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Research Paper

Suburbanization and shale gas wells: Patterns, planning perspectives, and reverse setback policies

Matthew Fry[a,*], Christian Brannstrom[b], Michael Sakinejad[a]

[a] Department of Geography and the Environment, University of North Texas, Denton, TX 76203, USA
[b] Department of Geography, Texas A & M University, College Station, TX 77843, USA

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ABSTRACT

From 2002 to 2015, the Dallas-Fort Worth Metroplex (DFW) experienced high population growth rates and booming shale gas production via hydraulic fracturing of the Barnett Shale. In response, DFW municipalities adopted gas well drilling ordinances and enacted setback distance policies to regulate the proximity between new gas wells and homes. However, landscape and planning impacts arising from subsequent development of homes around hydrocarbon extraction sites are unknown. Here, we use quantitative and qualitative methods to 1) quantify spatial and land-use effects of gas well production sites, 2) identify municipal staff perspectives on overlapping gas well and suburban landscapes, and 3) evaluate municipal governance strategies for dealing with subsequent development of homes around production sites. Our results show that production sites occupy approximately 3000 ha in DFW and nearly 2% of surface areas in some high growth municipalities. Over time, developed land covers increasingly surrounded gas production sites. We identified three statistically significant social perspectives among municipal officials, two indicating concern with how gas wells impede future urban development. The majority of municipal governments place the onus on homebuyers to decide whether to live near gas wells, though a few municipalities require notification of their presence. The parallel pressures to develop surface and mineral interests by two powerful industries – property developers and oil and gas operators, respectively – create a complex regulatory and planning environment for municipalities where protections of resident health, safety, and welfare are left to the discretion of corporate entities and social licenses.

> Our elected officials provided for more growth and even gave incentives to companies to build their…subdivisions…Developers believed they had the God-given right to develop the land and make a profit.
>
> – Dallas-Fort Worth resident (Nov 2000), cited in Friedberger (2006)
>
> Because of both production and population growth across this state, our communities are more commonly touched by the development of oil and gas.
>
> – Christi Craddick, Chairwoman of the Railroad Commission of Texas (Dec 2014)

1. Introduction

In the Dallas-Fort Worth Metroplex (DFW), the presence of lucrative hydrocarbons in the underlying Barnett Shale attracted an urban gas drilling frenzy starting in 2001. As gas drilling entered city territories, a new hydrocarbon energy governance pattern emerged: elected and career city officials became responsible for energy production management and began negotiating citizen concerns regarding noise and emissions with the demands of hydrocarbon firms to drill in city territories (Fry, Brannstrom, & Murphy, 2015). However, little is known about the many spatial and political issues created when gas drilling and production enter municipal territories. Here we determine drilling site area and surrounding land covers, which we link to municipal planner and stakeholder views on how drilling sites may influence subsequent land development. Our findings are the first to quantify spatial and subjective aspects of urban drilling in detail, offering a comparison to other sites of hydrocarbon extraction and energy production sited near urban land uses and populated places.

From 2000 to 2015, counties in the DFW area (Fig. 1) added 1.9 million people (a 36.5% increase) for a total population of 7.1 million, the fourth largest metropolitan area in the US (U.S. Census Bureau, 2015a). DFW also is known for its sprawling suburban expansion, dramatic land-use and land-cover change, and a political climate tailored to real-estate developers (Friedberger, 2006; Lyons & Luker, 1998). In the 1980-90s, portions of the Barnett Shale in the DFW area

* Corresponding author.
E-mail addresses: mfry@unt.edu (M. Fry), cbrannst@geos.tamu.edu (C. Brannstrom), msakinejad@icloud.com (M. Sakinejad).

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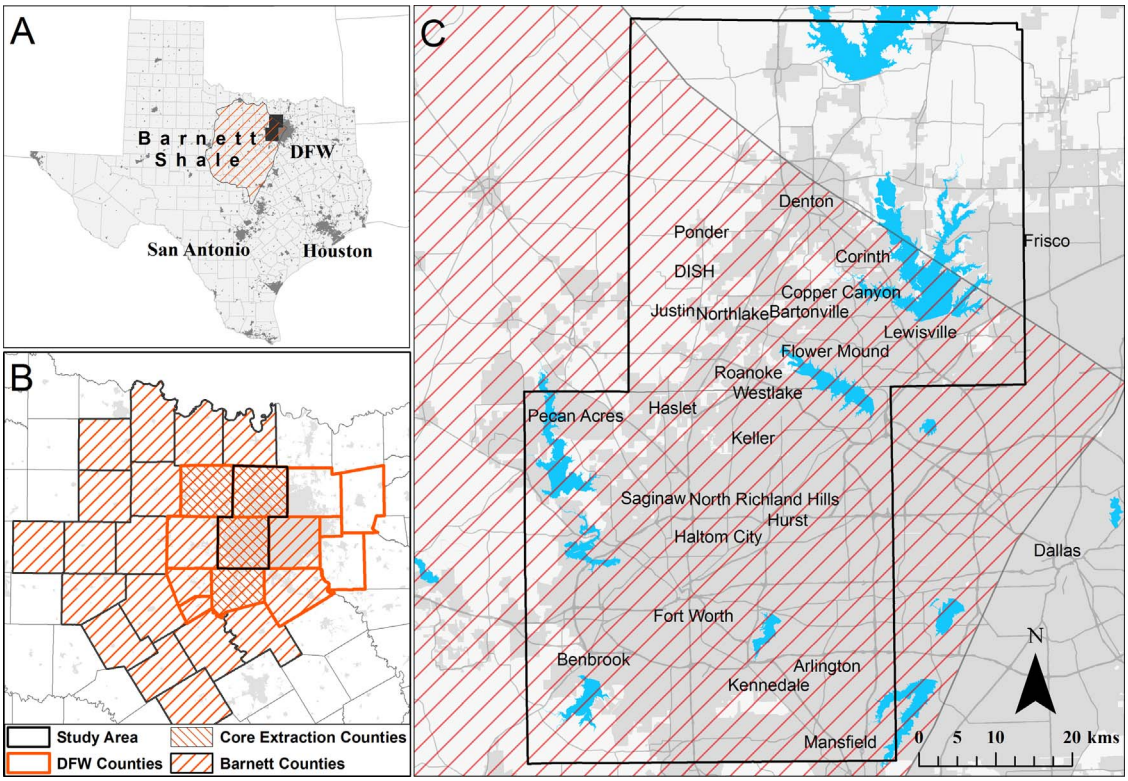

