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RAPPORTEURSHIPS "FACING CLIMATE CHANGE"

"DAY ZERO. LEARNING FROM CAPE'S TOWN WATER CRISIS?"

SESSION WITH **KEVIN WINTER.**

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Day Zero. Learning from Cape Town's water crisis?

Invited Speaker: Dr. Kevin Winter. University of Cape Town, South Africa

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This report is a synthesis of the debate carried out with Dr. Kevin Winter in the conference series “Facing climate change” organised by Catalunya Europa Foundation in the context of the Re-City project. This session, entitled "*Day Zero. Learning from Cape Town’s water crisis?*" consisted of a public lecture, a seminar with participants from the academic sector of Catalonia and a lunch-debate that brought together personalities from the economic, social, political and business sector of Catalonia. The mentioned activities were held in Barcelona at the Antoni Tàpies Foundation on October 2018. The content order along the report is thematic and does not represent the order in which it was exposed by Kevin Winter. The conference series “Facing climate change” is developed in collaboration with BBVA, Generalitat de Catalunya, Àrea Metropolitana de Barcelona and Barcelona City Council.

Biography

Kevin Winter is a senior lecturer in the Environmental & Geographical Science Department (ENGEO) at the University of Cape Town since 2013 and principal researcher at the Urban Water Management Research Group of the ENGEO since 2004. Winter completed his Bachelor of Arts and obtained his Higher Diploma in Education in Cape Town. Later, he completed his Master of Arts in London. Finally, he obtained his PhD in Water Resources working at Future Water Research Institute, University of Cape Town, South Africa.

Urban Water Management Research Group aims to contribute to the transformation of South African settlements by finding innovative ways of mitigating water scarcity, improving water quality and thereby protecting ecosystems. This would be achieved through the development of water sensitive urban areas that are sustainable, resilient and adaptable to change, while simultaneously being a place where people want to live. Winter is also participating in the Liesbeek River Life Project, which is being carried out with a collaborative effort between the Friends of the Liesbeek (a non-governmental organization) and the UCT's Urban Water Management Research Unit. The main goal of this project is to contribute to plans and designs for restoring and offering better support to social and ecological life of the Liesbeek River.

Two of the most relevant papers he has written or collaborated in are "Water Research Paradigm Shifts in South Africa" (Siebrits *et al.*, 2014) and "A Gap Analysis of the South African Innovation System for Water" (Rose & Winter, 2015). In both papers, he analyses the South African system of innovation for water and subsequent paradigm shifts within water research to face the drought induced by climate change. Moreover, Winter has also collaborated in many scientific reports and book chapters about water management.

Day Zero. Learning from Cape Town's water crisis?

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Summary

"A city without water would be an unprecedented disaster." This was how forceful was **Kevin Winter**, professor of Environmental Sciences at the University of Cape Town and expert in water management, at the conference he offered in Barcelona as part of the Re-City conference series **"Facing Climate Change"** organized by the **Catalunya Europa Foundation** and **BBVA.**

Kevin Winter explained his experience in Cape Town. It was the first major city in the world to face the dreaded "Day Zero" in April 22nd, the moment in which the city could run out of water as a result of several consecutive years of severe drought. Fortunately, the rains and a series of urgent measures managed to avoid the fateful day. However, the threat continues to hover over 2019 as the level of the reservoirs continues to drop. During this crisis, the **South African capital worked on several fronts to** drastically **lower the level of water consumption** to 50 litres per person per day, whereas in Spain the average was 132 litres per inhabitant per day in 2017 –a consumption considered low compared to other countries such as the United States, which exceeds 300 litres per person per day. In fact, thanks to a conscious population, in just five weeks Cape Town managed to go from a daily consumption of 700 million litres to 500 million. Simultaneously, they also invested in improving infrastructure, as a percentage of water leaks of 14% was detected.

According to Winter, cities that are sensitive to the use of water must be encouraged. One of the initiatives carried out in Cape Town has been the construction of channels that take advantage of rainwater and create green areas that favour the appearance of new species that until then they never had been part of the city. Furthermore, they promote the creation of urban gardens that improve neighbourhood coexistence. According to professor Kevin Winter, "the social benefits of building this channel have surpassed those of all behavioural programs that had been attempted in Cape Town."

Climate change is real –we have experienced it, and we need to adapt more quickly. Cities, together with citizens, social media and partnerships between the public and private sectors, must become agents of change. We cannot expect governments to solve this issue all alone because they do not have the capacity to act so quickly in terms of climate change, as concluded by the South African professor.

Climate change is real – we need to adapt much faster

Nowadays evidences about un-precedent (and human-induced) changes in global climate have been largely supported by scientific data linking climate models and real-world data by thousands of scientific papers and IPCC reports (Intergovernmental Panel on Climate Change reports). One of the most pressing challenges induced by an exacerbating climate condition is water, particularly, fresh and rain-water availability. The southern region of Africa is moving into a much warmer and drier environment (Figure 1). As stated by Winter, this climate change will affect Cape Town and the city needs to adapt faster to it. For example, in the city the rainfall is generated by a cold front system which happens in mid-latitude cyclone (40-60º S). The high-pressure systems, called the South Atlantic Highs, are dominant, and they are forcing these cyclones to travel southwards. Therefore, during the winter rainfall period, every three to five days this cold front would arrive into the region and pass over the southern Cape and fill the city's dams. After that, the city would experience a long period of drought until next rainfall period. In this context, climate change is affecting the dominance of that system because the warming of the ocean has an influence on upper atmosphere. Consequently, Cape Town will have to adapt to frequent droughts since their return period is increasing.

