

Article

Comparative Analysis of Hydraulic Fracturing Wastewater Practices in Unconventional Shale Development: Newspaper Coverage of Stakeholder Concerns and Social License to Operate

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Abstract: In this article we review prior literature regarding the concept of social license to operate, and related concepts, including corporate social responsibility, sustainable development, stakeholder management and cumulative effects. Informed by these concepts, we search for newspaper articles published in North American provinces and states where the Barnett, Duvernay, Marcellus and Montney shale plays are located. Using these data, we tabulate coverage of stakeholder concerns related to hydraulic fracturing and wastewater practices, and compare the extent to which these concerns vary over place and time. Our vocabulary analyses identify differences in the types and quantities of newspaper coverage devoted to concerns regarding hydraulic fracturing activities in general and wastewater practices in particular. We interpret these differences as suggesting that obtaining a social license to operate is likely not a one size fits all proposition. By understanding which stakeholder concerns are most salient in particular places and times, oil and gas operators and regulators can better tailor their strategies and policies to address local concerns. In other words, the findings from this study indicate that conventional understandings of risk as a technical or economic problem may not be adequate for dealing with unconventional resource challenges such as hydraulic fracturing. Operators and regulators may also need to manage social and cultural risks.

Keywords: social license to operate; hydraulic fracturing; oil and gas industry; sustainability; stakeholder management; corporate social responsibility; cumulative effects management

1. Introduction

Fracking, a process that combines hydraulic fracturing with horizontal drilling, has spawned a “shale gas revolution” [1,2]. Seizing on these breakthroughs, some actors have heralded a “golden age of gas” [3,4], positing natural gas as a possible “bridge fuel” to a more sustainable energy future [5,6]. At the same time, the rapid expansion of unconventional shale development has generated numerous environmental, health, and safety concerns (e.g., [7–10]).

In this article, we focus on an emerging set of concerns related to the handling, treatment, and disposal of wastewater generated primarily as a result of hydraulic fracturing. The seriousness

of these concerns has prompted the involvement of a growing number of stakeholders, commonly defined as “any group or individual who can affect, or is affected by, the achievement of a corporation’s purpose” [11] (p. vi). In the case of unconventional shale development, stakeholders may include company employees, oil and gas regulators, host communities, environmental activists, and the public at large, among others.

The findings reported in this article are part of a larger research program designed to assess and summarize extant knowledge regarding hydraulic fracturing wastewater management. The starting point for the overall project was the conceptualization of the hydraulic fracturing wastewater context as comprised of three potentially interrelated spheres of action (Figure 1). By delineating between operator practices, regulatory requirements and stakeholder concerns, our goal was to better understand the extent to which these different spheres affected one another, if at all. In essence, we conceptualized the hydraulic fracturing wastewater context as a dynamic process in which any one sphere has the potential to influence the other two.

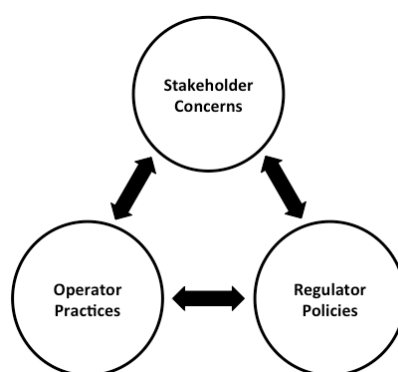


Figure 1. Conceptualization of the hydraulic fracturing wastewater context.

Relative to the overall conceptual framework, this article focuses on one of these spheres specifically: *stakeholder concerns*. In particular, we identify stakeholder concerns related to hydraulic fracturing and associated wastewater practices (see [12,13] for a comparative analysis of operator practices and regulator policies, respectively). The foundation for our analysis of stakeholder concerns is a comprehensive review of prior literature on social license to operate (SLO). Although there is no single consensus definition of SLO, it is generally defined as the extent to which a project, company or industry is perceived by stakeholders as being acceptable and legitimate [14–17], a connection we revisit in the discussion. Building on our review of SLO, we then conduct a vocabulary analysis [18,19] of newspaper coverage of stakeholder concerns related to hydraulic fracturing and wastewater practices in articles published in the North American provinces and states (hereafter jurisdictions) where the Barnett, Duvernay, Marcellus and Montney shale plays are located. The analyses reveal spatial and temporal differences in both the types and quantities of concerns that receive newspaper coverage.

We conclude by synthesizing across our various analyses and discussing implications for operators and regulators. Since there were clear variations in the types and quantities of stakeholder concerns that received newspaper coverage, it appears that obtaining and maintaining a social license to operate is likely not a one size fits all proposition. By understanding which stakeholder concerns are most salient in particular places and times, oil and gas operators and regulators can better tailor their strategies and policies to address these concerns. Finally, we discuss limitations of the research and suggest possible future research directions. Opportunities include extending the analysis using social media; studying other fracking related concerns; employing more sophisticated analytic techniques; further examining the linkages between SLO, organizational legitimacy and issues such as values, risk, and trust; and considering stakeholder concerns in their technical, relational and temporal contexts.

2. Social License to Operate (SLO)

Over the past decade, unconventional shale development in Canada and the United States has generated increased stakeholder scrutiny for both oil and gas operators and regulators. In many cases, responding to such stakeholder concerns has proven challenging because relevant data simply have not been available. For instance, in a report on the environmental impacts of shale gas extraction, the Council of Canadian Academies indicated that “many of the pertinent questions are hard to answer objectively and scientifically, either for lack of data, for lack of publicly available data, or due to divergent interpretations of existing data” [20] (p. 216). Uncertainty is another reason why unconventional shale development has been challenging. Given the many complexities involved, even in cases where data exist, operators and regulators have not been able to fully enumerate all possible future states, let alone assign them probabilities [21–23].

Given this state of affairs, it is perhaps unsurprising that opinions about hydraulic fracturing among members of the general public range from support to indifference to opposition. In fact, different polls have yielded different results. For instance, in Canada, results of an October 2014 poll found that “70% of Canadians support a national moratorium on hydraulic fracturing until it is scientifically proven to be safe” [24]; yet results of a June 2013 poll found that opinions regarding unconventional shale development in New Brunswick were almost evenly split, with 49% supporting and 44% opposing hydraulic fracturing activities [25]. In an effort to explain these diverging opinions, scholars observed that public opinions of hydraulic fracturing vary predictably based on socio-demographic factors [26]. In the United States, for instance, age, education, frequent television use and conservative political ideology are significant predictors of support for hydraulic fracturing, whereas female gender, an egalitarian worldview, and frequent newspaper use are significant predictors of reduced support for hydraulic fracturing [26].

Against this backdrop, operators and regulators have become concerned about the industry’s social license to operate (SLO), which we review in the remainder of this section. However, despite growing use of the term *social license to operate* by oil and gas operators and regulators, we found limited peer-reviewed literature on the concept. Thus, we expanded our literature search to include industry articles and presentations, reports by consultants and non-governmental organizations, popular books, and other so-called gray literature. In all cases, we followed forward and backward citations. The resulting pool of literature reveals how the SLO concept emerged within the industry, various ways it has been defined, as well as its relationship to other accountability concepts such as sustainability, corporate social responsibility, stakeholder management, and cumulative effects. Together, these findings informed our data collection and analysis.

