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Fracking equity: A spatial justice analysis prototype

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ABSTRACT

Although current environmental justice analyses shed light on fracking and fracking's environmental and public health policy, a comprehensive justice analysis framework is needed in order to cover the policy gap of fracking impacts on the total environment, communities, and sustainability. Based on a concise summary of the effects of fracking on the total environment, the society and economy, and land use, this brief communication designs a conception of fracking equity and its spatial justice analysis prototype. Fracking equity is much beyond the scope of current environmental justice or social justice that is spatially limited within certain distance to fracking wells. Fracking equity based on the benefit and harm associated with fracking, not only encompasses environmental justice, social justice, but also emphasizes all stakeholder groups, the spatiotemporal characteristics of the justice of fracking, sustainable development, and the integrated analyzing methods including GIS, decision making, demographic analysis, spatiotemporal modeling at different scales, and long term analysis of fracking equity. Spatial justice of fracking unites the environmental, social, economic, ecological factors and their processes that are temporally changing and reshaping the space people live in and depend on, and these complicated factors and their dynamic interactions are the core of spatial justice.

1. Introduction

After more than one decade's development, hydraulic fracturing, i.e., fracking, has been a dominant technique for natural gas and oil mining from unconventional petroleum reservoirs across the world. In the U.S. from 1947 to 2010, there were about 1.8 million fracking records (Gallegos and Varela, 2014), and currently fracking is also called high volume hydraulic fracturing that has been employed across 21 states, where the available fossil fuels are different and fracking techniques change. Typically at each fracking well, about 8000–80,000 m^3 of water with proppants of sand and numerous types of chemicals are injected into reservoir with high pressure (e.g., about 10,000–20,000psi) to fracture impermeable reservoir rocks (Jackson et al., 2014; Meng, 2015). The United States, South Africa, Russia, Poland, Mexico, Libya, France, China, Canada, Brazil, Australia, have natural gas reservoirs with at least about 3×10^{12} m^3 (Jackson et al., 2014); and many of these countries have started fracking.

Fracking has caused significant effects on the total environment through huge amount input and output of air, liquid, and solid disposals with numerous complicated chemical components in the processing of drilling and fracking (Meng, 2017). For instance, scientists have been focusing on fracking related ground water and drinking water pollution. Although the fracking regulation has been issued by the U.S. Department of the Interior (2015), wastes and wastewater from fracking are still poorly monitored, which is not managed as hazardous waste by the Resource Conservation and Recovery Act. In the Uinta Basin, Karion et al. (2013) found about 55,000 ± 15,000 kg CH_4 leaking into the atmosphere per hour; Pétron et al. (2014) estimated about 4% leakage in the Denver Basin, Colorado. Fracking pads and the lined pits for containing wastewater change the affected surface soil and harm vegetation, which can also extremely impact on the neighboring environment (Meng, 2015; Meng 2017). Osborn et al. (2011), Steinzor et al. (2013), Rabinowitz et al. (2015), and Wener et al. (2015) have found significant increases of methane in drinking water wells and increased occurrences of upper respiratory and dermatologic problems. Atkinson et al. (2016), Petersen et al. (2015), Schultz et al. (2015a,b), and Skoumal et al. (2015) revealed the spatiotemporal association between seismicity and fracking in USA, Canada, and Poland.

However, people have recognized that the increasing use of natural gas has significantly improve emission reduction (Venkatesh et al., 2012; Lu et al., 2012a,b). For example, in the United States, given per unit of energy produced, natural gas electricity plants only emit about 44% of CO_2 compared with coal power plants, and about 40% emission reduction of NO_x and 44% reduction of SO_2 (De Gouw et al., 2014), which are significant contributions to air quality and climate change mitigation.

In addition to the pollution and damages to physical environment, fracking also causes huge changes of anthroposphere by developing new transportation networks and establishing large concrete fracking pads by bulldozing the original land cover (Meng, 2014, 2015, 2016).

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Based on the current scientific studies, Meng (2017) summarized the total environmental impacts of fracking across atmosphere, hydrosphere, lithosphere, biosphere and anthroposphere, and proposed a total environmental study paradigm including total 26 scientific fields, which include many critical environmental aspects of terrestrial biomes, climate change, watersheds, ecological niches, wildlife habitats, species invasion, geomorphology, weathering and soil erosion, and land degradation.

Public health concerns caused by fracking have been recently reported in different studies according to the chemical releases from drilling, fracking, and wastewaters. Hill (2013), McDermott-Levy et al. (2013), McKenzie et al. (2014), Rabinowitz et al. (2015), Bamberger and Oswald (2015), and Stacy et al. (2015) reported potential health problems including neourologic, respiratory, gastronintestinal, dermatologic, vascular, mental health, and pregnancy and infant health. Therefore, based on the potential public health problems caused by fracking, researchers have started the environmental justice studies of fracking. Using the state of Pennsylvania as an example, Clough and Bell (2016) conducted a distributive environmental justice study, in which they examined whether fracking's hazards are related to the proximity of fracking wells and whether the benefits from fracking industries are fairly distributed. Based on right-based environment justice, Short et al. (2015) stated that significant harms to residents should be evaluated and addressed in the process of fracking. Ogneva-Himmelberger and Huang (2015) and Fry et al. (2015) emphasized that both hazard distribution and benefit sharing associated with fracking needs to be fair. Additionally, what are the stakeholders who need to involve in decision making for fracking regulations and selections of fracking locations need to be concerned in current environmental justice and social justice studies of fracking.

