34 | 2
Dossier Central
Bitácora 34 (2) 2024: 75-89
ISSN electrónico 2027-145X. ISSN impreso 0124-7913.
Universidad Nacional de Colombia, Bogotá

Review of plans for SLR in C40:
how plans accentuate inequalities

Revisión de planes para el SLR en C40:
cómo los planes acentúan las desigualdades

Revisão dos planos para o SLR na C40:
como os planos acentuam as desigualdades

Examen des plans de SLR dans la C40 :
comment les plans accentuent les inégalités

Fuente: Autoría propia

Autores

Victor Moura Bussolotti
Universidade Federal do Espírito Santo
victorbussolotti@hotmail.com
https://orcid.org/0000-0002-8645-5879

Miguel Amado
Instituto Superior Técnico
miguelpamado@tecnico.ulisboa.pt
https://orcid.org/0000-0002-9152-4226

Izabela Uliana Pellegrini
Universidade Federal do Espírito Santo
izabela.pellegrini@gmail.com
https://orcid.org/0000-0001-9942-1072

Cristina Engel de Alvarez
Universidade Federal do Espírito Santo
Cristina.engel@ufes.br
https://orcid.org/0000-0002-3898-8515

Recibido: 29/2/2024
Aprobado: 24/6/2024

Cómo citar este artículo:
Moura Bussolotti, V., Uliana Pellegrini, I., Amado, M., Engel de Alvarez, C. (2024). Review of plans for SLR in C40: how plans accentuate inequalities. *BITÁCORA URBANO TERRITORIAL*, 34(II): 75-89.
https://doi.org/10.15446/bitacora.v34n2.113258

Abstract

The rise in sea levels associated with climate change may have consequences for coastal cities, which need to adapt to minimize their vulnerabilities. It is observed that in some locations, the rise of the oceans is already felt, so adaptation strategies are already being employed. Therefore, the objective of the research is to carry out a documentary review of the climate action plans of cities participating in C40 Cities that may face the consequences of rising sea levels, identifying possible climate injustices. The methodology used consisted of choosing the cities to be studied, reading and analyzing their action plans, systematizing their content and analyzing the data obtained. The results indicate that there is a difference between the profile of cities that are already prepared to face rising sea levels and those in which effective measures have not yet been taken, especially when comparing the Global North and South. With this, it was concluded that climate change could accentuate the differences between cities in the North – which appears to be more prepared – and the Global South – which may have its vulnerabilities even more accentuated.

Keywords: sea level, climate change, climate change adaptation, Global North, Global South

Autores

Victor Moura Bussolotti

PhD candidate in the Postgraduate Program in Architecture and Urbanism at the Federal University of Espírito Santo, studying a sandwich period at the Instituto Superior Técnico of the University of Lisbon, Portugal.

Izabela Uliana Pellegrini

PhD candidate in the Postgraduate Program in Architecture and Urbanism at the Federal University of Espírito Santo, studying a sandwich period at the Instituto Superior Técnico of the University of Lisbon, Portugal.

Miguel Amado

Full Professor at Civil - Department of Civil Engineer, Architecture and Environment of Instituto Superior Tecnico.

Cristina Engel de Alvarez

Full Professor at the Department of Architecture and Urbanism at the Federal University of Espírito Santo.

Resumen

El aumento del nivel del mar asociado al cambio climático puede tener consecuencias para las ciudades costeras, que deben adaptarse para minimizar sus vulnerabilidades. Se observa que en algunas localidades ya se siente el aumento de los océanos, exigiendo que sean empleadas estrategias de adaptación. Así, el objetivo de esta investigación es realizar una revisión documental de los planes de acción climática de las ciudades participantes en C40 Cities que pueden enfrentar las consecuencias del aumento del nivel del mar, identificando posibles injusticias climáticas. La metodología utilizada consistió en elegir las ciudades a estudiar, leer y analizar sus planes de acción, sistematizar su contenido y analizar los datos obtenidos. Los resultados indican que existe una diferencia entre el perfil de las ciudades que ya están preparadas para enfrentar el aumento del nivel del mar y aquellas en las que aún no se han tomado medidas efectivas, especialmente si se compara el Norte y el Sur Global. Con esto, se concluyó que el cambio climático podría acentuar las diferencias entre las ciudades del Norte —que parece estar más preparada— y el Sur Global, que puede tener sus vulnerabilidades aún más acentuadas.

Palabras clave: nivel del mar, cambio climático, adaptación al cambio climático, Norte Global, Sur Global

Resumé

La montée du niveau de la mer résultant du changement climatique devrait avoir des conséquences sur les villes côtières, qui doivent s'adapter pour minimiser leurs vulnérabilités. On observe qu'à certains endroits, la montée des océans se fait déjà sentir, de sorte que des stratégies d'adaptation sont déjà mises en œuvre. L'objectif de la recherche était donc de réaliser une revue documentaire des plans d'action climat des villes participant au C40 Villes qui doivent faire face aux conséquences de l'élévation du niveau de la mer, en identifiant les éventuelles injustices climatiques. La méthodologie utilisée a consisté à choisir les villes à étudier, à lire et analyser leurs plans d'action, à systématiser leur contenu et à analyser les données obtenues. Les résultats indiquent qu'il existe une différence entre le profil des villes déjà préparées à faire face à la montée du niveau de la mer et celles dans lesquelles des mesures efficaces n'ont pas encore été prises, notamment si l'on compare le Nord et le Sud de la planète. Il a ainsi été conclu que le changement climatique pourrait accentuer les différences entre les villes du Nord – qui semblent mieux préparées – et celles du Sud – dont les vulnérabilités pourraient être encore plus accentuées.

Resumo

O aumento do nível do mar associado às mudanças climáticas pode gerar consequências para as cidades costeiras, que necessitam de se adaptar para minimizar as suas vulnerabilidades. Observa-se que em algumas localidades, a elevação dos oceanos já é sentida, de modo que estratégias de adaptação já estão sendo empregadas. Dessa forma, o objetivo da pesquisa consiste em realizar uma revisão documental nos planos de ação climática das cidades participantes do C40 Cities que podem enfrentar as consequências do aumento do nível do mar, identificando possíveis injustiças climáticas. A metodologia empregada consistiu na escolha das cidades objeto de estudo, leitura e análise de seus planos de ação, sistematização dos seus conteúdos e análise dos dados obtidos. Os resultados indicam que há uma diferença entre o perfil das cidades que já se encontram preparadas para enfrentar o aumento do nível do mar e aquelas em que ainda não foram tomadas medidas efetivas, especialmente na comparação entre o Norte e o Sul Global. Com isso, concluiu-se que as mudanças climáticas podem acentuar as diferenças entre as cidades do Norte – que se demonstra mais preparado – e do Sul Global – que pode ter suas vulnerabilidades ainda mais acentuadas.

