

Balancing energy security and a healthy environment

Policy recommendations for Vaca Muerta's hydrocarbon development

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Key messages

- The concept of a global and just transition away from fossil fuels calls for different levels of responsibility among countries, with lower-income countries such as Argentina given wider latitude to continue extracting fossil fuels for its own economic development.
 - Non-conventional fossil fuel production, known as “fracking”, has grown in Argentina’s Vaca Muerta region in the past decade, with plans to accelerate these activities.
 - Using the spatial data platform OBSERVAR, we find that more than 3000 fracking wells pose a contamination risk to local water sources, farms and population centers, threatening public health and livelihoods.
 - We recommend greater regulations and oversight over fracking activities and increased transparency from oil companies so local governments can make informed decisions and protect the public.
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Introduction

Policy debates on fossil fuel extraction and climate change focus on what entities get to produce and how much, amid conflict between economic growth and mitigating impacts of climate change. They rarely address *how* it is produced and the trade-off it creates between better economic outcomes at the national level and the detriments to environmental and community health locally.

This brief presents the case of shale gas and oil production in Vaca Muerta, a large hydrocarbon-rich geological formation located in the northern Patagonia region of Argentina. The formation underlays the provinces of Neuquén, Río Negro, Mendoza and La Pampa. In recent decades, the oil-rich area has gained importance in national energy



security and macroeconomics, based on its exploitation potential of 308 trillion cubic feet of natural gas and 16 billion barrels of oil (EIA, 2015).

Proponents of Vaca Muerta's exploitation consider these reserves a significant opportunity to increase the country's hydrocarbon production, reduce its dependence on foreign oil, and promote regional development through job creation and technological advances in extraction. Hydrocarbon production in Vaca Muerta currently yields about 400 000 barrels per day (Mejor Energía, 2024). Plans to expand production to 1 million barrels daily by 2030 as part of a 2013 agreement between Chevron and YPF, a mostly state-owned Argentine energy company, would generate total revenues of USD 30 billion in exports by 2030 (Rystad Energy, 2023). At present there are 11 operators with Pan American Energy and Tecpetrol, two of the biggest gas producers (Aleph Energy, 2023). However, under the current operations and policy, the environmental and social impacts will be extensive, leading to potentially devastating outcomes locally.

Data availability and access challenges

The rate of fossil fuel production expansion in the Vaca Muerta region has led to a piecemeal regulatory approach at the municipal and provincial levels, with some enforcement of the environmental policies already in place. An initial study indicated that lack of data and transparent information on the impacts of non-conventional fossil fuel production (known as "fracking") on local resources was a great concern among community members (Forni et al., 2021).

SEI, in collaboration with the Faculty of Agricultural Sciences at the University of Comahue, are addressing these data needs by collecting and processing existing quantitative and qualitative data on potential impacts of fracking on the local environment and livelihoods. The goal is identifying hotspots of fracking activity to collect environmental data that can inform decision-making on local regulations for oil production. The team leveraged geospatial data derived from remote sensing (Planet® and Sentinel-2), local studies, official databases and interviews with local experts and civil society to develop spatially determined indicators for the environmental impacts of fracking. These data and information were used to develop an online platform at (OBSERVAR, 2024), which helps a diverse user base evaluate potential environmental risks from fracking. While remote sensing and local knowledge have improved the potential for analysis, some data, such as oil companies', have remained difficult to obtain or decipher.

Data platform OBSERVAR

The open-access platform we created is freely available on the web, developed on the open-source Google Earth Engine service. Users can examine the environmental implications of fracking expansion by using the interactive map and use the data to inform policies. The platform's mapping tools contain location-based indicators of wells' environmental risk that respond to challenges shared by local professionals and stakeholders. Fracking wells that are close in proximity to water resources, human infrastructure and other oil increase risk of pollution. To reflect the importance of these considerations in policymaking, we developed a user-friendly mapping tool that allows stakeholders the ability to visualize fracking risk.

