How is Climate Change covered in French National Newspapers?

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Abstract: While media play a crucial role in people's perception and action regarding climate change, and although attention to this issue has increased in recent years, the way in which the subject is addressed in news media seems out of step with the scientific reality. In this paper, we focus on five major French daily national newspapers and study the topics related to climate change covered in these journals for the period 2013-2022. Using BERTopic, a recent topic detection tool, we find the most covered subjects are Conferences of Parties (COPs) along other political topics, and that more generally, the societal dimension (as opposed to the Scientific & Ecological dimension) accounts for the overwhelming majority of the articles' themes. In order to characterize the influence of the coverage of COPs on the coverage of other issues, we simulate predictions with only half the articles related to COPs using Long-Short Term Memory (LSTM); we find very few correlations between COPs' media coverage and other themes' coverage, suggesting articles are written quite independently. Our results show that French national newspapers' climate change coverage is biased towards societal implications and makes few connections between the latter and climate science.

1. Introduction

On July 29, 2022, the French regional journal *Midi Libre* published a front page with a swimmer lounging in the water, and accompanies the image with the following description: "Exceptional phenomenon: the Mediterranean flirts with the 30°C. The effects on the underwater fauna and flora could be catastrophic." This triggers a wave of reactions denouncing the lightness of the picture compared to the gravity of the climatic and environmental situation. A month and a half later, on September 14, 2022, a group of French journalists published a charter "For a journalism at the level of ecology", signed by nearly six hundred media professionals. Among the signatories, four journalists from *Midi Libre*, but no one from the editorial staff of the latter or of the major French dailies such as *Le Monde*, *Le Figaro* or *Libération* [22]. Yet, according to the Intergovernmental Panel on Climate Change (IPCC), media shapes the public discourse about climate change and how to respond to it: this power can usefully build public support to accelerate climate mitigation – the efforts to reduce or prevent the emission of the greenhouse gases that are heating our planet – but "on occasion, the propagation of scientifically misleading information by organized counter-movements has fuelled polarization, with negative implications for climate policy" [26].

Unfortunately, messages disclosed by the IPCC are hardly shared by the media. While 80% of French people say they are worried about environmental protection and climate change [16], the first French television channel TF1 did not grant a single word about the publication of the IPCC WGII report on its release day according to Climat Médias, a collective mobilizing to get more and better coverage of climate and biodiversity in the media [4].

Hence, media plays a crucial role in providing information on climate change but often fall short. This effect becomes apparent when one notices that a forest fire, concrete and with a palpable urgency, is much more talked about in the newspapers than a report of the IPCC in which the catastrophic risks and threats that can materialize in a forest fire are described. Moreover, there can also be a bias in the sources when covering subjects related to climate change [13]: in their paper, Ekayani et al. find that in Indonesia, while most stakeholders believe that scientists can deliver reliable information in policy agenda-setting, the news media does not recognize the knowledge of scientists as the most reliable reference in forest fire discourse [9]. Motivated by this inconsistent and prob-

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lematic situation, we try in this paper to characterize the coverage of climate change in French national newspapers. We want to understand what interests media in terms of climate change (what is talked about the most: political issues, economic issues, extreme events?) but also if themes such as Conference of Parties (COPs) have an impact on the media coverage of other themes. We can indeed imagine that if an exceptional flood takes place shortly after a COP, a link with climate change will be made; therefore, it will be talked about more than without the COP. The idea is to test an aspect of the understanding of climate issues, that is their integration to and linkage in more concrete events such as a extreme events. Hence, for a 10-year time span and five newspapers, we will consider two main questions:

RQ1. What are the predominant and neglected themes in climate change's coverage by French national newspapers?

To answer this question, we will apply an automated content analysis called BERTopic [12] which extracts themes from a corpus of texts. We will analyse themes' nature as well as their evolution.

RQ2. How does the media coverage of COPs influence the coverage of other issues?

Here, we use Long Short-Term Memory (or LSTM), a recurrent neural network that can process and predict sequences of data such as time series. We will simulate predictions with or without the articles related to COPs to analyze the difference (or lack thereof) obtained for the coverage of other themes.

