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Rainfall and social disputes in Iran

Mehdi Feizi*, Najmeh Heidarzadeh Janatabadi and Ahmad Saradari Torshizi

Department of Economics, Ferdowsi University of Mashhad, Mashhad, Iran

**Corresponding author. E-mail: feizi@um.ac.ir*

Abstract

Water crisis and, particularly, drop in rainfall in Iran are not only an environmental matter but also a security issue. This paper tries to draw attention to the substantial social consequences of climate change in Iran and particularly addresses whether precipitation scarcity from 2007 to 2014 has a conflict-making effect in the province of Iran using the system GMM model. We show that rainfall shortage and the Standardized Precipitation Evapotranspiration Index (SPEI), as an index of drought, could stimulate the propensity for individuals to engage in disruptive activities in provinces of Iran.

Keywords: Climate change; Domestic conflicts; Global warming; Water scarcity

1. Introduction

'*O Ahura-Mazda! Save my country from droughts, lies, and wars*.'

Cyrus the Great, founder of the first Persian Empire.

Iran is undergoing a severe water crisis, suffering from a terrible socioeconomic drought and facing *water bankruptcy* (Madani *et al.*, 2016) where water demand exceeds its natural supply. Numerous droughts together with over-abstraction of surface and especially groundwater have adversely accelerated the water situation in the country to a *critical level*, as *Hamid Chitchian*, former head of the Ministry of Energy, stated in December 2013. This crisis is more than evidenced by drying lakes (e.g., *Orumieh Lake*), rivers (e.g., *Zayanderud*) and wetlands (e.g., *Gavkhouni*), diminishing groundwater levels, soil erosion, desertification, and dust storms, to name just a few.

The average annual precipitation in Iran is estimated at 250 mm, varying from 50 mm in parts of the central water basin to more than 1,600 mm in some coastal areas near the Caspian Sea (Fahmi, 2012), classifying Iran as arid and semi-arid climate characterized with long summers and short, cold winters.

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Nevertheless, there is considerable diversity in its different provinces. Figure 1 depicts precipitation in millimeters across different areas of Iran where numbers indicate selected populations in millions of people.

