Public Perceptions of the Environmental and Health Impacts of Shale Gas Extraction in Zawia city

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Abstract

Shale gas and shale oil have rapidly revolutionized the energy supply and security landscape in various parts of the world. As Libya has a notable deposit of shale gas, this study sought to gain insight into the public perception of potential health and environmental impacts of a hydraulic fracturing and its associated controversies. It also sought to determine whether there is a need for public awareness of the science and economics associated with hydraulic fracturing. In this study, 304 local residents in Zawia city in the north west of Libya were surveyed on their views on the exploration of shale gas. The purpose of the survey is to understand the factors that influence local residents' support or opposition to the use of shale gas, such as energy independence, environmental consciousness, and risk/benefit perceptions. The results show that the respondents are generally supportive of shale gas extraction, the study show that 52% of the respondents express support or strong support for shale gas exploitation. Both this and future studies have the potential to improve public discourse and decision-making around the development of unconventional gas and oil industries.

Keywords

Fracking, public perception, risk perception, shale gas, hydraulic fraction, health and environmental awareness.

الملخص

لقد أحدث الغاز الصخري والنفط الصخري ثورة سريعة في مشهد إمدادات الطاقة والأمن في أجزاء مختلفة من العالم .نظرًا لأن ليبيا لديها مخزون ملحوظ من الغاز الصخري، فقد سعت هذه الدراسة إلى الحصول على نظرة ثاقبة للتصور العام للآثار الصحية والبيئية المحتملة للتكسير الهيدروليكي والخلافات المرتبطة به .كما سعت إلى تحديد ما إذا كانت هناك حاجة للوعي العام بالعلوم والاقتصاد المرتبط بالتكسير الهيدروليكي .في هذه الدراسة، تم استطلاع آراء 304 من السكان المحليين في مدينة الزاوية شمال غرب ليبيا حول وجهات نظرهم فيما يتعلق باستكشاف الغاز الصخري .الغرض من الاستطلاع هو فهم العوامل التي تؤثر على دعم السكان المحليين أو معارضتهم لاستخدام الغاز الصخري، مثل استقلال الطاقة، والوعي البيئي، وتصورات المخاطر / الفوائد .وأظهرت النتائج أن المستطلعين يؤيدون بشكل عام استخراج الغاز الصخري، وبينت الدراسة أن 52% من المستطلعين يعبرون عن تأييدهم أو دعمهم القوي لاستغلال الغاز الصخري .كل من هذه الدراسة والدراسات والمستقبلية لديها القدرة على تحسين الخطاب العام وصنع القرار حول تطوير صناعات الغاز والنفط غير التقليدي.

1. Introduction

The need to diversify energy sources has become increasingly urgent in light of the growing demand for energy at both the national and international levels. The dramatic transformation of the energy landscape due to the introduction of shale gas has been remarkable. In a relatively short period, it has evolved from a relatively unknown and unutilized resource to one of the most sought-after energy sources [1]. Shale formations are found all over the world and many countries have begun exploring their potential for shale gas and oil, to get the chance to start the process for change and development of the industry that can play a significant role in the transformation of all walks of life. There are a number of challenges associated with the exploration and production of shale gas, many of which are related to the hydraulic fracturing process that is used to generate gas flow in shales. here the hydraulic fracturing is a process in which a combination of high-pressure water, sand, chemicals, and other additives are injected into a well in order to fracture the surface of the underlying shales and release trapped natural gas [2, 3,4]. The injection pressure of this fracking fluid can range from 100 MPa to 1000 bar with a flow rate of 265 l/second. Cracks produced range from 50 m to 100 m in diameter and are generally less than 1mm in width [5]. The combination of chemical substances and sand is regarded as a means of introducing contamination into the aquifer systems that support life. If the fractures occur along a fault line, they could lead to a decrease in the depth of the aquifer, resulting in the mixing of chemicals. Building upon the fact that Water is the main fluid used in the hydraulic fracturing process for the production of shale gas [6,7]. The large volumes of water used for hydraulic fracturing leads to the unavoidable generation of large volumes of wastewater. Accordingly, when assessing the effects of water requirements of the shale gas development, there are cumulative factors to be considered: handling, treating, and disposing of

wastewater [8]. Furthermore, the risk of gas escaping through the fractures and contaminating of groundwater has been a major concern [7].On the other hand; it is considered a lack of availability of water could impede the development of shales in many places around the world. The consequences of this could extend to the consumption of drinking water, that the use of hydraulic fracturing (Fracking) could have a significant impact on the amount and quality of both surface and groundwater water. It may lead to a decrease in the amount of drinking water available and the potential introduction of contaminants into drinking water systems [9]. Fracking fluid can contain contaminants that can seep into water sources through cracks in the rock or get into drinking water systems in other ways [10,11,12]. It can therefore be anticipated that significant alterations in this energy sector will have an impact on the status of water resources at various levels, thus necessitating an in-depth analysis of these changes [5]. The production and exploration of natural gas can have a considerable influence on the quality of air [13, 14], The extraction and processing of shale gas can produce a wide range of air pollutants, which can vary in type and quantity during the production process. This is in contrast to traditional oil and gas development, in that there is more extensive well completion operations such as hydraulic fracturing, as well as a higher density of wells and increased trucking activity[6]. The production of natural gas in the Shale plays a role in the release of pollutants into the atmosphere, including methane(CH_4), nonmethane hydrocarbons (NMHC), Carbon Dioxide (CO_2), and Hydrogen Sulphide (H_2S) [37,38], although the various stages of the gas production process produce distinct sets of pollutants[15,16]. The effects of air and water pollution, especially from fracking additives, have been shown to have adverse health consequences, including damage to the nervous system, respiratory, and gastrointestinal health, as well as cancer risk [17,18] and an increase in infant mortality [17,19]. Shale gas and the extraction process of

