Joint Research Centre

Global Covenant of Mayors: A Comprehensive Assessment of Climate Adaptation Plans

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2025

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JRC144177
EUR 40515

PDF ISBN 978-92-68-33096-8 ISSN 1831-9424 doi:10.2760/3086954 KJ-01-25-546-EN-N

Luxembourg: Publications Office of the European Union, 2025

How to cite this report: Treville, A., Kuster, C., Palermo, V., Barbosa, P., Hernandez Moral, G. et al., *Global Covenant of Mayors: A Comprehensive Assessment of Climate Adaptation Plans,* Publications Office of the European Union, Luxembourg, 2025, https://data.europa.eu/doi/10.2760/3086954, JRC144177.

Contents

Abstract

In a comprehensive analysis of climate adaptation efforts, this report reveals significant progress and challenges in addressing climate hazards and vulnerabilities worldwide by the Global Covenant of Mayors for Climate and Energy (GCoM) municipalities. 3 538 municipalities have conducted risk and vulnerability assessments (RVAs), with extreme heat, droughts, and floods identified as prevalent climate hazards. Notably, only 67 % of high-risk hazards have corresponding adaptation actions in place. A substantial gap persists between identified risks and the implementation of actions, particularly in vulnerable sectors and populations. Policymakers are called to bridge this gap to improve resilience against climate impacts.

Acknowledgements

This work has been developed by the European Commission's Joint Research Centre as part of its activities in support to the Global Covenant of Mayors for Climate and Energy.

We would like to thank the Directorate-General for Energy (DG ENER) and the Directorate-General for Climate Action (DG CLIMA) for their strategic vision and guidance on the Global Covenant of Mayors initiative and for their comments on this document.

We also thank the Global Covenant of Mayors Secretariat for the valuable work with municipalities, for the data management support and for reviewing this document.

Additionally, we are grateful to our colleagues at the JRC, who have provided thorough reviews and feedback on this document, enhancing its quality and relevance.

The authors are also grateful to Christian Thiel for his unwavering support and guidance.

Authors

Treville, A., C. Kuster, Palermo, V., Barbosa, P., Hernandez Moral, G. Melica, G.

Executive summary

As cities and regions worldwide face escalating climate challenges, the importance of robust climate adaptation strategies has never been more critical. This report presents a comprehensive analysis of adaptation efforts undertaken by municipalities of the Global Covenant of Mayors for Climate and Energy (GCoM), utilising data from official reporting platforms.

Policy context

Cities and local authorities are pivotal in climate adaptation efforts, a role emphasised by the European Commission since the Covenant of Mayors' (EU CoM) inception in 2008. Originally focusing on energy emissions, the initiative broadened with the 2015 adaptation pillar and the 2016 formation of the Global Covenant of Mayors for Climate and Energy (GCoM). These efforts align with the EU Adaptation Strategy and the EU Adaptation Mission, reinforcing the European Green Deal's objectives. These frameworks prioritise enhancing urban resilience to climate impacts, emphasising municipalities' roles in implementing climate adaptation measures. By fostering local engagement and addressing vulnerabilities, these initiatives are crucial to the EU's commitment to building climate-adaptive communities.

Key conclusions

The report underscores the necessity for enhanced and targeted adaptation actions to mitigate high-risk climate hazards. It suggests that current policies could be refined to better address region-specific vulnerabilities and align actions with identified risks. Key recommendations include prioritising adaptation strategies for extreme heat, droughts, and floods, and improving data collection for informed decision-making. The findings confirm the importance of existing measures but highlight gaps in addressing vulnerable populations. New policy measures should consider these gaps and leverage innovative solutions to build resilience. Significant knowledge gaps remain, particularly in understanding the regional impacts of climate hazards, necessitating further research and policy adjustments.

Main findings

The report identifies that 85 % of Risk and Vulnerability Assessments (RVAs) highlight extreme heat as a primary hazard, with droughts (79 %) and floods (78 %) following closely. Vulnerabilities are significant in sectors like agriculture (14 %), biodiversity (12 %), and water supply (9 %). There is a notable gap between identified risks and actions, with only 60 % of reported vulnerable sectors addressed by adaptation measures. Data integration improvements are crucial to enhance policy effectiveness. The findings emphasize the need to prioritise high-risk hazards and incorporate vulnerable groups, ensuring comprehensive adaptation strategies. By addressing these gaps, the report offers a basis for more targeted climate adaptation policies.

Related and future Joint Research Centre work

This report is part of a series of JRC reports assessing the Covenant status in order to track the overall progress of the initiative based on action plans and monitoring reports transmitted by Global Covenant cities (European Commission. Joint Research Centre., 2022a, 2022b, 2024).

Specific aspects of the Covenant are also explored in dedicated studies (e.g. adaptation actions tackling urban overheating (Ulpiani, Treville et al., 2024; Ulpiani, Yenneti et al., 2024), methodology

to harness GCoM data (Franco et al., 2024), and key GHG predictors of mitigation and adaptation cities (Franco et al., 2023, 2022)).

Quick guide

This report offers an overview of climate adaptation efforts under the Global Covenant of Mayors (GCoM). It analyses data from MyCovenant, up to January 2025, (Bezerra, Paula; Papaiordanidis, Stefanos; Kuster, Corentin; Treville, Aldo; Melica, Giulia, 2025) and CDP-ICLEI Track, up to December 2024 (CDP, 2024), focusing on adaptation plans from municipalities worldwide. Key concepts include 'Risk and Vulnerability Assessments (RVAs)' which identify climate risks from hazards like extreme heat and floods, and 'adaptation actions,' which encompass measures, strategies, and local policies such as climate-proofing urban infrastructure to effectively address these risks. The methodology involves evaluating reported data from the two platforms and selecting appropriate variables to analyse the adaptation efforts.

1. Introduction

In the face of growing climate challenges, cities and regions worldwide are increasingly recognising the importance of climate adaptation strategies. This report provides a comprehensive analysis of adaptation efforts across various regions, highlighting the risks, vulnerabilities, and actions undertaken by municipalities [1]. By leveraging data from the Global Covenant of Mayors for Climate and Energy (GCoM) reporting platforms, this document aims to offer insights into the current state of climate adaptation initiatives and their effectiveness.

The report begins by outlining the Global Covenant of Mayors' approach to adaptation, emphasising the commitment to conducting thorough risk and vulnerability assessments (RVAs) and defining targeted adaptation actions. It then delves into an in-depth analysis of climate hazards, vulnerable sectors, and population groups, presenting key findings and trends observed across different regions. Furthermore, the report examines the alignment and gaps between identified vulnerabilities and the adaptation actions implemented, providing a critical assessment of current practices.

Through this detailed exploration, the report seeks to inform policymakers, stakeholders, and practitioners about the progress and challenges in climate adaptation at local level, fostering a collaborative effort towards building more resilient communities.

The report is organised into several key sections. Section 2 outlines the GCoM's approach to climate adaptation, detailing the framework and goals. Section 3 discusses the datasets and methodology, including data sources and analytical techniques used to gather and assess climate adaptation efforts. Section 4 delves into RVAs, highlighting climate hazards, vulnerable sectors, and population groups, with a regional focus on these areas. Climate adaptation goals are explored in Section 5, setting the groundwork for Section 6, which examines the actions taken to address identified risks, including cross-sectoral initiatives and their regional applications. Section 7 investigates the adaptation ‘gap’ by analysing potential incoherence between risk assessments and actions. Section 8 covers monitoring efforts to track progress, and the report concludes with Section 9, summarising key insights and providing recommendations.

[1] Throughout this document, the term ‘municipalities’ is used to refer to the cities and local governments that are signatories of the Global Covenant of Mayors (GCoM). These terms are used interchangeably to denote the same entities involved in climate adaptation efforts under the GCoM framework.

2. The Global Covenant of Mayors’ approach to adaptation

The Global Covenant of Mayors' approach to climate adaptation is structured around five key components, and data is collected and reported for each of them:

1. Commitment to climate adaptation: municipalities pledge to take decisive action to adapt to the changing climate, demonstrating leadership and responsibility at the local level.
2. Risk and vulnerability assessment (RVA): each participating municipality conducts a detailed RVA to identify climate hazards and the most vulnerable sectors and groups within their jurisdiction. This assessment forms the foundation of their adaptation planning.
3. Defining adaptation goals: based on the RVA findings, municipalities set clear and measurable adaptation goals. These goals guide the development of strategies and actions tailored to local needs and priorities.
4. Developing adaptation actions: local governments define and prioritise specific adaptation actions that address the identified vulnerabilities. These actions are designed to enhance resilience and reduce risks across various sectors.
5. Monitoring progress: continuous monitoring and evaluation are integral to the adaptation approach. By tracking progress, municipalities can assess the effectiveness of their actions and make necessary adjustments to improve outcomes.

Reporting requirements on adaptation for GCoM are set by the Common Reporting Framework (CRF), a set of global recommendations aimed at streamlining measurement and reporting procedures, to enable global aggregation and comparison of data.

3. Datasets and methodology

3.1. Data sources

The datasets used in this report are sourced from the MyCovenant (Bezerra, Paula; Papaiordanidis, Stefanos; Kuster, Corentin; Treville, Aldo; Melica, Giulia, 2025) and CDP-ICLEI Track [2] (CDP, 2024) reporting platforms and their reported data with a cut-off date of January 2025 and December 2024 respectively. The integration of these ensures a comprehensive dataset, capturing the diverse climate adaptation data and initiatives undertaken by municipalities and regions worldwide. Where discrepancies were identified due to differing data collection methods or regional variations, the definitions and methodologies from the GCoM Common Reporting Framework (CRF) (GCoM, 2023) were applied to standardise the analysis. Hence, 'GCoM data' in this report refers to the aggregated datasets from these platforms, reflecting the latest available information. **Table 1** below summarises the number of GCoM municipalities by region, highlighting those that have reported risk and vulnerability assessments (RVAs) and adaptation actions.

Table 1. GCoM municipalities and adaptation action plans by region.

GCoM Region	Total municipalities	with reported RVA		with reported adaptation actions	
European Union & Western Europe	11 044	2 481	22 %	2 298	21 %
Eastern Europe & Central Asia	808	209	26 %	194	24 %
Latin America & the Caribbean	760	403	53 %	350	46 %
Sub Saharan Africa	393	60	15 %	63	16 %
Middle East & North Africa	327	38	12 %	54	17 %
North America	251	184	73 %	179	71 %
Southeast Asia	111	68	61 %	68	61 %
East Asia	85	35	41 %	35	41 %
Oceania	54	33	61 %	32	59 %
South Asia	53	27	51 %	26	49 %
Grand Total	13 886	3 538	25 %	3 299	24 %

Source: JRC elaboration based on GCoM data

Notably, only 25 % of municipalities have reported information on the adaptation pillar. This limited reporting is partly due to the historical focus of the European Covenant of Mayors on mitigation efforts. Mitigation, in this context, refers to the reduction of greenhouse gas (GHG) emissions through a series of actions across various sectors such as energy, transportation, and waste management. Originally, the initiative began with a commitment to mitigation, particularly in Europe. Over time, the scope expanded to include adaptation, reflecting the growing recognition of the need to address climate impacts comprehensively. Adaptation involves implementing strategies

[2] CDP-ICLEI Track is a climate reporting platform and progress tracker for cities developed by the Carbon Disclosure Project (CDP) and the International Council for Local Environmental Initiatives (ICLEI).

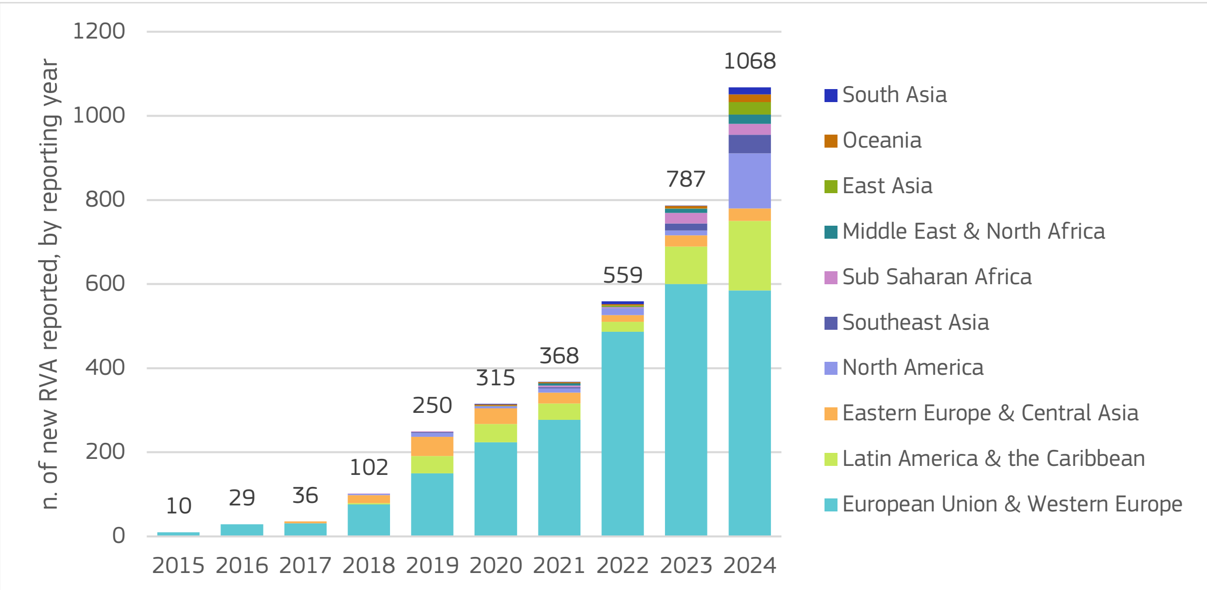
and policies to increase resilience against climate-related hazards such as extreme weather events, including measures like enhancing flood defences and climate-proofing urban infrastructure.

Regions such as North America and Oceania exhibit high levels of engagement, with 73 % and 61 % of municipalities reporting RVAs, respectively. This contrasts with regions like the Middle East & North Africa and Sub-Saharan Africa, where engagement in adaptation remains comparatively lower at 12 % and 15 %, respectively. Latin America & the Caribbean and South Asia also show significant participation, with more than half of its municipalities reporting RVAs.

There are 3 299 municipalities reporting adaptation actions (24 % of the total), with similar but slightly lower shares compared to the RVA reporting. The only exception are Sub-Saharan Africa and Middle East & North Africa, where there are municipalities reporting actions without having completed an RVA. The GCoM approach, as detailed in section 2, ideally involves planning adaptation actions following the completion of an RVA and goal setting to ensure coherence. However, the reporting platforms allow for the submission of adaptation actions even without an RVA, accommodating initiatives that address both mitigation and adaptation, or those arising from specific ongoing projects.

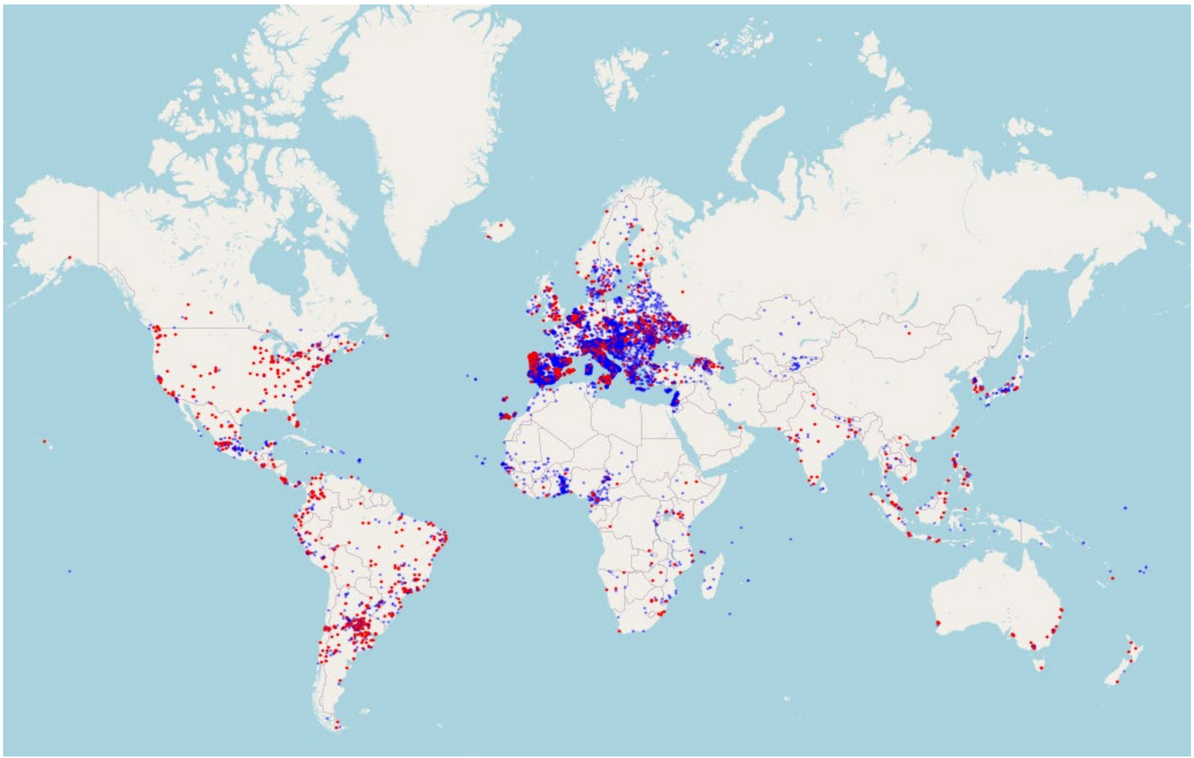
Figure 1 illustrates the annual growth and regional distribution of Global Covenant of Mayors (GCoM) municipalities reporting adaptation RVA information from 2015 to 2024, and **Figure 2** show their geographical distribution. The total number of RVAs has increased over time, reaching 3 538 as of December 2024. Overall, there is a positive trend with a noticeable increase in 2023 and 2024. The European Union & Western Europe region leads with a significant number of municipalities, accounting for approximately 70 % of the total. Latin America & the Caribbean and Eastern Europe & Central Asia regions also show substantial engagement, with 403 and 209 municipalities, respectively. North America, with 184 municipalities, demonstrates varying but consistent growth, particularly peaking in 2024. Southeast Asia, Sub-Saharan Africa, and the Middle East & North Africa have fewer municipalities but show a gradual increase in participation, especially in the later years, suggesting growing awareness and involvement of municipalities reporting adaptation information (RVAs).

Figure 1. GCoM municipalities reporting information per reporting year.



Source: JRC elaboration based on GCoM data

Figure 2. GCoM municipalities (in blue) and municipalities reporting RVAs (in red).



Source: JRC elaboration based on GCoM data

3.2. Methodology

In the development of a comprehensive dataset for the GCoM, data from the CDP-ICLEI Track and MyCovenant platforms was methodically integrated to support various analyses, including those for the annual GCoM impact reports and research initiatives. The methodology adopted ensured a systematic consolidation of data from these two primary sources, ensuring its applicability and reliability.

The initial step involved identifying and accessing datasets from CDP-ICLEI Track, spanning the years 2018 to 2024 (CDP, 2024), and the MyCovenant data up to January 2025 (Bezerra, Paula; Papaiordanidis, Stefanos; Kuster, Corentin; Treville, Aldo; Melica, Giulia, 2025). These datasets were sourced through the CDP Open Data Portal and JRC data catalogue, respectively. The CDP-ICLEI Track data was compiled into a comprehensive dataset by merging data from all available years, with a focus on retrieving the most recent information from all municipalities while ensuring the inclusion of historical data to provide necessary context and continuity. Notably, the CDP-ICLEI Track data is not subject to a cleaning process, whereas the MyCovenant data undergoes a rigorous quality-harnessing procedure by the JRC to ensure data accuracy and coherence (Franco et al., 2024).

Following this, a comparison and merging process with MyCovenant data was initiated. Using the GCoM unique identifier (GCoM ID) as a reference point, CDP-ICLEI Track data was combined with MyCovenant data to create a new consolidated file. In instances where municipality data was present in both platforms, a merging process was employed, systematically removing less recent or incomplete data to maintain the dataset's integrity and accuracy.

To standardise data fields across the two platforms, adaptation tables were structured to include mandatory fields as per the GCoM Common Reporting Framework (CRF). This included aligning fields such as climate hazards, probability, impact, and intensity, among others. Conversion tables were developed to reconcile differences in terminology and options between MyCovenant and CDP-ICLEI Track datasets, ensuring consistency and facilitating an accurate merging process.

The methodology placed a strong emphasis on prioritising data completeness. Where discrepancies in the number of records existed between datasets, the dataset with a higher number of records was prioritised, ensuring the most comprehensive data was utilised. Furthermore, detailed documentation of the data consolidation process was maintained to enable future updates and ensure the replicability of the methodology for analyses in subsequent years.

Additionally, while the primary focus was on integrating common data fields, the methodology also acknowledged the potential of using additional data available only on one platform for future research, detailed analyses, and complementary charts. This comprehensive approach to data integration provided a robust foundation for analysing aggregated GCoM data, offering valuable insights for policymaking and research initiatives.

Lastly, two methods were employed to analyse the datasets and are outlined in the following sections: 1) a first method involves counting the total number of reported records (i.e. hazards, sectors, groups) and calculating their respective shares; 2) the second, alternative method counts the number of GCoM municipalities reporting each type of data (i.e. hazard, sector, group) at least once. The second approach avoids double counting because it focuses assessing the frequency of each data point's mention across municipalities, rather than simply aggregating the total reported instances.'