2.1. The Concept of SLO

Recent use of the concept of SLO has been traced to Jim Cooney, a Canadian mining executive who proposed the idea during a 1997 meeting with World Bank personnel in Washington [17]. The term reportedly surfaced again during a May 1997 World Bank-sponsored mining conference, at which point it was assimilated into the mining industry’s vocabulary. At the time, public perceptions of the mining industry were increasingly negative in the wake of environmental damage resulting from spills, tailings pond mismanagement, and community frustrations with project organization [17]. Given this context, industry members initially conceived of SLO as a means of addressing community relations problems while avoiding regulatory or governmental involvement [16]. In other words, SLO emerged as a form of industry self-regulation [27–30].

As the Internet facilitated the rapid spread of information in the late 1990s, communities became more aware than ever of the potential for lasting environmental damage, economic impacts related to jobs and land values, health impacts, and general boom and bust phenomena. Indeed, more communities were (and still are) choosing to become involved in the process of resource development, whereas in the past the process was nearly devoid of extensive community consultation [16]. Social unacceptability dramatically impacted the viability of resource extraction

projects in communities around the world; as such, social risk was another driving force behind the need for SLO [16]. Within this literature, SLO came to be defined as the extent to which a project, company or industry is perceived by stakeholders as being acceptable and legitimate [14–17].

And yet, even as SLO has become a prominent topic, it remains both intangible [31] and difficult to measure [32]. It has been argued that this is due to the fact that the concept itself is contingent on the vested interests of concerned parties [33]. For instance, some have characterized SLO as a kind of insurance policy against the possibility that stakeholders might negatively impact operations, and even prematurely end a project [34]. However, there are no formal bureaucratic means for obtaining social license, as it is not administered by an agency, and differs for each industry, project and community [16,17,35]. Indeed, there are no explicit documents, policies, or written confirmation that SLO exists at all. For this reason, SLO has also been described as a relational concept that indicates the extent to which a project is accepted, approved, and even co-owned by a community [17]. Under such a definition, a company has obtained SLO once it has gained the “broad acceptance of society to conduct its activities” [16] (p. 52). Others have defined SLO as a more dynamic and evaluative process, with expectations determined by local stakeholders and citizens more generally about how a business should operate [15]. For instance, public opinions are not static, and thus SLO can be impaired or lost as perceptions change [36]. Likewise, operating standards for businesses are subject to change. Because of this fluidity, maintaining SLO is a continuous practice that requires constant attention in order to maintain rapport within a community [17,34].

2.2. Related Concepts

Scholars have argued that SLO overlaps with other accountability concepts that are widely utilized within industry and academia. We summarize the key characteristics for these related concepts in Table 1. *Corporate social responsibility* (CSR), for example, refers to the contributions of a business’s activities to economic, social, and environmental sustainability [37]. CSR provides a framework for understanding companies’ attitudes and relationships with stakeholders [38], and thus is an umbrella term used to indicate the extent to which a company is both required and willing to act in order to generate socially feasible projects. Wilburn and Wilburn [39] distinguished the terminology by suggesting that SLO is a model nested within a larger CSR strategy. A very similar term to CSR is *corporate responsibility* (CR). Encana Corporation [40] described CR as a consideration that “encompasses the corporate response to the governance, ethical, financial, economic, environmental and social performance issues facing today’s corporations” (p. 1).

Table 1. Summary of terminological characteristics for social license to operate and related terms.

Term	Key Characteristics
Social License to Operate (SLO)	Specific to each unique project Process: legitimacy, credibility, full trust Consistent consultation with stakeholders over life of project Not guaranteed based on past success/failure of firm
Corporate Social Responsibility (CSR)/ Corporate Responsibility (CR)	Firm-driven policy, may be overarching Firm is willing (not required) to act Does not require action on specific projects for success Variation between firms, industries
Stakeholder Management	Can be selective, based on vested and non-vested stakeholders Broader social concerns are not necessarily included Firm interested in satisfying a defined group of stakeholders
Sustainability/Sustainable Development	Value-based Broad societal concept that transcends the firm Can refer to environmental, social, or economic sustainability
Cumulative Effects	Extends beyond firm policies and procedures Collaborative management, may be inter-firm and multi-industry Effects are successive and incremental in nature

Another way to delineate how corporations view stakeholders is through the lens of *stakeholder management*, which can be compared to social issue management. Clarkson [41] suggested that “it is necessary to distinguish between stakeholder issues and social issues because corporations and their managers manage relationships with their stakeholders and not with society” (p. 10). Thus, stakeholder management would suggest allegiance to interests that are salient to stakeholders, but may not transcend into the realm of social best interest or the broader social discourse.

SLO also has some overlaps with *sustainability* and *sustainable development* [34], defined as meeting “the needs of the present without compromising the ability of future generations to meet their own needs” [42] (p. 41; for reviews see [43,44]). Since the term is adaptable to different values, sustainability can be a community-defined term, which can positively contribute to the integration of stakeholder perspectives in project success indicators [45]. By asking stakeholders about their shared values and beliefs, a company gains valuable insight into what it can do to ensure that the community’s perception of sustainability is upheld throughout the life of the project [33].

Lastly, *cumulative effects* refers to the “changes to the biophysical, social, economic and cultural environments caused by the combination of past, present and reasonably foreseeable future actions” [46] (p. 1). Cumulative effects are successive, incremental, and can be both positive and negative; thus, each additional project can potentially impact prospective projects [47]. As such, cumulative effects management necessitates cross-company collaborative approaches in order to efficiently “produce better sustainable development outcomes” [47] (p. 7). This approach requires industry players to work outside of specific company mandates.

Despite growing agreement that SLO matters, different organizations are likely to respond with very different environmental, social and governance practices [15,48]. These heterogeneous practices compound the challenge of creating a common definition of what constitutes SLO. Nonetheless, many actors within the resource sector have embraced SLO in an attempt to secure stakeholder engagement and improve project feasibility [49]. In the United States, some investors in unconventional resource development projects have requested thorough reporting on environmental and community concerns, consistent with SLO concerns [36,50]. For example, in 2012, shareholders requested that ExxonMobil and Chevron disclose short- and long-term environmental and community impacts, suggesting that maintenance of SLO requires full disclosure regarding risk, challenges, and best management practices over a project’s lifecycle [51].

2.3. Obtaining SLO

As an early proponent of SLO, the mining industry pioneered the process of obtaining social license. Thomson and Boutilier [17] conceptualized the process as a “pyramid” with three distinct boundaries: legitimacy, credibility, and trust (Figure 2). First, legitimacy is vital for a company to convey alignment with community values [16]. During this stage, communities are said to consider the manner in which relationships are constructed, questioning whether there is perceived respect from project and/or company authorities. Then, once a project is seen as legitimate, it moves to the credibility stage. Transparency is critical during this stage, which is based on open dialogue between community members and industry representatives. Over the course of this process, community members are said to discern whether or not a company will deliver on the initial promises and commitments it made. Project approval is determined based on successful “credibility litmus tests” [17]. Reaching the identification stage entails much more than fulfilling commitments and keeping promises; instead, the focus returns once again to building relationships. Integrating the community as a partner in the project is fundamental to moving across the full trust boundary into the co-ownership stage [17]. When identification exists, a community assumes responsibility for a project and its members begin to advocate the project to other interest groups as though it were their own.