hydraulic fracturing and horizontal drilling or "fracking" as it is commonly referred to are both highly economically, environmentally, and socially significant. Therefore, it is not unexpected that this issue may become a major topic of discussion [20,21]. Many surveys have been done on how people feel about fracking. The potential effects of hydraulic fracturing (fracking) is often met with varying opinions, as is the case with other forms of energy generation. Shale gas, as a new technology with a lot of unknowns, so it's gotten a lot of academic attention. Many research has focused on what people think and how they feel about using it. For more than three decades, scientists and politicians have been trying to figure out how people feel about energy technologies. Previous research has shown that there are regional differences in how people feel about using shale gas. Many surveys have been done on how people feel about fracking. This has been the focus of a lot of research in Europe and the US [22,23,24]. Although there has been a limited amount of research conducted on the perception of European shale, the number of studies is increasing, particularly in the United Kingdom [25]. Previous research on how people feel about energy and other controversial technologies has shown that people's views on environmental and tech risks are based on a variety of worries and values that go beyond just measuring risk [22,26]. Risks and benefits aren't the only things that people think about people's cultural values and world views, how they relate to things, how they react to things, whether they think the system is fair or not, how much trust they have in risk management and regulations, and how they feel about protecting things like landscapes [22,26,27]. Public opinion on U.S. Shale operations can vary significantly over time. For instance, Pennsylvania respondents were generally in favor of the industry [29, 30], while those in New York were against it [31, 32]. However, even within a relatively homogenous geographic area, public opinion on unconventional gas in the United States can fluctuate over time

[33]. Other studies have looked at the effects of quantitative structured surveys on how people feel about different things. For example, when it comes to new energy technologies, people tend to be less likely to support them if they think there is too much risk involved [34]. Lots of work has been done to figure out how people feel about the risks and benefits of shale gas, and it turns out that people who think the extraction of shale gas is risky are less likely to vote for it [29]. In addition, previous research has shown that public attitudes towards shale gas technology are influenced not only by the potential risks of fracking, but also by the perceived economic benefits [29,35]. It is also considered that the two most significant drawbacks of fracking can be easily conceptualized in terms of fear and uncertainty. Chemical contamination of drinking water has long been a cause of concern, as clean water is essential for human life. As the lack of scientific evidence regarding the two, most significant disadvantages of fracking may further increase the concerns of laypeople, rather than reduce their importance ratings. Human health and environmental damage can also be conceptualized as fear and uncertainty [36]. However, the exploitation of shale gas may lead to adverse effects that may affect public opinion and decisions regarding its development. There are more potential factors influencing risk perceptions, like the terminology used to describe the issue, personal values, demographics, and experience of shale operations. In addition, the public's perception of risk is influenced by a variety of social and cultural elements [2,37,38]. More environmental challenges is issue of the human health, noise, ecosystem damage, as shale gas production is characterized by continuous activity throughout the day, seven days per week, for a prolonged period of time. Hydraulic fracturing involves the additional challenge of injecting large quantities of water mixtures with high rates and pressures to produce natural gas; this necessitates the use of more trucks, longer drilling times, more powerful pumps and larger holding ponds than in traditional gas production [6].

