2020

Household Water Security: An Analysis of Water Affect in the Context of Hydraulic Fracturing in West Virginia, Appalachia

Bethani Turley
West Virginia University

Martina Angela Caretta
West Virginia University, martinaangelacaretta@gmail.com

water

MDPI

Article

Household Water Security: An Analysis of Water Affect in the Context of Hydraulic Fracturing in West Virginia, Appalachia

Bethani Turley and Martina Angela Caretta *

Department of Geology and Geography, West Virginia University, Morgantown, WV 26505, USA; bt0023@mix.wvu.edu

* Correspondence: martina.caretta@mail.wvu.edu

Received: 25 June 2019; Accepted: 12 December 2019; Published: 3 January 2020

check for updates

Abstract: Hydraulic fracturing has been booming in the last decade in the United States. While natural gas extraction and production has improved the national energy security, it has raised questions around the water security of those communities where extraction is taking place. Both scientists and residents are concerned about hydraulic fracturing's impacts on surface- and groundwater, especially regarding how hydraulic fracturing impacts residents' access to safe household well water. In the past decade, the Marcellus Shale has been developed in Northwestern West Virginia, yet the human geography dimensions of oil and gas extraction in West Virginia remain to be investigated. This article, based on 30 in-depth interviews, explores household groundwater insecurity due to hydraulic fracturing experienced by residents (i.e., mineral owners, surface owners, and concerned citizens) in Northwestern West Virginia. The concept of water affect is used to attend to the emotional and subjective dimensions of water security by unveiling the power, emotional struggles, and mental stress inherent in water testing practices and environmental regulation around hydraulic fracturing. Water testing is typically conducted by contractors hired by oil and gas companies, but it is mired in delayed test results and incorrect testing procedures, triggering residents' negative feelings toward oil and gas companies. This article furthers the understanding of water security, commonly defined in terms of individual access to adequate water quality and quantity, by studying Appalachian residents' anxieties about well water contamination and uncertainty around the long-term water impacts of hydraulic fracturing. By investigating the uneven power relations around groundwater in West Virginia, the emotional experiences and responses are articulated to further the notion of water affect as impacting household groundwater security.

Keywords: household water security; water affect; emotions; power; hydraulic fracturing; Appalachia

1. Introduction

The United States (US) is currently the world's largest producer of natural gas [1]. In the last two decades, Appalachia went from producing less than 2% to producing 40% of the total US natural gas production because of unconventional natural gas extraction in the Marcellus Shale [2]. Hydraulic fracturing, the essential process and technology that releases natural gas from tightly held non-porous shale, requires approximately 7 million gallons of water per well [3]. Due to this use of large and increasing amounts of fresh water, this process has raised questions about how water resources are being traded for energy resources [4–6]. The liquid substance used for hydraulic fracturing is a mixture of water, sand and various chemicals [3]. Companies may keep hydraulic fracturing chemicals proprietary [7] but the chemicals that have been disclosed are known carcinogens [8]. The contamination of water—from hydraulic fracturing fluid, chemicals, and sedimentary radioactivity—has produced public concern over the impacts on fresh water [9,10].

The increasing extraction of natural gas has ostensibly led to increased energy independence for the US. Natural gas extraction proponents have invoked the rhetoric of energy independence as a benefit that accrues to the nation [11]. Energy independence is leveraged to persuade individuals to lease gas and mineral resources to promote public good and to pledge allegiance to one's country by freeing it from foreign and unstable markets [1]. The notion of US energy independence, thanks to natural gas, is probed against the fact that the US is a major exporter of natural gas, that US citizens might not have access to the locally extracted gas, and the fact that environmental and social sustainably of this form of energy is in question [1,12,13]. Further embodying these contradictions, the United States Undersecretary of Energy, Mark Menezes, termed the exporting of natural gas as "spreading freedom gas throughout the world", constructing natural gas exports as part of the nation's prerogative [14].

Against this backdrop, natural gas production is an exceptional case for examining the concept of water security vis a vis the current discourse on energy independence. Water and energy are crucially interlinked resources for human needs [4,15] and yet, as this article will illuminate, they risk being mutually exclusive. Water security has emerged as a concept which encompasses a range of needs across scales, including individual households, and provisioning for agriculture and industrial production. Water security is a debated concept, although there is agreement that water security assumes a chronic threat to water quality and quantity [16,17]. In this article, we explore threats to household water security due to ongoing extraction of natural gas through hydraulic fracturing of the Marcellus Shale in West Virginia. We aim to advance the concept of household water security by exploring the dimension of water affect [18] through its inherent power—focusing on the practice of baseline water testing—and emotional dimensions, zooming in on people's anxieties and uncertainty about well water contamination. We contribute to the ongoing debates over critical water resource geography [19–22] by exploring the emotional and affective dimensions of water contamination, or presumed contamination, in a Global North context.

We first outline the composite and debated concept of water security. We then present the rise of unconventional oil and gas extraction across the US to situate our case study in northwestern West Virginia. Then, we explain the methodology used to explore the threats to water security at the household scale. Finally, we present our research findings related to power and emotions and situate them within the literature on water affect and the emotional responses to water insecurity.

2. Water Security—A Composite Concept

Water security is a term that has been used in multiple contexts and disciplines. Water security is widely considered a societal issue; however, the way in which the concept is operationalized and what water security is for—e.g., health, livelihoods, ecosystems production—depends on the definition that is adopted [18–25]. Grey and Sadoff [26] broadly defined water security as, "the availability of an acceptable quantity and quality of water for health, livelihoods and ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies" (p. 545). Grey and Sadoff [26] included water-stress and risks in their definition of water security because water abstraction and pollution characterize current economic development. In fact, while water security can be facilitated by economic development, it might not necessarily feature conservation measures that can maintain or improve ecosystem services [27]. Water security has been defined by several authors in terms of risk, referring to the need to manage water risk to acceptable levels (see also Garrick and Hall [24]). Building on this, UN-Water [28] defined water security as "the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability" (p. 1). In 2010, the UN General Assembly also declared water security—i.e., access to safe and clean drinking water and sanitation for the full enjoyment of life—a human right [6]. Along these lines, Jepson et al. [29] explicitly linked water security to economist Amartya Sen's capabilities theory, in which access to adequate water is inextricably linked to "the functioning necessary for basic human existence" (p. 109). They stated that, without access to adequate, clean and safe water and sanitation, society cannot advance in its functioning, as people's everyday lives and relations are impaired by the lack of water or the stress of having a limited access to it and hence, they cannot fully participate in decision-making around water.

Water security generally refers to a situation whereby access to, and quality and quantity of water and sanitation is constant, adequate, reliable and affordable [30]. This term is popular with development agencies, governments and water managers, yet metrics used to assess water security are dependent on what the agencies' conceptualization of water security is [18,23,24]. Particularly when including the risk dimension into the definition of water security, it becomes challenging to give a score and to establish risk-based goals [24]. Additionally, scales and measurements of water security have mostly focused on the national scale to encourage governments to get behind water conservation and management initiatives [27,31].

Notwithstanding all these different definitions, there is widespread agreement that water security is currently threatened by chronic hazards such as inadequate water supply and sanitation and climate extremes e.g., droughts and floods [24,25,27,28]. However, threats to water security are time and place specific. In the USA, the Environmental Protection Agency refers to water security in the context of homeland security and stresses the importance of prevention and protection against contamination and terrorism against water infrastructure [32].

Much of the literature on water security focuses on the Global South, given the incidence of water hazards due to a lack of water and sanitation infrastructures and climate extremes [33–36]. Critical geographers explore governments' responses to water hazards and lack of infrastructure through their implementations of water development and modernization programs. They analyze how these attempts to modernize water infrastructures by increasing distribution and efficiency may expand water access while exacerbating water quality issues, and how these risks intersect with gender, class and social stigma [22,37–41]. In addition to intersectional and gendered analyses, research on water pollution and risk in the Global South brings attention to the emotional suffering caused by water quality and water access [38,40,42]. In general, critical water research attends to the complexity of water security and is invested in finding solutions attentive to geographic and social contexts rather than implementing "top down" technical solutions [19,39,43]. We draw on these critical perspectives to explore embodied water hazards and risk. We focus on the research participants' daily lives to attend to how social, cultural, material and discursive contexts shape water hazards.

We are indebted to critical scholarship on water in the Global South, but depart from it by exploring the concept of water security and affect in the context of the ongoing shale gas development in the Global North, where threats to water are posed by industry practices. Specifically, we investigate the scale of the household and how households' water security is threatened by hydraulic fracturing. We adopt a definition of water security derived from Jepson [18] (p. 109): "one can identify three dimensions of household water security:

1. Water access: the capacity to access water for consumptive purposes, including physical access, affordability, and reliability.
2. Water quality acceptability: the broad range of biophysical characteristics of water quality (taste, color, smell, biochemical, etc.) that influences water usage and health/well-being.
3. Water affect: the emotional, cultural, and subjective experiences of water."

We focus particularly on the last dimension of water affect by focusing on how power shapes water security and how water security is embodied through emotions.

3. Shale Gas Extraction in West Virginia, Appalachia

Shale gas extraction proliferated across the US due to the increased price of natural gas in the mid-2000s [44]. Regions with expedient and widespread development include the Bakken Shale in

North Dakota, the Barnett Shale in Northern Texas, and the Marcellus Shale in Appalachia (Figure 1) [44]. The Marcellus Shale lies under 95,000 square miles from West Virginia to New York and its depths range from 2000 to 9000 feet deep below the ground surface [45].

Various social dimensions of natural gas extraction in the Marcellus Shale have garnered attention in Pennsylvania, New York, Ohio and Maryland. New York and Maryland have moved to ban hydraulic fracturing [2,46]. Pennsylvania, where Marcellus drilling began, has been the major focus for social scientists, who have characterized the social impacts of gas, including the changing community dynamics through the lens of gender [47], environmental health risks [8,48], and tensions between industry supporters and social mobilization [49,50].

