Corporate communication about climate science

A comparative analysis of top corporations in New Zealand, Australia, and Global Fortune 500

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Abstract

Purpose – The purpose of this paper is to comparatively analyze how top corporations in New Zealand, Australia, and the Global Fortune 500 group communicate about climate science.

Design/methodology/approach – A combination of keyword count and quantitative content analysis is used to develop a reliable set of indicators to measure corporate communication about climate science.

Findings – Just a few corporations mention or explicitly agree with scientific consensus on climate change and few report science-based targets. They report more frequently on societal risks of climate change, as well as business contribution and responsibility. New Zealand based corporations generally do poor reporting compared to Australian corporations, who do as well as the biggest corporations in the world.

Research limitations/implications – There is a further need for cross-country research and for more longitudinal analysis to understand how organizations communicate about scientific issues to its stakeholders.

Practical implications – This paper can inform communication managers about the need to pay attention to how their communication, individually and in comparison with their peers, is likely interpreted by the stakeholders. Managers may attend to scientific consensus messaging to gain stakeholder approval for ambitious business actions on climate change.

Social implications – Organizations are powerful social and economic drivers. Understanding how they interpret and communicate a scientific issue has implications for public and policy discourses and outcomes.

Originality/value – This is the first paper to comparatively identify common and contextual drivers of business communication of complex scientific issues. A reliable scale to measure climate science communication by corporations will be helpful for future researchers to replicate in other sectors.

Keywords CSR, Issues management, Organizational communication, Corporate communication, Environmental communication

Paper type Research paper

Scientists agree that humans are the primary drivers of climate change. Increasing greenhouse gas (GHG) emissions, which play a critical role in industrialization and economic development, is the primary cause of recent climatic change (IPCC, 2013). As a result, climate change has emerged as a complex and wicked issue particularly for businesses, who are major producers and consumers of energy. Just 90 large companies have caused nearly two-thirds of historic emissions since industrialization. These companies include energy-based companies, such as Chevron, ExxonMobil, BP (UK), Saudi Aramco (Saudi Arabia), BHP Billiton (Australia) and Coal India (Goldenberg, 2013). Emissions from a few large Global 500 companies such as Rio Tinto are larger than countries such as New Zealand (Patenaude, 2011). Unless emissions remain stable or decline by 2020, meeting the recent goals of the Paris Climate Agreement will likely become unattainable (Figueres et al., 2017).

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Climate change is at the top of the corporate environmental agenda, particularly after the Paris Climate Agreement (Averchenkova et al., 2016; Bui and de Villiers, 2017; Okereke et al., 2012; Schlichting, 2013; Sullivan, 2010). Corporations primarily communicate about their commitments and action on social issues through their Corporate Social Responsibility (CSR) reports. These CSR reports not only inform stakeholders about business action, but also reveal underlying attitudes and values of the company and its managers (Carroll and Shabana, 2010; Thomson et al., 2015). Research suggests that organizational CSR communication strategies impacts stakeholder perceptions, including among socially responsible consumers (Kim, 2014; Kim and Ferguson, 2019).

Understanding corporate communication about climate science is important as organizations are powerful economic and social actors, with the ability to shape public and policy discourses. Empirical studies, for example, show that industry sponsored studies are likely to pursue research and communicate results that are favorable to the sponsored organizational business goals. Such research distorts scientific progress and government policies (see Lundh et al., 2017). Studies focusing on climate change communication find that at least some energy-based companies are likely to claim environmental stewardship, even as they continue polluting the environment, termed as greenwashing (Miller, 2016; Plec and Pettenger, 2012). Others have argued that corporate reporting lacks addressing systemic changes (Ihlen and Roper, 2014; Pal and Jenkins, 2014; Plec and Pettenger, 2012). Corporations are likely to use several devices, for example, heightening social risks, persuading the public they need collective social action and deflecting attention from business responsibility (Domenec, 2012; Jaworska, 2018). A large part of the American divide on climate change, including the loss of trust in scientists and in scientific consensus, is partly the result of the public misinformation campaign organized by the oil and gas industry (Leiserowitz et al., 2013; McCright and Dunlap, 2011; Oreskes and Conway, 2012). Moreover, while corporations seek to cultivate a positive environmental image in the stakeholder’s mind (Domenec, 2012), they are also likely to use trade associations to collectively advocate for fewer or less stringent regulatory outcomes (e.g. Gaither and Gaither, 2016), a form of “strategic schizophrenia” (Roper and Collins, 2005).

While an important issue, few studies have focused on corporate communication about science in general, fewer still on corporate communication about climate change in particular. The current study primarily applies theories of CSR strategy and its communication (Carroll and Shabana, 2010; Thomson et al., 2015), and adapts research from science communication, particularly from organizational reports (van der Linden et al., 2015; Supran and Oreskes, 2017) to identify organizational communication strategies about climate science.

This research contributes to literature on CSR organizational communication management about scientific issues in three ways. First, while a majority of previous studies focused on corporations in the USA and Europe, this research explores science communication in organizational contexts by comparatively evaluating top corporations in New Zealand and Australia, with top Fortune Global 500 corporations’ communication on climate science. In fact, corporations outside the USA and Western Europe are often omitted for analysis, even if they feature in the top global companies (e.g. Pollach, 2016). Countries such as New Zealand are important to analyze given their global image as “100 percent pure” country, which is the government’s tourism campaign to market the country as clean and green. In addition, New Zealand has the seventh highest per-capita emissions in the world, with about 20 percent increase in emissions since 1990. Australia’s emissions will increase by 9 percent above 2005 levels by 2030, instead of a national target of 15–17 percent decrease (Bourne et al., 2018).

