Cholera, WASH and climate change

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LETTERS
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Anthropogenic contribution to global occurrence of heavy-precipitation and high-temperature extremes

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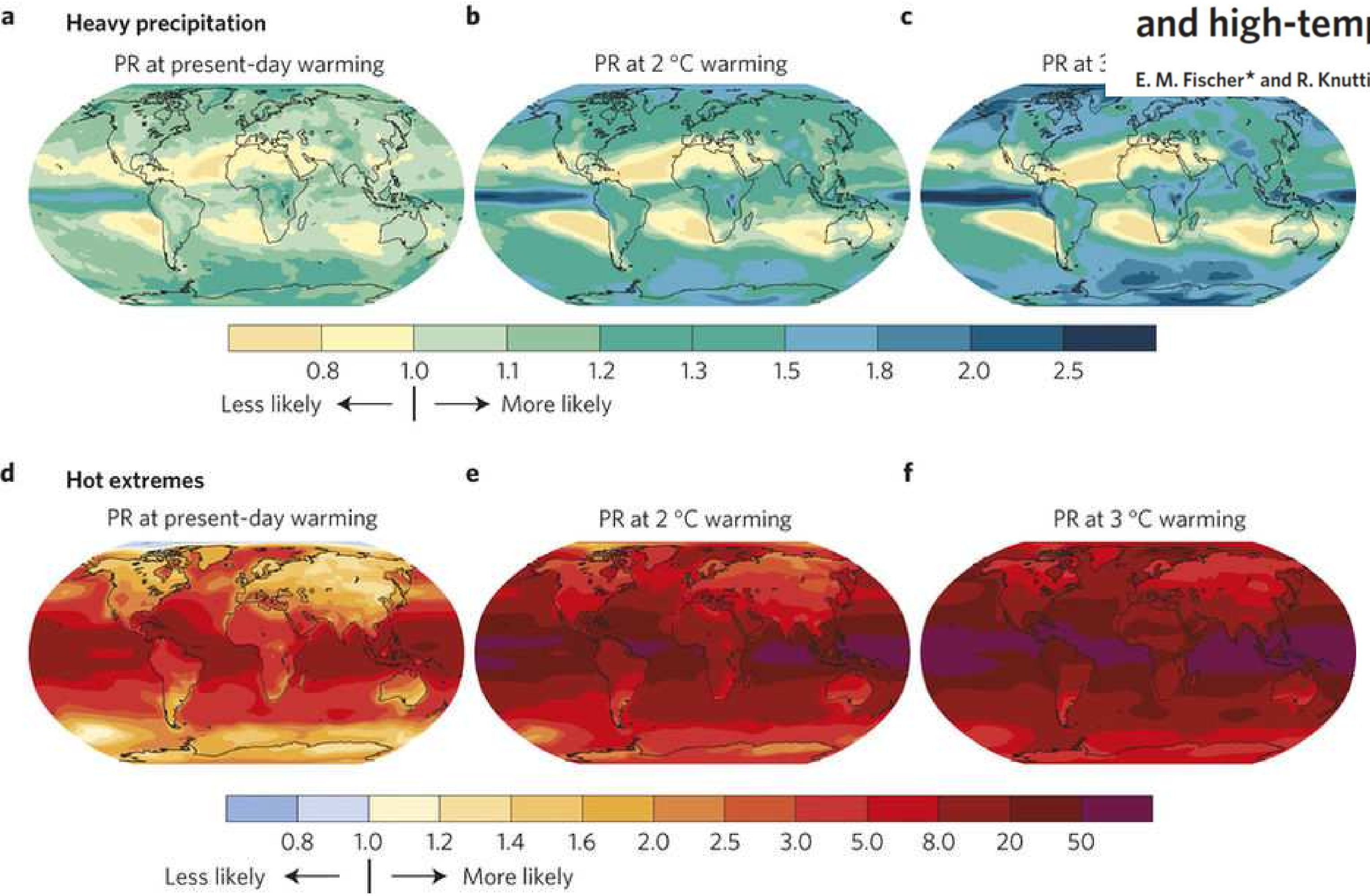

Extreme weather events: Should drinking water quality management systems adapt to changing risk profiles?

