
COMPARING CLIMATE STRATEGIES ON WATER MANAGEMENT

HOW DO DIFFERENT CITIES DEAL WITH DROUGHTS,
FLOODS, AND COASTAL WATER ISSUES IN THEIR
CLIMATE STRATEGIES?

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ABSTRACT

Cities are growing at a rapid rate and climate change is affecting them, which makes that they are facing major water management challenges. Therefore, the following question is asked in this paper: “How does sustainable water management relate to the development of urban strategies, what are the difference and similarities in this for Cape Town, Los Angeles, Barcelona, and Sydney with regards to their climate strategies and what can they learn from each other?” In water management the main focus is on adaptation and the environmental aspect of sustainability. Therefore, these indicators will be studied, together with the issues that the cities focus on. The cities are compared by looking at their climate strategies. All of the compared cities have a main focus on adaptation and that public participation is equally mentioned, but there is a difference in the policies on mitigation. Sydney and Los Angeles can implement carbon sinks as mitigation policy. Environmental sustainability is the most focused on and most cities also have a large focus on the economic aspect of sustainability. The focus on social sustainability should grow in all the cities to make sure that everyone has equal water challenges. Los Angeles and Sydney should improve the most by looking more at the water quality. All cities have a main focus on the issue of droughts, but it is important for the cities to combine it with floods. Cape Town also needs to start to look at their coastal plan with urgency. Overall, there is a good basis in sustainable urban water management to be found, yet the cities can still learn from each other and there should be more focus on mitigation, social sustainability, and coastal issues.

Key Words: Climate Change – Urban Strategies – Sustainability – Water Management – Cape Town – Los Angeles – Barcelona – Sydney

TABLE OF CONTENTS

ABSTRACT	1
INTRODUCTION	3
THEORETICAL FRAMEWORK	4
CONCEPTUAL MODEL	5
HYPOTHESES	6
METHODOLOGY	6
RESULTS	8
CAPE TOWN	8
LOS ANGELES	10
BARCELONA	12
SYDNEY	14
COMPARISON	16
KIND OF POLICY/MEASURE	16
KIND OF SUSTAINABILITY	17
ISSUE FOCUS	18
CONCLUSION	19
REFERENCES	21
APPENDICES	25
APENDIX 1 – RAW DATA CITIES	25
APENDIX 2 – COMPARISON OF THE RAW DATA	29

INTRODUCTION

Around half the pollution is living in cities, while they only take up 2.8% of the global land area (Dodman et al., 2031). The populations of cities are still growing which makes for major water management challenges (Yang et al., 2016). This has to do with the fact that the urban areas have a lot of water usage. Next to this, climate change is increasing these water management challenges as it will increase extremes, as droughts and floods (Jalota et al., 2018). Next to this, the coastal cities also have to deal with the rising sea level due to climate change. Urban sustainable water management is largely focused on the constraint of the resource and climate change (Bell, 2020).

These densely populated cities create problems, but also opportunities. The urban centres give opportunities for sustainability as it is seen that the countries that have the most sustainable economic growth are also the ones that are the most urbanised (Dodman et al., 2013). The reason that the cities provide this drive in sustainability is due to the opportunities for different social and cultural activities, and the fact that a lot of innovations in science, technology and education take place here. The actions that are taken in the urban areas do not only affect the urban areas, but they also have implications for the rest of the world.

The fact that cities are facing these major water challenges, while they are also the centres for sustainable development, makes that it is useful to study their strategies. Cities have major differences between each other in for example institutional structure and economic development, which influences their policies (Wolman, 2019). This makes that cities develop different policies and have a lot to learn from each other. Due to the rising issues in water management, it is also found that more comparative research is needed on this topic (Wescoat, 2009). The selected cities have not yet been compared and this study will therefore add to the knowledge on sustainable water management and what the cities can learn from each other.

The main question of the research will be:

“How does sustainable water management relate to the development of urban strategies, what are the difference and similarities in this for Cape Town, Los Angeles, Barcelona, and Sydney with regards to their climate strategies and what can they learn from each other?”

The sub-questions that will be answered in the research are:

1. What does sustainable water management mean for making urban strategies in cities?
2. How is it possible to compare the different climate strategies on sustainable water management?
3. What are the sustainable water management climate strategies from the compared cities?
4. Where do they differ from each other and on what points are they the same?
5. What can the compared cities learn from each other?

The thesis will first study the theoretical framework that comes with the research question which will explain all the concepts and is followed by a conceptual model. After this, there a hypothesis will be given, and the methodology will be explained. Then, all four cities will be investigated and then compared using a content analysis. This comparison will lead to the conclusion of this report.

THEORETICAL FRAMEWORK

Firstly, it is important to define the concept of sustainable water management. Sustainable water management will be explained as water that is managed in such a way that it satisfies the changing demand, both human and environmental, now but also in the future (Pearson et al., 2007). This has to be done while maintaining the ecological and environmental integrity the water has or should have.

Sustainable water management is integrated into sustainable urban strategies. These strategies are developed to create cities that are beautiful, healthy, and ecological satisfying (Leyzerova et al., 2016). The strategies should be achieved by the officials, but also by the residents of the city. The strategies are there to ensure a better quality of life. They are focused on finding a balance between the natural environment and the city itself. With sustainable urban strategies, it is important to turn a part of developed land back to its natural state as this will get rid of the human-created pollution in that area. The changing of this land can not only be done while looking at the environment, but it also should study the economic and social aspects that come with it. Sustainable water management is currently focused on the constraining of the resource and climate change (Bell, 2020), but this should also be done in a sustainable urban way. This means that cities should improve while also managing the water.

The kind of policies that the cities use in these strategies is relevant. The main kind of climate policies are mitigation, adaptation, and public participation (Jiang et al., 2020). In sustainable water management, the focus is primarily on adaptation (Mata & Budhooram, 2007). There is also some focus on public participation, but the focus on mitigation is restricted. This makes that the indicator is interesting to study. Mata & Budhooram (2007) define the different kinds of policies. Climate mitigation is about reducing greenhouse gas emissions, examples of mitigation in water management are the usage of hydropower and the reduction of energy in irrigation systems. Climate adaptation is about adjusting the facility and environment to avoid or control the negative outcomes of climate change. This can be done by plans on efficient water usage and/or by creating reservoirs. Policies that focus on public participation are about informing the public on climate change, but also on involving the people in the policies. Day Zero is a good example of this, as Cape Town managed to reduce its residents water usage so much that the city did not run out of water (LaVanchy et al., 2019). Cities must have policies of all kinds as water management has a broad focus and there are still quite some uncertainties. By having a broader focus, the urban strategies will become broader and uncertainties have to be taken into account in these strategies.

Sustainability is defined by multiple aspects, the social, the economic and the environmental aspect (Klopp & Petretta, 2017; Pires et al., 2017). Planning and policy-making issues have become more and more focused on the protection of natural resources, climate change mitigation and other aspects of environmental sustainability (Finn & McCormick, 2011). This is because the environment is seen as a critical component of the larger idea of sustainability. There is an interconnection between the environmental, economic, and social aspects of sustainability. However, it is important that planning is not only focused on the environmental part but that the holistic idea of planning for sustainability is taken into account. It is relevant to see if indicators, but also plans and policies, actually include all of the aspects of sustainability (Pires et al., 2017). Pires et al. (2017) identify the different kinds of water sustainability. Social water sustainability will be defined as the access to water of a drinkable quality and the needed quantity for human needs. This means that enough water of a good quality is equally distributed among the population. It should also not harm any cultural important landmarks or hurt norms and values and the whole population should be protected against the rising issues. Economic water sustainability can be defined as the handling and efficient use of water that should promote urban and rural development. It can also be about implications that generate economic income, like fines. Environmental water sustainability will be defined as the appropriate protection of natural resources taking into account the soil, biota, and water itself. It is also about the protection and/or restoration of healthy ecosystems.