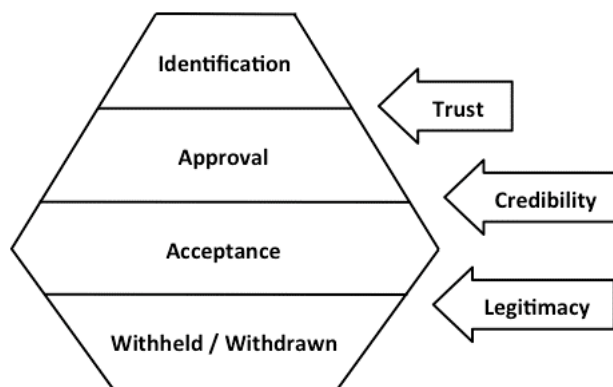


Figure 2. Pyramid model of social license to operate (adapted from [17]).

As it became more widespread in the mining industry, obtaining SLO came to be regarded by industry members as a way to move new projects forward [34]. While a wave of industry-focused literature has been published regarding SLO processes and development, academic literature remains limited on this subject [52]. For instance, in a recent review, Raufflet et al. concluded, “most definitions have been generated by practitioners and policymakers”, whereas “definitional and theoretical developments from academic researchers remain scarce” [14] (p. 2224).

More recently, Moffat and Zhang [49] proposed and tested a model of some key components of social license—namely, impacts on social infrastructure, intergroup relations, and perceived procedural fairness within mining operations. By focusing on social psychological trust behaviors, the authors suggested that the perceived potential impact of a project is the factor that least affects a community’s trust in a company; rather, genuine procedural fairness and high quality community interactions are most important for facilitating more effective and positive projects.

In Canada, recognition and use of the term SLO became commonplace within the resource extraction industry, as exemplified by the Canadian Association of Petroleum Producers (CAPP) President Dave Collyer’s focus on industry-directed communication around social license at the Synergy Alberta Conference in 2011 and the Developing Unconventional Gas Canada Conference in 2012 [53,54]. Industrial leaders in Canada also tend to publicly discuss social license. For example, in an article in the March 2012 issue of *Alberta Oil* magazine, Imperial Oil Ltd. (Calgary, AB, Canada). CEO Bruce March proclaimed that SLO will be required in order to provide energy for the world’s needs. In contrast, industry members in the United States have not embraced the term social license, instead employing concepts such as sustainability, or corporate social responsibility.

3. Materials and Methods

3.1. Research Context

Unconventional shale gas development has emerged rapidly over the past several decades, notably following the application of so-called slickwater fracking to the Barnett play in the Dallas, Texas (TX) area, beginning in 1997 [55–57]. In addition to the Barnett, we analyze stakeholder concerns associated with three other shale gas plays: the Marcellus, located principally in Pennsylvania (PA), West Virginia (WV), and New York (NY); the Montney, spanning Alberta (AB) and British Columbia (BC); and the Duvernay, in Alberta (Figure 3).

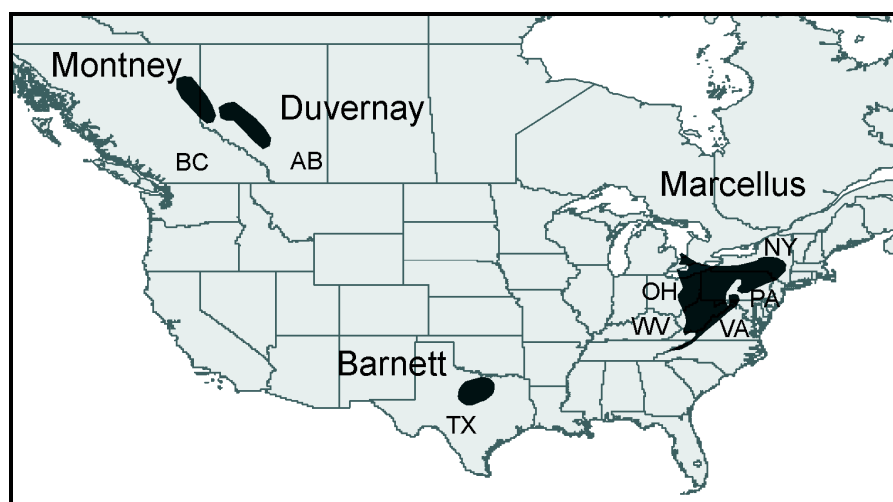


Figure 3. Locations of the Barnett, Duvernay, Marcellus and Montney shale plays.

We selected these four shale plays because they have important similarities and differences. All four plays were actually or potentially economically significant to the jurisdictions where they are located. At the same time, the four plays differ from one another in the extent of commercialization, typical operating practices, and regulatory approaches. Table 2 summarizes various aspects of the four shale plays along several dimensions.

Table 2. Comparison of the four shale plays.

	Barnett	Duvernay	Marcellus	Montney
Areal extent of shale	13,000 km ²	7500 km ² (wet gas window)	167,300 km ²	130,000 km ²
Original volume of gas in place (Tcf)	225–750	443	1500	178 (AB) 271 (BC)
Approximate wastewater volumes	10,600 m ³ /well	50,000 m ³ /well	11,500–26,500 m ³ /well	10,000–25,000 m ³ /well
Regulators involved	TX Railroad Commission; TX Commission on Environmental Quality	AB Energy Regulator	PA Department of Environmental Protection; OH Department of Natural Resources; NY Department of Environmental Conservation; WV Department of Environmental Protection	AB Energy Regulator; BC Oil and Gas Commission

Source: Adapted from [13].

3.2. Data Analysis

As fracking has become more common, media coverage has grown rapidly. For instance, the terms *hydraulic* fractur** OR *fracking* OR *fraccing* were mentioned a total of only 702 times during the 8-year period from 2000–2007 (* denotes a wildcard search character). By comparison, these terms were mentioned 111,894 times during the 2008–2014 period, increasing from 325 mentions in 2008 to 37,752 mentions in 2014. Although talk of fracking grew rapidly, what exactly was the discussion about? And how, if at all, did this vary across place and time?

To answer these questions, we relied on vocabulary analysis [18,19], a technique in which the occurrence of different vocabularies is used to trace changes in salience and meaning, whether across geographies, industries, time, or some combination of these. After experimenting with different search queries to eliminate false positives and unrelated results, we considered a newspaper article to be hydraulic fracturing related if it included any of the following keywords: *hydraulic fracturing*, *fracking*,

hydrofracking, shale gas, or unconventional gas (cf. [58]). Collectively, we refer to these five keywords as *hydraulic fracturing terms*. As described below, we developed three further vocabularies, and then traced the co-occurrence of hydraulic fracturing terms and these vocabularies in newspaper articles within jurisdictions overlaying the four shale plays.

First, we investigated the extent to which SLO and related accountability concepts co-occurred with the hydraulic fracturing terms. Specifically, we performed 35 separate keyword searches by pairing each of the five hydraulic fracturing terms with each of the seven accountability concepts identified through our SLO literature review (i.e., *social license [licence] to operate, sustainability, corporate responsibility, corporate social responsibility, sustainable development, cumulative effects, stakeholder management*). In other words, only newspaper articles containing terms from both vocabularies were included in our analysis.

Second, we investigated the extent to which specific “matters of concern” [59] co-occurred with hydraulic fracturing terms. To develop this vocabulary, we conducted a review of published literature and reports, consulted with colleagues who research various hydraulic fracturing related issues, and searched Google using phrases such as “concerns about hydraulic fracturing”. The resulting vocabulary included: health, contamination, chemicals, waste, produced water, flowback water, wastewater, moratoria, and bans. In total, we performed 45 separate keyword searches by pairing each of the five hydraulic fracturing terms with each of the nine potential matters of concern. In the results below, we further grouped these into three sub-categories: general concerns (i.e., *health, contaminate* and related terms, *chemical, waste*), wastewater concerns (i.e., *wastewater, flowback water, produced water*), and political concerns (i.e., *moratorium, ban*).

