ILO Working Paper 30

May / 2021

The impact of extreme weather on temporary work absence

Authors / Nekeisha Spencer, Mikhail-Ann Urquhart

ISBN: 978-92-2-034343-2 (print)
ISBN: 978-92-2-034344-9 (web-pdf)
ISBN: 978-92-2-034345-6 (epub)
ISBN: 978-92-2-034346-3 (mobi)
ISSN: 2708-3446

ILO Working Papers summarize the results of ILO research in progress, and seek to stimulate discussion of a range of issues related to the world of work. Comments on this ILO Working Paper are welcome and can be sent to ilocarib@ilo.org.

Authorization for publication: Dennis Zulu, Director

ILO Working Papers can be found at: www.ilo.org/global/publications/working-papers

Suggested citation:
Spencer, N., Urquhart, M. 2021. *The impact of extreme weather on temporary work absence*, ILO Working Paper 30 (Geneva, ILO).

Abstract

The study examines the impact that extreme weather has on temporary work absence in Jamaica, a central concern given the country's negative experience with such events. The study uses quarterly data containing key labour market indicators on an unbalanced panel of individuals along with climatic data for the period 2004 to 2014. The findings are several.

Firstly, neither excess rainfall nor hurricane affects the odds of being temporarily absent from work. However, including interactions between these weather variables and other key labour market indicators show that only excess rainfall increases the odds of being temporarily absent from work.

Secondly, the estimated increase due to excess rainfall translates into a probability of 0.002 per cent of being temporarily absent. Although very marginal, this estimated outcome of excess rainfall is plausible given that workers may be unable to navigate flooded roads to attend work or perhaps are confined due to unforeseen conditions arising in their home environment.

Thirdly, using compensation of salaried employees which includes salaries and benefits, we calculated that the average estimated cost of temporary daily absence from work to the labour market is approximately US$2.81. The estimated results and losses, though negligible, can possibly have implications for the labour market which may involve developing e-commuting policies to combat these unfavourable outcomes.

The absence of an impact as it relates to hurricanes possibly indicates that existing mechanisms are working to mitigate storm impacts, or the closure of workplaces due to disruptions in the economy from storm occurrences, results in no work.

About the authors

Dr. Nekeisha Spencer is a senior lecturer at the University of the West Indies, Mona Campus. She holds a PhD in Economics from Binghamton University, State University of New York, USA. Her areas of research include environmental and resource economics, climate economics and labour economics.

Mikhail-Ann Urquhart is the Senior Director of Research and Measurement at the Jamaica Productivity Centre. She is also a doctoral candidate at the University of the West Indies, Mona. Her research interests include development economics, labour market dynamics, and human capital attainment. She has garnered over 10 years of experience lecturing undergraduate economics and statistics, researching various aspects of the Caribbean economy, and working as an economist in the public sector of Jamaica.

Table of contents

List of Tables

Executive Summary

This study examines the impact that extreme weather has on temporary work absence in Jamaica, which is important given the country's negative experience with such weather events. To carry out this investigation, this study uses quarterly data containing key labour market indicators on an unbalanced panel of individuals along with climatic data for the period 2004 to 2014.

The results of this study indicate several things. Firstly, neither excess rainfall nor hurricane affects the odds of being temporarily absent from work. However, including interactions between these weather variables and other key labour market indicators show that only excess rainfall increases the odds of being temporarily absent from work. Secondly, the estimated increase due to excess rainfall translates into a probability of 0.002 per cent being temporarily absent. Although very marginal, this estimated outcome of excess rainfall is plausible given that workers may be unable to navigate flooded roads to attend work or perhaps are confined due to unforeseen conditions arising in their home environment. Thirdly, using the compensation of salaried employees which includes salaries and benefits, we calculated that the average estimated cost of temporary daily absence from work to the labour market is approximately US$2.81. The estimated results and losses, though negligible, can possibly have implications for the labour market which may involve developing e-commuting policies to combat these unfavourable outcomes. The absence of an impact for hurricanes possibly indicates that existing mechanisms are working to mitigate storm impacts, or the closure of workplaces due to disruptions in the economy from storm occurrences, results in no work.

Introduction

Jamaica is susceptible to extreme weather conditions and it is categorized as one of the most extremely vulnerable islands in the Caribbean (Kaly et al. 2004). Extreme weather such as hurricanes and excess rainfall are known to keep employees grounded at home (Bureau of Labor Statistics (BLS), 2012) due to infrastructural damages and the danger of working in unsafe conditions (Delp et al. 2009). Furthermore, extreme weather can cause unintended health consequences (Greenough et al. 2001; Bourque et al. 2006) for workers which can prevent them from being present at work. Since Jamaica is vulnerable to extreme weather conditions like other countries in the Caribbean, presumably there are impacts on temporary work absences in the local labour market. In addition to absences from work resulting in lower productivity (Allen 1983) which can impact economic growth, workers may have to deal with less income which has implications for economic welfare (Thomas et al. 2010; Karim and Noy 2014; Henry et al. 2020).

There are several studies investigating the impact of extreme weather on labour market outcomes (including Belasen and Polachek (2008), Pecha (2017)[1] – hurricanes, employment and earnings; Acevedo (2016) – rainfall, labour supply and income; and Graff Zivin and Neidell (2014) – temperature and hours worked). However, the literature is limited in its investigation with only a few studies quantifying the impact of extreme weather on temporary absences from work. The studies (including Coleman and Schaefer 1990 and Zander et al. 2015) that exist, focus only on temperature and on countries outside of the Caribbean. Even if one uses these studies as a basis to understand how extreme weather impacts the labour market, it is difficult to draw any conclusions regarding non-temperature events. For example, there seems to be no consensus on the directional impact of temperature on absences as these studies point to either lower (Coleman and Schaefer 1990) or higher temperatures (Zander et al. 2015) resulting in increasing work absences. Furthermore, in contrast to the Caribbean, and even Jamaica specifically where the temperature is relatively stable, the countries in these studies have significant variation in temperature; thus, extreme temperatures would reasonably impact work absences in those settings. The lack of consensus in the bad-weather-work-absence literature and its far-fetched applicability to the Caribbean, warrants further investigation as to the impact of extreme weather on work absence. Therefore, this study proposes to quantify the impact that extreme weather events, including hurricanes and excess rainfall, have on temporary absence from work in Jamaica.

Jamaica is particularly a good case study for several reasons. Firstly, it is vulnerable to extreme weather given its geographical location and size. It often experiences hurricanes[2]. Moreover, the climate change literature (Knippertz et al. 2000; Paciorek et al. 2002; Fischer-Bruns et al. 2005; Schiermeier 2011; Haarsma et al. 2013; Alfieri et al. 2015) suggests an increase in cyclonic activity and extreme rainfall or flooding with warmer weather. Secondly, in line with the latter, Jamaica has been experiencing an increased number of excess rainfall events which have significantly affected economic and social activities (Nandi and Smith 2016; Glas et al. 2017; Fontes de Meira and Phillips 2019). Thirdly, there is evidence indicating that absences from work is related to bad weather. For example, in a national survey[3], workers reported that bad weather was a cause of their absence from work. Furthermore, the Government has provided direction, indicating that hurricane-related absences should be recorded as leave (Jamaica Information Service 2010).[4] [5]

1 Pecha's (2017) study of the Jamaican labour market reveals that hurricanes increase the probability of labour informality but have no impact on persons becoming unemployed.
2 For the sample period, 2004 to 2014, Jamaica experienced 11 hurricanes ranging from categories 1 to 5 based on the Saffir Simpson scale. See Table 1 for more details.
3 The Labour Force Survey of Jamaica (LFS) is administered by the Statistical Institute of Jamaica (STATIN).
4 Unfortunately, there is no information available to indicate previous practice before the Government provided this direction or when this practice was instituted.
5 It should be noted that it is unclear what the Government means regarding hurricane-related absences. Perhaps, when a hurricane strikes and workers are not present at work, they are to report that they are on leave rather than being absent.

