy (electricity and other), water (supply, waste, stormwater), and food (production and access) system (physical and institutional) and what are the associated regional linkages/dependencies?

6. What is the current urban policy and socio-institutional governance landscape in the three T 1 cities, with specific relevance to the climate change, water and energy sectors?
7. What city-region decision pathways can be identified for the uptake of increasingly detailed climate information?
8. How are cities / city regions accounting for and dealing with uncertainty in their medium-term decision-making? AND/OR How can cities / city regions account for and deal with uncertainty, specifically relating to climate information, in their medium-term decision-making?
9. What are the relevant baselines and their associated uncertainty in the observations / observation-based products? (Both climate and non-climate)
10. What are the multi-scale (time and space) atmospheric/land/ocean drivers, processes, process chains, and interactions that drive local scale climate variability and long-term climate change?
11. What are the causal reasons for the range of projections from predictive tools and methods (e.g. GCMs, downscaling methods, spatial disaggregation methods, impacts models)?
12. What is the most informative way for climate scientists to quantify and present the range of estimated future climates to facilitate the co-production of useful climate information for practitioners assessing climate vulnerability and climate change adaptation in the partner cities.

FRACTAL work is grounded in and informed by nine southern African city contexts, to varying degrees. A brief overview of engagements that have taken place in these cities is presented below[1].

Blantyre: team members from The Polytech, University of Malawi have attended FRACTAL annual learning meetings since 2015. This team has led work focused on co-developing narratives with a variety of stakeholders in Blantyre, thereby supporting discussions about the potential impacts of climate change on the city (through the NERC narratives project). The final output from this research is currently being written up. Blantyre team members have also explored the perspectives that underpin the potential decision to turn waste to energy in the form of "think tank" sessions (through the innovation fund project). The Blantyre team is currently working alongside a team in Harare and ICLEI to implement a Small Opportunity Grant (SOG), which will support multi-stakeholder platforms to unpack decision making

[1] This is a summary of activities in cities in which FRACTAL has been working; it is not an exhaustive list and some information about city activities might be missing. A more detailed account will be shared at the annual meeting in February 2019.

pathways related to issues of water under a changing climate in these two cities. The outcome of this SOG will be the recommendation of best practices for all stakeholders involved in managing water issues going forward, with a focus on integrating climate information.

Cape Town: the City of Cape Town has supported attendance of representatives at the FRACTAL annual learning meetings since 2015. As a self-funded city, Cape Town has not been involved in core project activities but has worked closely with CSAG on other climate change-related work, allowing for cross-pollination of learnings. In the second year of FRACTAL, a Small Opportunity Grant (SOG) was implemented with CoCT to support the development of a common language for climate change in the City of Cape Town (see working paper here). Amy Davison (Head: Climate Change at the Environmental Management Department at CoCT) has attended many external events alongside FRACTAL team members (e.g. IPCC Cities Conference, Adaptation Futures), sharing lessons about dealing with climate issues in Cape Town. Amy also took part in a FRACTAL learning webinar entitled *City government-research partnerships: reflections from Cape Town and Johannesburg* (see learning brief here).

Durban: eThekwini Municipality has supported attendance of representatives at the FRACTAL annual learning meetings since 2015. As a self-funded city, eThekwini Municipality supported the embedding of a researcher from the University of Kwa-Zulu Natal (UKZN) into the municipality to work on issues related to climate change impacts on Durban's biodiversity. This Embedded Researcher has also led the publication of a conference paper entitled *Working towards climate-resilient cities in southern Africa through an Embedded Researcher approach* (see AF2018 conference proceedings here), as well as a similar journal article (recently submitted). Through a FRACTAL SOG, the team in Durban hosted representatives from Lusaka, during which they signed the Durban Adaptation Charter (DAC).