Indicator on well proximity to water sources, farms and population centers

This indicator measures proximity to water sources, agricultural areas, and populations to signal risks to the environment and public health. It is derived from peer-reviewed literature using data from the United States and Europe that links well locations with contamination risk (Meng, 2015). Figure 1 shows the proximity of wells to these sensitive areas in the communities of Barrio Isla 10, Barrio Emergente, Barrio Costa Oeste and Barrio Calle Ciega No. 10. Overall, in provinces of Río Negro and Neuquén, 3017 fracking wells are within high-risk proximities (less than 1 km) to rivers, population centers, schools and agricultural irrigation canals, and 2430 are located at medium-risk proximities (1–2 km).

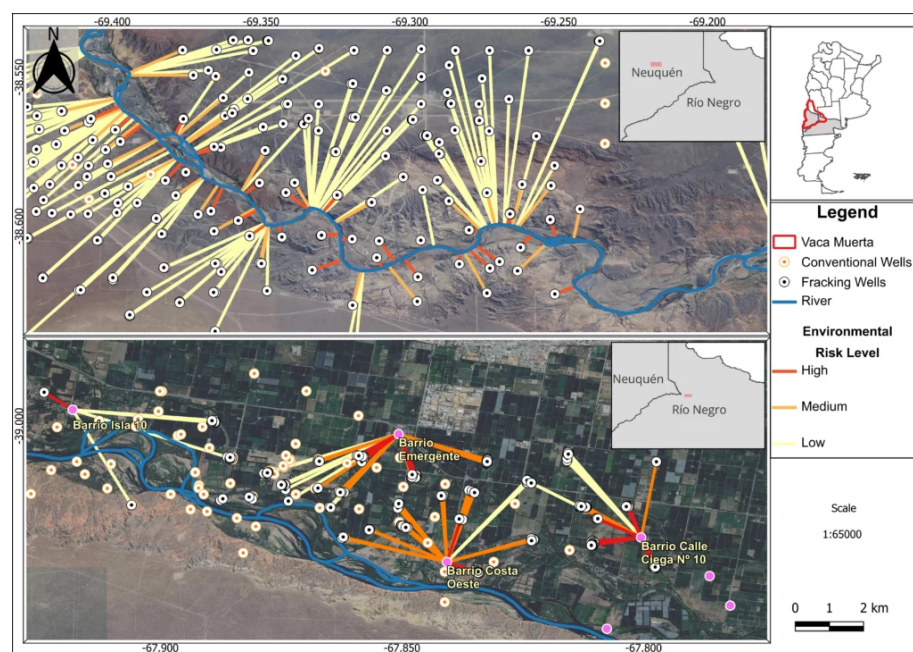


Figure 1. Map of proximities of fracking wells to a) the Neuquén River in the Sauzal Bonito region (top), and b) to populations in the localities of Barrio Isla 10, Barrio Emergente, Barrio Costa Oeste and Barrio Calle Ciega No. 10 (bottom).

Image: [OBSERVAR / SEI](#)

Indicator on well proximities to evaluate contamination risk from well failure

The high pressure and seismic activity induced by fracking can damage nearby, older conventional oil wells (Loveless et al., 2019), which can, in turn, contaminate the surrounding land and water sources. Figure 2 shows an example of one of the zones for potential interaction between wells due to fracking operations to determine the areas with possible risks of oil leakage to groundwater. The platform shows that an area of 202 km², equivalent to the area of the city of Buenos Aires, concentrated mainly in the province of Neuquén, is at high risk of leaks and subsequent contamination because of the risk fracking poses to these older oil wells. In a recent case, a local farmer, Norma Ramírez, found oil in her farm's groundwater, originating from a conventional oil well that was estimated to have been leaking oil for a year, likely resulting from this interaction between wells (Álvarez Mullally, 2023).

unaccounted for. Looking at the wells reflected in the available data (Figure 5), 2729 wells show data on fracking water and produced water, while 865 wells have no data on fracking water, but small amounts on produced water. This means that almost one-quarter of wells in the effective extraction category only have information on flowback water, and not on the volume of water that was injected initially. This indicates that the data collected does not reveal the true scope of water used. Only 10 wells contain data on reuse, and two on disposal water, which is wastewater going to sink wells. A miniscule percentage of the millions of litres of water used to produce oil and natural gas are tracked after use, let alone treated and reused. In addition, local reporting has documented claims from residents that fossil fuel companies were throwing this polluted water into public sewers, questioning the companies' wastewater management (Calalesina, 2024).