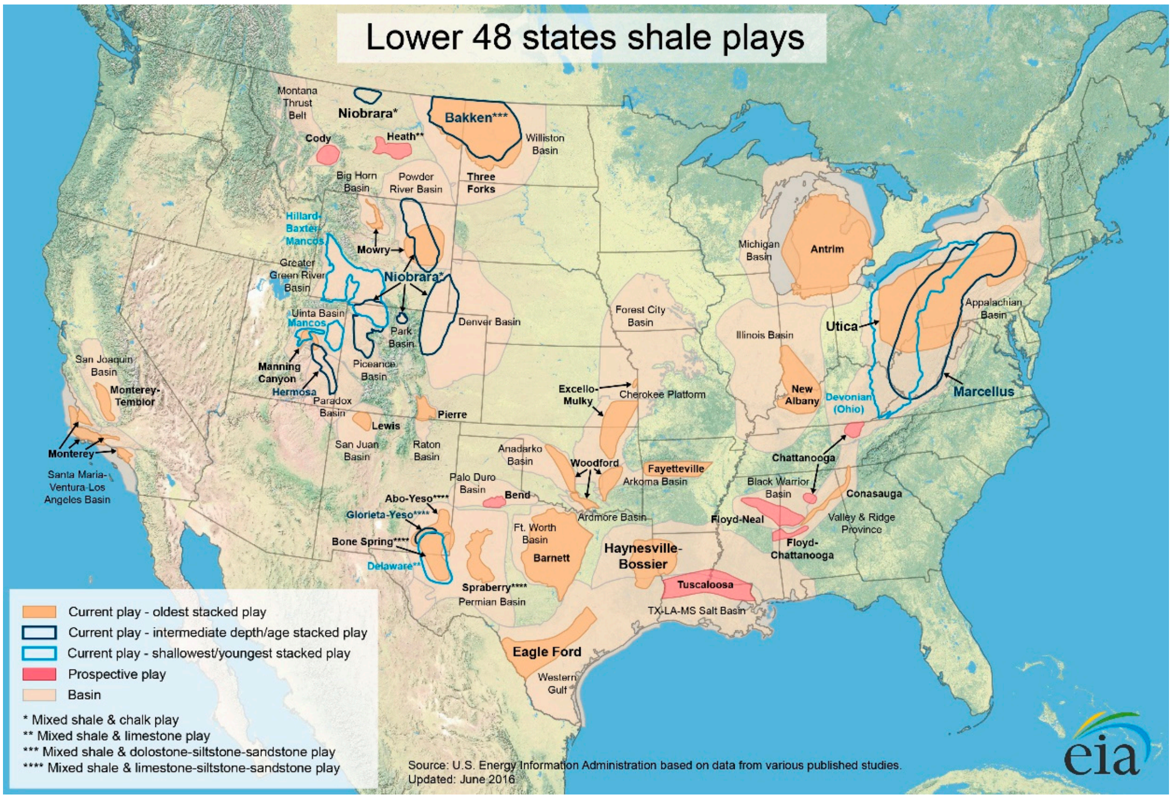

Figure 1. Shale development areas across the USA. The map shows currently drilled and prospective shale layers and depicts regions that have overlapping or stacked shale layers residing at different depths [51].

There is a lack of social science analysis of West Virginia's gas boom, except for Jacquet et al.'s [46] review of legacy natural resource extraction in West Virginia and Sangaramoorthy et al.'s [52] study of West Virginia, intended to inform policy making in Maryland. This article addresses this gap by attending to counties in Northwestern West Virginia. In West Virginia, approximately 2500 wells have been drilled since 2008, and the state is currently the fifth largest oil and gas producing state in the US [46]. The US Energy Information Administration (EIA) estimates that Appalachia overall produces 31,602 million cubic feet of gas per day, as of March 2019 [53].

Northwestern West Virginia is in the heart of the Marcellus shale extraction and the northwestern counties have the largest unconventional oil and gas (UOG) development footprint in the state (Figure 2). The approximate count of active wells per county in the counties where our research took place is: Marshall, 110; Doddridge, 613; Harrison, 355; Kanawha, 30; Marion, 105; Monongalia, 69; Ritchie, 255; Tyler, 292; Upshur, 130; and Wetzel, 622 [54]. Like much of rest of West Virginia, the northwestern counties have a low population density and are classified as rural [55]. Additionally, the northwestern counties have a long history of conventional oil and gas extraction, dating back to the 19th century, and coal mining [56]. Although there is a long history of natural resource extraction in these counties, unconventional gas extraction differs from conventional gas extraction because it includes larger well-pad developments, deeper vertical wells (as the Marcellus Shale is located 5-6k feet below the surface), and horizontal drilling of up to two miles [3,57].

Gas extraction legally proceeds when mineral owners lease their rights to oil and gas companies. In West Virginia, surface and subsurface mineral rights have been severed, meaning that surface and subsurface rights can be held by different owners [58]. Moreover, mineral ownership is considered dominant under common law, providing a legal context to promote the development of these minerals, even when it is against the surface owners' wishes [59]. Well-pad development has been controversial in West Virginia because companies have built well pads in close proximity to homes (Figure 3). Setback distances regulate where a gas well head can be drilled in relation to an existing water well and occupied dwellings. West Virginia currently mandates setback distances that state that wells are not to be drilled within 250 feet of an existing water well or spring used for human or animal consumption and that the center of the well pad cannot be within 625 feet of an occupied building. Living near a well pad entails increased light, noise, and traffic disturbances during the construction of the well pads and during drilling and fracturing. Less disturbance occurs after drilling and fracturing are complete, but well workers must still visit the well pad daily for upkeep and monitoring.

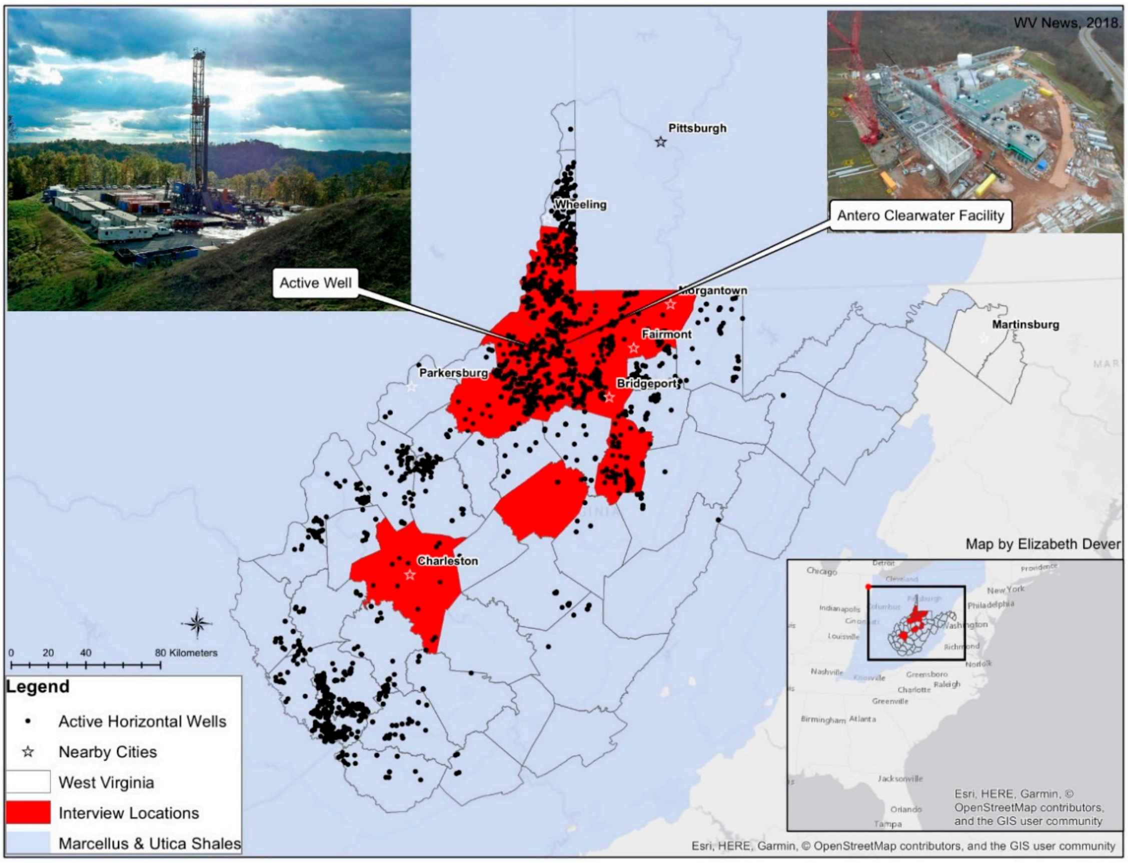

Figure 2. Map of West Virginia by Elizabeth Dever depicting locations of active horizontal wells, nearby cities, and interview locations within the Marcellus and Utica shale.

As elsewhere in neighboring states such as Pennsylvania and Ohio and across the US, natural gas extraction in northwestern West Virginia is changing the rural landscape, as well as the relationships between residents, and residents' perceptions of threats posed to groundwater by hydraulic fracturing [13,60–63]. Approximately 15 million US households rely on private sources of drinking water such as groundwater wells [64]. Across the US, groundwater is historically unregulated [65], as the US Environmental Protection Agency (USEPA) does not regulate private water wells [66]. According to estimates by the Water Use Section of the West Virginia Department of Environmental Protection (WVDEP), in the eight northwestern counties where this research took place, there are about 150 thousand residents relying on groundwater [67].

Figure 3. Well pad proximity to houses in northwestern West Virginia. In this photo, the well pad is approximately 650 feet from the house on the left, and 750 feet from the house on the right. Google Earth. 2 June 2019.

Groundwater contamination does not stem directly from the process of hydraulic fracturing, because the fractures in the shale are too far from groundwater sources. Pathways to water contamination include well casing holes and failures, and migration from old unplugged wells [68]. Most often, however, contamination is caused by spills during the transportation and storage of flowback and produced waters. Flowback water consists of a mixture of sand, chemicals and water that returns to the surface after it is pumped into the ground for hydraulic fracturing. About 0.5 to 4 million gallons of flowback water is created per well during the first decade of gas production [69]. Produced water is the water that continues to return to the surface along with the natural gas. These waters include hydraulic fracturing fluids, mixed with sedimentary brines. The chemical mixtures in flowback and produced waters include organic compounds including known carcinogens such as benzene, heavy metals and radioactive constituents [68].

The impact on groundwater quality due to natural gas extraction has emerged as a contentious issue in the Marcellus Shale, with debates common amongst scientists, researchers, and the public [10,70,71]. Residents have been concerned that hydraulic fracturing fluid causes water contamination, and their concerns are compounded given that chemicals are proprietary and typically unreported and undisclosed, due to the lack of state and federal requirements [12]. In their 2016 report on gas extraction's impact on water resources, the USEPA characterized the chemical composition of hydraulic fracturing fluid, and specifically urged decision-makers to give attention to spills that result in chemicals reaching groundwater, the injection of wastewater into old injection wells, and the disposal of wastewater into surface waters [72]. They also noted that "data gaps and uncertainties" prevented them from fully characterizing oil and gas' impacts on water resources [72].