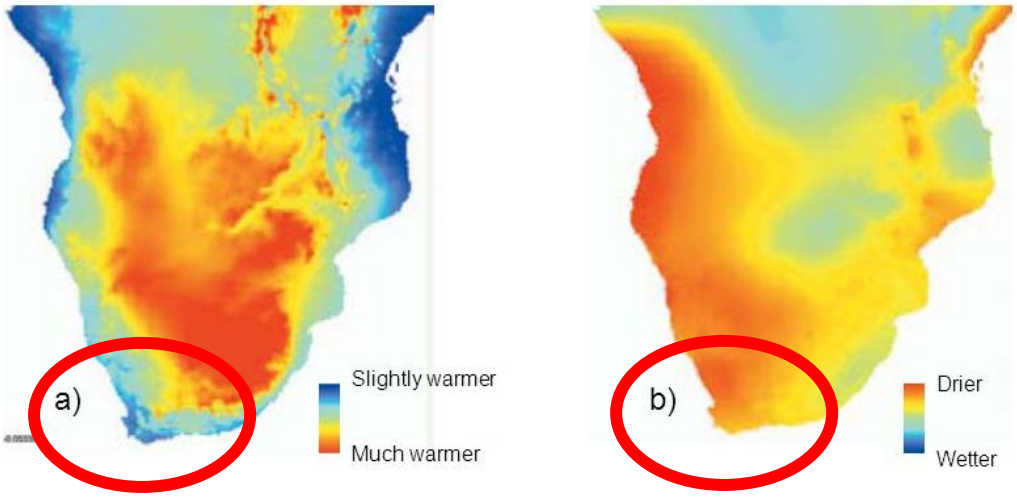

Figure 1. Projected climate change in southern Africa. HADCM3 climate model projections of changes in a) temperature and b) precipitation for 2050 relative to mean conditions over the 1961 to 1990 period, under the IPCC SRES A2 (high emissions) scenario. Extracted from: Scholes *et al.* (2004).

The technical report "The Future We Don't Want" shows the 1.5ºC scenario (i.e. a scenario in which the global average temperature is 1.5ºC above its preindustrial value), aiming to understand and disseminate key climate challenges that cities are and will be facing (Rosenzweig & Solecki, 2018). Winter believes that this report shows a very undesirable situation, mentioning that by 2050 1.6 billion people would be regularly exposed to extreme temperatures; more than 800 million people in 570 cities would be vulnerable to sea level rise and coastal flooding; 2.5 billion people would be

living in more than 1600 cities, where national food supply is threatened; and 650 million people would run the risk of declining freshwater availability.

According to these scenarios, cities will look different from those we are used nowadays. Furthermore, once an ecological and climatic threshold is surpassed, the impacts of cascade effects could exceed what we now foresee. For this reason, Winter stated that we must not surpass these "tipping points" (meaning the threshold where systems collapse provoking a cascade effect of failures) if we want to stay within the daily scenario supporting our living as we know - or it could be difficult (or impossible) to adapt or bounce back to previous states.

Avoiding the Day Zero in Cape Town?

The South African city of Cape Town was facing from 2016 to 2019 its worst drought ever. While exploring this issue, Winter mentioned that notwithstanding being in a developing country, Cape Town shares with Barcelona quite similar rainfall regimes and related climate change risks, since both cities are in Mediterranean climate regions.

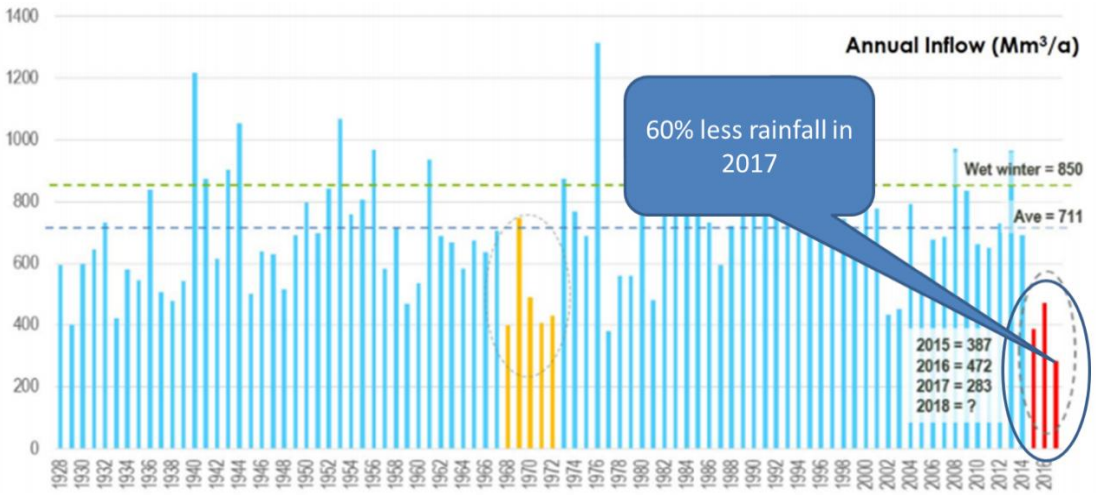

Figure 2. Annual inflow from runoff from rainfall (Mm^3/a) in Cape Town from 1928 to 2017. Extracted from: "Water Outlook 2018 Report" (DWS, 2018).

Figure 2 shows rainfall records since 1928, indicating the great variability of annual inflows. Wet and dry periods alternate in cycles. However, **climate change is causing the interval between droughts to get shorter**. In 1970, Cape Town experienced its first severe drought since 1928, which lasted 5 years. Back then, the city had a population of 1 million people to supply with freshwater. Nowadays, there are about 4 million people living in the city, so the numbers have changed massively since that first drought. Later in 2004-2005 Cape Town experienced another severe drought (although at that time the Government did not help very much to keep the water demand down

to low levels). Since 2015, there is a severe drought and the rainfall was still decreasing in 2018. This was a huge problem for Cape Town.

Considering the exposure to drought risks in the last decades, Winter claims that Cape Town has not adapted quick enough to climate change and, therefore, they have almost achieved Day Zero (defined as the day when the city's domestic taps would have run out of water). Within a Day Zero scenario, the dam water levels would be under the emergency line (less than 10%, Figure 3), meaning that most of domestic taps throughout Cape Town could be turned off, saving the last part of available fresh water for hospitals and key assets, while people would need to queue for a daily water ration of 25 litres per person that would be distributed through 200 "water collection emergency sites" planned across the city.

Figure 3 shows Cape Town's dam levels during the drought in 2017-2018. From November 2017 to February 2018, total dam storage was at the upper level of the failure zone, and it represented between 25% and 35% of the maximum storage. After that, from March to May 2018, total storage was at the upper level of the danger zone. Although the system risk was reduced, total storage of water diminished as it represented between 20% and 25% of its maximum. Since June 2018, total stored water has been well above the danger zone and thus above the failure zone as well. In October 2018, the storage of major dams was already 75% of its maximum. However, Winter stated that this value will diminish again because of the seasonal pattern of water. According to Winter, dam levels should be over 80% by October, and never be under 30%.