Gaborone: team members from the University of Botswana (UB) have attended several FRACTAL annual learning meetings since 2015. This team has led work focused on co-developing narratives with a variety of stakeholders in Gaborone, thereby supporting discussions about the potential impacts of climate change on the city and inspiring the potential development of a city-specific plan to tackle climate change (through the NERC narratives project). The final output from this research is currently being written up. To further explore options to develop this plan, a representative from UB and the municipality in Gaborone attended the third Windhoek Learning Lab, which focused on the development of the Windhoek Climate Change Strategy and Action Plan (CCSAP).

Harare: team members from Chinhoyi University have attended FRACTAL annual learning meetings since 2015. This team has led work focused on co-developing narratives with a variety of stakeholders in Harare, thereby supporting discussions about the potential impacts of climate change on the city (through the NERC narratives project). The final output from this research is currently being written up. Harare team members have also explored the perspectives that underpinned the decision to upgrade the Morton Jaffray Water Works in the form of "think tank" sessions (through the innovation fund project). The Harare team took part in a city exchange with Windhoek to explore water and climate related issues, and how these could be managed. The team is currently working alongside a team in Blantyre and ICLEI to implement a Small Opportunity Grant (SOG), which will support multi-stakeholder platforms to unpack decision making pathways related to issues of water under a changing climate in these two cities.

Johannesburg: the Global Change Institute (GCI) at the University of the Witwatersrand has supported attendance of representatives at the FRACTAL annual learning meetings since 2015. As a self-funded city, Johannesburg has not been involved in core project activities but has worked with CSAG on other climate change-related projects, allowing for cross-pollination of learnings. Coleen Vogel (academic staff at GCI) has attended many external events alongside FRACTAL team members (e.g. Adaptation Futures, ACC Conference), sharing lessons about dealing with climate issues in Johannesburg. Coleen also took part in a FRACTAL learning webinar entitled *City government-research partnerships: reflections from Cape Town and Johannesburg* (see learning brief here).

Lusaka: team members from the University of Zambia and Lusaka City Council have attended FRACTAL annual learning meetings since 2015. The Lusaka team recently hosted the fifth and final learning lab, during which stakeholders reflected on lessons learned and mapped a way forward beyond FRACTAL. These learning labs have enabled the exploration of burning issues related to water supply, groundwater levels and pollution, and flooding. These issues have been unpacked through a climate lens during the co-development of these briefs with a variety of stakeholders including climate scientists. Alongside learning labs in Lusaka, high-level breakfasts have been organised to share FRACTAL findings with policy and high-level decision makers, as well as provide space for their steer of FRACTAL activities. Representatives from Lusaka have expressed a desire to continue learning lab-type platforms after the project ends and have also identified efficient points for policy brief dissemination within relevant organisations and ongoing interventions. One point of entry is the Lusaka Water security Action Plan, which is currently being supported by GiZ. The Lusaka team also developed a SOG for a city-to-city exchange with Windhoek, during which representatives from the local universities, municipalities and water entities explored the effects

of climate change on water security for the cities, as well as potential action plans (read about this exchange in a blog by the Lusaka and Windhoek ERs). A second SOG in Lusaka is currently underway, which will support training of councillors for the development of a water security action and investment plan for the City of Lusaka, integrating a climate perspective and information. Climate change-related training was also provided for councillors near the beginning of FRACTAL work in Lusaka. Lusaka team members have also explored the perspectives that underpinned the decision to upgrade the Lusaka Pipeline in the form of "think tank" sessions (through the innovation fund project). A SOG-funded Talanoa dialogue has recently been hosted in Lusaka, during which fundamental questions related to climate change planning were discussed, namely: where are we? Where do we want to go? How do we get there? These questions were discussed by Lusaka City Council, National Water Supply and Sanitation Council (NWASCO), Lusaka Water and Sewerage Company (LWSC), the Lusaka Water Security Initiative (LUWSI) and researchers from the University of Zambia.