The issues that occur due to climate change in cities are mainly droughts and floods, due to a change in precipitation (Bell, 2020). Yet, a lot of cities are also located at the coast due to the great biological productivity of these areas (Goodarzi et al., 2016). The coastal areas are also very important in sustainable water management as they are vulnerable areas that are affected by social and economic conditions. All three, floods, droughts, and coastal issues, are influenced by climate change and must be considered while developing urban strategies for coastal cities (Organization for Economic Cooperation and Development, 2013).

In the creation of urban strategies, it is important that all three of the different indicators are present. This means that strategies should include different kind of policies/measures, focus on all types of sustainability, and take all the arising issues into account. Urban water management strategies have to focus on different aspects of water, such as water supply, wastewater treatment, flood protection, urban drainage, and the preservation of surface and underwater resources of a city (Jalilov et al., 2018). The strategies should also take measures on the supply and the demand aspect of water management (Dalhuisen et al., 2010). The supply side of water comes with two kinds of uncertainty that should be considered, hydrological and technical uncertainty (Shabani et al., 2020). Hydrological uncertainty is about the instability of nature, so the amount of rainfall, the frequencies, and the duration of drought periods. The technical uncertainty is about the creation of new technologies, but also about the flaws in existing technology. On the demand side of water management there are also uncertainties. These come from socioeconomic aspects, laws, and regulations. Examples of this are population growth and the usages of water per capita. Urban strategies should maintain a balance between the supply and the demand side of water.

CONCEPTUAL MODEL

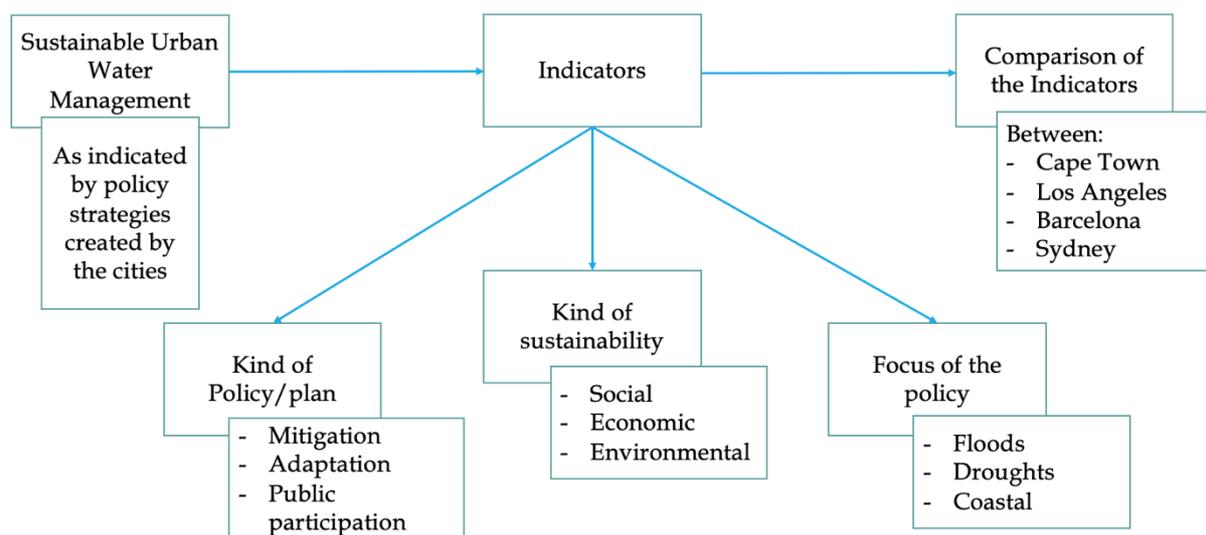


FIGURE 1 CONCEPTUAL MODEL

HYPOTHESES

The research hypothesis is that there will be some differences in the kind of policies and/or plans that the cities have. It is expected that all cities will have a main focus on adaptation, but there should be some differences in the amount of mitigation and public participation policies. It is expected that Cape Town will have a bigger focus on public participation, in comparison, as that is how they dealt with 'Day Zero'.

There should also be differences in the kind of sustainability because the cities will probably have different focuses on sustainable urban water management. Therefore, some cities will focus more on the economic aspects of sustainable urban water management where others might focus more on the social or environmental aspects. This difference in focus is important to find as, in the end, all three aspects need to be integrated to reach a good sustainable urban water management program.

Between the cities, there will also be different focuses on droughts, floods and coastal issues. It is expected that Sydney will have the largest focus on floods as they have the highest amount of precipitation.

METHODOLOGY

With the research question: "How does sustainable water management relate to the development of urban strategies, what are the difference and similarities in this for Cape Town, Los Angeles, Barcelona, and Sydney with regards to their climate strategies and what can they learn from each other?" It is important to use primary data collection from the climate strategies of the four different cities, as this provides the official climate strategies of the cities. While going through these documents carefully all spatial policies that are about sustainable water management will be copied into an excel file. In this file, every policy will be coded on all three indicators. The first indicator that they will be assessed on is the kind of policy it is. They will receive a 1, 2, or 3 on this where 1 stands for mitigation, 2 stands for adaptation, and 3 stands for public participation. The definition of the three kinds of policies is given in the theoretical framework. The second indicator that the policies/ measures will be assessed on is the kind of sustainability. For this a policy/measure will receive an A, B, and/or C, with A being social sustainability, B being economic sustainability and C being environmental sustainability. The kind of sustainability is defined as mentioned in the theoretical framework. The last indicator that will be looked at for each policy/measure is on which of the water management issues it focuses on. For this each will get an I, II, and/or III with I being floods, II being droughts and III being the coast.

The usage of coding is chosen due to the many options that it gives. By coding, it is easy to compare the cities, see if there are linkages between the codes and it gives great opportunities to generate figures. As the primary data that is used is text this is also the most logical option.

The cities are selected by looking at cities that are coastal and have drought and flood issues arising due to climate change. Of these cities it is important that the documents that are published are in a language that you can understand, in this case English or Dutch. The cities are all located on different continents and it is important that the strategies are not too old. Cape Town was chosen as this city had already battled Day Zero (LaVanchy et al., 2019) and it seemed interesting to see what their whole strategy looked like. Barcelona's climate strategy is found to be one of the best in Europe (European Union News, 2018) and was therefore chosen. Los Angeles and Sydney were chosen on respectively North America and Australia. These cities face the same issues in water management and all together they create a diverse group of cities.

The documents that will be used are all PDFs and are all written in English, they are the following:

- Five-Year Integrated Development Plan: July 2017 – June 2022
- Cape Town Resilience Strategy
- A Greater LA: Climate Action Framework
- BCN Climate Plan 2018-2030
- Adapting for Climate Change A long term strategy for the City of Sydney
- Environmental Action 2016-2021 Strategy and Action Plan

The data for Cape Town, Barcelona, and Sydney was found on the websites of the municipalities. For Los Angeles, the data was found on the website of 'a greater LA' as the creation of this policy document was outsourced by the municipality. For Los Angeles and Barcelona, there was only one strategy used each and for Cape Town and Sydney there were two strategies used to get a clear overview. By taking two documents for the other two cities the number of policies/measures are around the same and the depth of focus as well. 'A Greater LA' worked together with the municipality, which makes that all four cities have documents that are used by the municipality. Therefore, the quality of the strategies is comparable. The quality of the strategies can also be seen as good, as the strategies are actually used by the cities to improve them.

As there are no documents or other data used that contain private information there are no ethical considerations that need to be considered. The documents used are already public.