Winter stated that reaching Day Zero is a catastrophe that must be avoided. At the same time, he also remarked that although adaptive and responsive measures have to be taken urgently, the state of urgency should not lead to panic or to unsustainable decisions (as it partially happened in Cape Town). Luckily, the rain and a series of urgent measures managed to avoid the fateful day in Cape Town. However, the

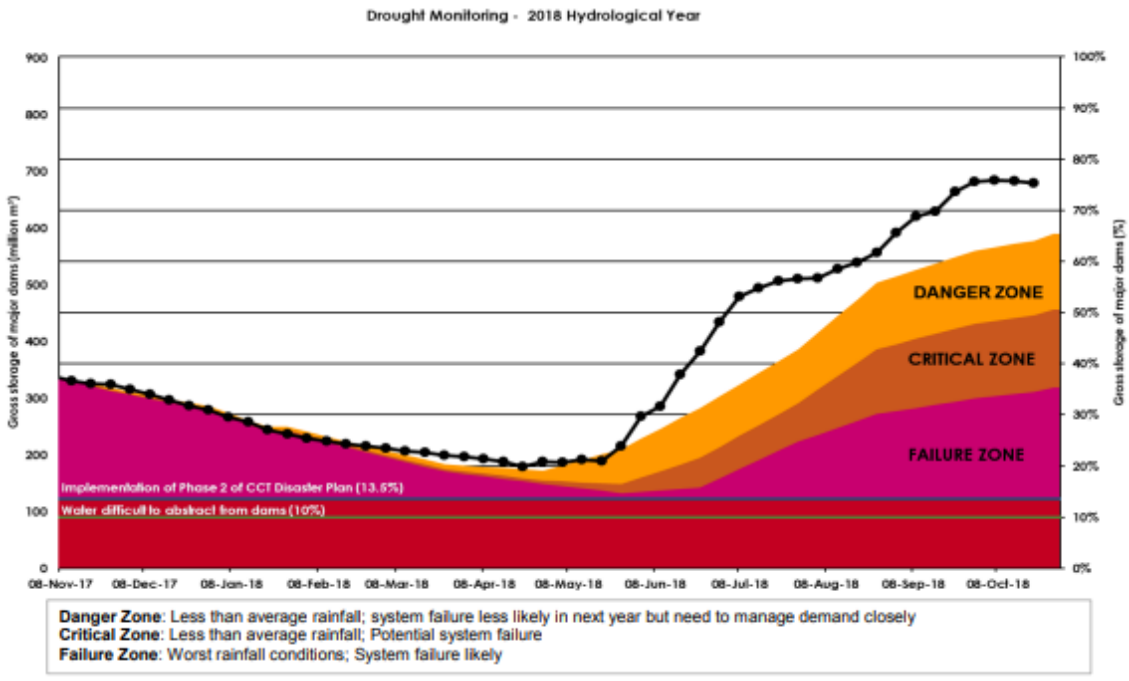

Figure 3. Western Cape Water Supply System (W[illegible]) drought monitoring from November 2017 to October 2018. This graph depicts total dam storage against potential system risk scenarios. Extracted from: "City of Cape Town: Dam Levels Report" (CCT, 2019).

vulnerability to drought remained in Cape Town as the water availability remains scarce.

Some of the unsustainable, critical and potentially counterproductive solutions to drought proposed during the emergency consisted in planning new desalination plants, a part of a set of more sustainable measures oriented in reducing the use of water, trying to get into the groundwater extraction and recycling wastewater (water re-use henceforth).

Cape Town started to work with very small desalination plants, with a capacity of 10 million litres per day, in order to understand how these infrastructures operate. They suddenly realised that obtaining high-quality water from the sea needed more attention and investment than they first thought. Furthermore, they realised that the post-treatment was very expensive, and the linkage of the desalination plant to the existing infrastructure was extremely costly as well. Winter remarked how this pilot testing was a lucky experience, since avoided to fall into the error of jumping into desalination as the main solution to drought, which would have been a fatal error because of the high economic costs associated to it, and because of capacity issues. Indeed, besides the economic costs implied in the construction and maintenance of a desalination plant, there might be negative implications for the environment. Many scientific papers have studied this situation, and from the Australian examples it has been determined that there has been an increase in the salt content along the coastal region of Perth after 50 years of desalination plant operating, demonstrating that desalination it is not based on low-impact processes. In the case of Cape Town, their pipelines go no longer than 200 metres beyond the actual shoreline, so they are near the city and coastal ecosystems. Winter valued very positively the fact that experts of the city understood the ocean currents, the mixing of warm and cold-water issues, the different pH values, and the different pollution content to diminish the ecological impacts of the desalination plants. Another negative impact of using desalination plants is the high energy cost of it, and the indirect implications about the related carbon footprint of desalt water, when non renewably-powered plants are used.

However, at the same time these concerns were raised about desalination, Winter also mentioned that it will be the only solution for the long term future but not as an emergency response, since a plant of 200 million litres per day will probably save the city from droughts, (CCT, 2017). Indeed, according to the rainfall cycle, a new wet period should come soon, so Winter remarked about the relevance of not spending too much money in short-term investments but looking to long term strategies.

A policy recommendation to align long term solution to current urban agenda, is **to plan and prevent, instead of reacting during the crises.** For example, in Perth, where water supplies have also halved during the last decades because of the reduced rainfall, the authorities planned a solution to prevent the water crisis –they invested in a wind-powered desalination plant that turn seawater into drinking water, so now 55%

of Perth's water come from renewably-powered reverse osmosis of sea water. Therefore, they could adapt to climate change while using renewable energies, and so aligning climate resilience with sustainable development strategies.

Good practices for a sustainable water management in a warming world

In this section the learnings from Cape Town experience in dealing with drought, in the light of the above mentioned "over-reacting trap" through unsustainable solutions is provided. There have been many actions, ideas and experience worth exploring, since these could be replicated and mainstreamed in other cities dealing with similar climate threats.

