SUSTAINABILITY LESSONS FROM THE UNITED STATES TO MEXICO'S SHALE FRONTIER

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Introduction

Mexico has a lot to learn from the advent of **hydraulic fracturing** in the United States, keeping in mind that **although this industry reversed the decline of hydrocarbon production** in this country, it has also subjected many communities to **great environmental and public health damage**. As such, this paper draws lessons from the United States regarding the issues of **land clearing, volumetric consumption of water, waste management, local community impacts, and significant emissions of green house gases and volatile organic compounds**, presenting a summary of **early warnings** regarding Mexico's nascent shale gas industry aimed at advising the Ministry of Energy (SENER), the National Hydrocarbons Commission (CNH), and the Agency of Security, Energy and the Environment (ASEA) as they develop regulation to address Mexico's shale development; while informing academics, non governmental organizations, and the public in general about the main concerns regarding Hydraulic Fracturing.

Background

The advent of **hydraulic fracturing** in the U.S. has dramatically changed the oil and gas industry. Since 2008, this country has **increased** its **production** of oil and natural gas by almost 85 billion cubic meters/year and crude oil by over 3 million barrels per day (*US EIA 2014*).

The marked rise in drilling activity along with new drilling methods meant that **regulations were slow to catch up** (*Brady and Crannell 2012*) , and given that the federal government avoided the question, it was left up to states to fill this gap which resulted in **different regulatory approaches** for hydraulic fracturing **across the United States**.

Operators have the greatest information regarding the hydraulic fracturing process, however they are not always willing to disclose it. More recently, academics, non-governmental organizations (NGOs), and government have begun developing research to address this information asymmetry which has shed light into the **impacts** that this industry has caused in the U.S. which are mainly: **water contamination, air pollution, ecosystem disruption, spills, releases of toxic materials, greenhouse gases (GHG) and volatile organic compounds, strained resources, public health concerns, noise, traffic, and increased crime.**

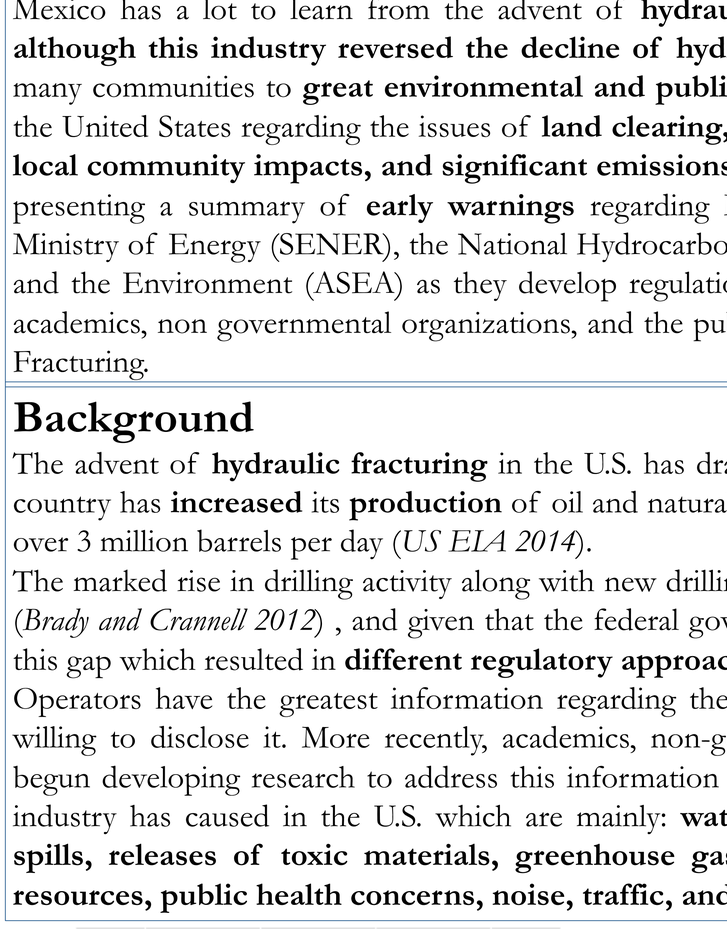

Figure 2: Water Use per Well (Cubic Meters), (Skytruth 2014) Evidences the volumetric consumption of water in Hydraulic Fracturing.