We explore the related literature in the next section; then, we describe the data selection and the method used to answer each research question. Finally, we share our results, comment on them, and provide suggestions for improving our work. The implementation of the experiments of this paper can be found in a github repository [1].

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[1] https://github.com/AlexLsn/Media_coverage_of_climate_change

2. Previous Work

2.1. Agenda-setting theory

The role of the mass media in informing and mobilising the general public as well as reflecting public opinion has been pointed out in the literature [5, 2]. First introduced in the 1920s by Walter Lippmann, the agenda-setting theory suggests that the media has the ability to shape public opinion by determining what issues are given the most attention [28]. In this line, studies of the attention given to one issue (such as climate change) relative to others, i.e., its rank on the media agenda, show that the more attention an issue gets, the more likely it is to seem important to the audience. [23, 6, 19, 13]. Moreover, print publications are assumed to have a stronger agenda-setting impact than, for example, television news (with a broader impact for 'quality' newspapers such as *Le Monde*) [20]. The recent emergence of social media and relative decline of traditional newspapers might nuance these results, but we think they continue to play an important role in agenda setting.

2.2. Media coverage of climate change

There is already a broad literature focusing on media coverage of climate change, with various angles of approach. In their 2014 paper, Schäfer et al. [25] identify and compare, using time series regression, the factors that influence media coverage of climate change in three countries (Australia, Germany, India) over a 15-year period. They use Liu et al. [19] model in which they distinguish three groups of factors: factual indicators surrounding the problem (e.g. average temperature, short-term extreme events, etc), focusing events (e.g. COPs, IPPC reports release, movie on the topic, etc), and feedback (e.g. citizen complaints, feedback from the science community, etc). Barkemeyer et al. [3] also adopt this framework to focus on the differences between countries by taking as dependent variables their characteristics such as their GDP or their exposure to climate change, covering 41 different countries for the year 2008 and using an OLS regression. Hase et al. (2021, [14]) conduct a study across 10 countries and 12 years, using time series regression but also structural topic modeling to identify themes associated to the retrieved articles. Their last experiment illustrates that "journalists across the world neither concentrated on the science behind climate change nor on abstract ecological

changes. In contrast, news mostly focused on a societal dimension by describing how humans are aware of, affected by, battle, or cause climate change. Journalists do not cover climate change as an abstract or unobtrusive issue but instead underline its far-reaching societal implications." This result was already suspected [24], and fits with our intuition presented in the introduction, as well as a common findings shared by these studies as well as by previous papers, stating that long-term, slowly developing phenomena tend to be omitted by news media, while abrupt events are much more discussed [3, 25, 14, 5].

2.3. Deep learning for sequential data

To our knowledge, no paper dealing with climate change media coverage has used deep learning methods to study correlations across time between extracted themes. Actually, deep learning is usually predominantly used to learn, process, and predict data. In the case of sequential data, networks must be able to store information for an arbitrary duration, which has lead to the development of specific neural networks; we will here focus on very successful networks called LSTMs. LSTMs, or Long Short Term Memory networks, [15] are a special kind of recurrent neural networks capable of learning long-term dependencies. It introduces an information flow control mechanism that stores previous states to form long-term memory capabilities. The gates in the LSTM unit are: forget gate, input gate, output gate. These gates are used to determine whether to store or forget previous states, thus structuring a longer temporal relationship.

Such methods have been applied to many kinds of data, such as clinical diagnoses [18] or solar radiations [10]. Here, we to apply it to media coverage data but above all we propose a novel approach where we simulate predictions made by LSTM with or without the articles related to COPs to analyze the difference (or lack thereof) obtained for the coverage of other themes. More details are given in Section 5.

2.4. Our contribution

Our research contributes to the existing literature through the following points:

1. We focus on French national newspapers, while most studies concerned others countries (mostly English-speaking contries) [25, 17, 19,

5, 14] or performed an international comparison too wide to integrate topics centered on France [3]. To our knowledge, only A.Dirikx and D.Gelders [8] conducted an study specific to France and the Netherlands, but it concerned another time span (2001-2007) and they used a framing analysis (e.g., attribution of responsibility, economic consequences) rather than a thematic analysis.