1. Always manage city water demand

According to the water assessment performed in Cape Town, to manage the daily water demand of the city in a sustainable way, each person should use no more than a certain defined volume per day. This control mechanism set the base also for the first and necessary drought response. In January 2015 the use of water in Cape Town was very high, over 1200 million litres per day (Figure 4), corresponding to a water consumption per capita up to 600 litres, depending on the neighbourhood. When the

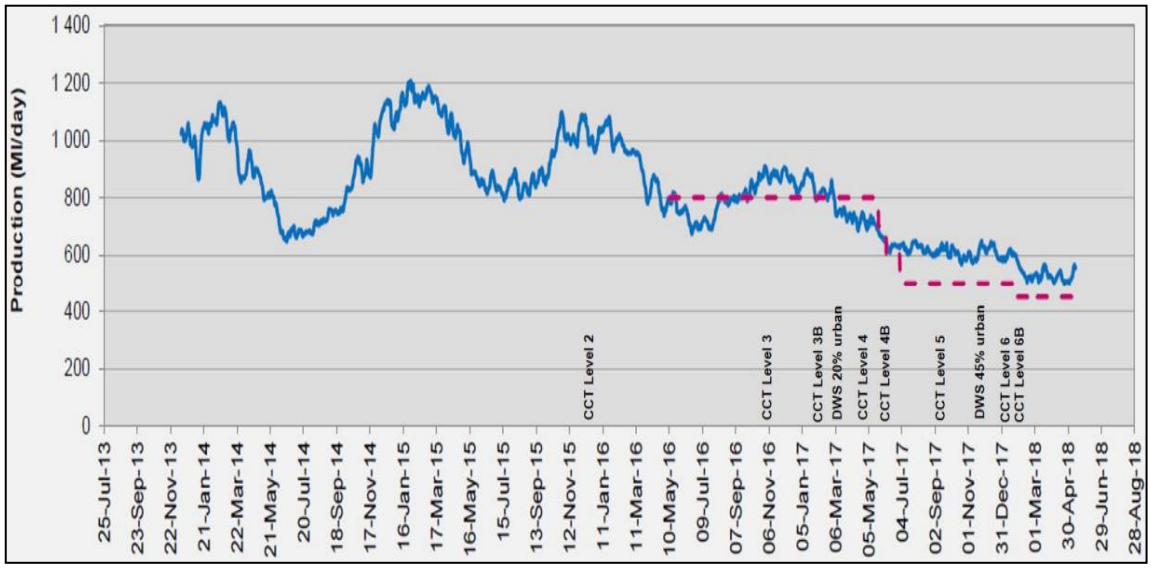

Figure 4. Water usage from large dams comprising the Western Cape Water Supply System from July 2013 to August 2018. Discontinued line indicates the target production. Retrieved from: "Water Outlook 2018 Report" (DWS, 2018).

drought hit, thanks to the control of water usage and punitive tariffs, water consumption diminished consequently every year. Nowadays, water use is over 500 million litres per day in Cape Town, representing approximately 125 litres per resident per day.

Although residential consumption of water represents 70% of total water consumption of Cape Town, water consumption in cities also involves industrial and tourism use, which should also reduce water consumption without compromising the economy**.** It is worth noting that Cape Town launched campaigns for tourists with the slogan "Save water as a local", and indeed, Winter explained that tourists do saved water, not representing a real threat for Cape Town, rather being one of the economic engines of the city. Winter stated industries can move much faster to face climate change and some proposed measures are: i) re-use water as much as possible and ii) buy water that has been previously treated.

2. You cannot manage what you do not measure

Winter believes that one of the major errors was not monitoring water usage within the city and its region. As always happens when having to manage scarce resources, it is key to assess the available stock and the consumption trends. This was one of the pending tasks for Cape Town. The most cost-effective strategy is to know how much water people are using.

One action that has been taken in Cape Town to manage better the water use **is the installation of Water Management Devices (WMDs) in households' meters.** These devices have been installed obligatorily in households that exceeded constantly 10.5 thousand litres per month. WMDs restrict household water use to 350 litres per day. If water consumption exceeds this value, the household have no running water for the next 24 hours. Poor households that also exceeded their water allocation have been also forced to accept WMDs, regardless the fact that some of these households that are officially for 4 people can be occupied by more than 20 people. However, social justice issues like this are part of the problem and need to leverage discussion and management strategies addressing urban informality and climate change.

Thanks to the water demand and consumption management program, Cape Town also detected water leaks up to 14%. Knowing this value made possible to invest in improving water infrastructures.

There are many countries and cities that pay a flat rate for water and do not have a proper control of what people are using. There is still a lot to be done in terms of technological improvements. For example, Cape Town is a metered city that is metered through an analogue system –they have two thousand people who are involved in going to the neighbourhood every month and check their meters. Winter stated that these old analogue systems have to be replaced and have to be replaced by the digital ones. There are many cities around the world, that are investing in electronic metering so that they can know at any moment the amount of water that is being used or the existence of water leaks.

3. Cities as a water catchment: a good practice for climate change adaptation and mitigation

As detailed in the Water Sensitive Cities Index (WSC, 2018), there is a gradient between water supply cities and water sensitive cities. Besides these two extreme categories, four categories have been established at intermediate levels. In this context, it has been stated that any city should shift into a water sensitive city. This change must be led by socio-political drivers. Cape Town is considered a drained city – i.e. the third level considering the water supply city as the first one– because its water is still coming mainly from the dams that collect stormwater that lies outside the city (90%) and there is a little use of the groundwater, which is unexploited, but available.

That's why Winter stated that, as part of the solution, Cape Town should be seen as a catchment, instead of taking water from catchments outside the city as the main water source**.** Furthermore, as stated by Winter, it is **more efficient to store the city's water underground as evaporation can be avoided and it does not compromise the ecology of the environment**. Winter remarked that, as cities become drier and drier, is imperative to keep water within their boundaries. He pointed out that compact cities will save the planet from the ongoing global urbanization process and ecological crises. Cape Town is growing too fast and is spreading too far into green areas. According to Winter, these features are not typical of a sustainable city as spreading too fast is inefficient. However, as stated by Koen De Ridder (see: Koen De Ridder report), spread cities have some advantages, since they have lower heat island effects. Moreover, as suggested by Peter Newman (see: Peter Newman report), a city can have a low carbon footprint and a strong local economy when energy, water and food are delivered via networked infrastructures and using localised production and consumption systems. This concept is known as the "distributed" system model.

