



Perspective

MediaWatchers4Climate: Assessing the Accuracy of Climate Change Narratives in Greek Media Through Machine Learning

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Abstract: This study introduces MediaWatchers4Climate, a methodological framework that leverages machine learning to evaluate the accuracy and rhetorical framing of climate change narratives in Greek online media. The model is designed to analyze large-scale textual data from over 1500 certified digital outlets registered in the Greek Online Media Registry. Through keyword-based filtering, thematic clustering, and content comparison techniques, the framework aims to detect discursive shifts, trace the replication of news stories, and identify misinformation patterns. While the current phase focuses on model development and data structuring, preliminary observations suggest significant content repetition across sources and a lack of original reporting on climate issues. The project ultimately seeks to promote evidence-based reasoning and enhance public resilience to misinformation related to the climate crisis.



Keywords: climate change; media literacy; machine learning; Greek media

Academic Editor: Francesco Folino

Received: 11 April 2025

Revised: 29 May 2025

Accepted: 6 June 2025

Published: 13 June 2025

Citation: Baltzi, T.; Nikitaki, S.; Galatsopoulou, F.; Kostarella, I.; Veglis, A.; Vasilopoulos, V.; Papaevangelou, D.; Skamnakis, A.

MediaWatchers4Climate: Assessing the Accuracy of Climate Change Narratives in Greek Media Through Machine Learning. *Mach. Learn. Knowl. Extr.* **2025**, *7*, 53.

<https://doi.org/10.3390/make7020053>

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1. Introduction

Climate change remains one of the most pressing challenges of our time, with profound social, economic, and environmental consequences. Despite advancements in scientific research and global efforts to address it, a significant gap persists between scientific understanding and public perception of the phenomenon [1,2].

The portrayal of climate change in the media often influences public opinion—sometimes positively, sometimes negatively—depending on the framing, political context, and information management [3,4]. On a global scale, studies have highlighted fluctuations in public concern about climate change. In the United States, public interest in climate change has shown significant declines during periods of economic and political upheaval, as noted in Gallup research [5]. Similarly, in Europe, citizens tend to trust information from specialized media outlets more than general news sources, yet skepticism about the reliability of news remains prevalent [6].

Greece is no exception, with misinformation and unverified news replication affecting public understanding of climate change. In the specific context of climate change reporting, misinformation and false narratives have been recurring challenges for decades. Media reporting on climate change often distorts reality or amplifies sensationalism, widening the gap between scientific findings and public understanding [3,4]. The MediaWatchers4Climate initiative addresses these issues by leveraging machine learning to analyze

and evaluate the accuracy of climate change narratives in Greek and Cypriot media. MediaWatchers4Climate aspires to provide journalists, communication researchers, and the general public with a reliable tool for verifying sources and identifying patterns of misinformation in climate change reporting.

This paper describes the development stages of the MediaWatchers4Climate tool, including the systematic review to identify key themes and keywords, the annotation process, and the final structuring of related labels. By monitoring narratives and analyzing media coverage, the project aims to assess rhetorical shifts, detect patterns of plagiarism or repetitive storytelling, and contribute to enhancing the transparency and credibility of environmental journalism. While similar tools have been developed internationally—such as the Climate change misinformation by the Center for Countering Digital Hate (<https://counterhate.com/topic/climate-change-misinformation/>, accessed on 10 April 2025), MediaWatchers4Climate constitutes the first attempt to adapt algorithmic analysis specifically to the Greek media landscape. Its innovative contribution lies in combining large-scale content harvesting with automated thematic filtering and discourse tracking, offering a dynamic approach to evaluating climate change narratives in local media.

1.1. The Influence of Public Perceptions by Media

The perception of climate change depends on various factors that shape public understanding and attitudes. Mass media has served as a powerful mediator between scientific reports and public perception [7]. “The press may not be successful most of the time in telling people what to think, but it is stunningly successful in telling them what to think about” wrote Cohen in 1963 [8], reflecting the core idea of agenda-setting theory, which suggests that while the media may not directly shape opinions, it significantly influences the topics people perceive as important by highlighting specific issues. People often use the media to learn about the environment, making the media an important “tidbit provider” about environmental issues [9]. Environmental information reaches individuals through traditional media, and nowadays mainly through social media, offering a lens through which they perceive environmental issues. These sources shape beliefs about the environment’s condition, enhance awareness of environmental challenges, and influence concern for ecological well-being.

Since the environmental news beat was born, news coverage of the environment has been the subject of intense scrutiny and criticism. Several studies have been conducted to determine the quality of environmental and science news stories and have attempted to uncover the connection between the media agenda and public agenda in relation to environmental issues [3,10]. In the case of climate change in particular, news coverage is often influenced by the interests of industrial and economic bodies because it is an area with significant political and economic consequences. The concentration of media ownership in business groups with interests in sectors such as energy and transport influences both the selection of topics and how they are presented to the public [11].