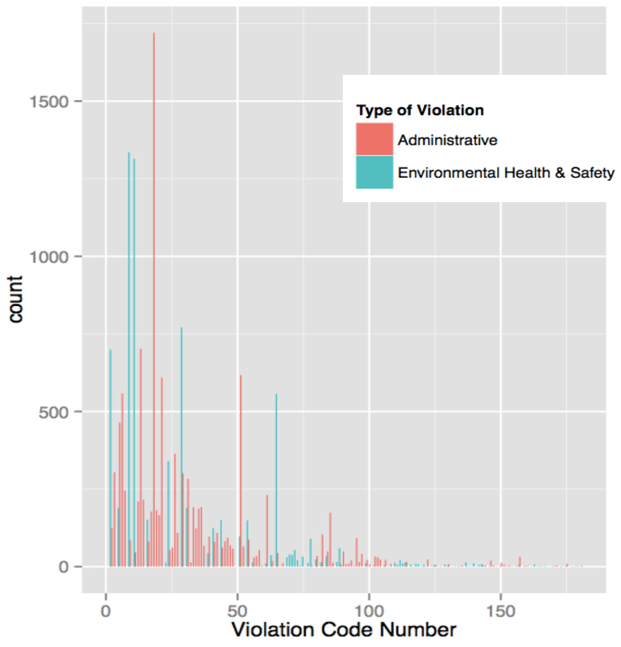

Figure 4: Frequency of Violations from Operators by Violation Code in Pennsylvannia, (period from 2010 to 2014)

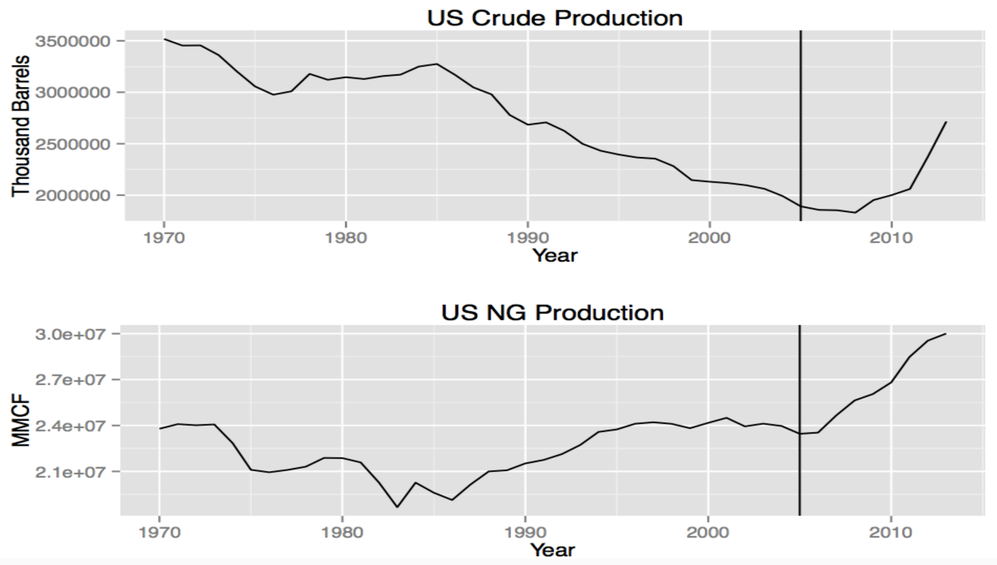

Figure 1: US Oil and Natural Gas (NG) Production, (US EIA 2014a) Through the development of hydraulic fracturing, production volumes increased significantly. This is evidenced by the reversal of the U.S.'s decline in production shown in this figure.

Main Environmental Impacts in the U.S

A) Land Impacts: 1) Land clearing: Portion of land required, estimated to be at 7.4 acres or roughly 30,000 square meters., **2) Toxic Spills:** A study by *Adams (2011)*, simulated a spill of hydraulic fracturing fluid upon an experimental forest. The forest experienced significant mortality: "Two years after fluid application, 56% of the trees within the fluid application area were dead", **3) Poor Restoration Activities**: Which did not allow for the recovery of the impacted land.