RESULTS

In this chapter, the results from all four cities will be presented following by a short comparison of the results. With all four cities, there will also be some context given about the reason that the strategy was developed or what reaction came after the strategy was released.



CAPE TOWN

Cape Town is a city on the South West coast of South-Africa and has a population of 4 million dispersed over an area of 2461 km². The city has a Mediterranean climate with an average temperature of 17°C and 213.4 mm of precipitation per year.

Climate change will affect the city in the following ways (City of Cape Town, 2017):

- Decrease in annual average rainfall and a changed seasonality of rainfall
- An increase in mean annual temperature
- An increase in average wind and maximum wind strength
- An increase in both intensity and frequency of storms (in land and coastal)
- Rising sea level



FIGURE 2 CAPE TOWN (CREATED WITH MAPS OF ARCMAP ONLINE)

The five-year integrated development plan: July 2017 – June 2022 was published in June 2017. At this time Cape Town was suffering from the worst drought in centuries (Agence France Presse, 2017). This was the third year in a row that there was a severe drought happening in the city. Residents were only allowed to use water for essential cleaning, cooking and drinking. For essential cleaning, they asked people to shower for two minutes only and to only flush the toilet when it was really necessary. These three seasons of droughts were the reason for the climate strategy (City of Cape Town, 2017). In the same month, Cape Town was also announced the most biodiverse urban area in the world (Chambers, 2017). The city was at that point home to approximately 3000 species of plants, 361 birds and 83 mammals. The biodiversity is however in danger due to the growing population. In August 2019, the Cape Town Resilience Strategy was published, and this did not go unnoticed. This is because Cape Town is one of only 13 cities in Africa that is taking measures on climate change (Rebelo, 2020). Even though, Africa will be the continent that is facing the most chance due to climate change. Critics said that the strategy is in the right direction, but that there are some gaps when looking at the nature aspect.

When studying the results that are found in the strategies of Cape Town looking at sustainable water management, it is found (Figure 3) that there is a main focus on adaptation, which is expected. There is also quite a large focus on public participation and some policies/measures on mitigation. For the kind of sustainability (Figure 4), it is seen that the main focus here is on the environment, but economic and social sustainability are also focused on quite a lot. The issues that the city is facing in water management (Figure 5) the main focus is on droughts, but floods are also focused on a lot. There is little focus yet on coastal issues, but it is said that the city is creating a plan for this.

Cape Town

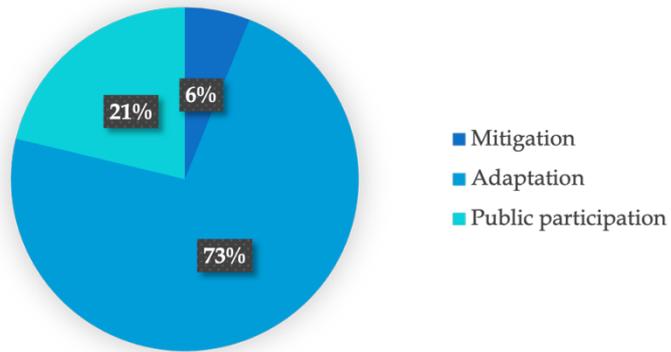


FIGURE 3 KIND OF POLICY/MEASURE CAPE TOWN

Cape Town

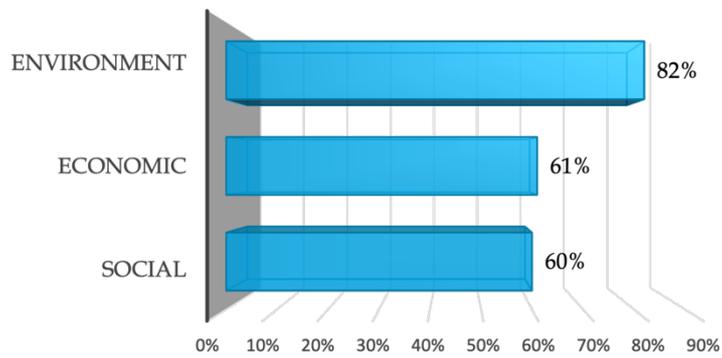


FIGURE 4 KIND OF SUSTAINABILITY CAPE TOWN

Cape Town

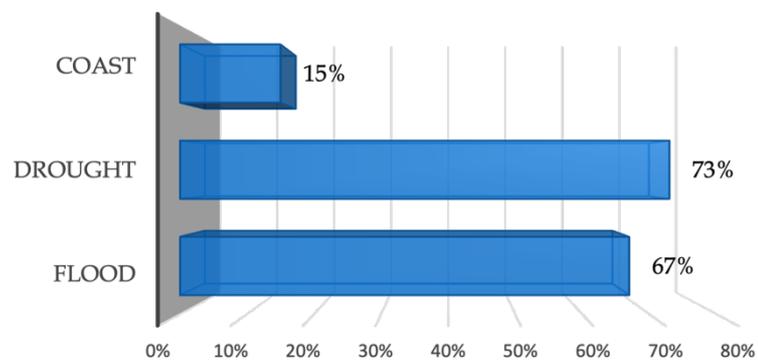


FIGURE 5 ISSUE FOCUS CAPE TOWN



LOS ANGELES

Los Angeles is a city at the South West coast of the United States of America and has a population of almost 4 million people in 2020. These people are distributed over 1302 km². The climate of Los Angeles is a Mediterranean climate, with an average temperature of 18.3°C and average precipitation of 379 mm.

Climate change will affect the city of Los Angeles in the following ways (Los Angeles Regional Collaborative for Climate Action and Sustainability & LA County Metro, 2016):

- Increase in extreme heat
- Rising sea levels
- Intense droughts and floods
- Less available drinking water

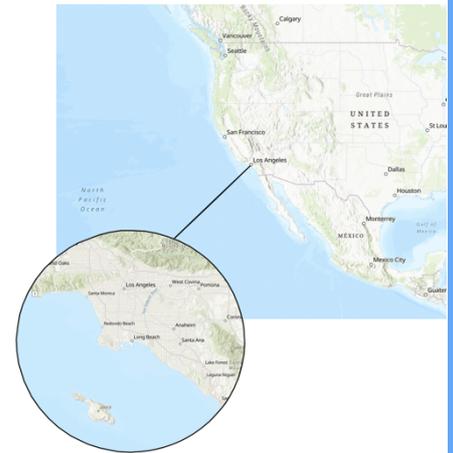


FIGURE 6 LOS ANGELES
(CREATED WITH MAPS OF
ARCMAP ONLINE)

A Greater LA climate action framework was published in December 2016, and a month before this the Bureau of Reclamations released the Los Angeles Basin Study (Targeted News Service, 2016). This study looked at the potential impacts of climate change on the basins in the area. It was mentioned that it is important for Los Angeles to look at local water supplies, as it is now heavily reliant on imported water. At this time, US companies were also trying to convince the president-elect, Trump, to not abandon the Paris Climate Agreement (The Frontrunner, 2016). In January 2017, just after the publication the US jurisdiction also published an implementation plan to meet the water quality standards (US official News, 2017). At the end of January, the state of California released that they would fight back to make sure that the climate action plans will stay in place after the president said to eliminate them (Xinhua General News Service, 2017).

When studying the results found in Los Angeles you can again see the main focus on adaptation (Figure 7). The focus on mitigation is very small here, as it is only 2% of all the policies/ measures. In Figure 8 it is seen that the focus on the environmental and the economic aspects of sustainability is equal. The focus on social sustainability is relatively lower. The main issue that the city focuses on is droughts (Figure 9). There is an equal focus on coastal issues and floods.