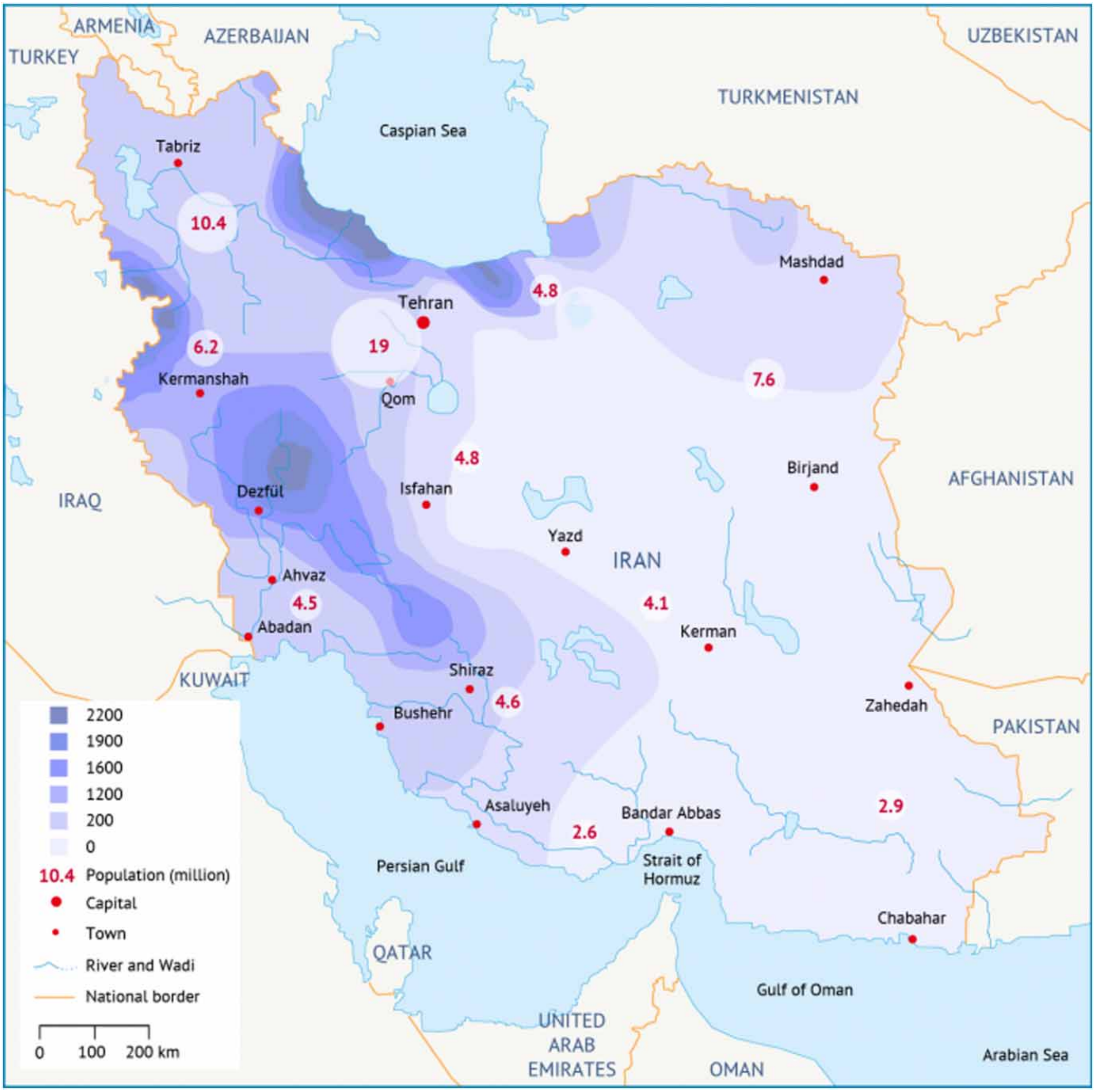

Fig. 1. Precipitation in Iran in mm (Fanack Water[1]).

[1] Fanack Water provides accessible, well-researched information on the state of water resources in the Middle East and North Africa (MENA) region through peer-reviewed country files and special reports, as well as interviews and opinion pieces on latest developments in the water sector of each MENA country.

Climate change and particularly drought have become far worse in the last 10 years. In this period, Iran's precipitation has declined about 11%, surface water has diminished about 44%, renewable water has decreased about 32%, and the average temperature of main cities in Iran has increased about 0.6-degree centigrade, all in comparison with their long-run average. Moreover, substantial probable changes in precipitation and temperature regimes are anticipated for the coming decades. Forecasts for the coming 15 years exhibit between a 0.7 (in the intermediate scenario) and 1 (in the worst case scenario) degree increase in the temperature (The Research Center of Islamic legislative Assembly, 2018).

The Global Trends 2030 report of the US National Intelligence Council also predicts that average precipitation patterns will change such that wet areas will become wetter while arid areas will become more so. Especially in Iran, precipitation is forecasted to decline by 15.6%. The decline in rainfall in 2017 has been unsurpassed in the last 5 years, and almost 90% of the country is facing drought, though in different extents[2].

The results of Najafi & Moazami (2015) also show a significant overall declining trend of the annual precipitation in Iran, especially during winter. The simulations of Roshan *et al.* (2011) also show a 4.41 °C increase in Iran's mean temperature by 2100. Therefore, if immediate measures are not taken to unravel these problems, the situation could become even more catastrophic soon.

Since water is the only natural resource that has no substitute, and the need for it is overwhelming, constant and immediate, competition over access to it might lead to tension and conflict. Indeed, the competition to get access to scarce water resource, at least unconsciously, could lead people to demonstrate selfish, non-cooperative and even aggressive and violent behaviors. Moreover, lack of precipitation might reduce the income of people, say in the agriculture sector, and therefore, the associated anxiety and stress could drive people to violence. These effects have some obvious explicit consequences in not only intra-state conflicts but also social disputes and unrest within countries facing water scarcity.

In this paper, we examine the implicit effects of water shortage on non-cooperative and violent behaviors in Iran. More precisely, we assess some of the subtler psychological and broader spectrum social consequences of water scarcity, namely aggressive and violent disputes in Iran's provinces. To the best of our knowledge, this study is the first consideration of this topic in Iran.