Third, we investigated the extent to which more technical wastewater related concerns co-occurred with hydraulic fracturing terms. We developed this vocabulary based on a review of published literature and reports, and in consultation with other scholars, industry executives, and oil and gas regulators. For instance, in interviews by the Pacific Institute, stakeholders suggested that two of the dominant water-related concerns associated with hydraulic fracturing in the United States include wastewater management and groundwater contamination [60]. Through this process, we identified 10 potential keywords. However, several of these keywords, including *pit, pond, spreading, and landfill*, proved unusable because they sometimes generated false positives, making interpretation unreliable. Accordingly, we limited the search to the following six terms: *injection well(s), impoundment(s), treatment, reuse, discharge, and illegal dumping*. As with the other vocabularies, we performed 30 separate keyword searches by pairing each of the five hydraulic fracturing terms with each of the six specific wastewater concerns, in all cases including the term *water* as a further qualifier.

In the results section below, we report on co-occurrences of these vocabularies between 1 January 2008 (the first year in which hydraulic fracturing began to appear as a regular topic in newspapers and other popular accounts) and 30 June 2014 (the end of our study window). Taken together, this approach provides insight into the extent to which different stakeholder concerns were implicated in discourse related to fracking across place and time.

3.3. Data Sources

The data for our analysis originate in newspaper articles published in the jurisdictions where the Barnett, Duvernay, Marcellus, and Montney shales are located. In Canada, we searched newspapers published in AB and BC to identify stakeholder concerns potentially related to the Montney and Duvernay shale plays. We selected newspapers based on three criteria: daily publication, estimated circulation distribution of 5000 copies or more; and availability via the Canadian Newsstand Complete database. Canadian newspapers meeting these criteria were: the *Calgary Herald* and *Edmonton Journal* in AB; and the *Daily Townsman* (Cranbrook), *Dawson Creek Daily News*, *Alaska Highway News* (Fort St. John), *Kamloops Daily News*, *The Daily Bulletin* (Kimberley), *Nanaimo Daily News*, *Alberni Valley Times* (Port Alberni), *Prince George Citizen*, *Trail Times*, *The Province* (Vancouver), *The Vancouver Sun*, and *Times Colonist* (Victoria) in BC.

In the United States, we used newspapers published PA, NY, and WV to identify stakeholder concerns related to the Marcellus shale play, and newspapers published in TX to identify concerns related to the Barnett shale play. Since populations in U.S. jurisdictions are substantially higher, we opted to sample daily newspapers published in counties overlaying the relevant shale play and available via the LexisNexis database. The American newspapers meeting these criteria included: the *Buffalo News* in NY; the *Charleston Gazette* in WV; the *Pittsburgh Post-Gazette*, *Pittsburgh Tribune Review*, *Intelligencer Journal/Lancaster New Era*, *Altoona Mirror*, and *Beaver County Times* in PA; and the *Fort-Worth Star Telegram*, *Weatherford Democrat* (Parker County, TX, USA) and the *Cleburne Times-Review* (Johnson County, TX, USA). Based on reviewer feedback, we further expanded our coverage in TX to include the *Denton Chronicle-Record* and the *Dallas Morning News*. As neither newspaper was available through LexisNexis, these data were manually collected.

4. Results

4.1. Media Coverage of SLO and Accountability Concepts

We begin by discussing the extent to which terms from our accountability vocabulary co-occurred with hydraulic fracturing terms in newspaper coverage. Overall, the co-occurrence of these was higher in AB and BC (a combined 236 out of 280 articles) than in NY, PA, TX, or WV (a combined 44 out of 280 articles). Figure 4 depicts this overall trend visually, showing that accountability co-occurred with hydraulic fracturing terms most frequently in BC.

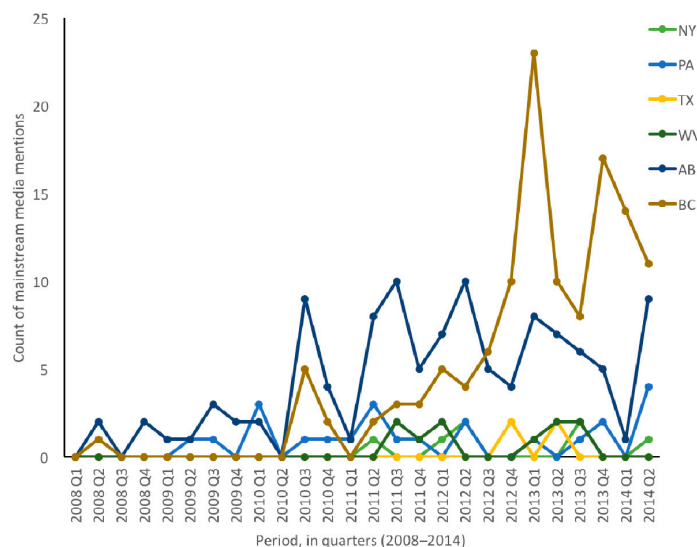


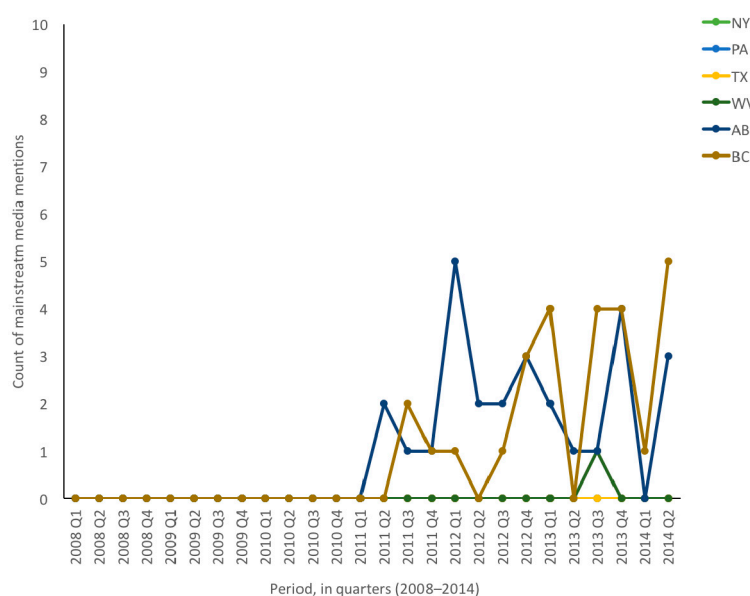
Figure 4. Newspaper coverage of accountability concepts and hydraulic fracturing.

In Table 3, we provide a tabular summary of these data. The data reveal that BC newspapers accounted for 124 (44%) of total accountability related articles. In the remainder of this sub-section we discuss and depict spatial and temporal differences in the use of specific accountability concepts.

With regard to SLO specifically, as shown in Figure 5, newspaper coverage was relatively scant across the jurisdictions overlaying all four shale plays, with greater coverage in the Canadian provinces (AB and BC) than in the American states (NY, PA, TX and WV). In fact, whereas Canadian newspapers accounted for 53 out of 54 co-occurrences, the American newspapers included in this study failed to mention SLO almost entirely, with a WV newspaper accounting for the only mention. Moreover, this latter case was the result of a direct quote from an industry executive, suggesting it was a concern for his company, but not necessarily a stakeholder concern. By comparison, a number of Canadian newspaper articles specifically described activities related to securing SLO among concerned stakeholders within the context of hydraulic fracturing.