Palavras-chave: nível do mar, mudanças climáticas, adaptação às mudanças climáticas, Norte Global, Sul Global

34 (2)

Review of plans for SLR in C40:
how plans accentuate inequalities

Mots-clés : niveau de la mer, changement climatique, adaptation au changement climatique, Nord global, Sud global

Introduction

The sixth assessment report, known as AR6, published by the Intergovernmental Panel on Climate Change – IPCC –, a panel from the United Nations that studies and establishes consensus in research on Climate Change, points out that the global average temperature from 2011 to 2020 is already around 1.1°C higher than the reference period of 1850-1900 and this increase is strictly linked to human activities on the planet (Calvin et al., 2023).

To stop this increase, the adoption of efficient measures by public managers is necessary. However, what has been done so far has proven to be ineffective, since projections of the current trajectory indicate a warming of 2.7ºC by the year 2100 in the planet's average surface temperature in relation to pre-industrial levels. Furthermore, it is estimated that this temperature will continue to increase for centuries to come (Climate Analytics and Nexclimate Institute, 2022).

The concept of Climate Justice is understood as the equitable management of resources for development and the guarantee of human rights and the fair distribution of the burdens and benefits of actions to combat climate change (Mary Robinson Foundation, 2017).

It is also estimated that climate change will make certain territorial contexts uninhabitable due to extreme heat, food and water insecurity, impacts on urban infrastructure and pluvial floods or floods related to SLR (acronym for sea level rise). This reality, in addition to causing human and biodiversity losses, also generates movements of people and profound changes in the structure of affected cities, including an increase in climate injustice.

Additionally, the World Bank estimates that in the year 2050 more than 216 million people may have to abandon their homes due to uninhabitable conditions caused by climate change (Clement et al., 2021). Those facing this situation are known as climate refugees. In Sub-Saharan Africa alone this number could exceed 86 million people.

This scenario is even more worrying when it is noted that changes in climate could intensify even further in certain future scenarios, and that they should generate an increase in the intensity and frequency of the extreme climate events mentioned, including rising sea levels, causing a series of problems for coastal cities (Calvin et al., 2023).

The rise of the oceans is linked to the increase in the volume of water due to warming and the increase in the melting of land ice or the net loss of land water reservoirs. Tectonic activities, the dynamics of the Earth's mantle or glacial isostatic adjustment also influence the dynamics of sea level rise (Oppenheimer et al., 2019).

The average level of the oceans around the planet is already increasing and it is estimated that extreme sea level events should be more frequent, going from an occurrence every 100 years to annual by the year 2100 and, in higher estimates pessimists, until the year 2050. The magnitude of these events should also be greater (Calvin et al., 2023; Paulik et al., 2020). It should also be added that the speed of sea level rise threatens coastal communities, especially on small islands or low-lying cities where the effects of SLR are more relevant (Oppenheimer et al., 2019).

Furthermore, studies indicate that great efforts will be needed to protect coastal communities over time. Thus, it is stated that great adaptation efforts must be made to preserve the built and cultural heritage of cities threatened by rising sea levels (Strauss et al., 2021).

In this context, the adoption of action plans that consider climate justice is more effective in responding to the effects of climate change and SLR, especially when they involve the population's participation in decisions (Nurhidayah & McIlgorm, 2019). The concept of Climate Justice is understood as the equitable management of resources for development and the guarantee of human rights and the fair distribution of the burdens and benefits of actions to combat climate change (Mary Robinson Foundation, 2017). This work will use this concept as a basis for its discussions on the topic.

When climate actions do not consider equity when mapping priority areas for intervention or choosing the measures to be adopted, the possibility of trade-offs such as the generation of climate gentrification becomes much greater. The term climate gentrification refers to the expulsion of the poorest people from certain territories due to the increase in land value or the unequal occurrence of the effects of climate change over the territory, generating more devastating effects for more socioeconomically vulnerable populations and creating new urban geographies due to human movement caused by climate change and, in particular, by the sea level rise (Li & Grant, 2022).

It is possible that this context will further increase the existing differences between countries in the Global North and those in the Global South, as the South tends to suffer more from climate change, being more vulnerable, despite being the countries in the Global North the most responsible for climate change.

The division of countries between the "Global North" and the "Global South" emphasizes geopolitical issues and power relations. The use of such terms proves to be more appropriate than others such as "periphery", "third world" or "underdeveloped countries" when referring to regions mainly in Latin America, Africa and Asia; and terms such as "industrialized countries", "developed countries" and "first world countries" to deal mainly with Europe and North America (Dados & Connell, 2012). Therefore, this article will use the terminology of Global North and South to classify the countries and the cities addressed.

Faced with this scenario, coping, adaptation and mitigation measures are becoming increasingly necessary and urgent, and are being widely discussed by global organizations related to climate change. An example of this is the C40 Cities Climate Leadership Group (2023), a network that integrates leaders from nearly 100 cities all around the world, seeking to establish actions to face the climate crisis. Among these cities, there are the coastal cities, whose plans are the subject of study in this article.

In addition to coping measures, there are also mitigation measures, that is the search for reducing Greenhouse Gas (GHG) emissions. In this case, the search is to slow down the anthropogenic impact on the climate, allowing for more favorable future scenarios. Such scenarios are established by IPCC (acronym for Intergovernmental Panel on Climate Change) reports and, in its most recent publication (Calvin et al., 2023), are called SSP (Shared Socioeconomic Pathways). The SSP depends on the level of GHG emissions and the forms of interaction between countries and, for each of the five scenarios listed as probable by the IPCC, the likely energy imbalance will be different, generating more or less adverse impacts.

The SSP derives from the RCPs (Representative Concentration Pathways) present in the publication of its fifth report, known as the AR5 (2014), and based only on GHG emissions (O'Neill et al., 2017). Given the recent publication date of the AR6, many studies still use data from RCPs present in the AR5.

Therefore, for effective mitigation and coping measures, managers and decision-makers in coastal cities need to develop efficient climate action plans, capable of minimizing the consequences of rising sea levels in their territories. And, to this end, it is necessary to carry out mappings, simulations and the definition of strategies and the practice of actions that use reliable future scenarios.

Thus, identifying in which climate scenery cities are working and reviewing the actions and strategies already adopted can serve as a basis for a good methodological definition of the development of action plans. In addition, identifying cities in the Global North and Global South that will be victims of rising sea levels and comparing their status in terms of adopting mitigation and coping actions and strategies can confirm the potential that climate change must further accentuate the differences between the most and least vulnerable countries and cities.

Thus, the objective of the article is to carry out a documentary review of the climate action plans of cities participating in C40 Cities that will face the consequences of rising sea levels.

