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The Public Opinion of the Environmental and Health Impacts of Shale Gas Extraction in Ghadames Region (Libya)

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ABSTRACT

Shale gas is a form of natural gas found trapped within shale formations. Shale gas is vastly distributed around the world. Recently, there has been increasing interest in exploiting shale gas for energy production. As a source of energy, many countries started to investigate their shale gas potential. To understand the public's views on the extraction of shale gas and its long and short-term health and environmental consequences, this study was undertaken to recognize Ghadames region residents' awareness of the environmental and health effects resulting from the extraction of shale gas in their areas. Ghadames region is located in northwest Libya, where a potential deposit of shale gas is spotted; therefore, it was perfect as a study area. A population survey from a random sample (N=251) drawn from local residents; it was designed to detect the public opinion of the most likely adverse direct and indirect health and environmental outcomes as a result of fracking; the possible benefits were also included as well. The results show that the majority of respondents support shale gas extraction in their hometown, no matter how the consequences will affect their health and environment, about 70% of the respondents show support for shale gas exploitation.

تصور قاطني نطاق غدامس للأثار البيئية والصحية لاستخلاص الغاز الصخري

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النفط في الصخور القشرية هو شكل من أشكال النفط المتشرب داخل التكوينات الصخرية القشرية. ويوجد على نطاق واسع حول العالم وفي الآونة الأخيرة أصبح الاهتمام متزايد لاستكشاف النفط الصخري لإنتاج الطاقة والعديد من الدول بدأت فعلا في استغلال مخزونها من النفط الصخري باعتباره مصدرا للطاقة. لفهم آراء الجمهور حول استخراج الغاز الصخري وعواقبه الصحية والبيئية طويلة وقصيرة المدى. أجريت هذه الدراسة للتعرف على وعي سكان نطاق غدامس بالآثار البيئية والصحية الناتجة عن استخراج الغاز الصخري في مناطقهم، تقع غدامس في جنوب غرب ليبيا، حيث تم رصد ترسبات محتملة من الغاز الصخري فيها لذلك تم اعتبارها مثالية كمنطقة دراسة. تم إجراء مسح باختيار عينة عشوائية (N=250) مأخوذة من السكان المحليين لقدامس و ضواحيها و قد تم تصميم المسح لرصد التأثيرات السلبية البيئية و الصحية المباشرة و غير المباشرة إضافة الى الفوائد المحتملة. أظهرت النتائج أن المستجيبين يدعمون استخراج الغاز الصخري في مناطقهم، بغض النظر عن مدى تأثير استخراجه على صحتهم وبيئتهم، حيث تبين أن حوالي 70٪ من المستجيبين يدعمون استخراج الغاز الصخري.

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INTRODUCTION

Economic growth is reinforced by available energy

sources of various kinds to go parallel with the huge demand of energy. Shale gas extracted through hydraulic fracturing, as a new source of energy, could enhance energy security, hydraulic fracturing and horizontal drilling has fueled a boom in the production of oil from geological formations. The boom has been accompanied by concerns about negative externalities, including impacts to human health, environment, and quality of life in producing regions and contribute to economic and social development. Some energy sources have a particularly controversial side effects. The hydraulic fracturing technique started in the United States of America (Chivers 2013), when the first two small-scale commercial vertical wells were initiated in Oklahoma and Texas respectively around 1949 (Zuckerman 2013; Rogers 2011). The United States of America and China are the two countries which have the largest stock of shale gas (Iwaz 2016), hydraulic fracturing requires large quantities of water with additives considered carcinogenic chemicals, these chemicals are extremely serious for human health. They can lead to severe diseases such as cancer, reproductive problems, and neurological problems (Etzel and Balk 2011). Moreover, the massive amounts of water needed in the extraction process could create heavy demand on the water supply. When considering shale gas extraction, other environmental concerns are also associated with this extraction procedure, including potential impacts on safety, air quality, noise, visual pollution, biodiversity, nature conservation objectives, and even seismic triggering (DEC 2011; Gény 2010). Studies have provided evidence of environmental public health risks related to shale gas development, specifically contributions of pollutants to ambient air linked to increases in risk of morbidity and mortality (Shonkoff *et al.* 2014). By weighing potential benefits against risk of harm from shale gas extraction, it is often assumed that natural gas exploration will provide a great economic prosperity, where the likely range of economic benefits is extraordinarily large, including direct market impacts, positive externalities, incomes, employment, and tax revenues. Aside from directly assessable impacts, there are also associated social impacts that have secondary influence upon community. Within the public health literature, there is an important need to understand not just the biophysical effects of risks, but also the socio-cultural and psychological dimensions of risk perception, and the effect that these have upon resource development (Gény 2010).