Table 3. Media coverage of accountability and hydraulic fracturing, by quarter and jurisdiction.

Year	Quarter	NY	PA	TX	WV	AB	BC
2008	Q1	0	0	0	0	0	0
	Q2	0	0	0	0	2	1
	Q3	0	0	0	0	0	0
	Q4	0	0	0	0	2	0
2009	Q1	0	0	0	0	1	0
	Q2	0	1	0	0	1	0
	Q3	0	1	0	0	3	0
	Q4	0	0	0	0	2	0
2010	Q1	0	3	0	0	2	0
	Q2	0	0	0	0	0	0
	Q3	0	1	0	0	9	5
	Q4	0	1	0	0	4	2
2011	Q1	0	1	0	0	1	0
	Q2	1	3	0	0	8	2
	Q3	0	1	2	0	10	3
	Q4	0	1	1	0	5	3
2012	Q1	1	0	2	0	7	5
	Q2	2	2	1	0	10	4
	Q3	0	0	0	0	5	6
	Q4	0	0	0	2	4	10
2013	Q1	0	1	1	0	8	23
	Q2	0	0	2	2	7	10
	Q3	2	1	2	0	6	8
	Q4	0	2	0	0	5	17
2014	Q1	0	0	0	0	1	14
	Q2	1	4	0	0	9	11

**Figure 5.** Media coverage of SLO and hydraulic fracturing.

Of the five other accountability concepts studied, *sustainability* was the most commonly co-occurring vocabulary term. As shown in Figure 6, sustainability was most frequently mentioned in BC based newspapers (66 of 133 total mentions), followed by AB based newspapers (40 of

133 mentions). By comparison, sustainability was mentioned infrequently by American newspapers (PA = 13 mentions; NY = 6 mentions; WV = 6 mentions; TX = 2 mentions). Although the results are not quite as lopsided as with SLO, there is still a clear pattern: sustainability and hydraulic fracturing terms co-occur in newspapers far more often in Canada than in the United States.

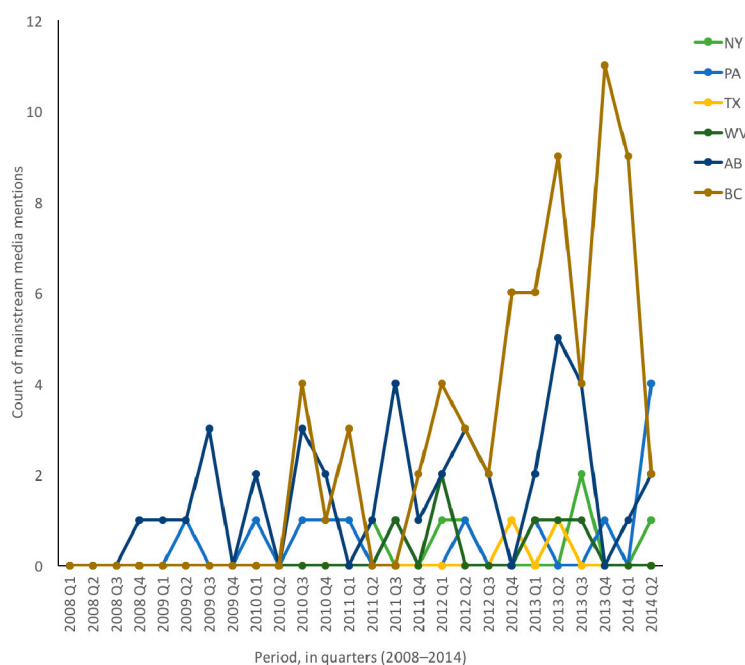


Figure 6. Media coverage of sustainability and hydraulic fracturing.

Mirroring the results for sustainability, the keywords *corporate social responsibility* or *corporate responsibility* co-occurred in conjunction with hydraulic fracturing terms more frequently in BC (25 of 52 articles for CR; 0 of 6 articles for CSR) and AB (25 of 52 articles for CR; 3 of 6 articles for CSR) newspaper articles. Within the Marcellus shale play, there was a total of only five mentions of either term in conjunction with hydraulic fracturing terms: two CSR and two CR articles in PA, and one CR article in WV. *Cumulative effects* co-occurred with hydraulic fracturing terms in a total of 25 newspaper articles across the six jurisdictions we studied: nine articles each in AB and BC, along with four articles in PA and three articles in NY. Finally, the term *stakeholder management* was not mentioned in connection with hydraulic fracturing terms in any of the jurisdictions studied.

4.2. Media Coverage of Matters of Concern to Stakeholders

Next, we discuss the extent to which various matters of concern co-occurred in newspaper coverage of hydraulic fracturing terms. Table 4 provides a tabular summary of these data, grouped by keyword sub-category. We discuss the results for each sub-category below.

Table 4. Media coverage of hydraulic fracturing-related concerns, by jurisdiction.

Jurisdiction	General Concerns	Wastewater Concerns	Political Concerns	Total
AB	858	29	177	1064
BC	892	56	177	1125
NY	718	62	234	1014
PA	2430	412	589	3431
TX	471	44	117	632
WV	538	58	128	724
Total	5907	659	1422	7988

Looking collectively across the three categories of stakeholder concerns, it is clear that such concerns co-occurred with hydraulic fracturing terms much more frequently in PA newspapers as compared with newspapers in other jurisdictions we studied. As shown in Figure 7, PA newspaper coverage peaked in mid-2011, though was surging again as of mid-2014, the end of our study window. The only other notable spikes were in BC in early 2013, and to a lesser extent in AB, in early 2012.

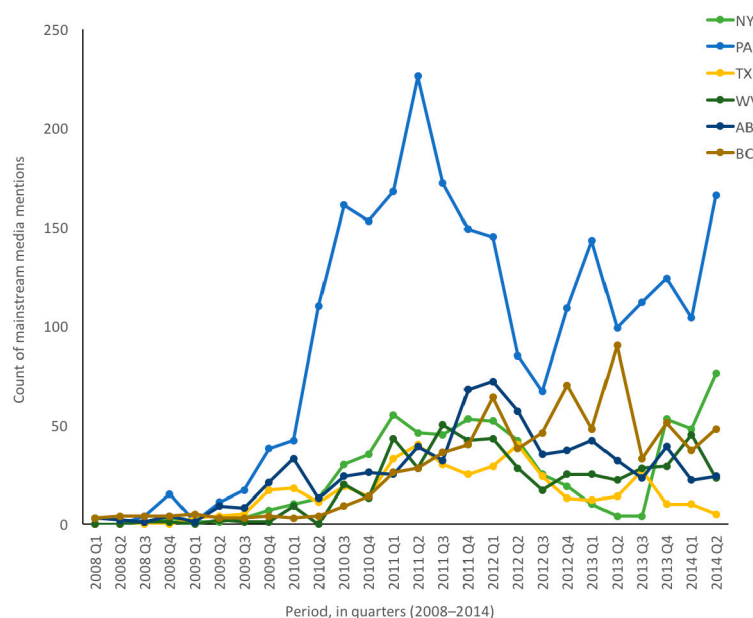


Figure 7. Media coverage of matters of concern and hydraulic fracturing.

We used four keywords to evaluate media coverage of what we termed general concerns: *health*, *contaminate*, *chemical*, and *waste*. Figure 8 depicts the co-occurrence of health and hydraulic fracturing terms in newspapers during the study period. Newspaper coverage in PA again dominated, especially peaking during 2010–2011, whereas coverage in BC peaked in late 2012 and into 2013.