To support resilience to disaster-related vulnerabilities and climate change, a clear understanding of the impact of extreme weather on temporary absence from work is needed to inform the development of adaptation and employment policies[6] so as to maintain or mitigate possible reductions in productivity levels that can arise from weather-related absences from work. We therefore propose a study to determine the extent to which extreme weather impacts those who report temporary absence from work. Moreover, the results can be applied to other Caribbean countries experiencing the ill-effects of climatic shocks. Additionally, the study will fill the existing gap in the literature that fails to quantify the impact that extreme events such as hurricanes and excess rainfall have on temporary absence from work.

The analysis produces some interesting findings for extreme weather conditions. We find that the odds of individuals being temporarily absent from work is unlikely given hurricane strikes. This estimated outcome indicates several possibilities. Firstly, the reported absences could be unrelated to hurricane strikes given the Government's decree to report such absences as leave from work (Jamaica Information Service 2010), in which case, employees would not be working. Secondly, Jamaica possibly has a labour market where existing mechanisms are working to reduce the impact of hurricanes. In this regard, one may want to note that Pecha (2017) finds the absence of a hurricane impact on unemployment in the Jamaican labour market, thus supporting possible resilience, a phenomenon that is not new to the labour-disaster literature (Belasen and Polachek 2008; Belasen and Polachek 2009). With the lack of documentation on existing mechanisms, which are possibly ad-hoc, one can surmise that employers perhaps arrange transportation for workers who are unable to travel due to disruption in public transportation or that hurricane warnings would have given employers enough time to arrange for work to resume virtually should the level of destruction restrict movement. Thirdly, this outcome could also be an indication of workplaces being closed due to disruptions in the economy resulting in an unobservable impact of hurricanes on temporary absences.

In addition, the estimations reveal that excess rainfall is more likely to increase the odds of individuals reporting temporary absence from work due to bad weather.[7] This result is reasonable since workers may be unable to travel to work due to impassable roads, or perhaps they are absent due to related and unforeseen conditions at home. This estimated result points to the need to design and implement policies governing e-commuting to mitigate possible impacts on productivity. These policies would require formalized agreements between employers and employees regarding delivery of outputs as would be needed to avoid the interruption of production processes. Where e-commuting is not possible, employers would have to arrange for employees, whose work has to take place on the work site, to be present. However, where working on site or the e-commuting of certain tasks are beyond the control of the employers, the development of policies could involve providing avenues for employees to contribute to the production through assisting with e-commuting tasks to improve efficiency and delivery of outputs.

The remainder of the paper is organized as follows: In the next section we discuss the survey and weather data along with the descriptive statistics; section 2 covers the econometric estimations and results; followed by the conclusion of the report.

6 Perhaps such policies could be in relation to working from home.
7 A report issue by the BLS (2012) points to absence from work due to storm related flooding.

1 Data and descriptive statistics

Individual data

The source of data is the Labour Force Survey (LFS) of Jamaica that is administered by the Statistical Institute of Jamaica (STATIN). Although this survey started in 1974, the study is restricted to 2004-2014 due to the accessibility of the full features of the data required for the study. On an annual basis, the survey collects quarterly individual level information on the activities of persons 14 years of age or older, who are in and outside of the labour, as well as their demographic information. Thus, a survey is done each year in January, April, July, and October. A special feature of the LFS is that it is constructed based on a rotating panel which enables the construction of a panel of individuals for 2004-2014. As it relates to the structure of the panel, some individuals on the panel are interviewed for two consecutive periods and are then used again the subsequent year, while half of the panel are used between successive surveys. This structure allows for a panel construction enabling both annual and quarterly comparison.

The LFS provides data on variables that are central to the objective of this study where the focus is on employed individuals. Importantly, the survey asks respondents who reported being employed, whether they were temporarily absent from work and the reasons why – where one primary reason given is bad weather. This allows us to create two binary variables: a general absence from work variable and an absence from work variable capturing individuals who report not going to work due to bad weather. Furthermore, the survey also asks respondents why they worked less hours per week and one reason given is bad weather. This allows us to supplement the analysis of temporary absences due to bad weather.[8]

The LFS consistently collects many individual level variables that can be useful controls in the analysis. These are: years of schooling, age, job tenure, work sector, occupation type, employer/company size, location/place of work and type of employment.[9] The details of these controls can be seen in Table 2. It must be noted that while the analysis can benefit from variables such as the complete terms-of-work contracts under which individuals operate, their mode of transportation to work and their health status, the survey does not collect these data. Regarding health, an aspect of health that may be of interest is meteoropathy, which occurs when environmental factors such as changes in weather affect the human body (Žikić and Rabi-Žikić 2018). Meteoropathic individuals can experience challenges that affect their participation in the labour market, such as being temporarily absent from work or working less hours than individuals not affected by meteoropathy. Unfortunately, the survey does not ask respondents to report whether they are meteoropathic. While this may be important to the analysis, there is no evidence to date that this is a condition experienced by labour market participants in Jamaica and there are no data that exists otherwise that can be used as a proxy for this condition. Furthermore, there is no literature supporting the impact that being meteoropathic has on the labour market. As a result, this lack of such information is not expected to affect the estimated relationship between extreme weather and temporary absences from work.

[8] A notable limitation is using this dataset to disentangle the effect of extreme weather in this survey refers to period of a week when soliciting responses from participants. If bad weather takes place outside of this reference week then weather related absences would not accurately be captured, thus leading to possible measurement error. Note this is a common problem experienced with surveys (BLS 2012). We explore the use of lags in the analysis to also investigate the timing of weather effects.

[9] Unfortunately, the LFS does not report any information on commuting modality, which could serve as a useful control.

Hurricane destruction

Hurricane is the most extreme weather event that affects Jamaica. As a result, it is important to have an accurate measurement of hurricanes' destruction. There is now growing literature (Strobl 2012; Spencer and Urquhart 2018; Ishizawa and Miranda 2019) that is moving away from using storm incidence dummies (Spencer 2017) as proxies of destruction, towards using measures of hurricane destruction that takes into account the physical characteristics of the storm. Such characteristics include its location relative the points of interests, namely, where geographical coordinates of individuals, the maximum wind speed, the backward and forward motion of the storm as well as the point of landfall, if the storm makes direct contact with land. It is noteworthy to point out that, in the case of Jamaica, not all storms make landfall but as experiences show, significant damages have been caused as a result of the size and strength of some storms.