Second, a cross-country analysis with a focus on countries in Asia-Pacific will help identify differences in organizational discourses about climate science. Previous business
studies suggest that regulatory conditions and corporate attitudes to climate changes are likely to shape business communication about climate change (Dahl and Fløttum, 2019; Jeswani et al., 2008; Schlichting, 2013; Weinhofer and Busch, 2013). Nevertheless, even studies that focus on corporations from different countries leave country-comparison for future studies (Weder et al., 2019). Other studies have focused on Australia (Galbreath et al., 2016) or New Zealand (Roper and Collins, 2005) but not comparatively as this research does.

Third, this is one of the few studies that explicitly seek to identify how climate science is communicated in corporate reports (Supran and Oreskes, 2017). While there has been a burgeoning increase in studies that identify how corporations frame risks and responsibilities – sometimes opportunities – resulting from climate change, few focused on the dimensions of science reported, including gravity of the challenge (Ihlen, 2009), reporting of scientific consensus (Supran and Oreskes, 2017) and science-based targets. Previous studies in climate change communication show that perceived scientific consensus shapes an individual’s perceptions of risks and behaviors related to climate change. There is little cross-disciplinary research integrating findings from science communication research with strategic management communication.

This paper comparatively evaluates 90 large corporations reporting of climate change, particularly the science of climate change. It uses both keyword search, as well as quantitative analysis, in line with recent studies that use mixed methodologies (Dahl and Fløttum, 2019; Hahn and Kühnen, 2013). It also tests several contextual factors that likely shape patterns of business communication about the science of climate change, including, annual revenue, number of employees, company type and participation in voluntary disclosure programs (Dawkins and Fraas, 2011; Hrasky, 2011; Weder et al., 2019).

**Literature review**

There is burgeoning research on corporate communication about environmental and social issues in the form of CSR communication. Called by multiple names of sustainability reporting (Bowers, 2010), CSR reporting (Jaworska, 2018), or CSR communication (Thomson et al., 2015), the central role of such corporate communication is to secure business and reputational risks (e.g. Carroll, 1991). While there is no universal agreement on the definition of CSR, it encompasses economic, legal, ethical and philanthropic expectations of society from a corporation, in a pyramid fashion, with economic responsibility forming the fundamental requirement for CSR (Carroll, 1991, 2016). A recent meta-analysis about the definition of the term has added stakeholders and voluntary involvement (as opposed to mandatory) to the four dimensions (see Sarkar and Searcy, 2016). Because CSR efforts can potentially influence stakeholder perceptions (Kim, 2014; Kim and Ferguson, 2019), CSR communication has emerged as a key area of study (Campbell, 2000; Dahl and Fløttum, 2019; Thomson et al., 2015).

Through CSR, corporations demonstrate their commitment to key global issues and ways they seek to achieve goals in changing conditions. Through reporting an issue as a business concern, corporations legitimize some issues over others as deserving the attention and engagement of the business community, or issue acceptance (Mahon and Waddock, 1992). Issue acceptance plays a key role in how managers engage with important societal issues. Nevertheless, these measures could be merely to manage stakeholder expectations symbolically without substantive investment by companies: “Issue acceptance cannot be interpreted as a performance improvement, but should be seen as the acknowledgement that an issue deserves importance on the corporate environmental agenda” (Pollach, 2016, p. 9). Corporations are also likely to use CSR reports to construct the problem and potential solutions to resolve the issue, or reality construction (e.g. Campbell, 2000). It is also referred to as strategic or issue management, where corporations seek to control how society and political authorities perceive an issue (e.g. Schlichting, 2013). To conclude, CSR
communication can also be a business negotiating its responsibilities with its stakeholders on important issues, through “demythologization of [...] normative positions argumentatively” (Wehmeier and Schultz, 2010, p. 23).

While there are several studies on CSR reporting, they tend to be about general trends and not issue specific. According to Weder et al. (2019), without issue-specific framing, CSR may appear insincere, merely as greenwashing. It can result in CSR being defined as a hollow notion and likely increase public skepticism of corporate motives. Instead, issue-specific frames help businesses constitute and justify allocation of resources and taking of responsibility – or reveal contradictions (Weder et al., 2019). Issue-specific CSR communication can also help understand specific-issue trends in corporate communication.

**Corporate communication of climate science**

Although important, only few studies have specifically focused on the science communication aspects of corporate communication related to climate change (Dahl and Fløttum, 2019; Domenec, 2012; Ihlen, 2009; Jaworska, 2018; Schlichting, 2013; Weder et al., 2019). Even among these, few studies have explicitly focused on identifying climate science reporting. In this paper, corporate communication of climate science is viewed through three most occurring themes in corporate reporting about climate change: problem construction (Ihlen, 2009) that includes reporting of scientific consensus, risks such as business or physical risks (Dahl and Fløttum, 2019; Jaworska, 2018) and business responsibility (Dahl and Fløttum, 2019; Schlichting, 2013).

Addressing the global climate change issue, at the very least, requires adequate problem recognition (Ihlen, 2009). Ihlen (2009) investigated the non-financial reports downloaded from the websites of the top 30 Global Fortune 500 corporations. Using keyword search and topical analysis, the study found that “global warming” is mentioned in passing, yet corporations discuss the gravity of the climate challenge. The study found a large variation in the choice of keywords used by different corporations. In a study of three energy majors, Statoil, Suncor Energy and Total, Dahl and Fløttum (2019) found energy, carbon and oil were top 3 frequently used words. In a 10-year longitudinal analysis of corporate sustainability reporting, Pollach (2016) found the keyword “climate” grew by 238 percent between 2001 and 2010. Jaworska (2018), investigating CSR and environmental reports by major oil companies, found that the most frequently adopted term is “climate change,” while the two other terms “global warming” and “greenhouse effect” are used very rarely.

