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Title:

To dam or not to dam? A genealogy of media discourses to highlight human-river relationships in the Anthropocene

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S.F. designed the study with input from H.P. and Y.F.L.L. S.F. built and analysed the corpus. S.F. wrote the article with contributions from H.P. and Y.F.L.L.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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1 Title

2 To dam or not to dam in an age of anthropocene: Insights from a genealogy of media discourses

3 Abstract

Numerous studies have highlighted the negative consequences of dams (long-term alterations of 4 5 Earth systems and social and economic injustices), and have questioned the sustainability of dams, 6 i.e., the capacity of dams to meet the social, economic, and environmental needs of the current 7 generation without compromising the needs of future generations. After having stalled in the 1990s, 8 dam construction has entered a new period of growth. Recent research has shown that this new 9 phase in dam building can be explained by the promotion of hydropower as clean energy. To clarify 10 the continuing debate on the construction of dams, particularly on their impacts and sustainability 11 into the future, this paper examines the discourses on dams within the public domain. We used a 12 collection of newspaper articles published in Le Monde from 1945 to 2019 on dams that were 13 planned and built throughout the world (n=1,471). Results show a rise of different discourses on 14 water infrastructure, which with time deal less with positive technical appraisals and more with 15 controversies. Since the mid-2000s, new arguments are defended (green energy) and new 16 controversial discourses on the social and economic sustainability of dams (bearability, equitability) 17 have emerged along with environmental questions (greenhouse gas footprint). These discourses 18 reveal different understandings of sustainability which increase the complexity of the debate on 19 dams. Results from this study suggest a need for a stronger dialogue between the scientific and 20 public domains on the impacts of dams. Knowledge transfer and exchange would be particularly 21 beneficial on 'renewable energy' and 'green energy,' and alternative modes of governance regarding 22 dams.

23

24 Keywords

- 25
- 26 Dams
- 27 Discourse
- 28 Genealogical approach
- 29 Hydropower
- 30 Sustainability
- 31

32 **1. Introduction**

33 During the past century, numerous dams have been built throughout the world (Roe, 2012), with

34 purposes that include irrigation, hydropower, water supply, flood prevention and navigation. These

35 hydraulic infrastructures interrupted the flow of water and created reservoirs upstream. Dam

36 construction stalled during the 1990s, leading some to conclude that the era of big dams was over

37 (e.g., Graf, 1999; McCully, 2001). This decline may be explainable by the reduction of attractive

38 sites for dams, by changing water paradigms (Gleick, 2000) and by the progressive adoption by the

39 water sector of the principles of sustainable development (Allan, 2003), whereby the needs of the

40 current generation are met without compromising the needs of future generations (Brundtland,

- 41 1987, p. 37).
- 42

43 Nevertheless, since the end of the 2000s, dam construction has entered a new period of growth. 44 Plans for 'mega-dams' (Best, 2019) and for smaller dams (Fung et al., 2018) have multiplied, 45 coupled with schemes for hydropower. Currently, 3,700 major hydropower dams are planned or 46 under construction in the world (Zarfl et al., 2015). Even so, the amount of power produced, given 47 the projected growth demand, is likely insufficient to replace non-renewable electricity resources 48 (Zarfl et al., 2015, p. 167). Such a rebound in dam-building raises environmental questions that are 49 both social and ecological. It feeds the scientific debate on long-term environmental degradation in 50 the context of global environmental change, especially within an anthropocene era of accelerated 51 human interactions with Earth systems (Chin et al., 2013). The consequences of constructing dams 52 remain diverse (e.g., social, economic, ecological, and geomorphological), at different scales (local, 53 corridor, regional, and even global) (Baghel, 2010; Gross, 2016; Skalak et al., 2013; Williams et al., 54 2014; World Commission on Dams, 2000). As numerous studies have demonstrated, dams have 55 profoundly affected flow conditions, channel morphology and river ecosystems (e.g., Power et al., 56 1996; Poff et al., 1997; Rollet et al. 2014). They have even been described as an example of the 57 "exploitation of Earth's resources" which characterises the "Anthropocene" (Crutzen, 2002), and 58 due to the drastic alteration of the world's river systems they have caused, dams have been depicted 59 as characteristic of the human domination of the Earth (Nüsser and Baghel, 2017). Recent research 60 has shown that dams may not always be an advantageous option considering climate change. The 61 reliance on reservoirs can worsen water and energy shortages (Di Baldassarre et al., 2018). Plans for 62 hydropower dams in Eastern and Southern Africa, for example, will increase some countries' 63 dependence on hydroelectricity and therefore their exposure to the "risk of climate-induced 64 electricity disruption" (Conway et al., 2017, p. 949). Moreover, not only can the resurgence of dam building lead to the disappearance of the last free-flowing rivers (Grill et al., 2019; Nilsson, 2005), 65 66 the impact of climate change will also be greater on impounded rivers than on free-flowing rivers, 67 which are expected to be more resilient (Palmer et al., 2008). Furthermore, during the past years, restoration ecology and other environmental fields have promoted dam removal to prevent further 68

69 biodiversity loss and 'reconnect' watersheds (Magilligan et al., 2016). Among social scientists,

70 debates regarding dam-building and the impact of dams are also strong, as they have shown how a

new discourse on climate change and sustainability (Crow-Miller et al., 2017) is fuelling dam-

72 building for hydropower or multipurpose reservoirs. Some states and institutions are framing

73 hydroelectricity, for example, as renewable, 'clean', 'green' energy (Ahlers et al., 2015; Fletcher,

74 2010; Warner et al., 2017). Altogether, scholars in different scientific fields are questioning the

75 sustainability of dams (Di Baldassarre et al., 2021).