To construct the destruction proxy, we take the households in which individuals live as $i=1,....,I$ which are located in enumeration district, $j=1,.....,J$ that experience storms, $s=1,......S$ with lifetime $l=1,.....L$ and calculate hurricane destruction for each i during time t[10] as follows:

$$H_{ijt} = \sum_{s=1}^{S}\sum_{l=1}^{L}\left(W_{ijslt}\right)^3 \quad (1)$$

where $W \geq W^*$ and W*= 119mph which is the threshold above which wind will be damaging for individual households (see Henry et al. 2020). The value of W* is the lowest point that defines hurricane damage according to the Saffir-Simpson wind scale. Thus, W and W* are used to calculate a unique H, the hurricane destruction index value for each individual household in the sample. Note that hurricane wind speed values are cubed since monetary losses and the power of hurricanes increases as the cube of the maximum wind speed goes up (Emanuel 2005). These indices are calculated using the Boose et al. (2004) wind field model that is based on Holland's (1980) equation. The hurricane index is considered valid since it is constructed using non-economic data and is therefore exogenous. The index is advantageous in the sense that it allows for a more comprehensive estimation of destruction done by these storms. The data to create H are obtained from the North Atlantic Hurricane database and the National Hurricane Center of the National Oceanic and Atmospheric Administration (NOAA). Over the sample period, there were 11 storms that the island experienced (see Table 1).

Table 1. Hurricanes that affected Jamaica from 2004-2014

Storm	Year (Month)	Saffir-Simpson scale
Charley	2004 (August)	3
Ivan	2004 (September)	5
Dennis	2005 (July)	3
Emily	2005 (July)	5
Wilma	2005 (November)	5
Dean	2007 (August)	5
Gustav	2008 (August)	4
Ike	2008 (September)	3
Paloma	2008 (November)	3
Tomas	2010 (November)	1
Sandy	2012 (October)	1

10 Time t goes from 2004 quarter 1 to 2014 quarter 4.

Other weather variables

High resolution (0.5 times 0.5-degree cells of global land areas) quarterly values of rainfall, measured in millimeters, and the average temperatures, measured in Celsius are used as controls. The source of these data is the TRMM satellite derived database. Including these weather controls are important as pointed out by Auffhammer et al. (2013) since hurricanes can be correlated with other climatic variables that can affect temporary absence from work. The works of Hsiang (2010) and Henry et al. (2020) also support the inclusion of other climatic variables since omitting these could bias expected results. In addition, excess rainfall is constructed using the number of rainfall days that fall above the 90th percentile threshold as indicated by local weather stations.

Descriptive statistics

Table 2 provides descriptive statistics for the variables used in the analysis. As can be seen, on average, approximately 2 per cent of employed people reported being absent from work, while 0.1 per cent and 0.5 per cent reported absence and working less hours due to bad weather. Thus, there is a higher number of individuals reporting that they work less hours (0.5 per cent) than those reporting temporary absence (0.1 per cent) due to bad weather. The mean value of the hurricane index when it takes on non-zero values, that is, when a storm is damaging, is 0.007.[11] The average values for rainfall, extreme rainfall and temperature respectively are, 4.7 millimeters, 5.2 days and 26.9 degrees Celsius. The average age of the sample is 41 years, and the number of years of schooling averages around 10 years.

As it relates to job tenure, the majority (68.7 per cent) of the sample taken works for five or more years. However, there is a big disparity between those working at least five years and those working for less than 5 years. As Table 2 shows, roughly 15 per cent of employees have two and five years' tenure at their current jobs. The smallest percentage (1.7 per cent) tenure recorded was less than one year but over nine months. The majority of the sample report were employees of private sector companies (47 per cent) as well as own account workers (37 per cent). Place of work appears to vary significantly among respondents. As the Table 2 shows, most of the respondents (34 per cent) reported that they work at a factory; 19 per cent at a farm; and 14 per cent at a shop. The remaining places of work included construction sites, the market, employer's house, and home, and each totalled approximately 7 per cent and below. Finally, the majority of respondents belong to the private sector (47 per cent), followed by self-employed (40 per cent) and then public (13 per cent).

[11] This value is normalized by 1.0e+09 to make the figures more readable.

▶ **Table 2. Descriptive statistics**

Variables	Mean	Std. dev.
Dependent		
Temporary absence	0.019	0.137
Temporary absence due to bad weather	0.001	0.025
Work less hours due to bad weather	0.005	0.071
Other weather		
Hurricane	0.007	0.005
Extreme rainfall	5.178	4.303
Rainfall	4.822	3.218
Temperature	26.868	1.825
Other controls		
Age	41.131	13.802
Age-squared	1882.303	1251.875
Years of schooling	9.992	2.460
Job tenure dummies		
Less than 3 months	0.032	0.176
3 months but less than 6 months	0.029	0.167
6 months but less than 9 months	0.024	0.152
9 months but less than 12 months	0.017	0.129
1 year but less than 2 years	0.065	0.247
2 years but less than 5 years	0.147	0.354
5 or more years	0.687	0.464
Sector		
Employee of central or local government	0.095	0.294
Employee of other government agencies	0.030	0.170
Employee of private sector	0.458	0.498
Unpaid family worker	0.013	0.115
Employer	0.029	0.168
Own account worker	0.372	0.483
Not given	0.002	0.043
Employment by industry		
Agriculture	0.002	0.047
Mining	0.063	0.242
Manufacturing	0.068	0.251
Electricity	0.055	0.228
Construction and installation	0.084	0.278
Wholesale and retail	0.188	0.391
Transport and storage	0.194	0.395
Financing and insurance	0.140	0.347
Community and social services	0.060	0.238
Industry not stated	0.146	0.354
Employer size		
1 person	0.451	0.498

2-4 persons	0.161	0.368
5-9 persons	0.084	0.277
10-49 persons	0.170	0.375
50+ persons	0.135	0.342
Workplace		
Home	0.053	0.223
Farm	0.187	0.390
Employer's house	0.061	0.240
Factory	0.343	0.475
Street (fixed location)	0.030	0.170
Street (no fixed location)	0.052	0.223
Shop	0.138	0.345
Market	0.026	0.158
Employment type		
Public	0.125	0.331
Self	0.402	0.490
Private	0.473	0.499
Observations	23,928	

2 Econometric estimation and discussion

Econometric model

To estimate the impact of extreme weather on temporary absence from work, we use the following benchmark model and conditional fixed effects logistic regressions.

$$TA_{ijt} = \propto_1 + \propto_2 \sum_{l=0}^{1} H_{ijt-l} + \propto_3 \sum_{l=0}^{1} X_{ijt-l} + \propto_4 W_{ijt-l} + \propto_5 C_{ijt} + y_y + q_d + p_d + \gamma_i + \varepsilon_{ijt}$$

(2)

where TA_{ijt} is the temporary absence binary variable for individual i[12] in district j at time t[13]. H_{ijt} is the hurricane wind damage index defined in (1) and X_{ijt} is extreme rainfall. W_{ijt} is a vector containing rainfall and temperature. *l* captures the lagged weather variables, where *l* goes from *t*=0 to *t*=1.[14] *C* is a vector of other controls, which are years of schooling, age, age-squared, job tenure dummies, work sector dummies, occupation type dummies, employer/company size dummies, location/place of work dummies and type of employment dummies. y_y, q_d and p_d are year, quarter, and parish fixed effects while γ_i captures individual specific unobservables that are possibly correlated with other explanatory variables. Finally, ε_{ijt} is the error term and are clustered at the enumeration district level.