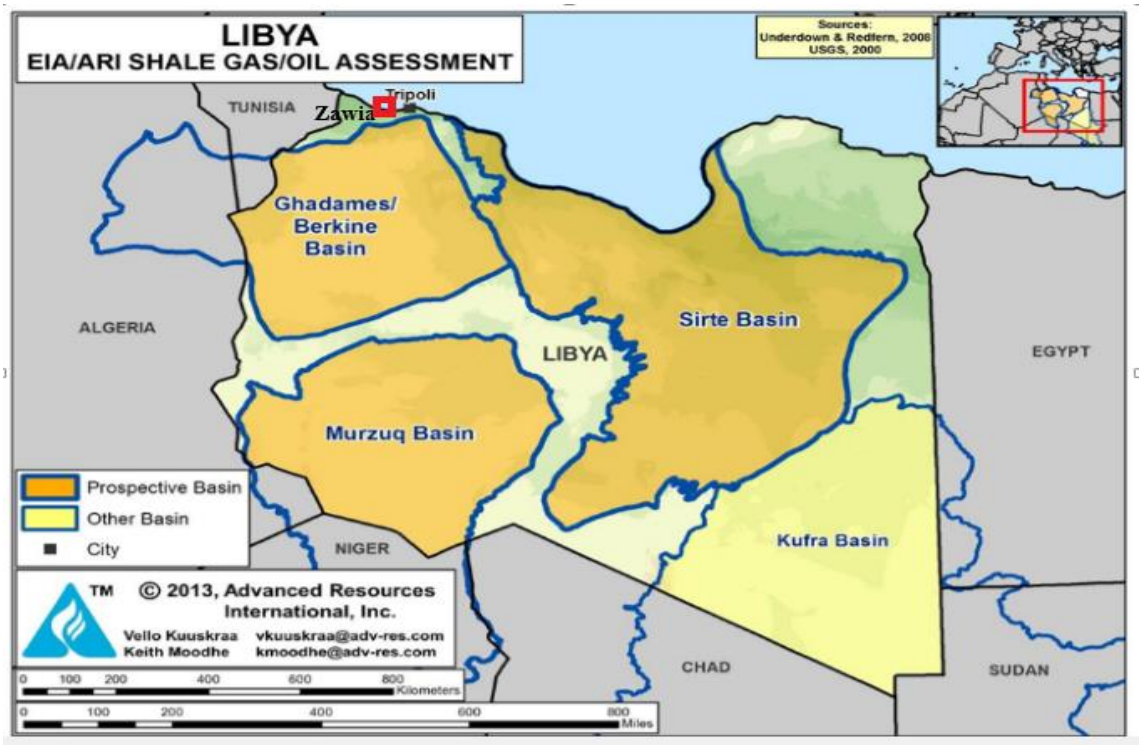
The health consequences of exposure to hazardous physical and chemical substances from the production of shale gas are typically classified as an occupational health concern. However, long-term chronic health concerns at the community level are more associated with low-level, long-term exposure to air pollutants, including benzene and volatile organic compounds (VOCs), as well as radiionuclides present in drinking water sources, which can potentially lead to cancer[6]. Concerns have been raised about the potential consequences of constructing drilling facilities, such as the potential for fragmenting public lands, the displacement of wildlife, and the destruction of the natural environment, where drilling operations are often carried out in areas of significant natural beauty that include sensitive wildlife habitats [39]. In addition to the direct impacts, there are also other social impacts that affect the health of the community. Investment in a new resource, resulting in an increase in the number of non-residents employed, and a new infrastructure in the rural community. Although the economic advantages of new extractive activities are largely accepted, there are numerous adverse effects.[17],these include: Loss of aesthetics and amenity Loss of access to nature and wildlife Housing and infrastructure issues leading to higher housing prices and housing poverty Environmental injustice Higher crime rates leading to increased psychosocial stress[17,40]. Libya is a major oil and gas producing country in North Africa, with a proven track record of success in the oil and gas sector. According to a survey carried out by the Energy Information Administration (EIA) in 2013[32], Libya is one of the 10 countries with the most oil and gas reserves in the world, with an estimated total of 10 billion barrels, table (1) Shows top 10 countries with technically recoverable shale oil resources [41].

Table 1. Shows top 10 countries with technically recoverable shale oil resources.

Rank	Country	Shale oil (billion barrels)	
1	Russia	75	
2	USA	58	48
3	China	32	
4	Argentina	27	
5	Libya	26	
6	Australia	18	
7	Venezuela	13	
8	Mexico	13	
9	Pakistan	9	
10	Canada	9	
	World total	345	335
EIA estimate used for ranking order, ARI estimates in parentheses (source:ARI,2013)			

The current Shale Resource Assessment has focused on three of the most promising basins and their Shale source rocks in Libya; however, it is probable that further exploration will uncover additional Shales in additional basins and formations [4].figure (1) shows the shale gas and shale oil basins of Libya[4]

Fig.(1) Shale Gas and Basins of Libya



2. Aim of the study

With the goal of providing a positive contribution, the objective of this study is to assess public attitude towards the potential effects of the exploration and production of shale gas through the use of hydraulic fracturing (fracking), particularly in the context of increasing concerns regarding water usage and the associated hazardous pollution risks. It is considerable that the authors are not associated with the development of shale gas. Therefore, our goal is to be an independent voice in the public debate.

3. Materials and methods

3.1 Design

As a study area, Zawia city was chosen, fig. (1), in northwestern Libya, situated on the Libyan coastline of the Mediterranean Sea, about 47 km west of Tripoli, to conduct the survey . As a relevant setting for the research, zawiya city contains oil facility for refining oil, where the facility's main activities are Crude oil refining, asphalt manufacturing, blending and packaging of mineral

oils. In addition, to exporting crude oil through the oil harbor, and supplying some oil derivatives needed by the local market. Residents of this city, importantly, are directly involved in the operations of the oil installations, thus creating a mix of positive and negative impacts on the local population, which adds an element of realism to the public perception of shale gas investment in Libya. As well as, the city of Zawia was chosen for its theoretical significance in terms of the potential risks and rewards associated with oil investments in general. A survey was conducted of 304 of zawia residents during the period 1st December 2019 to 1st March 2020, participants was randomly selected to monitor the public's comprehension of the health and environmental impacts of the Shale Gas extraction process. In order to assess the public's opinion on the short and long-term impacts of the extractive process, a series of questions were formulated. Generally, the participants were provided with brief general information without influencing their opinion.

3.2 Measures and materials

Previous research and other countries' experiences with fracking were used to identify specific items to include in the survey questions. Previous research has shown mixed impacts of demographics such as age, income and education on how people view the development of shale gas [12,36,42,43]. The criteria for selection were based on the idea that different members of the public could make informed decisions based on common experience and specific topics [44]. It is also thought that the individuals who chose to participate may have been the most engaged members of their local community. Further criteria were also taken into account and used to ensure diversity of view within groups were and socioeconomic factors like, age, gender, level of education and how much money you make., as set out in Table 2. The survey questions inquired about the awareness of fracking, the associated negative and positive meanings associated with the terminology associated with fracking, and the

potential consequences of fracking, including the potential environmental and health risks, as well as the economic advantages. An overall question was also included to identify the level of support or opposition. For all subsequent analysis, we used IBM SPSS Statistics, version 23 (2015), the analysis was carried out in accordance with accepted standards for qualitative data analysis.