76

77 To clarify the continuing debate on the construction of dams, particularly on their impacts and 78 sustainability into the future, this paper examines the discourses on dams within the public domain. 79 We focus on the public due to the relevance of dams on people's lives, such as in relation to water 80 resource management and energy production, and since the public often exerts political power for 81 decisions concerning dam-building. We also focus on the public discourses on dams since the mid-82 20th century, because this period includes the peak in dam building and the development of 83 controversies regarding the negative impacts of dams (Roe, 2012). In this paper, we therefore 84 address the following research questions. First, how have the discourses and debates on dams, and 85 notably on the sustainability of dams, developed within the public domain? Second, how can tracing 86 a 'genealogy' of discourses on dams inform their sustainability into the future?

87

88 2. Approach, material and methods

89

90 2.1 General Approach

91 This paper approaches the research questions with a Foucauldian perspective. Foucault promoted a 'genealogical' approach that examines "how series of discourse are formed [...]; what are their 92 93 specific norms, and what are their conditions of emergence, growth and variation" and a critical approach that "distinguishes forms of exclusion, limitation and appropriation" (Foucault, 1971, p. 94 95 62-63). Accordingly, we investigate not only the genealogy of discourses relating to dams, but also 96 the controversies at work during different periods. This post-structuralist framework invites us to 97 question and highlight the emergence and the development of new discourses regarding dams. It 98 also helps to reveal how older discourses may still be present and are adaptable to current issues. 99 We consider a discourse is made of oral or written statements (Adger et al., 2001). It is also "a 100 shared way of apprehending the world. Embedded in language, it enables those who subscribe to it 101 to interpret bits of information and tie them together into coherent stories or accounts" (Dryzek,

102 2012, p. 9). Following Foucault, previous studies on water and hydraulic infrastructure have

103 illustrated the role and power of discourse, and notably its political ramifications (e.g., Duarte-

104 Abadía et al., 2015; Boelens et al., 2016; Boelens et al., 2019).

105 In a nutshell, the relevance of studying discourses is twofold. On one hand, the study of discourses allows documentation of the relationship between society and dams, because discourses materialise 106 107 this relationship in oral and written statements. On the other hand, since discourses have a 108 performative value, studying discourses also allows better understanding of how planning choices 109 regarding dams are made, and more generally how "political decision-making takes place" (Hajer, 110 1995: 44). While studies in natural sciences have increasingly highlighted the ecological impacts of 111 dams since the 1960s (e.g., Scope, 1972), social sciences have often focused on controversies 112 related to dam-building and their social consequences (e.g., Kaika, 2006; Hommes et al., 2016). 113 Such research has focused on case studies situated in specific timeframes and socio-political

114 contexts.

115 To consider more generally the public debate on dams and build a genealogy of discourses on dams, we used media as a primary source. Media capture the public domain well as places or forums in 116 117 which individuals "engage each other about subjects of shared concern" (Pezzullo and Cox 2017, p. 20). Media and newspaper accounts also present many biases, as they personalise information, 118 119 dramatise events, and tend toward novelty (Boykoff and Boykoff, 2007). Nevertheless, media play a 120 role in political agenda setting (Downs, 2016) and reflect social concerns (de Loë, 1999). They are 121 arenas among which new economic and environmental models can be produced (Burgess, 1990). 122 Previous studies have highlighted the 'centrality' (Foxwell-Norton and Lester, 2017) of media in the communication of environmental issues and have recognised their value as a valid source to 123 124 study environmental conflicts and as a stakeholder in environmental politics (e.g., Lester, 2010; 125 Hansen, 2015). For these reasons, they can be valid for the study of environmental topics and 126 controversies and their evolution over time. In other words, media allow study of the progression of 127 "environmental issues in the public sphere" (Hansen, 2015, p. 217). In the social sciences and 128 environmental studies, media sources have been successful to identify and distinguish different 129 periods in water management on national scales (Wei et al., 2017, 2015).

In this study, we focus on both national and international news. This paper is based on media
narratives from *Le Monde*, a French newspaper with a strong interest in international news and

132 global socio-political debates (in a similar way to *The New York Times* or *The Guardian*). This

133 source is particularly useful as *Le Monde* has digital archives dating back to the newspaper's

134 foundation in 1944. Although previous studies have largely relied on content analysis (Wei et al.,

135 2017), we implemented a method based on textual data analysis (also often called 'text mining').

136 This study therefore details the evolution of discourses on dams (between 1945 and 2019). It

137 situates in time the integration of social, economic, and ecological issues within the debate on dams.

138 We then discuss results within the international scientific literature and debates on dams into the

139 future.