The next section reviews some recent incidents of conflicts over water in different provinces of Iran, as well as some recent unrest which happened in areas with a history of water crises. Section 3 reviews the related literature on global water-related violence, socio-psychological consequences of resource scarcity and mainly sociopolitical disputes due to rainfall shortfalls. Section 4 introduces data and their sources as well as econometrics strategy to empirically assess their associations. Section 5 demonstrates our results and discuss our findings. Finally, Section 6 offers conclusions.

2. Background

The climatic and environmental conditions in Iran in the course of history, including general aridity and water scarcity, had encouraged communal cooperation for the construction and upkeep of underground water channels, *qanat* or *kariz* (Katouzian, 2009). Although water used to be a source of

[2] http://ifpnews.com/exclusive/irans-precipitation-rate-hits-record-low-50-years/.

cooperation in Iran, as people needed each other to find water in such a dry country, lately as the period of drought has been prolonged for more than 15 years, water stress has been an explicit reason for several incidents of social unrest, clashes and dissensions between two provinces or within a province. The speaker of the parliament of Iran, as well as head of its security commission, also stated lately that water crises in Iran have already become a security issue[3].

In June 2016, in *Boldaji*, a city in Chaharmahal and Bakhtiari province, a conflict over water became violent, and more than 100 people were injured. The clash between police and a group of residents began after they planned to stop the pipeline project from transferring water to a steel plant in 50 km from Boldagh. The annual transfer of two billion cubic meters of water from the Zagros Mountains to the plains of Iran and some main central cities such as Isfahan and Yazd, severe damage to underground aquifers due to the deep excavation of illegal wells, and reduction in rainfall have created a psychological background for conflicts[4].

This province used to be one of the watery regions in Iran, and now it suffers deeply from water scarcity, especially since it depends on agriculture and animal husbandry. Later in August, villagers' water-related clash in the same province led to two deaths and two people wounded. The disagreements of village residents over water have intensified with the onset of droughts in the region[5]. In the same month and province, due to dissension over water in a village near *Shahrekord*, two people died[6]. In May 2016, in a clash between two families over agricultural water in a village in Khuzestan province, one person died while others were injured[7]. In March 2013, a week of demonstrations in *Varzaneh* in Esfahan province against the government decision to divert water from this province to Yazd province ended with violent clashes, with dozens being injured and more being arrested[8]. All in all, the trigger for disputes over water resource was either illegally access to water or diverting surface water that led to revenge from others in the community.

Socioeconomic implications of precipitation shortfalls could be more visible in vulnerable and social fragile regions. For instance, some small cities, such as *Izeh*[9] and *Doroud*[10], which were on the news in the January 2018 uprising have had some water crises. Ever growing demand for water for agricultural activities in the Izeh Plain has enhanced the use of groundwater. Unfortunately, the overall static water level, due to immense groundwater abstraction since 1985, has fallen by more than 5 m, reflecting that the aquifer is under stress condition (Kalantari *et al.* 2009).

3. Related literature

The available evidence in most of the papers to support the association between resource scarcity and violence has been provided through different methodologies: theoretical papers (e.g., Maxwell &

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[3] https://www.radiozamaneh.com/350149.
[4] http://www.bbc.com/persian/iran/2016/07/160719_l10_.
[5] https://www.radiozamaneh.com/294034.
[6] http://www.bbc.com/persian/iran/2016/08/160815_l12_iran_shahrekord_water_crisis.
[7] https://www.radiozamaneh.com/276942.
[8] http://www.al-monitor.com/pulse/originals/2013/11/water-scarcity-frustrates-iranians.html.
[9] http://khouzestan.isna.ir/default.aspx?NSID=5&SSLID=46&NID=97765.
[10] http://www.irna.ir/fa/News/82830538.

Reuveny, 2000), empirical analysis based on real dispute data (e.g., Allen *et al*., 2016), experiments either in the laboratory (e.g., Safarzynska, 2018) or in the field (e.g., Prediger *et al*. 2014).

Maxwell & Reuveny (2000) present a simple dynamic model of renewable resource and population interaction, featuring the possibility of conflict triggered by per capita resource scarcity. Findings of Allen *et al*. (2016) also confirmed that individuals are prone to violence in times and places of resource scarcity.