Researchers have attempted to characterize the levels of contamination in water in comparison to drinking water standards or maximum levels set by the EPA. In general, studies have only shown the contamination levels in surface water, not groundwater. Vengosh et al. [5] described three ways that drinking water contamination can occur in the Marcellus region: stray gas (methane) migration, spills and leaks, and the accumulation of toxic sediments near disposal sites and from spills [5]. However, they only provided specific data about the increased levels of contaminants in surface waters in the Marcellus region, noting how chlorine concentrations rose 6000-fold, and bromide rose 12,000-fold where wastewater was discharged into streams [5]. Vidic et al. [73] also characterized surface water contamination levels in the Marcellus basin. They compared these levels to EPA maximum contaminant levels; however, the EPA only has maximum contaminant levels for one of the constituents they measured, barium.

Harkness et al.'s [74] three-year study of pre- and post-drill water data argued that West Virginia's groundwater has not been contaminated from gas well heads. Instead, they track levels of salinity, and various metals in a nearby creek downstream of a spill for at least one and half months after the spill to show that spills have polluted surface waters [74]. However, they also stated that these specific levels are below "ecological or drinking water standards" (p. 331) even though the specific drinking water standards are not given [74]. Another report by Ziemkiewicz et al. [75] characterized the composition of gas well flowback, specifically comparing flowback in terms of how its chemical composition exceeds drinking water standards. All their flowback water samples "exceeded drinking water standards for barium, chloride, iron, manganese, total dissolved solids and radium 226" (p. 87), and 77% of the samples exceeded drinking water standards of benzene, and 23% exceeded standards of toluene [75].

Despite some USEPA oversight, the oil and gas industry is regulated at the state level, and in West Virginia, is under the purview of the West Virginia Department of Environmental Protection (WVDEP). In West Virginia, gas companies are required to carry out water testing before and after drilling and hydraulic fracturing. Per the WV code 22-6A-18 in the 2013 Natural Gas Horizontal Well Control Act, oil and gas companies can be presumed liable for water quality changes under certain conditions. West Virginia's regulation requires testing of water wells within 1500 feet of the well head. In accordance with this code, residents must allow oil and gas company's hired contractors to take baseline water test pre-drilling, and subsequent water tests, to determine oil and gas companies' liability if and when the water quality changes.

However, these industry-generated water quality data are not made available to the public or to researchers [70,76]. The general lack of specific data about water contamination levels around oil and gas extraction is because oil and gas extraction is exempt from regulation under the Safe Drinking Water Act, which leads to industry and state practices of not disclosing water quality data [77]. The fact that chemicals used in hydraulic fracturing are not subjected to federal regulation such as the Safe Drinking Water Act and the Clean Water Act is often referred to as "The Halliburton Loophole", as Halliburton's CEO introduced this regulatory exemption [77].

The WVDEP does manage underground injection well permits, and the USEPA has oversight in this one aspect due to their underground injection control (UIC) program [78]. There is currently a debate about how to best manage the wastewater produced from hydraulic fracturing [79]. Injection wells have been used because they are the cheapest option, but injections wells have been known to cause earthquakes in the Midwest and Western US [79]. In a recent report by the Natural Resources Defense Council, it was found that the WVDEP has failed to adhere to Safe Drinking Water Act's Underground Injection Control program requirements for injecting wastewater into storage wells in West Virginia. In particular, it was found that, often, wastewater was injected under expired permits, and that over half of the wells have been abandoned without being plugged [68]. Other forms of wastewater, runoff, and leachate from landfills holding toxic drill cuttings have been managed by municipal water treatment facilities or discharged into streams [9].

In the context of these risks to groundwater from wastewater contamination, in an area where many residents rely on household groundwater wells, and where municipal water is sometimes sourced from groundwater [67], we explored the notion of household groundwater security around natural gas extraction.

4. Methods

For this research, we used qualitative methods to explore the contextual and personal aspects of household water security. As in other studies on critical water resources geography [18,38,40,80], we grounded our analysis on a case study approach aimed at in-depth analysis rather than statistical generalizability or correlation (cf. see [81,82]). This qualitative approach was apt to achieve our aim to explore the phenomenon of affective water security in its situated context in WV, analyzing the social, political and material structures shaping space and place. Our approach was particularly guided by feminist epistemology, aware of the hierarchical relationships produced during research and striving to overcome these by building rapport with participants [83–85]. In practice, we built rapport with research participants by spending time with them prior to and following our research interactions by sharing personal details about our origins—one of us being from WV and the other one being a foreigner—by distributing interview transcripts and asking if interviewees wanted to add or rectify anything and, most importantly, by sharing the research results with them.

As opposed to a positivist quantitative approach to science, feminist and critical geographical epistemologies champion situated knowledge and lived experiences of those directly facing the study phenomenon on an everyday basis [84,86,87]. Accordingly, our case study contributes to existing knowledge grounded on local people's experiences of unconventional gas and oil extraction [52,63,88–90], and complicates and deepens the understanding of what current energy extraction practices imply in terms of people's perception of their water.

We based this article on 30 semi-structured in-depth interviews conducted between April and July 2018 with stakeholders in eight northwestern West Virginia counties. Semi-structured interviews have been championed for their effectiveness of exploring environmental risk, versus other modes of assessing risk via econometric and psychometric studies, because they allow for a narrower focus on individuals and communities, not just the nature of particular hazards [91].

This research was approved by the West Virginia University Institutional Review Board (IRB) (protocol number 1803035011) in March 2018. All of the research participants gave their informed consent to participate in the research. We utilized purposive snowball sampling, intended to maximize outreach to participants who are surface and/or minerals owners, with oil and gas infrastructure development on or near their properties [92]. Our sample also included stakeholders such as concerned citizens and representatives from statewide organizations whose work is related to oil and gas such as West Virginia Surface Owners' Rights Organization, West Virginia Royalty Owners Association, and West Virginia Farm Bureau. With snowball sampling, the research sample does not necessarily reflect the demographics of the case study area in terms of age or gender. Additionally, non-disclosure agreements (NDAs) used by oil and gas companies when homeowners have water contamination hindered the participation of several respondents. Due to the nature of an NDA, there is not much literature written about NDAs and hydraulic fracturing except for Vasi et al. [10]. Hence, it is difficult to determine how many WV residents' have signed NDAs, but the role of non-disclosure shaped our sample by limiting our access to individuals with verified instances of water contamination who have signed agreements with oil and gas companies.

The majority of research participants have had direct interactions with oil and gas companies and contractors, and regulators from the West Virginia Department of Environmental Protection (WVDEP). Additionally, approximately two-thirds of the research participants rely on household groundwater wells (as opposed to municipal public water) and thus were involved in groundwater testing due to unconventional drilling and fracturing in their counties.

The interview guide covered several themes. In relation to groundwater contamination and testing, participants responded to interview questions about drilling happening near their home, how that drilling changed the landscape around their home, what their quality of life was like before and after drilling, what their concerns were related to drilling and hydraulic fracturing, and their stress levels due to drilling and hydraulic fracturing. Interviews lasted between one and two hours with some including mobile interviewing [93] as the research participant provided a tour of the development—well pad, ongoing pipeline construction—around their homes and neighborhoods.

We transcribed all the interviews and provided the transcripts to the research participants so that they could correct and/or redact information. This practice was done with the goal of transactional validity [94], which was reached as interviewees added minor clarifications to their interviews and did not remove any statement they had made. The transcriptions were analyzed with the assistance of qualitative analysis software NVivo 12. We used provisional coding, which entails coding for predefined themes and codes [95], which in this case were related to water, such as baseline water testing.

In line with our feminist epistemological methodology, we used member checking as another method for developing rapport with research participants and the community by returning to the field and disseminating preliminary results. Member checking is carried out as a method of transactional validity to validate the data and preliminary analysis with input from participants [85,96]. The advantages of this method include the opportunity to collect more data from participants as they respond to the preliminary analysis, and to validate and/or conversely complicate the preliminary analysis of the data [85]. We carried out two member-checking and dissemination sessions with the research participants and the public. We disseminated a preliminary written research analysis to the research participants, conducted a short presentation, and then asked for participant and public comment on the analysis. The participants responded in agreement to our preliminary analysis, and they contributed additional information about water contamination. By sharing preliminary analysis and having it confirmed by participants, we not only ensured the validity of our data, but we reiterated to the study participants our commitment to their communities and to the rapport we had built with them. Since this study has been carried out, we have kept in close contact with them and have met them again, which shows that we were at least partly able to undo positivistic research hierarchies, as inspired by feminist epistemology [84,97].

5. Water Affect in the Marcellus Shale

Natural gas production from the Marcellus Shale in Appalachia is promoted as ensuring energy independence for the United States. However natural gas extraction, and the storage of wastewater, presents risks to groundwater quality in the extraction zones. Accordingly, in this paper, we explore the water affect of water security created around hydraulic fracturing, to more fully understand the costs of gas extraction in the context of this rhetoric about natural gas' benefits to the county, state and nation.

Residents living in areas of the US where unconventional oil and gas extraction is ongoing are faced with the potential and actual risks related to water contamination due to drilling [73,98,99]. Even in places where water is abundant, as in West Virginia, water insecurity can be an everyday reality for individuals in rural areas who are dependent on water wells and are not connected to city water. Their household water security is seriously curtailed or nullified when surface spills, well casing holes and failures, and migration from old unplugged wells happen. However, incidents are not the only way that residents experience water insecurity, as we show.

Departing from Jepson's [18] (p. 109) definition of water affect as "the emotional, cultural, and subjective experiences of water", we present our research findings on how household water security from groundwater wells is threatened and perceived as potentially threatened by ongoing hydraulic fracturing. We discuss our findings through the concept of water affect in conjunction with Wutich et al.'s [80] exploration of emotional distress due to uncertainty and injustice around water access. Previous studies have mostly focused on the uncertainty generated by droughts and the lack of access to an adequate amount of water [100–104] or perceived injustice and unfairness due in water distribution [38,105,106]. The vast majority of these studies were also based on ethnographic data gathered in the Global South. Drawing on these analytical examples, in this article we present a different case: mental stress caused by household groundwater insecurity due to the current shale boom energy development in North America.