140

141 2.2. Material

142

143 We targeted the newspaper *Le Monde* for the history of the debate on dams, tracing the genealogy 144 of discourses on dams and the framing of dams as sustainable levers. Although a French newspaper 145 may suggest a Franco-centred perspective, Le Monde pays much attention to international news and 146 its reporting considers different and often diverging points of view. It is also one of the few major 147 daily newspapers with archives available in formatted text. Notably, it is accessible through university library subscriptions (through its website, www.lemonde.fr or through online platforms 148 149 such as www.europresse.com). Le Monde's archives go back to the newspaper's foundation in 150 1944. Therefore, this source allows a longitudinal approach. Only a few other newspapers provide 151 digitised archives over such a time span. For such reasons, Le Monde has been useful beyond 152 francophone scholarship (Brossard et al., 2004).

153

154 2.3. Data collection

We combined different queries to avoid collecting articles that did not focus on hydraulic dams. The terms included "dam & river" (*"barrage & rivière"*, *"barrage & fleuve"*), "dam & lake" (*"barrage & lac"*), "dam & reservoir" (*"barrage & réservoir"*), "dam & licence" (*"barrage & concession"*). These queries produced over 6,000 articles. Many duplicates were automatically excluded from the corpus. We then read and examined the articles individually. We excluded from the corpus articles that only briefly evoked dams. This process led to inclusion in the corpus of 1,471 articles published between 1945 and 2019.

162

163 2.4. Data preparation

We collected and tabulated metadata on each article (publication date, author, article title). We also carried out a basic content analysis from the reading of the articles, focusing on information such as the dam site, the river or the river basin, and the country on which the article was centred. When the article only concerned one site, river, river basin or country, we also recorded this information in the

- 168 metadata table. Moreover, for each article, we determined if the newspaper mentioned a
- 169 controversy, i.e., an opposition or a disagreement between different stakeholders or communities
- 170 involving the dam. Finally, using the scale elaborated by de Löe (1999), we determined whether the
- 171 newspaper adopted a pro- or anti-dam tone, a neutral tone, and whether it presented both the pros
- and cons or simply whether the dam played a marginal role in the article.
- 173

174 2.5. Data analysis

To explore and analyse the data in the metadata table, we firstly summarised and plotted several key 175 176 characteristics. The number of articles published per year, for example, identified periods of over and under news coverage. We also considered the evolution of dam building in the world between 177 178 1945 and 2020, based on the World Register of Dams (ICOLD, 2018), which represents dam builders and managers, and the International Commission on Large Dams (ICOLD), and which 179 180 contained information on the building date of 51,514 dams throughout the world. After culling the 181 data for the building of dams per year, we also measured the ratio between the dam coverage by Le 182 Monde between January 1945 and December 2019, according to our corpus, and the total number of articles published each year in the newspaper. We further identified the countries and dams that 183 benefited from a broad coverage by Le Monde: we were able to attribute countries to 1,425 articles 184 185 out of 1,471.

186

187 Secondly, we performed a quantitative textual data analysis with the open-source programs 188 Iramuteq (Ratinaud and Déjean, 2009) and TXM (Heiden et al., 2010). Textual data analysis, also 189 often called 'text mining', is definable as a set of methods that rest on statistics to analyse text 190 corpora (Beaudouin, 2016; Heiden et al., 2010). Iramuteq relies on R software and Python language 191 to perform analyses such as the classification algorithm (Reinert, 1990, 1983), which comprises five main phases (Cottet et al., 2015). The classification algorithm proceeds through several steps. First, 192 193 it segments the corpus into phrases (of 40 words approximately). Second, it lemmatises¹ the words 194 using a grammatical dictionary. Third, it produces a contingency table between the lemma and other forms such as the metadata and the text segments. Fourth, it builds a top-down hierarchical 195 classification based on the contingency table (using χ^2 metrics). Fifth, it leads to the description of 196 different lexical classes that present the degree of association between each class and the different 197

 $^{^{1}}$ In linguistics, a lemma is generally defined as "a set of lexical forms having the same stem and belonging to the same major word class, differing only in inflection and / or spelling" (Francis and Kucera, 1982: 1). In general, a lemma is the standard dictionary entry of a word. To lemmatise means to tag words of a corpus according to their stem. In this case, the software we use matches each word of the corpus to a dictionary entry.

- forms (also using χ^2 metrics). Recent studies have used this method to identify discourses on different environmental subjects, such as invasive species (Cottet et al., 2015), rivers (Comby et al., 200 2019), and water conservation (Boyer et al., 2021). In this case, the classification algorithm allowed for the identification of 12 different lexical classes. We then considered the degree of association between the different classes and the decade of publication of the texts. We used the open-source data visualisation framework RAW Graphs (Mauri et al., 2017), and in particular the 'area graph', to represent the χ^2 for each class according to the different decades.
- 205

In parallel, we used the 'progression' function of TXM (which also relies on R statistical libraries)
to examine the evolution of specific words and expressions within the corpus, according to the
publication year of the newspaper articles. We produced graphs displaying the cumulative

209 frequencies of different expressions such as "wild river" ("rivière|fleuve sauvage") and "living

210 river" ("rivière|fleuve vivant") or "greenhouse gas" ("gaz à effet de serre").

211

Thirdly, we conducted a qualitative and interpretative analysis. We read all 1,471 articles comprised in the corpus. Based on the reading of the corpus and keyword searches performed in TXM, we

214 identified quotes reflecting evolutions that we had previously statistically observed.