Table 2 summarises the analysis conducted in each of the following sections, highlighting the attributes, records, and plans examined. Section 4 covers risk and vulnerability assessments, analysing thousands of climate hazards, vulnerable sectors, and population groups. Section 5 reviews 7 318 climate adaptation goals. Section 6 assesses 33 699 adaptation actions, including those targeting specific hazards and sectors. Section 7 identifies gaps and incoherences between RVAs and actions. Section 8 focuses on monitoring data for adaptation actions. Overall, the report evaluates a total of 3 538 GCoM municipalities, offering a comprehensive view of climate adaptation data reported within the GCoM framework.

Table 2. Summary table with the number of attributes examined in each section.

Sections	Attributes analysed	N. of records analysed	N. of plans analysed
Section 4 Risk and vulnerability assessments (RVAs)	Climate hazards	25 439	3 538
	Vulnerable sectors	72 251	3 246
	Vulnerable population groups	27 590	2 054
Section 5 Climate adaptation goals	Climate adaptation goals	7 318	2 186
Section 6 Climate adaptation actions	Adaptation actions	33 699	3 299
	Adaptation actions addressing climate hazards	20 789	2 729
	Adaptation actions addressing vulnerable sectors	31 739	3 077
	Adaptation actions addressing vulnerable population groups	8 344	1 042
Section 7 Adaptation 'gap' and potential incoherence among RVA and actions	High-risk climate hazards in RVA and in adaptation actions	3 770	1 667
	Vulnerable sectors in RVA and in adaptation actions	71 115	3 172
	Vulnerable population groups in RVA and in adaptation actions	6 654	1 730
Section 8 Monitoring	Climate adaptation actions with implementation data	32 911	3 130
Total GCoM municipalities analysed			3 538

Source: JRC elaboration based on GCoM data

4. Risk and vulnerability assessments (RVAs)

As mentioned in **Table 1**, there are 3 538 GCoM municipalities with an RVA. In cases where multiple RVAs where found, the most recent one was retained for this analysis. Each RVA includes mandatory information on the climate hazards, as well as other information on vulnerable sectors and population groups.

4.1. Climate hazards

While only one hazard is the minimum reporting requirement, municipalities averagely identify six hazards, and the dataset includes more than 25 000 hazards. Each hazard has the following data associated:

- Level 1 (L1) hazard or level 2 (L2) sub-hazard
- Current hazard probability
- Current hazard impact/Consequence
- Expected change in hazard intensity
- Expected change in hazard frequency
- Timeframe: short-term, mid-term, long-term, not known (not possible to define).

The GCoM Common Reporting Framework, CRF (GCoM, 2023), as detailed in Annex D, offers a comprehensive list of climate hazards categorised into Level 1 (L1) and Level 2 (L2), along with detailed definitions and attributes for reporting climate hazard data. For this analysis, all reported hazards coming from the reporting platforms were re-classified using the CRF categories, with ten L1 categories (plus 'Other'), and some of them allowing a possibility of L2 sub-hazards.

Within the CRF, the risk is intended as the result of the combination of 'Probability of Hazard' and the 'Consequence of hazard'. The impact is therefore intended as the consequence of the climate event or hazard and is linked to exposure and vulnerability. The impact represents the realization of the risk driven by the hazard, the exposure, and the vulnerability. Further information on the definition of climate hazards and risk can be found in the guidebook published by JRC (European Commission. Joint Research Centre., 2025b).

A total of 25 439 records are reported for climate hazards, of which only 9 017 (37 %) specify a level 2 sub-hazard definition (see **Table 3**). In the table, hazards listed in bold refer to Level 1 (L1) categories, while those not in bold represent Level 2 (L2) sub-hazards. The term 'unspecified' indicates a Level 1 hazard that does not have a specified Level 2 sub-hazard.

Table 3. Climate hazards reported: L1 hazards and L2 sub-hazards .

Climate hazard	Count of records	%
Floods & sea level rise	**4 400**	**17.3 %**
(Unspecified)	2 743	
River flood	733	
Flash / surface flood	424	
Coastal flood	363	
Groundwater flood	104	
Permanent inundation	33	

Climate hazard	Count of records	%
Heavy precipitation	**3 888**	**15.3 %**
(Unspecified)	2 611	
Rain storm	786	
Hail	253	
Heavy snow	114	
Fog	110	
Monsoon	14	
Extreme heat	**3 293**	**12.9 %**
(Unspecified)	3 091	
Heat wave	120	
Extreme hot days	82	
Droughts & water scarcity	**2 914**	**11.5 %**
Drought	2 819	
(Unspecified)	95	
Storm & wind	**2 702**	**10.6 %**
(Unspecified)	1 620	
Severe wind	675	
Lightning / thunderstorm	181	
Cyclone (Hurricane / Typhoon)	80	
Tropical storm	45	
Tornado	44	
Storm surge	44	
Extra tropical storm	13	
Wildfires/Wildfires [3]	**2 647**	**10.4 %**
(Unspecified)	2 020	
Forest fire	479	
Land fire	148	
Mass movement	**1 980**	**7.8 %**
(Unspecified)	1 399	
Landslide	415	
Rock fall	73	
Subsidence	66	
Avalanche	27	
Extreme cold	**1 408**	**5.5 %**
(Unspecified)	1 336	
Extreme cold days	33	
Extreme winter conditions	20	
Cold wave	19	

[3] The CRF's guidance note (GCoM, 2019). defines 'Wild fire' as weather conditions conducive to triggering and sustaining wild fire, usually based on a set of indicators and combinations of indicators including temperature, soil moisture, humidity and wind. Fire weather does not include the presence or absence of fuel load. Forest fire: Type of wildfires in forested/wooded area. Land fire: (brush, bush, pasture) type of wildfires in a non-wooded area such as bush, grassland, scrub or pasture.
In this document, the CRF term 'wild fire' is also referred as 'wildfires' to be consistent with the terminology used by the JRC EU Science Hub and the Copernicus European Forest Fires Information System (EFFIS) (European Commission. Joint Research Centre., 2025a).

Climate hazard	Count of records	%
Biological hazards	**1 112**	**4.4 %**
(Unspecified)	557	
Insect infestation	179	
Vector-borne disease	170	
Water-borne disease	119	
Air-borne disease	87	
Other [4]	**763**	**3 %**
(Unspecified)	763	
Chemical change	**332**	**1.3 %**
(Unspecified)	187	
Atmospheric CO2 concentrations	81	
Salt water intrusion	51	
Ocean acidification	13	
Grand Total	**25 439**	**100 %**

Source: JRC elaboration based on GCoM data

Figure 3 shows both L1 and L2 sub-hazards, following the CRF definitions.

Based on the data analysed, the most frequently reported climate hazards in municipalities' RVAs are 'floods & sea level rise' (approximately 17 % of entries), with 'river flood' being the most common sub-hazard at 733 records. 'Heavy precipitation' accounts for 15 % of reports, with 'rain storms' leading as the predominant sub-hazard at 786 records. 'Extreme heat' represents 12 % of the entries. 'Droughts & water scarcity' make up 11 % of reports.

Further notable categories include 'storms & wind,' with 'severe wind' reported 675 times, and 'wildfires,' with 'forest fire' documented 479 times.

[4] The category 'Other' allows municipalities to report climate hazards not explicitly listed in the CRF categories. However, upon analysing the text entries under 'Other', it becomes apparent that they often include hazards already present in the list but written in a language other than English. In some cases, the text is in English but refers to a recognised climate hazard, suggesting a possible misunderstanding by the municipality (e.g., terms like 'extreme hot temperature' or 'increasing heat' should be classified as 'extreme heat'). Additionally, some entries describe impacts rather than climate hazards, such as 'loss in green space/green cover' or 'coastal erosion'. Occasionally, the text pertains to non-climate hazards (e.g., 'earthquakes') or other concerns (e.g., 'air pollution').

Figure 3. Most reported L1 climate hazards (inner circle) and L2 sub-hazards (outer circle) [5].

Source: JRC elaboration based on GCoM data

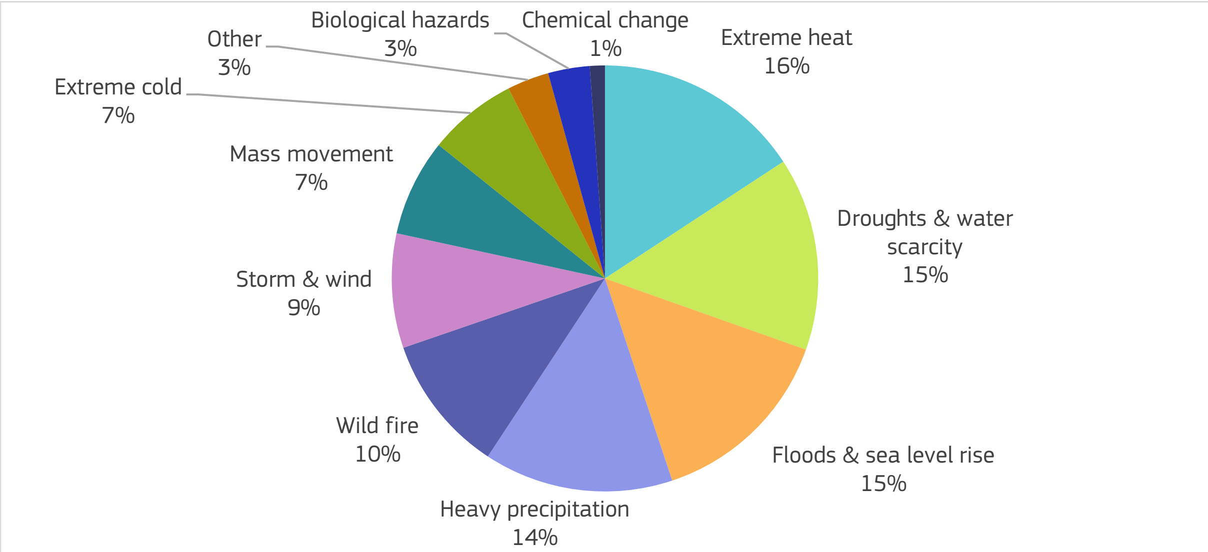
5 Due to the small size of some slices in the donut pie chart, labels may not be fully visible. Please refer to the accompanying **Table 3** for a detailed breakdown of all categories and their corresponding values and shares.

Both the CDP-ICLEI Track and MyCovenant reporting platforms can lead to duplicate entries, due to their respective storage methods, albeit in slightly different ways [6, 7]. When these datasets are aggregated, as explained in section 3.2, the duplication issue can result in an inflated count of reported hazards.

To address these duplication issues and provide a more accurate representation of the most reported hazards, a data cleaning process was undertaken. This process considered duplicates municipality by municipality, ensuring that only one hazard type (L1) could exist for each municipality. For example, if a municipality reported three flood hazards—L1 flood and sea level rise, L2 river flood, and L2 coastal flood—these were consolidated into a single L1 flood and sea level rise record. In doing so, the most severe characteristics among the original entries, such as the highest probability or most significant future frequency change, were used to represent the consolidated record. As a result of this cleaning process, the refined hazard dataset consists of 19 097 records, reduced from the original 25 439 records.

The following **Figure 4** shows the updated shares, with a shift in the most reported hazards, compared to **Figure 3**: extreme heat (16 %), droughts & water scarcity (15 %), floods & sea level rise (15 %), and heavy precipitation (14 %).

Figure 4. Most reported climate hazards in cleaned dataset.



Source: JRC elaboration based on GCoM data

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6 The CDP- ICLEI Track data contains numerous duplicate records, where the same hazard is reported multiple times with only minor differences in associated information. These differences may include variations such as identical text presented in different languages or the separate recording of vulnerable groups and sectors for each hazard ID, rather than linking them to a single hazard ID.

7 In MyCovenant reporting platform, duplicate records can occur due to the way Level 1 (L1) and Level 2 (L2) information is documented. For example, if a municipality reports both 'sea level rise' and 'river flood,' the system might generate an L1 record for 'floods & sea level rise' due to the overarching category, as well as separate L2 entries for each specific hazard ('sea level rise' and 'river flood'). This could lead to three records being created: one for the general category and two for the specific sub-hazards, instead of the expected two records (one for each specific hazard).

An alternative method to analysing reported hazards, which also avoids double counting, focuses on assessing how frequently each L1 hazard is mentioned across municipalities in their RVAs (see **Table 4**) [8], rather than summing the total reported hazards (as shown in the pie chart above). This methodology identifies whether L1 hazards were mentioned in each municipality's assessment and confirms the top reported hazards from the cleaned dataset without overrepresenting L1 hazards that encompass multiple sub-hazards, such as 'floods & sea level rise.'

— 'Extreme heat' is identified as a climate hazard in 85 % of RVAs, with 3 011 out of 3 538 municipalities mentioning it.

— 'Droughts & water scarcity' appear in 79 % of RVAs, reported by 2 799 municipalities.

— 'Floods & sea level rise' are present in 78 % of RVAs, cited by 2 763 municipalities.

— 'Heavy precipitation' is noted in 78 % of RVAs, with 2 743 municipalities mentioning it.

— 'Wildfires' is mentioned in 57 % of RVAs, with 1 999 municipalities reporting it.

— Other hazards appear in less than 50 % of RVAs: 'storm & wind' (47 %), 'mass movement' (40 %), 'extreme cold' (36 %), 'other' (17 %), 'biological hazards' (17 %), and 'chemical change' (6 %).

Table 4. Climate hazards reported in municipal RVAs.

Climate Hazard	Count of municipalities mentioning the climate hazard	Share of municipalities in %
Extreme heat	3 011	85 %
Droughts & water scarcity	2 799	79 %
Floods & sea level rise	2 763	78 %
Heavy precipitation	2 743	78 %
Wildfires	1 999	57 %
Storm & wind	1 658	47 %
Mass movement	1 407	40 %
Extreme cold	1 290	36 %
Other	606	17 %
Biological hazards	603	17 %
Chemical change	218	6 %
Total of municipalities with an RVA	**3 538**	**100 %**

Source: JRC elaboration based on GCoM data

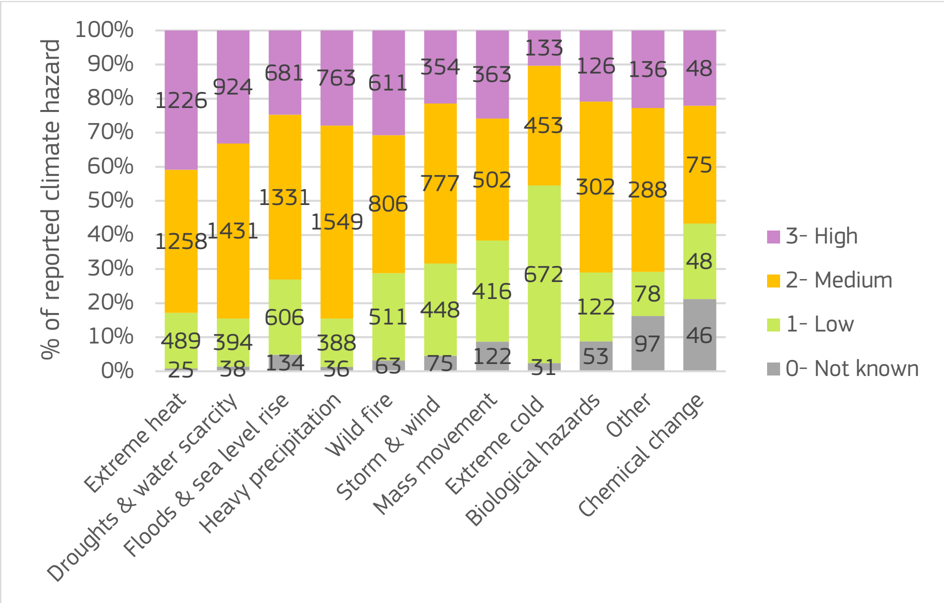
8 This alternative approach removes the necessity for data cleaning to address duplicates since each Level 1 (L1) hazard category is counted only once per municipality, irrespective of how many times it is reported by the same city. This method will be employed in subsequent analyses to evaluate the most frequently identified vulnerable sectors and population groups, as well as the most commonly addressed hazards, sectors, and groups in adaptation actions.

The two following figures (**Figure 5** and **Figure 6**) include the level of probability and impact reported by municipalities in their RVAs for the 19 097 hazard records. To ensure dataset consistency, data homogenisation was performed [9].

Among the climate hazards, 'extreme cold' is reported with the lowest probability and impact, suggesting it is a less prominent concern. In contrast, 'chemical change' and 'other' categories have the highest proportion of entries marked as 'not known,' indicating uncertainty or lack of data for these hazards.

The remaining climate hazards predominantly exhibit medium to high levels of both probability and impact, suggesting general recognition among municipalities of the significant risk these hazards pose.

Figure 5. Probability of occurrence of the climate hazard in the present [10].



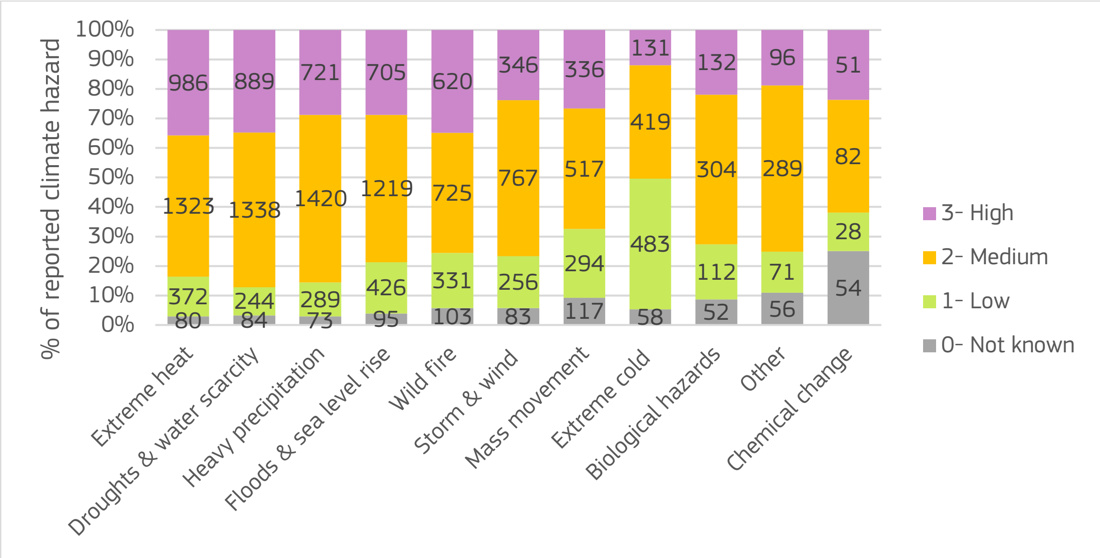
High = extremely likely that the hazard occurs (e.g., greater than 1 in 20 chance of occurrence).
Moderate = likely that the hazard occurs (e.g., between 1 in 20 and 1 in 200 chance of occurrence).
Low = unlikely that the hazard occurs (e.g., between 1 in 200 and 1 in 2 000 chance of occurrence).
Not known =municipality has not experienced or observed climate hazards in the past or has no way of accurately reporting this information based on evidence or data.

Source: JRC elaboration based on GCoM data

[9] For the purpose of these charts, certain attributes have been reclassified: 'medium high' and 'medium low' were both categorised as 'medium'; 'does not currently impact the municipality' was reclassified as 'low'; 'not expected to happen in the future' was labelled as 'decrease'; 'not available' was designated as 'not known'; and 'immediately' was reclassified as 'short term.' The 'future expected magnitude' field was excluded from this analysis as it is not part of the CRF. Additionally, L2 hazards were reclassified to their corresponding L1 categories for these analyses.

[10] For further information on these definitions, see Box 4 'Guidance on probability and consequence of hazards' in the CRF's guidance note (GCoM, 2019). They are also part of the Covenant reporting guidelines (CoM Europe, 2020).

Figure 6. Impact/consequence of the climate hazard in the present [11].



High = the hazard represents a high (or the highest) level of potential concern for your jurisdiction; when it occurs, the hazard results in (extremely) serious impacts to the jurisdiction and (catastrophic) interruptions to day-to-day life.
Moderate = the hazard represents a moderate level of potential concern for your jurisdiction; when it occurs, the hazard results in impacts to your jurisdiction, but these are only moderately significant to day-to-day life.
Low = the hazard represents a lower (the lowest) level of potential concern for your jurisdiction; when it occurs, the hazard results in impacts to your jurisdiction, but these are deemed less significant (or insignificant) to day-to-day life.
Not known = municipality has not experienced or observed climate hazards in the past or has no way of accurately reporting this information based on evidence or data.