Another primary finding from these studies is a shift in business discourses about climate change. In an analysis of ten global company’s sustainability efforts, Bowers (2010) found that compared to previous reports that performed compliance but indicated economic opportunities and competitive advantage, recent reports conveyed direct economic benefits that sustainable actions bring to the company. For example, the CEO of Nike, in its letter in the 2001 report states that the company is “just beginning to understand what a sustainability business means.” In the 2006 report, Nike emphasized the economic potential offered by sustainability. Similarly, Domenec (2012) evaluated annual letters of Exxon, Chevron and BP published between 2003 and 2009 and found a gradual shift from framing environment as a potential threat for company performance to stressing a responsible and proactive behavior toward environmental issues.

Schlichting (2013) identified three phases of industry actors’ framing of climate change. The first phase in early to mid-1990s, led by US organizations, used doubt and uncertainty about existence of climate change. The second phase framed climate change as a socioeconomic consequence, arguing that particularly after the Kyoto treaty, climate sanctions would harm economic progress. In contrast, the European industry pioneered the industrial leadership frame – the third phase – acknowledging corporate responsibility and business opportunities while acting on climate change.
Communicating climate risks

A key strategy used in corporate communication, particularly by major oil companies, has been to emphasize climate change as a business risk. Ihlen (2009) found that corporations highlight the gravity of the problem in their annual reports. Dahl and Fløttum (2019) found that the three European oil majors highlight risks of climate change most often, followed by business responsibility. These risks are discussed as transition related, primarily about carbon pricing policy, rather than physical risks. Jaworska (2018) found that for major oil companies, climate risks only emerged as a key theme in the 2000s. The author found that risk co-occurs with climate change as singular risk 106 times, and 35 times in plural as “risks,” indicating a corporate strategy to flag climate change as a collective threat.

A further examination found that the risks were primarily on businesses and portrayed them as victims of climate change. In addition, climate risks, which initially were framed as manageable by the industry, are increasingly framed as “unpredictable and out of control agent” (p. 213).

This portrayal of climate change risks is also prevalent in business surveys. Gasbarro et al. (2017) analyzed risk drivers among 1,896 companies on the basis of the following question as part of the Carbon Disclosure Project (CDP) database: “Have you identified any inherent climate change risks (or opportunities) that have the potential to generate a substantive change in your business operations, revenue or expenditure?” The main climate-related risks drivers identified were: change in precipitation extremes and droughts (9.6 percent); reputation (8 percent); fuel/energy taxes and regulations (6.6 percent); changing consumer behavior (6 percent); carbon taxes (5.7 percent); and cap and trade schemes (5.6 percent). Based on these studies, the current study tests different dimensions of climate change risks, differentiating between social, physical and material impacts. Business CSR communication about climate science is conceptualized as relating to problem construction, risks and business responsibility. Also included is reporting science-based target initiatives, a joint initiative by several organizations to enable companies to set targets, in alignment with the Paris Agreement, to limit temperature rise to 2°C (https://sciencebasedtargets.org).

Cross-country findings

Few cross-country studies identify differences in CSR communication about climate change in different countries. For example, Weder et al. (2019) analyzed 12 energy corporations’ CSR communication from 8 countries, but do not analyze or explain cross-country differences. After analysis of three oil giants in three European countries, Dahl and Fløttum (2019) concluded that Statoil, now called Equinor, presented climate change as an opportunity, while Suncor Energy presented climate change primarily as a business risk, probably because its main source is oil sands, and it is not aligned with Canada’s climate ambitions and commitment. Analyzing the top 20 US and the top 20 German companies, (Einwiller et al., 2016) found that while German companies emphasized environmental performance, and portrayed CSR as a management task that is integrated into corporate strategy, US companies focused more on social and community dimensions. Similarly, Schlichting (2013) found country-differences in how European corporations are more proactive in framing climate change as business responsibility and opportunity, with US and Australian corporations catching up. Previous studies have exclusively focused on Australia or New Zealand, without comparing them.

Australia and New Zealand are developed countries in the Asia-Pacific with unusually high contribution of agriculture – a climate sensitive industry – to its economy and emissions profile. About half of New Zealand’s emissions and about a fourth of Australia’s emissions are attributed to agriculture sector, compared to average of less than 10 percent in EU, USA and other developed regions. Both are Anglo-settler societies with a history of colonization, and climate science and policies in one country are likely to influence policies in the other, as
evidenced by scientific and government collaborations (see O’Gorman et al., 2016). A majority of business leaders and publics in both the countries support climate change and sustainability policies (e.g. Leining and White, 2015; The Climate Institute, 2017). Further, New Zealand and Australian corporates share unique corporate cultural traits, for example, on issues of corporate governance and ethics (Milton-Smith, 1997).

Yet, there are few significant differences. Energy production, primarily reliant on coal, accounts for the largest share of emissions in Australia, which is also one of the largest exporters of coal. In particular, regulation has taken distinct paths in the two countries. Australia has witnessed several climate change and sustainability regulations, for example, introduction of carbon pricing in 2012, which similarly saw an increase in corporate activism on the issue (see Crowley, 2017). The three companies in CDP A list from the region were based in Australia – BHP, Stockland and Telstra Corporation. While Australia has seen more regulation, it has been equally uncertain as in New Zealand. In 2014, the Australian Government repealed national carbon pricing scheme and the emissions have risen by 1 percent a year (e.g. Crowley, 2017).