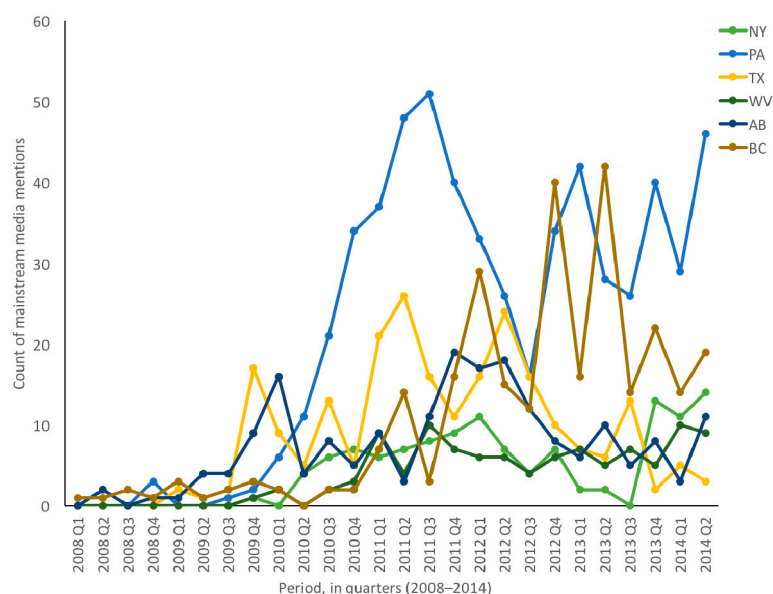


Figure 8. Media coverage of health and hydraulic fracturing.

We used three keywords to evaluate newspaper coverage of what we termed wastewater concerns: *wastewater*, *flowback water*, and *produced water*. As shown in Figure 9, newspaper coverage of wastewater and hydraulic fracturing terms was most prevalent in PA, accounting for 362 of 589 articles in our study. By comparison, none of the other jurisdictions published more than a few dozen articles in which mentions of wastewater concerns co-occurred with hydraulic fracturing terms: 61 in NY; 53 in WV; 49 in BC; 37 in TX; and 27 in AB. PA newspapers also provided greater coverage of flowback water (33 of 39 articles) and produced water (17 of 31 articles) in connection with hydraulic fracturing terms than any of the other jurisdictions.

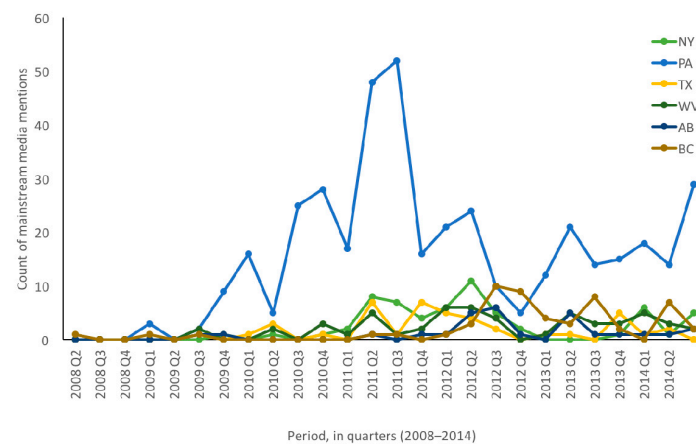


Figure 9. Media coverage of wastewater and hydraulic fracturing.

We used two keywords to investigate media coverage of what we termed political concerns: *moratorium* and *ban*. We found a total of 636 articles in which moratorium and hydraulic fracturing terms co-occurred, and a total of 582 articles in which ban and hydraulic fracturing terms co-occurred. Newspapers in PA accounted for a plurality of coverage in both cases (199 co-occurrences of moratorium; 215 of ban). Moratorium co-occurred somewhat frequently in BC (135 times), AB (111 times) and NY (92 times), and less frequently in TX (62 times) and WV (37 times). Ban also co-occurred somewhat frequently in NY (121 times) and AB (100 times), and less frequently in WV (55 times), TX (46 times) and BC (46 times). Figure 10 depicts the pattern of co-occurrences for moratorium and hydraulic fracturing terms during the period of our study.

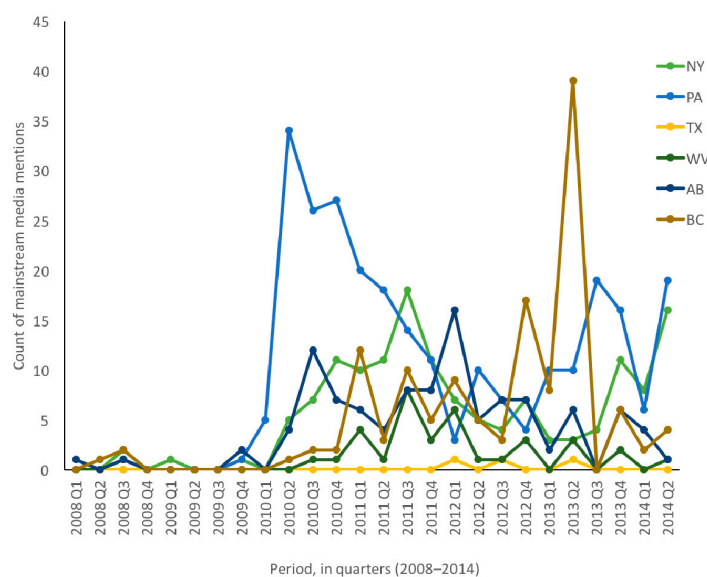


Figure 10. Media coverage of moratorium and hydraulic fracturing.

4.3. Media Coverage of Specific Wastewater Concerns

Our final set of analyses evaluated newspaper coverage of more technical wastewater-related concerns using the following vocabulary: *injection well(s)*, *impoundment(s)*, *treatment*, *reuse*, *discharge*, and *illegal dumping*. Overall, these terms co-occurred with hydraulic fracturing terms and water most often in PA newspapers (534 of 858 combined articles on these topics). Table 5 provides a complete summary of these results.

Table 5. Media coverage of specific wastewater-related concerns, by jurisdiction.

Jurisdiction	Injection Well	Impound-Ment	Treatment	Reuse	Discharge	Illegal Dumping	Total
AB	10	2	32	14	3	0	61
BC	3	1	33	18	17	0	72
NY	2	2	54	6	16	0	151
PA	26	74	274	49	106	5	619
TX	3	0	20	3	1	3	18
WV	14	3	32	5	12	3	66
Total	68	82	447	95	155	11	858

Figure 11 depicts newspaper coverage of treatment in the context of hydraulic fracturing. This group of articles accounted for 447 of the 858 articles. As with the overall results, PA newspapers led the way, accounting for 274 articles (61.3%), followed by NY (54 articles), AB (34 articles), BC (33 articles), WV (32 articles) and TX (20 articles). By comparison, coverage of the other five technical wastewater-related concerns was more scant. Discharge co-occurred in 155 articles (68.4% in PA). Reuse co-occurred in 95 articles (51.6% in PA). Impoundment co-occurred in 82 articles (90.2% in PA). Injection well co-occurred in 68 articles (38.2% in PA). Illegal dumping co-occurred in just 11 articles (45.5% in PA).