Also, a growing body of research highlights the strong correlation between right-wing political ideologies and the denial of human-induced climate change [12–16]. As Boykoff [3] and Molek-Kozakowska [17] argue, media outlets and political circles leaning to the right often label climate scientists and activists as ‘alarmists’ and promote misinformation that undermines public trust in science, making social mobilization more difficult. This rhetoric is not merely the result of ideological bias; it is also connected to a broader system of institutional, political, and economic dependencies that determine news production [18].

Specifically, when talking about the news agenda in Greece, it is important to say that it is heavily influenced by the interaction between political, business, and journalistic inter-

ests [19]. The Greek media have developed within a system of clientelistic relations [20]. According to Solomon's "Who Owns the Media" (2024), twelve leading businessmen and their families control a significant percentage of the media, while operating in strategic sectors of the economy, such as energy, shipping, and construction (Solomon is an independent investigative journalism collective based in Athens, specializing in transparency, human rights, and public accountability. The *Who Owns the Media* survey began in November 2022 and was published on 29 October 2024. It investigates the intersections between media ownership and economic interests in Greece, revealing that twelve prominent businessmen and their families control a significant share of the country's media landscape while also being active in strategic sectors such as energy, shipping, and construction. https://media-ownership.eu/findings/countries/greece/#elementor-toc_heading-anchor-1, accessed on 10 April 2025). This concentration of ownership limits pluralism and fosters the reproduction of narratives that serve political and economic agendas [16]. At the same time, the media's dependence on advertising revenue and state funding generates self-censorship and the suppression of criticism directed at influential actors [18], while state advertising functions as a means of political retribution or exclusion. In this context, coverage of climate change cannot be considered simply a journalistic choice; it is more likely to be influenced by the structural dependencies that determine news production.

Research from around the globe has addressed this topic. In their meta-analysis, Schäfer and Schlichting [21] identified 133 studies analyzing media coverage of climate change. Overall, existing research heavily focuses on outlets located within the U.S. or U.K. In Portugal, Cabecinhas, Lázaro, and Carvalho [22] found that watching public service channels was positively related to climate change knowledge. In Greece, Theodosiadou, Kostarella and Tsantopoulos [23] concluded that the quantity of environmental information in the Greek press was not considered satisfactory, while they underlined the role that conflicting interests play when media organizations belong to business conglomerates with activities in related to the environment areas. Furthermore, the analysis of Zerva et al. [24] covering the entire territory of Greece showed that citizens regard documentaries as an important source of environmental information, along with specialized websites and books or magazines.

According to Pan et al. [25], public literacy regarding climate change is primarily cultivated by the media. Monitoring news related to politics and current affairs enhances public awareness through information dissemination, potentially increasing concerns about the significance of climate change impacts and the need for action. Boto-García and Bucciol [26] demonstrated in a recent study that individuals who spend more than 30 min per day consuming climate change-related news exhibit greater concerns about its impacts and are more willing to take action to combat it. Therefore, following news related to current events may encourage people to cultivate individual responsibility and accountability regarding environmental issues.

According to the study conducted by Muñoz and Sommer [27], media in Europe tends to convey more accurate information about climate change issues. Specifically, their research model indicated that European citizens who read, listen to, or watch news more frequently are more likely to believe in the existence of climate change and its anthropogenic causes. However, as mentioned in other studies, this evidence varies depending on variables such as gender, age, and political orientation.

However, as Cheng and Gonzalez-Ramirez [28] note, the public may be reluctant to accept the messages conveyed by the news due to the abundance of fake news and misinformation. Therefore, while European citizens who follow climate journalism may be more aware, a significant portion of the population remains skeptical of the information they receive. An illustrative example can be seen in the survey "*How Media, Information*

Sources, and Trust Shape Climate Change Denial or Doubt” [29], where citizens do not trust climate change reporting by the media of an opposing polar approach, due to the strong link between political power and the media. They are therefore unilaterally informed and as a result, they are unable to form a holistic approach to climate change. At the same time, the superficial coverage of specific issues related to climate change, due to its interdisciplinary nature, leads the public to reject and question climate journalism more easily.

This results in maintaining a steady active percentage of skepticism about climate change, both among Europeans and U.S. citizens [29]. Studies have shown that skepticism chooses to be informed mainly through New Media, where information is more abundant and richer. Indeed, through research conducted by Biddlestone et al. [30], it was proven that those who do not believe in the anthropogenic causes of climate change are more informed by New Media and therefore are more exposed to false information.

