Societal Implications of Structural Inequities in Midstream Oil and Gas Infrastructure

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Abstract

Midstream oil and gas infrastructure comprises vast networks of gathering and transmission pipelines that connect upstream extraction sites to downstream processors, exporters, and consumers. In the United States (US), public policies and corporate decisions continue to promote the extraction and consumption of oil and gas, and they have prompted a wave of proposals for gathering and transmission pipelines in recent years. The ongoing build-out of midstream infrastructure calls for close scrutiny of associated human health risks and related societal impacts. Urgency is warranted considering that at least part of this infrastructure, the US natural gas pipeline network, is concentrated more heavily in areas of high social vulnerability than areas of low social vulnerability, highlighting inequity in the distribution of societal harms. Emerging research on ways in which midstream pipelines affect Indigenous peoples and rural communities in the US demonstrates the complex nature of potential harms. The spatial distribution of midstream infrastructure, together with the complexity of societal impacts underscore the need to clearly understand and carefully consider these impacts during infrastructure planning and permitting. We offer recommendations for scientists and decision-makers who are interested in evaluating these impacts through the lens of environmental justice.

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Abstract

Midstream oil and gas infrastructure comprises vast networks of gathering and transmission pipelines that connect upstream extraction sites to downstream processors, exporters, and consumers. In the United States (US), public policies and corporate decisions continue to promote the extraction and consumption of oil and gas, and they have prompted a wave of proposals for gathering and transmission pipelines in recent years. The ongoing build-out of midstream infrastructure calls for close scrutiny of associated human health risks and related societal impacts. Urgency is warranted considering that at least part of this infrastructure, the US natural gas pipeline network, is concentrated more heavily in areas of high social vulnerability than areas of low social vulnerability, highlighting inequity in the distribution of societal harms. Emerging research on ways in which midstream pipelines affect Indigenous peoples and rural communities in the US demonstrates the complex nature of potential harms. The spatial distribution of midstream infrastructure, together with the complexity of societal impacts underscore the need to clearly understand and carefully consider these impacts during infrastructure planning and permitting. We offer recommendations for scientists and decision-makers who are interested in evaluating these impacts through the lens of environmental justice.

Plain Language Summary

Recent years have brought a wave of investments in oil and gas infrastructure in the United States (US) and elsewhere. Research and decision-making related to human health and other societal impacts of oil and gas tend to focus on upstream activities, such as hydraulic fracturing, and on downstream activities, such as refining and electricity production. However, gathering and transmission pipelines, which connect upstream and downstream parts of the supply chain, can also have major implications for nearby communities. The existing network of natural gas pipelines in the United States tends to be concentrated in places that experience high levels of social vulnerability. This pattern raises concerns about the inequitable distribution of environmental, health, and other burdens from pipelines and other infrastructure. We illustrate the complicated nature of these burdens by highlighting research on the ways in which oil and gas pipelines affect Indigenous peoples and rural communities more generally in the US. We urge researchers and decision-makers to look closely at these types of impacts, especially in light of environmental justice policy, which calls for close scrutiny of potential harm to marginalized people during planning and permitting of infrastructure projects.

Main Text

Energy policy in the United States (US) has shifted in recent years from a focus on energy independence toward so-called energy dominance (The White House, 2019). This shift coincides with major investments in pipelines and other infrastructure to support ongoing extraction and consumption of oil and gas (U.S. Energy Information Administration, 2019). Expansion of oil and gas infrastructure has implications for greenhouse gas emissions, and it also affects the long-term health of people and ecosystems worldwide via climate change (IPCC, 2018). Besides the indirect impacts of climate change, oil and gas infrastructure may pose direct risks to nearby communities. At both upstream and downstream ends of the oil and gas supply chain, communities experience environmental degradation and incur health and safety risks associated with hydraulic fracturing, directional drilling, refining, electricity production, and other practices (Bullard, 2018; Colborn et al., 2014; Davies, 2019; Olmstead et al., 2013). In the US and elsewhere, these impacts fall disproportionately on racially marginalized people, low-wealth communities, or other vulnerable groups.

Although societal impacts of oil and gas infrastructure are well documented for upstream and downstream ends of the supply chain, the impacts are not as well known for the middle, so-called midstream infrastructure, which comprises gathering and transmission pipelines, pumps, compressors, and storage facilities that link upstream and downstream ends of the oil and gas supply chain (cf., Buse et al., 2019). A wave of proposals in recent years for midstream pipelines – some completed and others not – emphasizes an urgent need for research into societal impacts of midstream infrastructure, including social and health-related inequities created or exacerbated by these projects. The urgency is underscored by spatial patterns of natural gas

gathering and transmission pipelines and social vulnerability in the US, which reveal disparities associated with midstream infrastructure and its societal impacts. We discuss emerging research on the complexity of impacts to rural and Indigenous communities, which are often affected by the construction of midstream infrastructure. Finally, we connect this work to US environmental justice policy and discuss implications for environmental decision-making.