Prediger *et al*. (2014) indicated robust experimental evidence on pastoralists' readiness to engage in antisocial behavior towards their fellow common users in case of exposure to persistent resource scarcity on the commons. It also showed a higher risk of conflict (decreasing another's payoff below one's own) among resource users in areas of greater scarcity. In a laboratory experiment, Safarzynska (2018) showed that subjects protect themselves from resource exhaustion in the presence of shocks that can destroy a part of resources by engaging in conflict and taking resources from the out-group instead of reducing extraction.

Other than methodology, we could classify the literature on social effects of climate change and particularly water scarcity based on different scales of conflicts, namely, international, civil, and interpersonal.

3.1. International water-related conflicts

The scarcity of water has played a significant and perilous role not just in influencing the nature but also some other major socioeconomic factors including the spirit of states and their relationship with society and even the collapse of civilizations. The technological necessity of the provision and control of water supplies led to the emergence of the Asiatic state and its various institutional characteristics (Katouzian, 2003).

There is a concern that water resources will be a cause of friction and tension and a source of bargaining power, both regionally and internationally, for states that control access to surface and groundwater supplies (Gleick, 1993; Klare, 2001)[11]. Shared water resources are more salient to comparatively rainfall-scarce countries than those whose freshwater needs are met adequately by domestic, renewable surface sources. The Global Trends 2030 report of the US National Intelligence Council predicts that countries such as Iran could become embroiled in conflicts with neighbors over dwindling water from shared river basins. Afghanistan has a water treaty with Iran over the Hirmand River, signed in 1973 (Abidi, 1977).

However, a long squabble between two countries over shared water resources seems to be escalating, and a recent deficiency of rainfall has contributed to this dispute. The quarrel has taken a new course since the start of the *Khamal Khan Dam* project, which would severely affect the amount of water flowing into the *Sistan and Baluchestan* province in Iran. In 2015, a dispute between Afghanistan and Iran over the allocation and rights to water of the *Harirud* lead to at least 10 deaths of Afghan villagers while there were trying to collect river water[12].

Throughout the world, there are many instances of struggles in providing clean water, and how it has been a strategic instrument of ethnic and religious conflict and even recently regional and local clashes

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[11] As *Isamel Serageldin*, then-Vice President of the World Bank, stated, '*the wars of the next century will be about freshwater*.' Alternatively, as President Barack Obama stated in his acceptance lecture on the occasion of the Nobel Peace Prize award, '*There is little scientific dispute that if we do nothing, we will face more drought, … which will fuel more conflict for decades.*'
[12] http://conflictwater.com/.

(Kreamer, 2012). Recently, there has been an upsurge in incidences of water-related violence around the world. Not only the old Israel-Palestine conflict, at least partially, could be explained by water scarcity (Lonergan & Brooks, 1994; Rouyer, 1999; Selby, 2003; Shuval & Dweik, 2007; Zeitoun, 2008); even the overwhelming civil war in Syria is by and large, the result of challenges associated with drought (Kelley *et al*., 2015) and multifarious interrelated religious and sociopolitical motives and hurdles linked with climate variability and the availability and use of freshwater (Gleick, 2014). Especially in these regions, the situation in the future may even get much worse, given the growing rate of population (Sivakumar, 2011; Petersen-Perlman, 2012).

According to Waterbury (2013), droughts that occurred before 2011 drove to the devastation of agricultural land on which at least 800,000 people influenced in eastern Syria and the death of at least 85% of their livestock. This shock, in turn, led to the displacement of the residents of rural areas who went to find a job in Syria's larger cities, where they formed disenfranchised belts of disparate communities surrounding these cities. This immigration due to climate change contributed to the outbreak of conflict in Syria.

3.2. Rainfall shortfalls and civil disputes

Climate change has been responsible for prevalent violence incidents, and its relationship with sociopolitical conflicts is drawing attention. There is an extensive body of studies on the controversial relationships between the climate change and environmental issues on the one hand, and violent conflict and social cooperation among sub-national or national groups, on the other hand, particularly possible socioeconomic implications of precipitation shortfalls in vulnerable and politically fragile regions.