2. Regarding the methodology applied for topic detection, we choose to use a rather different approach than in [19, 25] and to use powerful tools provided by recent developments in machine learning to automatically classify articles by themes. Moreover, concerning the use of LSTM, we take advantage of the fact that deep learning allows us to process a lot of data without adding complexity to the model (which would be the case with regression for example). Moreover, by using such methods, we avoid exhaustive collection of multiple data such as temperature, dates of COPs, of forest fires, etc. Besides the fact that the latter requires resources beyond our reach, the idea here is really to let the machine speak at first, and then to adjust parameters if needed. Hence, we provide a new perspective on how to study media coverage of climate change.

3. Data selection

3.1. Database

We used data from the Europresse database that contains online press (http://www.europresse.com/fr/). We focused on the French most widely circulated national dailies: *Le Monde, Le Figaro, Les Echos, Libération, La Croix* [1]. According to the the Special Eurobarometer public opinion survey on the environment, carried out in the 28 European Union Member States [11], national newspapers are the first source of information about the environment when it comes to print media in France. We excluded the newspaper *L'Equipe* from the study (despite his third place at the ranking mentioned above), as we chose to deal only with the French general press. We believe the selected newspapers cover a wide political field and reach a large number of French people.

We focused on articles published between January 1st, 2013 to December 31st, 2022, i.e. over a ten-year period, which allows us to have a large amount of data covering a period rich

in climate change related events, while maintaining a reasonable computation time. We aggregated the data by month to ensure a better visualization of the observed trends and variations.

3.2. Articles selection

We only considered articles dealing with climate change as their main topic. We took advantage of the possibility to use boolean search strings on the Europresse search bar and used the method of Hase et al. [14]. The latter constitute their corpus of articles with those containing at least twice one of the following expressions: "climate change", "global warming", "greenhouse effect" (in French: "changement climatique", "réchauffement climatique", "effet de serre" [2]). This search was carried out throughout the whole article (title, introduction and body text).

We finally deal with 7757 articles (*Le Monde*: 2659, *Le Figaro*: 1242, *Les Echos*: 1825, *Libération*: 1048, *La Croix*: 983). In order to be independent of the size of the journal and to enable comparisons, we will hereafter use an *attention to climate change* corresponding to the percentage of the number of articles concerning climate change relative to the number of articles published, for each journal and each month. We therefore also collected the total number of articles published each month by each of the newspapers considered by using blank searches. Figure 1 shows the evolution of the attention to climate change per journal from January 1st, 2013 to December 31st, 2022.

In order to evaluate the selection error, we randomly looked at 20 articles of each journal and counted the number of articles that we thought did not treat of climate change as their main topic. Very few articles (between 0 and 1 for each journal) were found irrelevant. This nice result was to be expected given our selection method; we preferred to skip some articles and select only interesting ones. Indeed, we first tried a much broader search (with the keyword 'climate'), hoping that the thematic breakdown would allow us to remove non-relevant themes, but the results were disappointing. Thus, we chose to greatly narrow the search based on the

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[2]Search in Europress search bar: TEXT= "changement climatique" >2 | "réchauffement climatique" >2 | "effet de serre" >2 | "changement climatique" "réchauffement climatique" | "changement climatique" "effet de serre" | "réchauffement climatique" "effet de serre".

method of Hase et al. [14] and are aware that we may be missing some articles and that this error is difficult to assess.

3.3. First analysis

Figure 1 shows the evolution of the attention to climate change per journal from January 1st, 2013 to December 31st, 2022. We find that all newspapers have increased their share of articles related to climate change; however, this share remains low, between 0.05% (*Le Figaro*) and 0.22% (*Le Monde*) in January 2013, compared to 0.43% (*Le Figaro*) and 1.25% (*Le Monde*) in December 2012. Some peaks are easily identifiable and always around COPs, at the end of each year, with a particularly strong peak for COP21 in Paris in December 2015. An interesting fact is that the COPs seem to be making noise in the studied newspapers only since 2015; indeed, we note that in 2013 and 2014, we do not distinguish any particular variation at the end of the year, while the increases in attention in December are obvious from 2015 to 2022.