215

216 **3. Results**

217 **3.1 Characteristics of coverage by** *Le Monde*

218 The coverage by Le Monde was mostly strong during the main period of dam building throughout 219 the world, i.e., between the 1950s and the 1970s (Fig. 1). The coverage was characterised by 220 various peaks (e.g., 1952, 1959, 1982, 1990). The qualitative analysis allowed us to link some of 221 these peaks to specific dam projects and controversies: the building of Tignes Dam in France 222 received much attention in 1952; in 1959, Le Monde published a series of articles on the Malpasset 223 disaster (Southern France); other peaks such as the 1982 and 1990 ones did not coincide with a 224 single project event or controversy. After 1980, and during a period in which less dams were being 225 built, Le Monde paid less attention to dams (Fig. 1). However, after 2010, the coverage of dams 226 increased again.



Fig. 1. Dam building in the world and dam coverage in *Le Monde* (1945-2019). a, Number of dams
built between 1945 and 2020 according to the World Register of Dams database (n=51,514). b,
Number of articles in the corpus on dams published between 1945 and 2019 in *Le Monde*

252 (n=1,471). c, Total number of articles published in *Le Monde* between 1945 and 2019

253 (n=2,594,606). d, Ratio between the number of articles on dams published in year in Le Monde, and

the total number of articles published per year by the newspaper (per mille).

255

256 Le Monde's coverage was both international and Franco-centred. The corpus included 582 articles

257 focused on France (40,1%). It also encompassed articles on 105 other countries (Fig. 2). Much

attention was paid to dams planned or built in Egypt and China, and in particular to the Aswan High

259 Dam (with some articles also focused on Sudan) and the Three Gorges Dam (Fig. 2).



261

Fig. 2. Spatial characteristics of *Le Monde*'s coverage of dams (1945-2019). a, Articles on dams per country (excluding France). b, Cumulative frequency of the number of articles published on the ten main countries based on the corpus (excluding France). c, Cumulative frequency of the number of articles published on the ten main dams based on the corpus.

266

3.2. From economics to livelihoods: Twelve themes relating to dam-building (1945-2019)

Twelve major themes that relate to dams appeared in *Le Monde* (Fig. 3). Politics and geopolitics represented 1/5 of the newspaper articles' content (classes 3, 5 and 10). Journalists also lengthily

270 described the landscape and the populations affected by dam-building (classes 1 and 4). Technical

- characteristics of the infrastructures, rivers and lakes, also often appeared (classes 7, 11 and 12).
- 272 Industry and economy, as well as the funding issue, were also topical issues (classes 2 and 9).
- 273 Whereas environmental protests represented one of the smallest classes of the corpus (class 6,

- 6.5%), development and sustainability played a relatively important role in the articles (circa 8%).
- 275 These themes related to discourses held on dams that have evolved through time.



- Fig. 3. The 12 lexical classes of *Le Monde*'s articles on dams (1945-2019). The figure is the result
 of the hierarchical classification of the textual segments performed with Iramuteq. The authors
 added the keywords, established through a qualitative analysis, underneath the class numbers to
 facilitate reading the figure.
- 280

3.2. A discourse focused on the materiality of dams and on their economic and energy

282 performances (1945-1960s)

From 1945 to the beginning of the 1970s, three lexical fields were over-represented in Le Monde's

articles on dams (Fig. 4). The journalists described in great detail technical aspects of dams,

- attaching particular importance to the size of the infrastructures.
- 286
- 287 Energy consumption and production were also a major theme of the articles in the 1940s and 1950s.
- 288 This issue, coupled with economic questions along with industry, capital, finances, and
- 289 development, were also frequently evoked. The focus on energy and economics is explainable by
- 290 the fact that, during this period, whereas France was experiencing economic growth (the 'Trente
- 291 Glorieuses' period, in connection with the Marshall Plan), the newspaper mainly described dams

- 292 planned or under construction in France. The newspaper also focused on countries historically
- 293 linked to France (colonies or ex-colonies, such as Morocco or the Ivory Coast), and dams
- 294 financially supported by France or with involvement from French engineers (such as Aswan in
- 295 Egypt, Fig. 2c, or Cahora Bassa in Mozambique).





Fig. 4. Evolution of the 12 lexical classes between 1945 and 2019. The figure, made with RAW Graphs, shows the degree of association (χ^2) between the different classes and the decade of publication of the newspaper articles. The degree of association can be positive or negative (above or below the horizontal lines). The scale representing the degree of association is shown in the topleft corner of the figure.