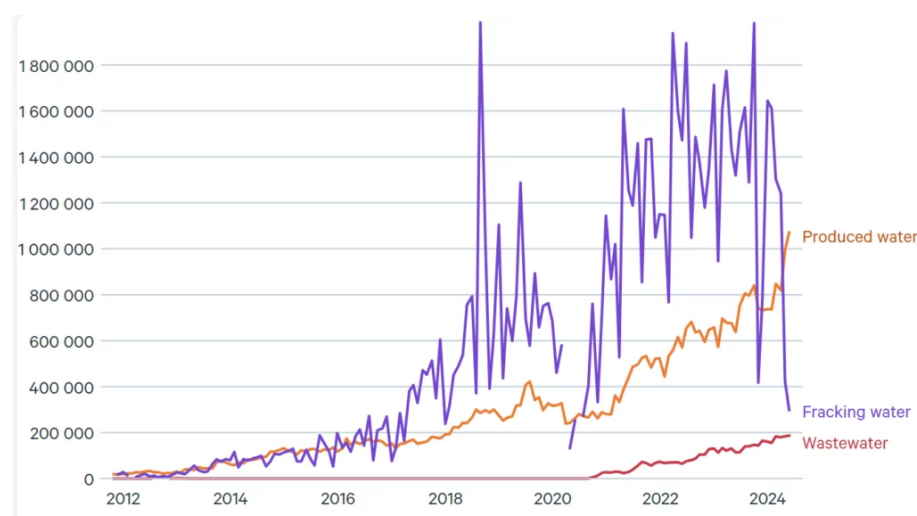


Figure 4. Volumes of fracking water (water used for fracking), produced water (flowback), and wastewater (water that goes into pozos sumideros or is reused). Note this is the data reported, which means it could be undercounted for at least one or for all of these categories.

Image: SEI

Policy considerations

Each province has different environmental policies, particularly on water policy for fossil fuel extraction. This provides an opportunity to examine with greater detail the contamination risks posed by fracking to surface and groundwater sources in each watershed, and to foster greater decision-making participation from established local basin authorities, such as the Interjurisdictional Authority of the Limay, Neuquén and Negro River Basins (AIC) and the Interjurisdictional Committee of the Colorado River (COIRCO).

Key characteristics of the provincial environmental policies

The province of Neuquén enacted in 1975 a water law (Legislatura Provincia del Neuquén, 1975) which, together with decree 790/99 (Legislatura Provincia del Neuquén, 1999), establishes a regulatory framework. This framework guides the sustainable management and protection of water resources across the province, prioritizing human consumption and irrigation over industrial water use. Decree 1483 (Legislatura Provincia del Neuquén, 2012) contains the norms and procedures for fracking, which states that the Subsecretary of Environment and Sustainable Development can request

an environmental risk analysis (Article 3). Decree 1483 also restricts groundwater use for fracking, especially in the top 100 metres below the ground (Article 9). Surface water use is restricted during peak demand in low flow periods to ensure sustainable water supply (Article 8). The purpose of these regulations is to protect groundwater and surface water resources for essential human needs (IARH, 2024 – time 1:05:30). Flowback regulation requires the reuse of flowback and disposing it in *pozos sumideros*, or disposal wells (Article 10). The disposal of flowback to surface water bodies is prohibited and it cannot be stored in open-air receptacles (Article 11). The regulation also mandates a monitor for each disposal well.