Recently, the conceptualization of energy justice was discussed by scientists such as Hernández (2015), McCauley et al. (2013), which focuses on energy policy and the theme of energy systems so that all people across all areas are provided with safe, affordable and sustainable energy. Hernández (2015) further concluded the four types of right to healthy and sustainable energy production, to best available energy infrastructure, to affordable energy, and to uninterrupted energy service. From a worldwide viewpoint, Sovacool and Dworkin (2015) described energy justice as a decision-making framework in order to make eight types of decisions including availability, affordability, due process, good governance, sustainability, intergenerational equity, intragenerational equity, and responsibility. The conceptualization of energy justice is a good guidance for the justice of the global energy resource exploitation, but how the above four types of right and the eight types of decisions can be applied to local or regional (in)justice issues related to fracking has not been discussed. For example, besides the above four types of right, how about the right to unpolluted water and air, unpolluted soil, natural landscapes, unharmed rural landscapes and urban landscapes (e.g., amenity values), and the right to the sustainability of ecology and wildlife habitats, and all the other elements of the total environment that fracking impacts on. More often we observe fracking in rural regions that provides gas and oil for urban use, but sometime fracking occurs in urban landscapes, how these beneficial and harmful aspects can be balanced locally and regionally is also challenging and has not been addressed. Fracking has created a totally new, complex, and controversial environmental policy decision (North et al., 2014).

In short, the (in)justice issues of fracking are much beyond energy supply, availability, sustainability, and the current available policy instruments; these issues related to the worldwide energy needs are more localized, regionalized, and comprehensive including but not limited to fracking in urban areas and rural regions, landscape (amenity values) degradation, environmental pollution, groundwater consumption, air and soil pollutions, and revenue and royalty distribution, which are also spatially differentiated, and for instance, these issues are different from state to state in the United States. A spatial analysis paradigm is needed to fill these knowledge gaps of local and regional (in)justice issues caused by fracking, which has tremendously influences the total environment, social and economic changes, and sustainability including both apparent and hidden benefit and cost aspects across fracking sites, communities, and states (Meng, 2017, 2015, 2014; Clough and Bell, 2016; Ogneva-Himmelberger and Huang 2015).

2. Fracking equity

In this brief communication, we design a new term of fracking equity. Fracking equity is raised as a comprehensive conception, which will enhance the understanding of fracking's impacts on the total environment, the society, and sustainability. The conception of equity represents that all communities should have the same basic needs, the burdens and rewards that should be evenly divided across the communities, and all have the equal opportunity to participate in the policy that should be created and regulated impartially and fairly (Sandag.org, 2004); and temporally, we need to consider its sustainability in a long run. The equity in fracking not only includes potential benefit and harm caused by or associated with fracking, but also emphasizes the involvement of all stakeholders; additionally, the indirect social, economic, cultural, and environmental driving force or any overlooked effects of fracking (e.g., education, neighborhood security, landscape, and others) should also be concerned and be covered by fracking equity, because those issues are related to the basic needs or certain things that the people and community require.

Both environmental justice and social justice are needed in order to have comprehensive understanding of (in)justice aspects caused by fracking. Justice on environmental pollution or exposures to different air pollution and unwanted land uses is called environmental justice (Hernández, 2015; McCauley et al., 2013; Dryzek et al., 2013; Walker, 2012; Schlosberg, 2007). Social justice emphasizes racial and socioeconomic disparities in a variety of health, education, and economic opportunities and burdens (Hernández, 2015; McCauley et al., 2013).

In this proposed fracking equity study prototype, environmental justice focuses on harm or hazard caused by fracking, while social justice concentrates on fracking benefit and benefit sharing (Fig. 1). Environmental justice especially fair treatment and involvement in fracking environmental monitoring, regardless of race, color, national origin, or income is centered on the harms and hazards caused by fracking. Social justice focuses on fracking associated labor market, family income, taxation, education, public services, regulations, and social insurance. We then introduce spatial justice, which emphasizes environmental policy and sustainability that meet the contents of equity, which has been raised by fracking including landscape changes, environmental degradation, land-use abuse, and groundwater pollution; and methodologically spatial justice focuses on both spatial and temporal dimensions of equity analysis or modeling by using GIS and demographic related theory and methods.

3. Environmental justice and fracking

According to US EPA (https://www.epa.gov/environmentaljustice), environmental justice is "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies". Therefore, the specific objective EPA's environmental justice of fracking could be interpreted: to make sure all communities and people enjoy equal access to decision-making of fracking in order to have a healthy living and working environment, and to enjoy the same degree of environmental protection from health hazards caused by fracking (Fig. 1); to the best of our knowledge, it has typically not conducted in practice with all stakeholders to be involved in the management of private landowner's and local community's decisions.

Therefore, environmental justice analysis of fracking needs to focus

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