327 A qualitative analysis of the newspaper articles showed that, between 1945 and the end of the 1960s, dams were described as solutions to different types of crises such as drought, flood, water 328 329 supply or energy shortage. The articles presented dams as tools for development and modernisation, 330 most often on a national scale. Although most newspaper articles remained neutral (i.e., they did 331 not explicitly support the dam projects), some articles demonstrated pride towards the 332 infrastructures and engineering technicity. Regarding the Roselend scheme in the French Alps, a 333 journalist asserted France's superiority over the United States or the Soviet Union: "None of the 334 foreigners [who were visiting the dam and its power plant, La Bâthie] claimed to have something better at home. Not even a Soviet. Not even an American" (Le Monde, 10th August 1961). Dams 335 336 were tightly linked with a discourse on national interests and on political and economic independence in the post-World War II and Cold War contexts. Some articles highlighted the beauty 337 338 of the dams by comparing them to temples or cathedrals. In the newspaper articles, water was 339 represented as raw material that does not have a cost, as a resource that could be entirely exploited for human activities by implementing "rational" projects. The Dordogne River (in the southwest of 340 341 France) was described as having been "rationally equipped" and as one of the "best examples of the complete usage of a river" (Le Monde, 1st July 1953). The newspaper articles rarely described the 342 source of water and the environment in which water flows. Rather, journalists mentioned head and 343 344 flow rate, "white coal" ("houille blanche") when they described water, or "liquid stairways" (Le *Monde*, 25th May 1964). 345

346

326

347 Nevertheless, some articles mentioned debates, disputes and controversies before the 1970s. Local 348 negative consequences were evoked, notably those related to land loss (e.g., during the construction 349 of the Tignes Dam in the Central French Alps), and regional oppositions between downstream and upstream interests (e.g., Serre-Ponçon Dam and the Durance valley in the French Southern Alps). 350 351 Although some articles focused on the benefits of the Aswan High Dam (in Egypt), others 352 underlined the geopolitical tensions linked to the project and the archaeological consequences of the 353 inundation of Nubia even after the reconstruction of the Abu Simbel temple. The international 354 campaign related to the dam, carefully followed and reported on by Le Monde, influenced French 355 journalists to adopt a more critical perspective regarding the benefits of dams. By the end of the 1960s, a shift had taken place: while economics, energy production and the technical characteristics 356 357 of dams played an increasingly smaller role in the discourses on dams, the articles began to question 358 the assets of dams.

360 **3.3.** A discourse increasingly adding value to the socio-natural environment and landscape

361 **(1970s-1980s)**

362 During the 1970s and the 1980s, as dam building reached its peak, dams were extremely topical

363 (Fig. 1b and 1d). Nevertheless, these two decades did not present major specificities from a

364 discursive point of view (Fig. 3). Although some themes grew during the 1970s—such as landscape

365 (Fig. 3, class 4)—and the 1980s—such as politics and conflicts (class 3) or environmental protests

366 (class 6)—they did not dominate the articles as much as energy or the technical aspects of dam

- 367 building that dominated the articles in the 1950s.
- 368

369 While the journalists continued to focus on France or on the dams planned in France, the articles 370 also turned towards North and South American dams (the most publicised having been Itaipu, 371 Fig. 2c, on the border between Brazil and Paraguay) and towards some Asian dams. From the 372 1970s, the negative consequences of dams appeared more and more although some articles 373 continued to assert the benefits of dams in terms of development. The Oil Crises (which were evoked in three articles between 1977 and 1979) might have played a role in the latter case. The 374 debates and controversies were no longer simply local or regional but were national and even 375 international. The opposition to the Silent Valley Dam in India was described, for example, as part 376 377 of a broad campaign to defend tropical environments and in particular tropical forests throughout the world. The inundation of farmland was increasingly cited (in particular in the Loire valley with 378 379 Villerest or Naussac, Fig. 2c, in the centre of France but also in Haïti). By raising this topic, the 380 journalists questioned both the type of nature desired by society and the economic model dominant 381 in France and throughout the world. While the foreign dams built with French assistance continued 382 to specifically attract the attention of journalists (for example, Itaipu, Fig. 2c), compared with 383 articles of the 1950s and 1960s, the articles of the 1970s and 1980s were much more critical of 384 French foreign aid. The building of dams on the Senegal River was described as leading to the 385 "disappearance of subsistence agriculture in favour of the development of export crops" (Le Monde, 386 15th October 1983). Ongoing and past debates on American dams— the O'Shaughnessy in the 387 Hetch Hetchy Valley or the Marble Canyon on the Colorado River-were evoked.

388

In some articles, dams became synonymous with environmental degradation and destruction. Since its inauguration in 1971, the Aswan High Dam has remained newsworthy (Fig. 2c) because of its negative impacts: the increase in soil salinity, river bank erosion, the disappearance of certain species such as sardines (*Sardina pilchardus*), and the regression of the Nile's delta. In recent articles, Aswan has become a symbol of negative consequences of dams, in particular for arid

- 394 countries. More attention was also paid to rivers in terms of pollution, yield, temperature, and algae
- 395 development. Subjects such as hydro-peaking, flushing flows, and discontinuity became
- 396 newsworthy. For some journalists, once the dams were built, the nature of the river changed. The
- 397 Verdon River (in the Southern French Alps) "has ceased to exist for a third of its distance" (Le
- 398 *Monde*, 28th June 1982), for example, and the Tagus (in Central Spain) was "imprisoned by a series
- 399 of dams" (*Le Monde*, 12th March 1971). During this period, the expressions "wild river" and "living
- 400 river" appeared in journalistic vocabulary (Fig. 5a), which revealed the growing concern for pristine
- 401 and rare environments. Starting in the 1980s, some articles focused on or evoked plans for dams,
- 402 which were cancelled because of environmental considerations in France but also in Germany,
- 403 Australia, the United States and the Soviet Union.
- 404
- 405 According to Le Monde, dams became particularly controversial hydraulic infrastructures during the
- 406 1970s and 1980s, although no lexical fields particularly stood out in the corpus. During these two
- 407 decades, while environmental concerns emerged, economic and social issues split apart as some
- 408 dams were described as economically interesting but socially questionable.
- 409
- 410
- 411
- 412



413 Fig. 5. Significant keywords and expressions and their evolution between 1945 and 2019. a,
414 Cumulative frequencies of the expressions "wild river" and "living river". b, Cumulative
415 frequencies of the expressions "indigenous|native population|community|people", "sustainable
416 development", "climate change", "global warming", "greenhouse gas". c, Cumulative frequencies

417 of the expressions "hydroelectricity" and "renewable energy".