Regulations for the province of Río Negro are somewhat different. Río Negro has Law 2952 (Legislatura de Río Negro, 1995), which, like Neuquén, prioritizes water allocation for the different sectors. However, one important detail is that while the highest priority of water allocation are the human populations (same as Neuquén), it also includes industries with low levels of consumption within the first priority. Irrigation is second priority, and third is other uses. The law is ambiguous on what low levels of consumption for industrial uses are and how that applies for fracking. In addition, Río Negro's regulation is broader than Neuquén's on controls and monitoring, since it follows the national policy from 1993. With the recent expansion of fossil fuel industries and the complex environmental challenges in the basins, along with new knowledge about the environmental impacts of fracking, it would be advisable to update the regulations, particularly the Río Negro province, following those proposed by the AIC (Cifuentes & Labollita, 1996; Menone et al., 2021)

Key implications of these policies

In Neuquén, there is a stronger regulatory policy structure than in Río Negro to safeguard the environment and people from the potential harm of fossil fuel extraction. However, it is unclear if the enforcement of Neuquén's regulatory policies is adequate, given the increase in fracking in the past decade and the ongoing budgetary restrictions from the national government, affecting public organizations at the provincial level. Río Negro needs more rigorous policies entirely. Conversations with local experts indicate that provincial public institutions need greater financial support to ensure adequate monitoring efforts. Ensuring policy enforcement is highly important now and especially in the coming years, with the planned exponential growth of the number of barrels oil industries will produce per day. One reason for the need for stronger budget support is the unavailability of clear and transparent data and information on the wells and the lack of reporting of the quantities of waste disposed. For example, while the regulation requires that all flowback is either reused or disposed of, the data available shows that only a small portion of flowback is disposed (Figure 4). The vast majority of flowback is unaccounted for, with only two disposal wells containing data, masking where most wastewater is disposed (Figure 5).

In Río Negro, the environmental policy is less detailed than Neuquén's, and it has more reported incidents of contamination. Figure 6 shows the location of publicly reported incidents of groundwater contamination caused by oil leakage from conventional wells located near fracking wells. The figure focuses on one fracking well to show its proximity to two publicly reported oil spills into the groundwater, named for the families Ramirez and Pedernera. The local university received accounts of five families reporting incidents in the region. The media has also reported other incidents, with details of

these found in Orrego et al. (2023). The image on the top-right corner of Figure 6 shows the provincial boundary between the two provinces, divided by the Neuquén River, and the risk areas from well interaction.