4. Results and analysis

4.1 demographic Characteristics

The most common demographics used to predict public attitudes toward the development of shale gas are age, gender and education, family income. The sample demographics are as follows: 59.9% Female, the monthly income ranged from 751 to 3000 LD. The majority of sample are good educated with a level of education between high school and postgraduate, about 21.5% High School Graduates, 68.6% Graduates. More detailed Demographic Characteristics of Respondents are shown in Table (2):

Table2. Demographic Characteristics of Respondents

Age group	
18-24	48.7%
25-34	21.5%
35-44	14.2%
45-54	10.3%
55-64	4.3%
≥ 65	1%
Gender	
Male	40.1 %
Female	59.9 %
Monthly Family income	
Less than 750	39.5%
751-950	25.7%
951-1200	10.9%
1201-1500	13%
1501-2000	8%
2001-3000	2.8%
Education level	

Primary	6%
High School Graduate	21.5%
Some College or Technical School	6.3%
College Graduate	58.6%
Graduate or Professional Degree	7.3 %
Not sure	0.3%
marital status	
Single	53.7 %
Married	41 %
Divorced	3.3%
Widowed	2%

4.2. Familiarity with the shale gas extraction.

Previous studies, the available geological and geochemical exploration as well as , basin modeling studies conducted by the National Oil Corporation of Libya (NOC), and other entities, all suggest the existence of numerous extensive layers of shale gas formations, including the Cretaceous Shales of the Sirte Basin and the Silurian and Devonian Shales of the Ghadames Basin and Murzuq Basin [41]. When Knowledge is provided with three channels namely the source, content and means of communication, mass media can significantly influence the understanding and discussion of hydraulic fracturing. When assessing the respondent's familiarity of shale oil as well as their level of understanding of the hydraulic fracturing process. The majority of respondents, 58%, indicated that they had a good understanding of shale gas extraction as shown in fig.(2). The mean familiarity with the hydraulic fracturing process was estimated to be 1.42% fig.(3), with a standard deviation (SD) of 0.494. In contrast, only 43.7% of respondents revealed a comprehensive understanding of the hydraulic fraction process, with a standard deviation of .903, M =2.66