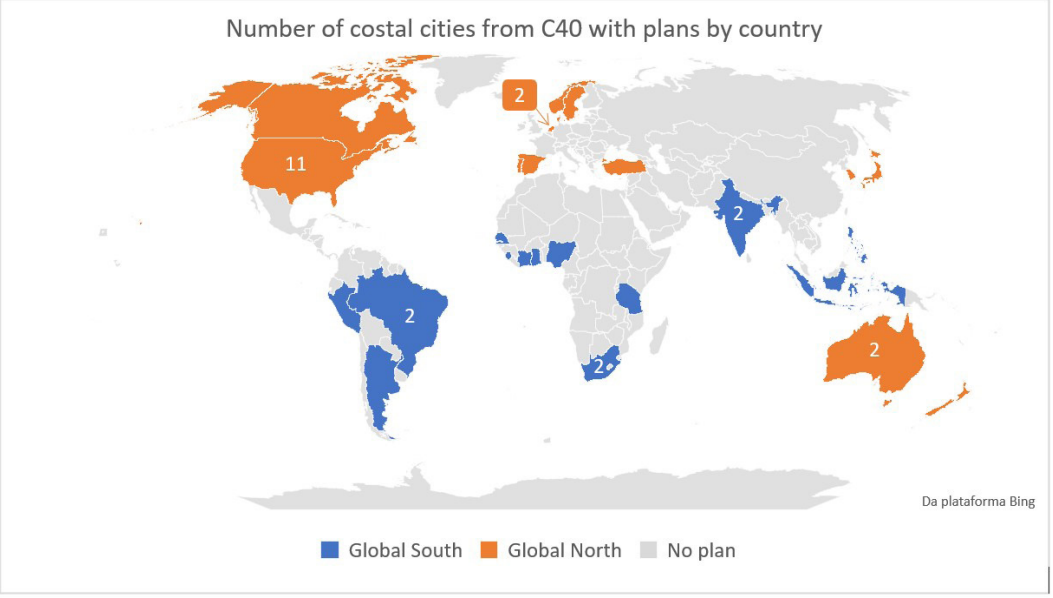


Figure 1.42 cities whose climate action plans were analyzed, by country
Source: The authors.

Methodological Procedures

The methodological procedures used for the development of the article consist, first, in defining the criteria for the selection of the objects of study and the systematic review of the documents, and, later, in organizing and discussing the results on the climate action plans identified in the first part of the methodology.

Thus, the cities whose climate action plans were analyzed for the development of this article were initially defined. It was decided to choose as objects of study those cities that are part of the C40 Cities Leadership Group (2023) organization. The choice of such cities is justified by the clear willingness among their members to face the consequences of climate crises. In addition, member cities of the C40 Cities organization carry out studies and develop action plans focused on climate-related issues. Thus, there is already a documentary production prepared by these cities and some of them are already implemented.

To this end, among the 97 member cities of the organization, a simulation was carried out using the "Coastal Risk Screening Tool" (Climate Central, 2023), which evaluated the worst possible sceneries of sea level rise and considering the combination of rising sea levels and flooding, which cities would have their territory completely or partially flooded in future scenarios. The tool uses simulations using as a basis the model proposed by the AR6 of the IPCC, which is considered a widely accepted model in current scientific literature. Thus, after carrying out the mentioned simulations, it was reached to a total of 42 cities of the organization suffering from risks related to SLR in future climate sceneries.

The C40 Cities database (C40 Knowledge Hub, 2023) was then used to obtain the climate action plans available for the selected cities. As some of the cities have more than one climate action plan, the total number of plans analyzed was 74 documents.

Analyses were carried out in relation to the year of publication of the plans, the type of plan and the deadlines for achieving the goals proposed by the plans. In addition, focusing on aspects related to sea level rise, the focus of study in this research, it was identified in which plans sea level rise was being addressed and how such content was presented, highlighting the mapping of zones at risk and the actions already employed or the strategies to be implemented.

The variables are the year of publication of the plans; it's type; and deadlines for achieving the goals. For the focus of study in this research it was identified in which plans SLR was being addressed and how the content was presented. The limit of the study was highlighting mapping of zones at risk and actions already employed or strategies to be implemented.

Additionally, an analysis was carried out regarding the issue of sceneries used to estimate the future climate, especially to determine the areas that would be affected by rising sea levels. Thus, it was identified which plans used the IPCC sceneries as a basis, and which of the future climate scenarios were used, as well as their version.

In this way, it was possible to obtain an overview of actions related to sea level rise because of climate change in the coastal cities that are members of C40 Cities.

Continent	Country	City	Global North	Global South	Plans by City	Plans by Country	Plans by Continent
Africa	South Africa	Cape Town			2	3	10
		Durban			1		
	Costa do Marfim	Abidjan			1	1	
	Ghana	Accra			1	1	
	Nigeria	Lagos			1	1	
	Senegal	Dakar			2	2	
	Sierra Leone	Freetown			1	1	
	Tanzania	Dar es Salaam			1	1	
North America	Canada	Vancouver			2	2	32
	USA	Boston			3	30	
		Houston			3		
		Los Angeles			3		
		Miami			3		
		New Orleans			4		
		New York			3		
		Philadelphia			2		
		Portland			1		
		San Francisco			2		
		Seattle			3		
		Washington DC			3		
Central and South America	Argentina	Buenos Aires			1	1	5
	Brazil	Rio de Janeiro			1	2	
		Salvador			1		
	Peru	Lima			2	2	
Asia	Philippines	Quezon City			1	1	8
	India	Chennai			1	2	
		Mumbai			1		
	Indonesia	Jakarta			2	2	
	South Korea	Seoul			2	2	
	Japan	Tokyo			1	1	

Europe	Denmark	Copenhagen			2	2	15
	Spain	Barcelona			1	1	
	Netherlands	Amsterdam			2	4	
		Rotterdam			2		
	England	London			1	1	
	Norway	Oslo			2	2	
	Portugal	Lisboa			2	2	
	Sweden	Estocolmo			2	2	
	Türkiye	Istanbul			1	1	
Australasia	Australia	Melbourne			2	3	4
		Sydney			1		
	New Zealand	Auckland			1	1	

Table 1. Cities whose climate action plans have been analyzed by country and continent
Source: The authors.

In addition, the cities were identified and grouped as part of the Global North or South and by continent, helping to compare the results obtained between different socio-economic contexts of cities and countries, to identify the aspects of climate justice involved.

Results and Discussions

The 42 coastal cities of C40 Cities and their 74 climate action plans published on the organization database were mapped according to the countries to which the cities belong, identifying those that had more than one city participating in this study and separating them between being part from the Global North or South. The map containing this information can be seen in Figure 1.