Temporary work absence

The impact of hurricanes on respondents who reported being absent from work is first estimated without controlling for individual specific fixed effects, γ. The second column of Table 3 shows the estimated odd ratios. As can be seen, this estimation produces an insignificant coefficient on *H*, suggesting that there is no impact on temporary absence from work. This also holds true for extreme rainfall, rainfall and temperature[15]. Estimating the fixed effects produces the same outcome except for the slight changes in the odd ratios for other weather controls as shown in column 3. Thus, controlling for time invariant individual specific effects can have a bearing on estimated outcomes, and as a result, this is the preferred model that is used for the remaining discussion of this variable since it reduces the biasedness of estimates. Overall, the results show that extreme weather, specifically hurricanes and excess rainfall, do not affect the odds of employees being temporarily absent when compared to a case of no extreme weather. This overall view is a possible indication of a labour market that is not susceptible to extreme weather, which has also been a notable characteristic in the works of Pecha's (2017) on Jamaica with hurricanes, and Belasen and Polachek (2008) on Florida with hurricanes, where the studies focused on indicators such as wages and employment. Furthermore, as Wilson (2017) indicates, economies become less sensitive to weather conditions with which they are familiar. Since Jamaica's weather history is marked by hurricanes, disruptions to the labour market as a result of storms appear to have a non-discernable impact.

12 i equals to 11,557.
13 Time t goes from 2004 quarter 1 to 2014 quarter 4 so t equals to 44.
14 Please note that Ht captures hurricane in current time (t) while Ht-1 captures hurricane the time period before.
15 See Spencer and Urquhart (2021) which also shows a non-temperature effect.

▶ Table 3. The impact of extreme weather on temporary work absence

Variables	(1) - Pooled	(2) - Fixed effects
Hurricane	1.000	1.000
	(1.07e-08)	(1.06e-08)
Excess Rainfall	1.0120	1.0070
	(0.0101)	(0.0127)
Rainfall	1.000	1.015
	(0.0175)	(0.0209)
Temperature	0.987	0.959
	(0.0131)	(0.0413)
Observations	23612	15504[1]

[1] The observations reduced to 15504 owing to the lack of variability where individuals reported either absence from work or no absence from work. For those individuals that remained in the analysis, their status varied from absent to not being absent or vice versa.

Notes: (i) Models (1) and (2) present the odd ratios and include all the controls listed in Table 2.

(ii) The dependent variable is temporary absence from work where temporary absence is 1, 0 otherwise.

(iii) Standard errors in parentheses.

Table 4 gives the same outcome for hurricanes but with a different reality for excess rainfall. The Table features the interactive effects of hurricanes and excess rainfall with workplace and employment type. Firstly, model 1 features the interactions with hurricanes. As the results show, the odds of an employee being absent from work due to hurricanes is improbable, with the emphasis on those working in factories. Noteworthy is the fact that excess rainfall increases the odds of being absent from work and is at least 1.085 higher than if there was no excess rain. The focus here is on those working at home, on a farm, in a shop and at the market. This impact can be attributed to road conditions (Miller 2009) which makes it difficult to get to work or the lack of public transportation given its vulnerability to weather (Leviäkangas et al. 2011; Kaufman 2012). However, increasing absence for those working at home is unexpected. Although intriguing at first, there is a plausible explanation. It is quite likely that excess rainfall prevents other household members from leaving home, thereby resulting in distractions (Srivastava et al. 2015), thus rendering an at-home worker incapable of accomplishing work responsibilities. Interestingly, excess rainfall reduces the odds of a factory worker being absent from work. This could be likely due to factory employers providing transportation for workers or perhaps workers live in close proximity to the factory. Examining model 2, which adds public and private sector workers, we see that excess rainfall increases the odds of temporary absence by 1.039.[16] We also note that compared to a private sector worker, the odds of an individual working in the public sector and being temporary absent from work due to excess rainfall is 0.91 lower than being absent if there is no excess rainfall. As in the case of a factory worker, perhaps there is a transportation system in place for public workers to get to work or the infrastructure is in place for them to carry out work from home, and in that case, they are less likely to report absent from work.[17]

[16] This means that there is a 0.002 per cent increase in the probability of being temporarily absent due to excess rainfall. This calculation uses the marginal effect (0.0000003) on excess rainfall times the maximum number of rainfall days above the 90th percentile times 100. Note that in order for someone to be absent from work, one would have to be very close to the margin (probability=0.5) of being absent. Therefore, calculating out probabilities are nonsensical given the small probability.

[17] A concern may arise regarding the use of excess rainfall and hurricanes together. While the model is line with the literature (including Auffhammer et al. 2013 and Henry et al. 2020), sensitivity analyses were done to satisfy queries and the results were not impacted.

Table 4. The impact of extreme weather on temporary work absence: Interaction effects

Variables	Model 1	Model 2
Excess Rainfall	1.000	1.000
	(2.10e-08)	(2.25e-08)
Rainfall	1.022	1.039*
	(0.0209)	(0.0216)
Temperature	0.995	0.999
	(0.0212)	(0.0215)
Temperature	0.953	0.949
	(0.0413)	(0.0411)
Interaction: Workplace_"type"*Hurricane		
_Home*Hurricane	1.000	1.000
	(4.01e-08)	(4.37e-08)
_Farm*Hurricane	1.000	1.000
	(3.31e-08)	(3.59e-08)
_EmployersHouse*Hurricane	1.000	1.000
	(5.15e-08)	(5.24e-08)
_Factory*Hurricane	1.000*	1.000
	(2.49e-08)	(2.56e-08)
_Street-Fixed*Hurricane	1.000	1.000
	(6.43e-08)	(6.53e-08)
_Street-NotFixed*Hurricane	1.000	1.000
	(4.04e-08)	(4.11e-08)
_Shop*Hurricane	1.000	1.000
	(3.92e-08)	(4.02e-08)
_Market*Hurricane	1.000	1.000
	(6.44e-08)	(6.73e-08)
Interaction: Workplace_"type"*ExcessRainfall		
_Home*ExcessRainfall	1.070**	1.064**
	(0.0287)	(0.0319)
_Farm*ExcessRainfall	1.097***	1.091***
	(0.0289)	(0.0311)
_EmployersHouse*ExcessRainfall	1.044	1.030
	(0.0350)	(0.0342)
_Factory*ExcessRainfall	0.949***	0.973
	(0.0175)	(0.0183)
_Street-Fixed*ExcessRainfall	1.049	1.042
	(0.0406)	(0.0425)
_Street-NotFixed*ExcessRainfall	1.022	1.019
	(0.0361)	(0.0367)
_Shop*ExcessRainfall	1.085***	1.070**
	(0.0288)	(0.0288)
_Market*ExcessRainfall	1.092*	1.085
	(0.0533)	(0.0549)

Interaction: Employment_"type"*Hurricane		
_Public*Hurricane		1.000
		(2.35e-08)
_Self*Hurricane		1.000*
		(2.72e-08)
Interaction: Employment_"type"*ExcessRainfall		
_Public*ExcessRainfall		0.905***
		(0.0147)
_Self*ExcessRainfall		0.982
		(0.0190)
Observations	15504	15504

Notes: (i) Models (1) and (2) present the odd ratios and include all the controls listed in Table 2.

