The Internet's Plumbing Consists of Garden Hoses:
A Critical Analysis of the Advantages and Pitfalls of Metaphors Use for Critical Maritime Infrastructures

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Introduction

Maritime critical infrastructures, such as submarine data cables, are generally areas of limited knowledge in society.[1] However, during the Russian aggression against Ukraine and because of the sabotage attacks on the Nord Stream pipeline, the issue has increasingly gained attention from government actors, private corporations, and the media. Yet, technical functions and complex interrelationships of basic maritime infrastructures are difficult to grasp for citizens unfamiliar with the subject. In journalism and science communication, metaphors and figurative language are, therefore, often used to illustrate certain aspects of those interrelations. References to submarine data cables as "the internet's plumbing" and "garden hoses" are only two of many possible examples which we will reflect upon in this work.

However, the employment of such images and metaphors should not be mistaken as mere stylistic devices. Since metaphors and analogies evoke associations, they can serve as strategical carriers of argumentative narratives in science communication. Therefore, metaphors and their application in scientific contexts should be reviewed critically in terms of epistemological, social and ethical issues involved.[2] From a communication perspective, their utilisation provides benefits but also has limitations and can even cause harm, for instance, if metaphors reinforce outdated paradigms and stereotypes or lead to misunderstandings.[3] Accordingly, focusing on the maritime part of the global internet infrastructure, we pose this research question for the following work:

What figurative language do authors deploy for reporting on submarine cables, and what advantages and problems arise from its use?

In the scope of this work, we particularly analyse the use of metaphors in the communication of maritime infrastructure issues. First, we briefly summarise the current state of research on the topic of metaphor in science communication and essential maritime infrastructure. We then elaborate on our method to identify and systematise relevant metaphors and present our result of systematically clustered metaphors. In the final part of this work, we discuss these results and draw a conclusion.

Related work

For decades, linguists have argued that the omnipresence of metaphors is not a purely linguistic phenomenon but reflects "*general principles of understanding*"[4]. In their fundamental research, they have explored how humans understand abstract concepts metaphorically through other domains of knowledge. Brown specifically focuses on the issue of scientific discourses and identifies metaphors as tools of

[1] Franken 2022.
[2] Frezza 2016, 21-22.
[3] Taylor & Dewsbury 2018, 2.
[4] Lakoff & Johnson 1980, 116.

reasoning and persuasion.[5] Taylor and Dewsbury discuss socio-political messages and general limitations of metaphors for cases of specific science communication domains such as biology and ecology.[6] Jäkel et al. reflect on why the analysis of the role of metaphors in science has remained widely understudied.[7] Thereby, they criticise that the role of metaphors has been minimised in many scientific disciplines due to the prejudice that a metaphor refers to a rhetorical or stylistic device. In contrast, Sewell claims that, traditionally, linguist domains such as discourse, rhetoric and speech acts are rising in popularity among communication scholars.[8]

Beyond the more abstract notion of persuasion, Buzan et al. have developed the *securitisation theory,* which explores how political discourses are constructed as discourses of security through the rhetorical presentation of an issue as an existential threat[9] From the perspective of pragmatic linguistics, language expressions (i.e. *speech acts*) do not only convey information but also have "effects" and thus generate *meaning*. Specialising on the aspect of critical infrastructure, Aradau argues that material objects can be formed through speech acts. In particular, the securitisation of infrastructure is realised through the framing of infrastructure as the "foundation of society"[10]. Such material-discursive practices intend to produce the effect that, on the one hand, an object should be protected and, on the other hand, that some materials appear more important than others.[11]

Securitization attempts are only successful if the audience knows and recognises the threatened referent object.[12] The works above focus either on well-researched issues in their respective disciplines or land-based infrastructures. However, Bueger and Liebetrau identified a fundamental lack of public awareness of fixed subsea infrastructures like pipelines, data and energy cables.[13] For them, this phenomenon is rooted in the triple invisibility of maritime, buried, and taken-for-granted infrastructures. And because the objects of critical maritime infrastructures are mostly less-known, authors may more intensively apply metaphors, analogies, comparisons, and paraphrases, which are intended to replace the explanation of the complex utilities as such. Therefore, examining the linguistic, stylistic elements used in the context of submarine cables is necessary to fill the empirical research gap in the niche field of maritime infrastructures (see also Seydel 2023 in this publication). Additionally, we aim to contribute to the research in this field by examining the opportunities and risks of employing various metaphors in science communication and reporting on maritime infrastructures.