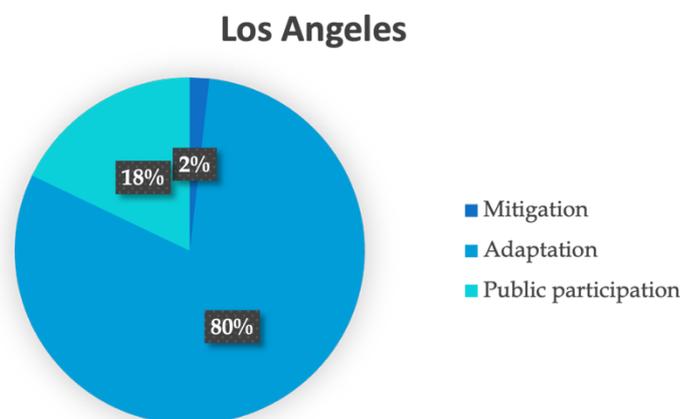


FIGURE 7 KIND OF POLICY/MEASURE LOS ANGELES

Los Angeles

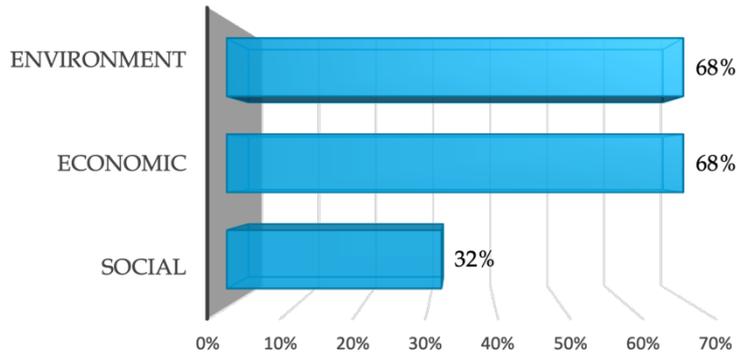


FIGURE 8 KIND OF SUSTAINABILITY LOS ANGELES

Los Angeles

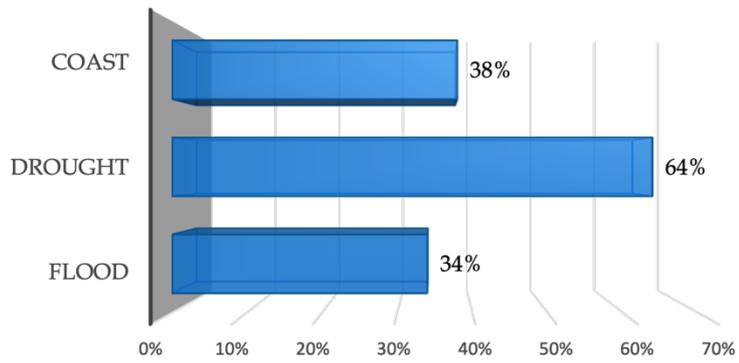


FIGURE 9 ISSUE FOCUS LOS ANGELES



BARCELONA

Barcelona is a city in the North-East of Spain located between the Mediterranean Sea and the Coastal Mountain Range. The city is very densely populated with a population of 1.6 million living in an area of 101.3 km². The climate is a Mediterranean climate with an average temperature of 17.6°C and an average of 587 mm of precipitation per year.

Climate change will affect Barcelona in the following ways (Ajuntament de Barcelona, 2018):

- A higher mortality of elderly people and children due to heat
- Due to higher temperature more disease-bearing animals will come
- More discomfort due to heat
- Emergency situations will increase due to heat waves, flooding, droughts or fires
- A scarcity of water due to droughts
- A higher energy demand due to extreme temperatures
- Disappearance of species and landscapes
- Loss of beaches

The biggest challenges of these are the rising temperatures, reduced availability of water, increased flooding, and shrinking beaches.

The BCN Climate Plan 2018-2030 was released in March 2018. In April of 2018 Barcelona hosted the climate week (Premium Official News, 2018). The climate week was about different topics related to climate action in the Mediterranean area and allowed for different actors to exchange ideas on how to tackle the challenges. In April, FC Barcelona also got a green light for building their new stadium (European Union News, 2018). The roof of the new stadium will catch rainwater which will be used to water the pitch and will use solar energy to grow the grass (Adrian Addison, 2018). This new stadium is already in line with the new climate plan. In October 2018, it was released by the European Union that Barcelona was one of the cities to receive funding for their innovative climate change solutions (States News Service, 2018). The Major of Barcelona also mentioned that one of the pillars of the climate plan is climate justice (The Bangkok Post, 2018).

When looking at the data that is found in the climate plan of Barcelona, it is again found that the main focus in the kind of policies/actions is on adaptation (Figure 11). There is however also quite some focus on mitigation and public participation. In Figure 12 it is seen that the main focus in Barcelona is on the environmental aspect of sustainability. The economic aspect of sustainability is the least focused on in this case. Barcelona mainly focuses on droughts (Figure 13), then on the coastal issues and the least on floods.



FIGURE 10 BARCELONA
(CREATED WITH MAPS OF
ARCMAP ONLINE)

Barcelona

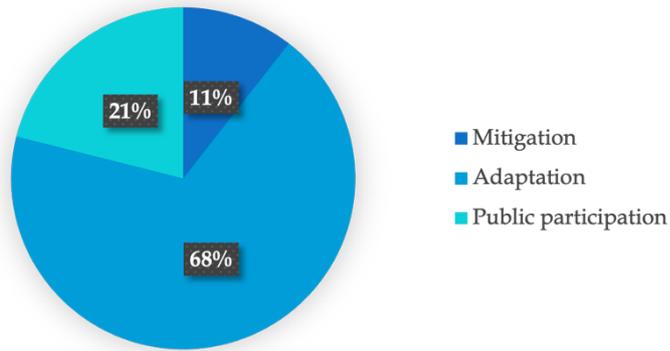


FIGURE 11 KIND OF POLICY/MEASURE BARCELONA

Barcelona

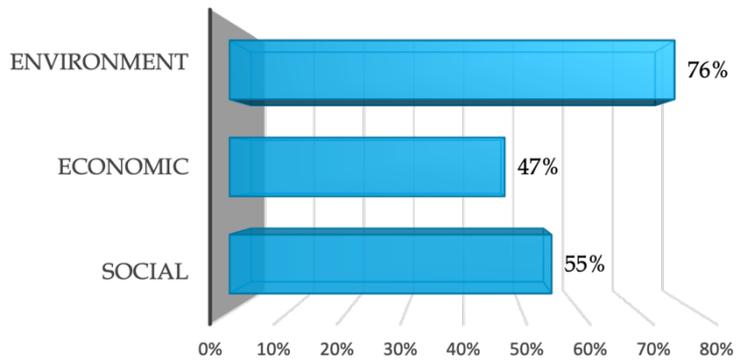


FIGURE 12 KIND OF SUSTAINABILITY BARCELONA

Barcelona

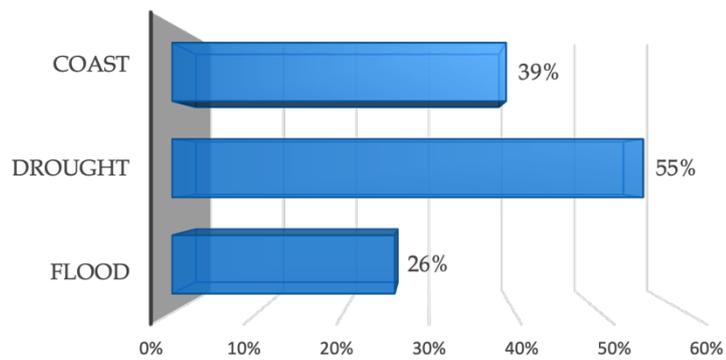


FIGURE 13 ISSUE FOCUS BARCELONA



SYDNEY

Sydney is a city at the east coast of Australia and the City of Sydney has a population of 200,000 people over an area of 25 km². The Metropolitan area of Sydney is a bit bigger with a population of 5.3 million people spread out over 12,367.7 km². The climate of Sydney is a humid subtropical climate with an average 1,147 mm of precipitation per year and a temperature of 18.5°C.