We present and discuss our findings according to the concept of water affect and its dimensions of power and emotions. Power is manifested through the role of baseline water testing as a way to assert experts' knowledge and to discount residents' experiential knowledge. Emotions are recounted by interviewees as embodied sensations triggered by the perceived risks and threats posed to household groundwater security. The following two sub-sections will discuss how our case study adds to the literature on emotional distress from water quantity and unfair distribution by exploring how uncertainty and injustices [40] manifest around the system of water monitoring and regulation due to residents' disenfranchisement from the water testing process.

5.1. Power

Residents experience water insecurity around natural gas extraction when they are voided of their power through the uncertainty and injustices that arise around baseline water testing. WV code 22-6A-18, or presumed liability, states that water contamination is presumed to be the fault of drilling activity when a pre-drill and post-drill test shows that water quality has been affected, if the changes occur within 6 months and if the water well is within 1500 feet of the gas well, assuming the other conditions of the code are met. This regulation does not safeguard water from contamination, but it aims to protect land owners by instituting presumed liability to oil and gas companies if water contamination occurs due to gas well drilling. This legislation is meant to provide landowners with water security protections by reducing uncertainties regarding liabilities and financial consequences if their household groundwater is contaminated. When found liable for water contamination, companies may install water filtration systems to filter water and/or vent off chemicals [107] or install water 'buffalos' (large storage tanks) to provide water. Many of the research participants mentioned having water buffalos or seeing their neighbor use water buffalos. However, as we show, presumed liability and baseline water testing can contribute to uncertainties and injustices rather than ameliorate them.

All of the research participants asserted that baseline water testing of their water wells must be conducted before any activity related to natural gas extraction occurred on or near their property, even when drilling and fracturing was outside of regulatory setback and presumed liability distances. Baseline water testing is fundamental for judging water's safety for consumption by tracking the chemicals parameters in well water. Notably, test results are crucial for residents to have legal standing if well water quality changes are detected. Although water contamination is highly debated, the participants discussed instances in which companies bought out properties because of water contamination. Additionally, some interviewees indicated that their neighbors signed non-disclosure agreements after having their homes purchased or having remediation systems put in place by companies.

However, many residents asserted that they did not trust the companies to do the baseline test, because they argued that companies did not want to be truthful about what is in the water, in order to avoid blame. Interviews show that one factor in individuals' violated trust is delayed test results. Oil and gas companies hire third part contractors to carry out water testing. The interviewees reported that the water test results were not returned to them promptly and often the test results were delayed by many months. Delayed test results produce anxieties about water quality and about the reasons why the results are delayed.

> *After I complained and complained in August … they came out and they did a test and I didn't know it because they never told me. I didn't know of this until through FOIA I got the information … what I found out was that about two months or a month and a half after I started complaining, they tested the water … And it wasn't just that I had lost water, but now my water was contaminated with E. coli. I said you mean to tell me that government … had a report that said my water was contaminated and should not be consumed by humans and they didn't tell me especially because I was emailing them every other day?* (Resident #22, 27 July 2018)

We had pictures of them fracking, then the very following month when they got the water samples that's when we had elevated arsenic and sodium ... But they didn't tell us this. They had the test in their office and they never told us. So, we drank this water for 6 months. Actually, my dad said to the guy that was out here testing, can we get a copy of these results, we never see them . . . He said well yeah call into our office and we'll mail you a copy. When they mailed the copy and we got looking through the, that's when we discovered the arsenic and all that and that's when we called the attorney and got the DEP and basically, they hid it from us. The fact that it was ... we drank that for 6 months, arsenic and everything else. (Resident #5, 6 June 2018)

If water contamination occurs, individuals may continue to use and drink the water daily before being able to see their test results. Delayed results are a product of uneven power relations between companies and residents, who cannot get their test results delivered in a timely manner, even when they consistently call or ask for them. Research participants question whether it should be the companies themselves carrying out the water tests and have their worries confirmed when test results are delivered to them late and incomplete. They interrogate the completeness of the water tests, because hydraulic fracturing chemicals are often proprietary, and because there are different sets of parameters that can be tested for [108]. Additionally, research participants reported that contractors do not always follow the correct testing procedures, which violates the trust of homeowners who know the correct testing procedures, hence triggering in residents a feeling of uncertainty about the actual correctness of the water tests. Consultants echo this problem:

They [residents] don't trust the company, so they don't trust anyone that is associated with them. Sometimes the companies themselves . . . perpetrate that by making things difficult . . . A lot of times those folks won't communicate with the land owners . . . to collect a groundwater sample you should purge a well . . . you want the fresh groundwater coming in. A lot of times consultants have come out and not worn gloves, they have not purged the well they fill up a jar at the sink and leave. (Consultant #2, 19 April 2018)

Residents perceive a conflict of interest when the industry is left to monitor the groundwater that they themselves could be accountable for polluting [109]. This attitude is confirmed by Macnaghten, who showed that there is general skepticism towards government and industry motives for promoting natural gas extraction in the US and the UK [109]. Because of this, the burden falls on the individuals and families to be aware of any slight changes to their water, which they recount experiencing through changes in taste or sensations on skin, in order to report problems to the companies. Individuals with well water may need the companies to do water testing to have any legal ground to defend their property if changes in water quality were to occur, but their trust is violated due to interactions with the companies. The research participants emphasized that companies retain power over the water testing process and legal outcomes of water contamination. The residents' sense of uncertainty about whether water contamination exists, and if the water tests will show it, characterizes the uneasy water affect around natural gas and household ground water. However, subjective experiences are not usable within the legalistic framework regulating water and sensory claims have not been permissible in legal cases [110]. Residents rely on baseline water testing to prove these changes and certify their groundwater quality. As shown by Davies [111], they effectively need baseline water testing to transform subjective experiences into legible and legalistic forms using exclusive scientific knowledge. Injustices are perceived when this scientific knowledge does not reflect experience.

Although water testing can show when contamination occurs post-drilling, water testing does not always lead to company responsibility, because companies may contest aspects of presumed liability and rely on unknowns about water quality [76]. Presumed liability legislation does not hold companies liable if the landowner did not allow the company to take a pre-drilling test, if the water supply is beyond the presumed liability distance of 1500 feet of the well, if changes happen after 6 months, or if another cause (i.e., land use change, legacy industrial contaminants) can be identified. Participants talked about instances in which legal recourse was not attained despite testing that showed water quality changes occurred. One resident recalled when their baseline and subsequent tests showed water quality changes after drilling, but the company and experts did not see the causal link between drilling and fracturing and increased arsenic in the drinking water.

> *Their argument is that arsenic . . . is naturally occurring in the ground. Which, I agree it is naturally occurring in the ground ... But, they also had a specialist, when our well was contaminated . . . and one of the first things he asked me when we were standing by the well was if anybody had did any excavating or disturbing of anything right around the house there, he said because arsenic is in the ground and any construction or anything you do can make the arsenic show up in your water . . . I said no nobody has done anything, other than you all in the neighborhood drilling, you're on the work that's going on . . . We still have no water. You would think a company the size of that, a multi-million, multi-billion-dollar company could ... I'm not saying they did anything wrong, it's just something that happened.* (Resident #5, 6 June 2018)

One of the provisions in the code is that the company must be allowed entry to the property by the owner in order to test pre-drilling. While residents may want to hire their own contractor for testing, excluding the gas company from testing could hinder their chances at enacting presumed liability legislation. Uneven power relations around baseline water testing are upheld as this environmental regulation is written so as to require that the companies manage the water testing while providing multiple ways that the companies can contest their liability for water contamination.

Additionally, the mandated distance and time frame of presumed liability legislation constructs and limits the potential causes of water contamination. In other words, presumed liability is curtailed for water contamination that occurs later and further from the gas well head, for example from continuing occurrence and transportation of flowback waters. The distances mandated by setbacks and presumed liability are based on government compromises, not public health science [112,113]. Reviewing multiple studies, Zwick [114] contended that setbacks should be at least 2000 feet, with many studies suggesting much higher distances. There is disagreement between the companies, government, and residents about which distances, if any, ensure safe water wells [114]. Presumed liability regulations create uncertainty for those with water wells outside of the presumed liability distance. Distances further than 1500 feet are considered 'safe' legislatively, even if individuals do not think that their well is a 'safe' distance from a gas well. Outside of 1500 feet of the gas well, it becomes residents' responsibility to test that water, often paying out-of-pocket expenses.

The state and industry are effectively on the same side, emptying residents' power to assert the wrong that has been done to them and practically nullifying their chances of getting any sort of compensation. We contribute to the analysis of these uncertainties and injustices by arguing that they take the form of epistemic injustices. Epistemic injustice refers to how some knowledge claims gain credibility over others [115]. Epistemic forms of injustices around industrial pollution become apparent in the dismissal of "local claims of toxic harm" [111,116]. Residents experience uncertainty and injustices due to uneven power relations between themselves and the companies. There are tensions between the industry's regulatory compliance and understanding of risk, and residents' understanding of risk to water and their desire for protection from this risk. Whereas oil and gas companies see their role as complying with regulations by producing objective baseline water tests [76], residents see how baselining is contentious [76] and how they bear the brunt of water contamination that can impact every facet of their everyday lives. In this sense, the tensions between industry experts and residents reflect tensions documented in other contexts, in which experts construct environmental hazards as solvable with technical solutions, which contrast with perspectives that encompass social, cultural and discursive factors to water hazards [19].

Within environmental regulation and legislation, industry perspectives about safe and unsafe distances from gas wells, and sources of water contamination, are routinely upheld versus residents' perspectives on space and accountability [117,118]. The government and the industry have the power to decide whose story "counts" [111]. Our data show that scientific proof of water quality changes count more than experiential accounts from residents.

Lastly, although homeowners can be compensated monetarily or provided water if their household groundwater wells are contaminated, they also stand to lose the value of their house if they no longer have access to usable water. Companies can buy out residents' properties, but if they do not, homeowners report that their house loses all monetary value, and that there is no way to sell their home to move. This is an example of uneven power, as residents are relying on companies to either purchase their home or provide them with clean water. Ultimately, it is not the companies that stand to lose their investment into property if water contamination occurs. Like in many contexts around the world, private property ownership is highly valued, and there is a cultural expectation for both access to clean water, and property that appreciates, not depreciates, value. These uneven power relations—legislation, delayed results, accountability and property loss—produce uncertainties and injustices impacting water insecurity residents with household groundwater wells.

In this case study, concern, worries for the future, fear, and loss are due to uncertainties and injustices around water contamination, its health impacts, and long-term consequences. While previous studies on hydraulic fracturing focused on perceived risks and potential health hazards [52,119,120], we zoom in on household water security and particularly the feelings that are triggered when this is at stake.