Despite a lengthy history of water-related cooperation which is often missing in disputes over transboundary resources (Wolf, 1998, 2007), an extensive literature contradicts these results, supported with a long history of tensions over, or related to, shared freshwater resources. For instance, several studies (Bernauer & Siegfried, 2012; Fjelde & Uexkull, 2012; Gartzke, 2012; Hsiang & Burke, 2014; Carleton & Hsiang, 2016) have appraised the relationship between climatological changes and sociopolitical conflicts, at communal, interstate, and civilizational levels, through amplifying well-documented drivers of these conflicts such as poverty and economic shocks. Cashin *et al*. (2017) illustrated that droughts associated with an exogenous El Niño shock have a growth-damping effect and lead to lower economic activity in developing and emerging countries, e.g., India and Indonesia, as well as advanced economies, e.g., Australia and New Zealand.

The results of Hsiang *et al*. (2011) revealed that the stability of modern societies relates strongly to the global climate. A meta-analysis of Hsiang *et al*. (2013), examining populations in the post-1950 era, suggested that the magnitude of climate's influence on modern conflict, ranging from interpersonal violence, crime, and intergroup violence to political instability, institutional breakdown, and the collapse of civilizations, is both substantial and statistically significant.

The results of Hendrix & Salehyan (2012) illustrated a significant effect of rainfall variability on political conflict and insurgency. Maystadt & Ecker (2014) found causality between droughts and local violent conflicts in a within-country setting over a short time frame in Somalia. Devlin & Hendrix (2014) identified that distinguished higher long-term mean variability in precipitation is associated with the outbreak of militarized interstate disputes.

According to Landis (2014), prolonged periods of stable warm weather are consistently associated with an increased risk of civil war onset and non-state conflict. More specifically, Burke *et al*.

(2015) showed that deviations from moderate temperatures and precipitation patterns systematically increase conflict risk. Sarsons (2015) demonstrated that adverse rainfall shocks are a strong predictor of Hindu-Muslim riot incidence in India, even when we control for income shocks in agriculturally dependent regions.

However, Uexkull *et al*. (2016) suggested that drought has little impact on the short-term likelihood that a group challenges the state by military means. However, drought can contribute to sustaining conflict, mainly for agriculturally dependent groups in impoverished countries. Detges (2016) stated that drought-related communal violence in sub-Saharan Africa is more likely in regions where the significant part of the population lacks access to an improved water source. Crost *et al*. (2018), using unique data on conflict-related incidents in the Philippines, found that adverse rainfall shocks lead to an increase in conflict incidents initiated by insurgents.

3.3. Interpersonal consequences of (natural) resource scarcity

There is a small but growing body of evidence which tackled the social consequences of climate change. Indeed, once there is scarcity, the competition to get access to limited resources can lead people to demonstrate violent and non-cooperative behaviors and even aggressive and violent actions. Almost all of the studies in the literature have assessed this relationship between climate change and intergroup/interstate conflict, including riot and civil war, and evaluated whether global climate has been responsible for episodes of widespread violence.

Miguel (2005) discovered that murders of women accused of being witches in Tanzanian villages rise when local rainfall is extremely low or high. Lecoutere *et al*. (2010) conducted a framed field experiment with small-holder irrigators from semi-arid Tanzania that replicates appropriation from an irregularly scarce common water flow. They showed that, on average, water scarcity induces selfish appropriation behavior in the experiment, which is regarded as conflictive in the Tanzanian irrigator communities.

Anderson & DeLisi (2011) concluded that the consequences of fast global warming increase the risk of violent behavior in three channels: firstly, the effects of uncomfortably warm temperatures on irritability and aggression; secondly, the indirect effects of global warming on factors which put people at risk of becoming violence-prone, and finally, the effects on populations whose livelihoods and survival are suddenly at risk.

Kristofferson *et al*. (2017) showed that simple exposure to scarcity (limited-quantity promotion advertising) stimulates consumers to perceive others as competitive threats to purchasing a desired good and can activate actual aggression that manifests even outside the domain of the promoted good. The CLimate, Aggression, and Self-control in Humans (CLASH) theory of Rinderu *et al*. (2018) anticipated that aggression and violence increase as climates become hotter and seasonal variation becomes smaller by influencing time orientation and self-control.