According to Winter, sustainable **watering makes cities more liveable**. Cities must enhance and invest in disruptive innovations in water management, sanitation and supply. The use of vegetation (green infrastructures) is also relevant in cooling the city

Figure 5. The pathway installed along Liesbeek River. Extracted from: Winter (2018a).

but is sometimes limited by hard infrastructures presence or investments. One of the initiatives carried out in Cape Town for decentralizing and greening the infrastructures consists on a community-based organisation leading a project that brings water and its ecosystems into the city. This organisation is called **Friends of the Liesbeek**, named after the river that flows through Cape Town. In 2011, the Friends of the Liesbeek started encouraging reeds to grow in the cracks and crevices in a canalised section of the river. Within 5 years, the ecology of the river began to show some remarkable improvements. A diversity of bird species also increased. Further, a neighbourhood named Kudos to champions raised funds to install an attractive pathway along the Liesbeek River, and to grow a public garden and a vegetable garden within public space (Figure).

Besides, they also engaged with homeless people in the area, found out their names and stories, and encouraged a more humane approach to manage public open spaces. As stated by Winter, improving an environment by raising the level of biodiversity can have unimaginative positive impacts to human wealth as well.

If we work with the concept of the city as a catchment, then how do we ensure that the city becomes more water sensitive whereby water availability, water quality, amenity value and ecology systems together are capable of enhancing the health of the city? By developing communities with **water sensitive urban design** (WSUD). Some examples of cities as water catchments are Stockholm, Singapore, Mexico DF and Rotterdam.

Figure 6 shows some possibilities of casing and using water to support urban food security, ecological services and the ecology based on **the green district Hammarby Sjöstad, in Stockholm.** Food security is typically defined as access to food in terms of its affordability and availability. For example, urban agriculture –e.g. community gardens– can strengthen urban food security. A global economic crisis, fuel price hikes, or changes in rainfall patterns might increase the need for food security and require more space and water for urban gardens and local agriculture (Burton *et al.*, 2013). On the other hand, ecological services are any beneficial natural process arising from healthy ecosystems. Some examples of these services are the purification of water and air, the pollination of plants, and the decomposition of waste. Furthermore, the ecology of a place is the pattern of relations between organisms and their

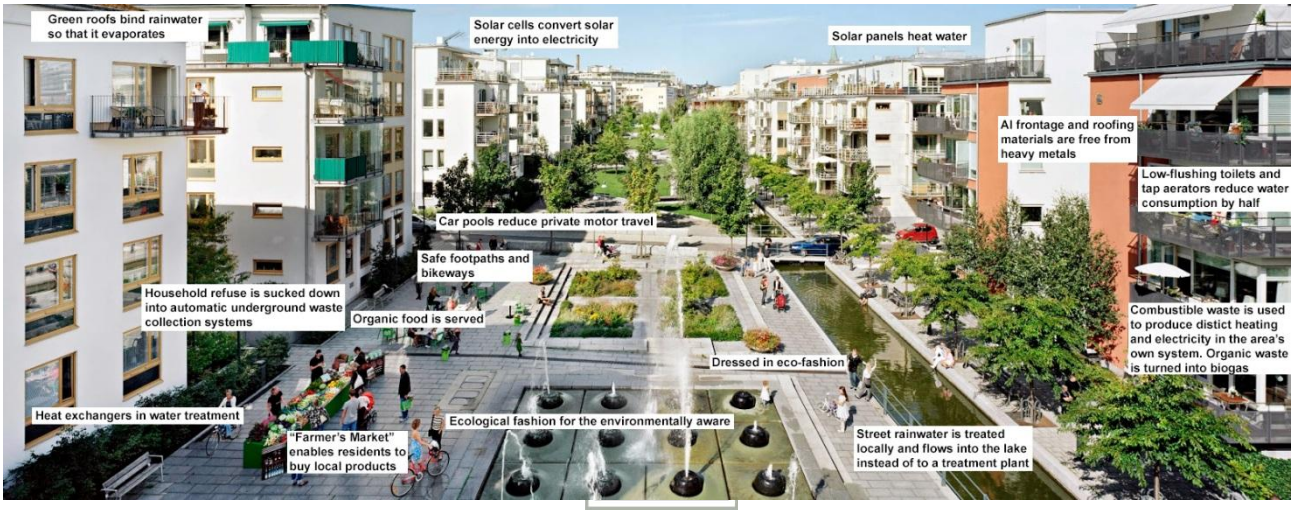

Figure 6. Stockholm's green district Hammarby Sjöstad and principles for sensitive urban water management. Extracted from: "The Story Behind Sustainable Stockholm" (Diogo, 2014).

environment.

The green district Hammarby Sjöstad was built between 1995 and 2008 on land formerly used by the port, and it was fully completed in 2018. It is widely accepted as **a best practice model for sustainable urban development.** Hammarby Sjöstad is home to 25 thousand people, with 12 thousand apartments and 20 thousand workplaces. The energy usage is around 35-40% lower than the Swedish average, and with the implementation of advanced technology (e.g. shifting from fossil to electric cars) it may sink another 20% (GLASHUSETT, 2013; NORDREGIO, 2018).

According to Winter, the health of a city is seen in its waterways. **Singapore's Public Utility Board is considered one of the most active initiatives in building water sensitive cities.** These initiatives are premised on the slogan of conserving, valuing and enjoying water. We seem to be leaving the word *enjoyment* out of much of our current and future plans. There is a lot to be said for changing the conservation of water threats and risks to one of enjoyment. Figure is a picture of Singapore showing a once canalised river with low rise housing on either side. The canal has been removed, and there is now room for the river. The accommodation has shifted to high rise apartments that overlook a beautiful garden environment. Winter believes that this transformation is truly inspirational. However, he is aware of the economic cost of this shift and the maintenance of the water system.

Figure 7. Bishan Park next to high rise apartments in Singapore before (left) and after (right) the redevelopment of Kallang River. Extracted from: "Bishan-Ang Mo Kio Park" (WIKIPEDIA, 2018) and "Bishan Park" (DREISEITL, 2012).

Furthermore, in Singapore, water coming from a treated effluent is being stored in an artificial pond in the middle of the city and citizens can use it for their enjoyment and relax as they can bathe their feet.