The city will be affected by climate change in the following ways (City of Sydney, 2017a):

- Increase in average temperature
- An increase in extreme heat days
- An increase in air particulates and pollution
- Increase in rainfall intensity and storm events
- Continued variability in annual rainfall
- An increase in bushfire conditions
- An increase in drought conditions
- An increase in sea level and the extent of coastal inundation

The Adapting for Climate Change, a long term strategy of the City of Sydney was published in 2017, and the Environmental Action Plan was published in March 2017. In February 2017 the hottest day was measured at 42.9°C, which was the hottest day in 35 years (Lagan, 2017). In that summer, there were hundreds of people who went to the hospital for heat-related issues. In March 2017, scientists said that the hot summer is due to climate change and that the city is not prepared for the increasing temperatures (Wahlquist, 2017). The scientists hope that the city will start to take real action against climate change as it is known what needs to be done. At this point the world was looking at the Paris Agreement, and what to do with the fact that the USA is not participating anymore (Westcott & George, 2017). In March Sydney also participated in Earth Hour and turned off the light on the Opera House to raise awareness for climate change (Ardhali, 2017).

When looking at Figure 15, it is seen that the City of Sydney is not focussing on mitigation policies/measures at all. The main focus is as expected again on adaptation. In Figure 16 it is seen that the city has an almost equal focus on the environmental and economic aspects of sustainability. When looking at the water management issues it is seen that the main focus is on droughts and floods (Figure 17). This is kind of expected as Sydney has the most amount of precipitation. There is little focus on the coastal issues and social sustainability.



FIGURE 14 SYDNEY (CREATED WITH MAPS OF ARCMAP ONLINE)

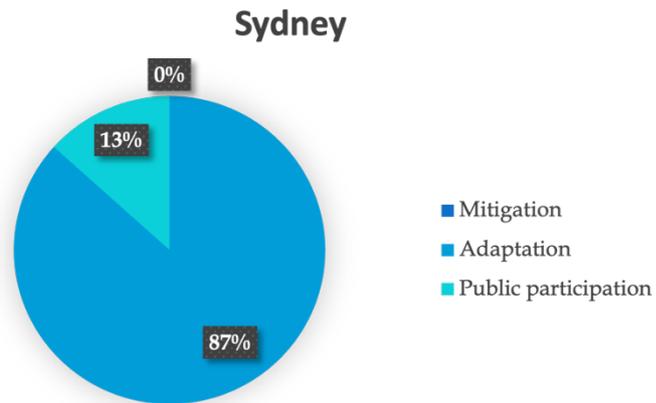


FIGURE 15 KIND OF POLICY/MEASURE SYDNEY

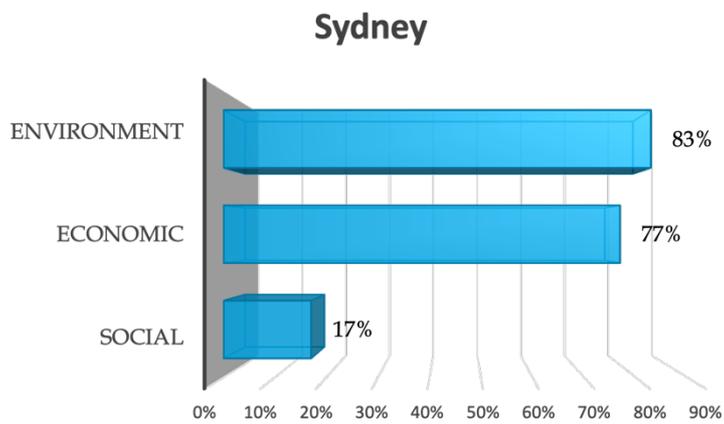


FIGURE 16 KIND OF SUSTAINABILITY SYDNEY

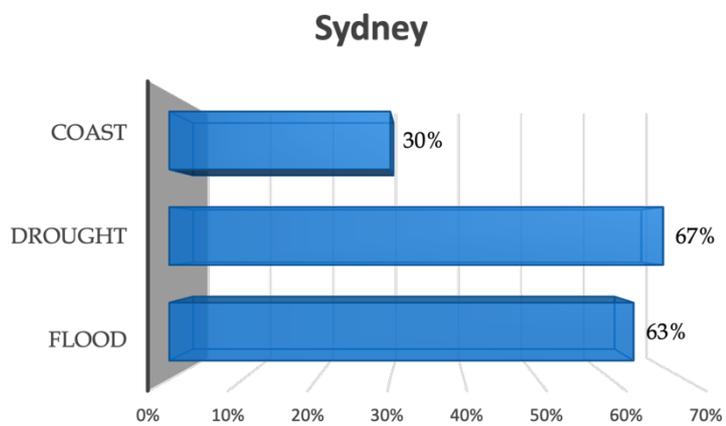


FIGURE 17 ISSUE FOCUS SYDNEY

COMPARISON

In this chapter the results of the different cities will be compared and the applicability of the policies in other cities will be evaluated.

KIND OF POLICY/MEASURE

When looking at the kind of policy/measure that the cities have (Figure 18) it is noticeable that adaptation is the most common. This was expected as it was also found in the literature. All the cities have some focus on public participation, but there are no big differences in these kinds of policies. As expected, the focus on mitigation is the smallest, yet it is remarkable to see that Sydney has none of them and Los Angeles has almost none of them. For both cities it would be smart to look at Barcelona, but also at Cape Town to see what kind of mitigation policies/measures there are possible in water management.

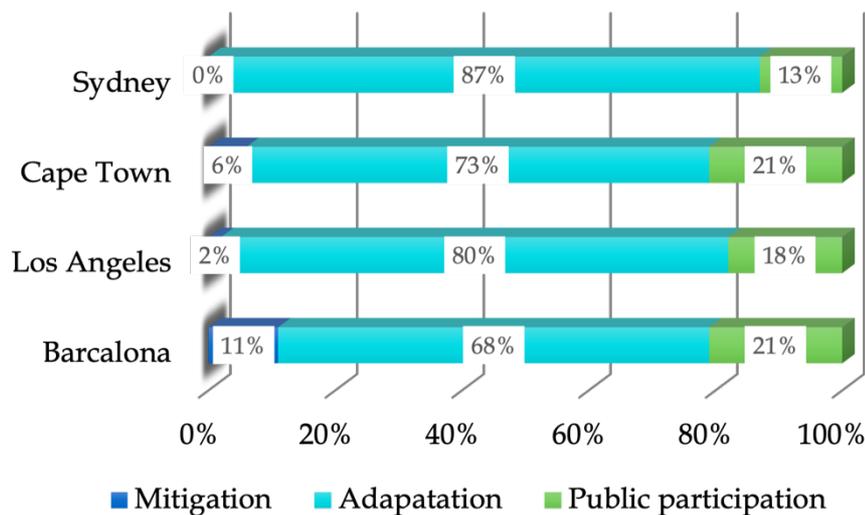


FIGURE 18 COMPARISON KIND OF POLICY/MEASURE

The first kind of policy/measure that is focusing on mitigation in water management is the use of hydropower as an alternative energy source. Barcelona is the only one that implemented this in their strategy, while all the cities have the option to use it. This is due to the fact that all cities are located between mountains and the sea, with rivers going from the mountains to the sea. In the plans of Barcelona and Cape Town, they are also looking at the carbon sinks and how to protect and/or restore them. In the plan of Barcelona, they also wanted to create more biodiversity in the reefs to stimulate the amount of carbon that can be taken up by the ocean. For Los Angeles, it is definitely possible to restore the carbon sinks in the area and try to create a more biodiverse reef. In the case of the City of Sydney, they are able to implement these strategies in their area, but it might be more useful to do these implementations with more municipalities in the area so that the whole metropolitan area is participating and the impact will be larger.