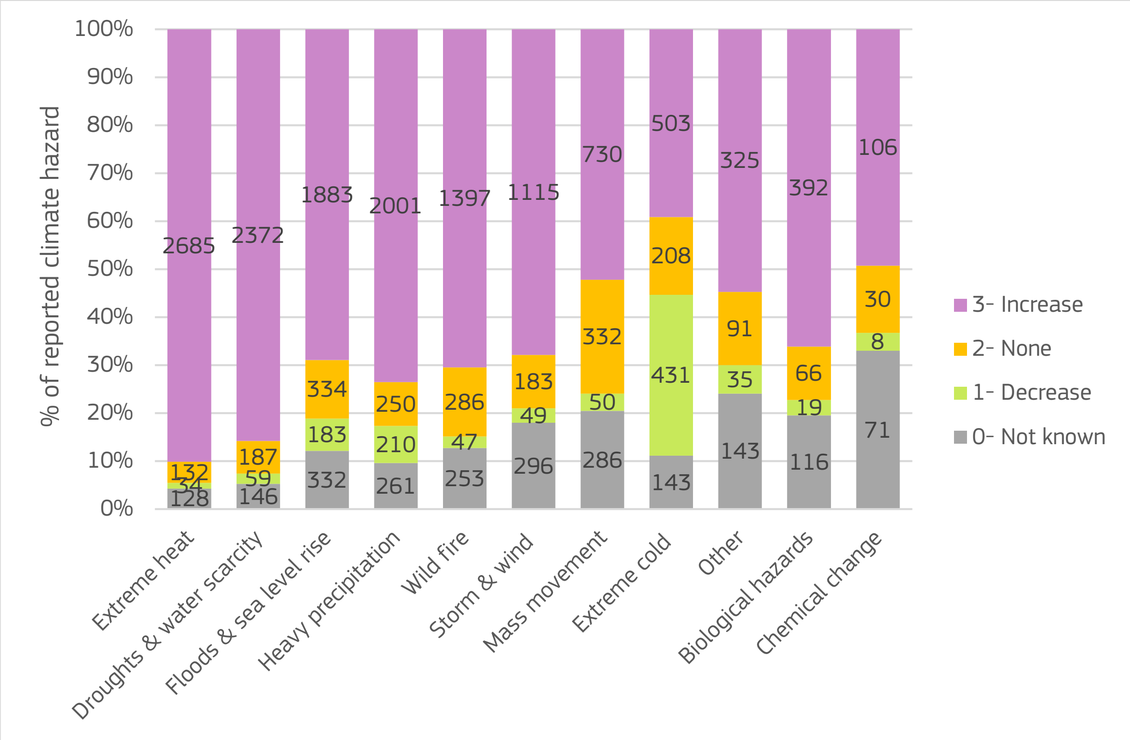
Source: JRC elaboration based on GCoM data

The two following figures (**Figure 7** and **Figure 8**) include the future expected change in hazard intensity and frequency as reported by municipalities in their RVAs. They provide an overview of the anticipated future changes in both the intensity and frequency of climate hazards, as reported in municipality RVAs. The data indicates a general expectation for an increase in both intensity and frequency across most climate hazards. Notably, ‘extreme heat’ is projected to increase in intensity in approximately 91 % of records and in frequency in about 90 % of records. Similarly, ‘droughts & water scarcity’ are expected to increase in intensity in over 88 % of records and in frequency in nearly 86 % of records.

Conversely, ‘extreme cold’ stands out as the hazard most frequently expected to decrease, with anticipated decreases in intensity in around 31 % of records and in frequency in about 34 % of records.

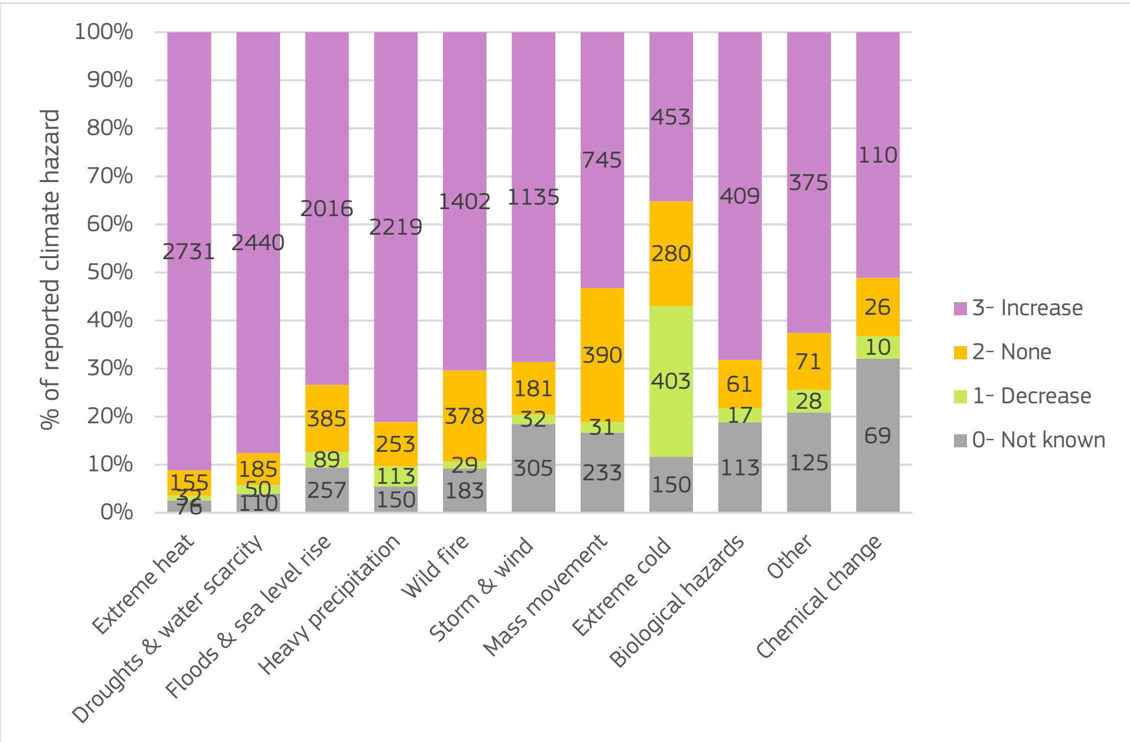
[11] For further information on these definitions, see Box 4 ‘Guidance on probability and consequence of hazards’ in the CRF’s guidance note (GCoM, 2019). They are also part of the Covenant reporting guidelines (CoM Europe, 2020).

Figure 7. Future expected change in hazard frequency.



Source: JRC elaboration based on GCoM data

Figure 8. Future expected change in hazard intensity.

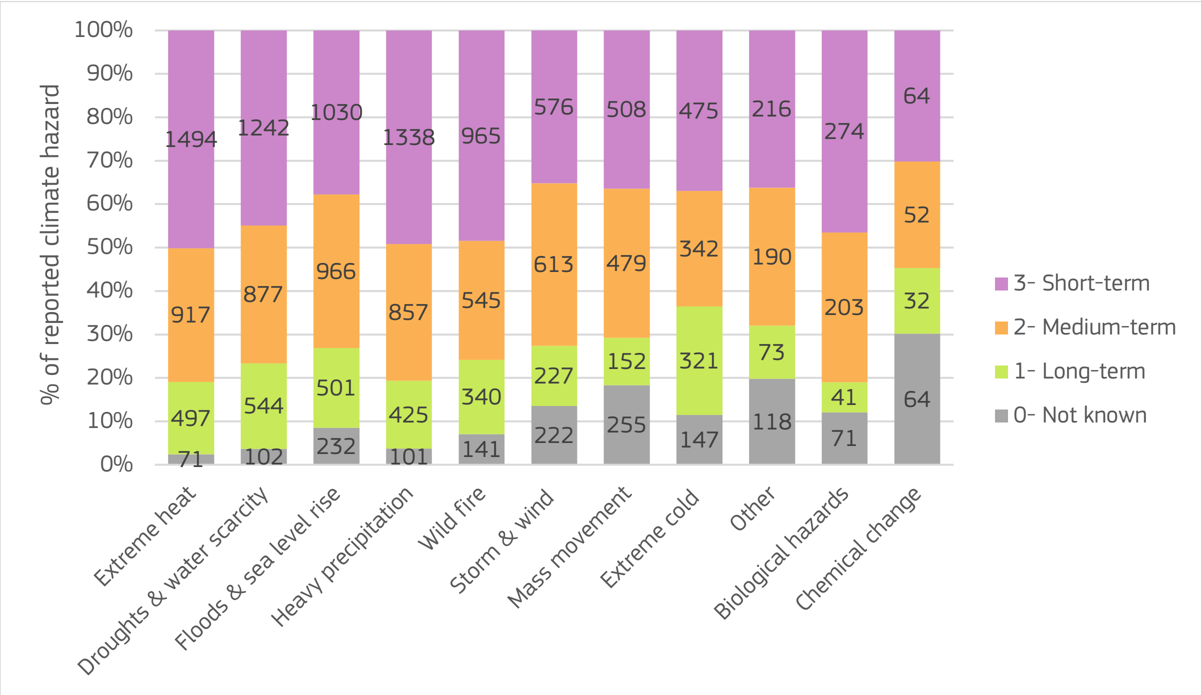


Source: JRC elaboration based on GCoM data

Figure 9 shows the timeframes of reported climate hazards [12]: the chart indicates that most climate hazards are expected to change in the short-term. 'Extreme heat' is projected for short-term changes in about 50 % of records. 'Droughts & water scarcity' and 'heavy precipitation' are expected to change in the short-term in approximately 45 % and 49 % of records, respectively. 'Floods & sea level rise' show nearly equal expectations for medium-term and short-term changes. 'Wildfires' changes are anticipated in the short-term for about 48 % of records. 'Storm & wind' and 'mass movement' display a more even distribution between medium-term and short-term timeframes.

A notable portion of records, around 8 %, is marked as 'not known,' indicating uncertainty or lack of specificity regarding when changes in these hazards are expected to occur. Proportionally, 'chemical change' has the highest percentage of 'not known' entries, with approximately 30 % of its records lacking a specified timeframe, highlighting significant uncertainty in this area.

Figure 9. Timeframe of reported climate hazards [13].



Source: JRC elaboration based on GCoM data

Figure 10 shows all climate hazards and their attributes for comparison:

12 Multiple options can be selected by signatories for each climate hazard reported in RVA in MyCovenant, while in CDP-ICLEI Track there is only one timeframe option per hazard.

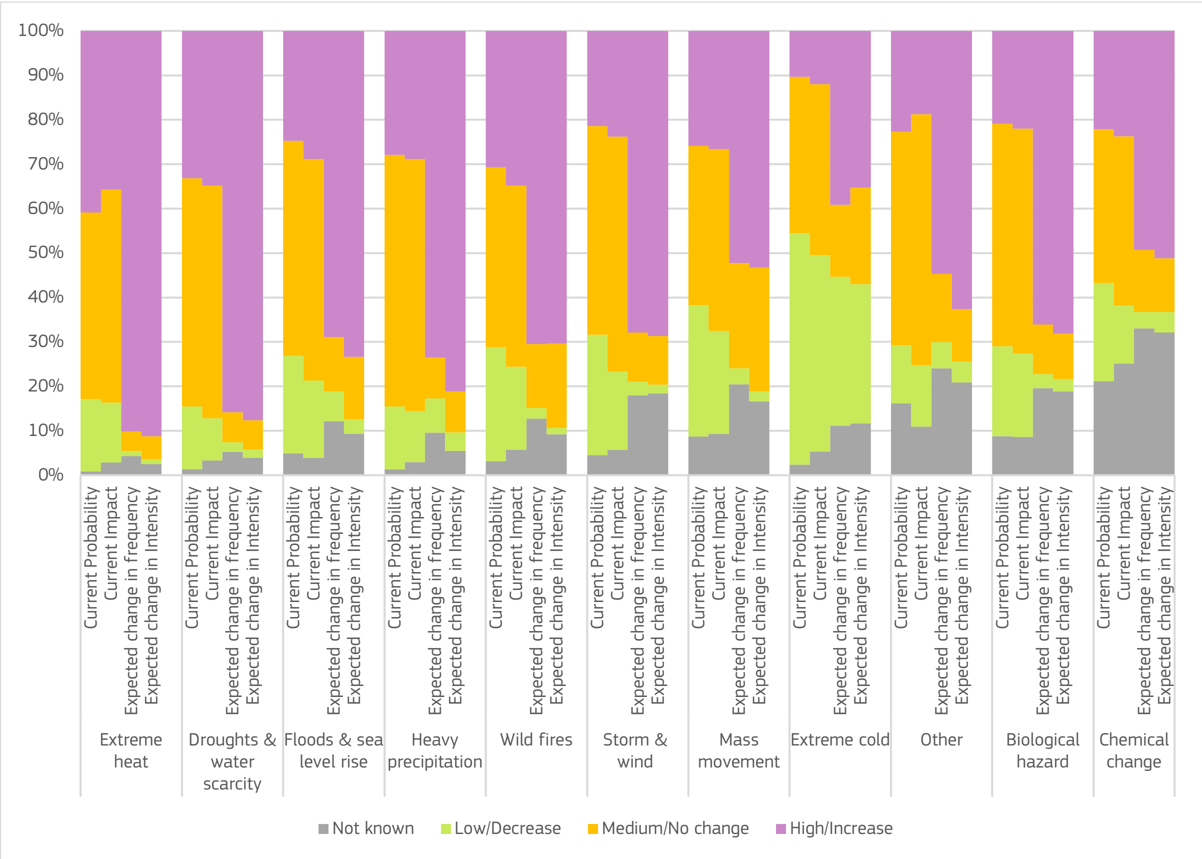
13 Timeframes are analysed here as reported on the reporting platforms. There is a slight difference in how they are defined in the CRF (Short-term = by 2025; Medium-term = 2026-2050; Long-term = after 2050) (GCoM, 2023, 2019) and in the Covenant reporting guidelines (Short-term = 20-30 years from now; Mid-term = after 2050; Long-term = close to 2100) (CoM Europe, 2020). The data presented here reflects the information collected by the two platforms without any reclassification, and the definitions should be interpreted according to the CRF specifications

— Looking at the shift from current to future (first two bars vs. last two bars), 'extreme heat' and 'droughts & water scarcity' exhibit the most significant reported expected change, indicating a future increase in both intensity and frequency.

— Considering the green bars, 'extreme cold' is reported with the current lowest impact and probability and is also expected to have the highest decrease in both intensity and frequency. All other climate hazards predominantly show medium to high impact and probability, with an expected increase in intensity and frequency.

— Considering the grey bars (not known), it is apparent that estimating future conditions is more challenging for certain hazards, particularly 'chemical change,' 'mass movement,' and 'biological hazard,' which have a higher proportion of records with unknown future projections.

Figure 10. Climate hazards and their attributes as reported in GCoM dataset [14].



Source: JRC elaboration based on GCoM data

Overall, nearly half of the municipalities with an RVA (47%) have identified at least one high-risk hazard, defined as climate hazards with both high probability and high magnitude/impact. **Table 5** provides a detailed overview of the high-risk climate hazards identified in municipal RVAs. Compared to **Table 4**, the order of the five most reported hazards remains largely consistent, with

[14] Climate hazards are ordered by number of records having the four characteristics analysed (current probability and impact, future expected change in hazard frequency and intensity).

the exception of ‘floods & sea level rise’ and ‘heavy precipitation’, which are switched in their ranking.

Table 5. High-risk climate hazards reported in municipal RVAs.

High-risk climate Hazard	Count of municipalities mentioning the high-risk climate hazard	Share of municipalities in %
Extreme heat	778	22%
Droughts & water scarcity	678	19%
Heavy precipitation	541	15%
Floods & sea level rise	467	13%
Wild fire	461	13%
Mass movement	289	8%
Storm & wind	216	6%
Biological hazards	95	3%
Extreme cold	91	3%
Other	77	2%
Chemical change	40	1%
Total of municipalities with an RVA mentioning high-risk hazards	**1 660**	**47 %**
Total of municipalities with an RVA	**3 538**	**100 %**

Source: JRC elaboration based on GCoM data

4.1.1. Regional distribution of climate hazards

There are 3 538 RVAs submitted by 3 538 municipalities, one per each of them. As presented in the previous section, there are 19 097 hazard records. **Figure 1** presented the count of RVAs by region and year. The following figure (**Figure 11**) offers an overview of the distribution of reported climate hazards across various global regions, highlighting the reporting share of each hazard category within each GCoM region:

— In **European Union & Western Europe** municipalities ‘extreme heat,’ ‘droughts & water scarcity,’ ‘heavy precipitation’, and ‘floods & sea level rise’ are the most prevalent hazards, each exceeding 2 100 records.

— In **Latin America & the Caribbean**, ‘droughts & water scarcity’ and ‘floods & sea level rise’ are the most frequently reported hazards, followed by ‘extreme heat’.

— **Eastern Europe & Central Asia** reports a more balanced distribution of hazards, with notable occurrences of ‘extreme heat’ and ‘heavy precipitation.’

— In **North America** ‘extreme heat’ and ‘floods & sea level rise’ are the most common hazards.

— In **Southeast Asia**, ‘floods & sea level rise’ emerges as the predominant hazard, reflecting regional climatic and geographic challenges.

— In **Sub-Saharan Africa** ‘floods & sea level rise’ is the most frequently mentioned hazard.

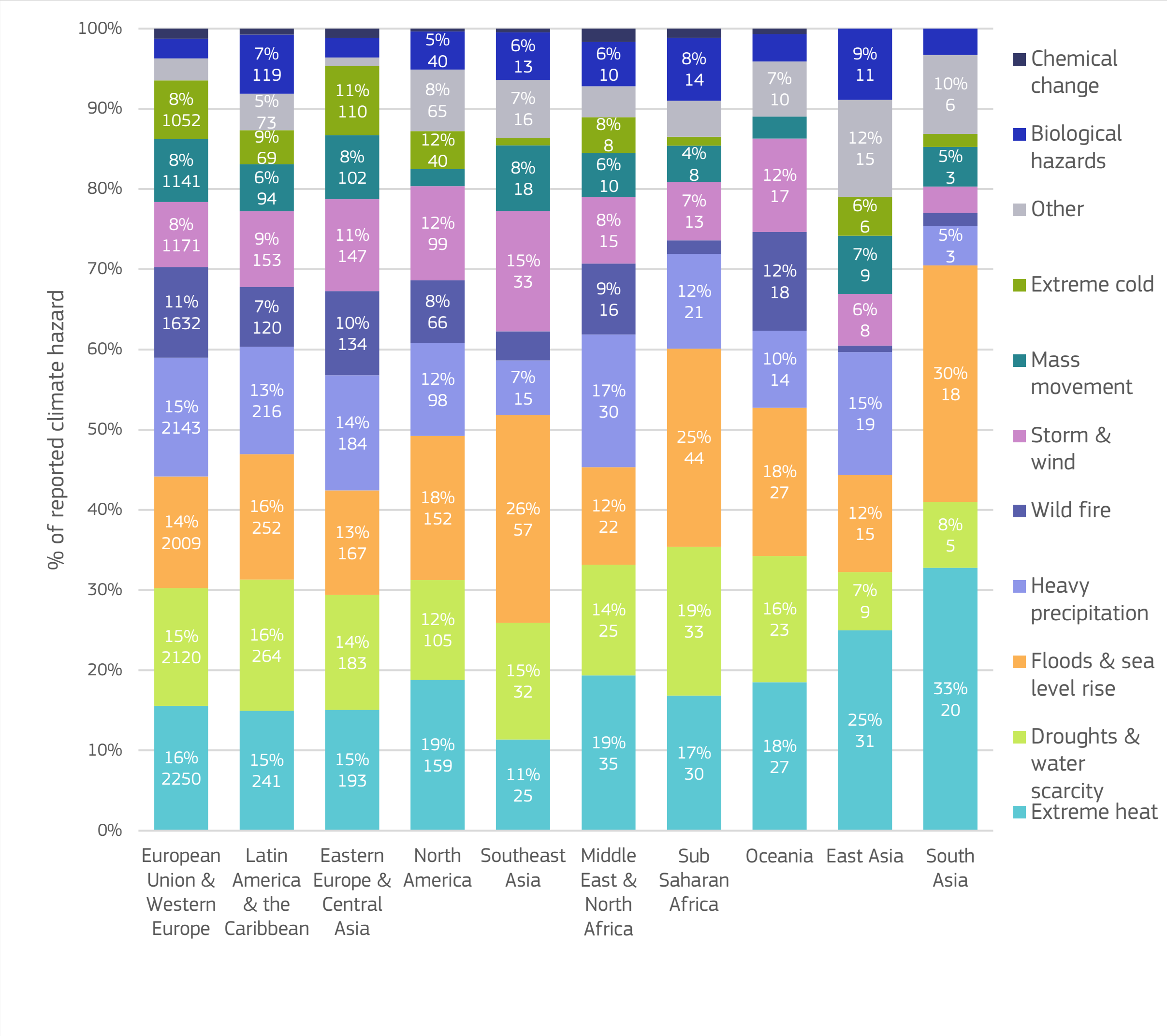
— **Middle East & North Africa** reports a more even distribution, with notable occurrences of ‘extreme heat’ and ‘heavy precipitation’.

— **East Asia** reports ‘extreme heat’ as the most is the most frequently mentioned hazard.

— **Oceania** reports a similar number of instances for ‘extreme heat’ and ‘floods & sea level rise’.

— **South Asia** shows a focus on ‘extreme heat’ and ‘floods & sea level rise’.

Figure 11. Most reported climate hazards in GCoM regions [15].



Source: JRC elaboration based on GCoM data

Of all the hazards reported by a region, some are proportionally reported with a higher share compared to other regions (**Figure 11**):

— **Extreme heat** is most prominently reported in South Asia and East Asia, where it constitutes 33 % and 25 % of hazard reports, respectively, indicating a major regional concern.

— **Droughts & water scarcity** are most reported in Sub-Saharan Africa, making up 19 % of the region's reports, highlighting its significant impact.

15 To enhance chart clarity, labels representing low shares that overlap have been omitted from display.

— **Floods & sea level rise** are most frequently mentioned in Southeast Asia and South Asia, accounting for 30 % and 26 % of reports, respectively.

— **Heavy precipitation** is proportionally most reported in the Middle East & North Africa and East Asia, with 17 % and 15 % of reports, indicating these regions' focus on this hazard.

— **Wildfire** is most reported in Oceania, comprising 12 % of the region's hazard reports, and European Union & Western Europe, with 11%, reflecting their susceptibility to fire-related issues.

— **Storm & wind** is most frequently reported in Southeast Asia, where it accounts for 15 % of the reports, highlighting its significance.

— **Extreme cold** is most commonly reported in Eastern Europe & Central Asia, making up 9 % of the reports, reflecting regional climatic conditions.

— **Mass movement** is most prominently reported in both Southeast Asia and Eastern Europe & Central Asia, indicating a focus on geological hazards.