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Table 1
Water quality and quantity consequences of extreme weather events and possible mitigation strategies.

Extreme event	Duration of effect after the event[a]	Adverse supply impact	Effective mitigation strategies
Heavy rainfall and floods	Short	• Elevated turbidity due to increased particulate and soluble substances in storm runoff • Overflow of combined sewer systems • Increased pathogen and contaminant concentrations • Decreased disinfection efficacy • Damage to infrastructure, including electrical supply • Very short retention times in reservoirs due to short-circuiting	• Diversifying water sourcing options • Pre-filtration of surface waters prior to intake in drinking water plants • Additional or increased disinfection processes • Supply of point-of-use filtration devices and personal water quality testing kits • Alternate delivery of potable water (*e.g.*, tankers) • Issuing of boil water advisories • Implementation of enhanced treatment options prior to a forecast event
Superstorms and high winds	Short	• Similar to "heavy rainfall and floods" above. • Loss of key staff due to transport difficulties or damage to their own property.	• Similar to "heavy rainfall and floods" above, plus: • Building redundancy into water supply systems, including back-up power generators • Plan to have alternate staff available on call or accessible electronically • Availability of alternate water sources
Drought	Moderate	• Increased nutrient loads after extended period of drought • Large "flushes" of organic carbon once rainfall occurs • Elevated risks of algal and cyanobacterial blooms • Intrusion of saltwater in coastal area groundwater, which can lead to increased brominated disinfection by-products	• Diversifying water sourcing options • Additional filtration in early stages of drinking water production • Increased monitoring of surface water reservoirs for signs of algal or cyanobacterial blooms
Extreme heat	Moderate	• Elevated risks of algal and cyanobacterial blooms • Accelerated loss of disinfectant residual in distribution system • Early onset of nitrification in chloraminated systems	• Diversifying water sourcing options • Careful monitoring and application of disinfectant • Vertical mixing of water supply reservoir • Stricter nutrient management in the catchment
Extreme cold	Moderate to Long	• Salinisation from de-icing salts • Lake destratification and mixing • Intake ice blockages and distribution system failures	• Careful control of road surface runoff • Enhanced distribution system monitoring and maintenance
Wildfires	Long	• Increased magnitude of storm runoff • Increased nutrient and contaminant loads • Increased organic carbon • Elevated risks of algal and cyanobacterial blooms • Elevated microbial activity and DOC transformation • Presence of fire-fighting chemicals	• Diversifying water sourcing options • Additional filtration in early stages of drinking water production • Careful monitoring and application of disinfectant • Additional monitoring of contaminants • Prevention of particulate matter entering water-courses (eg straw bales, construction of swales)

[a] Short = days to weeks, moderate = weeks to months, long = years.

Some possible mechanisms for extreme weather events impacting on cholera risk

- Pollution of wells & Boreholes
- Damage to infrastructure
- Damage to distribution networks
- Flooding out of latrines
- Turning to less safe drinking water sources

Table 1 | Excess risk of cholera during the flood (week 30–38) and post-flood (week 39, 1998– week 14, 1999) period in Dhaka

	Flood period					Post-flood period				
	Observed (O)	Expected* (E)	O/E	95% CI	p value†	Observed (O)	Expected* (E)	O/E	95% CI	p value†
Total	350	59.3	5.9	5.0, 7.0		422	199.1	2.1	1.9, 2.4	
Hygiene and sanitation										
Drinking water source										
Tube well	108	22.9	4.7	3.6, 6.2	0.05	260	97.2	2.7	2.3, 3.1	<0.001
Tap water	241	36.1	6.7	5.4, 8.2		162	100.8	1.6	1.3, 1.9	
Distance to water source										
More than 5m	228	38.4	5.9	4.8, 7.3	>0.2	303	141.6	2.1	1.9, 2.5	>0.2
5m or less	122	20.8	5.9	4.4, 7.8		118	56.8	2.1	1.7, 2.6	
Type of toilet										
Unsanitary	136	24.5	5.6	4.3, 7.2	>0.2	266	100.9	2.6	2.3, 3.1	<0.001
Sanitary	214	34.8	6.1	5.0, 7.6		156	98.2	1.6	1.3, 1.9	

*The expected values were the season-specific average over the two preceding (1996–97) and subsequent (2000–01) years.