5.2. Emotional and Mental Stress

As noted in the previous section, delayed tests results trigger anxiety in residents. The majority of residents interviewed that use groundwater in their household expressed worry about potential well water contamination. The psychological impacts of hydraulic fracturing have previously been explored as the stresses caused by increased light and noise pollution in rural environments [112]. We add to this literature by analyzing how emotional and mental distress are also caused by threats to water security due to hydraulic fracturing. In the previous section, we showed how this emotional and mental distress is produced from uncertainties and injustices created around power hierarchies interwoven into environmental regulations, such that resident experiences and perspectives systematically do not count. Here we focus on research participants' concerns about the long-term effects from use and contact with contaminated water. Even when potable water is available for drinking and cooking, bottled water does not easily accommodate other household usages such as bathing, which presents equal or increased risks for the household.

> *I've been in WV all my life, so this is where my support system is, as I'm aging, I think I want to go south. But I just absolutely love it in my hollow. I'm afraid to stay here long term, I'm sure you hear that from other people. Those of us who knows what's happening, this is not where you want to live out your days. That was always my plan, was to live out my days here. Probably won't happen. I worry about my water, I worry about my air.* (Resident #23, 27 July 2018)

This statement is representative of many others and conveys a sense of anguish, uncertainty and concern over the quality of the household water that one is ingesting and using for daily tasks. Respondents communicate doubt, hesitation about using water, and insecurity; all feelings which challenge the notion of their home and their community as a safe place. Worries about long-term health impacts extend beyond the immediate family, as interviewees also mention neighbors and workers that encountered water with hydraulic fracturing chemicals and flowback via storage ponds, cleanup of fluids, transportation, etc.

> *I am afraid over time in 30,40,50 years when there are more health problems as a result of this . . . they had drained the water out of the frack pond and were in the process of cleaning up the sludge . . . which you know was radioactive, before they could take the liner out. And these kids ... 20-year-old kids probably . . . They took off their respirators and pulled their hazmat suits down and tied them*

around their waist took their gloves off and they are there with their hands scooping this stuff up. (Resident #1, 18 May 2018)

In the instance highlighted above, referring to what the respondent had witnessed in the early phase of shale development in the late 2000s, the gas company was storing flowback and produced water in a lined pit beside the well pad. Currently, it is unlikely that the West Virginia DEP would approve a permit for an impoundment for hydraulic fracturing flowback fluids due to studies showing that in West Virginia impoundments are likely to be improperly constructed and are the cause of nearly half of the documented cases of water contamination in Pennsylvania [121]. This particular pond liner had ripped, and the produced water soaked into the ground, affecting the household's well water. In this example, contaminated water was a risk also for workers who cleaned up the contaminated waters and may have health problems that do not present themselves until later in life. Residents experience the stress of long-term health impacts from coming into contact with contaminated waters. Another additional layer is a financial worry in which water contamination not only affects health and daily life but impacts the long-term investment that homeowners make into their homes as they retire.

The greatest concern I have … if the water goes who wants to buy it? If there's a well site over there who wants to buy it? ... Wild wonderful WV? No way. Its toxic and terrible … we've done a lot of the work on this place ourselves, finishing it and looking that this would be our retirement place. Poured a lot into and the concern over what's going to happen and how its going to affect us and what's going to happen to the water. Those worries. (Resident #15, 11 July 2018)

The water was the straw that broke the camel's back. We knew the drilling, we knew it was going to be active we were trying to tolerate it the best that we could knowing one of these days they're going to be done. But by them destroying the ground water … the pre-test of our water system show all of these fracking fluids in there at levels that you don't want to drink or bathe in. We can't live the rest of our lives with that on our backs. We're putting our whole livelihood into this. (Resident #1, 18 May 2018)

Many residents stated that they invested their retirement savings into their home and that they planned to spend their retirement in a rural setting. Interviewees, specifically surface owners, discussed how impacted well water diminishes the value of one's home and makes it unsellable. They worry about losing their investment and wonder who would want to buy their homes if they decided to sell and move. Owning a home in a rural area that has effectively been turned into an industrial zone [122], where well water quality is under threat or has already been deteriorating and is without connection to city water, could mean losing all of one's life savings. The stakes are high for homeowner's investment, and so even the potential for well water contamination causes worry for homeowners near UOG development. This financial worry adds to the constant mental stress of questioning the quality of the water that one is using and drinking daily. Many residents support the notion of energy development, noting that neighbors and communities can benefit from increased income and tax revenues, and that natural gas extraction has benefited their counties by increasing jobs, tax revenues, and individual economic gains from mineral royalties. However, the apprehension about water impacts, the uncertainty about whether these impacts are potentially occurring and who will be responsible for them, and the health and everyday burdens of having contaminated water culminate in mental stress that outweighs the benefits of living in rural areas with oil and gas development.

Several authors have documented how anxiety, concern, fear, and apprehension cause a continuous sense of mental stress in relation to water insecurity [40,80,123]. Stevenson et al. [123] analyzed how water insecurity is linked to women's psychosocial distress, using household surveys. Wutich and Ragsdale [40] employed a random sample survey to study water and emotional distress in urban Bolivia. Their study explored aspects of water insecurity that produce emotional distress, in particular water supply, access to water distribution systems, seasonal water sources, gender and economic and social assets and entitlements [40]. They ascertained the progression of emotions by calculating percentage of households' experiences of fear, worry, anger, and bother [40]. Zenko and Menga [124] explored how constructed water scarcity in Iran can produce physical and mental health impacts for water users. They argued that mental health is integral to well-being and thus it should be always be a factor when analyzing changes to water use and management [124]. Our study most closely aligns with Wutich et al.'s [80] ethnographic account of how uncertainty and power injustices produce emotional and mental distress. We do not quantify or measure the range of emotions produced due to water insecurity, but instead focus on how uncertainties and power injustices produce a particular form of water insecurity: water affect manifested through the emotional and subjective experience of water.

The residents experience fear of living out their lives surrounded by oil and gas and there is a sense of exhaustion due to the impacts of oil and gas which force residents to be engaged in a constant battle with oil and gas companies and with the state environmental regulators to have their rights to access clean and safe water recognized. Coupled with these unrelenting relations with the industry, residents' daily lives, value and feeling of home are broken by the reality or the possibility of well water contamination. The goal of producing cheap and abundant gas and oil appears to be at odds with the possibility of accessing clean safe drinking water for some rural residents. Water security is too much of a tradeoff for the benefits of abundant gas. Security is an ontology grounded in self-validating notions of certitude which are in turn based off one's everyday lived reality. When these notions start faltering because of real or potential threats, then one's existence and everyday material life is put into question. This generates painful and uneasy emotions [18], as recounted by our interviewees. Adding a Global North perspective on the work of Wutich and Ragsdale [40], our data shows how the current shale gas boom is causing residents to experience the everyday emotionally taxing reality of living with the risk of contact with contaminated water.

6. Conclusions

Critical water resources geographies are concerned with how water access and hazards are shaped by injustices and power struggles that are manifested in communities and individuals' lives through a multiplicity of social, cultural, material and discursive contexts [19–22,40,80]. Often, studies of critical water resource geographies have focused on the Global South and have brought to light the intrinsic emotional and affective dimensions of water [38,42,125,126]. Departing from Wutich's and Jepson's [18,80] works, we contribute to this literature by advancing the understanding of water affect through a case study of ongoing shale gas boom in a Global North context.

This study adds to the growing body of critical scholarship on water and hydraulic fracturing in Appalachia and the Marcellus Shale [13,63,76]. Additional studies focusing on the Marcellus region have noted how individuals come to feel alienation rather than attachment to water due to natural gas extraction [63] and the gendered uncertainty and injustices around public health impacts [8]. Our work deepens these themes by exploring how uncertainties and injustices manifest when residents are alienated or marginalized from the process and outcomes of base water testing and water governance. Baseline water testing is assumed to be a neutral process, but it is rather a contentious practice for making claims about the environment and legal responsibility [76]. Our study confirms what Kinchy [76] argued: due to industry's control of baseline testing and data, it is likely that "counter-baselining reactions" from citizens will emerge. Organizations such as the West Virginia Surface Owner's Rights Organization (WVSORO) have created guides about properly testing household water wells and guides for water testing parameters, to support residents who want to hire private water well testing [108]. However, most residents that we interviewed and who have been affected or suspect of having been affected by groundwater contamination do not have the financial resources to be able to contract private well water testing. We agree that increased homeowner participation in baselining may positively impact their access to their baseline data, potentially ameliorating some of the issues emerging in this research around delayed test results and lack of trust in the testing procedures. However, as stated by Kinchy [76], increased residents' participation in baseline testing is not likely to guarantee a shift in power from industry to residents in ensuring industry's legal responsibility for water quality damages.

This study shows that a critical approach to water resources is particularly relevant in the context of managing flowback water, which presents residents with an ongoing sense of risk regarding surface and groundwater contamination. Even though current policy in West Virginia is based on the principle of "presumed liability" for water contamination around gas drilling, our research shows that there is a need for more expansive policy, including water governance models that allow for community decision making about the protection and management of water that go beyond the limited scope of baseline testing. Accordingly, this study provides another example for the growing area of critical water geography scholarship conceptualizing models of water governance based on notions of common resource and use [7,127–129]. These debates center on whether models of water as a commons, in contrast to human rights to water, work to better prevent the privatization, commodification and appropriation of water [128,129]. Kinchy and Aagaard [76,127] argued that water governance might be re-framed as evaluating legal responsibilities to water by competing "uses" i.e., when community or resident use of surface and groundwaters conflicts with industry use, rather than as baseline testing. While this article contributes to the scholarship on the current model of baseline water testing, more work needs to be done to understand how common-resource models of water governance could work specifically around the oil and gas industry in Appalachia.

This study also furthers critical water geographies by articulating the power injustices and the emotional toll of the residents' marginalization from groundwater monitoring and water quality outcomes around natural gas extraction in West Virginia. We show how power operates through baseline water testing by specifically considering the uneven power relations inherent in environmental regulations, water test results, and residents' loss of property. Each of these aspects, from companies' management of water testing, to their reporting of results, and then the immediate and long-term effects of verified water contamination, contributes to residents' sense of uncertainty and perceived injustices. In the context of ongoing scientific, industry and regulatory debate about whether natural gas extraction produces water scarcity and contamination or not [70,71,130–132], we argue that this debate fundamentally misses the third aspect of water security that we have explored in this article; water affect.