KIND OF SUSTAINABILITY

When looking at the kind of sustainability that the cities focus on (Figure 19), the main focus of all the cities is on environmental sustainability. This was expected as the literature also had found this, yet, expectantly, in Los Angeles, there is an equal focus on the economic aspect of sustainability. When looking at economic sustainability Sydney and Los Angeles take the lead in this with Cape Town following close. Barcelona however does not have a lot of focus on the economic aspect of sustainability. Looking at social sustainability, Cape Town has a big focus on this and so does Barcelona. Los Angeles and Sydney have a lot less focus on this aspect of sustainability. It is surprising to see that social sustainability scores a lot lower compared to the economic and environmental aspects.

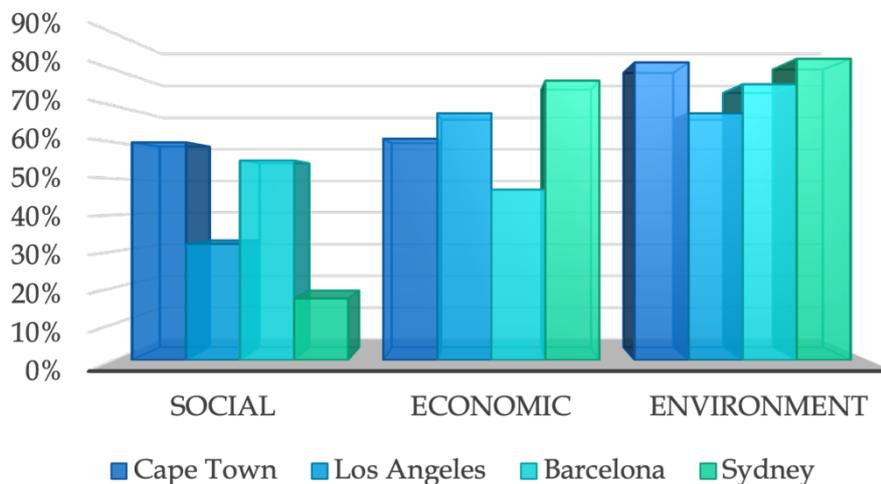


FIGURE 19 COMPARISON KIND OF SUSTAINABILITY

Looking at the economic sustainability options in water management it is important to see what Barcelona could implement more. When looking at Sydney the main difference seems to be that almost all of the policies/measures are focused on urban planning, whereas in Barcelona there are also quite some policies/measures that do not actually create a change in the urban design. For Barcelona, it is possible to create more policies/measures on this. Looking at Los Angeles there is also a focus on how to create a sustainable fishery, which might be interesting for all the cities to look into. All the cities do have fishing activities and by looking at this in an economic and environmental sense this can become a sustainable industry.

When looking at the social aspect of sustainability in water management, Sydney and Los Angeles could learn some things from Cape Town and Barcelona. In Cape Town and Barcelona, these policies/measures mainly focus on making sure the quality of the water is good, and on making sure there is enough water available (in dry periods). In Sydney, there is no focus on the quality of the water, which probably indicates that this is not a real problem right now but implementing a policy to monitor the water quality is also a good idea. For both Los Angeles and Sydney, it would be smart to look at Cape Town as they have the water sensitive urban design principle. This is made so that all urban design is low in water usages and also ready to experience heavy rainfall. This is a social policy as it gives equal protection against floods for everyone and makes sure that enough water remains for human usages. Even Barcelona could look at this principle to implement it. The reason that this social focus is missing in Los Angeles can be because the strategy is created by a company instead of a governmental organisation.

ISSUE FOCUS

When looking at Figure 20, it is seen that all cities have quite a large and equal focus on droughts in their strategies. Cape Town and Sydney also have a large focus on floods. Especially for Sydney, this was expected as it has the highest amount of precipitation. In comparison, Los Angeles and Barcelona have a lot less focus on this. Looking at the coastal issues that are arising Los Angeles, Barcelona, and Sydney, are focusing the most on this and Cape Town should look at these cities for inspiration. Cape Town is aware that their coastal focus is still lacking and have announced that their coastal policies should be released this year. It is however remarkable that one city is, for now, choosing to almost ignore the coastal issues in their urban strategies.

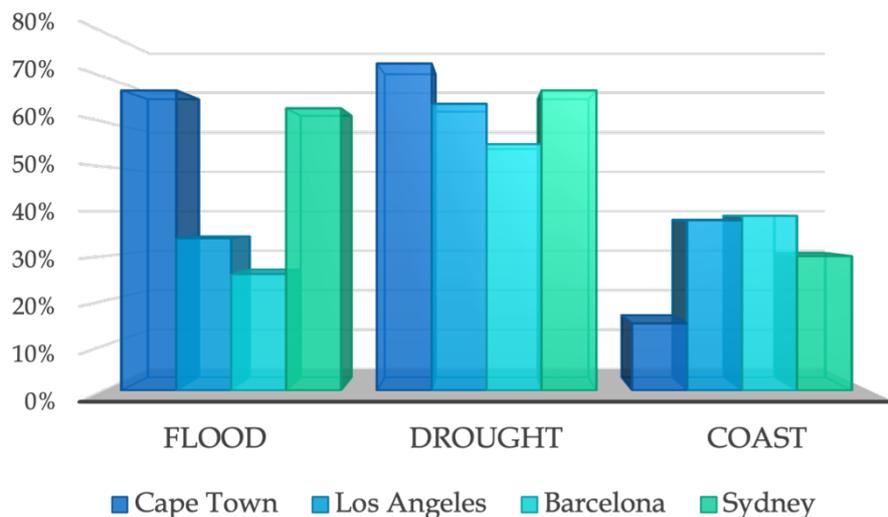


FIGURE 20 COMPARISON ISSUE FOCUS

When looking at the main difference between Cape Town and Sydney, and Los Angeles and Barcelona, is the fact that a lot of the policies/measures focusing on droughts are also looking at floods in Cape Town and Sydney. It would be smart for Los Angeles and Barcelona to look at how to create measures that are both useful for dry periods as for flood events.

Los Angeles and Barcelona noticeably had a chapter dedicated to the coastal issues and are the cities with the most focus on this. Especially for Cape Town it would be smart to add this to their strategy. Both Barcelona and Sydney have the focus on making sure that in events of heavy rainfall, not all the water is just going into the ocean. Barcelona also has policies to create a more biodiverse reef and to make sure that the coast will not disappear due to sea-level rise. Los Angeles has policies on the maintaining of coastal resources such as lagoons and wetlands. All three of the cities have policies on making sure that the coast will be adapting to climate change. Cape Town can implement most of these policies, but the one for coastal resources is only useful if they have these.

CONCLUSION

In this paper the following question is answered: How does sustainable water management relate to the development of urban strategies, what are the difference and similarities in this for Cape Town, Los Angeles, Barcelona, and Sydney with regards to their climate strategies and what can they learn from each other?

First, it is needed to understand what the important aspects are to develop sustainable water management in urban strategies. Multiple factors play a role in sustainable water management. Implementing policies/measures should improve the overall city to be an active part of the development of urban strategies. The polies/measures need to include adaptation, public participation, and mitigation actions. At this moment there is a focus on the adaptation part in water management. Next to this all three the aspects of sustainability should also be considered. These are social, economic, and environmental sustainability, where right now the focus is on the environmental aspect. Then it is also important to look at all the different issues that the city is facing in water management. In this report that being floods, droughts, and coastal issues. For sustainable urban water management, it is also needed to look at the supply and demand side and the uncertainties that are connected to water management.