Other researchers examining the complex relationship between media, trust, and beliefs about climate change have found that conservative media use leads to greater uncertainty about reality and human causes of climate change. This trend is partly explained by the negative effect of conservative media use [31]. In a study conducted in America, it was found that skeptics show greater trust in the media they choose to inform themselves from, which usually aligns with their political approach, while simultaneously questioning other sources of information about climate change [32].

Finally, it is also the framing of narratives about climate change that plays a crucial role in shaping individuals’ perceptions of this global challenge [32]. Often, media coverage of climate change focuses on extreme weather events, emphasizing the immediacy and severity of the issue. This dramatic focus may inadvertently lead to a biased perception of climate change, emphasizing natural causes over anthropogenic ones [24].

1.2. Evolution of Public Opinion on Climate Change

Despite increased research and scientific progress regarding the existence and impacts of climate change, a significant gap remains between the scientific community and public perception of the phenomenon. Researchers such as Cook et al. [33,34], Doran and Zimmerman [2], Fairbrother et al. [35], Lynas et al. [36], and Oreskes [37] have highlighted the existing asymmetry in perceptions of climate change between the scientific community and the public. According to Dunlap and Brulle [38], public discourse often amplifies this gap through the framing of climate change narratives that distort reality and the dissemination of false news [3,4,31].

In the United States, organizations have been conducting annual surveys to track public opinion on climate change [32]. These surveys reveal significant fluctuations in public concern over time. For instance, research by Gallup found that the percentage of individuals expressing “very” strong concern about climate change rose from 26% in 2004 to 41% in 2007, only to drop sharply to 28% by 2010. Such shifts in concern can be attributed to multiple factors, including changes in individual beliefs, broader cultural and political realities, and external influences such as extreme weather events and scientific communication [5,39].

Similarly, in Europe, public perception is shaped by factors such as media coverage, political ideology, and demographic characteristics [33]. Studies like the Special Eurobarometer 513 [6] reveal a decline in skepticism toward climate change among the European population. However, despite increased awareness, climate change remains a low-priority issue compared to economic and political concerns. Research has shown that the prioritization of climate change does not always translate into motivation for meaningful action. Even as awareness grows, superficial media coverage and the perpetuation of misinformation, often linked to political dynamics, hinder public engagement. This dynamic

leads many individuals to remain passive or even challenge the impacts of climate change, despite acknowledging its existence [34–36].

1.3. Using Machine Learning for Analyzing News Articles

Climate change is considered one of the most important challenges that mankind is facing today, and media coverage plays a very important role in shaping public perception of the issue [11,40,41]. The study of climate change discourse in news articles is a demanding task because it is very difficult (and in most cases not feasible) to manually collect and analyze large volumes of news articles across extended time periods [42,43]. The solution is to utilize machine learning and supervised learning approaches that can automate the analysis of large volumes of data to a certain extent (in this case, news articles related to climate change) [44–47].

Machine learning (ML) is a field of Artificial Intelligence that involves the creation and analysis of systems that can learn from data [48]. Specifically, ML utilizes statistical algorithms that can learn from training data and generalize new data, thereby performing tasks without following specific instructions [49]. There are two main approaches to machine learning: supervised and unsupervised learning. In the first case, the supervised learning model is trained using data labeled by humans [48]. In unsupervised learning, the algorithm employs only unlabeled data [50].

Using natural language processing and supervised learning, one can track subtle changes in language, identify emerging narratives and frame analysis, and see how different aspects of climate change are emphasized or downplayed over time [51]. In supervised machine learning the process starts with a training dataset where articles are manually labeled according to relevant categories such as primary themes (e.g., “climate policy,” “scientific findings,” “economic impacts”), framing approaches or stance [52]. These labeled examples were used to train classification models that can automatically categorize new articles based on what they have learned.

2. Materials and Methods

2.1. Research Aims and Project Motivation

We begin with the assertion that the use of AI tools to assess media coverage of environmental issues will enhance the accuracy and efficiency of identifying informational biases, thematic trends, and sentiment in reporting, compared to traditional manual content analysis methods. While AI has been used in media analysis, there have been limited applications and evaluations of AI tools specifically designed to analyze media coverage of environmental issues [38]. Context sensitivity and dataset limitations are among the most important gaps that should be addressed to advance the application of AI in evaluating the quality and impact of media coverage on environmental issues [53,54].

In this concept paper, we present a research protocol that will lead to the creation of the MediaWatchers4Climate algorithm, a machine learning tool designed to systematically analyze journalistic coverage of climate change issues. The tool will ultimately enable the collection and organization of data from Greek and Cypriot media, identifying news and articles, and analyzing narrative frames and information patterns, in order to understand how the media presents climate change and how it influences the shaping of public perception, evaluates the accuracy and reliability of news, and enhances transparency and quality in environmental journalism.