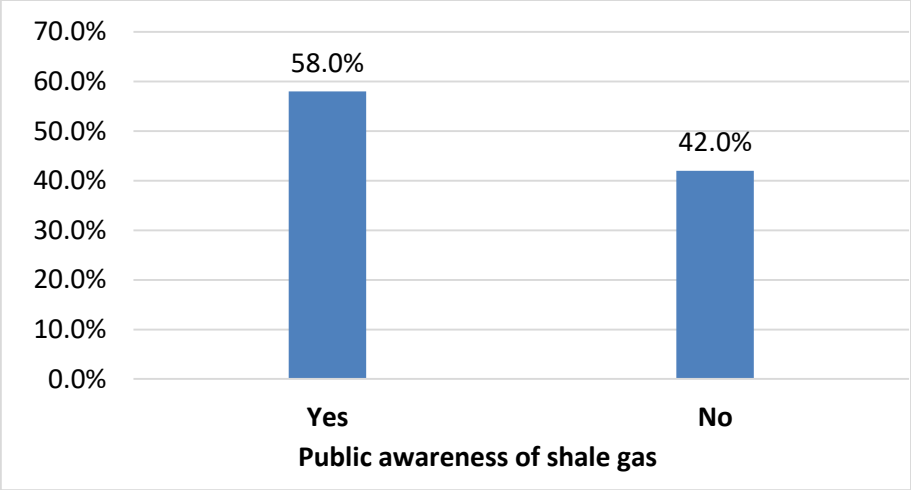


Fig.2 Public awareness of shale gas

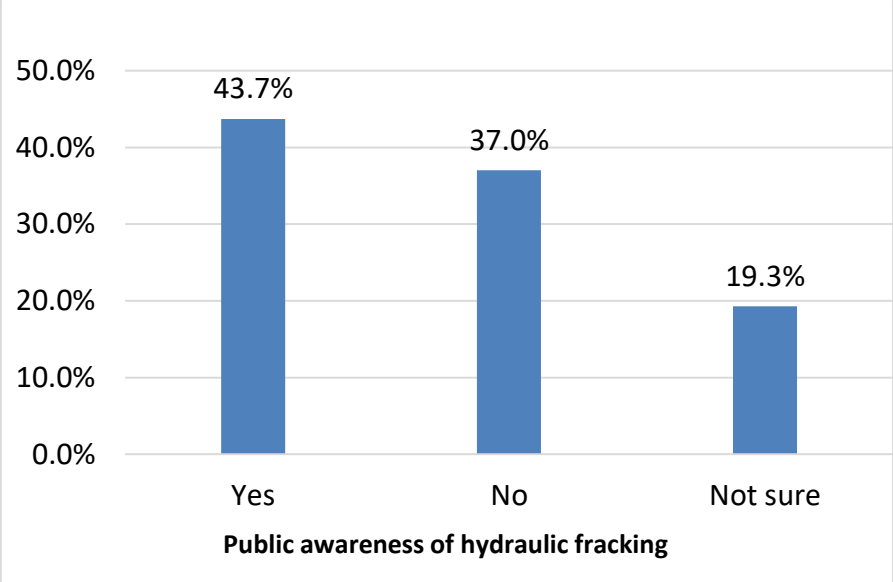


Fig. 3 Public awareness of hydraulic fracking

4.3 The risks of fracking

When participants asked if they considered hydraulic fracking to be beneficial or detrimental, almost half of participants 45% indicated a positive response, while 23% of respondent think that fracking is negative expression and 32% were not sure about it. The mean response was 2.09 (SD = 0.737), see Fig. (4). On the other hand, the risks associated with fracking were evaluated by a

single survey item, ranging from 1 (no risks) to 10 (extreme risks) as shown in Fig. (5). Nearly 40% of respondents indicated that they believed hydraulic fracturing had no significant adverse effects on local populations, with a mean response of 2.09% points SD = 0.737 , it is notable that 29 .6% of respondents indicated that shale gas will have moderate risk on the scale of 1 to 10

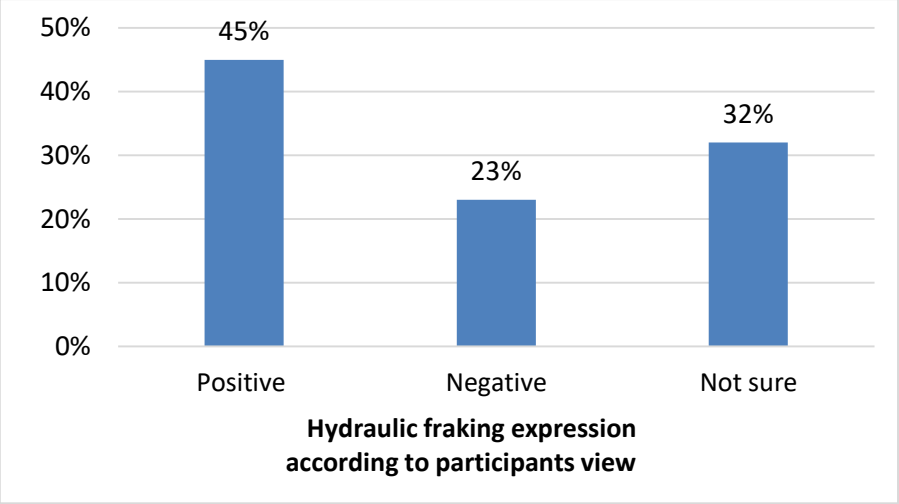


Fig. 4 Hydraulic fraking expression according to participants view

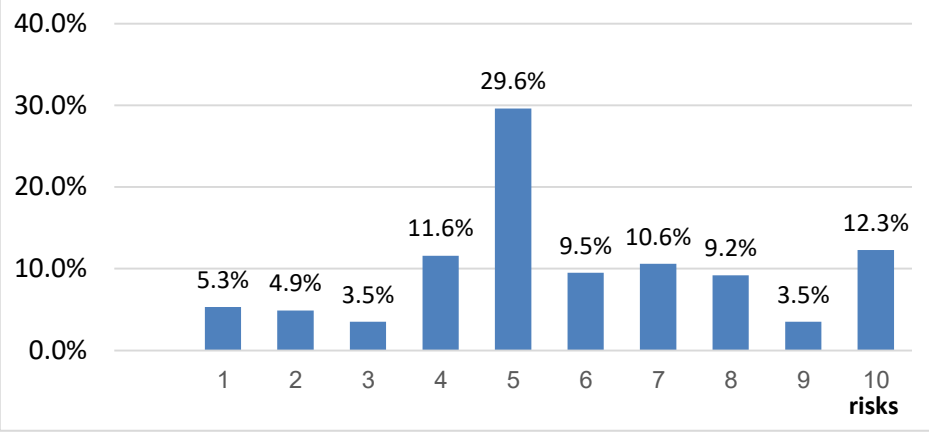


Fig. 5 Respondents perception of potential risks that affect health, environment and safety on the scale of 1 to 10 (1 = no risk)

4.4 Perceptions of environmental and human health impacts

In order to assess public opinion regarding the potential health and environmental risks associated with hydraulic fracking for residents living in close proximity to drilling sites, parameters related to health and environment were established as pertinent. Respondents were then asked to select the most probable health and environmental impacts of hydraulic fracking for residents. Fig. (6) illustrates the views on various levels of health and environmental consciousness. It is noteworthy that respondents placed human health issues and water issues at the top of their list of more potential adverse impacts than other topics.