Understanding public view towards new energy sources like shale gas is important to include local residents' concerns into decisions regarding oil and gas industry development. Public participation is a tool for establishing democracy and enhance social cohesion

between government and their citizens, especially in the providing of quality and sustainable services (Sangweni 2008). While some find that the impacts and/or risks caused by shale gas exploration are not severe and should not be allowed under any circumstances, others think that such impacts can be controlled and managed through a set of reliable and adequate regulation and risk assessments. Even though there is a push to try the US case and replicate some of the economic successes, the situation in Europe on the topic remains unsteady. Hydraulic fracturing is banned in France, the Netherlands, and Luxembourg due to concerns on the environmental impacts involved (Sovacool 2014). Considering the need to understand and identify the public perception of health and environmental impacts of shale gas exploration and exploitation, this paper examines the public's attitudes to shale gas fracking, including those living in areas where it could be extracted in the future in Ghadames region in the northwest Libya. A designed survey conducted with a multiple variable that asked respondents about the potential health and environmental consequences and beneficial aspects of shale gas development in communities like theirs, as well as public engagement. It is a good practice to include local residents' input into shale gas development decision-making. As a way of detecting latent public concerns at an early phase of a technology development, this study aims to track the public awareness of shale gas and what they believe to be the environmental impacts of its extraction and use, as well as its acceptability as an energy source.

METHODOLOGY

1 Design

As it contains deposits of shale gas, Ghadames region was targeted as a study area to predict the future health and environmental situation (Barbour R 2007; Grisle 2014). A survey was undertaken by involving random samples of individuals of Ghadames region during December 2019 to track the public understanding of environmental impacts of Shale Gas Development (SGD) where fracking is likely to occur in the future based on the proximity to shale basins. The respondents were requested to be part of a discussion about the environment, human health, and energy. Several questions were designed to evaluate public attitude towards the long-short term consequences of the extracting process. Brief general information was sometimes provided to the participants without influencing their opinion.

2. Measures and Materials

The Public Opinions on Fracking Survey data collection period began on April 11, 2019 and continued through August 1, 2019. The total number of people that

have responded to the paper survey was (N = 251), they were randomly selected for survey participation. Analysis was performed in accordance with agreed norms on qualitative data analysis (Xiao and McCright 2015; Mason 1996; Potter and Wetherell 1987). The first part of the survey refers to the respondent's information and location, where participants were chosen from Ghadames region as relevant residents. Other criteria used to ensure a variety of views were age, gender, levels of education, household income, and socioeconomic status. Comparisons of the distributions of socio-demographic variables like gender, age, levels of education, and household income between survey data is a widespread method for evaluating the likely of nonresponse tendency (Groves; Smith 1983; Theodori and Douglas 2019).