4. Data and empirical strategy

Indeed, *climate* and *conflict* are rather vague concepts, and scholars have exploited different measures for each. In this paper, we define conflict as different sorts of interpersonal aggressive, violent, and antisocial behavior such as assault and murder in the public sphere while we measure climate change through changes in rainfall and a drought index.

We hypothesize that climate change systematically increases the risk of conflict between people. In other words, more extreme weather with rainfall shortage and excess temperatures results in more violent behavior.

Controlling for macroeconomic variables, we investigate the dynamic linkages between social disputes and rainfall as well as SPEI, for 21 provinces of Iran within 8 years, using an estimation method proposed by Blundell & Bond (1998), and the extended version of the GMM estimator known as system GMM (sys-GMM) dynamic panel estimation.

Dynamic panel data estimation is indeed more appropriate than usual static models in cases where some unobservable factors affect the dependent variable as well as the explanatory variables. Moreover, static panel estimation is misspecified as it omits dynamics and passes over the impacts of lagged dependent variable on its level, causing dynamic panel estimation bias (Bond, 2002; Baum, 2006).

Furthermore, the sys-GMM method treats the measurement error, unobserved province heterogeneity, and omitted variable bias via first-differencing. It also fixes endogeneity bias (time-varying component) through instrumenting the explanatory variables. Instruments for differenced equations are obtained from lagged, at least twice, of explanatory variables, and those for leveled equations are formed from lagged differences of the variables.

Our baseline estimating equations that illustrate how climate can influence aggressive interaction in Iran are

$$D_{i,t} = \alpha_0 + \alpha_1 D_{i,t-1} + \alpha_2 \mathrm{Rain}_{i,t} + \alpha_3 \mathrm{Pop}_{i,t} + \alpha_4 \mathrm{Unemp}_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$D_{i,t} = \beta_0 + \beta_1 D_{i,t-1} + \beta_2 \mathrm{SPEI}_{i,t} + \beta_3 \mathrm{Pop}_{i,t} + \beta_4 \mathrm{Unemp}_{i,t} + \epsilon_{i,t} \quad (2)$$

where i indicates the province ($i = 1, \ldots, 21$) and t indicates the period ($t = 2007, \ldots 2014$).

Data we have used for disputes are adopted from the jurisdiction chapter of the Iran statistical yearbook[13], provided by the statistical center of Iran. This chapter extracts statistics from the number of registered crime, including threat, distraint, professing ruffianism, poisoning, and battery incidences. We aggregated all these rates and divided it by the working population to obtain our dependent variable, disputes (D).

Our explanatory variables are the logarithm of the average height of annual rainfall in milliliters (Rain) and the Standardized Precipitation Evapotranspiration Index (SPEI), while our control variables are the growth of working population (Pop) and the logarithm of the number of unemployed people over 10 years old (Unemp).

Since a higher likelihood to react in a conflictive way to water scarcity coincides with real macroeconomic characteristics such as unemployment and population growth, we controlled for these variables. All of these variables are drawn from the annual report of Iran statistics center, except SPEI which is from Iran National Drought Warning and Monitoring Center[14].

The SPEI is a multi-scalar drought index which takes into account both precipitation and potential evapotranspiration. It combines the simplicity of the calculation of the Standardized Precipitation Index (SPI) with the sensitivity to changes in evaporation demand, caused by temperature fluctuations and trends. It is statistically robust that allows comparison of drought severity through time and space. While like the SPI,

[13] https://www.amar.org.ir/english/Iran-Statistical-Yearbook.
[14] http://ndc.irimo.ir/far/wd/4625-SPEI.html.

Table 1. Descriptive statistics.

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
Disputes per 1,000 people	184	6.4189	8.5008	0	66.0271
Log(rainfall)	184	5.3424	0.7031	3.6240	7.1156
SPEI	184	−0.3944	0.7780	−2.4900	1.4100
Population growth	161	−0.0003	0.0641	−0.1899	0.2581
Log(unemployment)	184	11.0169	0.8712	9.4329	13.429

the SPEI can measure drought severity according to its intensity and duration, since the SPI cannot identify the role of temperature rise in future drought conditions, the use of the SPEI is superior.