Therefore, the focus of this study is to document the steps required for the development of the tool, with the goal of ensuring the effectiveness and scientific validity of MediaWatchers4Climate. The objective is to present the process of creating a structured list of keywords to record the basic concepts and themes of climate change, the design and implementation

of an annotation process that allows the categorization of news databased on conceptual and thematic criteria, and finally, the training of the algorithm using high-quality data to identify patterns and narratives in articles by utilizing machine learning methods.

The tool was further developed and trained within the framework of the MediaWatchers4Climate project, funded by the Hellenic Foundation for Research and Innovation. This project aims to enhance the quality and transparency of environmental journalism by introducing advanced methods for analyzing media coverage of climate change. Next, we outline the steps followed in the development process.

2.2. The MediaWatch Tool

The core of the MediaWatchers4Climate tool is MediaWatch (<https://mediawatch.io/>, accessed on 10 April 2025), an open-source (<https://github.com/cvcio/mediawatch>, accessed on 10 April 2025) AI-driven platform, developed by the Civic Information Office (CVCIO) (<https://cvcio.org/>, accessed on 10 April 2025), a non-profit civic tech organization based in Athens, Greece, designed to detect bad actors and networks of propaganda by continuously analyzing online media outlets. By leveraging advanced artificial intelligence algorithms, MediaWatch clusters articles based on similarities, claims, quotes, entities, topics, or other custom features, enabling journalists, researchers, and fact-checkers to efficiently analyze trends, identify coordinated disinformation campaigns, and respond quickly to emerging narratives. The architecture of the tool comprises four modules (Figure 1).

Tool architecture

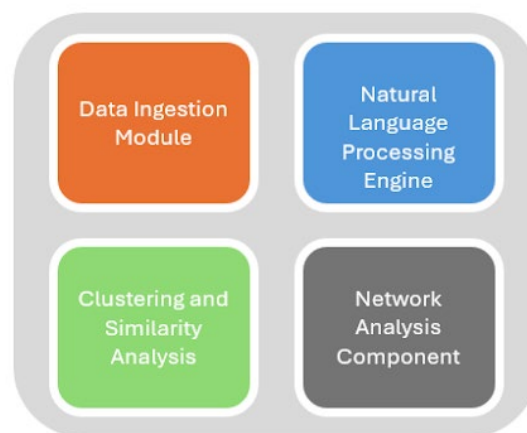


Figure 1. MediaWatch system architecture.

- **Data Ingestion Module:** This module continuously collects data from a diverse range of online media sources, including news websites, blogs, and news aggregators (approximately 2.300 Greek Media Outlets, accessed on 17 December 2024).
- **The Natural Language Processing (NLP) Engine:** Uses machine learning techniques to process and categorize articles based on their content and context.
- **Clustering and similarity analysis:** Identify related articles by analyzing common claims, quotes, topics, and entities, allowing users to track the evolution of narratives over time.
- **Network analysis component:** Map relationships between media outlets, identifying coordinated networks, and potential sources of disinformation.

Data collection includes RSS feeds and Twitter ingestion (deprecated), utilizing feed and listening services to aggregate data from multiple sources. During the preprocess-

ing stage, article content is extracted, and the text data is cleaned, normalized, noise is removed, and the format is standardized. The tool also incorporates an enrichment and feature extraction stage, during which linguistic and contextual features are captured to facilitate classification and clustering, alongside entity recognition and topic classification. For relationship mapping, the compare microservice employs the go-plagiarism algorithm (<https://github.com/cvcio/go-plagiarism> (accessed on 10 April 2025)) to detect text reuse patterns, identifying ‘Chains of Misinformation’—a phenomenon where an existing narrative is modified into multiple similar forms to highlight a specific agenda or frame (<https://medium.com/cvcio/reporting-plagiarism-the-chain-of-misinformation-f3fc8c52c951> (accessed on 10 April 2025)). Finally, the tool uses Elasticsearch to store raw articles, Neo4j to manage relationships, and MongoDB to handle metadata, ensuring scalable data management.