While studies did not comparatively evaluate, evidence suggests that sustainability reporting in Australia is generally better compared to New Zealand, primarily due to regulatory compliance, managerial attitudes, such as engagement with scientific information (e.g. Linnenluecke et al., 2015), exposure to climate impacts (e.g. Haigh and Griffiths, 2012), public pressure (Crowley, 2017), among others. For example, while regulatory compliance is evidenced in Australia, in a separate study, Collins et al. (2007) found little external stakeholder and regulatory compliance pressure to adopt sustainable practices among New Zealand businesses. Identifying similarities and differences arising from home-country institutions and expectations (Einwiller et al., 2016) in two big economies in the Asia Pacific is likely to understand content and drivers of corporate communication about climate change.

As previous research suggests that contextual factors likely shape patterns of business communication on climate science (e.g. Bae et al., 2013; Dawkins and Fraas, 2011; Hrasky, 2011), the following contextual factors are tested: revenue, number of employees, country of origin, energy intensity, participation in voluntary disclosure, adhering to Global Reporting Initiative (GRI) standards (an international independent standards organization assisting businesses to communicate on climate change) and mentioning the UN Sustainable Goal 13 (https://sustainabledevelopment.un.org/sdg13) that specifically aims for urgent action to combat climate change and its impacts. As no previous research, at least to our knowledge, has evaluated climate science coverage in corporate communication, we propose the following research questions:

*RQ1a.* How do top New Zealand, Australian and Global 500 corporations report on climate science?

*RQ1b.* Do top Australian corporations report more compared to top New Zealand corporates on climate science?

*RQ2.* Are there any significant differences between top companies in New Zealand, Australian and Global 500 group reporting on climate science?

*RQ3.* Are there any contextual differences in corporate reporting on climate science?

**Method**

**Sample**
The current research uses quantitative content analysis to benchmark the top 30 New Zealand companies with the top 30 corporations in Australia and the top 30 Global 500 companies, for a total sample of 90 companies. Revenue was selected as the measure of
company size, as it is used by Fortune magazine to compile its Fortune 500 and Fortune Global 500 lists. We used the 2017 Global 500 list. There are several ways that corporations communicate about climate change, including financial reports (annual reports), non-financial reports (sustainability reports, CSR reports, etc.), websites and other reports submitted, for example, as part of the CDP. In this study, we focused on the communication of climate change engagement in the latest non-financial reports. This choice was informed by prior research that showed that companies preferred non-financial reports to communicate about climate change (Ihlen, 2009; Ihlen and Roper, 2014; Pal and Jenkins, 2014; Sullivan, 2010). We pilot tested the five largest New Zealand and five largest Australian corporations to identify the best-sourced document. Initial analysis revealed that of all the modes of corporate communication, non-financial reports tended to provide the most information on climate change actions and beliefs. Webpages devoted to sustainability and climate change rarely provided additional information or information not also found on the company’s non-financial reports. Some companies used the CDP to communicate engagement. While this source reliably provides more information than non-financial reports, we elected not to analyze CDP data because not all sampled companies disclosed with the CDP.

Only a minority of New Zealand firms produced non-financial reports (10 out of 30), in alignment with other studies (McGuinness and Foreman, 2018), while majorities of Australian (23 out of 30) and Global 500 (26 out of 30) did. For those companies that did not produce a non-financial report, we analyzed the latest annual financial reports. We downloaded the latest reports from the companies’ websites. Most reports were from the 2017 financial year, while a small number covered the 2016 or 2018 financial years.

Codes measuring corporate coverage of climate change science were developed based on previous studies, as well as analysis of prominent climate change science themes as listed in the Intergovernmental Panel on Climate Change (IPCC, 2013). The research that helped developed codes for each dimension is indicated in the study’s codebook (See Table I). These codes, for example, assessed report and agreement with scientific consensus (IPCC, 2013; Supran and Oreskes, 2017), gravity of challenge (Ihlen, 2009), patterns of current or future emissions, businesses’ contribution to atmospheric GHGs and climate change (Jeswani et al., 2008; Sullivan, 2010), temperature rise (IPCC, 2013), responsibility for action (Jeswani et al., 2008; Sullivan, 2010) and science-based targets. These were dichotomously measured as absence (coded 0) or presence (coded 1) of these climate science dimensions.

<table>
<thead>
<tr>
<th>Reports on the importance/gravity/challenge of climate change (Ihlen, 2009)</th>
<th>New Zealand (%)</th>
<th>Australia (%)</th>
<th>Fortune 500 (%)</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reports on the climate change scientific consensus (Supran and Oreskes, 2017)</td>
<td>17</td>
<td>53</td>
<td>43</td>
<td>9.17*</td>
</tr>
<tr>
<td>Explicitly agrees with the climate change scientific consensus</td>
<td>3</td>
<td>13</td>
<td>17</td>
<td>2.92</td>
</tr>
<tr>
<td>Reports on observed patterns of global GHG emissions</td>
<td>3</td>
<td>13</td>
<td>17</td>
<td>2.92</td>
</tr>
<tr>
<td>Reports on observed or future patterns of global temperatures</td>
<td>7</td>
<td>17</td>
<td>27**</td>
<td>4.32</td>
</tr>
<tr>
<td>Identifies any material or physical impacts</td>
<td>10</td>
<td>43</td>
<td>43</td>
<td>10.18**</td>
</tr>
<tr>
<td>Identifies any human or social impacts</td>
<td>20</td>
<td>50</td>
<td>30</td>
<td>6.30*</td>
</tr>
<tr>
<td>Identifies businesses’ contribution to atmospheric GHGs and climate change (Jeswani et al., 2008; Sullivan, 2010)</td>
<td>27</td>
<td>23</td>
<td>27</td>
<td>0.11</td>
</tr>
<tr>
<td>Identifies businesses’ responsibility to respond to climate change (Jeswani et al., 2008; Sullivan, 2010)</td>
<td>20</td>
<td>40</td>
<td>37</td>
<td>3.15</td>
</tr>
<tr>
<td>Science-based target initiative</td>
<td>7</td>
<td>20</td>
<td>17</td>
<td>2.34</td>
</tr>
</tbody>
</table>