Another example of WSUD can be seen in Mexico City. As explained in the report "**Towards a Water Sensitive Mexico City**. Public Space as a Rain Management Strategy" (Marín Salinas *et al.*, 2016), the drainage system of Mexico City is a large-scale complex system of mixed sewerage infrastructure that collects rain water, greywater (household) and blackwater (sewage). The water is discharged into a main underground system through a series of collectors that transport all mixed wastewater outside of the urbanized valley basin. 90% of the total water used in the city is drain into sewage and the other 10% is reused. This re-used water is mainly used in public gardens and public ponds (83%), but also in industrial (10%), agricultural (5%) and

Figure 8. The Ecoduct Río de la Piedad. It was built in 2017 to fight against climate change, to improve urban landscape and to recover public spaces. Extracted from: "Ecoducto Río de la Piedad" (ECODUCTO, 2019).

commercial sectors (2%). The watering of the gardens of the city helps in cooling the city. As part of the implementation of actions to fight against climate change, improvement of urban landscape and recovery of public spaces, the Government of Mexico City built the **Ecoducto Río de la Piedad** in 2017 (Figure). According to the Government, inhabitants will benefit from the recreational area, which is also designed for the treatment of 30 thousand litres of wastewater from La Piedad River. **The process to purify the wastewater is through eight biodigesters and four artificial wetlands. With this treatment, the Government will save up to 300 thousand pesos a year, which are used to purchase treated water.** Moreover, in this space there are 4.8 thousand square meters of vegetation and 50 thousand specimens of plants, thus contributing to the reduction of 50 tons of carbon emitted into the atmosphere each year.

Finally, **Rotterdam** also developed a project to manage heavy rainfall, which is called the **Water Square** (**¡Error! No se encuentra el origen de la referencia.**). The

intervention of the Water Square offers space for the immediate and temporal storage of heavy rainfall, thus preventing the flooding in other more vulnerable areas. The technical design allows water to flow into groundwater and open waterbodies, instead of being directed into the combined sewers. This prevents local droughts, as the groundwater is kept balanced. The social design has offered the local community the opportunity to become part of the design process, providing the community with the desired program and atmosphere.

Looking to these examples Winter highlighted the importance of making water management/engineering a more strategic, more connected to planning and co-designed and co-managed with citizens. Engineering students do not want to opt for water engineering because it is not an attractive field, as there is no innovation. Disruptive innovations must be developed in water supply, re-use, management, etc. to make it a more attractive science for students and, at the same time, to enhance its innovation. Otherwise, there is no future.

4. The price of water and users' behavioural change

In a context in which drinkable water has been always provided free of charges (Cape Town experience), Winter mentioned the importance of taxing the use of water to achieve a reduction in water consumption even when the water crisis has not arrived yet or when it is already over. Furthermore, energy, water and waste are highly interlinked. An example of this is the increasingly amount of international funded projects which are developing robust studies to try to bring this link closer. Winter believes that we should start assessing and understanding better the political ecology of water and its ecological footprint. Water generation and water transport costs should be estimated and integrated in the water price. At the same time, an unfair tax increase can represent a big problem for the population with less incomes which is already struggling to pay for water. Winter believes that subsides and incentives can be useful governance tools to achieve this goal. He stated that water is a human right and in South Africa it has a key impact influence on health, productivity and on supporting livelihoods. Therefore, the population of Cape Town living with less than 2 dollars per day has free access to water.

Even if framed through punitive tariffs, the city needs water to be enjoyable, so we should not give up on greening the city because of water getting very expensive. **Indeed, Winter stated that while a climate resilient strategy must have the cooling of the city among its targets, this can be reached through green infrastructure and a sustainable use of water.**

Global warming is going to affect our cities more or less intensively depending on the measures we will take. For this reason, **we need a behavioural change**. One example can be found in the case of water tanks and fountains. Many people believe that these types of water storage are not a good option because they will allow mosquito

outbreaks and the consequent vector-borne diseases. However, Winter believes that the right solution is not to take off the water, but to take measures in order to avoid these outbreaks while keeping a sustainable water cycle within the city.

Another example of potential improvement is the use of plastic and bottled water, which many cities are trying to reduce. Bottled water is a detrimental option for sustainability because plastic is needed to build the bottle and many trucks are required to transport all the bottles from the source to the cities. To reduce our ecological footprint, Winter defended the use of tap water instead of the bottled one. He remarked that sometimes the quality of water does not depend on the source, but on the pipelines. Thus, water's quality can suffer a decrease during its transport. For this reason, in many parts of the world people install purifying systems at home-scale level (i.e. US among others are great buyers of this option).

5. Cities have to lead, governments will follow: How to empower the local level

In South Africa, governments were under great restrictions and could not react quickly to any emergency, including the recent drought. On the other hand (probably also induced by knowing the limitation of state measures) citizens reacted with panic and adapted through individual-survival measures. For this reason, Winter called for more coordinated and sustainable actions when facing adaptation.

Winter pointed out that Cape Town aims to be a leader in urban water management in South Africa, and in order to achieve this goal, social and institutional competencies are being built in the city, as well as technical competencies. Winter remarked that there is a national framework to act but he is convinced that cities must take the lead in water management, ahead of the national regulatory frameworks, because at **local level cities have a greater knowledge and control over local socio-physical constraints, participation practices and local concerns.** He argued that **climate change is acting very fast and political changes at national level are too slow. Hence, in certain circumstances and topics, cities have to lead the transformation, and the governments will follow** them adapting legislation accordingly.

Among the key steps helping the city in framing better responses to drought, Winter stated that it was and still is very important for Cape Town to be a member of the "**100 Resilient Cities**" network (100RC Network, 2019). 100RC was created by the Rockefeller Foundation on its Centennial in 2013. They began working with their first group of 32 cities in December 2013. In 2014, they received 330 applications from 94 countries for their second cohort, and they announced the 35 cities of round 2 in December – among these 35 cities, there was Cape Town and Barcelona. By participating in the program, the cities obtain access to tools, finance, technical assistance and other resources to build urban resilience to a total value of 1 million dollars, which the Rockefeller Foundation provides for each city member. 100RC and

other city networks are important because they allow to **share experiences and information with other cities.**

Winter also positively valued **the use of resilience indexes** not to compare to other cities, but **to analyse and think about our own cities, and empower them**. Winter pointed out the efforts that the group Arup is making in building water resilient cities. Arup is an independent firm of designers, planners, engineers, consultants and technical specialists, working across every aspect of today's-built environment. The report written by this group, called **"Water Resilience for Cities"** (ARUP, 2011) presents a high-level approach to urban water management and practical case studies for mayors and city administrations to consider, as they put climate change adaptation policies into action. Besides this report, **Arup have also developed the "City Resilience Index: Understanding and Measuring City Resilience"** (ARUP, 2016) to help cities understand and measure their capacity to endure, adapt and transform. The outcome of the resilience analysis is a chart of indicators divided in four categories:

- Leadership and Strategy.
- Health and Wellbeing.
- Economy and Society.
- Infrastructure and Ecosystems.