2.3. Methodology

The steps required for the development of the MediaWatchers4Climate tool are presented in Figure 2. Next, each step is presented in detail:

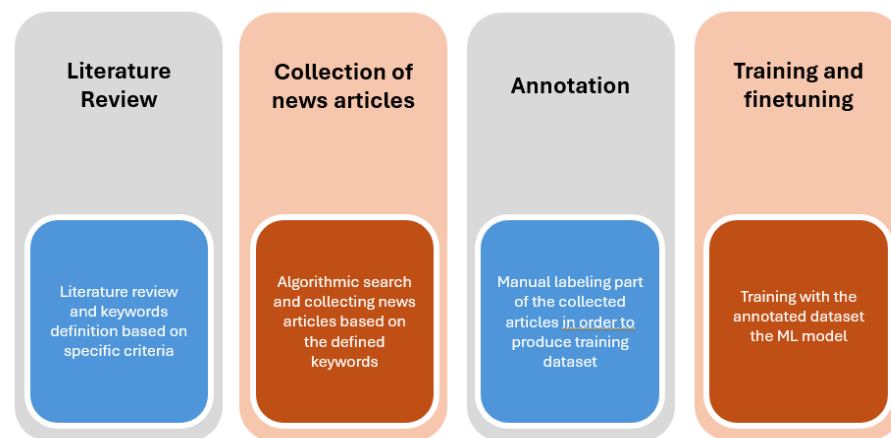


Figure 2. Steps for the development of the MediaWatchers4Climate tool.

Literature review

The research employed a systematic literature review, utilizing rigorous analysis to uncover the complexities surrounding communication on climate change. This provided a comprehensive mapping of public perception and the influence of the media. The specific research period for this study spans from October 2023 to March 2024. Prior to the review, clear objectives and research questions were established to delineate the scope of the literature search and analysis. The selected research questions were: (i) What is the public’s perception of climate change issues? (ii) What factors determine the public’s trust in media coverage of climate change? and (iii) What is the influential factor in shaping the public’s perception of news on this topic?

Thereafter, comprehensive searches were conducted in multiple academic databases, including but not limited to Google Scholar, ResearchGate, and Scopus. Simultaneously, to ensure complete coverage of the relevant literature, specific keywords were used during the search process. These keywords included “climate change”, “climate crisis”, “perception of climate change”, “environmental coverage by the media”, “communication and climate change”, and related terms. The selection of these keywords aimed to identify studies, reports, and research regarding the intersection of public perception of climate change and trust in media coverage of climate change.

To ensure the rigor and quality of the literature review, specific exclusion criteria were applied to avoid irrelevant or low-quality sources. In identifying and evaluating keywords, the following criteria were used: frequency of occurrence in reputable academic sources and public discussions, relevance to the central concepts of the research, and the ability to connect them to narrative frames that reflect the topicality of the phenomenon. Additionally, specific exclusion criteria were established, including

- Non-empirical studies, such as opinion articles, editorial notes, and non-peer-reviewed publications, were excluded as they do not meet the standards of academic rigor and scientific documentation. The use of strictly peer-reviewed articles enhances the reliability of the review and reduces the potential for bias.
- Studies that focused on highly specialized aspects of climate change without a social or communicative dimension were rejected.

The process of data extraction and analysis was a critical stage of the literature review, as it yielded the main findings and the lists of keywords that will be used in the collection and analysis of news data on climate change. The extraction and analysis were organized in a systematic and structured manner to ensure the completeness and reliability of the results. Specifically, for each study, the following data were recorded:

- Title and authors of the study
- Publication date and source
- The research questions examined by the study
- The methodological approach followed
- Thematic areas identified in the study's results
- Central concepts and narratives related to climate change
- Frequently recurring keywords and patterns that emerged from the study

Overview of Findings and Vocabulary Extraction

To operationalize the results of the literature review for the creation of a functional keyword system for news content, the reviews were systematically coded to extract recurring themes, narrative structures, and word patterns. Three main analytical themes emerged from this synthesis:

1. Thematic areas:

Frequently cited areas included the phenomenon itself (e.g., 'climate change', 'climate crisis'), causal mechanisms (e.g., 'CO₂ emissions', 'greenhouse effect'), consequences (e.g., 'extreme weather events', 'climate migration'), and response strategies (e.g., 'sustainable development', 'just transition', 'green growth'). These themes align with those previously identified in studies such as those by Dunlap and Brulle [38], Cook et al. [1], and Oreskes [37].

2. Central notions and dominant narratives

The review identified recurring narrative frames, such as:

- ✓ Threat/emergency situation (e.g., climate crisis', heatwaves', floods')
- ✓ Technological optimism/hope (e.g., green growth', 'renewable energy')
- ✓ Responsibility/justice (e.g., 'just transition', 'environmental responsibility', 'corporate social responsibility').
- ✓ Distrust/misinformation (e.g., 'fake news', 'media bias', 'ideological framing').

These narratives were categorized according to their frequency of occurrence and their role in public discourse, in line with the framing typologies presented in the studies of Molek-Kozakowska [17], Boykoff [3] and Nisbet et al. [31].

3. Frequently repeated keywords:

The list of 23 keywords (see Appendix A) was formulated based on the following selection criteria:

- ✓ appearance in at least three reputable scientific sources
- ✓ Lexical proximity to central concepts (e.g., ‘climate’, ‘green’, ‘CO₂ emissions’)
- ✓ The ability to detect narrative nuances or ideological context.