— The category **Other** is most frequently reported in East Asia and South Asia, comprising 12% and 10% of the regions' reports, respectively. This suggests a range of additional concerns reported, such as air pollution, or potential reporting issues, like language barriers in identifying hazards within the CRF categories. Refer to the footnote 4 of **Table 3** for further details.

— **Biological hazard** and **chemical change** data is limited and spread across regions, making it difficult to draw conclusions about its prominence in any specific area.

4.2. Vulnerable sectors

More than 75 200 local vulnerabilities (see **Table 2**) are reported by municipalities for specific vulnerable sectors [16] and are part of 3 246 RVAs [17]. While 3 538 RVAs address climate hazards, only 92 % of them (3 246) include vulnerable sectors, indicating that some assessments identify hazards without detailing sector impacts.

Figure 12 presents key vulnerable sectors [18], with food & agriculture accounting for approximately 14 % of records, making it the most frequently reported sector. Environment, biodiversity, and forestry follow at 13 %, and the public health represents 11 %. Buildings sector, civil protection & emergency services, and water supply & sanitation each account for around 10 %, 9 %, and 9 %,

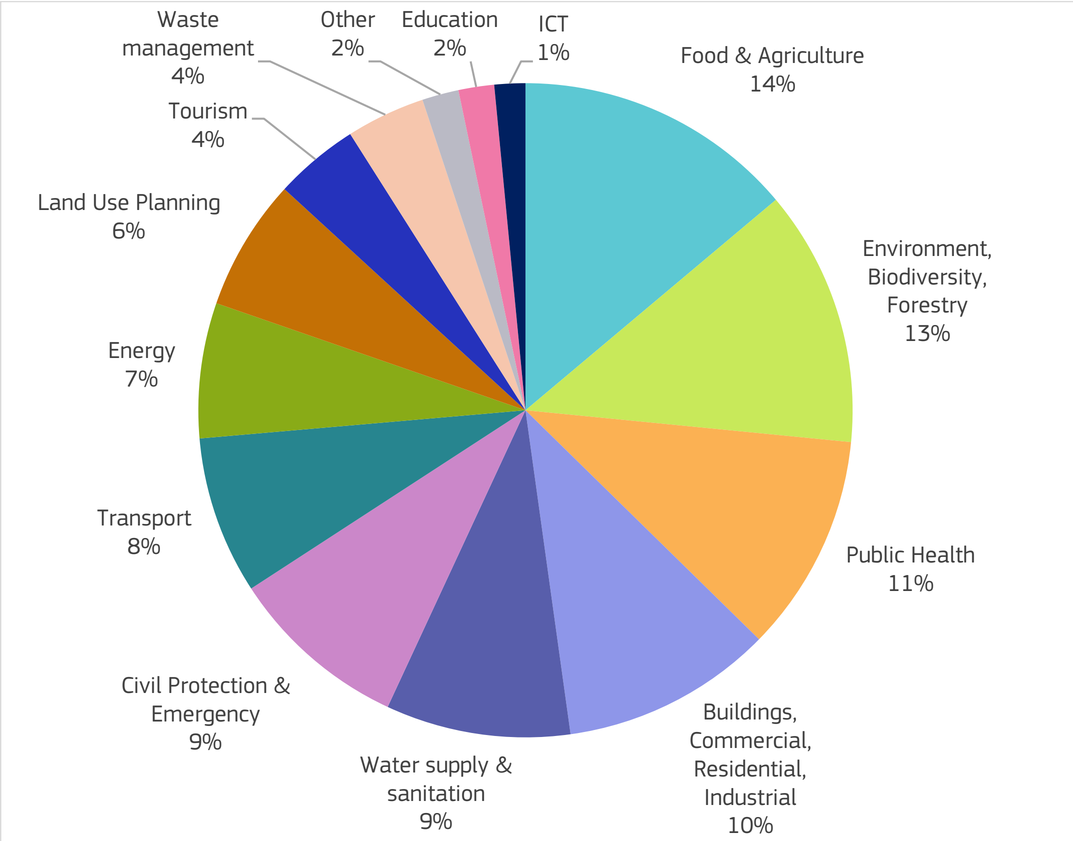
[16] In the CRF, risk is defined as the combination of the probability of hazard and the impact of hazard, with impact representing the consequences of a climate event and its connection to exposure and vulnerability. According to this framework, vulnerability and exposure are interrelated: the RVA incorporates analyses of both aspects, assuming that the vulnerable sectors and population groups identified for each hazard are those also considered exposed. Therefore, the vulnerable sectors are exposed sectors and impacted by the climate hazards. For further information, see the JRC guidebook 'How to develop a risk and vulnerability assessment' (European Commission. Joint Research Centre., 2025b)

[17] Local sector vulnerabilities refer to records in the dataset listing sectors vulnerable, exposed, or impacted by a specific hazard. Since a single hazard can affect multiple sectors, the number of impacted sectors exceeds the number of hazards, with an average of 5.6 sectors impacted per hazard.

[18] MyCovenant and CDP-Track use different labels for sectors. The ones from the CRF are used here, and a re-classification was conducted (i.e. 'Commercial' re-classified as 'Buildings').

respectively. Transport and energy sectors also feature prominently, each contributing around 8 % and 7 % of the reports. Land use planning, tourism, and waste management sectors are noted at 6 %, 4 % and 4 %, respectively, while other, education and information and communication technologies (ICT) are reported with the lowest shares.

Figure 12. Most reported vulnerable sectors.



Source: JRC elaboration based on GCoM data

Because each sector is reported as vulnerable to a specific climate hazard, it is possible to analyse the most reported hazards per sector. **Figure 13** shows that:

— **Food & agriculture**: 'droughts & water scarcity' are the most significant concern, accounting for 20 % of the sector's vulnerabilities, followed by 'extreme heat' at 17 %.

— **Environment, biodiversity, forestry**: both 'droughts & water scarcity' and 'extreme heat' are leading concerns, each representing 20 % and 18 % of vulnerabilities, respectively.

— **Buildings, commercial, residential, industrial**: 'floods & sea level rise' dominate this sector, making up 23 % of vulnerabilities, with 'heavy precipitation' also significant at 17 %.

— **Public health**: 'extreme heat' is a major concern, comprising 29 % of the vulnerabilities.

— **Civil protection & emergency**: 'floods & sea level rise' and 'heavy precipitation' are the primary concern, accounting for 20 % and 18 % of vulnerabilities, with 'wildfires' also notable at 15 %.

— **Water supply & sanitation**: 'droughts & water' scarcity are the predominant concern, constituting 30 % of vulnerabilities, with 'extreme heat' at 20 %.

— **Transport**: 'floods & sea level rise' and 'heavy precipitation' each account for 23 % and 22 % of vulnerabilities, respectively.

— **Energy**: 'extreme heat' is the leading concern, representing 28 % of the vulnerabilities, with 'storm & wind' also significant at 15 %.

— **Land use planning**: 'floods & sea level rise' are the most significant, accounting for 24 % of vulnerabilities, with 'heavy precipitation' also at 18 %.

— **Tourism**: 'extreme heat' leads with 22 % of vulnerabilities, with 'floods & sea level rise' and 'heavy precipitation' each at 16 %.

— **Waste management**: 'floods & sea level rise' are the predominant concern, representing 28 % of vulnerabilities, followed by 'extreme heat' at 17 %.

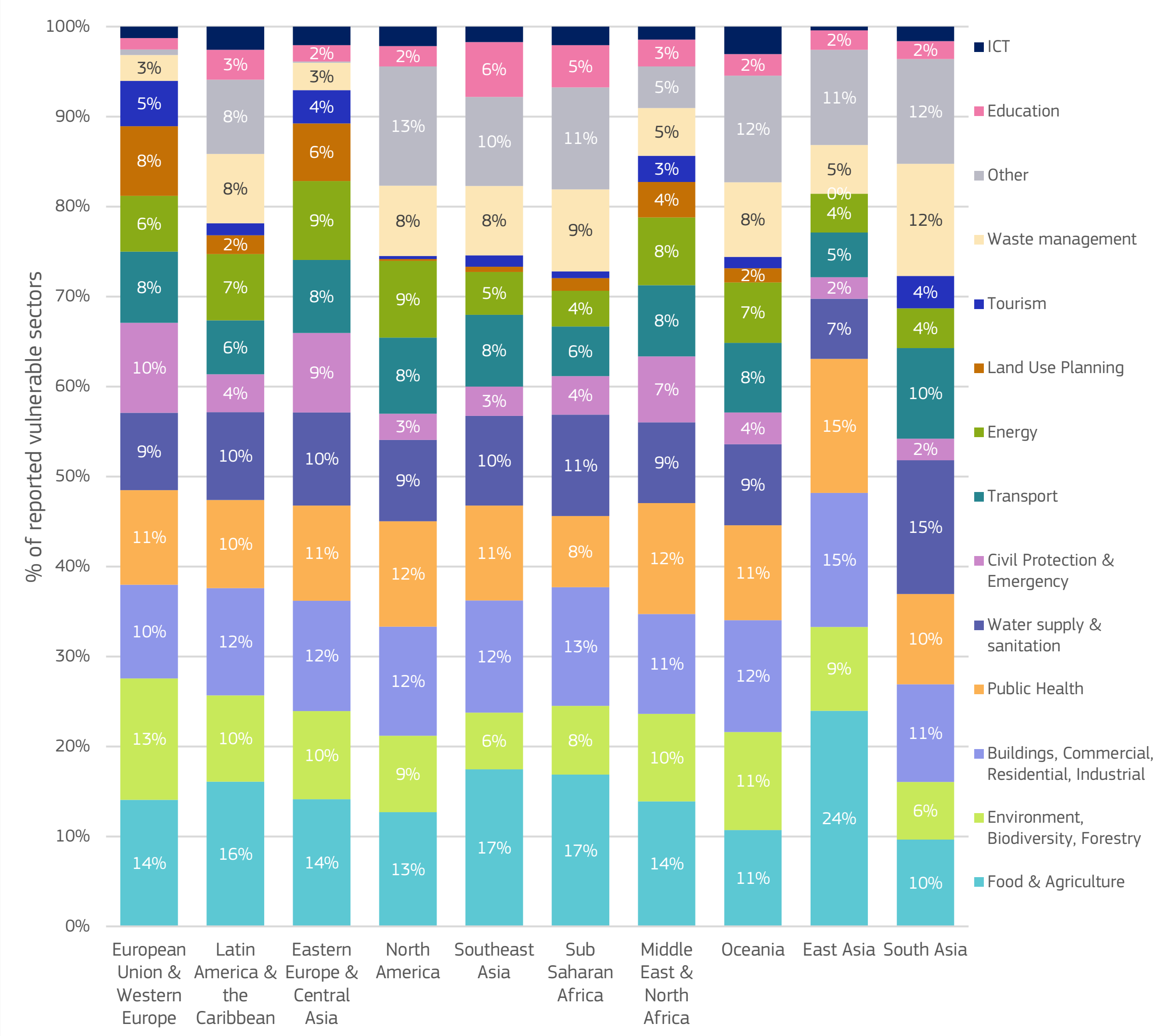
— **Other** [19]: 'floods & sea level rise' dominate at 30 %, with 'storm & wind' also significant at 13 %.

— **Education**: 'floods & sea level rise' and 'extreme heat' are leading concerns at 23 % and 20 %, respectively.

— **ICT**: 'storm & wind' is the primary concern, constituting 22 % of vulnerabilities, followed by 'floods & sea level rise' at 21 %.

[19] The category 'Other' allows municipalities to report sectors not explicitly listed in the CRF categories. However, analysis of CDP-ICLEI Track data reveals that this category often includes sectors already present in the list but written in languages other than English. In some instances, even when the text is in English, it refers to a recognised sector, indicating a potential misunderstanding by the municipality. To ensure consistency between MyCovenant and CDP-ICLEI Track data, certain categories that are absent from MyCovenant—specifically Financial and Insurance Services, Community & Culture, Administrative and Support Services, and Professional, Scientific and Technical Services—were reclassified as 'Other'.

Figure 13. Vulnerable sectors and climate hazards.



Source: JRC elaboration based on GCoM data

An alternative method to analysing reported sectors, similar to the one presented to analyse the hazards (see **Table 4**), avoids double counting and focuses on assessing how frequently each sector is mentioned across municipalities in their RVAs (see **Table 6**) [20], rather than summing the total reported sectors (as shown in the pie chart above). This methodology identifies whether these sectors were mentioned in each municipality's assessment and confirms the top sectors, albeit with a slight difference in their ranking (e.g., 'public health' is more preponderant in this analysis).

[20] This alternative approach removes the necessity for data cleaning to address duplicates since each sector category is counted only once per hazard per municipality, irrespective of how many times it is reported by the same city. This method will be employed in subsequent analyses to evaluate the most frequently identified vulnerable population groups, as well as the most commonly addressed hazards, sectors, and groups in adaptation actions.

Table 6. Sectors reported as vulnerable/impacted in municipalities' RVAs.

Vulnerable/Impacted Sector	Count of municipalities' RVAs mentioning that sector	Share of municipalities in %
Food & agriculture	2 707	83 %
Public health	2 680	83 %
Environment, biodiversity, forestry	2 629	81 %
Water supply & sanitation	2 558	79 %
Buildings, commercial, residential, industrial	2 514	77 %
Transport	2 068	64 %
Energy	1 889	58 %
Civil protection & emergency	1 857	57 %
Land use planning	1 648	51 %
Waste management	1 206	37 %
Tourism	1 009	31 %
Education	640	20 %
ICT	554	17 %
Other	531	16 %
Total municipalities with an RVA including sector vulnerabilities	**3 246**	**100 %**

Source: JRC elaboration based on GCoM data

4.2.1. Regional distribution of vulnerable sectors

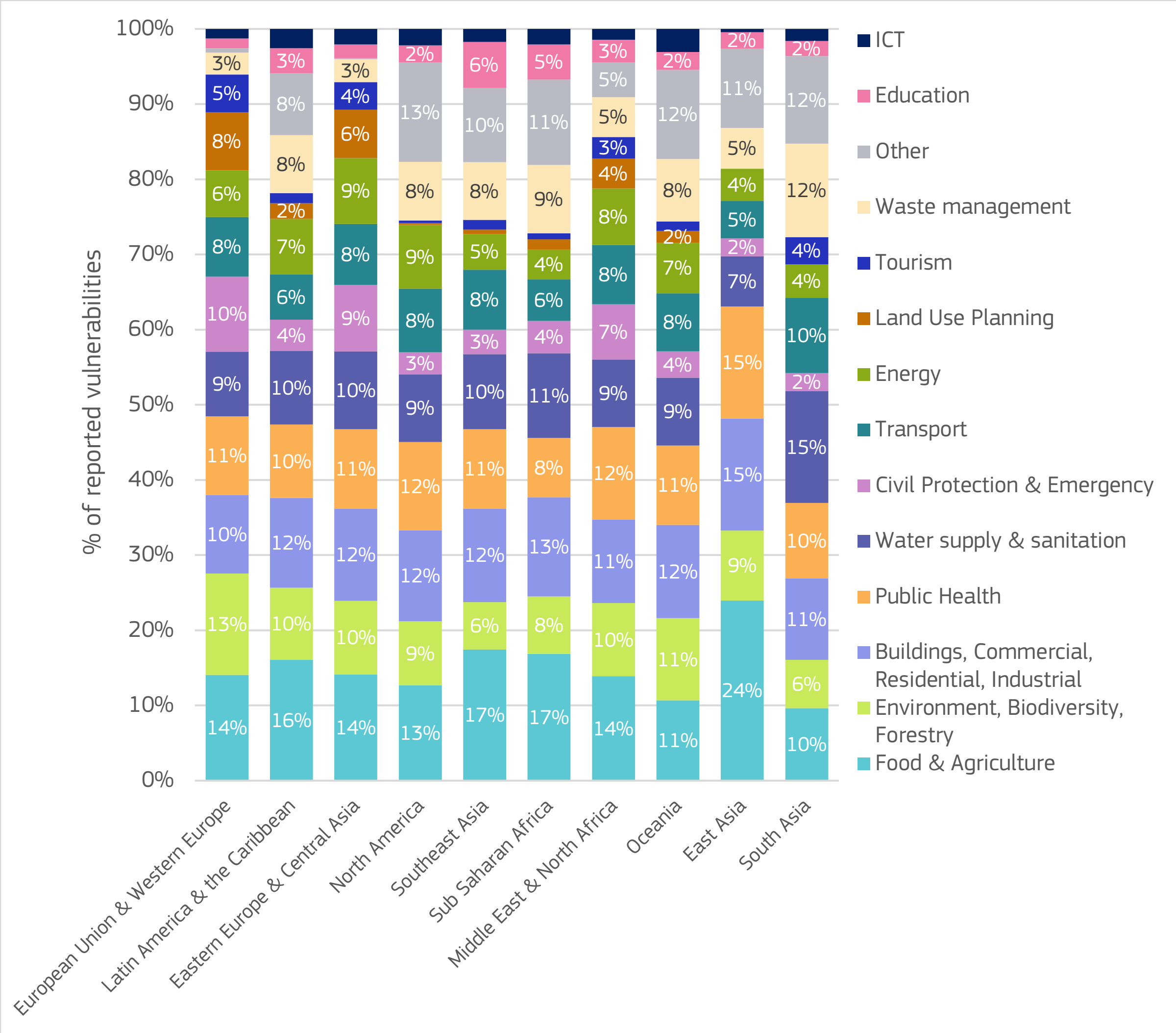
When analysing the most reported sectors in GCoM regions, some proportional differences become apparent (see **Figure 14**). Of all the sectors reported by a region, certain sectors are identified more often compared to others:

- **Food & agriculture** is most reported in East Asia, comprising 24 % of the sector reports in that region.
- **Environment, biodiversity, and forestry** has a higher proportion in European Union & Westen Europe at 13 %.
- **Buildings, commercial, residential, and industrial** sectors are notably reported in East Asia with 15 %.
- **Public health** is most reported in East Asia, at 15 %.
- **Water supply & sanitation** is emphasised in South Asia, making up 15 % of the reports.
- **Civil protection & emergency** services are most frequently reported in European Union & Western Europe, with 10 %.
- **Transport** has the highest proportion in South Asia, at 10 %.
- **Energy** vulnerability reports are more prominent in Eastern Europe & Central Asia and North America, each with each 9 %.
- **Land use planning** and **tourism** see higher reporting in European Union & Western Europe, at 8 % and 5 %.
- **Waste management** has a notable proportion in South Asia, at 12 %.

— The **Other** category is most reported in North America, at 13 %.

— **Education** and **ICT** are less frequently mentioned, making it difficult to draw conclusions about its prominence in any specific area.

Figure 14. Most reported vulnerable/impacted sectors in GCoM regions.



Source: JRC elaboration based on GCoM data

4.3. Vulnerable population groups

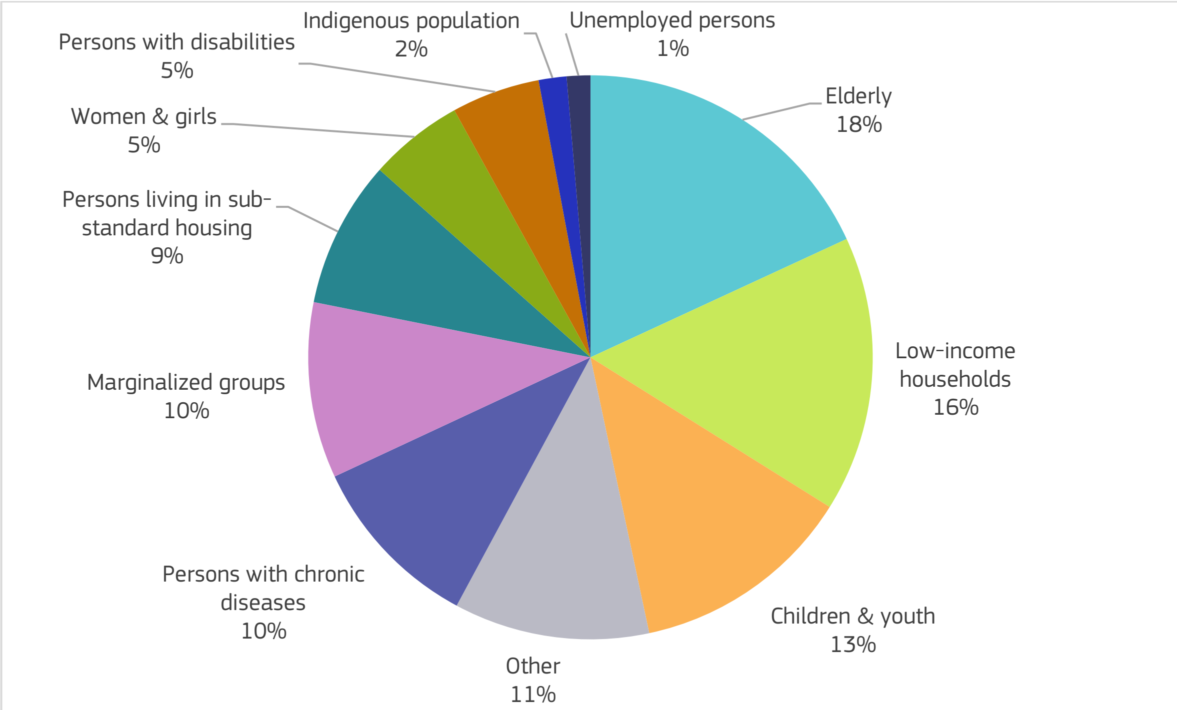
More than 27 590 local vulnerabilities [21] are reported by municipalities for specific vulnerable population groups and are part of 2 054 RVAs. While 3 538 RVAs identify climate hazard, only 52 %

[21] Local vulnerabilities refer to records in the dataset listing population groups vulnerable, exposed, or impacted by a specific hazard. Since a single hazard can affect multiple groups, the number of vulnerable groups exceeds the number of hazards, with an average of 3.8 groups impacted per hazard.