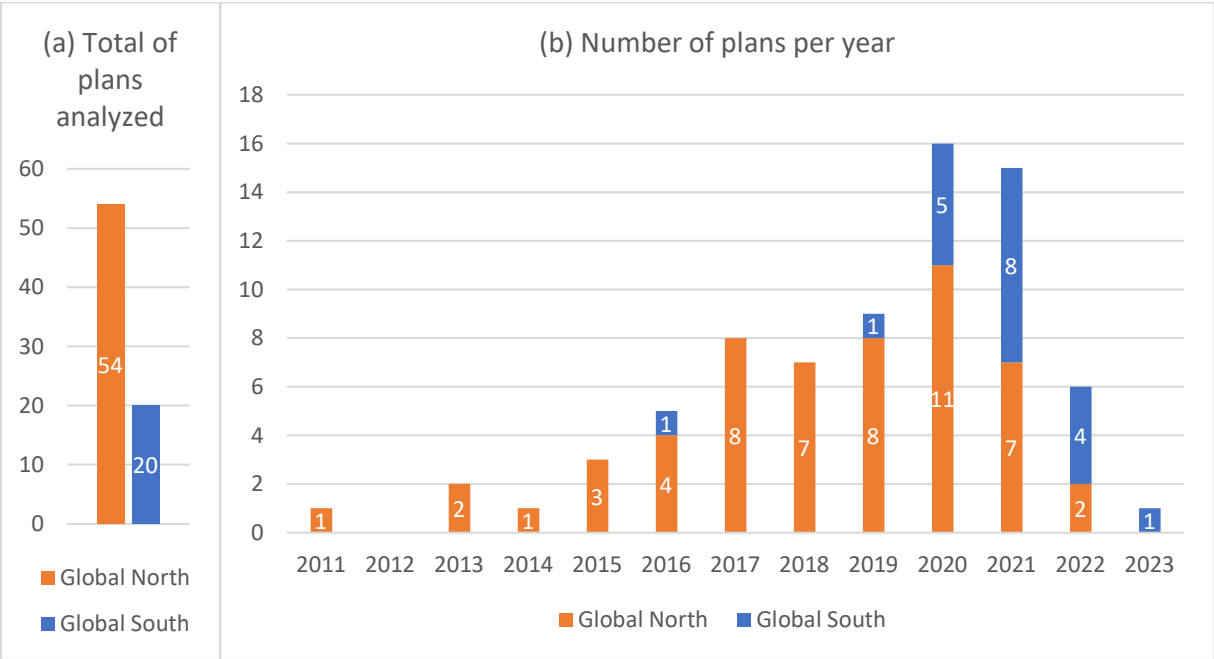
It is possible to note that the number of cities selected in the USA is significantly higher than in other countries, with 11 in total, representing more than 26% of the cities in this study, which contributes to the total number of cities studied in the Global North being superior to the Global South. It is also possible to mention that the Netherlands and Australia, in the Global North, have two cities analyzed each and Brazil, South Africa and India, in the Global South, also have two cities each. The other countries covered only have one city included in this study.

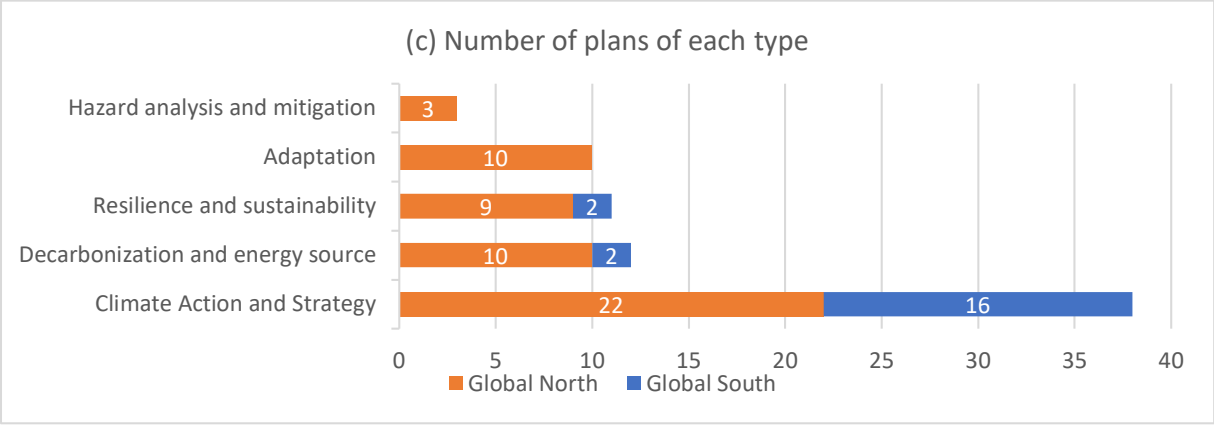
Advancing further in the characterization of the cities under study, Table 1 was created, which, in addition to demonstrating the number of cities per country and their classification between Global North and South, makes a separation by continent and computes the numbers of plans drawn up by each city, the sum of plans for cities in the same country and the sum of plans for countries on the same continent.

First, it can be seen that of the plans analyzed, 54 belong to the 26 cities in countries considered as the Global North and only 20 plans are from the 16 cities located in the Global South (Figure 2a). This gives an average of 2.07 plans for each city in the Global North and 1.25 plans for the Global South. In other words, proportionally, among cities in the Global North there is a quantitative production of around 65.6% more plans per city than those in the Global South, with only 27% of cities in the Global North having only one plan, while in the South the number represents 75% of cities.

When it comes to evaluating the results relating to the years in which the 74 climate action plans were launched, it is understood that the publication of plans that address the climate crisis, despite being recent, presents temporal divergences when it comes to the Global South and North. (Figure 2b). It was thus identified that until 2016, only cities in the Global North had plans aimed at Climate Change, and the effective presence of plans in cities in the Global South only occurred from 2019, eight years after the first plan analyzed by this study.

This data may already indicate the existence of problems linked to obtaining resources and the organization and planning of cities in the Global South that may be delaying the adoption of actions to combat climate change. The timeline of the plans may also indicate the tendency of some countries, mainly located in the Global North, to be more prepared to face the effects of climate change





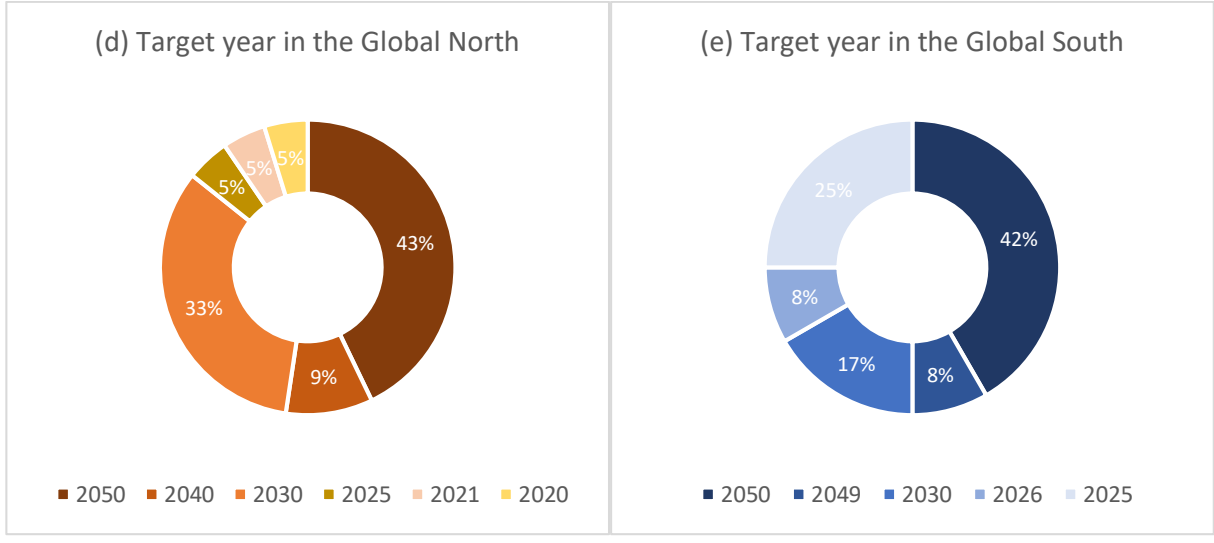


Figure 2. Graphic representation of: (a) Total of plans analyzed (b) Number of plans per year (c) Number of plans of each type (d) Target year in the Global North (e) Target year in the Global South