Method

To gain an insight into the use of metaphors and figurative language in reporting on the topic of submarine cables, we generated a text corpus from the database *Nexis*[14]. The main corpus includes all newspaper articles[15] from

[5] Brown 2003.
[6] Taylor & Dewsbury, 2018.
[7] Jäkel et al. 2016.
[8] Sewell 2010.
[9] Buzan et al. 1998, 23–25.
[10] Aradau 2010, 500.
[11] Ibid., 505.
[12] Denker, Schäfer, and Steinebach 2019, 130.
[13] Buerger & Liebetrau 2021, 393.
[14] Nexis Uni 2023.

[15] Types of sources filtered: Content: *News*; Article Type: *Reviews, Broadcast Transcripts, Editorials & Opinions, Letters & Comments, Interviews*; Business News: *Business & Industry News, Company Activities & Management, Economy & Economic indicators, Science & Technology, Trade & Development*; News Sources: *Newspapers, Magazines & Journals, Newswires & Press Releases*

the past five years (01.01.2018 - 15.05.2023) with the keywords "submarine communication cable", "Subsea data cable" or "subsea internet cable". Thereby, the query results in 743 hits of articles from anglophone newspapers of a wide variety of countries, although predominantly from Anglo-American and Australian regions. In addition, we created a sub-corpus which contains only the articles classified as "Major World Publication". This sub-corpus contains 50 articles from high-circulation supra-regional newspapers such as *The Guardian* and *The Australian*, whereas the main corpus also contains regional publications.

At first, we performed a qualitative content analysis based on the sub-corpus to identify and categorise any occurring metaphors. In the second step, we verify their quantitative occurrence in the main corpus. Finally, we will highlight the benefits and risks of each of these metaphors used and discuss them in more detail for the most prevalent ones of each category.

Analysis and results

By means of the qualitative content analysis, 18 metaphors were identified. We employed iterative clustering processes that identified commonalities in meaning. Ultimately, we assigned these expressions to five distinct categories: (1) *Nature*, (2) *Human body*, (3) *Everyday items*, (4) *Other networked infrastructures* and (5) *Warfare*. The quantitative analysis of the main corpus further reveals which of these metaphors are most frequently deployed overall. In Table 1, the metaphors are arranged in descending order of frequency within their cluster. Furthermore, in the three columns on the right, we have summarised which explanatory power, but also which loss of information and which potential misleading effects can be identified for each metaphor. In this section, we will discuss general assessments and selected examples of each category in more detail.

Overall, the categorisations, as well as the frequency distributions, demonstrate that science communication preferably draws on imageries related to nature (97 occurrences), the human body (85 occurrences) and other forms of infrastructure (46 occurrences) (see Figure 1). Presumably, the aspect of abstraction is most relevant for the employment of categories and elements thereof.

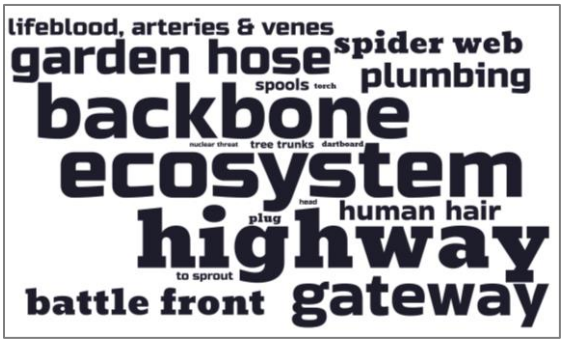

Figure 1: Word cloud of metaphors identified in the corpus. The size of an expression depends on its frequency.