(2 054) include population group vulnerabilities, indicating that some assessments identify hazards without their impact on people [22].

As shown in **Figure 15** [23], ‘elderly’ (18 %), ‘low-income households’ (16 %), ‘other’ [24] (13 %), and ‘children & youth’ (13 %) are the most frequently reported vulnerable groups, while ‘women & girls’ (5 %), ‘persons with disabilities’ (5 %), ‘indigenous people’ (2 %), and ‘unemployed persons’ (1 %) have lower reports.

Figure 15. Most reported vulnerable population groups.



Source: JRC elaboration based on GCoM data

Given that each group is identified as vulnerable to particular climate hazards, it is possible to analyse the most frequently reported hazards for each group. **Figure 16** reveals that:

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22 In MyCovenant reporting platform, this information is not mandatory.

23 MyCovenant and CDP-ICLEI Track use different labels for some vulnerable population groups. The ones from the CRF are used here, and in some cases a re-classification was conducted (i.e. ‘children’ re-classified as ‘children & youth’). To avoid double counting, each category was counted as one even when reported multiple times (as vulnerable to multiple hazards). The category ‘all’ was ignored for this analysis.

24 The category ‘other’ allows municipalities to report vulnerable population groups not explicitly listed in the CRF categories. However, an analysis of CDP-ICLEI Track data indicates that this category often includes groups already present in the list but written in languages other than English. In some cases, even when the text is in English, it refers to a recognised group, suggesting a potential misunderstanding by the municipality. To ensure consistency between MyCovenant and CDP-ICLEI Track data, certain categories absent from MyCovenant—specifically ‘migrants and displaced people’, ‘frontline workers’, ‘people experiencing homelessness’, and ‘small businesses’—were reclassified as ‘other’.

— **Extreme heat**: 'elderly,' 'children & youth,' and 'persons with chronic diseases' are reported as most vulnerable to 'extreme Heat,' with 29 %, 30 %, and 33 % respectively.

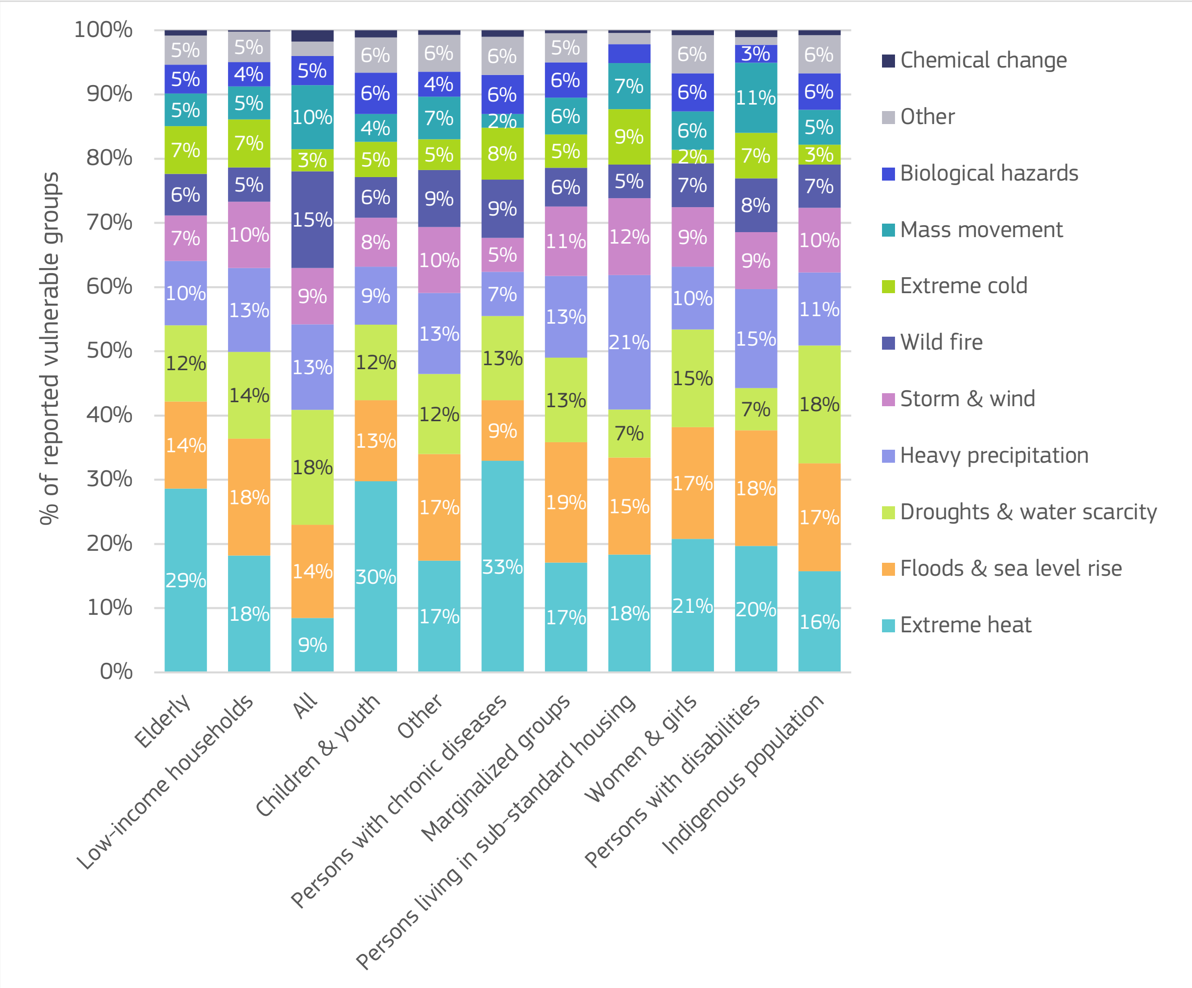
— **Floods & sea level rise**: 'low-income households', 'marginalised groups', and 'persons with disabilities' are most affected by 'floods & sea level rise,' accounting for 18 %, 19 %, and 18 %.

— **Heavy precipitation**: 'persons living in sub-standard housing' report the highest vulnerability to 'heavy precipitation' at 21 %.

— **Mass movement**: 'persons with disabilities' show significant vulnerability to 'mass movement,' with 11 %.

— **Drought & water scarcity**: 'indigenous people' and 'unemployed persons' show significant vulnerability to 'drought & water scarcity,' with 18 %.

Figure 16. Vulnerable population groups and climate hazards.



Source: JRC elaboration based on GCoM data

Considering only the municipalities reporting high-risk hazards, defined as climate hazards with both high level of probability and high level of impact, data shows that there are 1 668 such hazards. These hazards affect municipalities with an estimated total amount of population of more than **449 million of inhabitants globally.**

Another approach to analysing the reported vulnerable groups, similar to the one presented to analyse the hazards (see **Table 4**) and vulnerable groups (see **Table 6**) avoids double counting and focuses on assessing how frequently each group is mentioned across municipalities in their RVAs (see **Table 7**). This methodology identifies whether these groups were mentioned in each municipality's assessment and confirms the top ones, albeit with a slight difference in their ranking (e.g., 'children & youth' is more preponderant in this analysis):

Table 7. Population groups reported as vulnerable/impacted in municipalities' RVAs.

Vulnerable/Impacted Population Group	Count of municipalities' RVAs mentioning that group	Share of municipalities in %
Elderly	1 631	79 %
Children & youth	1 278	62 %
Low-income households	1 265	62 %
Persons with chronic diseases	1 095	53 %
All	875	43 %
Marginalised groups	848	41 %
Persons living in sub-standard housing	735	36 %
Women & girls	572	28 %
Persons with disabilities	544	26 %
Other	516	25 %
Outdoor workers	392	19 %
Migrants and displaced people	223	11 %
Indigenous population	212	10 %
Unemployed persons	153	7 %
Frontline workers	138	7 %
People experiencing homelessness	22	1 %
Total municipalities with an RVA including vulnerable groups	**2 054**	**100 %**

Source: JRC elaboration based on GCoM data

4.3.1. Regional distribution of vulnerable population groups

When looking at the most reported vulnerable population groups in GCoM regions, some differences can be noted proportionally (**Figure 17** below). Of all the groups reported by a region, some are proportionally reported at a higher share compared to other regions:

— **Elderly** are most reported in 'East Asia' at 20 % and also has a significant share in 'European Union & Western Europe' at 19 %.

— **Low-income households** are most reported in 'North America' and 'Oceania' at 20 %.

— **Other** and **Persons with chronic diseases** groups are most reported in 'East Asia' with 22 % and 14 %.

— **Children & youth** groups are most reported in 'South Asia' with 22 %.

— **Marginalised groups** are most reported in 'North America' with 16 % and 'Oceania' at 14 % and have a lower share in 'Eastern Europe & Central Asia' at 3 %.

— **Persons 'living in sub-standard housing**' are most reported in 'Eastern Europe & Central Asia' at 16 % and have a lower share in 'North America' at 1 % each.

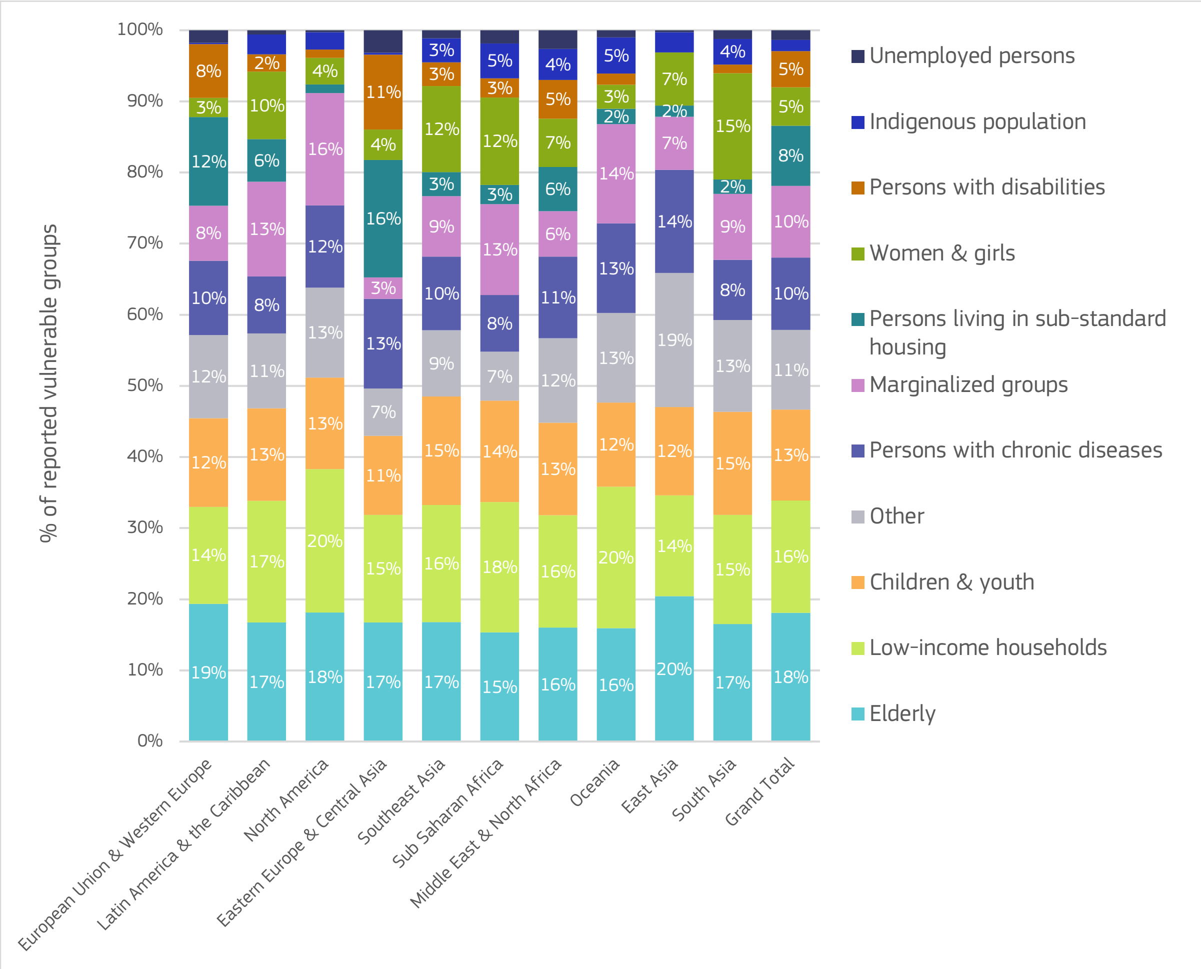
— **Women & girls** are most reported in 'South Asia' at 15 % and also have a significant share in 'Sub Saharan Africa' and 'Southeast Asia' each at 12 %.

— **Persons with disabilities** have a relatively low share across regions, ranging from 1 % in 'North America' and 'East Asia' to 11 % in 'Eastern Europe & Central Asia'.

— **Indigenous population** have a relatively low share across regions, ranging from 0 % in 'North America' and 'East Asia' to 3 % in 'Middle East & North Africa' and 'Eastern Europe & Central Asia'.

— **Unemployed persons** have a relatively low share across regions, ranging from 0 % in 'European Union & Western Europe', and 'Eastern Europe & Central Asia', 2 % in 'North America'.

Figure 17. Most reported vulnerable groups in GCoM regions.



Source: JRC elaboration based on GCoM data

5. Climate adaptation goals

The dataset contains 7 318 adaptation goals from 2 186 municipalities.

According to the CRF, municipalities are expected to define adaptation goals and specify for each: a goal description, unit, metric/key performance indicator (KPI), the baseline year and the delivery/target year (see Table 5 of CRF, (GCoM, 2023) [25]. More than 60 % of these goals have numeric or categorical targets (e.g., %', 'ha'), while the remaining goals are qualitative. The European Union & Western Europe report the highest amount of quantitative goals both in absolute and relative terms, whereas Oceania has the lowest share of quantitative goals. However, a comprehensive analysis was not performed in this report, as data from the two platforms require further harmonisation and the application of text analytical tools.

'Extreme heat' and 'floods & sea level rise' are overwhelmingly the most cited hazard, followed by 'other', 'drought & water scarcity', 'heavy precipitation', 'storm & wind', and 'wildfires'. Other hazards were addressed in less than 500 goals. The top cited hazards slightly differ from the most identified hazards in RVAs, for example 'droughts' is less prominent in the goal definition compared to the RVAs.

Goals are primarily addressing water resilience and management (water supply and conservation, stormwater management) and urban greening and nature-based solution (NbS, such as increasing tree canopy, green infrastructure development, ecosystem and biodiversity restoration). Other themes addressed by the goals are heat resilience (urban heat island (UHI) reduction and cooling, protecting vulnerable population, governance and infrastructure), infrastructure and built environment, governance, planning and community resilience.

The target years for the adaptation goals provide insight into the planning horizons of municipalities:

— Short- to medium-term goals (2024-2030): many goals are set with target dates in the near future. These often involve foundational activities like developing plans (e.g., 'develop a heat vulnerability index by 2024' to improve the RVA and improve monitoring data), implementing specific projects (e.g., 'pilot a stormwater control measures'), and achieving initial quantitative targets (e.g., 'increase canopy cover across the municipality to 25 % by 2030').

— Long-term vision (2040-2050 and beyond): the years 2040 and 2050 are common milestones for more transformational, long-term goals. These include objectives like achieving a 40 % tree canopy, becoming a fully 'climate-robust' municipality, having zero persons evacuated due to storms, and preparing the municipality for climate changes projected out to 2100.

Future analyses could categorise these goals to assess their validity and relevance to true adaptation efforts, as well as explore their regional distribution and thematic focus.

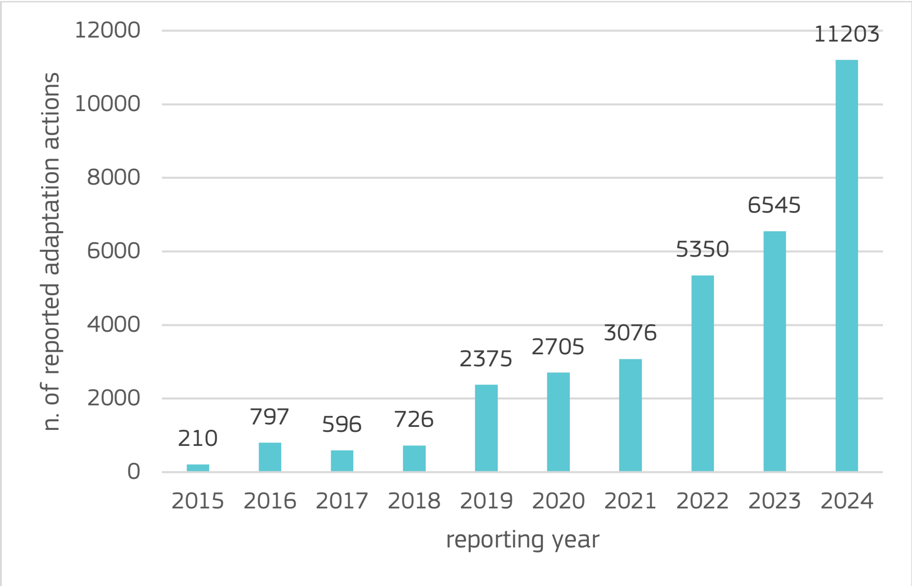
[25] Example of goal definitions are listed in the JRC guidebook (European Commission. Joint Research Centre., 2025): 'Reduce the annual expected loss due to floods in the city by at least 80% by 2030', with a base year value of €10 000 000 in 2025 (and target value of €2 000 000 in 2030).

6. Climate adaptation actions

More than 33 000 adaptation actions are reported by municipalities; among them, 11,7 % (3 934) are reported by municipalities as both mitigation and adaptation actions, and 0,7% (228) are reported as both energy poverty and adaptation actions (see section 6.4 for further data on synergies).

As shown in **Figure 18**, since the beginning of explicitly including adaptation in the Covenant of Mayors initiative the number of actions implemented has grown every year from 2015 up to 2021, with an accelerated increase from 2021 to 2024.

Figure 18. Adaptation actions with their reported year.



Source: JRC elaboration based on GCoM data

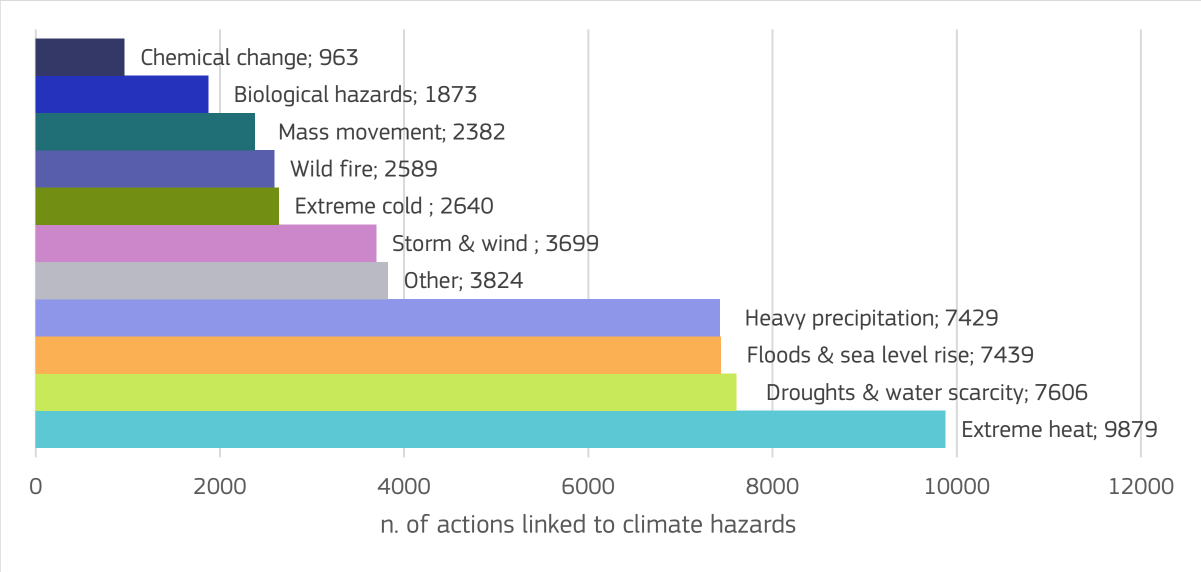
6.1. Actions and most addressed climate hazards

A total of 20 789 out of 33 699 adaptation actions (62 %) report which climate hazard(s) they are addressing. Multiple hazards can be selected for each action.

According to the data shown in **Figure 19**, the most frequently addressed hazards are 'extreme heat', 'droughts & water scarcity', 'floods & sea level rise', and 'heavy precipitation'.

This slightly differs from the most reported hazards in the RVA (see also 4.1).

Figure 19. Adaptation actions and most frequently addressed climate hazards.



Source: JRC elaboration based on GCoM data

As introduced in section 3.2 and used on the previous sections on RVA, the second approach to analysing the actions and the most addressed climate hazards is to examine their recurrence in municipalities by reviewing each municipality's action plan [26] (see **Table 6**), and noting whether the hazards were mentioned. This methodology helps eliminate bias, and confirms the top addressed hazards, albeit with a slight difference in their ranking (e.g., 'wildfires' is more preponderant in this analysis).

Table 8. Climate hazards addressed across municipal action plans.

Climate hazard addressed by actions	Count of municipalities' action plans addressing that hazard	Share of municipalities in %
Extreme heat	2 001	73 %
Droughts & water scarcity	1 911	70 %
Floods & sea level rise	1 734	64 %
Heavy precipitation	1 674	61 %
Other [27]	1 168	43 %
Wildfires	983	36 %
Storm & wind	910	33 %
Mass movement	863	32 %
Extreme cold	748	27 %
Biological hazards	593	22 %
Chemical change	340	12 %
Total municipalities with an action plan targeting climate hazards	**2 729**	**100 %**

Source: JRC elaboration based on GCoM data

26 In this context, 'action plan' refers to the data reported by municipalities on the platforms, detailing the key elements of their climate action plans (CAP), or, in Europe, the Sustainable Energy and Climate Action Plan (SECAP).