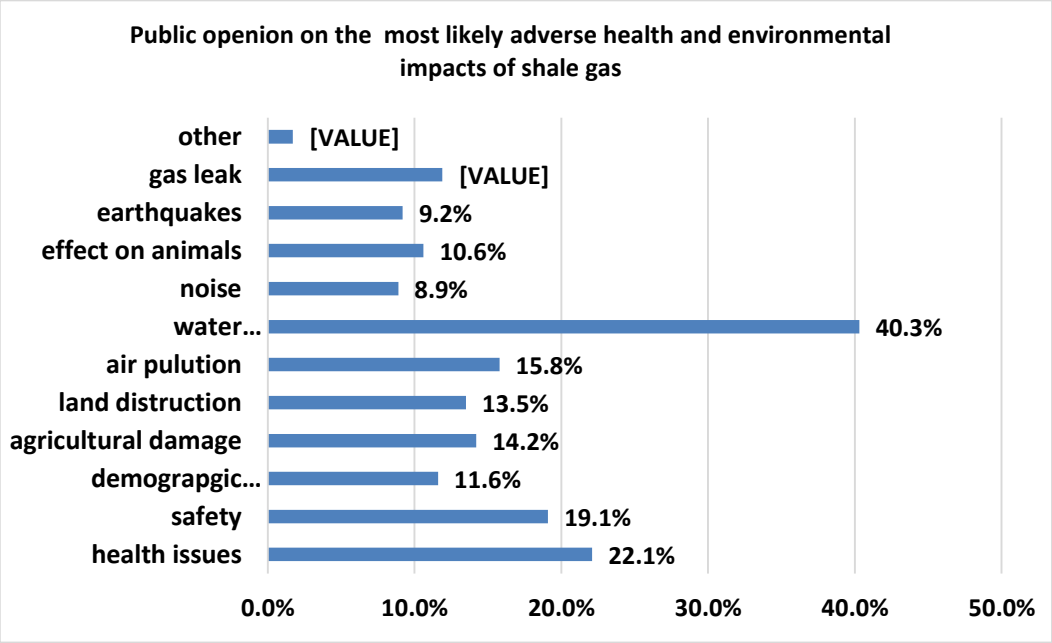


Fig. 6 Public opinion on the most likely adverse health and environmental impacts of shale gas

4.5 Economic growth and demand for energy

When respondents were asked how important they thought the shale gas was in the economy, their answers ranged from "very important" to "somewhat important", "not very important" and "not sure". As shown in Fig.(7). More than half of surveyed people 64.3% consider extracting of shale gas to be very important, and are more likely to be convinced of the economic benefits, and

15.1% of them think it is somewhat important, while 8.7% of them feel it is not very important. Only 4% think it is not at all important, and 25 % are not sure. The average level of economic support is 2.48 (SD = 1.678 . In addition, about 82.1% of respondents believe that the exploration of shale gas will create new jobs (M = 1.18, SD = .384). as well as, more than half of respondents 65.9% revealed that shale gas would be a low cost source of energy (M=1.34, SD=.476).

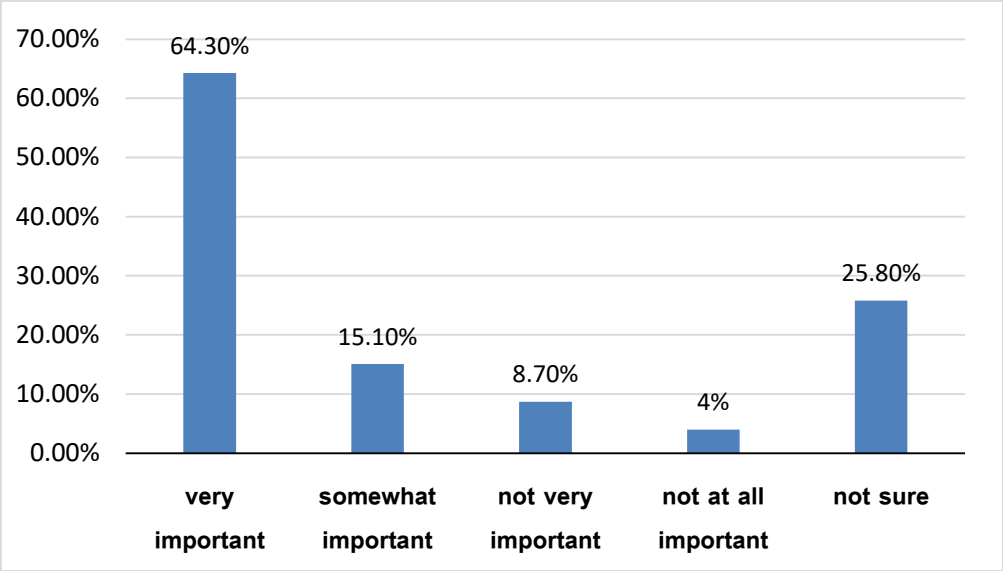


Fig.7 public perception of economic benefits

4.6 Regulation

Regarding the public awareness and concerns of shale gas as a new source of energy is suggested to be framed and regulated to avoid the potential adverse impacts and allay public concerns about the risks [23]. In this study, the majority of respondents (92.6%) in the Zawia city believe that SGD regulations should be implemented. (M = 1.07, SD = 0.263)

4.7 Overall Governance

By including a direct question about public support for shale gas, the average level of support for shale gas was designed as a scale of 1 −4 (strongly agree, somewhat agree, somewhat disagree strongly disagree, not sure). In our

sample, 23% of participants expressed strong support for Shale gas and 29% revealed somewhat degree of support , while 17.7% of surveyed expressed somewhat disagreement, and 8.3% said they didn't agree with it at all, in addition, 22% of respondents were not sure of it, (M = 2.77 SD = 1.459) . In general, our findings demonstrate that there is a significant 52% level of public support for the exploration of shale gas in zawia city. As respondents demonstrated a tendency to public acceptance of shale gas development, and expressed that this energy source is essential for the development of positive future prospects in their local areas. Those who have expressed opposition to the extraction of shale gas generally place the preservation of the natural environment at the top of their priority list [46]. fig.(8) below illustrate the attitudes in various levels of support, as well as the percentage of supporters.