For instance, the term ‘sustainability’ was selected due to its dual representation as a technological and ethical imperative, while ‘ultra-tourism’ was included to emphasize the conflicts between environmental and economic priorities. This tripartite composition ensures that the keywords were not chosen arbitrarily but rather emerged from an analytical treatment of scientific discourse. This allows the MediaWatch4Climate tool to detect thematic diversity and narrative complexity in the presentation of climate change in the press.

Collection of news articles

This stage includes the collection of the data with the help of the MediaWatch platform (<https://mediawatch.io/>, accessed on 10 April 2025). Our dataset comprises 333,300 articles published between 4 November 2023 (2023-11-04T13:21:51Z), and 4 November 2024 (2024-11-04T13:45:41.542Z), sourced from approximately 1500 Greek media outlets using MediaWatch’s automated data pipeline. The selection of the specific period was based on the following three criteria:

- Temporal representativeness: Media coverage of climate change-related issues such as fires in summer and floods and energy issues in winter varies with the seasons, and a full calendar year allows for the capture of these variations.
- Operational competence and stability: The period that has been selected is when the MediaWatch data collection system was fully and continuously operational. This ensured a steady and consistent flow of articles without any technical interventions or changes to the system’s architecture.
- Sufficiency for analysis: The twelve-month period provides adequate data quantity and range to underpin both statistically and thematically meaningful analyses, both at the level of individual sub-topics and in terms of overall accounts and tendencies.

The initial dataset was created using the Transparency Engine of the Online Media Registry, which brings together digital content from around 1500 officially registered Greek media outlets. In the pre-processing stage, data cleaning procedures were applied, such as removing duplicate records, homogenizing formatting, and excluding non-journalistic content (e.g., advertisements, press releases or entertainment programs).

Articles were initially classified under the broad categories of POLITICS and ENVIRONMENT, reflecting climate change’s intersection with policy and ecological discourse. From this corpus, we derived 14 climate-specific subtopics through keyword-based queries (e.g., “climate change”, “global warming”) to capture granular themes. Subtopics ranged from high-frequency issues like “climate disasters” (93,805 articles) to niche subjects such as “hyper-tourism” (1929 articles). The queries that were employed in order to locate the articles are included in Table 1.

Table 1. Queries employed for the collection of news articles.

#	Keyword/Keyword Combination
1	(climate AND crisis) OR (climate AND change) OR (environmental AND crisis)
2	(global AND warming) OR (global AND overheating)
3	effect AND greenhouse
4	emissions AND CO2
5	increase AND temperature
6	(climate AND disasters) OR (environmental disasters)
7	green AND development
8	planet
9	(green AND transition) OR (just AND transition) OR (sustainable AND transition) OR (sustainable AND model)
10	flood victims
11	natural AND resources OR drought OR crops OR over-extraction
12	overtourism
13	(individual AND responsibility) OR (social AND responsibility) OR (corporate AND responsibility) OR (environmental AND responsibility)
14	overheating OR snow OR (weather AND conditions)

Annotation process

To ensure representativeness within the dataset, a stratified sample of 12,000 articles is manually annotated (sampling 292–1484 articles per subtopic), prioritizing diversity in media bias and geographic coverage. Annotations were guided by domain experts to resolve ambiguities (e.g., distinguishing “green growth” from “sustainable growth”) [20]. The annotation process is a critical stage of the methodology design, as it facilitates the systematic categorization of the data and their organization into thematic units. The annotation employed both inductive and deductive thematic content analysis [55–57].

Inductive analysis explores textual data to identify new themes and patterns, whereas deductive analysis confirms and refines existing theoretical frameworks. Both methodologies complement each other and are flexibly employed in numerous studies to align with research objectives and data characteristics [58,59].

Initially, thematic units guiding annotation emerged from the literature review, identifying central themes such as “Climate Crisis,” “Environmental Responsibility,” and “Just Transition,” based on existing studies of public perceptions of climate change. This process led to the creation of a preliminary catalog of keywords, reference sources, and descriptive annotations (see Table A1).

The articles included in the study were selected based on the above-mentioned pre-determined keywords, such as “climate change,” “green development,” and “CO₂ emissions.” Each article was thoroughly examined, and relevant thematic labels were assigned according to its content. The process involved the following steps:

- **Content Analysis:** Identification of contextual information related to thematic areas. For example, articles on social implications of climate change were labeled “Environmental Responsibility”.
- **Contextual Recording:** Documentation of recurring concepts and patterns, ensuring consistency in classification.
- **Thematic Organization:** Categorization of annotations into thematic tables, linking each article to relevant thematic categories.