Emerging research from the overlooked middle

Compared to upstream and downstream ends of the oil and gas supply chain, midstream infrastructure has received less attention from researchers and decision makers concerned about environmental, health, or societal impacts of fossil fuel extraction and consumption (Buse et al., 2019). The comparatively overlooked middle includes vast, continental networks of pipelines and related equipment used to collect and transport oil and gas. For natural gas alone, the US midstream network comprises more than 300,000 km of gathering and transmission pipelines traversing more than 70% (2,259 of 3,142) of US counties (Fig. 1).

The US natural gas pipeline network exhibits an important but previously undocumented relationship with social vulnerability. Social vulnerability describes a community's ability to adapt to and recover from health crises, pollution, climate change, or negative impacts of resource exploitation (Cutter et al., 2003). For the 2,259 US counties with natural gas pipelines, the density of pipelines (pipeline km per km^2 of county area) is positively correlated with social vulnerability ($R = 0.14$, $p < 0.001$). As a result of this correlation, counties in the top quartile of social vulnerability (i.e., counties with the most vulnerable populations) have a pipeline density

that is 67% higher, on average, than counties in the lowest quartile of vulnerability (7.5 versus 4.5 pipeline km per 100 km^2 of county area; $F = 45$, $p < 0.001$).

The correlation between pipeline density and social vulnerability suggests that negative impacts from the US natural gas gathering and transmission pipelines, including air and water pollution, public health and safety concerns, and other burdens, fall disproportionately on communities with limited resources to deal with the challenges these impacts create. The correlation neither implies that vulnerable communities were targeted by pipeline developers nor that vulnerable communities sprang up near pipelines. Nevertheless, it reveals a structural inequity that warrants further scrutiny. Although the concentration of infrastructure in areas of high social vulnerability is consistent with patterns observed at upstream and downstream ends of the oil and gas supply chain (Colborn et al., 2014; Davies, 2019), emerging research suggests that midstream infrastructure may pose different challenges for communities in rural areas, where pipelines and related infrastructure are often located.

Decision-makers responsible for permitting midstream pipelines have justified rural routes by implying that societal risk is connected to population size density, asserting, in some cases, that societal risks are greater in urban areas than to rural areas. For example, federal regulators eliminated an early route for the Dakota Access Pipeline partly because of its proximity to the city of Bismarck, ND and its urban water supply. Regulators instead chose a rural route adjoining the present-day Standing Rock Sioux reservation (Whyte, 2017).

Although population density may help predict the severity of certain impacts (e.g., a gas pipeline explosion may harm more people in an urban area than an equivalent explosion in a rural area), we contend that rural pipeline impacts, in general, are not simply diffuse or less intense versions of urban impacts. Instead, a body of emerging research suggests that gathering and transmission pipelines pose distinct cultural, economic, and other challenges for rural areas (Caretta & McHenry, 2020; Donnelly, 2018; Emanuel & Wilkins, 2020; Whyte, 2017). The recent wave of oil and gas pipeline development in the US and elsewhere highlights the need for more nuanced review of such impacts during planning and permitting and, more broadly, during discussions about the societal costs of public policies that promote the expansion of infrastructure networks in rural areas. We highlight two areas of research, in particular, that illustrate the complexity of societal impacts associated with rural pipeline infrastructure. They include the unique impacts to Indigenous peoples and their territories, and impacts related to pipeline easements through rural, private lands.

Several oil and gas transmission pipelines proposed or built in recent years have major implications for Indigenous peoples. The Dakota Access, Keystone XL, Trans Mountain Expansion, Enbridge Line 3, and Atlantic Coast pipelines are major, midstream projects that traverse present-day or ancestral territories of Indigenous peoples in the US and Canada. Some Tribes and First Nations oppose these projects not only because of concerns over pollution or risks to human health, but also because of the pipelines' potential to cause irreparable cultural harm by damaging or destroying landscapes that have religious, historical, or cultural significance.