Le Monde is the best performer, most of the time with more attention than the other newspapers, while Le Figaro is very often behind. As the latter is a newspaper with a right-wing editorial line, which in France has traditionally had little interest in climate change, these results are not surprising. Note that *Les Echos*, a liberal newspaper attached to the economic press, has seen a relatively strong increase in attention in recent years; the latter suggests a better integration of economic issues with climate issues.

4. Topic modeling

4.1. Methodology

To classify the articles by themes, we used BERTopic [12], a recent topic modeling technique that leverages Hugging Face transformers [29] and BERT model's pre-trained embeddings [7]. This tool takes as input a corpus of texts and returns a set of associated themes: each text is associated with one theme.

Our scrapping method only allowed us to access what was displayed on the Europresse search page, and in particular, for each article, the title and the extract containing at least one of the searched keywords (see Appendix A.2). Thus, due to computational constraints and limited human resources (retrieving the entire arti-
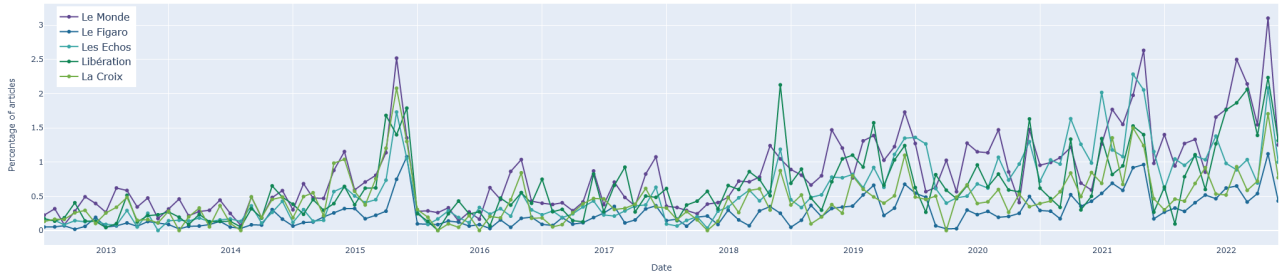
Figure 1: Percentage of articles with climate change as their main topic per month and per journal, from January 1st, 2013 to December 31st, 2022. The percentage is derived relatively to the number of published articles by each journal.

cles would have required an inordinate amount of time, which is not appropriate for the scale of this study), we performed topic modeling on the maximum available data, that is a concatenation of the title and the extract for each article that we will call 'text' in the following.

We identify themes from the texts of all the selected articles, i.e. all the newspapers in our study. BERTopic allows the user to define a topics' number or to let the algorithm choose it. After several experimentations, we chose to fix the number of topics to 40. We also applied one function to reduce frequent words and encourage word diversity among topics. To find themes, we used BERTopic default method, called c-TF-IDF, relying on an adjusted *term frequency-inverse document frequency* representation. It takes into account what makes the documents in one cluster different from documents in another cluster. Morevoer, some articles were not assigned to any theme (outliers); after looking at these, we estimated we could keep them and thus forced the algorithm to assign each of these articles to one of the existing theme.

4.2. Results

We ended up with 39 topics that are displayed on Table 1. We got the top 5 words for each of them, and reported only the most relevant ones for readability (we deleted repetitions for example). We named each topic ourselves; the allocation by theme and dimension is strongly inspired by Hase et al. [14]. Note that the prevalences (number of articles of one topic divided by the total number of climate change related articles) do not add up to exactly 100 due to the rounding of each value.

We chose to separate COPs from Climate Politics as we are particularly interested in COPs for the second part of this paper. Even in doing so, both themes are the most discussed in our sample, with peaks around COPs and particu-

larly on November 2015 when COP21 and the Paris Agreement took place (Table 1 and Figure 2). Moreover, the so-called "Climate Science & Impacts on the Ecosystem" theme accounts for just over 8% of the articles on climate change, while the societal dimension accounts for the overwhelming majority of the articles' themes, as mentionned in previous literature [3, 14, 19]. One might also notice that Wine (0.62) has been more covered in the last 10 years than Air travel (0.45%) or Clean energy (0.31%), which is most likely due to the special status of wine in France.