(ii) The dependent variable is temporary absence from work where temporary absence is 1, 0 otherwise.

(iii) Standard errors in parentheses.

(iv) *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Temporary work absence due to weather conditions

The reported temporary absence from work does not necessarily allow one to infer the causes of such absence. As such, using a more specific sample, Table 5 shows the results from focusing on individuals who reported being absent from work because of bad weather. Of course, one may want to note, in general, that unfavorable weather can potentially impact productive processes (Strobl 2012) through the closing of workplaces, impassable roads (Spencer et al. 2016), disruption in the transportation system (Kaufman 2012) and general safety concerns (Delp et al. 2009). In this regard, the results are limited in the sense of not being able to identify the specific channel through which one's absence from work can be impacted due to bad weather. Nevertheless, we can draw some insights from the results.

It can be noted in Table 5, that controlling for individual specific fixed effects does make a difference in the overall significance of the estimates, especially as it relates to rainfall. Observing the odd ratios of model 2 indicate that extreme weather events have an impact on temporary absence from work where the focus is on those who report absence for a specific reason, that is, bad weather.[18] One can see that hurricane strikes significantly lower the odds of one being temporarily absent from work by 0.999. Thus, one is less likely to report being absent from work. However, this is close to being absent, so one is nearly likely to go to work. In this case, the impact of a hurricane will not be noticeable.

On the other hand, one observes that excess rainfall significantly increases the odds of being temporarily absent. In other words, the odds of temporary absence due to excess rainfall is 1.229 higher when compared to the situation in which there was no extremity in rainfall levels. As highlighted before, this outcome is attributable to a number of reasons including road conditions (Spencer et al. 2017), transportation and safety issues (Leviäkangas et al. 2011; (Delp et al. 2009)). Understandably, the usual rainfall levels decrease the odds of employees being absent by 0.737.

[18] There are other options that the survey captures as possible reasons for absence from work including maternity/paternity leave, labour dispute or vacation.

▶ **Table 5. The impact of extreme weather on temporary work absence due to bad weather**

Variables	(1) - Pooled	(2) - Fixed Effects
Hurricane	0.999*	0.999***
	(5.71e-08)	(7.27e-08)
Excess Rainfall	1.063	1.229**
	(0.0656)	(0.119)
Rainfall	0.882	0.737**
	(0.0906)	(0.108)
Temperature	1.085	0.900
	(0.0978)	(0.253)
Observations	7469	618

Notes: (i) Models (1) and (2) present the odd ratios and include all the controls listed in Table 2.

(ii) The dependent variable captures individuals who report temporary absence from work due to bad weather where temporary absence is 1, 0 otherwise.

(iii) Standard errors in parentheses.

(iv) *** p<0.01, ** p<0.05, * p<0.1.

Table 6 extends model 2 in Table 5 to include interaction effects of hurricane and excess rainfall with types of employment and employees' place of work. Model 1, which features weather interactions with workplace shows that hurricane and excess rainfall do not significantly affect the odds of temporary absence regardless of one's place of employment. On the other hand, model 2, which adds interactions with type of employment, produces different results. Firstly, we note that excess rainfall increases the odds of temporary absence for farm and factory workers by 1.22 and 1.32, respectively. Furthermore, compared to a private sector worker, the odds of an individual who is working in the public sector being temporary absent from work due to excess rainfall is lower by 0.65; an outcome that can be explained by the public sector possibly having mechanisms in place to reduce absence, for example, through transportation and work-from-home infrastructure. Of course, the higher likelihood of absence due to excess rain implies associated flooding which impacts movement and travel to work. Conversely, normal rainfall would generally not cause major disruptions and so it is understandable why workers are less likely to be absent.

▶ **Table 6. The impact of extreme weather on temporary work absence due to bad weather: Interaction effects**

Variables	Model 1	Model 2
Hurricane	0.999	0.999
	(1.28e-07)	(1.67e-07)
Excess Rainfall	1.126	1.212
	(0.130)	(0.152)
Rainfall	0.769*	0.750*
	(0.120)	(0.119)
Temperature	0.926	0.941
	(0.280)	(0.284)
Interaction: Workplace_"type"*Hurricane		
_Home*Hurricane	0.999	0.999
	(7.27e-07)	(7.59e-07)

_Farm*Hurricane	1.000	1.000
	(1.97e-07)	(1.97e-07)
_EmployersHouse*Hurricane	0.999	1.000
	(1.54e-06)	(2.27e-06)
_Factory*Hurricane	0.997	0
	(0)	(0)
_Street-Fixed*Hurricane	0.999	1.000
	(244.2)	(14,400)
_Street-NotFixed*Hurricane	0.999	1.000
	(1.71e-07)	(2.07e-07)
_Shop*Hurricane	0.999	1.000
	(5.430)	(0.479)
_Market*Hurricane	0.999	1.000
	(0.018)	(0.004)
Interaction: Workplace_"type"*ExcessRainfall		
_Home*ExcessRainfall	1.073	1.074
	(0.187)	(0.218)
_Farm*ExcessRainfall	1.147	1.220*
	(0.108)	(0.144)
_EmployersHouse*ExcessRainfall	1.820	1.530
	(1.345)	(1.146)
_Factory*ExcessRainfall	1.244	1.315*
	(0.204)	(0.216)
_Street-Fixed*ExcessRainfall	0.630	0.679
	(0.364)	(0.387)
_Street-NotFixed*ExcessRainfall	1.162	1.210
	(0.200)	(0.229)
Interaction: Employment_"type"*Hurricane		
_Public*Hurricane		0.999
		(0.001)
_Self*Hurricane		0.999
		(1.82e-07)
Interaction: Employment_"type"*ExcessRainfall		
_Public*ExcessRainfall		0.653*
		(0.164)
_Self*ExcessRainfall		0.889
		(0.094)
Observations	618	618

Notes: (i) Models (1) and (2) present the odd ratios and include all the controls listed in Table 2.

(ii) The dependent variable captures individuals who report temporary absence from work due to bad weather where temporary absence is 1, 0 otherwise.

(iii) Standard errors in parentheses.

(iv) * p<0.1.

Temporary work absence: Lagged weather effects

Many in the disaster literature field have explored the persistent impact the extreme weather (including Spencer and Urquhart 2018; Spencer and Polachek 2015 and Henry et al. 2020). As a result, it is instructive to examine if extreme weather impacts are long-lasting. These results are shown in Table 7. Model 1 presents the results for all workers who report being absent from work. Here we note the significance of the one period hurricane lag[19], which implies that the lack of an effect is only noticeable a quarter later after a hurricane strikes. Model 2 shows the results for workers who report being absent from work specifically due to bad weather. This subsample estimation reveals that once again, one quarter after a hurricane strikes, there is no impact on the odds of being absent. On the other hand, excess rainfall increases the odds of being absent by 1.07. Thus, we can conclude that the experience of hurricanes has strengthened the labour market to mitigate against such shocks beyond current time period. As it relates to excess rainfall, the effect is likely to be persistent, as in the case of model 1, perhaps because of the slow recovery of either infrastructure or employees having to cope with the effects of excess rain. Although unknown, one may want to note that it may be possible that employees report absence due to bad weather but could be facing circumstances related to excess rainfall such as family and health issues or they could just be using bad weather as an opportunity to shirk work obligations (Shi and Skuterud 2015; Žikić and Rabi-Žikić 2018).