Despite the high stakes for Indigenous peoples, few culturally-oriented pipeline assessments exist. Those that do are commissioned mainly by affected Tribes or First Nations in response to regulatory processes that fail to address concerns they deem important (e.g., Honor the Earth, 2020; Tsleil-Waututh Nation, 2015). These assessments describe how pipeline construction and operation may disrupt, for example, the ability of Indigenous peoples to maintain place-based food traditions or cultural practices. They also highlight ways in which regulatory proceedings renew or exacerbate longstanding ethical and legal issues surrounding the participation of Indigenous peoples in decision-making about their own lands and communities (Emanuel & Wilkins, 2020; Honor the Earth, 2020; Tsleil-Waututh Nation, 2015; Whyte, 2017). Beyond negative impacts on the ground, this work explains how planning and permitting exclude Indigenous perspectives, weaken sovereignty, or otherwise undermine Indigenous self-determination. Such societal impacts, which are independent of population density, are rarely considered in pipeline planning and permitting.

A second area of emerging research suggests that pipeline easements on privately-owned lands may catalyze transformation of rural landscapes and communities. Easements are property rights obtained through landowner negotiation or through eminent domain, a legal process that requires landowners to relinquish certain property rights to pipeline builders and operators. The societal implications of easements, however, extend far beyond delineated and compensated boundaries. Easements place practical restrictions on adjacent land use, they affect nearby property value, and – in some cases – they increase the risks of fire or catastrophic explosions in areas far away from easement boundaries. Research from rural Appalachia confirms that easements through privately-owned lands facilitate drastic alteration of communities, quickly transforming rural

156 landscapes into sprawling, industrial settings (Caretta & McHenry, 2020; Donnelly, 2018). The
157 societal implications of these relatively rapid changes, including the implications for rural public
158 health, are not well known.
159
160 Both research areas undermine the idea that midstream pipelines have negligible societal impacts
161 in rural areas simply because populations are less dense than in urban areas. Moreover, the
162 correlation between pipeline density and social vulnerability (Fig. 1) suggests a pressing need to
163 reconsider whether it is in the public interest to maintain or reinforce existing structural
164 inequities that place a disproportionately large share of burdens on vulnerable populations.
165
166 Recommendations for researchers and decision-makers
167 Environmental justice (EJ) offers a policy framework for contextualizing pipeline impacts on
168 communities and for evaluating the broader societal implications of US energy dominance. In
169 the US, federal EJ policy already requires inclusion of socioeconomic analyses in pipeline
170 regulatory reviews to help identify and address adverse environmental and subsidiary impacts
171 that could fall disproportionately on vulnerable populations as a result of permitted activities
172 (e.g., Emanuel & Wilkins, 2020). Federal guidance includes tools for identifying disparities in
173 impacts by race or income status, but agencies have wide latitude to choose or develop their own
174 analyses. Decades of research has improved the ability of decision-makers to identify disparities
175 with respect to vulnerable populations, but EJ policy implementation has also been criticized as
176 methodologically unsound, procedurally rote, or ineffective at preventing or minimizing negative
177 impacts disproportionately imposed on socially vulnerable populations (Bullard, 2018; Davies,
178 2019; Emanuel & Wilkins, 2020). In some cases, EJ assessments involve only cursory

179 demographic screenings, which can mask racial disparities or other social inequities in pipeline
180 routing (Emanuel & Wilkins, 2020). Moreover, the two emerging areas that we highlight show
181 that demographic data alone are unlikely to capture the complexity of concerns held by
182 Indigenous, low-wealth, or racially marginalized communities. Scientists and decision-makers
183 must re-envision screening tools and follow-up analyses to more fully incorporate the societal
184 costs of pipelines and related infrastructure into planning and permitting.
185
186 Research has brought clarity to socioeconomic, cultural, and other impacts of midstream
187 pipelines, yet much of this work has not been integrated into decision-making. For example,
188 Indigenous peoples are often well-equipped to assess pipeline impacts to their own territories and
189 communities, but they often have limited opportunities to participate meaningfully in decision-
190 making (e.g., Emanuel and Wilkins, 2020). To remedy the situation, corporations and regulators
191 must commit to early, good-faith efforts to incorporate Indigenous perspectives into decision-
192 making. In other areas, scientists can help close gaps by partnering with communities to
193 describe and quantify impacts related to environmental degradation, health and safety, and other
194 issues. For rural areas, this work could include quantifying the value of property or assets lost
195 through eminent domain for the construction of pipelines and related infrastructure, and
196 identifying the extent to which midstream infrastructure increases societal tensions or desires to
197 relocate from rural communities. Opportunities also exist for scientists and others to hold
198 regulators to high standards when they design and implement EJ analyses.
199
200 Scientists and decision-makers should also pay closer attention to the cumulative impacts of co-
201 located pipelines, compressors, and other equipment in rural communities. Regulatory analyses