Source: The authors.

than other countries affected by the same risks, since they have been getting ready for it for a longer amount of time.

Furthermore, it was possible to observe that there is a growing approach to the topic, as evidenced by the quantitative increase observed year after year. And it is understood that, although the years 2021 and 2022 do not show quantitative growth in relation to previous years, this does not mean a decrease in the number of publications, but rather that there may be plans already developed, but not yet made available on the basis used.

To complement the results of the graphs, a categorization was carried out regarding the typological characteristics of the plans, as it was observed that some plans did not focus on climate action, but on cross-cutting issues, as resilience or risk analysis (Figure 2c).

Five main categories were identified in terms of their types: "Climate Action and Strategy", which deal with publications really focused on the actions that must be implemented to combat climate change and their strategies for their use; "Adaptation", which specifically deals with adaptation measures; "Hazard analysis and mitigation", which consist of carrying out an analysis of the risks existing in the municipalities' territories and mentioning measures to mitigate them; "Decarbonization and energy source", which deal with ways to achieve net-zero, or how to reduce greenhouse gas emissions in pursuit of decarbonization and renewal of energy matrices; and "Resilience and Sustainability", which deals with ways to make the city more resilient and also more sustainable.

Thus, it was possible to observe that cities in the Global South mostly have "Climate action plans and strategies", with only one of the cities that have plans aimed at "Resilience" or "Decarbonization" also not having a "Climate action plan and strategies". Cities in the Global North, on the other hand, showed greater variability in the approach to plans, as, although they still have a predominant presence of "Action plans and climate strategy", 35% of cities do not present this topic in any of their plans.

Furthermore, despite the focus of the search being "Climate action plans", almost half of the plans studied were not classified as belonging to this typology. Thus, it is noted that the "Decarbonization and energy sources" plans occupy the second position with a total of 12 publications and, adding to the "Adaptation" and "Resilience and sustainability" plans, it reaches around 45% of the total publications.

During the analysis of the content of the plans, it was possible to observe that part of the plans had deadlines for achieving the goals proposed in their development. Thus, the years established as a target to achieve the objectives proposed in the plans were also analyzed, when this information was explicit in the document, for the Global North (Figure 2d) and for the Global South (Figure 2e).

And thus, it was observed that the years 2050 and 2030 consist of the main stipulated dates, with the sum of the two years leading to 76% of publications with deadlines for action in the Global North and 59% in the Global South. It is observed that these two annual milestones align with the main existing climate agendas.

Furthermore, advancing in the analysis of the content of the plans, it was found that there are some cities whose plans do not effectively address the issue of rising sea levels, even if their territories will suffer from its consequences. Therefore, the total number of cities that deal with this issue was quantified: specifically, where rising sea levels are identified as a problem and strategies are presented to combat them; general, where sea level rise is only mentioned as a problem, but no measures are indicated to deal with it; and cases where it is not addressed. Figure 3 presents the graphs that calculate the number of cities and plans with each of these approaches and the year of publication of only the plans with a specific approach.

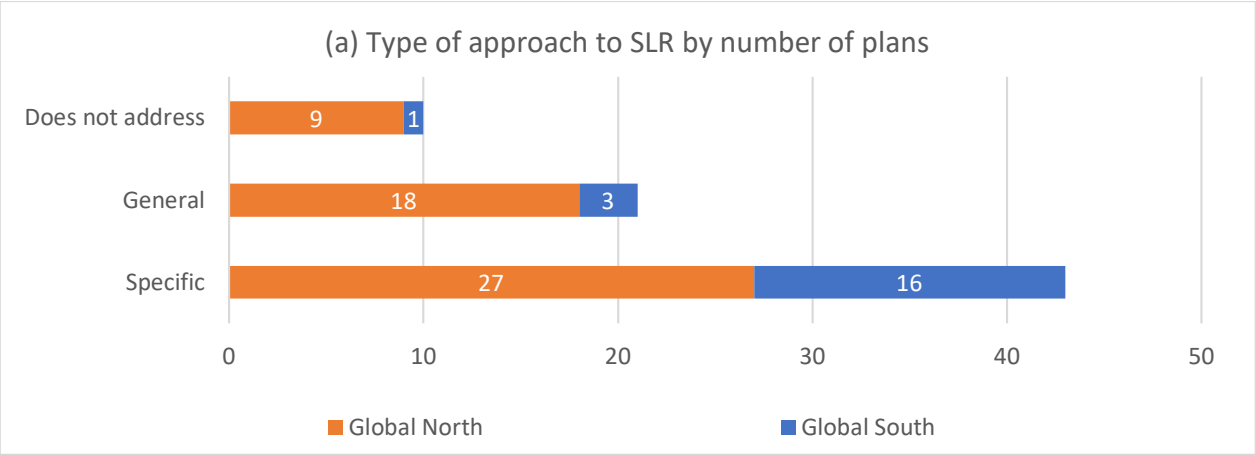
It is possible to note that regarding the total number of plans that address the issue with SLR, of the 74 studied plans, 10 do not deal with the subject and 21 only mention rising sea levels as a threat to their territories but did not demonstrate any additional action. However, the finding that 43 of the city plans analyzed already present strategies to deal with this problem demonstrates the assertiveness of the approach (Figure 3a).