Another index that Winter believes should be considered in order to empower cities to assess their status, and frame their policy in order to lead the change, is the **Water Sensitive Cities Index** (WSC Index, 2018). It differs from the City Resilience Index in that it considers a particular topic and not a wide range of themes. The WSC Index is a tool designed to benchmark a city's current performance against seven goals of a water sensitive city. These include both biophysical and socio-institutional goals, which organised 34 corresponding indicators. Each of the 34 indicators are scored on a 1-5 rating scale in a collaborative workshop process. The data is then entered into a web-based platform that can filter the results according to what is most useful for the user.

In order to lead the change, Winter believes that **beyond assessments and indicators, cities need the private sector to be willing to collaborate through public-private partnerships.** In the challenge of water management, there is a need of private support to be able to shift into new methods and technological innovations, since governments are slow in dealing with paradigm shifts. Many advances and investments in water management have already been made by private businesses, and these must keep improving in order to be less dependent on water. For instance, they should change their technologies to reduce or even avoid the use of water in factories or use less amount of water per kilogram produced in crops. In other words, Winter thinks that water management should be based on socio-technical solutions too.

From one side, private sector is key to enable the change. From the other side, there is a political debate around how to involve it without promoting potential social inequalities. According to Winter, European countries have a better ability to build and

manage public-private partnerships. However, South Africa is a country with developmental inequalities and high levels of poverty, and because of this people are worried about private sector involvement in water as it could imply an increase in the cost of water. Moreover, public-private partnerships usually can exclude stakeholders and people's voice. **Winter wants to see cities leading the change through a greater connection not only between private and public sector, but also with the community involvement.**

A good example of this in Cape Town is represented by **the Franschhoek Water Hub,** an exciting new project which Winter believes that will inspire a new generation of leaders in water management in the context of rapid urbanisation and limited financial resources. Through collaboration with government, research institutions and industry, The Water Hub wants to promote more liveable cities and towns, healthier rivers and wetlands and increased food security. The Water Hub is a building located at an abandoned water treatment facility in Franschhoek that aims to explore new options for the treatment of contaminated water, including the use of natural systems and bioprocesses. Here, people also determine what kind of data is available and what researchers can do with it. This is a good option for researchers because they do not have to collect new data –instead, they can use already existing data, thus accelerating the process.

While there are other similar projects around the globe, this will be the first of its kind to demonstrate state-of-the-art techniques and technologies suitable for the African context. **According to Winter, this is a good example of how a crisis can turn into an opportunity.** Moreover, the hub is a good example about data accessibility, demonstrating that researchers and governments should open their data and information about water storage and consumption to public access. This would improve not only research and the design of new actions, but also to improve people's habits and accountability, building trust and confidence. For this purpose, the model of data and information displayed should be easy to understand because it will be addressed to all kinds of people, not only scientists –e.g. journalists, social media, etc. Another example of opening data to society is how Cape Town is sharing its information about weekly dam water levels on the website: "Dam Levels" (DWS, 2019).

Finally, besides technological improvements and innovations, broader social implication is needed in order to empower the local level. Winter believes that one of the reasons why Cape Town did not learn from past droughts is because social media was not particularly active at the time of the first two severe droughts (1928-1933 and 2004-2005; see: Figure 2). For instance, in January 15th 2018, the magazine TIME published a report that stated that Cape Town was 90 days away from running out of water (Baker, 2018). People panicked and water consumption markedly diminished. This case shows that media has a lot of influence, so Winter believes that **media should show very frequently how the situation is going on and act in a positive way, rather than alarming, over climate change.**

What Barcelona can learn from all this?

Based on his experience in Cape Town, Winter perceived that notwithstanding Barcelona is a city of the global north, with technologically advanced infrastructures and monitoring systems, there could be lessons to be learned from the governance perspective, about how to adapt climate crises.

Barcelona is a city of around 1.6 million inhabitants and is the central core of the Metropolitan Area of Barcelona (AMB), which in 2012 had around 656 km^2 and 3.2 million inhabitants (AMB, 2012). AMB is located in a naturally water- stressed area. Several consecutive years of severe drought indeed triggered an unprecedented water crisis in 2008. Ahead of the summer season, the city's reservoirs were only 25% full. This situation caused public awareness campaigns and drastic cuts in Barcelona's water consumption, that nowadays is around 110 litres (average) of water per capita per day. Monitoring water consumption is not an issue in Barcelona as it was in Cape Town since, in the metropolitan area of Barcelona, many municipalities are currently enjoying the advantages of the electronic metering.

Through the Cape Town experience, Barcelona learnt that water-use monitoring, and diversification of the sources were among the 2 factors contributing to exacerbating the drought effects. In Barcelona, although the city gets more of its fresh water from dams built out of the city (thanks to the 2 rivers of Llobregat and Besos), a desalination plant was built during the drought experienced in 2007 and 2008. The Llobregat desalination plant was opened in 2009 and could produce up to 200Ml litres of water per day (60hm^3 per year). If working at full regime, this plant could provide water to 4.5 million people (Barcelona hosting 1.6 million inhabitants, its metropolitan area 3,2M and the whole Catalunya region beyond 7M). Although the energy consumption of this installation is 3 kWh/m^3, which is quite low thanks to the advanced technology of the desalination plant (inverse osmosis), it remains the most expensive way of getting water in Spain, among other available resources. Respect to Cape Town experience (see the section on emergency response, in which pilot desalination plants challenges are described), the Llobregat plant does not suffer from problems related to the quality of quarter in-taken, since sea water is captured 2.2 kilometres away from the coast and 30 meters deep. The system's performance is 45%, which means that for each 100 litres of seawater captured, 45 are converted into potable water and 55 are returned to the sea. In order to avoid the environmental impact of brine, discarded water is mixed with fresh water resulting from the nearby sewage plant, so that the water returned to the see has a similar salinity to that of the sea (AMB, 2011). Since it is too costly to stop the plant and re-active it during a water crisis – all the inverse osmosis membrane would need to be changed if not used – the plant needs to work even if there is no need of its water.