The annotation accuracy was verified through cross-checking by the research team members to minimize errors and subjectivity in the categorization. The outcome

was a structured and organized database reflecting the thematic areas that emerged from the literature review and publications.

Through inductive analysis during the literature review, patterns and themes are identified directly from the data without predetermined categories. This method allows researchers to construct categories and theories grounded in the data itself [51]. The central categories, such as “Climate Crisis,” “Environmental Responsibility,” and “Just Transition,” were identified through the analysis of studies examining the public’s perception of climate change. These thematic units served as guidelines for the annotation of the articles.

Following the initial annotation, a systematic deductive analysis is conducted by researchers already familiar with the annotation and coding procedures. Deductive analysis employs an established coding scheme to systematically extend existing knowledge [57,60,61]. Preparation for this analysis included the removal of visuals, advertisements, and irrelevant text segments and a first sample of 40 articles was analyzed. All researchers coded the same sample and applied predefined theoretical categories to identify relevant segments, examining detailed subcategories. If segments did not align with existing categories, new categories were created, or existing ones modified, ensuring comprehensive analysis [51]. After discussing the findings and refining the process, the members of the research team were assigned a number of articles to code.

Upon completion of coding, researchers analyzed patterns, relationships and discrepancies within categories, interpreting findings relative to the theoretical framework and research objectives. All identified themes, patterns, and categories formed labeled datasets that would be used to train the MediaWatchers4Climate model.

The data were further classified into primary and secondary labels. Primary labels, such as “Climate Change” and “Climate Crisis”, represent the central narratives. Secondary labels, such as “Environmental Sustainability”, “Extreme Weather Events”, and “Social Impacts”, represent specialized thematic areas. For example, “green development” and “renewable energy sources” were categorized under “Environmental Sustainability” label, while “floods” and “heatwaves” were placed under the “Extreme Weather Events”.

This structured annotation process was critical to analyzing narratives and media frames related to climate change, providing valuable datasets to train the MediaWatch4Climate tool.

Training and fine-tuning process

For the training step in the development of the MediaWatch4Climate tool the cvcio/mediawatch-el-climate model (<https://huggingface.co/cvcio/mediawatch-el-climate?doi=true> (accessed on 10 April 2025)) [WIP], we will extend the existing cvcio/mediawatch-el-topics framework (<https://huggingface.co/cvcio/mediawatch-el-topics?doi=true> (accessed on 10 April 2025)), based on the RoBERTa Greek base model (<https://huggingface.co/cvcio/roberta-el-news> (accessed on 10 April 2025)) pre-trained on Greek news articles. Using MediaWatch’s data pipeline, we collected the articles previously classified under the “ENVIRONMENT” or “POLITICS” topics and manually annotated them with granular climate-related subtopics (e.g., renewable energy, climate policy, extreme weather events). Annotation guidelines will be developed collaboratively with climate scientists and journalists to ensure domain relevance. The dataset will be split into training (80%), validation (10%), and test (10%) sets, with class imbalance mitigated via stratified sampling. We will fine-tune the base RoBERTa Greek model (<https://huggingface.co/cvcio/roberta-el-news> (accessed on 10 April 2025)) using a sequence classification head, optimizing hyperparameters (learning rate: 2×10^{-5} , batch size: 16, epochs: 4) on an NVIDIA A10 GPU. Performance will be evaluated [WIP] using macro-F1 (0.00) and accuracy (0.00), with error analysis revealing improved precision on politically polarized climate narratives due to MediaWatch’s pre-existing bias-detection features. The final model will be inte-

grated into MediaWatch's enrichment microservice, enabling real-time subtopic tagging and cross-referencing of climate claims across outlets.

3. Future Work and Recommendations of MediaWatchers4Climate

Through the development of a specialized machine learning tool, the project strives to enhance the analysis of journalistic content related to climate change, identify patterns in reporting, and promote a more accurate representation of the issue across the media landscape. The central objective of MediaWatchers4Climate is the creation of a comprehensive AI tool capable of systematically analyzing and categorizing media coverage of climate change. Some of the key aspects our tool aims to contribute to are categorizing coverage based on major themes and understanding how climate change is framed in different media outlets, highlighting potential framing bias (e.g., focusing on economic, political, or social aspects over scientific facts).

The contribution of machine learning in assessing media coverage lies in its ability to analyze large datasets of news articles, identifying patterns, biases, and trends that may not be immediately apparent through traditional manual analysis. Machine learning algorithms can efficiently process vast amounts of data to recognize narratives, sentiments, and framing techniques used in climate change reporting. This allows for a more systematic, objective, and scalable approach to understanding how environmental issues are portrayed in the media, highlighting areas where the coverage may be imbalanced or inaccurate. Additionally, machine learning can be used to track shifts in public discourse and monitor the evolution of climate change narratives over time.