On the one hand, this involves the abstraction that must be made from the viewer to the observed object, i.e., the degree of general knowledge and awareness. The categories and elements used for explanation are those that are generally known by the publication's audience. Nature and the human body are convenient because people are inevitably surrounded by them and, therefore, automatically have a certain basic knowledge from which they can abstract. On the other hand, the abstraction is made starting from the observed object. Thus, categories and elements are employed that are closely related to the initial object. For instance, since data cables are laid through the sea, they are inherently surrounded by elements of nature, and they can, therefore, also be described in partial aspects by these.

	Table 1: Metaphors and figurative language	Count	Explanatory power	Information loss	Potential deceptions (selection)
Nature	**Ecosystem** (Nair 2023)	88	• High complexity • Interdependences, Interplay of entities • Fragility/Adaptability • Trans-border	• Coordinated development / expansion • Ownership • Human decision-making • Sedimentation of power structures	• Universal, all-encompassing • Public good: Global Common
	Spider web (de Quetteville 2022)	5	• Global linkages • Centers & peripheries	• (Diverse/complex) ownership and usage	• Architecture: Monocentric and symmetric • Purpose of capturing/trapping (instead of creating flow) • Fragility (single points of failure)
	To sprout (de Quetteville 2022)	2	• Temporality (1. time-lagged expansion 2. long-term planning processes)	• Intentionality • Territoriality (source related) • Supply and maintenance costs	• Natural process, randomness
	Tree trunks (de Quetteville 2022)	2	• Representation of size ratios, varying diameter • Robustness	• Vagueness of size ratio	• Robustness
Human body	**Backbone** (Dupont 2020)	75	• Central role as digital infrastructure • Incapacity of self-regeneration	• Ownership • Territoriality • Plurality / Redundancies	• Natural resilience and strength • Irreplaceability
	Human hair; hair thin (*The Press* 2021)	5	• Representation of size ratios	• Existence of protection layers • Technical complexity: Electricity dependency • Ownership • Territoriality	• Natural (re)growth • Fragility • Necessity of constant maintenance
	Carrier of lifeblood (Leicester 2022)	4	• Essential for the functionality of the system	• Ownership • Territoriality	• Damage is irreversible and life-threatening • Extreme vulnerability
	Head of the digital world (Field 2018)	1	• Central role • Complexity	• Ownership • Territoriality	• Centre of human consciousness
Everyday items	**Garden hose** (de Quetteville 2022)	17	• Representation of size ratios	• Existence of protection layers/hardness of used materials • Technological complexity: layered construction	• Weak points can be patched easily
	Spools (of cotton, metal, glass) (de Quetteville 2022)	3	• Basic material components • Visual appearance • Installation process: Unwinding the cable at sea; Splicing	• Technological complexity • Different types of cables	• Simple and inexpensive availability • Substitutability
	Torch (across a darkened field at night.) (*The Press* 2021)	1	• Basic technical functioning	• Existence of protection layers • Technological complexity	• Oversimplification of fibre optic technologies • Quantity of data traffic
	Dartboard (de Quetteville 2022)	1	• Targets are identifiable by their landing points • Estimate location of cable is publicly available • Geopolitical actors	• Plurality / Redundancies	• Securitisation, alarmism: Targeted attacks are the normality • Oversimplification of sabotage acts • Subjective differentiation between "high" and "low" value targets
Other networked infrastructures	**(Information-; Digital-; Super-; Highspeed-) Highway** (Groch 2022)	27	• Fast transmission speed • Plurality / Redundancies • Ownership diversity	• Possibility of switching directions instantly	• Multi-directionality • Accessibility • Potential of protection (fences, cameras etc.)
	Gateway (Nair 2023)	11	• Access and connectivity • Landing points • Gatekeeping function of coastal states	• Technological complexity • Territoriality: Cable in international waters between landings	• Distance ratio: Length of cable between landing points • "Inside" and "outside" space
	Plumbing of the internet (*National Post* 2018)	6	• Essential basic structure, usually hidden and buried • Fundamental lack of societal awareness	• Technological complexity: different architectures and functions	• Unidirectionality • Centralisation of flows
	Plug (*The Press* 2021)	2	• Cable landing points • Electrical dependency	• Redundancies • Survivability	• Unidirectionality • Dependency on single points of failure • Accessibility • Probability of complete blackout
Warfare	**Battle front** (Page and O'Keeffe 2019)	6	• Strategical interests: infrastructure partly used by the military	• Ownership vs territoriality • Accessibility	• Securitisation, alarmism • ICT infrastructure as an obvious (legitimate) target in conflicts • Changing criticality of communication infrastructures: more drastic consequences in case of failures
	Nuclear threat (Groch 2022)	1	• Small set of actors capable of meaningful sabotage	• Likelihood of successful deterrence • Likelihood of immediate loss of life	• Securitisation, alarmism • Exaggeration of consequences • Threat capacity of infrastructure is vastly unknown