**Notes:** $n = 90$. Italic text refers to significant differences. *compared to New Zealand only; **compared to Global 500 and New Zealand. *$p < 0.05$; **$p < 0.01$.
Frequency counts of four key terms were conducted: “climate change,” “global warming,” “carbon” and “greenhouse.” Each report was carefully read, highlighting and labeling examples of text that corresponded with a particular code or codes. Pilot coding of the five largest New Zealand, Australian and Global 500 companies (total 15) was undertaken by two researchers to test the validity and the relevance of the codes. Codes were refined and initial inter-coder reliability tests indicated moderate to high level of reliability (Cohen’s kappa (κ), ranging from 0.81 to 0.91). This high inter-coder reliability allowed one researcher to accurately code the remaining company reports.

The following company characteristics were also captured, as previous research indicated a significant difference in corporate communication on environmental and sustainability issues based on country, size of the company as identified by revenue ($M = 80,820.15$ USD, SD = 108,642.73), number of employees ($M = 199,306.51$, SD = 415,698.55), energy or carbon intensive sector (59.3 percent), part of the voluntary disclosure group (83.1 percent) and adhering to GRI standards (50 percent).

**Analysis**

Due to the dichotomous nature of the outcome variables, Kruskal–Wallis test was used to test the overall significance of differences between the three groups, followed by Mann–Whitney tests comparing each group to the others using Bonferroni correction (see Field, 2009, p. 566). To test differences between the three groups on individual climate science measures, each of the three groups of corporations were compared with the others using Pearson’s $\chi^2$ test of significance. In addition, one-way ANOVA with LSD posthoc tests were used for pairwise comparisons to test for overall differences in the three groups (Field, 2009). Finally, we created an index of the ten climate science communication items to test if the scale and individual item results match. Since binary items violate the basic assumption of a normal distribution, we used tetrachoric correlations between the ten items. These correlations were calculated by using a SPSS program, TETRA-COM (Lorenzo-Seva and Ferrando, 2012), and are presented in Table II. The results of the tetrachoric correlations were then examined by conducting exploratory factor analysis using unweighted least squares extraction method (see Lorenzo-Seva and Ferrando, 2012). One to four factor results were tested to identify dimensions of problem construction, risks and responsibility, as mentioned above. The results show that one factor solution was most optimum for the data.

| 1. Reports on the gravity of the challenge | 1 |
| 2. Reports on the climate change scientific consensus | 0.55 1.00 |
| 3. Explicitly agrees with the climate change scientific consensus | 0.55 1.00 1.00 |
| 4. Reports on observed patterns of global GHG emissions | 0.62 0.67 0.67 1.00 |
| 5. Reports on observed or future patterns of global temperatures | 0.63 0.89 0.89 0.94 1.00 |
| 6. Identifies any material or physical impacts | 0.66 0.61 0.61 0.51 0.61 1.00 |
| 7. Identifies any human or social impacts | 0.73 0.67 0.67 0.59 0.70 0.99 1.00 |
| 8. Identifies businesses contribution to atmospheric GHGs and climate change | 0.20 0.50 0.50 0.28 0.40 0.45 0.46 1.00 |
| 9. Identifies businesses responsibility to respond to climate change | 0.58 0.50 0.50 0.53 0.52 0.55 0.65 0.61 1.00 |
| 10. Integrates basic concepts of climate change science | 0.02 0.62 0.62 0.46 0.72 0.42 0.52 0.46 0.34 1.00 |

**Note:** All correlations significant at $p < 0.05$ level
with individual loadings ranging from 0.55 to 0.99. Reliability of the scale was tested using a Kuder–Richardson KR20 statistic (a version of Cronbach’s α for dichotomous items), which was 0.84, considered high. Finally, non-parametric tests such as Spearman’s rank-order correlation and Mann–Whitney tests were conducted to examine if contextual variables of revenue, number of employees, energy intensive, membership in voluntary disclosure groups and others were significantly associated with corporate reporting of climate science.

Results

Climate science keywords

The keyword “climate change” is used by 66 out of the 90 corporations. Four global companies such as Amazon, United Health Group, Ping An Insurance and Berkshire Hathaway do not mention “climate change” at all in their non-financial reports. “Global warming” received the least mention, with only 29 out of the 90 corporations mentioning it. “Greenhouse” was featured by 68 corporations, led by AGL Energy (81). “Carbon” was the most often featured keyword with 77 corporations using it. On average, “carbon” was used 24 times, “climate change” 15 times, “greenhouse” 10 times and “global warming” only once among the 90 corporations. Six New Zealand corporations (Sky Network Television Limited, Restaurant Brands, A2 Milk Company, Tower Insurance, Xero and Oceana Healthcare), and two Australian (Viva Energy and Metcash), do not mention any of the keywords. There is a wide variation in how different keywords are used by corporations (Figure 1).

For “climate change,” a Kruskal–Wallis test showed there was a significant difference between the three groups, $H(2) = 23.88, p < 0.001$. Australian corporations (Mdn = 16.50) frequently quoted “climate change” compared to New Zealand corporations (Mdn = 0.50), $U = 151.50$, $z = −4.49$, $p < 0.001$, $r = −0.58$. Similarly, Global 500 corporations (Mdn = 8.50) were more likely to report “climate change” compared to New Zealand corporations (Mdn = 0.50), $U = 201.50$, $z = −3.738$, $p < 0.001$, $r = −0.48$. There was no significant difference between Australian and Global 500 corporations ($U = 349.50, p = 0.137$).