A striking fact is the absence of the IPCC theme, which does not even appear as a keyword. Even running the algorithm multiple times with different number of topics did not help; we can therefore conclude that this subject is of very little interest to the major French newspapers, which recalls the observation made in the introduction. Another missing element is education: no top word is related to it, and theme Awareness is very poorly covered (1.24%). This is notably what the French student collective Pour un Réveil Ecologique (For an ecological awakening, [27]) is fighting for, as it denounces the fact that too many students leave their training without ever having been informed about ecological issues or trained to respond to them.

Figure 2 shows the temporal evolution of the number of articles published for each theme. All themes (except Awareness, which concerns one particular French political event, the Convention Citoyenne pour le Climat or Citizen's Climate Convention) show on average an increasing number of articles over time. The only themes that show marked peaks are COPs and Climate Politics; the other themes, although less marked, also show peaks in coverage and often at the same time as the political peaks. This result suggests a global approach to climate change when a political event takes place; in the absence of such an event, the other themes are

Themes/Topics	Prevalence	Top terms (original French words)	Top terms (English translation)
		Societal Dimension (90.56%)	
Theme: Causes of & Solutions to Climate Change (10.59%)			
Topic: Meat consumption	1.01%	vaches, élevage, production de viande	cows, livestock, meat production
Topic: Cars & boats	0.84%	navires, diesel, volkswagen, constructeurs	ships, diesel, volkswagen, manufacturers
Topic: Energy renovation	0.76%	rénovation énergétique, électricité, énergie en France	energy renovation, electricity, energy in france
Topic: Clean energy	0.31%	hydrogène vert, électrolyse, azotés	green hydrogen, electrolysis, nitrogenous
Topic: Nuclear	1.31%	énergie nucléaire, atome, japon	nuclear energy, atom, japan
Topic: Greenhouse gases	3.25%	émissions, gaz, effet de serre	emissions, gases, greenhouse effect
Topic: Global emissions	3.11%	stables, émissions mondiales, vont continuer à grimper	stable, global emissions, will continue to rise
Theme: COPs (20.64%)			
Topic: COPs	20.64%	cop, paris, accord	cop, paris, agreement
Theme: Climate Politics (other than COPs) (35.97%)			
Topic: France	8.75%	carbone, france, gaz, effet de serre, émissions	carbon, france, gas, greenhouse effect, emissions
Topic: China	3.62%	chinois, jinping, pic	chinese, jinping, peak
Topic: Germany	1.55%	angela merkel, chancelière, respecter ses engagements	angela merkel, chancellor, keeping commitments
Topic: Monetary policy	1.61%	bce, christine lagarde, politique monétaire	ECB, christine lagarde, monetary policy
Topic: Canadian oil pipeline	1.35%	justin trudeau, harper, oléoduc géant	justin trudeau, harper, giant oil pipeline
Topic: Brazil	3.21%	bolsonaro, changement, brésil	bolsonaro, change, brazil
Topic: Climate refugees	1.17%	bangladesh, réfugiés climatiques, étranger	Bangladesh, climate refugees, foreigner
Topic: US	6.59%	joe biden, américain, plan	joe biden, american, plan
Topic: Europe	5.75%	europe, union, bruxelles, émissions	europe, union, brussels, emissions
Topic: Citizens' climate convention & social justice	2.37%	au moins 40%, émissions, esprit, justice sociale	at least 40%, emissions, spirit, social justice
Theme: Awareness (1.24%)			
Topic: Civic engagement	1.24%	communautés locales, agissent, économie circulaire	local communities, act, circular economy
Theme: Impacts on humans (12.30%)			
Topic: Food access	1.02%	famine, madagascar, kenya, milliards habitants	famine, madagascar, kenya, billion people
Topic: Floods	3.33%	inondations, phénomènes, eaux	floods, phenomena, water
Topic: Migrations	0.84%	droit, mouvements migratoires, monde gouverné	law, migratory movements, governed world
Topic: Rising sea levels	1.51%	océans, île, courants, niveau	oceans, island, currents, level
Topic: Threats to habitable spaces	1.61%	vanuatu, petites îles, continent africain	vanuatu, small islands, african continent
Topic: Wine	0.62%	vins, bordeaux, viticole française	wines, bordeaux, french wine industry
Topic: Forest fires	1.75%	australie, incendies, abbott, habitant	australia, fires, abbott, resident
Topic: Health	2.62%	premières victimes, enfants, santé mentale, pandémie	first victims, children, mental health, pandemic
Theme: Economic Impacts (9.82%)			
Topic: Tourism	0.35%	tourisme, responsable, hébergement, voyages	tourism, responsible, accommodation, travel
Topic: Ski	2.93%	glaciers, stations, les alpes	glaciers, ski resorts, the alps
Topic: Air travel	0.45%	transport aériens, avions, kérosène, aéroport	air transport, aircraft, paraffin, airport
Topic: Finance	0.83%	banques, banques centrales, risques financiers	banks, central banks, financial risks
Topic: Petrol	1.13%	actionnaires, exxonmobil, pétrolier, majors	shareholders, exxonmobil, oil companies, majors
Topic: Corporations	4.13%	macron, villes, entreprises, dollars	macron, cities, companies, dollars
		Scientific & Ecological Dimension (8.46%)	
Theme: Climate Science & Impacts on the Ecosystem (8.46%)			
Topic: Glacial impacts	0.79%	glaciologie, température, surface	glaciology, temperature, surface
Topic: Deforestation	1.65%	déforestation, forêts, pompiers, tropicales	deforestation, forests, firefighters, tropical
Topic: Species	1.97%	oiseaux, invasives, exotiques, pollution	birds, invasives, exotics, pollution
Topic: Corals	0.84%	barrière de corail, récifs, récifs coralliens	barrier reef, reefs, coral reefs
Topic: Temperatures	1.78%	la plus chaude, copernicus, record, européen	warmest, copernicus, record, European
Topic: Air pollution	1.43%	concentrations de gaz, ppm, record	gas concentrations, ppm, record