Moreover, submarine cables are an infrastructure of their own, so an attempt to explain them based on other infrastructures is an obvious choice.

In the category of nature, the visual language's special explanatory power lies in highlighting systemic complexity. Like an *ecosystem*[1]**,** there are fragile but also adaptable properties whose connections are hardly apparent at first glance. The image of the *spider web*[2] follows a similar line yet may mislead audiences into perceiving the internet as monocentric. Global connections as well as the importance of centres and peripheries become clear. However, we see a danger in this kind of imagery because it creates the appearance of a public, self-sustaining good.

Regarding the domain of the human body, the *backbone*[3] is particularly often used as a metaphor or comparison. On the one hand, this illustrates particularly poignantly the central role that submarine cables serve for the digital infrastructure. At the same time, however, such comparisons lose sight of the fact that the network structure of submarine cables, unlike the human body, has redundancies but lacks self-healing capacities. Individual failures, contrary to the human backbone, are not irreparable impairments. Also, the conceptual boundaries of the *internet backbone* need to be clarified, as it often includes land networks and distribution infrastructure such as IXP.

In the two previous categories, we find that territoriality, ownership, and human decision-making cannot be explained. The occurrence and development of submarine cables are presented either as natural or random, or as fragile and irreplaceable.

Comparisons with a *garden hose*[4] are widespread from the everyday items category. Similar to other images such as *tree trunks*[5] and *hair*[6] , which rather belong to the categories above, the explanatory power here lies particularly in the attempt to represent size ratios. However, important aspects of technological complexity, such as the existence of protective layers, variability of thickness, and the hardness of used materials, are lost. Thus, the impression may arise that submarine cables, like garden hoses, are easily accessible and repairable tubes.

Furthermore, we have identified that the metaphor of the *highway*[7], often in combination with extensions such as *digital*, *super,* or *high-speed*, is utilised to illustrate the rapid speed of data transfers. Further explanatory power of this can be recognised in the fact that (in contrast to the nature above and body metaphors) the aspect of plurality and redundancies also becomes clearer here: If there is a traffic jam or construction site on one road, it can be bypassed via other routes. The aspect of ownership diversity with private and public investors is also more explicit in this case. On the other hand, we are critical of the fact that this generally creates a false picture regarding accessibility, regulations, and potential of protection, which is much more complex and, to a lesser extent, possible with submarine cables than with highways. The possibility of switching and changing direction immediately is likewise not reflected in the example of the highway, as there are usually two fixed directions of travel.