Maputo: team members from the Eduardo Mondlane University and Maputo Municipality have attended FRACTAL annual learning meetings since 2015. The Maputo team has supported the implementation of two learning labs, during which issues related to water and climate change have been explored. Two dialogues have also been hosted, during which representatives from the water sector have explored management structures and challenges associated with water in Maputo. During the recent dialogue, Raul Chilaule presented the Municipal plan for adaptation as a tool for decision-making in the water sector and the team explored why information on climate projections and impacts on water supply that has already been developed has not yet been integrated into planning in Maputo. One technical training session has taken place in Maputo. Through a SOG, the Maputo team has also been exploring the co-designing of an improved early-warning tool for climate-induced vector-borne and water-borne diseases within the Maputo City Municipality.

Windhoek: The third Learning Lab has recently been hosted in Windhoek. The FRACTAL city learning process has supported the development of the Windhoek Climate Change Strategy and Action Plan (CCSAP); during the most recent lab, stakeholders representing several organisations and perspectives provided input to this plan, which is currently being finalised. A councillors training on climate change issues has been implemented in Windhoek, as well as a transformational Leadership for Climate Change Planning training has also been hosted, during which decision makers in Windhoek co-developed principles of transformational leadership for climate change issues (see blog here). The Windhoek team has been involved in two city exchanges to explore issues related to water and climate change, as well as measures to overcome these, one with Harare and one with Lusaka. A SOG-funded Talanoa dialogue has recently been hosted

in Windhoek, during which fundamental questions related to climate change planning were discussed, namely: where are we? Where do we want to go? How do we get there? These questions were discussed by Namibian National Climate Change Committee, national and local representatives, as well as representatives from the World Food Programme, the Development Bank of Namibia, and the University of Namibia.

Annex D: List of commitments from FRACTAL team members (until June 2019)

February	March	April	May	June	Oct
Distillation working paper	Windhoek TL workshop 4-8 march	Receptivity co-exploration decision makers paper	Maputu LL 4 (final)	ZMD, INAM, DCCMS training	FCFA - African climate risk conference
Windhoek SOG energy	Windhoek decision making briefs and video (AMP + CADO)	Day zero Hakuna Mati exercise (maputo)	Maputo SOG report	Windhoek LL (last)	
Psychological distance paper	FRACTAL presentation to new mayor (Maputo)	Local 5-day writeshop (city?)	Windhoek to maputo LL	FCFA co-production synthesis product	
Innovation fund outputs (city)	Strat planning for CC training in durban for urban planners	ER paper	Dissemination of START project findings	Blantyre SOG report + policy brief	
Embedded researcher video	Finish the SOG paper	Learning lab in Blantyre	Water and climate change gov in 3 cities working papers	Receptivity journal article	
Narratives paper submission	SOG report due: ICLEI	Windhoek + LA "bring and braai"	Draft plan for scaling up and enabling city to city learning going forwards	Research submission to journal	
	Learning lab in Harare	Windhoek city youth climate change	DFID reporting	Content analysis (paper, blog, other sharing?)	
	Showcase climate cluster outputs/ outcomes to CMIP6 workshop	Narrative paper (gabs, Harare, Blantyre)	Lusaka/Zambia extremes paper		
	Lusaka strategic plan DM case	Distillation paper	Urban caucus	Windhoek writeshop	
	WMARS DM case	Working paper on the interface of academia and practitioners in Lusaka	Urban IWRM training for decision makers	Windhoek impact story submitted	
	Spectral nudging paper 30 march - CSIR	Co-co-trans paper	8km resolution outputs - CSIR	comms/infographic on the narrative process (ICLEI)	
		LL working paper	Energy SOG report Windhoek	Day zero paper – (CSIR)	
		City distillation stories	FRACTAL research conference?	Resilient cities (BONN)	

February	March	April	May	June	Oct
		Case study of DS application in Lusaka and touching base with GIZ for the Lusaka WSIAP		Learning output	
		UJAMS governance paper		Distillation platform	
				FCFA annual review (round 2)	
				FRACTAL impact case studies	
				complete draft process sent to the relevant IPCC chapters	