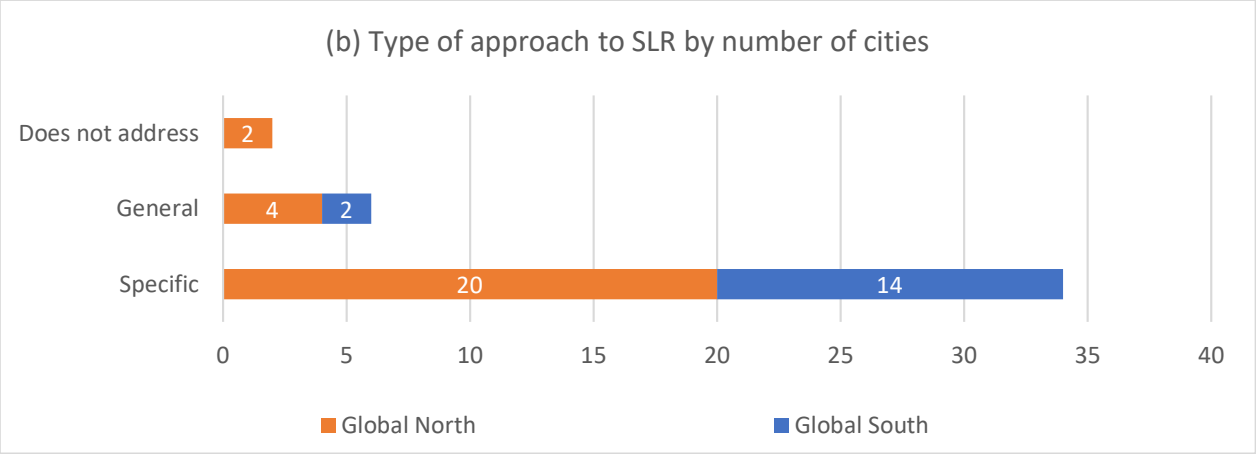
And the data for cities further demonstrate the correct choice of the study objects, given that only two cities do not deal with the SLR, six deal with it in a general way and 34 deal with the sea level rise in a specific way (Figure 3b).

It is also observed that an imbalance remains in relation to the specific approach to sea level rise between the Global North and South. The proportion of 27 plans for 20 cities with a specific approach to the Global North leads to an average of 1.35 plans per city. In the South, the 16 plans for 14 cities generate only 1.14 plans per city dealing with SLR specifically.

It is also noted that there are only cities with one or two plans that specifically address sea level rise. There are seven cities in the Global North with two computed plans, all of them American. In the Global South, there are two cities included.

The analysis of the graph containing the dates of the most recent studies related to sea level rise specifically also demonstrates growth in the topic (Figure 3c), but





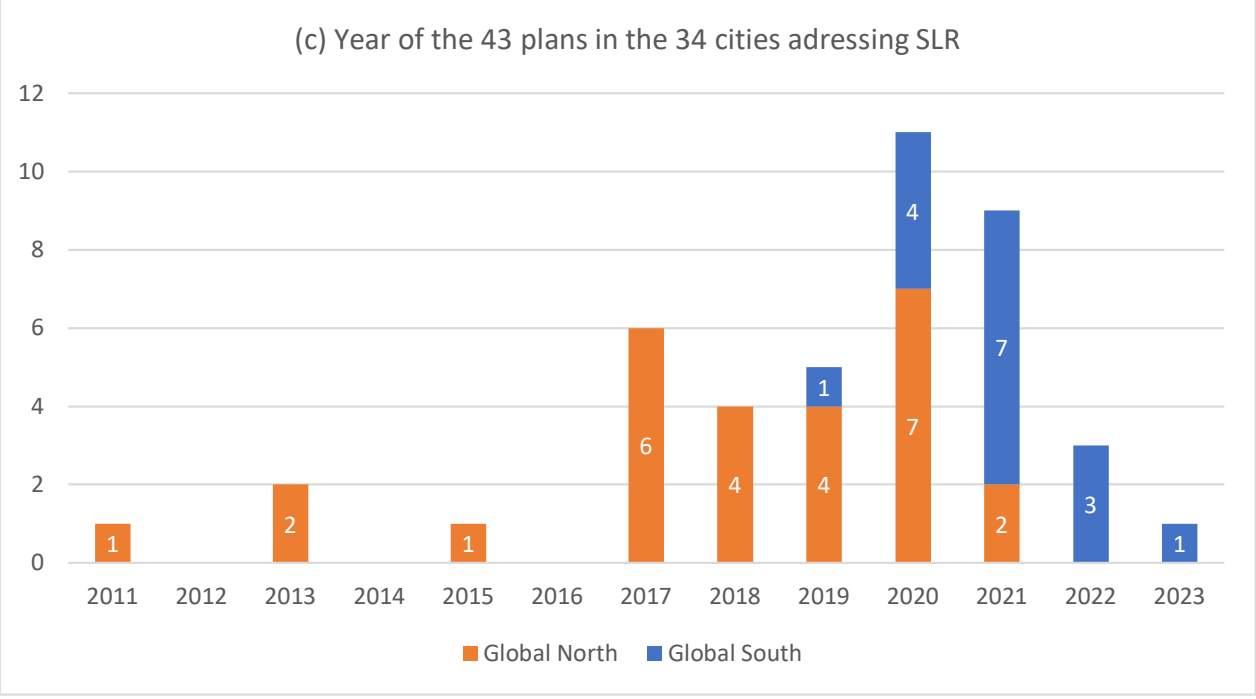
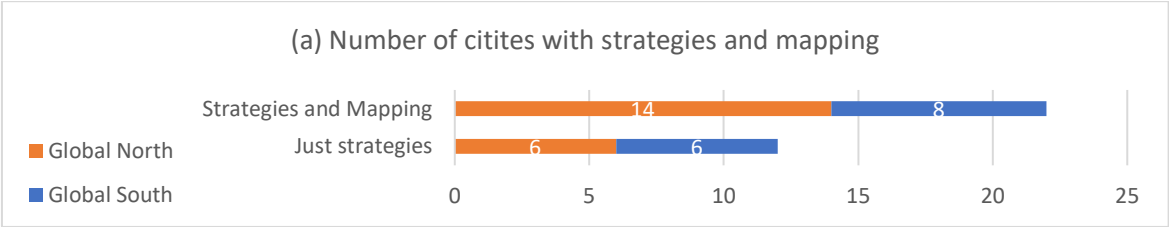
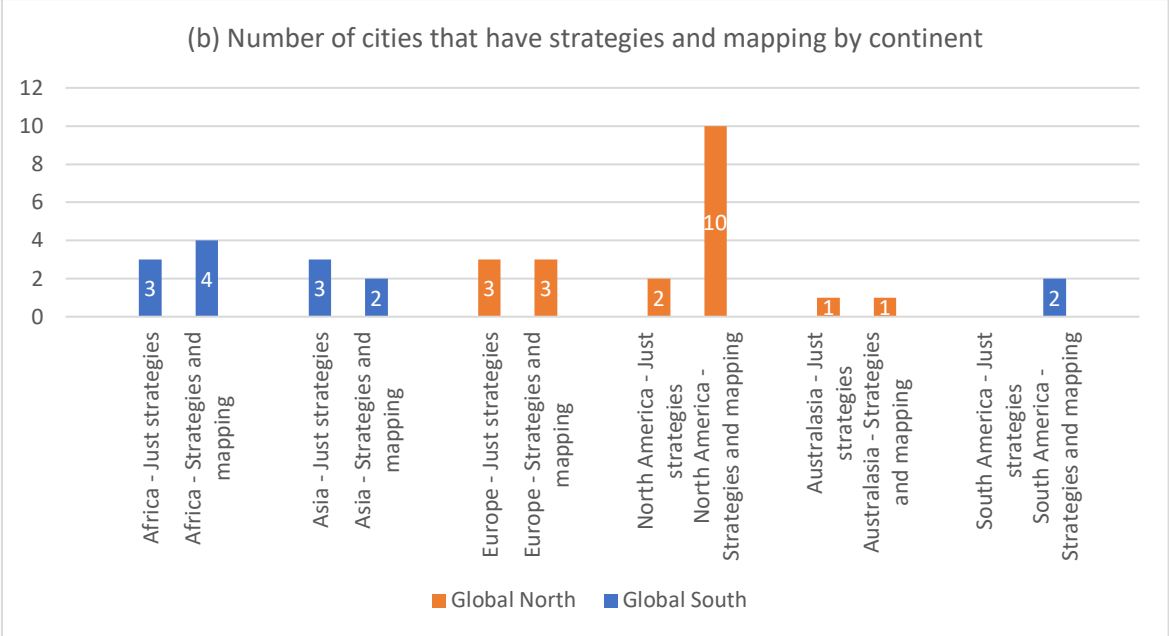
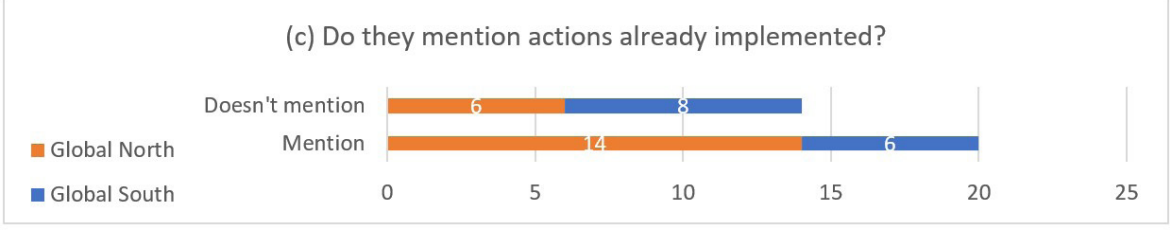