▶ **Table 7. The impact of extreme weather on temporary work absence and absence due to bad weather: Lagged weather effects**

Variables	Model 1	Model 2
Hurricane	1.000	1.000**
	(1.06e-08)	(7.18e-08)
Excess Rainfall	1.007	1.271**
	(0.0127)	(0.126)
Rainfall	1.014	0.714**
	(0.0209)	(0.108)
Temperature	0.960	1.044
	(0.0416)	(0.308)
Lag 1_Hurricane	1.000*	1.000**
	(7.45e-09)	(4.72e-08)
Lag 1_ExcessRainfall	0.999	1.074*
	(0.0054)	(0.0413)
Observations	15346	615

Notes: (i) Models (1) - (2) include all the controls listed in Table 2.

(ii) The dependent variable: captures individuals who report temporary absence from work where temporary absence is 1, 0 otherwise for model 1; captures individuals who report temporary absence from work due to bad weather where temporary absence due to bad weather is 1, 0 otherwise for model 2.

(iii) Standard errors in parentheses.

(iv) ** p<0.05, * p<0.1.

[19] Model specification choice (one period lag) is based on robustness.

Temporary work absence: Working less hours due to bad weather[20]

Another alternative to using the variable that captures workers' temporary absence from work, is to examine those who report working less than 32 hours due to bad weather since this would amount to being absent from work temporarily. Table 8, which displays these results, substantiate the general evidence of hurricanes not affecting the labour market. Specifically, the odds of working less hours due to bad weather is not affected by hurricanes. Note also that excess rainfall does not affect the odds of working less hours and this effect is consistent with a one period lag. Perhaps this outcome can be explained by employees working from home; thus, they take account of the fact that they are still working and are counting hours. However, this is contrary to those reporting absences due to bad weather. One can therefore conclude that perhaps these respondents make a distinction between being physically present and working from home, where the latter consider themselves working but physically absent from the workplace.

[20] Extreme weather can have varying effects geographically. We divided Jamaica into several geographical areas that could possibly make sense for comparison. These include but are not limited to the least acceptable, north and south and the most acceptable and is used commonly as an administrative demarcation, Cornwall, Middlesex and Surrey. However, we did not find any results geographically for excess rainfall. This indicates that excess rainfall does not have any geographical effects on temporary absence from work.

▶ **Table 8. The impact extreme weather on working less hours due to bad weather**

Variables	Model (1)	Model (2)
Hurricane	1.000***	1.000***
	(1.74e-08)	(1.75e-08)
Excess rainfall	1.036	1.037
	(0.0264)	(0.0266)
Rainfall	0.970	0.970
	(0.0348)	(0.0351)
Temperature	0.968	0.964
	(0.0825)	(0.0824)
Lag 1_Hurricane		1.000
		(1.32e-08)
Lag 1_ExtremeRainfall		0.989
		(0.0112)
Observations	4711	4653

Notes: Models (1) - (2) include all the controls listed in Table 2.

The dependent variable: captures individuals who report working less hours due to bad weather where working less hours is 1, 0 otherwise for model 1.

Standard errors in parentheses.

*** p<0.01.

The cost of temporary work absence due to bad weather

The literature presents a wide variation of the cost of worker absenteeism (Godet-Cayré et al. 2006; van Tulder et al. 1995; Ivanova 2009; Prater and Smith 2011; Gianino et al. 2019). Although not related to this study directly, the most detailed are Godet-Cayré et al. (2006) who estimated the additional annual cost to employers to be €233 (US$261) for each salary replacement; and van Tudler et al. (1995) who found that the annual mean cost for each absenteeism case was US$4,622. For this study, it is instructive to carry out a similar exercise, that is, estimating the cost of absenteeism due to bad weather, which does not exist in the current literature. Using data on salaried employees[21], which captures salary itself and benefits, we find that the average estimated cost of temporary daily absence from work due to excess rainfall is approximately US$2.81.[22] Based on what is observed in the literature, this cost is rather small. Nevertheless, it helps labour market policy makers to appreciate that the costs for being temporarily absent is not zero, and as such, although it might not be a pressing issue, they can consider how to combat any effects of excess rainfall on absence if these were to be magnified.

[21] We use data compiled by the Jamaica Productivity Centre from National Income and Product Report by STATIN for 2004-2014, the time-period of analysis for this study.

[22] We use the estimated marginal effect on excess rainfall (0.0000003) and calculate out how this effect reduces the salaries of employees annually. We then divided this amount by 261, the number of workdays estimated annually. Further, we then take the average of all years to arrive at this figure. The sum of daily losses for all years is roughly US$31.

Conclusion

This study investigated the impact that extreme weather has on temporary absence from work. The estimations show that hurricanes do not affect the odds of being absent from work. The absence of a hurricane effect can be explained by a labour market that is able to cope because of its past experience with such storms (Wilson 2017). However, excess rainfall does impact the odds of being absent from work. This depends on the place of employment, where in some cases, for example, farm and shop workers are more likely to be temporarily absent from work. In other cases, such as working in a factory or being a public sector worker, the probability of temporary absence is lower. A number of possible reasons for the increased likelihood of absence were identified including poor road conditions, disruption in the public transportation system or other unforeseen circumstances arising at home (Miller 2009; Kaufman 2012). On the other hand, lower likelihood of absence can be attributed to employers having in place arrangements for work to be carried out in the face of unfavourable weather conditions.

The outcome of this study has important implications for the positioning of the Jamaican labour market to deal with the impact of excess rainfall, an extreme event that has been common locally (United Nations Economic Commission for Latin America and the Caribbean (ECLAC) 2002; Planning Institute of Jamaica 2007; The Gleaner 2019) and even across the Caribbean (Fontes de Meira and Phillips 2019). Jamaica, in particular, has a long history of excess rainfall that causes landslides and renders roads unsafe for travel (Manning et al. 1992; Ahmad et al. 1993; ECLAC 2002; Miller 2009; The Gleaner 2019). Furthermore, with climate change, excess rainfall is quite possible (Guhathakurta et al. 2011). As a result, the local labour market has to focus on steps to mitigate the impact that excess rainfall has on employees' absence from work. The importance of this step can be seen from appreciating the impact that absence from work can have on labour productivity (Herrmann and Rockoff 2012) and economic growth. The labour market, therefore, needs to institute e-commuting policies to mitigate the impacts that excess rainfall has on work absence to protect productivity. Where such policies are deemed inappropriate, employers need to make arrangements for employees, whose work has to take place on the work site, to be present.