The SPEI could detect, monitor, and analyze the commencement, length, and extent of drought conditions and classify different drought types and impacts. The SPEI is easily calculated on a range of timescales from 1 to 48 months, and values between −5 and 5 where smaller values indicate stronger degrees of drought, and larger values indicate higher degrees of moisture (Ma *et al.* 2015).

In Table 1, we present the descriptive statistics of all variables. On average for every 1000 people, provinces experienced more than six dispute incidents per year which go up to 62 episodes. The population has been scaled down by 1,000.

5. Results and discussion

Table 2 provides estimates of the relationship between rainfall and disputes per 1,000 people while Table 3 shows us how our result is robust, taking into account the SPEI instead. In Tables 2 and 3, all coefficients in all models are relatively stable, which show that the primary model of both tables, Model III, has robust and reliable results.

Provinces in Iran have substantial dissimilarity concerning the incidence of disputes. As there are factors within each province which are sometimes just impossible to capture, such as cultural features, ethnic characteristics, and even biological aspects, we use the lag of disputes per 1,000 people which

Table 2. Sys-GMM panel estimation regression of disputes per 1,000 people over rainfall.

	Model I	Model II	Model III
Constant	7.317*** (0.348)	7.473*** (0.435)	8.986*** (0.900)
Disputes per 1,000 people (−1)	0.479*** (0.001)	0.479*** (0.001)	0.476*** (0.001)
Log(rainfall)	−0.682*** (0.066)	−0.710*** (0.081)	−0.621*** (0.081)
Working population growth		0.237 (0.195)	0.495** (0.194)
Log(unemployment)			0.195** (0.086)
Observation	161	161	161
Number of instruments	26	27	28
Wald χ^2	151905.67***	149663.93***	135365.62***
Sargan-*p*-value	0.46	0.48	0.62
AR(1)-*p*-value	0.6	0.61	0.61
AR(2)-*p*-value	0.3	0.3	0.3
Diff-Sargan-*p*-value	0.363	0.908	0.998

Robust standard errors in parentheses. ***, ** and * indicate that the coefficients are significant at 1%, 5% and 10%, respectively.

Table 3. Sys-GMM panel estimation regression of disputes per 1,000 people over SPEI.

	Model I	Model II	Model III
Constant	3.485*** (0.093)	3.376*** (0.141)	7.920*** (0.815)
Disputes per 1,000 people (−1)	0.478*** (0.001)	0.480*** (0.002)	0.472*** (0.002)
SPEI	−0.460*** (0.021)	−0.448*** (0.024)	−0.430*** (0.023)
Working population growth		0.521** (0.237)	0.394** (0.177)
Log(unemployment)			0.409*** (0.081)
Observation	161	161	161
Number of instruments	23	24	25
Wald χ^2	158815.14***	146384.21***	97361.44***
Sargan-*p*-value	0.29	0.39	0.43
AR(1)-*p*-value	0.62	0.63	0.61
AR(2)-*p*-value	0.31	0.31	0.3
Diff-Sargan *p*-value	0.317	0.891	0.997

Robust standard errors in parentheses. ***, ** and * indicate that the coefficients are significant at 1%, 5% and 10%, respectively.

inherits these factors. Lagged of disputes per 1,000 people are always significant, positive and highly persistent in all models, showing that disputes of each province in a specific year are strongly affected by its history of conflicts and even bio-cultural backgrounds.

Rainfall is also very significant and has a substantial adverse effect, meaning that the more shortfall in rainfall, the more disputes. This finding is consistent with studies that exhibit a significant effect of adverse rainfall shocks on intergroup violence risk at the local level.

The SPEI, which incorporates not only precipitation but also temperature, has a similarly significant effect on disputes per 1,000 people. Although its impact is less than rainfall, in absolute terms, it is still more than control variables in all models of Table 3 and almost comparable to the lag of disputes per 1,000 people.

Interestingly, the effect of rainfall and the SPEI in our models, in absolute terms, are more than any other variables and therefore, at least in the case of Iran, the overall contribution of drought measures and shortage in rainfall to predicting violent events is not modest. This significant finding does not conform to some studies (e.g., Detges, 2016), which undermine the importance of precipitation shortfalls as a conflict-facilitating factor.