When comparing the four cities it is seen that they all indeed carry the focus on adaptation and the environmental aspect of sustainability. This is in line with the found literature on this. Barcelona and Cape Town also have some mitigation policies that could be implemented in the other cities. These are policies to protect/restore carbon sinks and the use of hydropower. They all have almost the same focus on public participation. Barcelona has less of a focus on the economical aspect of sustainability, because less of their policies/measures promote urban development. When looking at social sustainability Cape Town and Barcelona take a lead in this. Sydney should look at their policies/measures to measure the quality of water. For all the cities it would be smart to look at Cape Town and their water sensitive urban design principle. It is interesting that economic sustainability in some cities had the same focus as environmental sustainability, as this was not expected. All the cities have the focus on drought issues in the cities, yet in Cape Town and Sydney these are combined with the flood policies/measures. It would be smart for Los Angeles and Barcelona to look at how they can combine this more. Cape Town should look at Los Angeles, Barcelona, and Sydney for the coastal policies/measures. Cape Town could create more reefs, maintain the coastal resources, and keep the beaches from sinking due to sea-level rise.

As mentioned, the main focus of the cities is in line with the found literature, but after conducting this research it is found that all of the cities have quite a low focus on social sustainability. The literature clearly states that the focus should be on all three aspects and therefore it is important sustainable urban water management also focuses on this. Increasing the focus on social water sustainability would mean that the whole population in the city will have equal access to drinkable water, but also all of them will be protected to all of the arising issues. This is important as a lot of the time poor people do not have equal access, nor equal protection.

Half of the cities seem to completely ignore the fact that there are possibilities for mitigation policies in water management. Even though it was expected that there would be little focus on this, awareness should be raised so that urban strategies can include this to make it more complete. By mitigating climate change as much as possible the effects will stay minimal and therefore, they are also needed in water management. While the theory shows that coastal issues are in fact important in sustainable water management and that they should be included in the urban strategies not all cities have done this. Coastal issues should be included in these plans so that the city is prepared for all of the arising issues.

All of the indicators have some policies/measures which gives hope for sustainable urban water management. It is important that the cities that have comparable issues look at each other to fill in the gaps in their policies. Overall, there is a good beginning, but there are most definitely still improvements to be made in all cities around the world.

The biggest issue that the research encountered is the fact that the City of Sydney is way smaller than the other municipalities and it would be better if they were all the same size. It would also be a good idea to look at cities from South America and Asia to see if they have other policies/measures; however, these documents were not published in English. The method of coding made it possible to compare the cities, but there is always the change that some things were missed in the strategies, by conducting this research with more people the chance of this happening becomes smaller. For future research it would be beneficial to look at how the policies/measures from the other cities can be implemented. It would also be nice to do this kind of comparison with other cities and include the other continents.

REFERENCES

- Addison, A. (2018, February 19). Nou feel Inside Barcelona's £550million, revamped Nou Camp with boosted 105,000 capacity, new indoor arena and a roof that catches rain in order to water the pitch; Europe's biggest stadium is about to get a long-overdue face-lift, with work set to take four years. *TheSun.Co.Uk*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5RP3-RF31-F021-63J1-00000-00&context=1516831>
- Agence France Presse. (2017, June 1). Cape Town cuts back to survive worst drought in 100 years. *Agence France Presse*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5NNY-78P1-JBV1-X26K-00000-00&context=1516831>
- Ardhali, R. (2017, March 26). Earth Hour: Lights turned off at world famous landmarks to raise awareness about climate change as Big Ben, the Sydney Opera House and the Eiffel Tower are plunged into darkness. *MailOnline*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5N5R-PCB1-JCJY-G0J6-00000-00&context=1516831>
- Ajuntament de Barcelona. (2018, March). *BCN Climate Plan 2018–2030*. Barcelona City Council.
- Bell, S. J. (2020). Frameworks for urban water sustainability. *WIREs Water*, 7(2), 1–13. <https://doi.org/10.1002/wat2.1411>
- Chambers, D. (2017, July 4). Cape Town “most biodiverse city in the world.” *Daily Dispatch (South Africa)*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5NY2-N4Y1-DXHF-W2XW-00000-00&context=1516831>
- City of Cape Town. (2017, July). *Five-Year Integrated Development plan; July 2017 - June 2022*.
- City of Cape Town. (2019, August). *Cape Town Resilience Strategy*.
- City of Sydney. (2017a, March). *Adapting for Climate Change a long term strategy for the City of Sydney*.
- City of Sydney. (2017b, March). *Environmental Action 2016 - 2021 Strategy and Action Plan*.
- Dalhuisen, J. M., Rodenburg, C. A., De Groot, H. L., & Nijkamp, P. (2003). Sustainable Water Management Policy: Lessons from Amsterdam. *European Planning Studies*, 11(3), 263–281. <https://doi.org/10.1080/09654310303636>

Dodman, D., United Nations Environment Programme, McGranahan, G., & Dalal-Clayton, D. B. (2013). *Integrating The Environment In Urban Planning And Management: Key Principles And Approaches For Cities In The 21st Century* (International Institute for Environment and Development, Ed.). United Nations.

European Union News. (2018, April 18). FC Barcelona make breakthrough in bid to build new stadium and “Barça” district. *European Union News*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5S4M-P021-DXCW-D0VJ-00000-00&context=1516831>

Finn, D., & McCormick, L. (2011). Urban climate change plans: how holistic? *Local Environment*, 16(4), 397–416. <https://doi.org/10.1080/13549839.2011.579091>

Goodarzi, M. S., Sakieh, Y., & Navardi, S. (2016). Scenario-based urban growth allocation in a rapidly developing area: a modeling approach for sustainability analysis of an urban-coastal coupled system. *Environment, Development and Sustainability*, 19(3), 1103–1126. <https://doi.org/10.1007/s10668-016-9784-9>

Jalilov, S. M., Kefi, M., Kumar, P., Masago, Y., & Mishra, B. K. (2018). Sustainable Urban Water Management: Application for Integrated Assessment in Southeast Asia. *Sustainability*, 10(2), 122. <https://doi.org/10.3390/su10010122>

Jalota, S. K., Vashisht, B. B., Sharma, S., & Kaur, S. (2018). Chapter Two: Climate Change Projections. In *Understanding Climate Change Impacts on Crop Productivity and Water Balance* (1st ed., pp. 55–86). Academic Press. <https://ebookcentral.proquest.com/lib/rug/detail.action?docID=5303035#>

Jiang, C., Zheng, S., Ng, A. K. Y., Ge, Y. E., & Fu, X. (2020). The climate change strategies of seaports: Mitigation vs. adaptation. *Transportation Research Part D: Transport and Environment*, 89, 1–14. <https://doi.org/10.1016/j.trd.2020.102603>

Klopp, J. M., & Petretta, D. L. (2017). The urban sustainable development goal: Indicators, complexity and the politics of measuring cities. *Cities*, 63, 92–97. <https://doi.org/10.1016/j.cities.2016.12.019>

Lagan, B. (2017, February 10). Temperature hits 42.9C on Sydney’s hottest day. *The Times Co. Uk*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5MVB-TRM1-JCJY-G151-00000-00&context=1516831>

LaVanchy, G. T., Kerwin, M. W., & Adamson, J. K. (2019). Beyond ‘Day Zero’: insights and lessons from Cape Town (South Africa). *Hydrogeology Journal*, 27(5), 1537–1540. <https://doi.org/10.1007/s10040-019-01979-0>

Leyzerova, A., Sharovarova, E., & Alekhin, V. (2016). Sustainable Strategies of Urban Planning. *Procedia Engineering*, 150, 2055–2061. <https://doi.org/10.1016/j.proeng.2016.07.299>