Table 1: Topics extracted by BERTopic. The names of each topic, theme and dimension are given by the researcher. The allocation by theme and dimension is strongly inspired by Hase et al. [14]. Prevalence refers to the share of each topic within the climate change articles. The percentages do not add up to exactly 100 due to the rounding of each value.
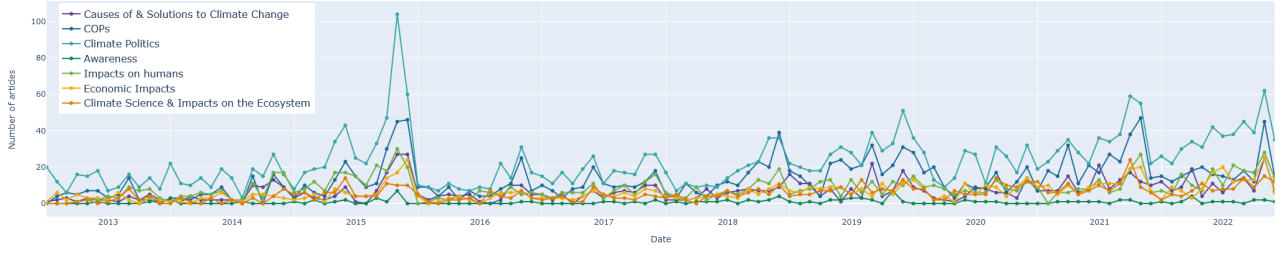
Figure 2: Number of articles concerning each theme per month and all journals, from January 1st, 2013 to December 31st, 2022.

relatively smooth, despite extreme events like forest fires or IPCC report releases. In other words, when a COP takes place, economic impacts or meat consumption are more discussed than when an IPCC report is released. We will deepen this question in the next section.