We argue for the importance of considering water affect, in addition to water quantity and quality, to understand water insecurity in general and specifically around hydraulic fracturing in Appalachia. We show how the analytical lens of water affect, or the experiential and subjective aspects of water insecurity [18], unveils epistemic injustices around water contamination and household groundwater security in Appalachia. A mere focus on water security solely understood as depleted water quality or quantity would not have illuminated the complex set of power and emotional dynamics related to water that West Virginia residents living in the proximity of unconventional oil and gas development experience daily. By exploring water affect, we show how the current mode of producing energy through unconventional gas extraction can be mutually exclusive with household water security.

Notably, groundwater is at the core of our analysis. Its potential contamination due to hydraulic fracturing is a salient environmental problem as residents, especially in the northwestern counties, rely on household groundwater wells. This focus on groundwater in the context of critical water resources geography is novel (except for [39,63,133]) and bridges the current discussions on the role of the underground and of groundwater and energy in shaping the Anthropocene [133–135].

Author Contributions: Conceptualization, M.A.C.; Data curation, B.T. and M.A.C.; Formal analysis, B.T. and M.A.C.; Funding acquisition, M.A.C.; Investigation, B.T. and M.A.C.; Methodology, M.A.C.; Validation, B.T. and M.A.C.; Writing—original draft, B.T. and M.A.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded West Virginia University Energy Institute O'Brien Energy Research Fund. The APC was funded by The West Virginia University Libraries.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Neville, K.J.; Baka, J.; Gamper-Rabindran, S.; Bakker, K.; Andreasson, S.; Vengosh, A.; Lin, A.; Singh, J.N.; Weinthal, E. Debating Unconventional Energy: Social, Political, and Economic Implications. *Annu. Rev. Environ. Resour.* **2017**, *42*, 241–266. [CrossRef]
2. Sangaramoorthy, T. Maryland Is Not for Shale: Scientific and Public Anxieties of Predicting Health Impacts of Fracking. *Extr. Ind. Soc.* **2019**, *6*, 463–470. [CrossRef]
3. Kondash, A.J.; Lauer, N.E.; Vengosh, A. The Intensification of the Water Footprint of Hydraulic Fracturing. *Sci. Adv.* **2018**, *4*, 5982–5997. [CrossRef]
4. Zhu, T.; Ringler, C.; Cai, X. Energy Price and Groundwater Extraction for Agriculture: Exploring the Energy-Water-Food Nexus at the Global and Basin Levels. In Proceedings of the International Conference of Linkages between Energy and Water Management for Agriculture in Developing Countries, Hyderabad, India, 28–31 January 2007.
5. Vengosh, A.; Jackson, R.B.; Warner, N.; Darrah, T.H.; Kondash, A. A Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States. *Environ. Sci. Technol.* **2014**, *48*, 8334–8348. [CrossRef]
6. Palmer, R.; Short, D.; Auch, W. The Human Right to Water and Unconventional Energy. *Int. J. Environ. Res. Public Health* **2018**, *15*, 1858. [CrossRef]
7. Kinchy, A.; Schaffer, G. Disclosure Conflicts: Crude Oil Trains, Fracking Chemicals, and the Politics of Transparency. *Sci. Technol. Hum. Values* **2018**, *43*, 1011–1038. [CrossRef]
8. Abatsis McHenry, K. Fracking Women: A Feminist Critical Analysis of Hydraulic Fracturing in Pennsylvania. *IJFAB Int. J. Fem. Approaches Bioeth.* **2017**, *10*, 79–104. [CrossRef]
9. Hopey, D.; Templeton, D. Belle Vernon Sewage Plant to Stop Accepting Contaminated Landfill Runoff. *Pittsburgh Post-Gazette*, 16 May 2019.
10. Vasi, I.B.; Walker, E.T.; Johnson, J.S.; Tan, H.F. "No Fracking Way!" Documentary Film, Discursive Opportunity, and Local Opposition against Hydraulic Fracturing in the United States, 2010 to 2013. *Am. Sociol. Rev.* **2015**, *80*, 934–959. [CrossRef]
11. Sica, C.E. Stacked Scale Frames: Building Hegemony for Fracking across Scales. *Area* **2015**, *47*, 443–450. [CrossRef]
12. Pothukuchi, K.; Arrowsmith, M.; Lyon, N. Hydraulic Fracturing: A Review of Implications for Food Systems Planning. *J. Plan. Lit.* **2017**, 1–16. [CrossRef]
13. Finewood, M.H.; Stroup, L.J. Fracking and the Neoliberalization of the Hydro-Social Cycle in Pennsylvania's Marcellus Shale. *J. Contemp. Water Res. Educ.* **2012**, *147*, 72–79. [CrossRef]
14. O'Neil, L. US Energy Department Rebrands Fossil Fuels as "Molecules of Freedom". *The Guardian*, 29 May 2019.
15. Perrone, D.; Murphy, J.; Hornberger, G.M. Gaining Perspective on the Water-Energy Nexus at the Community Scale. *Environ. Sci. Technol.* **2011**, *45*, 4228–4234. [CrossRef] [PubMed]
16. Bakker, K. Water Security: Research Challenges and Opportunities. *Science (80-)* **2012**, *337*, 914–915. [CrossRef] [PubMed]
17. Loftus, A. Water (in)Security: Securing the Right to Water. *Geogr. J.* **2015**, *181*, 350–356. [CrossRef]
18. Jepson, W. Measuring 'No-Win' Waterscapes: Experience-Based Scales and Classification Approaches to Assess Household Water Security in Bcolonias b on the US-Mexico Border. *Geoforum* **2014**, *51*, 107–120. [CrossRef]
19. Mustafa, D. The Production of an Urban Hazardscape in Pakistan: Modernity, Vulnerability, and the Range of Choice. *Ann. Assoc. Am. Geogr.* **2005**, *95*, 566–586. [CrossRef]
20. Mustafa, D. *Water Resource Management in a Vulnerable World: The Hydro-Hazardscapes of Climate Change*; IB Tauris & Co Ltd.: New York, NY, USA; London, UK, 2013.
21. Meindl, C. Water, Water, Everywhere?: Toward a Critical Water Geography of the South. *Southeast. Geogr.* **2011**, *51*, 615–640. [CrossRef]
22. Sultana, F.; Loftus, A. (Eds.) *Water Politics Governance, Justice and the Right to Water*, 1st ed.; Routledge: London, UK, 2019.
23. Gerlak, A.K.; Mukhtarov, F. 'Ways of Knowing' Water: Integrated Water Resources Management and Water Security as Complementary Discourses. *Int. Environ. Agreem. Polit. Law Econ.* **2015**, *15*, 257–272. [CrossRef]

24. Garrick, D.; Hall, J. Water Security and Society: Risks, Metrics, and Pathways. *Ssrn* **2014**. [CrossRef]
25. Cook, C.; Bakker, K. Water Security: Debating an Emerging Paradigm. *Glob. Environ. Chang.* **2012**, *22*, 94–102. [CrossRef]
26. Grey, D.; Sadoff, C.W. Sink or Swim? Water Security for Growth and Development. *Water Policy* **2007**, *9*, 545–571. [CrossRef]
27. Foster, S.; MacDonald, A. The 'Water Security' Dialogue: Why It Needs to Be Better Informed about Groundwater. *Hydrogeol. J.* **2014**, *22*, 1489–1492. [CrossRef]
28. UN Water. What Is Water Security? Infographic. Available online: http://www.unwater.org/publications/water-security-infographic/ (accessed on 23 May 2019).
29. Jepson, W.; Budds, J.; Eichelberger, L.; Harris, L.; Norman, E.; O'Reilly, K.; Pearson, A.; Shah, S.; Shinn, J.; Staddon, C.; et al. Advancing Human Capabilities for Water Security: A Relational Approach. *Water Secur.* **2017**, *1*, 46–52. [CrossRef]
30. UNESCO. *Water: A Shared Responsibility*; UNESCO: New York, NY, USA, 2006.
31. Vörösmarty, C.J.; Mcintyre, P.B.; Gessner, M.O.; Dudgeon, D.; Prusevich, A. Global Threats to Human Water Security and River Biodiversity. *Nature* **2010**, *467*, 555–561. [CrossRef] [PubMed]
32. Morley, K.; Janke, R.; Murray, R.; Fox, K. Drinking Water Contamination—Warning Systems: Water Utilities Driving Water Security Research. *J. Am. Water Work. Assoc.* **2007**, *99*, 40–46. [CrossRef]
33. Falkenmark, M. Growing Water Scarcity in Agriculture: Future Challenge to Global Water Security Author(s): Malin Falkenmark Source: Philosophical. *Philos. Trans. R. Soc. A: Math. Phys. Eng. Sci.* **2013**, *371*. [CrossRef]
34. Rosegrant, M.W.; Ringler, C.; Zhu, T. Water for Agriculture: Maintaining Food Security Under Growing Scarcity. *Annu. Rev. Environ. Resour.* **2009**, *34*, 205–222. [CrossRef]
35. Sadoff, C.; Harshadeep, N.R.; Blackmore, D.; Wu, X.; O'Donnell, A.; Jeuland, M.; Lee, S.; Whittington, D. Ten Fundamental Questions for Water Resources Development in the Ganges: Myths and Realities. *Water Policy* **2013**, *15* (Suppl. 1), 147–164. [CrossRef]
36. Whittington, D.; Hanemann, W.M.; Sadoff, C.; Jeuland, M. The Challenge of Improving Water and Sanitation Services in Less Developed Countries. *Found. Trends®Microecon.* **2007**, *4*, 469–609. [CrossRef]
37. Andersson, L.; Caretta, M.A. Arsenic Poisoning in Rural Bangladesh: An Intersectional Analysis of Impacts on Women. *wH*$_2$*o J. Gend. Water* **2017**, *6*, 4–23.
38. Sultana, F. Suffering for Water, Suffering from Water: Emotional Geographies of Resource Access, Control and Conflict. *Geoforum* **2011**, *42*, 163–172. [CrossRef]
39. Sultana, F. Water, Technology, and Development: Transformations of Development Technonatures in Changing Waterscapes. *Environ. Plan. D Soc. Sp.* **2013**, *31*, 337–353. [CrossRef]
40. Wutich, A.; Ragsdale, K. Water Insecurity and Emotional Distress: Coping with Supply, Access, and Seasonal Variability of Water in a Bolivian Squatter Settlement. *Soc. Sci. Med.* **2008**, *67*, 2116–2125. [CrossRef] [PubMed]
41. Birkenholtz, T. Groundwater Governmentality: Hegemony and Technologies of Resistance in Rajasthan's (India) Groundwater Governance. *Geogr. J.* **2009**, *175*, 208–220. [CrossRef]
42. Swistun, D.A.; Auyero, J. *Flammable: Environmental Suffering in an Argentine Shantytown*; Oxford University Press: Oxford, UK, 2009.
43. Halvorson, S.J.; Williams, A.L.; Ba, S.; Dunkel, F.V. Water Quality and Waterborne Disease in the Niger River Inland Delta, Mali: A Study of Local Knowledge and Response. *Health Place* **2011**, *17*, 449–457. [CrossRef] [PubMed]
44. Ratner, M.; Tiemann, M. *An Overview of Unconventional Oil and Natural Gas: Resources and Federal Actions*; Congressional Research Service: Columbia, WA, USA, 2015.
45. Ogneva-Himmelberger, Y.; Huang, L. Spatial Distribution of Unconventional Gas Wells and Human Populations in the Marcellus Shale in the United States: Vulnerability Analysis. *Appl. Geogr.* **2015**, *60*, 165–174. [CrossRef]
46. Jacquet, B.; Junod, A.N.; Bugden, D.; Wildermuth, G.; Fergen, J.T.; Jalbert, K.; Rahm, B.; Hagley, P.; Brasier, K.J.; Scha, K.; et al. A Decade of Marcellus Shale: Impacts to People, Policy, and Culture from 2008 to 2018 in the Greater Mid-Atlantic Region of the United States. *Extr. Ind. Soc.* **2018**, *5*, 596–609. [CrossRef]
47. Mchenry-Sorber, E.; Schafft, K.A.; Burfoot-Rochford, I.; Hall, D. The Masculinized Work of Energy Development: Unequal Opportunities and Risks for Women in Pennsylvania Shale Gas Boomtown Communities. *J. Rural Soc. Sci.* **2016**, *31*, 1–23.