Finally, the category of warfare should be considered. Although metaphors from this domain were used relatively infrequently, they highlight a new, important aspect of maritime infra-

[1] Nair 2023.
[2] De Quetteville 2022.
[3] Dupont 2020.
[4] De Quetteville 2022.
[5] Ibid.
[6] The Press 2021.
[7] Groch 2022.

structure: a distinction from the previous categories. Metaphors such as the *battle front*[8] particularly foreground strategic interests. The partial military use of the submarine cables matches this image as well. However, we are critical of the alarmism created by this, especially by comparing it to *nuclear threats*. Also, ICT infrastructures are then often portrayed as an obvious, easy, and legitimate target in conflicts. The consequences of failures are implicitly depicted as more drastic than they are in most cases due to existing redundancies. While exaggerating threats supports securitization attempts, the proposed solutions may be distorted by alarmist language.

Discussion and conclusion

In our study, we discovered that metaphors and figurative language are commonly employed within a specific context. We subjectively categorized them into five groups, each exhibiting differing levels of abstraction and ambiguity. Although certain categories pose fewer concerns than others, it is important to note that all figurative language entails a loss of information. Comparisons based on size or metaphors closely associated with the initial object of subsea infrastructures, such as other networked infrastructures, were found to be less problematic. On the other hand, we identified metaphors implicating alarmism and over-simplification as more problematic aspects of figurative language usage.

The analysis has, of course, some limitations. First, we analyzed only a small subsample of all public texts on submarine cables. Our first round of coding metaphors from what is perceived as a "Major World Publication" is biased towards Western, industrialized, English-speaking and democratic contexts. Therefore, future work could well address additional languages and non-Western research contexts. After all, most countries suffering from low vulnerabilities are non-English speaking countries.[9] Second, because of our limited database for the initial detailed coding of the sub-corpus, we could not include all commonly used metaphors. Text documents such as speeches, academic articles, and grey literature (think tank reports, assessments, briefings) have not been considered yet and could contribute new insights. For example, Ursula von der Leyen pronounced that *"[p]ipelines and underwater cables […] are the lifelines of data and energy"*[10] at the European Parliament in October 2022. Also, some metaphors were mentioned far more frequently than others, ranging from 88 occurrences to only one or two. Readers should be conscious that the latter may potentially be outliers. Therefore, our collection of figurative speech and its topical clusters could well be extended in future works, thereby also checking for outlier formulations.

Our short analysis supports previous studies highlighting the significance of utilizing figurative language in effectively communicating intricate scientific concepts. Nevertheless, through our study of the reporting on submarine data cables, we identified certain drawbacks associated with its application. Firstly, oversimplification may lead to misunderstandings regarding the complexities of potential solutions. Secondly, the use of alarmist language, while serving to securitize actors, can foster erroneous perceptions of the actual threat landscape. In conclusion, while figurative speech offers advantages, its appropriate usage is contingent upon the specific context, target audience, and presumed knowledge level. Science communicators, including researchers, journalists, and political actors, need to be cognizant of these factors when crafting texts.

[8] Page & O´Keefe 2019.
[9] Franken et al. 2022.
[10] Von der Leyen 2022, 2.

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Bibliography

Aradau, Claudia. 2010. 'Security That Matters: Critical Infrastructure and Objects of Protection'. *Security Dialogue* 41 (5): 491–514. https://doi.org/10.1177/0967010610382687.

Brown, Theodore L. 2003. *Making Truth : Metaphor in Science*. Univ. of Illinois Press.

Bueger, Christian, and Tobias Liebetrau. 2021. 'Protecting Hidden Infrastructure: The Security Politics of the Global Submarine Data Cable Network'. *Contemporary Security Policy* 42 (3): 391–413. https://doi.org/10.1080/13523260.2021.1907129.

Buzan, Barry, Ole Wæver, Ole Wæver, Jaap De Wilde, and others. 1998. *Security: A New Framework for Analysis*. Boulder, CO: Lynne Rienner Publishers.