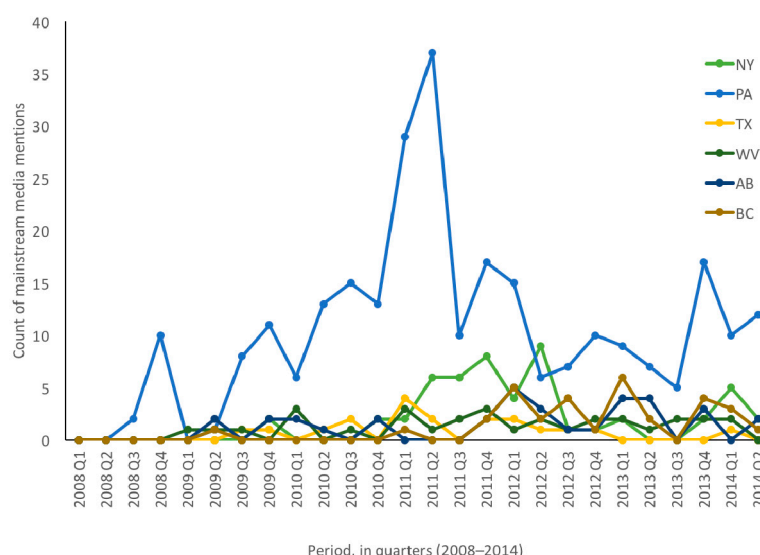


Figure 11. Media coverage of treatment and hydraulic fracturing.

5. Discussion

5.1. Synthesis of Results

We began our analysis by reviewing prior literature on SLO and related accountability concepts. Then, we tabulated the extent to which hydraulic fracturing terms co-occurred with three other vocabularies in newspapers located in six different jurisdictions. Overall, SLO was mentioned very infrequently (see Section 4.1). Thus, despite tremendous discussion of SLO more generally, newspaper

coverage of this concept in connection with hydraulic fracturing was minimal during the study period. Of the other five accountability concepts studied, sustainability was the most frequently mentioned concept, followed by corporate social responsibility. Cumulative effects and stakeholder management received scant newspaper coverage. In all cases, words from the accountability vocabulary appeared more frequently in Canadian than American newspapers, suggesting a clear difference in the tenor of press coverage across the two nations.

We then investigated differences in newspaper coverage of stakeholder concerns in the context of hydraulic fracturing, delineating between what we termed general concerns, political concerns and wastewater concerns (see Section 4.2). Overall, newspaper coverage of stakeholder concerns was highest in the Marcellus shale play, lowest in the Barnett shale play, and moderate in the Montney and Duvernay shale plays. General concerns (measured by the keywords *health*, *contaminate*, *chemical*, and *waste*) received the most newspaper coverage across the jurisdictions we studied (5907 mentions). Next in frequency were what we termed political concerns (keywords: *moratorium*, *ban*; 1442 mentions), and finally, what we termed wastewater concerns (keywords: *wastewater*, *flowback water*, *produced water*; 659 mentions). Looking across all three categories of stakeholder concerns, newspaper coverage in PA (3431 mentions) was more than triple that of BC (1125 mentions), AB (1064 mentions), and NY (1014 mentions). Newspaper coverage of matters of concern in the other jurisdictions was even lower: 722 in WV and 632 in TX.

Finally, we analyzed newspaper coverage of more technical wastewater-related concerns (see Section 4.3). Of these keywords, treatment (447 articles) received the most newspaper coverage, followed by more moderate levels of coverage related to discharge (155 articles), reuse (95 articles), impoundments (82 articles), injection wells (68 articles), and relatively little newspaper coverage of illegal dumping (11 articles). Of the jurisdictions studied, PA accounted for the majority of newspaper coverage for five of the six vocabulary terms studied, and the plurality of articles with the sixth term.

Taken as a whole, it is worth revisiting the results in light of our conceptual framework (Figure 1) relating stakeholder concerns to operator practices and regulator policies. The divergences across jurisdictions and time suggest several potential interpretations. One possibility is that different vocabulary frequencies reflect differences in the salience of these vocabularies across jurisdictions and time. Simply stated, newspaper coverage reflects underlying differences in stakeholder concerns. For instance, newspapers in PA dominated coverage of impoundments (see Section 4.3), a practice that is permitted by the state's regulator and accordingly one that is commonly utilized by operators in the state [61]. However, given that Marcellus wells are sited within rural but still relatively populated areas, this practice is quite visible to the public. It seems plausible that newspaper coverage is directly influenced by this combination of factors. A second possibility is that the co-occurrence of these vocabularies varies because the meanings, and hence the meaningfulness, of these vocabularies varies across jurisdictions and time (cf. [62]). For instance, SLO appeared a total of 54 times in our results, with 53 of these co-occurrences in AB and BC (see Section 4.1). This interpretation also seems plausible, namely SLO had considerable cultural relevance in the Canadian context, but virtually no meaning in the American context.

In order to compare newspaper coverage across these different analyses, we calculated a simple ratio by dividing the number of articles that discussed stakeholder concerns by the number of articles that discussed accountability concepts. Since more than one stakeholder concern or accountability concept may have been identified in a single article, we re-calculated both measures on a per article basis. Accordingly, the totals in Table 6 may vary from those reported earlier. The results provide an indicator of the overall tenor of hydraulic fracturing-related newspaper coverage in each jurisdiction. Despite its simplicity, the index appears to have some face validity. For instance, after a seven-year moratorium on unconventional shale development, in December 2014, the New York State legislature formally banned all hydraulic fracturing. The high concern to accountability ratio may reflect processes that resulted in this outcome.

Table 6. Concerns versus accountability index, by jurisdiction.

Jurisdiction	Total Concern Mentions	Total Accountability Mentions	Concern to Accountability Ratio
AB	692	126	5
BC	715	112	6
NY	672	7	96
PA	2822	30	108
TX	414	4	105
WV	496	10	50

At the same time, both PA and TX also have high concern to accountability ratios. Although both states have witnessed rapid and extensive shale development, the surface-level similarity in their ratios belies very different patterns of newspaper coverage. Namely, the amount of newspaper coverage in PA was six times higher than in TX. In the case of TX, although the Barnett was an important development, it was against a backdrop of hundreds of thousands of existing wells. In the case of PA, the Marcellus was a much more visible departure from its recent development history. Perhaps reflecting both the high concern to accountability ratio in PA and the overall high volume of coverage, it is worth noting that numerous contentious regulatory changes were implemented during the study period, including the state's first ever severance tax (called an "impact fee") on oil and gas wells [63]. In terms of our conceptual framework, it could be that the preponderance of stakeholder concerns and the relative dearth of accountability discourse precipitated intervention by the state's regulator. Here we are reminded of Freeman's [64] observation: "Think about a business that's not a good citizen in the community... That doesn't pay attention to the quality of life in the community, doesn't pay attention to issues of corporate responsibility, of sustainability, of its effects on civil society. That's a business that's soon to be regulated into decline". Although PA operators appear far from being regulated into decline, the state's regulator is slowly catching up with its counterparts in other oil and gas jurisdictions.

Finally, the two Canadian provinces are remarkable for their similar but much lower concern to accountability ratios. In comparison with NY, for instance, we see that concerns received similar levels of newspaper coverage in all three jurisdictions. What varied was the concomitant newspaper coverage of accountability related concepts. In fact, the difference with regard to accountability mentions in Canadian newspapers as compared with American newspapers is striking.

5.2. Implications for Industry Operators and Regulators

The findings of this study have several implications for those involved in hydraulic fracturing activities. First, the analysis revealed clear spatial and temporal differences in the types and quantities of newspaper coverage devoted to concerns regarding hydraulic fracturing activities in general and wastewater practices in particular. The data show that concerns in PA are extremely high compared to all other jurisdictions. Apparently, operators in PA would benefit from being sensitive to these dynamics as they strive to obtain and maintain SLO. More generally, we believe the kind of analysis undertaken in this article can serve as an important input to operators as they seek to create a more meaningful dialogue with members of the communities where they operate.