5. Influence of COPs coverage

5.1. Method

The aim of this section is to answer RQ2, that is *How does the media coverage of COPs influence the coverage of other issues?* Here's our idea: we use the time series corresponding to each theme (as represented in Figure 2) as both input and output data. We use the data from the past 12 months $(x_{t-1}, \ldots, x_{t-12})$ to predict, using LSTM, the value of current month x_t, where the data for each month has 7 dimensions (since we have 7 time series in total). As we only have 120 observations (120 months), wee set the first 70% as training data and the last 30% as testing data. Once the model trained, we divide by two the whole COPs time serie's values, predict the other themes' time series with this new input and the previously trained model, and see how it affects their shape. The idea here is to measure how correlated the different themes' coverage are to COPs' coverage: for example, if the prediction with whole or reduced COPs articles are similar, then the correlation is weak, and we can think journalists do not link COPs to other climate-relate subjects. We think using LSTM in our framework is particularly interesting because despite being part of black-box models, its interpretation is here simpler than a regression with a hundred variables and time lags.

The model parameters are set to: 7 for both input and output size, that transforms into a hundred dimensions in the two layers of LSTM. The network training gives good results, with a Mean Squared Error (MSE) of 0.11 on the

test data, showing that our LSTM model indeed fits well in our multivariate time series (see Appendix A.3 for more details).

5.2. Results

Figure 3 shows original and predicted time series for each theme, the predicted one being obtained after dividing the COPs' time serie values by two. What we find overall is the similarity between both time series for each theme: less articles about COPs do not mean significantly more or less articles about other subjects. Still, a little less articles are found for "Causes of Solutions to Climate Change" from 2016, then it goes back to the original track on 2022, suggesting COPs and the latter theme are discussed together, or at least at the same time, in newspapers. A bit more articles are also predicted for "Climate Science & Impact on the Ecosystem" from 2016, which leads to the opposite conclusion.

Hence, it seems that there exists only a weak tie between certain themes of climate change in terms of media coverage article numbers. We can explain this through multiple reasons: (1) It seems that some other cofounder variables can affect time series with different themes at the same time. For example, not writing about COPs does not mean not having a COP, and we can indeed see that all predicted time series showed peaks around COPs. (2) Our model might be overfitting, which means time series could be predicted almost only by itself. Indeed, in order to keep as much data as possible and have a global view of the evolution of time series, we used 70% of the same dataset (except for COPs) for training and prediction.

6. Discussion

As previously highlighted, news media plays an important role in people's perception of climate change. The fact that political topics are
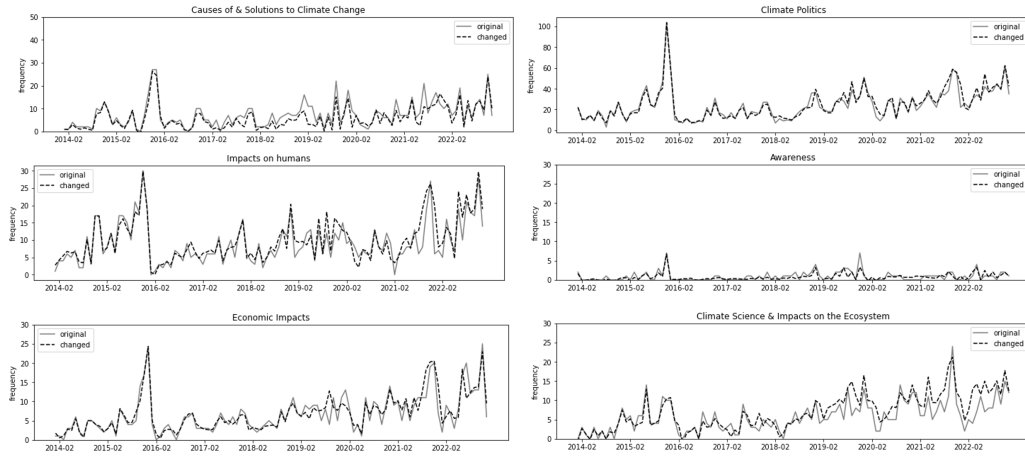
Figure 3: Original and predicted (changes) time series for each theme, the predicted one being obtained after dividing the COPs' time serie values by two. The predictions were obtained using LSTM.

largely more covered than scientific and ecological ones underlines the dominance of the societal dimension in the media; the high coverage of COPs and of climate change in times of COPs suggests that the subject is assimilated to a state dimension, countries that gather, discuss, argue and, sometimes, agree; economic and even scientific issues are thus linked to politics. This may create a bias in the representation of climate change: a subject that does not belong to the individual sphere (which the few articles on awareness seem to confirm), which comes back to the agenda every year in a very punctual manner. Even the research presented may be biased: a study published in April 2023 shows that current criteria for newsworthiness select very specific features of climate change research that may move the public but that are unlikely to trigger public movements [21].