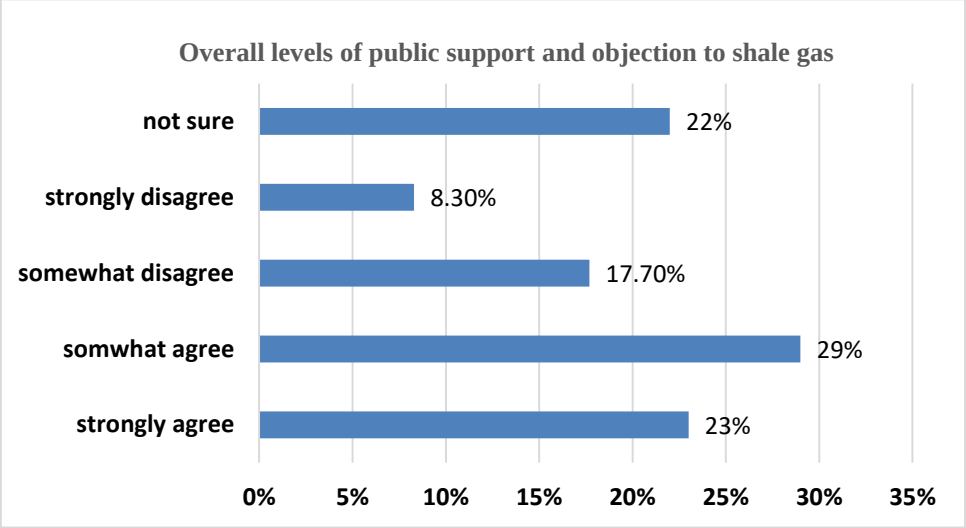


Fig. 7. Overall levels of public support and objection to shale gas

Discussion

Zawiya city, some 40 kilometers west of Tripoli, is the home of Libya's biggest functioning oil refinery. The refinery was opened in 1974 It is connected to Sharara field. Since the city is involved in convential oil investments. It is chosen as a study area on the basis of its theoretical significance in relation to the potential risks and advantages associated with oil investments. Residents

of Zawia city was selected as they know more about oil production process and surveyed to understand their attitudes towards shale gas development. In order to gain better understanding of how people perceive several parameters was analyzed to reach the overall attitude; these parameters included (1) the larger picture and its implications for society; (2) the mechanics of fracking; (3) the advantages of fracking; and (4) the risks of fracking.

Demographically, more than half of participants were female, Education levels ranged from some high school to postgraduate study. when assessing the level of awareness of shale oil and the topic of hydraulic fracturing (fracking), Broadly, the results shows average levels of shale gas knowledge, tending towards higher awareness, with less knowledge of fracking process. a few different questions were included . Our results indicate that more than half of respondents 60.9% had “significant knowledge” about shale oil and, and 39.1% heard nothing at all. Regarding fracking, when evaluating the public's understanding of hydraulic fracturing, there is a lack of familiarity with the process, only 43% of participants reported being familiar with the fracking process.

Potential Environmental impacts

Lots of research has shown that people use more than just 'the risks' to make decisions about a technology [47].The reason might be that residents living in less developed regions, tend to pay more attention to the benefit rather than the risks about the potentially hazardous facility in their communities [48,49,50]. Another explanation is that the majority of local residents’ information has focused on the positives rather than the negatives of SGE [50,51], which also makes local residents more receptive to the positives of SGE.

Participants in our study expressed a wide range of reasonable concerns regarding the use of hydraulic fracturing. Although all participants understood

how shale gas could bring about substantial economic growth, most perceive these benefits does not weigh the cost of environmental effects, safe working conditions, and social fragmentation. In this study, we included the survey a multiple variables that asked respondents about the potential health and environmental effects of shale gas exploration in communities like theirs. The most mentioned potential effect was the human health issue, as 40.9% of the participants promote human health issue as the most negative impacts of shale gas exploration and a bigger public concern. Then comes water issue as another dominated public concern with 32.6%. As the Chemical pollution of drinking water is a classic source of concern because clean water is essential for the survival of human beings [36]. In addition, the debate surrounding potential development of shale gas is centered on issues of water – both quantity and quality. In other words, respondents may be concerned about the overall level of contamination of drinking water, regardless of whether the source of the contamination is chemical additives [12]. Across the study, participants expressed concern about more potential environmental impacts, they indicated the safety issue as a an adverse potential impact of shale gas investments with 32.6%, followed by land destruction with then comes air pollution with 16.5%. More environmental risks indicated by the survey was dominated by water pollution with 32.6%,followed by safety with 23.9%, land destruction with 20.9%, and air pollution with 16.5%. In accordance with the majority of research findings, economic and environmental factors are the primary causes of opposition and support to hydraulic fracturing [3]. Therefore, institutions involved in the development and production of shale gas should consider the impact on the environment. However, at this early stage of the public discussion about fracking, it is good to see that the arguments that are relevant to laypeople are generally in line with the scientific evidence.