B)Air Impacts: 1) GHG Emissions: The massive addition of natural gas for electricity production increases the overall greenhouse gas emissions derived from power generation. There is also a negative net effect due to methane leakages that outweigh any carbon reduction benefits derived from natural gas replacing more carbon intense fuels for electricity generation, **2) Volatile Organic Compounds Emissions**: Which are toxic precursors to ozone. To be more specific they are benzene, toluene, ethylbenzene, xylenes, BTEX, and n-hexane (US EPA 2011a).

C)Water Impacts: 1) Volumetric Consumption of Water: According to "*FracFocus*" in the United States the scale of water demands for hydraulic fracturing is in the ranges from 22,290 to 1,994,000 cubic meters total per day, **2) Surface Contamination of Aquifers**: Generally caused by spills, leaks and accidental releases, **3) Subsurface Contamination of Groundwater:** Most likely due to poor cementing measures in the annulus of the well, given that migration from deep shales is unlikely.

Main Community Level Impacts in the U.S

The **visual and audible impacts** of oil and gas are some of the largest complaints that communities have regarding development. In addition to this, hydraulic fracturing activities cause **significant increases in traffic and the consequences thereof**: traffic accidents, local air pollution, and wear-out of roads.

Moreover, **public health damages**, arise from several **exposure pathways** mainly: **drinking water, skin contact, soil and food, and the atmosphere**. The exact damage and health risk is largely **dependent on concentration and vector of delivery**, and the toxicity potential of the compounds and its derivations,. This strongly suggests the **need for full disclosure** from operators in terms **of chemicals used, and accidental events**.

In regards to **crime increase** in communities that surround these developments it has been show that: "…shale-rich counties experienced **faster growth in rates of both property and violent crimes** including rape, assault, murder, robbery, burglary, larceny and grand theft auto (*James and Smith 2014*).

Violations

To demonstrate risks from operators practices, we analyzed data from Pennsylvania (*PA DEP 2014*). The five most **frequent violations** were: **failure to plug a well** (9.8% of total), **failure to minimize accelerated erosion, implemented environmental safety (E&S) plan and maintain E&S controls** (7.6% of total), **failure to properly store, transport, process or dispose of residual waste** (7.5% of total), **failure to adopt pollution prevention measures** prescribed by DEP by handling materials that create a danger of pollution (4.4% of total), and **failure to submit well record within 30 days of completion** of well (4% of total).

Recommendations

- Creating a new **independent and transparent agency** to oversee the industry with **representatives from academia, NGO's, and members of impacted communities.**
- Establish **baseline registry** for **water quality, ecosystem characteristics, biodiversity and air quality** before hydraulic fracturing operations begin.
- Develop **codes** for **cement casing, infrastructure, and waste management**.
- Requiring the use of methods of **separation of hydrocarbons from produced water** aimed at removing total suspended solids.
- Requiring the submission of accidents and spills **contingency plans** by operators as part of the permitting process.
- Establish mechanisms to ensure that **operators are responsible for remediation, cleanup and restoration activities**.
- Promote **public engagement and transparency**.
- Ensuring the **public** has a chance to be involved in shaping plans through a mixture of **participation channels** (online, written, face-to-face meetings, etc).
- Establish mechanisms to ensure **periodic audits** to operation sites establishing a public record to document every inspection.
- Develop a strong violations code with associated onerous **fines and/or criminal liability depending on the severity of impacts**.

Lessons Learned for Mexico

Jenner and Lamadrid (2013) put the cost-benefit analysis in terms of a direct comparison with coal and concludes **that any benefits rely on an thoroughly effective environmental management program**.

The benefits of hydraulic fracturing must always be weighed against the harms it causes to communities and the environment. If hydraulic fracturing is to be pursued, **transparency in the regulatory processes and dynamism of the framework are crucial** to keep up with the fast growth pace of this industry and to ensure **public preparedness** for its activities. If policy efforts are directed towards preventing and restoring all potential associated impacts, hydraulic fracturing can give high returns at low environmental and societal costs, but **if not carefully addressed the results may be devastating** and the costs too high to bear.