![Figure 1. Top 5 corporates use of keywords each from Global 500, Australia and New Zealand](image)
Similarly, for “global warming,” a Kruskal–Wallis test showed there was an overall significant difference between the three groups, $H(2) = 15.05$, $p < 0.001$. In two separate Mann–Whitney tests, Australian ($Mdn = 0.001$, $U = 276$, $z = -3.39$, $r = -0.44$, $p < 0.01$) and Global 500 ($Mdn = 0.50$, $U = 278$, $z = -3.77$, $r = -0.49$, $p < 0.001$) corporations showed a higher proportion of reporting of “global warming” compared to New Zealand corporations ($Mdn = 0.0001$), while no difference was detected between Australian and Global 500 corporations ($U = 422$, $z = -0.45$, $r = -0.48$, $p = 0.651$). A similar result was found for “greenhouse.” For “carbon” ($H(2) = 9.265$, $p < 0.001$), there was a significant difference only between Global 500 ($Mdn = 20$) and New Zealand ($Mdn = 7.5$) ($U = 253$, $r = -0.38$, $p = 0.004$). A sum of all four keywords replicated the above results $H(2) = 19.35$, $p < 0.001$. In two separate tests, both Australian ($Mdn = 48$) ($U = 191$, $r = -0.44$, $p < 0.001$) and Global 500 ($Mdn = 47.5$) ($U = 195.5$, $r = -0.48$, $p < 0.001$) corporations were significantly more likely to report compared to New Zealand ($Mdn = 13$), respectively, while no difference was detected between Australian and Global 500 ($U = 440.5$, $p = 0.88$).

Corporate communication about climate science

Corporate reporting about different dimensions of climate change science was low to moderate. Only ten corporations (11 percent) reported on the scientific consensus about climate change, or reported explicit agreement with the consensus. However, the companies that did acknowledge the scientific consensus were emphatic. Other companies such as AGL and BHP Billiton referenced the IPCC and the findings of its recent assessments.

Only 13 corporations (14.4 percent) reported on the science-based target initiatives. For example, Auckland Airport stated they became the first company in Oceania to have an approved science-based target for future carbon reductions. Similarly, few corporations reported on observed or future patterns of GHG emissions (17 percent), observed or future patterns of global temperature rise (32 percent), identified any material or physical impacts (33 percent), the gravity of the climate change challenge (38 percent) and human or social impacts (40 percent). A quarter or more of corporations reported on business contributing to GHG’s and climate change (25 percent), or business responsibility to respond to climate change (32 percent).

Significant differences between corporations on business climate change communication were found in only four of the ten variables measuring science communication. There was a significant difference in reporting the importance and gravity of the climate change challenge ($\chi^2(2) = 9.17$, $p < 0.05$; $F(2, 87) = 4.94$, $p < 0.001$). Australian ($M = 0.53$, $SD = 0.50$) and Global Fortune 500 ($M = 0.43$, $SD = 0.50$) corporations were more likely to report on the gravity of the climate challenge compared to New Zealand companies ($M = 0.16$, $SD = 0.37$). There was no significant difference between Australian and Global Fortune 500.

A $\chi^2$ test was significant among corporations from New Zealand, Australia and those in Global 500 on their reporting on observed patterns or future projections of temperature rise $\chi^2(2) = 10.17$, $p < 0.01$, with about half of Australian ($M = 0.43$, $SD = 0.50$) and Global 500 ($M = 0.43$, $SD = 0.50$) reporting it, with only few New Zealand ($M = 0.10$, $SD = 0.30$) corporations reporting it. Similarly, Australian corporations (50 percent) were more likely than New Zealand businesses (20 percent) to identify material or physical impacts due to climate change ($\chi^2(2) = 6.30$, $p < 0.05$; $F(2, 87) = 3.27$, $p < 0.05$), while there was no difference between Australian corporations and Global 500, or Global 500 and New Zealand corporations.

Both Australian and Global 500 corporations were more likely to report on human and social impacts compared to New Zealand (20 percent) corporations ($\chi^2(2) = 14.44$, $p < 0.01$; $F(2, 87) = 8.316$, $p < 0.001$). In addition, while comparing Australian and Global 500, the former was more likely to report on human and social impacts ($\chi^2(1) = 6.67$, $p < 0.01$). Finally, Global 500 corporations (27 percent) were more likely to report on observed patterns of global GHG emissions compared to New Zealand corporations (7 percent) ($\chi^2(1) = 4.32$, $p < 0.05$).
For the climate science communication scale, a Kruskal–Wallis test replicated the above individual tests. There was a statistically significant difference in climate science reporting score between the three clusters ($H (2) = 10.19, p < 0.01$). Three separate Mann–Whitney tests showed that both Australian ($\text{Mdn} = 4$) ($U = 243.5, r = -0.41, p < 0.01$) and Global 500 ($\text{Mdn} = 2$) ($U = 294, r = -0.28, p < 0.05$) corporations were significantly more likely to report compared to New Zealand ($\text{Mdn} = 0$), respectively, while no difference was detected between Australian and Global 500 corporations ($U = 388, p = 0.35$). The top 10 corporations best reporting on dimensions of climate science are as follows: Suncorp Group (Insurance/finance, Australia), Walmart (Retail, USA), Ford Motor Company (Automotive, USA), BP (Energy/oil and gas, UK), Air New Zealand (Airline, New Zealand), Wesfarmers (Conglomerate, Australia), General Motors (Automotive, USA), Rio Tinto (Mining, Australia), Origin Energy (Energy, Australia) and Total (Energy, Australia).