418

419 3.4. From social and environmental impacts to controversies on sustainability (1990s-2010s)
420

421 3.4.1. A discourse on the impact of dams on water and physical environment and their interactions
422 with society (1990s-mid 2000s)

423

During the 1990s and the beginning of the 2000s, the coverage of issues related to dams slightly
decreased in *Le Monde* (Fig. 1d). Nonetheless, environmental protests became more topical during
the 1990s in relation to specific debates (for example, the Three Gorges project in China, Fig. 2c).
The social and environmental impacts of dams continuously appeared—although the tone of the

journalists remained neutral in general. Impact on water (quality and quantity) also became morecentral (Fig. 4).

430

431 The introduction of such topics in the newspaper's accounts were linked to various events. Firstly, 432 in 1992 the French government passed a water law and defined water as a national heritage. 433 Secondly, at the end of the 1990s, some members of the French government considered 434 implementing a sustainable water development scheme for the Loire River basin. At the end of the 435 1990s, such a program implied abandonment of dam projects, with an important example being the Chambonchard Dam (Le Monde, 19th February 1999). It represented a major turn for water 436 437 development in France, as dam projects were cancelled due to environmental concerns and protests. 438 Thirdly, the newspaper also highlighted newly discovered environmental impacts of dams, in 439 particular the biological consequences of the release of methylmercury after the flooding of forests 440 or boglands in Canada (Le Monde, 27th December 1991) or the release of greenhouse gas. The newspaper's columns debated the latter, when the main French operator Électricité de France 441 442 (EDF) was obliged to temporarily shut down its newly inaugurated dam and power plant of Petit 443 Saut in French Guyana. The flooded tropical forest released so much methane that many fish 444 suddenly died. Scientific studies demonstrating that the reservoir released important quantities of 445 greenhouse gas that were quoted by the newspaper led journalists to conclude that "hydroelectric 446 dams are not insignificant in terms of greenhouse effect" (Le Monde, 28th August 1995). The subject 447 of greenhouse gas was introduced in some articles on dams since the early 1990s (Fig. 5b) but only 448 became topical at the end of the 1990s and even more so after 2004.

449

450 *3.4.2.* When sustainability enters the discourse on dams (from the mid-2000s)

451

Although international conferences and reports introduced the concept of sustainable development 452 453 at the turn of the 1990s (with the 1987 report *Our Common Future* and the 1992 Rio Earth Summit), 454 based on Le Monde's reporting, the sustainability of dams only became central in the discourses on 455 dams after the mid-2000s. The expression "sustainable development" appeared regularly since 2005 (Fig. 5b). Similarly, the use of the expressions "climate change", "global warming" and 456 457 "sustainability" increased substantially after 2004 (Fig. 5b), possibly in relation to the 2001 Third 458 Assessment Report of the Intergovernmental Panel on Climate Change. Economic development was 459 tightly linked to environmental and social sustainability, as shown in the class 8 (Fig. 3), which 460 gained momentum in the last decade (Fig. 4). Sustainability was shown as a paradigm for

461 development and for water management that can be invoked to either defend or criticise dams.

462 Livelihoods, living standards, social equity and justice and human rights were more and more

463 reported on after 2000 (Fig. 4). Le Monde participated in giving indigenous communities an

464 international audience (Fig. 5b), in particular in the cases of Southeastern Asian dams (such as

465 Murum in Malaysia) or of South and North American dams (such as Belo Monte in Brazil, Fig. 2b

466 or Agua Zarca in Honduras, or various Canadian projects), which may endanger these communities'

467 livelihoods, according to the newspaper.