There have been lots of critical reactions from the civil society when the desalination plant was built, since the drought hit the city just before the worst economic crisis in

Europe. The huge cost of the plan (notwithstanding co-funded for its 80% by Europe) and the cost of its maintenance (it must be kept active at a minimum regime) contributed to people claiming that during economic crisis the budget for public education, health and social aid were cut dramatically, but at the same time money was invested in such an expensive infrastructure, which is considered from experts as a potential "lock-in". In the case of Cape Town, the pilot testing of desalt plants demonstrated their un-sustainability.

However, back to the diversification of water sources, if from one side Cape Town needed to explore desalination technology because they have no other sources of water, Barcelona is already using ground water (low quality) to gardening and cleaning the city. Furthermore, in a near future it is going to use more groundwater together with re-used water coming from the domestic sewage for environmental, industrial and agricultural activities (and also for diminishing salt-water intrusion, by pumping it into the ground and reinforce the aquifer barrier to sea water intrusion).

Nevertheless, **investing in water reuse could be better than investing in new supply schemes** that might be very expensive, like in groundwater abstraction.

Winter believes that new water supply schemes are also needed to prevent the consequences on the ecology of our rivers. That is why he believes that hydrological plans are needed in Spain to regulate water at the basin level.

In Spain, there are 25 river basin districts –including freshwater, transitional and coastal water (See: "*Demarcaciones Hidrográficas*" (MITECO, 2007), which are managed using a continuous adaptive process based on the monitoring of the current hydrological plan of each district.

The hydrological planning of the Catalunya's river basin district is integrated by the plan *Pla de Gestió del Districte de Conca Fluvial de Catalunya* (PGDCFC, in English: Management Plan of the Catalunya's River Basin District) and its *Programa de mesures* (in English: Action Program, ACA, 2009).

Although a good water management has been achieved in Catalonia, there are still some issues to be resolved, such as the water consumption of agriculture and the pollution of water. Ecosystem services must be considered as human and ecosystem goods. Therefore, it is very important to invest in and preserve ecosystem services because they are under human responsibility. Winter highlighted the case of the agricultural sector, as it has a very large water use. Farmers should not get cheaper or free water in order to protect their businesses because it would compromise water storage of the city, as they both share the same dams. Furthermore, respect to the city, agriculture could adapt quicker to climate change and droughts as farmers can use groundwater even constructing their own wells, or little dams for water consumption. Indeed, farmers are becoming increasingly efficient technologically

because they are aware of the cost of energy involved in bringing water and irrigating the crops.

In Spain there are increasing practices for improving the efficiency of water use in agriculture. A decade ago in Murcia and Alicante, farmers started letting fresh water flow into cities, where water was used, filtered and given back to farmers in summer, when the touristic season is high, and a lot of fresh water is required. Barcelona needs to push further on this, especially regarding pollution of water coming from agriculture.

Respect to the governance of water, and in general about climate and city resilience, Winter strongly supported Barcelona in running the **Department of Urban Resilience within the City Council**. This Department, launched in 2015, allows the city to be really engaged with international programs. The document **"Barcelona: Building a Resilient City"** (AjBCN, 2017), written by this Department, contains all the information about Barcelona and its current resilience model and strategy. Among other city resilience related actions, the City Council also released the document **"*Pla CLIMA*"** (AjBCN, 2018), preparing Barcelona to meet the Paris Agreement (UNFCCC, 2015) in 2030. Winter believes that this political and institutional framing of the agenda makes the decision-making processes more powerful.

To sum up, In Catalonia there should be a proper debate about sustainable and resilient water management. A brainstorm about disrupting innovations is required in order to find the adequate management strategy. However, it is not only needed an agreement between the national and local governments, but also with the private sector and the community, aligned with the key value of the ecosystem at local and regional levels. An example about unsustainable water management strategy, which was a reaction to the drought, was the water transfer from the French Roine River to Llobregat or Besòs Rivers. Or a pipe bringing river water to Barcelona from the Spanish Ebro river. However, these ideas were sanctioned from the European Commission in the light of the Water Framework Directive, which is calling for a sustainable and water basin driven management of water, and thus discarded. Other more sustainable strategies have been put forward in the last years, as for example:

- The construction or rehabilitation of emergency wells in several Catalan urban areas. This was managed by *Agència Catalana de l'Aigua* (in English: Catalan Agency of Water; Ribas Palom and Saurí Pujol, 2009).
- The improvement of water mains.
- The rehabilitation of water channels.
- The construction of desalination plants.

One of the big barriers for sustainable and socially inclusive water management in Barcelona are the data availability and its transparency and accountability. Electric and water companies are indeed not forced to give information (and by law these company can refuse to provide data even to the municipalities). Hence, **it is difficult to get**

specific data about energy and water consumption because companies do not perform long-term analysis, and therefore they claim to not store large amounts of data. This problem is due to the fact that energy and water are public services operated by private companies. As data is difficult to obtain, Barcelona City Council is measuring water re-use, acoustic contamination, and other variables.

Contrary to Cape Town, Barcelona raised the cost of water in 2009, acting as a successful measure to reduce water consumption and maintaining it low even after the crisis.

In Catalonia, water related taxes have allowed the Government to invest in a good network of pipelines and infrastructure in the long term. Nowadays, Barcelona and its metropolitan region are more prepared for the next drought, needing to address its governance approach to be less focused on public private partnerships, and more on decentralized and inclusive perspectives. One of the last insights from Cape Town has been the Liesbeek river project (Figure 5), through which people were involved in the management of the river paths and ecosystem. This would be a paradigm shift of people being increasingly considered prosumer, rather than consumer, even regarding public spaces and urban ecosystems. This would allow a truly integrated and sustainable management of the city and its resources, through a needed behavioural change.

The role of Catalunya Europa Fundation in Barcelona's transformation

According to Winter, decision-making is key since it has to deal with economy, people's life, standard of living and political impacts. As any other frontrunner city, learning from its own and other's experiences, Barcelona needs to get decision makers informed through reliable (and hopefully open) data, showing empirical evidences and good practices about how to deal with shocks and stresses. New indicators should be proposed. Avoiding measuring only what we already know and understanding how different indicators relate to each other is key to understand how our complex systems (cities) evolve. During the last two years, scholars, city practitioners and political officials have been meeting in Cape Town to discuss about the challenges they are facing in the city, in terms of water management. This is similar to what *Catalunya Europa Fundation* is doing through the Re-City project, and according to Winter this is an innovative way of addressing complex problems we are facing, interrelating climate, economy and society. The role of research and researchers should not be underestimated, since are key in providing data and evidences through platforms that discuss how actions and strategies should be taken.

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