Nevertheless, MediaWatchers4Climate does not automatically label content as 'misinformation'. Instead, the tool (<https://mediawatch.io/> (accessed on 10 April 2025)) focuses on the thematic classification of content. The tool enables researchers to analyze news material in real time and identify relevant articles. When a user identifies and classifies an article as misinformation, the tool enables them to track its spread and find related content online. This makes it possible to study the spread of specific narratives or false information in a phenomenon known as 'Chains of Misinformation'.

Additionally, by integrating reasoning capabilities with MediaWatch's (<https://mediawatch.io/> (accessed on 10 April 2025)) proven infrastructure, MediaWatchers4Climate can establish a gold standard for climate media analysis. A hybrid approach that combines the scalability of LLMs with domain-specific safeguards, enabling actionable insights for journalists, policymakers, and the public. Future work can focus on expanding multilingual support and fostering collaborations akin to the ClimateNLP (<https://nlp4climate.github.io/> (accessed on 10 April 2025)) community's interdisciplinary efforts.

In conclusion, the proposed framework of MediaWatchers4Climate represents a significant advancement in the way we analyze and evaluate media coverage of environmental issues, particularly climate change. By leveraging the power of machine learning, this framework promises to enhance the accuracy, efficiency, and depth of content analysis, enabling a more objective and systematic approach to understanding media portrayals of climate change. MediaWatchers4Climate encourages responsible journalism and facilitates better communication strategies by providing both journalists and the public with the tools to critically engage with environmental news.

Author Contributions: Conceptualization, T.B., I.K., A.S. and A.V.; methodology, A.V., A.S., F.G., T.B., S.N. and V.V.; software D.P.; validation, F.G., V.V. and S.N.; formal analysis, A.V., T.B., I.K. and A.S.; investigation A.V., A.S., F.G., T.B., S.N., V.V. and I.K.; resources, A.V., T.B., I.K. and A.S.; data curation, V.V., S.N. and F.G.; writing—original draft preparation, T.B., I.K. and A.V.; writing—review and editing, A.S. and F.G.; visualization, A.V.; supervision, A.S.; project administration, T.B. and S.N.; funding acquisition, A.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Hellenic Foundation for Research and Innovation within the framework of the National Recovery and Resilience Plan “Greece 2.0” with the funding of the European Union–NextGenerationEU under Grant [number 16825]. The specif: 1825.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data used for this study are available upon request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. List of keywords.

A/A	Keyword	Source	Description
1	Environmental Crisis	[30,38]	It is described as an urgent issue, often with a dramatic dimension in the media.
2	Impact of Climate Change	[34]	It encompasses the social, economic, and environmental consequences of climate change.
3	Global Warming	[1,33,34]	It is referred to as the main result of human-induced greenhouse gas emissions.
4	United Nations	[25,40]	The role of the UN in shaping international climate policies is highlighted.
5	Sustainability	[27]	It is linked to development strategies that ensure long-term environmental balance.
6	Sustainable	[27,46]	It focuses on sustainable development practices at the regional and global levels.
7	Just Transition	[26]	It refers to the need for a fair distribution of the burdens from the green transition.
8	Climate Migration	[38]	It focuses on population movements due to extreme climate events.
9	Natural Resources	[38,40,41]	It includes the management and over-extraction of natural resources.
10	Drought	[38,41]	It appears as a consequence of climate change, with an emphasis on agriculture and water consumption.
11	Crops	[1,33,34]	The impact of climate change on agriculture and food security is highlighted.
12	Over-extraction	[1,33,34]	It is related to the excessive use of resources, particularly water and energy.
13	CSR	[26,33,34,44]	It highlights the responsibility of businesses for sustainable practices.
14	Environmental Responsibility	[34,44]	It focuses on institutional and individual responsibility for the environment.

Table A1. Cont.

A/A	Keyword	Source	Description
15	Heatwave Temperatures	[26,44]	An extreme event that underscores the need for adaptation actions to climate change.
16	CO2	[26,33,34,44]	It focuses on human-induced emissions as the primary cause of global warming.
17	Green Transition	[33,34]	A strategy for reducing emissions through innovative technologies and energy transition.
18	Green Development	[26,33,34,44]	It refers to economic development that integrates environmentally sustainable practices.
19	Overtourism	[25]	It highlights the environmental impacts of excessive tourism activity.
20	Greenhouse Effect	[33,37]	The scientific basis for understanding global warming.
21	Climate Change	[34,38]	It includes the gradual change in the climate and its causes.
22	Climate Crisis	[30,38]	It refers to the dramatic dimension of the phenomenon and the urgent need for action.
23	Extreme weather events	[33,44]	Phenomena such as floods, heatwaves, wildfires, and snowfalls.

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