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Cholera Outbreak Linked with Lack of Safe Water Supply Following a Tropical Cyclone in Pondicherry, India, 2012

Tony Fredrick, Manickam Ponnaiah, Manoj V. Murhekar, Yuvaraj Jayaraman, Joseph K. David, Selvaraj Vadivoo, Vasna Joshua

Figure 1. Distribution of diarrhoea cases by date of onset, Pondicherry, India, 2012

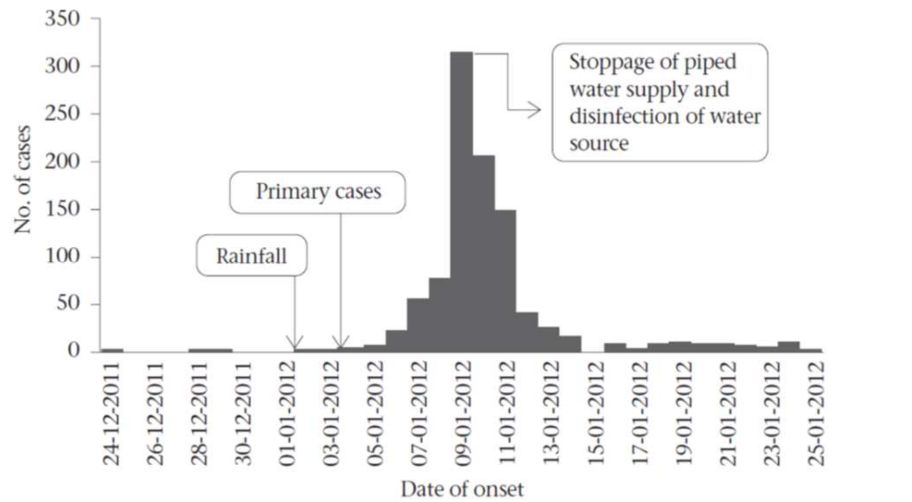

Figure 2. Spot map of diarrhoea cases by place of distribution, Pondicherry, India, 2012