Fig. 1. Study area in Texas and within the Barnett Shale and Dallas-Fort Worth Metroplex and counties (A and B); and selected cities within the study area (C).

became the proving ground for slick water hydraulic fracturing (fracking) techniques, which in the early 2000s combined with horizontal drilling, record high natural gas prices, and lax environmental regulations to make shale an economically viable source for natural gas (EIA, 2015). In 2002, the first shale gas wells were drilled inside DFW municipal territories. Since then, commingling of residential homes and gas well production sites has steadily increased.

In addition to transforming U.S. and global energy sectors, hydraulic fracturing stimulated a highly polarized debate. Proponents pointed to economic benefits, including jobs, taxes, and royalties (e.g. King, 2012; Engelder, 2011; Weber, Burnett, & Xiarchos, 2014), and critics argued against health and environmental impacts, including water contamination, methane emissions, health effects, and earthquakes (e.g. Howarth, Santoro, & Ingraffea, 2011; Kassotis, Tillitt, Davis, Hormann, & Nagel, 2013; Keranen, Weingarten, Abers, Bekins, & Ge, 2014; McKenzie et al., 2014). These debates were amplified in DFW municipal territories where over 4000 wells were drilled since 2002. Peer-reviewed studies on the Barnett shale gas boom and its effects on ground water, earthquakes, and governance processes have been instrumental in clarifying propaganda from facts (e.g. Frohlich, 2012; Fry et al., 2015; Hildenbrand et al., 2015). Yet, to date, there is little data on landscape effects, defined as surface area occupied and surrounding land uses, and municipal planner and stakeholder views on well distribution associated with urban drilling in the Barnett. Although Welch (2013) argues that complex policy issues may arise from urban drilling, he provides few details or empirical evidence. Anderson and Theodori (2009) describe local leader perceptions on the impacts of drilling in the Barnett and Fry (2013) analyzes municipal setback distance policies, but neither discusses how drilling and production sites affect urban planning decisions. In his recommendations for managing urban drilling, Briggle (2013) points out that shale gas development "transforms from a matter of energy policy to a matter of land-use policy as it leaves the abstract realm of commodity and enters the lived place of community." However, he says little about drilling's land-use effects in lived places or how local governments manage drilling and production sites. To address these research gaps, we use land change science techniques to quantify the spatial landscape impacts associated with gas well production sites in DFW. To evaluate how municipal officials and other stakeholders value landscape patterns created by the overlap of gas well production sites and suburbs, as well as assess municipal strategies for dealing with this overlap, we draw on semi-structured interviews, results of Q-method analysis, and textual analysis of key documents and archived city meetings.

The paper begins with a review of relevant literature on land-use change and shale gas drilling, the local landscape effects of drilling production sites, and the challenges urban drilling poses for municipal officials. Because energy systems are multi-scalar, local-level analysis can be used to inform broader trends (Zimmerer, 2011). We focus on the production or pad site—the smallest unconventional hydrocarbon landscape scale—and scale up to examine regional impacts. Following the literature review, we present our methods, results, and discussion sections. In the conclusion, we point to the need for further research into urban land change, oil and gas development, and urban land use decision making.

2. Literature

2.1. Land change and shale hydrocarbons

Although the conversion of agriculture and forested lands to urban uses is a key component of global environmental change (Seto, Solecki, & Griffith, 2015), the expansion of energy production activities or 'energy sprawl,' not urbanization, is the largest driver of land-use change in the U.S. (Trainor, McDonald, & Fargione, 2016). This was particularly apparent in the 2000s when extensive areas of crop and rangeland in the U.S. and Canada were converted to unconventional and shale hydrocarbon production activities (Allred et al., 2015), which led to calls for better planning efforts to balance energy production with land-use change (Hughes, 2013).

Remote sensing and geospatial information techniques can be used