Figure 3. Graphic representation of: (a) Type of approach to SLR by number of plans (b) Type of approach to SLR by number of cities (c) Year of the 43 plans in the 34 cities adressing SLR

Source: The authors.







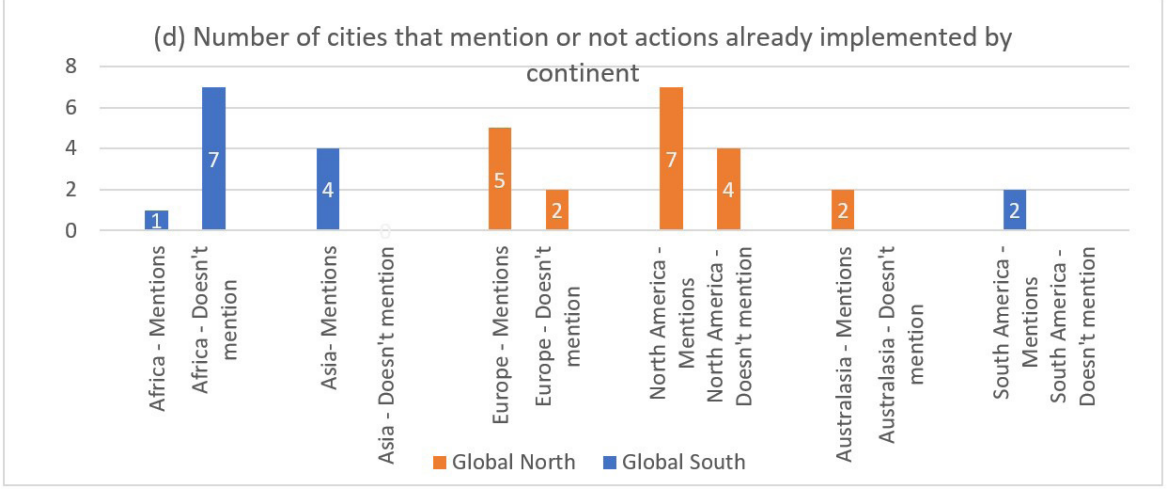


Figure 4. Number of cities (a) with strategies and mapping (b) that have strategies and mapping by continent (c) that mention or not implemented actions and (d), that mentions or not implemented actions by continent

Source: The authors.

more irregular than the growth in the number of plans in general (Figure 2b). It is also observed that, in this graphic, the plans drawn up by cities in the Global South, only started in 2019. They were again later than those in the Global North, started in 2011.

Continuing with the computation of the data obtained, we sought to quantify among the 34 cities with a specific approach, those that only presented strategies and those that already presented mappings of areas influenced by the increase in sea level in their territory, so that could it be identified how developed their plans were.

This is due to the fact that mapping already presupposes a study of the specificities of their territories, while the simple presence of strategies to combat sea level does not guarantee adequacy to the territory's own characteristics and, sometimes, these may be ineffective actions when replicated from places with different contexts. Such data are represented in Figure 4, which also includes the differentiation of cities in the Global North and South and the separation of results by continent.

It is possible to observe, from the graph containing the number of cities with strategies and mappings (Figure 4a), that both in the Global North and South there is already a predominance in the number of cities with mapping presented, which is a positive result. However, it is important to note that, although most cities already have strategies to combat sea level rise and mapping, it is considered that there is still a significant number of cities that have not yet presented identification in their plans of areas that will be flooded and that need to be protected.

In addition, there is proportional evidence of new inequality between the North and the South, given that there are 14 cities with mapping for six cities with strategies only in the North, while in the South the proportion is only eight to six.

However, it can be seen from the graph with the distribution by continents (Figure 4b) that only North America stands out with its mappings in relation to just strategies. No other continent, whether in the Global North or South, has significant differences in values.

In addition to this quantification, among the 34 cities with a specific approach, those whose plans expressed results or descriptions of actions already implemented related to sea level rise were also calculated. Such data is important to identify cities' capacity to implement proposals and their power to act, which are fundamental for adequately addressing the consequences of climate change. These results (represented in Figure 4c and Figure 4d) also contains the differentiation of cities in the Global North and South and the separation of results by continent.

Thus, when analyzing the graph referring to the actions already implemented (Figure 4c), the differentiation between the global North and South becomes even more evident. While in the North the proportion of cities with actions already implemented in relation to cities without implementing actions is 14 to six, in the South this proportion is six to eight. In other words, while the global North has more than double the number of cities with actions already implemented compared to those without, in the South there are more cities without implemented actions than with actions already taken.

Such data are particularly worrying given that the use of actions to combat climate change in general depends on a series of factors, ranging from the governance capacity of managers and convincing public opinion to issues of economic and technical viability. Therefore, being able to implement an action requires a series of steps and time. And, given that the effects of rising sea levels are already being observed in some places, delays in action can lead to a point of no return in certain contexts, causing the vulnerabilities of certain populations to be accentuated.