With the limited literature that exists in this area of research, future studies must consider a few issues to strengthen estimated outcomes especially when using survey data. Firstly, the analysis could benefit from health data on employees as a control variable since absence from work can be impacted by health conditions.[23] Secondly, it is not possible to identify the exact mechanisms (including impassable roads, workplace closure and family situation) through which absence is impacted due to bad weather. Thirdly, there is no clear definition of bad weather in the survey. Fourthly, there is no information on whether employers are facilitating or can facilitate work-from-home in times of extreme weather events. Thus, future surveys can be refined to capture these data. Furthermore, since the labour force survey takes place quarterly, the survey can include specific questions on different types of weather events.

[23] Finally, STATIN carries out an annual survey of living conditions (SLC) which collects data on health. Since this survey uses a sample of the LFS, it may be possible to merge the quarterly LFS with the SLC to garner data on health as a control variable.

References

Acevedo, Maria Cecilia. 2016. "The Effect of Extreme Hydro-Meteorological Events on Labor Market Outcomes: Evidence from the Colombian Caribbean." *Unpublished paper, World Bank, Washington, DC*.

Ahmad, Rafi, Aedan H. Earle, Peter Hugues, Russell Maharaj, and Edward Robinson. 1993. "Landslide damage to the board river water supply pipeline, Bromley Hill, Jamaica: Case study of a landslide caused by hurricane Gilbert (1988)." *Bulletin of the International Association of Engineering Geology-Bulletin de l'Association Internationale de Géologie de l'Ingénieur*, *47*(1):59-70.

Alfieri, L., P. Burek, L. Feyen, and G. Forzieri. 2015. "Global warming increases the frequency of river floods in Europe." *Hydrology & Earth System Sciences Discussions*, *12*(1).

Allen, Steven G. 1983. "How much does absenteeism cost?" *Journal of Human Resources*, pp.379-393.

Auffhammer, Maximilian, Solomon M. Hsiang, Wolfram Schlenker, and Adam Sobel. 2013. "Using weather data and climate model output in economic analyses of climate change." *Review of Environmental Economics and Policy*, 7(2):181-198.

Belasen, Ariel R., and Solomon W. Polachek. 2008. "How hurricanes affect wages and employment in local labor markets." *American Economic Review*, *98*(2):49-53.

Belasen, Ariel R., and Solomon W. Polachek. 2009. "How disasters affect local labor markets the effects of hurricanes in Florida." *Journal of Human Resources*, *44*(1):251-276.

Boose, E.R., Serrano, M.I. and Foster, D.R. 2004. "Landscape and regional impacts of hurricanes in Puerto Rico." *Ecological Monographs*, 74(2):335-352.

Bourque, Linda B., Judith M. Siegel, Megumi Kano, and Michele M. Wood. 2006. "Weathering the storm: The impact of hurricanes on physical and mental health." *The Annals of the American Academy of Political and Social Science*, 604(1):129-151.

BLS (Bureau of Labor Statistics). 2012. "Work absences due to bad weather: analysis of data from 1977 to 2010." *Issues in Labor Statistics*, U.S. Bureau of Labor Statistics, Summary 12-1 / February 2012.

Coleman, Daniel F., and Norbert V. Schaefer. 1990. "Weather and absenteeism." *Canadian Journal of Administrative Sciences/Revue Canadienne des Sciences de l'Administration*, 7(4): 35-42.

Delp, Linda, Laura Podolsky, and Tomás Aguilar. 2009. "Risk amid recovery: Occupational health and safety of Latino day laborers in the aftermath of the Gulf Coast hurricanes." *Organization & environment*, *22*(4): 479-490.

ECLAC (Economic Commission for Latin America and the Caribbean). 2002. Macro-socio-economic assessment of the damage done by flood rains and landslides.

Emanuel, Kerry. 2005. "Increasing destructiveness of tropical cyclones over the past 30 years." *Nature*, 436(7051): 686-688.

Emanuel, Kerry, Ragoth Sundararajan, and John Williams. 2008. "Hurricanes and global warming: Results from downscaling IPCC AR4 simulations." *Bulletin of the American Meteorological Society*, 89(3):347-368.

Gianino, Maria Michela, Gianfranco Politano, Antonio Scarmozzino, Michela Stillo, Viola Amprino, Stefano Di Carlo, Alfredo Benso, and Carla Maria Zotti. 2019. Cost of sickness absenteeism during seasonal influenza outbreaks of medium intensity among health care workers. *International Journal Of Environmental Research and Public Health*, *16*(5):747.

Fischer-Bruns, Irene, Hans von Storch, J. F. González-Rouco, and Eduardo Zorita. 2005. Modelling the variability of midlatitude storm activity on decadal to century time scales. *Climate Dynamics*, *25*(5), pp.461-476.

Fontes de Meira, Luciana, and Willard Phillips. 2019. *An economic analysis of flooding in the Caribbean: The case of Jamaica and Trinidad and Tobago*.

Glas, Hanne, M. Jonckheere, A. Mandal, S. James-Williamson, Philippe De Maeyer, and Greet Deruyter. 2017. "A GIS-based tool for flood damage assessment and delineation of a methodology for future risk assessment: case study for Annotto Bay, Jamaica." *Natural Hazards*, *88*(3):1867-1891.

Godet-Cayré, Virginie, Nathalie Pelletier-Fleury, Marc Le Vaillant, Jérôme Dinet, Marie-Anne Massuel, and Damien Léger. 2006. "Insomnia and absenteeism at work. Who pays the cost?" *Sleep*, *29*(2):179-184.

Graff Zivin, Joshua, and Matthew Neidell.2014. "Temperature and the allocation of time: Implications for climate change." *Journal of Labor Economics*, *32*(1):1-26.

Greenough, Gregg, Michael McGeehin, Susan M. Bernard, Juli Trtanj, Jasmin Riad, and David Engelberg. 2001. "The potential impacts of climate variability and change on health impacts of extreme weather events in the United States." *Environmental Health Perspectives*, 109(suppl 2), pp.191-198.

Guhathakurta, P., O. P. Sreejith, and P. A. Menon. 2011. "Impact of climate change on extreme rainfall events and flood risk in India." *Journal of Earth System Science*, *120*(3):359.

Haarsma, Reindert J., Wilco Hazeleger, Camiel Severijns, Hylke De Vries, Andreas Sterl, Richard Bintanja, Geert Jan Van Oldenborgh, and Henk W. van den Brink. 2013. "More hurricanes to hit western Europe due to global warming." *Geophysical Research Letters*, 40(9):1783-1788.

Henry, Michael, Nekeisha Spencer, and Eric Strobl. 2020. "The impact of tropical storms on households: evidence from panel data on consumption." *Oxford bulletin of economics and statistics*, 82(1), pp.1-22.

Herrmann, Mariesa A., and Jonah E. Rockoff. 2012. "Worker absence and productivity: Evidence from teaching." *Journal of Labor Economics*, *30*(4), pp.749-782.

Hsiang, Solomon. 2010. "Temperatures and cyclones strongly associated with economic production in the Caribbean and Central America." *Proceedings of the National Academy of Sciences*, *107*(35), pp.15367-15372.

Holland, Greg. 1980. "An analytic model of the wind and pressure profiles in hurricanes." *Monthly Weather Review*, 108(8), pp.1212-1218.

Ishizawa, Oscar A., and Juan Jose Miranda. 2019. "Weathering storms: Understanding the impact of natural disasters in Central America." *Environmental and Resource Economics*, 73(1), pp.181-211.