The second part of the survey was designed according to multiple aspects related to health and environment to measure public attitudes and beliefs about shale gas exploration. The most important part is hydraulic fracking, which needs excessive quantities of water and discarding contaminated water. Besides, more items were designed to detect the participant's awareness about the health and environmental outcomes of the process. The familiarity of shale gas development was assessed by the question (have you ever heard of shale gas before?). In addition, the respondent's knowledge about the hydraulic fracturing process was estimated using a single survey. The hydraulic fracturing process is used to extract oil from shale formations. Would you say that you have heard about this technique, or have you never heard about it before? (Borick et al. 2014). Participants were also asked if they think the hydraulic fracturing process is a positive or negative expression. Another item was included to measure how serious do they think that hydraulic fracturing would impact the president's health, safety, and environment. Participants were asked to rate the risk on a scale from 1 to 10, where 1 indicates no risk and 10 indicates extreme risk. For those who think the hydraulic fracturing is negative expression, an item was designed to weigh the most health and environmental parameters influenced. (What is the most important risk related to hydraulic fracturing in Libya? (water problems, health issues, land destruction, earthquakes, gas leaks, safety issues, environmental damage, air pollution and ecological damage). Another question related to energy, regulations, and laws were involved to reflect the public understanding. Several items were set for weighing up the benefits of SGD, such as socio-economic development. An important item analyzed in this study was an overall question that asked participants; "Counting everything, do you support or oppose SGD in Libya?" (Evensen et al. 2017). For all subsequent analysis, IBM SPSS Statistics, version 22 (2013) was used.

RESULTS AND ANALYSIS

1 Demographics Characteristics

Age, gender, and education are most common socio-demographic variables to predict public views toward shale gas development; the sample was 55.8% female, level of education ranged from some high school to postgraduate with around 2.4% were high school graduates, 10.8% had some college or trade school, 51.8% were college graduates, and 33.1% completed post-graduate study. Table (1) below shows the participant's demographics characteristics of respondents.

Table (1) Participants demographics characteristics

Age group	
16-24	5.6%
25-34	12.4%
35-44	53%
45-54	10.3%
55-64	14.4%
≥ 65	4.4%
Gender	
Male	44.2%
Female	55.8 %
Monthly Family income	
Less than 750	7.2%
751-950	37.5%
951-1200	21,5%
1201-1500	5.2%
1501-2000	26.7%
2001-3000	2%
Education level	
Primary	0.4%
High School Graduate	2.4%
Some College or Technical School	10.8%
College Graduate	51.8%
Graduate or Professional Degree	33.1%
Not sure	1.6%
marital status	
Single	28.5%
Married	65.1%
Divorced	8%
Widowed	5.6%

2. Familiarity With The Sale Gas Extraction

According to previous studies and available geological, geochemical exploration, and basin modeling studies performed by the National Oil Corporation of Libya (NOC) and other companies, all indicating the presence of many thick formations of shale gas, such as Cretaceous shales in the Sirte Basin, and Silurian, and Devonian shales in the Ghadames and Murzuq regions (Abualkhir E 2016). Mass media also may influence public awareness and discourse of fracking as well (Boudet et al. 2014; Vasi et al. 2015).

Participants were asked to indicate the amount of knowledge they have about shale gas. Most respondents (89.9%) claimed to know a lot about shale gas technology. The mean level of familiarity with the process of hydraulic fracturing was 1.14 (SD = 0.348). Regarding respondent's knowledge about hydraulic fracturing process, 57.4% were familiar with the process, while 14.1% were not sure. The mean level was 1.57 (SD = 0.727).