27 Refer to footnote 4 of table **Table 3** for further details on the 'Other' category.

6.1.1. Regional distribution of actions and most frequently addressed climate hazards by actions

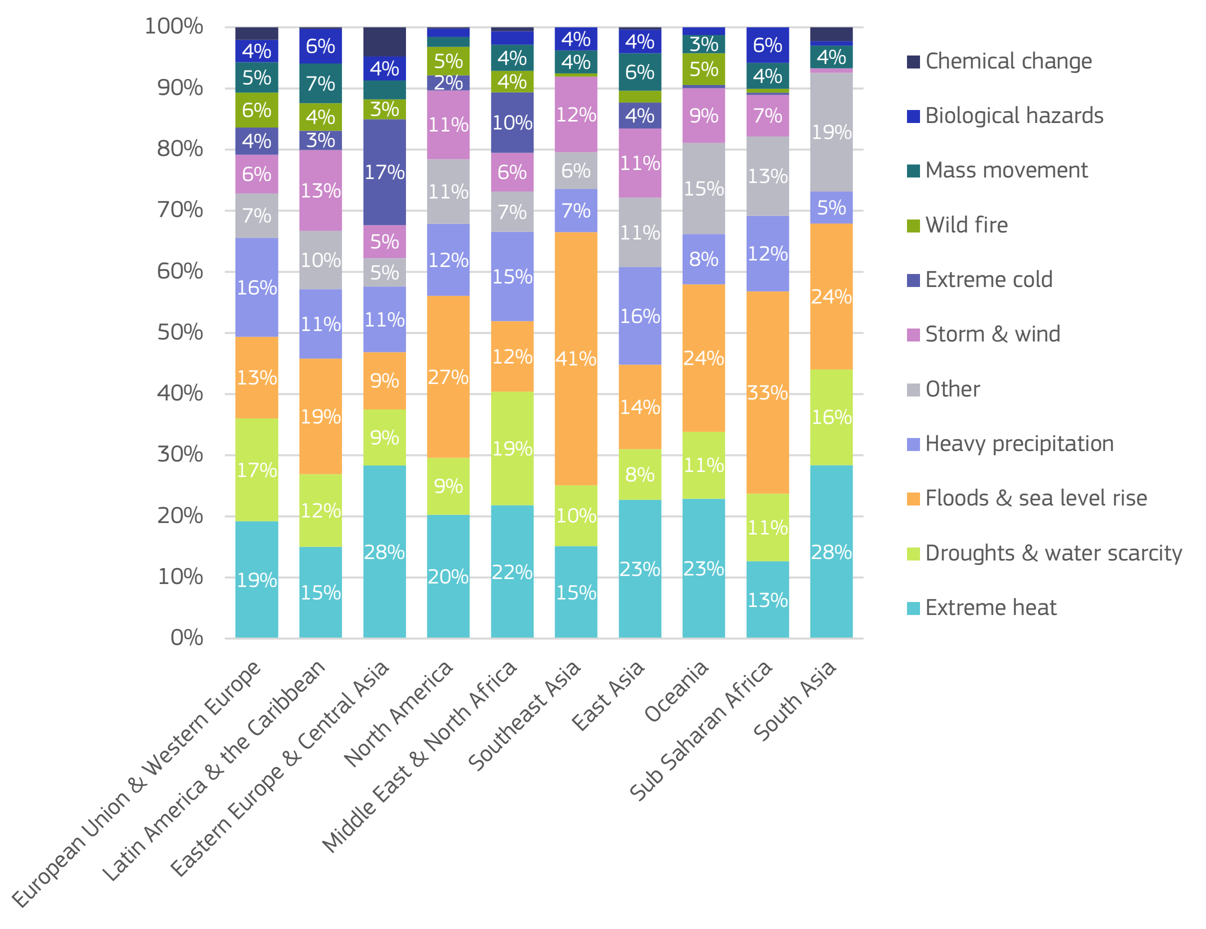
Most frequently addressed climate hazards by actions vary in GCoM regions. **Figure 20** shows the regional differences:

- in **European Union & Western Europe**, besides 'extreme heat', 'droughts & water scarcity' is the most addressed hazards, followed by 'heavy precipitation'.
- in **Latin America** 'floods & sea level rise' is the most addressed hazard.
- in **Eastern Europe & Central Asia** 'extreme heat' and 'extreme cold' are the most addressed hazards.
- in **North America** 'floods & sea level rise' is the most addressed hazard, followed by 'extreme heat'.
- in **Middle East & North Africa** 'extreme heat' and 'droughts & water scarcity' are the most addressed hazards.
- in **Southeast Asia** 'floods & sea level rise' is the most addressed hazard, followed by 'extreme heat' and 'storms & wind'.
- in **East Asia** 'extreme heat' is the most addressed hazard, followed by 'heavy precipitation'.
- in **Oceania** 'floods & sea level rise' is the most addressed hazard, followed by 'extreme heat'.
- in **Sub Saharan Africa** 'floods & sea level rise' is the most addressed hazard.
- in **South Asia** 'extreme heat', is the most addressed hazards.

When looking at the hazards separately, some regional differences can be noted, proportionally:

- **Extreme heat** is the most addressed climate hazard overall, but in particular for 'South Asia' and 'Eastern Europe & Central Asia' (28 % of their reports).
- **Droughts & water scarcity** is most addressed in 'Middle East & North Africa'.
- **Floods & sea level rise** is most addressed in 'Southeast Asia'.
- **Heavy precipitation** is most addressed in 'East Asia' and 'European Union & Western Europe'.
- **Other** is most addressed in 'South Asia'.
- **Storm & wind** is most addressed in 'Southeast Asia'.
- **Extreme cold** is most addressed in 'Eastern Europe & Central Asia'.
- **Wildfires** is most addressed in 'European Union & Western Europe'.
- **Mass movement** is most addressed in 'Latin America & the Caribbean'.
- **Biological hazard** is most addressed in 'Sub Saharan Africa' and ''Latin America & the Caribbean'.
- **Chemical change** is most addressed in 'Eastern Europe & Central Asia'.

Figure 20. Adaptation actions and most addressed climate hazards in GCoM regions.



Source: JRC elaboration based on GCoM data

6.2. Actions and most targeted vulnerable sectors

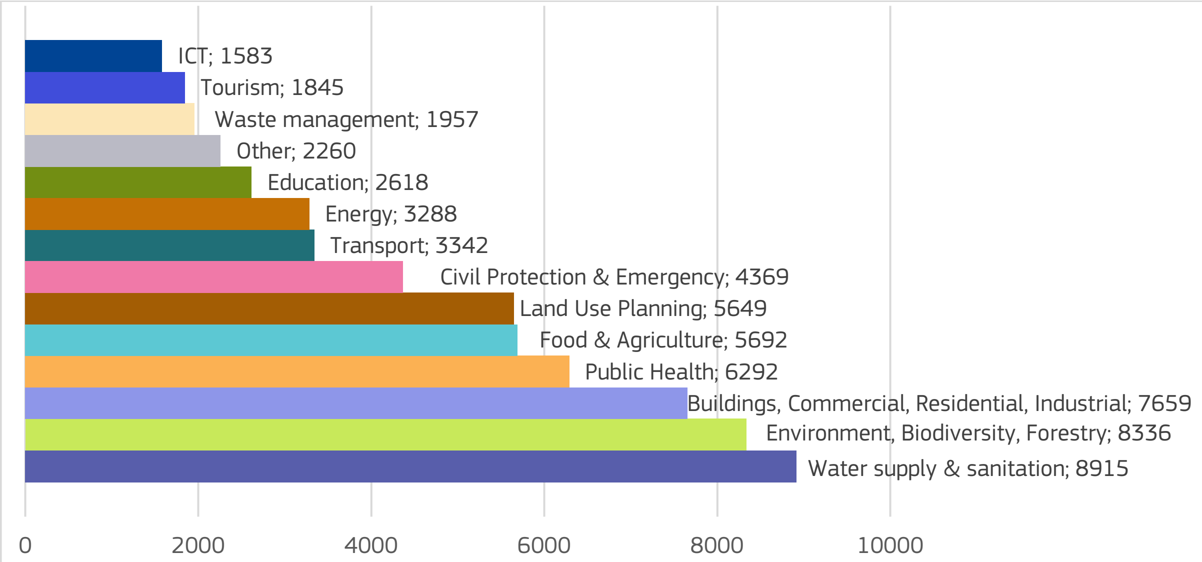
94 % of adaptation actions (31 739 out of 33 699) report which sector they are targeting. This information is mandatory for all actions in the current version of the common reporting framework [28]. Multiple sectors can be selected.

According to the data shown in **Figure 21**, the most targeted sectors are ‘water supply & sanitation’, ‘environment, biodiversity, forestry’, and ‘buildings, commercial, residential, industrial’.

That slightly differs from the most reported sectors in the RVA (see also 4.2).

[28] The CRF outlines the mandatory information required for reporting on the platforms. For actions, reporting the climate hazard and sector is mandatory, while specifying vulnerable population groups is optional (GCoM, 2023).

Figure 21. Adaptation actions and most targeted vulnerable sectors.



Source: JRC elaboration based on GCoM data

As introduced in section 3.2 and used on the previous sections, the second approach to analysing the actions and the most addressed climate hazards is to examine their recurrence in municipalities by reviewing each municipality's action plan (see **Table 9**) and noting whether the sectors were mentioned. This methodology helps eliminate bias, allows, and confirms the top addressed sectors, albeit with a slight difference in their ranking.

Table 9. Vulnerable sectors addressed across municipal action plans.

Vulnerable sectors addressed by actions	Count of municipalities' action plans addressing that sector	Share of municipalities in %
Water supply & sanitation	2 467	80 %
Environment, biodiversity, forestry	2 104	68 %
Buildings, commercial, residential, industrial	2 054	67 %
Food & agriculture	1 972	64 %
Public health	1 879	61 %
Land use planning	1 677	55 %
Civil protection & emergency	1 608	52 %
Transport	1 217	40 %
Energy	1 163	38 %
Education	1 100	36 %
Waste management	951	31 %
ICT	735	24 %
Tourism	691	22 %
Other [29]	624	20 %
Total municipalities with an action plan targeting vulnerable sectors	**3 077**	**100 %**

Source: JRC elaboration based on GCoM data

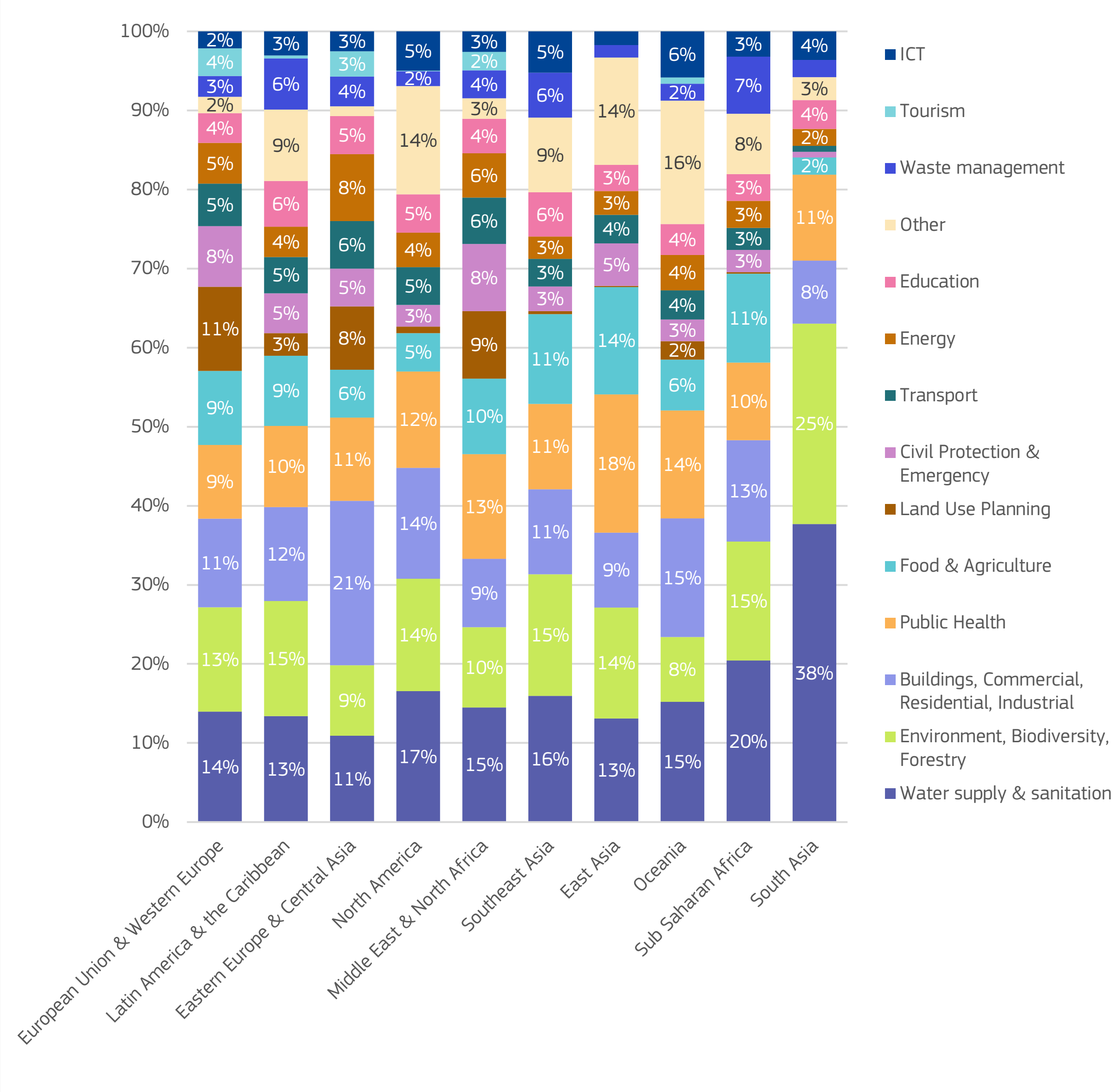
[29] Refer to footnote 19 for further details on the 'Other' category.

6.2.1. Regional distribution of actions and most frequently addressed sectors

When looking at the most reported sectors in adaptation actions in GCoM regions, some differences can be noted proportionally (**Figure 22**). Of all the sectors reported by a region, some are proportionally reported a higher share compared to other regions:

- **Water supply & sanitation** is most reported in 'South Asia'.
- **Environment, biodiversity, forestry** is most reported in 'South Asia'.
- **Buildings, commercial, residential, industrial** is most reported in 'Oceania' and 'North America'.
- **Public health** is most reported in 'East Asia'.
- '**Food & agriculture** is most reported in 'East Asia'.
- **Land use planning** is most reported in 'European Union & Western Europe'.
- **Civil protection & emergency** is most reported in 'Middle East & North Africa' and 'European Union & Western Europe'.
- **Transport** is most reported in 'Eastern Europe & Central Asia' and 'Middle East & North Africa'.
- **Energy** is most reported in 'Eastern Europe & Central Asia'.
- **Other** is most reported in 'Oceania'.
- **Waste** is most reported in 'Sub Saharan Africa'.
- **Tourism** is most reported in 'European Union & Western Europe'.
- **ICT** is most reported in 'Oceania'.

Figure 22. Most reported sectors in adaptation actions GCoM regions.



Source: JRC elaboration based on GCoM data

6.3. Actions and most targeted vulnerable population groups

Only 25 % of adaptation actions (8 344 out of 33 699) report which vulnerable population group they are targeting [30]. This information is optional in the current version of the CRF (GCoM, 2023).

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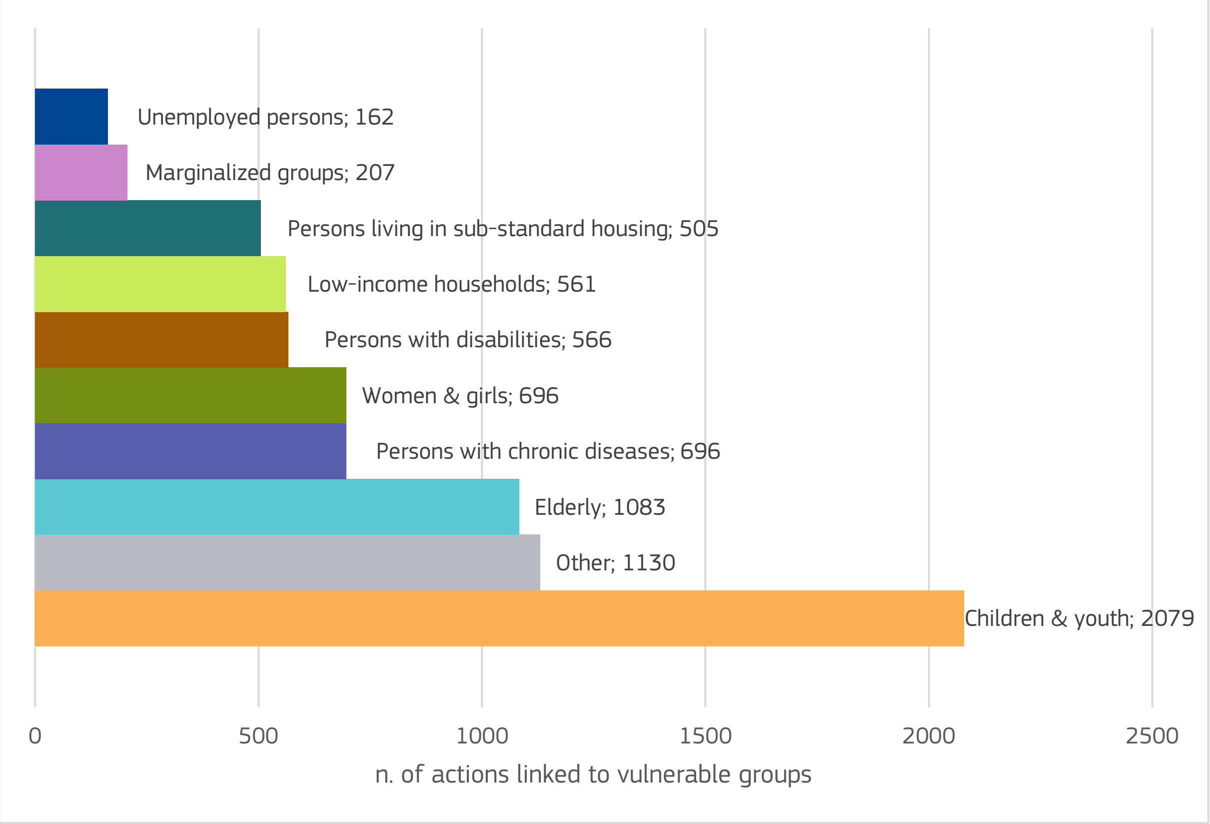
30 In the current version of the dataset, the CDP-ICLEI Track data does not include vulnerable population groups associated with climate actions; consequently, this analysis relies solely on MyCovenant data.

According to the data shown in **Figure 23**, the most targeted population groups are [31] ‘children & youth’, ‘other’ [32], and ‘elderly’.

That slightly differs from the most reported vulnerable population groups in the RVA (see also 4.3).

Figure 23. Adaptation actions and most targeted vulnerable population groups.



Source: JRC elaboration based on GCoM data

Another approach to analysing the actions and the most addressed vulnerable groups is to examine their recurrence in municipalities by reviewing each municipality’s action plan (see **Table 6**) and noting whether the groups were mentioned. This methodology helps eliminate bias, and confirms the top addressed vulnerable population groups, albeit with a slight difference in their ranking.

[31] The reporting platforms allows selecting ‘all’ and other categories at the same time (multi-choice option). 5 805 records are reported as ‘all’ in the vulnerable population groups section of the action template, but they have been discarded for purpose of this analysis.

[32] Refer to footnote 24 for further details on the ‘other’ category. In the analysis, entries from RVAs and actions were matched based on the category ‘other’, where a hazard impacting ‘other’ was aligned with an action targeting ‘other’. However, these matches may not always represent true alignment; for example, an RVA might classify a hazard affecting farmers under ‘other’, while the corresponding action could be aimed at migrants, also classified under ‘other’.

Table 10. Vulnerable population groups addressed across municipal action plans.

Vulnerable group addressed by Actions	Count of municipalities' action plans addressing that group	Share of municipalities' in %
All	856	82 %
Children & youth	412	40 %
Elderly	354	34 %
Other	270	26 %
Persons with chronic diseases	238	23 %
Low-income households	231	22 %
Persons with disabilities	187	18 %
Persons living in sub-standard housing	187	18 %
Women & girls	148	14 %
Marginalised groups	109	10 %
Unemployed persons	78	7 %
Total municipalities with an action plan targeting vulnerable groups	**1 042**	**100 %**

Source: JRC elaboration based on GCoM data

6.3.1. Regional distribution of actions and most frequently addressed vulnerable groups

When looking at the most reported vulnerable groups addressed by adaptation actions in GCoM regions, some differences can be noted proportionally (**Figure 24**). Of all the sectors reported by a region, some are proportionally reported a higher share compared to other regions:

— **Children & youth** is the only reported group in 'Latin America & the Caribbean' (by 2 municipalities, the only ones reporting vulnerable groups in their actions), and the group representing 36 % of the reports in 'Eastern Europe & Central Asia'.

— **Other** is most reported as targeted in actions in 'Middle East & North Africa' (23 % of the 124 actions in the region reported with vulnerable groups).