Ivanova, Jasmina I., Howard G. Birnbaum, Seth Samuels, Matthew Davis, Amy L. Phillips, and Dennis Meletiche. 2009. "The cost of disability and medically related absenteeism among employees with multiple sclerosis in the US." *Pharmacoeconomics* 27(8): 681-691.

JIS (Jamaica Information Service). 2010. "Public Servants' Absence from Work." Available at: https://jis.gov.jm/public-servants-absence-from-work/

Kaly, Ursula, Lino Briguglio, Helena McLeod, Susana Schmall, Craig Pratt, and Reginald Pal. 1999. *Environmental Vulnerability Index (EVI) to summarise national environmental vulnerability profiles*. SOPAC.

Karim, Azreen, and Ilan Noy. 2014. “Poverty and Natural Disasters: A Meta-Analysis”, School of Economics and Finance Working Paper No. 04/2014.

Kaufman, Sarah M., Carson Qing, Nolan Levenson, and Melinda Hanson. 2012. *Transportation during and after Hurricane Sandy.*

Knippertz, P., U. Ulbrich, and P. Speth. 2002. "Changing cyclones and surface wind speeds over the North Atlantic and Europe in a transient GHG experiment." *Climate Research*, *15*(2): 109-122.

Leviäkangas, Pekka, Anu Tuominen, Riita Molarius, Jari Schabel, Sirra Toivonen, Jaana Keränen, Jouko Törnqvist et al. 2011. “Extreme weather impacts on transport systems.”

Manning, Paul AS, Trevor McCain, and Rafi Ahmad. 1992. "Landslides triggered by 1988 Hurricane Gilbert along roads in the Above Rocks area, Jamaica." *R. Ahmad, Special Issue* 12: 34-52.

Miller, Servel, Tim Brewer, and Norman Harris. 2009. "Rainfall thresholding and susceptibility assessment of rainfall-induced landslides: application to landslide management in St Thomas, Jamaica." *Bulletin of Engineering Geology and the Environment* 68 (4): 539.

Nandi, A., Mandal, A., Wilson, M. and Smith, D., 2016. Flood hazard mapping in Jamaica using principal component analysis and logistic regression. *Environmental Earth Sciences*, *75*(6), p.465.

Nandi, Arpita, Arpita Mandal, Matthew Wilson, and David Smith. 2016. "Flood hazard mapping in Jamaica using principal component analysis and logistic regression." *Environmental Earth Sciences* 75 (6): 465.

Paciorek, Christopher J., James S. Risbey, Valérie Ventura, and Richard D. Rosen. 2002. "Multiple indices of Northern Hemisphere cyclone activity, winters 1949–99." *Journal of Climate* 15 (13): 1573-1590.

Pecha Garzón, C.J., 2017. *The effects of natural disasters on the labour market: Do hurricanes increase informality?* (No. IDB-WP-854). IDB Working Paper Series.

Pecha Garzón, Camilo José. 2017. *The effects of natural disasters on the labour market: Do hurricanes increase informality?* No. IDB-WP-854. IDB Working Paper Series.

Planning Institute of Jamaica (PIOJ). 2007. *Assessment of the socio-economic and environmental impact of Hurricane Dean on Jamaica*.

Prater, Tammy, and Kim Smith. 2011. “Underlying factors contributing to presenteeism and absenteeism.” *Journal of Business & Economics Research (JBER)*, *9*(6), 1-14.

Saunders, Mark A., and Adam S. Lea. 2008. “Large contribution of sea surface warming to recent increase in Atlantic hurricane activity.” *Nature*, 451(7178), pp.557-560.

Schiermeier, Quirin. 2011. “Increased flood risk linked to global warming: likelihood of extreme rainfall may have been doubled by rising greenhouse-gas levels.” *Nature*, *470*(7334), pp.316-317.

Shi, Jingye, and Mikal Skuterud. 2015. “Gone fishing! Reported sickness absenteeism and the weather.” *Economic Inquiry*, *53*(1), pp.388-405.

Spencer, Nekeisha and Solomon Polachek. 2015. “Hurricane watch: Battening down the effects of the storm on local crop production.” *Ecological Economics*, 120:234-240.

Spencer, Nekeisha, Solomon Polachek and Eric Strobl. 2016. “How do hurricanes impact scholastic achievement? A Caribbean perspective.” *Natural Hazards*, *84*:1437-1462.

Spencer, Nekeisha. 2017. “Look what the hurricanes just blew in: analyzing the impact of the storm on criminal activities.” *Journal of Crime and Justice*, 40(4):417-429.

Spencer, Nekeisha and Mikhail-Ann Urquhart. 2018. “Hurricane strikes and migration: Evidence from storms in central America and the Caribbean.” *Weather, Climate, and Society*, 10(3):569-577.

Spencer, Nekeisha and Mikhail-Ann Urquhart. 2021. "Extreme Climate and Absence from Work: Evidence from Jamaica." International Journal of Disaster Risk Science 2021: 1-8.

Srivastava, Kriti, Amritha Sethumadhavan, Harini Raghupathy, Shreya Agarwal, and S. R. Rawat. 2015. “To study the Indian perspective on the concept of work from home.” *Indian Journal of Science and Technology*, *8*(S4): 212-220.

Strobl, Eric., 2012. “The economic growth impact of natural disasters in developing countries: Evidence from hurricane strikes in the Central American and Caribbean regions.” *Journal of Development Economics*, 97(1):130-141.

The Gleaner. 2019. More roads impacted by heavy rainfall – NWA. Available from: http://jamaica-gleaner.com/article/news/20190925/more-roads-impacted-heavy-rainfall-nwa.

Srivastava, Kriti, Amritha Sethumadhavan, Harini Raghupathy, Shreya Agarwal, and S. R. Rawat. 2010. “Natural Disasters and Household Welfare: Evidence from Vietnam”, World Bank Policy Research Working Paper Series No. 5491.

van Tulder, Maurits W., Bart W. Koes, and Lex M. Bouter. 1995. “A cost-of-illness study of back pain in The Netherlands.” *Pain*, *62*(2): 233-240.

Wilson, Daniel. 2017. *The impact of weather on local employment: Using big data on small places.* Federal Reserve Bank of San Francisco.

Zander, Kerstin K., Wouter JW Botzen, Elspeth Oppermann, Tord Kjellstrom, and Stephen T. Garnett. 2015. “Heat stress causes substantial labour productivity loss in Australia.” *Nature Climate Change*, *5*(7):647-651.

Žikić, Milorad, and Tamara Rabi-Žikić. 2018. “Meteoropathy and meteorosensitive persons.” *Medicinski pregled*, 71(3-4):131-135.

Advancing social justice, promoting decent work

The International Labour Organization is the United Nations agency for the world of work. We bring together governments, employers and workers to improve the working lives of all people, driving a human-centred approach to the future of work through employment creation, rights at work, social protection and social dialogue.

Contact details

ILO Regional Office for Latin America and the Caribbean
DWT/CO–Port-of-Spain

ILO Decent Work Team and Office
for the Caribbean
6 Stanmore Avenue - PO Box 1201
Port of Spain
Trinidad and Tobago

ISBN 978-92-2-034343-2