Thus, it is possible to see that the data indicates a potential for an increase in distinctions between the Global North and the Global South, with a potential to strengthen climate injustices. This statement becomes even more assertive when analyzing the data from the graph of actions implemented by continent (Figure 4d). In it, it is possible to identify a significant gap in the capacity of African cities to implement actions. The continent is the only one with a greater number of plans that do not mention applied actions compared to those that do, and with a ratio of seven to one. This data highlights how necessary it is for the African continent to advance in implementing actions to combat rising sea levels, otherwise it risks further accentuating its vulnerabilities.

To enter a new category of analysis, it is known that the use of strategies drawn up in climate plans must be in accordance with the mappings and simulations carried out. And, to this end, an adequate characterization of possible future climate scenarios is necessary. Therefore, the standardization of criteria and scenarios used as a basis for carrying out simulations is one of the factors that can contribute to the validation of the maps presented in the plans. So, among the 42 cities studied, were investigated which ones used the future climate scenarios present in the IPCC reports as a basis for their mapping and simulations.

It was found that most cities already use the IPCC as a basis for implementing their climate action plans, in a proportion of 23 to 19, that is, around 55% to 45% of the total of 42 cities. In addition, it was noted that in some of the plans the sources used for mapping and simulations

do not disclose, so it is possible that the number of cities using IPCC data is even greater. However, the fact that more than half of the cities already use the organization's data already identifies that it is the main source of data available and highlights that the IPCC should be used for future climate simulations.

Additionally, as the IPCC has its data updated periodically through its reports, it is important to identify which version of the reports is being used by the cities. It was possible to observe that most of the climate action plans that use the organization as a basis for their simulations –21 of the 23 total plans– are working with data from the AR5 fifth assessment report published in 2014. However, there is already a sixth version of the assessment report, from 2022, the AR6, in which only one of the plans has already been updated and, there is also a plan working with an even older version than AR5.

It should be noted, however, that most of the plans computed are prior to 2022, so it is natural that, as new climate action plans emerge, data from the AR6 will be incorporated, replacing the old AR5 data.

Finally, among the different possible climate scenarios, it is important to calculate which greenhouse gas emission trajectory is being adopted, so that it is understood whether cities are preparing for light, medium or high emissions scenarios.

Given that most plans are based on the fifth version of the IPCC Assessment Report, AR5, the scenarios were computed according to the RCPs system, instead of the SSPs system, which is the present in the most updated report.

The results indicate that: 11 cities use actions for RCP 4.5 and RCP 8.5 scenarios; 3 cities for RCP 2.6 and RCP 8.5; 1 city for RCP 2.6, RCP 4.5 and RCP 8.5; 3 cities only for RCP 8.5 scenario. And 5 other cities used other scenarios without the RCP 8.5.

Therefore, it was noted that the RCP 8.5 emissions scenario, considered the worst possible scenario among those available in the AR5 model, is the one most used by cities, showing that they seek to prepare for the worst possible consequences of rising sea levels. This finding is also positive, since it is understood that the actions taken to face the consequences predicted for the RCP 8.5 scenarios will also be sufficient for other future scenarios.

The finding that the RCP 4.5 scenario – considered intermediate emissions and one of the most likely to be achieved – is the second most used, also shows an alignment of cities with the most recent climate research publications, which indicate that light emission scenarios, such as RCP 1.9 and RCP 2.6, are unlikely to be achieved.

Conclusions

From the results obtained, it is concluded that the methodological procedures used to carry out the experiment are sufficient to achieve the proposed objective. Furthermore, the relevance of the topic studied is reinforced based on the number of publications identified dealing with the topic and based on the identification of shortcomings in some climate action plans.

It is expected that the gaps identified can be addressed by the managers of the municipalities in question, updating existing plans and giving the necessary focus to the issue of rising sea levels.

The methodology applied can also be used to carry out similar studies regarding other stressors arising from climate change, such as heat islands – if it undergoes some changes specific to the subject.

It is also concluded that the results show the possibility of an increase in climate injustices if the differences between the plans of countries in the Global North and the Global South remain. Therefore, it is imperative to employ appropriate actions to better adapt the cities part of the Global South.

It is therefore recommended that city managers in the Global South develop their climate action plans by integrating the necessary actions with appropriate vulnerability mapping and action implementation. In terms of scientific research, the next steps for continuing research in this area include regular monitoring of updates to coastal city plans and literature reviews of the policies implemented in the cities studied.

References

C40 CITIES CLIMATE LEADERSHIP GROUP. (2023). *About* C40. C40Cities. https://www.c40.org/about-c40/

C40 KNOWLEDGE HUB. MAPPED: *Cities whith a climate action plan.* (2023). C40 Cities. www.c40knowledgehub.org/s/article/Mapped-Cities-with-a-climate-action-plan?language=en_US

CALVIN, K. ET AL. (2023). IPCC, 2023: *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.* [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland. https://www.ipcc.ch/report/ar6/syr/

CLEMENT, V. ET AL (2021). *Groundswell Part 2: Acting on Internal Climate Migration.* World Bank, USA. https://openknowledge.worldbank.org/entities/publication/2c9150df-52c3-58ed-9075-d78ea56c3267

CLIMATE ANALYTICS AND NEXCLIMATE INSTITUTE (2022). *The CAT Thermometer.* Climate Action Tracker. https://climateactiontracker.org/global/cat-thermometer/

CLIMATE CENTRAL (2023). *Coastal Risk Screening Tool.* Climate central. https://coastal.climatecentral.org/

DADOS, N., & CONNELL, R. (2012). The global south. *Contexts, 11*(1), 12-13. https://doi.org/10.1177/1536504212436479

LI, H.; GRANT, R. J. (2022). Climate gentrification in Miami: A real climate change-minded investment practice? *Cities, 131*. https://doi.org/10.1016/j.cities.2022.104025

NURHIDAYAH, L.; MCILGORM, A. (2019). Coastal adaptation laws and the social justice of policies to address sea level rise: An Indonesian insight. *Ocean and Coastal Management, 171*, 11-18. https://doi.org/10.1016/j.ocecoaman.2019.01.011

OPPENHEIMER, M. *ET AL.* (2019). Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. Pörtner, H.-O. et al. (Eds.). *IPCC Special Report on The Ocean and Cryosphere in a Changing Climate.* Cambridge University Press. https://www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/

PAULIK, R. *ET AL.* (2020) National-Scale Built-Environment Exposure to 100-Year Extreme Sea Levels and Sea-Level Rise. *Sustainability 12*(4), 1513. https://doi.org/10.3390/su12041513

STRAUSS, B. H., KULP, S. A., RASMUSSEN, D. J., & LEVERMANN, A. (2021). *Unprecedented threats to cities from multi-century sea level rise.* Environmental Research Letters. https://doi.org/10.1088/1748-9326/ac2e6b