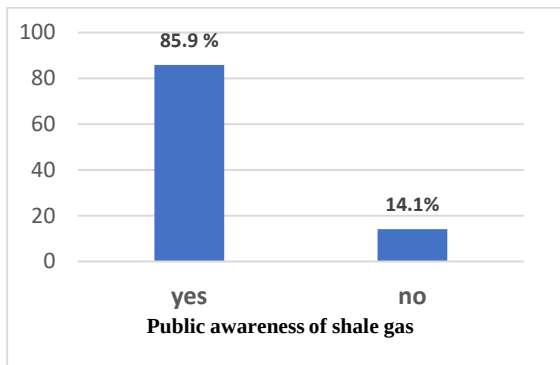


Fig. 1. Public awareness of shale gas

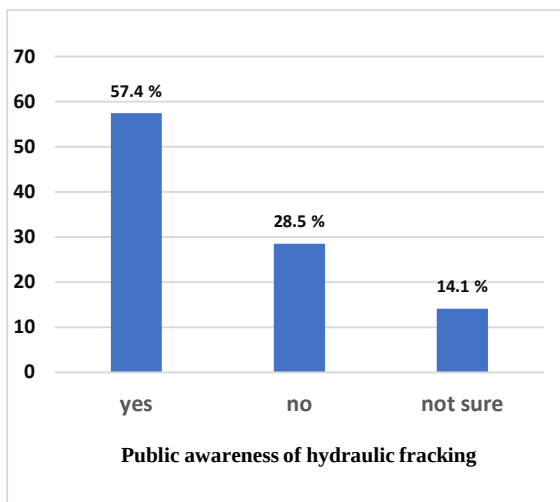


Fig. 2. Public awareness of hydraulic fracking

3 The Risks Of Fracking

When participants asked whether they felt shale gas is a positive or negative concept. Many participants 57% showed a tendency to accept the hydraulic fracking as positive, the mean was 1.78 (SD = 0.525), while 5.2% answered 'don't know' to this question, see Fig. (3). Risks of fracking was assessed using a single survey item that ranged from 1 (no risk), to 10 (extreme risk). Almost four in ten respondents (40%) reported they think hydraulic fracturing has no serious impact on residents, the mean is 2.72 (SD=1.954), see Fig. (4).

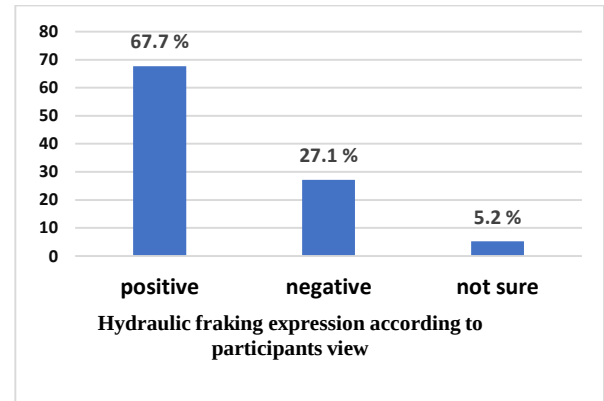


Fig. 3. Hydraulic fracking expression according to participants view

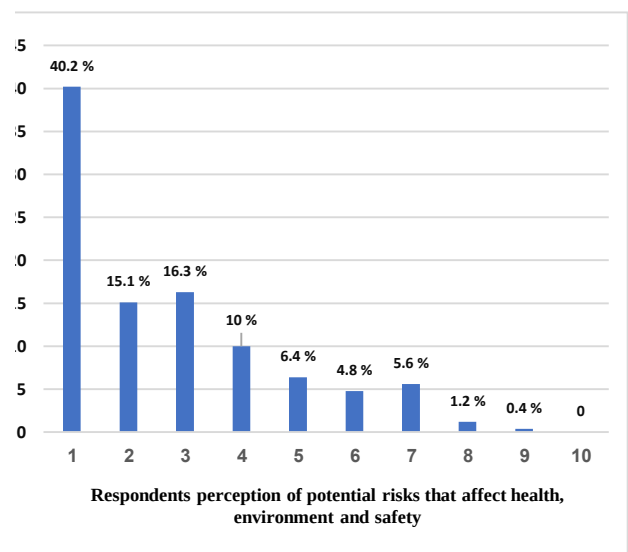


Fig. 4. Respondents perception of potential risks that affect health, environment and safety on the scale of 1 to 10 (10 = no risk)

4 Perceptions Of Environmental And Health Impacts

To detect the public opinion on potential risks for residents near drilling sites, health and environmental parameters were set as relevant to the hydraulic fracking, respondents were asked to pick the likely health and environmental consequences of hydraulic fracking on residents, Fig. 5 shows the attitudes in different scales of environmental awareness. It is notable that respondents ranked demographic change and health issue highest as more potential adverse effects than other factors.