Denker, Kai, Marcel Schäfer, and Martin Steinebach. 2019. 'Darknets as Tools for Cyber Warfare'. In *Information Technology for Peace and Security*, 107–35. Wiesbaden: Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-25652-4_6.

Dupont, Alan. 2020. 'China Sets out a Snare for the Worldwide Web'. *The Australian*, 16 May 2020. www.nexisuni.com.

Field, Matthew. 2018. 'Google and Orange Team up for 4,100-Mile Subsea Cable'. *The Daily Telegraph*, 13 October 2018. www.nexisuni.com.

Franken, Jonas. 2022. 'Seekabel Als Maritime Kritische Infrastruktur'. In *Dreizack 21: Von Historischen Bis Zukünftigen Herausforderungen Im Maritimen Raum*, edited by Henrik Schilling, 22–25. Laboe/Kiel.

Franken, Jonas, Thomas Reinhold, Lilian Reichert, and Christian Reuter. 2022. 'The Digital Divide in State Vulnerability to Submarine Communications Cable Failure'. *International Journal of Critical Infrastructure Protection*, March. https://doi.org/10.1016/j.ijcip.2022.100522.

Frezza, Giulia. 2016. 'Metaphor: The Good Argument in Science Communication'. *Rivista Italiana Di Filosofia Del Linguaggio*, no. 10 (December): 21–33. https://doi.org/10.4396/20161206.

Groch, Sherryn. 2022. 'Undersea Cables, a Coming Theatre of War'. *Sydney Morning Herald*, 5 November 2022. www.nexisuni.com.

Jäkel, Olaf, Martin Döring, and Anke Beger. 2016. 'Science and Metaphor: A Truly Interdisciplinary Perspective. The Third International Metaphorik.de Workshop'. https://www.metaphorik.de/sites/www.metaphorik.de/files/journal-pdf/met26-intro_0.pdf.

Lakoff, George, and Mark Johnson. 1980. *Metaphors We Live By*. Univ. of Chicago Press.

Leicester, John. 2022. 'EXPLAINER: A Deep Dive into Risks for Undersea Cables, Pipes'. *The Independent*, 30 September 2022. www.nexisuni.com.

Nair, Nivashni. 2023. 'Digital Infrastructure - Ship Lands World's Largest Subsea Cable System off KZN'. *Business Day*, 9 February 2023. www.nexisuni.com.

National Post. 2018. 'How One Company Plumbed an Ultra-Fast Internet Route across the Bottom of Lake Ontario', 12 October 2018. www.nexisuni.com.

'Nexis Uni'. 2023. Database. Nexis Uni. 15 May 2023. www.nexisuni.com.

Page, Jeremy, and Kate O'Keeffe. 2019. 'US in Undersea Battle with China for Internet Control'. *The Australian*, 14 May 2019. www.nexisuni.com.

Quetteville, Harry de. 2022. 'Why Hi-Tech Undersea Cables Are the Real Threat to National Security'. *The Telegraph*, 22 January 2022. www.nexisuni.com.

Sewell, Graham. 2010. 'Metaphor, Myth, and Theory Building: Communication Studies Meets the Linguistic Turn in Sociology, Anthropology, and Philosophy'. *Management Communication Quarterly* 24 (1): 139–50. https://doi.org/10.1177/0893318909351584.

Taylor, Cynthia, and Bryan M. Dewsbury. 2018. 'On the Problem and Promise of Metaphor Use in Science and Science Communication'. *Journal of Microbiology & Biology Education* 19 (1): 19.1.40. https://doi.org/10.1128/jmbe.v19i1.1538.

The Press. 2021. '20 Threads That Keep Us Connected', 24 May 2021. www.nexisuni.com.

von der Leyen, Ursula. 2022. 'Speech on Russia's Escalation of Its War of Aggression against Ukraine'. Speech at the European Parliament Plenary, Strasbourg, October 5. https://ec.europa.eu/commission/presscorner/detail/en/speech_22_5964.