- Los Angeles Regional Collaborative for Climate Action and Sustainability & LA County Metro. (2016, December). *A Greater LA Climate Action Framework*. Los Angeles Regional Collaborative for Climate Action and Sustainability.
- Mata, L. J., & Budhooram, J. (2007). Complementarity between mitigation and adaptation: the water sector. *Mitigation and Adaptation Strategies for Global Change*, 12(5), 799–807. <https://doi.org/10.1007/s11027-007-9100-y>
- Organization for Economic Cooperation and Development. (2013). *Water And Climate Change Adaptation: Policies To Navigate Uncharted Waters: OECD Studies On Water*. Organization For Economic Co-Operation & Development.
- Pearson, L. J., Coggan, A., Proctor, W., & Smith, T. F. (2009). A Sustainable Decision Support Framework for Urban Water Management. *Water Resources Management*, 24(2), 363–376. <https://doi.org/10.1007/s11269-009-9450-1>
- Pires, A., Morato, J., Peixoto, H., Botero, V., Zuluaga, L., & Figueroa, A. (2017). Sustainability Assessment of indicators for integrated water resources management. *Science of The Total Environment*, 578, 139–147. <https://doi.org/10.1016/j.scitotenv.2016.10.217>
- Premium Official News. (2018, April 25). State of play on climate in the Mediterranean: 2018 UfM Climate Week in Barcelona. *Premium Official News*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5S64-D421-J9XT-P41Y-00000-00&context=1516831>
- Rebelo, I. (2020, November 10). Cape Town’s climate strategy isn’t perfect, but every African city should have one. *The Conversation*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:6189-DW01-DXP7-10C3-00000-00&context=1516831>
- Shabani, M., Shams Gharneh, N., & Akhavan Niaki, S. T. (2020). A sustainable urban water management model under uncertainty: a case study. *Management of Environmental Quality: An International Journal*, 32(2), 376–397. <https://doi.org/10.1108/meq-09-2020-0187>
- States News Service. (2018, October 10). COMMISSION GRANTS 22 CITIES WITH FUNDING FOR INNOVATIVE PROJECTS; LAUNCHES NEW CALL FOR PROJECTS FOR SECURITY IN PUBLIC URBAN SPACES. *States News Service*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5TFY-YBP1-DYTH-G4Y1-00000-00&context=1516831>
- Targeted News Service. (2016, November 17). Stormwater Management Importance Underscored in Los Angeles Basin Study Released by Bureau of Reclamation. *Targeted News Service*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5M6D-2YS1-JC11-135H-00000-00&context=1516831>

- The Bangkok Post. (2018, December 8). Societies must seek to take care of those “menaced” by costs of green shift. *The Bangkok Post (Thailand)*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5TXH-1HH1-JCH9-G0TD-00000-00&context=1516831>
- The Frontrunner. (2017, January 16). US Companies Urge Trump Not To Abandon Paris Climate Agreement. *The Frontrunner*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5MN5-BX21-DXCW-D2TB-00000-00&context=1516831>
- Wahlquist, C. (2017, March 2). Climate scientists say likelihood of extreme summers surging due to global warming; Report’s authors say Sydney unprepared for knock-on effects of a significant increase in average summer temperatures. *The Guardian (London)*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5N0J-J841-JCJY-G2WP-00000-00&context=1516831>
- Wescoat, J. L. (2009). Comparative International Water Research. *Journal of Contemporary Water Research & Education*, 142(1), 61–66. <https://doi.org/10.1111/j.1936-704x.2009.00055.x>
- Westcott, B., & George, S. (2017, May 31). What does the Paris climate deal look like without the United States? *CNN.Com*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5NP5-6G61-JBPX-X54H-00000-00&context=1516831>
- Wolman, H. (2019). Capital cities and regions [E-book]. In R. W. Ortung (Ed.), *Capital Cities and Urban Sustainability* (1st ed., pp. 25–46). Taylor & Francis. <https://doi.org/10.4324/9780429426049>
- Xinhua General News Service. (2017, January 21). California renews climate change fight as Trump to kill Climate Action Plan. *Xinhua General News Service*. <https://advance-lexis-com.proxy-ub.rug.nl/api/document?collection=news&id=urn:contentItem:5MP7-60K1-JBTY-T51N-00000-00&context=1516831>
- Yang, W., Hyndman, D. W., Winkler, J. A., Viña, A., Deines, J. M., Lupi, F., Luo, L., Li, Y., Basso, B., Zheng, C., Ma, D., Li, S., Liu, X., Zheng, H., Cao, G., Meng, Q., Ouyang, Z., & Liu, J. (2016). Urban water sustainability: framework and application. *Ecology and Society*, 21(4), 1–14. <https://doi.org/10.5751/ES-08685-21040>

APPENDICES

APENDIX 1 - RAW DATA CITIES

Total amount of policies/measures about water management in Cape Town was 33.

TABLE 1 RAW DATA CAPE TOWN

	Times mentioned	Score
Mitigation	2	6.06%
Adaption	24	72.73%
Public participation	7	21.21%
Social sustainability	18	54.55%
Economic sustainability	20	60.61%
Environmental sustainability	27	81.82%
Floods	22	66.67%
Droughts	24	72.73%
Coastal	5	15.15%

Total amount of policies/measures about water management in Los Angeles are 56.

TABLE 2 RAW DATA LOS ANGELES

	Times mentioned	Score
Mitigation	1	1.79%
Adaptation	45	80.35%
Public participation	10	17.86%
Social sustainability	18	32.14%
Economic sustainability	38	67.86%
Environmental sustainability	38	67.86%
Floods	19	33.93%
Droughts	36	64.29%
Coastal	21	37.5%

Total amount of policies/measures about water management in Barcelona are 38.

TABLE 3 RAW DATA BARCELONA

	Times mentioned	Score
Mitigation	4	10.53%
Adaptation	26	68.42%
Public participation	8	21.05%
Social sustainability	21	55.26%
Economic sustainability	18	47.37%
Environmental sustainability	29	76.32%
Floods	10	26.32%
Droughts	21	55.26%
Coastal	15	39.47%

Total amount of policies/measures about water management in Sydney are 30.

TABLE 4 RAW DATA SYDNEY

	Times mentioned	Score
Mitigation	0	0%
Adaptation	26	86.67%
Public participation	4	13.33%
Social sustainability	5	16.67%
Economic sustainability	23	76.67%
Environmental sustainability	25	83.33%
Floods	19	63.33%
Droughts	20	66.67%
Coastal	9	30%

APENDIX 2 – COMPARISON OF THE RAW DATA

The table below shows how the cities score compared to each other. Red means very low, orange means lower wanted and green means high enough, or high on that certain indicator.

TABLE 5 RAW DATA COMPARISON

	Cape Town	Los Angeles	Barcelona	Sydney
Mitigation	6.06%	1.79%	10.53%	0%
Adaptation	72.73%	80.35%	68.42%	86.67%
Public participation	21.21%	17.86%	21.05%	13.33%
Social sustainability	54.55%	32.14%	55.26%	16.67%
Economic sustainability	60.61%	67.86%	47.37%	76.67%
Environmental sustainability	81.82%	67.86%	76.32%	83.33%
Floods	66.67%	33.93%	26.32%	63.33%
Droughts	72.73%	64.29%	55.26%	66.67%
Coastal	15.15%	37.5%	39.47%	30%

This table shows the average scores on all the indicators.

TABLE 6 AVERAGES ON EACH INDICATOR

	Average
Mitigation	4.59%
Adaptation	77.04%
Public participation	18.36%
Social sustainability	39.66%
Economic sustainability	63.13%
Environmental sustainability	77.33%
Floods	47,56%
Droughts	63,74%
Coastal	30,53%