The perception of benefits was reflected in respondents' acknowledgment of infrastructure improvements, general agreement with the growing number of jobs and incomes. The most common benefits of fracking are economic growth and energy independence , creating jobs [2]. On the scale of 1 to 4 it is found t found that approximately 59.0 % of respondents believed that developing shale gas would be "very" or "extremely impactful" in boosting local economies, The majority of respondents (81%) also expressed the belief that the development of natural gas would result in the promotion of energy independence. (67.3%) of respondents were sure that shale gas will offer a cheap source of energy , while another 32.7% were of the opinion that it would not. Perceived benefits tend to be related to economic, investment activities, job offers and energy independence [2].

Our survey revealed that the majority of participants 93% expressed their support for the introduction of legislation on the shale gas industry that would cover the hydraulic fracking process. Several studies promote establishing a regulations that fit the purpose and able to protect the environment and human health against the effects of shale gas activities [52]. Accordingly, it is important that authorities and operators follow the rules and regulations that are in place for the exploration and production of shale gas, with the aim of avoiding or reducing any negative effects on the environment and human health. As well as, Regulatory agencies and shale companies should focus on providing tangible advantages, and such objectives may include improving the reputation of the community, broadening the scope of the media's service of general economic interest coverage, and enhancing local infrastructure. In addition, strategies that enhance the emphasis on the safety of the service of general economic interest (SGE) facilities, such as improving the legislative and regulatory framework for SGE, and the health risk communication between professionals and local populations, should also be taken into account.

Because it provides an opportunity to shape the future patterns of resource development with a particular emphasis on future planning and cumulative effects risk management, performance reporting, and continual improvement processes [53]. Shale gas projects have local impacts, so regulations at the local level need to be taken into account when it comes to deciding if a project is worth investing in. It is important to have strategic thinking and collaboration between stakeholders, to build trust and confidence in potential investors.

By evaluating the overall public opinion regarding hydraulic fracturing in Zawia city. Our finding revealed that only a moderate acceptance was expressed .The majority of participants (51.8%) believe that the advantages of hydraulic fracturing (fracking) outweigh its potential risks; however, this opinion does not necessarily mean that they support fracking as gas extraction technique. It is the environmental-minded respondents who lead to the higher probabilities to exclusively oppose [46]

In this view. When it comes to things like fracking, just having scientific risk knowledge is not enough to justify support, because in new complicated, or ever-changing situations, "uncertainties" can cause people to disagree. This may be due to the fact that people living in less developed areas, are more likely to focus on the benefits of the facility rather than the potential risks associated with the facility in their community [54,55]. Another potential explanation may be that the majority of local residents' information has been focused on the advantages of SGE rather than its drawbacks, which in turn encourages local residents to focus on the positives of SGE [50,56].

Conclusion

Basically. Our findings are in line with other recent research indicating that the public is divided on the issue of shale gas, though there appears to be an awareness of the potential risks rather than the advantages. This study has identified the factors that influence public opinion regarding the exploration of

shale gas, which can be used to inform policy makers in order to make more sustainable decisions. It also sought to determine whether there is a need for public awareness of the science and economics associated with hydraulic fracturing. It is pretty obvious from what we talked about before, that our findings indicates that local people's acceptance of Shale gas extraction is based on how they feel about the potential risks and benefits of the exploitation. The most important thing is that benefit perception influences acceptance more than risk perception. It is evident that the provision of information plays a critical role. It is important to note that the survey revealed a humble population's knowledge of shale oil, with less than half of respondents claiming to be familiar with the topic. In light of this, there is a need for further research on how public understanding of the scientific and economic aspects of fracking could reinforce or diminish views of the benefits and drawbacks, as well as more public discussion of the potential effects of shale gas extraction. It is essential to conduct further research into the public's perception of energy technology at a preliminary stage of technological development. Libya, with limited water resources, has a lot of potential for shale gas in different parts of the country that requires large quantities of water to be extracted. On the other hand, the lack of availability of water could impede the development of shales in many places around the world including Libya. Libya suffers from a shortage of water and is mainly dependent on groundwater sources, which represent approximately 97% of all water supply in the country, most of the groundwater comes from water aquifers in the south of the country. The reliance of many Libyan households on the groundwater from the shallow aquifers was indicated by respondents as they highlighted the water issue as the biggest potential adverse impact of shale gas extraction followed by health issues. Individuals with strong environmental advocacy will likely find it challenging to convince them of the advantages of shale gas

unless it can be successfully presented as being relatively environmentally friendly. Our findings suggested a regulatory framework for unconventional resources, including hydraulic fracturing operations to safeguard public and environmental health and safety, the public deserves assurance that the full economic, environmental and energy security benefits of shale gas development will be realized without sacrificing public health, environmental protection and safety. The proper development and implementation of these regulations necessitates the explicit involvement of all relevant stakeholders, including government, the general public, scientific bodies, industry, and environmental organizations. As well as, uncertainties about impacts need to be quantified and clarified; a measures should be implemented to give the public reason to believe that the nation's considerable shale gas resources will be developed in a way that is most beneficial to the nation. It is suggested that further research be conducted into the public's response to energy technology at a preliminary stage of technological development. Additionally, further investigation should be conducted into the potential impact of public education on the scientific and economic aspects of fracking on the perception of the benefits and drawbacks of fracking, as well as the public discourse surrounding fracking. In conclusion, both public and scientific evaluations may evolve over time as a result of real-world occurrences and new information. Therefore, our findings should be re-evaluated regularly.

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