48. Komarek, T.; Cseh, A. Fracking and Public Health: Evidence from Gonorrhea Incidence in the Marcellus Shale Region. *J. Public Health Policy* **2017**, *38*, 464–481. [CrossRef]
49. Matz, J.; Renfrew, D. Selling "Fracking": Energy in Depth and the Marcellus Shale. *Environ. Commun.* **2015**, *9*, 288–306. [CrossRef]
50. Willow, A.J.; Zak, R.; Vilaplana, D.; Sheeley, D. The Contested Landscape of Unconventional Energy Development: A Report from Ohio's Shale Gas Country. *J. Environ. Stud. Sci.* **2014**, *4*, 56–64. [CrossRef]
51. US EIA. Maps: Oil and Gas Exploration, Resources, and Production. Available online: https://www.eia.gov/maps/maps.htm (accessed on 30 December 2019).
52. Sangaramoorthy, T.; Jamison, A.M.; Boyle, M.D.; Payne-Sturges, D.C.; Sapkota, A.; Milton, D.K.; Wilson, S.M. Place-Based Perceptions of the Impacts of Fracking along the Marcellus Shale. *Soc. Sci. Med.* **2016**, *151*, 27–37. [CrossRef] [PubMed]
53. US EIA. Drilling Productivity Report. In *US Energy Information Administration Independant Statistics & Analysis*; US EIA: Coiumbia, WA, USA, 2019.
54. WVDEP. *Oil and Gas Wells Geodatabase*; West Virginia Department of Environmental Protection: Charleston, WV, USA, 2019.
55. US Census. *West Virginia*; US Census: Huetland Sutland, MD, USA, 2010.
56. WVGES. *History of WV Mineral Industries-Oil and Gas*; West Virginia Geological and Economic Survey: Charleston, WV, USA, 1826.
57. Lave, R.; Lutz, B. Hydraulic Fracturing: A Critical Physical Geography Review. *Geogr. Compass* **2016**, *17*, 739–754. [CrossRef]
58. Ryder, S.S.; Hall, P.M. This Land Is Your Land, Maybe: A Historical Institutionalist Analysis for Contextualizing Split Estate Conflicts in US Unconventional Oil and Gas Development. *Land Use Policy* **2016**, *63*, 149–159. [CrossRef]
59. Collins, A.R.; Nkansah, K. Divided Rights, Expanded Conflict: Split Estate Impacts on Surface Owner Perceptions of Shale Gas Drilling. *Land Econ.* **2015**, *91*, 688–703. [CrossRef]
60. Jefferson, M. Safeguarding Rural Landscapes in the New Era of Energy Transition to a Low Carbon Future. *Energy Res. Soc. Sci.* **2018**, *37*, 191–197. [CrossRef]
61. Morrone, M.; Chadwick, A.E.; Kruse, N. A Community Divided: Hydraulic Fracturing in Rural America. *J. Appalach. Stud.* **2015**, *21*, 207–228. [CrossRef]
62. Willow, A.J. Wells and Well-Being: Neoliberalism and Holistic Sustainability in the Shale Energy Debate. *Local Environ.* **2016**, *21*, 768–788. [CrossRef]
63. Willow, A.J. Troubling Water: Shale Energy and Waterscape Transformation in a North American Extraction Zone. *Anthropologica* **2016**, *58*, 166–178. [CrossRef]
64. Krometis, L.; Patton, H.; Wozniak, A.; Sarver, E. Water Scavenging from Roadside Springs in Appalachia. *J. Contemp. Water Res. Educ.* **2019**, *166*, 46–56. [CrossRef]
65. Ternes, B. Groundwater Citizenship and Water Supply Awareness: Investigating Water-Related Infrastructure and Well Ownership. *Rural. Sociol.* **2018**, *83*, 347–375. [CrossRef]
66. US EPA. Private Drinking Water Wells. Available online: https://www.epa.gov/privatewells (accessed on 25 October 2019).
67. WVDEP. *West Virginia Water Resources Management Plan*; West Virginia Department of Environmental Protection: Charleston, WV, USA, 2013.
68. Treiger, M.; Monk, G.; Mall, A.; Olson, E. *West Virginia's Groundwater Is Not Adequately Protected from Underground Injection Control Pollution*; NRDC: New York, NY, USA; Washington, DC, USA, 2019.
69. Kondash, A.J.; Albright, E.; Vengosh, A. Quantity of Flowback and Produced Waters from Unconventional Oil and Gas Exploration. *Sci. Total Environ.* **2017**, *574*, 314–321. [CrossRef] [PubMed]
70. Scheck, T.; Tong, S. *EPA Reverses Course, Highlights Fracking Contamination of Drinking Water*; American Public Media Reports. Available online: https://www.apmreports.org/story/2016/12/13/epa-fracking-contamination-drinking-water (accessed on 20 December 2019).
71. Rapier, R. No, the EPA Has Not Actually Changed Its Conclusion on Risks of Fracking to Drinking Water. *Forbes*, 15 December 2016.
72. U.S. EPA. Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States. *Exec. Summ.* **2016**. [CrossRef]

73. Vidic, R.D.; Brantley, S.L.; Vandenbossche, J.M.; Yoxtheimer, D.; Abad, J.D. Impact of Shale Gas Development on Regional Water Quality. *Science* **2013**, *340*, 1235009. [CrossRef]
74. Harkness, J.S.; Darrah, T.H.; Warner, N.R.; Whyte, C.J.; Moore, M.T.; Millot, R.; Kloppmann, W.; Jackson, R.B.; Vengosh, A. The Geochemistry of Naturally Occurring Methane and Saline Groundwater in an Area of Unconventional Shale Gas Development. *Geochim. Cosmochim. Acta* **2017**, *208*, 302–334. [CrossRef]
75. Ziemkiewicz, P.; Hause, J.; Gutta, B.; Fillhart, J.; Mack, B.; O'Neal, M. *Final Report: Water Quality Literature Review and Field Monitoring of Active Shale Gas Wells Phase I*; West Virginia University: Charleston, WV, USA, 2013.
76. Kinchy, A. Contentious Baselining: The Politics of "Pre-Drilling" Environmental Measures in Shale Gas Territory. *ENE Nat. Space* **2019**. [CrossRef]
77. Healy, N.; Stephens, J.C.; Malin, S.A. Embodied Energy Injustices: Unveiling and Politicizing the Transboundary Harms of Fossil Fuel Extractivism and Fossil Fuel Supply Chains. *Energy Res. Soc. Sci.* **2019**, *48*, 219–234. [CrossRef]
78. US EPA. Unconventional Oil and Natural Gas Development. Available online: https://www.epa.gov/uog (accessed on 25 October 2019).
79. Walton, B. EPA Considers Options for Reuse and Discharge of Oil and Gas Wastewater. *Circle of Blue*, 23 May 2019.
80. Wutich, A.; Brewis, A.; Chavez, J.B.R.; Jaiswal, C.L. Water, Worry, and Dona Paloma: Why Water Security Is Fundmental to Global Mental Health. In *Global Mental Health: Anthropological Perspectives*; Kohrt, B.A., Mendenhall, E., Eds.; Routledge: Apple, NY, USA, 2015. [CrossRef]
81. Clough, E.; Bell, D. Just Fracking: A Distributive Environmental Justice Analysis of Unconventional Gas Development in Pennsylvania, USA. *Environ. Res. Lett.* **2016**, *11*, 25001. [CrossRef]
82. Evensen, D.; Stedman, R.; O'Hara, S.; Humphrey, M.; Andersson-Hudson, J. Variation in Beliefs about "fracking" between the UK and US. *Environ. Res. Lett.* **2017**, *12*. [CrossRef]
83. Bondi, L. Understanding Feelings: Engaging with Unconscious Communication and Embodied Knowledge. *Emot. Space Soc.* **2014**, *10*, 44–54. [CrossRef]
84. England, K. Getting Personal: Refexivity, Positionality, And Feminist Research. *Prof. Geogr.* **1994**, *46*, 80–89. [CrossRef]
85. Caretta, M.A. Member Checking: A Feminist Participatory Analysis of the Use of Preliminary Results Pamphlets in Cross-Cultural, Cross-Language Research. *Qual. Res.* **2016**, *16*, 305–318. [CrossRef]
86. Haraway, D. Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Fem. Stud.* **1988**, *14*, 575–599. [CrossRef]
87. Rose, G. Situating Knowledges: Positionality, Reflexivities and Other Tactics. *Prog. Hum. Geogr.* **1997**, *21*, 305–321. [CrossRef]
88. Willow, A.J. The New Politics of Environmental Degradation: Un/Expected Landscapes of Disempowerment and Vulnerability. *J. Polit. Ecol.* **2014**, *21*, 237–257. [CrossRef]
89. Malin, S. There's No Real Choice but to Sign: Neoliberalization and Normalization of Hydraulic Fracturing on Pennsylvania Farmland. *J. Environ. Stud. Sci.* **2014**, *4*, 17–27. [CrossRef]
90. Poole, A.; Hudgins, A. "I Care More about This Place, Because I Fought for It": Exploring the Political Ecology of Fracking in an Ethnographic Field School. *J. Environ. Stud. Sci.* **2014**, *4*, 37–46. [CrossRef]
91. Baxter, J.; Eyles, J. The Utility of In-Depth Interviews for Studying the Meaning of Environmental Risk. *Prof. Geogr.* **1999**, *51*, 307–320. [CrossRef]
92. Rapley, T. Sampling Strategies in Qualitative Research. In *The SAGE Handbook of Qualitative Data Analysis*; SAGE Publications Ltd.: Thousand Oask, CA, USA, 2014; pp. 49–63. [CrossRef]
93. Evans, J.; Jones, P. The Walking Interview: Methodology, Mobility and Place. *Appl. Geogr.* **2011**, *31*, 849–858. [CrossRef]
94. Cho, J.; Trent, A. Validity in Qualitative Research Revisited. *Qual. Res.* **2006**, *6*, 319–340. [CrossRef]
95. Saldaña, J. *The Coding Manual for Qualitative Researchers*; SAGE Publications Inc.: Thousand Oask, CA, USA, 2009. [CrossRef]
96. Caretta, M.A.; Pérez, M.A. When Participants Do Not Agree: Member Checking and Challenges to Epistemic Authority in Participatory Research. *Field Methods* **2019**, 1525822X1986657. [CrossRef]
97. O'Reilly, K. Ethnographic Returning, Qualitative Longitudinal Research and the Reflexive Analysis of Social Practice. *Sociol. Rev.* **2012**, *60*, 518–536. [CrossRef]