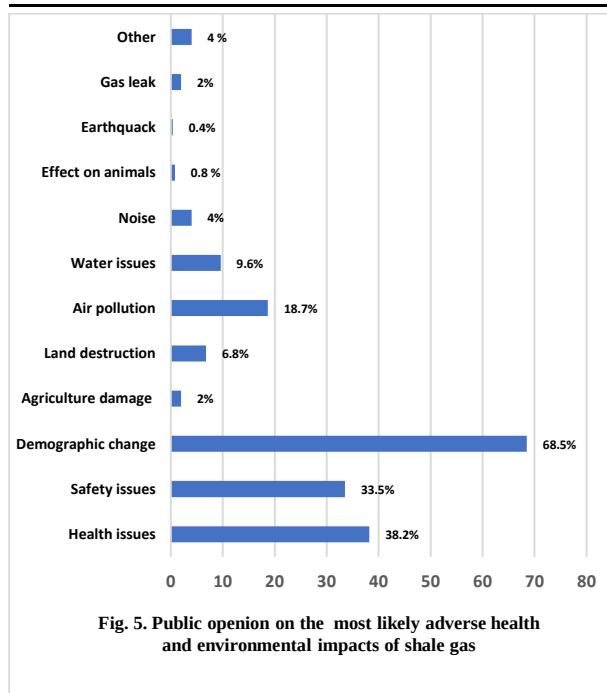


Fig. 5. Public opinion on the most likely adverse health and environmental impacts of shale gas

5 Economic Growth And Demand For Energy

Respondents were asked to indicate how important the shale gas in the economic growth is, response categories included: “very important”, “somewhat important”, “not very important”, “not sure”. As shown in (Fig. 6), 65.3% of respondents think that shale gas development is very important, and tend to be more convinced of economic benefits, whereas 19.9% were not sure, the mean level of economic support was 1.95, (SD=1.569). A solid majority of about 99.6% believed that shale gas exploration will offer new jobs (M=1, SD=.063), similar percent (99.6%) think that shale gas is a cheap source of energy (M=1, SD=.063).

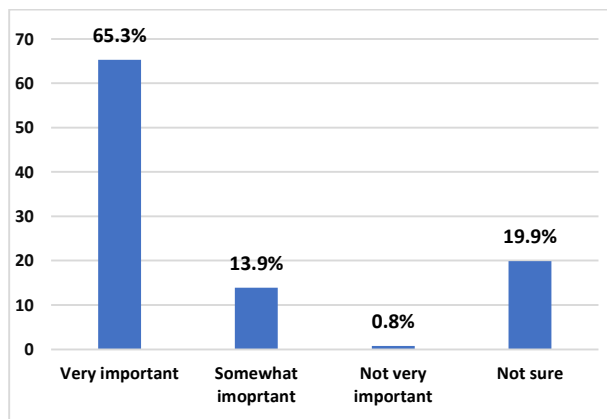


Fig. 6. Public perception of economical benefits

6 Regulations

A plurality of respondents (100%) in Ghadames region believe that regulations related to SGD should be established (M=1, SD=0).

7 Overall Governace

More than half of the publications in our sample, 67.7% strongly agree with SGD, whereas 0.4% strongly disagree (M=1.95, SD=1.602). Accordingly, people show a controversial tendency to support shale gas development. Overall, our respondents believed that this source of energy is important for positive futures in their communities. Figure (7) presents the attitudes in different scales of environmental awareness, and shows the proportion of supporters.