468

469 The newspaper also explained, however, how different projects may contribute to sustainability. Le 470 Monde reported that the Nam Theun 2 project, planned in Laos, was defended by the World Bank-471 although the World Bank had previously refused to finance some other dam projects—and 472 presented by the international institution as an example of sustainable development (Le Monde, 14th 473 September 2004). The construction of the multipurpose Kandadji Dam on the Niger River in the 474 South of Niger was also said to have raised no opposition "because the dam was conceived according to the standards of sustainability" (Le Monde, 10th May 2012). Instead, the story of an 475 irrigation dam planned on the Acheloos River in Greece, was reported in the newspaper after the 476 477 decision taken by the Greek Council of State (i.e., the Supreme Administrative Court) to prohibit the dam's construction as the project contradicted the principles of sustainability recognised by the 478 Greek constitution (Le Monde, 6th March 2014). In many recent articles focusing on China (which is 479 480 the second most newsworthy country, Fig. 2a and Fig. 2b), the journalists argued that sustainability 481 has entered the discourse of Chinese officials. This discourse focused on justifying the building of 482 new dams when, in fact, the multiplication of dams and the accompanying growth and climate change "put pressure on hydrology" (Le Monde, 12th November 2008). The Three Gorges Dam, 483 484 proposed by the Chinese government who "assured that such construction work is essential for the 485 modernisation of a country where energy shortages are slowing development" (Le Monde, 16th 486 December 1994), in fact "amplifies the consequences of global warming which has already contributed to diminishing the Yangzi River's yield" (Le Monde, 30th December 2009). While 487 488 irrigation represented a controversial topic, as demonstrated by the debates on the Sivens Dam project in Southwest France (Fig. 2c), "sustainable", "development" and "renewable" are amongst 489 490 words that co-occurred most with the word "hydroelectricity" in the newspaper corpus. Although 491 hydropower remained much less articulated as a theme connected to dam building than it was in the 1940s and 1950s, hydroelectricity became more topical in the newspaper also at the turn of the 492 493 second millennium (Fig. 5c). The newspaper revealed the complexity of the debate. While 494 indicating the possibility of greenhouse gas release related to certain dam-reservoirs, it also 495 explained that after "the Fukushima accident, the questioning on nuclear power and the struggle

496 against greenhouse gas emissions should speed up the scramble to large infrastructures" (Le Monde, 19th April 2011). The journalists covered explicitly the return to large infrastructures, especially in 497 developing countries. While reporting on a meeting between the African Union and ICOLD, 498 499 journalists explained that hydropower is presented as a clean "alternative to fossil energy resources" 500 and the organisations' "intentions are clear: large dams must become once again instruments for the development of nations" (Le Monde, 27th November 2008). The journalists also highlighted, 501 502 however, that this return to large infrastructures can be a source of major political tensions, for 503 example in the case of the Great Ethiopian Renaissance Dam, which the newspaper has very often 504 reported on in recent years (Fig. 2c). By 2019, with the rise of an environmental discourse on 505 economic, social and environmental sustainability, and the emergence of themes such as climate 506 change, global warming and greenhouse gas emissions, the reporting on dams has therefore become 507 more ambiguous and associated with uncertainty.

508

509 **4. Discussion**

510

511 Despite the fact that Le Monde does not specialise in environmental issues, the results of the analysis showed that the newspaper documented changes in discourses on hydraulic infrastructures 512 513 such as dams. It provided insights on a continuing dilemma over the period and into the future: to 514 dam or not to dam? Although dams have been controversial infrastructures as early as the 1940s, it 515 was mostly after the 1970s that that they were portrayed as disrupting social and environmental configurations, the daily living environments of the local inhabitants. From this point of view, the 516 517 results showed a time gap between the scientific controversy on the impact of dams, which emerged 518 during the 1960s at conferences such as the Royal Geographical Society symposium on "Man-made 519 lakes" (in 1965), and the media and political debate. The necessity to take into account the local population and conduct impact assessments, which was proposed by the scientific community at the 520 521 beginning of the 1970s (Scope, 1972), was not advanced in newspaper articles of Le Monde until 522 later years of the same decade. The characterisation of dams and hydropower as 'clean' and 'green', 523 which has been debated within the scientific community since the 1990s (Rosenberg et al., 1995), only appeared in the media in the mid-2000s. Moreover, while Allan (2003, p. 2) underlined that 524 525 "the water sector in the North adopted the principles of sustainable development during a protracted discursive struggle from the late 1950s to the mid-1970s", the issue of sustainability only 526 527 progressively emerged in newspaper articles in the 1970s and only became a prominent topic, 528 conceptualised as such, in the past decade.

530 These results are similar to those of other studies on media coverage of environmental issues. In a 531 study of the coverage of climate change in the mass-media of the United States, Boykoff and Boykoff (2007) explained that "Even though scientists had warned for years that emissions of 532 carbon dioxide and other greenhouse gases would lead to changes in the Earth's climate, this did 533 not capture large-scale media attention in the US until 1988" (p. 1195). The time gap is also 534 535 explainable by events not directly connected with dams, but which triggered a sudden interest in 536 such infrastructure and its sustainability. In France, in the mid-2000s, the government organised a 537 multi-party debate on ecology and sustainable development ('Grenelle Environnement'), whose aim 538 was to elaborate a list of measures to implement. In 2002, the name of the Ministry for Environment 539 ('Ministère de l'Environnement'), which had kept the same name since 1971, was changed to 540 'Ministry for Ecology and Sustainable Development' ('Ministère de l'Écologie et du 541 Développement Durable'). These political events could potentially explain the growing interest in 542 the sustainability of dams in the mid-2000s. As Boykoff and Boykoff (2007) underlined, increases in the media coverage of environmental topics are often attributable to "a combination of 543 544 circumstances that [are] far from purely scientific in nature" (p. 1196). 545 From both a genealogical and critical perspective, results of this study showed that, until the 1970s, 546