The population growth is an essential driver for water-related activities and problems (Sivakumar, 2011). We include it to control for the possibility that provinces with more inhabitants will be more prone to disputes. As we expected, working population growth as a control variable became significant once we consider unemployment as well. Indeed, the more people we have in a province, the more dispute and aggressive behavior we would observe. Interestingly, working population growth has almost the same magnitude of effect as lagged disputes per 1,000 people.

The conflicts and disputes are complex phenomena contributed by different variables which are very hard to measure. The robustness of the constant, in terms of significance and magnitude, in all models confirms this fact and indicates that there are still some other factors which could explain variations in the disputes but have not been captured in the models.

Although the countries in the Middle East and North African (MENA) region are very diverse in terms of wealth and natural resources, they have the same threat: water scarcity. While our data is on

Table 4. Stationary tests.

	PCD	Rain	SPEI	Pop	Unemp	Ineq
IPS	−1.743***	−6.941***	−7.420***	−5.957***	−3.072***	−2.918***
ADF	79.952***	130.141***	151.688***	132.150***	90.415***	79.453***

***Rejection of the null hypothesis of being non-stationary at 99% level of confidence.

Iran, the empirical results could be still relevant for the rest of the MENA countries. These countries with underdeveloped capacities for adaptive governance to water scarcity (Sowers *et al.* 2011) are vulnerable to climate impacts on water resources that cause a deterioration in agricultural production, the development of terrorist organizations, and fueling conflicts over resources.

Table 4 demonstrates that all variables are stationary based on both Fisher-type augmented Dickey-Fuller (ADF) and Im, Pesaran and Shin (IPS) tests.

Our results of regressions in both tables could not reject the null hypothesis of the Sargan–Hansen test for overall validity of the instruments, namely the instruments are overall exogenous. Therefore, over-identifying restrictions (instruments) are valid, and there is no correlation between instrumental variables and error term in the model.

Moreover, our results reject the null hypothesis of the Wald test, namely all coefficients of the model are zero; therefore, the model in total is significant. Furthermore, as our results could not reject the null hypothesis of the Arellano–Bond test, namely, there is no autocorrelation in first-differenced errors. Accordingly, there is no such autocorrelation in the error term.

We could not reject the null hypothesis of serial correlation tests AR(1) and AR(2) that the error term of the differenced equation is not serially correlated. A *p*-value of AR tests indicates the presence of no serial correlation at the first order and the second order, and therefore, the instruments of all models are reliable and the model specification is valid.

The steady-state assumption suggested by Roodman (2009) requires that the estimated coefficient on the lagged dependent variable in the model should point out convergence by having a value less than unity in absolute terms. Since the estimated coefficients of the lagged disputes per 1,000 people in Table 2 are between 0.476 and 0.479 and in Table 3 lie between 0.472 and 0.480, the steady-state assumption holds.

To address cross-sectional dependence, we used the Sargan's difference test for cross-section dependence. As we could not reject its null hypothesis that there is no cross-section dependence between disputes and rainfall (Table 2) or between disputes and droughts (Table 3), our current estimation method is well made.

6. Conclusion

Environmental issues play a significant role in threatening security, violent conflicts, and tensions among sub-national or national groups. In this paper, we tried to draw attention to the social aspect of climate change in Iran, particularly water crisis and drought. This study is probably the first to investigate the dynamic relationship between rainfall shortfall and social disputes in the case of Iran.

Because water is a reserve with no replacement and consistent, and instant need, struggle to get access to its scare resource might lead people to show non-cooperative, and even hostile and violent behaviors.

Moreover, precipitation deficiency might give an income shock, make people nervous, and make them violent.

Our finding indicates a substantial social consequence of climate change in Iran. Particularly we illustrate that there is a significant effect of adverse rainfall shocks and the SPEI, as an index of drought, on the interpersonal dispute in provinces of Iran. Indeed, the overall contribution of rainfall shortfall and drought measure, as conflict-facilitating factors, on aggressive and violent events is remarkable. Moreover, working population growth and unemployment could explain a significant part of violent behavior and aggressive disputes.

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