focus on the implications of newly-proposed infrastructure and – with few exceptions – disregard impacts associated with the gradual accumulation of infrastructure in a community. Yet people nearby do not experience newly-proposed facilities in isolation; they are exposed to the cumulative effects of all surrounding infrastructure on air quality, noise, explosion risks, and more. Moreover, because much oil and gas infrastructure pre-dates environmental policies aimed at avoiding or minimizing societal impacts, the build-up of pipelines and other facilities in these communities may reinforce historic practices of oppression imposed upon Indigenous, racially marginalized, and low-wealth communities. Developers cite economic or technical advantages to co-locating pipelines and other facilities with existing midstream infrastructure; the potential downsides of accumulated infrastructure warrant similar scrutiny and consideration.

As research emerges on the impacts of oil and gas infrastructure in rural communities, synthesis work is needed to determine the extent to which the ongoing build-out of midstream pipelines and related infrastructure adds to environmental, public health, and other burdens already experienced by vulnerable populations. Such work complements current research on societal burdens associated with the oil and gas supply chain by acknowledging the often-overlooked middle ground between upstream and downstream infrastructure. A more complete view of the supply chain can inform decision-makers and the general public about the larger societal costs of US energy dominance, including the extent to which vulnerable rural communities subsidize this policy through inequitable exposure to environmental, health, and other risks.

References

Bullard, R. D. (2018). *Dumping in Dixie: Race, class, and environmental quality*. Routledge.

Buse, C. G., Sax, M., Nowak, N., Jackson, J., Fresco, T., Fyfe, T., & Halseth, G. (2019). Locating community impacts of unconventional natural gas across the supply chain: A scoping review. *The Extractive Industries and Society*, *6*(2), 620–629. https://doi.org/10.1016/j.exis.2019.03.002

Caretta, M. A., & McHenry, K. A. (2020). Perspective Appalachia: A perspective on the everyday lived experiences of rural communities at the frontline of energy distribution networks development. *Energy Research & Social Science*, *63*, 101403.

Colborn, T., Schultz, K., Herrick, L., & Kwiatkowski, C. (2014). An exploratory study of air quality near natural gas operations. *Human and Ecological Risk Assessment: An International Journal*, *20*(1), 86–105.

Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards. *Social Science Quarterly*, *84*(2), 242–261.

Davies, T. (2019). Slow violence and toxic geographies: 'Out of sight' to whom? *Environment and Planning C: Politics and Space*, 2399654419841063. https://doi.org/10.1177/2399654419841063

Donnelly, S. (2018). Factors influencing the location of gathering pipelines in Utica and Marcellus shale gas development. *Journal of Geography*, *6*(1), 1–10.

Emanuel, R. E., & Wilkins, D. E. (2020). Breaching Barriers: The Fight for Indigenous Participation in Water Governance. *Water*, *12*(8), 2113.

Honor the Earth. (2020, May 12). Anishinaabeg Cumulative Impact Assessment. Retrieved from https://www.mnchippewatribe.org/impact_assessment.html

IPCC. (2018). *IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]*. Intergovernmental Panel on Climate Change.

Olmstead, S. M., Muehlenbachs, L. A., Shih, J.-S., Chu, Z., & Krupnick, A. J. (2013). Shale gas development impacts on surface water quality in Pennsylvania. *Proceedings of the National Academy of Sciences, 110*(13), 4962–4967.

The White House. (2019, May 14). Fact Sheet: President Donald J. Trump Is Unleashing American Energy Dominance. The White House. Retrieved from https://www.whitehouse.gov/briefings-statements/president-donald-j-trump-unleashing-american-energy-dominance/

Tsleil-Waututh Nation. (2015). *Assessment of the Trans Mountain Pipeline and Tanker Expansion Proposal*. Retrieved from https://twnsacredtrust.ca/wp-content/uploads/2015/05/TWN-Assessment-Summary-11x17.pdf

U.S. Energy Information Administration. (2019). *Financial Review: Third-Quarter 2019*. Retrieved from https://www.eia.gov/finance/review/pdf/financial_q32019.pdf

Whyte, K. (2017). The Dakota Access Pipeline, environmental injustice, and US colonialism. *Red Ink, 19*(1).

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Figures

Figure 1: Natural gas gathering and transmission pipelines in the conterminous US, with social vulnerability index shown for each US county. Alaska and Hawaii are included in statistical analyses but are not shown. See supplementary materials for a description of methods.