547 Le Monde produced and conveyed a discourse highlighting human domination over nature. This 548 discourse mostly promoted development and paid much attention to the infrastructures themselves. 549 From the end of the Second World War to the 1970s, the media's discourse can essentially be described as 'Promethean' or 'Modernist' (Kaika, 2006), i.e., a discourse about taming and 550 551 controlling a 'savage' nature (Boelens et al., 2019). With a strong focus on industrial development, 552 the newspaper also highlighted the dependency of capitalist States and companies on the building of 553 new dams and hydraulic infrastructure. In this perspective, dams appeared as 'hydraulic fixes'---in other words, hydraulic projects branded by their supporters as tools for growth, social and economic 554 555 development, but which in fact contribute essentially to the longevity of hydraulic companies and 556 capitalist States (Swyngedouw, 2015). Evidenced in articles published after the 1970s, the 557 newspaper had apparently distanced itself from the Promethean discourse and adopted a more 558 critical tone. The media began to pay more attention to human livelihoods but also to other 559 nonhuman living beings. The evolution of the newspaper's discourses illustrates how dams have 560 become the 'symbol of an exogenous development model that is imposed on vulnerable local 561 societies' (Barraud, 2008: 3)².

² Translated from French by the authors.

563 The genealogical approach utilised in this study also revealed how sustainability has entered the 564 discourse on dams and shows a coexistence of different conceptions of sustainability. Although 565 different stakeholders seemingly agree today that sustainability involves three constituent 566 elements—ecology, economy and society—the newspaper articles showed changing prioritisations 567 of these three elements (equitability, viability, bearability). The articles of the 1970s and the 1980s, 568 for example, highlighted the opposition between stakeholders who favoured economy and who 569 expressed few concerns regarding ecology-putting forward dams as equitable development 570 levers-and stakeholders concerned with social changes related to dams, and finally an emerging 571 group of stakeholders concerned with ecological issues. By the 2010s, sustainability was apparently 572 central to stakeholders on all sides-i.e., against or in favour of dams-and the environmental 573 impact of energy infrastructures in particular was brandished by both dam proponents and dam 574 opponents. For some stakeholders—in particular for some governments or hydraulic institutions— 575 the articles showed that sustainability was more connected with social and economic aspects than 576 with environmental ones. More generally, the tension between the different pillars of sustainability 577 and the consequences of dams at different scales (e.g., local, national, and global) underlines the 578 importance of deliberation in order to move towards concerted decision-making. It also reveals the 579 extent to which the sustainability of dams, and notably the criteria we use to define viability (the 580 opposition between river ecology conservation and carbon emission control) and equitability, has 581 today become extremely controversial in the public domain.

582

562

583 5. Conclusions

584

585 In conclusion, analysis of media discourses held on dams since the mid-20th century revealed how 586 different generations of debates on dams, water planning and more generally on development 587 paradigms have emerged and evolved. Results of the genealogical study of the newspaper *Le* 588 *Monde* provided answers to the research questions posed in this paper as follows:

589

590 First, how have the discourses and debates on dams, and notably on the sustainability of dams,

591 developed within the public domain?

592 Our analysis shows that between 1945 and 2019, different discourses have been developed on dams.

593 Until the 1960s, the dominant discourse focused on the materiality of dams and their economic and

594 energy performances. Essentially Promethean, this discourse was occasionally opposed to a

595 discourse presenting dams as controversial and having negative social and cultural impacts. During

596 the 1970s and the 1980s, i.e., a decade after the beginning of the scientific controversy on dams, the

597 discourse on dams increasingly added value to the socio-natural environment and landscape

affected by dam projects; dams tended to be presented as economically interesting but socially and

599 even environmentally questionable. After the 1990s, the impacts of dams were more and more

600 highlighted, in relation to society and to the physical environment. Finally, our results showed the

601 extent to which the debate on the sustainability of dams has gained momentum during the past ten

602 years.

However, the notion of sustainability was addressed in newspaper articles on dams in an ambivalent
way. On one hand, negative social and environmental impacts of dams were listed to demonstrate
that dams are incompatible with sustainability. On the other hand, the newspaper articles explained
how in some cases hydropower projects could contribute to sustainable development.

607

Second, how can tracing a 'genealogy' of discourses on dams inform their sustainability into thefuture?

610 Analysing past and present discourses on dams can help inform future discussions on dams and 611 their sustainability. Our results have shown that controversies about dams are not new in the public domain, and that the notion of sustainable development has to some extent reactivated the 612 Promethean discourse in which dams are presented as solutions to a range of socio-environmental 613 problems. Commonalities between past and present discourses can be found, even though the 614 615 Promethean discourse is no longer dominant in the media we analysed. 616 The analysis of media discourses on dams also showed the complexity of the public debate 617 regarding the knowledge of the social and ecological impacts of dams, of both short-term and long-618 term environmental alterations they may cause, and of the political choices to be made in the future. 619 To gain more complete insights and continue informing discussions on dams and sustainability, 620 future work can extend to other media sources, as archives are becoming more and more digitised.

621 Additional sources may reveal different trends in the evolution of discourses on dams and the

622 integration of sustainability within these discourses. Other avenues may include exploration of the

623 sustainability of dams as producing 'green energy', as well as the study of other sources, notably the

advertisements (e.g., leaflets, posters, etc.) produced by hydropower companies. Results from this

study further suggest a need for a stronger dialogue between the scientific and public domains.

626 Knowledge transfer and exchange would be beneficial on topics including the meaning of

627 'renewable energy' and 'green energy,' and alternative modes of governance regarding dams.

628

629 6. References

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- 654 **Competing interests**
- 655 The authors declare no competing interests.

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