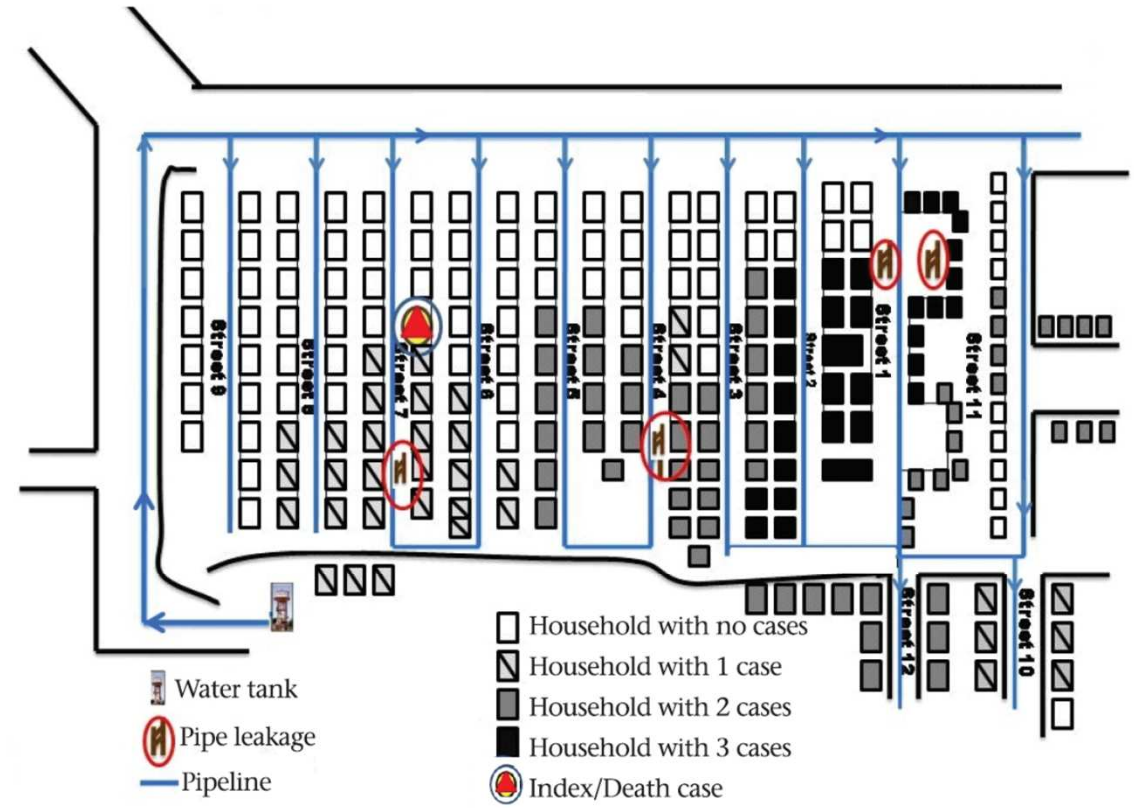

Table 2. Frequency of selected exposures among acute diarrhoea cases and controls, matched case-control study, Pondicherry, India, 2012

Risk factor	No. (%) of case-patients (N=66)	No. (%) of controls (N=88)	Matched odds ratio (95% CI)
Consumption of water from the public drinking-water system	64 (97)	40 (45)	37.0 (4.0-285.0)
Not boiling water	64 (97)	44 (50)	35.0 (4.0-269.0)
Use of common latrine	35 (53)	26 (29)	2.7 (1.3-5.6)

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CASE REPORT

Cholera and household water treatment why communities do not treat water after a cholera outbreak: a case study in Limpopo Province

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Estimated R0 values for cholera in Zimbabwe and Haiti (Mukandavire & Morris 2015)

Province	R0	95%CI
Zimbabwe (country)	1.15	1.08-1.23
Harare	1.52	1.14-1.96
Bulawayo	1.36	1.12-1.61
Mashonaland Central	1.38	1.21-1.54
Mashonaland East	1.11	0.90-1.32
Mashonaland West	1.87	1.34-2.38
Midlands	1.39	1.23-1.56
Manicaland	2.06	1.78-2.34
Matebeleland South	2.72	1.19-4.24
Matebeleland North	1.72	1.44-1.99
Masvingo	1.61	1.20-2.03

Department	R0	SE
Haiti(Country)	1.55	0.41
Artibonite	2.63	0.18
Centre	1.37	0.24
Grande Anse	1.27	0.35
Nippes	1.06	0.21
Nord	1.53	0.23
Nord Ouest	1.40	0.11
Nord Est	1.44	0.21
Ouest (Ouest)	1.18	0.06
Port-au Prince (Ouest)	1.89	0.13
Sud	1.44	0.09
Sud Est	1.17	0.14

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Conclusions

- Climate change is likely to increase risk of cholera outbreaks and epidemics
- The main driver of this increased risk is likely to be an increase in the incidence of extreme weather events.
- However the impact of extreme weather events on cholera risk will often be dictated by pre-existing WASH provision or by the damage to WASH infrastructure or behaviours

Research needs

- Development of tools to identify those communities most likely to experience cholera outbreaks after extreme weather events.
- Tools to identify those communities where rapid WASH interventions can prevent subsequent cholera outbreaks
- Tools to identify those communities experiencing outbreaks of cholera where oral cholera vaccine campaigns may be insufficient to control an outbreak.
- Understand better how urgent behavioural change may be implemented when appropriate.