A Spearman’s rank-order correlation test showed a positive association between revenue of the company and climate science reporting ($r_s(88) = 0.292, p < 0.01$). A similar test between the number of employees and climate science reporting was just short of significance ($r_s(88) = 0.207, p = 0.05$). More energy intensive corporations ($\text{Mdn} = 2.5$) were more likely to report on climate science compared to others ($\text{Mdn} = 0.5$), $U = 745.00, p < 0.05, r = -0.24$. Corporations that were part of any voluntary disclosure program ($\text{Mdn} = 3$) were more likely to report climate science compared to corporations not involved in such disclosure programs ($\text{Mdn} = 0$), $U = 510.50, p < 0.001, r = -0.42$. Corporations that reported adhering to GRI standards ($\text{Mdn} = 3$) were also more likely to report on climate science compared to others ($\text{Mdn} = 0$), $U = 481.50, p < 0.001, r = -0.47$. Finally, corporations that mentioned UN Sustainable Development Goal 13 ($\text{Mdn} = 4$) were also more likely to report more on climate science compared to those that did not report the sustainable goal ($\text{Mdn} = 0.5$),$U = 477.00, p < 0.001, r = -0.37$. These indicate medium ($r > 0.3$) to large effect ($r > 0.5$) sizes (Field, 2009).

**Discussion**

Among the top organizations based in New Zealand, Australia and the Global 500 group, only a minority report on scientific consensus about climate change. Few corporations report science-based targets, indicating a science-business expectation gap – a lack of strategic alignment between corporations’ emission reduction strategies and actions, and climate science demands to meet the Paris Agreement goals. Yet, these corporations report more frequently on societal risks of climate change, as well as business contribution and responsibility.

Based on the frequency of keywords, “climate change” appeared in 66 organizational reports while “global warming” received the least mention, with only 29 out of the 90 corporations mentioning it. This finding is consistent with Ihlen’s (2009) study that among the top 30 Global Fortune 500, only two corporations did not use “climate change,” while 20 corporations did not use “global warming.” This probably indicates mainstreaming of “climate change” in corporate discourse and a gradual withdrawal of “global warming,” which is in alignment with recent scientific reports’ usage of climate change as a more appropriate term. According to Jaworska (2018), oil industries’ greater use of “climate change” instead of “global warming” is a way to identify this issue as a less threatening phenomenon. Indeed, public opinion research indicates that individuals perceive climate change to be less threatening than global warming (Leiserowitz et al., 2014; Whitmarsh et al., 2013). Together, whether a result of strategic business choice or mainstreaming of an issue, these findings suggest that “climate change” is gaining favor among top corporations, mirroring a similar shift in scientific and media usage of the term.

This is the first study to show low reporting of scientific consensus about climate change among top corporations. Previous studies have tested scientific consensus reporting in the
media (Boykoff and Boykoff, 2004; Painter and Ashe, 2012) and its potential influence in increasing polarization of climate change beliefs, at least in the USA (Leiserowitz et al., 2013). Only 3 percent of New Zealand corporations explicitly acknowledge or agree with scientific consensus about climate change, and only a minority of corporations do so in Australia (13 percent) and among Global 500 (17 percent). An optimistic interpretation is that the science of climate change is settled, and therefore corporations do not feel the need to report. Another interpretation is that scientific topics such as climate change are only meaningful to corporations in terms of its risks and opportunities for business.

Lack of acknowledgment or incorporation of scientific messaging, however, is a missed opportunity for communication managers to help institutionalize CSR (Coombs and Holladay, 2009) as well as address stakeholder concerns or apathy. A large majority of publics in the USA (85 percent, Leiserowitz et al., 2018), Australia (43 percent, The Climate Institute, 2017) and New Zealand (47 percent, Leining and White, 2015) doubt the overwhelming scientific consensus about climate change. As perceived scientific consensus is a gateway belief to public beliefs, attitudes and policy support (Ding et al., 2011; van der Linden et al., 2015), it is important to encourage more corporations to highlight the consensus message to instill confidence and manage stakeholder expectations.

Corporations highlight several societal risks of climate change, primarily negative human or social impacts, material or physical impacts, among others. This finding is consistent with recent studies that find corporations primarily frame climate change as a business risk (Dahl and Fløttum, 2019; Gasbarro et al., 2017; Jaworska, 2018). This increasing prevalence of climate risks in corporate reports indicates a shift from framing climate change as an object that can be tackled to “an unpredictable and out of control agent with harmful consequences mostly to businesses” (Jaworska, 2018, p. 215). For example, this increased attention to risk helps portray the oil industry as a victim of climate change, who are nevertheless heroically fighting for the society (Dahl and Fløttum, 2019; Jaworska, 2018).

Only about a quarter of businesses reported their GHG contributions and a third acknowledged business responsibility to respond to climate change. Emission reporting is a key acknowledgment of an individual organization’s responsibility. This low reporting highlights that corporate communication managers are missing a key opportunity to claim legitimacy as responsible social organizations in addressing a global challenge (Campbell, 2000). Previous studies have found businesses do not specifically highlight organizational responsibilities for action. Instead, responsibility is framed in general terms (Dahl and Fløttum, 2019), probably explaining the low reporting on emission contributions and responsibility in this study.

Similarly, few corporations reported science-based targets. This probably indicates a lack of strategic alignment between management goals and global issues. For example, Jaworska (2018) found that while major oil companies CSR and environmental reports emphasize the notion of risk – a finding similar to this study – she concluded that hedging devices are used in the report to obscure business contribution and groom a positive public image. Together, highlighting societal risks along with muted acknowledgment of business responsibility or specific targets can be critically viewed as a business strategy to shift the responsibility to consumers and governmental agencies, and make everyone equally responsible. Future experimental research can help us determine how stakeholders are likely to respond to these organizational frames when reporting on science and technology issues.