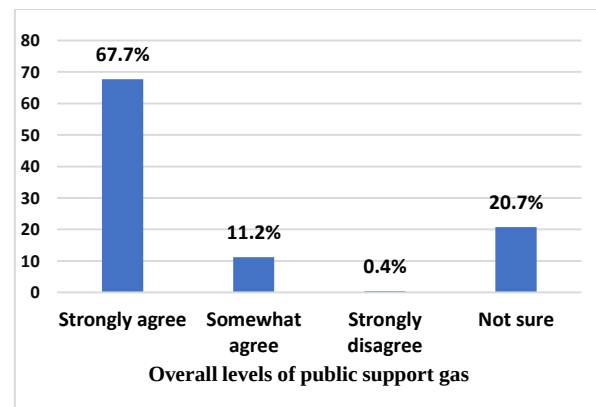


Fig. 7. Overall levels of public support and objection to shale gas

DISCUSSION

The current study examined Ghadames resident's perspectives on fracking. Participants were selected randomly, and their viewpoints may not reflect the perspectives of Libyan community. Demographically, the sample is more educated, more female. As the majority of the sample consisted of women, considerably women have been notarized to be more involved and vocal about environmental injustices (Sangaramoorthy *et al.* 2016; Iwaz 2016; Xiao and McCright 2015). Regarding Familiarity with shale gas, participants showed high level of knowledge 85.9%, while only 57.4% of them expressed being familiar with the hydraulic fracture process. Based on the information above, the high level of shale gas public knowledge found might be associated with the broad use of mass media, where online communication has brought information to people and audiences that previously could not be reached, besides the previous studies and oil companies investigations, hydraulic fracturing had come to public attention. In exploring the most likely adverse health and environmental impacts associated with hydraulic fracking, respondents showed more fear of demographic change than health and environmental consequences that may affect their life. With majority of

68.5%, locals prefer not to change demographic characteristics of their city.

For the other potential adverse environmental effects, respondents indicated the health issues and safety with reasonable proportion of 38.2% and 33.5% respectively, the rest of likely adverse impacts air pollution, land destruction, noise, effect on animals and agricultural damage are less mentioned. Regarding water issue risks in our survey only 9.6% of respondents referred to water contamination as an adverse effect of hydraulic fracking operations. Importantly, the results revealed some knowledge gaps because of the low attention of water as an essential contamination source that may affect human health either by chemicals used in fracking fluids and/or by disposal of fracking flowback wastewater.. Furthermore, the hydraulic fracking requires excessive water quantities that may lead to a fall in the availability of public water supply (O'Hara *et al.* 2015). When weighing up the risk of fracking, the majority of participants feel that hydraulic fracking has no series impact on their community and expected more benefits than problems in the future. Considering the absence of the active role of health and environmental organizations, the knowledge gap revealed is controversial, as the most of locals focus on the economic benefits. Indeed, considerable studies showed that people use several kinds of information further on than 'the risks' to put a judgment on specific technology (Sturgis and Allum 2004; Williams *et al.* 2017; Thomas *et al.* 2016). In contrast, those who opposed the extraction process have taken into account loss or destruction of the natural environment as their most frequent concern in addition to demographic change. In terms of regulation, one issue about which participants of different views agree on the need for adequate regulations and laws that organize shale gas extracting. In this survey, adopting of suitable rules related to shale gas development is completely accepted by all participants. By assessing the overall Governance, a solid majority of respondents, with high level of agreement, indicate support to fracking, the finding that higher levels of support for shale gas development might be related to the thought that using the environment and natural resources available to improve well-being. This result could be valid to put into consideration for further research to interpret the relation between economic growth and acceptance for extractive industries that transform rural communities. In this study, less than half of the participants disagree on shale gas exploring. This opposing view is likely due to the growing public knowledge of environmental, social, and health impacts associated with the shale gas technology as their most frequent concern, or from the impression that common resources could have been utilized in a different manner.

Overall, public perceptions are not static; they change over time in response to some events.

CONCLUSION

Social acceptance has become an imperative consideration in the planning and implementation of energy policies as an indicator that can be measured and managed. Thus, the fracking problem is not just about the existence of adverse impacts; it is also about the public's ability to understand them. In the present study, we have outlined the most common potential adverse and beneficial impacts of shale gas extracting on health, environment, and economy. The preceding descriptive and statistical analysis provide insights into resident's views; the results reveal humble levels of anxiety about various potential impacts of shale gas exploration. It is obvious that respondents are totally supporting shale gas technology, and a considerable familiarity level with the extracting process was detected as well. Thus, it is evident that the majority of participants who stated they are familiar with hydraulic fracking promote positive impacts of shale gas development. When assessing the public opinion, participants revealed anxiety about the demographic change as an adverse impact more than the other impacts, and they think the quality of life and community identity will be threatened by the activities to be undertaken by gas industry operators. Public perceptions are not static; they change over time in response to world events and new scientific evidence. Therefore, further investigations must be carried out regularly to observe such changes.

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