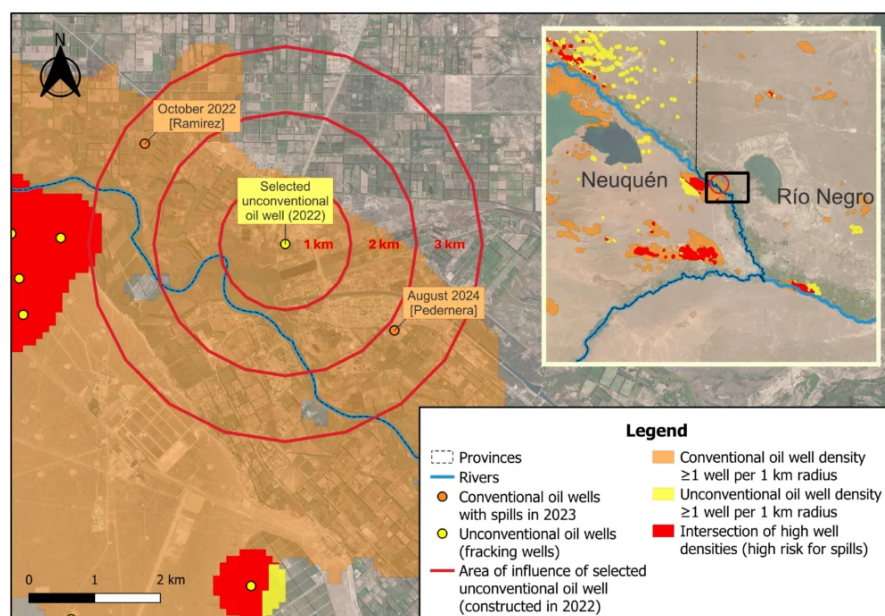


Figure 6. Main map shows two public incidents (Ramirez and Pedernera) near a fracking well from 2022, where fossil fuel contamination of groundwater occurred. Fossil fuel leakage came from conventional wells. The top-right corner map shows the location of interaction areas between conventional oil wells (orange), unconventional oil wells (yellow) and conventional and nonconventional (red), as well as the red circle around the contamination incidents from a watershed view.

Image: OBSERVAR / SEI

The highest concentration of wells is in Neuquén (Figure 6). The natural configuration of the river is such that the floodplain is on the east side (Río Negro), where the rich agricultural area is located and where most of the incidents occur. Therefore, policy considerations on regulating fracking's water impacts must transcend political boundaries and encompass the natural basin. While Neuquén approves and monitors wells on their side of the river, the impacts can extend to the other side in Río Negro (OBSERVAR, 2024). Policy, regulation, monitoring and decisions about well approval should be considered within a watershed framework, and therefore, the interprovincial basin authorities should have more power to provide regulatory input.

Recommendations

Based on our research, we recommend the following key policies:

- **A more active role from AIC and COIRCO** as watershed governance institutions that can review the legislation. The watershed needs integrated water resources management with greater technical and administrative capacities, as well as more personnel and infrastructure to carry out oversight with improved, updated and modern regulations. These institutions need more funding, along with enhanced coordination and participation within a watershed perspective. Involvement from other professionals and institutions working on this issue is also essential.
- **More transparent and accessible information on industry operations** that includes relevant data and information, particularly on regulatory enforcement and reporting

obligations from the industries. This includes better reporting on: volumes of water use, location of water withdrawals, and wastewater management and disposal; planned treatment and reuse of wastewater; the location of planned fracking wells; and publishing environmental impact assessments.

- **Before approving new fracking wells, the condition of older conventional wells should be reviewed.** The Río Negro provincial government will open a bidding process in the coming months for fracking in the area north of Cinco Saltos (Government of the Province of Río Negro et al., 2024). The area's conventional wells should be inspected for safety before fracking begins because of the risk the proposed wells pose to groundwater sources and proximities to the Lake Pellegrini.
- **Creation of buffer zones** (from, for example, water sources, agricultural areas and population centers) as part of territorial planning and in connection with the above-mentioned recommendations. One consideration is to prohibit drilling in high-risk areas, namely spaces within 1 to 3 km of schools, population centers and waterways, as shown on OBSERVAR.

The region has only reached 40% of planned production. The industry plans to continue expansion over the next five to 10 years, and without strengthening oversight in all provinces, the potential environmental damage could be catastrophic and irreversible.

Conclusions

The principle of a global just transition from fossil fuels calls for a gradual phase-out of fossil fuels, prioritizing lower-income countries' use of hydrocarbons for economic growth in response to climate equity concerns.

However, in Argentina, environmental regulatory and monitoring processes are lacking and the available data is not easily accessible. Monitoring contamination in water and soil needs to be expanded in high-risk areas using OBSERVAR to prioritize areas. Reducing environmental impacts to ensure the sustainability of natural ecosystems is needed to prevent potential harm to local communities and agricultural production areas that are entirely dependent on irrigation water.

Balancing the tensions between fracking-fuelled economic development, environmental health and social equity in the Vaca Muerta region is a challenge. Local communities face environmental risk requiring swift action in the form of environmental policymaking and enforcement. This study shows how one case in Argentina underscores the global importance of monitoring and spotlighting the environmental impacts of fracking so that the race for fossil fuel extraction in lower-income countries does not cause irreparable local damage.

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