Comparatively, New Zealand corporations generally lagged in reporting different dimensions about climate change compared to Australian companies on several factors of climate change. On the dimension of human and social impacts, Australian corporations communicated more frequently than even the Global 500 industries. The findings from keyword counts are similar to the findings from the scale of climate science communication,
namely that New Zealand corporations are less proactive communicating on climate science, compared to Australian and Global 500 industries. This important finding provides credence to previous studies (e.g. Ihlen, 2009; Pollach, 2016) that have used keywords as proxy to measure overall business engagement with climate change.

Providing external validity to the findings of this study, a recent analysis of the top 200 largest corporations in New Zealand showed that only 58 of the corporations mentioned climate change related keywords, and only 5–16 percent of the corporations reported on climate risks, targets or initiatives (McGuinness and Foreman, 2018). The authors concluded that “New Zealand has a long way to go before we know we are walking the talk” (McGuinness and Foreman, 2018, p. 58).

Australian corporations do better reporting than New Zealand, even though the economies and emissions profiles are similar. Potential explanations include varying managerial attitudes, media and public attention, more regulatory focus in Australia compared to New Zealand, among others. If indeed regulation is key to explain the differences, this finding highlights the need for policy – or at least policy threats, from government or public – in shaping how corporates communicate about issues. In Australia, voluntary carbon disclosure among Australia’s 100 largest companies increased significantly between 2006 and 2008 even though the National Greenhouse and Energy Reporting Act was not operational till 2009 (Bae et al., 2013). In New Zealand, policy uncertainty and a lack of business advocacy ensured reactive management strategies (e.g. Bui and de Villiers, 2017). Another interesting finding is that Australian corporates generally do equally well as Global 500, potentially indicating a mainstreaming or standardization of reporting expectations and norms among more globally connected corporations. Most New Zealand corporations serve domestic consumers, with Air New Zealand being more internationally focused, which probably explains its exemplary reporting standards as found in this study.

Further studies are needed to understand how regulatory conditions, national cultures and domestic stakeholder pressures impact corporate communication about climate change in different countries. This requires a diverse set of methods, including interviews with corporate communication managers from different countries, which is beyond the scope of this study. Nevertheless, this study sets up future research to investigate reasons for differences on different dimensions of climate science, and more broadly on other science and technology issues.

Among the contextual variables, energy intensive, revenue, being part of a voluntary disclosure program, adhering to GRI standards, and those that mentioned UN Sustainable Development Goal 13 were likely to report on climate science. Large or energy intensive corporations are likely to be high in the radar of regulation, public opinion and media visibility with regards to action of climate change (Dawkins and Fraas, 2011) and may have additional resources to devote to climate communication.

**Limitations**

A primary limitation of this study is that it is a snapshot in time. More longitudinal analysis of keyword use (e.g. Pollach, 2016), or reporting of scientific consensus (e.g. Supran and Oreskes, 2017), and other dimensions of climate science is likely to help better understand shifting corporate discourses about climate change (e.g. Schlichting, 2013). While corporate reports have been studied, future researchers should encompass other news reports as such industry sponsored reports may not sufficiently account for actual corporate behavior. While this research identified and developed reliable scales on climate science, it is possible that there are equally other important dimensions that it failed to capture. While the top 30 Global 500 companies were used to test against New Zealand and Australian corporations, they are based in different countries: USA (11, 18 percent), UK and EU (8, 10.2 percent), China (7, 11.7 percent;
Taiwan, 1, 1.7 percent), Japan (2, 3.3 percent) and South Korea (1, 1.7 percent). This study ignored these differences, even as it shows that country-differences matter. The Global 500 corporations were used to benchmark how Australian and New Zealand corporations communicate about climate science. But as the results show, Australian corporates – which are much smaller in size than the Global 500 – communicate equally well, if not better, compared to Global 500 on the different dimensions, indicating that company size or revenue alone may not a factor. Future research could include a more diverse set of countries to evaluate business communication on climate science.

**Theoretical implications**

Theoretically, this research is an important contribution to communicating science in organizational contexts, as it integrates concepts and frameworks from diverse fields such as CSR communication, business strategy and science communication. Few prior studies have explicitly studied how climate science is communicated in organizational contexts, most of which were limited to a few corporations in the USA and Europe. This study offers an analytical framework that can be employed in future studies to identify different strategies corporations use when communicating about scientific issues. Equally important is to experimentally test how communicating on different dimensions affects stakeholder’s perceptions of CSR efforts on climate change. For example, it is possible that the high visibility of societal risks of climate change in corporate reports helps manage stakeholder’s perceptions of whether a business is a villain or a victim of climate change (Jaworska, 2018). As businesses may be potential drivers of media coverage, future research can explore how corporate communication is reflected in media coverage of climate change (Schmidt et al., 2013).

**Practical implications**

Corporate communication managers may need to pay attention to how their communication, individually and in comparison with their peers, potentially shapes stakeholder’s perceptions and regulatory pressures. A good strategy is to align CSR efforts to core values of the organization, in order to address consumer skepticism about corporate efforts in resolving global issues. Another suggestion, as the findings show, is for corporations to align with global reporting standards to improve general standards of CSR (Einwiller et al., 2016). Finally, communicating the scientific consensus message could be a key gateway belief to help organizations manage stakeholder expectations, as studies in science communication show (van der Linden et al., 2015).

**References**


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Table A1. Sample description

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