This study has some limitations that need to be taken into consideration. First of all, the articles' selection was made from a result by Hase et al. [14], using English keywords. We used the same result and translated the keywords in French, which might introduce some error if different words are used in these languages when taking about climate change. We were also not able to evaluate the error in terms of articles we may have missed. Concerning topic modeling, we could only apply BERTopic on a small fraction of the articles' bodytext, which limits the model's performance. Additionally, we lack replicability of results as BERTopic has some random components we were not able to fix. Furthermore, when applying LSTM, we partly used the same data for training and prediction, leading to overfitting; either reducing the predic-

tion size (but risk having a low number of interpretable data) or having more data could help overcome this issue. Finally, following Liu et al. [19] and Schäfer et al. [25], we omitted from our analysis and comments of temporal evolutions the conditions and characteristics of journalistic work (such as editorial resources or political positions).

For further research, we think it would be of interest to study the attention to climate change in terms of articles' length, or even the share of articles dedicated to climate change, in order to better understand the transversality of the subject (e.g. one could include journals like *L'Equipe*, and study if climate change is integrated with sport). Moreover, the position of the article in the newspaper (e.g. on the cover or at the end) could also be an interesting point to complement studies like ours. Furthermore, making comparisons between newspapers and relating them to the number of readers and their profile would allow for a more concrete understanding of who has access to what type of information and thus identify reactions and behaviors resulting from this exposure.

Acknowledgments

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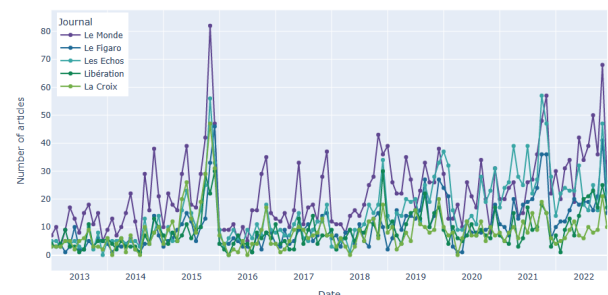
A. Appendix

A.1. Absolute number of articles

Figure 4: Number of articles with climate change as their main topic per month and per journal, from January 1st, 2013 to December 31st, 2022.

A.2. Topic modeling

A.3. LSTM

Figure 6 represents the evaluation result of model training, where x-axis stands for the running epoch as time goes by and y-axis stands

Figure 5: Screenshot of the Europresse page after the search described above (section 3.2). The information on the page is what we could retrieve for analysis.
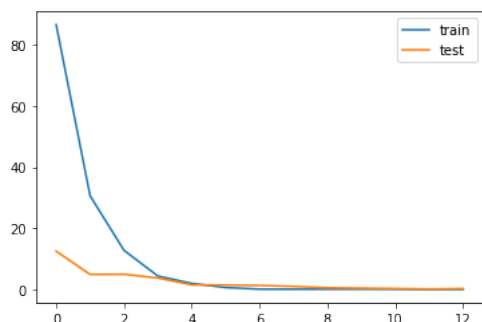

Figure 6: Loss on training and testing data.

for the MSE loss. According to the picture, we can clearly see that MSE loss drops steadily and is close to 0 in both training data and testing data. After running 300 epoches, MSE loss in training data is 0.0049, MSE loss in testing data is 0.1153. This illustrates that LSTM model indeed fits well in our multivariate time series.

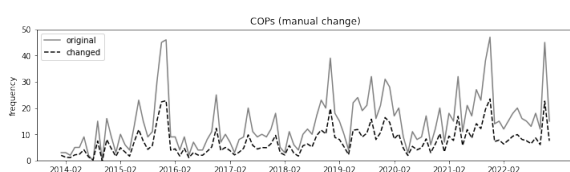Figure 7 shows theme COPs time serie before and after having divided all values by two.

Figure 7: Resulting theme COPs time serie after dividing all values by two.