Second, our results indicate there was greater balance between stakeholder concerns and accountability concepts in media discussions in Canada than in the United States. Given the descriptive nature of our research design, we are not in a position to provide a causal explanation for these differences. However, several factors may be worth further consideration. For instance, differences in media coverage by jurisdiction may reflect differences in the relevant regulatory regimes (e.g., the Pennsylvania Department of Environment Protection versus the Alberta Energy Regulator). They could also be driven by the contexts in which wells are sited. Whereas PA is relatively densely populated, many wells in Western Canada are located in more sparsely populated areas. Another possibility is that whereas hydraulic fracturing has emerged as a highly salient issue in PA, it could

be that tar sands development, national pipelines and liquefied natural gas (LNG) terminals are more salient concerns in AB and BC, perhaps deflecting stakeholder attention away from hydraulic fracturing concerns.

Third, implicit in the conceptual model introduced earlier (see Figure 1) is the possibility that stakeholder concerns are amplified or attenuated endogenously as a function of operator practices and regulator policies. For instance, at the outset of Marcellus shale development in Pennsylvania, operators commonly disposed of fracking flowback at publicly owned treatment works, a practice allowed by the state's regulator. As awareness of this practice and the harm it was doing to Pennsylvania's watersheds became publicized by news media, however, the regulator intervened, initially by recommending that operators voluntarily seek alternatives. When it became clear this voluntary measure was insufficient to stem the problem, the regulator mandated alternative disposal practices. Viewed in terms of our conceptual model, this example illustrates how stakeholder concerns are themselves constituted by the practices and policies in place; counterfactually, it is possible that this particular stakeholder concern might have been avoided given different operator practices or regulator policies. More generally, operators interested in building and maintaining SLO would appear to benefit from adopting strategies that are responsive to the most salient local concerns. Although operators have made some efforts to share best practices related to technical issues (e.g., [65]), to the extent the industry shares a single "reputation commons" [66,67] it may be valuable for operators to collaborate on best practices related to the management of stakeholder concerns within the specific plays where they operate, which to our knowledge is a novel recommendation.

5.3. Opportunities for Future Research

In this article, we relied exclusively on newspaper articles. Although such sources have long been used by scholars as the de facto record of historical events [68,69], increasingly, scholars have suggested the need to analyze whether alternative media in general and social media in particular might yield different insights (e.g., [58,70]). For instance, concerns about hydraulic fracturing have been expressed in reports from a variety of nongovernmental organizations; in tweets and on blogs and Facebook pages, and even in films, such as *Gasland* and *Promised Land*.

We also focused specifically on stakeholder concerns involving both hydraulic fracturing in general, and wastewater handling, treatment and disposal practices in particular. However, these issues are just a subset of fracking related concerns. Examples of other concerns that have received media attention include: (a) induced seismicity from wastewater disposal [71]; (b) aquifer contamination from untreated wastewater injected into disposal wells [72]; (c) leaking impoundments [73]; (d) improperly treated wastewater reintroduced into the ecosystem [74]; (e) municipal water treatment plants that are unprepared to effectively treat the wastewater from industrial operations [75]; (f) the presence of naturally occurring radioactive material in wastewater [76]; (g) the presence of salt and brine in produced water [77]; (h) surface spreading of untreated wastewater [75]; and (i) illegal dumping of untreated wastewater [78]. Of course, the trajectories these concerns may take remains to be seen; some may become irrelevant and fade away, while others could become salient and scale up. Regardless, future research can extend our understanding of SLO by examining whether the spatial and temporal differences we observed follow similar patterns across this wider array of concerns, or whether these concerns give rise to different dynamics.

In addition to our use of traditional media, our analyses are strictly tabular and comparative. We documented the types and quantities of newspaper coverage devoted to stakeholder concerns related to hydraulic fracturing activities in general and wastewater practices in particular. These analyses reveal considerable spatial and temporal differences in the stakeholder concerns reported in the jurisdictions associated with the Barnett, Duvernay, Marcellus and Montney shale plays. Although our research represents an important first step, in the future researchers can extend our understanding of the relationship between media coverage of stakeholder concerns and SLO by

engaging in more sophisticated analyses. Examples include traditional content analysis [79], natural language processing [80], and other emerging “big data” techniques (e.g., [81]).

Our review of the SLO concept reminds us of the importance of what scholars have termed *organizational legitimacy*. Indeed, all organizations—whether business, government, nonprofit, or even religious—depend on social acceptance for their survival and success [82–84]. SLO is merely the latest articulation of this fundamental principle. What remains to be better understood is how organizational legitimacy both affects and is affected by the triad of operator practices, regulator policies and stakeholder concerns (refer back to Figure 1). In other words, a key gap to be addressed in future research is to go beyond the observation that “legitimacy matters”. For instance, there is an opportunity for researchers to investigate why organizational legitimacy seems to be challenged more in some times and places than in others, or why some operators and some regulators receive more scrutiny than others. It may also be worthwhile to connect with research on “discursive regulation” [85], which has shown, for instance, how forestry and mining companies strategically deploy sustainability narratives as a way of regulating their own contradictions.

In addition to explicitly focusing on organizational legitimacy, in the future researchers may consider issues such as trust in organizations [86–88], cultural theories of risk [89,90], and organizational values practices [91–93], all of which have been suggested as playing a role in SLO. For instance, when it comes to trust, it may be important to investigate the relative role of procedural versus distributive justice [94]. Similarly, the findings suggest that conventional understandings of risk management may not be adequate for dealing with unconventional resource challenges such as hydraulic fracturing [23,95]. Organizational values have long been considered essential to organizational legitimacy [96,97], suggesting another fruitful path for consideration. Finally, the results of this study reinforce the need for answers to questions such as these to be contextualized—technologically, relationally, and temporally [43,98]. For instance, even though we reviewed only four plays, we found marked differences across plays, countries and times. One way of bringing context into the analysis is to embrace a community perspective [99].

6. Conclusions

In this article, we reviewed and synthesized prior literature regarding social license to operate (SLO) and related accountability concepts. Informed by this review, we analyzed newspaper coverage of stakeholder concerns related to hydraulic fracturing and wastewater practices in articles published in the North American jurisdictions where the Barnett, Duvernay, Marcellus and Montney shale plays are located. The analyses revealed spatial and temporal differences in both the types and quantities of concerns that received newspaper coverage during the period of our study. These differences suggest that obtaining and maintaining a social license to operate is likely not a one size fits all proposition.

All organizations depend on social acceptance for their survival and success, and SLO appears to be the latest articulation of this principle. By understanding which stakeholder concerns are most salient in particular places and times, oil and gas operators and regulators can better tailor their strategies and policies to address these concerns. Compared with traditional understandings of risk as an exclusively technical or economic problem, our study suggests that unconventional shale development confronts operators and regulators with the additional need to manage social and cultural risks. Looking ahead, we see opportunities to explore the shifting dynamics associated with stakeholder concerns, and to develop more comprehensive understandings of operator and regulator approaches to obtaining and maintaining social license to operate.

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Abbreviations

The following abbreviations are used in this manuscript:

AB	Alberta
BC	British Columbia
CR	Corporate responsibility
CSR	Corporate social responsibility
NY	New York
PA	Pennsylvania
SLO	Social license to operate
TX	Texas
WV	West Virginia

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