— **Elderly** is most reported in 'European Union & Western Europe'.

— **Persons with chronic diseases** is most reported in 'European Union & Western Europe'.

— **Women & girls** is most reported in 'Eastern Europe & Central Asia'.

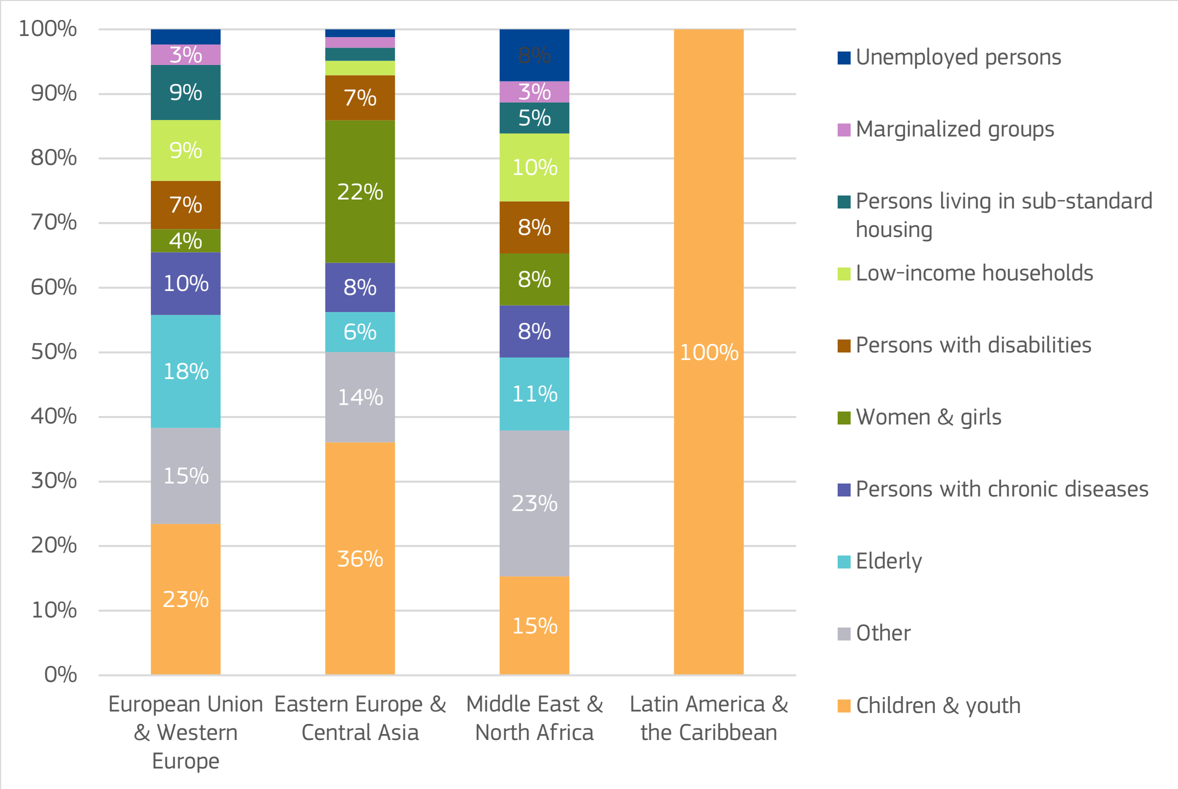
— **Persons with disabilities** is most reported in 'Middle East & North Africa'.

— **Low-income households, persons living in sub-standard housing, marginalised groups, migrants and displaced people** are most reported in 'European Union & Western Europe'.

— **Unemployed persons** group is most reported in 'Middle East & North Africa'.

— There are no actions reported as targeting specific vulnerable groups in North America, Oceania, Asia (Southeast Asia, South Asia, East Asia), and Sub-Saharan Africa [33].

Figure 24. Most reported vulnerable groups in adaptation actions GCoM regions.



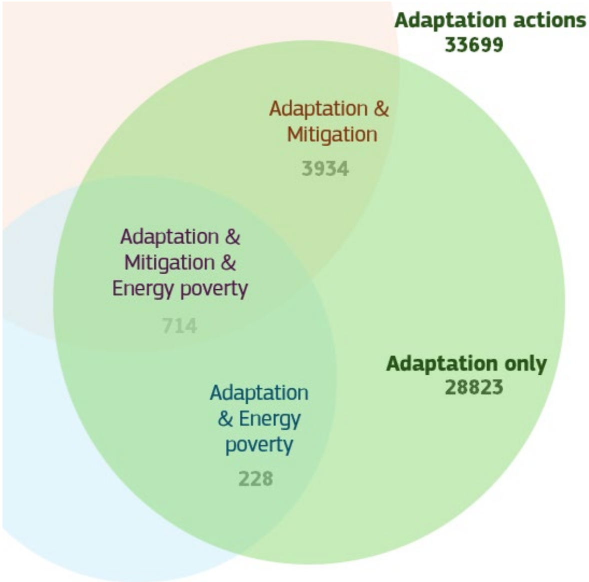
Source: JRC elaboration based on GCoM data

6.4. Adaptation actions and GCoM pillars

Actions reported by municipalities within the GCoM initiative can be marked as 'mitigation', 'adaptation', and 'energy poverty/access'. Of the actions reported as adaptation (33 699), 85.5 % are reported as adaptation only (28 823), while 11.7 % (3 934) are also addressing mitigation, 0.7 % (228) are also addressing energy poverty, and 2.1 % (714) are also addressing both mitigation and energy poverty (see **Figure 25**).

[33] The absence of actions targeting specific vulnerable groups in North America, Oceania, Asia, and Sub-Saharan Africa is due to data limitations. As noted in footnote 30, CDP-ICLEI Track data does not include vulnerable population groups linked to climate actions, and these regions primarily use CDP-ICLEI Track for data submission. Consequently, this analysis relies solely on MyCovenant data, which does cover vulnerable groups, leading to the observed gap.

Figure 25. Actions and their share among the three pillars of the GCoM initiative.



Source: JRC elaboration based on GCoM data

6.4.1. Regional distribution of adaptation actions and GCoM pillars

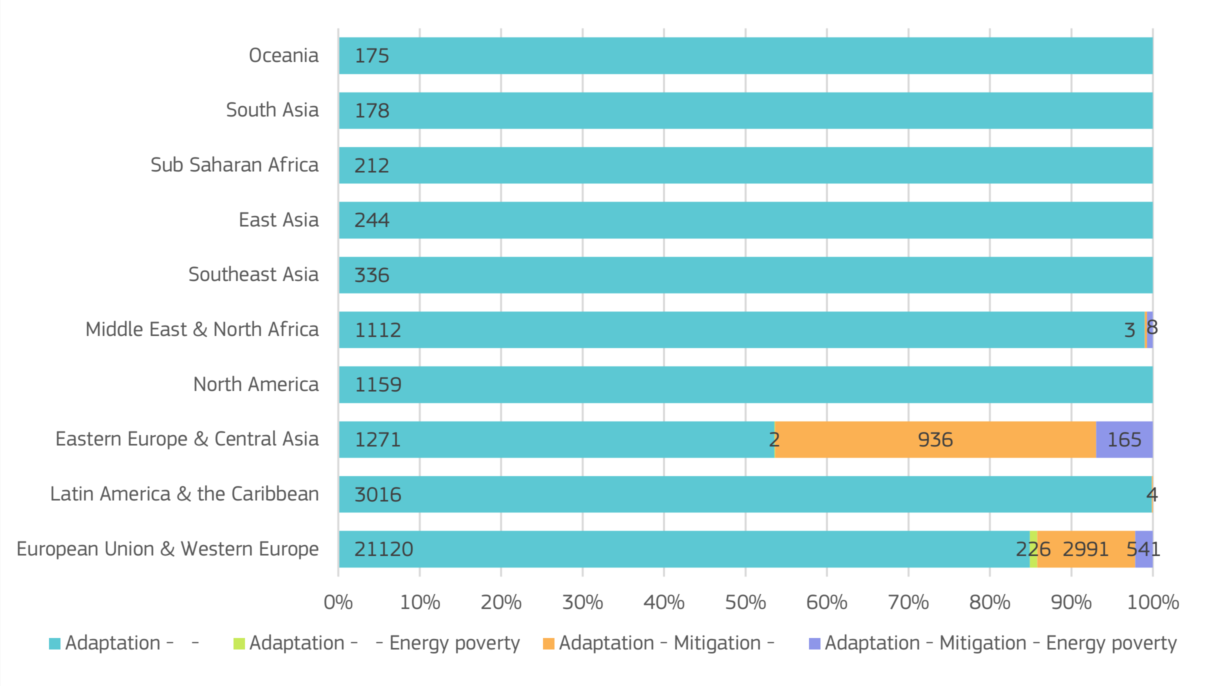
'European Union & Western Europe' leads with 24 878 adaptation actions, followed by 'Latin America & the Caribbean' with 3 020 and 'Eastern Europe & Central Asia' with 2 374 adaptation actions. Climate actions reported in municipalities climate plans refer to the three GCoM pillars (mitigation, adaptation, energy poverty), allowing overlap among them. **Figure 26** shows some regional differences:

— The share of adaptation actions also marked as mitigation is higher in 'European Union & Western Europe' and proportionally higher in 'Eastern Europe & Central Asia'.

— The share of adaptation actions also marked as energy poverty/access is higher in 'European Union & Western Europe'.

— The share of adaptation actions also marked as both mitigation and energy poverty/access is higher for 'Eastern Europe & Central Asia'.

Figure 26. Number of adaptation actions and their share among the three pillars in GCoM regions.



Source: JRC elaboration based on GCoM data

7. Adaptation 'gap' and potential incoherence among RVA and actions

Section 4 provided a comprehensive analysis of RVAs, focusing on the climate hazards, vulnerable sectors, and population groups identified. Section 5 detailed the actions undertaken to address these identified risks. This section conducts a critical examination of the consistency between the hazards and vulnerabilities outlined in climate action plans (CAPs), which encompass RVAs and actions.

As noted in the previous sections, there is a slight incoherence among hazards and vulnerabilities reported in CAPs, which include goals, RVAs, and actions. The major differences are between the hazards reported in RVA and those targeted by actions are as follows (see **Table 11**):

— The top four climate hazards reported in RVAs ('extreme heat', 'droughts & water scarcity', 'floods & sea level rise', and 'heavy precipitation') are also the top four addressed hazards in adaptation actions. However, when considering high-risk hazards (defined as climate hazards with both high probability and high impact, as identified in 4.1), the order changes slightly, with 'heavy precipitation' and 'floods & sea level rise' switching positions.

— Although 'wildfires' are among the top five high-risk hazards in RVAs, they are not ranked among the top five hazards targeted by adaptation actions, which instead focus on the 'other' category.

Table 11. Comparative analysis of hazards and vulnerabilities in RVA and actions.

Order	Hazards in RVA	High-risk hazard in RVA	Hazards in Actions	Vulnerable sectors in RVA	Vulnerable sectors in Actions	Vulnerable group in RVA	Vulnerable group in Actions
I	Extreme heat	Extreme heat	Extreme heat	Food & agriculture	Water supply & sanitation	Elderly	All
II	Droughts & water scarcity	Droughts & water scarcity	Droughts & water scarcity	Public health	Environment, Biodiversity, Forestry	Children & youth	Children & youth
III	Floods & sea level rise	Heavy precipitation	Floods & sea level rise	Environment, biodiversity, forestry	Buildings, Commercial, Residential, Industrial	Low-income households	Elderly
IV	Heavy precipitation	Floods & sea level rise	Heavy precipitation	Water supply & sanitation	Food & Agriculture	Persons with chronic diseases	Other
V	Wild fire	Wild fire	Other [1]	Buildings, commercial, residential, industrial	Public Health	All	Persons with chronic diseases

Source: JRC elaboration based on GCoM data

When considering vulnerabilities identified in RVA and targeted in the actions:

— While 'food & agriculture' is the most reported vulnerable sectors in RVAs, it is not the most addressed sectors in the action plans, where 'water supply & sanitation' is prioritised.

— 'Environment, biodiversity, forestry' is both a top vulnerable sector and addressed sector in RVAs. However, 'buildings, commercial, residential, industrial' is the third most addressed sector by the actions, despite not being in the top four most vulnerable sectors in RVAs.

— While 'low-income households' is among the most reported vulnerable groups in RVAs, it is not among the top groups addressed in the action plans, where the focus is more on 'all' and 'other'.

Discrepancies in developing actions for certain hazards and sectors can be attributed to several challenges faced by local authorities. Addressing wildfires, for example, requires coordinated efforts that often exceed municipal capacities, necessitating regional or national collaboration. Similarly, in sectors like 'agriculture and forestry', local authorities in some EU municipalities are limited by regional or national regulations, restricting their ability to implement actions. In contrast, areas such as building codes, land use planning, and public education are where local authorities can exert more influence.

Inconsistencies between vulnerable population groups identified in RVAs and those targeted in actions often result from prioritising politically visible groups or those easier to address with available resources. Broader actions are sometimes implemented due to limited data or the complexity of systemic vulnerabilities, leading to a mismatch with RVA findings.

Resource constraints, including limited funding and expertise, compel authorities to focus on feasible actions rather than more urgent vulnerabilities. Political priorities and public perception may shift focus toward visible issues, while outdated or incomplete data can misalign current plans. Furthermore, infrastructural limitations and the pursuit of actions with multiple benefits can lead to prioritising less urgent areas, diverging from RVA urgencies.

The following sections delve deeper into the consistency between RVAs and actions, evaluating the extent to which the hazards, sectors, and groups identified in RVAs are also addressed by corresponding actions.

7.1. Climate hazards in RVA and actions

Considering 'high-risk hazards' **Figure 27** shows the proportion of municipalities reporting a 'high-risk hazard' and at least one matching action: those that are covered in the action plan are shown in blue, while those reported in RVA but not mentioned in the action plans are in green:

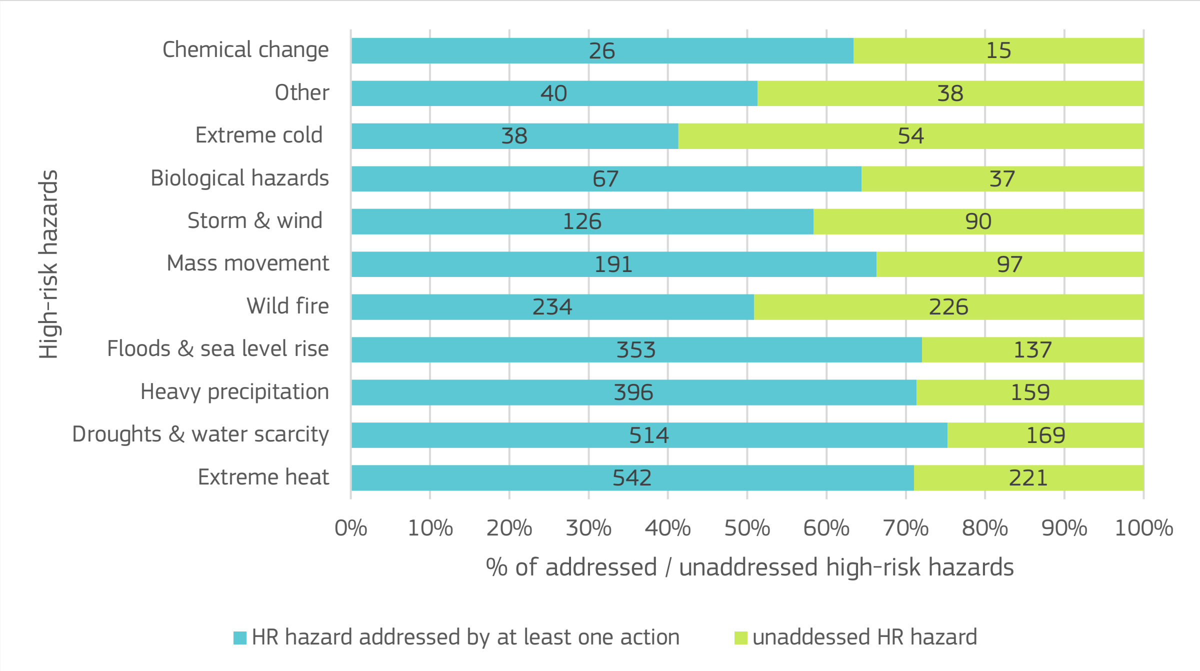
— Overall, among all the high-risk hazards reported in RVA by municipalities (2 527), 67 % of them (3 770) are already addressed by at least one adaptation action.

— 'Droughts & water scarcity (75 %), 'floods & sea level rise' (72 %), 'extreme heat' (71 %), and 'heavy precipitation' (71 %) are the hazards that, when identified as high-risk, have the highest proportion of being addressed by at least one adaptation action.

— 'Extreme cold' (41 %), and 'wildfires' (51 %) show lower share of addressed high-risk hazards by at least one action.

This result could be linked to the fact that while actions addressing extreme heat, droughts and floods are available and popular among municipalities, adaptation strategies for wildfires are more difficult to plan for local authorities.

Figure 27. Proportion of 'high-risk' hazard reported in RVA also reported with at least one matching action.



In blue: number of reported high-risk hazards covered in action plans.
In green: number of reported high-risk hazards not yet addressed in submitted action plans. Hazards are ordered by the number of municipalities reporting them as high-risk in their RVAs.

Source: JRC elaboration based on GCoM data

Considering the overall number of municipalities reporting high-risk hazards (1 087):

— 76 % (1 268 out of 1 667) of municipalities' RVAs reporting at least one high-risk hazard are also reporting at least one matching action to address it.

— While there is a gap between the overall climate hazards identified and the actions taken, it can be noted that when it comes to high-risk hazards, most action plans are probably well designed to address them.

7.1.1. Regional distribution of climate hazards in RVA and actions

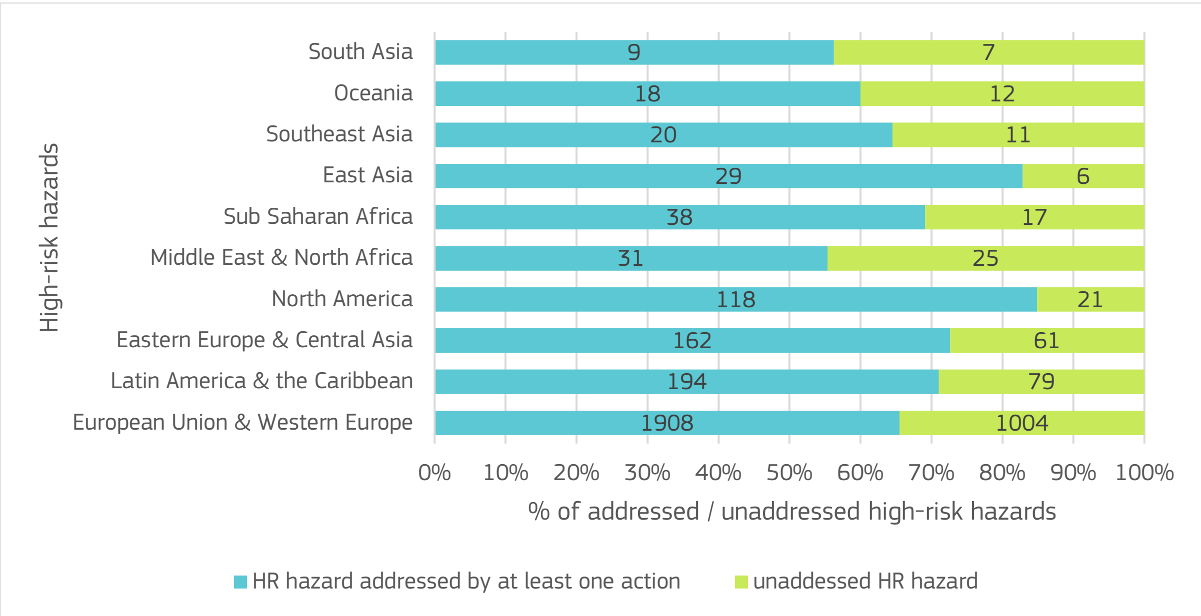
Most addressed climate hazards in actions can differ from the hazards reported in RVA, and this difference vary across regions (see the difference in top reported hazards in 4.1.1 and **Figure 20**).

Figure 28 shows the regional differences when considering high-risk hazards reported in RVA and the proportion of them that are covered by at least one adaptation action:

— 'North America' (85 %) and 'East Asia' (83 %), show the highest coverage rates of high-risk hazards covered by action.

— South Asia' (56 %) and 'Middle East & North Africa' (55 %) show the lowest coverage rates, leaving a higher share of unaddressed high-risk climate hazards.

Figure 28. Proportion of 'high-risk' hazard addressed by at least a matching action in GCoM region.