98. Darrah, T.; Vengosh, A.; Jackson, R.B.; Warner, N.; Poreda, R. Noble Gases Identify the Mechanisms of Fugitive Gas Contamination in Drinking-Water Wells Overlying the Marcellus and Barnett Shales. *Proc. Natl. Acad. Sci. USA* **2014**, *111*. [CrossRef]
99. Alawattegama, S.K.; Kondratyuk, T.; Krynock, R.; Bricker, M.; Rutter, J.K.; Bain, D.J.; Stolz, J.F. Well Water Contamination in a Rural Community in Southwestern Pennsylvania near Unconventional Shale Gas Extraction. *J. Environ. Sci. Health Part A* **2015**, *50*, 516–528. [CrossRef] [PubMed]
100. Berry, H.L.; Bowen, K.; Kjellstrom, T. Climate Change and Mental Health: A Causal Pathways Framework. *Int. J. Public Health* **2010**, *55*, 123–132. [CrossRef] [PubMed]
101. Stain, H.J.; Kelly, B.; Lewin, T.J.; Higginbotham, N.; Beard, J.R.; Hourihan, F. Social Networks and Mental Health among a Farming Population. *Soc. Psychiatry Psychiatr. Epidemiol.* **2008**, *43*, 843–849. [CrossRef] [PubMed]
102. Rios, J.M.; Palacios, F.F.; de A. González, M.; Sandoval, M.M. Construccion de Significados Acerca de La Salud Mental En Poblacion Adulta de Una Comunidad Urbana Marginal. *Salud Ment.* **2003**, *26*, 51–60.
103. Siddiqui, R.N.; Pandey, J. Coping with Environmental Stressors by Urban Slum Dwellers. *Environ. Behav.* **2003**, *35*, 589–604. [CrossRef]
104. Coelho, A.E.; Adair, J.; Mocellin, J. Psychological Responses to Drought in Northeastern Brazil: An Exploratory Study. *Interam. J. Psychol.* **2004**, *38*, 95–103.
105. Goldin, J.A. Water Policy in South Africa: Trust and Knowledge as Obstacles to Reform. *Rev. Radic. Polit. Econ.* **2010**, *42*, 195–212. [CrossRef]
106. Ennis-McMillan, M. *A Precious Liquid: Drinking Water and Culture in the Valley of Mexico*; Thomson Wadsworth: Belmont, CA, USA, 2006.
107. Collision Halts Production at Antero Pad in Doddridge. *Charleston Gazette-Mail*; Associated Press: New York, NY, USA, 2014.
108. Monk, G.; McMahon, D. Water Testing Before Drilling Starts: Why and How. Available online: https://wvsoro.org/water-testing-before-drilling-starts/ (accessed on 30 December 2019).
109. Macnaghten, P. Public Perception: Distrust for Fracking. *Nat. Energy* **2017**, *2*, 1–2. [CrossRef]
110. King, J.C.; Bryan, J.L.; Clark, M. Factual Causation: The Missing Link in Hydraulic Fracture-Groundwater Contamination Litigation. *Duke Environ. Law Policy* **2011**, *22*, 341.
111. Davies, T. Slow Violence and Toxic Geographies: 'Out of Sight' to Whom? *Environ. Plan. C Polit. Space* **2019**, 1–19. [CrossRef]
112. Kroepsch, A.; Maniloff, P.; Adgate, J.L.; McKenzie, L.M.; Dickinson, K. Environmental Justice in Unconventional Oil and Natural Gas Extraction: A Critical Review and Research Agenda. *Environ. Sci. Technol.* **2019**, *53*, 6601–6615. [CrossRef]
113. Fry, M. Urban Gas Drilling and Distance Ordinances in the Texas Barnett Shale. *Energy Policy* **2013**, *62*, 79–89. [CrossRef]
114. Zwick, A.L. Resource Boom to Revitalization: The Local Economic Planning and Governance Implications of Fracking in Northern Appalachia. Ph.D. Thesis, University of Toronto, Toronto, ON, Canada, 2018.
115. Fricker, M. *Epistemic Injustice: Power and Ethics of Knowing*; Oxford University Press: Oxford, UK, 2007. [CrossRef]
116. Davies, T. Toxic Space and Time: Slow Violence, Necropolitics, and Petrochemical Pollution. *Ann. Am. Assoc. Geogr.* **2018**, *108*, 1537–1553. [CrossRef]
117. Baka, J.; Hesse, A.; Weinthal, E.; Bakker, K. Environmental Knowledge Cartographies: Evaluating Competing Discourses in U.S. Hydraulic Fracturing Rule-Making. *Ann. Am. Assoc. Geogr.* **2019**, *109*, 1941–1960. [CrossRef]
118. Gullion, J.S. *Fracking the Neighborhood: Reluctant Activists and Natural Gas Drilling*; MIT Press: Cambridge, UK, 2015.
119. Adgate, J.L.; Goldstein, B.D.; McKenzie, L.M. Potential Public Health Hazards, Exposures and Health Effects from Unconventional Natural Gas Development. *Environ. Sci. Technol.* **2014**, *48*, 8307–8320. [CrossRef]
120. Boudet, H.; Clarke, C.; Bugden, D.; Maibach, E.; Roser-Renouf, C.; Leiserowitz, A. "Fracking" Controversy and Communication: Using National Survey Data to Understand Public Perceptions of Hydraulic Fracturing. *Energy Policy* **2014**, *65*, 57–67. [CrossRef]
121. Troutman, M.A. *Still Wasting Away: The Failure to Safely Manage Oil and Gas Waste Continues*; EARTHWORKS: Washington, DC, USA, 2019.

122. Caretta, M.A.; Abatsis McHenry, K. Pipelining Appalachia A Perspective on the Everyday Lived Experiences of Rural Communities at the Frontline of Energy Distribution Networks Development. *Energy Res. Soc. Sci* **2020**, *63*, 101403.
123. Stevenson, E.G.J.; Greene, L.E.; Maes, K.C.; Ambelu, A.; Tesfaye, Y.A.; Rheingans, R.; Hadley, C. Water Insecurity in 3 Dimensions: An Anthropological Perspective on Water and Women's Psychosocial Distress in Ethiopia. *Soc. Sci. Med.* **2012**, *75*, 392–400. [CrossRef] [PubMed]
124. Ženko, M.; Menga, F. Linking Water Scarcity to Mental Health: Hydro-Social Interruptions in the Lake Urmia Basin, Iran. *Water* **2019**, *11*, 1092. [CrossRef]
125. Perreault, T. Mining, Meaning and Memory in the Andes. *Geogr. J.* **2018**, *184*, 229–241. [CrossRef]
126. O'Reilly, K.; Halvorson, S.; Sultana, F.; Laurie, N. Introduction: Global Perspectives on Gender-Water Geographies. *Gender Place Cult.* **2009**, *16*, 381–385. [CrossRef]
127. Aagaard, T.S. Environmental Harms, Use Conflicts, and Neutral Baselines in Environmental Law. *Duke Law J.* **2011**, *60*, 1505–1564.
128. Bakker, K. Commons Vs Commodities: Political Ecologies of Water Privatization. In *Global Political Ecology*; Peet, R., Robbins, P., Watts, M., Eds.; Routledge: Apple, NY, USA, 2011.
129. Neimanis, A. Bodies of Water, Human Rights and the Hydrocommons. *TOPIA Can. J. Cult. Stud.* **2009**, *21*, 161–182. [CrossRef]
130. Moore, M.; Shaw, K.; Castleden, H. "We Need More Data!" The Politics of Scientific Information for Water Governance in the Context of Hydraulic Fracturing. *Water Altern.* **2018**, *11*, 142–162.
131. Phillips, S. Study: Fracking Didn't Impact West Virginia Groundwater, but Wastewater Spills Pollute Streams. *State Impact Pennsylvania*, 24 April 2017.
132. Elizabeth, W.; Boyer, P.H.D.; Bryan, R.; Swistock, M.S.; James Clark, M.A.; Mark Madden, B.S.; Dana, E.; Rizzo, M.S. The Impact of Marcellus Gas Drilling on Rural Drinking Water Supplies. *Cent. Rural Pennsylvania* **2011**.
133. De L. Melo Zurita, M.; Munro, P.G. Voluminous Territorialisation: Historical Contestations over the Yucatan Peninsula's Subterranean Waterscape. *Geoforum* **2019**, *102*, 38–47.
134. De Rijke, K.; Munro, P.; de L. Melo Zurita, M. The Great Artesian Basin: A Contested Resource Environment of Subterranean Water and Coal Seam Gas in Australia. *Soc. Nat. Resour.* **2016**, *29*, 696–710. [CrossRef]
135. De L. Melo Zurita, M.; George Munro, P.; Houston, D. Un-Earthing the Subterranean Anthropocene. *Area* **2018**, *50*, 298–305. [CrossRef]