Source: JRC elaboration based on GCoM data

7.2. Vulnerable sectors in RVA and actions

Looking at the sectors reported in RVA, it is possible to analyse how many of them are targeted by planned actions. **Figure 29** shows the proportion of vulnerable sectors in RVA also reported in at least one matching action: those that are covered in the action plan are shown in blue, while those reported in RVA but not mentioned in the action plans are in green:

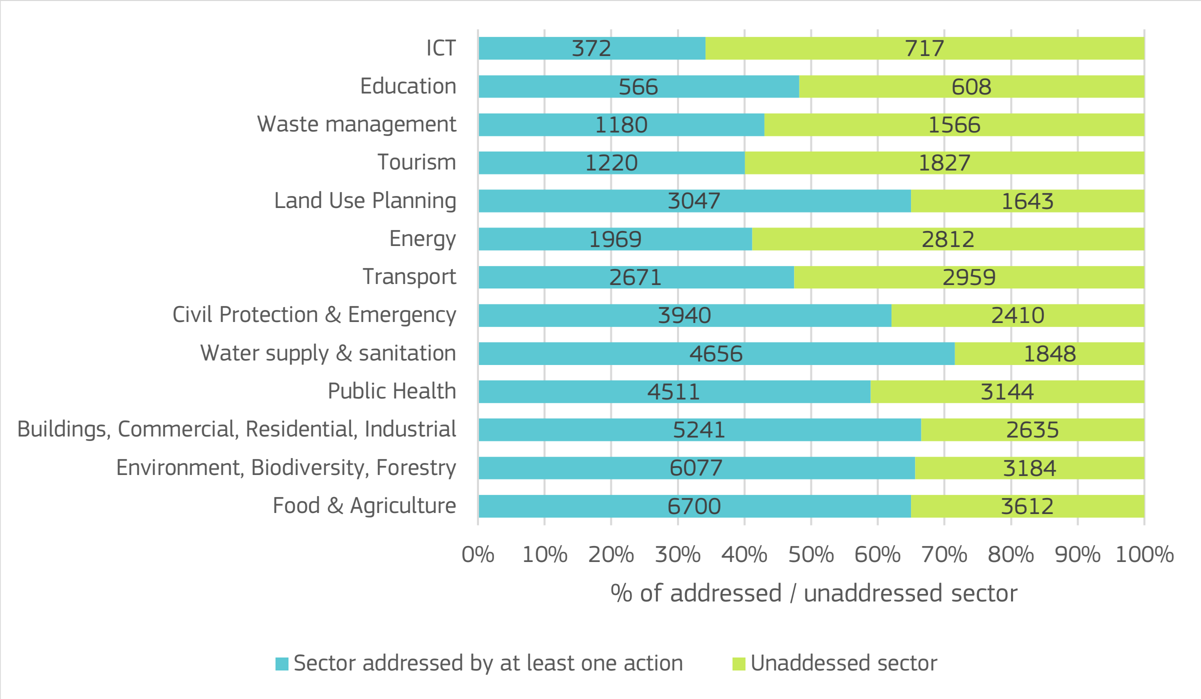
— Overall, among all the vulnerable sectors reported in RVA by municipalities (71 115), 59 % of them (42 150) are already addressed by at least one adaptation action.

— 'Water supply & sanitation' shows the highest share (72 %) of high vulnerable sector covered by at least one adaptation action, followed by 'buildings, commercial, residential, industrial' at 67 %.

— 'ICT' shows the lowest share (34 %).

Despite the fact 'buildings' is not among the top three vulnerable sectors, when reported as high vulnerable it is mostly addressed by at least one action. This is probably linked to the fact that acting on 'buildings' is in the governmental domain of most local authorities' municipalities of the GCoM (i.e. promoting sustainable building codes, resilient retrofitting of public owned buildings, etc.).

Figure 29. Proportion of sectors reported as vulnerable/impacted in RVA also reported in at least a matching action.



In blue: number of reported vulnerable sectors covered in action plans.
In green: number of reported vulnerable sectors not yet addressed in submitted action plans. Sectors are ordered by the number of municipalities reporting them as vulnerable in their RVAs.

Source: JRC elaboration based on GCoM data

Considering the overall number of municipalities reporting vulnerable sectors (2 065):

— 2 577 (81 % of 3 172) of municipalities action plans that report at least a vulnerable sector are also reporting at least one matching action to address it.

7.2.1. Regional distribution of sectors in RVA and actions

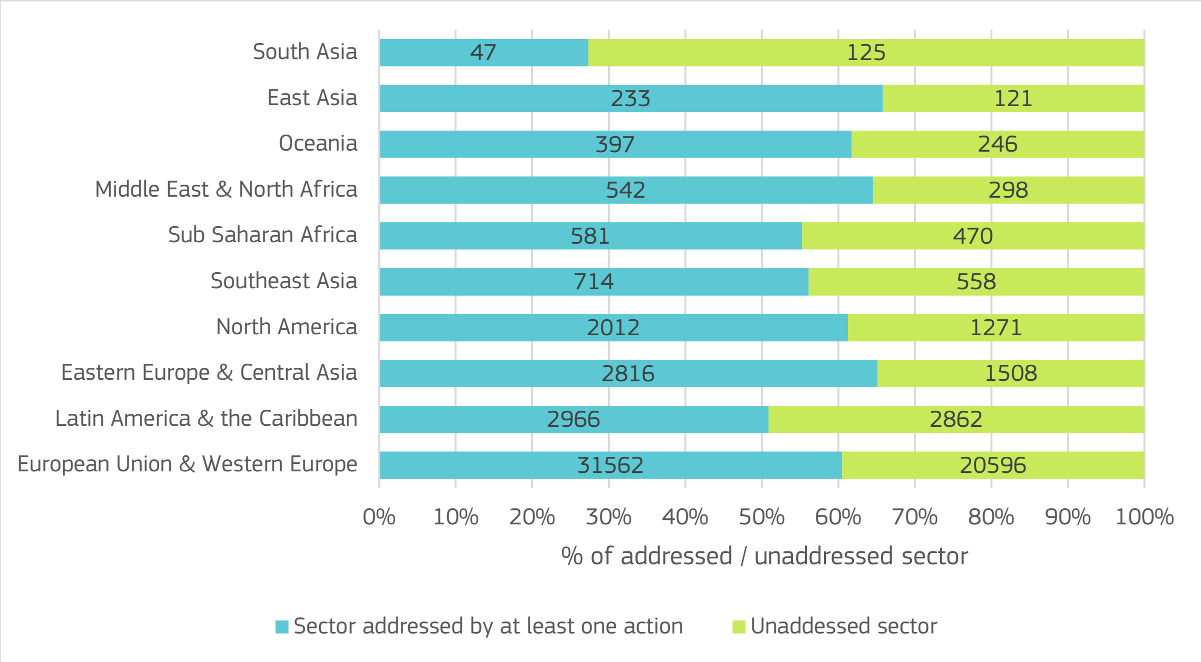
Most addressed sectors in actions can differ from the sectors reported in RVA, and this difference vary across regions (see the difference in top reported sectors in **Figure 14** in 4.2.1 and **Figure 22** in 6.2.1).

Figure 30 shows the regional differences when considering vulnerable sectors reported in RVA and the proportion of them that are covered by at least one adaptation action:

— 'East Asia' (66 %), 'Middle East & North Africa' (65 %), 'Eastern Europe & Central Asia' (65 %) show the highest coverage rates of sectors covered by at least an adaptation action.

— 'South Asia' (27 %) shows the lowest coverage rate.

Figure 30. Proportion of sectors addressed by at least a matching action in GCoM region.



Source: JRC elaboration based on GCoM data

7.3. Vulnerable population groups in RVA and actions

Looking at the vulnerable groups reported in RVA, it is possible to analyse how many of them are targeted by planned actions. **Figure 31** shows the proportion of vulnerable groups in RVA also reported in at least one matching action: those that are covered in the action plan are shown in blue, while those reported in RVA but not mentioned in the action plans are in green:

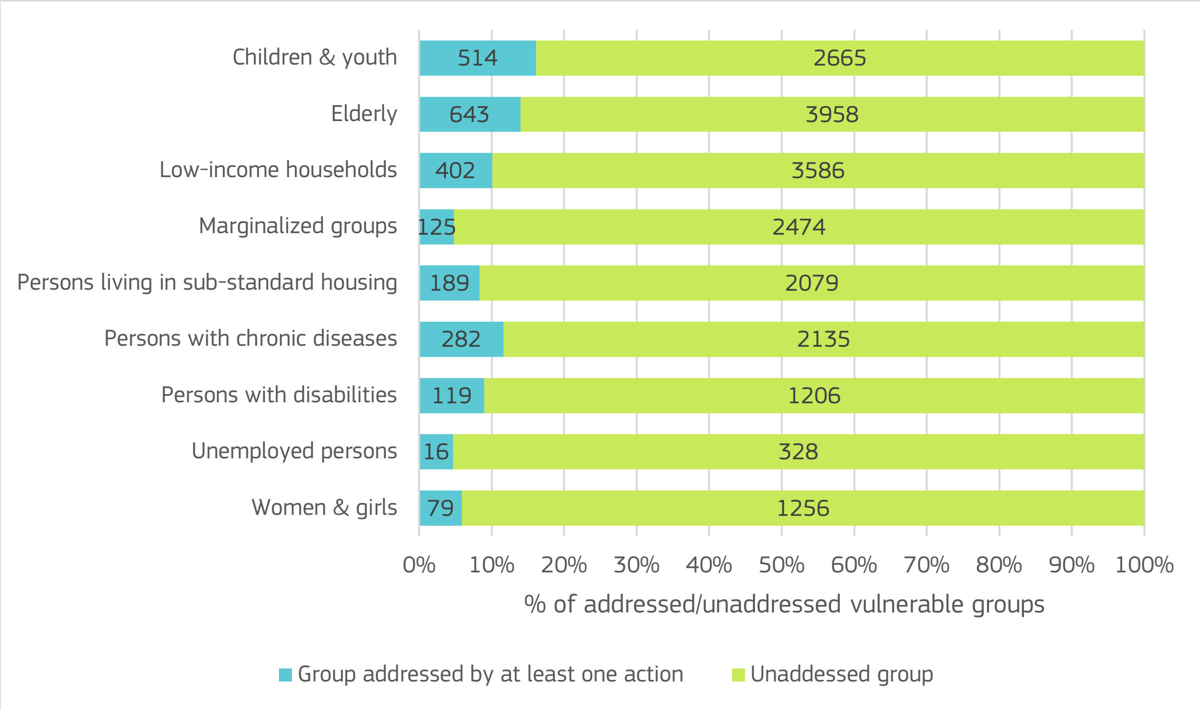
— Overall, among all the vulnerable groups reported in RVA by municipalities (22 056), only 11 % of them (2 369) are addressed by at least one adaptation action [34].

— 'Children & youth' and 'elderly' show the highest shares, 16 and 14 % respectively.

— 'Unemployed persons' and 'marginalised groups' show the lowest share (5 %) of vulnerable groups covered by at least one adaptation action.

[34] Category 'all' is excluded from this analysis.

Figure 31. Proportion of population groups reported as vulnerable in RVA also reported in at least a matching action.



In blue: number of reported vulnerable groups covered in action plans.
In green: number of reported vulnerable groups not yet addressed in submitted action plans. Groups are ordered by the number of municipalities reporting them as vulnerable in their RVAs.

Source: JRC elaboration based on GCoM data.

Considering the overall number of municipalities reporting vulnerable groups (1 730):

— 1 078 (62 %) of municipalities' action plans that report at least one vulnerable group are also reporting at least one matching action to address it.

Addressing vulnerable population groups is still one of the main challenges in GCoM municipalities.

7.3.1. Regional distribution of vulnerable groups in RVA and actions

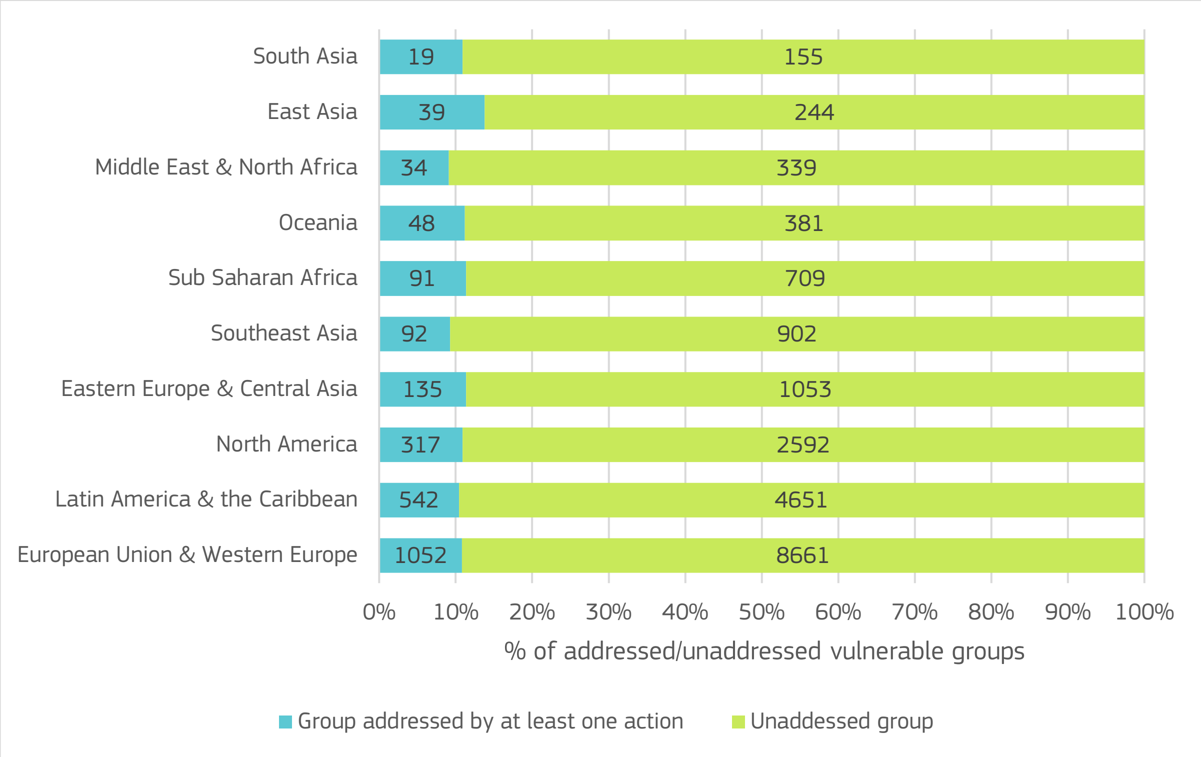
Most addressed vulnerable groups in actions can differ from the hazards reported in RVA, and this difference vary across regions (see the difference in top reported groups in **Figure 17** and **Figure 24** in 4.3.1 and 6.3.1).

Figure 32 shows the regional differences when considering vulnerable groups reported in RVA and the proportion of them that are covered by at least one adaptation action:

— 'East Asia' (14 %) shows the highest coverage rate of vulnerable groups covered by action.

— 'Southeast Asia' and 'Middle East & North Africa' (10 %) show the lowest coverage rate (9 %) of vulnerable groups covered by action.

Figure 32. Proportion of vulnerable groups addressed by at least a matching action in GCoM region.



Source: JRC elaboration based on GCoM data.

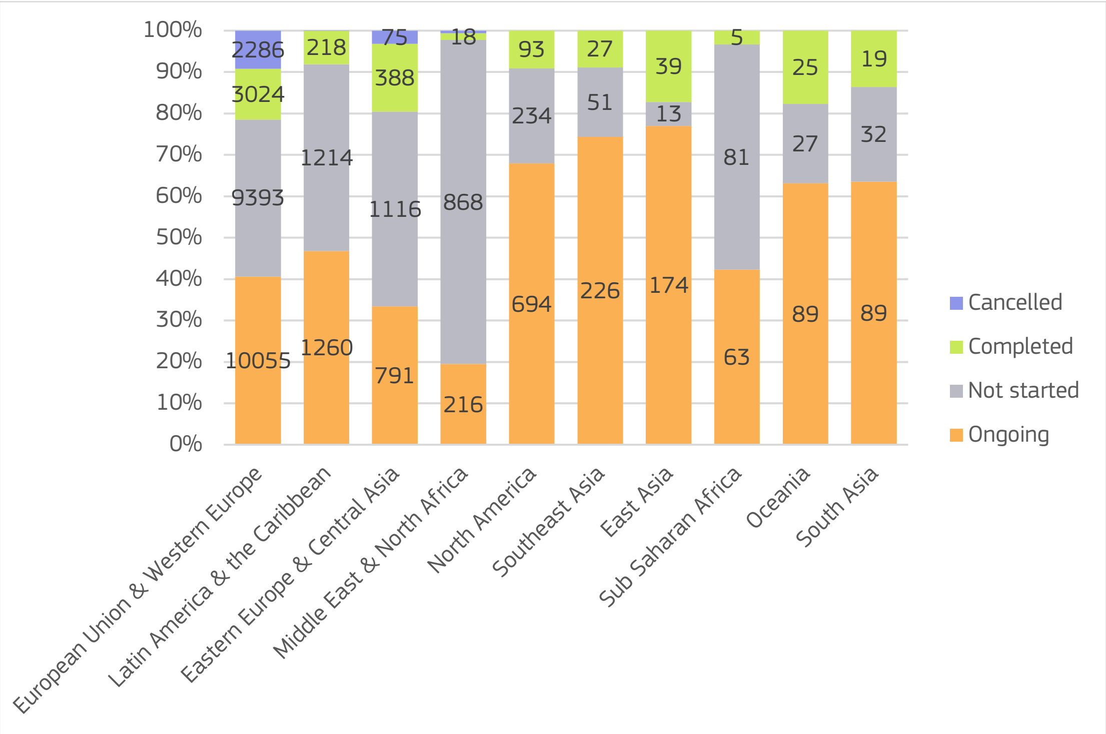
8. Monitoring

During the monitoring phase, municipalities can update all reported information, with particular emphasis on updates to the RVA, the implementation of actions, and the achievement of adaptation targets. This section focuses specifically on analysing the implementation of actions. RVA updates are infrequent within short time frames, and the GCoM dataset has limited monitoring reports available. Additionally, there is a scarcity of monitored adaptation goals. As noted in section 5 and per CRF guidelines, adaptation goals should be quantitatively defined to facilitate the monitoring and reporting progress toward targets. Future analyses could examine these quantitative goals and their associated monitoring data, once available, to assess progress over time and understand whether municipalities are on track to meet their adaptation targets.

Therefore, the information used in the dataset is the implementation status of adaptation actions [35]. The implementation status of the adaptation actions shows that 41 % of adaptation actions are reported as 'ongoing' while 34 % are 'not started'. Only 12 % of the reported actions are reported as 'completed'.

There are regional variations as shown in **Figure 33**.

Figure 33. Number of adaptation actions and their implementation status in GCoM regions.



Source: JRC elaboration based on GCoM data

35 Data homogenisation was performed to reclassify the implementation status to the 4 categories: ongoing, completed, cancelled and not started.

9. Conclusion

As climate change continues to pose significant threats to urban and rural communities alike, the necessity for robust adaptation strategies and resilience becomes increasingly evident. This report has provided a detailed examination of the current landscape of climate adaptation efforts spearheaded by the municipalities of the Global Covenant of Mayors for Climate and Energy (GCoM). By analysing data from two official GCoM reporting platforms, it has highlighted both the achievements and the areas needing improvement in the adaptation journey.

The analysis reveals that while substantial progress has been made in identifying climate hazards and vulnerable sectors, there remains a critical need for more comprehensive and targeted adaptation actions. The alignment of risk and vulnerability assessments (RVAs) with actionable plans is essential to effectively mitigate high-risk climate hazards and protect vulnerable populations. Furthermore, regional disparities in adaptation efforts underscore the importance of tailored strategies that address specific local challenges.

Looking ahead, enhancing the capacity for data collection and analysis, fostering cross-sectoral collaboration, and ensuring policy coherence will be pivotal in advancing climate adaptation initiatives. It is imperative for municipalities to leverage shared knowledge and best practices to bridge the adaptation gap and build resilient communities capable of withstanding the impacts of climate change.

This report serves as a call to action for policymakers, stakeholders, and practitioners to intensify their efforts and work collaboratively towards sustainable and resilient futures. By embracing innovative solutions and committing to continuous improvement, we can collectively rise to the challenge of climate change and safeguard our communities for generations to come.

GCoM can support cities in improving climate adaptation strategies by addressing several key challenges identified in the report. Discrepancies in data reporting hinder effective alignment of risk assessments with adaptation actions, so enhancing data harmonisation and providing clearer guidelines will ensure consistent reporting across platforms. Limited monitoring data on adaptation goals impedes progress tracking, thus encouraging cities to set quantitative targets and offering support for better monitoring practices is crucial. Regional disparities in adaptation efforts indicate a need for tailored strategies; by facilitating regional workshops and networks, cities can share best practices and develop solutions specific to their contexts. Moreover, cities benefit greatly from exchanging successful strategies and innovations, so creating a platform for sharing these approaches and recognising cities that excel in adaptation efforts will foster a collaborative environment. Lastly, some cities lack detailed assessments of sector impacts in their risk evaluations. Providing guidance to ensure comprehensive risk assessments that include both hazards and sector impacts will enhance the effectiveness of adaptation plans. By focusing on these areas, the GCoM Secretariat can significantly advance cities' resilience and adaptation capabilities.

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List of abbreviations and definitions

Abbreviations	**Definitions**
CAP	Climate Action Plan
CDP	Carbon Disclosure Project
CoM	Covenant of Mayors for Climate and Energy
CoM-East	Covenant of Mayors East (Eastern Partnership countries)
CoM-South	Covenant of Mayors South (Southern Mediterranean Partner countries)
CoM-SSA	Covenant of Mayors in Sub-Saharan Africa
CRF	Common Reporting Framework
DG ENER	European Commission's Directorate-General for Energy
DG CLIMA	European Commission's Directorate-General for Climate Action
EC	European Commission
EEA	European Environment Agency
EFFIS	European Forest Fires Information System
EU	European Union
EU-27	European Union with 27 Member States
GCoM	Global Covenant of Mayors for Climate and Energy
ICLEI	International Council for Local Environmental Initiatives
ICT	Information and Communication Technologies
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre
NbS	Natural Based Solutions
NUTS	Nomenclature of Territorial Units for Statistics
NUTS2	Level 2 regions based on the Nomenclature of Territorial Units for Statistics
NUTS3	Level 3 regions based on the Nomenclature of Territorial Units for Statistics
SECAP	Sustainable Energy and Climate Action Plan
TWG	Technical Working Group
UHI	Urban Heat Island
UNFCCC	United Nations Framework Convention on Climate Change
VPG	Vulnerable Population Group

List of figures

List of tables

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